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Stakeholder Webinar

The First Year of Operating Common Nordic Capacity Markets

21.11.2023

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Agenda

- What has happened until now?
  - Common Nordic aFRR capacity market
  - National mFRR capacity markets
- Evaluation report for the common Nordic aFRR capacity market
- Experiences from the Nordic Capacity Markets
- Status on future developments and changes
  - Change of mark-up method
  - A common Nordic mFRR capacity market
  - Harmonized CZC Allocation Methodology
  - 15-minutes MTU in capacity markets

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Purpose of the webinar

- To involve and inform relevant stakeholders about what we are working with on the TSO side
- To share experiences and give room for feedback and questions
- To give stakeholders an idea of what might be coming in the (rather) near future

What has happened until now?

Common Nordic aFRR capacity market and national mFRR capacity markets

The common Nordic aFRR Capacity Market

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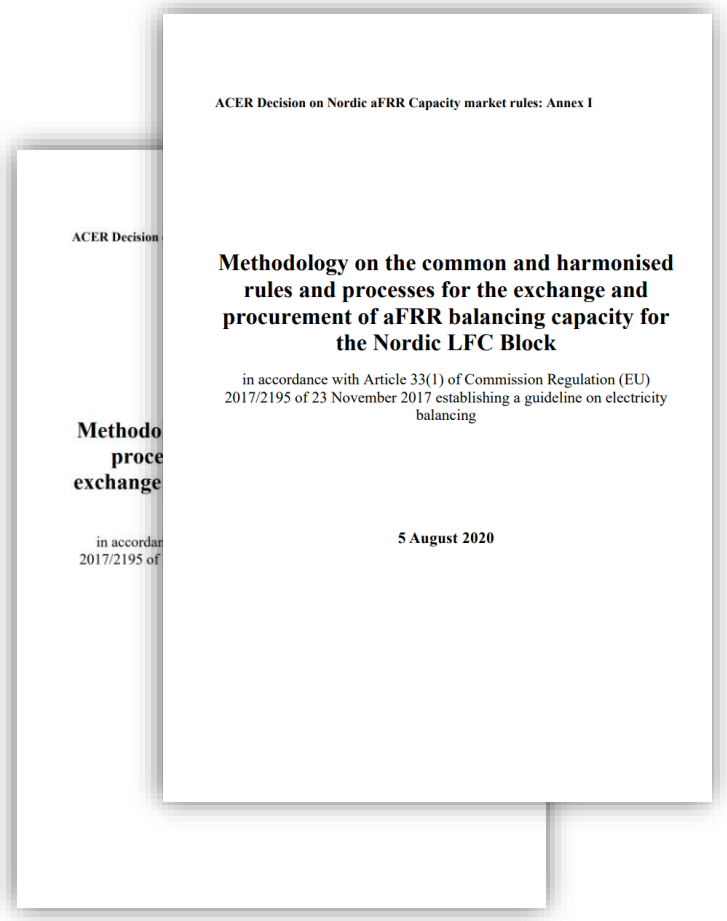
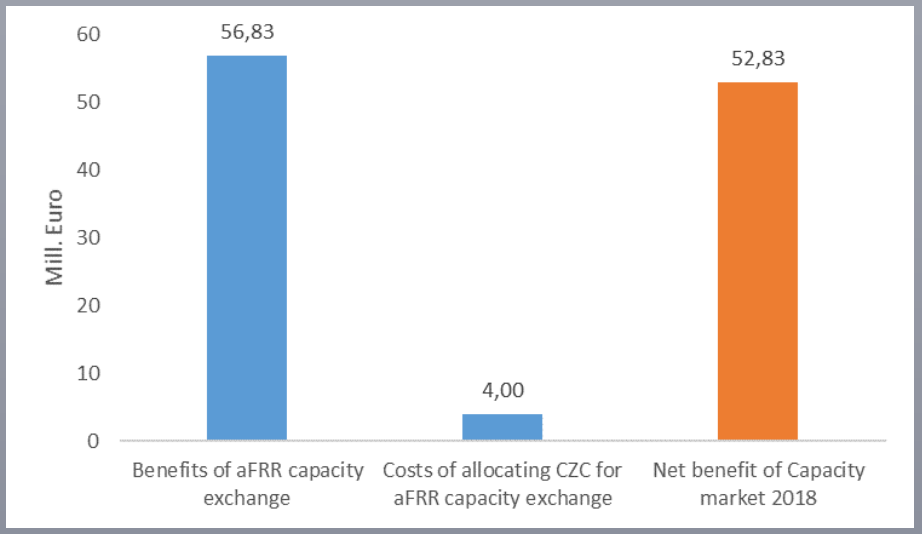
- The common Nordic aFRR capacity market was on the drawing board already in 2010, where the initial discussions started between the Nordic TSOs.
- It has been trough out the planning of common Nordic capacity markets also been the idea to implement a common Nordic mFRR capacity market.
- The aFRR capacity market was started by introducing national capacity markets with the same market conditions and then finally combining it to a common Nordic aFRR capacity market. **The common Nordic aFRR capacity market went live 7th of December 2022.**
- The mFRR capacity market is build on the same idea, where we right now are introducing national mFRR capacity markets with the same market conditions aiming for a common Nordic mFRR capacity market.



The ideas behind

Why introducing a common Nordic aFRR capacity market?

- The overall aim for the common Nordic market is to utilize capacity resources across borders to improve social welfare in the Nordic region and to secure that available resources from an overall perspective are used in the most efficient way
- With the ability to reserve transmission capacity for the exchange of reserves cheaper reserves in the northern parts of Sweden and Norway can help cover demand in southern parts of the Nordic region
- This optimizes the procurement and hence improves social welfare, but it also increases security of supply significantly in areas with low liquidity



A common Nordic Market of 300 MW aFRR was in 2018 estimated to generate a welfare gain of +50 mEUR per year

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Where are we now?

- Almost one year of operating a common Nordic aFRR capacity market with successful operation.
- National markets sharing the same underlying market rules and utilizing the same market platform has been implemented:
  - Denmark introduced a national mFRR capacity market in June 2023, where capacity is exchanged between the two Danish bidding zones.
  - Sweden introduced a national mFRR capacity market in October 2023, where capacity is exchanged between the four Swedish bidding zones.
  - Norway is introducing a the national mFRR capacity market as the next country.
  - Finland will only onboard the market rules when a Nordic market is introduced.

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The First Evaluation Report

Covering approximately the first three months of operation

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The first results

The Nordic TSOs are obliged to monitor the efficiency of the Nordic aFRR capacity market. This has been done in the first (of many) evaluation reports, where the forecasting methodology, the use of cross-zonal capacity and the economic surplus have been evaluated based on data for the first four month of operation.

The results can be found in the evaluation report here:
Value of common Nordic aFRR capacity market confirmed – nordicbalancingmodel

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Overall conclusions

Capacity

It has been possible to always transfer capacity from high-liquidity areas to low-liquidity areas during the first month

Competition

The increased competition across the Nordic area has impacted the volume of bids and the average price in a positive way

Forecast

The forecast method has actually performed better than expected – also bearing volatile price situations in mind

Surplus

The Nordic aFRR capacity market creates value! An average daily surplus of approx. 100’000 EUR on a Nordic level

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Performance of the forecasting method

- Performing better than expected with 14 of 22 borders having forecast errors in less than 20 percent of the time.
- The average forecast errors are relatively low. Only two border directions have an average error > 1 EUR/MW
- A positive number means that the forecast methodology overestimates the actual spread. A negative number means that the forecasted spread is underestimated compared to the actual spread. An average forecast error of zero essentially means that negative errors are balanced out by positive errors.
- The upside of perfect foresight is <10% of the theoretical market benefit. In 96% of all border-hour combinations there is no difference in welfare when using perfect foresight and forecast.
  The primary reasons for welfare loss are volatile DAM prices on especially one border, where the main loss comes from only two days.
- Be aware, that forecast errors are not equal to ‘wrong’ allocation decisions

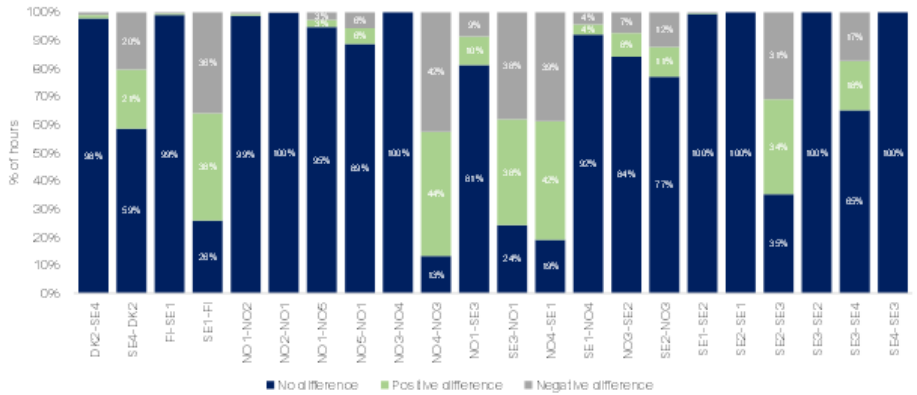

Figure 2 – DAM spread error in three categories [<0, 0, >0].

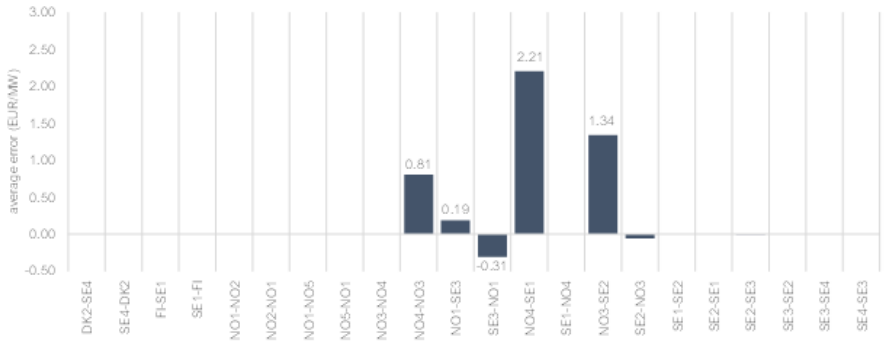

Figure 3 – Average DAM spread error (EUR/MW).

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Need to exceed NTC limit of 10 percent

Six borders have one or more hours when the reserved capacity is equal to or greater than the available capacity at 10% NTC, but only one of these borders (NO3->NO4) utilizes the possibility of reserving more than 10% NTC. One day with three hours of 12% NTC instead of 10%. This corresponds to 0.007% of all possible reservations in the aFRR CM in the period analyzed, and it had no effect in DAM.

The results show that for most of the borders, the 10% NTC limit is sufficient for an efficient allocation of aFRR across the Nordics. The NO1->NO5 border may be the only exception, where roughly every fourth hour had a CZC reservation equal to the capacity.

	DK2-SE4	SE4-DK2	FI-SE1	SE1-FI	NO1-NO2	NO2-NO1	NO1-NO5	NO5-NO1	NO3-NO4	NO4-NO3	NO1-SE3	SE3-NO1	NO4-SE1	SE1-NO4	NO3-SE2	SE2-NO3	SE1-SE2	SE2-SE1	SE2-SE3	SE3-SE2	SE3-SE4	SE4-SE3
Max Res (MW)	50	52	66	0	190	200	60	123	24	24	205	204	44	47	48	47	99	109	121	130	68	84
Min Res (MW)	10	38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	35
Average Res (MW)	40	41	13	0	49	85	27	37	7	4	93	43	13	14	15	18	12	20	7	61	53	67
Max Util (%)	29%	40%	60%	0%	100%	65%	100%	35%	120%	48%	100%	98%	88%	100%	80%	100%	30%	33%	17%	18%	17%	42%
Min Util (%)	6%	29%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	10%	13%
Average Util (%)	24%	31%	10%	0%	26%	27%	58%	10%	36%	4%	48%	21%	23%	24%	25%	25%	4%	6%	1%	8%	12%	25%
Hours at 100% Util	0%	0%	0%	0%	0%	0%	26%	0%	11%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

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Resulting economic surplus

Excluding extremes, a common aFRR CM corresponds to an economic surplus of 11.2 mill. EUR for the periode covering 8th of December 2022 to 24th of March 2023.

Is rather close to the estimate made prior to submission of methodologies.

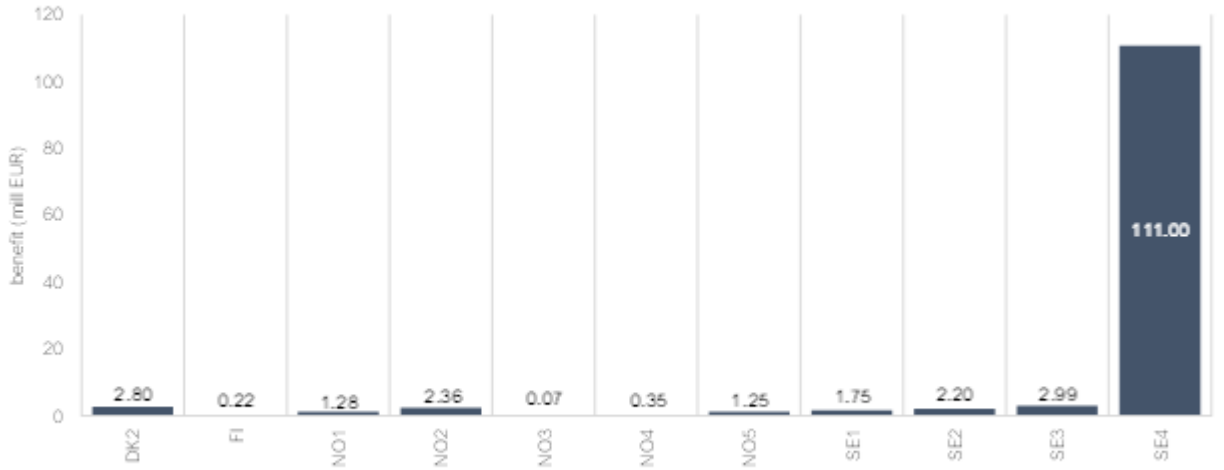

Figure 11 – Realized socio-economic benefit (mill. EUR).

	SDAC surplus	aFRR surplus	Total surplus	Avg. daily surplus
All bidding zones	-4'090'390	126'269'066	122'178'676	1'141'857
Excl. SE4 cons.surplus	-4'090'390	15'268'590	11'178'200	104'469

Table 6 – Economic surplus summary (EUR)

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Calculating economic surplus

We are comparing a Nordic market clearing with a local market clearing on bidding zone level. Hence what would procurement cost have been, if local bids were chosen instead of bids outside the bidding zone?

Results are very dependent on the methodology used for benefit calculation. In the Nordic market we have chosen a rather conservative approach, where benefits are set to zero if local bids are not able to cover demand. This is chosen because it is not possible nor appropriate to put a price on security of supply. This means, that results are conservative in low-liquidity areas.

Economic impact on SDAC is calculated as reserved capacity times DAM price spread, since Simulation Facility was not available. Corresponds to a cost of 4.09 mill. EUR for the calculated period.

Economic surplus is calculated as Δ producer surplus, Δ consumer surplus and congestion income, where producer surplus increases (as expected) in high liquidity areas and decreases in low liquidity areas. Consumer surplus is calculated as the difference in TSO procurement cost, where the clearing price becomes the driving factor. Congestion income is calculated as the CZC reservation times the difference in clearing prices.

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Experiences from the Nordic Capacity Markets

Ideas for improvement and further development

Nordic aFRR CM experiences

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- Main observation:
  - Bids are often skipped, i.e. not selected despite being “in the money”.
- Reasons:
  - Costs are non-convex (indivisible) due to the opportunity cost structure for balancing capacity.
  - Bid formats are imperfect, they do not represent fundamental costs well.
  - Bidding behaviour is not optimal.
- Analysis:
  - The market optimization does not receive good information on costs, and the selection of balancing capacity bids cannot be optimal.
  - Balancing capacity market (BCM) prices tend to be inflated if bids do not represent costs well.

(Hourly averages)	DK2	FI	NO1	NO2	NO3	NO4	NO5	SE1	SE2	SE3	SE4	Total
Skipped bids (% of accepted)	6.9%	1.2%	2.2%	4.6%	1.1%	0.1%	3.1%	4.5%	5.2%	7.9%	0.0%	3.3%
Skipped bids (MW)	0.0	1.1	0.4	7.9	0.2	0.1	3.1	1.5	2.9	0.4	0.0	17.6
Price spread to market price for skipped bids	4.1	3.5	17.6	2.7	10.7	2.5	4.4	5	6.7	6.1	0	4.8
Indivisible bids, % of total MW	88%	14%	36%	91%	84%	100%	76%	100%	97%	100%	100%	76%
Time block bids, % of total MW	0%	0%	2%	3%	0%	0%	0%	8%	35%	90%	95%	9%

The table shows observations from the first Nordic aFRR CM after startup on 2023-12-08 and until the end of September 2023.

Bid formats in the Nordic aFRR CM

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- "Simple" bids (price, quantity)
  - Divisible quantities unless an indivisible part is specified
  - One price applies to divisible and indivisible parts.
- Exclusive bids
  - Mutually exclusive (P, Q) combinations per MTU (MTU = «market time unit», i.e. hour in the Nordics).
- (Time) Block bids
  - All hours to be accepted or rejected
  - May be divisible or indivisible
  - The same volume is accepted for all hours.

For discussion (but not quite yet):
Do these formats represent provision costs well?

Do markets allocate resources well?

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- There is no price that clears a non-convex allocation problem
  - Marginal pricing implies skipping of bids.

Nature.
We adapt to it.

- Optimization needs good input
  - Bid formats must be able to represent provision costs.
  - Bidding behaviour must tend towards representation of costs.
    - And - market participants need to know their capacity costs, and this is difficult when energy market (SDAC) prices are unpredictable.

Culture.
We make it.

The table shows observations from the first 9.5 months of the Nordic aFRR CM after startup on 2023-12-08.

TSO view: Different types of capacity costs

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- FC: There may be a fixed cost per hour: [EUR/h]
- VC: There may be a variable cost per MW and hour: [EUR/MW/h]
- SC: There may be a cost for startup, not related to MW and duration of delivery: [EUR]

For discussion (but not quite yet):
Do these formats cover the provision costs?

- Typically, either FC or VC is zero or very small compared to the other.
- Typically, if SC is a cost component in a balancing capacity market, the offer of flexibility might be insufficient.

Costs in the aFRR CM: Convex and non-convex

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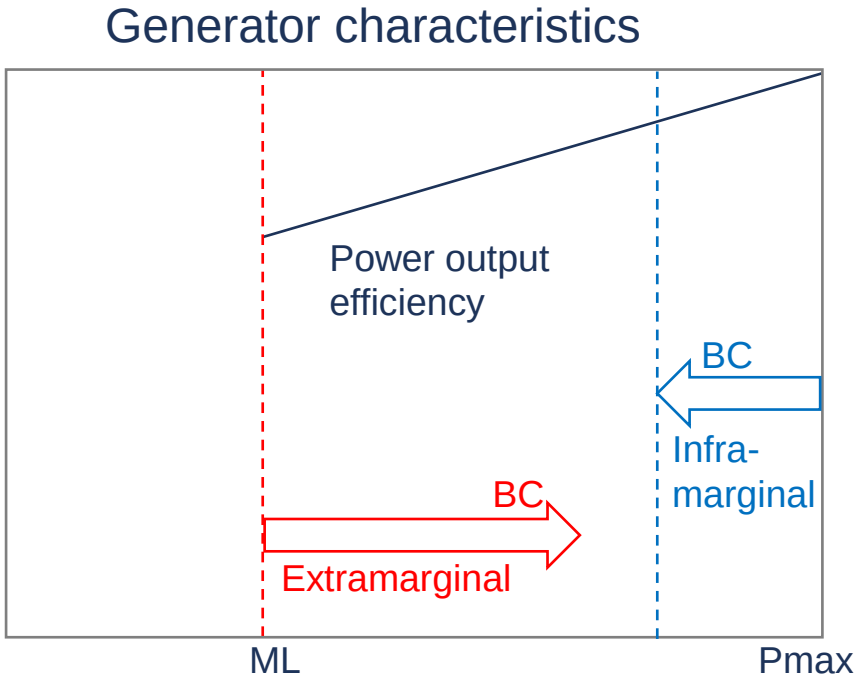
- Inframarginal energy provider
  - The expected energy price (e.g. SDAC) is higher than the production costs
    - Profit maximization for the energy market only suggests running at Pmax.
    - There is a variable (convex) cost per MW and hour of balancing capacity (BC).
- Extramarginal energy provider
  - The expected energy price is lower than the production costs
    - Profit maximization for the energy market only suggests not running at all.
    - Running at ML implies a fixed (non-convex) cost per hour of ML*(MC - SP).
      - Pmax: maximum load
      - ML: minimum load
      - MC: marginal cost
      - SP: energy market price
    - Balancing capacity provision has no variable cost per MW.



Convex and non-convex costs - example

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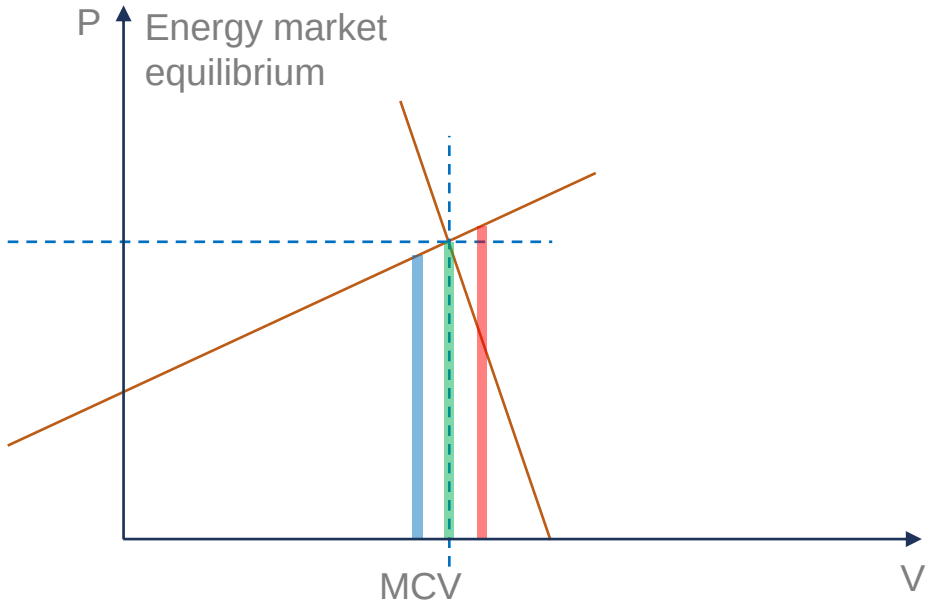
- Consider BC bids from three energy market participants, Blue, Green and Red.
  - Expected energy price (SDAC or ID) 50 EUR/MWh.
  - 100 MW units, 40 MW minimum load, and flat efficiency, i.e. energy cost independent of output.



- Blue has an energy cost of 46 EUR/MWh.
  - For each MW of BC provided, there is a loss of profit of 4 EUR. This is the opportunity cost of capacity per MW and the lowest acceptable BC price.
- Green has an energy cost of 50 EUR/MWh.
  - This market participant is indifferent to providing energy or balancing capacity, and the opportunity cost of capacity is zero. This is the lowest acceptable BC price.
- Red has an energy cost of 52 EUR/MWh and is "out of the money" in the energy market.
  - In order to provide balancing capacity, the market participant must run at minimum load (or more) at a loss of profit in the energy market equal to 40 * 2 EUR = 80 EUR. This **fixed cost** can be covered by income from the balancing capacity market. There is **no variable cost** per MW of BC provided.
  - **Note! It is the COST that is indivisible, not the offered quantity.**

Bid prices and quantities depend on the bid formats

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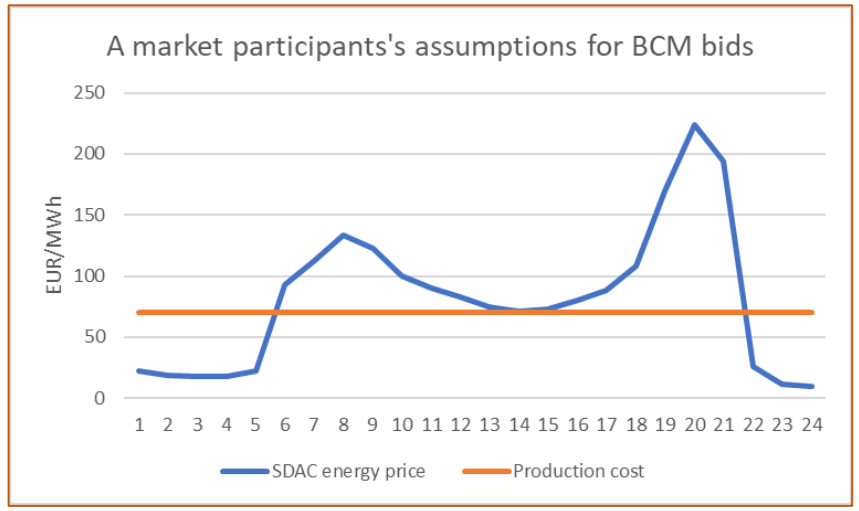
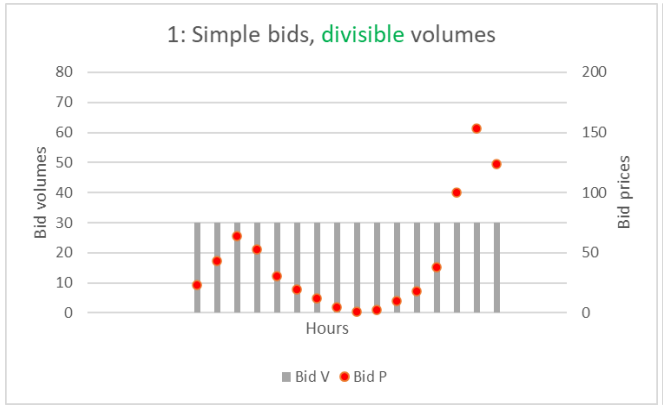
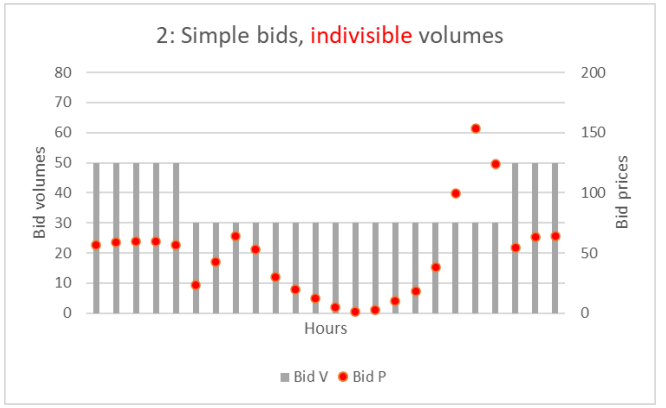
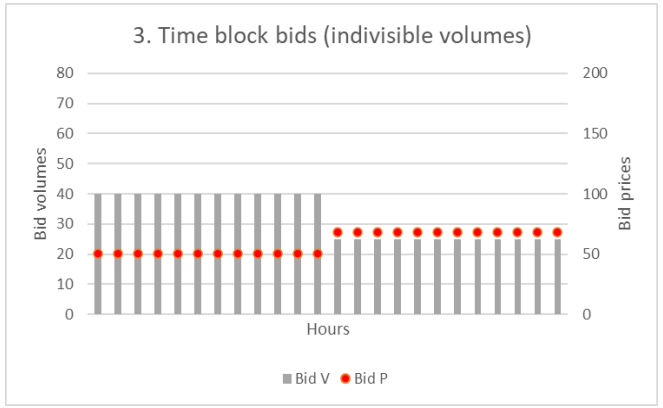
Consider the bid BCM preparation of a market participant in SDAC and BCM, and the impact of the bid formats available.

The SDAC prices are estimates at the time of the balancing capacity bid preparation.









- Divisible bids are risky when costs are fixed. This may reduce the offered quantities.
- Balancing capacity quantities are always divisible, but costs may be indivisible.
  - If a market participant has a fixed cost for BC and the bid format only permits “fixed quantity”, then the market participant must choose a bid quantity. This choice should be for the market algorithm to do.
- Bid formats are important for the input data quality of the market algorithm. (Time) Block bids hide the fundamental costs.
- Inadequate bid formats cause inflated bid costs and market prices.

Bidding behaviour

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- Indivisible and (time) block bid formats may be used by BSPs even when they are not needed.
  - Are indivisible costs implied for 100% of balancing capacity in some BZ? See the table below!
- Undue use of such bid formats causes bad input data for the market algorithm.
  - Welfare maximization then suffers.
- Undue use of such bid formats inflates the BC costs.
  - And too much CZC may be given to the exchange of balancing capacity!

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Time block bids, % of total MW	0%	0%	2%	3%	0%	0%	0%	8%	35%	90%	95%	9%

A side note: Undue use of complex bids is also a challenge for SDAC:

Our advice to market participants in tight market conditions is to minimise the use of blocks

To reduce a probability to be paradoxically rejected, market participants could also consider:

- offering (parts of) their volumes in curve orders instead of blocks,
- offering shorter exclusive groups and/or exclusive groups with lower volumes,
- specifying lower acceptance ratio in the blocks
- adding more flexibility on the demand side (e.g., offering a part of consumption at an opportunity cost of buying it in the intraday market instead of offering it price-independently).

Nord Pool will continue to work closely with market participants and National Regulatory Authorities on this matter.

https://www.nordpoolgroup.com/en/message-center-container/newsroom/exchange-message-list/2022/q3/summary-of-max-price-situation-in-estonia-latvia--lithuania-for-delivery-date--17th-august/

Bid formats, indivisible costs - discussion

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- How can we improve bid formats in order to represent indivisible costs?
  - Alternative 1: Only one bid format – [FC, VC, (SC,) Quantity]
  - Alternative 2: Keep only the "simple bid" format, but introduce parent-child bid linking to represent FC in the first MW and attach a divisible bid at low or no cost?
    - The parent bid must be selected in order for the child bid to be selected.
    - SC cost is not represented directly
  - Alternative 3: ?

Motivation:
- Fixed costs to be represented as such, not as indivisible volumes.
- The market algorithm should select the volumes where costs are fixed.

Bid formats, start costs - discussion

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- How can we accommodate start costs, if at all?
  - Alternative 1: Replace block bids with a "SC" element in the bid format, and consider indivisible quantities.
  - Alternative 2: Remove block bids with no replacement.
  - Alternative 3: ?

Motivation:
- The algorithm should decide the number of hours to accept and the MW per hour.
- The need to consider SC may be seen as an indicator of insufficient BC offer, and possibly phased out in the long term.

Bidding behaviour - discussion

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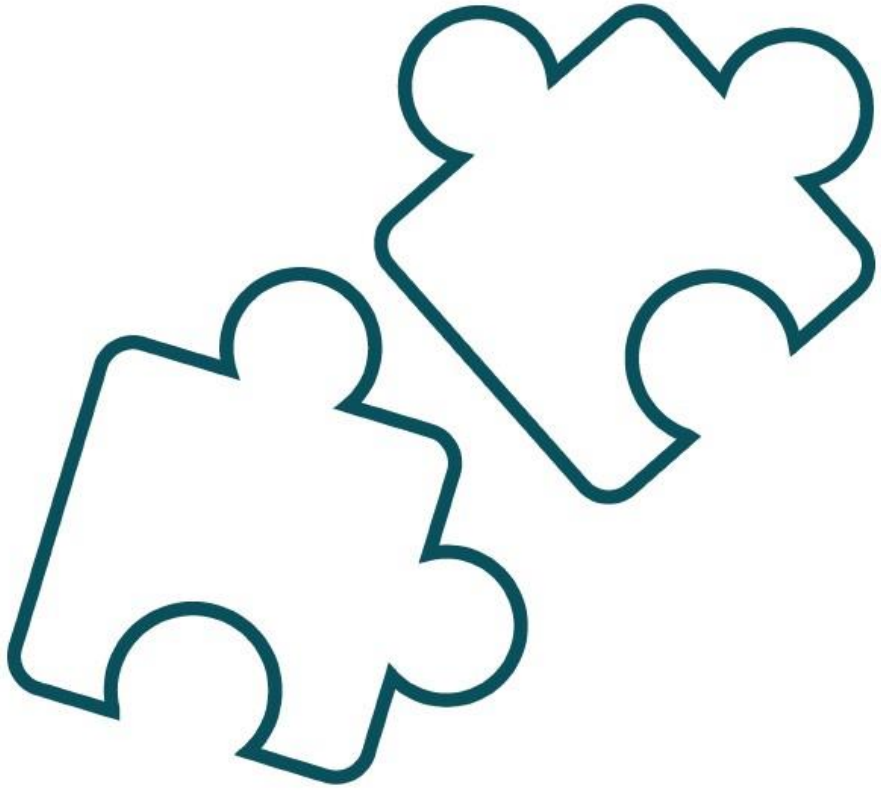
- How can we achieve bidding behaviour that is based on provision costs?
  - By incentives/prices, trust, or other means?
  - By publication of the impact of skipped bids?
    - E.g. "skipped volume per BZ and hour" and "(weighted) average difference between the market price and price of skipped bids"
  - By compensation of skipped bids?
    - E.g. "part of the difference between the market price and price of a skipped bid"

Next steps

- We would like some input on the bid formats:
  - Bilateral meetings?
  - Questionnaire?
- The Nordic TSOs are preparing a report describing and analyzing the experiences and possible improvements.
- The Nordic TSOs expect to deliver a change proposal and following that a public consultation process.



Coffee Break

Status on future developments and changes

Implementations that will have direct or indirect effect on stakeholders

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Change of mark-up methodology

A Common Nordic mFRR capacity market

Harmonized CZC Allocation Methodology

15-minutes MTU in capacity markets

Change of mark-up methodology

The Nordic NRAs required and approved an amendment of the markup calculation

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- Markups are added to the forecasted CZC costs to compensate for forecasting errors
- The amendment consists of:
  - A change of the initial markup from 1€ to 5€ for new borders included
  - A change of the maximum markup from 5€ to **unlimited, following the average forecast error**
- The current Nordic aFRR CM market is only affected by the second point as new borders are currently not planned to be reserved on.

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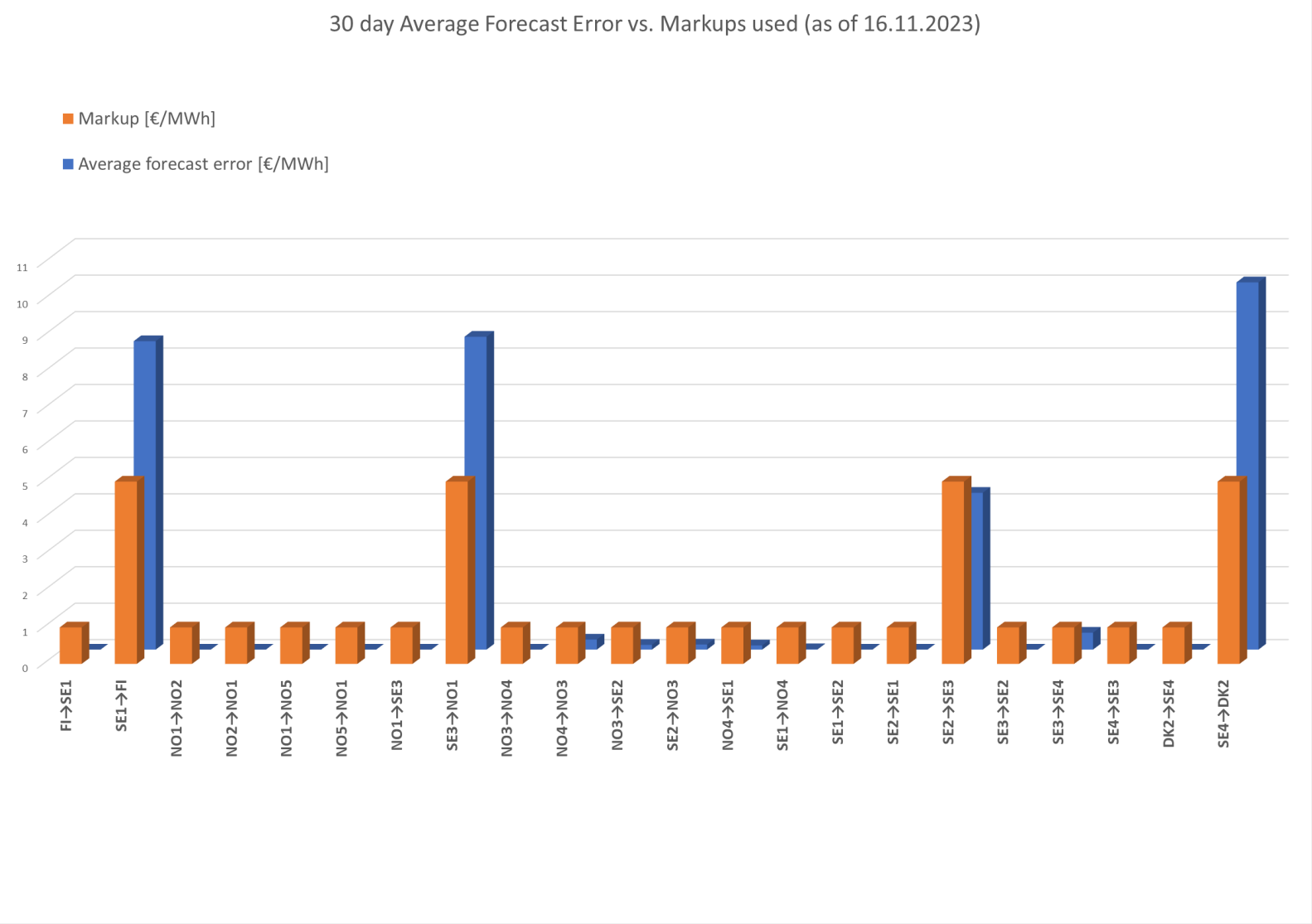
Maximum markup change consequences:

- With current forecast errors this will raise the reservation costs on 4 border directions to cover their average error:
- SE3→NO1, SE2→SE3, SE4→DK2,
- (SE1→FI)



Common Nordic mFRR Capacity Market

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Status of Nordic mFRR CM considerations

- The common Nordic methodologies for mFRR CM was withdrawn in April 2023 due to potential inconsistencies with methodologies regarding ramping on HVDCs.
- The Nordic TSO created a task-force to evaluate the different methodologies all together. This resulted in the Nordic TSOs withdrawing the methodology referring to SOGL art. 176 in end September 2023.
- The Nordic TSOs are now planning the methodology work going forward. This relates to 1) a Nordic mFRR CM and 2) ramping restrictions on FRR exchange.

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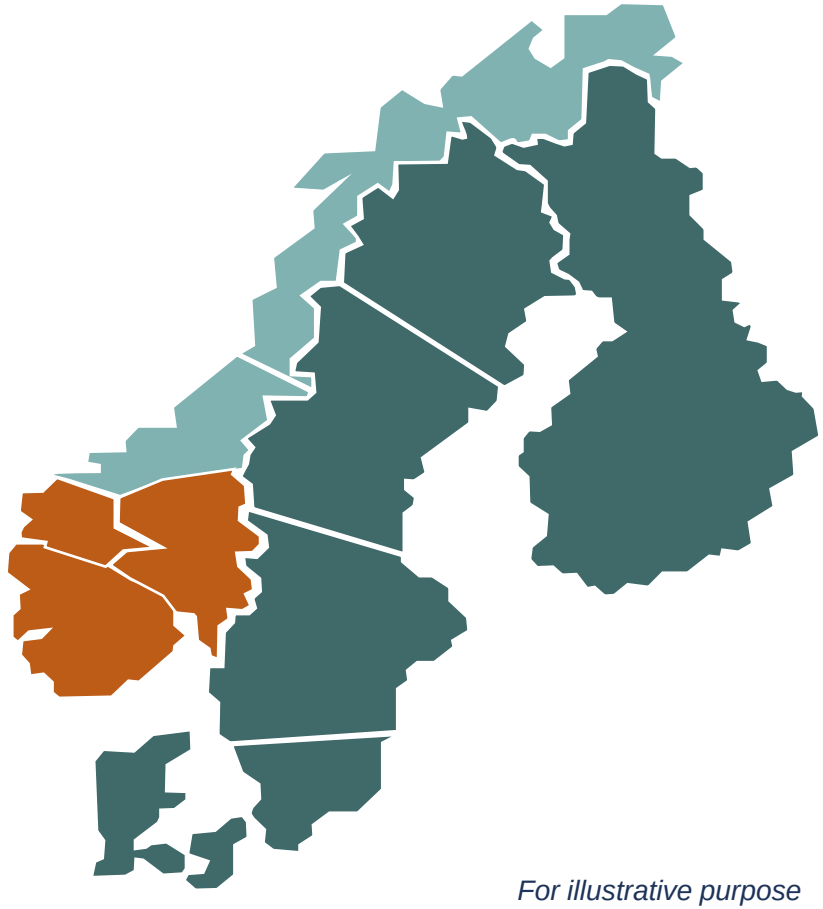
A Stepwise Nordic mFRR CM

- The Nordic TSOs work with an idea to expand the Danish mFRR CM to include bidding zones one by one. This will secure the best possible utilization of resources in low-liquidity areas.
- All Nordic TSOs have the same underlying market design to fit the common Nordic platform.
- The methodology referring to EBGL art. 41 for exchange and allocation of capacity is approved and covers both aFRR and mFRR.
- The Nordic TSOs believe that a methodology referring to EBGL art. 38 regarding the area of usage must be carried out and approved for a Nordic mFRR CM set-up.
- The methodology work is just about to start on the TSO side, and the Nordic TSOs expect to have a set of methodologies ready for public consultation in Q1 2024.



For illustrative purpose

Harmonized CZC Allocation Methodology

Harmonised Cross-Zonal Capacity Allocation Methodology (Art.38(3))

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- The methodology was approved in June but with a 1-year amendment request from ACER towards the TSOs. The amendment concerns governance specific questions.
- TSOs are working on the current amendment request and a public consultation can be expected during Q1 2024.
- The harmonised CZCA methodology requires Nordic to be compliant with the new methodology by 31/07/2026.
- The Nordics have taken part in the development of the Methodology and influenced with the experiences from Nordics.
- The aim from Nordic has been to make sure that the Methodology does not force a change of major parts of the Nordic market.
- The Harmonised Methodology allows for Capacity Markets to continue as Regional markets like the Nordic aFRR market (which is unlike the Energy markets with MARI/PICASSO). However, certain parts must be harmonised while other parts can remain regional.
- Nordic TSOs do not consider that the Harmonised Methodology will mean major changes from BRP/BSP perspective to the Nordic market at the given point in time.

15-minutes MTU in capacity markets

15 min MTU capacity markets?

- When the Day-Ahead Market (DAM) introduces 15 minute time resolution, capacity markets should also introduce 15 minute bid resolution.
- Capacity markets are obliged to allocate capacity in 15 minute time resolution.

Thank you for joining!