



Discussion points - EGC Workshop

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Agenda

- The framework for the market is changing
- Balancing market in Norway
- Summary of the Hasle-pilot project



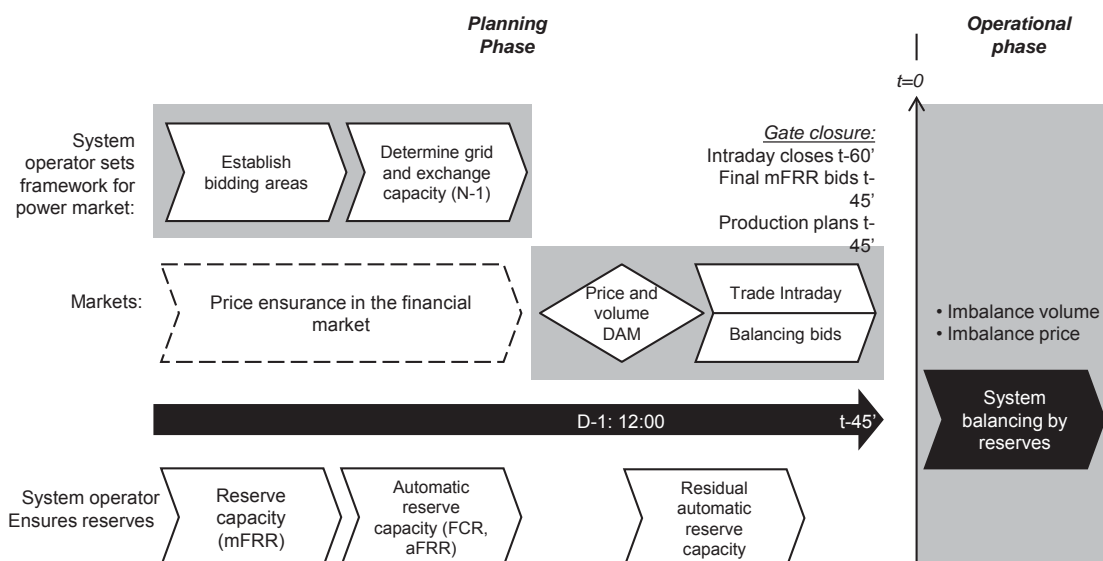
The new EU legislation

- As part of European Unions 3rd legislative package on energy a number of new regulations are being developed
- These regulations (Network codes or Guidelines) are:
 - 3 technical codes (Generator Connection, Demand Connection, HVDC)
 - 2 regarding system operation (System Operation, Emergency restoration)
 - 3 market codes/guidelines (Capacity allocation and congestion management, Forward allocation, Electricity Balancing)

The framework for the Nordic market is changing

- The Nordic countries will implement the Network codes and guidelines
- The Nordic market will be further integrated with the continental European market
 - Day-ahead market (already integrated)
 - Intra-day market (common IT system being developed)
 - Balancing market (to be integrated within the next 3-5 years)

Nordic Planning phase



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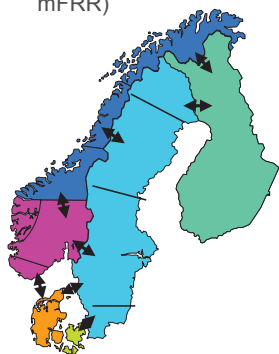
System balancing – timeline overview

Season

- TSOs define DAM bidding areas
- Reserve capacity market (FFR-M)

Week

- TSOs gives estimate for exchange capacity for the following week
- Reserve capacity markets for the following week (FCR, aFRR, mFRR)



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Every day

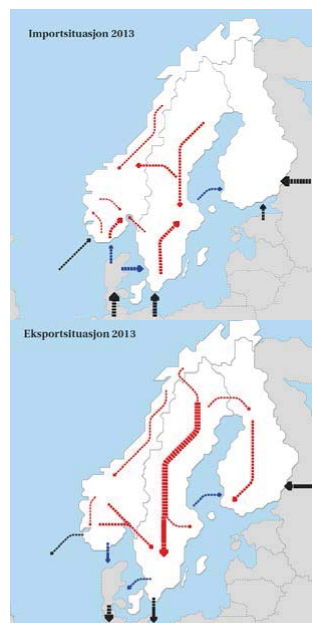
- <09:30: TSOs decide exchange capacity for the next day
- <12:00: Market participants delivers DAM bids to NordPool (European Day-ahead market)
- <14:00: NordPool publish the prices and power flows between areas
- >14:00: Intra day market opens
- <18:00: Gate closure for primary reserves, FCR
- <19:30: Production plans are delivered to Statnett
- <21:30: Preliminary gate closure for mFRR activation market

Operational day

- Planning at the control center: DAM power flow, consumption prognoses, production plans
- Changes to the production plan and mFRR bids can be made until 45 min before operational hour.

Nordic balancing

- Statnett is responsible for the imbalances in Norway
- Statnett is together with Svenska kraftnät activating balancing energy (mFRR), initiated by Nordic imbalances, from a common Nordic merit order list
- In the operating hour, after the producers have delivered final productions plans, they are not allowed to change production if not a balancing energy bid is activated by the TSO
- Balancing is supposed to be centrally performed by a TSO by activation of balancing energy bids



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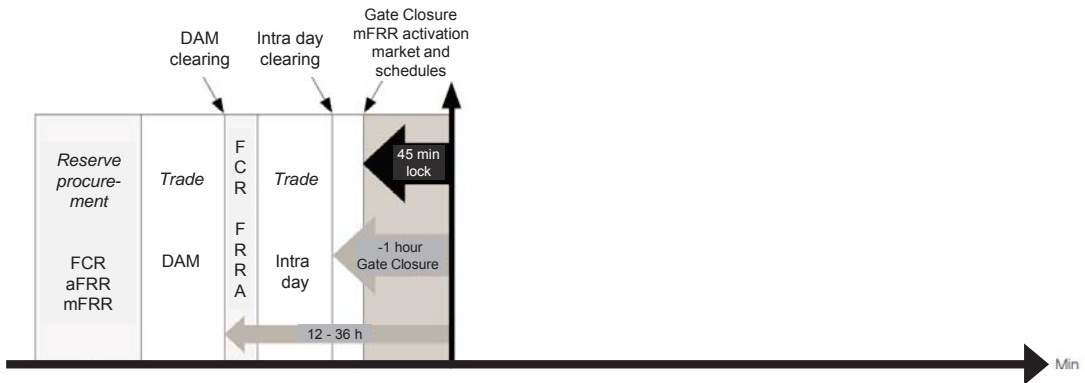
Current operator tools to handle imbalances

- General requirements
 - The Regulations for System Responsibility and NordPool Spot both require energy balance per hour
 - Hourly balances are monitored in the Balance Settlement
- Structural imbalances within an hour
 - In the planning phase: Administrative requirement for quarterly schedules when generation schedules change more than a given thresholds
 - During operation: TSO can shift schedules with up to +/-15 min from plan
- Stochastic imbalances (during operation)
 - Automatic reserves; FCR and aFRR
 - Manual reserves; Regulating Power Market (mFRR)
 - Frequency operated system protection

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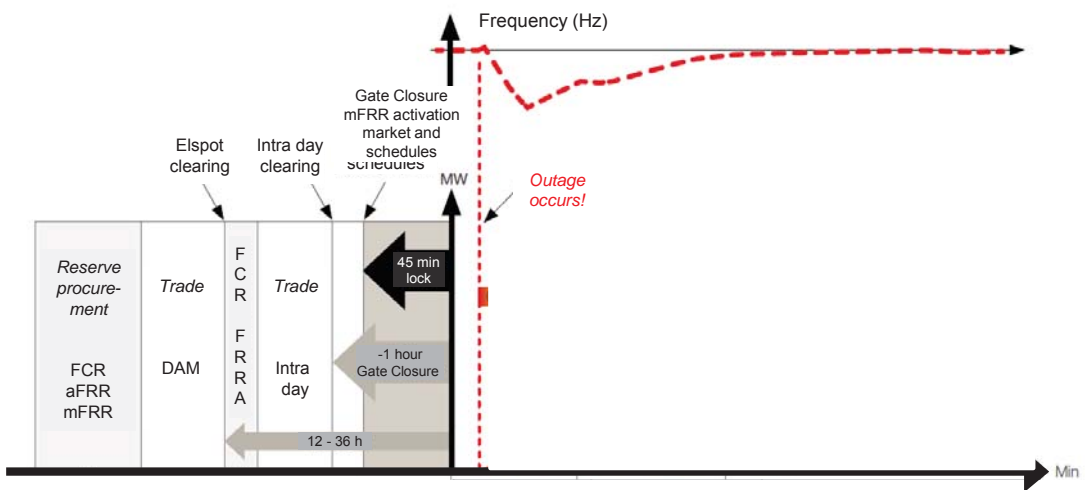
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Planning phase



Planning phase

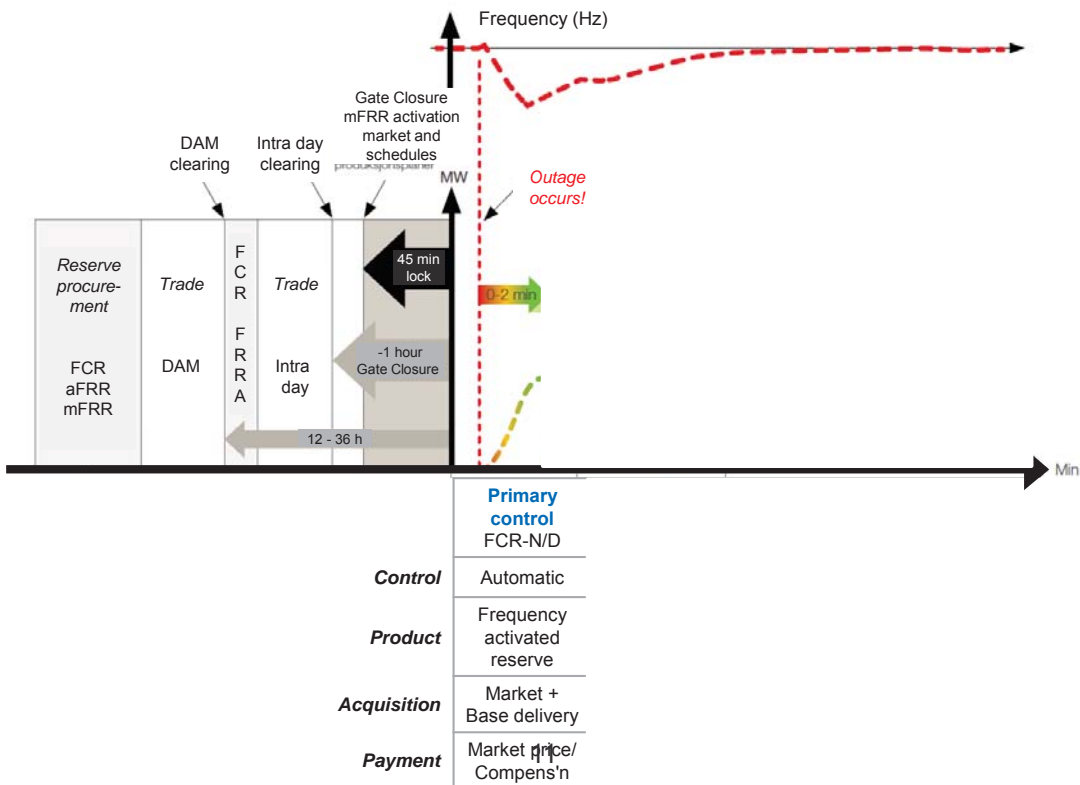
Operation phase



Planning phase

Operation phase

Statnett

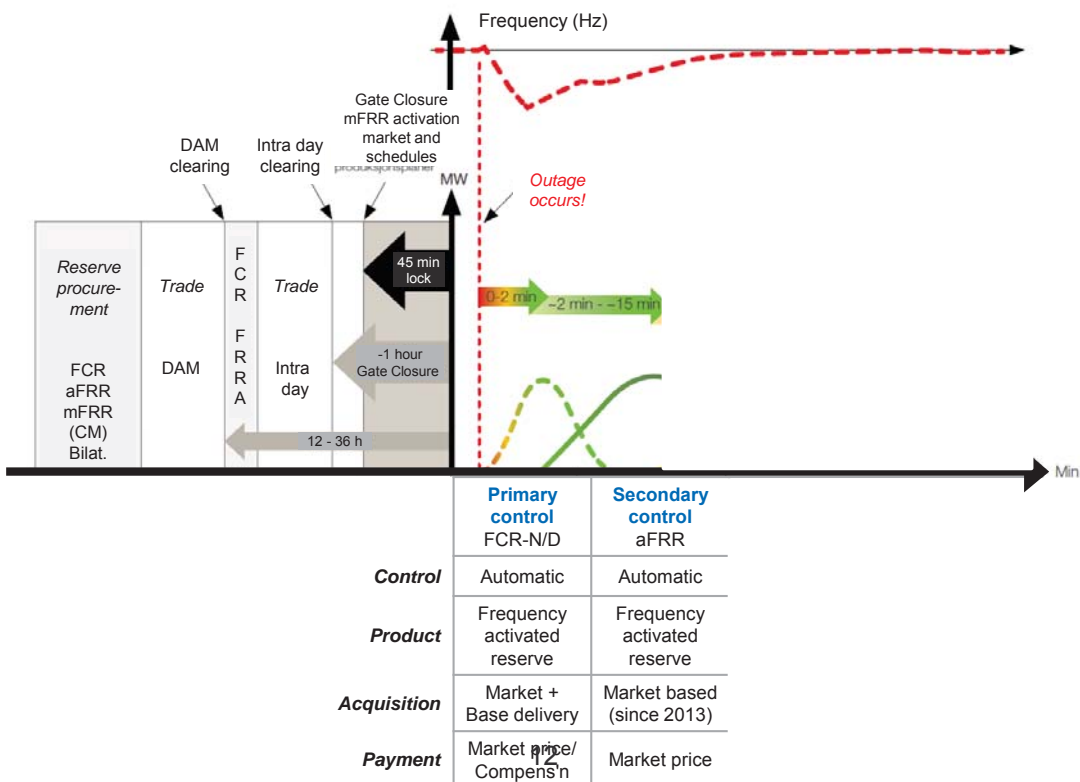


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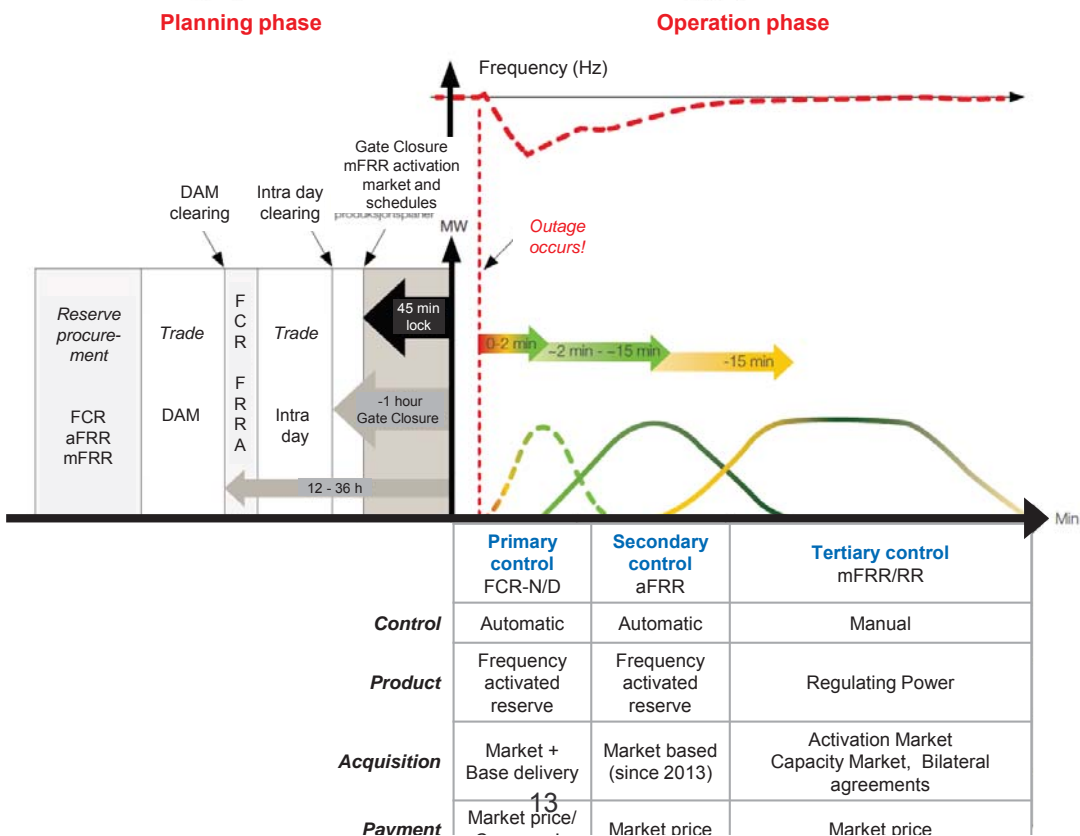
Planning phase

Operation phase

Statnett

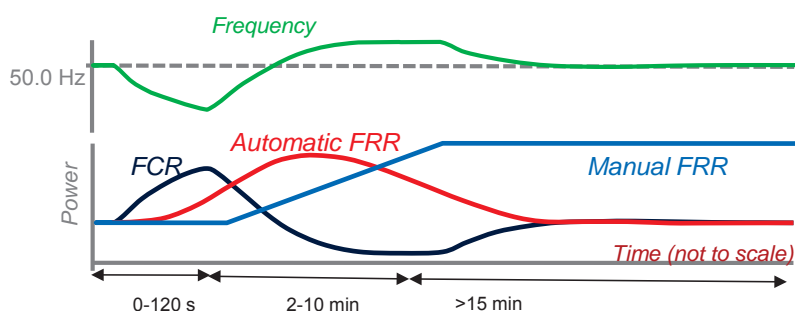


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Interaction between reserves



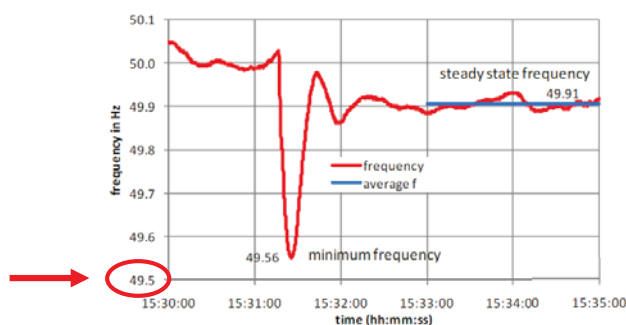
	FCR (Primary response)	aFRR (Secondary response)	mFRR (Tertiary response)
Objective	Stabilise frequency	Restore frequency to 50 Hz	Replace FCR and FRR Congestion management
Controller location	Decentralised at power plant	Centralised at TSO's control center	Manually instructed by TSO to reserve provider
Control parameter	Frequency (Hz)	Frequency (Hz)	Imbalance (MW)

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Primary regulation, FCR

- Primary regulation (Frequency containment reserve, FCR) is an **automatic frequency response to frequency deviation**.
- The objective of the FCR is to **maintain a balance** between generation and demand within the synchronous area.
- The primary regulation aims at **stabilizing the system frequency** at a stationary value after a disturbance of incident, within seconds, but without restoring the system frequency
- The **FCR Capacity** shall at least cover the Dimensioning Incident of the Synchronous Area.

The minimum acceptable steady state frequency in the Nordic SA is 49.5 Hz.



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FCR for normal operation and disturbances

- The FCR in the Nordic power system is divided into the frequency controlled normal operation reserve (FCR-N) and the frequency controlled disturbance reserve (FCR-D).
- The aim of FCR-N is to maintain the frequency in the normal range of 49.9 – 50.1 Hz
 - It shall be at least 600 MW in the Nordic system.
- FCR-D is activated automatically when the frequency drops below 49.90 Hz. The objective of the FDR is to ensure an acceptable minimum frequency and bring the frequency back to an acceptable steady state frequency (49.5 Hz).
 - It shall be at least equal to the dimensional fault deducted by 200MW (estimated contribution by load) which equals 1200 MW.
- Norway's share of primary response in the Nordics has been between 205-210 MW for FCR-N and around 350 MW for FCR-D.

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Geographical distribution of FCR

- Geographical distribution of inertia and automatic reserves within the power system is needed to avoid internal congestions in case of activation of the reserves, and in the case of network splitting.
- To maintain a distribution of reserves among the producing generators, Statnett require that all generators over 10 MVA have a droop setting of 12 % during winter and 6 % for the summer, if they do not participate in the FRC market.
- The providers can choose to deliver more reserves by lower the droop or run more generators than originally planned.

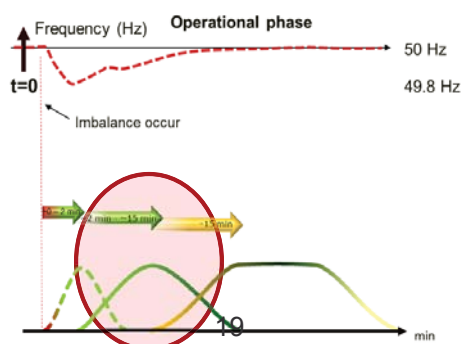


FCR market

- Acquiring primary response is a national responsibility. Dimensioning rules, technical requirements and limits for exchange is regulated by the Nordic system operational agreement.
- The required primary response is acquired through a FCR market, consisting of a daily and weekly market.
- The providers are able to participate in one or both sub-markets.
- The weekly market is run before the spot market, while the day market is run after spot in order to cover the remaining needs, including exchange of reserves from other TSOs

Secondary regulation (aFRR)

- The objective of the secondary regulation (Automatic Frequency restoration reserves, aFRR) is to
 - restore the frequency to the nominal value of 50 Hz
 - replace the FCR if the frequency deviation lasts longer than 30 sec, in order to make the system prepared for new system imbalances.
- aFRR is a centralized automatically activated reserve.
 - The reserves are activated by changing the set point of the generator, after signal from the TSO based on frequency deviation.
 - The time of response from the signal is received till the secondary reserve is activated is about 2-3 minutes.



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Acquisition of aFRR

- aFRR was implemented early 2013, and has shown a positive effect to the frequency quality, given a proper amount of capacity.
- The Nordic FFR-A capacity of 300 MW is acquired through weekly auctions on national basis.
- To be able to participate in the market, a control and management system must be in place for informing the production or consumption unit about the needed response.
 - This demands a direct link between the TSOs control center and the providers control center.
 - Today, most providers are power generators, but provisions are being made for consumers to participate in the reserve market.
- Common Nordic market for aFRR to be developed
 - Requirements for capacity and geographical distribution are now being developed by the Nordic TSOs.
 - The goal is to establish a common capacity market for the Nordics by 2018, and an activation market 6+12 months later.

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Tertiary Regulation

Manual Frequency restoration reserves, mFRR

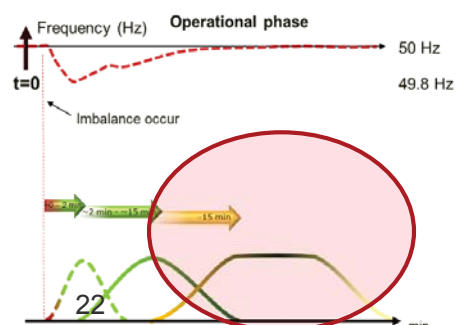


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Tertiary regulation

- Tertiary regulation (manual Frequency restoration reserves, mFRR) is used to:
 1. restore the automatic primary and secondary reserves when these reserves have been used or lost,
 2. mitigate forecasted imbalances, and
 3. manage local and Nordic congestions
- The mFRR is activated manually by the Nordic system operators
 - In Norway this is done by Statnett's National Control Centre.
 - The reserves shall be available within 15 minutes.



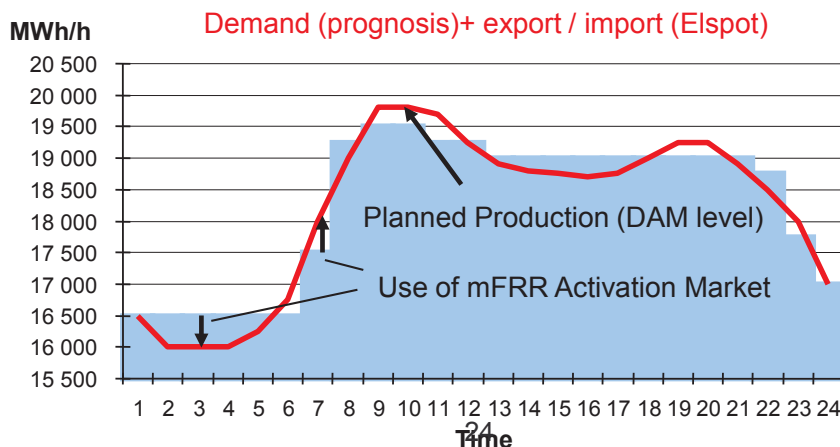
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Nordic Balancing Market.

- There is a common Nordic activation market for tertiary reserves, called the Nordic Balancing Market
 - The bids are sorted and initially activated by marginal price
 - In case of congestion management, the cheapest resource on the right side of the bottleneck will be activated first.
 - The activation market sets the price for imbalances of market players
- Statnett (Norway) and SvK (Sweden) activate bids in order to restore frequency
- mFRR is also used nationally to mitigate forecasted imbalances and manage local and regional congestion
- Both production and consumption units can offer mFRR
- To ensure available reserves, mFRR capacity is reserved nationally by the TSOs through
 - Capacity markets, and
 - Bilateral long term agreements

Using mFRR to balance the system

- DAM ensures hourly balance in the planning phase, but while generation changes on the hour, the consumption is never constant.
- mFRR is used to mitigate forecasted structural imbalances

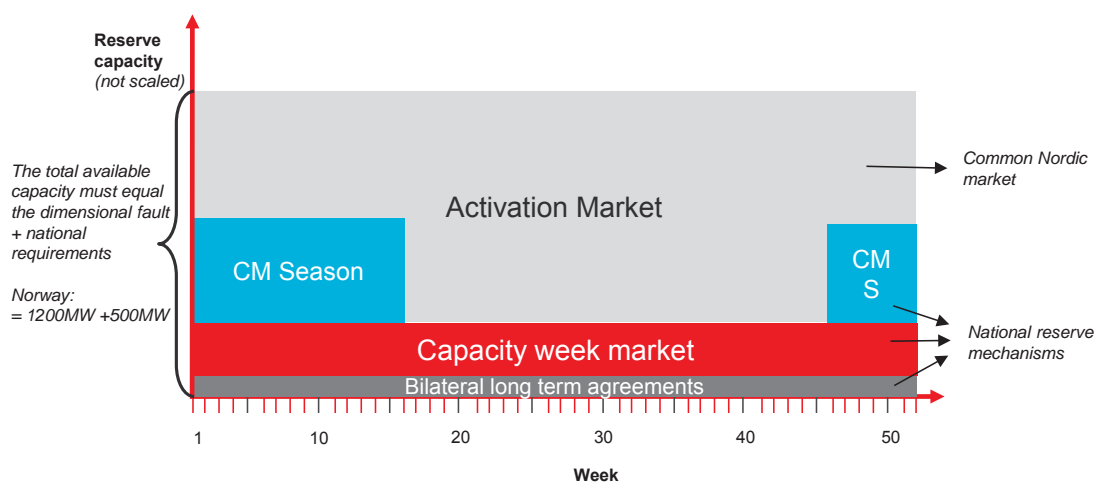


mFRR dimensioning

- The size of the mFRR is determined by the TSO's assessment of local requirements;
 - Bottlenecks on the network, dimensioning faults and similar are included when assessing this.
- Each Nordic country is obliged to have an mFRR capacity equal to the dimensional fault for its system, in order to cope with imbalances regardless of exchange limits.
- Norway has normally a dimensional fault on 1200 MW.
- In addition, Statnett has found it necessary to ensure 500 MW tertiary reserves in order to handle regional bottlenecks and imbalances.

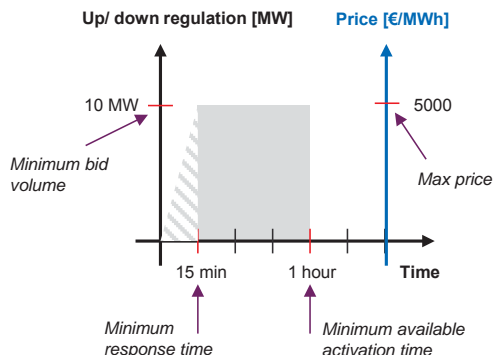


Acquisition of mFRR in Norway



Activation Market specifications

- Producers and consumers may place bids for up and/or down regulation
- Minimum quantity for bids is 10 MW. In case of operational difficulties however, Statnett can acquire access to all flexible power (production/ consumption) from 1MW
- FFR-M bids from the Nordic countries are used in equal terms, where the cheapest bid is initially activated first
- Most bids are activated manually, but implementation of automatic solutions is ongoing
- The regulation price is determined per bidding area after each hour. A reserve must have been activated for at least 10 minutes in order to be price decisive



Nordic Balancing Market

Balance - Bids activation/deactivation

Grid: last refresh 08:57:02, day 14, januar 2011, hour 07:08

Ti	Ear	Mark	Price / NOK	Price / EUR	Amount / MWh	Party	ELSPOT area	Internal area	Bid type	Activator
595			76.54	50	Statnett	NO2	NO2	CIAL		
596			76.54	30	Statnett	NO5	NO5	CIAL		
599			76.49	12	Svk	SE	SE1	CIAL		
590			75.89	11	Statnett	NO2	NO2	CIAL		
590			75.89	70	Statnett	NO2	NO2	CIAL		
585			75.25	25	Statnett	NO5	NO5	CIAL		
584			75.18	14	Energinet.dk	DK1	DK1	CIAL		
580			74.61	10	Statnett	NO5	NO5	CIAL		
580			74.61	25	Statnett	NO5	NO5	CIAL		
580			74.61	60	Statnett	NO5	NO5	CIAL		
578			74.35	12	Svk	SE	SE2	CIAL		
564			72.55	10	Svk	SE	SE2	CIAL		
561			72.22	20	Energinet.dk	DK1	DK1	CIAL		
566			71.99	20	Energinet.dk	DK1	DK1	CIAL		
555			71.39	25	Statnett	NO2	NO2	CIAL		
551			70.88	20	Energinet.dk	DK1	DK1	CIAL		
550			70.75	25	Statnett	NO2	NO2	CIAL		
540			69.46	27	Statnett	NO2	NO2	CIAL		
531			68.25	10	Energinet.dk	DK1	DK1	CIAL		
531			68.25	10	Energinet.dk	DK1	DK1	CIAL		
535			71.42	-10	Svk	SE	SE2	CIAL		
546			70.30	-50	Svk	SE	SE2	CIAL		
543			69.85	-12	Svk	SE	SE2	CIAL		
536			69.00	-30	Fingrid	FI	FI1	CIAL		
535			68.82	-10	Statnett	NO5	NO5	CIAL		
534			68.72	-60	Svk	SE	SE2	CIAL		
530			68.18	-8	Statnett	NO5	NO5	CIAL		
530			68.18	-55	Statnett	NO5	NO5	CIAL		
525			67.59	-10	Svk	SE	SE1	CIAL		
525			67.59	-50	Svk	SE	SE1	CIAL		
525			67.59	-15	Svk	SE	SE2	CIAL		
525			67.59	-23	Svk	SE	SE1	CIAL		
525			67.53	-32	Statnett	NO4	NO4	CIAL		
521			67.00	-50	Fingrid	FI	FI1	CIAL		
520			66.89	-47	Statnett	NO5	NO5	CIAL		
520			66.89	-238	Statnett	NO5	NO5	CIAL		
517			66.47	-23	Svk	SE	SE2	CIAL		

Summary:

MW	Total bids	Selected bids	Balance act.	Sp
Up	11212		820	
Down	-11570			

Balance Margin Price [NOK]

Tip	NO1	NO2	NO3	NO4	NO5	SE	DK1	DK2
Up		605,00			610,00	604,28	584,44	
Down								

Capacity market for mFRR (RKOM)

- In order to cover the Norwegian share mFRR Activation market at all times, options on tertiary regulation are bought at the capacity market for mFRR.
 - Statnett pays the providers to guarantee for participation in the activation market the coming season, or following week.
- The capacity market includes only **up regulation capacity**
 - increase of production or decrease of demand
- The bids can be given **per week or season** (week 46-16), where the weekly market is split into day and night segments
- Reserve capacity from **both producers and consumers** may be offered in the capacity market.
 - The capacity market stimulate the energy intensive industries to highlight and offer its flexibility, i.e. rapid reduction in consumption.
- Two products can be offered in the capacity market:
 - High quality reserves (*no limitations i.e. activation time or restoration time*)
 - Restricted reserves (*limitations i.e. activation time and/or restoration time. Maximum restoration time between activations is 8 hours*)

Reserves used in the operational phase

	Response	System needs	Objective	Acquisition	Activation/response
Reserves used in the operational phase	Automatic	Primary regulation	Stabilise frequency	Technical requirements: static level for generators above 10MVA. Market solutions: ARES: day and week-markets	Immediate response to frequency deviation The FCR-N is activated 49,90 Hz < f < 50,10 Hz, og shall respond after 5 seconds and be fully activated within 30sec. FCR-D shall respond within 2-3 minutes and works as an extension of FCR-N up regulation.
		FCR-N: 600MW (Nordic). FCR-D: 1200MW (Nordic)			
	Automatic	Secondary regulation	Subject of further investigation	Restore frequency to 50Hz Restore primary reserves for new imbalances	National market solutions A common Nordic market for aFRR activation shall be developed by 2017
Manual	Tertiary regulation	National requirements Norway: 1200 MW for dimensional fault and 500 MW for congestion management and imbalances.	Restore frequency and primary and secondary reserves Mitigate forecasted imbalances Congestion management	Regulerkraftmarkedet (RKM): Common Nordic market within producer and consumer participants. Norwegian capacity market for mFRR (RKOM) Bilateral agreements	The bids are primarily accepted after merit order (price) Manually instructed by TSO to reserve provider Shall be activated within 15 min



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Hasle aFRR pilot

Hasle-pilot for exchange with aFRR

- aFRR: An automatic, spinning reserve introduced in Nordics to improve frequency quality. Availability ensured before spot in a Capacity market
 - *Exchange requires that availability of Cross Zonal Capacity is ensured*
- Bilateral project: Svenska kraftnät and Statnett
 - Nordic TSOs informed
- A small scale pilot:
 - 8 weeks
 - Max 50 MW
 - Two countries

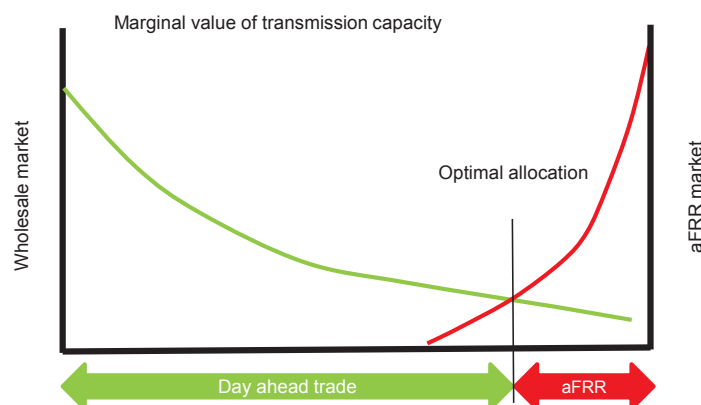


Purpose and Objectives of the Hasle pilot

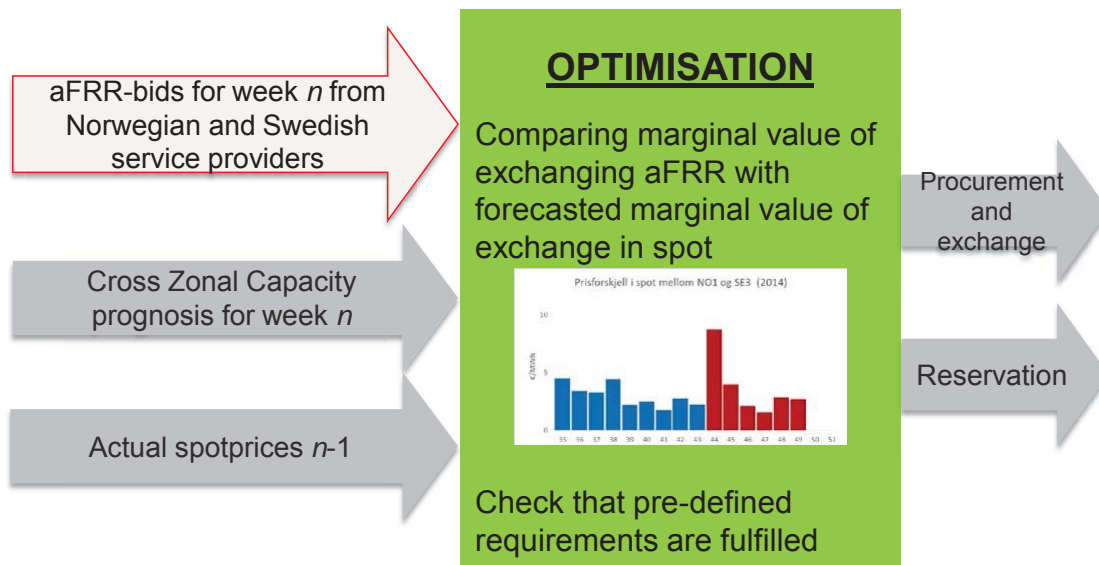
- Analyze the market consequences of transmission capacity reservation in Hasle
- Gain experience and be a step in direction of Nordic market for Balancing Capacity

Conservative approach in Hasle pilot Statnett

Methodology for optimising use of Cross Zonal Capacity in pilot is systematically in favour of spotmarket

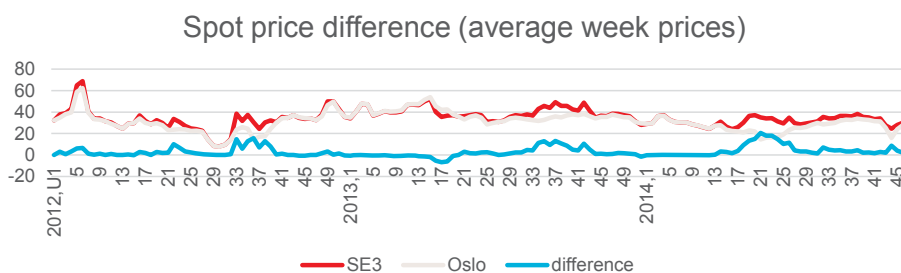


Weekly reservation for each block and each direction

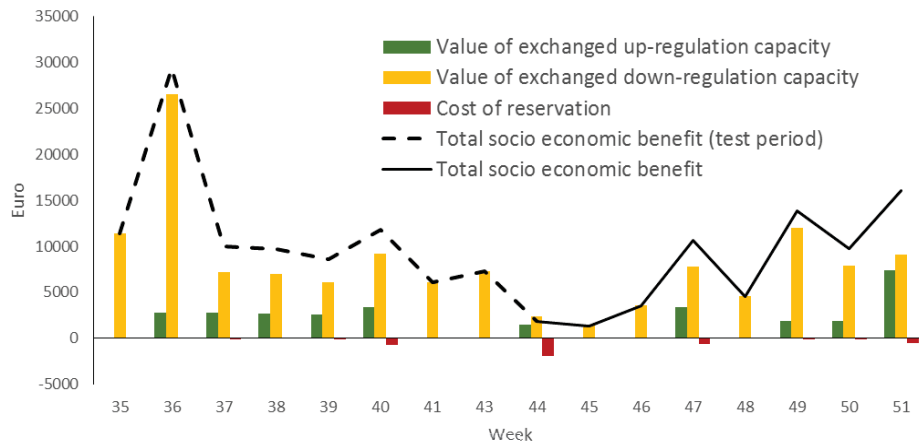


Market based reservation is feasible

- Increased volumes requires development
- Frequent allocation and fine time resolution increase efficiency



Increase of socio economic welfare*) Statnett

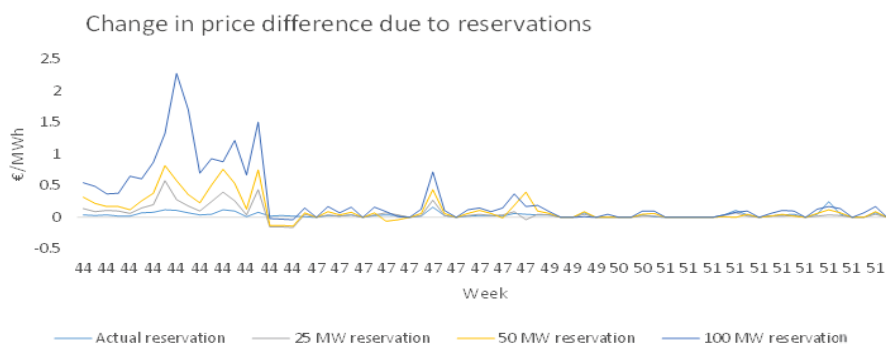


*) Here socio economic costs are calculated as actual price difference x reserved transmission capacity. The evaluation report will additionally include results of spot price impacts due to reduced transmission capacity volumes in spot market



Impacts of reservations on spot prices

- NordPool has calculated DAM results with different scenarios of reservation
- The results indicates small impact on spot prices



Useful to have a small scale pilot

- Prove that
 - Exchange gains socio economic welfare
 - Market based reservation is feasible
- Important experiences gain for permanent implementation
 - Market design and algorithm
 - Operation of auctions and cross zonal capacities

