Nordic System Operation Forum

1 December 2016
Nordic Light Hotel, Stockholm

Statnett FINGRID ENERGINET.DK SVENSKA KRAFTNÄT

Nordic System Operation Forum

09:30 - 10:00	**Registration and coffee**
10:00 - 10:05	**Opening of the Forum** / Erik Ek, Svenska kraftnät
10:05 - 10:30	**Challenges and opportunities for the Nordic power system** / Erik Ek, Svenska kraftnät
10:30 - 11:00	**Nordic office for system security coordination (RSC)** / Jens Møller Birkebæk, Energinet.dk
11:00 - 11:30	**The future of imbalance pricing** / Martin Høgh Møller, Energinet.dk
11:30 - 12:30	**Lunch**
12:30 - 13:00	**The Nordic market for automatic Frequency Restoration Reserve (aFRR)** / Jens Møller Birkebæk, Energinet.dk
13:00 - 13:45	**Frequency stability and new Nordic requirements for Frequency Containment Reserves (FCR)** / Erik Alexander Jansson, Statnett
13:45 - 14:15	**Coffee Break**
14:15 - 15:00	**Panel discussion - The changes in the power system from the market player's perspective** / Olof Klingvall, Svenska kraftnät
15:00 - 15:30	**Wrap up**

Challenges and opportunities for the Nordic power system

Statnett FINGRID ENERGINET.DK SVENSKA KRAFTNÄT SWEDISH NATIONAL GRID

Challenges and Solutions

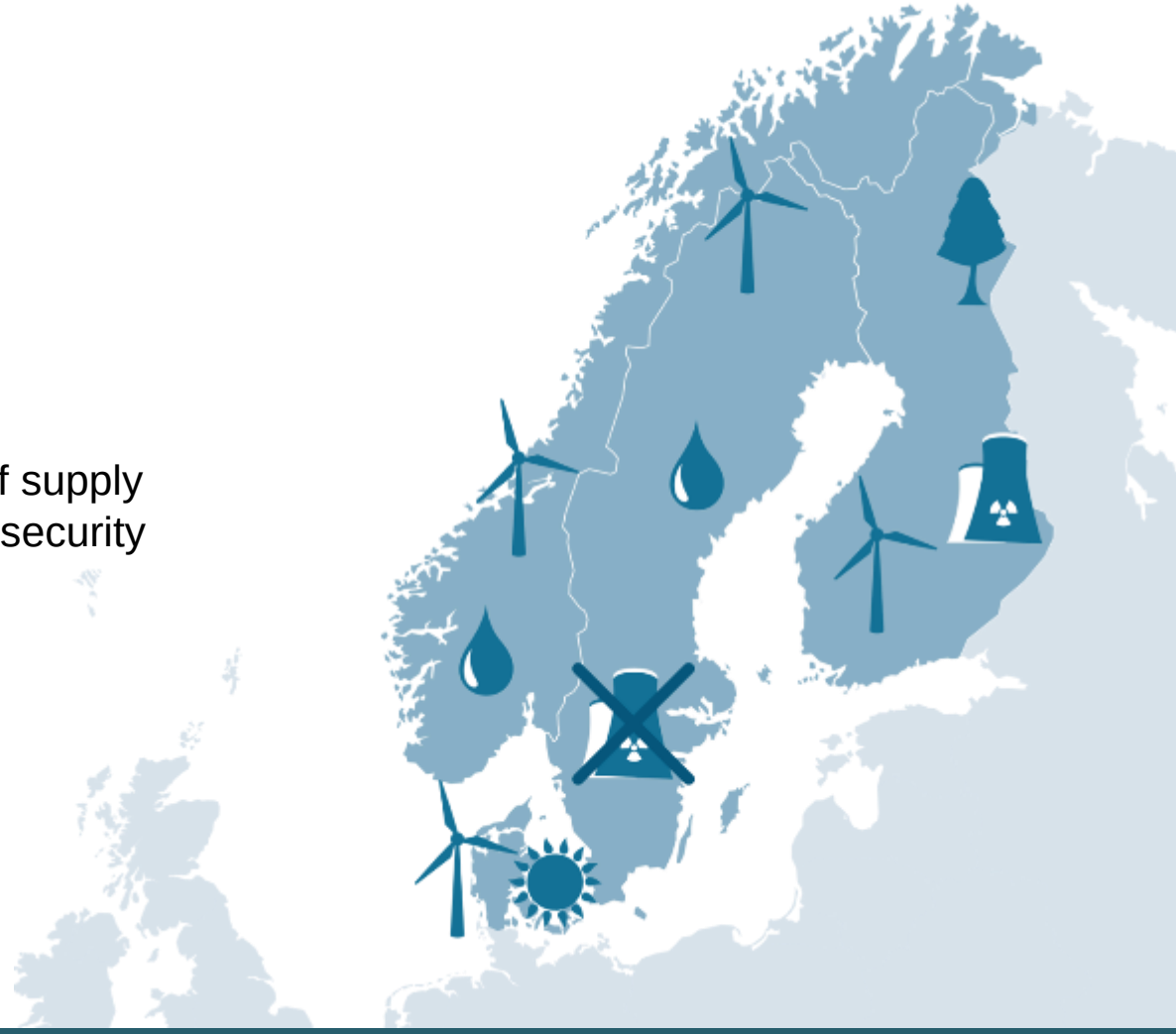
Stakeholder meeting Stockholm 2016

Erik Ek, Svenska kraftnät

Main challenges

- Balancing the system
  - Generation to ensure security of supply
  - Increased demand for flexibility
  - Transmission adequacy to ensure security of supply

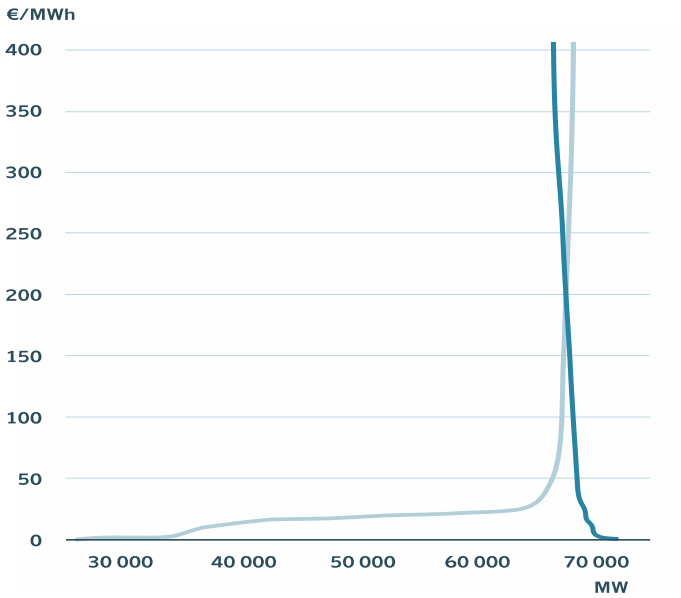
- The right quality in the Power System/Level och security of supply
  - Maintain good frequency quality to ensure operational security
  - Sufficient inertia to support system stability



Generation to ensure security og supply

Challenges

- Ensuring flexible capacity with market signals
- Lack of adequate assessment and methodologies



Demand-supply balance in the Nordic power system on 21 January 2016. The figure shows that on this date the demand-supply balance was very tight.

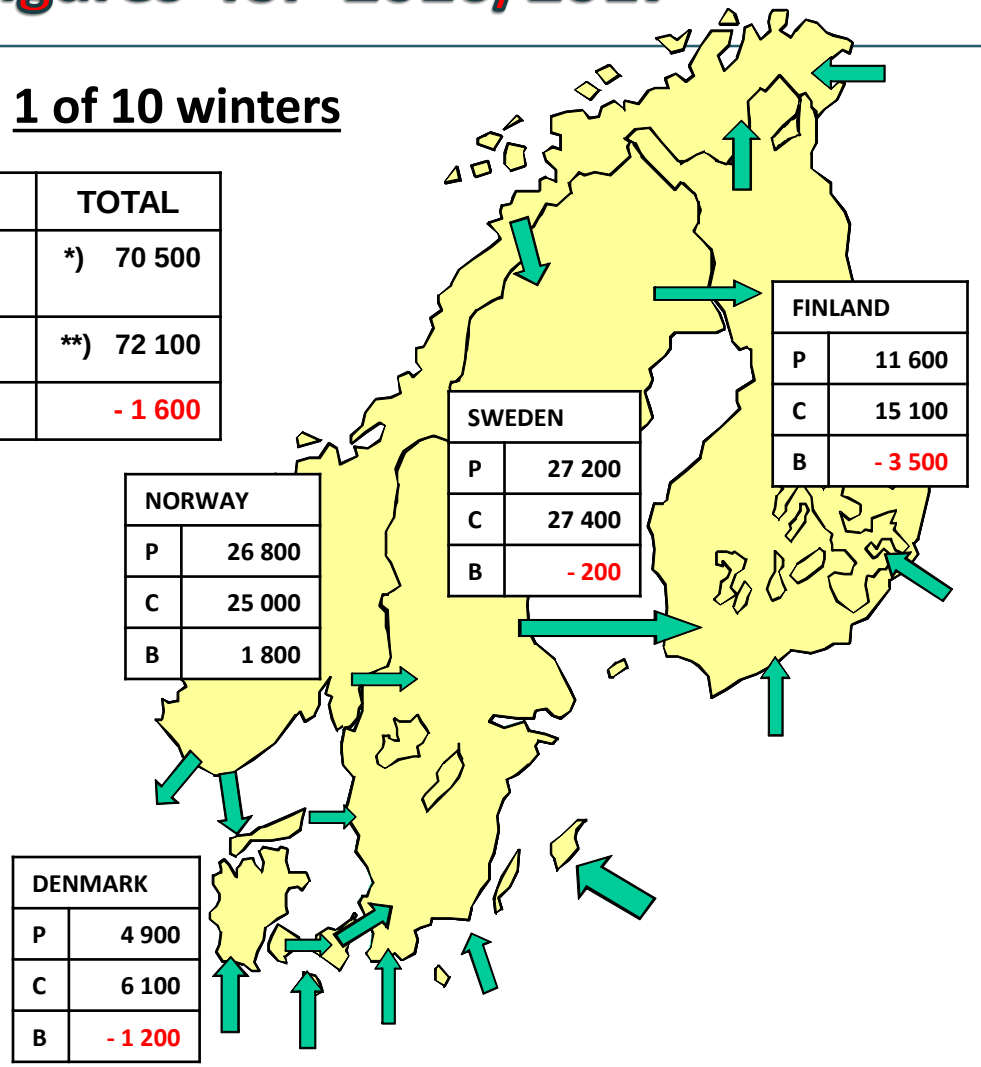
Possible solutions

- Develop harmonized Nordic common probabilistic methodologies
- Identify mitigation measures to address adequacy in a Nordic perspective, although the implementation can be both national and regional.
- Common definitions on generation adequacy that focus on defining a socioeconomically efficient level of security of supply.

Preliminary figures for 2016/2017

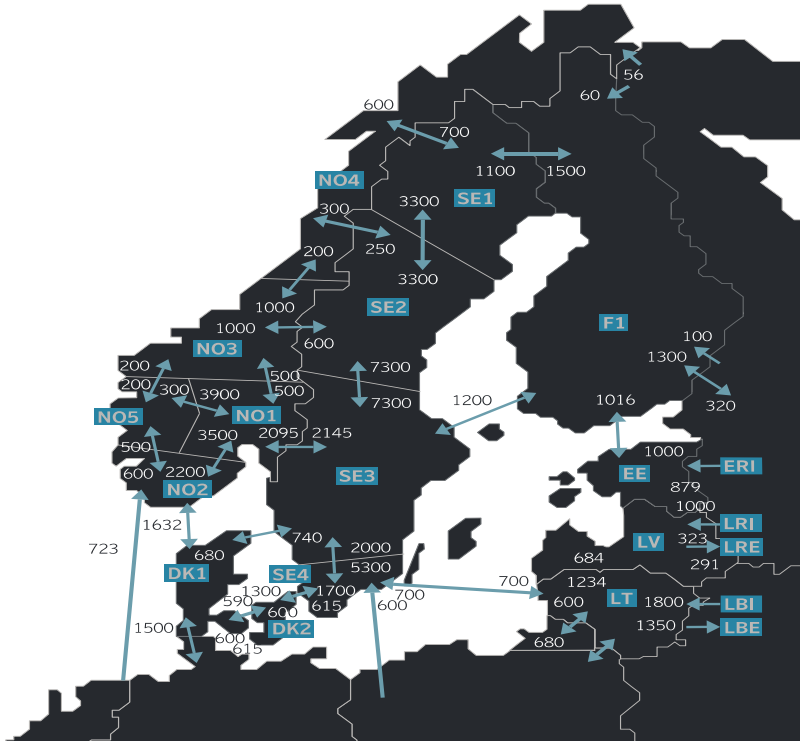
Cold winter day in 1 of 10 winters

NORDIC MARKET	TOTAL
P = Available capacity for market, TSO reserves excluded	*) 70 500
C = Peak demand	**) 72 100
B = Balance without power exchange	- 1 600



Statnett FINGRID ENERGINET.DK SVENSKA KRAFTNÄT

Transmission adequacy to ensure security of supply



Challenges

- Using correct assumptions and value all benefits when planning the transmission net
- Maintain operational security and an efficient market while reconstructing the grid

Possible solutions

- Develop the grid and addition transmission capacity can alleviate the challenges with flexibility and real-time balancing
- Clarify differences and common goals in the Nordics for grid development

Statnett FINGRID ENERGINET SVENSKA KRAFTNÄT

Draft content of report

Executive summary

1. **Introduction**
   a. Strategy: A Nordic Vision for 2025
   b. Nordic TSO cooperation
   c. Different “types” of solutions
   d. Purpose of the report

2. **Well-functioning energy markets and trade**
   a. Higher time resolution
   b. Full cost of balancing
   c. Flow based market coupling
   d. Linking wholesale and retail markets

3. **Further develop system and balancing services**
   a. Common Nordic specification for frequency quality
   b. Revision of Frequency Containment Process (FCP)
   c. Nordic approach to securing sufficient levels of inertia
   d. Common Nordic markets for ancillary services/reserves, general and specifically aFRR
   e. Nordic RSC office

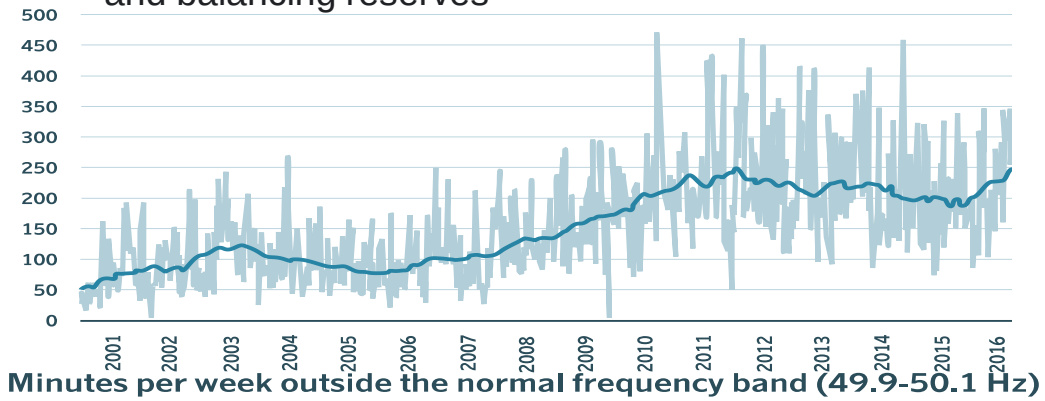
4. **Common plans and analysis**
   a. Common Nordic generation adequacy approach based on the ENTSO-E approach
   b. The Nordic grid development plan

5. **Cooperation on support systems to enhance a more efficient and secure system (New technology - common tools)**
   a. Common Nordic IT vision, Common Information Model (CIM), Nordic Digital Security
   b. Automation of operational processes
   c. R&D

Maintain good frequency quality to ensure operational security

Challenges

- Larger imbalances caused by ramping
- More unpredictable power generation will increase the forecast errors
- Increased need for, but reduced access to, reserve capacities
- Availability of transmission capacity for frequency and balancing reserves



Minutes per week outside the normal frequency band (49.9-50.1 Hz)

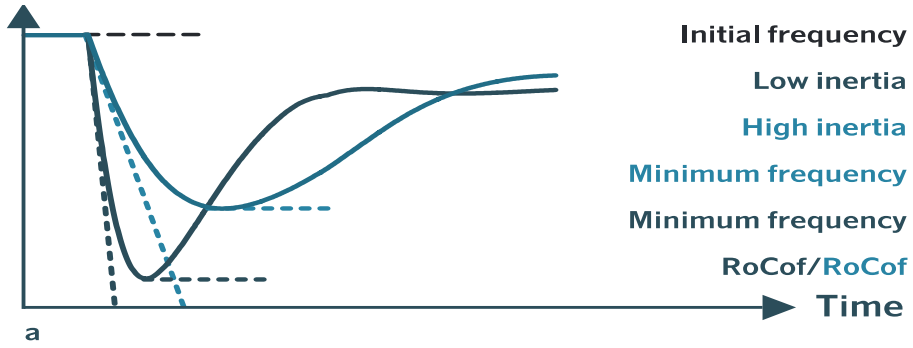
Possible solutions

- A common Nordic specification for the frequency quality
- Further develop joint Nordic ICT-solutions
- Introduce higher time resolution
- Stronger incentives for the Balance Responsible Providers to keep the balance
- Introduce efficient solutions for allocating transmission capacity to the reserve markets.
- Harmonize products and market solutions for frequency and balancing regulation

Sufficient inertia to support system stability

Challenges

- Having sufficient inertia in the system to ensure operational security
- Lack of minimum requirements i.e. a common understanding of how low level of inertia the system can handle and what is expected in the future Nordic power system

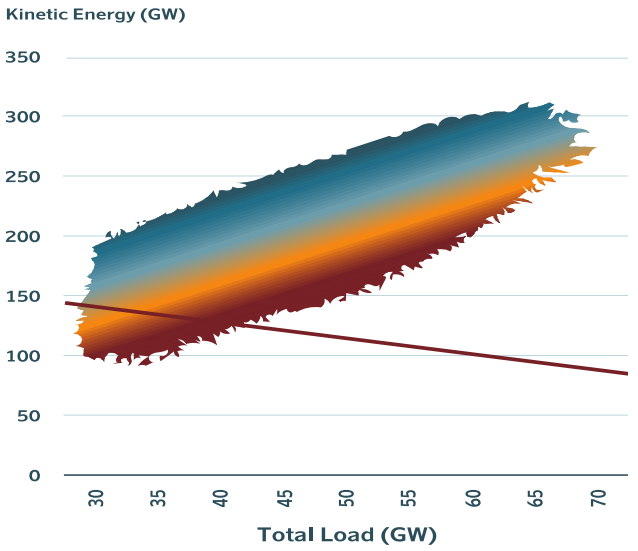


Frequency and power responses after a generator trip.
a) Initial frequency and frequency responses after a generator trip with high and low

Possible solutions

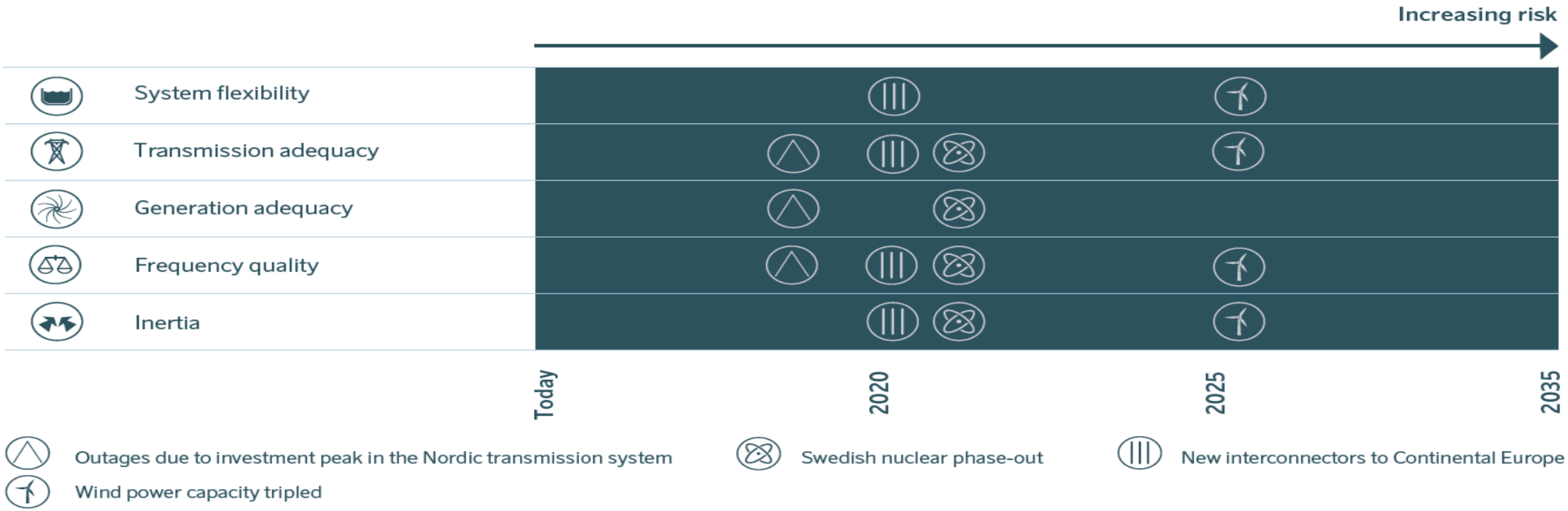
- Market solutions or incentives to ensure that enough inertia is maintained in the system at all times
- Installing system protection schemes
- PMU and the use of HVDC links/converters
- Increasing inertia from existing production units
- Add more frequency containment reserves

Estimated kinetic energy as a function of load



Estimated kinetic energy in 2025 as a function of total load including all climate years (1962–2012) of the market simulation scenario. The percentage of time when the estimated inertia measured by kinetic energy in 2025 is below the estimated required amount is 7.7 %

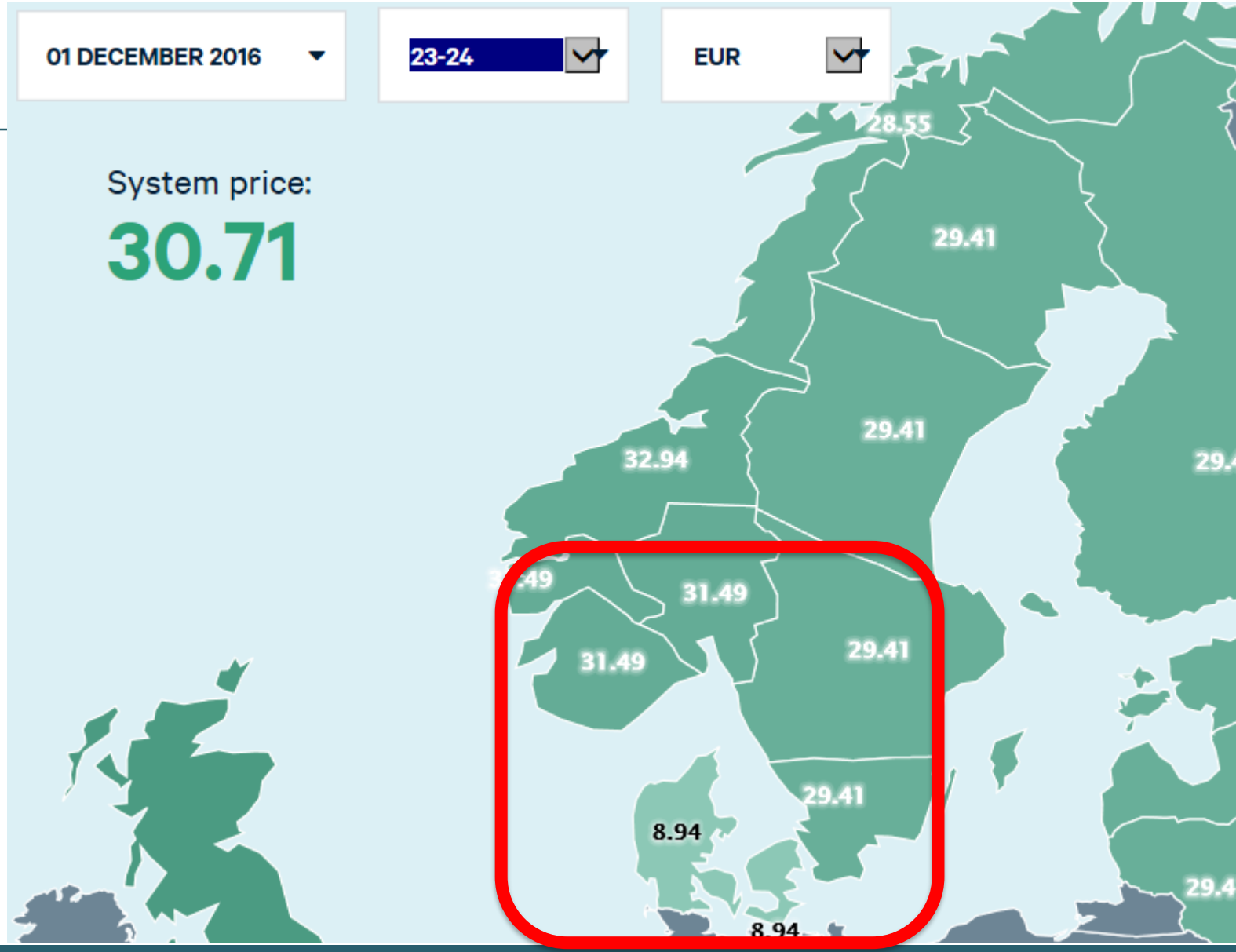
There is an urgency to deal with the challenges



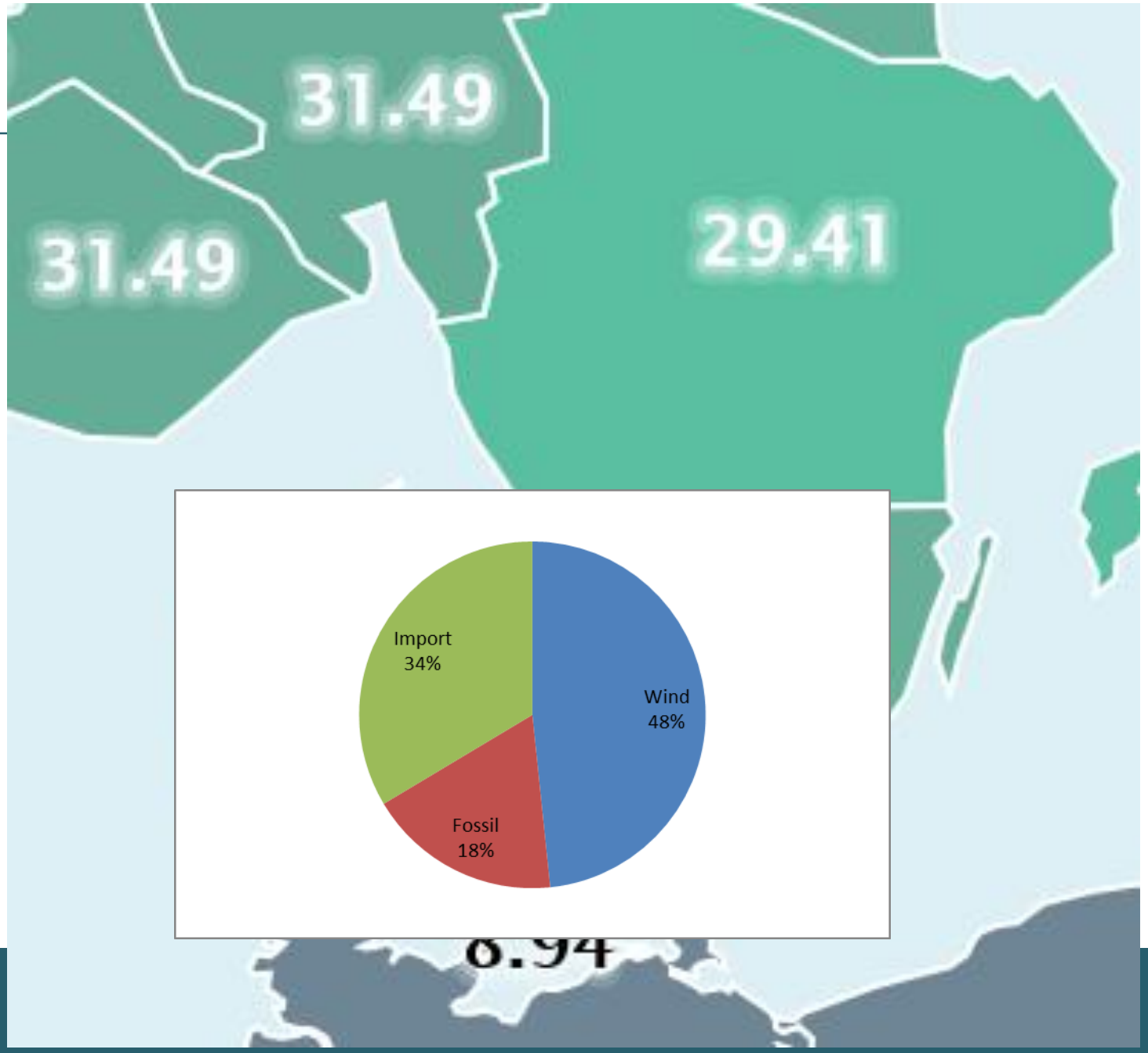
- The Nordic TSOs have to find the solution and move forward!
- And an extended cooperation across the power sector is needed to make this possible!
- **Maintaining security of supply as it is today requires action!**


IT'S OFFICIAL:
WE DID IT!
Adelaide reaches zero emissions
THE GREENS

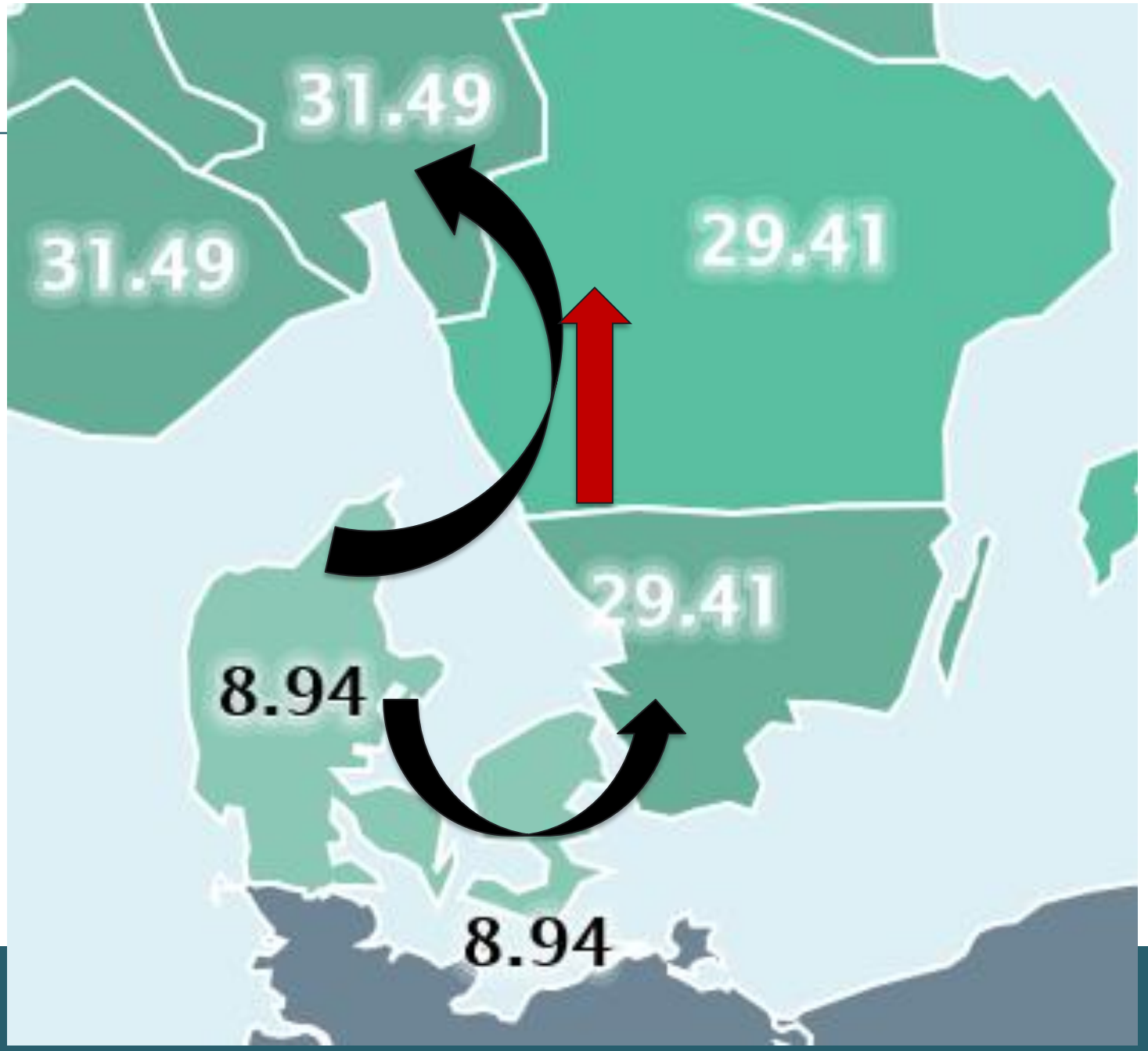
Australian disturbance, tonight?



Australian disturbance, tonight?



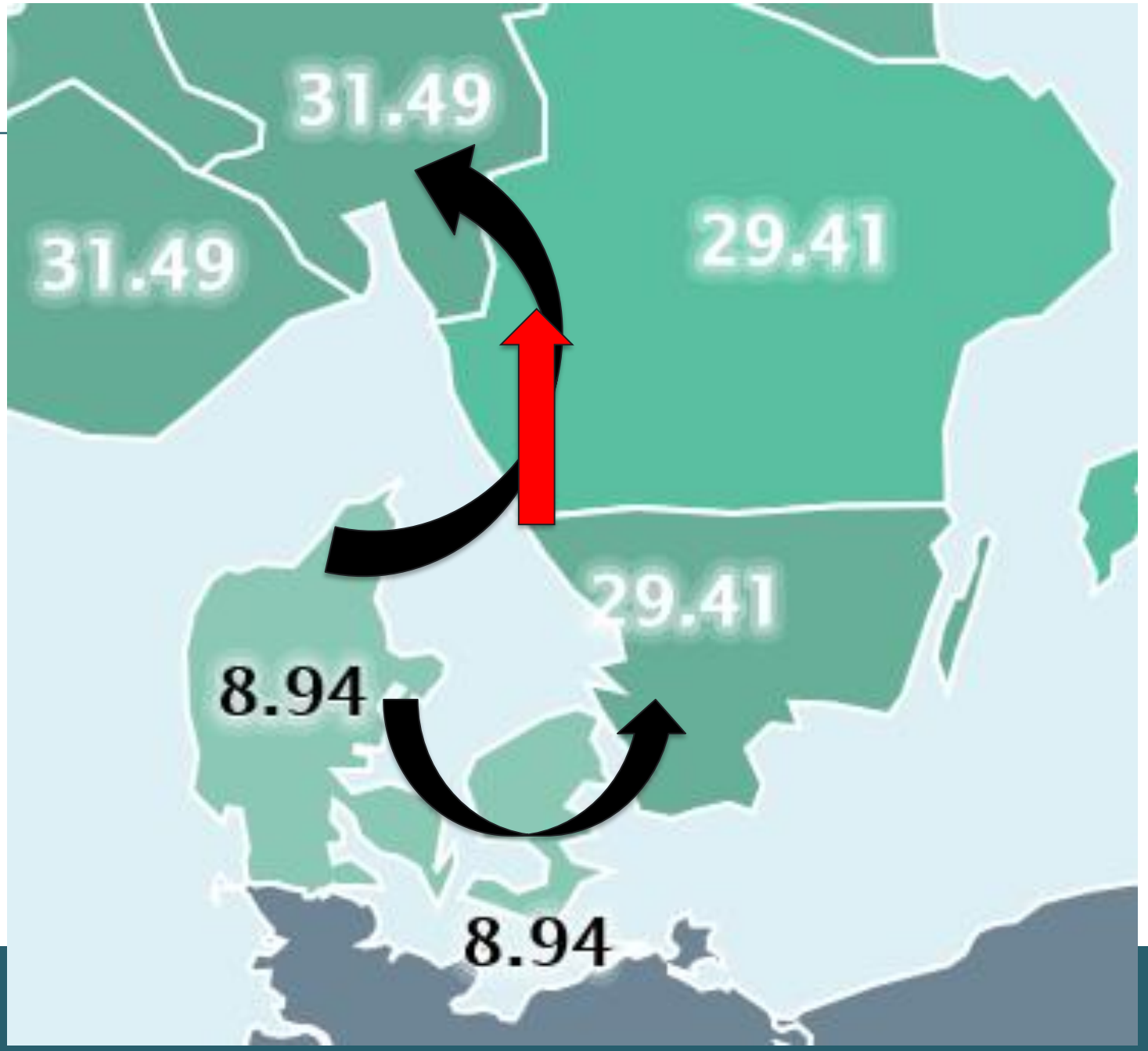
Australian disturbance, tonight?



Australian disturbance, tonight?

This happend i Austrailia
- Big storm from the south

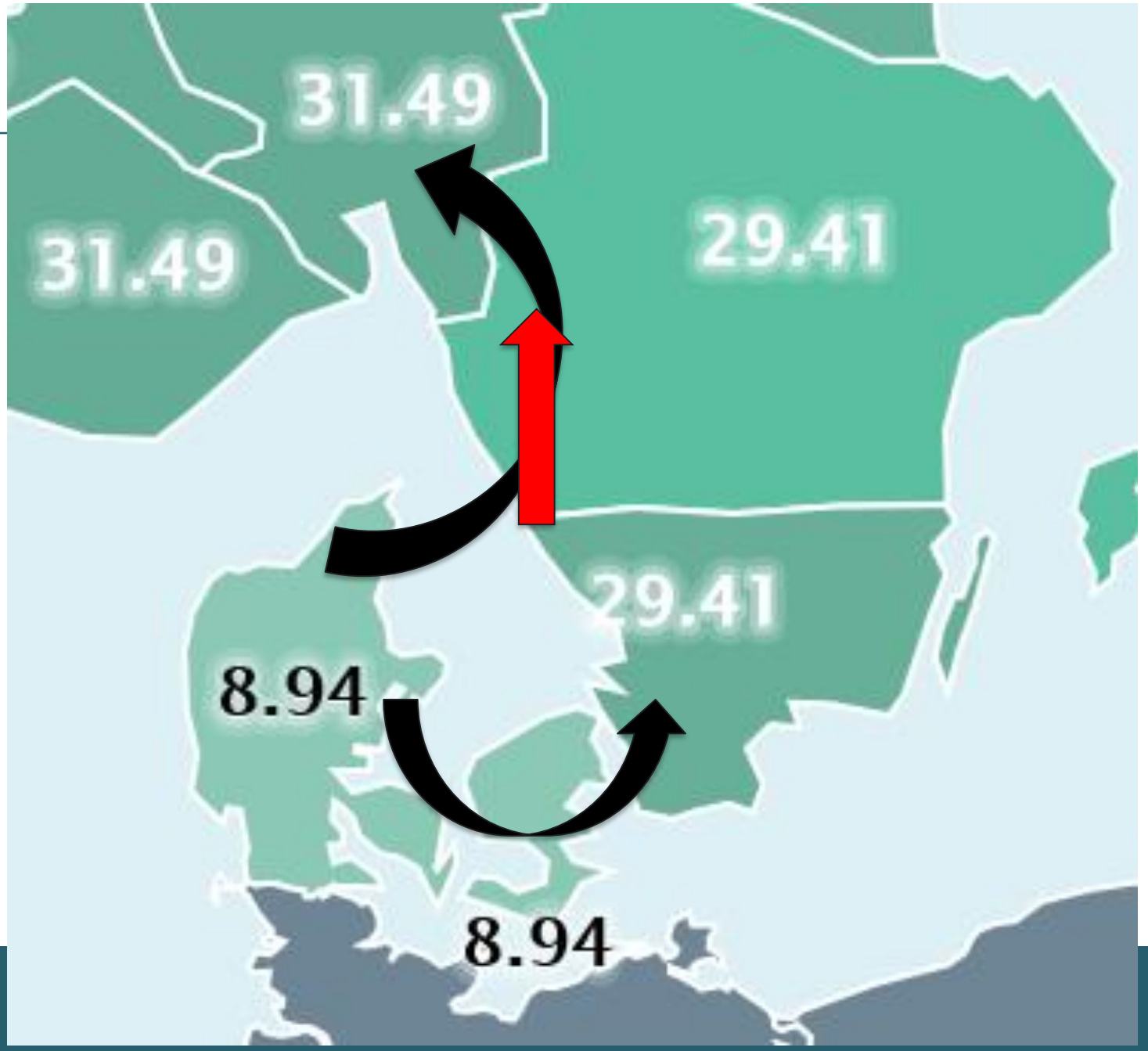
Within 15 minutes:
1.One 275 kV line tripps



Australian disturbance, tonight?

This happend i Austrailia
- Big storm from the south

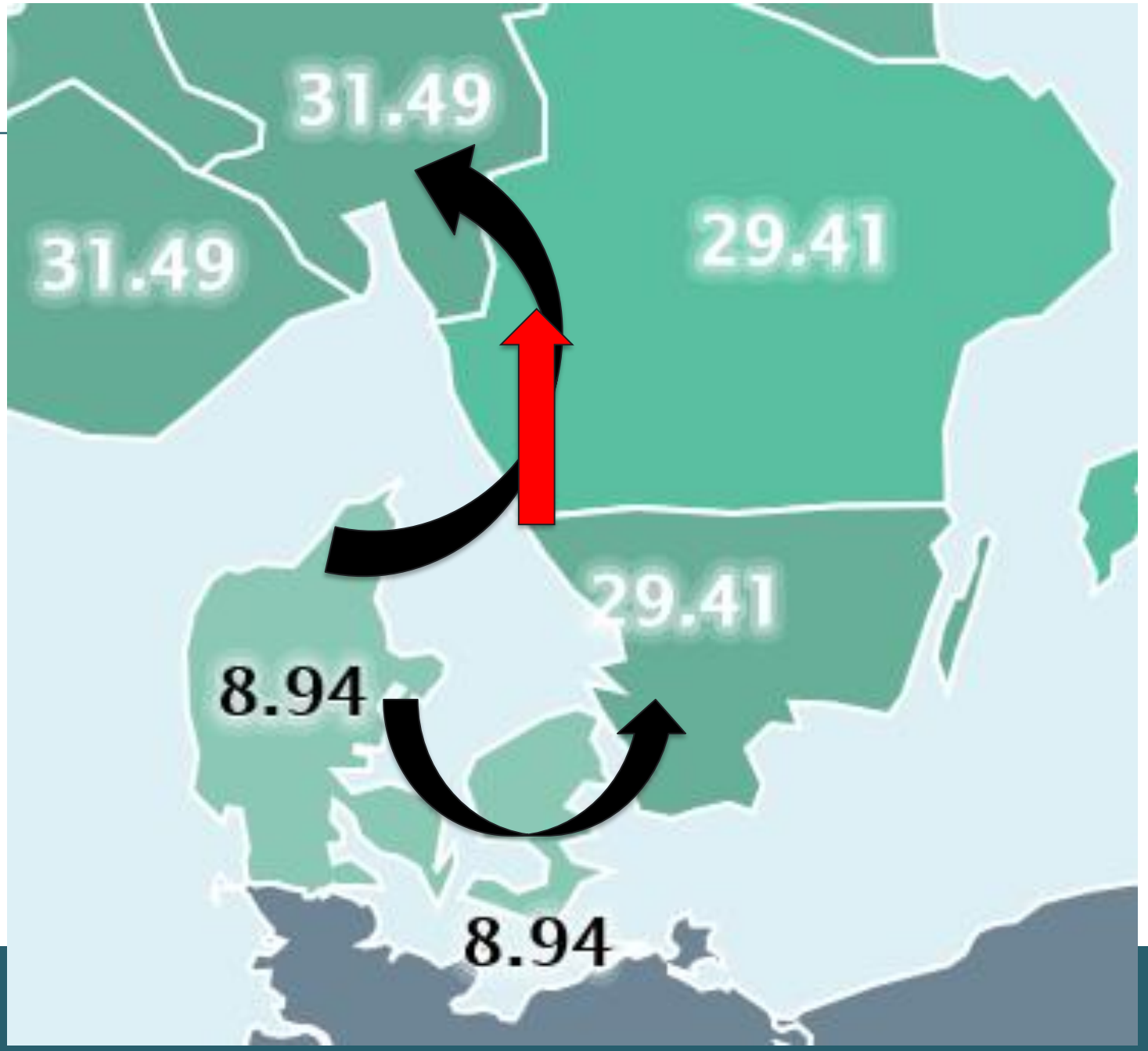
Within 15 minutes:
1.One 275 kV line tripps
2.Second 275 kV line tripps



Australian disturbance, tonight?

This happend i Austrailia
- Big storm from the south

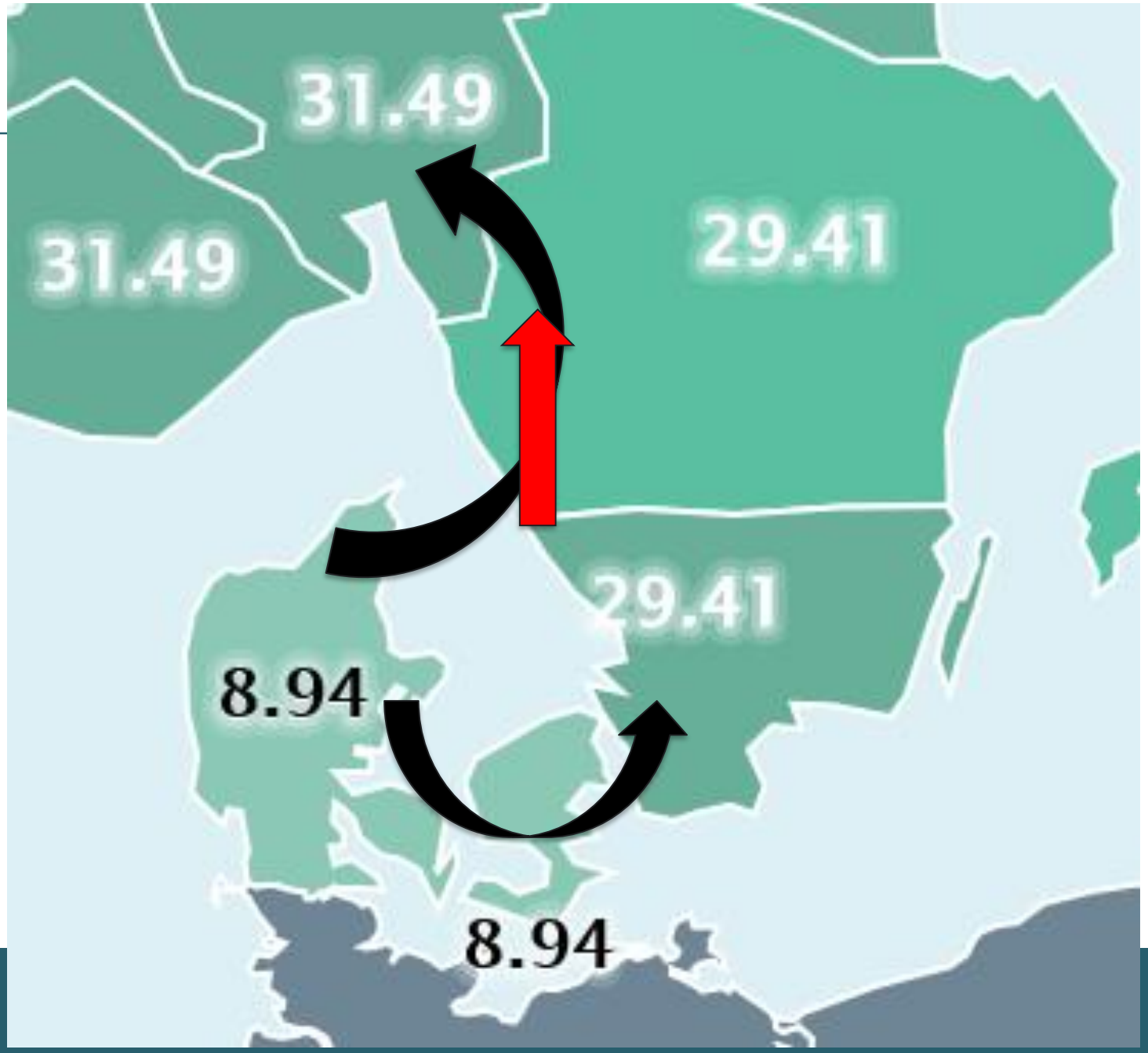
Within 15 minutes:
1.One 275 kV line tripps
2.Second 275 kV line tripps
3. Windfarms rapid change 123 MW



Australian disturbance, tonight?

This happend i Austrailia
- Big storm from the south

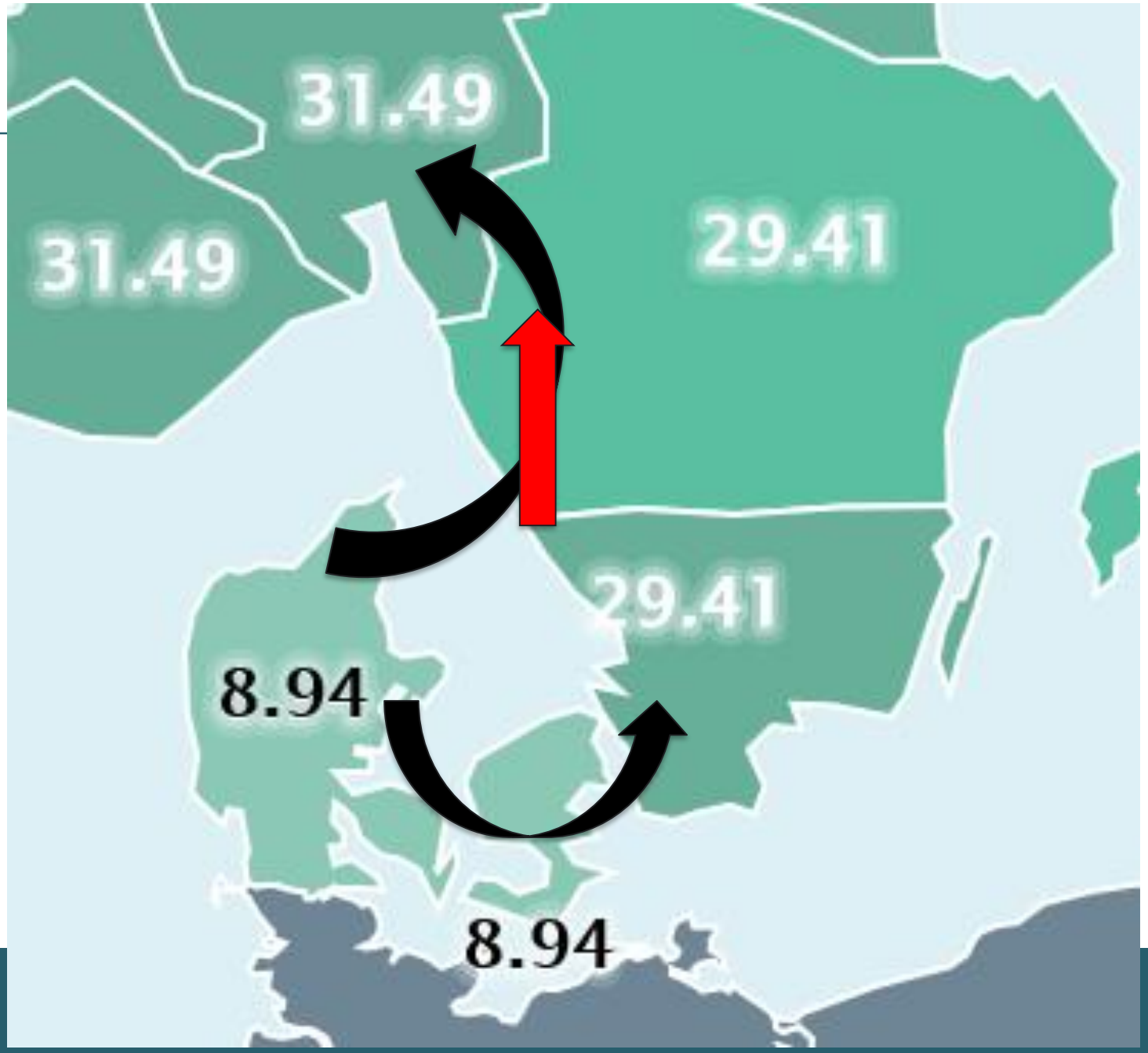
Within 15 minutes:
1.One 275 kV line tripps
2.Second 275 kV line tripps
3. Windfarms rapid change 123 MW
4. Third 275 kV line tripps



Australian disturbance, tonight?

This happend i Austrailia
- Big storm from the south

Within 15 minutes:
1.One 275 kV line tripps
2.Second 275 kV line tripps
3. Windfarms rapid change 123 MW
4. Third 275 kV line tripps
5. Windfarms rapid change 192 MW
6. Overload of line and disconnection



Australian disturbance, tonight?

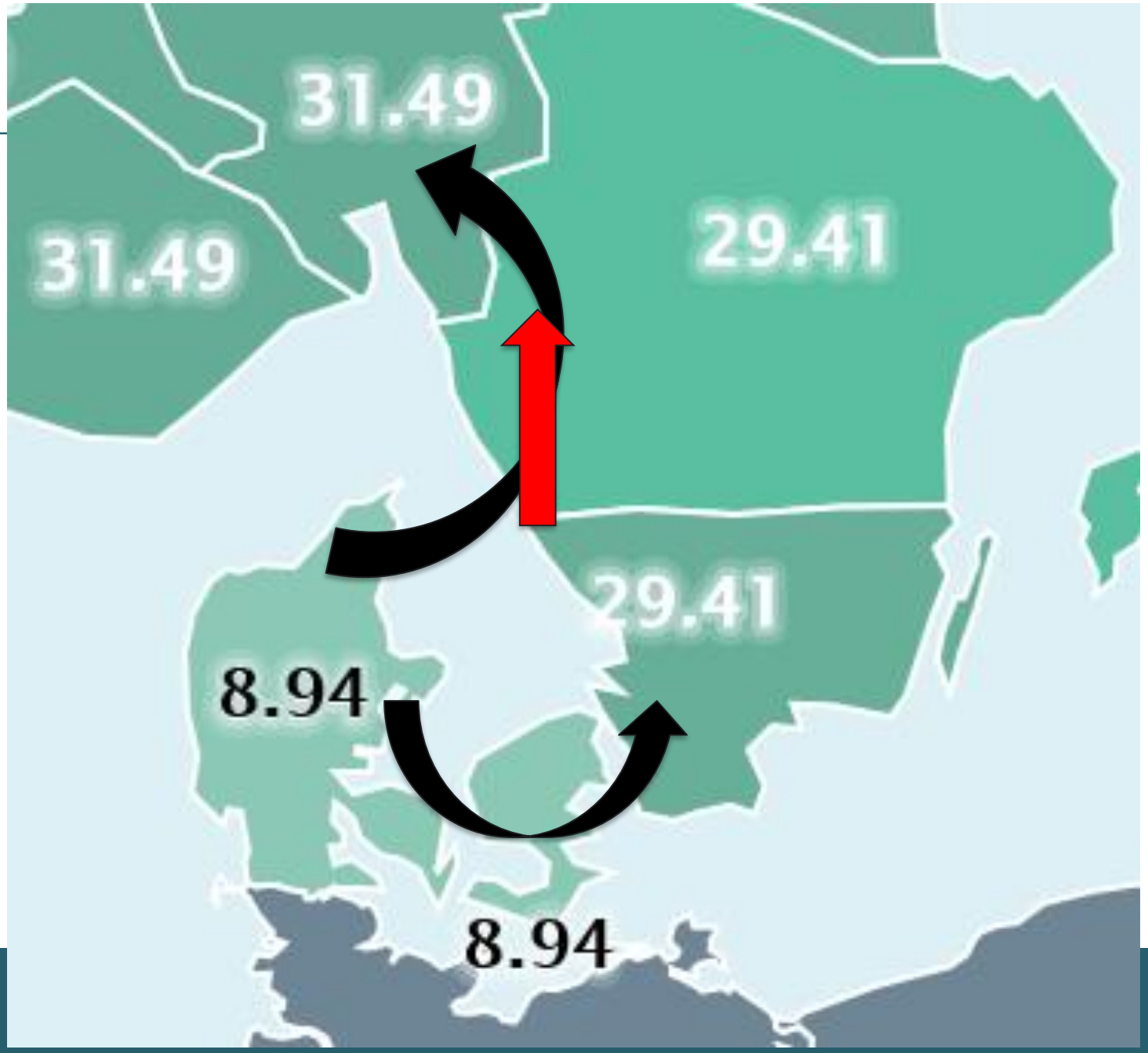
This happend i Austrailia

- Big storm from the south

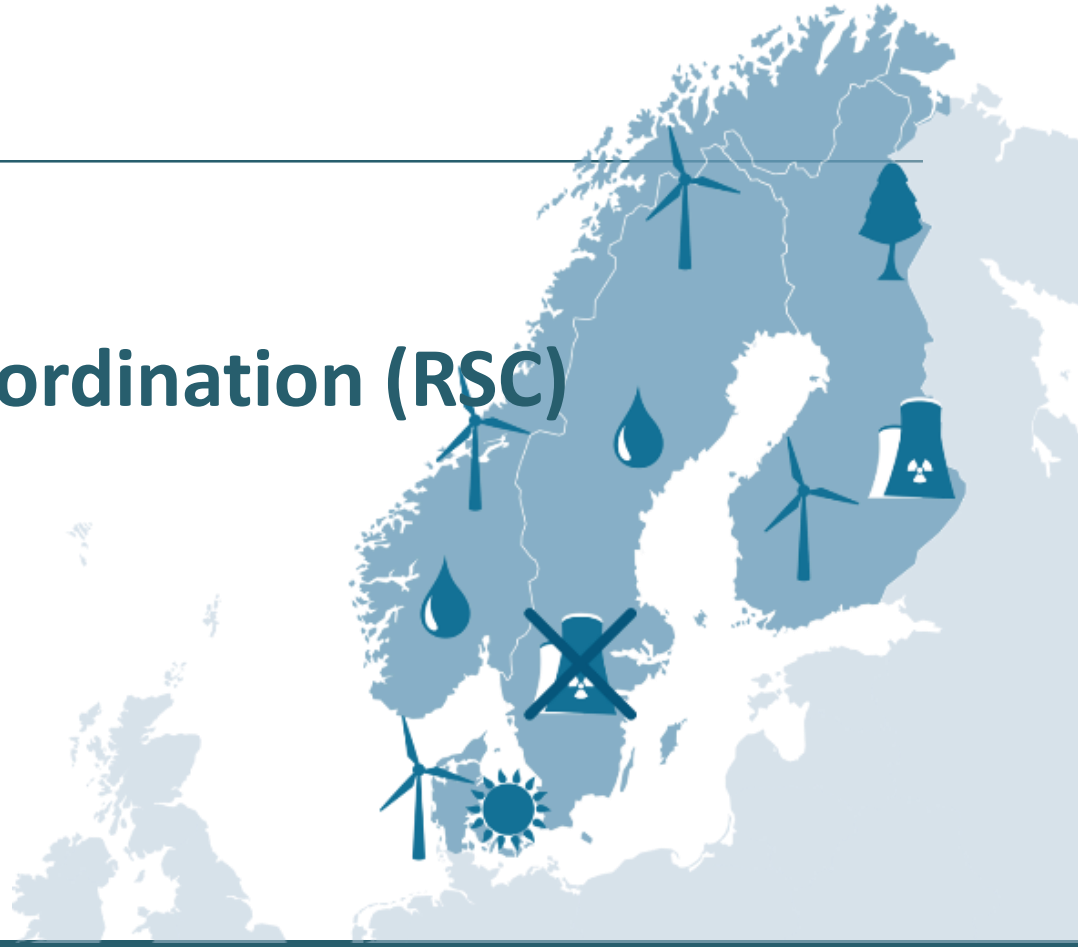
90 sekunds

Within ~~15 minutes~~.

1.One 275 kV line tripps
2.Second 275 kV line tripps
3. Windfarms rapid change 123 MW
4. Third 275 kV line tripps
5. Windfarms rapid change 192 MW
6. Overload of line and disconnection



Nordic office for system security coordination (RSC)



NORDIC RSC

FINGRID

Statnett

SVENSKA KRAFTNÄT

ENERGINET.DK

Jens Møller Birkebæk
Energinet.dk

Need for data analysis – when

«Det er inom driftsäkerhetsområdet som de store framtidiga problemener kommer at finnas»

«Detta ställer helt andra krav på datainsamling och programvara än vad vi hittils varat vana til. Först när vi har dette instrument i drift kan vi påstå at vi har tilfredsstillende kontroll på kraftsystemet ur säkerhets-synspunkt»

Need for data analysis – 1973

«Det er inom driftsäkerhetsområdet som de store framtidiga problemener kommer at finnas»

«Detta ställer helt andra krav på datainsamling och programvara än vad vi hittils varat vana til. Först när vi har dette instrument i drift kan vi påstå at vi har tilfredsstillende kontroll på kraftsystemet ur säkerhets-synspunkt»

Source: ”Elkraftsamarbete i Norden”, 1973

Nordic RSC Joint Office

Nordic RSC – Joint Office (RSC: Regional Security Coordination)

Intentions:

1. European Network Code implementation
2. Enhanced Nordic Power System Cooperation

Purpose:

Support the Nordic TSO´s in two key focus areas:

1. Security of Supply in the Nordic Area
2. Optimize the availability of the Green Nordic Power Grid

NORDIC RSC

FINGRID

Statnett

SVENSKA KRAFTNÄT

ENERGINET/DK

Nordic Cooperation - historical

1915	Øresund 25kV
…	
1963	Nordel
1965	Kontiskan 1
1975	Skagerak 1
1995	Nordic Power Market
2002	Nordpool Spot
…	
2005	Regulating Power market NOIS – Common TSO Information System
…	
2017	Nordic RSC - Joint Office

NORDIC RSC

FINGRID

Statnett

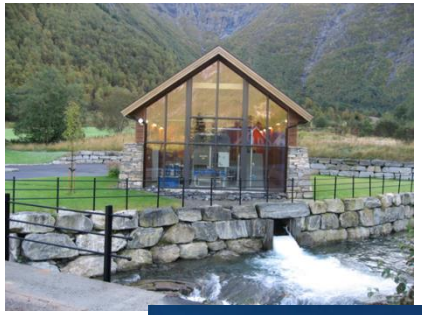
SVENSKA KRAFTNÄT

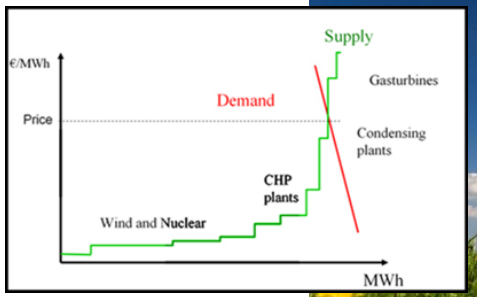
ENERGINET.DK

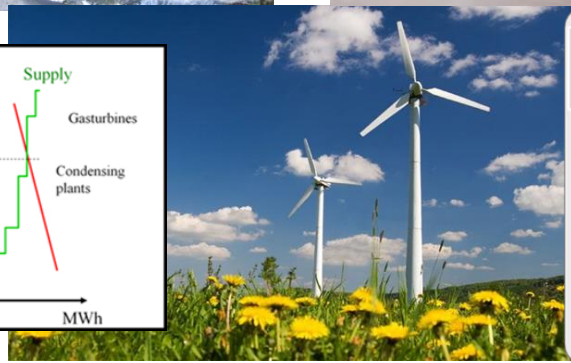
The Future is electric (Statnett)

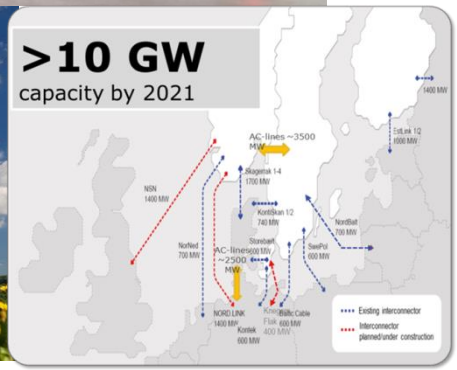
and:

- sustainable
- market based
- interconnected
- decentralized
- efficient
- digital
- regional
- ?







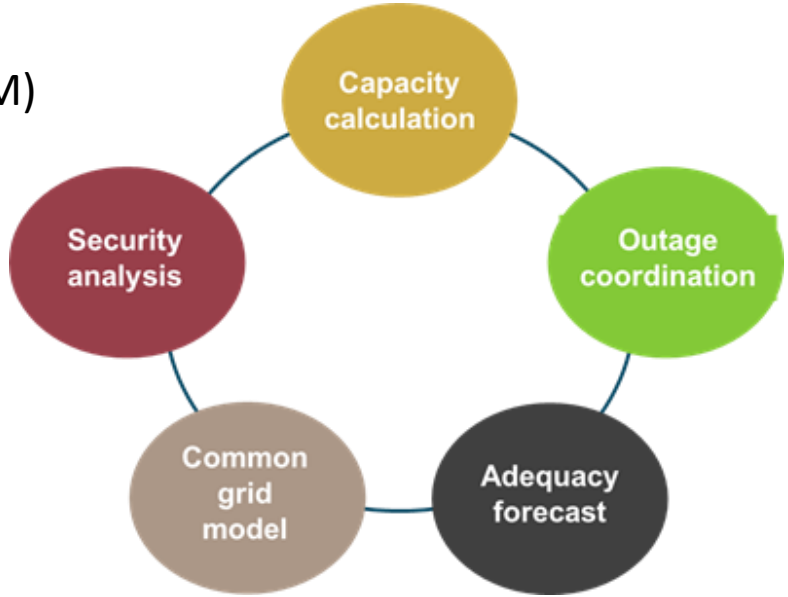


No electricity – nothing

Nordic Regional Security Coordination

Nordic RSC will deliver 5 services for the entire Nordic power system

1. Common Nordic data model in all timeframes (CGM)
2. Optimised capacity calculation
3. Common security analysis
4. Outage coordination
5. Short and medium term adequacy analysis



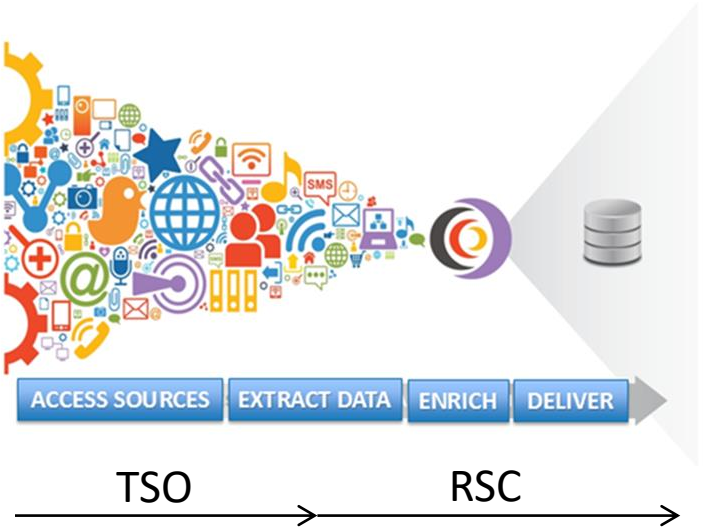
Nordic co-operation to a next level

Modern IT technology and data communication systems.

Data model for the Common Nordic Power system.(CGM)

Big Data analysis to optimize operational planning.

Operating the grid closer to its capability limits without sacrificing security of supply in the region

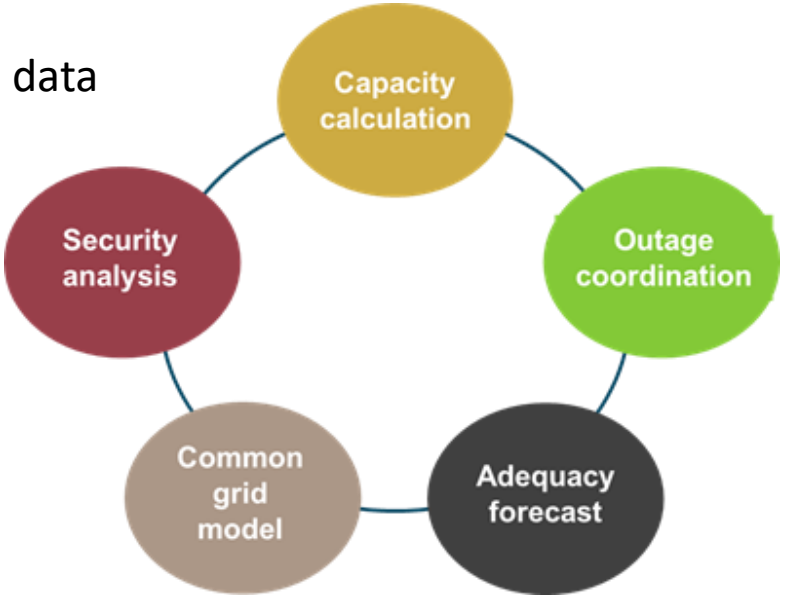


Nordic Regional Security Coordination

- Service center for secure and optimal operational planning

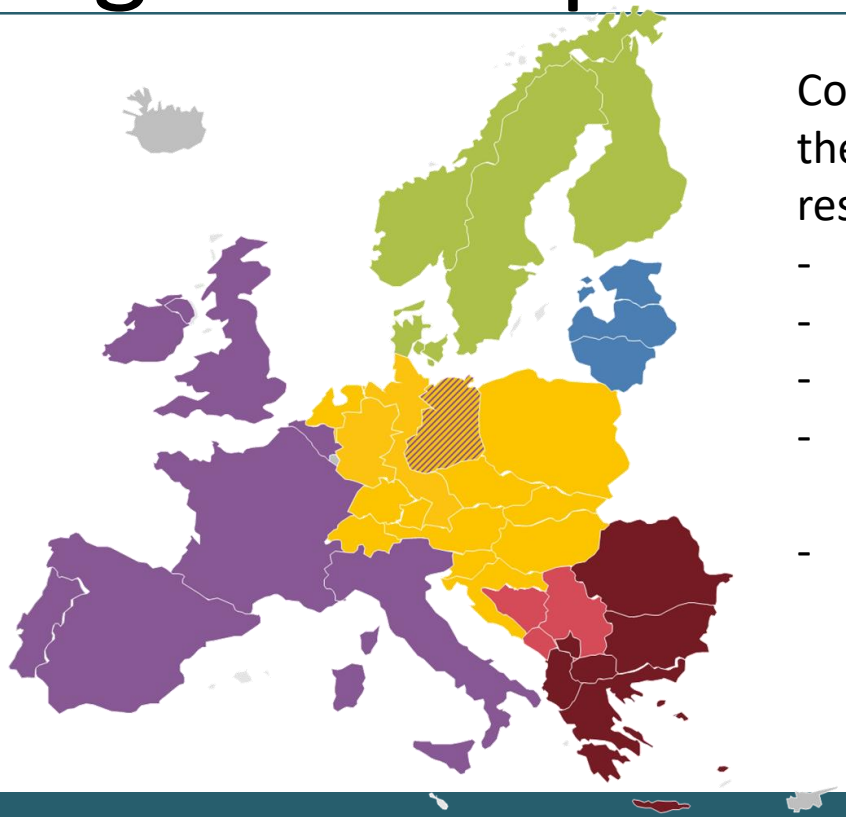
- Analysis og calculations based on Power system data for the entire Nordic region
  - Capacity calculations and -optimization
  - Security calculations
  - Outage coordinations and -optimisation
  - Production generation availability

- Responsibility for SoS and real-time operation remains with the National Control Centers



The regional map of Europe

Coreso
TSCNet
SCC
Nordic RSC
Baltic RSC
SEE RSC
TBC or N/A

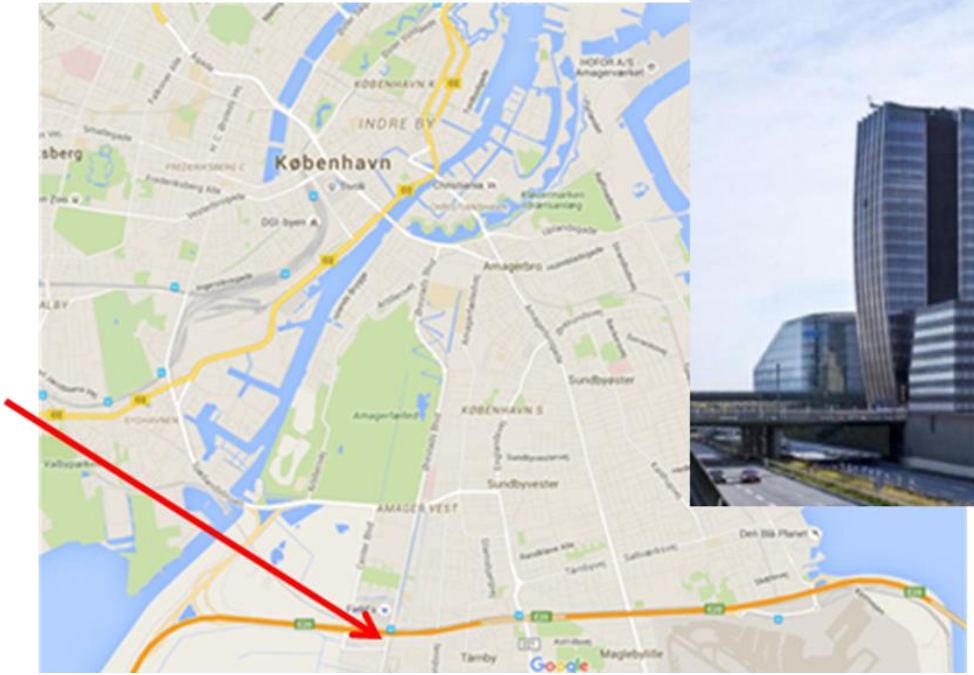


Coordination between the regions is an RSC/RSC responsibility

- Capacity
- Security
- Outage
- Adequacy

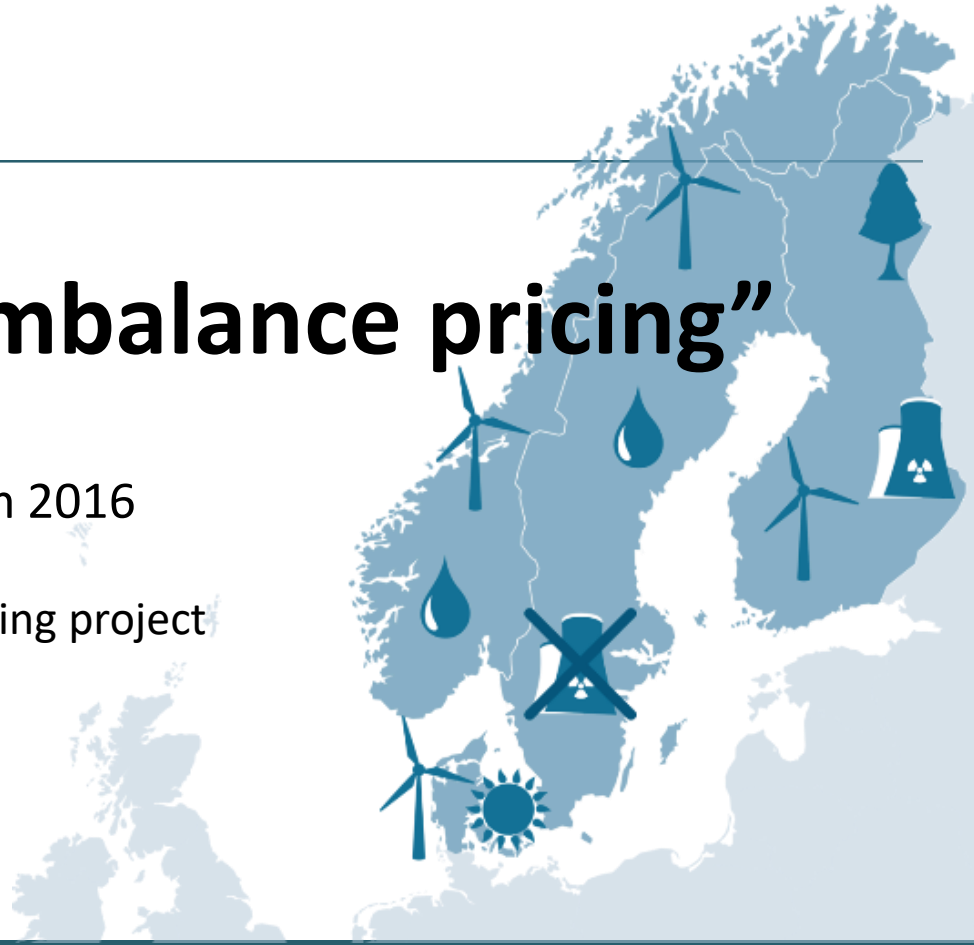
- Remedial actions to improve security and capacity

Nordic RSC - Joint Office in Cph.



Fully operational from Dec. 2017

“The future of Imbalance pricing”



Nordic System Operation Forum 2016

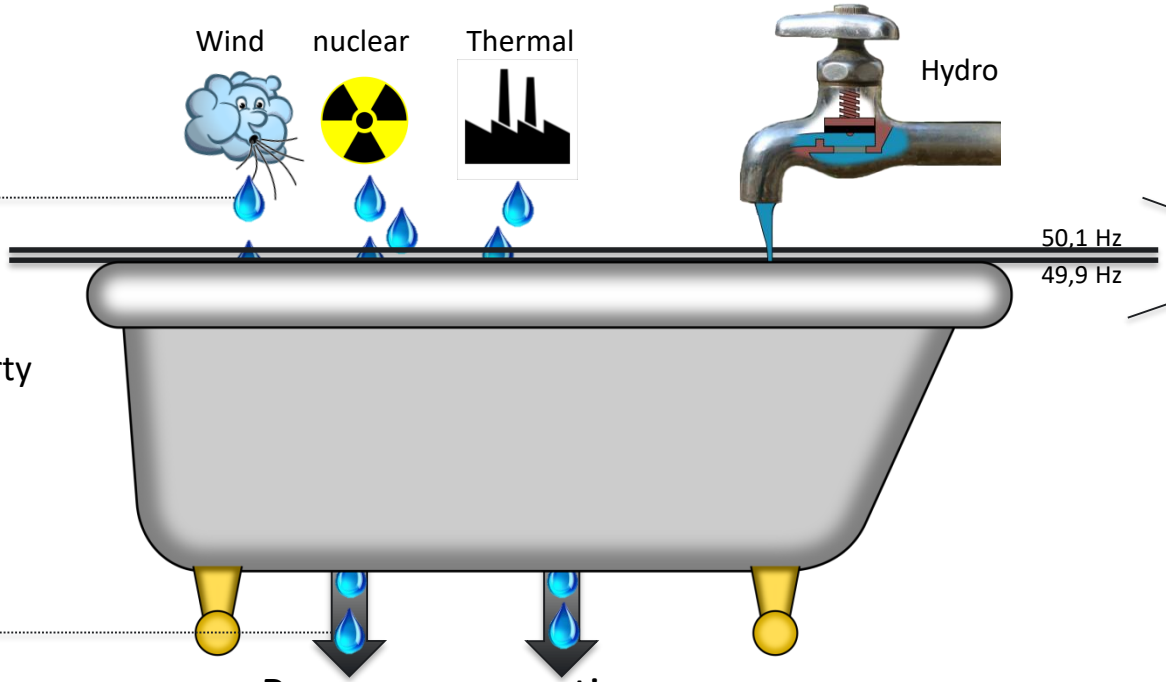
Presentation of the full cost balancing project
By Martin Møller, Energinet.dk

1st December 2016

Statnett FINGRID ENERGINET.DK SVENSKA KRAFTNÄT

Is todays imbalance pricing fit for the future balancing market, dominated with more intermittent production and a 15 min ISP ?

Balancing the Nordic Power system anno 2016



BRP

Balance Responsible Party
Input = output
Average over 60 min

TSO

- mFRR
- FCR-N
- (aFRR)

The system is balanced using three different markets

Day-a-head

GCT: 12-36 hours
Sold Volume 2015:
355.000 GWh (98%)

Intraday

GCT: 60 min
Sold Volume 2015:
4.000 GWh (1%)

Balancing Market

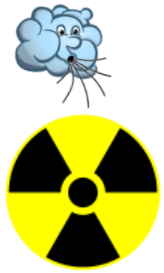
- mFRR
- FCR-N
- (aFRR)

GCT: 45 min
Activated Volume 2015*:
3.600 GWh (1%)

*Note: *The volume is the total activated volumes from both mFRR, aFRR and FCR-N. The GCT of 45 min only applies for mFRR*

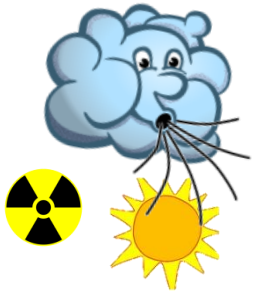
The Nordic Power System is changing

Today



More intermittent production

Tomorrow



Do we have the right toolbox for tomorrow?

Potential toolbox improvements

- More aFRR
- other products
- Reduced imbalance settlement period, from 60 min to 15 min
- Incentives for BRP's due to single/dual pricing/publication of information
- Common EU Balancing Market, via the Balancing Guideline

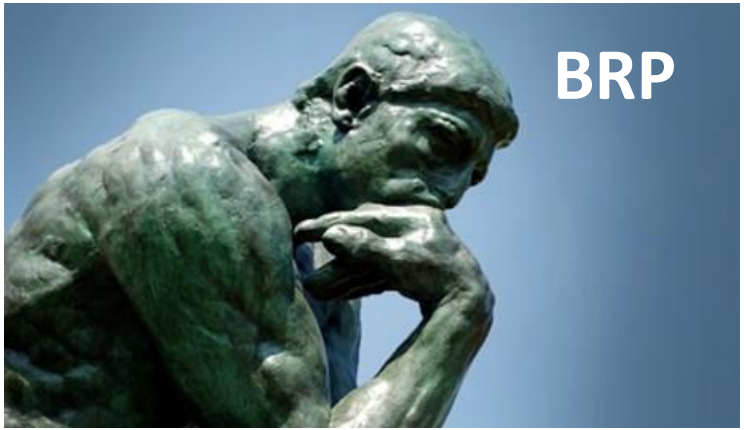
Who has to pay for the toolbox?

Today the cost of using the toolbox are partly covered by the **imbalance price** according to the polluter pays principles and the rest is re-claimed via various degree of socialisation

BRP

The overall question that the project will like to answer is:
If the new toolbox requires an updated methodology for calculating and applying the imbalance price ?

Imbalance settlement drives the business of BRP's

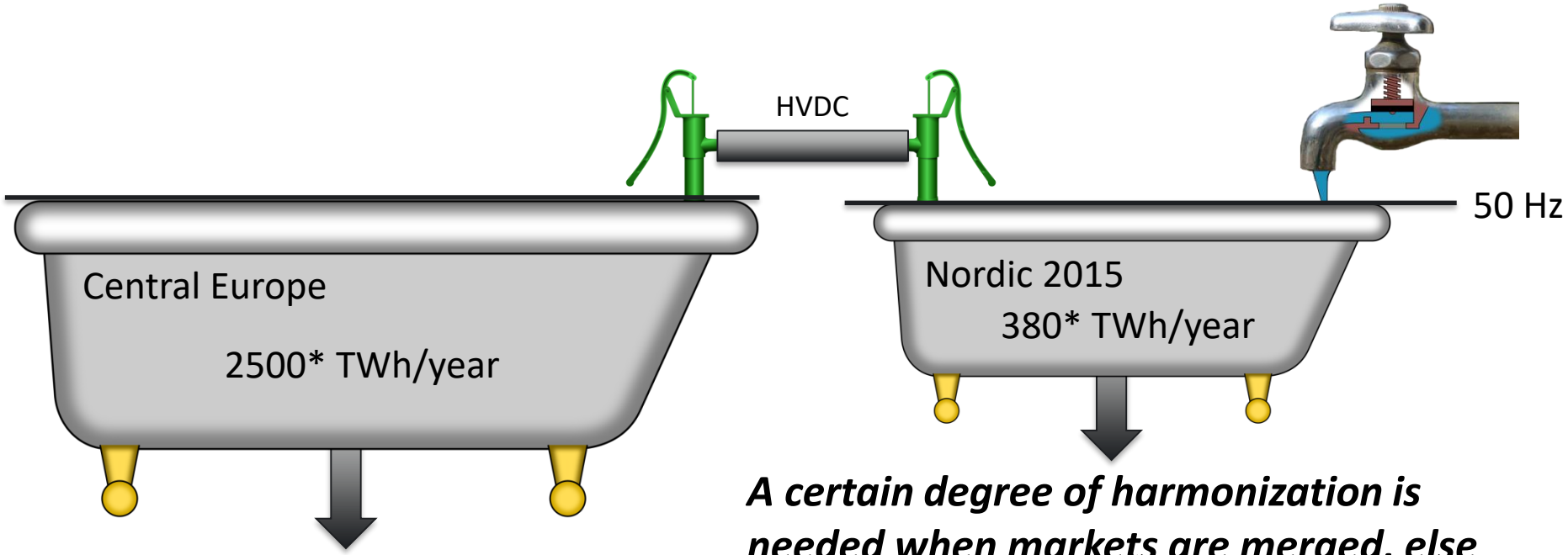


How can I maximize my overall profit by forecasting, trading and adjusting my position?

BRP's are financial responsible for any imbalances, but can up-front hedge the risk via a fixed price in the intraday

Imbalance price will be one of the most important tools in the energy only market

The Nordic Power System is connected to a bigger system and imbalance pricing needs to be somewhat harmonized in EU



A certain degree of harmonization is needed when markets are merged, else there will not be a level playing field

*Note: *ENTSO-E statistical factsheet 2015, consumption figures*

The future toolbox are influenced by European decisions

We do not know the toolbox of tomorrow – but already today we have a good guess

In 2018 the Balancing Guideline will have entered into force and will at least require

- Creation of a pan European market for Frequency Restauration Reserves (mFRR & aFRR)
- Harmonization of main principles for imbalance settlement (All TSO decision in 2018)
- Harmonization of Imbalance Settlement Period to 15 min in (2019-2022-???)

Hence we need to launch this project now in order to prepare our self for the upcoming European discussions in order to secure Nordic influence.

The Project will focus on reviewing the rules for calculating the BRP imbalance price in order to:

- Give incentives, information and price signals to BRPs leading to socio-economic efficient balancing of the future Nordic energy system
- Ensure that prices of relevant balancing products in the future, are reflected appropriately in the imbalance price
- Improve the market based transition into a highly efficient and secure green Nordic power system.
- Establishing arguments that can be used to influence the all TSO decisions on harmonizing the main principles for calculating the imbalance settlement price in the EB GL discussions.

Early learnings and reflections

The following slides are not project conclusions – but illustrates some of the discussions that we will have in the project

Understanding the difference between BSPs and BRPs as being introduced by the Balancing Guideline

BSP: Balancing Service Provider, provides bids to the TSO, and are activated if their offer is attractive. The TSO pays the BSP for the activated energy / procured capacity.

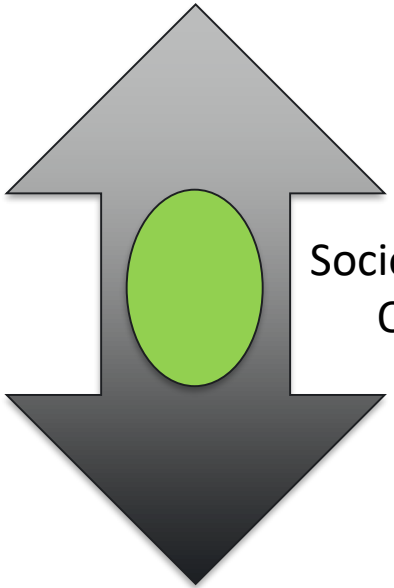
BRP: Balancing Responsible Party submit it's consumption, production and trading plans to the TSO, and are financial responsible for any deviations, and pays/recieves the imbalance price

Cash-flow

The BSP will receive money for the service supplied to the TSO.
The BRP will pay/receive the imbalance price if his realised position is either short or long

The imbalance price can be too high or too low

High imbalance Prices



Socio-economic Optimum

Low imbalance Prices

BRP's may withhold capacity for the market, in order to protect them self for high imbalance cost (self-balancing)

The imbalance price has to reflect the real-time value of energy
(The cost/savings for the next MWh)

BRP's are not incentivised to make good forecast and trade them into balance – consequence is high system imbalances

Potential de-link the settlement between BSP's and BRP's

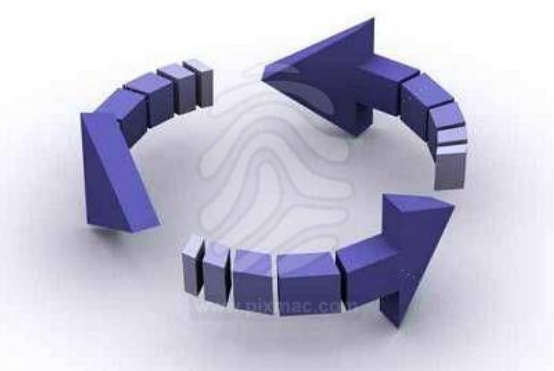
During the last 10 years the imbalance price has been equal to the marginal price of the manual regulating power price – hence only one common price between TSO-BRP and TSO-BSP

In the future the TSO might use different products from different merit order lists

- There can be several prices for BSP's depending on the products they deliver
- There will only be one price for BRP's depending on their imbalances

Imbalance Settlement Period: 60 Vs 15 min

Imbalance Settlement Price drives the BRP behaviour, and the BRP behaviour influence the imbalance settlement price



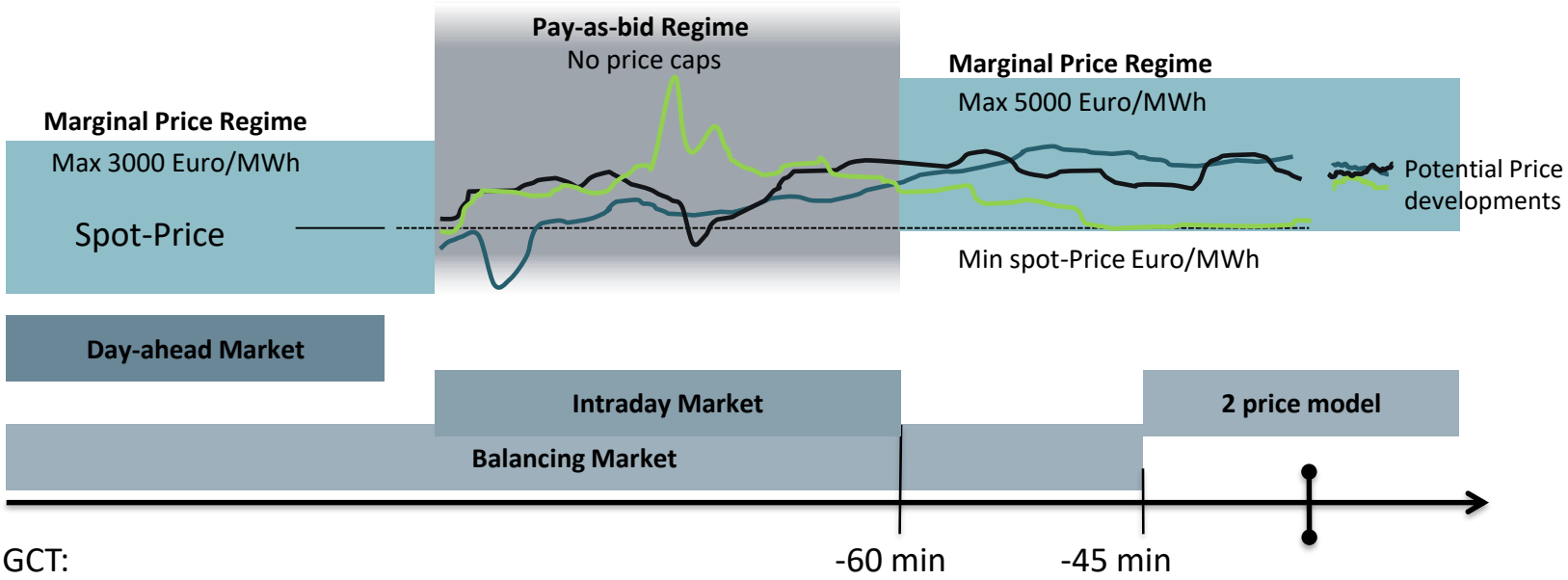
When discussing pros and cons for issues like

- Single/duel pricing
- If aFRR shall be part of the imbalance price
- When to publish prices, etc.

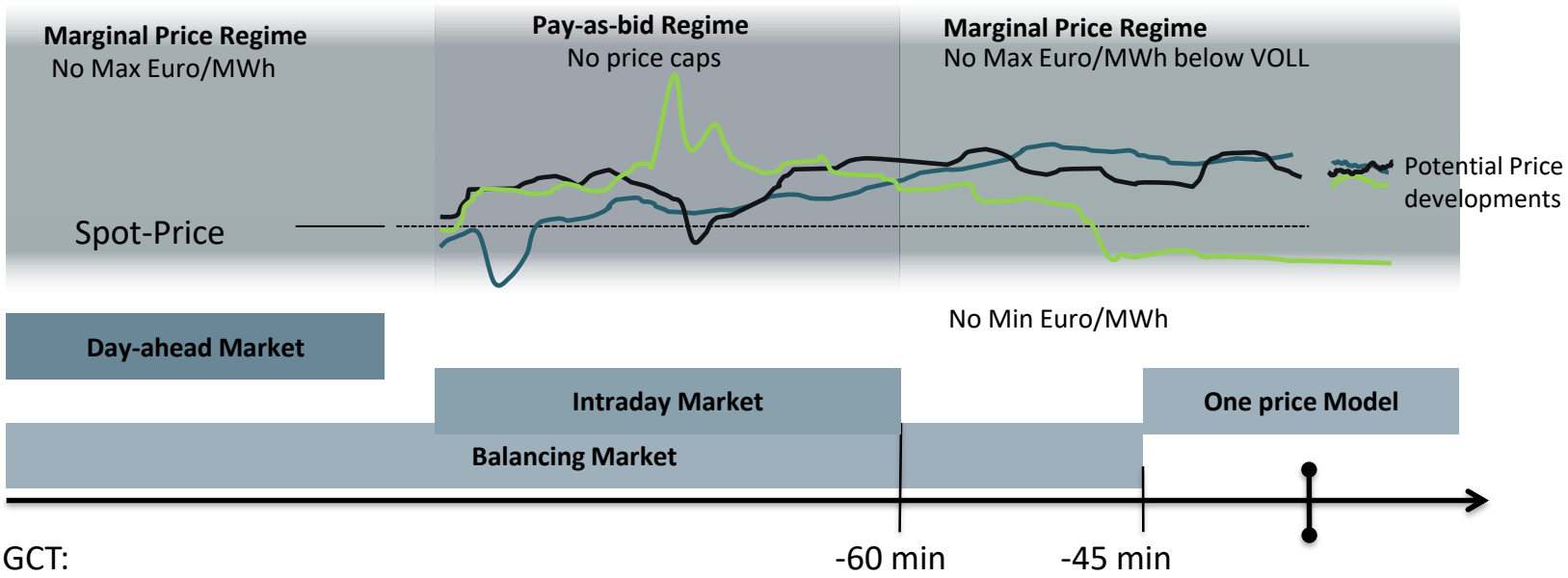
The answer depends on the length of the Settlement Period

In our discussion we will assume that a 15 min. settlement period has been decided

Todays price developments



Potential market design, Energy only with no price caps, but with a reference to Value of Lost Load (VOLL)



Will an eventual removal of price caps give the right incentives fro BRP’s and BSP’s ?

For

- BRP’s to make good forecast, plans and keep their balance – because of the risk of a high imbalance price (This can reduce the relative final balancing needs)

- BSP’s to identify all flexibility and offer that to the market, so more volumes will be available in the balancing market

We started with a question 20 min ago

Is todays imbalance pricing fit for the future balancing market, dominated with more intermittent production and a 15 min ISP ?

- **We conclude that the Imbalance pricing needs a service check**
- **But we don't have a solution ready – hence the project**

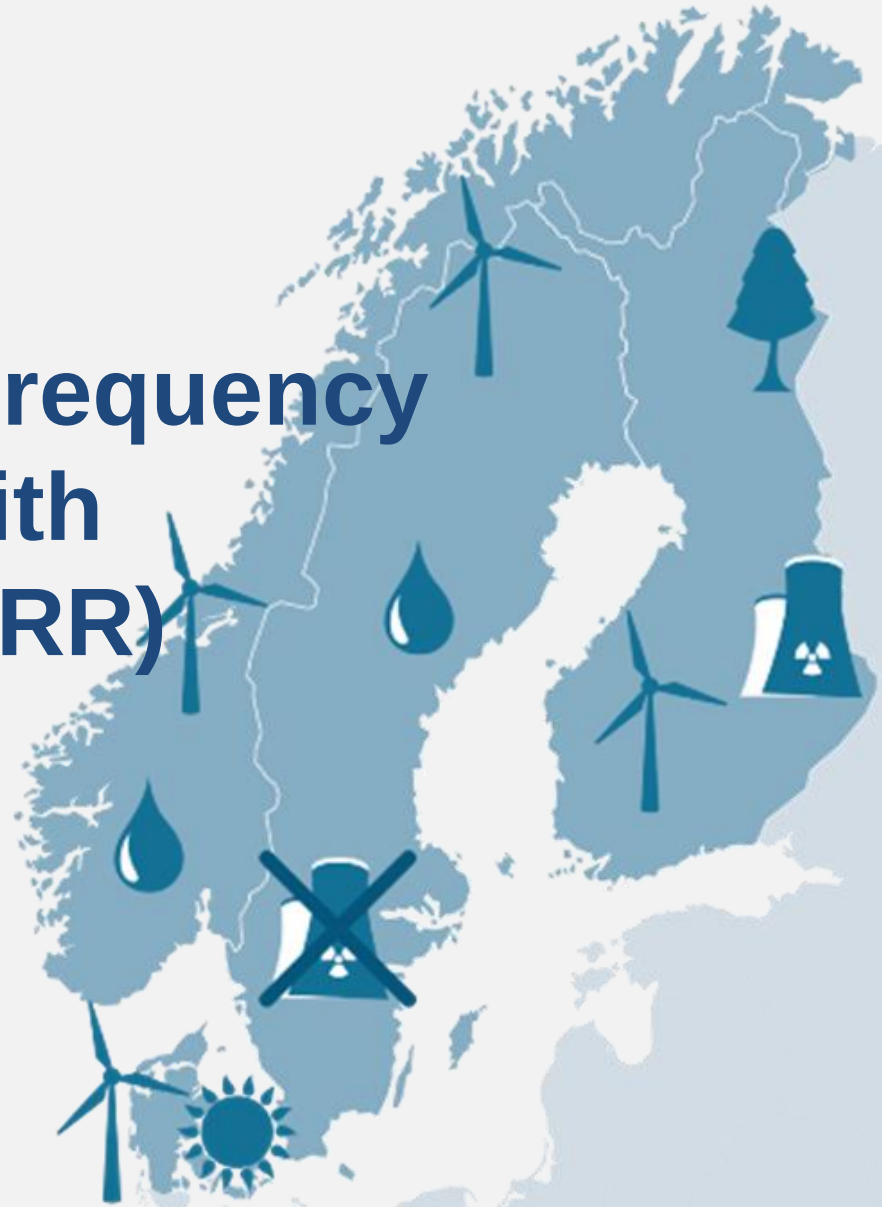
And we also know that you will be involved

Challenges and opportunities
for the Nordic power system

Statnett FINGRID ENERGINET.DK SVENSKA KRAFTNÄT SWEDISH NATIONAL GRID

Thank you for your attention

New Nordic Market for Frequency Restoration Reserves with automatic activation (aFRR)



System Operation Forum

1. December 2016

Jens Møller Birkebæk, Energinet.dk

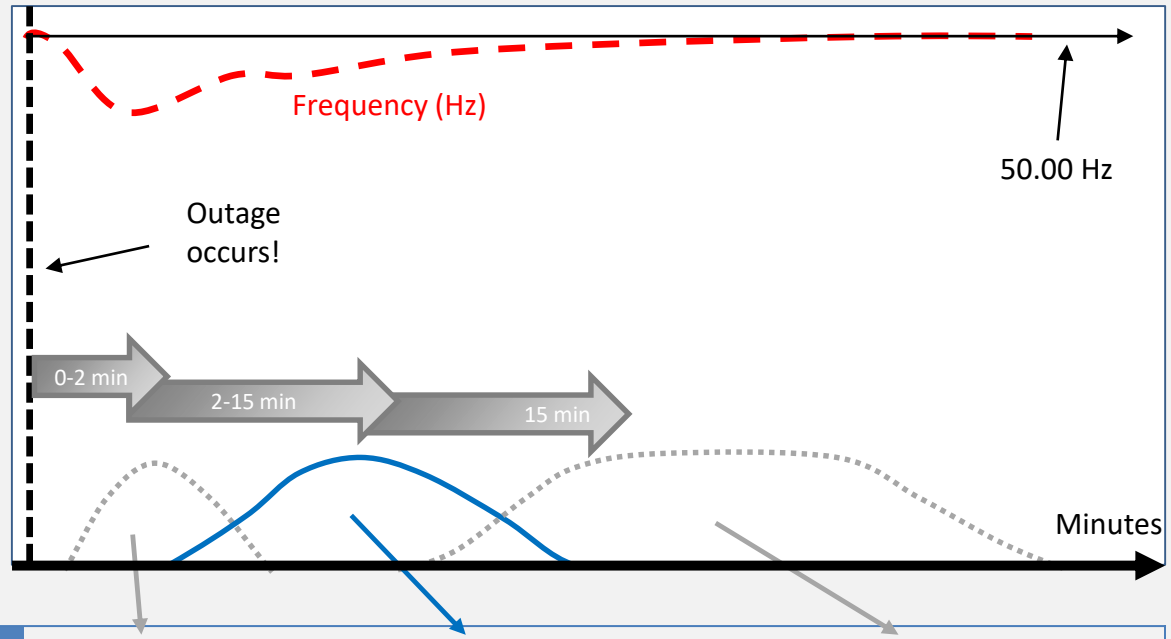
aFRR Capacity Market: Now in implementation

What do you think about … aFRR?

Balancing products in the Nordic synchronous area

The three main products to balance the system in the Nordic synchronous area :

- FCR (Frequency Containment Reserves)
  - FCR-D and FCR-N
- **aFRR (Automatic Frequency Restoration Reserves)**
- mFRR (Manual Frequency Restoration Reserves)



Product ->	FCR	**aFRR**	mFRR
Objective	Stabilize frequency	**Restore frequency to 50 Hz**	Replace FCR and aFRR Congestion management
Controller location	Decentralised at plant	**Centralized at TSO's control center**	Manually instructed by TSO to reserve provider
Controller parameter	Frequency (Hz)	**Frequency (Hz)**	Imbalance (MW)

The 4 products differ in response time, objective, and how they are controlled and quantified.

aFRR Capacity Market: General description

Current aFRR market

- National procurement in non-harmonised market design
- National volume obligation based on consumption shares

New Nordic aFRR market

- Common Nordic daily auction
- Geographical volume distribution based on historic (y-1) imbalance in bidding zones
- Bid optimisation with cross-bidding-zone capacity reservation
- Cost sharing between countries based on “polluter pays” principle

New Nordic aFRR Market

An innovative regional market solution

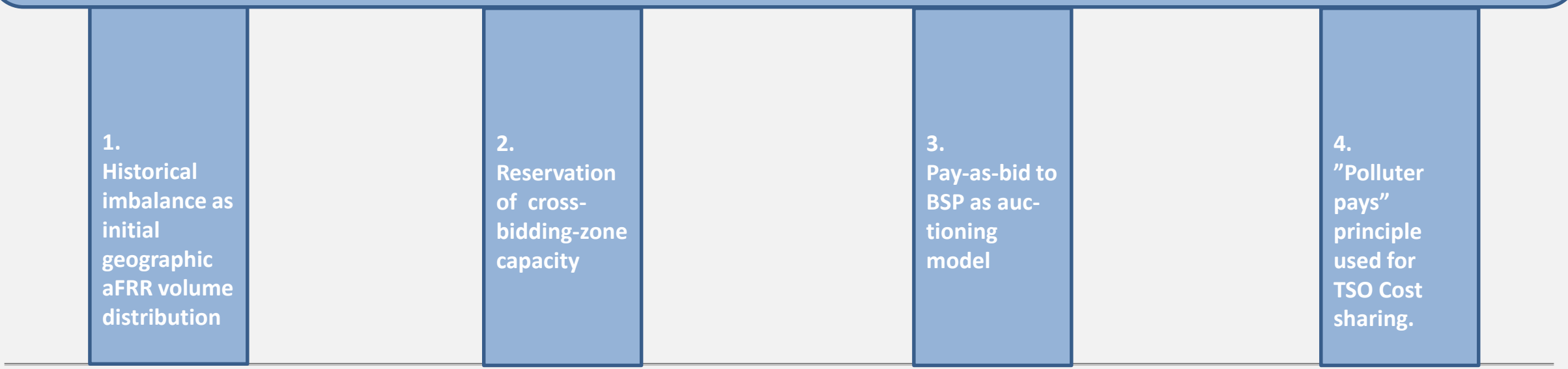
Key elements in the Nordic aFRR Market:

1. An attractive Nordic socio-economic solution
2. A market model reflecting the physical realities
3. A fair cost-sharing solution between countries

New Nordic aFRR Capacity Market

An innovative regional market solution

The Nordic aFRR Market design and Agreement - four interdependent pillars



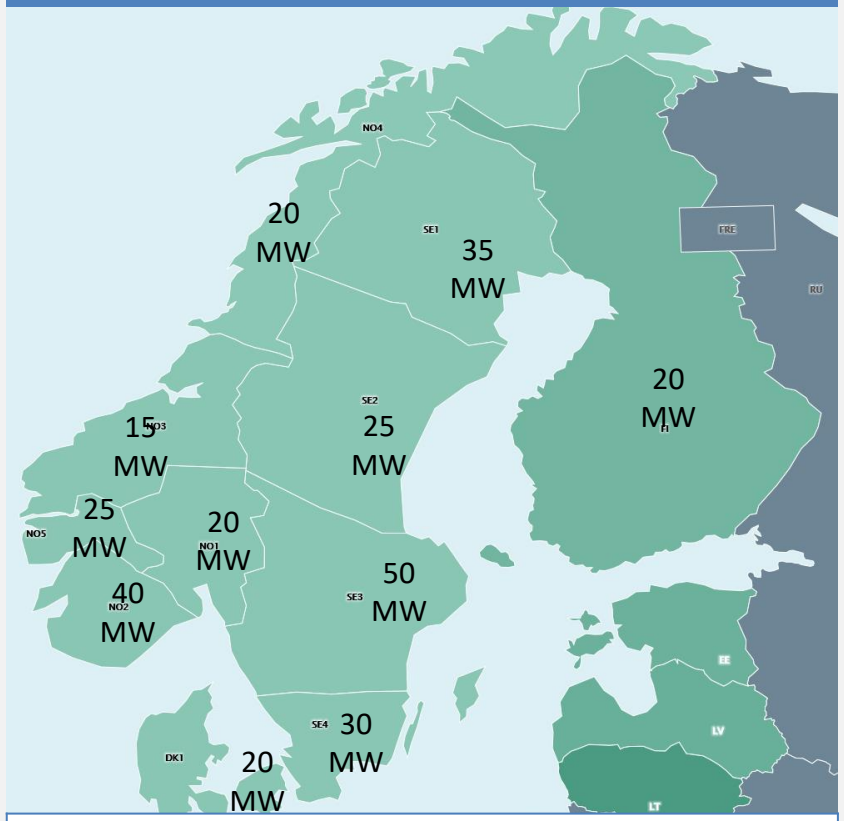
ENERGINET.DK SVENSKA KRAFTNÄT FINGRID Statnett

Pillar 1. Initial geographical distribution of contracted aFRR capacity

The need for aFRR is distributed and the available transmission capacity is finite.

- The Initial Geographic Distribution is defined as the total amount of aFRR Balancing Capacity to be procured and allocated among the Bidding Zones so as to minimise the risk of cross-zonal Congestion when aFRR Balancing resources are fully activated
- If capacity is to be allocated outside of the restriction determined by the initial geographical distribution, cross zonal capacity (CZC) needs to be ensured beforehand by applying prepared congestion management measures
- The initial geographical distribution is the starting point for the bid selection

Example of initial geographical distribution for upward regulation for 2014 and 300 MW



MW	DK2	FI	NO1	NO2	NO3	NO4	NO5	SE1	SE2	SE3	SE4	Total
Up	20	20	20	40	15	20	25	35	25	50	30	300
Down	20	30	20	35	10	20	20	35	25	50	35	300

ENERGINET.DK SVENSKA KRAFTNÄT FINGRID Statnett

Pillar 2. Reservation of interconnector capacity

Rationale

- In order to ensure that the aFRR capacity is available for activation, there must be sufficient Cross zonal capacity (CZC) between bidding zones
- CZC reservation for balancing reserves is foreseen in the new Electricity Balancing Guideline (Article 43) if this is proven socioeconomically beneficial
- The reservation method is considered conservative (”less reservation, beneficial for the spot market”) and takes expected price differences and flow direction into account
- The Hasle pilot was used for socioeconomic assessment in the design phase

Rules for CZC reservation

- CZC for aFRR might be reserved on all borders. Possible counter trade solutions will be the exception to the rule
- Reservation of CZC for aFRR will be made in both directions
  - With an up-lift (“penalty cost”) in the flow direction
  - Without an up-lift in the opposite direction
- Reservations will be based on a socioeconomic calculations
  - Based on forecasted value of CZC for the day-ahead market and actual aFRR capacity bids
  - Uplifts to the forecasted value of CZC are used to ensure a conservative estimation.

Pillar 4. Cost sharing for the aFRR Capacity Market

1. Short-term imbalance "pollution key" is calculated for previous year

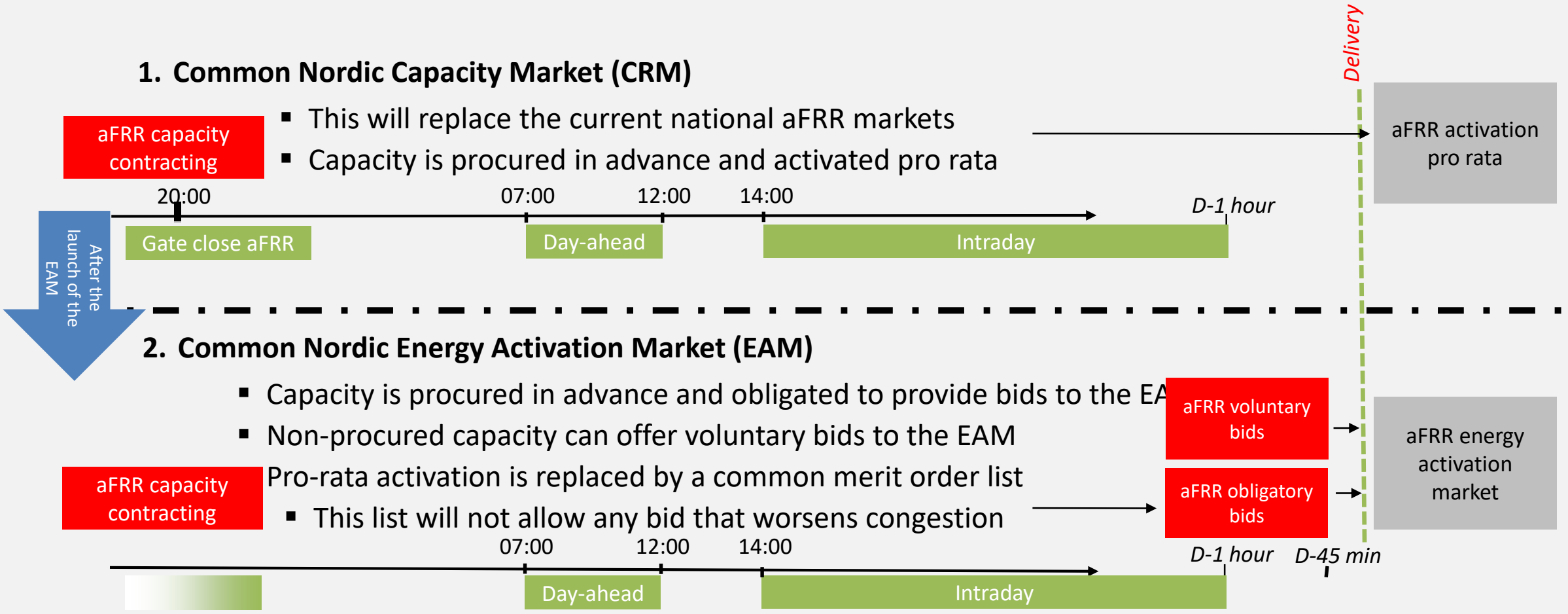
2. "Pollution key" used to calculate each TSO´s share of the procured capacity

3. Based on actual bid selection, costs are allocated so that the lowest cost bids are used nationally and the highest are exported. Importing TSOs pay the average export price

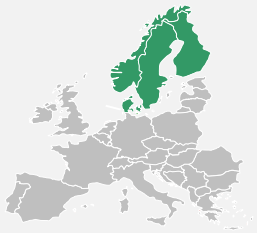
Cost sharing calculation

a. The share per bidding zone netted on TSO level is defined by the "pollution key".
b. Domestic demand is met by domestic bids (cheaper)
c. Exported bids are settled using the average unit cost for "imported capacity" (more expensive)

Model for aFRR in the Nordics in two steps

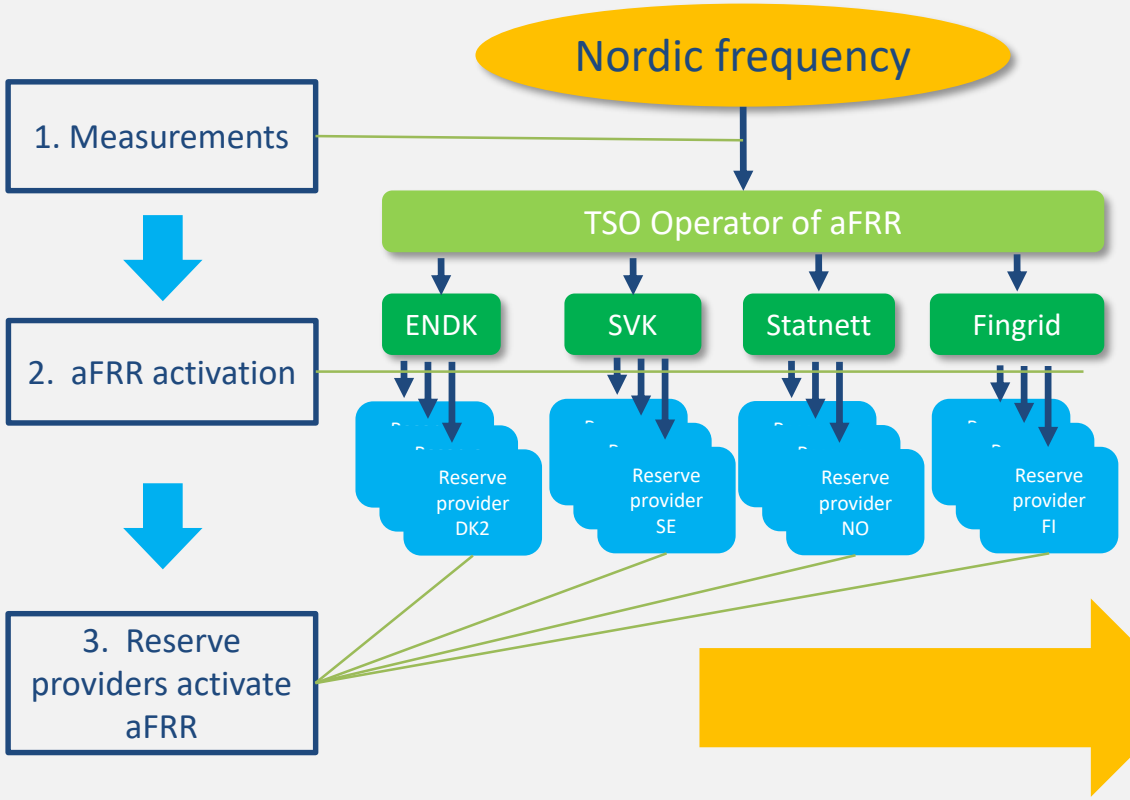


ENERGINET.DK SVENSKA KRAFTNÄT FINGRID Statnett



High-level overview of aFRR process:

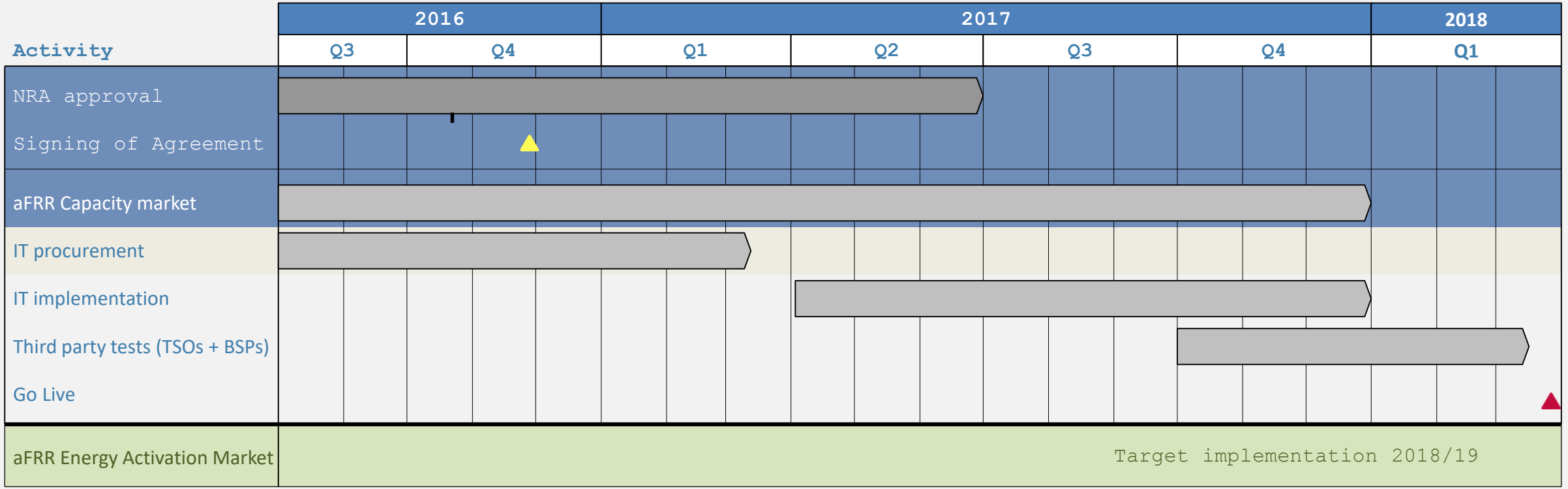
One operator, distributed activation of reserves



a. When activating aFRR there will be a bid selection process from a common merit order list.
b. Since there is need to take grid constraints into account real-time, the selected bid will be the most beneficial (cheapest available) bid both from a grid and economic perspective

ENERGINET.DK SVENSKA KRAFTNÄT FINGRID Statnett

Time plan (indicative)

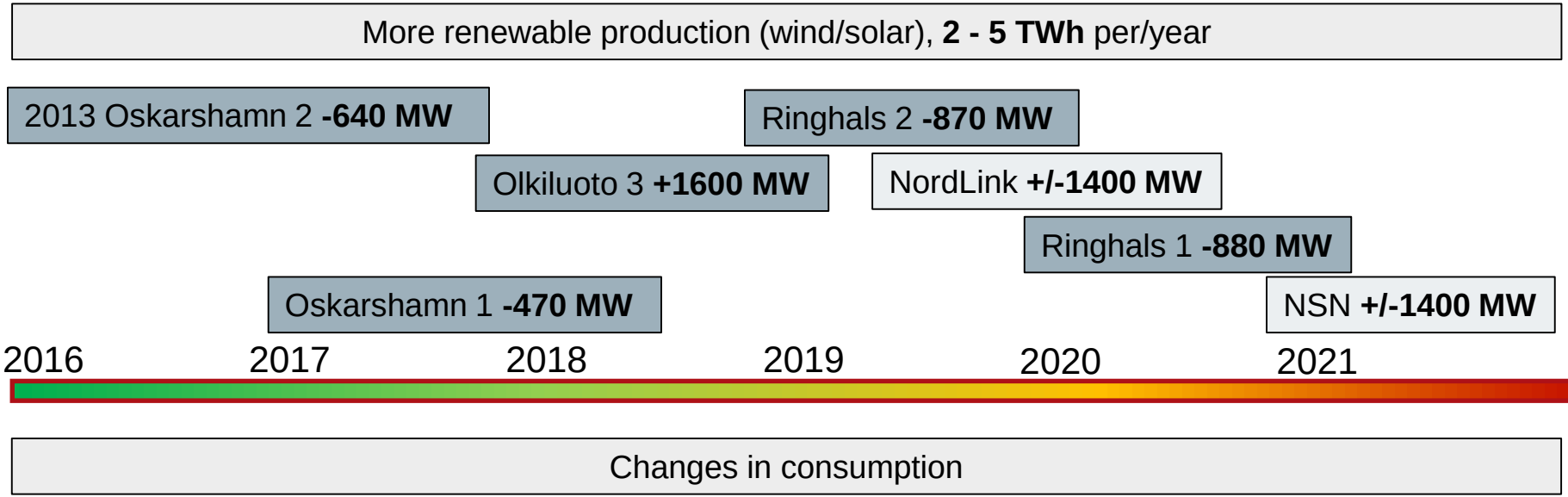


ENERGINET.DK SVENSKA KRAFTNÄT FINGRID Statnett

Frequency stability and new requirements for frequency containment reserves

Erik Alexander Jansson, Statnett
Nordic Analysis Group (NAG)

The system is changing



Nordic Analysis Group (NAG)

Effects on power system

- Larger units- big dimensioning faults
- Inertia decreases/inertia variance increases
- Issues related to frequency quality

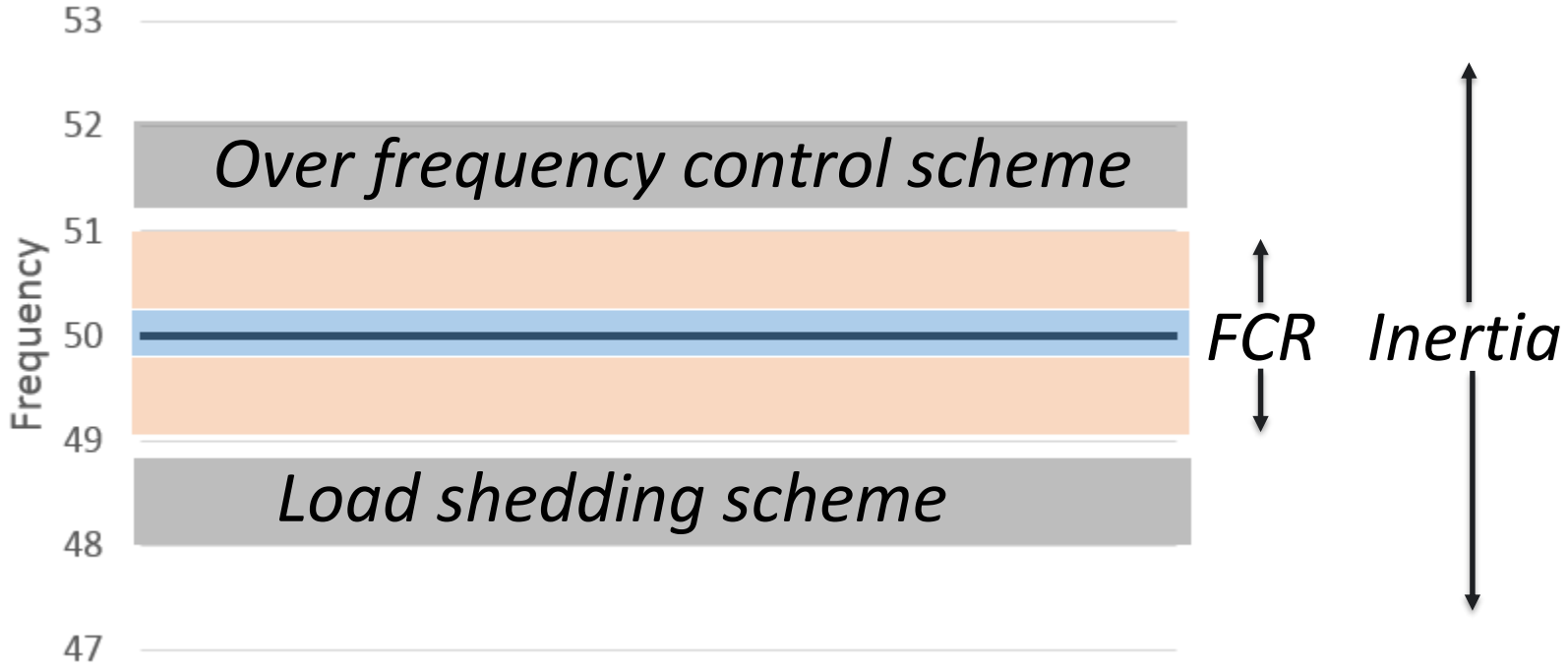
NAG focus

- Frequency quality
- Future Inertia
- Revision of the Nordic Frequency Containment Process

Frequency stability and performance

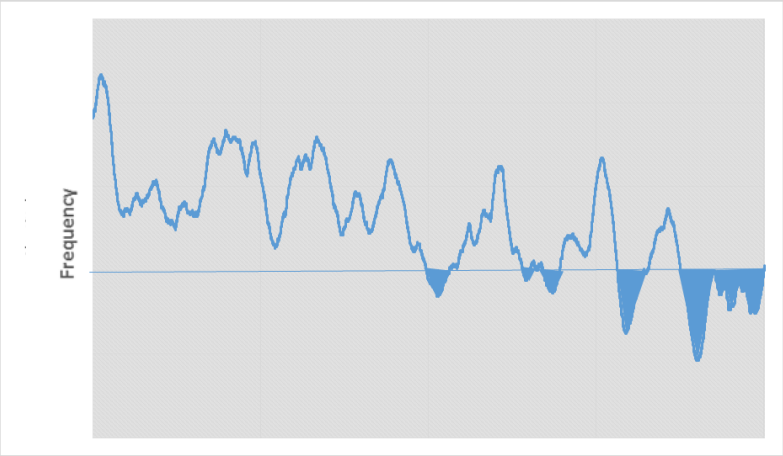
Pictures by Fingrid

Where are we?


53
52
51
50
49
48
47
Frequency
Over frequency control scheme
Load shedding scheme
FCR
Inertia

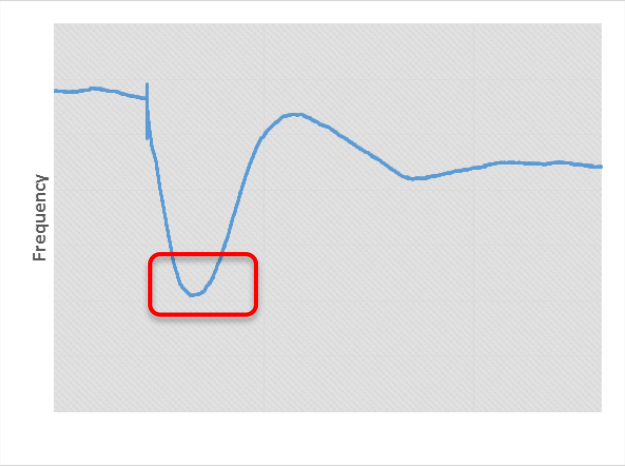
Frequency stability

Normal operation



Frequency oscillations

Disturbance

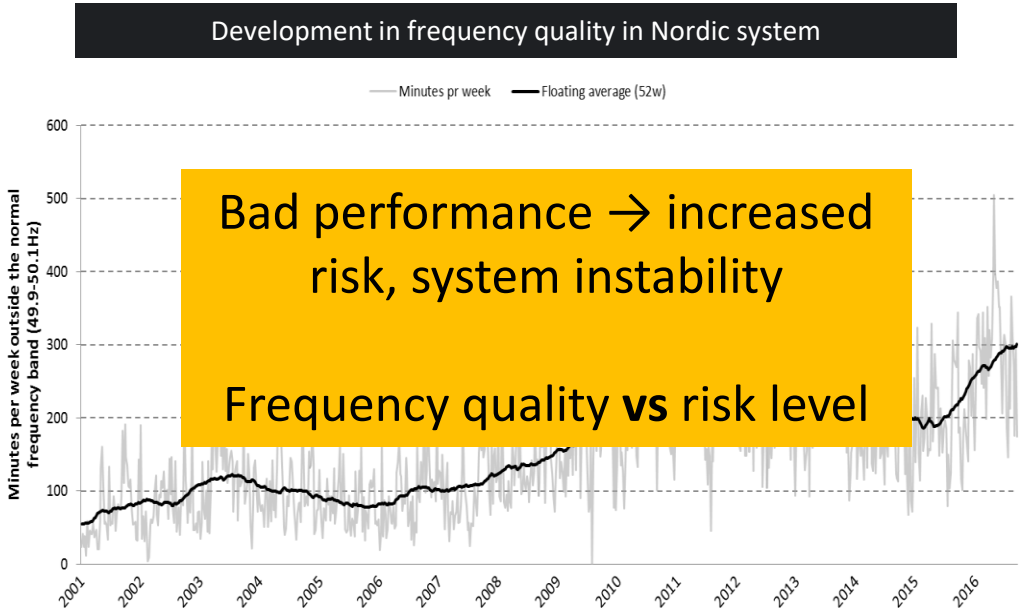


Severe frequency excursions

Frequency performance

How to handle normal imbalances in an efficient way?

Why do we need good performance?



System inertia- a key system factor

What is it? How do we measure it?

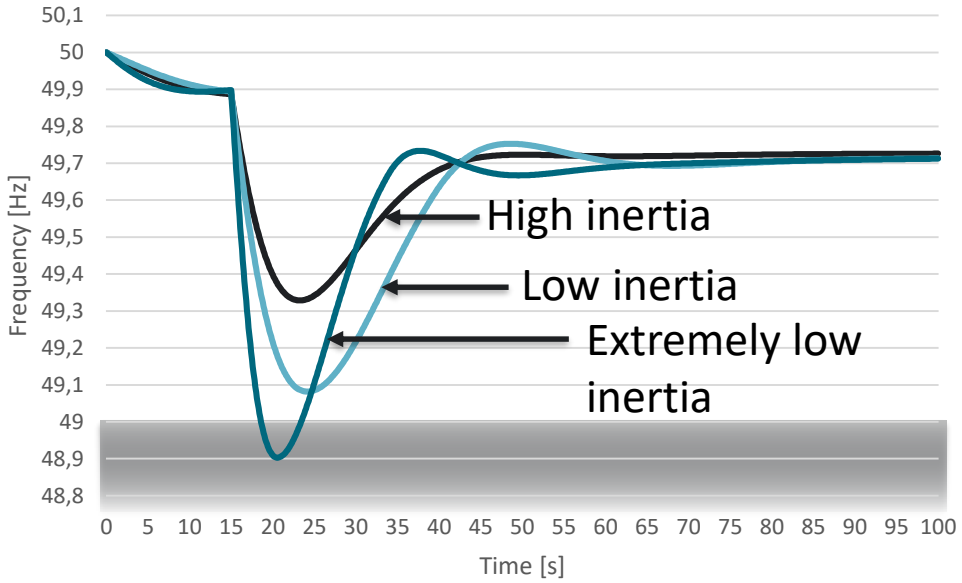
- *The ability of the power system to resist (fast) imbalances*
- *Consists of the contribution from all rotating elements* in the synchronous system*

inertia - system kinetic energy

System inertia

Low system inertia → increased risk for frequency instability during disturbance

*Disturbance = trip of **large** production unit or **HVDC**-connection* !



Measures to handle low inertia

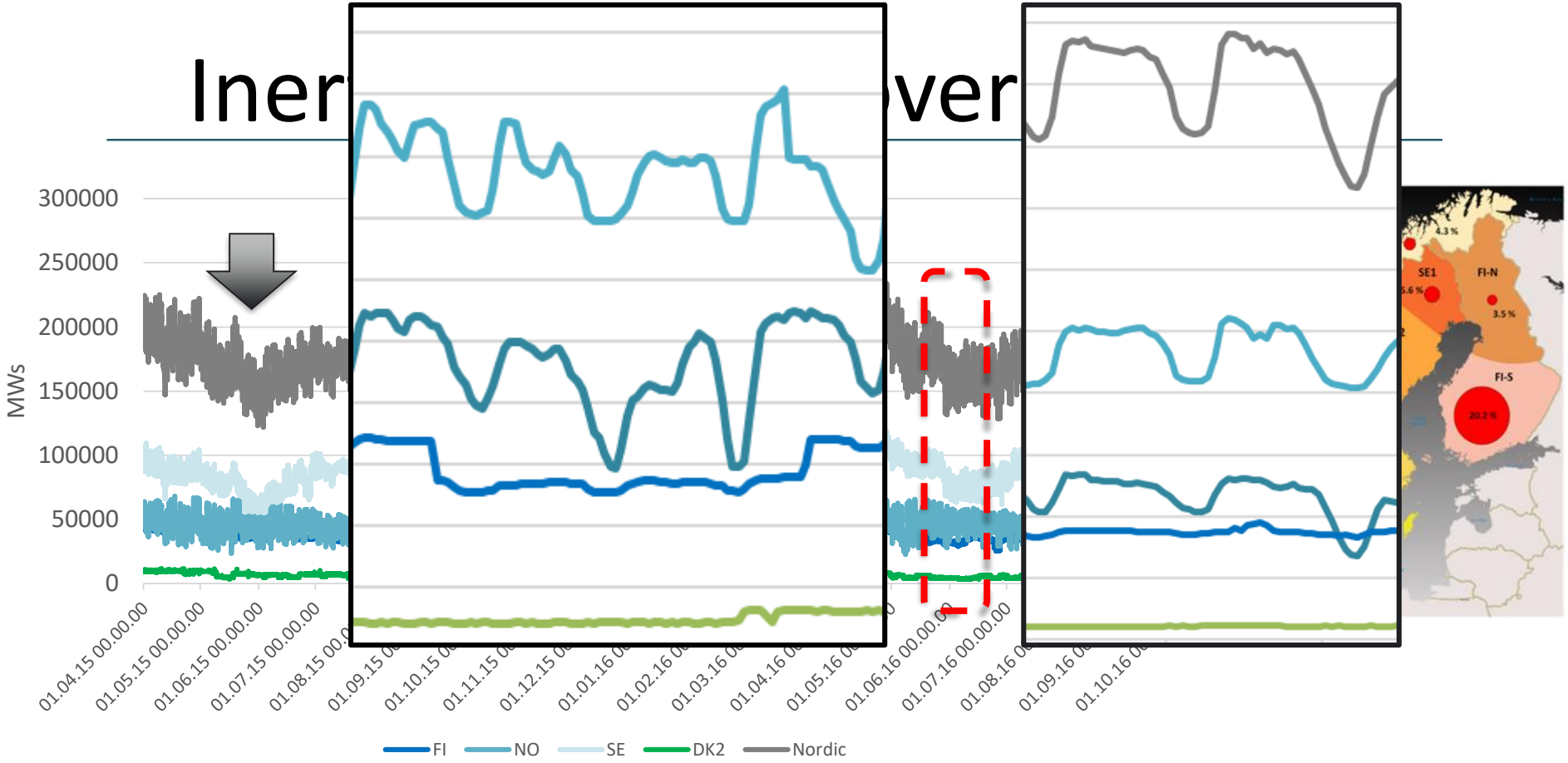
First of all, will there *be* a problem? **Future inertia estimation**

How can we deal with the problems? **Measures to handle low inertia**

How can we forecast/monitor inertia? **Inertia operational tools**

Current project focus until Q2 2017

Iner ver


300000
250000
200000
150000
100000
50000
0
MWs
01.04.15 00.00.00
01.05.15 00.00.00
01.06.15 00.00.00
01.07.15 00.00.00
01.08.15 00.00.00
01.09.15 00.00.00
01.10.15 00.00.00
01.11.15 00.00.00
01.12.15 00.00.00
01.01.16 00.00.00
01.02.16 00.00.00
01.03.16 00.00.00
01.04.16 00.00.00
01.05.16 00.00.00
01.06.16 00.00.00
01.07.16 00.00.00
01.08.16 00.00.00
01.09.16 00.00.00
01.10.16 00.00.00
FI
NO
SE
DK2
Nordic
4.3 %
SE1
FI-N
5.6 %
3.5 %
FI-S
20.2 %

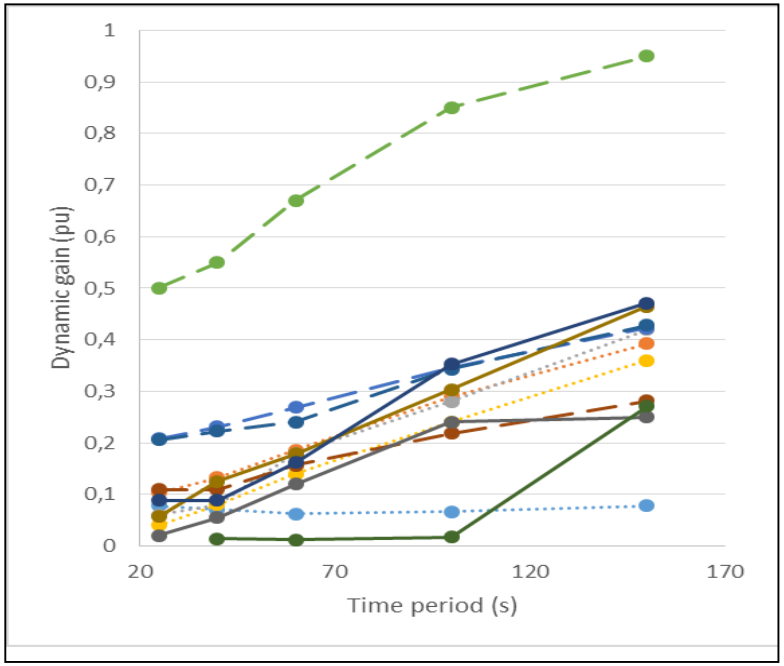
FCR to meet future system needs

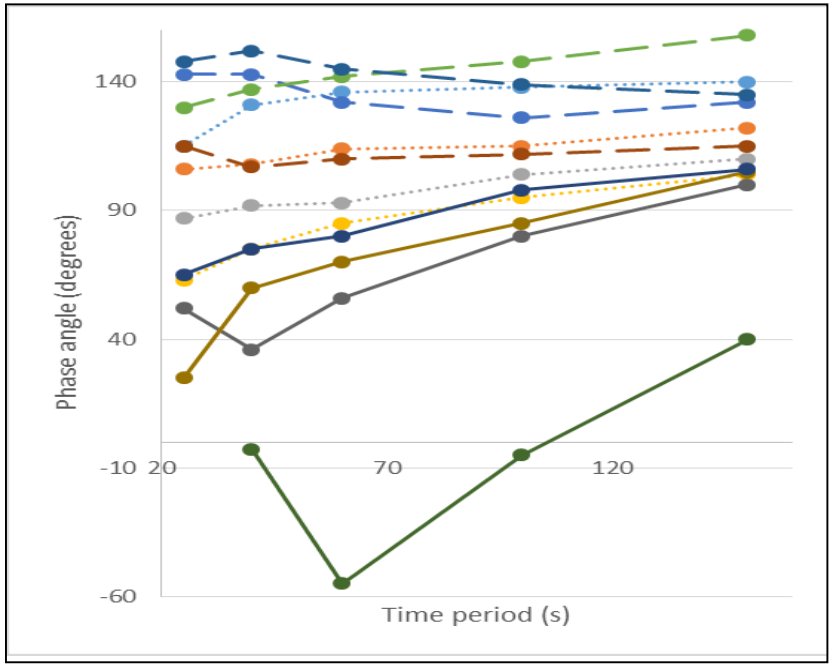
A **well functioning FCR** is a important measure to meet future system needs!

→

Revision of the Nordic **F**requency **C**ontainment **P**rocess

FCR in a complex way….





FCP project

- ✓ Nordic harmonization of FCR
- ✓ Run by 4 Nordic TSOs + reference group
- ✓ Current project phase to Q1 2017

Key elements:

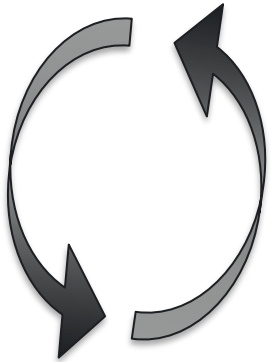
- *Harmonization! Technology neutral!*

Where to start?

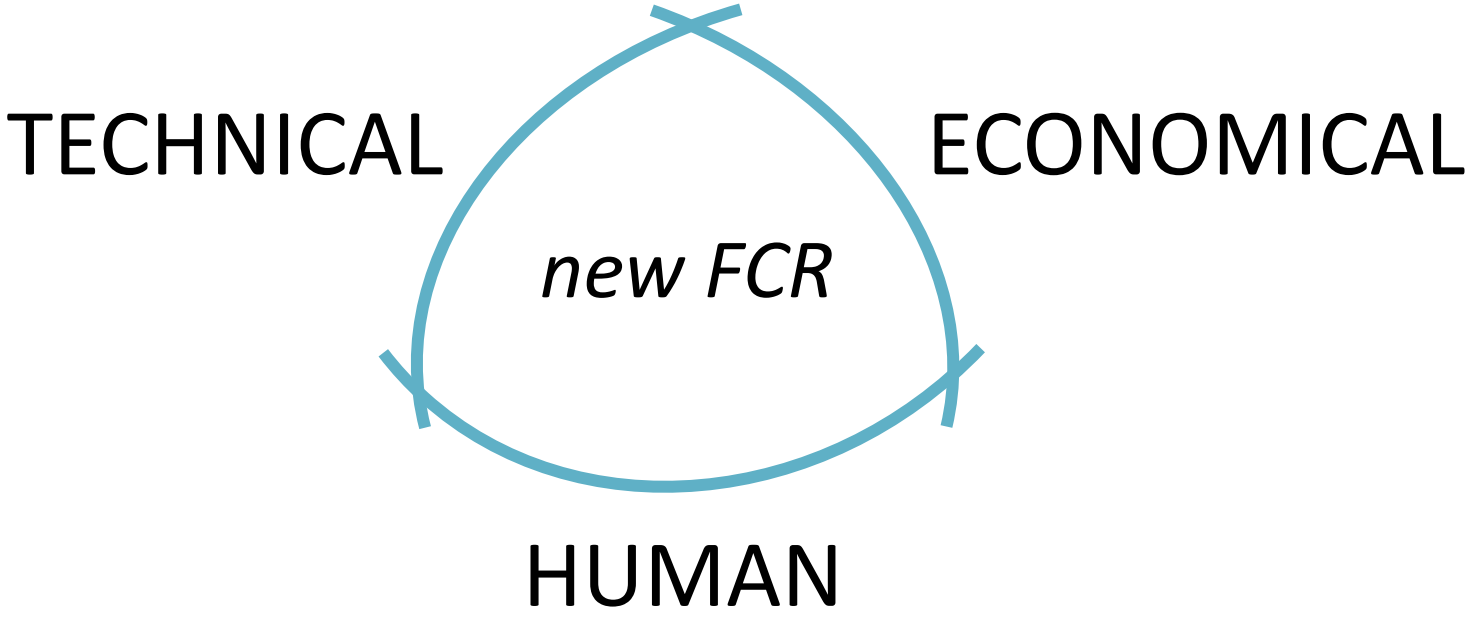
Requirements based on *current FCR provider performance*?

Or

Requirements based on *system needs?*

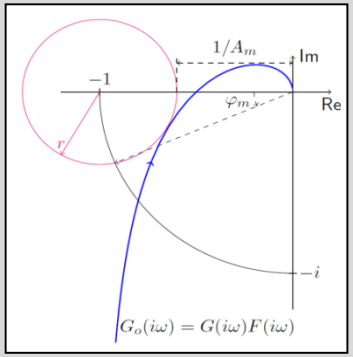


Optimization



The main idea

FCR RESPONSE



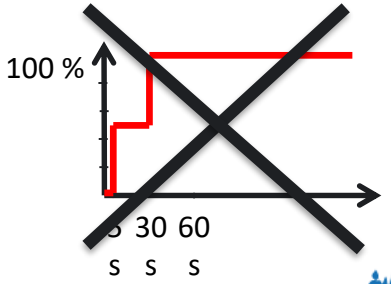
PRE-QUALIFICATION

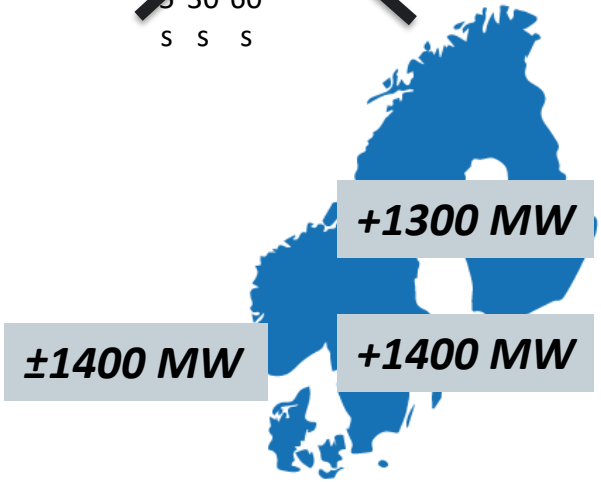
IMPLEMENTATION

What's new?

New FCR in 1-2-3:

1. Old response vs new response
   - Stability!
2. FCR-D
   - Postive and negative direction!
3. Pre-qualification
   - Testing/documentation /real time data!





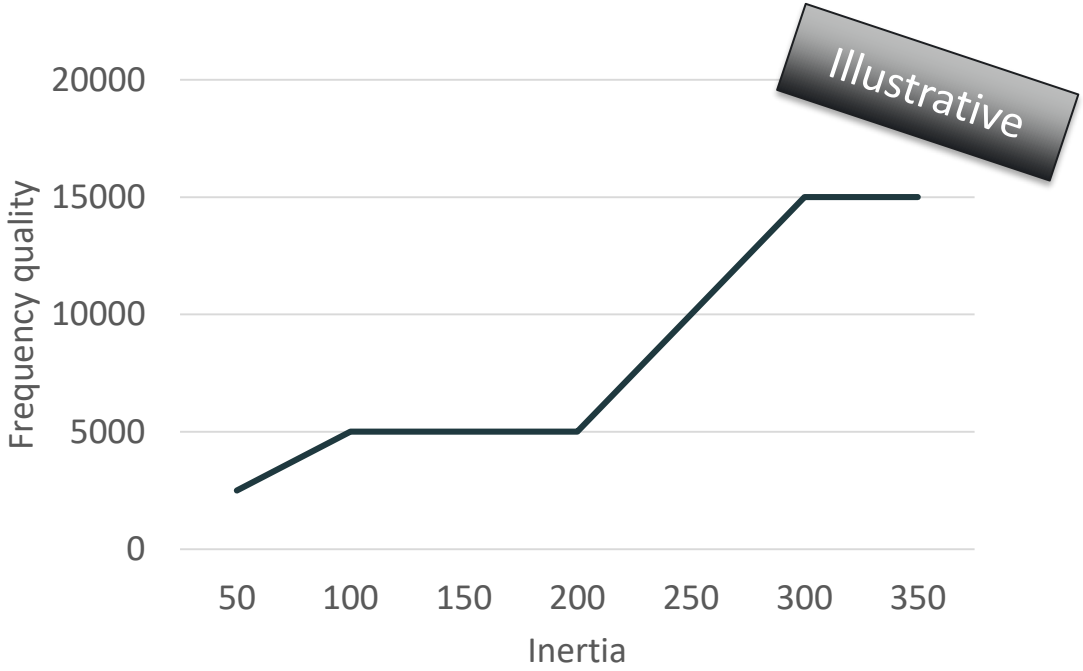
Varying need of FCR?

System operation with varying need of reserves

FCR-N

FCR-D

aFRR



The challenges

1. Easy, understandable requirements…
2. …but robust requirements!
3. Simple pre-qualification process
4. Mechanical dead band vs fine precision
5. Harmonization between Francis, Kaplan, Pelton…
   …and thermal, wind, loads!

From analyse to implementation

How to go from "paper-product" to implementation?

→ *moving into implementation planning*

Key success factor: good stakeholder involvement!

Any questions?

Thank you for your attention!

Panel discussion

The changes in the power system from the market player's perspective

Moderator:
Olof Klingvall, Svenska kraftnät

Panellists:
Lina Palm, Uniper Energy
Johan Hagsten, Vattenfall
Mikael Heikkilä, Fortum Power and Heat Oy
Stein Øvstebø, Hydro Energy AS