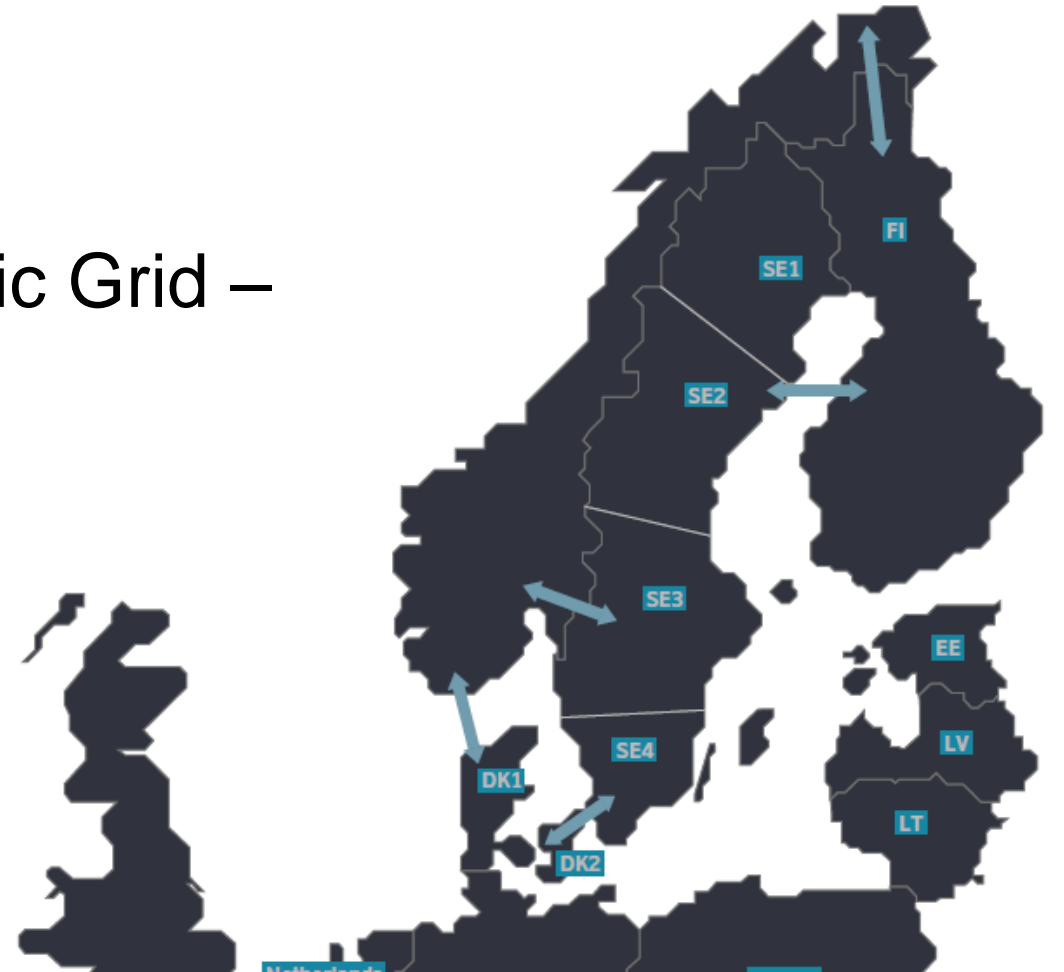


Challenges and Solutions in the Nordic Grid – Stakeholder Workshop

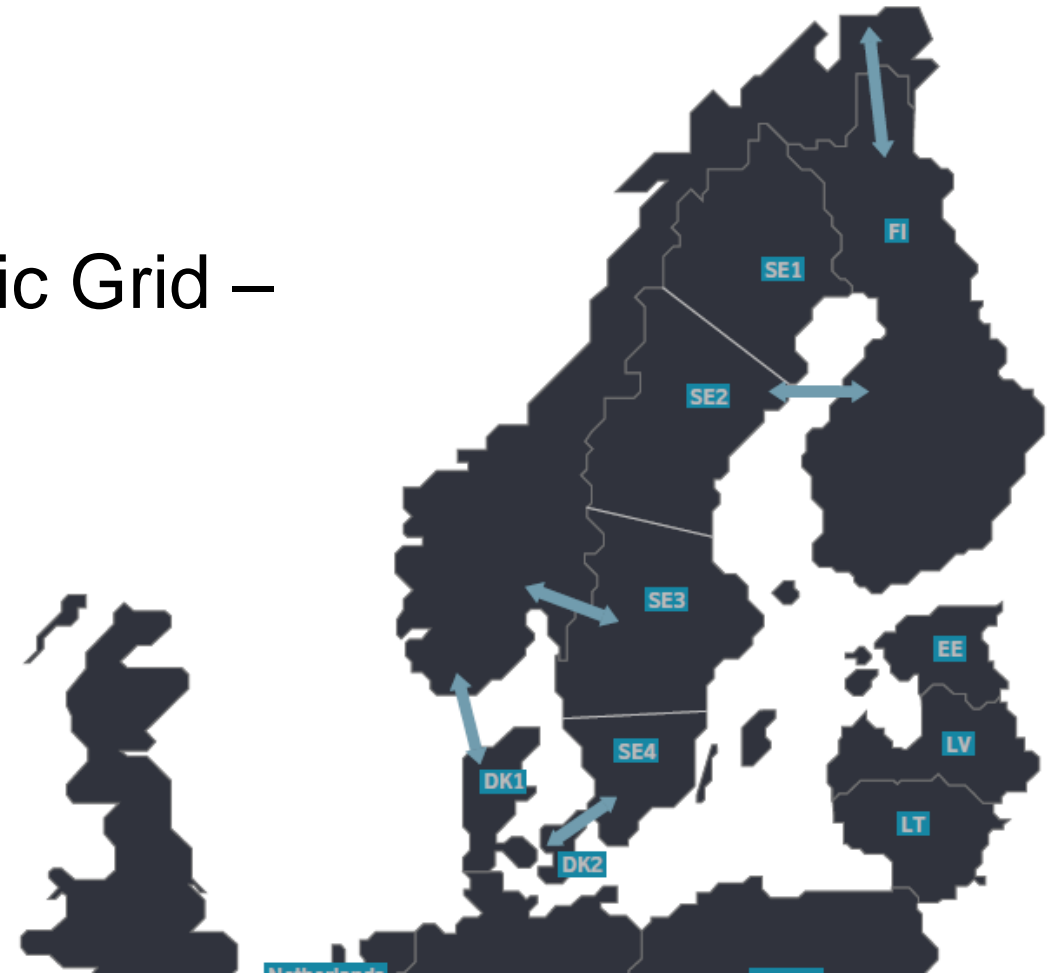


Challenges and Solutions in the Nordic Grid – Stakeholder Workshop

Welcome to the Workshop

Hanne Storm Edlefsen

Director, Strategic Planning, Energinet





TODAY, NOT TOMORROW

It is up to us to complete the green transition in the energy sector

SKOLSTREJK
FÖR
KLIMATET

TREND 1: ENERGY ACROSS BORDERS

Previously, energy supply was a national matter. Now, it is international.



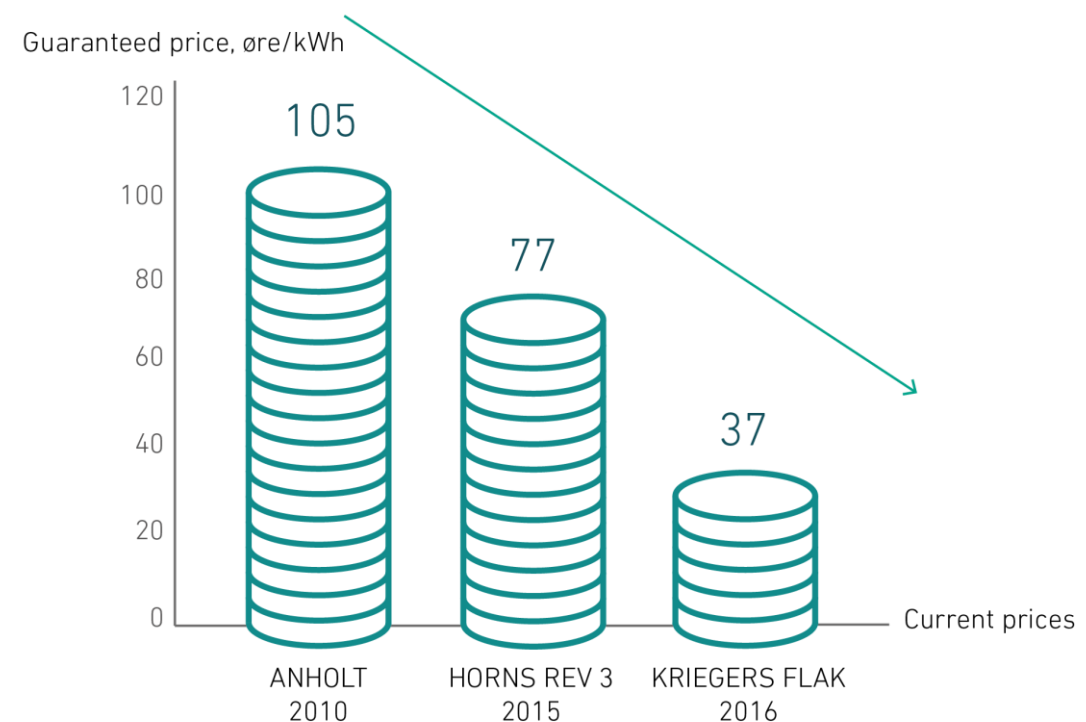
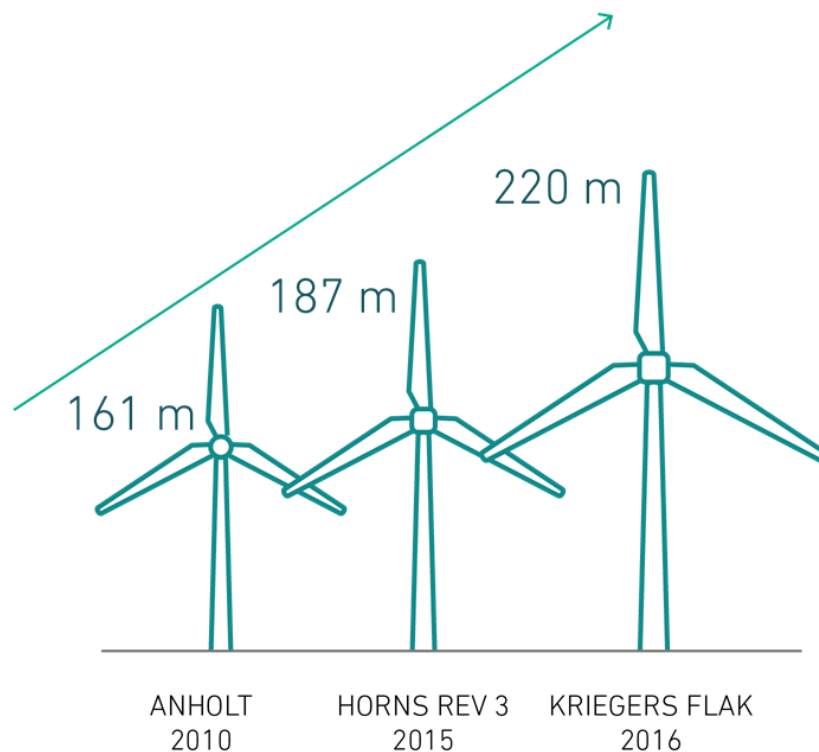
NATIONAL RULES AND
SOLUTIONS



EUROPEAN RULES AND
SOLUTIONS

TREND 2: GREEN ENERGY WITHOUT SUBSIDIES

Previously, green energy had to be adapted to the market. Now, green energy defines the market.

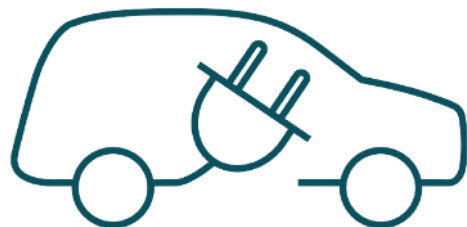


TREND 3: NEW TECHNOLOGIES ARE DEVELOPED

New technologies for producing, storing and consuming energy are being developed at great speed.



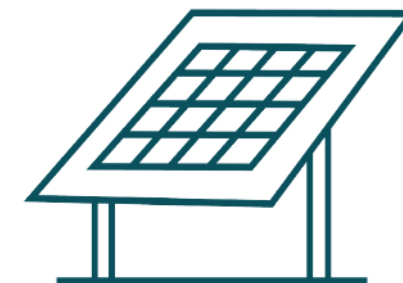
BIG DATA



ELECTRICITY FOR
TRANSPORT



GREEN GAS



SOLAR CELLS

GREEN ENERGY

IS A **JOINT** EFFORT

The green transition can only succeed if producers, consumers and the authorities all work together.



Overall Purpose of The workshop

Find out from you, the Stakeholders:

- What are your priorities?
- Are the solutions presented, the right ones to address the challenges related to the Nordic power system?
- Is there is any other work, that needs to be done by the TSOs to address the challenges?

STAKEHOLDER WORKSHOP ARRANGED BY THE NORDIC TSOs

Update to the Nordic Solutions Report

Facilitator: Kristian Pladsen, SVP Corporate Communication, Statnett

AGENDA

- 08.30 Sign-in and Breakfast
- 09.00 Introduction and Background
Hanne Storm Edlefsen, Director Strategic Planning, Energinet
- 09.15 Nordic Grid Development Plan Update
Elisabeth Larson, Head of System Development Projects, Svenska Kraftnät and Maarit Uusitalo, Planning Manager, Fingrid.
- 10.00 Regional Security Coordinator Update
Jens Møller Birkebæk, Nordic RSC Manager, Energinet
- 10.15 Break

AGENDA

- 10.30 Balancing and Inertia Management Update
Niclas Damsgaard, Senior Market Strategist, Svenska Kraftnät and Reima Päivinen, Senior Vice President, Fingrid
- 11.15 Short-term Market Options Update
Niclas Damsgaard, Senior Market Strategist, Svenska Kraftnät
- 11.30 Break
- 11.45 Panel: Challenges from a Stakeholder Perspective
Antti Paananen, Director of Markets Unit, Energy Authority Finland;
Tore Heide Villund, VP Data Centres, GlobalConnect;
Asbjørn Grundt, SVP Regulatory Affairs NWE, Statkraft;
Eva Vitell, Director, Vattenfall Eldistribution, and
Simon Horsholt, Consultant, Danish Agriculture and Food Council
- 12.45 Closing Comments
Håkon Borgen, Executive Vice President Technology & Development, Statnett
- 13:00 Lunch

Nordic Grid Development Plan 2019

*Stakeholder workshop arranged
by the Nordic TSOs, April 26th*

*Elisabeth Larson, Head of System Development
Planning, Svenska Kraftnat*

*Maarit Uusitalo, Planning Manager,
Fingrid*



Agenda

- Background
 - Purpose
 - Scope
 - Relation to European, regional and national plans
- Nordic reference scenario
- On-going development
- Bilateral studies
- Further work



Photo: Thomas Ärlemo

Purpose

- Energinet, Fingrid, Statnett and Svenska kraftnät publish a common Nordic Grid Development Plan every second year
- Describe the main drivers of the changing Nordic power system, and the planned and on-going grid development to meet the new needs
- Communicate results of new system analysis investigating the cost/benefit of further increasing the transmission capacity in the Nordic system
- The Nordic Grid Development Plan is intended to function as a complementary bridge between the national planning processes and the ENTSO-E Ten Year Network Development Plan

Scope

- Establish a common Nordic Reference Scenario based on ENTSO-E/TYNDP scenario “Sustainable transition”
- Harmonize CBA methodology for the evaluation of socioeconomic welfare
- Carry out non-binding bilateral studies of the five corridors for an early assessment of potential benefits from a Nordic system perspective



Relation to European, regional and national plans

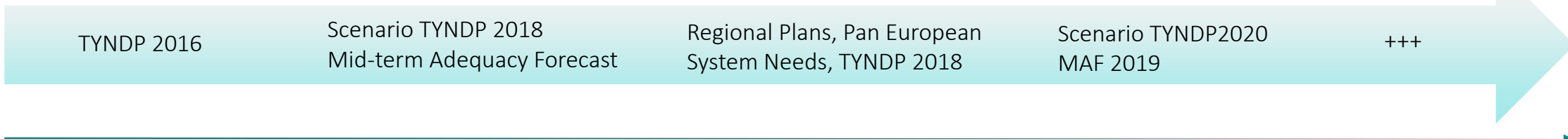
National plans



Nordic



ENTSO-E



TYNDP 2016

Scenario TYNDP 2018
Mid-term Adequacy Forecast

Regional Plans, Pan European
System Needs, TYNDP 2018

Scenario TYNDP2020
MAF 2019

+++

2016

2017

2018

2019

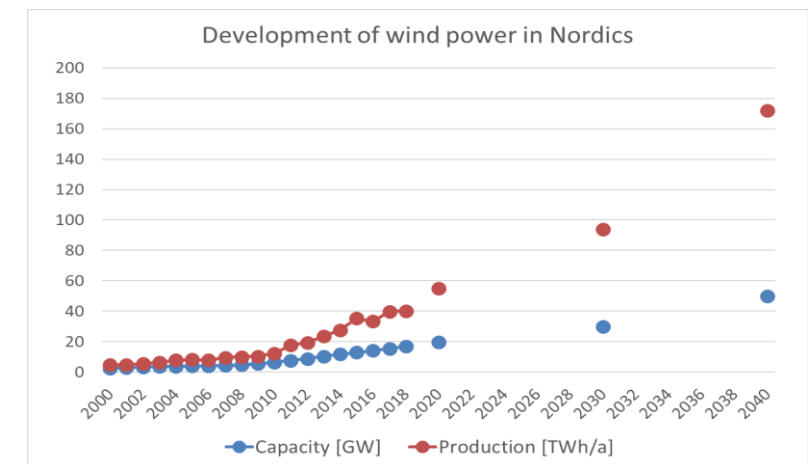
NGDP 2019

Nordic Reference Scenario



Main direction and drivers for grid investments

- The Nordic power system is likely to undergo large changes towards 2040
- Consumption is increasing;
 - Electrification of transport
 - Data centers
 - Heating and different types of industry processes
- The total capacity of more controllable power production will decrease;
 - including nuclear power and other types of thermal production
- Growth in renewable power production;
 - largely in form of wind power but also through solar power
- Less controllable and highly weather dependent production become dominant towards 2040
- The age and need for reinvestments within the existing grid are an important factor for the overall future level grid investments in the Nordic region



Development of wind power in the Nordic scenario from today to 2040. Both in annual energy production (TWh) and capacity (GW)

Nordic reference scenario – main assumptions

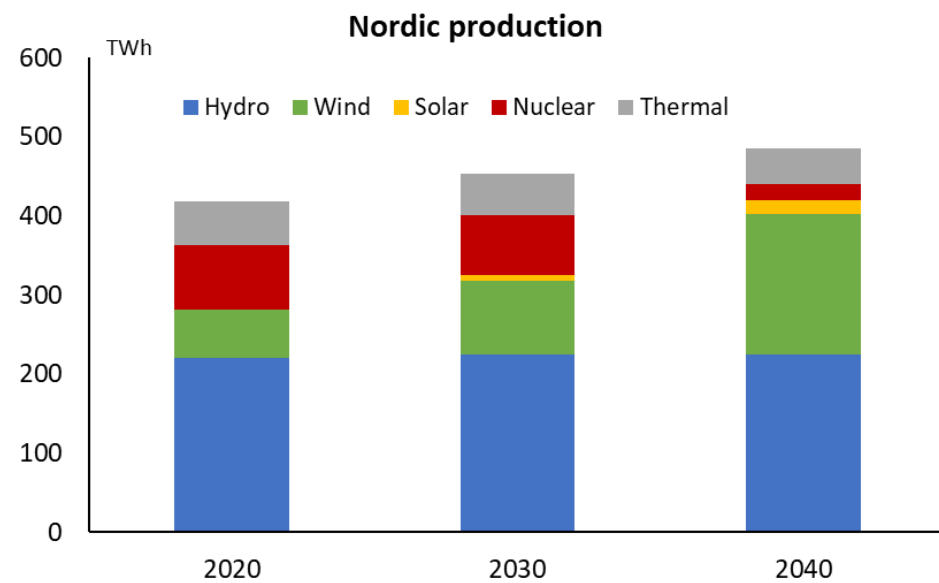
- Covers the period 2020-2040, with focus on 2030-2040
- Based on ENTSO-e scenario “Sustainable Transition” for continental Europe
- Both coal and gas is competitive in the merit order, coal is forced out due to national regulation ie EU ETS CO₂ price is still not the only driver for de-carbonization
- Rapid deployment of new renewable production.
- Demand is assumed to increase by approximately 15 %
- New sources of flexibility enters the market as thermal and nuclear is phased out



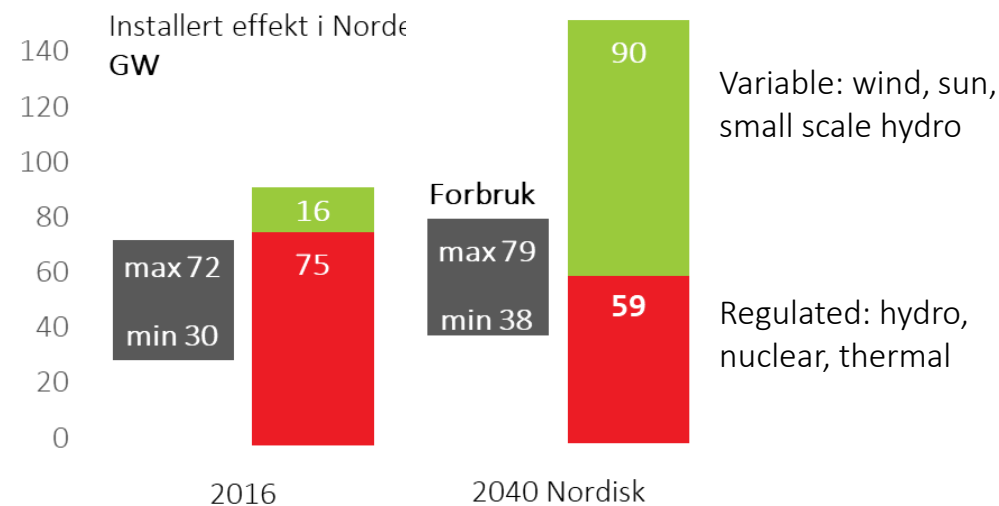
Photo: Magnus Mikaelsson

Towards 2040 variable production will dominate the Nordic system

- The Nordics will have a positive energy balance
- We expect both more scarcity (winter) and oversupply
- But power balance will be more important for prices and flows



Variable production become dominant



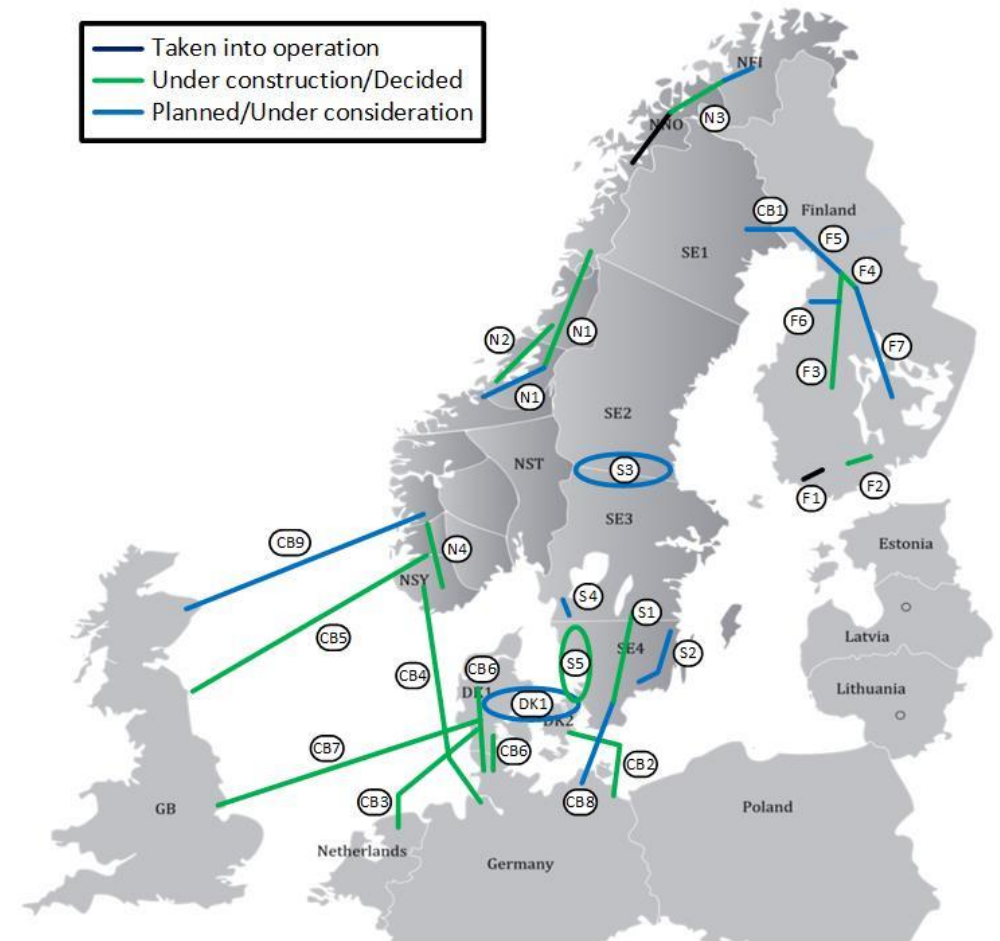
NGDP 2019

On-going development



On-going Nordic development

- Nordic TSOs are already preparing for future challenges with ongoing and planned projects
- The investments levels are at a historically high level and are foreseen to be so also in coming years
- In total, the Nordic TSOs plan to invest €15 billion until 2028
- This increases the overall transmission capacity, reduce bottlenecks in the system and make it possible to integrate large amounts of new renewable production



NGDP 2019

Bilateral studies



Bilateral studies

Transmission corridors of special interest with potentially large increase in power flows due to RES generation or transmission to larger consumption areas

Bilateral studies are based on common Nordic scenario and common framework

	Studies included	FI-SE	DK-NO	SE-NO	NO-FI	DK-SE
Monetized	Costs	█				
	Market benefits	█				
	Losses	█				
Non-monetized	Integration of RES	█				
	Sos –Adequacy	█				
	Environmental & Social	█				
	Flexibility	█				



DK – SE bilateral study

- **Main drivers for study and study focus:**
 - The corridor links areas with hydro power (Sweden and Norway) with areas with high dependencies on wind and solar power, and both Konti-Skan 2 (DK1-SE3) and the northern Oresund cable (DK2-SE4) are approaching the end of their expected technical lifetime around 2030.
 - Thus, the focus have been on increasing to todays level and further.
- **Preliminary study** focused on market benefits, investment cost and maintenance costs for different levels of cross-border capacity.
 - Reference alternative is current capacity levels without Konti-Skan 2 and the northern Oresund cable.
 - The study has looked at several alternatives: reinvesting to current capacity levels, increasing capacity between DK1-SE3, increasing capacity between DK2-SE4 and increasing capacity between both areas.
- **Preliminary results** show a positive net present value for all alternatives.



FI-SE bilateral study

Fingrid and Svenska kraftnät have made a joint study to investigate future cross-border HVDC sea-cable capacities between Finland and Sweden.

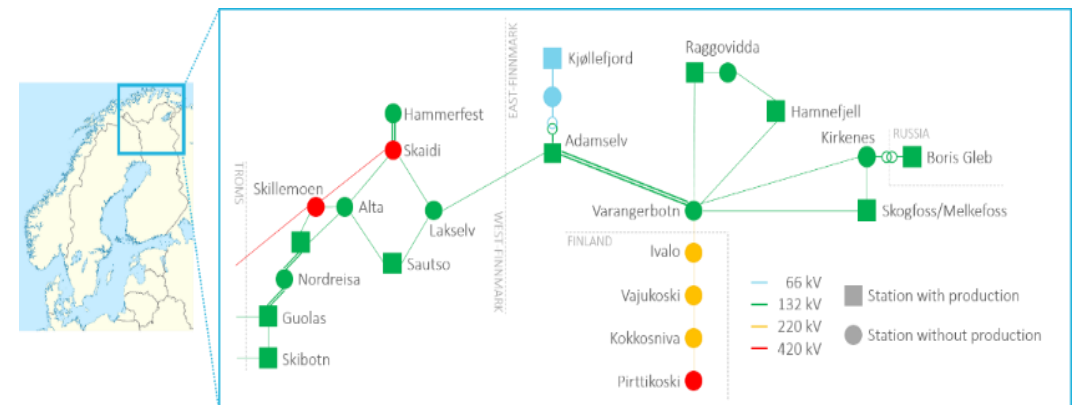
- Kvarken alternative is better from system aspects point of view, and is not as dependent on the commissioning of other planned grid reinforcements, compared to the Fenno-Skan alternative.
- From an environmental perspective the alternatives are equal, the Kvarken is more intrusive on the Swedish side and the Fenno-Skan on the Finnish side.
- Both alternatives have positive and rather equal Net Present Value.
- Overall, the Kvarken alternative would be more beneficial than the Fenno-Skan alternative.
- The benefits are mostly realizing in the 2040 situation, while the benefits at 2030 are rather modest, therefore it would be recommendable to have further analysis concerning the life-time of Fenno-Skan 1 cable in order to find the most optimal timing for the new HVDC connection.



NO-FI bilateral study

Fingrid and Statnett have made a joint study to investigate future cross-border capacity between Norway and Finland.

- Preliminary study shows that changing the current AC connection to a back-to-back with moderate capacity and a functioning market border
 - facilitates increased trade
 - makes it possible to integrate more wind and demand in Finnmark
 - allows controllability and stabilizes the grid on both sides
- In the next step, more detailed studies needed to find out
 - socio-economic,
 - environmental and
 - technical effects



SE-NO: Market benefits increases towards 2040

- Moderate calculated Nordic market benefit in 2030
 - Is likely to be a bit underestimated
 - Still probably too low to fund large grid capacity investments
- Higher benefit towards 2040 – may carry investments
 - Decommissioning of nuclear power
 - More wind power in the Nordic area
 - Increased volatility in continental power prices
- Overall cost/benefit is sensitive to several factors
 - Timing of final phase out of Swedish nuclear power
 - The emerge of other types of "competing" flexibility
 - Continental price level and volatility
 - Investments costs
- Main conclusion
 - Rational to await further grid investments
 - Further analysis on system adequacy and detailed network is needed



DK-NO: High value of keeping today's capacity

- Focus – possible future reinvestment of SK1 and SK2
- High calculated Nordic market benefit both in 2030 and 2040
 - Large increase in transmission capacity from Denmark to the continent and UK
 - Higher price volatility in continental / European power prices
 - More renewables in the Nordic area
- Positive overall cost/benefit with our base assumptions
- Grid development and handling of possible bottlenecks within Germany is an uncertainty
- Decision on possible reinvestment will be taken at a later stage
 - Need to clarify consequences of German grid development
 - And further update of this analysis



NGDP 2019

Further work



Concluding remarks and next steps

Main messages from the common work

- The system is getting more complex and integrated
- The Nordic TSOs meet these challenges with extensive project portfolios
- Future investments are dependent on the development of the power system
- The Nordic work on grid development is continuous with both common grid plans and bilateral studies of transmission investments

Further work

- The next Nordic grid development plan will be published in 2021
- The aim is to communicate
 - common Nordic view on the overall system development
 - the status of ongoing and planned investments of Nordic significance
 - a set of both common and bilateral studies relevant for future grid development
 - updated scenarios for market development, the overall need for more grid capacity north-south in the whole Nordic region and more interconnector capacity
 - regional cooperation in study of security of supply
- In addition to the market studies presented in the current NGDP, grid studies must be performed in order to analyze the full benefit of the projects
- A significant part of the Nordic co-operation on grid development is about sharing knowledge and data on the overall future system and market development, a closer cooperation on relevant scenarios, methods and data sets provides efficiency and increased quality

Regional Security Coordinator (RSC) Update

*Stakeholder workshop arranged
by the Nordic TSOs, April 26th*

*Jens Møller Birkebæk
Nordic RSC Manager*



Nordic Regional Security Coordination

Background

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

Purpose

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

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

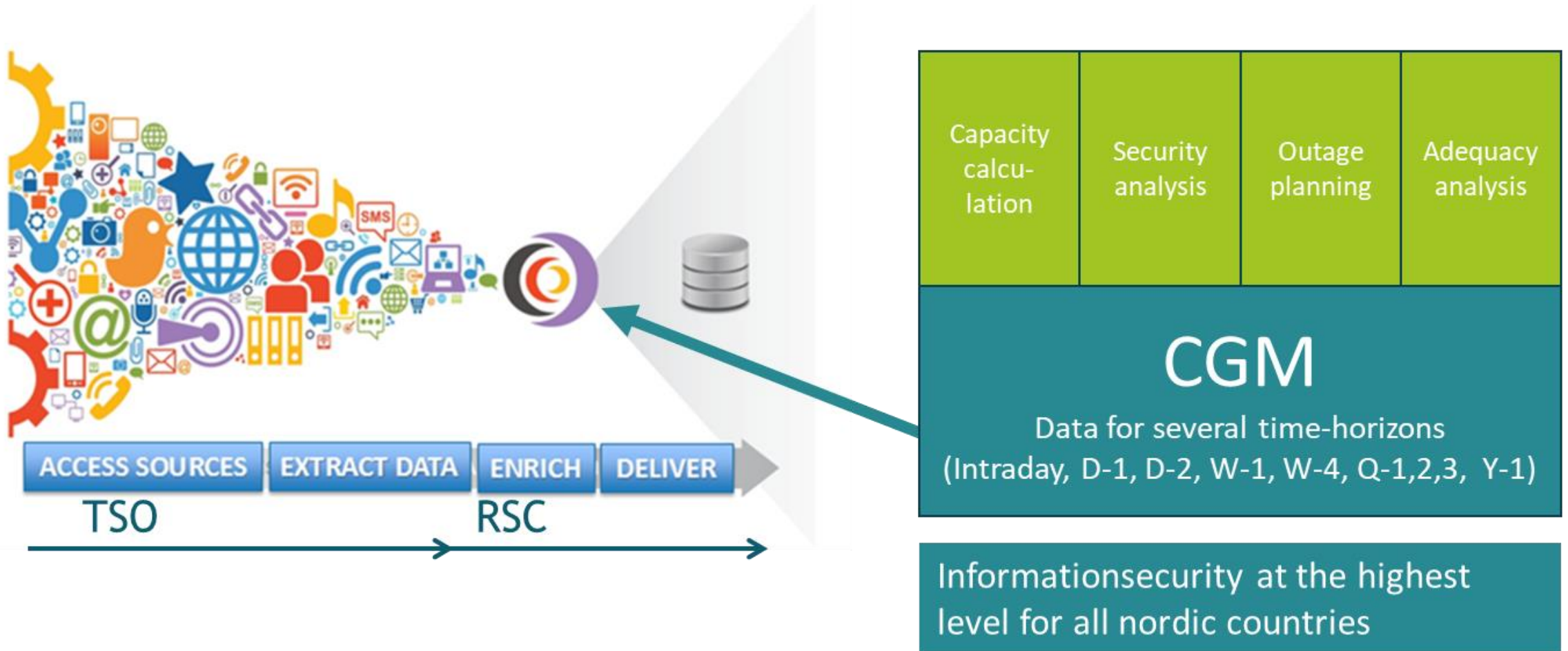
Tasks

Regional Operational Planning and Coordination in time horizons from year to intraday.

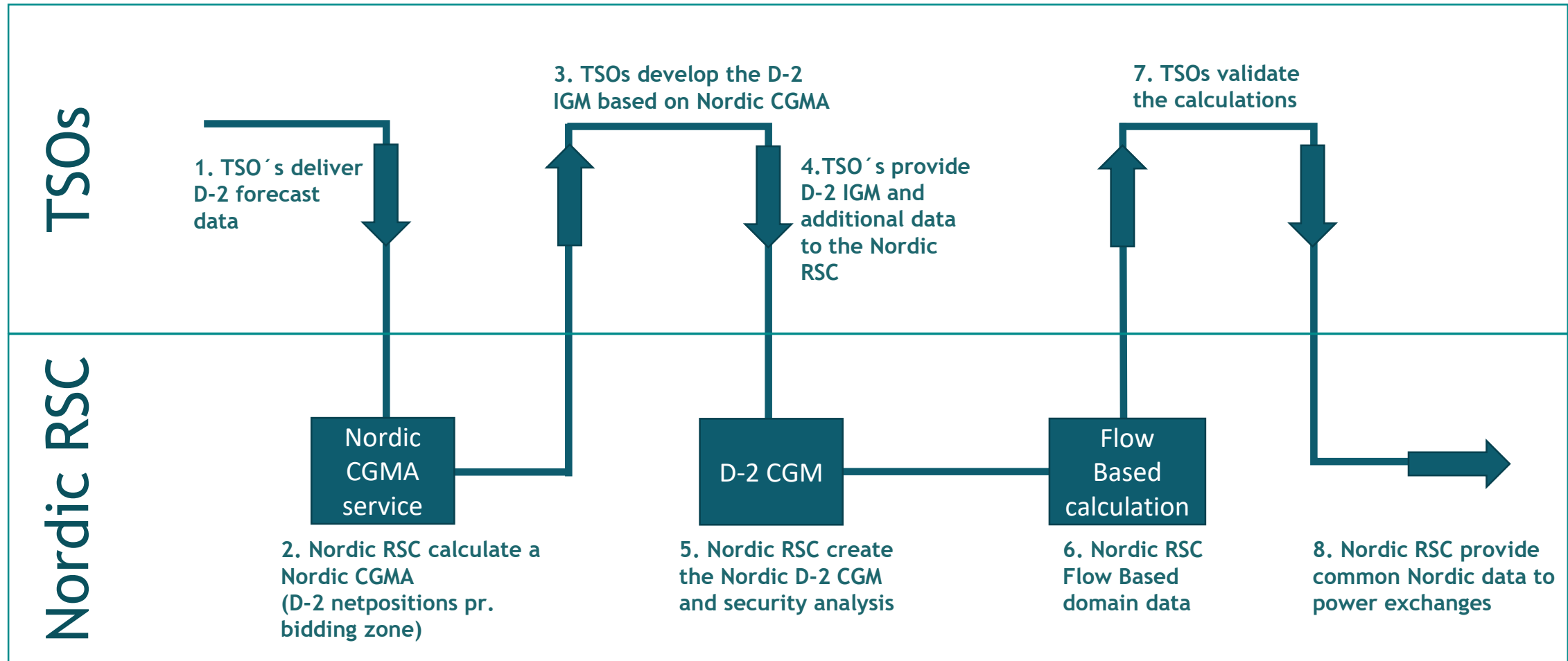


Digitalization of the Power System

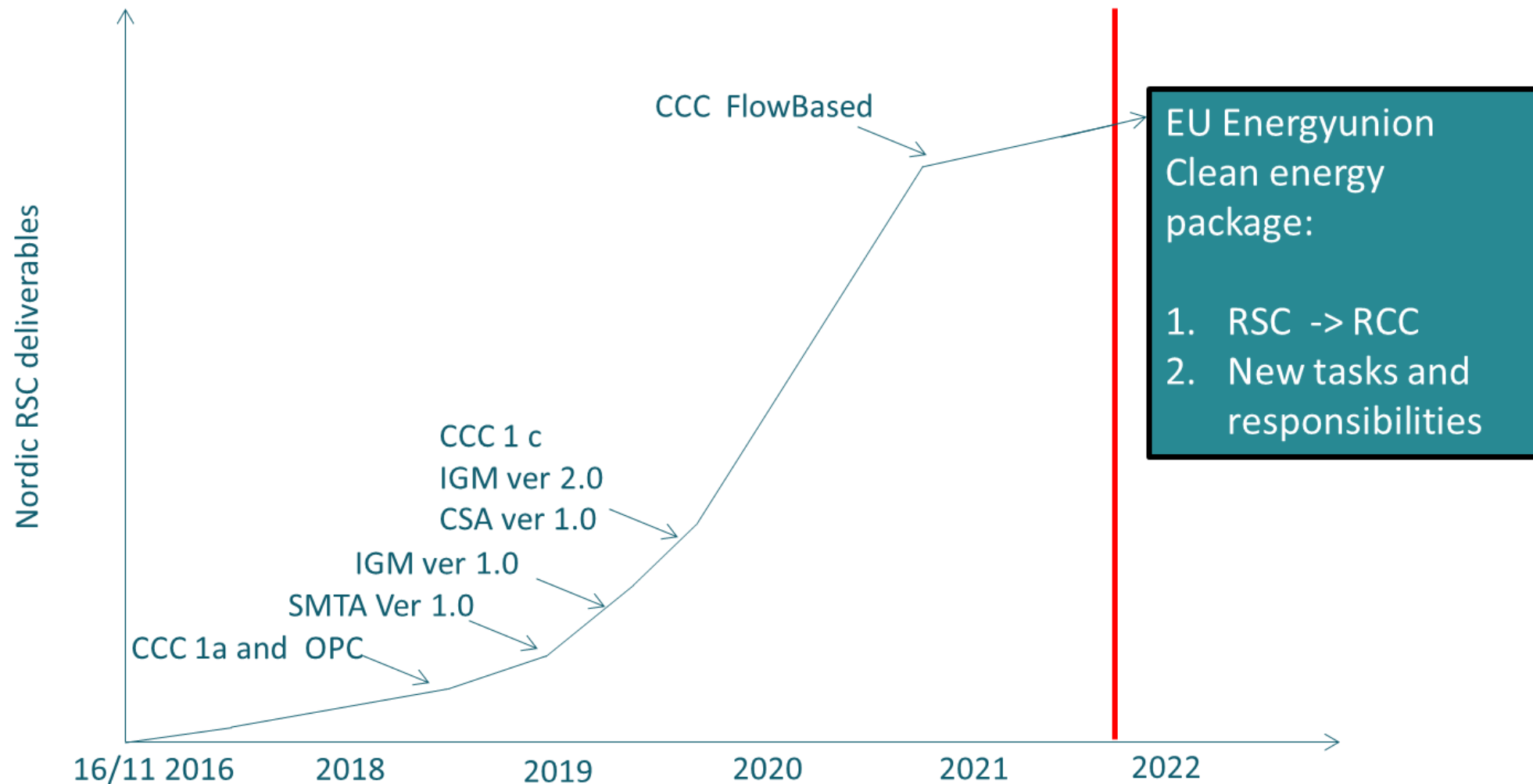
The Common Grid Model is the basis



Flow Based capacity calculation - proces



Nordic RSC – a journey and continuous development

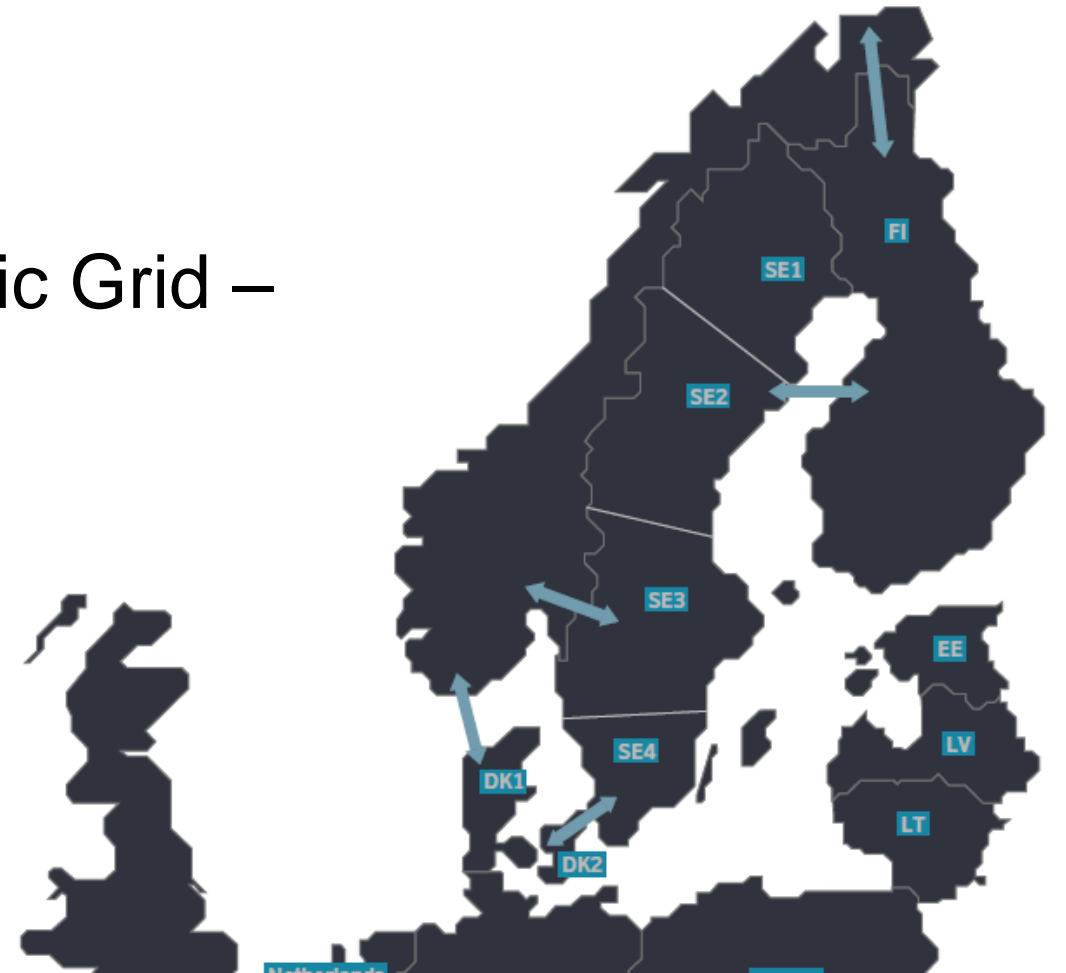


Nordic RSC – one of five European RSC's



Challenges and Solutions in the Nordic Grid – Stakeholder Workshop

Break



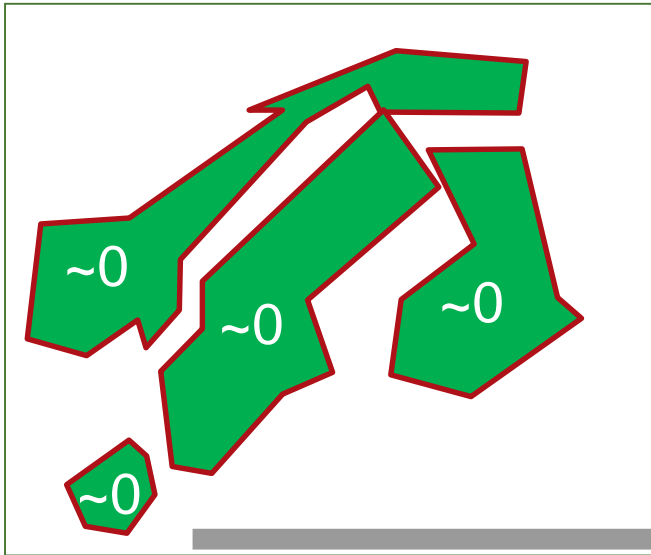
Status of Nordic Balancing Model including 15 minutes time resolution

Stakeholder workshop – update to the Nordic Solutions report
26 April 2019

Niclas Damsgaard, chair Nordic Balancing Steering Committee

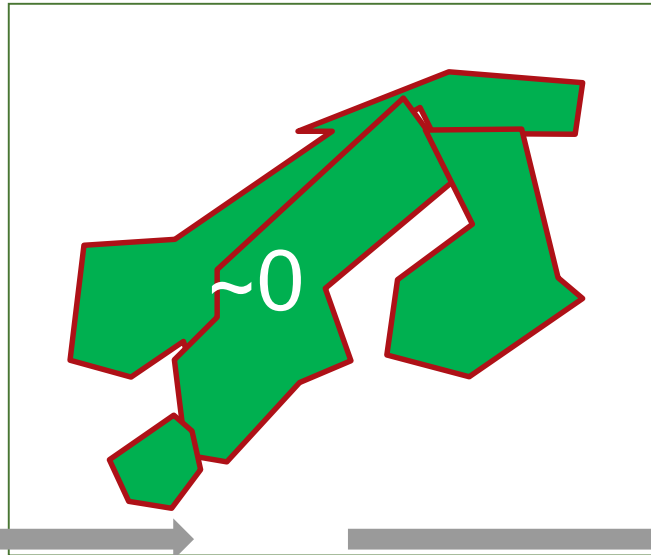
Development for balancing philosophy

ACE in each country



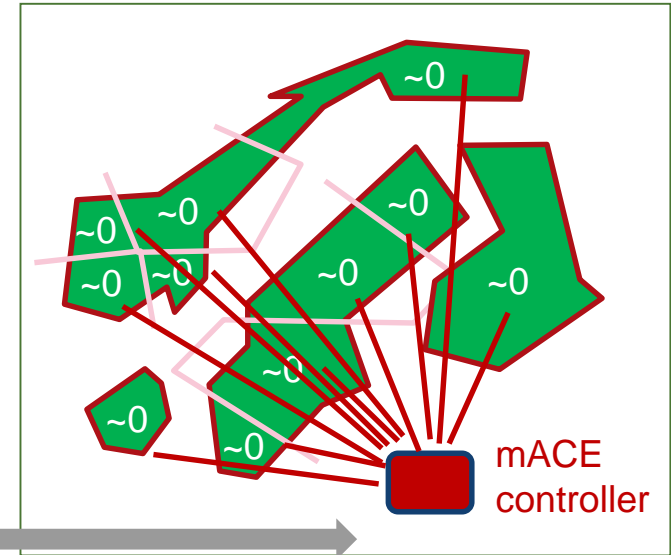
More efficient use of resources
Netting of imbalances
Merit order bid list

Frequency control



Digitalization of balancing
Better control with flows
Clearer responsibilities

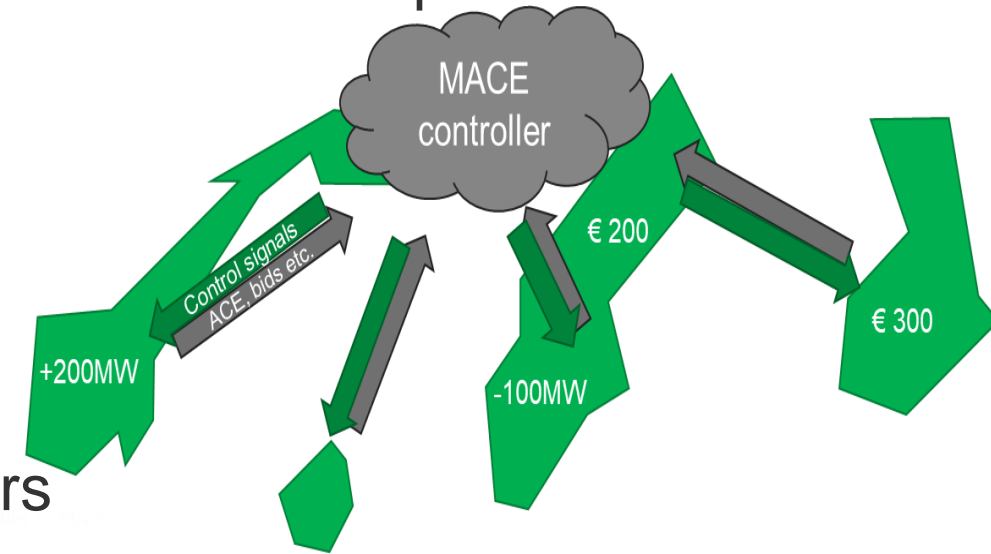
mACE



mACE control – efficient trade and netting

Imbalances and available reserves in each bid-area are optimized in a central algorithm. This secures

- optimized use of grid capacity
- efficient exchange of balancing products
- fair settlement between buyers and sellers



Our goals for the future Nordic power system

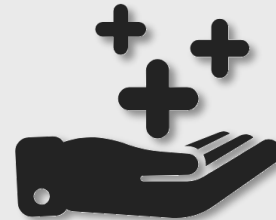
Strengthening system security in the Nordic synchronous area, improve efficiency, and harmonize with Europe

Ability to handle major changes in the power system and maintain system security in the short and long term



Create value and beneficial solutions for all Nordic countries through clear responsibilities and freedom of action for Nordic TSOs

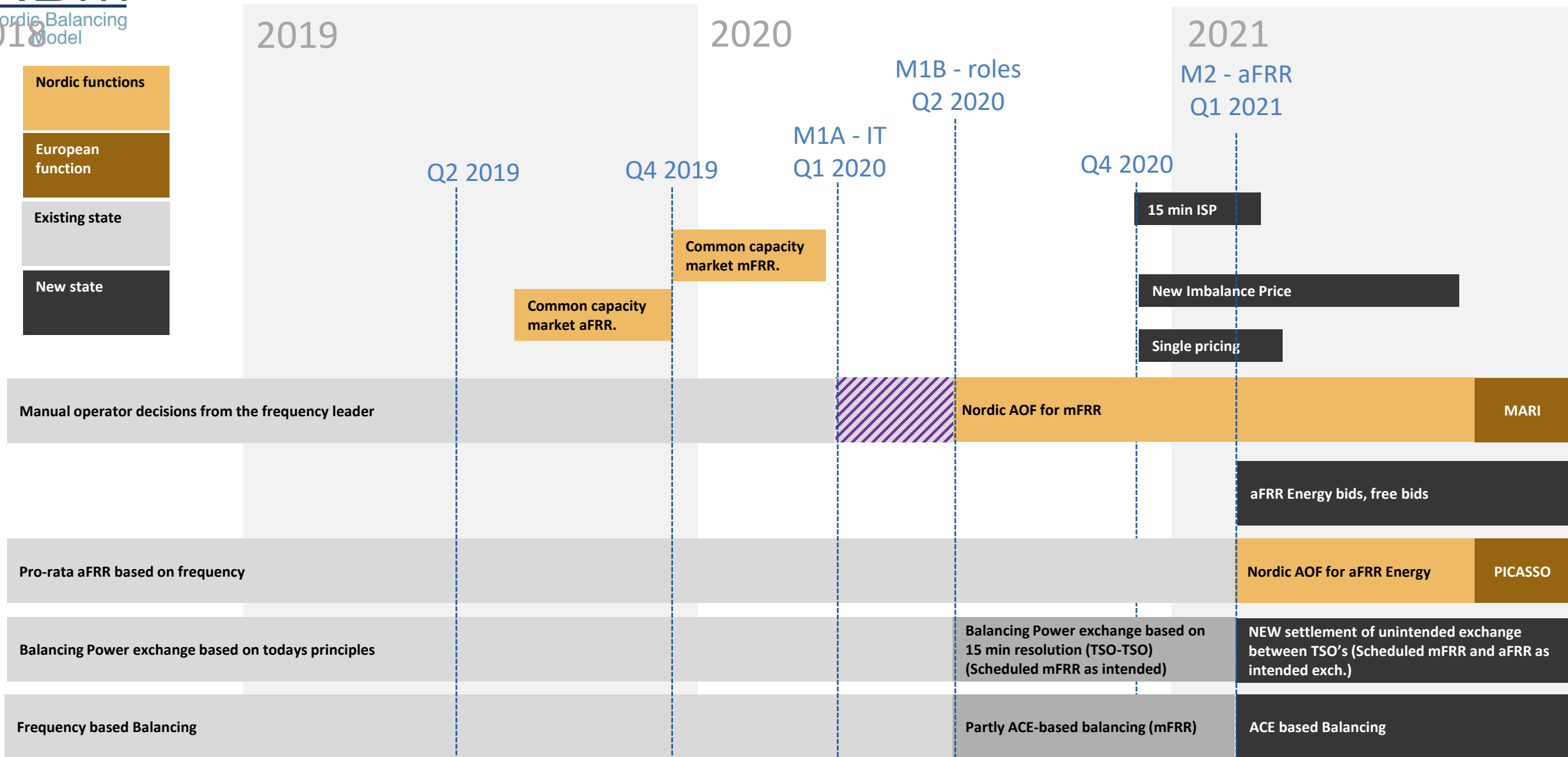
Incentivize development and modernization towards the power system of the future



Efficient integration with European markets and implementation of EU-regulation



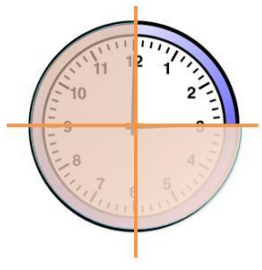
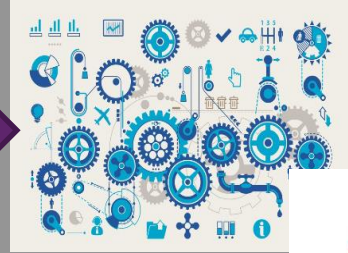
Original road map: The road map is subject to change – will be updated



aFRR Capacity Market

- Huge benefits of common capacity market – continues Nordic integration and efficiency
- IT development according to plan
- Proposal for Nordic aFRR capacity market and cross-zonal capacity allocation methodology submitted to Nordic NRAs for regulatory approval

Fundamental change in Nordic balancing



From manual processes based on operator knowledge and experience to automated processes. Necessary due to increase in complexity, and requires:

- Extensive change of control room processes
- Formalization of knowledge and routines
- Considerable IT-investments
- Significant improvement in data quality



From control based on balance in synchronous area to control based on balance within each bid-area

- Smaller building blocks a prerequisite for automated processes
- Provides consistency between authority and responsibility between TSOs
- Basis for correct settlement and proper incentives
- Depending on regulatory approvals

15 min Time Resolution

1.Generation mACE

2.Generation mACE



From an ambitious roadmap in parallel with other major development in system operation – to an ambitious and realistic plan for implementation.

Challenges encountered

- We can not add more complexity (e.g smaller bid size, fluctuations, interconnectors), nor less time (15 minutes time resolution) on the operators without extensive automated operator support
- The needed operator support comes with the IT-tools planned in Nordic Balancing Model
- Regulation is clear – there is no easy way to be compliant to 15 minutes resolution, without having support for 15 minutes trade

Timing of 15 minutes resolution in the Nordic region

- Implementation of 15 minutes resolution requires extensive automation of processes in the control centers and implementation of 15 min mFRR market.
- Changes are also needed within:
 - Datahubs
 - eSett
 - IT-systems of all market participants
 - Meters



Massive change for Nordic electricity markets and power system

Roadmap for NBM including 15 minutes time resolution will be updated

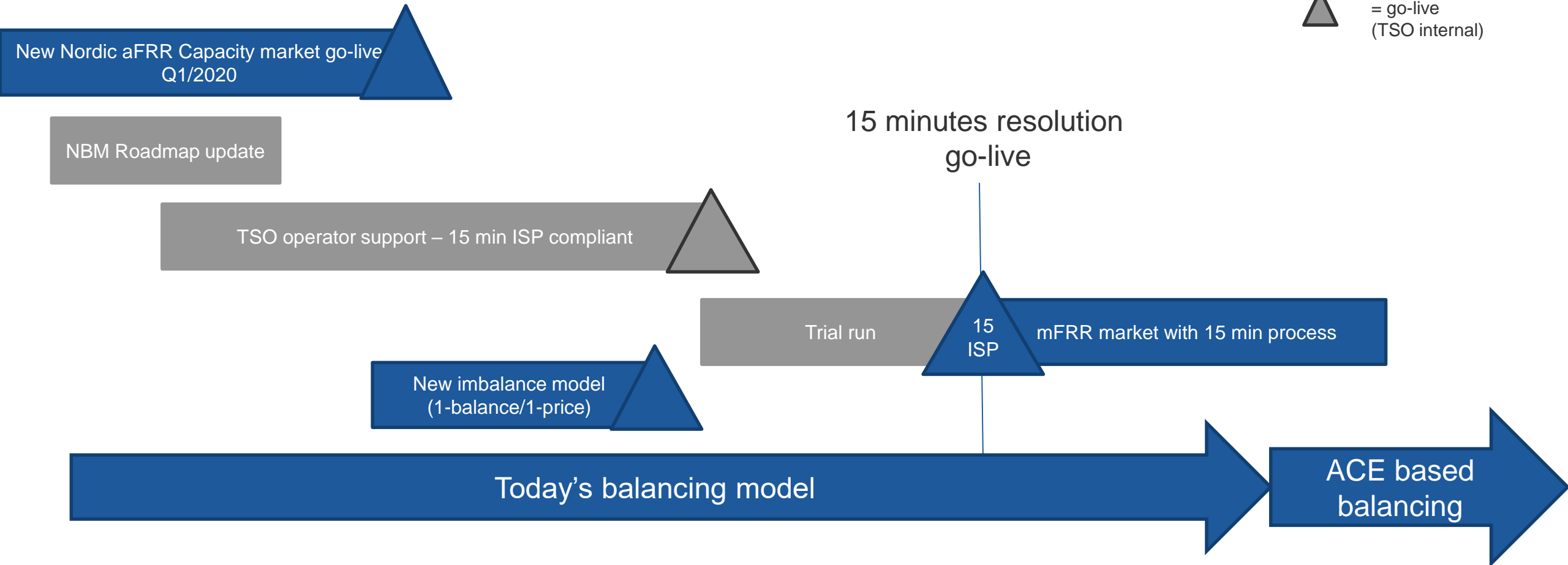
- TSOs are updating a joint roadmap for NBM including 15 minutes time resolution. Stakeholders will be consulted during the preparation of the roadmap.
- Implementation of AOF (Activation Optimization Function), automatic bid selection and 15min mFRR market are some of the prerequisites before 15 min ISP can be implemented.
- New TSO proposal for NBM roadmap will be presented at the stakeholder webinar on May 29.

Current status of roadmap work

- TSOs can now **confirm** that more time is required for implementation of 15 minutes resolution due to changes of TSO processes.
- TSOs can't decide on postponement of 15 minutes resolution go-live – NRA decision is needed.
- Recommendation based on the TSOs work so far and the current understanding: **Go-live of 15 minutes resolution requires at least more than a year compared with original road map.**

Current TSO work subject to change

▲ = go-live
▲ = go-live (TSO internal)



Stakeholder involvement

- Nordic reference group established:
 - Purpose
 - contribute to the planning of the common Nordic NBM Roadmap
 - follow the implementation phase
 - identify risks and propose ways to mitigate them
 - increase stakeholder awareness of NBM and 15 minutes time resolution
 - Members represent a wide range of market participants and are nominated to the group by industry associations of each Nordic country. Regulators are observer members in the group
 - First meeting May 21, the aim is to have four meetings per year
- Information is published on NBM website <http://nordicbalancingmodel.net/>
- Webinars to be organised on current topics

Next steps for NBM roadmap update process



NBM

Nordic Balancing
Model



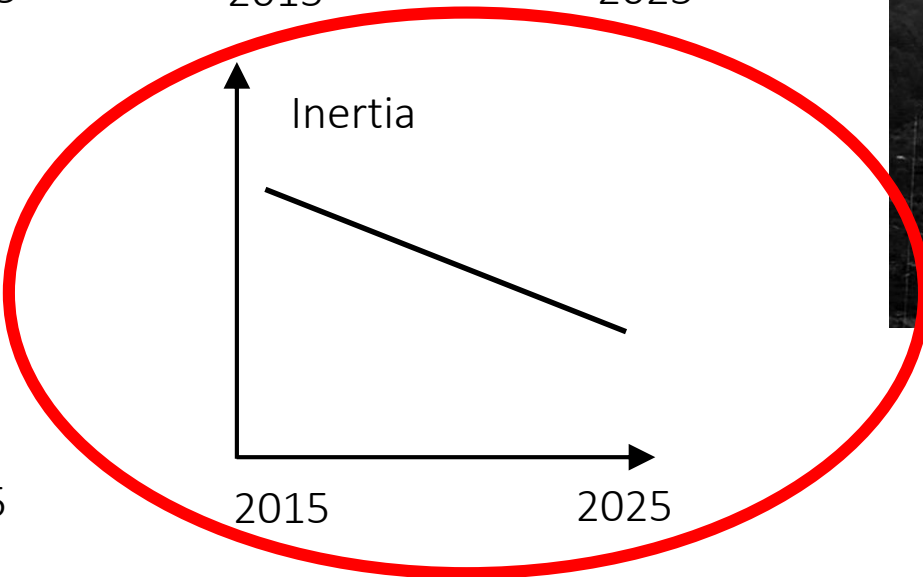
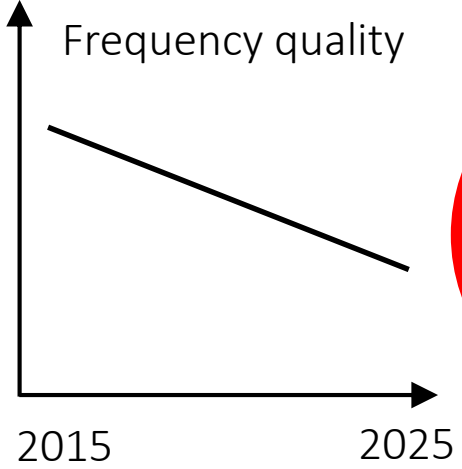
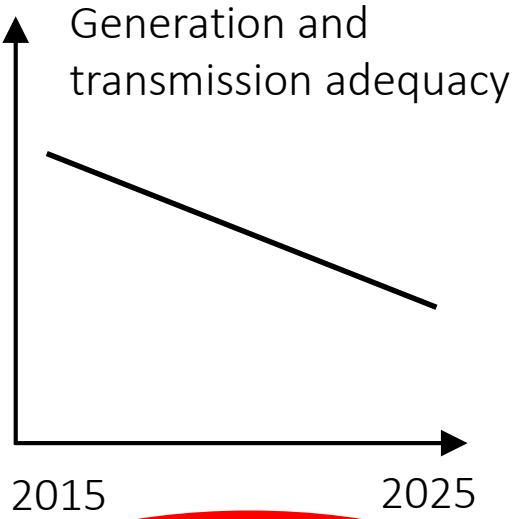
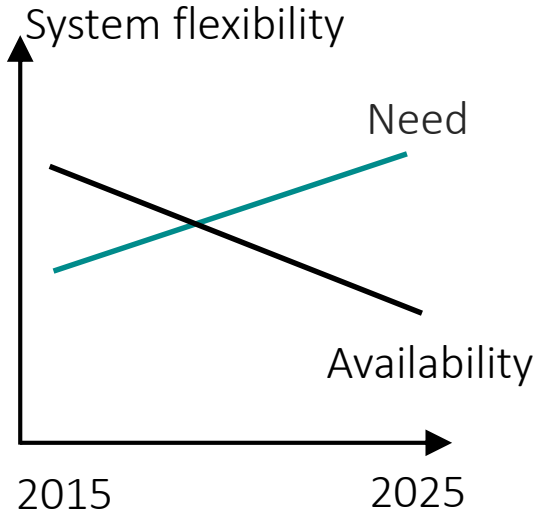
Inertia Solutions 2020

*Stakeholder workshop arranged
by the Nordic TSOs, April 26th*

*Reima Päivinen, Senior Vice President
Fingrid Oyj*



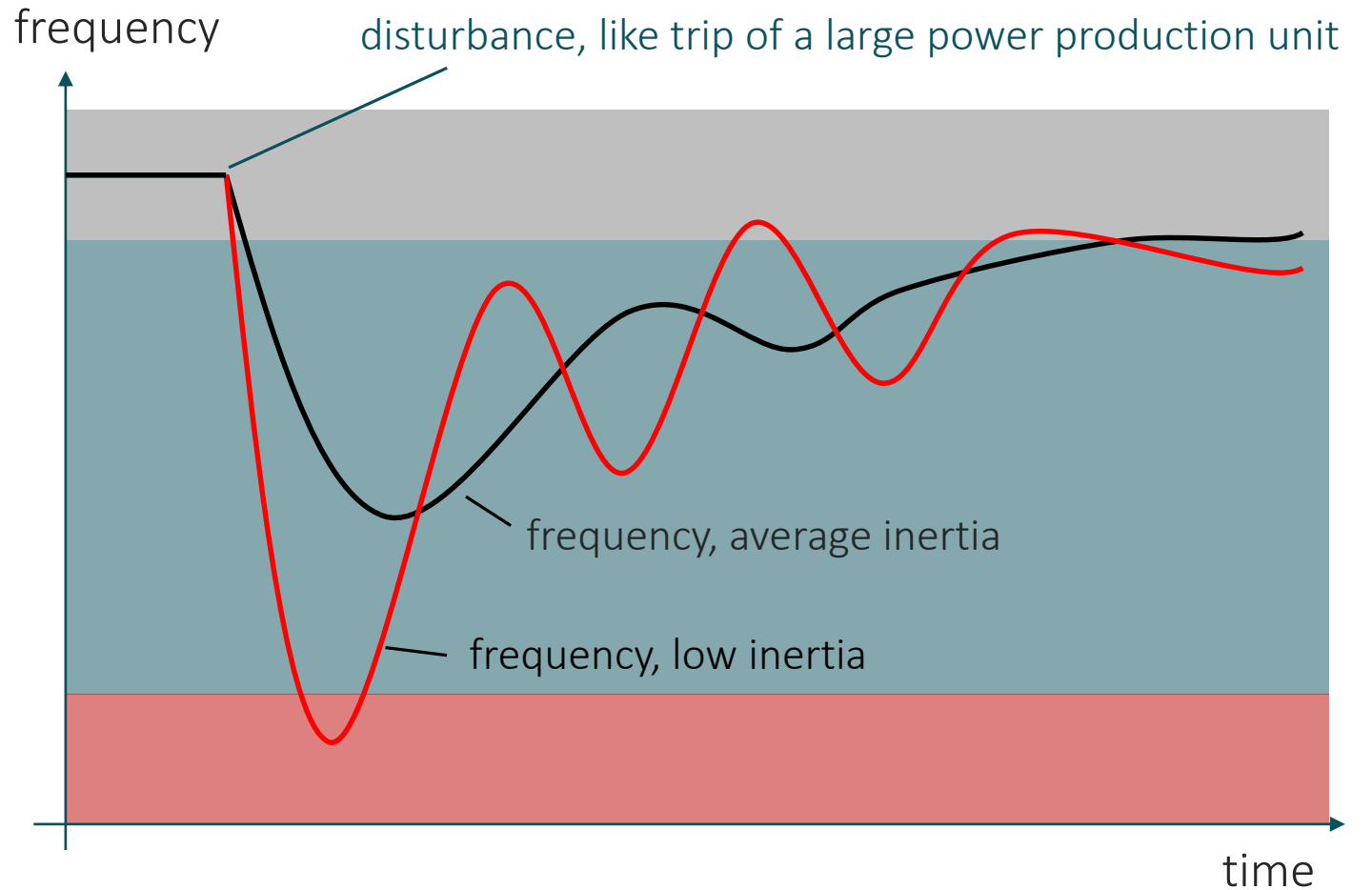
INERTIA IS ONE OF THE CHALLENGES FOR THE NORDIC POWER SYSTEM



INERTIA HAS AN IMPACT ON THE FREQUENCY CONTROL OF THE POWER SYSTEM

Inertia \sim resistance of change

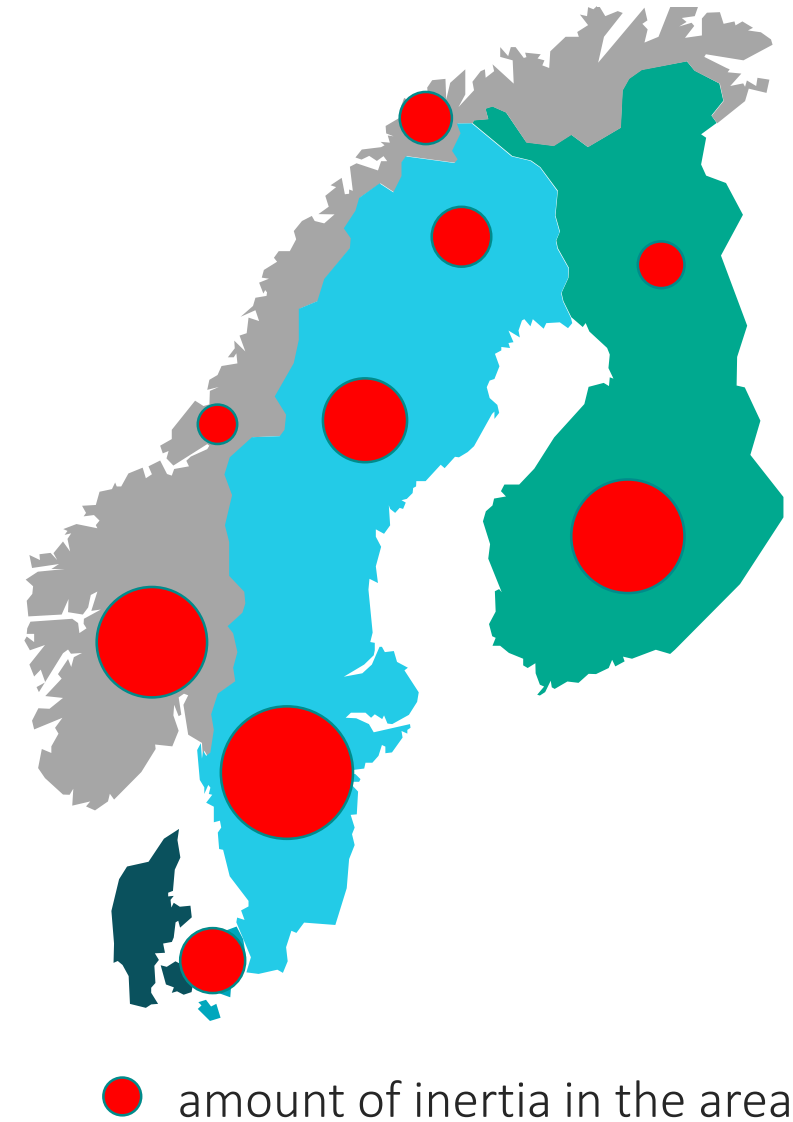
Masses rotating with the same frequency with power system provide inertia



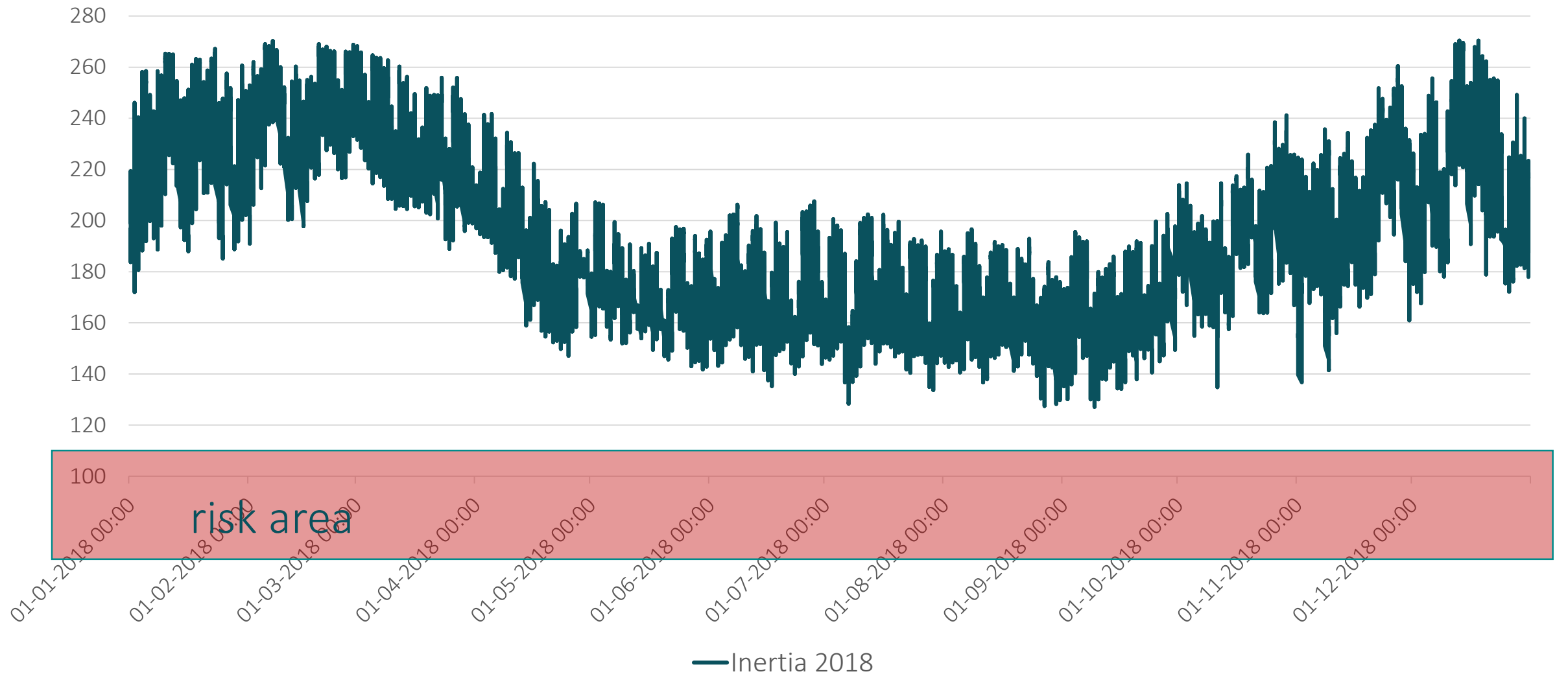
INERTIA IS A NORDIC ISSUE

Amount of inertia impacts the frequency of synchronous system

Nordic power system has common frequency

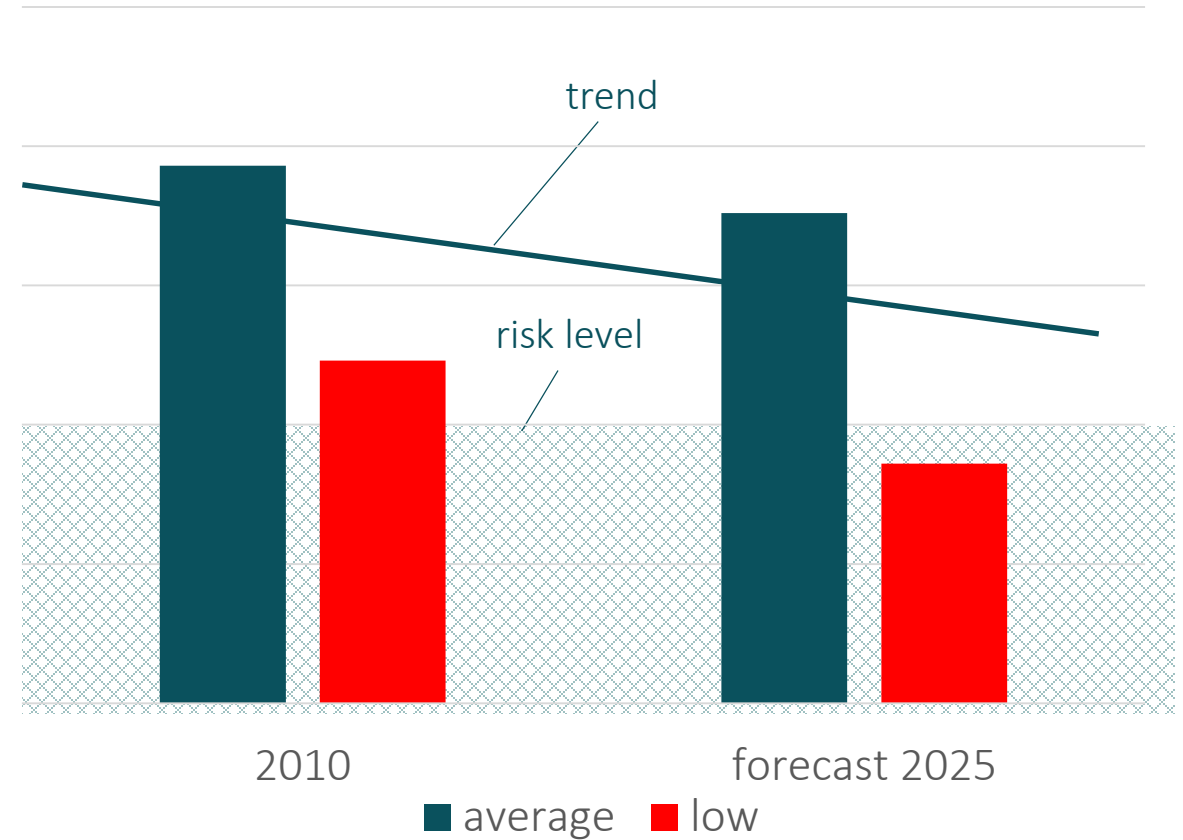


INERTIA VARIES DURING THE YEAR

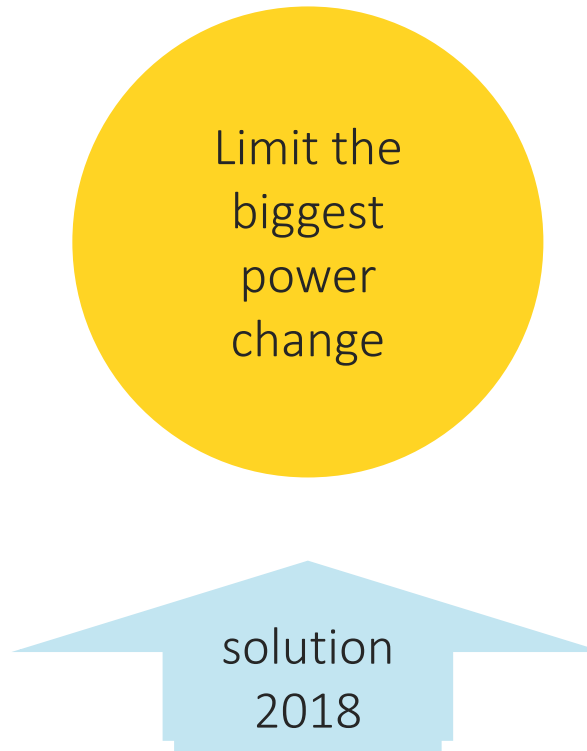
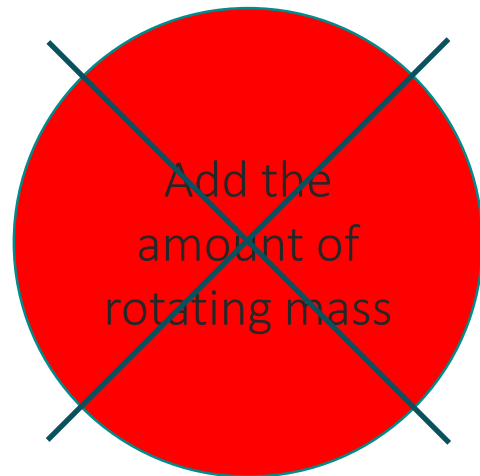


INERTIA IN POWER SYSTEM DECREASES AS THE PRODUCTION PORTFOLIO CHANGES

- More wind and solar power
- Shut down of nuclear units
- Shut down of condensing power units
- Load frequency dependence is decreasing due to the increased use of frequency converters.



THREE SOLUTIONS TO KEEP UP SYSTEM SECURITY DURING LOW INERTIA SITUATIONS



SUMMARY

The best way to manage decreasing inertia in the Nordic power system is to use fast reserves (FFR)

First version of FFR will be implemented 2020

- Initially national market solutions, but common technical requirements
- Continued development post 2020

Benefits:

- No negative market impact
- No reductions on power plant input or interconnectors
- Procured only when needed, reasonable cost impact

Nordic TSOs will start to publish real-time inertia value soon

Solutions for Future Short-term Market

*Stakeholder workshop arranged
by the Nordic TSOs, April 26th*

*Niclas Damsgaard,
Chair Market Steering Group*



SOLUTIONS FOR FUTURE SHORT-TERM MARKET

Stakholder workshop – update to the Nordic Solutions report
26 April 2019

Niclas Damsgaard, chair Market Steering Group



FINGRID

Statnett

ENERGINET

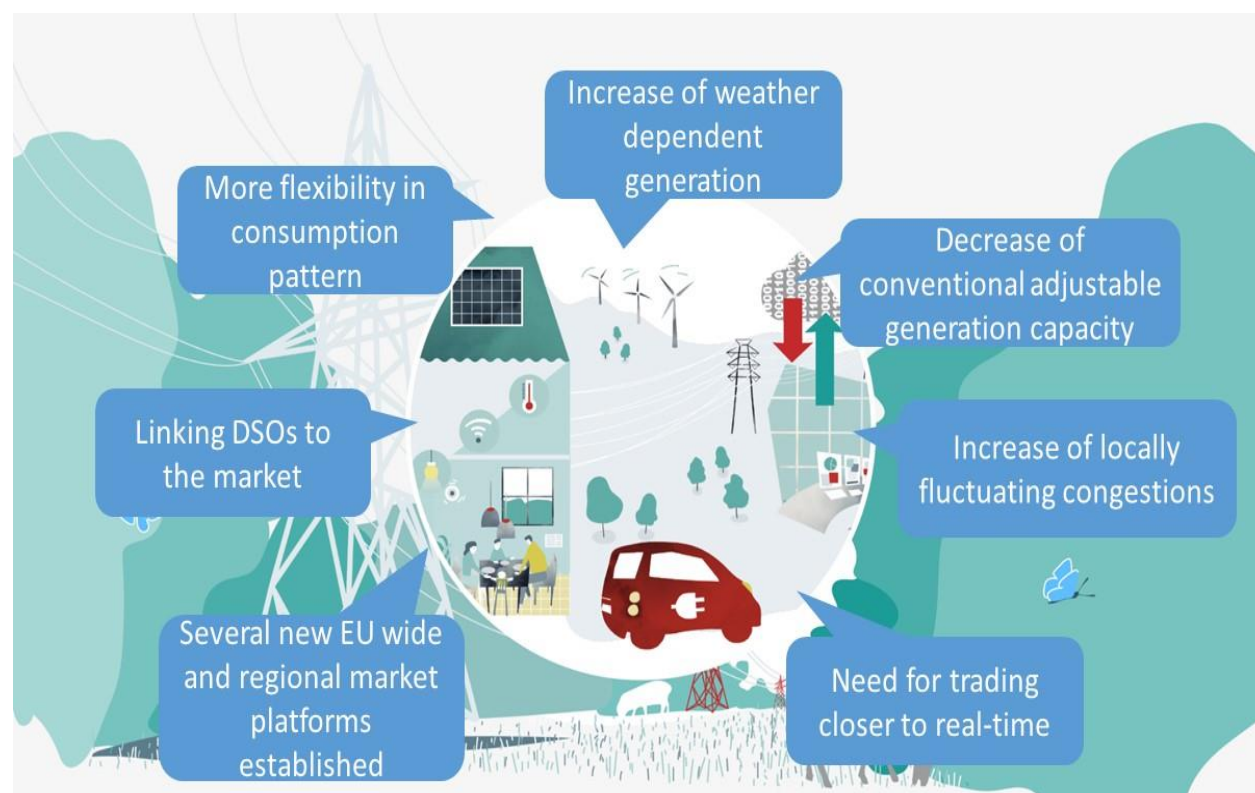
Why a discussion paper on solutions for future short-term markets*?

- Many ongoing initiatives – our main focus is on implementation of already decided solutions
- At the same time Nordic TSOs wish to initiate an early dialogue on future solutions
 - No firm positions or decided actions
 - Discussion on possible changes that could be relevant as a response to foreseen changes
- Aim: Stimulate a broader discussion and receive valuable input for the further thinking amongst the TSOs with respect to short term markets




* In the discussion paper “short term markets” indicate the present intraday and balancing market timeframes, as well as potential future stronger integration with the day-ahead market timeframe

Challenges

- **Several EU wide and regional platforms** to be established requesting cross-zonal transmission capacity
- **Transmission capacity pricing** to be considered in all timeframes
- **Trading in short-term market timeframes** is expected to increase
- **Geographic location of resources** in the transmission and distribution grid becomes relevant for allocation and system operation



Discussion paper includes

	<p>Foreword Introduction</p>	<ul style="list-style-type: none"> • context and purpose of the document • challenges in the short-term timeframe
	<p>Already agreed implementation initiatives for short-term markets</p>	<ul style="list-style-type: none"> • wrap-up from Solutions report
	<p>Discussion on possible future developments of short-term markets</p>	<ul style="list-style-type: none"> • main topics addressed: effects of several market platforms, need for locational information of resources in allocation and impacts on market timeframes • questions to stakeholders

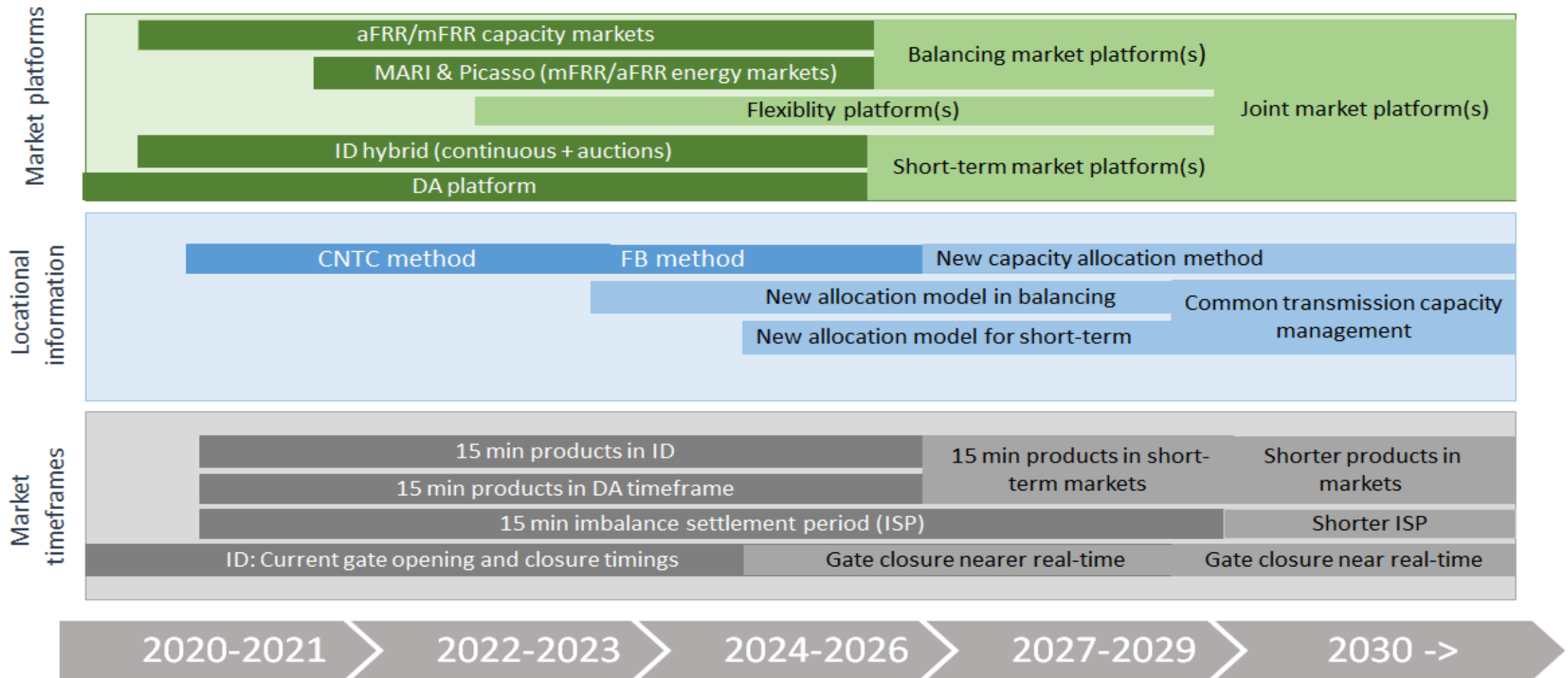
Possible future developments

Coordination between market platforms for efficient capacity allocation	<ul style="list-style-type: none">• What developments do you expect in the next 10-15 years for the market structure and market platforms covering the short-term market timeframe?• Any other views/comments related to the future short term market structure and market platforms?
Using flexibility to solve congestions in distribution grids	<ul style="list-style-type: none">• How do you see the role of flexibility providers in the future short-term markets?• Other possibilities to facilitate linking resources located in DSO grids to the short-term market?
Locational information	<ul style="list-style-type: none">• What actions from TSOs are needed to ensure that the existing transmission capacity will be allocated efficiently to the short-term market taking into account transition in the energy system?• Have you experienced that grid has constrained offering your resources to the short-term market?• What challenges would there be from the perspective of resource owner when moving from portfolio bidding to nodal or unit bidding?

Possible future developments

<p>Market timeframes</p>	<ul style="list-style-type: none"> • When is the optimal intraday gate opening time for future short-term markets from your perspective and why? • When is the optimal intraday gate closure time for future short-term markets? • Shall gate opening/closure time be different for cross-zonal trading and trading within a bidding zone? • Do you see the need for redesign of market timeframes?
<p>Towards real time trading</p>	<ul style="list-style-type: none"> • Have the TSOs described the most important issues from your perspective for changes towards the real-time trading? • Which design aspects should be considered to facilitate market participants' bid submission in the several platform environment?

Indicative timetable for further discussions



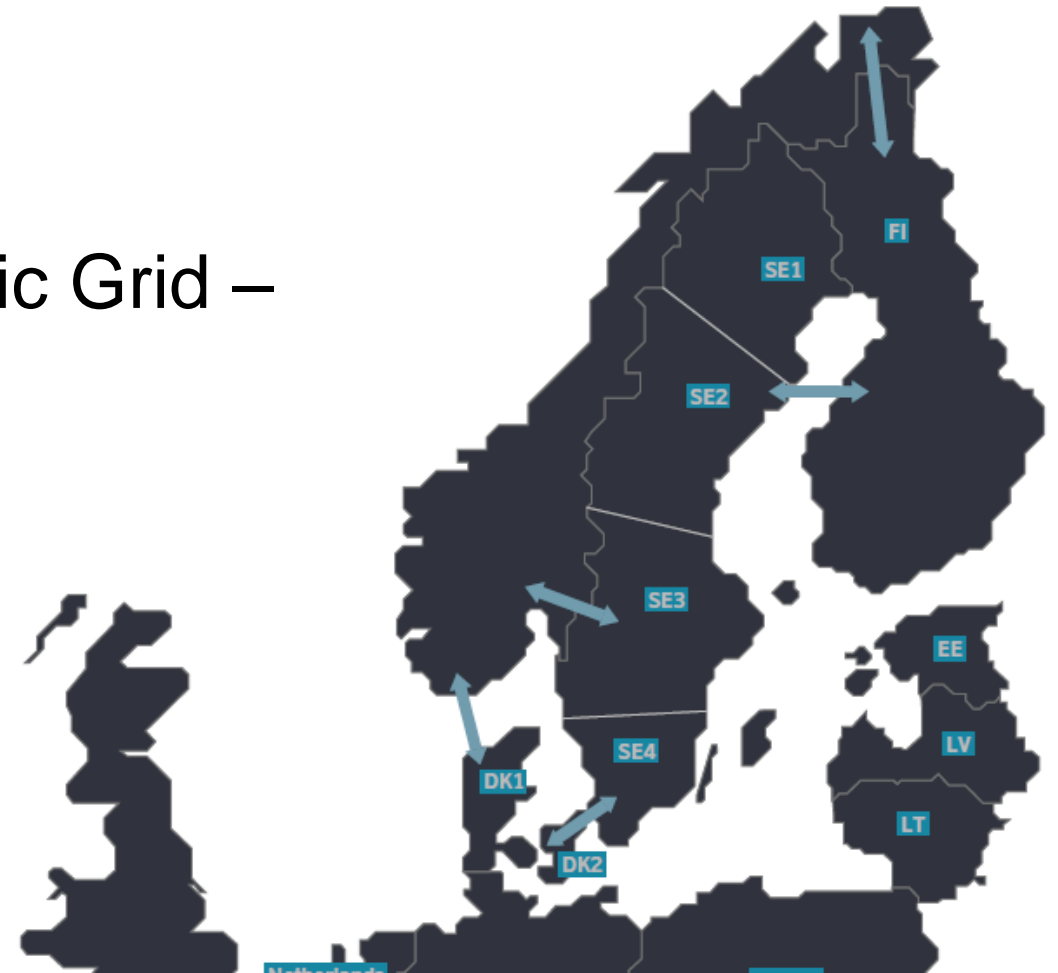
darker colours indicate already planned initiatives and lighter colours indicate new possible arrangements

Consultation process

- The discussion paper will be published for consultation next week
- Consultation for 2 months closing 1 July 2019
- Joint e-mail address for submitting responses

Challenges and Solutions in the Nordic Grid – Stakeholder Workshop

Break



Challenges from a Stakeholder Perspective

Stakeholder workshop arranged by the Nordic TSOs, April 26th



Challenges from a Stakeholder Perspective

Stakeholder workshop arranged by the Nordic TSOs, April 26th

*Antti Paananen, Director of Markets Units
Energy Authority Finland*





energy authority

CHALLENGES FROM A NRA PERSPECTIVE

Deputy Director General Antti Paananen

Energy Authority, Finland

Stakeholder Workshop arranged by Nordic TSOs 26 April 2019

Fair energy

WHERE WE ARE AND WHERE WE ARE MOVING?

We already have pan-European day-ahead and intraday markets and a common Nordic balancing market

We will move to pan-European balancing market guided by SOGL and EBGL regulation

- More efficient balancing of the European system as a whole with increased opportunities for Nordic market actors

Nordic Balancing Model initiative has been launched as one solution for the changing Nordic power system

Implementation of NBM initiative will require approvals on many issues by Nordic regulators

- In addition to following the exact rules stemming from the EU regulation, Nordic regulators are guided by a principle of well-functioning markets, striving for efficient price formation in all market time frames

POSSIBLE CHALLENGES WITH THE NBM

Implementation of a number of new market design elements

- Do the solutions work in practice and do they comply with the pan-European market integration?

Trade off with possible impact on efficiency in other market time frames

- Eg. reservation of transmission capacity for balancing

Barriers for market participants to enter the balancing market

- Bid sizes, aggregation, smart meters, 15 min ISP implementation

Move from manual processes to automatic processes

- Significant investments in ICT systems – not only by TSOs but also by market actors
- How to ensure quality of data?

HOW TO TACKLE CHALLENGES?

Prioritizing and keeping focus on the most essential issues - some of which follow from EU or national legislation - while implementing the Nordic balancing initiatives

Transparency and involvement in early stage to facilitate smooth implementation

- Cooperation and communication with stakeholders
- NRA discussions during preparation phase

Adequate impact assessments

Ambitious, but also realistic road map and timetable

Keeping also in mind, that Nordic balancing initiatives should fit and aim towards European harmonization!

Challenges from a Stakeholder Perspective

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Tore Heide Villund, Vice President Data Centres GlobalConnect



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*Asbjørn Grundt, SVP Regulatory Affairs NWE
Statkraft*



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*Eva Vitell, Director
Vattenfall Eldistribution*



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*Simon Horsholt, Consultant
Danish Agriculture and Food Council*

