Nordic Grid Development Perspective 2023

Stakeholder webinar 2023-10-25

SVENSKA KRAFTNÄT ENERGINET FINGRID Statnett

Meeting guidelines

In order to ensure technical quality in the meeting, we ask all attendees to adhere to the following guidelines:

- All microphones are automatically set to “MUTE”.
- All cameras are automatically set to “OFF”.
- To comment or pose a question, please write in the “CHAT” window.
- This webinar is being recorded

Agenda

10:00 Welcome

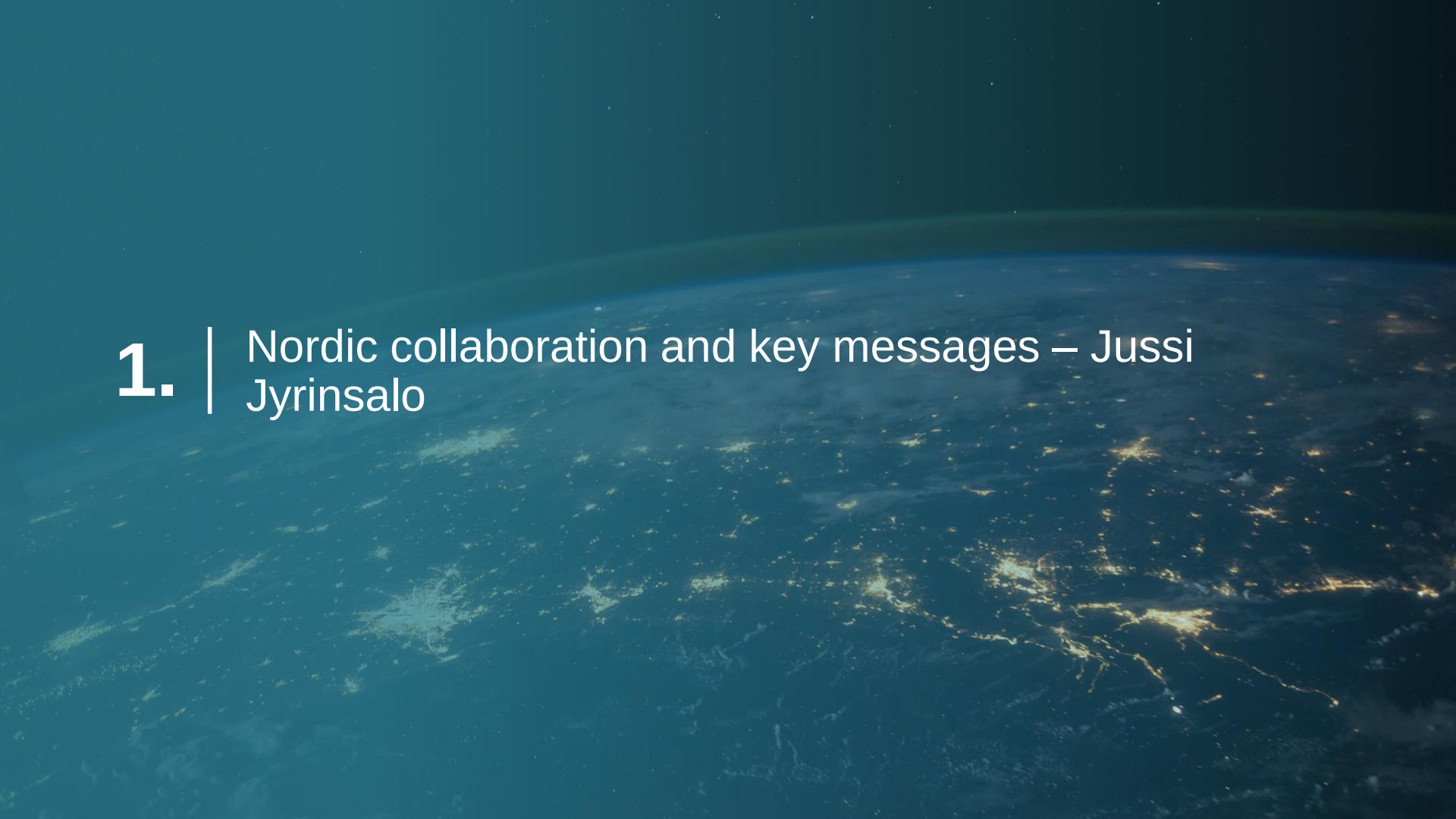
10.05 Nordic collaboration and key messages

10.15 High pace towards net zero emissions in the Nordics

10.25 Transition to a Power Electronic Interfaced Device dominated Nordic power system

10.45 Bilateral connections and grid development

10.55 Time for questions



1. Nordic collaboration and key messages – Jussi Jyrinsalo

Nordic collaboration

The main body of Nordic TSO cooperation is organized under four committees reporting to the Nordic CEO meeting:

- Market Steering Group
- Regional Group Nordic, system operation (also an ENTSO-E group)
- Nordic IT Group
- Nordic Planning Group (NPG).

NPG prepares a biannual publication called Nordic Grid Development Perspective (NGDP). Grid planning cooperation is also done on Baltic Sea level. We try to avoid parallel processes, i.e. not to create parallel grid plans, especially with respect to the ones published by ENTSO-E.

NGDP - history

NGDP 2017: current drivers for grid development, national projects of Nordic importance, five identified cross-border corridors to be further studied

NGDP 2019: current drivers for grid development, national projects of Nordic importance, five bilateral studies on the corridors

NGDP 2021: bilateral study updates, joint Nordic scenario for production and consumption development, identification of future price differences between Nordic price areas, focus area studies (north-south, adequacy, offshore wind)

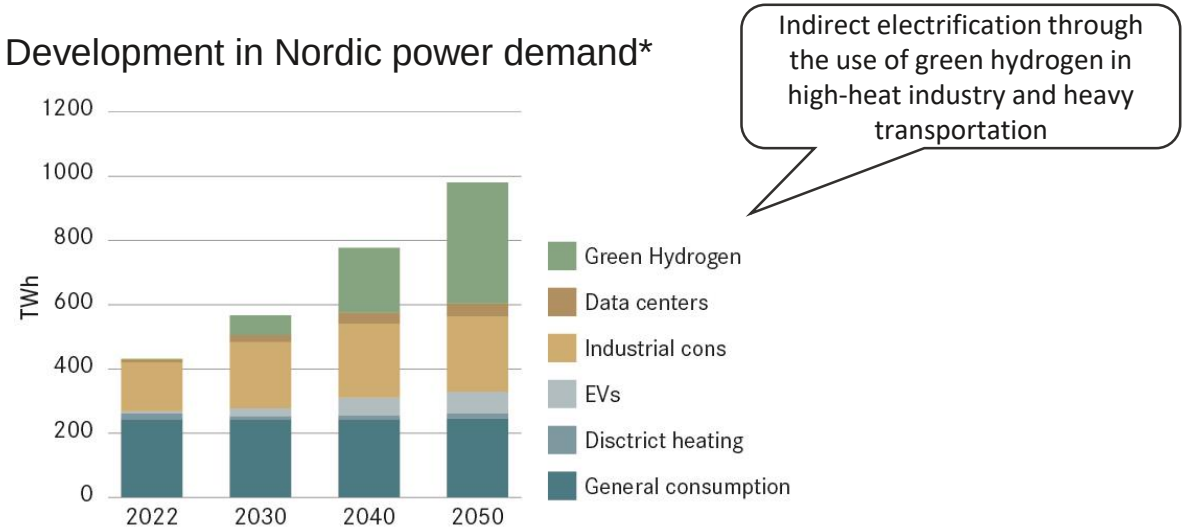
NGDP 2023 - content

Key messages

- The Nordic power system is well integrated due to a long history of cross border cooperation on grid, operations, and market development. This has been a core prerequisite for the high level of renewable production, and it will continue to be so with a Nordic power system which is expected to be carbon-free around 2035/40.
- The direction towards a carbon-free system has been laid out, and the Nordic TSOs are focused on making this possible even though it is complex and requires new solutions and increased collaboration to ensure the ambition of a good investment climate, increased amount of renewables, increased electrification, and continued high levels of security of supply.
- A strong and robust Nordic power grid is central to enable the right pace and evolvement of the system, and to ensure this we need significant amount of new grid investments. Having a strong grid both nationally and across borders enables continued utilization of national competitive advantages in the Nordic system.
- The expected high growth in power demand, alongside a surge in intermittent power production from solar and wind energy leads to escalating need for a rapid development of new flexibility within the power system which is better addressed in collaboration.
- A significantly higher proportion of power equipment, connected via power electronics, presents significant challenges to the future power system, but with a common development and testing of new solutions we can find new solutions for the Nordic power system.

2. High pace towards net zero emissions in the Nordics – Julie Gunnerød

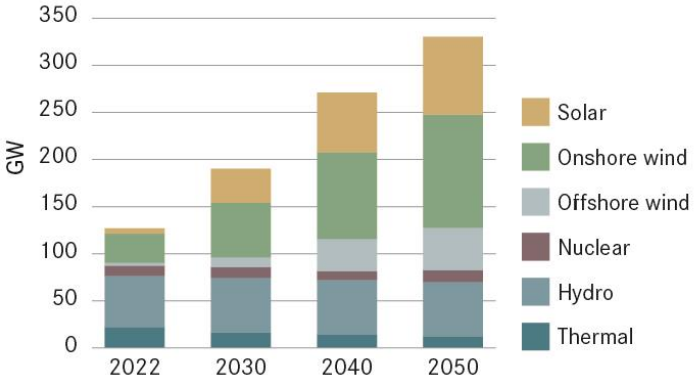
Electrification drives strong growth in power demand



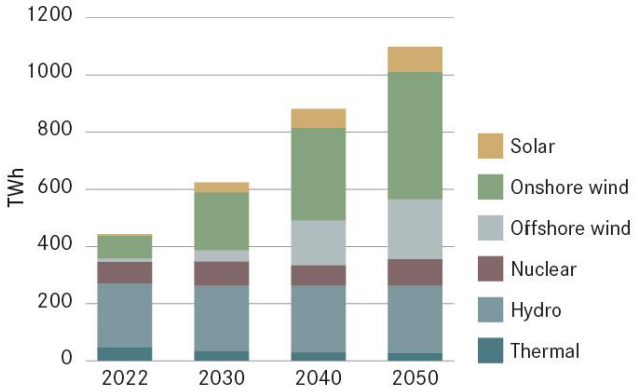
*TSO Scenarios summarized: Statnett LMA 2022 – Base case scenario. SVK LMA 2023 – scenario FM (to be published Q4 2023). Fingrid best estimate scenario. Energinet AF22.

Wind and solar to be largest sources of production

Development in Nordic power generation (GW)*



Development in Nordic power production (TWh)*



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Massive need for flexibility – the incentives increase

Reservoir hydro

Demand flexibility

Hydrogen – flexible demand, energy storage, fuel

Peak power plants

Transmission grid

High pace in the transition – challenges may rise

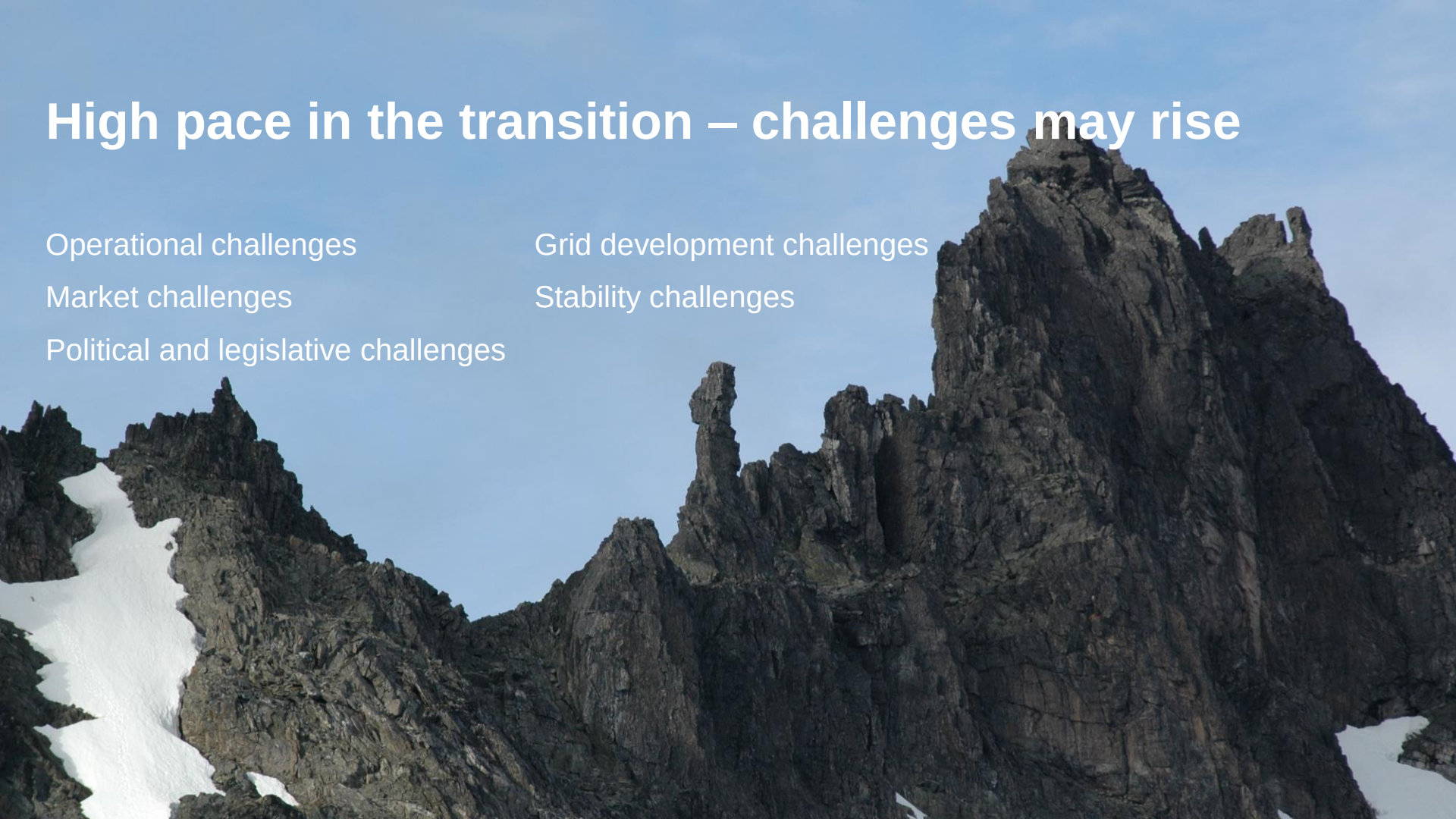
Operational challenges

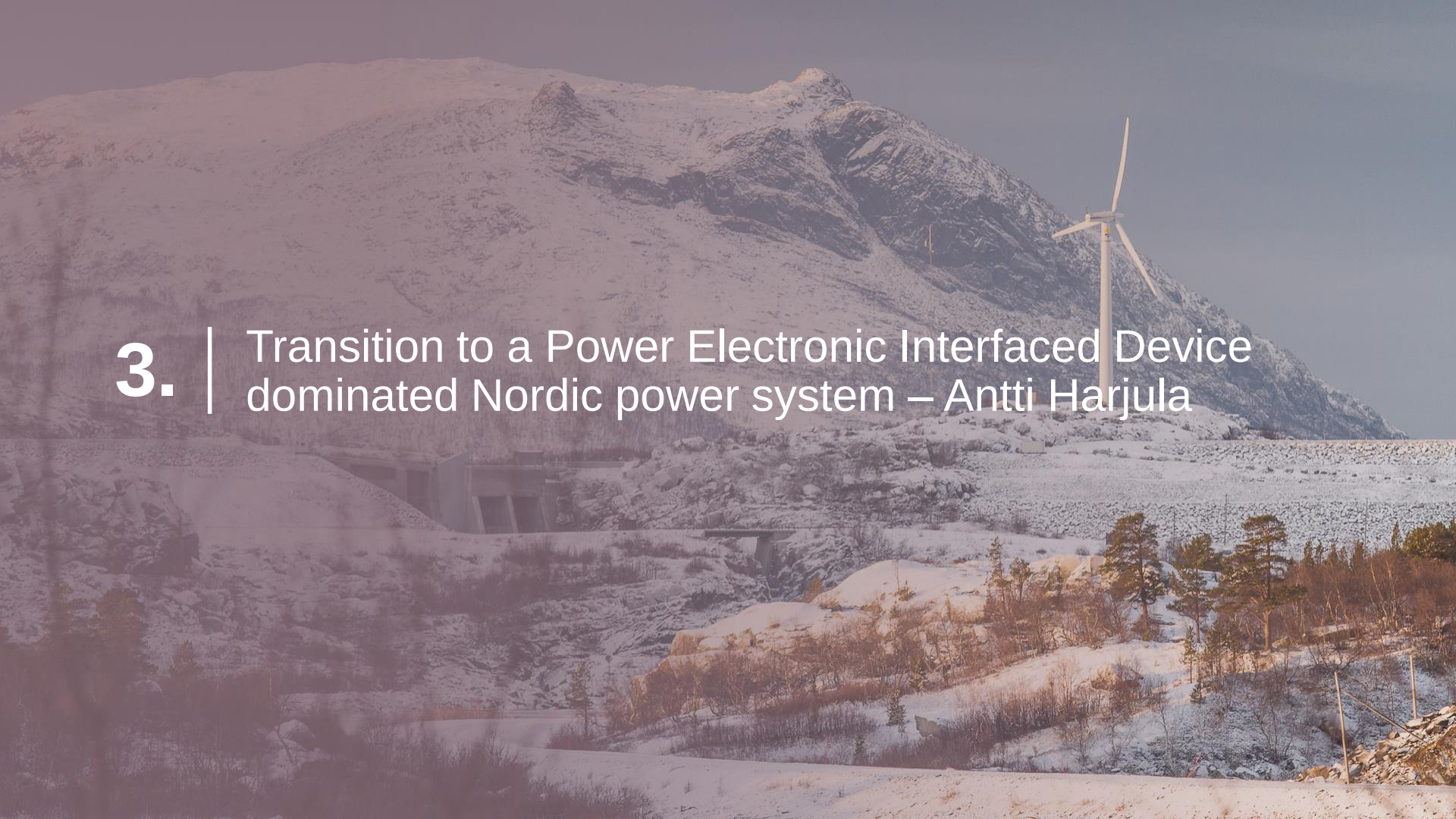
Market challenges

Political and legislative challenges

Grid development challenges

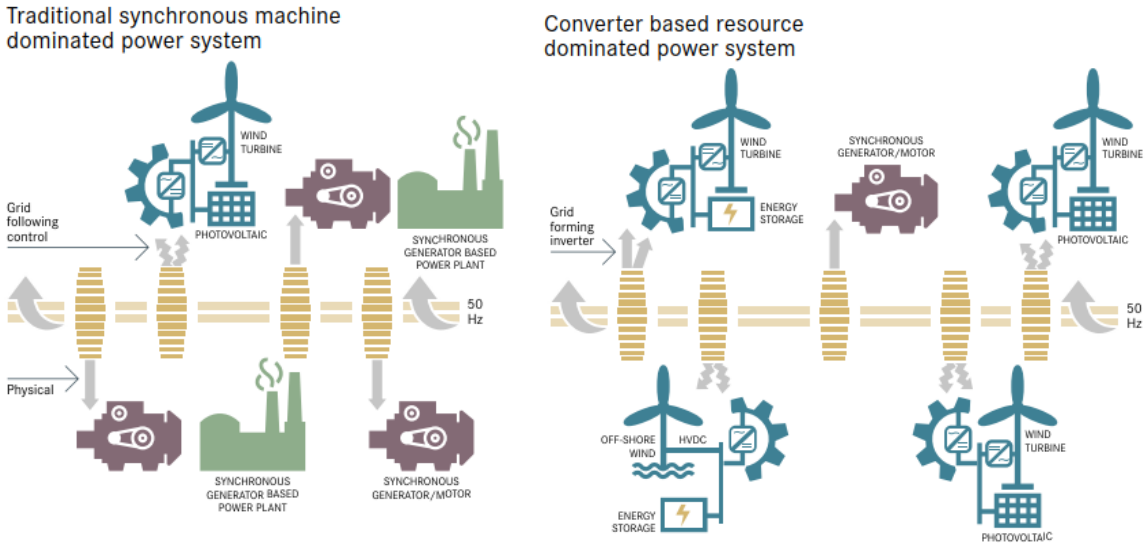
Stability challenges





3. Transition to a Power Electronic Interfaced Device dominated Nordic power system – Antti Harjula

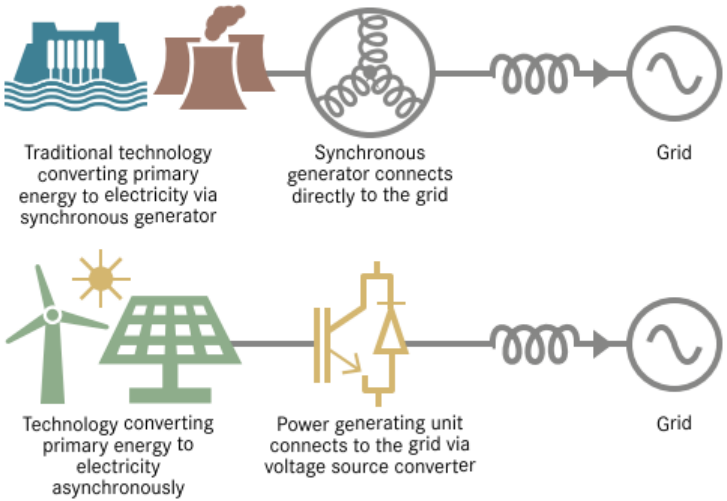
Change in technical coupling of generation with the power system



Ongoing energy transition leads to changes in the technical performance of the power system.

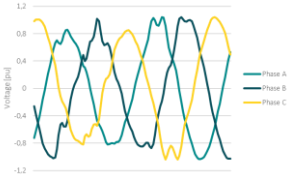
Left figure represents the traditional power system, where most power plants are synchronous machines with electrical-mechanical coupling to the grid. The figure on the right represents the converter dominated power system, in which most of the plants' connections to the grid are power electronic interfaced.

Power electronic interfaced generation vs. synchronous generation



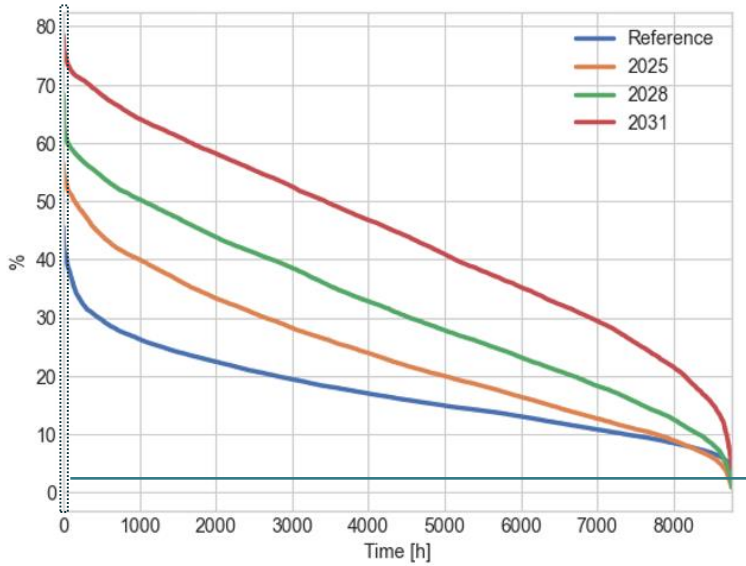
Power electronic interfaced generation (PEID) do not inherently have the same stabilizing characteristics as the synchronous generators.

Massive increase in share of grid following PEID generation can cause for example oscillations in voltage or voltage distortion.



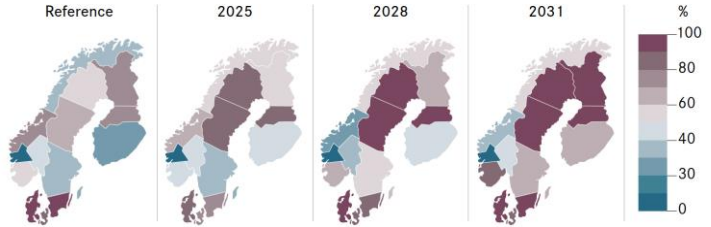
Share of PEID will be increasing, unevenly spread and more varying

Forecasted duration curves of share of wind and solar generation in the Nordic synchronous region



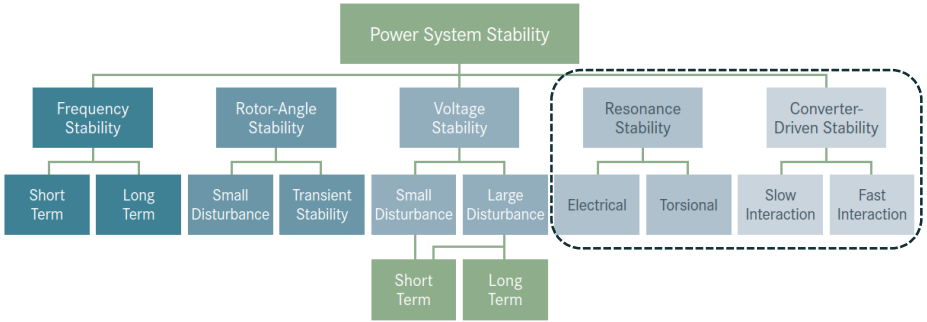
To operate a power system of very high penetration (>~65%) of power electronic interfaced generation new capabilities and solutions are needed. *

Share of converter connected wind and solar generation per market model region during system level maximum penetration hour



*** https://www.h2020-migrate.eu/**

Change in system characteristics - stability



Power system stability phenomena changes with increase in power electronic interfaced equipment.

New level of accuracy in models, and new ways to analyze, mitigate and monitor are needed.

Identified technical objectives that require Nordic co-operation

Technical objectives to ensure the system stability in Nordics with PEID dominated system
➢ System response during fault and recovery phase is managed
➢ Short term frequency stability / inertia response is managed
➢ Cross border and system level converter driven oscillations are managed
➢ Electromechanical inter-area oscillations are managed
➢ Nordic black start and islanding capabilities are maintained
➢ Cross-border resonance stability is managed
➢ Cross-border effects of voltage control is coordinated
➢ Cross-border relay protection systems are coordinated and well-functioning
➢ Cross-border power quality is managed

Tools for ensuring the technical performance of the future Nordic power system

Grid solutions

Market based solutions

Enhanced power plant technical capabilities

Joint Nordic actions initiated

Joint Nordic work has been started to enhance study capabilities and harmonize requirements/definitions.

Nordic TSOs are currently also developing a Nordic Stability Roadmap toward a reliable converter dominated grid.

The roadmap shall contain a strategy and action plan for implementation of a set of approaches to mitigate the foreseen challenges. The Stability Roadmap will be published in 2024.

4. Bilateral connections and grid development – Cecilie Hansen

Overview of the projects in the Nordics

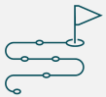
Nordic TSOs are massively increasing their investment levels

To balance power production and consumption

A strong grid is the key

To distribute power where it is needed

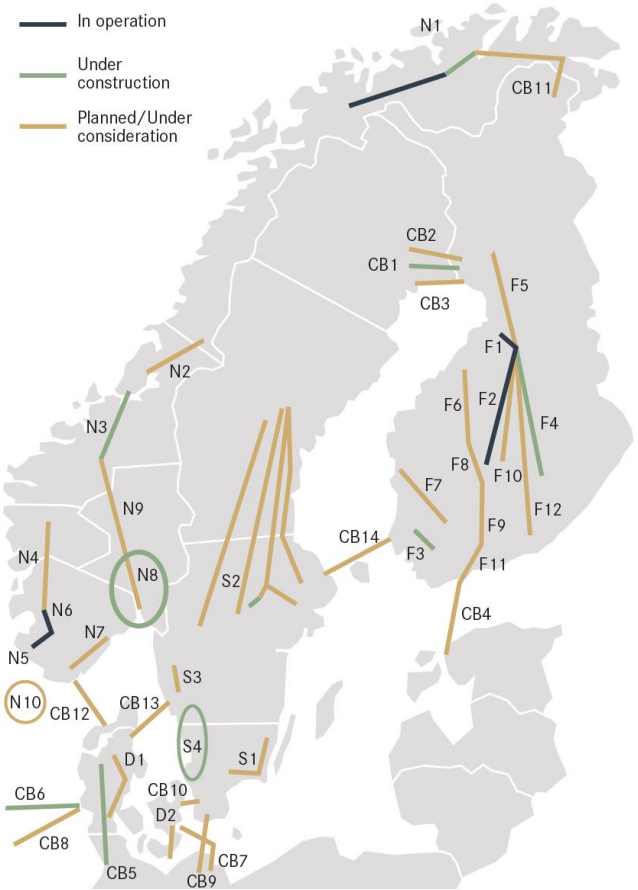
To allow for balancing support services and stabilizing measures over larger geographical distances



Many ongoing projects has significant Nordic impact

Bilateral connections (Nordic TSOs)

Grid development projects (internally and nearby TSOs)



Grid development projects in the Nordics

- Investments on interconnectors
  - Connections between the Nordic TSOs
  - Connections to nearby TSOs
- Internal investments
  - Grid renewals and expansions
  - Grid to offshore wind power

5. Questions