Nordic flexibility markets – Practical experience and lessons learned from Germany

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Agenda

1. Setting the scene | AFRY  
2. Experience from NODES markets  
3. Insights from Germany | E-Bridge  
4. Roundtable and Q&A
The energy transition is expected to increase the need for grid investments. Utilising flexibility might reduce or delay some of it.

**Total and peak Nordic electricity demand will grow by 2% and 3% per year until 2030**

**20GW of new intermittent RES capacity will be connected to the Nordic electricity grids by 2030**

**Electricity demand and intermittent renewables will grow unevenly across the Nordic countries, further increasing congestion issues**

**Approx. 30% of low voltage lines in Europe older than 40 years**

**>€16 bn investments in power distribution grid in Sweden and >€6 bn in Denmark until 2030**

**>€13 bn investments in power distribution grid in Norway until 2030**

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1) Eurelectric: Connecting the dots (2021); 2) https://enerwe.no/ny-rapport-nettelskapene-vil-investere-135-milliarder-i-stromnettet/167274; 3) AFRY projections (Central scenario)
Key drivers towards a successful market for local flexibility in the Nordics

- Demand for local flexibility
- Incentives for flexibility providers
- Processes and tools for flexibility procurement
- Market harmonisation
- Pilot, research and development projects
Need a solid regulative framework facilitating for

Electricity Market Directive
National regulation
Nordic cooperation (Flex4RES)

**MAIN REGULATORY CHALLENGES**

- Remove barriers of entry and incentivise innovation in new technology and independent aggregators
- Create incentives for DSO to optimise the mix of grid investments and flexibility procurement
- Holistic framework to avoid local differences that hinders efficiency and competition
Is there a demand for local flexibility?
Interviews carried out by AFRY on behalf of NER suggest that current need for flexibility is medium/low and DSOs may need stronger incentives to procure flexibility and higher certainty on the reliability of flex resources.
Those interviewed expected more flexibility procurement in the future, reducing or postponing some share of network investments.

Source: https://www.nordicenergy.org/article/new-report-market-design-options-for-procurement-of-flexibility/
To attract providers of local flexibility, reasonable economic incentives as well as practical solutions is essential.
A complete market design for flexibility involves a range of services covering complex problems that needs to be solved over time.
Numerous flexibility initiatives have evolved in recent years, driving innovation in the field. Eventually, some level of harmonisation is needed.

- NODES
  - Sthlmflex (SE)
  - NorFlex, FlexLab, Smart Senja, Engene (NO)
  - Mitnetz (DE)
  - IntraFlex (UK)
  - Euniversal project (PL,PT,DE)
- Coordinet – four pilots in SE
- Piclo (UK)
- Gopacs (NL)
- Enera (DE)
- Intereface, SysFlex and OneNet (European projects, funded by Horizon 2020)
- Flexens (FI)
- Other smaller pilots

Note: This map captures a wide range of initiatives in Europe, both active markets, pilots and ongoing projects. It is however not comprehensive.
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How does it work?
- practical examples
NODES market facilitates trading of flexibility between grid operators and flexibility providers
Clean Energy Package – the framework for change

- Enhanced role of the DSO, particularly in procurement of ancillary services, flexibility
- Equal treatment of generation, demand side response and storage
- Aggregation permitted
- Market based prices

Electricity Directive (recast)
2009 Directive, plus rules on:
- Reinforcing competitive energy markets
- Consumer rights, including billing, metering, dynamic pricing, switching, using aggregators, comparison tools and addressing energy poverty
- Framework for DSR and aggregation
- Assessing alternatives (e.g., DSR, storage) to new generation capacity
- Enhanced role of DSOs, particularly in procurement of ancillary services, flexibility, data management and integration of electric vehicles
- "Active consumers/consumers" and "citizens' energy communities"
- Reinforcement of NRA roles, including in regulation of ENTSO-E, EU-DSO and RCCs

Market principles
Competitive energy markets:
- Market-based prices
- Equal treatment of generation, demand-side response (DSR) and storage; aggregation of consumers, generators and demand response permitted
- Enhancement of more flexible generation and demand
- Measures to enhance independence of NRAs

Focus on flexibility
- No DSO/TSO ownership of storage (limited exceptions)
- Demand response – active customers and aggregators to be able to act without consent of suppliers, to be balance responsible and to compensate suppliers
- NRAs, TSOs, DSOs to ensure that DSR can participate fully
- Member States to incentivise DSOs to procure flexibility

(Digital) Flexibility value chain

**Buyers**
- BRP
- Grid companies
- DSO / TSO

**Marketplace**
- Transaction
- Trade confirmation
- Sales Bid

**Sellers**
- Flex Service Provider
- FSP/BRP

**Flex technology**
- Dispatch signal
- Compensation
- Flexibility

**Asset owner**
Implicit flexibility can be released by imposing a time based or dynamic tariff scheme on the customer.

Explicit flexibility can be released by:
- discount schemes (interruptible tariffs) towards customers which are willing to be interrupted.
- Market-based solution for buying LongFlex (availability contracts) will allow the grid operator to secure flexibility for future activation, or
- ShortFlex which is flexibility paid at activation price in the intraday time frame.

Market-based solution unlocks the true value of flexibility!
TSO-DSO coordination and activation of flexibility assets in the medium and low voltage grid
TSO-DSO coordination and activation of flexibility assets in the medium and low voltage grid.
TRANSPARENCY
COMMON LANGUAGE
Common language – and clear roles

Buyers
- Gridtools
  - Grid analysis
  - Simulation
  - Forecasting
  - Optimization
  - Congestion management
  - Buy flexibility

Marketplace
- Market Platform
  - Open
  - Transparent
  - Independent
  - Provide visibility and matching
  - Be cost effective and automatic
  - Connect to other markets

Sellers
- Flextools
  - Forecasting
  - Optimization
  - Aggregation
  - Activation
  - Verification
  - Re-balancing
  - Portfolio optimisation
  - Sell flexibility

Location
Price
Quantity
Role of a market

- A market is a place where buyers and sellers can meet to facilitate the exchange or transaction of goods and services.
- Markets establish the prices of goods and services that are determined by supply and demand.

www.investopedia.com
Bottom up – integrated market design
Flexibility offered bottom-up
Flexibility bought top down
Asset registration

- DSO market
- Congestion areas
- Asset registration with DSO
- Assets behind the meter
NorFlex – GridNodes - congestion zones

- Arendal sentralnettspunkt 420/132 kV
- Engene 132/22 kV
- Nettstasjon Feviktun 22/0.230 kV
NorFlex – corresponding order books

- Arendal sentralnettspunkt 420/132 kV
- Engene 132/22 kV
- Nettstasjon Feviktun 22/0.230 kV
Level playing field

- Transparent
- All types of flexibility compete on a level playing field
- Creating merit order on activation price (ShortFlex)
Drill down or aggregate up

Arendal sentralnettspunkt
420/132 kV

Engene
132/22 kV

Local bid forms part of the merit order stack higher up in the grid
TSO/DSO Coordination

NorFlex:
Coordination via sequential access to DSR

Value Stacking for flexibility providers
- NODES resolution 0.001 MW
- mFRR resolution 1.0 MW (exception from 10 MW – 5 MW rule)
Sequential vs Integrated TSO/DSO Coordination

NorFlex:
Coordination via sequential access to DSR

Potential for improvements if TSO/DSO access the same platform for congestion management.
Market data
Trading activity

**NODES market data:**
- **YTD 2021**
  - 103,3 MWh
  - 1 473 trades
  - Flexibility price range: 100-30 000 NOK/MWh

**IntraFlex**
- **NODES market data:**
  - Phase 1 & 2
  - 800 MWh
  - >1 400 trades
  - Flexibility price range: 1-360 GBP/MWh
  - Average price: 276 GBP/MWh

**Jan-Mar 21**
- 2 276,4 MWh
- Flexibility price range: 200 - 5 000 SEK/MWh
- TSO temporary subscription: 246-244 SEK/MWh
We facilitate so that you can innovate
Changed mindset? From train driver to pilot
GridTools - getting ready for DSO role

- GridTools
  - modelling grid use-cases (the problem)
  - predicts the problem based on input data (where, how much and for how long)
  - publish where problem is located (NODES grid nodes)
  - post buy orders on market (signal need for flexibility)
  - collects and evaluates offered flexibility from market (sell orders from NODES)
  - optimize use of flexible distributed energy resources (based on grid preferences)
  - trades flexibility in the market (activation)
  - problem solved!

Fully robotized value chain
- no operator intervention necessary after initial setup
GridTools – DSO connecting to NODES API
NODES rule book

Common framework for buyers and seller which allows for:

✓ reserve flexibility,
✓ activate flexibility,
✓ automate the transaction,
✓ send trade signals for activation,
✓ validate delivery and
✓ settle the transaction,

creating transparency, independence and a level playing field for all market participants.
Thank you!
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Extremely high costs for congestion management in Germany

- Every year, Germany incurs costs of more than EUR 1 billion for grid and system security measures - a very large part of this is incurred for redispatch by the transmission system operators.

- One reason for the high costs is that only a few generators are currently used for redispatch.
Approach to reduce costs for congestion management and enable flexibility: Consideration of generators in distribution networks for Redispatch 2.0

- The Bundestag passed the amendment to the Network Expansion Acceleration Act (NABEG 2.0) on April 4, 2019.
- The act includes new instruments for managing network congestion: Redispatch (so far: only for TSOs and conventional power plants) is extended to storage facilities, RES generators and CHP plants, thus softening the priority rule ("Redispatch 2.0").
- Redispatch 2.0 must be applied for congestions in the transmission and distribution network (so far: real time measures).
The use of flexibility is also necessary for congestion management in distribution networks in Germany.
Complex implementation in an extremely short period time: Go Live 1.10.21
Data Exchange between more than 100,000 market participants and 900 network operators is organized via Connect+

- Connect+ is a first joint cooperation of a large number of network operators nationwide and across all network levels to establish a common data exchange.

- Connect+ offers a uniform interface for data exchange between the market and the network operator (PVK) and between network operators themselves (NKK).

- Connect+ provides network operators and market participants with a uniform data channel in the sense of the new market role of the "data provider" as a national "single point of contact" for the exchange of master and planning data between all parties concerned.

- The basic data exchanged via Connect+ are mandatory "input and output data" for all Redispatch 2.0 processes.
Practical challenge for DSOs: New processes and IT systems must be implemented in very short period.

**Grid state analysis**
Development of a network condition forecast for observable and congested parts of the network, considering forecasts and planning data.

**Energetic compensation**
Management and procurement of the energetic compensation of the congestion measures and schedule management.

**Balancing and Accounting**
Implementation of processes for the handling of balancing zones as well as handling of accounting and billing processes.

**Forecast and validation**
Creation of forecasts and development of functions for optimization, intersection and validation of forecast quality.

**Redispatch dimensioning**
Process for dimensioning redispatch measures considering congestions, technical constraints, costs and measures taken by other network operators.

**Generator control (real time)**
Adaptation of the control system to the new requirements for curative congestion management.

**Data exchange**
Interfaces for data exchange via Connect+ and IT communication paths within the network operator.
Bottom-Up Approach for TSO-DSO Coordination to ensure network security and make use of possible efficiencies (“in a nutshell”)

Generators are informed about redispatch measures (correction of generation schedule)

Each DSO creates forecasts for generation of all RES connect to its network and provides them via Connect+ to all other network operators

TSOs calculate the optimal use of flexibility for congestion management considering the measures of DSOs and inform all other network operators about planned measures

Operation Manager of RES provide correction of the generation plans e.g. due to maintenance and information about the provision of reserve power

DSOs provide information about flexibility, which cannot be used by other network operators due to limits of the local network

DSOs calculate the optimal use of flexibility for congestion management and inform all other network operators about planned measures so that they can be considered

Data Exchange via

Netzbetreiberkooperation
New interfaces between market parties are necessary.
Processes can only be implemented with a high degree of automatization.

A degree of automatization requires a sufficient digital data bases of the network.

Cooperation projects of network operators have been very successful.

Several DSOs implemented a business process outsourcing to reduce costs and handle complexity.

IT systems were implemented outside of operation centers.

Software as a service solutions were favored in many cases.
Market-based flexibility

- Germany is very cautious about flexibility markets due to fears of inc-dec-gaming.
- A new law (§ 14 d EnWG 2021) provides a new approach due to pressure from the EU.
- It is discussed to use the “Redispatch 2.0 infrastructure” for a “hybrid model” which includes voluntary market-based offers from load and obligatory cost-based offers from generation.

Smart network integration of e-mobility

- A proposal for the possibility of direct control of e-cars by grid operators was withdrawn by the Ministry of Economics.
- Currently, several projects in Germany are aiming to use the “Redispatch 2.0 infrastructure” coordinate charging plans between BEV and DSOs to avoid local congestions.
- A relief of higher voltage level can be reached with time-variable network tariffs.

Enabling market-based flexibility (it’s a must!) and smart integration of e-mobility by using the processes and infrastructure of Redispatch 2.0
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CONCLUDING REMARKS

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More webinars will follow with relevant topics, and any update on the evolving situation.