The Nordic Capacity Calculation Methodology (CCM) project Stakeholder Forum

Web Conference (13.00-15.00)

25 April 2019

ENERGINET SVENSKA KRAFTNÄT FINGRID

Agenda

1	Welcome	13:00 – 13:05
2	Introduction and objective of the Nordic SHF web conference – Ulrik Møller (Energinet)	13:05 – 13:10
3	Background of the Request for Amendment (RfA) – Søren Søndergaard (DUR)	13:10 – 13:20
4	Questions and answers	13:20 – 13:40
5	Presentation on the impact of the amendments on the capacity calculation – Ritva Hirvonen (Fingrid)	13:40 – 13:55
6	Questions and answers	13:55 – 14:10
7	Presentation on the Dynamic Security Analysis – Hans Abildgaard (Energinet)	14:10 – 14:30
8	Open discussion; questions and answers	14:30 – 15:00

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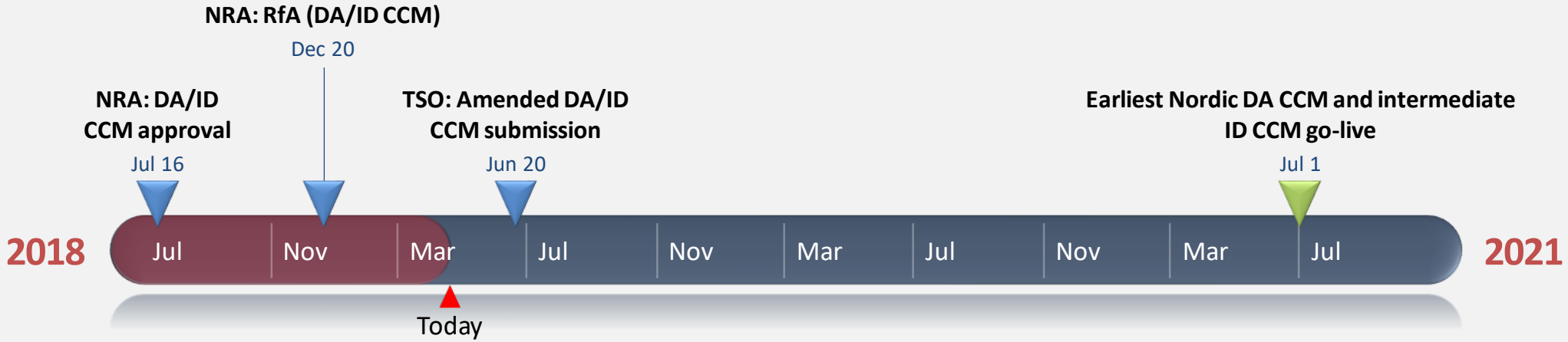
Introduction



- Nordic NRAs approved the Nordic DA/ID CCM in July 2018
  - ✓Nordic NRAs requested a one-year parallel run to be performed
- The NRAs of the Nordic CCR issued an RfA in December 2018
- The TSOs of the Nordic CCR amended the DA/ID CCM; a public consultation is ongoing

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Regulatory background for the changes to CCM in CCR Nordic

Energiavirasto, **Energimarknadsinspektionen** and **Forsyningstilsynet** made a joint agreement in combination with the approval of the CCM in July 2018. The main points in the agreement were:

- ”The CCM proposal is generally deemed **compliant** with relevant articles of CACM“
- ”The proposal does not provide suficient **clarity** on the roles in capacity calculation, especially regarding **dynamic stability calculation**“

Therefore:

- “The TSOs should start preparing to refine the now agreed methodology with processes and elements to enable for the **CCC to handle dynamic stability** in capacity calculation“
- “The CCC shall calculate the capacities using the **technical limitations** of the system needed to ensure secure system operation i.e. operational security limits”.
- “The appropriate format for the operational security limits shall not include any pre-calculation by the individual TSO where the operational security limits are transposed to flow limits presented with MW values”

Regulatory background for the changes to CCM in CCR Nordic

Following the joint agreement and discussions with the Nordic TSOs; Energiavirasto, Energimarknadsinspektionen and Forsyningstilsynet finished a request for **amendment to the CCM**, which was sent to the TSOs in December 2018.

The amendment request was built upon the agreement and the content was:

- ”The CCR Nordic TSOs shall deliver an amended methodology **within 6 months** following the reception of this RfA”
- “... request the TSOs to start developing an appropriate **grid model** in coordination with each other, in order for the CCC to handle dynamic stability ...”
- “The TSOs shall clarify the methodology by clearly defining and describing the roles and rules, ...”
- “... each Nordic TSO is required to provide **the operational security limits** to the **CCC** in an appropriate format as well as all the relevant data”
- “The methodology shall be amended to state that operational security limits shall be presented in appropriate units describing a specific power system physical property“
- “The Nordic CCR NRAs also expect that the **implementation plan** for having the CCC calculate the dynamic stability limits will **progress simultaneously** with the implementation of the approved capacity calculation methodology”

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Amendments requested by NRAs

- Methodology for determining operational security limits (Article 4)
  - each TSO to provide the operational security limits to the CCC in an appropriate format as well as all the relevant data needed to use the security limits in coordinated capacity calculation process
- Capacity calculation process (Article 31)
  - include the process presented in Figure 2 in a written format clarifying the roles and responsibilities of TSOs and the CCC in legally robust manner
- Publication and implementation (Article 32)
  - Dynamic Stability Assessment (DSA) to be performed on a dynamic CGM
  - a plan for empowering the CCC to perform DSA based on operational security limits and dynamic calculations to take place at the CCC

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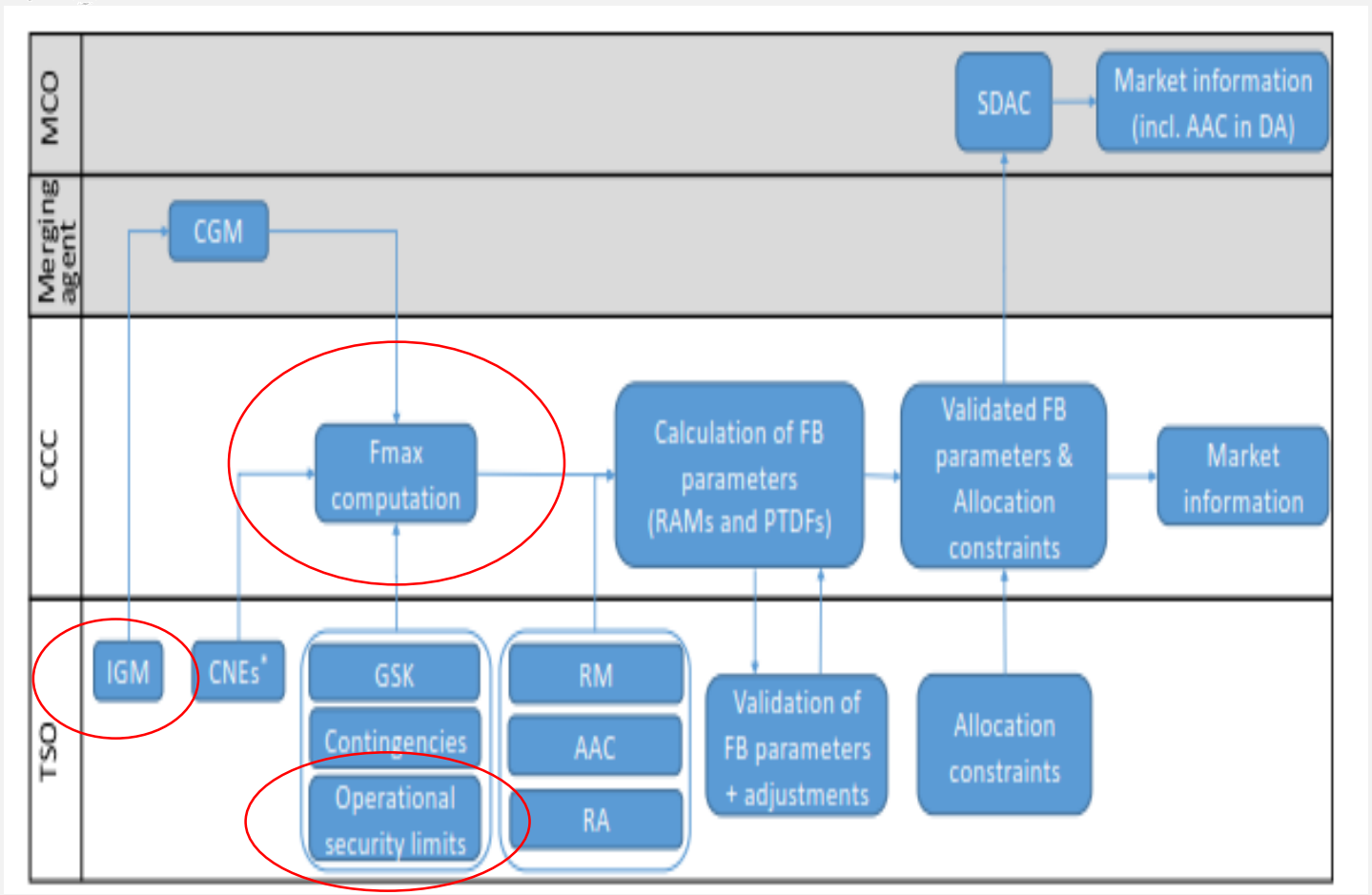
Capacity calculation process & entities involved



- IGM: includes dynamic data
- Operational security limits:
  - shall present operational security limits in an appropriate format describing a specific power system physical property
  - shall not include any pre-calculation by the individual TSO, where the operational security limits have been transposed to power flow limits presented with MW values
- F_{max} computation:
  - CCC responsible for calculations applying amended provisions operational security limits

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Amendments to Article 4(1) & 4(2) – operational security limits

4(1) The TSOs shall apply the same operational security limits as in the operational security analysis. These limits shall be defined in accordance with Article 25 of the SO Regulation. **The TSOs shall present these operational security limits in an appropriate format describing a specific power system physical property. The appropriate format shall include such as**

a) **thermal limits shall be presented as MVA or kA, for DC lines this implies MW;**

b) **voltage limits shall be presented related to nominal voltage (per unit) or kV;**

c) **frequency limits shall be presented related to nominal frequency or Hz; and**

d) **dynamic stability limits shall be presented per unit for voltage and damping for electromechanical oscillations**

4(2) Each TSO shall provide the operational security limits **for its bidding zone(s)** to the CCC to be used in the capacity calculation. **These operational security limits shall not include any pre-calculation by the individual TSO, where the operational security limits have been transposed to power flow limits presented with MW values**.

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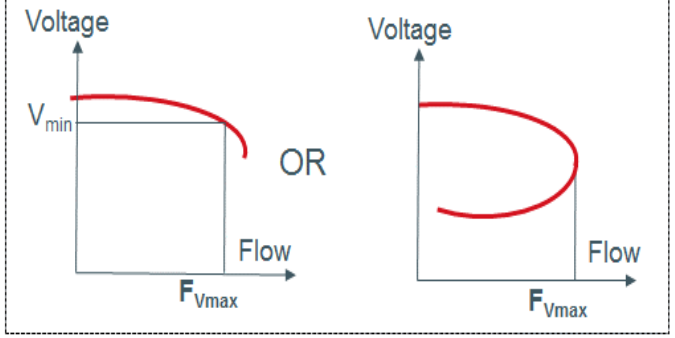
Definition of maximum flow (Fmax) for CNEs

Thermal limit

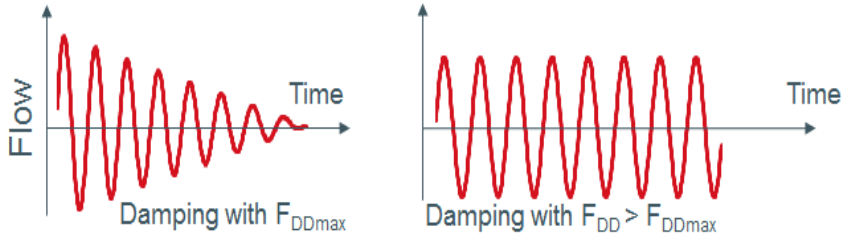
F_{Tmax} based on node voltage and max current for limiting component during a certain time

Voltage stability (static)



Dynamic system stability assessment

- **Voltage stability/collapse** - ability to maintain steady acceptable voltage and reactive power balance after disturbance → F_{DVmax}
- **Transient stability** - ability to maintain synchronism after disturbance → F_{DTmax}
- **Damping** – ability to damp power oscillations after disturbance → F_{DDmax}



Definition of maximum flow F_{max} on critical network element (FB) or on bidding zone border (CNTC)

Example:

Thermal limit → F_{Tmax}

Voltage limit (static) → F_{Vmax}

Voltage limit (dynamic) → F_{DVmax}

Transient stability → F_{DTmax}

Damping → F_{DDmax}

$F_{max} = \min(F_{Tmax}, F_{Vmax}, F_{DVmax}, F_{DTmax}, F_{DDmax})$

$= F_{DDmax}$

Need common static grid model for calculation

Need common dynamic grid model for calculation

Important that static and dynamic grid models are consistent in order to define F_{max} properly

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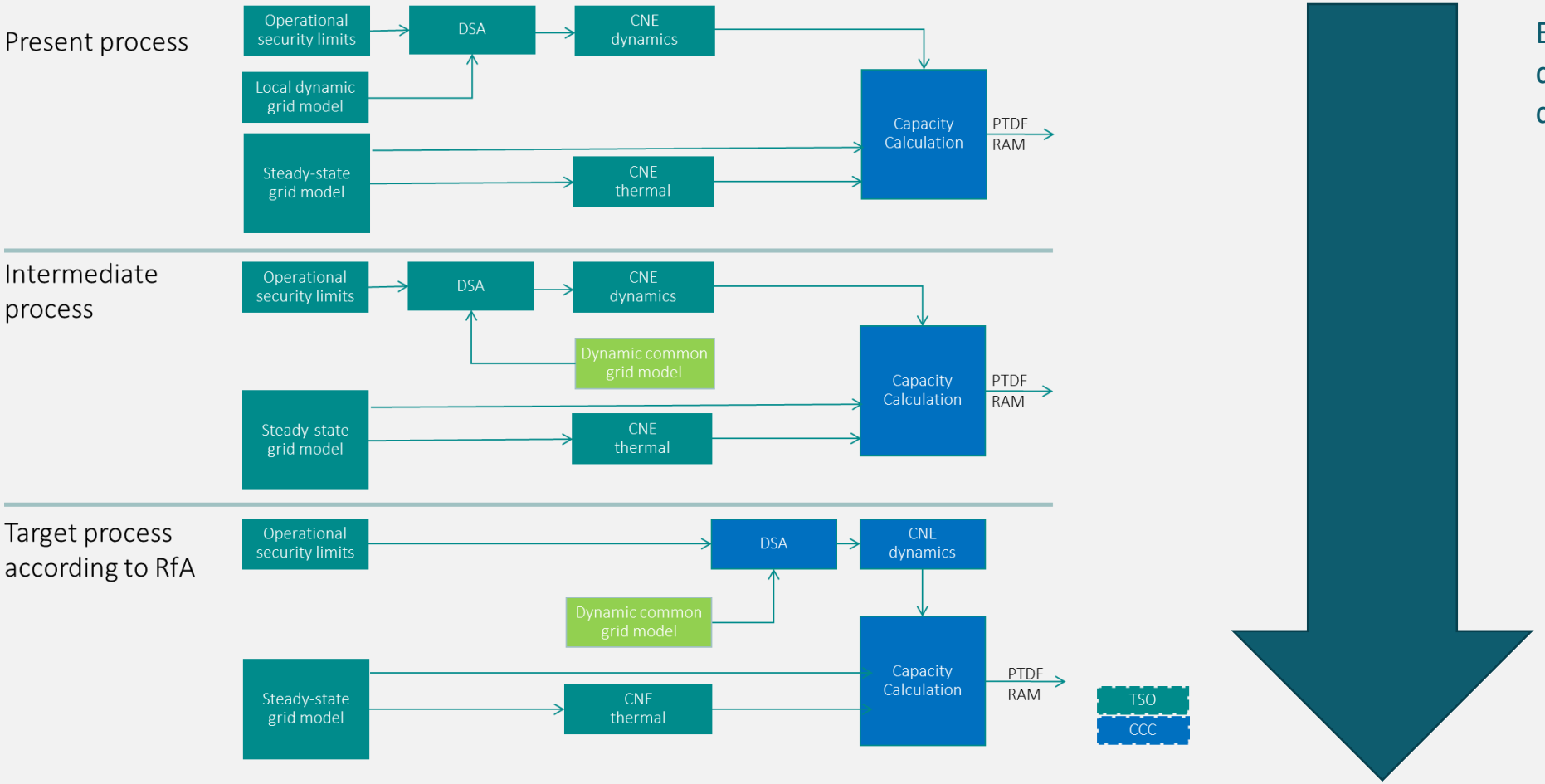
Article 32 - Implementation



Each TSO responsible for dynamic grid model and dynamic security analysis

CCC responsible for common dynamic grid model and dynamic security analysis

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Challenges

- Today, the Nordic TSOs do not have DSA available for all capacity calculation timeframes and for the entire Nordic power system.
  - Each TSO perform offline DSA on grid models and criteria tailored for specific issues
- In order to achieve the ambitious goal of enabling the CCC to perform DSA for capacity calculation, several fundamental prerequisites are necessary
  - For all hours a successful creation of Individual Grid Models (IGM) from the TSOs and CGM merging at the CCC.
  - Availability plans are included in the IGM for the all IGM timestamps. Planned outages must be considered.
  - All necessary information to allow calculations is available for all participants (TSOs and CCC).
  - Full interoperability between all simulation tools used by TSOs and CCC.

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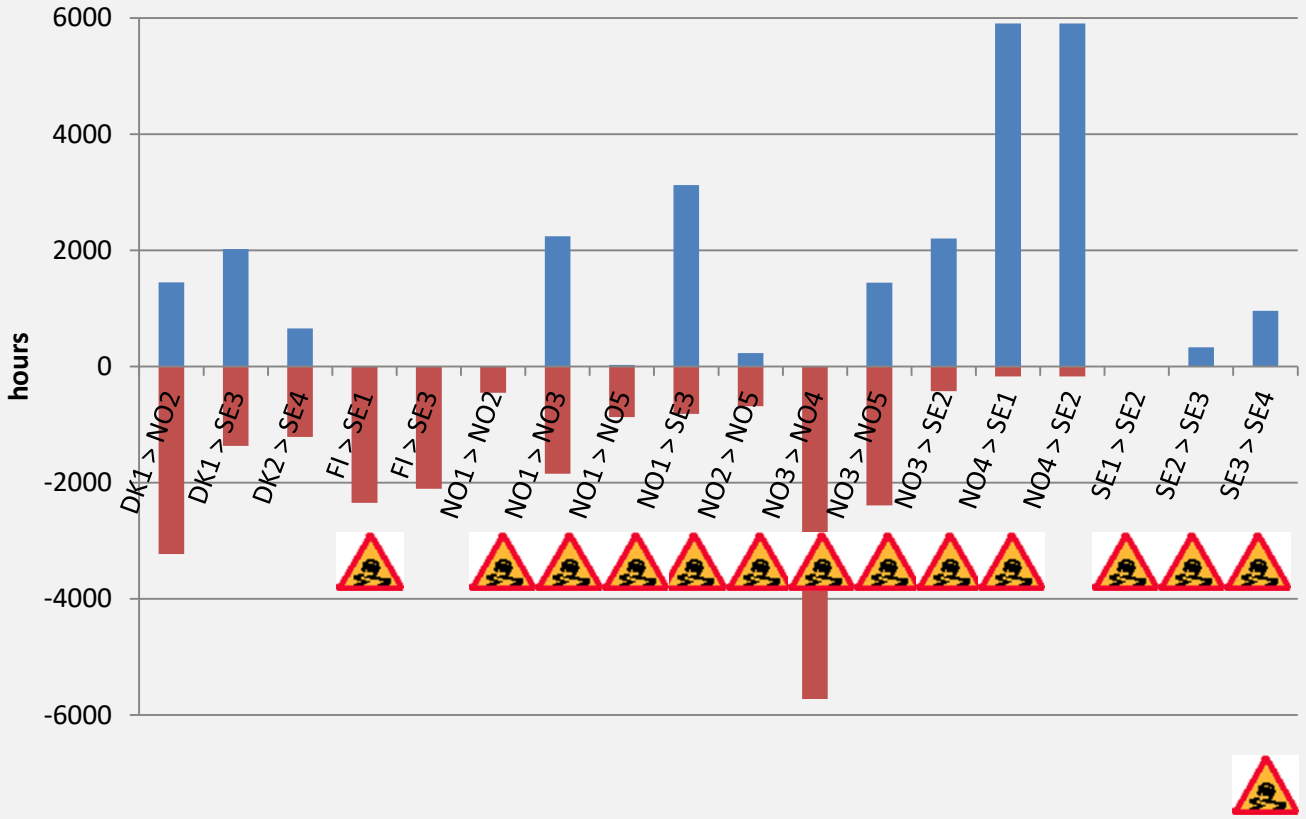
Dynamic issues are in some cases determining the market capacity on Nordic internal borders



Number of hours in 2017 where a border capacity led to a price split due to thermal or dynamic limits.
Positive numbers from BZ1 >BZ2
Negative numbers from BZ1<BZ2.

Dynamic issues involved in some cases

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Nordic DSA – main milestones

#	Milestone	Deliveries before moving to the next milestone
1	Calculation methodology RfA6	• Document the current calculation methodology used by each TSO for dynamic security analysis. • Align the existing calculation methodologies and develop a new harmonised approach where this is needed. • Ensure transparency between TSOs so that everybody is able to reproduce the result of the neighboring TSO. • Review of principles for season ahead CGM (Outage Planning Coordination).

Benefit for Capacity Calculation : *TSOs apply a coordinated methodology for calculation of dynamic CNEs*

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Nordic DSA – main milestones

#	Milestone	Deliveries before moving to the next milestone
2	Dynamic CGM – initial (proof of concept) RfA6, RfA8, RfA9, RfA10	• Make the dynamic data compatible with the Nordic CGM for operational planning. For dynamic coming from the Nordic planning model identify gaps between the operational and planning models to enable mapping of dynamic data on operational models. • Agree on how to exchange dynamic models (standard and user-defined models, parameters, current mode of operation). • Validate the implementation of individual generic dynamic models between simulation tools. • Issue an initial dynamic model to capture the “rough” system dynamics (intended proof of concept and test if information on methodology is sufficiently described). • Exchange format for dynamic “Operational Security Limits”.

Nordic DSA – main milestones

#	Milestone	Deliveries before moving to the next milestone
3	Dynamic CGM - extended (production grade) RfA6	• Request for information from tool vendors. • Include more details necessary for Coordinated Capacity Calculation (CCC), Coordinated Security Analysis (CSA), Outage Planning Coordination (OPC) • Validate the implementation of individual dynamic models between simulation tools. • Perform system model comparison against other simulation tools. • Perform system model validation against system incidents (measurement data). • Correction of modelling errors to provide correct response.

Benefit for Capacity Calculation: *TSOs apply a dynamic CGM for calculation of dynamic CNEs*

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Overall timeline

Number	Milestone	2019				2020				2021				2022				2023				2024				2025				2026			
		2019-01	2019-04	2019-07	2019-10	2020-01	2020-04	2020-07	2020-10	2021-01	2021-04	2021-07	2021-10	2022-01	2022-04	2022-07	2022-10	2023-01	2023-04	2023-07	2023-10	2024-01	2024-04	2024-07	2024-10	2025-01	2025-04	2025-07	2025-10	2026-01	2026-04	2026-07	2026-10
0	Clarification of security issues related to exchange of IGMs and dynamic data			■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
1	Calculation methodology	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
2	Dynamic CGM – initial (proof of concept)					■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
3	Dynamic CGM - extended (production grade)												■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
4	Pilot testing																					■	■	■	■	■	■	■	■	■	■	■	■
5	Processes and Rules									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
6	Development of requirements and specifications																				■	■	■	■	■	■	■	■	■	■	■	■	■
7	Tendering and procurement																					■	■	■	■	■	■	■	■	■	■	■	■
8	Implementation (including parallel run)																									■	■	■	■	■	■	■	■
9	Go live																															■	■

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