
Mitigating measures to reduce reductions in cross-border capacities due to the Swedish West-Coast cut

NordREG WS

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- > Introduction West Coast Corridor (WCC)
- > Capacity calculation and congestion management in WCC
- > Future development

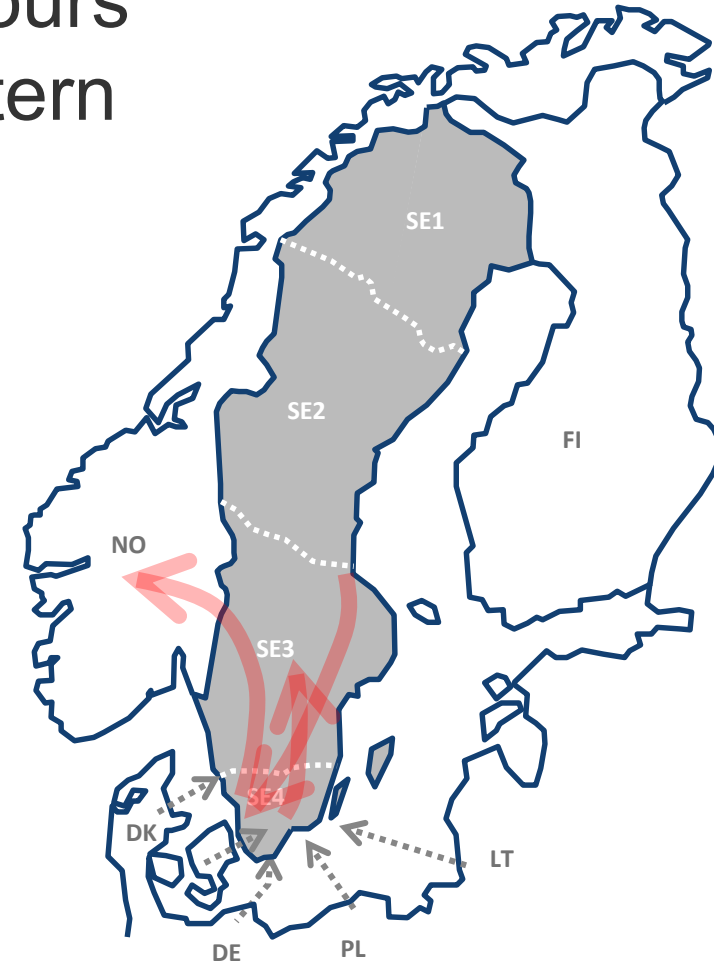
No challenge at the WCC in normal day-time operations

- > Day-time operation:
 - > + High load / high prices
 - > + Transmit power to DK, DE, PL and LT
 - > = Southbound flow



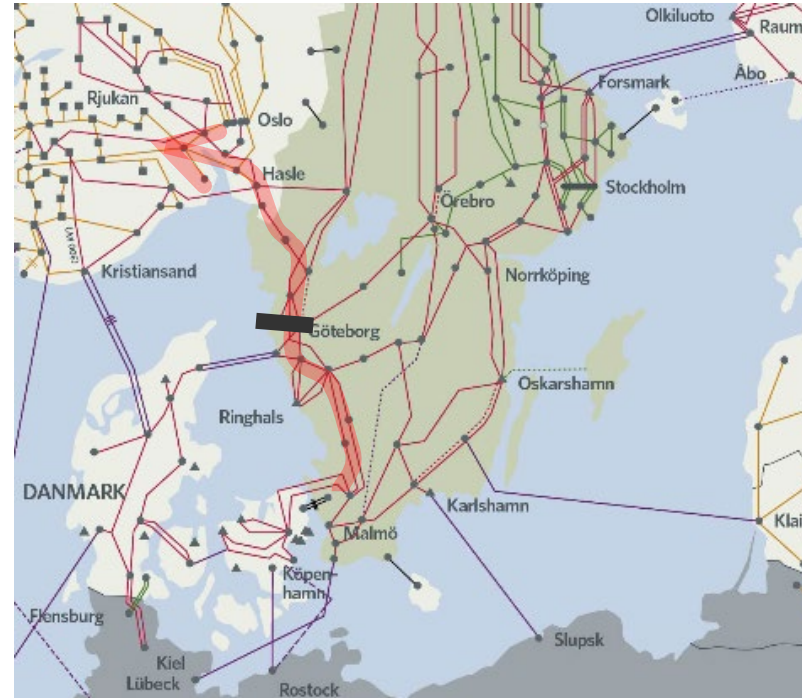
The challenge occurs in select hours especially at night when flow pattern shifts

- > Night time operation:
 - > + Low load
 - > + Save water in NO/SE1-2
 - > + High wind power from DK and DE
 - > = Northbound flow
 - > = No effect limit $SE4 > SE3$



Leads to congestion in the WCC and technical limitations

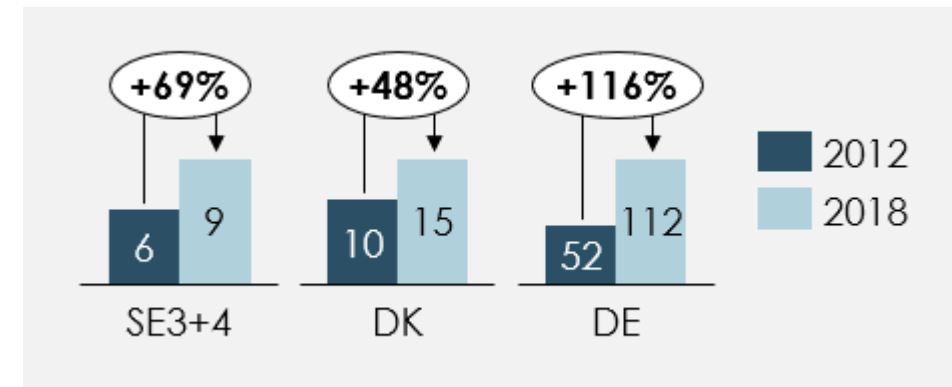
- > Technical limitations
 - > Overload after N-1 fault (SE3)
 - > Transient instability after N-1 fault (SE3-NO1)



Problem expected to be alleviated in 2012, but high increase in Danish and German wind needing transport to Norway

- > The Stenkullen – Lindome line was operational in 2012. Expected to alleviate the problem
- > However, additional wind deployment of between 50 – 120% in ‘the south’ has maintained pressure on WCC
- > Moreover, the proposed western part of the SouthWest Link, not approved by Norway

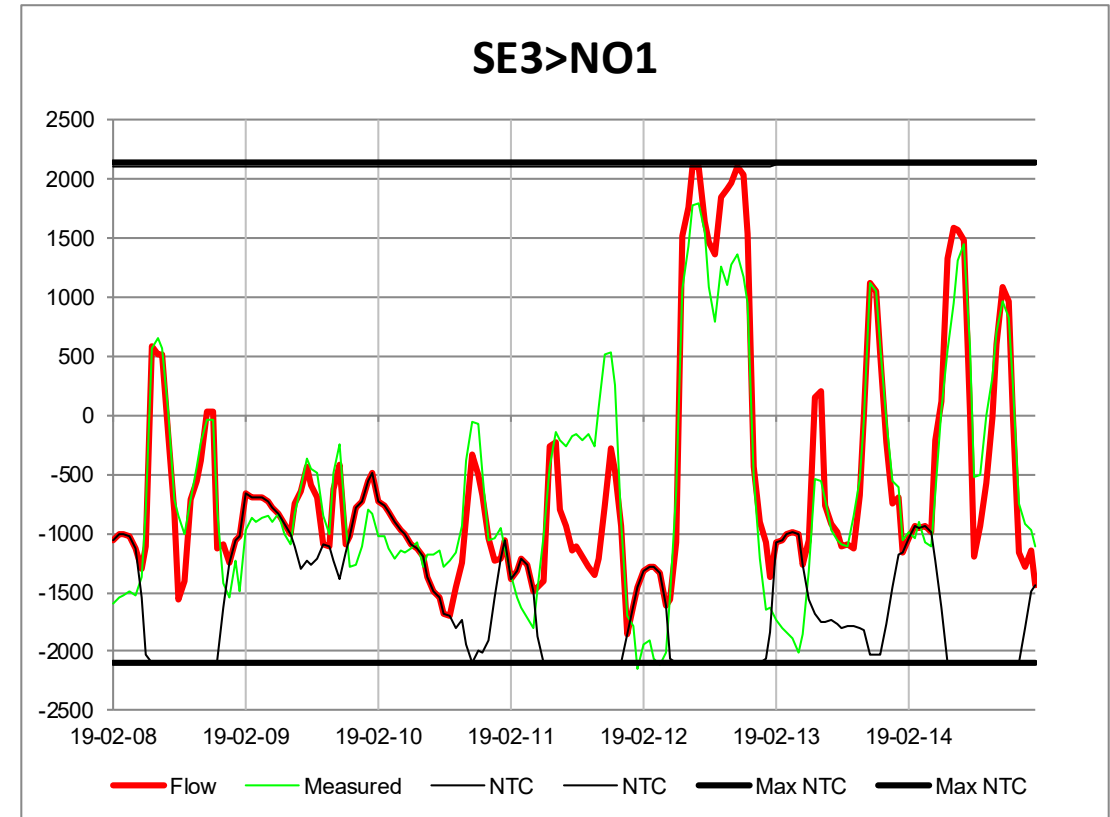
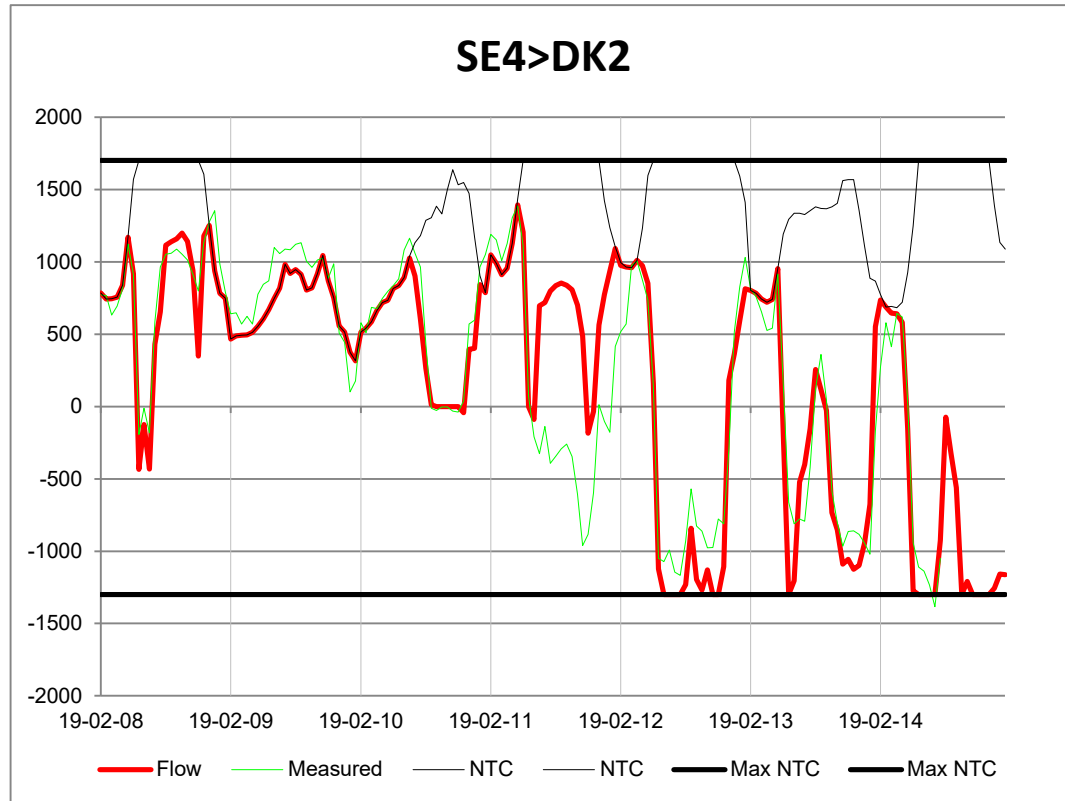
Increase in wind power generation 2012-2018 (TWh)



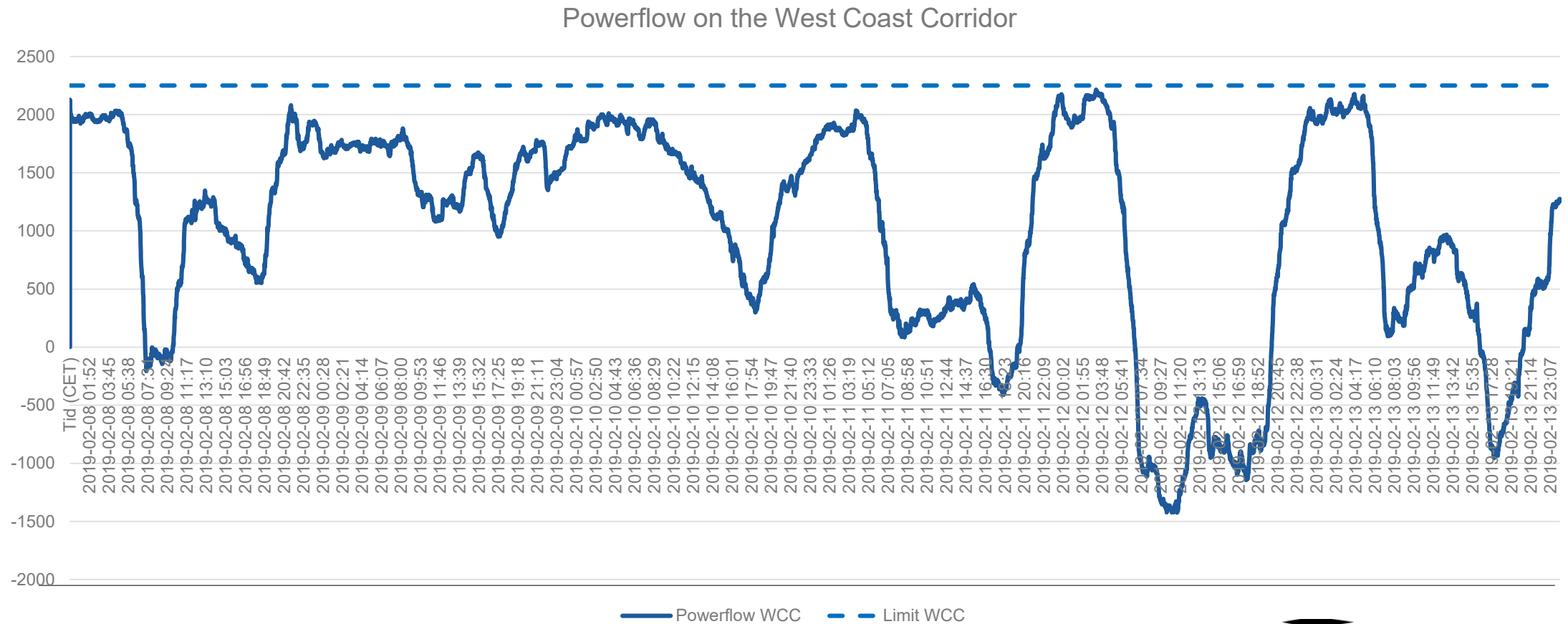
Source: Svenska kraftnät, Statistik per elområde och timme. Perspektivplan 2025, page 46 and 53. Danmarks Vindmølleforening(2012), Året der gik. Danmarks Vindmølleforening(2018), Vindmøller i Danmark. EEA(2011), Renewable Energy Projection. Bundesministerium für Wirtschaft und Energie(2019), Zeitreihen zur entwicklung der erneuerbaren energien in deutschland 1990-2018. Energiföretagen(2018), Energiåret 2017, page 8.

Note: Calculation of expectation for wind uses interpolation of actual capacity and production in 2012 and their expected values in 2025. Production of wind in Denmark and Germany in 2018 is calculated by using the same utilisation rate of expected capacity in 2018 as of actual capacity in 2012.

Import/export capacity pattern: Example 8 feb-14 feb

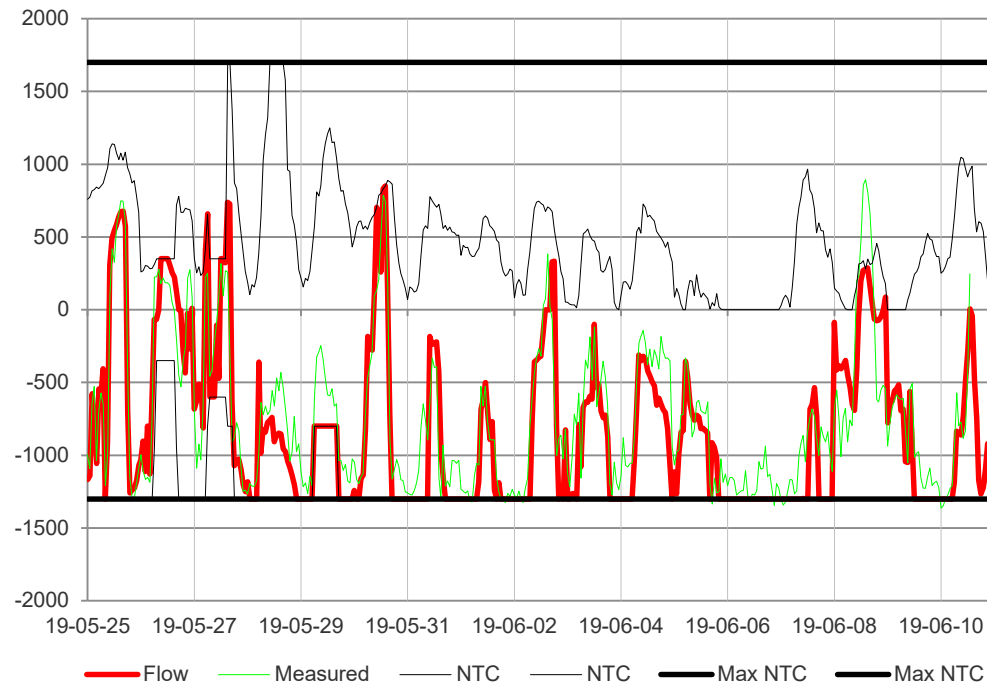


Measured flow in West Coast Corridor

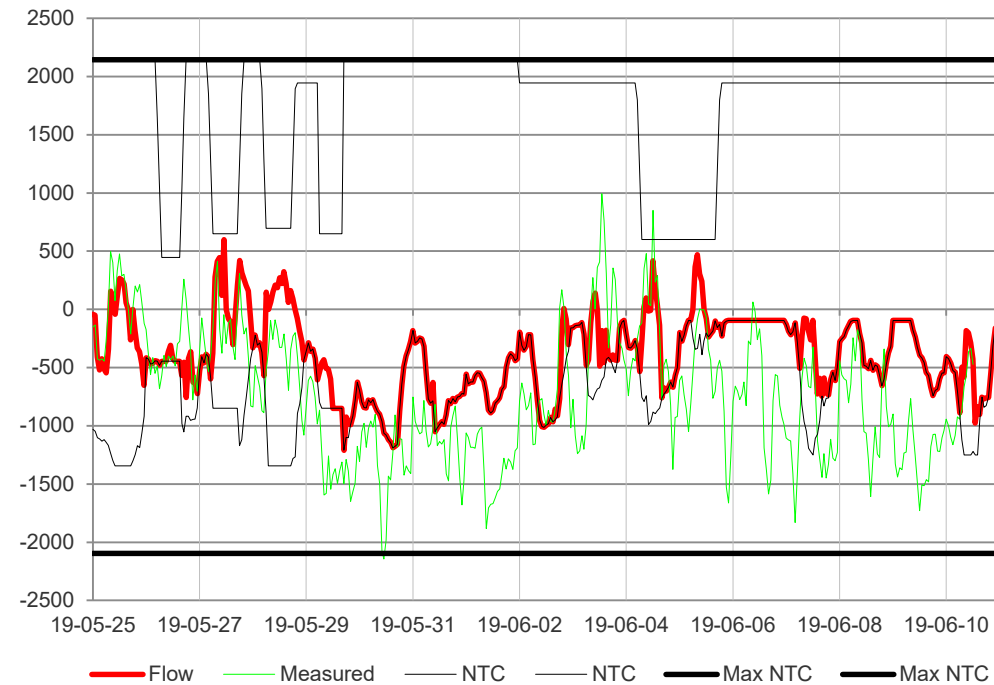


Import/export capacity last 2 weeks

SE4>DK2

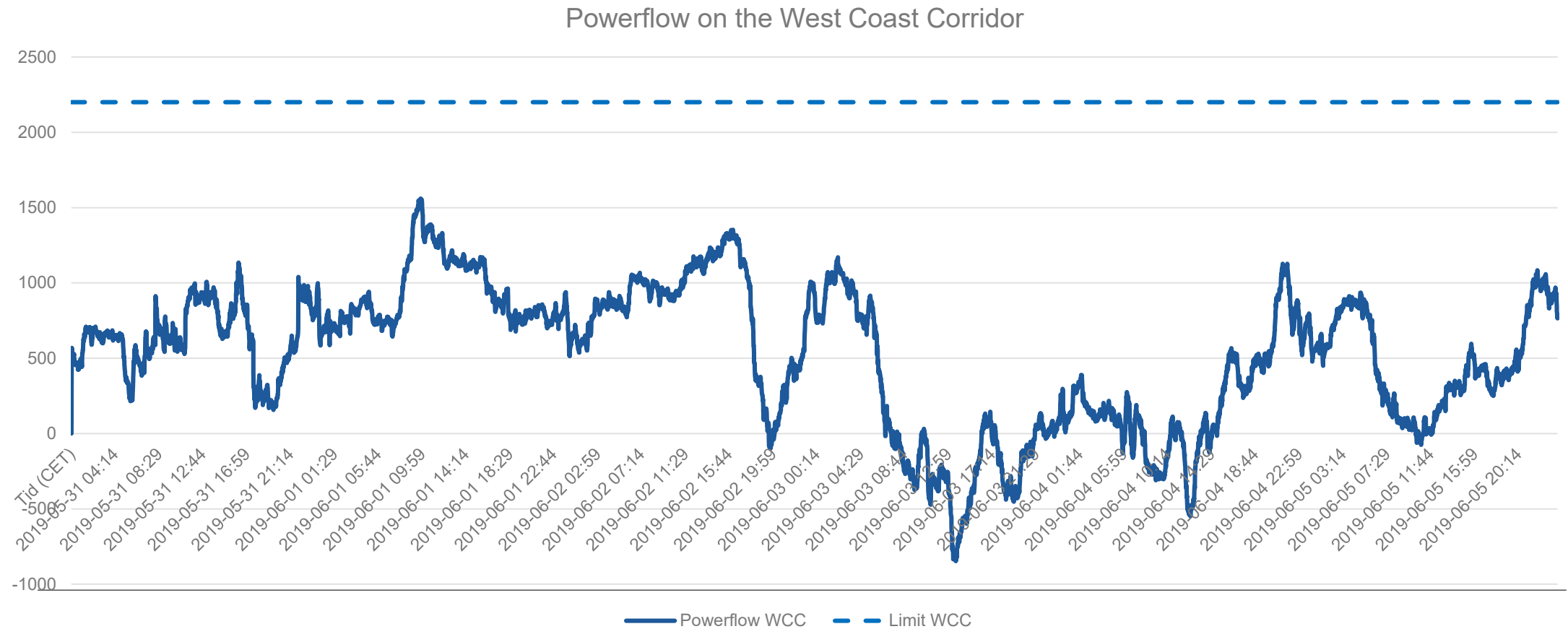


SE3>NO1



*Low capacities due to low load in Sweden and all affecting nuclear production in operation

Measured flow in West Coast Corridor last 2 weeks

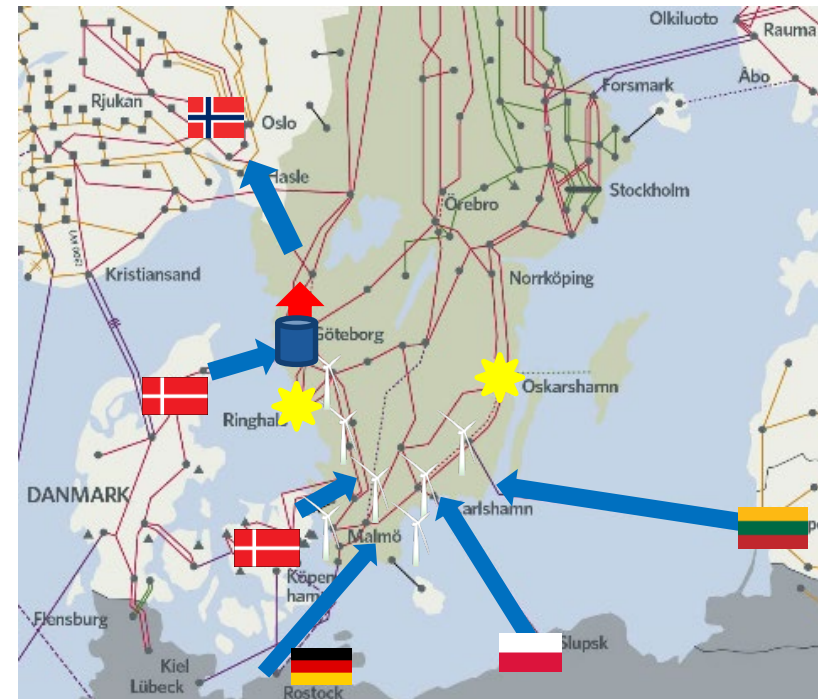
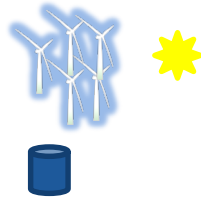


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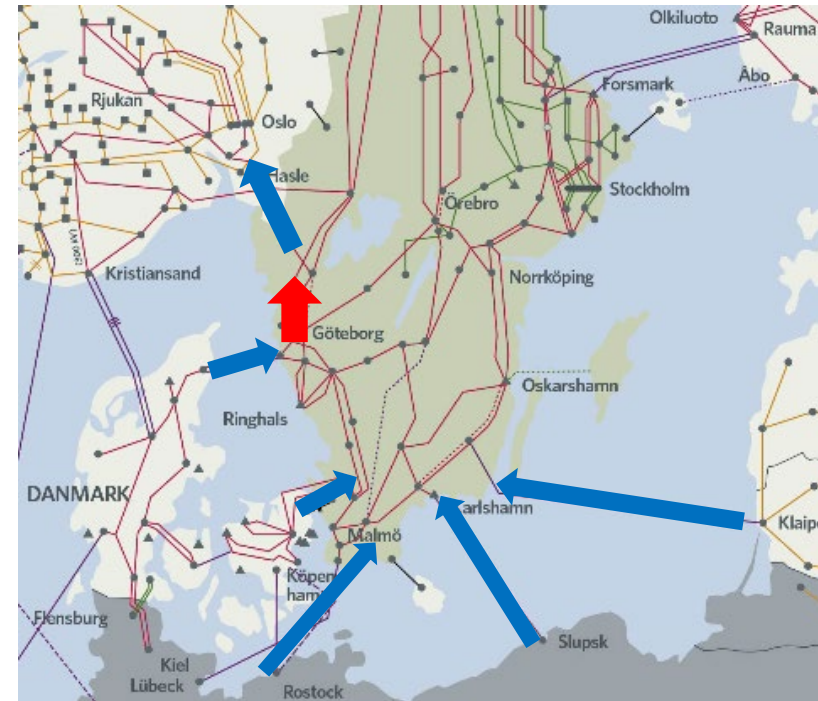
First, Svk determines expected domestic flow on WCC one day ahead

- > Expected flow on the West Coast Corridor
 - > Apply latest available prognosis data for domestic sources
 - > Wind- and nuclear power
 - > Load in Gothenburg and Malmö
 - > Expect possible flow
 - > Import from DK1, DK2, DE, PL and LT
 - > Export to NO1



Second, maximum flow through WCC is "filled up" and made available to the DA-market

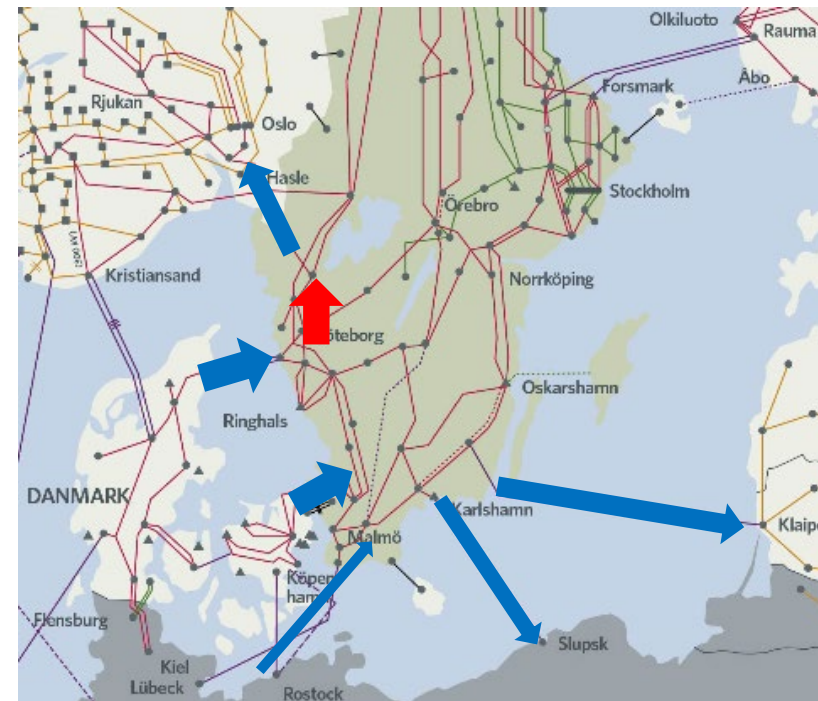
- > Available capacity allocated to each interconnector according to its NTC-size (pro-rata)
- > Variations may occur due to forecast differences, dry/wet year and other limiting outages



Illustrative example on possible capacity reduction between concerned interconnectors

After day-ahead, any unused import/export capacity on interconnectors is allocated to the ID-market

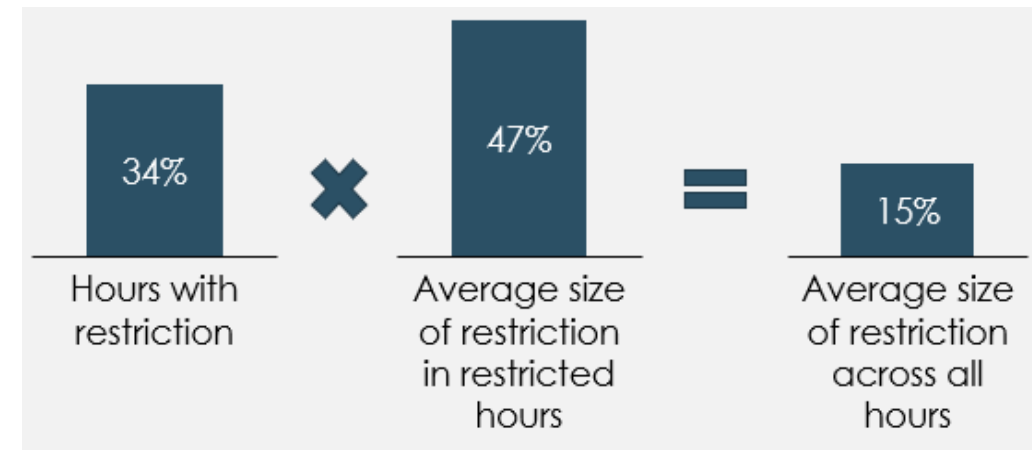
- > Adjust capacities on intraday (after day-head turnout)
 - > Optimize given ATC from latest available forecast on West Coast Corridor and wind power production
 - > Take account of unutilized ATC on interconnectors not taken part in the intraday-trading
 - > **Example:** DA-market led to export to LT and PL instead of import as expected. The import capacity otherwise allocated to LT+PL can now be used by DK and DE (plus additional import capacity due to exports to PL+LT)



On average, about 15% of import capacity is restricted in DA-market

- > Import capacity is restricted about 34% of the time
- > The average size of the restriction is 47% of interconnector capacity
- > Equalling an average 15% import restriction across all hours

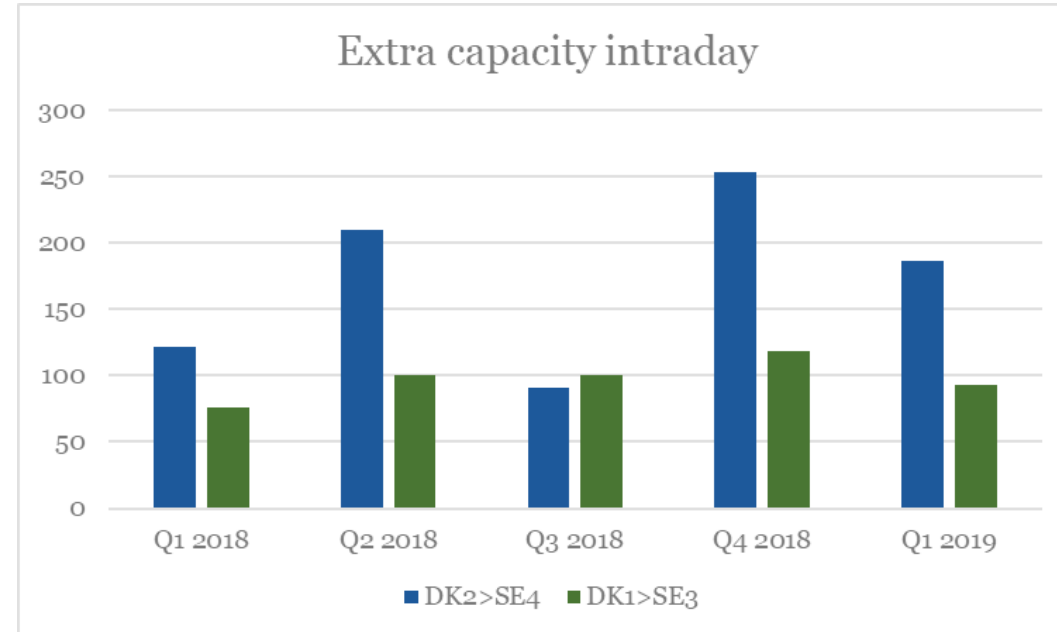
Average size of restriction and share of hours restricted in 2018



Source: Svenska kraftnät(2018), Swedish interconnectors case monitoring reports no. 15.

However, a large share is offered to the Intra-day market. About 10-15 percent (100-250 MW per interconnector)

Extra capacity released to intra-day market
MW



Source: Nord Pool historical market data

*Since the corridors are being affected by different outages during each quarter, explains why the additional capacity differs between them

Conditions to move capacities from intraday (ID) to day-ahead (DA)

- > **Condition 1:** Continuously improved forecast model
- > **Condition 2:** Continuously secure security of supply
- > **Condition 3:** Require available down/up regulation bids in order to adjust the planned WC-flow during operational hours

Security of supply: Up- and downregulation after N-1 fault

- > Up- and down regulate large volumes where regulating bids are scarce
 - > +1000 MW regulation volumes depending on WC-flows
 - > Down-regulation (fast active reserves) within 15 minutes
 - > Up-regulation for Nordic balancing
 - > = Security of supply demands restricted power flows

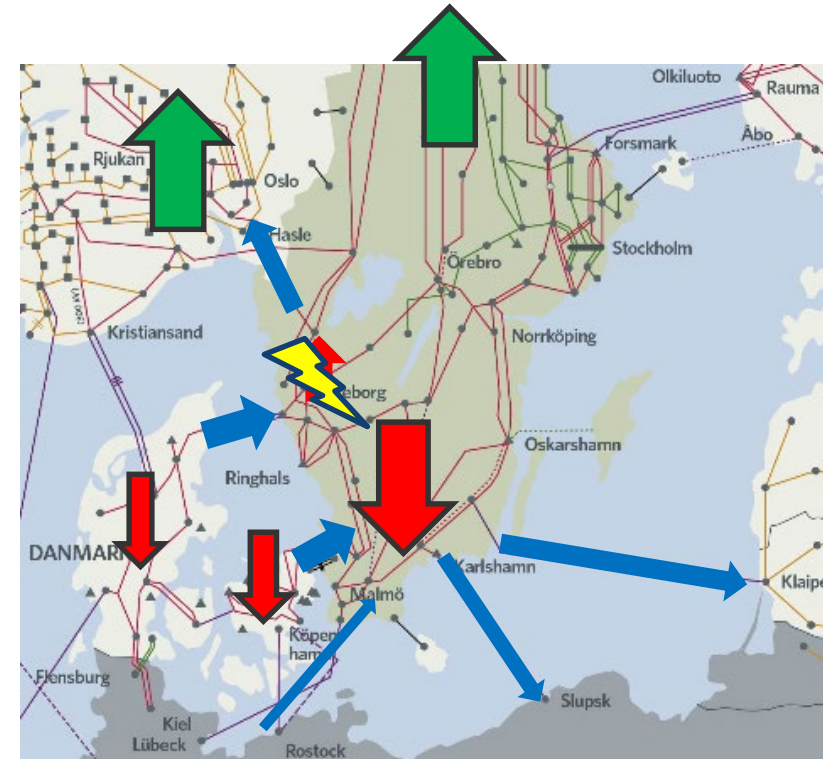
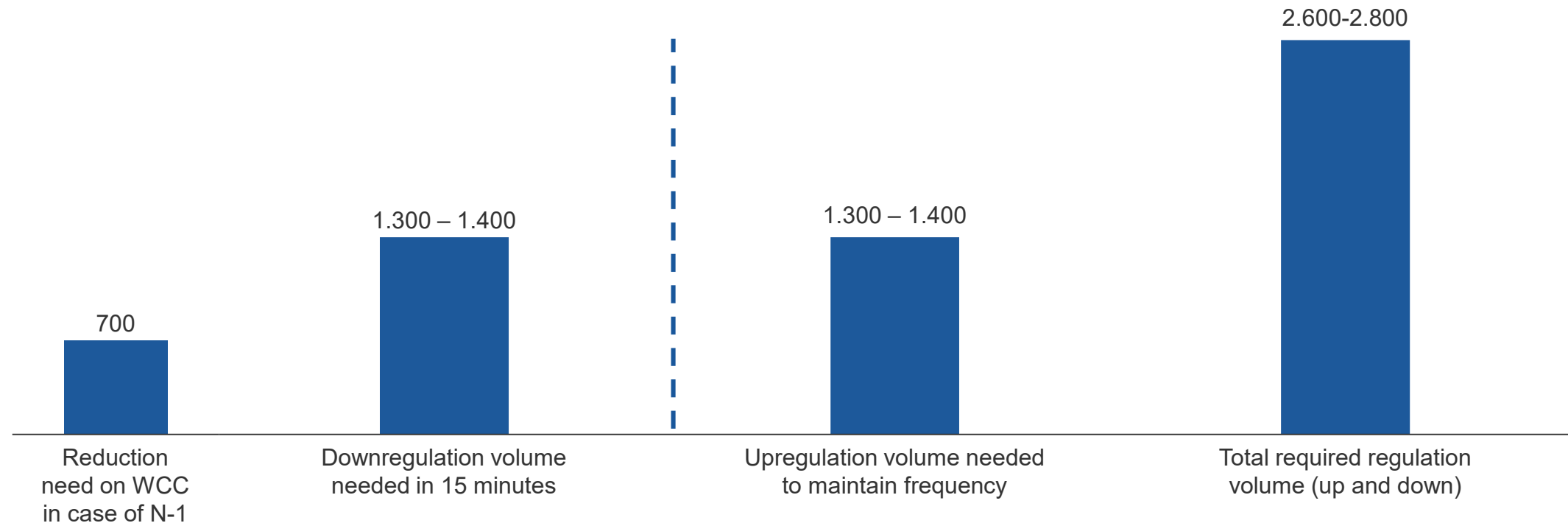


Illustration of the required volume of regulation in case of a reduction need on WCC in MW

This has to be done in 15 minutes!

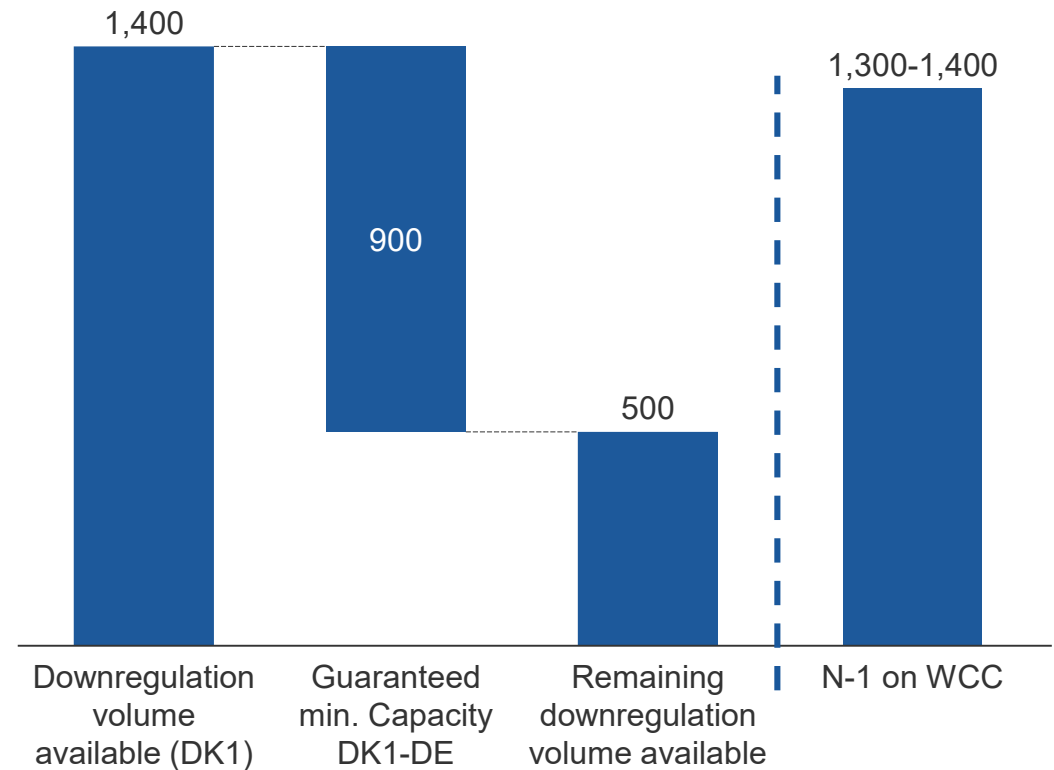
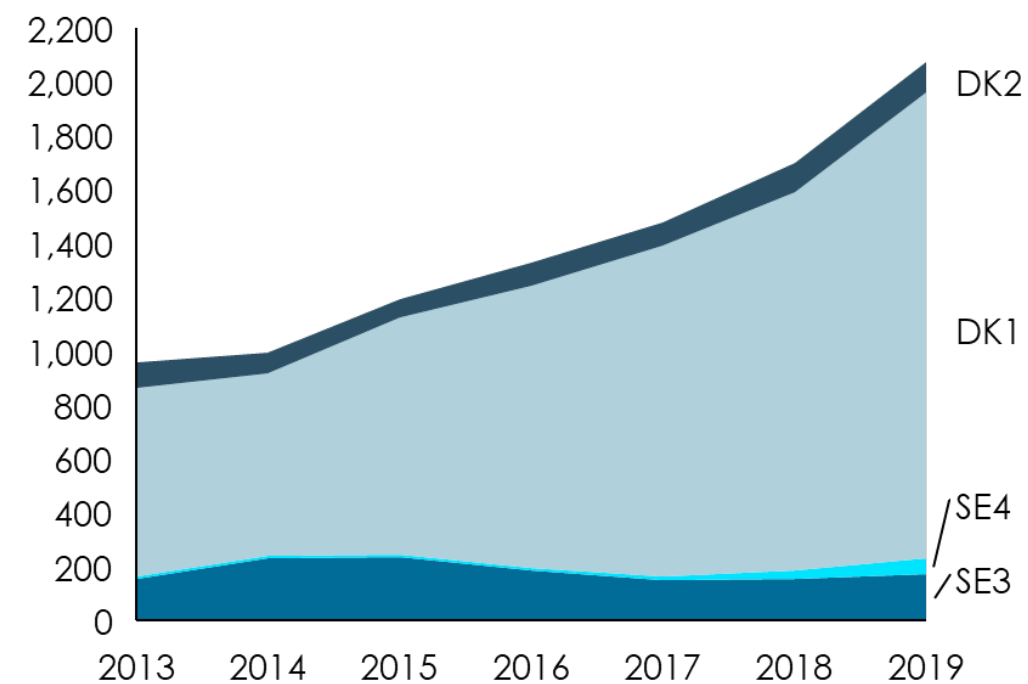


Limited volumes available currently, especially SE but also with current DK1/DE commitment of 900MW

Downregulation volumes across bidding

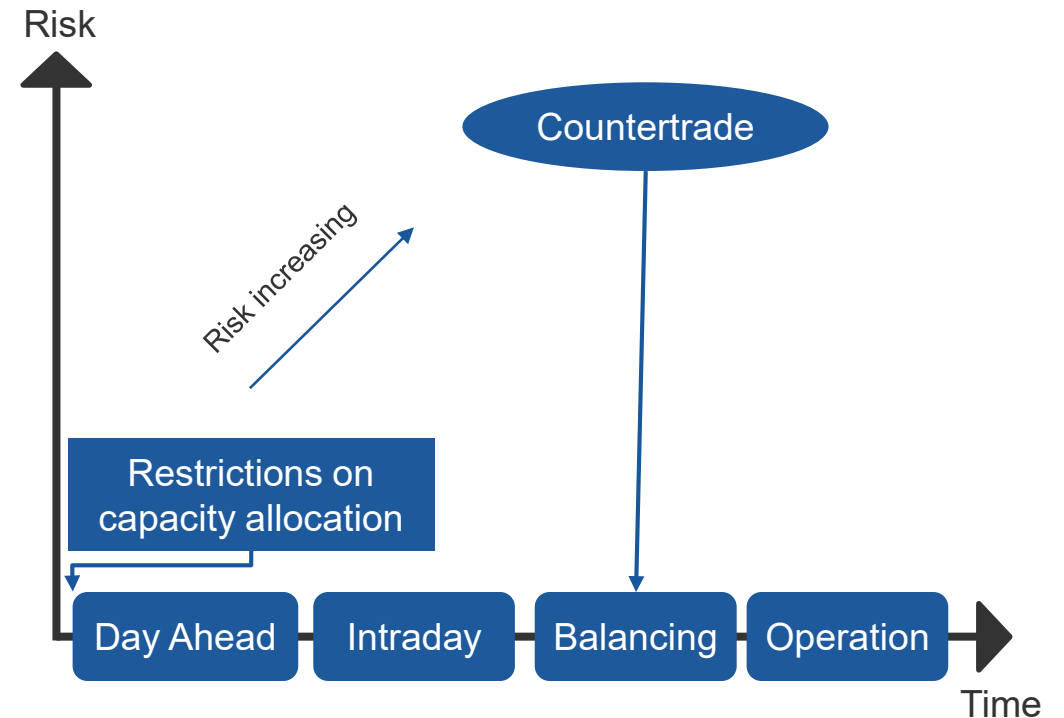
zones

MW



Using balancing volumes for countertrade will increase balancing risk for the entire Nordic system

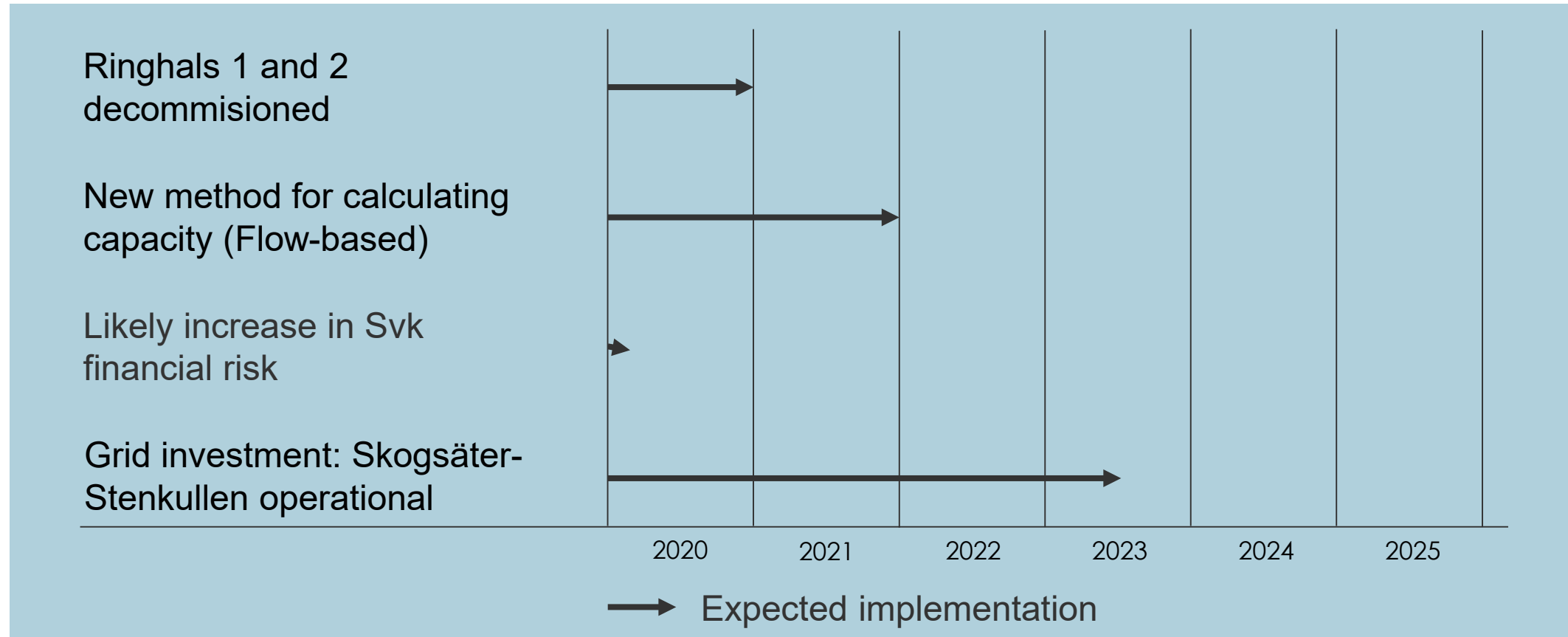
- > Using countertrade as an instrument “eats up” reserves that are meant for balancing both in the ID market and the frequency balancing in real-time
- > If e.g. wind prognosis goes wrong in real-time, and regulation volumes are used for countertrade, there is a big risk to security of supply
- > This risk will apply to all Nordic countries!



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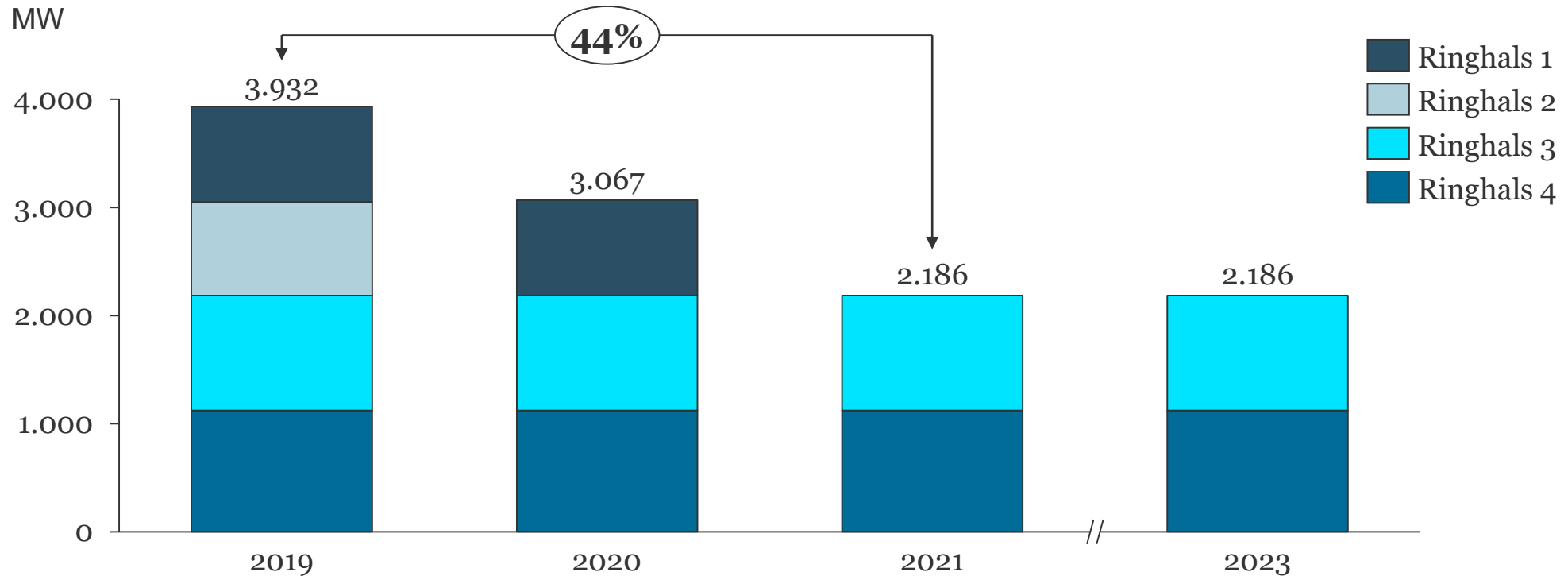
Within few years, the problem will first be reduced and then solved



Note: Uncertainty regarding implementation year.

Ringhals expected to reduce capacity by ~44 percent. Will alleviate WCC northbound flow with about 1.000 MW

Installed capacity in different reactors at Ringhals nuclear power plant 2019-2023

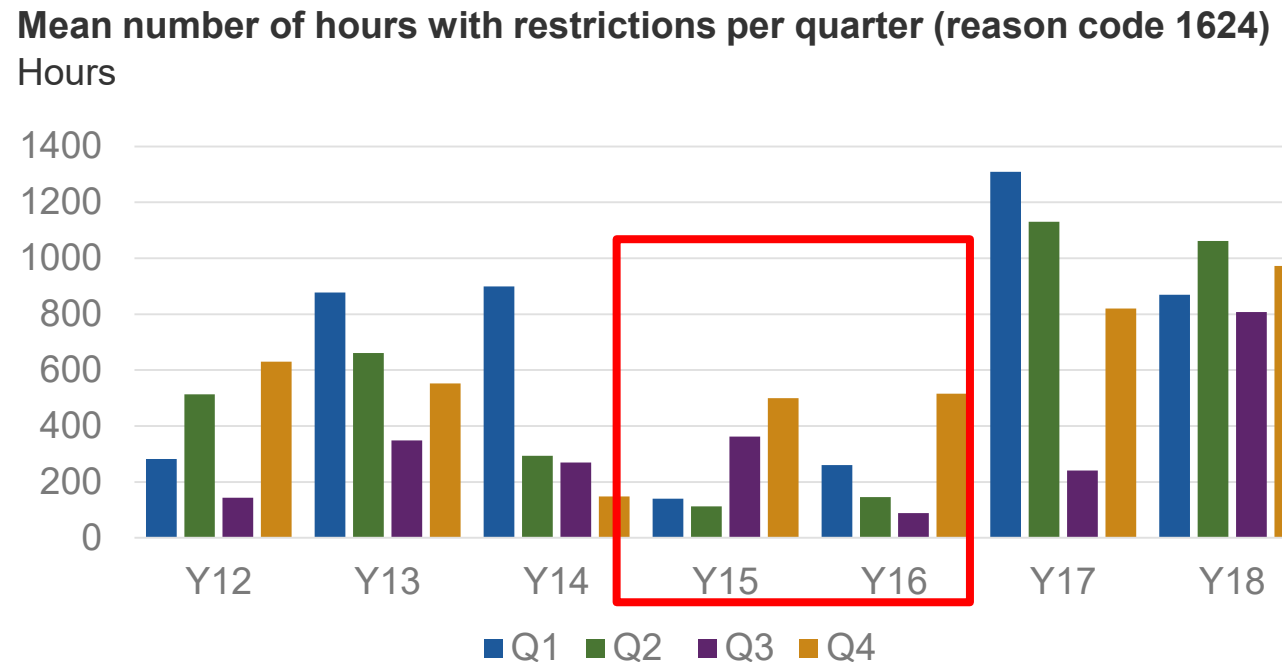


Source: Vattenfall, <https://corporate.vattenfall.se/om-oss/var-verksamhet/var-elproduktion/ringhals/>.

Note: Ringhals 2 and 1 are scheduled to be decommissioned by the end of 2019 and 2020 respectively.

Outage of Ringhals 2 confirms effect on the WCC and interconnector availability

- > Ringhals
15/6 2014 to 26/11 2016
- > Lower number of hours with reduction
- > Lower reduction on restricted hours



Source: Copenhagen Economics based on Svenska kraftnät(2018), Swedish interconnectors case monitoring reports no. 1-15.

*NordBalt provides an increased forecast possibility of northbound flow which stipulates an increased number of restricted hours Y17 and Y18

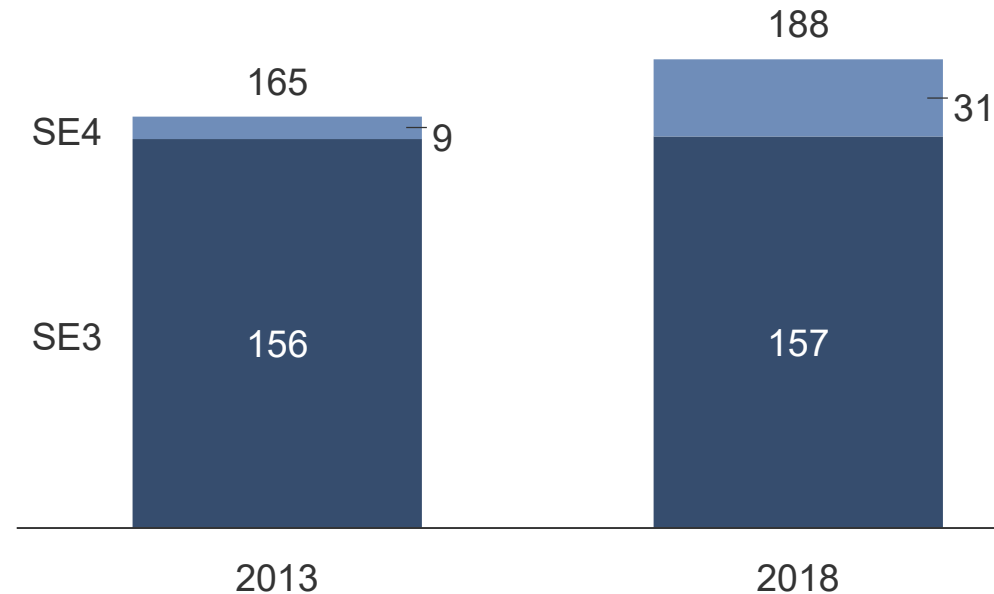
Flow-based capacity calculation will ensure that full WCC capacity is allocated to the day-ahead market thereby reducing potential distortions

	Current NTC method	Future flow-based method
Capacity calculation	<ul style="list-style-type: none">• Cross boarder constrained before allocation• Limitations are based on expectations on future flows• Capacities are allocated to cross-border interconnectors with a pro rata rule• Not taking socio economic surplus into account	<ul style="list-style-type: none">• Full cross border interconnector capacities are given to the market• The West coast corrdidor is included as a critcal network element• Capacities are allocated to the borders taking socio economic surplus into account

[illegible]

Very limited 15 minutes countertrade resources available in SE3+4 currently, but Svenska kraftnät looking to explore potential

Current available downregulation bids in SE3 and SE4
MW



Source: Nord Pool historical Market Data.

Note: The reported volumes include all bids at NOIS.

- > About 3.8 GW wind in SE3 and SE4, but unclear how much can be downregulated
- > To increase available volumes Svenska kraftnät is actively working to increase volumes:
 - > Meetings with market and operations stakeholder groups
 - > Meeting with Svensk Vind of the need and potential
Wind Power stakeholder meeting 20th of June
Bigger stakeholders contacted to discuss potential
 - > Ringhals partly in the RKM since 1st of May 2019

Svenska kraftnät will start taking a financial risk but no security risk. Starting from 17th of June

- 1 Take into account additional up & downregulation bids in the capacity forecast model (when security of supply after N-1 fault has been secured)
- 2 Budget & routines set
- 3 Test period
- 4 Evolution in security of supply. Also a Nordic issue!

Thank you for your attention!



**SVENSKA
KRAFTNÄT**