SVENSKA KRAFTNÄT

Swedish National Resource Adequacy Assessment using FB

Agenda

- Task
- Inputs
- Implementation of FB
- Reflections

Task*

Svenska kraftnät shall:

- follow the methodology in accordance with Article 24 of the Electricity Market Regulation,
- in particular must take into account distinctive features in the Swedish supply and demand for electricity and describe assumptions regarding this,
- consider previous statements from Acer regarding completed resource adequacy analyses,
- describe if the national assessment of resource adequacy deviates from the European one and report the underlying reasons for this.

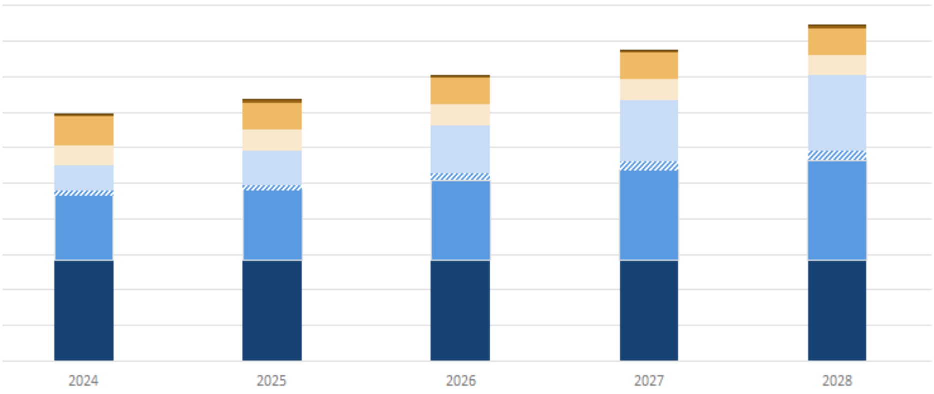
*From Swedish Ministry of Climate and Enterprise

What does a ERAA/NRAA methodology entail?

1. Create scenarios (Load, Production, Transmission)
2. Economic Viability Assessment -EVA (New production, mothballing, new DSR)
3. Update models with EVA
4. Determine LOLE (loss of load expectation – hrs per year) and EENS (expected energy not supplied) by:
   - probabilistic approach but using economic dispatch simulations with stochastic outages applied
   - 35 climate years are run several times (7 times in this case, resulting in 245 years of results for each year to be analysed)
   - Average results are computed

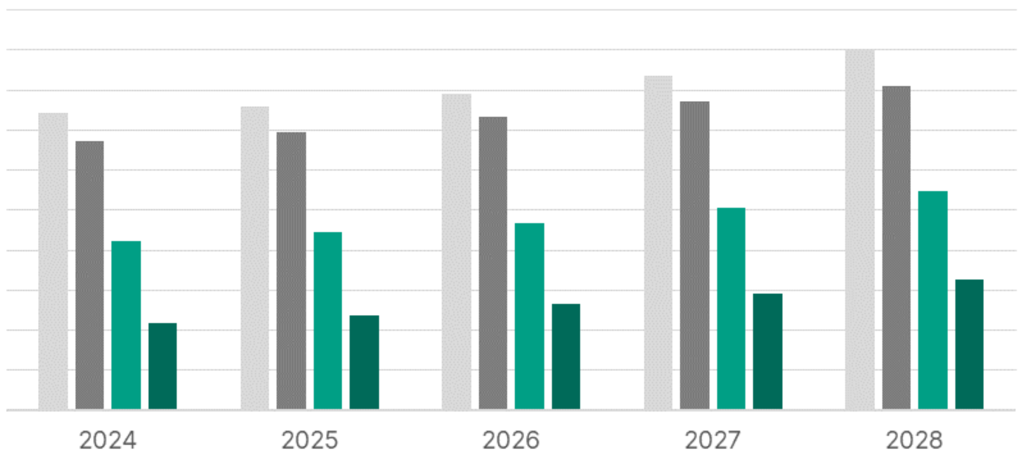
Inputs: Production

- Continued expansion of on-shore wind power
- Increased solar (in terms of installed production)



Inputs: Demand

- Increase in demand in the Nordics,
- But reduced rate of increase compared to previous results (Svenska kraftnät KMA 2022)



Inputs: Flex / Demand side response

- Increase compared values used in previous studies
- Based on joint national study from 2023*

Flex (MW)	Price [euro/MWh]	2024	2025	2026	2027	2028
Level 1	50-200	182	211	321	431	542
Level 2	200-300	182	211	321	431	542
Level 2	300-500	182	211	321	431	542
	Totalt	546	633	963	1293	1625

*Främjande av ett mer flexibelt elsystem (ei.se)

Inputs: Grid expansion

- SE-FI increased to 2000 MW in both directions 2026 (Aurora Line)
- DK-GB increases to 1400 MW (Viking link)
- 2026 and 2028 include grid changes relating to cut 2 in Sweden

Driftår	Snitt	Förändring (MW)	Total (MW)	Information/Namn
2024	DK1↔UK	+1400	1400	Viking Link
2025	SE1→FI FI→SE1	+800 +900	2000 2000	Aurora line (Messaure – Keminmaa)
	DK1↔DE	+1000	3500	Stage 2 Jylland-Tyskland
2026	SE2↔SE3 SE3↔FI SE3↔DK1	0 0 0	7300 1200 715	Upgrade of series compensation in cut 2. Will not increase max NTC but result in less restrictions due to east-west flows
2028	SE2↔SE3	+800	8100	Increase in Cut 2 capacity
2029	SE4↔DE	+700	1315	Hansa Power Bridge
2030	DK2→DE DE→DK2	+1000 +1000	1585 1600	Bornholm Energy Island
2032	DK1↔BE	+1400	1400	TritonLink
2034	SE2↔SE3	+1500	9600	Increase in Cut 2 capacity
2035	FI↔EE	+684	1700	Estlink 3
	NO2↔UK	+1400	2849	NorthConnect Link

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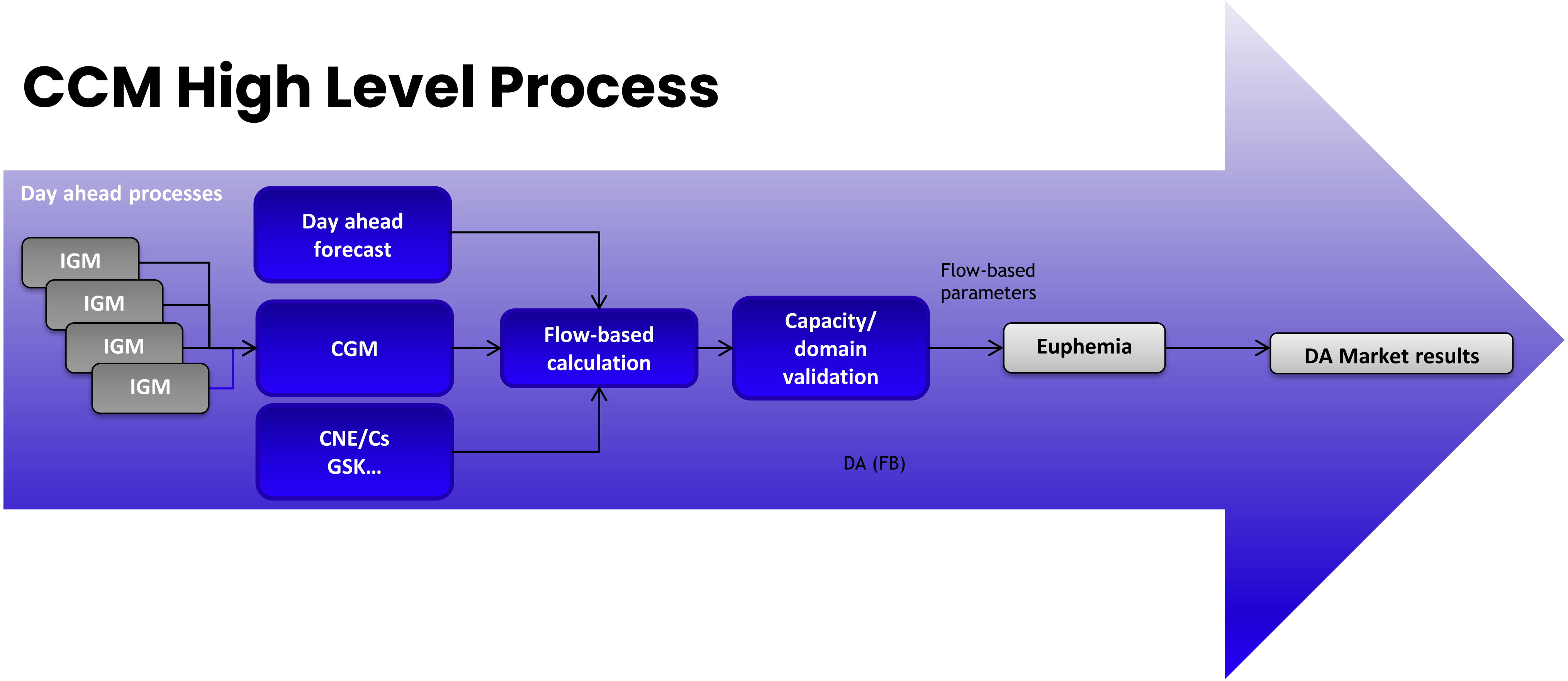
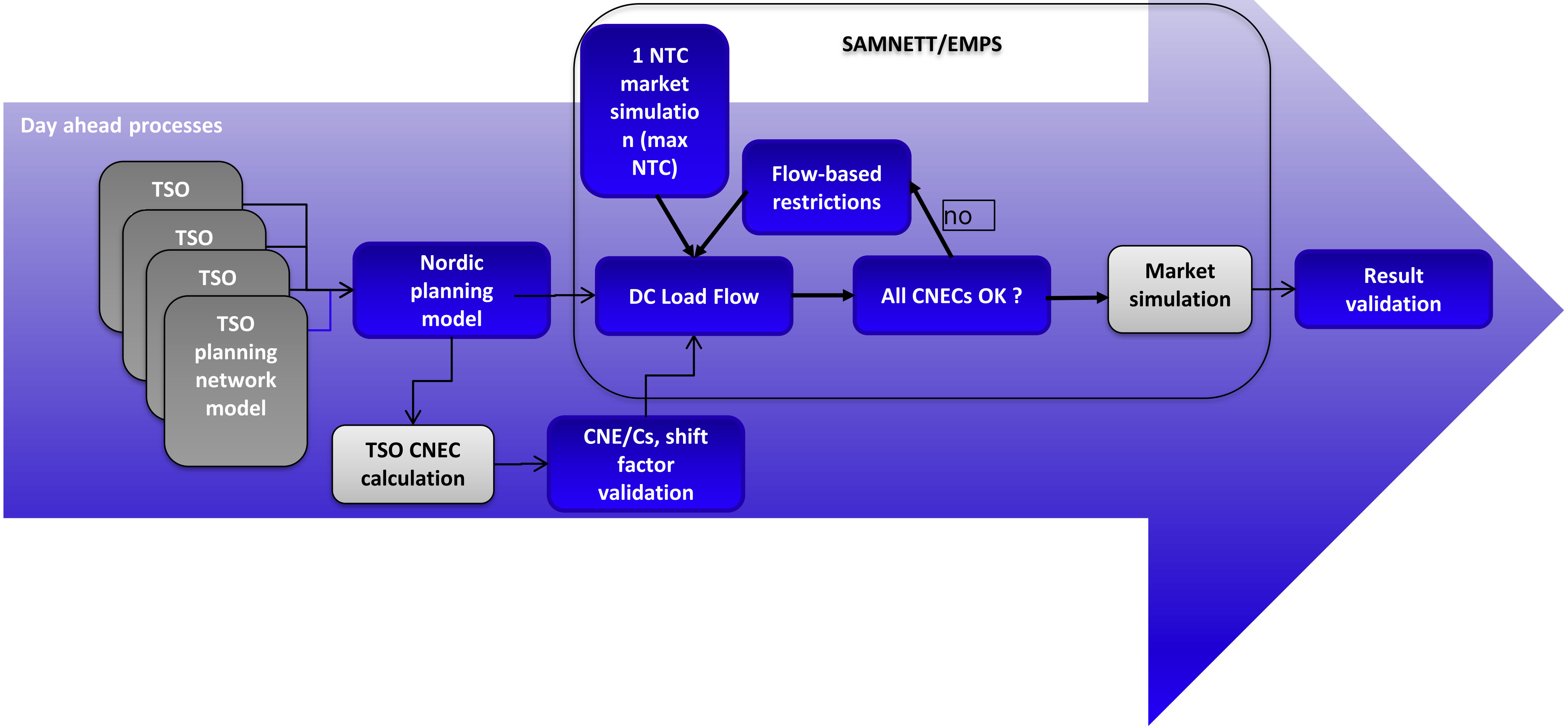
Flow-based in other studies

- With flow-based introduction to DA, other studies need to account for the effects of FB
- Some studies require use of FB
  - ERAA (article 23 of market regulation)
  - Correct evaluation of compliance to the 70 % rule

CCM High Level Process



Flow-based in long term market analys



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Flow-based is in NRAA

1. Nordic planning models used (2024-2028)
2. CNECs: Base case and Contingency analysis in PSSE, elements with loading more than 70 (Criteria used for both CNEs and CNEC)
3. Shift factors calculated for all CNECs (% of load on X shifted to Y after fault on X)
4. Fmax adjusted based on weekly temperature values and coordinates of elements
5. CNECs run the Samnett model, CNECs with PTDF < 5% deemed non-significant
6. Samnett rerun with updated CNEC-list
7. Evaluation of results and adjustment based on required study

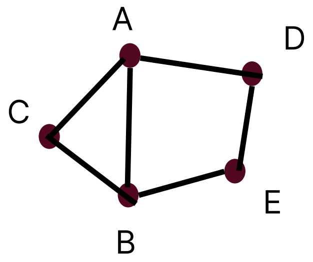
Nordic planning model

- Approximately 13 000 busses and 15 000 branches
- Main updates relate to Norway and Sweden
- Intact grid used. More representative for winter conditions (adequacy studies). Random outages applied on production and HVDC.
- All series capacitors in cut 2 in operation

Contingency analysis

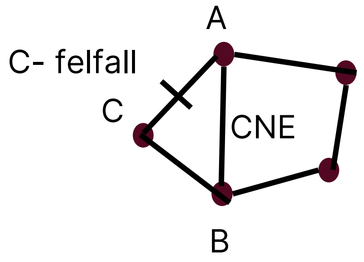
- Run for 8 different scenarios
- Loading on all element considered in N and N-1
- Loading over 70% is included
- Result: Approx. 400 CNEC:s for 2025 and approx. 150 for 2028

Example:
Line : A-B
PATL = 1000 MW,
Limit = 700 MW
TATL = 1400 MW,
Limit= 980 MW



CNE	C	Case	Flow	include
A-B	-	1-Hi Load	800	Y
A-B	A-C	1-Hi Load	900	N
A-B	A-C	2-Hi Wind	1050	Y
A-B	B-E	1-Hi Load	850	N
A-B	..	..	...	.
A-B	D-E	Case n	810	N

Shift Factor



For Each CNE, factor of flow on contingency (C) that is transferred to CNE is calculated.

- Example where A-B = CNE and A-C = C
- Load flow result show that Contingency on line A-C results in 30% of the flow on Line A-C is shifted to Line A-B
- This results in the following limitation to the market model: Flow A-B + 0.3*Flow A-C < Fmax(A-B)

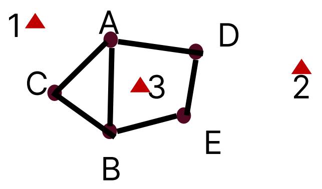
Calculation Fmax on CNEs based on temperatures

Step 1 Data collected regarding rates for components

Step 2 For each CNE calculate Fmax based on observed ambient Temp.

Observed ambient Temp calculated by comparing coordinates of lines with closest observation point

CNE	Rate	-10	0	+10	+20
A-B	Normal	1200	1200	1100	1000
A-B	Reserv	1600	1500	1400	1300



CNE	Rate	Tempstation id	Vecka	Temp	Rate
A-B	Normal	3	1	+5	1150
A-B	Reserv	3	1	+5	1450

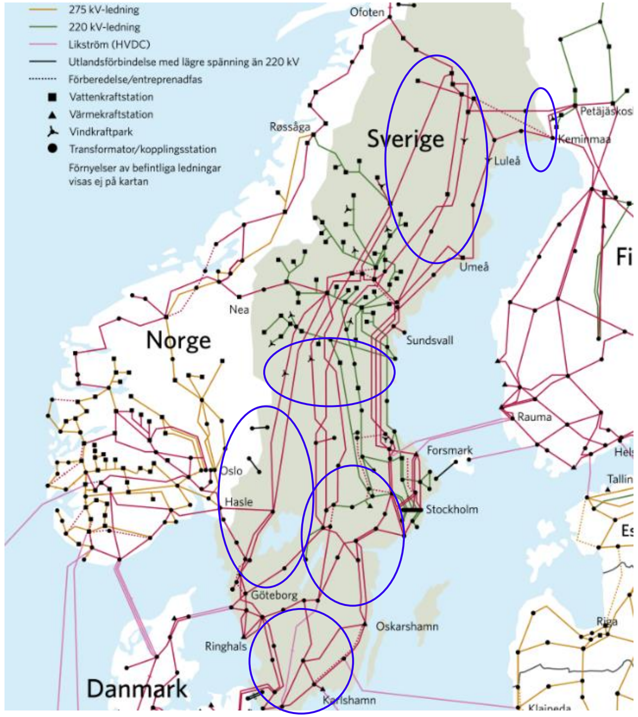
Implementation in Samnett

Step 1 Run Samnett for PTDF-calc and CNECs < 5% max PTDF are omitted

Step 2 5 % FRM applied

Results: Overall limiting CNECs

- Cut 2, both as a PTC and individual CNECs
- Typical CNECs for East-West flows
- Individual CNECs in southern Sweden
- Border CNECs SE-NO (individual CNE/Cs and PTC), SE-FI (PTC)



Final notes

- Report (in Swedish) will be submitted to Swedish Ministry of Climate and Enterprise on 16 Feb
- Results show similar trends as observed in EPR
- Useful improvements to adequacy studies using FB.
- Work to be continued and methodology improved