Statnett

Møtereferat

Sak:
ISB-møte

Møtedato/sted:
24. oktober 2019, Radisson Blu Nydalen

Deltakere:
Svein Elgstøen, Statkraft
Kristian Engan, Statkraft
Bertil Ekern, E-CO
Svein Håvard Pedersen, Sesam
Christer Ruud, Sesam
Rune Karlsen, Sesam
Rune Furre, Agder
Reidar Trydal, Agder
Bernt Dårbakk, SKS
Ståle Granberg, Eidsiva
Ingunn Tangnes, Eidsiva
Oscar Egnell, Brady
Berit Fjeld, Brady
Fredrik Villanger, BKK
Birger Morland, Powel
Terje Vinnes, Skagerak
Kristian Grimstvedt, Skagerak
Steinar Sunde, SKL
Nils Arne Vårdal, Lyse produksjon

Statnett SF
Per Otto Garsjø
Thor-Ole Johansen
David Andreas Fjellheim
Rita B Johnsen
Ole Bengt Eliassen
Ivar Rørstad
Lars Teigset
Åsne Tveita

Møteleder:
Lars Martin Teigset

Fraværende:

Ansvarlig/adm. enhet:
GDU

Kopi til:

Vår referanse:

Neste møte:
Torsdag 19. mars 2020

Dato:

Sign.:

.....

Saksliste

#	Sak	Ansvarlig
1.	**Innledning og velkommen** Oppfølging fra forrige møtereferat Hvordan 15 min visning vil bli er fremdeles for tidlig å si noe om, og må stå som aksjonspunkt til neste møte.	Lars T
2.	**Nye forbruksprognoser, status og veien videre, litt om andre prognoser som kommer** NBIS - Nordic Balancing Information System Se vedlagte presentasjon - det jobbes mye med å verifisere og kalibrere nyutviklet forbruksprognose	Ole Bengt Eliassen
3.	**NUCS/NBIS** Henter all informasjon som ligger på Entso-E sin transparensplattform NUCS – Nordic Unavailability Collection System NBIS - Nordic Balancing Information System Mulighet for å aggregere data og presentere dem grafisk. Status API før golive – aktører kan få tilgang til dette ved å sende en mail til NUCS@statnett.no Ønske fra aktører om å få en side på Statnett der informasjon og APIer ligger NBIS er planlagt golive i januar Se vedlagte presentasjon.	David Fjellheim
4.	**ECP - Energy communication platform** Energy communication platform - sikkert kommunikasjonssystem for bruk i energibransjen. Oppdateringer legges ut på eRoom – det er lurt å abonnere på meldinger derfra. Det er viktig at aktørene sikrer seg at de har oppdatert til samme versjon som Statnett. Jo mer som går via ECP jo viktigere blir dette. Se vedlagte presentasjon. Dersom det er noen spørsmål kan man sende dem til ecp@statnett.no Se på ECP knyttet til sikkerhetsloven. Spørsmål fra aktører: Hva med Statnett som tjenesteleverandør av ECP - har Statnett tenkt gjennom hva det betyr?	Morten Simonsen
5.	**ICCP, Status og fremdrift (Overgang fra Elcom til ICCP)** Se vedlagte presentasjon	Gunnhild Håhjem og

#	Sak	Ansvarlig
		Tor Kristian Vara
6.	**Fifty i kommende leveranser** Aktivert FCR vil nå bli beregnet i FCR-N og FCR-D. Må ha to koder. Edielportalen er oppdatert. Endringen vil skje ifm release av Fifty MMS versjon 15, ca 3. desember Nordicbalancing.net - info om NBM Fiftyweb skal over på ny teknologi - viktig å vite om hvilken browserstøtte applikasjonen må støtte – (rask spørring viste at mange bruker Chrome) Viktig for aktørene å få beskjed om endring av tabellstrukturer før overgangen skjer, slik at deres klipp og lim håndtering kan tilpasses i tide og ikke feiler. Fifty lurer på om det er enklest å endre format til CIM når man går over til et nytt marked, eller om det er enklest å gå over til CIM for alt på en gang. Leverandører: Ønsker å få spesifikasjon tidlig, slik at leverandørene deres igjen kan forberede seg og se på hva som er mulig, og hvor raskt de kan levere en slik tjeneste. Innføring av CIM gir også overgang til ECP som kommunikasjonsform. Se vedlagte presentasjon.	Thor-Ole Johansen
7.	**eBestill** Se vedlagte presentasjon Ønske/innspill fra BKK: • Hvordan teste skarpt i produksjon uten at man må bruke et reelt bud? Blir mer og mer aktualisert dersom bestillingen går rett til AGCen. • Dersom man får utfordringer med bestillinger, og noe blir manuelt og noe elektronisk, kan man få en "knapp" der man sier nullstill alt, og begynn med bestilling på nytt (per aktør)? Forenklet løsning elektronisk bestilling for små aktører Se presentasjon.	Ivar Rørstad Thor-Ole Johansen
8.	**NBM** Presentasjon av roadmap for NBM. Foreventet golive for aFRR kapasitetsmarked er utsatt til høsten 2020, muligens senere.	Olga Ingrid Steinsholt
9.	**Informasjon om Flowbased** Info om flowbased finnes på https://nordic-rsc.net/	Trond Jensen

#	Sak	Ansvarlig
	Dersom du vil være med i en referansegruppe så kan du kontakte Energi Norge eller Trond Jensen. På nettsiden finner du også informasjon om kommende møter. Det vil i forbindelse med overgang til Flowbased bli publisert mye ny kapasitetsinformasjon som aktørene kan ha interesse av. Aktørene oppfordres til å orientere seg i forhold til dette. Se vedlagte presentasjon.	
10.	**IKT Impelementeringsplan kort sikt** Ligger på statnett.no Oppdateres to ganger i året, rett etter ISB-møtene Innspill fra salen: Oppgraderinger bør ha andre rutiner og regler enn daglig drift.	Lars Teigset

Aksjonspunkter

#	Aksjon	Hvem	Når
1.	Hvordan vil GUI (graphical user interface) for 15 min vising bli? Viktig at aktører får informasjon så raskt som mulig når det er bestemt, da det sannsynligvis vil medføre endringer i deres excel makroer mm.		
2.	**ECP** Se på ECP knyttet til sikkerhetsloven. Hva med Statnett som tjenesteleverandør av ECP - har Statnett tenkt gjennom hva det betyr?		

ISB- **I**KT-gruppe for **S**ystemtjenetser og **B**alanseansvaret

Innledning

Statnett

Oslo, 24. oktober 2019

Hvor finner man informasjon om ISB?

https://www.statnett.no/om-statnett/moter-og-arrangementer/ikt-gruppe-for-systemtjenester-og-balanseansvaret/

Om Statnett / Møter og arrangementer / IKT-gruppe for systemtjenester og balanseansvaret

IKT-gruppe for systemtjenester og balanseansvaret

IKT-gruppe for systemtjenester og balanseansvaret (ISB) fungerer som koordineringsforum mellom aktørene i bransjen og Statnett, og fokuserer spesielt på endringer i funksjonalitet med IKT grensesnitt. Dette gjelder funksjonalitet som vil bli implementert i de neste 1- 2 årene.

ISB har normalt to møter i året.

Neste møte planlagt avholdt 24. oktober 2019

Publisert 03.04.2019 kl. 14.36

RELEVANTE DOKUMENTER OG VEDLEGG

Møtereferat ISB 210319 (2 MB)

Møtereferat ISB 25.10.18 (2 MB)

KONTAKT

Kontaktperson for IBS

Lars Martin Teigset, Avdelingsleder
lars.teigset@statnett.no / +47 23 90 34 46 / +47 917 35 749 (mob.)

Agenda ISB 24. oktober 2019

Tid	Tema	Hvem
10:30	Velkommen og gjennomgang av aksjonspunkter fra forrige møte	Lars Teigset
10:45	Nye Forbruksprognoser, status og veien videre, litt om andre prognoser som kommer	Ole Bengt Eliassen
11:00	NUCS/NBIS: Status og utvikling	David Andreas Fjellheim
11:30	ECP • Ulike versjoner, Forvaltning, nye tjenester • Hvor formidles info • Utfasing av EDIFACT	Morten Simonsen
12:00	Pause	
12:15	ICCP, Status og fremdrift	Gunnhild Håhjem
12:30	FIFTY • Versjon 15 • Versjon 16 • Versjonshåndtering fremover • FCR • MNA	Thor-Ole Johansen
13.15	eBestill • Tjenesteutsetting • Forenklet løsning	Ivar Rørstad Per Otto Garsjø
13:45	Pause	
14:00	Generelt NBM (Kapasitetsmarkeder (aFRR/mFRR))	Olga Ingrid Steinsholt/ Alexander Jansson
14:30	Flytbasert Markedskobling, hva kommer og når	Trond Jensen
14:45	Implementeringsplan kort sikt	Lars Teigset
15:00	Evt	

Statnett

Ønskede avklaringer fra forrige ISB-møte

Aksjonspunkter

#	Aksjon	Hvem	Når
1.	Hvordan vil systemene se ut med 15 min oppløsning?		
2.			

Svar:
Dette er et spørsmål vi vil belyse i flere forskjellige fora i tiden fremover.
Spørsmålet vil gjennom det bli besvart i god tid før dette blir implementert.

Prognoser

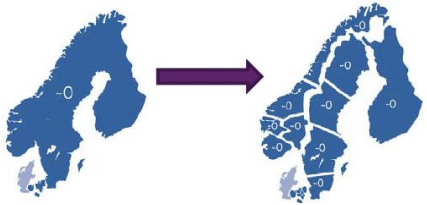
Ole Bengt Eliassen, ISB-møte

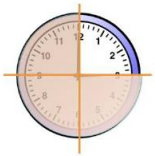
Statnett

Nydalen, 24.10.2019

Litt om bakgrunn

- Behovet for automatisering og prognoser har økt.
  - Økende kompleksitet i kraftsystemet.
    - Mer vind og uregulert vannkraft
    - Flere kabler
    - mACE
  - Flere krav til leveranser.
    - Nettkoder og retningslinjer fra EU
    - RSC (Regional Security Coordinator), MTA (Medium Term Adequacy, D-7)
    - Entso-E Transparancy platform
- Økende krav til kvalitet på prognosene.
  - NBM
  - 15 minutters tidsoppløsning
  - Beslutninger må tas oftere og for flere områder

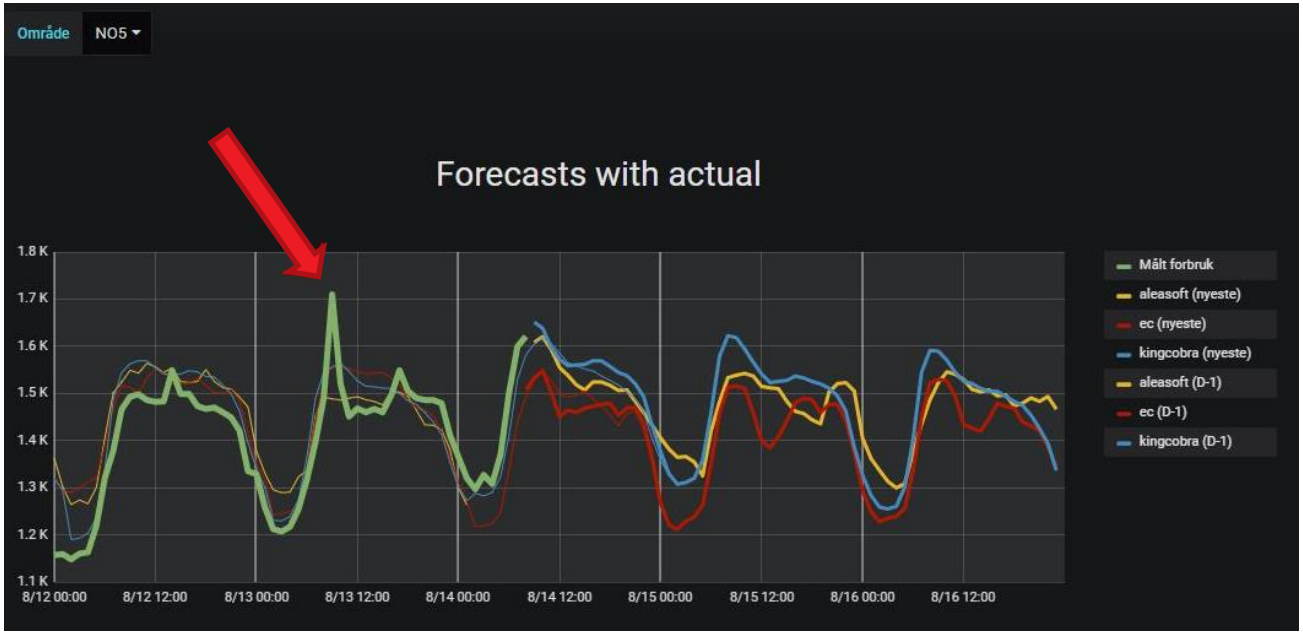




Behov for intern kompetanse og egenutvikling

- Mange utfordringer
  - Forbruksprognose
  - Vindprognose
  - Ubalanseprognose
  - ACE beregning
  - (RoR-prognose)
- God forståelse av behov og muligheter
- Vil ha bedre kontroll på hva som foregår internt i prognosemodellene
- Økt kunnskap om kunstig intelligens kan brukes på flere områder (f.eks. innen anleggsforvaltning)
- Alle rettigheter selv

Sammenligning av forbruksprognoser



X	Y	Z
1,0% h-1	0,7% h-1	0,9% h-1
1,6% h-2	1,7% h-2	1,4% h-2
2,7% h-3	2,5% h-3	2,2% h-3

Planen videre

- Finkalibrering av forbruksprognosen.
- Verifisere kvaliteten.
- Utarbeide en forvaltningsplan.
- Tidspunkt for ekstern publisering er usikkert (TP, NBIS).
- Vind- og ubalanseprognoser.

NUCS/NBiS Status

David Fjellheim, IU

Oslo, ISB, 24.10.19

Statnett

NUCS = Nordic Unavailability Collection System

Statnett

Bakgrunn

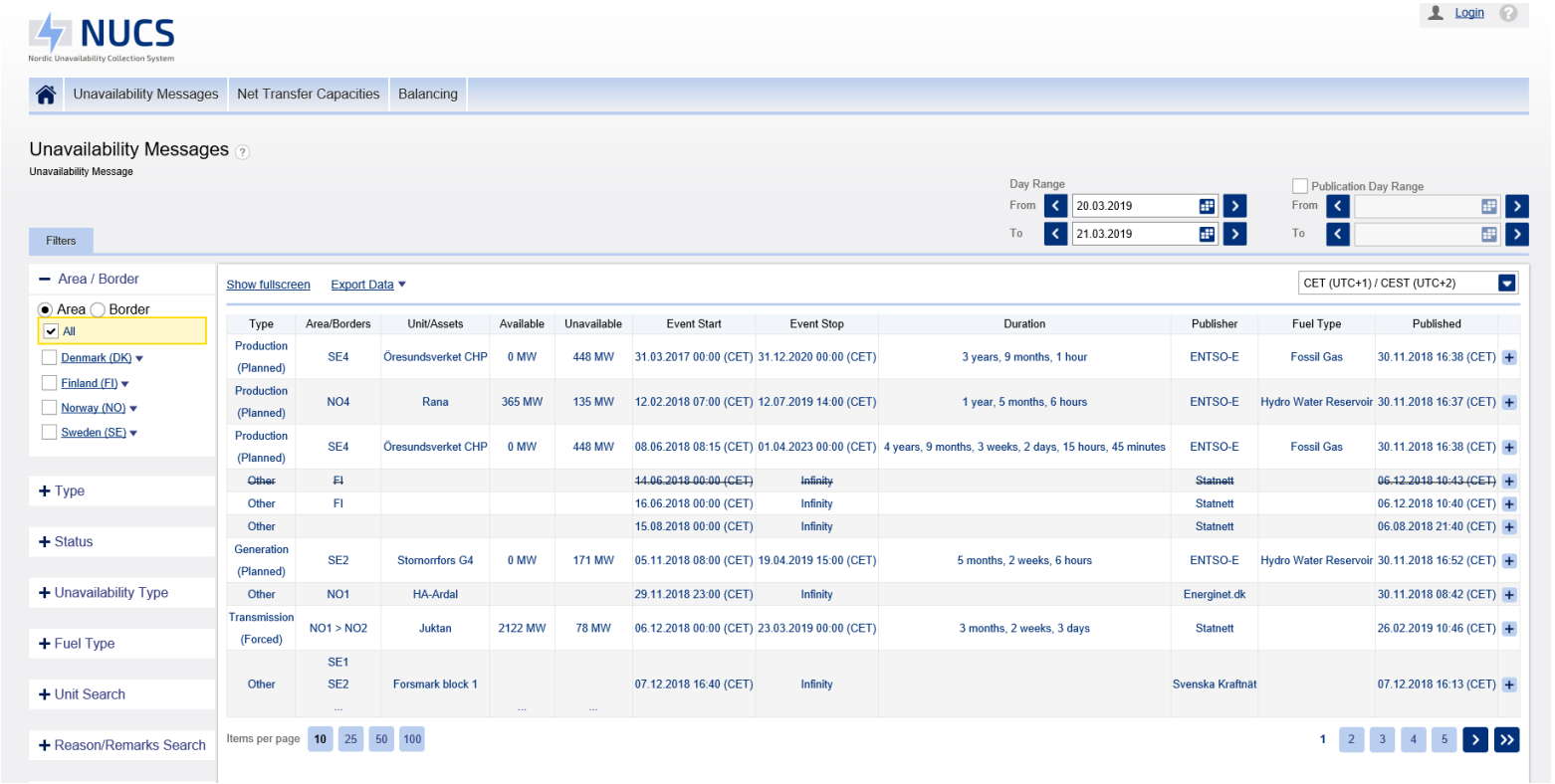
- MNA betinger en uavhengig tjeneste
- NUCS skal ikke konkurrere med Nord Pool UMM
- Markedsaktører kan bruke den tjeneste de ønsker
- Kan komme flere tjenestetilbydere

Prosjekt-status

- GO-live planlagt Desember
- NUCS tilgjengelig for markedsaktører etter GO-live
- API'er dokumentert

Statnett

Hovedformål



Type	Area/Borders	Unit/Assets	Available	Unavailable	Event Start	Event Stop	Duration	Publisher	Fuel Type	Published
Production (Planned)	SE4	Öresundsverket CHP	0 MW	448 MW	31.03.2017 00:00 (CET)	31.12.2020 00:00 (CET)	3 years, 9 months, 1 hour	ENTSO-E	Fossil Gas	30.11.2018 16:38 (CET)
Production (Planned)	NO4	Rana	365 MW	135 MW	12.02.2018 07:00 (CET)	12.07.2019 14:00 (CET)	1 year, 5 months, 6 hours	ENTSO-E	Hydro Water Reservoir	30.11.2018 16:37 (CET)
Production (Planned)	SE4	Öresundsverket CHP	0 MW	448 MW	08.06.2018 08:15 (CET)	01.04.2023 00:00 (CET)	4 years, 9 months, 3 weeks, 2 days, 15 hours, 45 minutes	ENTSO-E	Fossil Gas	30.11.2018 16:38 (CET)
~~Other~~	~~FI~~				~~14.06.2018 00:00 (CET)~~	~~Infinity~~		~~Statnett~~		~~06.12.2018 10:43 (CET)~~
Other	FI				16.06.2018 00:00 (CET)	Infinity		Statnett		06.12.2018 10:40 (CET)
Other					15.08.2018 00:00 (CET)	Infinity		Statnett		06.08.2018 21:40 (CET)
Generation (Planned)	SE2	Stornorrfors G4	0 MW	171 MW	05.11.2018 08:00 (CET)	19.04.2019 15:00 (CET)	5 months, 2 weeks, 6 hours	ENTSO-E	Hydro Water Reservoir	30.11.2018 16:52 (CET)
Other	NO1	HA-Ardal			29.11.2018 23:00 (CET)	Infinity		Energinet.dk		30.11.2018 08:42 (CET)
Transmission (Forced)	NO1 > NO2	Juktan	2122 MW	78 MW	06.12.2018 00:00 (CET)	23.03.2019 00:00 (CET)	3 months, 2 weeks, 3 days	Statnett		26.02.2019 10:46 (CET)
Other	SE1 SE2 ...	Forsmark block 1	...	...	07.12.2018 16:40 (CET)	Infinity		Svenska Kraftnät		07.12.2018 16:13 (CET)

Statnett

Unavailability Messages

Unavailability Message

Day Range
From 20.03.2019
To 21.03.2019

Publication Day Range
From
To

Filters

- Area / Border
  - Area / Border
  - All
  - Denmark (DK)
  - Finland (FI)
  - Norway (NO)
  - Sweden (SE)
- + Type
- + Status
- + Unavailability Type
- + Fuel Type
- + Unit Search
- + Reason/Remarks Search
- + Publisher
- + Market Participant

Clear filters

Show fullscreen | Export Data

CET (UTC+1) / CEST (UTC+2)

Type	Area/Borders	Unit/Assets	Available	Unavailable	Event Start	Event Stop	Duration	Publisher	Fuel Type	Published
Production (Planned)	SE4	Öresundsverket CHP	0 MW	448 MW	31.03.2017 00:00 (CET)	31.12.2020 00:00 (CET)	3 years, 9 months, 1 hour	ENTSO-E	Fossil Gas	30.11.2018 16:38 (CET)
Production (Planned)	NO4	Rana	365 MW	135 MW	12.02.2018 07:00 (CET)	12.07.2019 14:00 (CET)	1 year, 5 months, 6 hours	ENTSO-E	Hydro Water Reservoir	30.11.2018 16:37 (CET)

Message Validity	Duration	Version	Permalink	Attachment	History
12.02.2018 07:00 (CET) - 12.07.2019 14:00 (CET)	1 year, 5 months, 6 hours	1	Permanent link		Show history

Unavailability Type	Remarks	Reason	Reason Text
Planned		Foreseen Maintenance	

Affected Units	Market Participants
50WP00000000552X : Rana	Statnett

Area	From	To	Installed	Available	Unavailable
NO4	12.02.2018 07:00 (CET)	12.07.2019 14:00 (CET)	500 MW	365 MW	135 MW

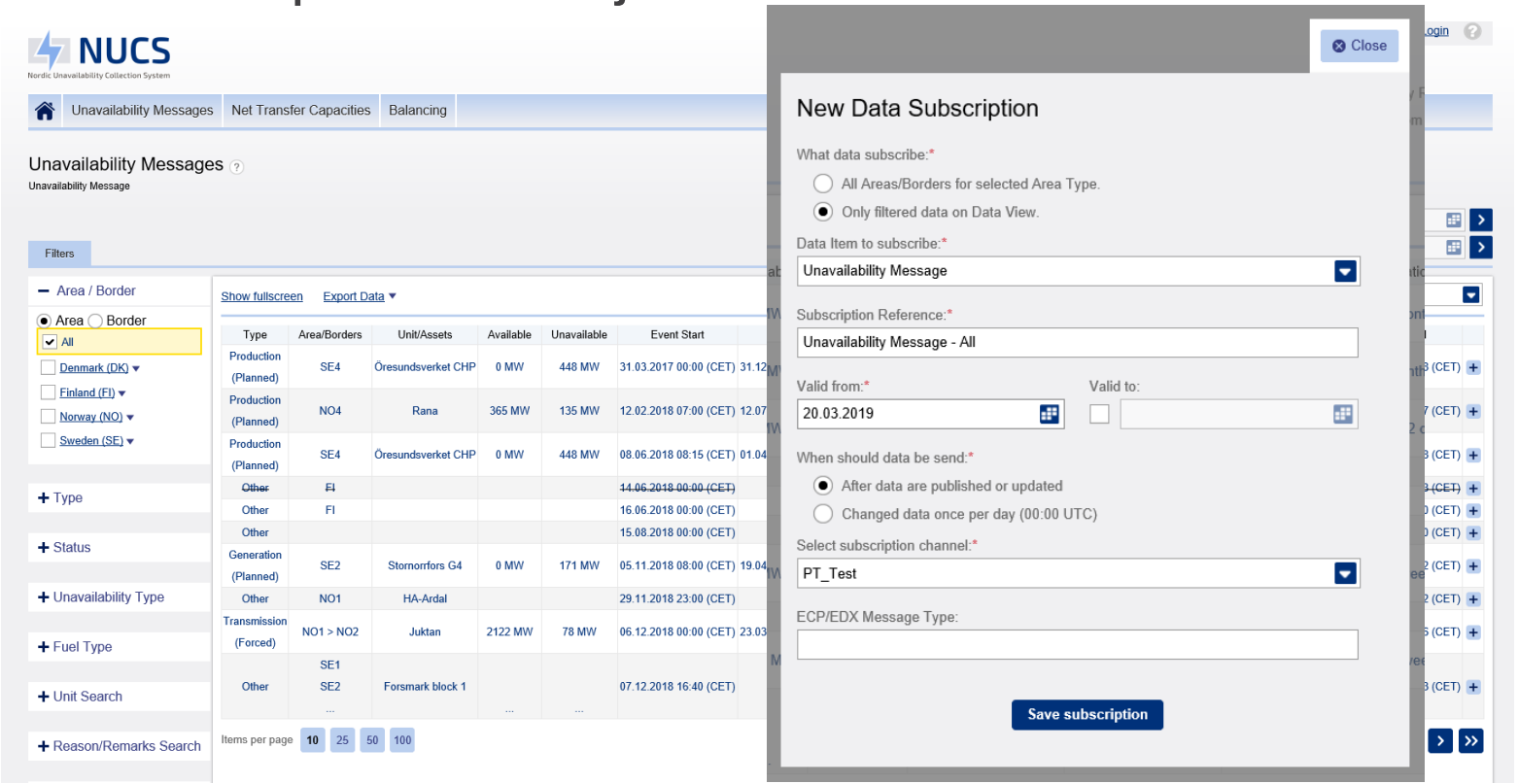
Export

Planned Unavailability of Production Units [15.1.C] XML XLS CSV

Production (Planned)	SE4	Öresundsverket CHP	0 MW	448 MW	08.06.2018 08:15 (CET)	01.04.2023 00:00 (CET)	4 years, 9 months, 3 weeks, 2 days, 15 hours, 45 minutes	ENTSO-E	Fossil Gas	30.11.2018 16:38 (CET)

Statnett

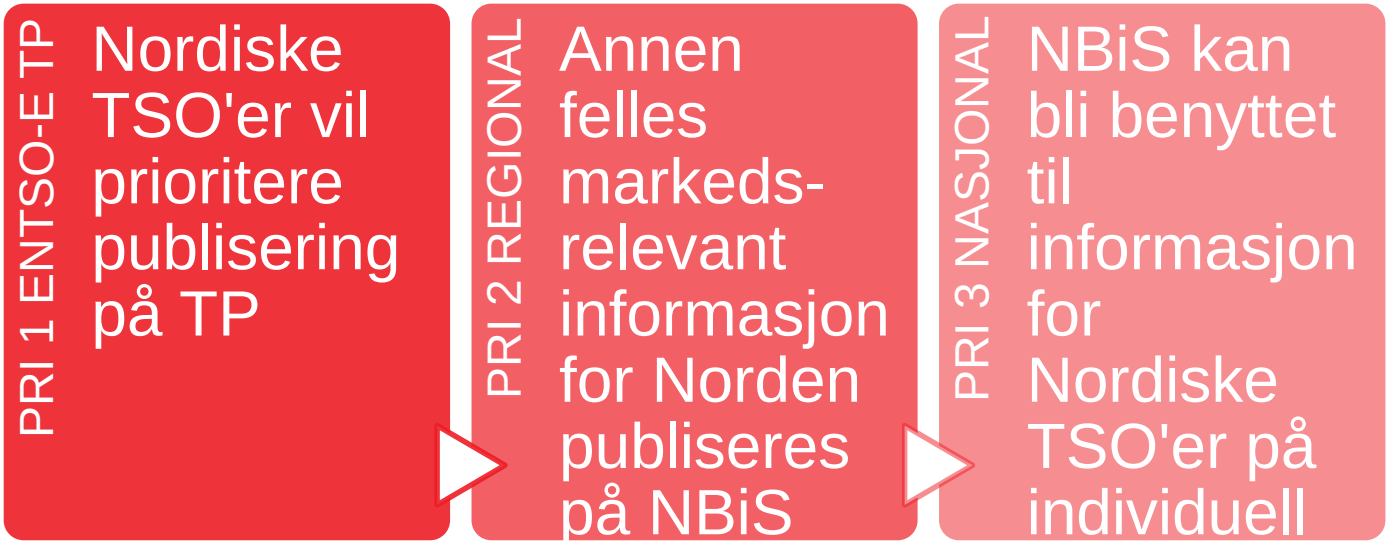
Abonnere på informasjon



NBiS = Nordic Balancing information System

Statnett

NUCS fremover



Statnett

Bakgrunn

- Behov for aggregerte og grafiske visninger visninger
- Tilgjengeliggjøring av nordisk kraftdata
- Abonnere på informasjon
  - API
  - ECP
  - Mail

Fremtiden

- Maximum NTC
- Aggregert visning av NTC og utilgjengelighet
- Forbruksprognoser
- aFRR

Statnett

NBIS Unavailability Messages Net Transfer Capacities Balancing Support Login

Forecasted Transfer Capacities - Year Ahead

Home / Forecasted Transfer Capacities - Year Ahead

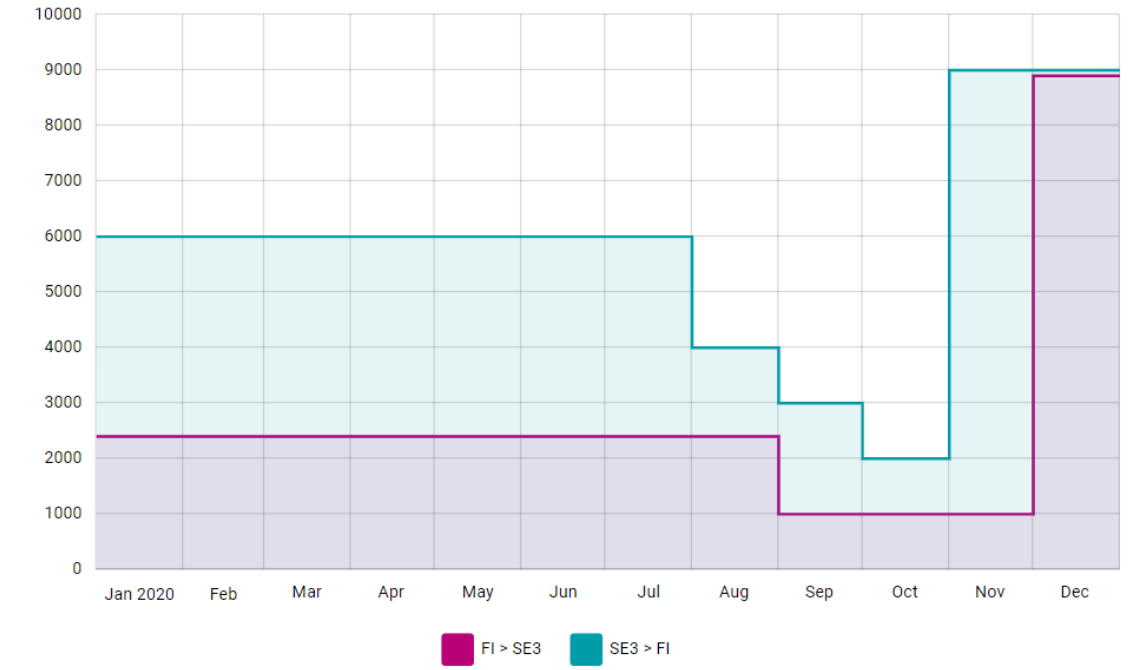
Filters Reset all

Date

2020

Area

- Denmark (DK)
- Finland (FI)
- Norway (NO)
- Sweden (SE)
  - SE1 - FI
  - SE1 - NO4
  - SE1 - SE2
  - SE2 - NO3
  - SE2 - NO4
  - SE2 - SE3



Statnett

Accepted Offers and Activated Balancing Reserves

Home / Accepted Offers and Activated Balancing Reserves

Filters Reset all

Date

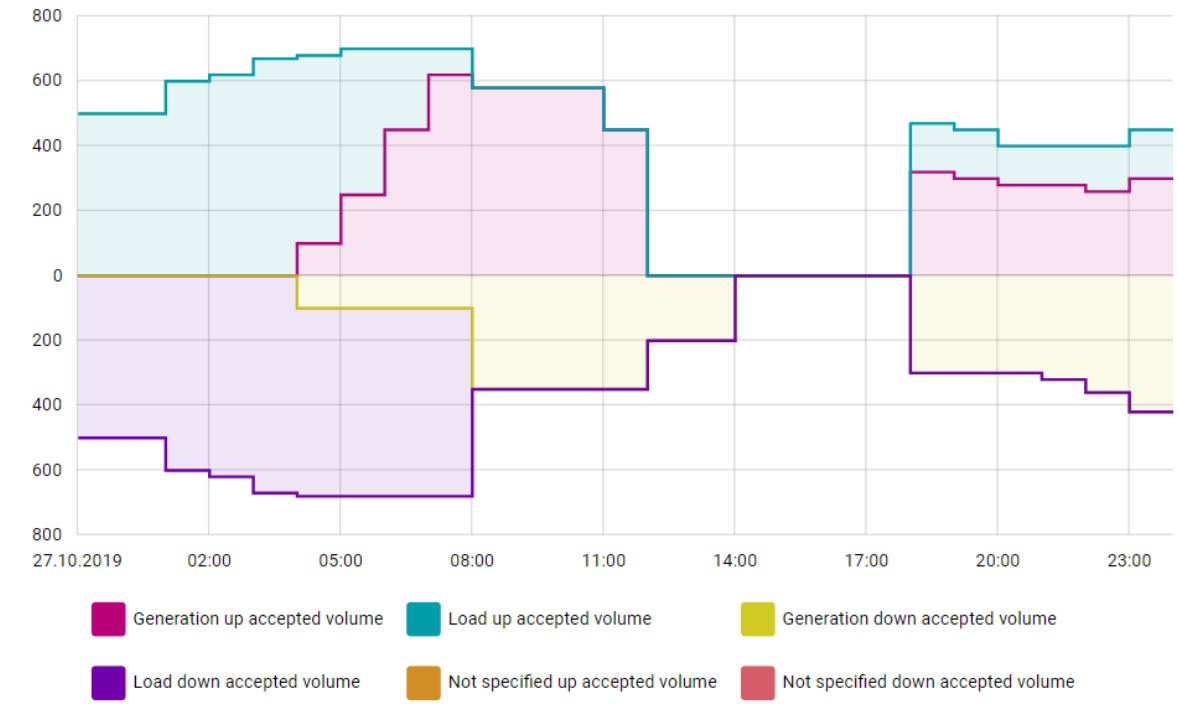
27.10.2019

Area

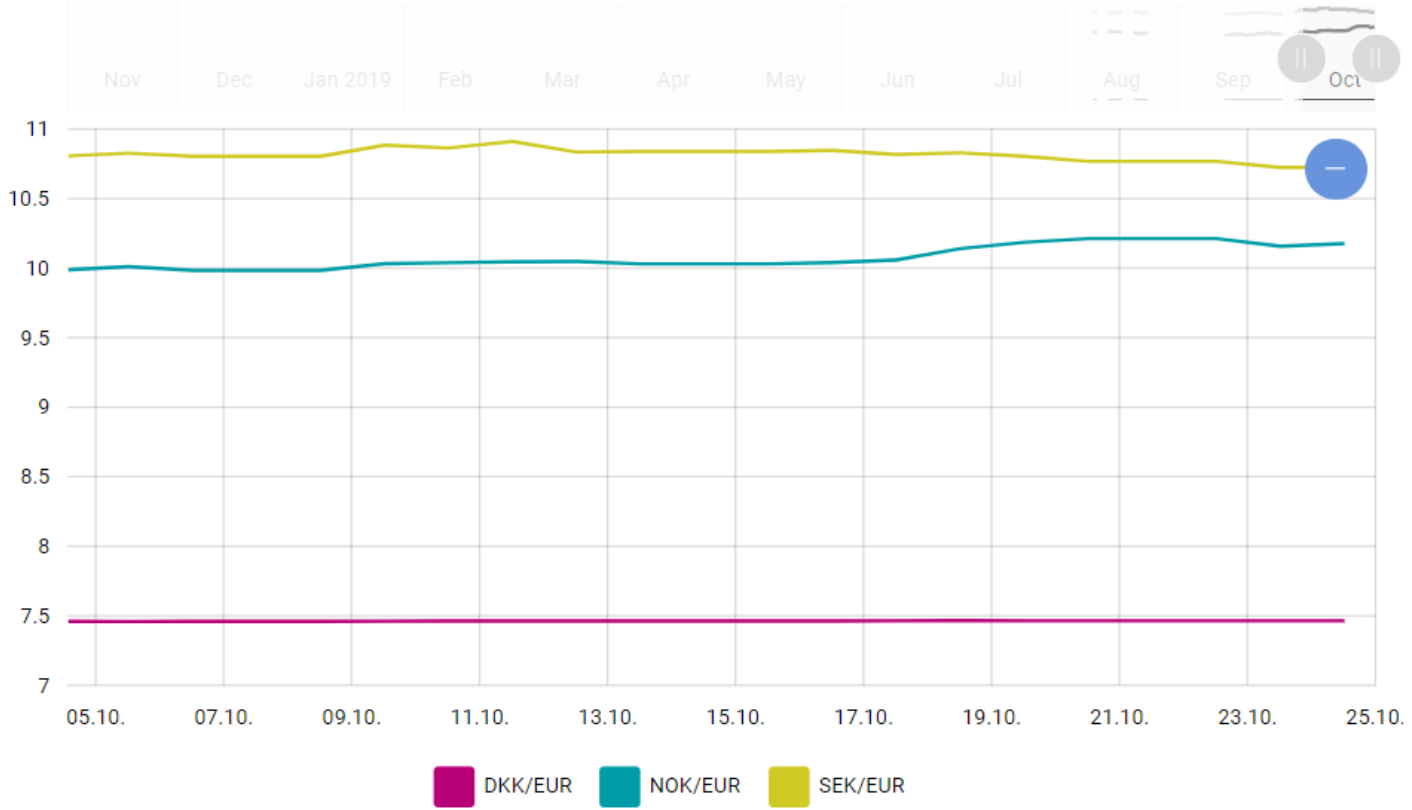
- [ ] Denmark (DK)
- [x] Finland (FI)
  - [x] MBA|FI
- [ ] Norway (NO)
- [ ] Sweden (SE)

Reserve type

- [x] aFRR
- [ ] FCR
- [ ] mFRR



Balancing Exchange rates




Fremtiden er **elektrisk**

ECP

status oktober 2018

Oslo, 21/10-2019

Statnett

ECP – hva er det?

- Sikkert kommunikasjonssystem for bruk i energibransjen
- Send en hvilken som helst melding/fil mellom systemer hos forskjellige aktører
- Eiet av ENTSO-e og utviklet av Unicorn
- Er under kontinuerlig utvikling
- Er i bruk over hele Europa og blir stadig viktigere
- Statnett er en viktig aktør og pådriver
- Bransjestandard(?)

ECP – teknisk

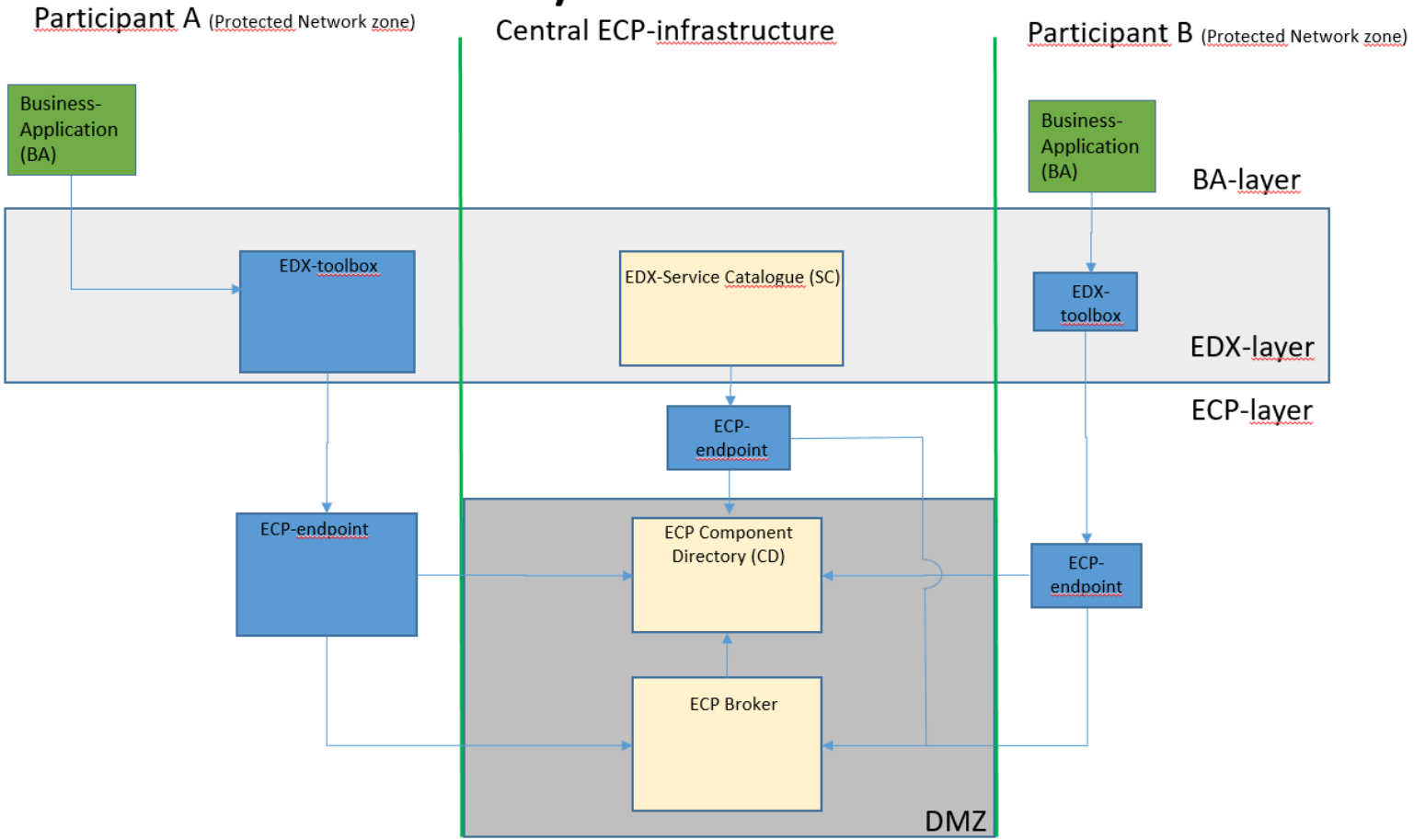
- Sertifikathåndtering er innebygget, sikker og automatisk
- Egen adressering innen nettverket
  - eks: 50V000000000188Y er en adresse til Statnett
- Enkelt å koble seg til for forretningssystemer
  - Ekstra utvikling for å sende > 30MB meldinger
- En aktør kan sette opp et endepunkt ved å følge en guide fra Statnett, på Linux eller Windows.

ECP - begrensninger

- Helst kun ett ECP-endepunkt pr aktør
- Moderat ytelse, men kan forbedres gjennom konfigurasjon, hardware og utvikling av ECP
- Direkte trafikk mellom aktører må avtales med Statnett
- Statnett har full kontroll over hvem som kan være med i nettverket

ECP/EDX

Statnett



Status - produksjon

- ECP 4.3 og EDX 1.4
- Produksjon fungerer stabilt
  - Ingen store hendelser sentralt
  - Nær sagt alle endepunkter er tilkoblet hele tiden.
- 131 endepunkter tilkoblet
  - 100++ nettselskaper (FASIT)
  - 16-17 kraftselskaper (elektronisk bestilling)

Status - test

- ECP 4.4 og EDX 1.5.1
- 27 endepunkter er tilkoblet
- Mange nye tjenester bruker ECP:
  - SS/MNA publiserer pris & flyt data
  - NVE publiserer magasinstatistikk
  - NBIS publiserer valutakurser
  - NUCS publiserer utilgjengelighetsmeldinger
  - AUTOFOS tar i bruk ECP – alternativ til FOSWeb
  - NFMMS tester AFFR-kapasitetsmarked mot Energinet og Fingrid
  - Produksjonsplanutveksling mellom DSO'er og Statnett

Status – nordisk samarbeid

- SvK skal ta en beslutning på om de vil ta i bruk ECP i løpet av oktober
  - SvK benytter idag SFTP
- ECP 4.5.1 og EDX 1.6 er ventet i slutten av oktober
  - Produksjonssetting av nyeste ECP/EDX kan forhåpentligvis skje i desember
  - Koble alle aktører i Danmark, Norge og Finland (og forhåpentligvis Sverige)

EDIFACT/SMTP migreres til CIM-XML/ECP

- For hver tjeneste/funksjon som skal migreres så vil Fifty måtte utvikles til å støtte:
  - Støtte innkommende trafikk for begge varianter (agnostisk)
  - Støtte to utgående tjenesteruter hentet fra Ruteregisteret
    - BKK-Bud-1: EDIFACT/SMTP, gyldig til 1 nov 2020
    - BKK-Bud-2: CIM-XML/ECP, gyldig fra 1 jul 2020
- Ruteregisteret skal administreres av Statnett, men informasjonen i registeret bestemmes aktørene
- Muliggjør overgang styrt av aktør (bestemmer datoer)
- Muliggjør myke overganger (overlapp) hvis ønskelig
- Muliggjør tilbakerulling (hvis en rute ikke fungerer som tenkt)

Framover – ECP-plattformen

- Penetrasjonstester finner ingen alvorlige svakheter, men en del mindre ting som blir fikset fortløpende av Unicorn
- Antivirus-støtte er ventet neste år
- Statnett sitter i en styringsgruppe for ECP i ENTSO-e og prioriterer omtrent i denne rekkefølgen
  - Fjerne alle sårbarheter som avdekkes
  - Økt robusthet (bugs)
  - Bedre feilhåndtering (graceful degradation)
  - Brukervennlighet
  - Enklere installasjon og oppgradering
  - Mer funksjonalitet

Informasjonskanaler

- ecp@statnett.no : ECP spørsmål, innspill, installasjon
- Eroom : Statnetts fildelingsløsning
  - Dokumentasjon
  - Installasjonsfiler
  - Viktige endringer (krever at man abonnerer på endringer)
- ISB-møte : Status
- Landsentralens meldingstjeneste på statnett.no

Overgang fra Elcom til ICCP

Gunnhild Håhjem

Statnett

Nydalen, 24.10.2019

Statnett

Bakgrunn for prosjektet

I tråd med funksjonskrav for kraftsystemet vil ICCP erstatte Elcom som ny standard for utvekslingen av driftsinformasjon mellom Statnetts driftssentraler og andre driftssentraler i Norge.

Fra FIKS 2012:
Informasjonsutveksling
Kontrollanlegg og/eller tilknyttet driftssentralsystem skal utføres med mulighet for å overføre målinger og meldinger til systemansvarlig. Elcom skal benyttes som standard ved slik overføring, med mindre annet er avtalt. Denne Elcom kommunikasjonsstandard planlegges endret til ICCP (IEC 60870-6/TASE.2), gjeldende fra 1.1.2016. I en overgangsperiode frem til 1.12.2019 vil det fortsatt være mulig å benytte Elcom. Nye driftssentralsystemer eller større systemoppgraderinger må derfor ta høyde for å kunne kommunisere med systemansvarlig via IEC 60870-6/TASE.2.

Prosjektet involverer

- 51 Aktører
- 3 TSOer

→ 63 Elcom forbindelser

Mange ulike typer driftssentralsystemer

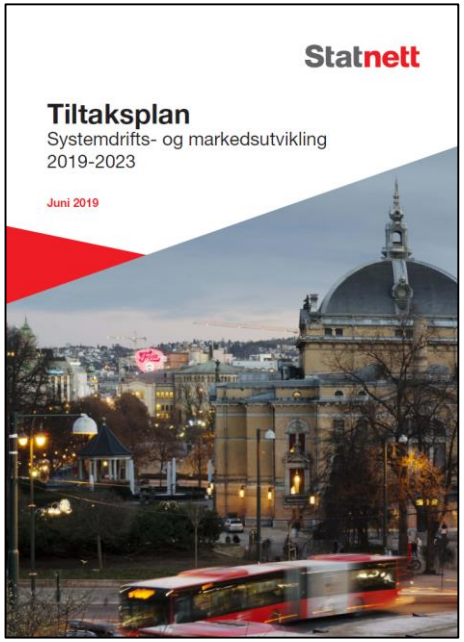
- Kartlegging viste at flertallet vil være klar 3. og 4.kvartal 2019
- Startet med aktører som varslet at de var klar for ICCP på våren
- Flere av aktørene planlegger oppgradering for å tilrettelegge for ICCP nå

Tiltaksplan 2019 - 2023

Statnett ser at det ikke er realistisk å få alle aktører over til ICCP dette året. Det er derfor satt ny frist til desember 2020.

I Tiltaksplan som ble publisert i juni er det informert om ny frist.
Tiltaksplan-systemdrift--og-markedsutvikling-2019-23---juni-2019.pdf

Statnett har som målsetting å fase ut Elcom og gå over til ICCP innen 1.12.2020, som er ett år senere enn det som ble kommunisert i FIKS 2012.
Nye driftssentralsystemer eller større systemoppgradering hos våre partnere må derfor ta høyde for å kunne kommunisere med Statnett via ICCP. Statnett bærer i dag kostnaden for løpende oppdatering av Elcom kildekode, men vil terminere dette når overgangen til ICCP er gjennomført.



Dette har vi gjort frem til nå…

- Etablert kontakt med alle aktører
- Opprettet AIEF skjema for opprettelse av ICCP- kommunikasjonen mellom Statnett og alle aktører
- Lagt over 7 forbindelser til ICCP
  - Driftssentral med Siemens system
  - Driftssentral med ABB Network Manager system
- Kjørt pilot sammen med ABB for Compass kunder
- 11 aktører er i gang med omlegging nå

- Statnett har gjennomført Business Impact Analyse og risikoanalyse og gjort en vurdering til kryptering av ICCP (Secure ICCP)
- Pilot av Secure ICCP er under planlegging

Erfaringer

- Statnett har fått mer erfaring med nytt driftssentralsystem
- Aktører / Leverandører har funnet og rettet flere feil
- Driftsmessig ser vi mer stabil kommunikasjon over ICCP
- Plan og rekkefølge på aktiviteter er god, men det er ikke alltid rett frem..

Det er avdekket og håndtert ulike typer feil:

- Inverterte statuser
- Feil på håndtering av datasett som ikke er like på begge sider
- Parametere som er feil tunet
- Tidsstempling på statuser

Statnett

Kontaktpersoner fra Driftssentalmodell (ITL)

Gunnhild Håhjem
Ekstern konsulent
Driftssentralmodell (ITL)

Tor Kristian Vara
Avdelingsingeniør
Driftssentralmodell (ITL)

Johan Harbitz Motzfeldt
Sivilingeniør
Driftssentralmodell (ITL)

Tommy Strøm
Senioringeniør
Driftssentralmodell (ITL)

Torstein Gombos
Ekstern konsulent
Driftssentralmodell (ITL)

Geir Karlsen
Sivilingeniør
Driftskritiske tjenester (ITD)

Fifty

Thor-Ole Johansen

Nydalen 24.10.19

Statnett

Fifty MMS

Kommende versjoner

Statnett

Fifty MMS v15

- **Planlagt release: 03.12.2019**

En versjon hvor det hovedsakelig har vært fokusert på å rydde opp i teknisk gjeld og forberede systemet for de fremtidige endringene vi ser kommer ved innføring av ny balanseringsmodell.

- Funksjonelt innhold
  - Støtte for FCR på forbruk
  - Ny beregning av aktivert FCR
    - Splitter beregningen i FCR-N og FCR-D
  - Forbedret funksjonalitet for eBestill

Statnett

Fifty MMS v16

- **Planlagt release mars 2020**

Nordic Balancing Model (NBM) begynner å få fart og det innledende arbeidet knyttet til dette begynner å krever utviklingsressurser fra Fifty MMS.

Videre ønsker vi å rigge oss til å kunne levere funksjonalitet hyppigere og som en del av dette legger vi opp til to hovedreleaser mot sommeren 2020.

- Funksjonelt innhold
  - Støtte for NordLink
  - Forberedelser for FCR-D Ned

FiftyWeb

Ny teknologistack

- Dagens arkitektur og teknologi på FiftyWeb er utdatert og trenger oppdatering
- Startet arbeidet med å gå over til ny teknologi
- Ikke klart nå løsningen er på plass
- Vil følge egen release-syklus, uavhengig av Fifty MMS
- I første omgang ingen ny funksjonalitet, men en konvertering for å bli mer future proof

Planer

Release uavhengig av funksjonalitet, og veien videre

Flere børser (MNA, Mulitiple Nemo)

- **Planlagt go-live 10.mars 2020**
- Valutakurser fra NBiS
  - NBiS henter siste tilgjengelige valutakurs fra ECB og publiserer denne som en valutakurs et gitt døgn

FCR

- FCR D-2 er planlagt Q2 2020
  - EDIEL oppdater februar 2019
- FCR-D Ned
  - 2021
  - Behovet oppstår blant annet grunnet økt eksport- og importkapasitet, og perioder med lite roterende masse.

Overgang fra EDIFACT til CIM

- **Hvorfor**
  - Forenkle og standardisere rundt integrasjoner
  - Harmonisere løsninger mellom Svk og Statnett
  - Bedre støtte for fremtidige endringer som 15 min oppløsning og nye produkter
  - Enklere testregime med automatiske tester

- **Plan**
  - Smidig overgang med støtte for både EDIEL og CIM
  - Tidspunkt ikke klart, men vurderer støtte for CIM fra innføring av FCR-D Ned

Veien videre

- Innfører SAFe for å kunne håndtere den nødvendige skaleringen i forbindelse med NBM
- Overgang mot DevOps og hyppigere releaser
- Slutt med versjoner, tenker funksjonalitet

eBestill

Status og informasjon om "tjenesteutsetting"

Statnett

Nydalen, 24/10-19

Innhold

- Status eBestill
- Ny funksjonalitet i Fifty MMS v.15
- Om arbeidet med "tjenesteutsetting" av eBestill
  - Avklaring knyttet til formidling av budpris i aktiveringsmelding
- Noen fremtidige uformaliserte behov

Status eBestill

- Statnetts inntrykk er at eBestill fungerer bra
- Flere aktører arbeider med sine løsninger og planlegger deltakelse i tiden som kommer
- Fortsatt gjelder krav om deltakelse innen utgangen av 2020
- Noen fremtidige uformaliserte behov

Ny funksjonalitet i Fifty MMS v.15

- Merking av stasjonsgrupper for unntak produksjonsflytting
- Mulighet for å endre effekt (etter avtale på tlf.) på pågående aktivering fra Statnett uten å stoppe aktivering først
- Forbedret varsling hos Statnett ved mislykket bestilling (f.eks. at bestilling av aktivering ikke er besvart, ikke er besvart i tide eller at melding med svar ikke kommer tilbake til Statnett)
- Samt en rekke forbedringer som medfører at prosess for bestilling og prosess for feilsøking blir enklere på Statnett sin side

Om "tjenesteutsetting" av eBestill

- Tjenesteutsetting: Når en annen part enn den balanseansvarlige aktøren skal motta bestilling av aktivering. Altså at en tjenesteytende aktør skal aktivere på vegne av balanseansvarlig.
- Konkurranserelatert problemstilling: Er det problematisk at RK budpris sendes til andre enn balanseansvarlig aktør ved bestilling av aktivering?
- Løsning: Statnett fortsetter å sende med pris ved tjenesteutsetting når dette godkjennes av balanseansvarlig aktør. Vilkår oppdateres med bestemmelser knyttet til håndtering av prisinformasjon

Noen fremtidige uformaliserte behov

- "Heartbeat" for eBestill
  - Å kunne sende sykliske testmeldinger f.eks. hvert 5. min som kan bidra til å avdekke om det har oppstått feil i kommunikasjonskjeden. Gjerne hele kjeden mellom Fifty MMS og aktørenes svarapplikasjon
- Redundante løsninger
  - Med overgang til 15 min oppløsning i reservemarkeder og fremtidig automatisering vil behovet øke for redundante systemløsninger. Statnett vil arbeide med å formalisere krav fremover

FORENKLET LØSNING ELEKTRONISK BESTILLING

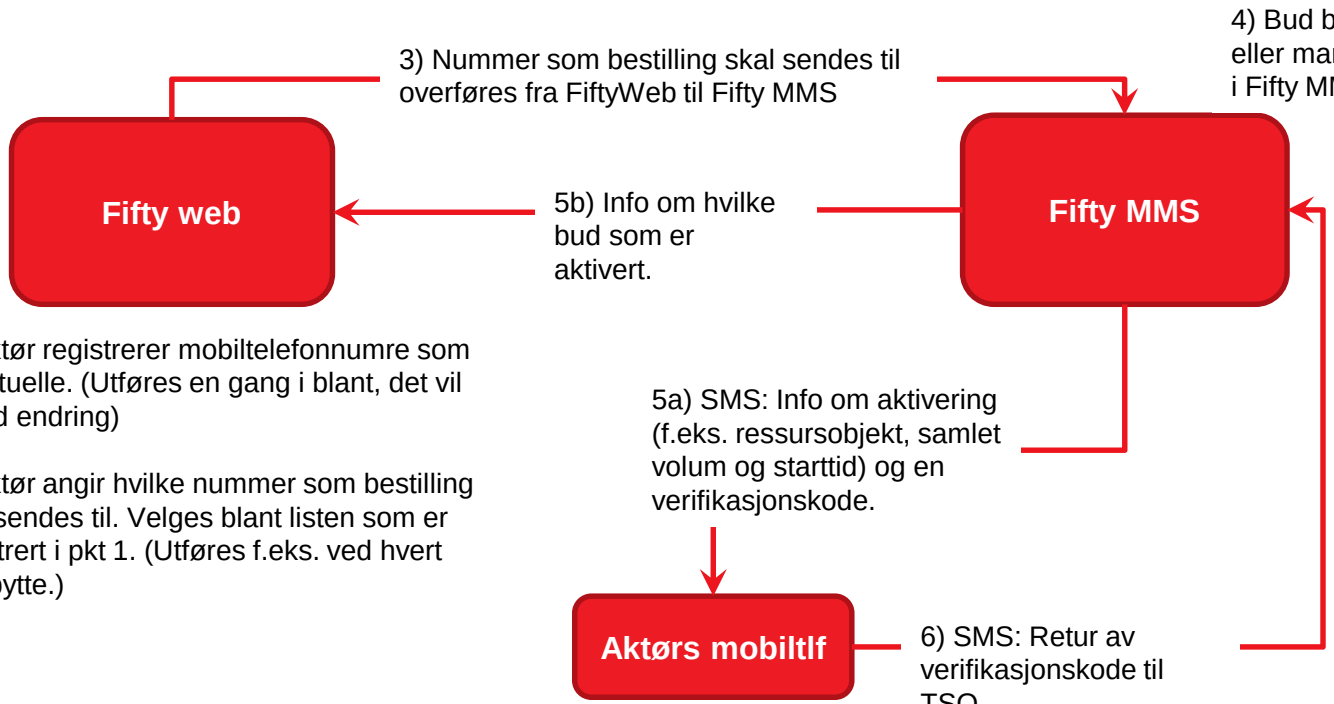
Forenklet løsning elektronisk bestilling

- For å redusere barrierer for "mindre" aktører har Statnett kommunisert at vi tar sikte på å etablere en forenklet løsning for elektronisk bestilling
- En forenklet løsning kommer til å ha begrenset funksjonalitet
- Om en forenklet løsning skal kunne benyttes som fallback vil bli vurdert

- Hovedegenskaper i foreslått konsept for forenklet elektronisk bestilling:
  - Bestilling og bekreftelse skjer via SMS
  - FiftyWeb benyttes for å angi hvilket/hvilke mobiltelefonnumre som elektronisk bestilling skal sende til

- Det er IKKE avklart om konseptet er akseptabelt sett fra et sikkerhetsståsted
- Vi ønsker likevel å presentere det mulige konseptet for å komme i dialog med potensielle brukere

Konsept for forenklet løsning for elektronisk bestilling



NBM og status aFRR CM

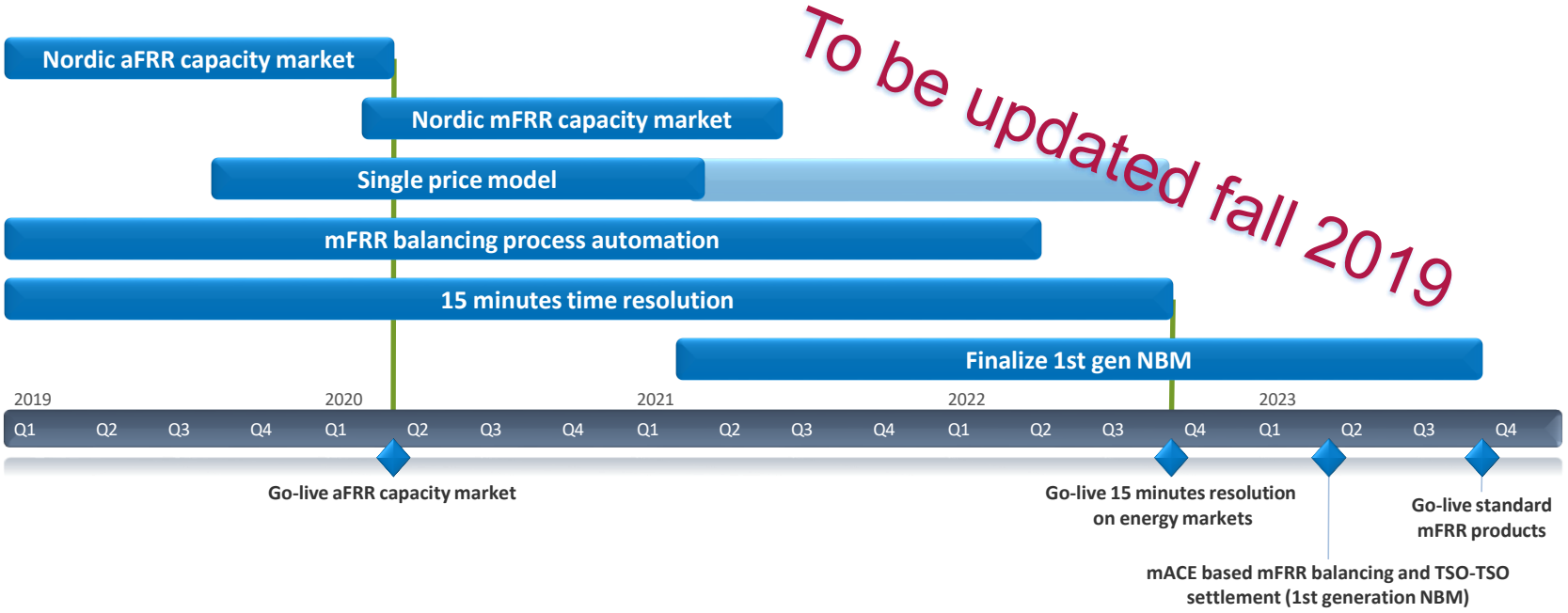
Olga Ingrid Steinsholt, Statnett

Statnett

Nydalen, 24.10.2019

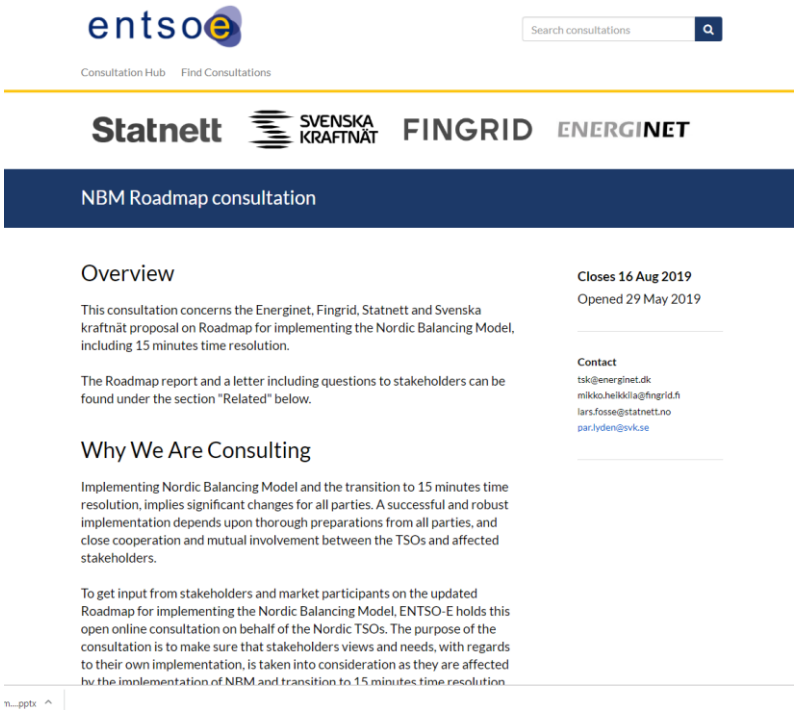
Statnett

Revised NBM roadmap May 29



Statnett

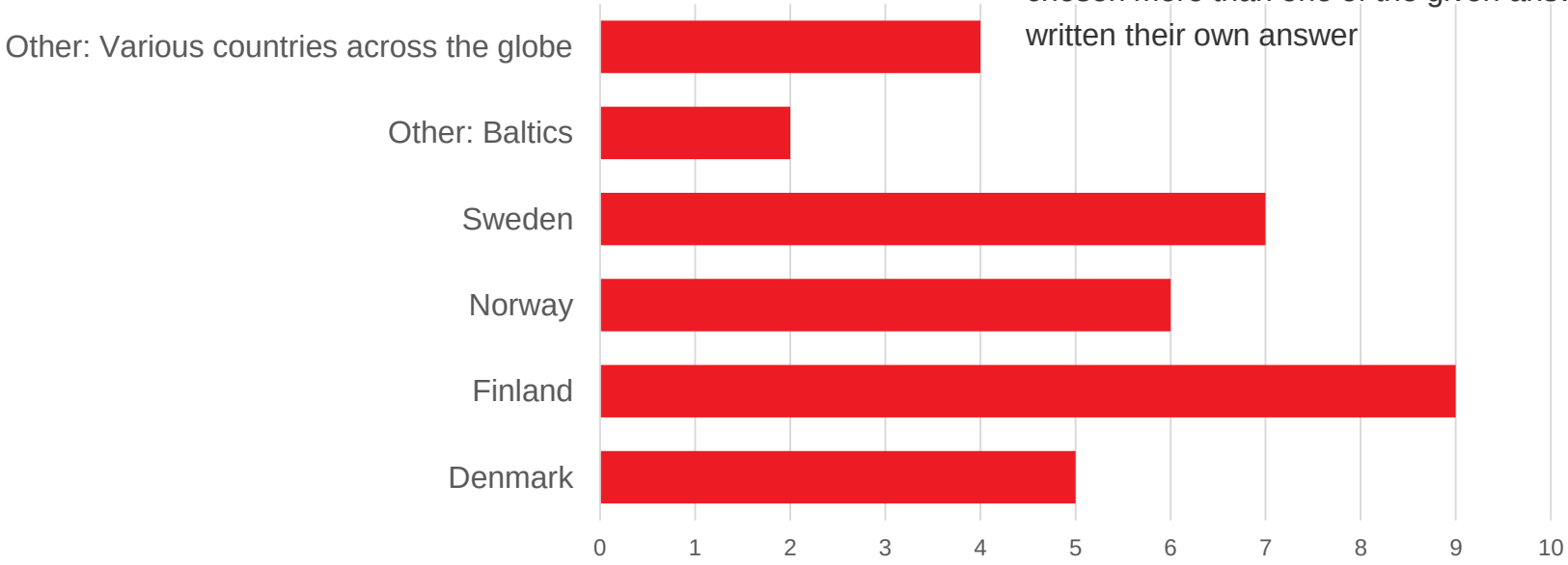
Revised roadmap published may 29



Statnett

In which country is your organisation based?

16 respodents in total, the respodents may have chosen more than one of the given answers or written their own answer



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General feedback (questions 1-3)

- More information in general is asked for:
  - Details of the markets, for example pricing of balancing energy and imbalances.
  - What will be the concrete effects for stakeholders and their IT-systems, business processes and business strategies?
  - There should be more visibility to costs and budget of the NBM program
- Timelines:
  - Should be realistic rather than overly ambitious
  - NRA processes and main risks should be visible
  - Exact dates of (at least) 15 min ISP and single pricing model are needed
- Better reasoning/analysis are needed:
  - Reasoning of the proposed roadmap and choices made
  - Why long delay is needed? How the delays will affect to socio-economic gains?
  - Do the TSOs have the right plan to go for new Nordic markets, why not go for European solutions (MARI, PICASSO)?

aFRR + mFRR capacity market (question 4, 5)

- General support for implementation of Nordic aFRR capacity market
- Almost all respondents have concerns regarding XB reservation methodology
- Support for quick implementation of marginal pricing
- Stakeholders do not think that implementation of Nordic mFRR capacity market should be a priority

Statnett

Single price model (questions 6-8)

- MP support quick implementation of the single price model
  - Prefer implementation in accordance with EBGL (that is by Q1/2021) of single price model simultaneously in all Nordic countries.
- MP see no need for a simultaneous implementation with 15 min ISP.
- Does not regard TSO operational concerns in some geographical areas and operational situations as a major drawback/wants more details concerning this.

15 minutes resolution (question 9-10)

- A postponement to Q4 2022 is reasonable in order to make the necessary preparations in an orderly way.
- MP stress that the new date for implementation of 15 min ISP presented in the revised roadmap should be firm.
- DSO’s have another perspective than producers. DSO's emphasis on coordination with development of datahubs.
- NEMO’s as soon as possible, DSO’s not in a hurry and producers are satisfied with the timeline.
- Important to have 15 minutes’ products available at least in ID-markets, but preferably also in DA-markets by when Nordic bidding zones swift into ISP 15.

mFRR balancing processes automation
(questions 11-15)

Standard products, mFRR balancing processes automation and AOF's, should be described better and be introduced as early as possible.

- Harmonization between NBM and the European platforms, when the latter are put into operation, is important.
- Standard products that are being introduced, and how the market participants shall interact with the TSO, should be described as soon as possible
- Better explanation of what bid filtering is.

Outlook for energy activation markets
(question 16)

- Support for European balancing markets and platform.
- Seamless transition between the NBM platforms for aFRR and mFRR activation products and the similar European platforms MARI and PICASSO
- The presented roadmap doesn’t describe harmonization and integration process in sufficient detail. The final roadmap should describe implementation deadlines for what TSOs describe as ‘2nd generation NBM’.

Stakeholder involvement (question 17)

- Satisfied with the increase of stakeholder involvement, but more is needed
  - Webinars and video conferences were asked for
  - Continuous update of plan on the website

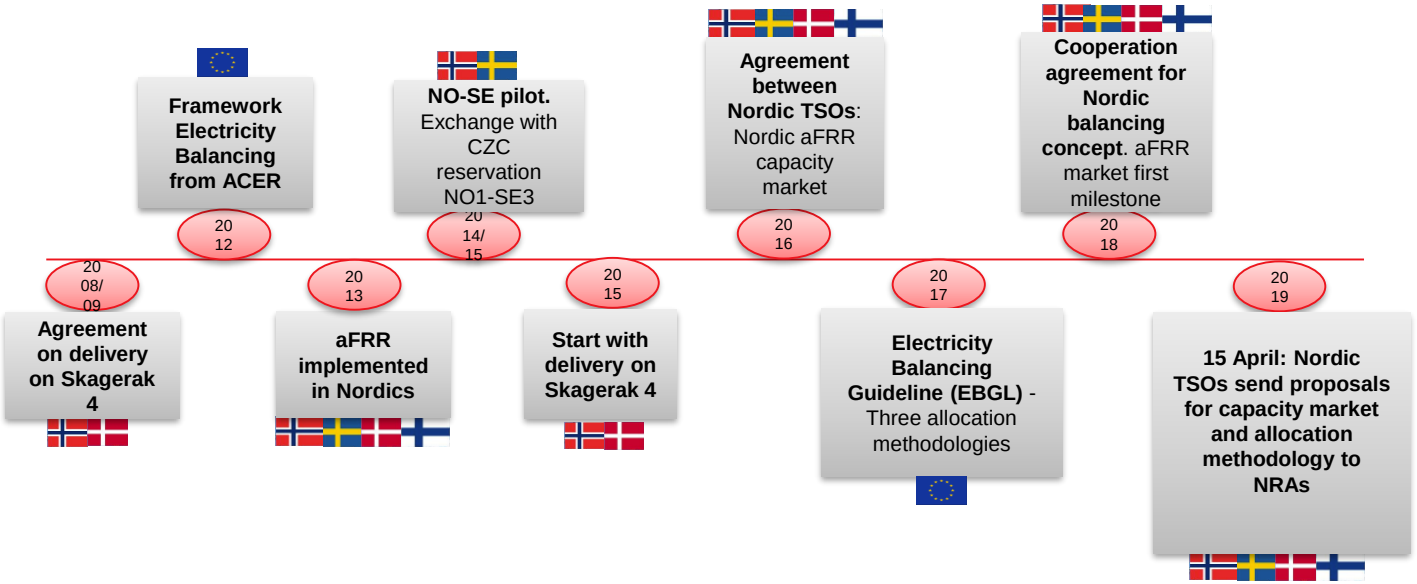
STATUS AFRR KAPASITETSMARKED

Bakgrunn aFRR CM

- Formålet med aFRR-kapasitetsmarkedet er å sikre tilgjengelighet av aFRR-reserver som er viktig for driftssikkerheten.
- Tilstrekkelige aFRR-volumer i Norden er nødvendig for en sikker overgang til den nye balansemodellen basert på 15-minutters oppløsning. Et felles nordisk marked for aFRR-kapasitet blir sett på som den mest effektive måten å sikre nødvendig økning av aFRR-volum.
- Ved å allokere overføringskapasitet til aFRR kan økte volumer effektivt gjøres tilgjengelig for balansering av det nordiske synkrone området, mens man tar hensyn til nettbegrensninger.

Statnett

Historical background of aFRR in Nordics

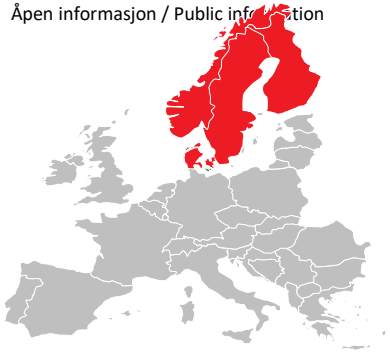


Regulatorsøknad aFRR CM

- I april sendte de nordiske TSO-ene juridiske forslag om et nordisk aFRR-kapasitetsmarked til NVE og tilsvarende øvrige reguleringsmyndigheter for godkjenning.
- En godkjenning fra de nordiske regulatorene er en forutsetning for å innføre et felles marked.
- De nasjonale regulatorene har nå gitt sine innledende tilbakemeldinger, og TSO-ene er bedt om å gjøre endringer i forslaget som et ledd i den videre godkjenningsprosessen.

Forventet go-live aFRR CM

- Vi har tidligere antydet en oppstart av markedet i Q1 2020, men dette ser vi nå ikke lenger som mulig.
- Neste beslutning fra regulatorene i godkjennelsesprosessen vil være i Q1 2020, og på det tidspunktet vil vi kunne gi mer informasjon om en forventet tidsplan.
- På grunn av omfattende godkjenningsprosess med regulatorene i de nordiske landene er den mest optimistiske prognosen for det planlagte aFRR-kapasitetsmarkedet nå neste høst, sannsynligvis senere.



Statnett

Capacity calculation methodologies explained

Flow Based market coupling (FB)
& Coordinated Net Transfer Capacity coupling (CNTC)

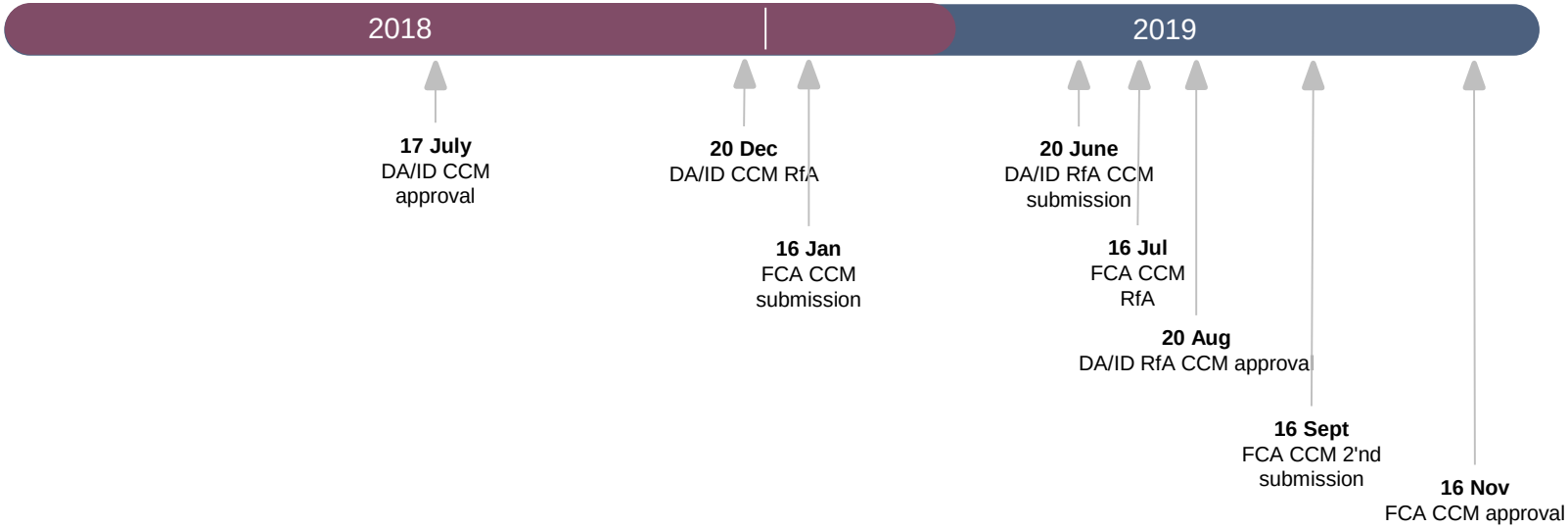
Explanatory slides for FB and CNTC
Nordic CCM project

Table of content

1. Introduction

- The purpose of capacity calculation is to translate physical transmission limits in the power-grid into limits on commercial trades at par with the market design and operational security
- Capacity calculation is a legal obligation for the TSOs to be carried out in a common coordinated process within each Coordinated Capacity calculation Region (CCR)
- In the Nordics, the coordinated capacity calculation process is assigned to the Regional Security Centre (RSC) office in Copenhagen, and the TSOs are responsible to deliver the local/national input to the coordinated capacity calculation process
- The legal background for capacity calculation is provided by both national legislation, and the CACM-GL, the FCA-GL, SO-GL and the Nordic CCM

Legislative process



Motivation

- **Legal requirements:** According to the CACM, the most efficient of two different capacity calculation methodologies, and corresponding market designs, shall be introduced within each CCR:
  - Flow Based market coupling (FB)
  - Coordinated Net Transfer Capacity market coupling(CNTC)

- As opposed to the CNTC approach, which is based on the provision of ATCs, the FB approach provides capacities for commercial power exchanges by the introduction of PTDFs and RAMs

- **Efficiency considerations:** The objective of both approaches is to improve operational security and economic efficiency of the Nordic and European electricity markets by the means of regional and Europewide coordination, and significant improvements in automatization and formalisation

- **Practical requirements:** Enhancements are also necessary from a practical point of view. Many new elements increases the complexity of the current Nordic power system, making it evermore complex to maintain and support the current manual capacity calculation process
  - Higher number of HVDC interconnectors
  - New AC lines and increased capacity on AC connected borders
  - Increased generation from renewable intermittent generation (wind and photovoltaic)
  - Increased efforts within market efficiency and system integration
  - Renewed focus on flexible consumption

Statnett

2. From physical limitations to exchange capacity

Exchange capacities

- Exchange capacities provides limitations for the electricity market, in terms of linearized constraints, on cross zonal exchanges.

- The exchange capacities are derived from the physical capacity of the power-grid to provide linear MW limits for commercial power exchanges. The linearized constraints are simplifications of the complex non-linear physical limitations of the power-grid

- According to the CACM, there are two options for providing exchange capacities for the European electricity market:

  a) **FB:** The electricity market receives a linearized "security domain" described by power transfer distribution factors (**PTDF**s) on critical network elements (**CNE**s). The flow on each individual CNE is limited by a MW margin representing the secure physical capacity of the component(s), while the PTDF gives the flow on each CNE from a one MW injection in each BZ

  b) **CNTC:** The electricity market receives a MW limit on bilateral exchanges between any two bidding zones. The MW limits are derived from the "security domain" (bidding zone configuration is applied in order to capture all relevant limitations)

From complexity to simplicity

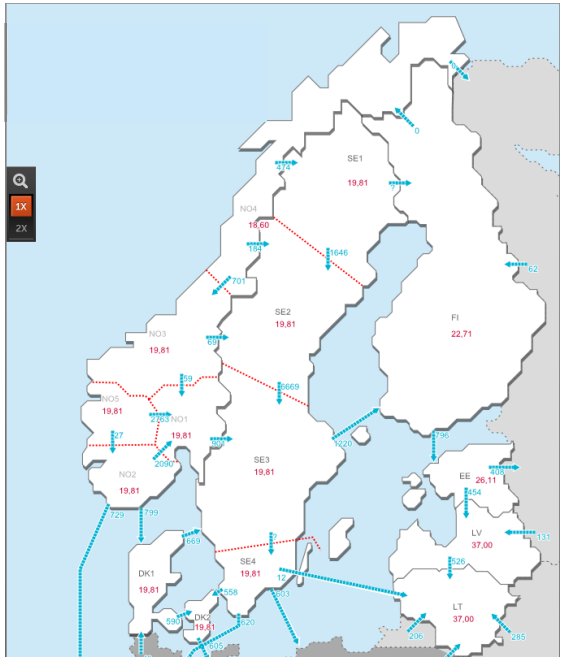
The physical world

Complexity → Simplicity

Detailed grid model — FB — CNTC

Capacity calculation is the process of translating the complex physical grid into a simplified form that can be understood and applied by the power exchange

The commercial world



Physical grid constraints

- All physical limitations in the grid must be respected during operation and thus can either be:
  - Imposed as limits to commercial exchanges (the electricity market), or
  - Managed directly by counter trade or re-dispatch during operation

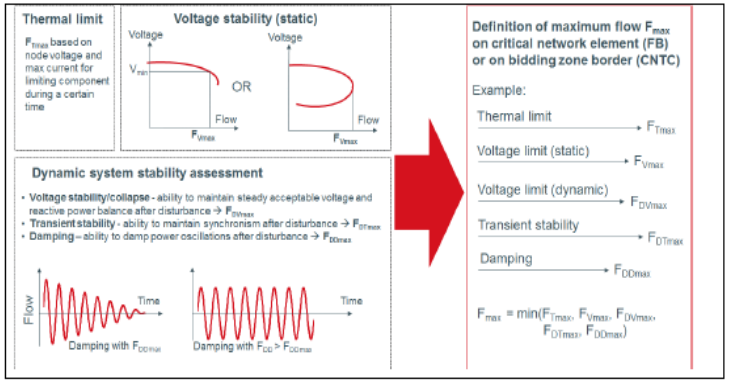
- The physical limitations are scattered around in the grid "having little regard" for actual bidding zones
  - Some physical limitations are located on, or close to, a bidding zone border
  - Other physical limitations are located inside bidding zones - internal constraints

- Bidding zone delimitation is "an attempt" to capture the limitations as efficiently as possible for the electricity market

Physical grid constraints

- The physical constraints are defined by the components of the power-grid and the state of the power system → How much power flow may be carried by the component(s) until an incident might occur
- Due to operational security and risk considerations, the "secure physical capacity" applied in operation will/may differ from the "maximum physical capacity" found in any given scenario
- Thus, the secure physical capacities of grid components will vary with grid topology, temperatures, loading and risk assessment
- **The secure physical capacity is a common base for the FB and CNTC approaches**

- The physical capacities constitute complex non-linear limitations on flows:
  - ✓ Thermal limitations for each grid element
  - ✓ Steady state and dynamic voltage limits for each grid element or group of elements
  - ✓ Dynamic stability limits for groups of grid elements
  - ✓ Short circuit limits
  - ✓ N-1 considerations



3. Principles of FB and CNTC capacity calculation

Converting physical grid constraints into linear constraints on cross border exchanges

The (linearized) security domain

The market has to respect all imposed limitations of the grid

- All possible market positions/market solutions respecting the imposed limitations from the grid constitute a secure domain in which physical overloads are prevented
- Thus the secure domain provides the boundaries for valid market positions / outcome from the market algorithm. Overloads may only occur in the market solutions due to missing, or ill-specified limitations on exchanges

The objective of capacity calculation is to calculate the security domain

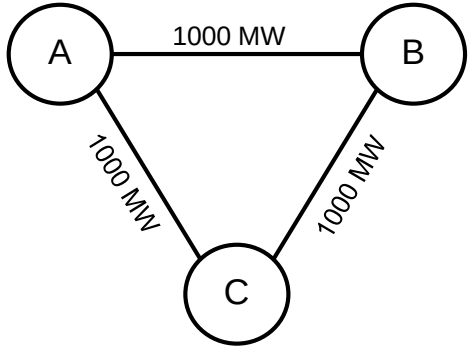
- The **full linearized security domain** is defined by the PTDFs and MW limits on CNEs applied in FB
- A "**reduced security domain"** is provided by ATCs (MW limits) applied in CNTC

Mathematically speaking, the security domain constitutes the solution space for the optimization of the objective function of the market algorithm. As such, the security domain will by definition be respected by the market optimization

Capacity calculation - Example

Example

- ✓ A power grid consisting of 3 bidding zones and three identical lines with the physical capacity of 1000 MW each
- ✓ A and B are "generation zones"
- ✓ C is a "consumption zone"



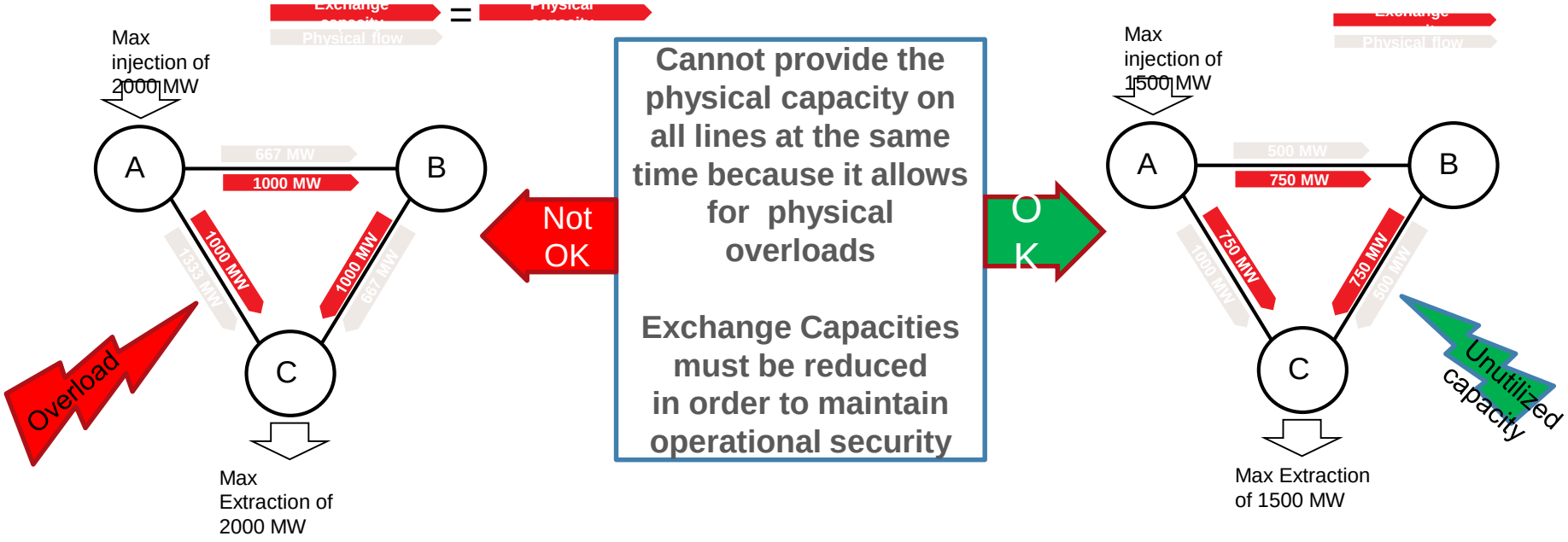
Simplifying assumptions

- ✓ No internal CNEs/grid constraints
- ✓ The only CNEs are the tie lines
- ✓ No reliability margin
- ✓ No contingencies
- ✓ No remedial actions

Objective: Calculate cross-border capacities

Capacity calculation - CNTC

- Capacity is provided as a MW limit (ATC) for bilateral exchange on each BZ border
- The market does not know real physics, and capacities are perceived as simultaneously available



Capacity calculation - CNTC

- The full set of CNTC values (ATCs) are referred to as a CNTC domain
- There is an unlimited set of potential CNTC domains available

CNTC capacities

Line	CNTC (1)	CNTC (2)	CNTC (3)	CNTC (4)	CNTC (N)
A -> B	750 MW	0 MW	200 MW	900 MW	? MW
B -> C	750 MW	1000 MW	200 MW	900 MW	? MW
A -> C	750 MW	1000 MW	1300 MW	600 MW	? MW

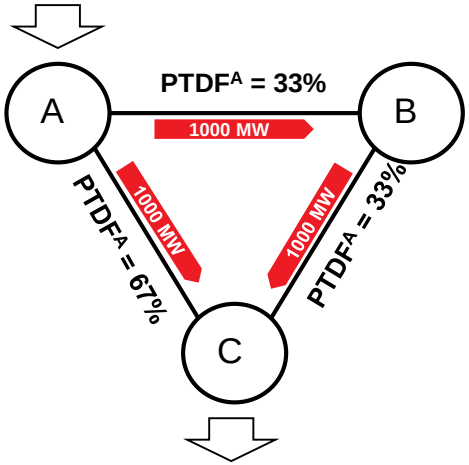
- Which ATCs to apply is based on a prognosis for the market outcome when attempting to provide capacity for the trades that are most likely to occur from a market perspective

Features of CNTC

- Priority for some bilateral trades
- Cannot fully utilize the security domain
- Complicated to manage in highly meshed grids with many BZs
- Flow determination is not a part of the market coupling (comes after), and thus there might be large differences between scheduled bilateral trades and physical flows
- The CNTC domain is not uniquely defined
- The CNTC capacities are simultaneously feasible

Capacity calculation - FB

- Capacity is provided by PTDFs, and CNEs with a MW limit/margin
- The market knows a linearized version of the real physics and understands that capacities are interdependent



- The lines (a-b), (b-c) and (a-c) are CNEs
- The full limit for each line can be provided (1000 MW)
- The PTDFs are the flows induced on each line by a net injection in A, B, and C extracted in C (slack node)
- Each BZ will have a unique PTDF on each CNE
- The PTDFs are calculated by a DC load flow process applied on a CGM (linearization)
- **The FB capacities constitute a simplified grid model to be applied by the power exchange**

Capacity calculation - FB

- The "full" security domain is provided directly as capacities to the market in the form of PTDFs and CNEs with MW margins
- The security domain is uniquely defined by the CGM

FB capacities

Line (CNE)	Max flows	PTDFs for BZ A	PTDFs for BZ B	PTDFs for BZ C (slack)
A -> B (CNE 1)	1000 MW	33 %	- 33 %	0
B -> C (CNE 2)	1000 MW	33 %	67 %	0
A -> C (CNE 3)	1000 MW	67 %	33 %	0

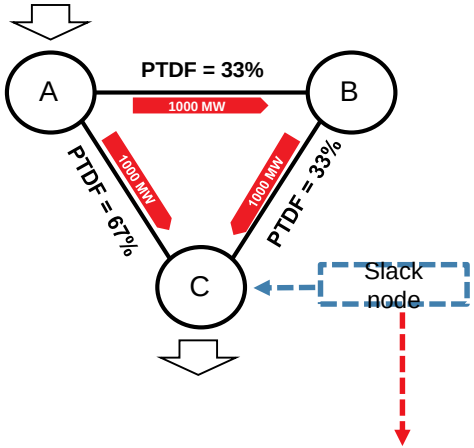
- The PTDFs are calculated by the CGM and thus depend on the impedances in the grid
- In this setting, the linearized security domain is often referred to as the FB domain

Features of FB

- Allows for price differences between uncongested areas - *increases the ability of the market to utilize all available capacity*
- The market coupling solves both net positions and flows and thus scheduled and physical flows are converging
- The FB domain is uniquely defined

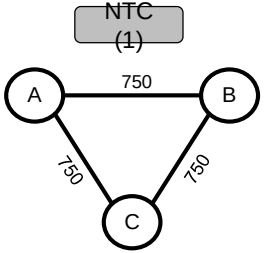
The slack node

- All flows on the CNEs are being monitored by linear PTDFs by injection in a particular node and extraction in a selected slack node - "Node to slack" PTDFs
- The slack node is the reference point in the PTDF matrix
- All PTDFs for the slack itself is zero (flow from slack to slack)
- The slack node is a necessary mathematical construct, but the choice of slack has no influence on the results
- All other "node to node flows" can be derived by the PTDF matrix:
- $PTDF_{i,j}^{n} = PTDF_{i,slack}^{n} - PTDF_{j,slack}^{n}$

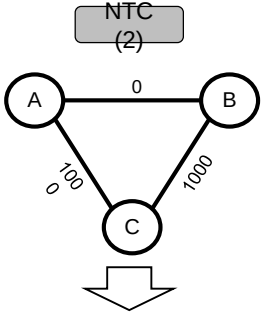


Line (CNE)	Max flows	PTDFs A	PTDFs B	PTDFs C
A -> B	1000 MW	33 %	- 33 %	0
B -> C	1000 MW	33 %	67 %	0
A -> C	1000 MW	67 %	33 %	0

FB vs CNTC

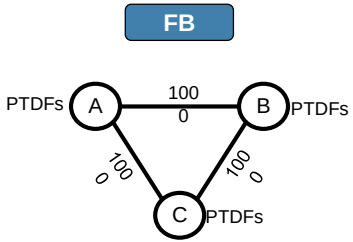


Max import/export in all BZs are 1500 MW



Max import/export in C is 2000 MW

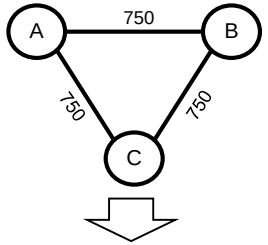
Max import/export in A and B is 1000 MW



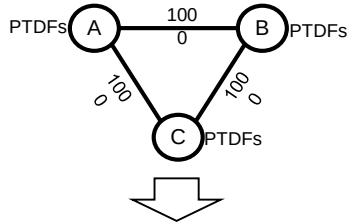
Max import/export in all BZs are 2000 MW (but not at the same time)

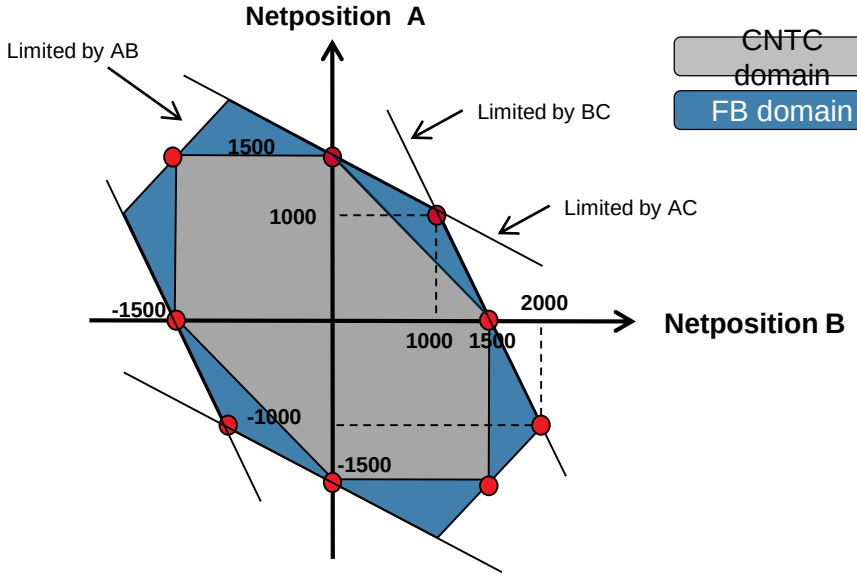
The FB and CNTC domains – Valid market positions

NTC (1)



FB



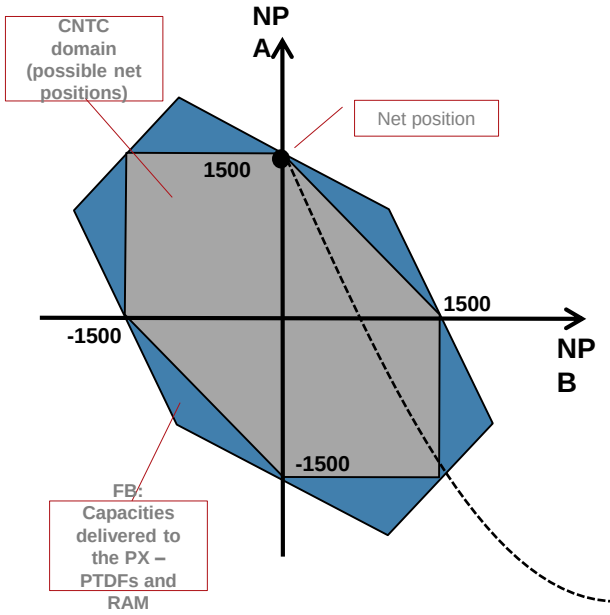


CNTC domain

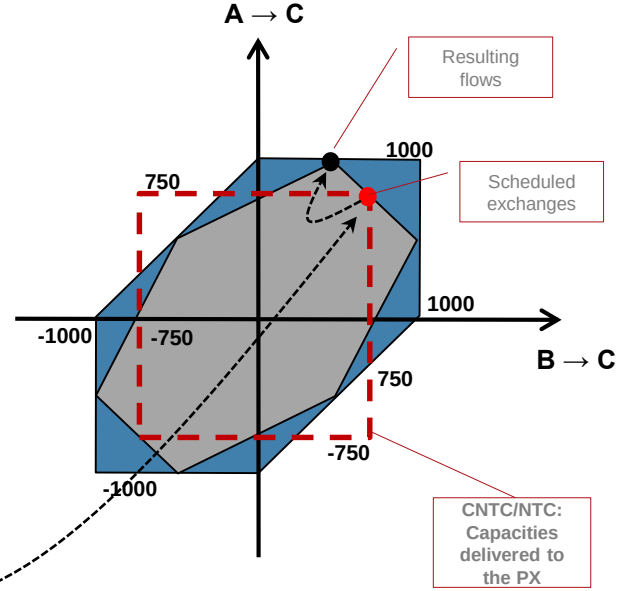
FB domain

The security domains can be illustrated in two ways

1. Which net positions are "allowed" in the market solution

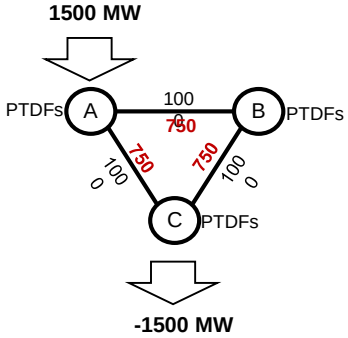


2. Which flows are "allowed" in the market solution



The CNTC limits are imposed on the right hand figure, but it does not compare to the domains

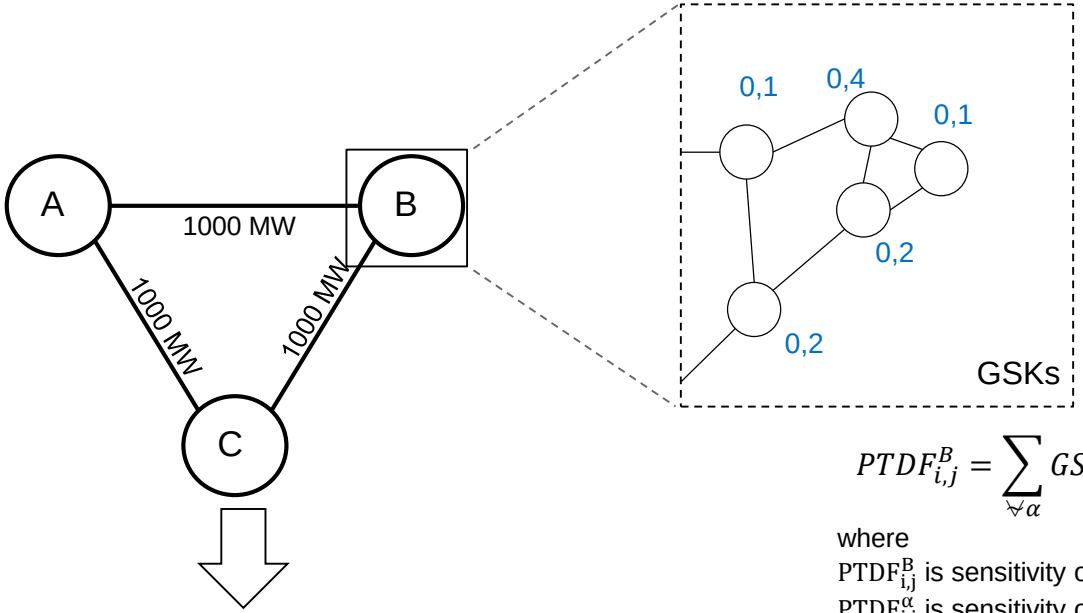
- ✓ CNTC values shows valid bilateral exchanges
- ✓ The CNTC flow domain is not uniquely defined by one unique set of ATCs
- ✓ The flow-domains shows valid physical flows



The zonal approach

- The FB and CNTC approach is based on the application of bidding zones (BZs)
- Each BZ contains multiple nodes (generation or consumption units) with a unique influence (nodal PTDF) on each constraint (CNE)
- BZs are not copperplates, but are perceived as copper plates by the market
  - All nodes inside each BZ will have the same BZ-specific influence on each CNE in the electricity market
  - Internal trades are not constrained

Generation Shift Keys (GSKs)



GSKs define how a net position change, in a given bidding zone, should be distributed to each production and load unit on that bidding zone

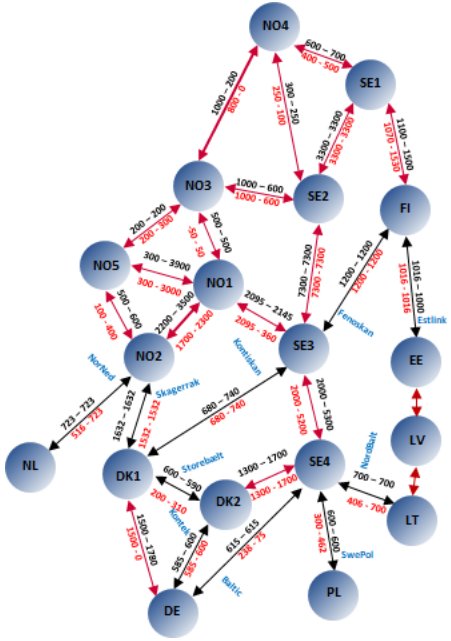
GSKs are used to calculate zone-to-CNE PTDFs, both for internal CNEs and interconnectors

$$PTDF_{i,j}^{B} = \sum_{\forall \alpha} GSK^{\alpha} PTDF_{i,j}^{\alpha} \quad \text{and} \quad \sum_{\forall \alpha} GSK^{\alpha} = 1$$

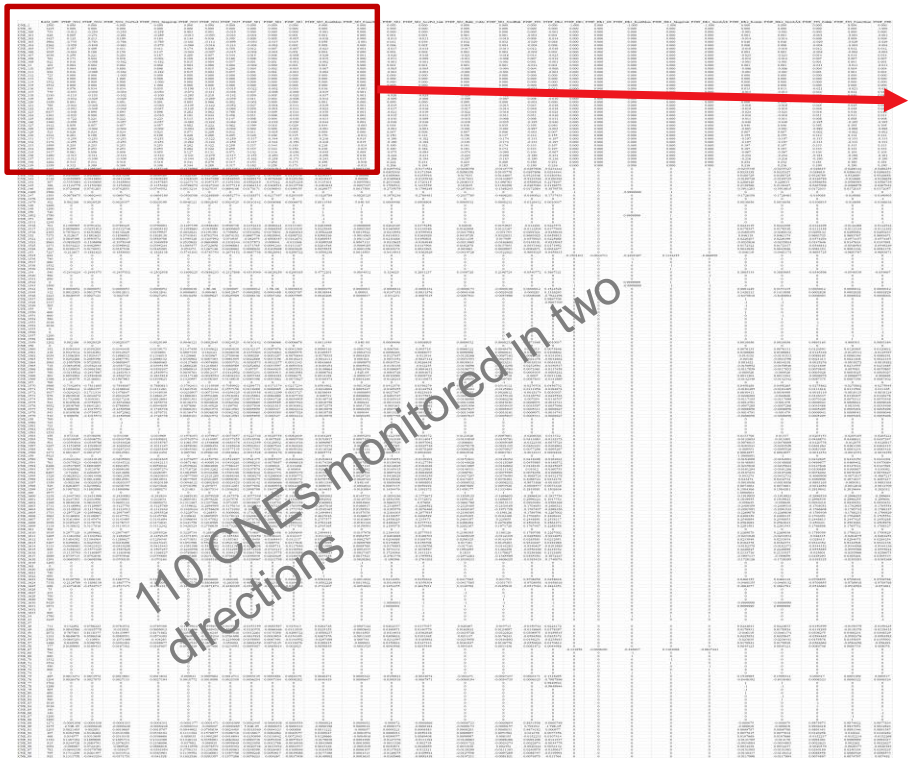
where
$\mathrm{PTDF}_{\mathrm{i,j}}^{\mathrm{B}}$ is sensitivity of transmission element *i,j* to injection in bidding zone B;
$\mathrm{PTDF}_{\mathrm{i,j}}^{\alpha}$ is sensitivity of transmission element *i,j* of injection in node α; and
GSK^{α} is weight of node a on the PTDF of zone B.

It gets slightly more complicated in the real world,……..

- 12 BZs in the Nordics + 14 more virtual BZ to manage the HVDCs
- 70-90 limiting CNEs monitored in both directions for every hour
- Both internal and cross-zonal CNEs
- Application of remedial actions, contingencies and reliability margins for all CNEs



A real world PTDF matrix – 27/02 2017 Hour 0



110 CNEs monitored in two directions

	RAM_MW	PTDF_NO1	PTDF_NO2	PTDF_NO2_NorNed	PTDF_NO2_Skagerrak	PTDF_NO3	PTDF_NO4	PTDF_NO5	PTDF_SE1	PTDF_SE2	PTDF_SE3	PTDF_SE3_KontiSkan
CNE_1	1500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CNE_10	1245	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CNE_100	753	-0.012	-0.254	-0.250	-0.258	0.003	0.001	-0.019	0.000	0.000	0.000	-0.001
CNE_101	826	0.005	-0.271	-0.261	-0.289	-0.013	-0.003	-0.043	-0.001	0.000	0.001	0.001
CNE_102	1427	0.125	0.213	0.199	0.184	0.144	0.036	0.305	0.009	0.005	-0.007	-0.018
CNE_103	1964	-0.735	-0.783	-0.786	-0.789	-0.401	-0.114	-0.699	-0.030	-0.017	0.015	0.058
CNE_104	2362	-0.059	-0.849	-0.863	-0.879	-0.069	-0.016	-0.214	-0.004	-0.002	0.003	0.008
CNE_105	1775	0.197	0.409	0.411	0.411	0.174	0.046	0.350	0.012	0.007	-0.007	-0.023
CNE_106	1025	-0.024	0.168	0.150	0.147	-0.024	-0.007	-0.015	-0.002	-0.001	0.001	0.004
CNE_107	1036	0.259	0.221	0.204	0.187	0.200	0.057	0.344	0.015	0.008	-0.008	-0.029
CNE_108	761	0.171	0.022	0.018	-0.003	0.100	0.029	0.160	0.008	0.004	-0.004	-0.015
CNE_109	922	0.010	-0.098	-0.362	-0.182	0.015	0.004	0.037	0.001	0.001	-0.001	-0.002
CNE_11	303	0.002	0.002	0.002	0.002	0.004	0.080	0.002	-0.002	0.000	0.001	0.001
CNE_110	3807	0.004	0.868	0.880	0.896	0.063	0.015	0.200	0.004	0.002	-0.003	-0.007
CNE_111	922	0.010	-0.098	-0.362	-0.182	0.015	0.004	0.037	0.001	0.001	-0.001	-0.002
CNE_112	723	0.000	0.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CNE_113	723	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CNE_114	1532	0.000	0.000	0.000	-1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CNE_115	1532	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
CNE_116	543	0.076	0.034	0.034	0.035	-0.198	-0.110	-0.015	-0.022	-0.002	0.010	0.016
CNE_117	779	-0.033	-0.030	-0.030	-0.030	-0.074	-0.411	-0.038	0.047	-0.006	-0.009	-0.015
CNE_118	1310	-0.115	-0.103	-0.102	-0.100	-0.295	0.219	-0.142	0.050	0.005	-0.020	-0.037
CNE_119	485	-0.032	-0.029	-0.029	-0.028	-0.083	-0.269	-0.039	0.011	0.004	-0.006	-0.012
CNE_120	1459	0.001	0.001	0.001	0.001	0.005	0.966	0.002	-0.001	0.000	0.000	0.001
CNE_121	788	-0.044	-0.040	-0.040	-0.040	-0.105	-0.442	-0.052	0.047	-0.004	-0.011	-0.019
CNE_122	918	-0.053	-0.048	-0.048	-0.047	-0.125	0.246	-0.062	0.050	-0.001	-0.013	-0.022
CNE_123	6437	-0.048	0.890	0.893	0.896	0.282	0.062	0.766	0.016	0.009	-0.014	-0.030
CNE_124	3181	-0.035	0.009	0.001	-0.010	0.191	0.042	0.456	0.011	0.006	-0.010	-0.020
CNE_125	6261	-0.722	0.221	0.222	0.223	0.113	0.034	0.147	0.008	0.004	-0.018	-0.013
CNE_126	1360	-0.059	-0.057	-0.057	-0.057	-0.082	-0.222	-0.062	-0.399	-0.018	-0.029	-0.044
CNE_127	1412	0.059	0.057	0.057	0.057	0.082	0.222	0.062	0.399	0.018	0.029	0.044
CNE_128	1380	-0.002	-0.002	-0.002	-0.002	-0.004	-0.080	-0.002	0.002	0.000	-0.001	-0.001
CNE_129	523	0.026	0.024	0.024	0.023	0.071	0.209	0.032	0.011	-0.005	0.005	0.009
CNE_130	1334	0.201	0.199	0.199	0.199	0.228	0.288	0.205	0.320	0.169	0.115	0.170
CNE_131	1173	-0.255	-0.253	-0.253	-0.253	-0.282	-0.322	-0.259	-0.337	-0.344	-0.150	-0.216
CNE_132	1172	-0.255	-0.253	-0.253	-0.253	-0.282	-0.322	-0.259	-0.337	-0.344	-0.150	-0.216
CNE_133	1599	0.255	0.253	0.253	0.253	0.282	0.322	0.259	0.337	0.344	0.150	0.216
CNE_134	1600	0.255	0.253	0.253	0.253	0.282	0.322	0.259	0.337	0.344	0.150	0.216
CNE_135	1417	0.061	0.056	0.056	0.055	0.127	0.131	0.071	0.102	0.116	-0.056	-0.045
CNE_136	1490	-0.313	-0.311	-0.310	-0.310	-0.341	-0.279	-0.317	-0.153	-0.250	-0.173	-0.256

Zone to slack PTDFs

4. Different perspectives of FB and CNTC

The FB and CNTC market coupling - Euphemia

FB MC:

Max $\sum$ (PS + CS + CI)

Subject to:

PTDF * NP ≤ RAM

CNTC MC:

Max $\sum$ (PS + CS + CI)

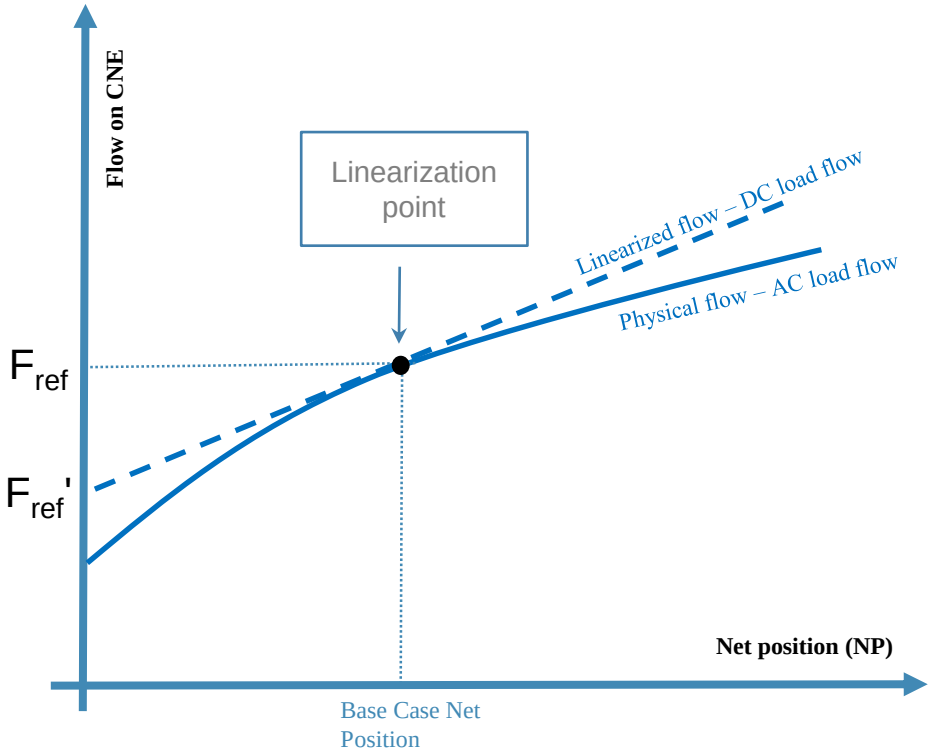
Subject to:

$NP \leq \sum_{\forall j} ATC_j$ (Exp)

$NP \geq \sum_{\forall j} -ATC_j$ (Imp)

- The objective functions are the same for FB and CNTC
- The constraints are different
- The constraints provide the solution spaces, which define the full space of valid market solutions
- When the same physical constraints are imposed on both FB and CNTC, the CNTC solution space is fully covered inside the FB solution space
- FB can provide market solutions not available to CNTC
- CNTC cannot provide market solutions unavailable to FB
- CNTC provides unique solutions for prices and net positions
- FB provides unique solutions for prices, net positions, and flows

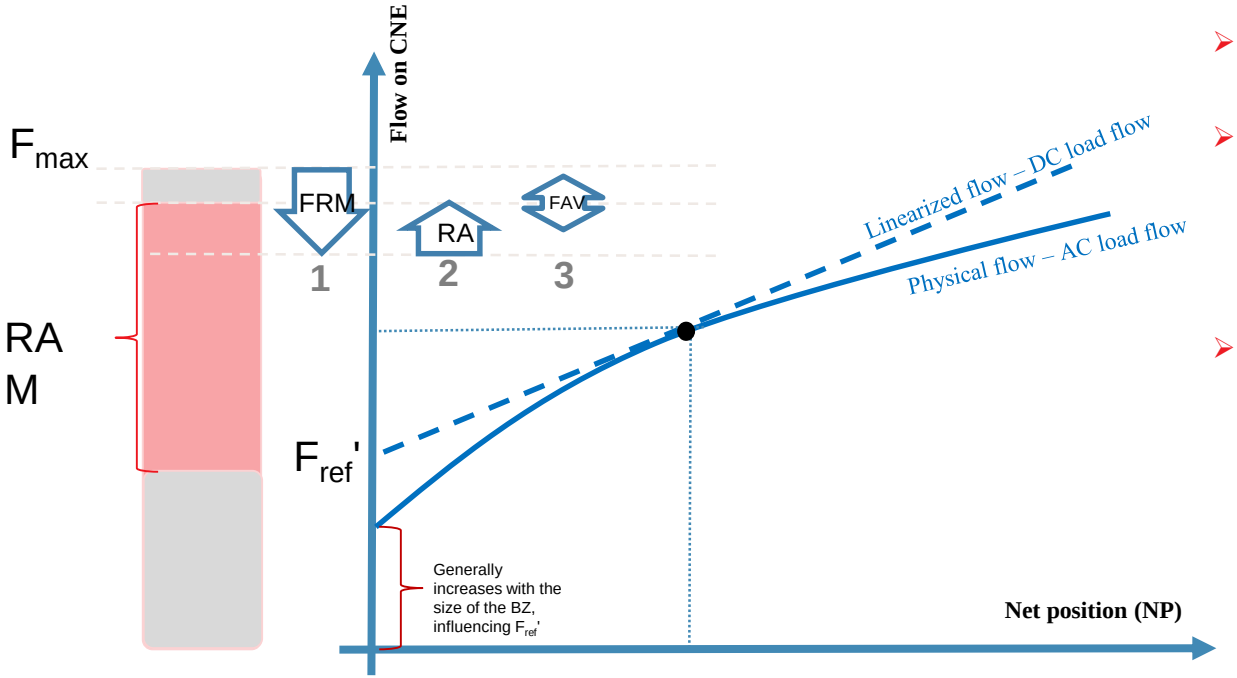
How the PTDFs are derived



- Physical flows are non-linear functions of power injections (NP)
- The PTDFs represent a linearization of these non-linear flows, calculated by a DC-load flow analysis based on the CGM
- For the PTDF to be as precise as possible, the linearization is made in the base case (forecasted market position)
- The forecasted flow is:

$$F_{ref} = F_{ref}' + PTDF * NP$$

How the margins of the CNEs are derived



- The max allowed flow (F_{max}) on the CNE are calculated in a (if necessary dynamic) grid model
- The max allowed flow is reduced / altered in three steps
  1. Subtract the flow reliability margin (FRM)
  2. Add Remedial actions (RA)
  3. If necessary, adjust the final result by last minute information (FAV), zero in the figure
- The constraint (Capacity) for the market becomes:

$$F_{ref}' + PTDF * NP \leq F_{max} + RA - FRM - FAV$$

$$\Downarrow$$

$$PTDF * NP \leq F_{max} + RA - FRM - FAV - F_{ref}'$$

$$\Downarrow$$

$$\mathbf{PTDF * NP \leq RAM}$$

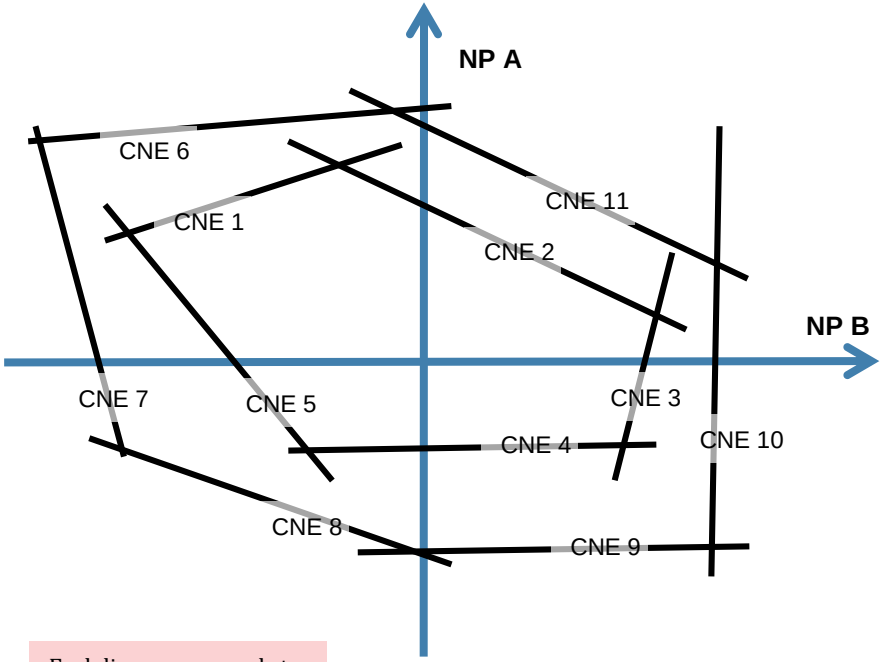
Ingredients of capacity calculation

- Input to capacity calculations
  - Common Grid Model (CGM)
  - GSKs
  - CNEs
  - Operational security limits
  - Contingencies
  - Remedial Actions (RA)
  - Reliability Margin (RM/FRM)
  - Final Adjustment Value (FAV – Applied in the final validation phase)
  - AAC (Already-allocated capacity)
  - Allocation constraints

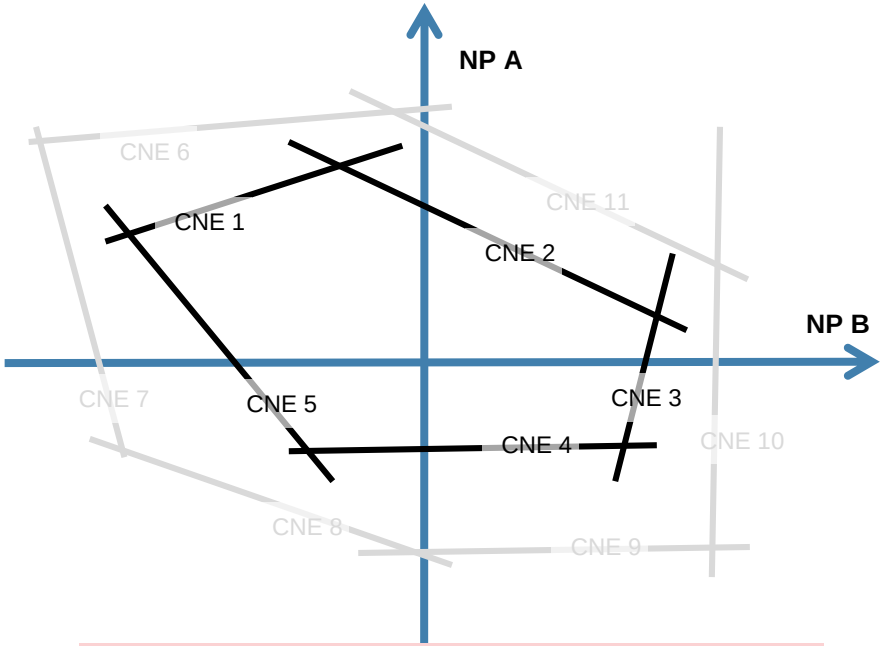
- Output from the market optimization
  - BZ prices (FB and CNTC)
  - BZ Net positions (FB and CNTC)
  - Flows (FB)
  - Shadow prices (FB and CNTC)

- The input data to CNTC and FB is the same
- The most important difference is the way grid constraints are provided to the market coupling and the fact that flow determination is a post process in CNTC with multiple possible solutions

Redundant CNEs and pre-solve



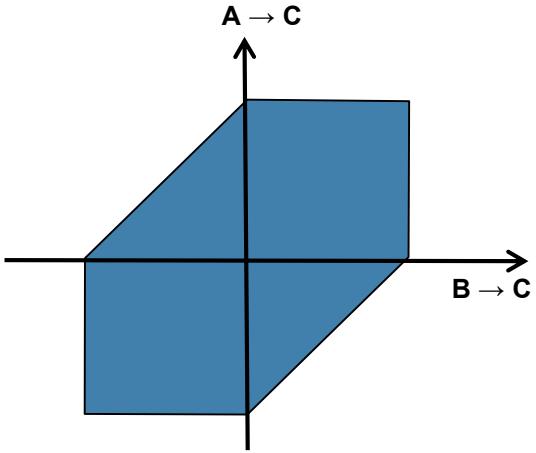
Each line corresponds to $PTDF \times NP = RAM$ for a given CNE



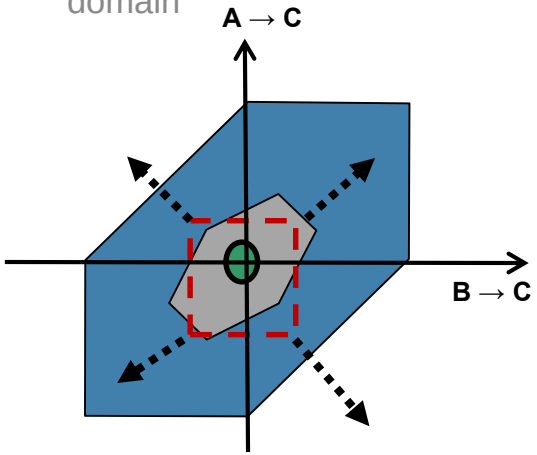
All CNEs in light grey are redundant because they do not limit the market coupling algorithm. These CNEs' constraints are located beyond other, non-redundant, CNE constraints (in black)

Principles for deriving a CNTC respecting the boundaries of the security domain

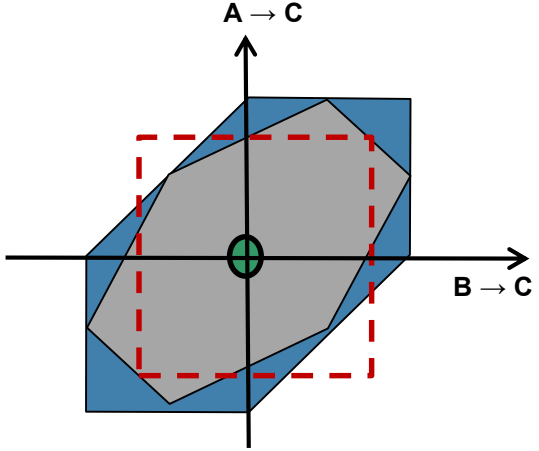
Step 1: define the security domain



Step 2: Define the objective function and constraints to find an optimal CNTC-domain from the security domain



Step 3: Extract the final and optimized CNTC values

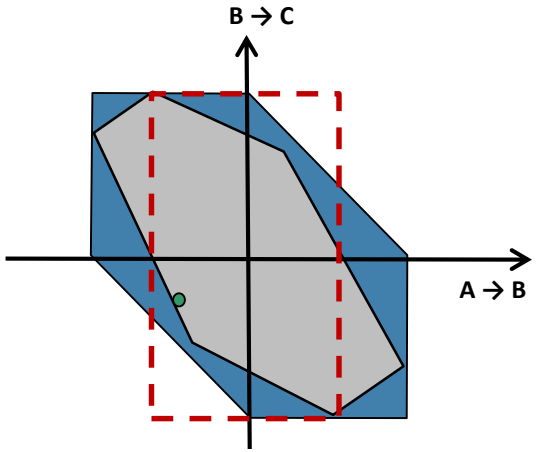


Possible approach: Maximize the product of "CNTC values"

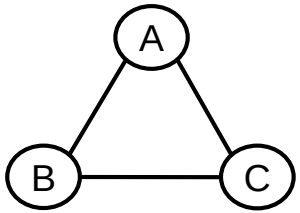
Subject to "All allowed flows shall be inside the security domain"

Relaxation of the constraints for the CNTC optimization

1. Let's assume the optimization provided the CNTC domain below. This has left "secure room" to move the base-case (expected market position, the green dot) "to the left"

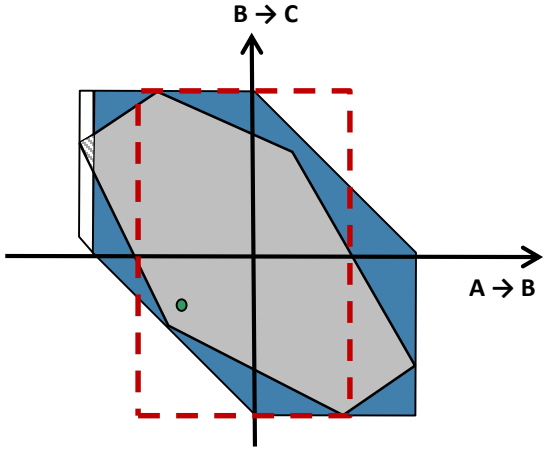


2. By relaxing one limiting constraints in the upper left corner of the security domain, we can add extra CNTC capacity for B → A with relatively low risk for the operational security

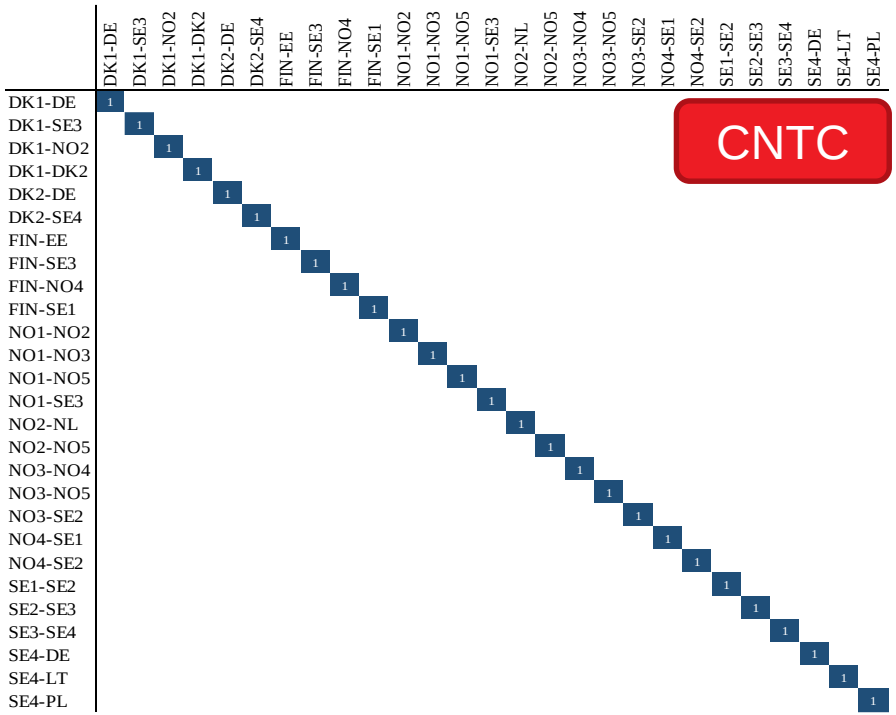


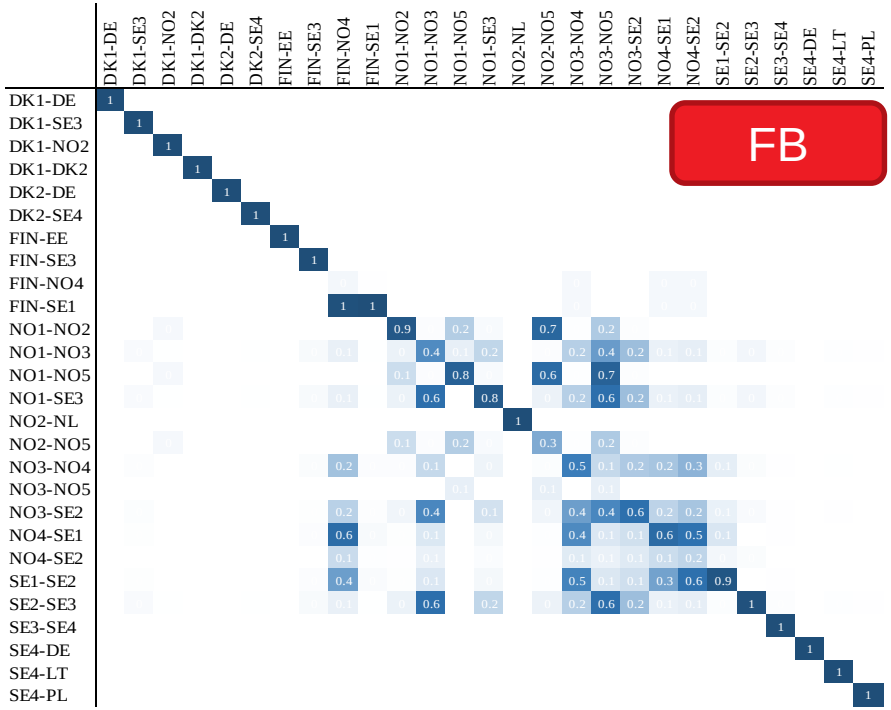
PS!
The model has been flipped

3. This comes at the cost of a small operational security risk for the opposite direction of the expected flow B → C (the small triangular shaded area)
   - Also applicable for FB



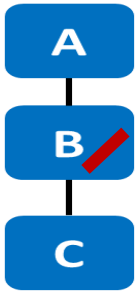
How bilateral exchanges are perceived by the market algorithm in FB and CNTC





Managing internal CNEs in FB and CNTC

Flow based method



Internal constraint modelled directly

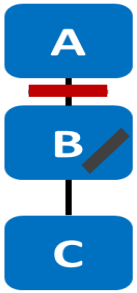
The internal constraint can be modelled directly

Capacity is allocated according to willingness to pay, and the difference in influence on the constrain from the different bidding areas

Add as a CNE to the PTDF-matrix

CNTC method

1



Constraint moved to border A-B

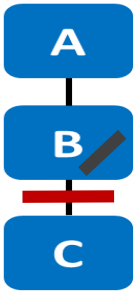
Exchange between area B and C is prioritized

Area A cannot utilize transmission capacity not used by areas B and C

No limit on exchange between B and C can lead to overloads

Or

2



Constraint moved to border B-C

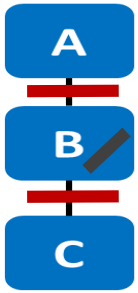
Exchange between area A and B is prioritized

Area C cannot utilize transmission capacity not used by areas A and B

No limit on exchange between A and B can lead to overloads

Or

3



Constraint on border A-B and B-C

All trade restricted

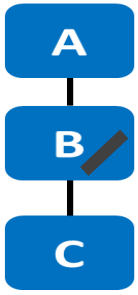
Distribution of capacity not according to willingness-to-pay

Capacity not used by one area cannot be used by another

No overloads on internal constraint from cross border exchange

Or

4



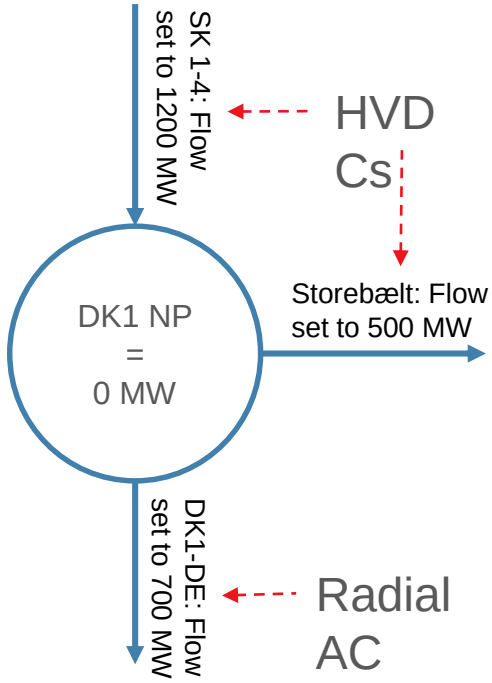
Constraint disregarded

No restrictions

Overloads to be solved by costly remedial actions

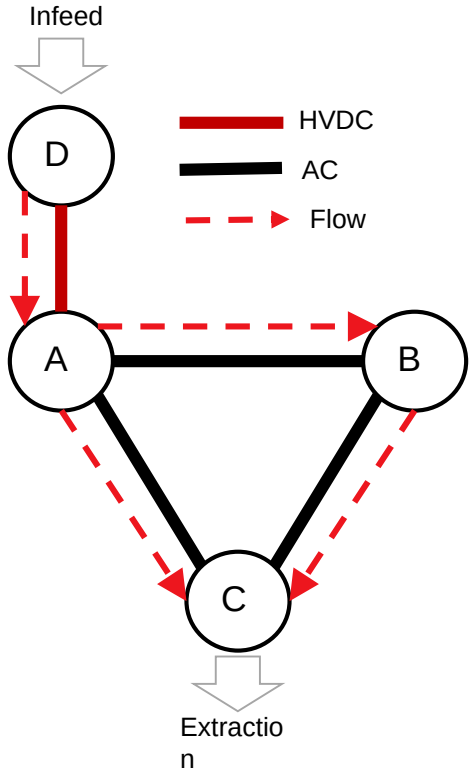
Managing HVDC connections

- While the flows in an AC grid fans out according to physical laws, the flow on an DC connection (or a radial AC connection) is fully manageable by the operator → don't need PTDFs to manage flows on an HVDC (or a radial AC connection) connection
- If all connections were either HVDC and/or radial, the CNTC approach would provide the same efficiency/market solution as FB
- With HVDC we can let the market decide the flows and simply set the system to realize the scheduled flows

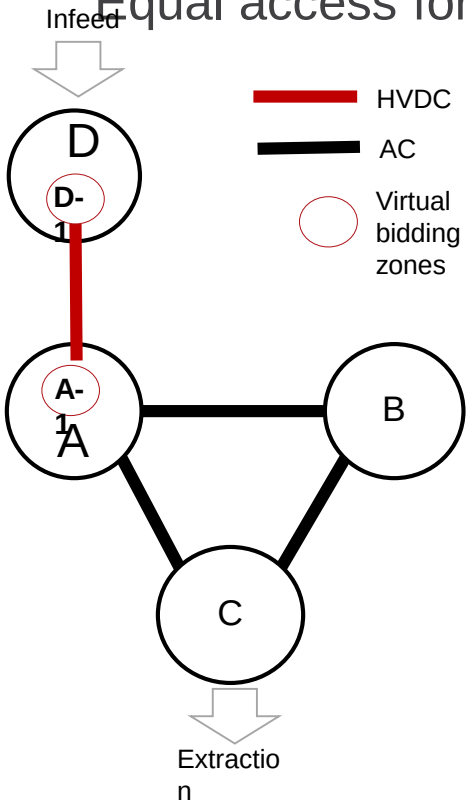


HVDC flows needs to be managed in the AC grid

- When the flows from HVDCs (and radial AC connections) enter the meshed AC grid, they will fan out according to the physical laws and occupy the limited capacity on the grid components
- Flows coming from HVDC (and radial AC) connections need to be managed in the AC grid
- The HVDC functions like a remote generator, creating the same flows in the AC grid as an internal generator



Equal access for HVDC are implemented by "virtual bidding zones"

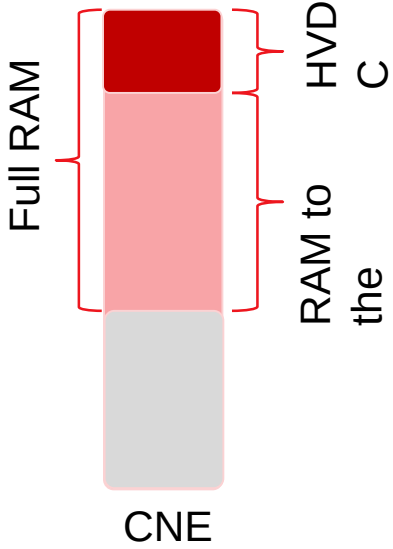


Line (CNE)	Max flows	PTDF A	PTDF B	PTDF C	PTDF A-1
A -> B (CNE 1)	1000 MW	33 %	- 33 %	0	45%
B -> C (CNE 2)	1000 MW	33 %	67 %	0	45%
A -> C (CNE 3)	1000 MW	67 %	33 %	0	55%

- ✓ A new bidding zone, A-1, is introduced in the PTDF matrix (for the "southern" control area)
- ✓ The HVDC is connected to the virtual bidding zone
- ✓ The virtual bidding zone is "empty", it contains no bids
- ✓ The virtual bidding zone will have a unique price in the coupling process, but will receive the price of the surrounding zone in the settlement process

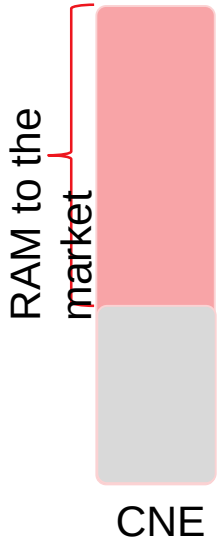
Two ways to manage HVDCs

Priority access = Standard hybrid coupling



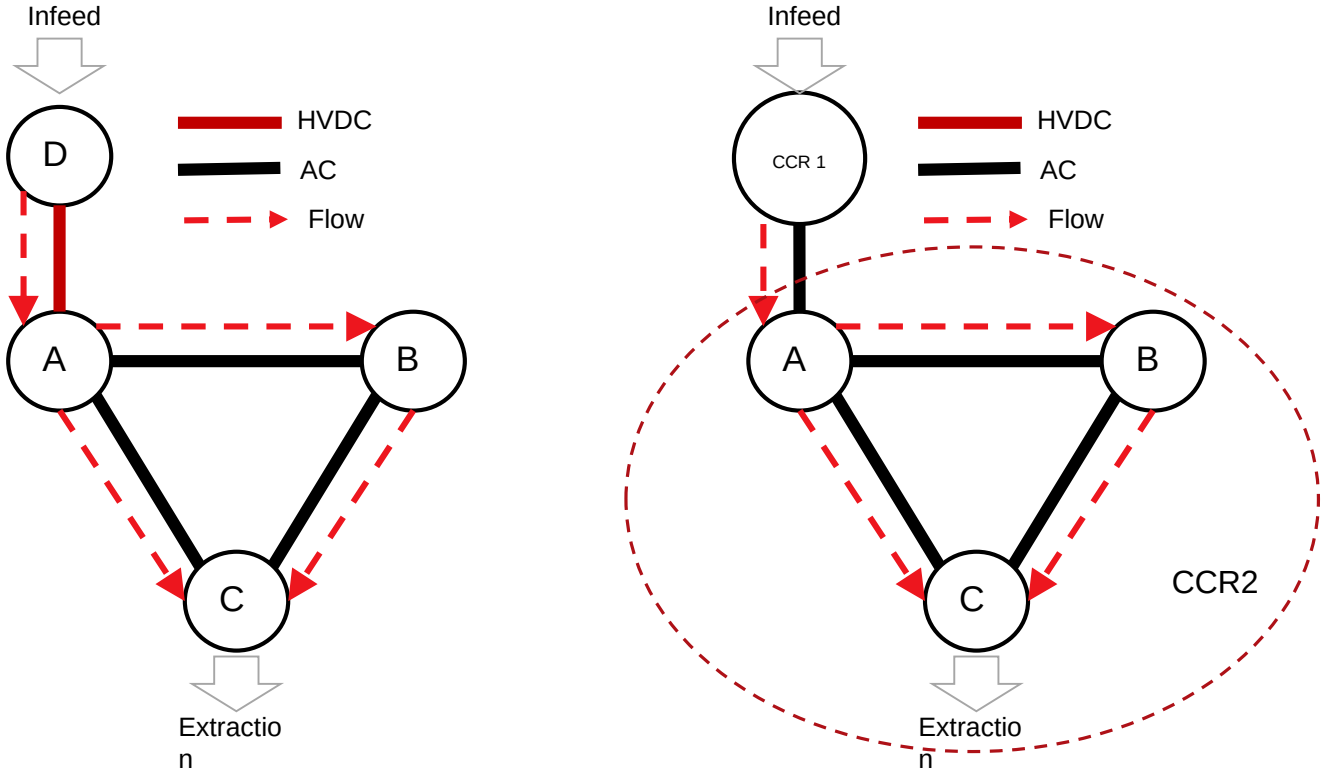
- ✓ Flows on AC components from HVDCs are calculated by PTDFs and flow prognoses for the HVDC
- ✓ Capacity are reserved on all influenced CNEs
- ✓ Less capacity for all other trades
- ✓ If the HVDC flow falls short of the expected flow, capacity is unused
- ✓ SHC is applied to minimize the influence on "the external" side of an interconnector

Equal access = Advanced hybrid coupling



- ✓ Flows on AC components from HVDCs are calculated during market coupling using PTDFs for the transformer station
- ✓ No capacity are reserved on any influenced CNEs
- ✓ Full capacity for all trades
- ✓ Flows from HVDCs compete for capacity with all other trades → normal flow competition
- ✓ If the HVDC flow falls short of the expected flow, all capacity is still available for other trades

Advanced Hybrid Coupling can manage HVDC, but also couple two CCRs with radial AC connection



"Non-intuitive" flows

- A non intuitive flow is a flow from a high price to a low price BZ
- Non intuitive flows are a result of the FB market optimization
- Non-intuitive flows occur to relieve congestions on constrained grid elements
- Non-intuitive flows occur when the welfare economic cost of a non-intuitive flow is smaller than the welfare economic benefit of relieving a congestion
- By relieving capacity on congested grid elements, non-intuitive flows contribute positively to the overall market efficiency, and thus generate a market wide efficiency gain
- In equilibrium, the marginal value of all trades are equal
- Non intuitive flows are applied in existing nodal price systems, and in the current Nordic market by enforcing the power to flow in a certain direction (NO1-NO3, and NO5-NO3)

Welfare optimum

- ***The first order condition for a global welfare optimum is:***

$$P^i = \lambda - \sum_n \rho_n \, PTDF_n^i$$

P^i = *The price/marginal value of power in BZ i*
λ = *The marginal value of power in the slack node (not the system price)*
ρ_n = *Shadow price of the constraining grid element n*
$PTDF_n^i$ = *The PTDF to the slack for BZi on CNE n*

- ***The marginal value of a bilateral trade from BZi to BZj can be derived from the f.o.c.:***

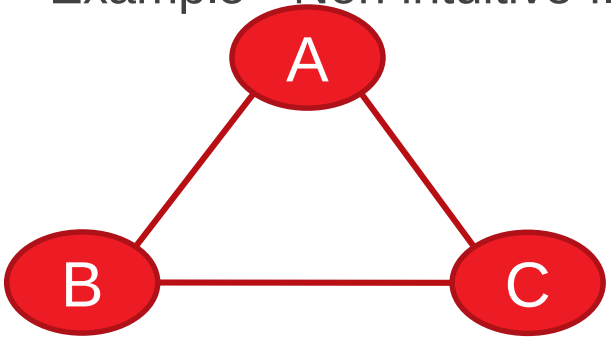
$$\rho_k \geq 0 \; and \; \rho_k\left(\sum_i NP_i * PTDF_k^i - RAM_k\right) = 0$$

$$\left(\frac{(P^j - P^i)}{\sum_n \alpha_n\left(PTDF_n^i - PTDF_n^j\right)}\right) = \sum_k \rho_k \qquad \alpha_n = \frac{\rho_n}{\sum_k \rho_n}$$

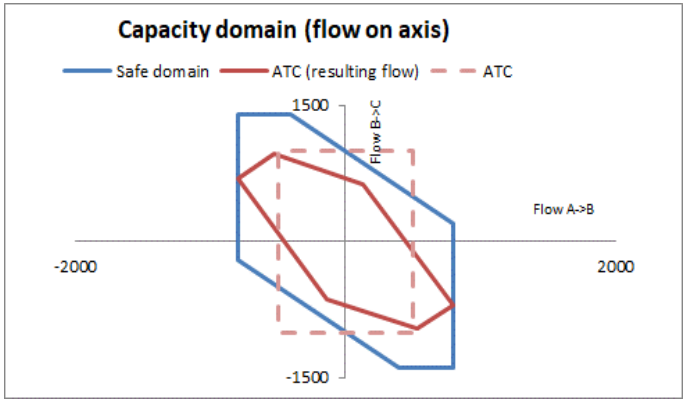
k = *the set of all limiting grid elements*, $n \in k$

➢ ***Non-intuitive flows are non-intuitive, not non-efficient***

Example - Non intuitive flow

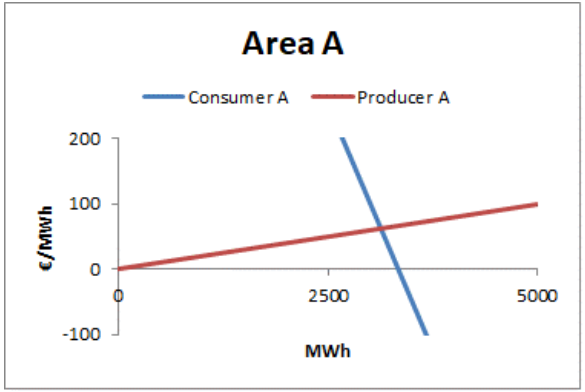


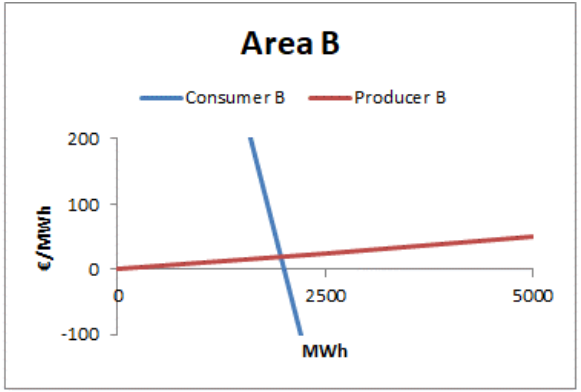
Line (CNE)	Max flow	Min flow	PTDF A	PTDF B	PTDF C
A -> B (CNE 1)	800 MW	-800 MW	33 %	- 33 %	0
B -> C (CNE 2)	1400 MW	-1400 MW	33 %	67 %	0
A -> C (CNE 3)	1000 MW	-1000 MW	67 %	33 %	0

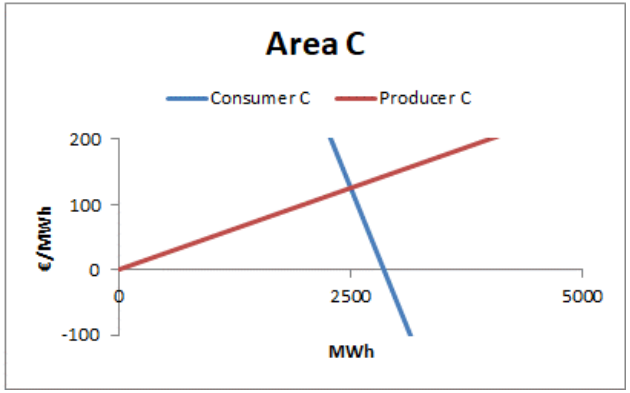


Line	Max NTC	Min NTC
A -> B	500 MW	-500 MW
B -> C	1000 MW	-1000 MW
A -> C	400 MW	-400 MW

Example – The market



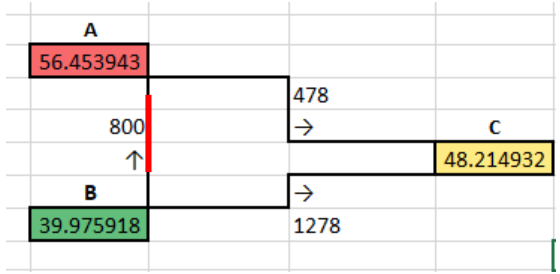


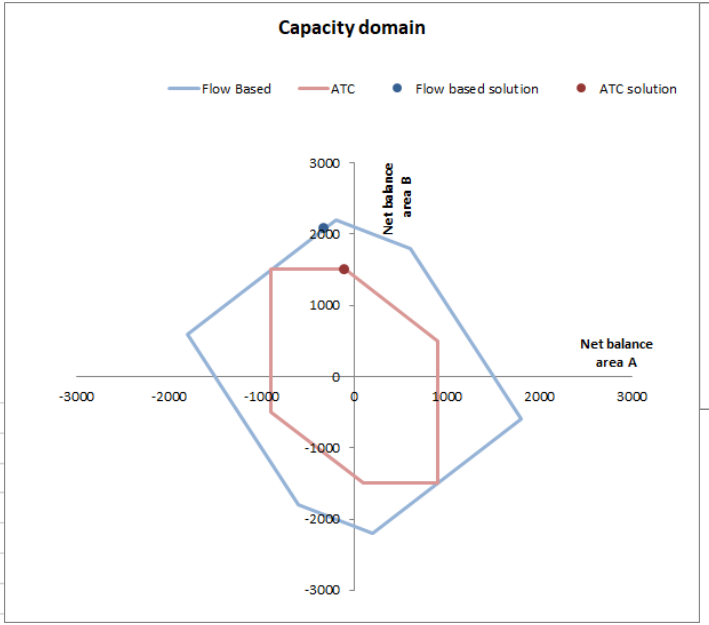


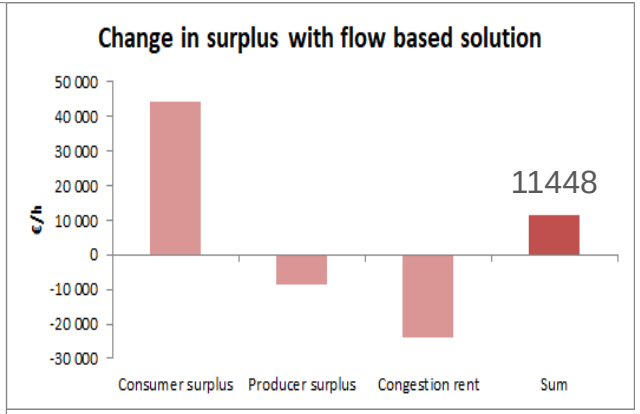
FB and CNTC market solution

FB: B-A congested
Non-intuitive flow A-C
Global optimum

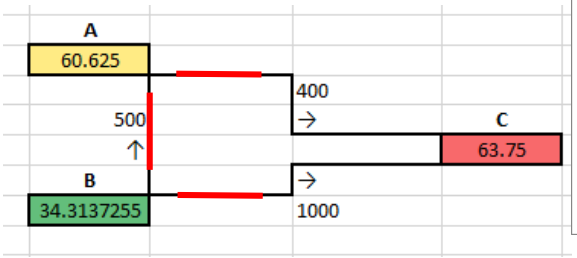
Marginal value of bilateral trades in FB							
A-B	B-A	B-C	C-B	A-C	C-A	Sum shadow prices	
24.717	24.717	24.717	24.717	24.717	24.717	24.717	





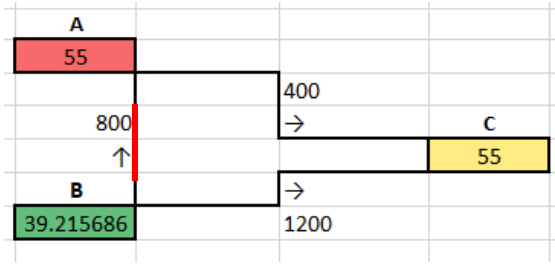


NTC: All lines congested

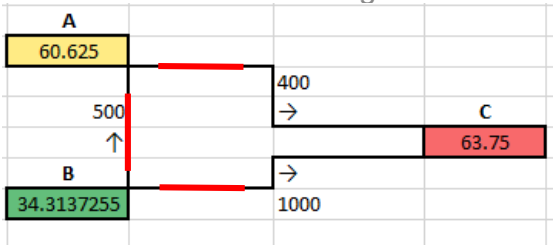


Intuitive FB and CNTC market solution

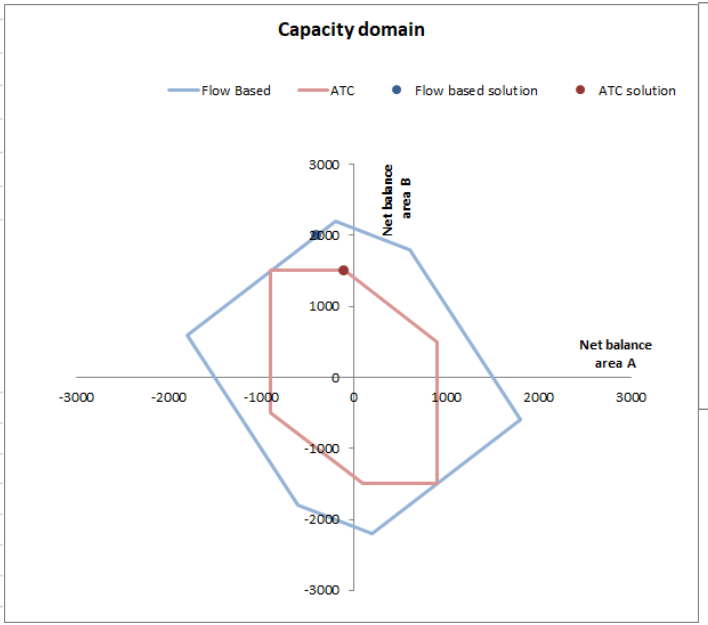
FB: B-A congested
Intuitive flow solution

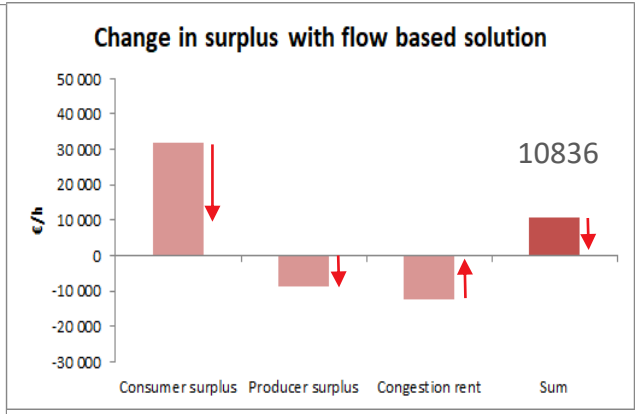


NTC: All lines congested



Marginal value of bilateral trades in FB						
A-B	B-A	B-C	C-B	A-C	C-A	Sum shadow prices
47.352	47.352	47.353	47.353	0.006	0.006	15.784



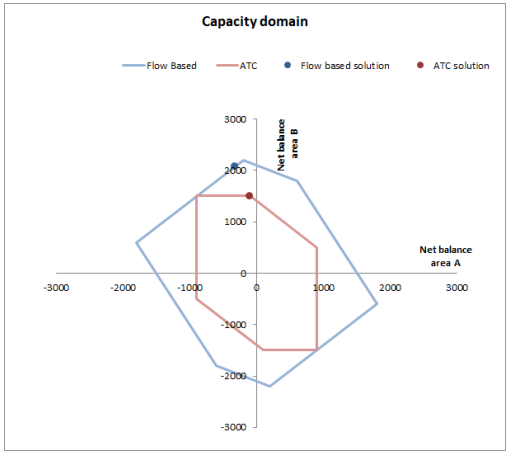


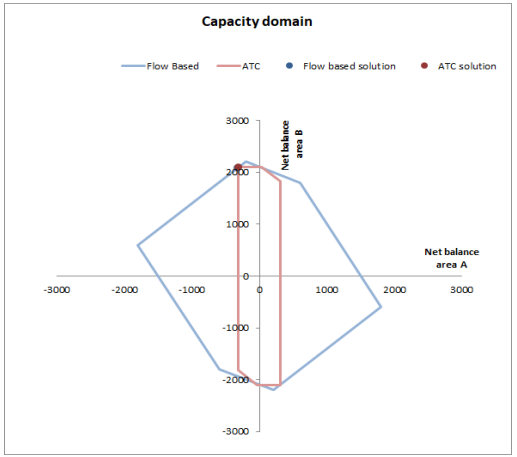
5% lower benefit from FB due to the non-intuitive constrain

FB vs CNTC

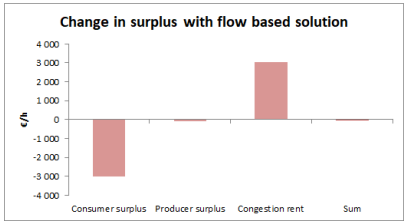
- It is possible for CNTC to go to the FB solution
- It comes at a cost of suppressing other borders (and BZs)

Line	Max NTC	Min NTC
A -> B	500 MW	-500 MW
B -> C	1000 MW	-1000 MW
A -> C	400 MW	-400 MW





Line	Max NTC	Min NTC
A -> B	140 MW	-140 MW
B -> C	1960 MW	-1960 MW
A -> C	170 MW	-170 MW



Management of internal grid constraints

- Internal grid constraints (CNEs) can only be applied in capacity calculation when:
  - Temporal (which is an undefined entity), and
  - Discarding them within the market coupling does not pose a risk to operational security, and
  - Managing them by countertrade (CT) or redispatch (RD) in operation provides a welfare economic benefit

- These principles are embedded in the Nordic CCM:
  1. Operational security test: Assess the availability for potential counter trade and re-dispatch resources for all internal CNEs during capacity calculation, and assess how much capacity can be added to each internal CNE due to availability of CT & RD resources (not fully operationalized yet)

  2. Economic efficiency test: Assess the potential welfare economic benefit of applying CT & RD on each internal CNE

Economic efficiency test

- Rule: If the marginal cost of CT or RD is lower than the marginal value of a MW added to the most expensive border for the relevant BZ, increase the capacity on the CNE

The marginal value of a MW added on a BZ border is expressed by the relation: $\left(\frac{(P^j - P^i)}{\sum_n \alpha_n \left(PTDF_n^i - PTDF_n^j\right)}\right) = \sum_k \rho_k \qquad \alpha_n = \frac{\rho_n}{\sum_k \rho_n}$

- We don't know the shadow prices in D-2 (ρ), thus we have to simplify the expression and apply the border PTDFs directly

Operational economic efficiency test

The model below is not a final solution, but the starting point for further development

Cost(RD) = $\frac{|P^{\uparrow} - P^{\downarrow}|}{PTDF^{\uparrow\downarrow}}$

Cost(CNE) = $\frac{|P^{A1} - P^{A2}|}{PTDF^{A1-A2}}$

Criteria for preparing RD:

$$\frac{|P^{\uparrow} - P^{\downarrow}|}{PTDF^{\uparrow\downarrow}} \leq \frac{|P^{A1} - P^{A2}|}{PTDF^{A1-A2}}$$

This can be rearranged to yield:

$$\boldsymbol{PTDF^{\uparrow\downarrow} \geq \frac{|P^{\uparrow} - P^{\downarrow}|}{|P^{A1} - P^{A2}|} * PTDF^{A1-A2}}$$

$\boldsymbol{P^{\uparrow}}$ = Up regulating price

$\boldsymbol{P^{\downarrow}}$ = Down regulating price

$\boldsymbol{P^{A1}}$ = Area 1 price

$\boldsymbol{P^{A2}}$ = Area 2 price

$\boldsymbol{PTDF^{A1-A2}}$ = Zone to zone PTDF for the relevant border

$\boldsymbol{PTDF^{\uparrow\downarrow}}$ = Node to node PTDF for the relevant CNE

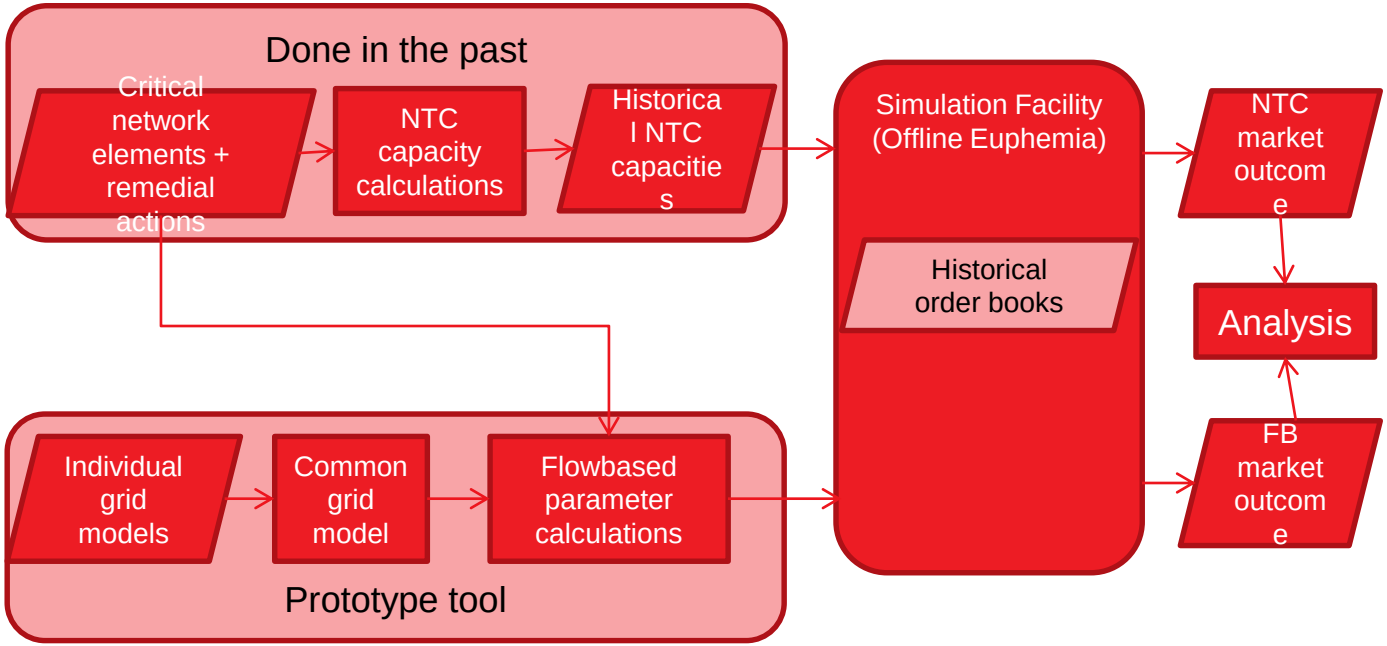
Known: $\boldsymbol{P^{\uparrow}}$, $\boldsymbol{P^{\downarrow}}$, $\boldsymbol{P^{A1}}$, $\boldsymbol{P^{A2}}$, $\boldsymbol{PTDF^{A1-A2}}$

Operator will asses the relevant $\boldsymbol{PTDF^{\uparrow\downarrow}}$

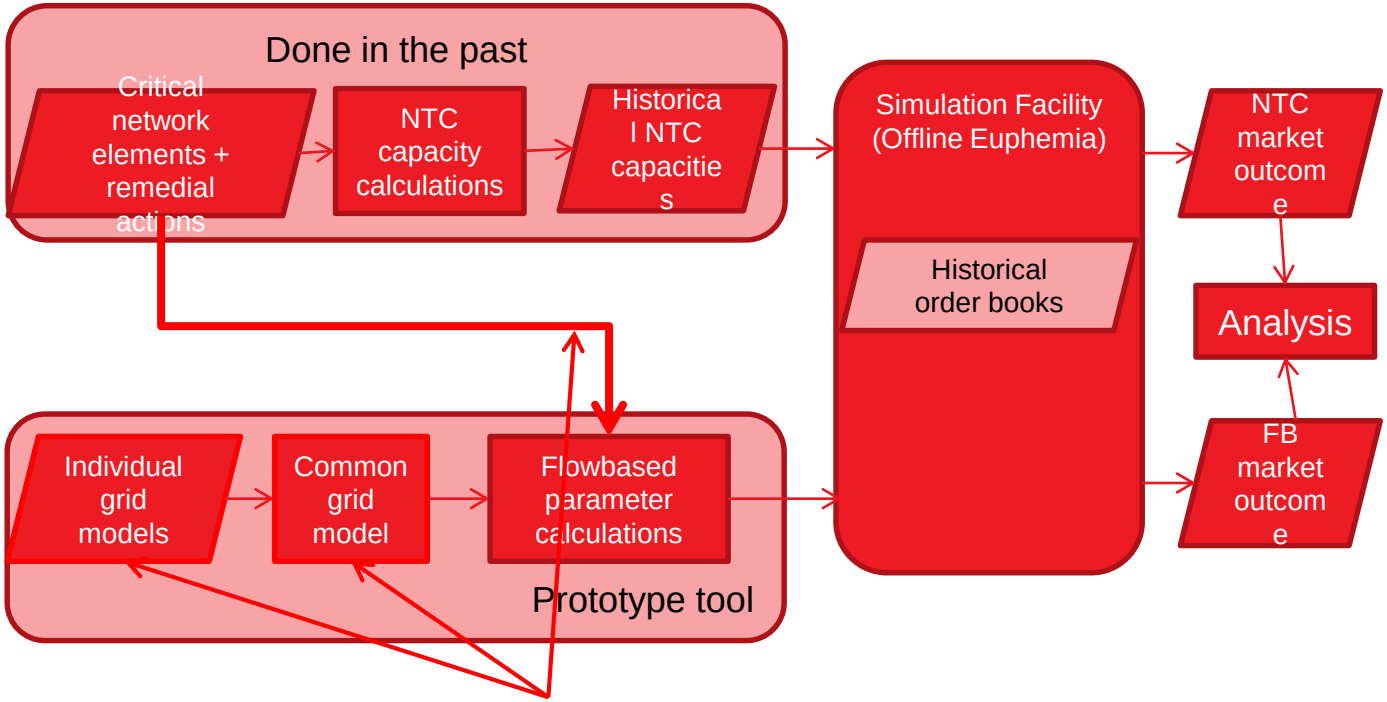
5. Market simulations of FB vs. NTC in the Nordics

- Simulation setup
- Social welfare
- Prices, flows
- Managing of West Coast corridor or others
- Power system impact analysis (overload of NTC and FB)
- Other relevant figures

Simulation setup in the CCM project



Simulation setup in the CCM project



Not straightforward due to lack of industrial tools

Requirements for fair comparison

To do fair comparisons between NTC and FB, we need to ensure that:

- The same critical network elements considered
- The same remedial actions considered
- The common grid model is a forecast D-2

Hours for which the above requirements are not met are removed from the analysis.

2017 Results

- The following results are for weeks 1-6 and 8-12, 2017 and compare the market outcomes with FB and with historical NTCs.
- Three typical situations appear in this comparison
  - Windy nights and better handling of the West Coast corridor => Lower prices => Higher consumer surplus
  - High loads + congestions in the Norwegian grid and on Sweden's Cut 2 => Difficulty to export cheap power from NO4 and Northern Sweden. Better handling of congestions with FB => Higher welfare.
  - Available capacity in the grid => No big change in SEW but redistribution between actors.

Socioeconomic welfare gains, week by week

- The graphs show the difference between the day-ahead socioeconomic welfare (SEW) with FB and with historical NTCs
- Day-ahead SEW = producer surplus + consumer surplus + congestion income

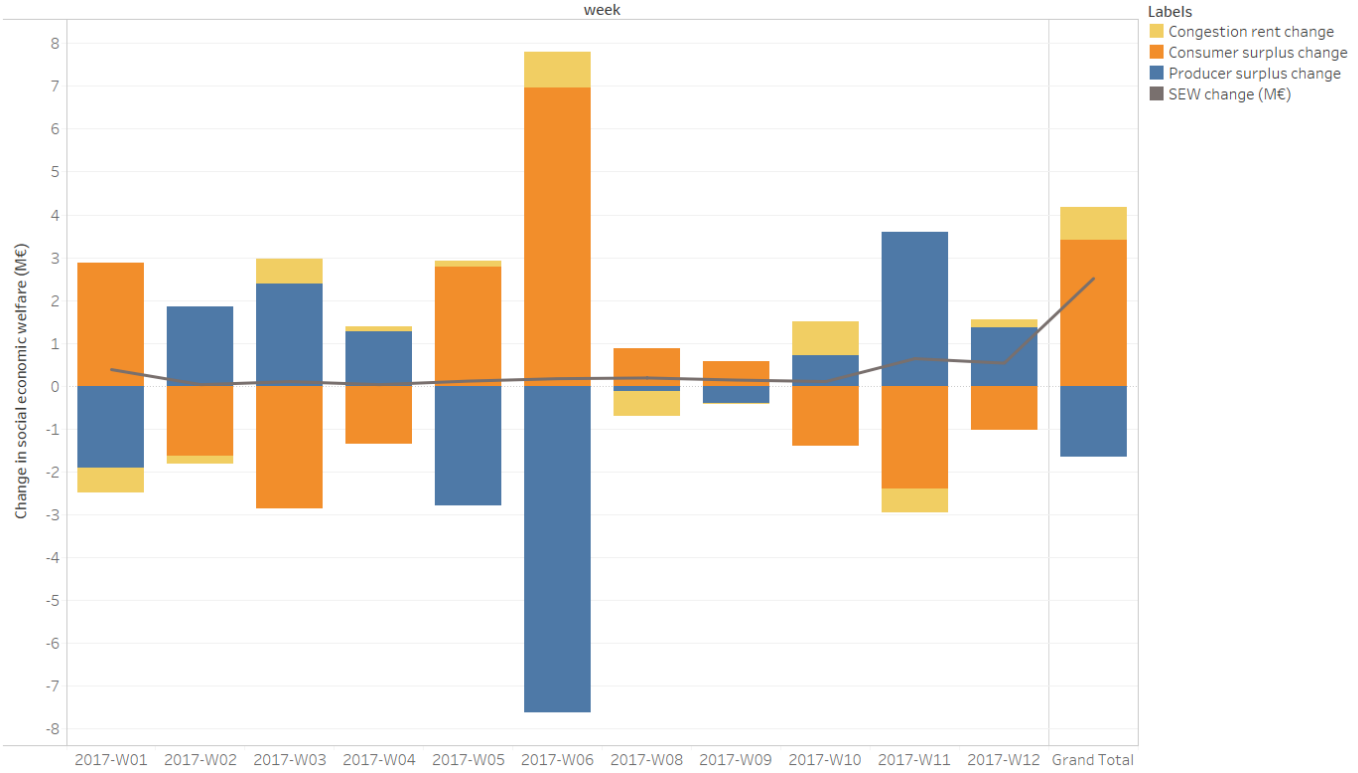
Socioeconomic welfare gains, week by week

- Positive figures mean a gain in SEW with FB.
- The colors correspond to the countries in which the gains and losses appear

Statnett

Socioeconomic

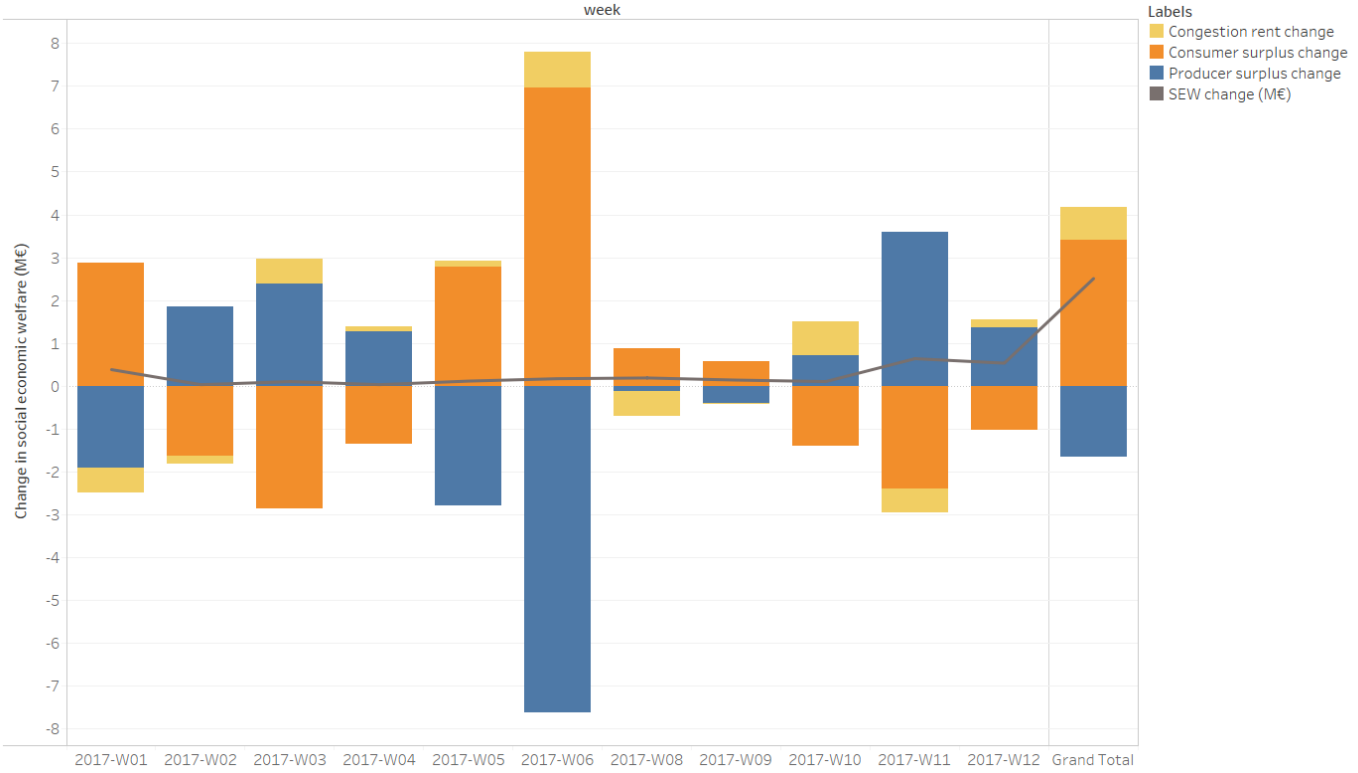
- The bars shows the changes in three components of the day-ahead SEW.
- The solid line is the aggregated change in SEW. It corresponds to the figures on the previous slide.



Statnett

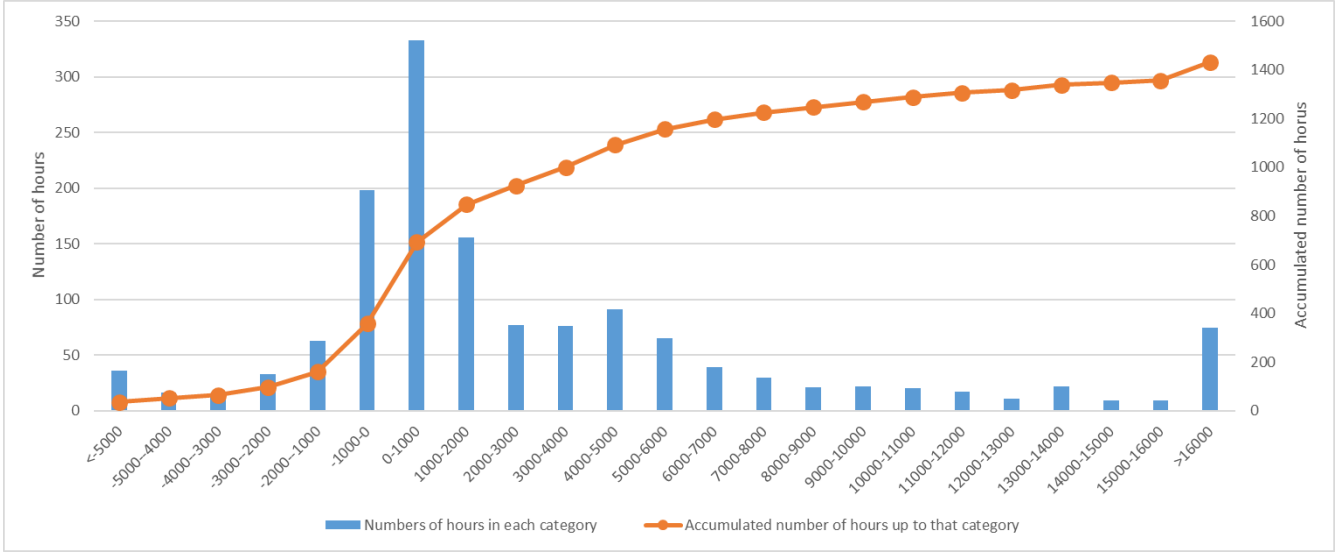
Socioeconomic

- We can observe some distributional effects even during the weeks with very little net changes.



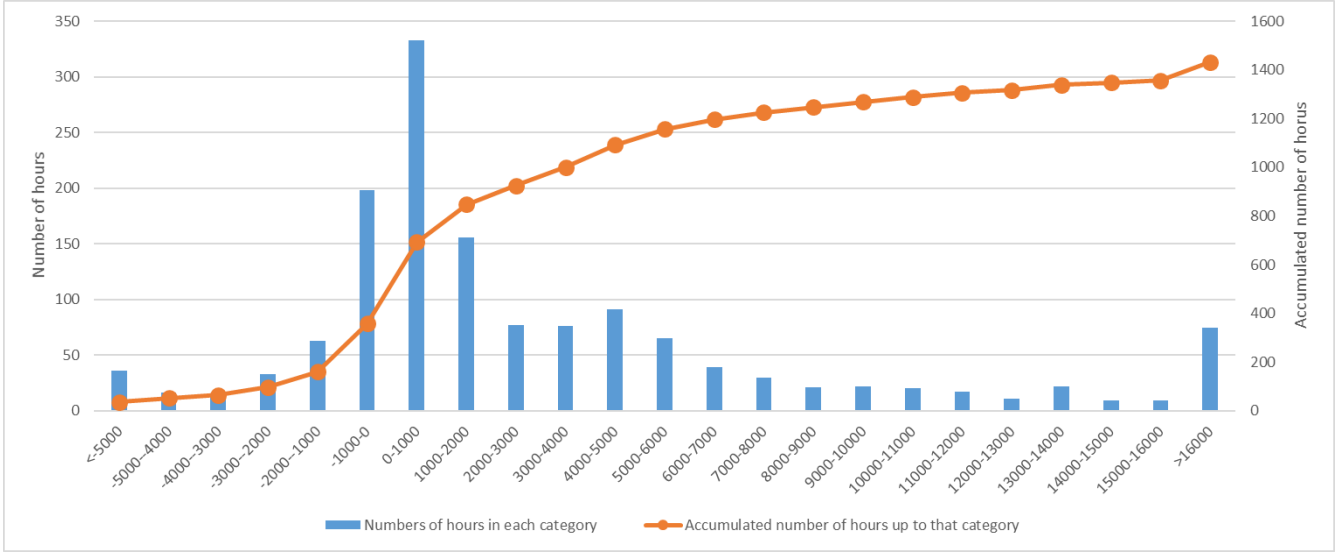
Statistical distribution of socioeconomic welfare gains

- Instead of time series aggregated per week as in the previous slides, we can also visualize the statistical distribution of the hourly changes in SEW
- The x-axis presents intervals of hourly changes in SEW, in €/h.



Statistical distribution of socioeconomic welfare gains

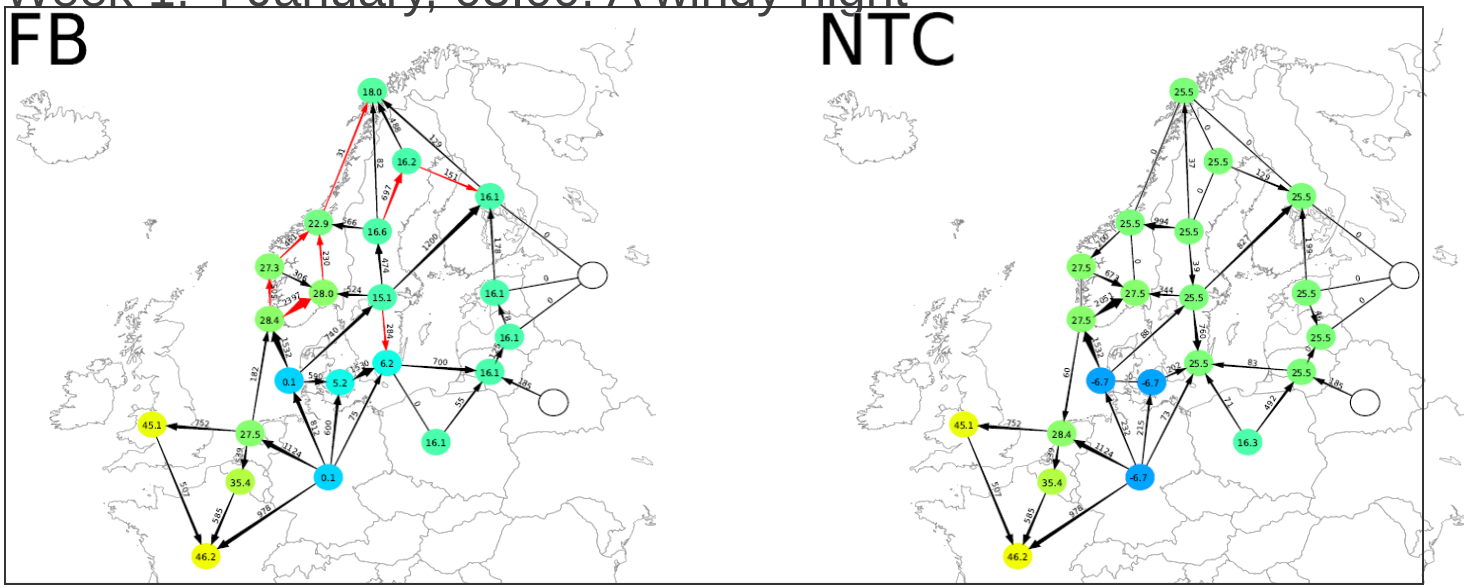
- About 350 hours with negative gains.
- About 1100 hours with positive gains.



Analyses of specific hours

- In the following slides, the differences between FB and historical NTCs for some specific hours are analysed in more detail

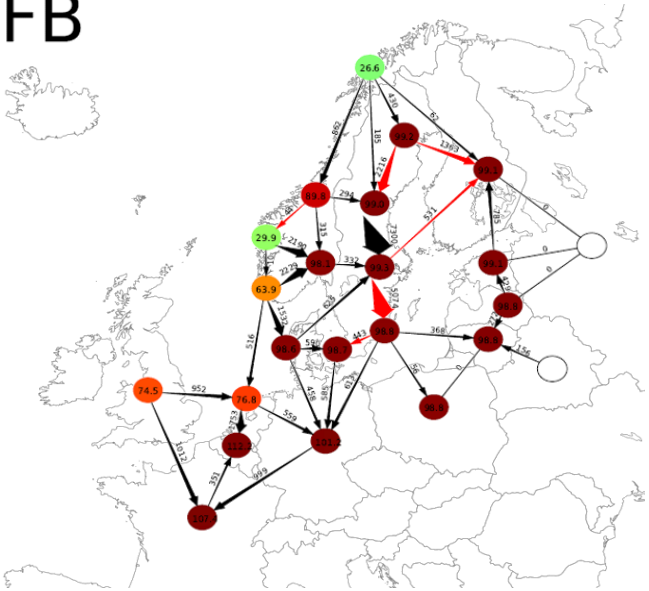
Week 1: 4 January, 03.00: A windy night



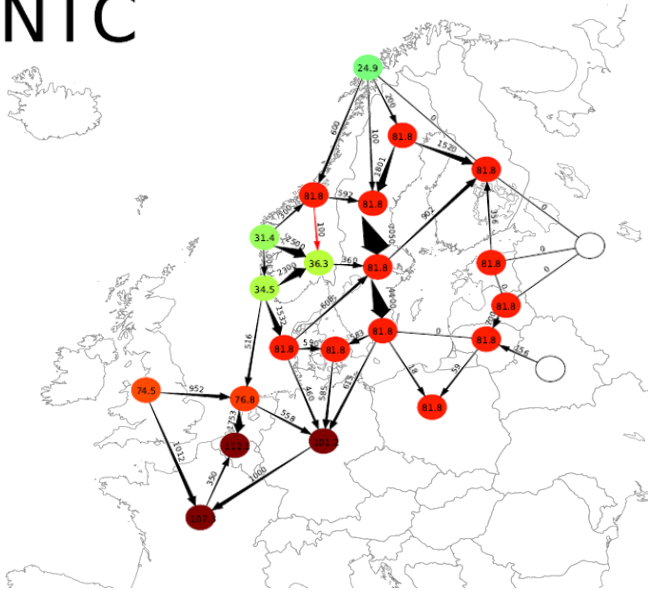
- A lot of wind to be exported from DK/GE to the Nordics
- With NTC, ex-ante limitations on DK1->SE3 and DK2->SE4 due to West Coast corridor
- With FB, capacity allocation in the market considers directly the West Coast corridor without need for limitations.
- Note that the limitations GE->SE4 are due to limitations on the German side.

Week 3: 16 January: 16.00. High load situation

FB



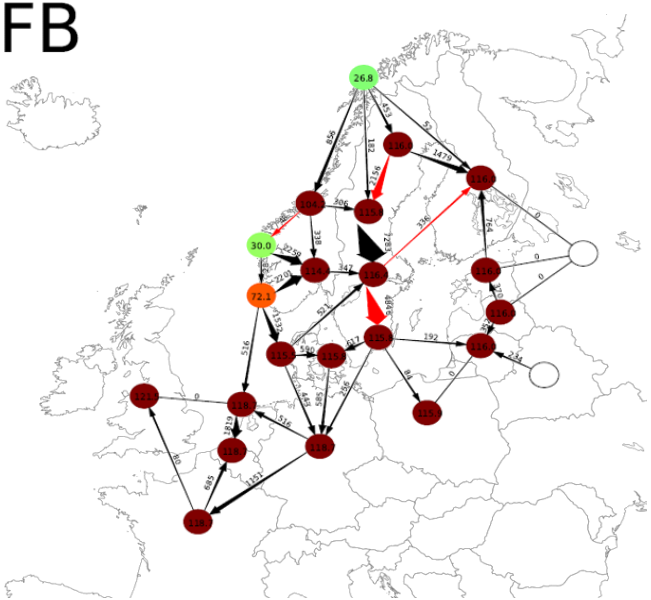
NTC



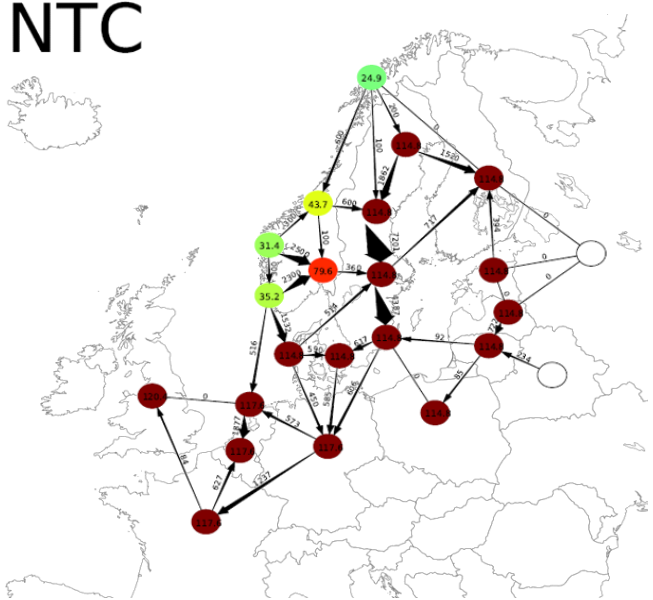
- With NTC, large congestions in Oslo area due to too much export from NO5 to the Oslo area in NO1 => NTC capacities given to the market not N-1 secure
- Production in NO4 blocked by limitations on NTC capacitiy
- With FB: -900 MW export from NO5 replaced by +500 MW export from NO4, + 200 MW export from NO2, + 100 MW SE1 and SE2
- Welfare gain of 12 k€

Week 3: 16 January: 17.00. High load situation

FB



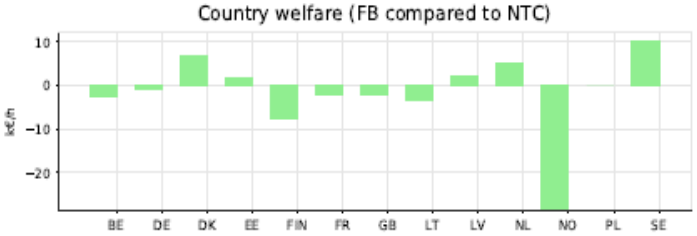
NTC

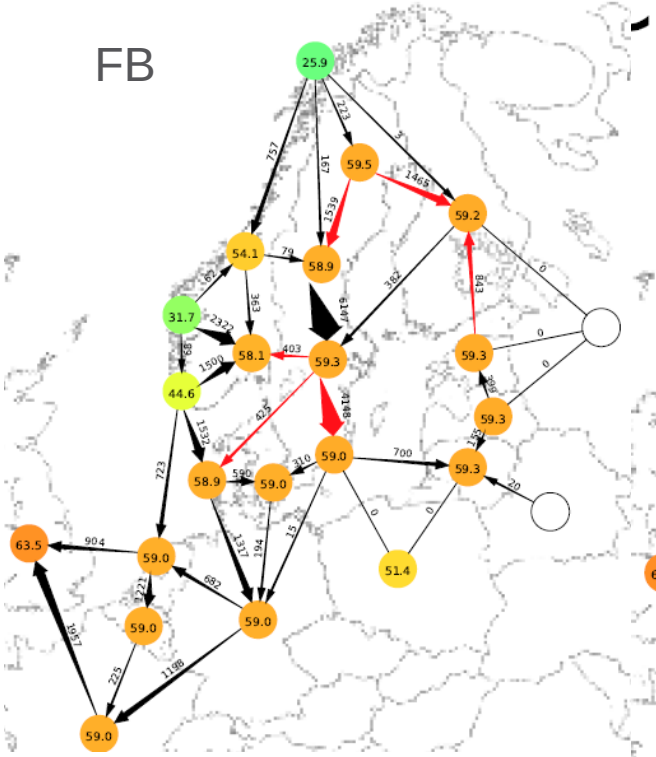


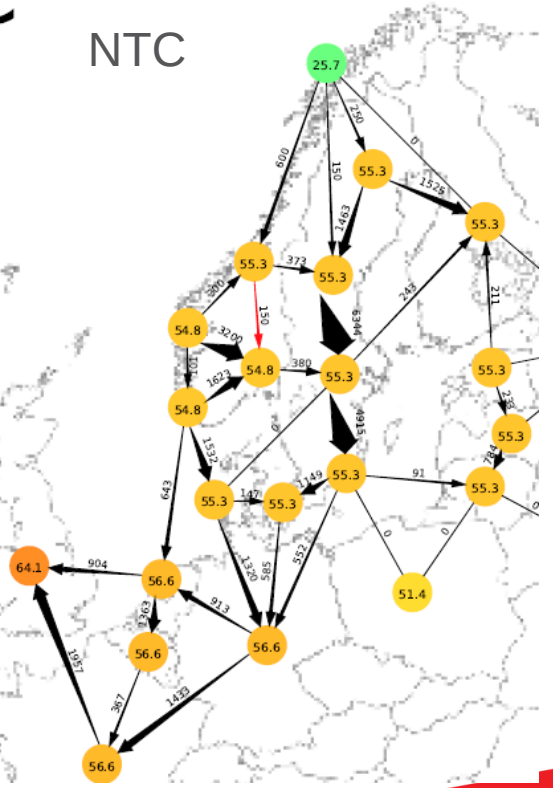
- Same situation as previous hour
- Grid congestions too important with NTC. Cannot be resolved with FB while maintaining at least the same welfare.
- Socioeconomic welfare loss with FB: 2 k€

Week 10, 07-03-2017 18:00

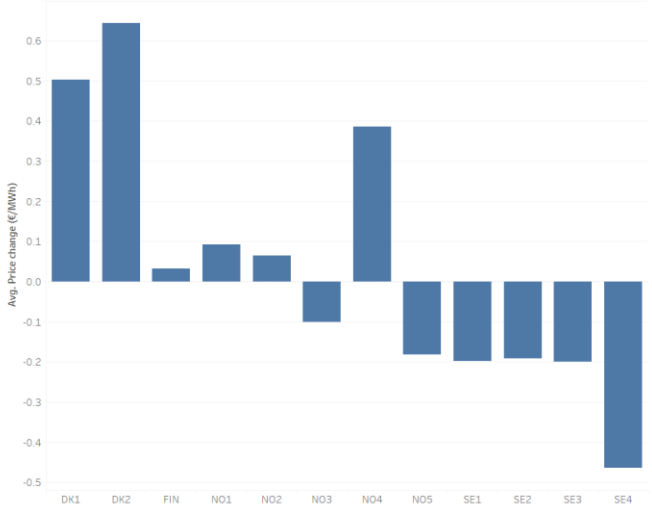
- Overloads around Oslo with the NTC market outcome
- FB is maximizing the capacity from NO2 and NO5 with non-intuitive flows from SE3 to NO1
- Negative change in SEW – mainly driven by a large reduction in Norwegian SEW





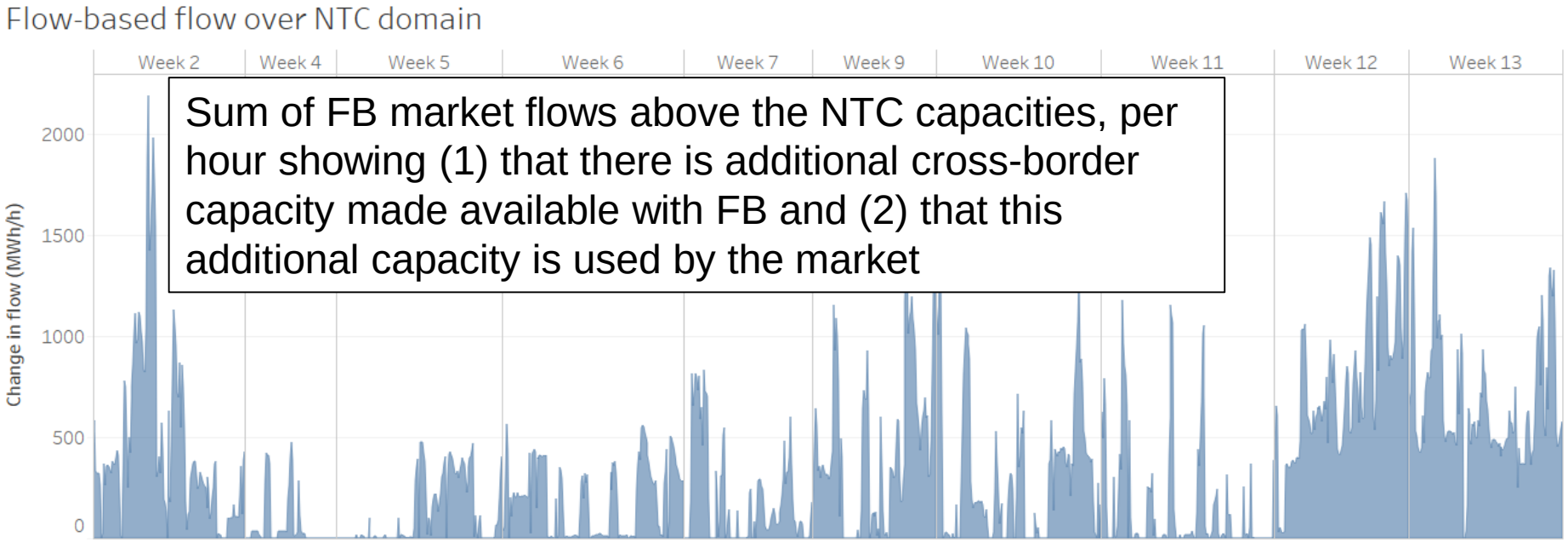


Prices, averages and changes from the 11 weeks of simulations



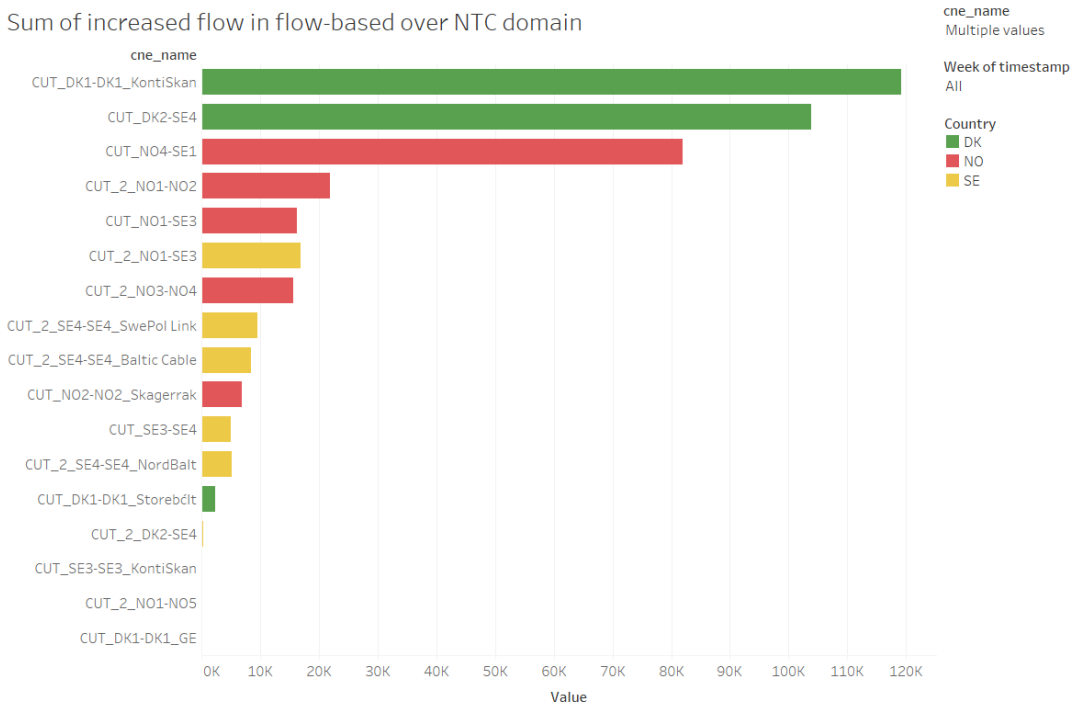
- Increase in DK1 and DK2
  - More export during windy nights
- Decrease in NO5 and increase in NO4
  - Shift of using producing in NO5 to producing in NO4
- Decrease in SE
- Mainly unchanged in FI
- Overall a slight increase in prices: 0.22 €/MWh

Use of extra capacity with FB



Use of extra capacity with FB

- This graph shows same information as the previous picture but aggregated per interconnector and for the whole 11-week period
- Note that CUT_2 means the reverse direction
- Many are related to a better handling of the West Coast Corridor and overloads in Norway



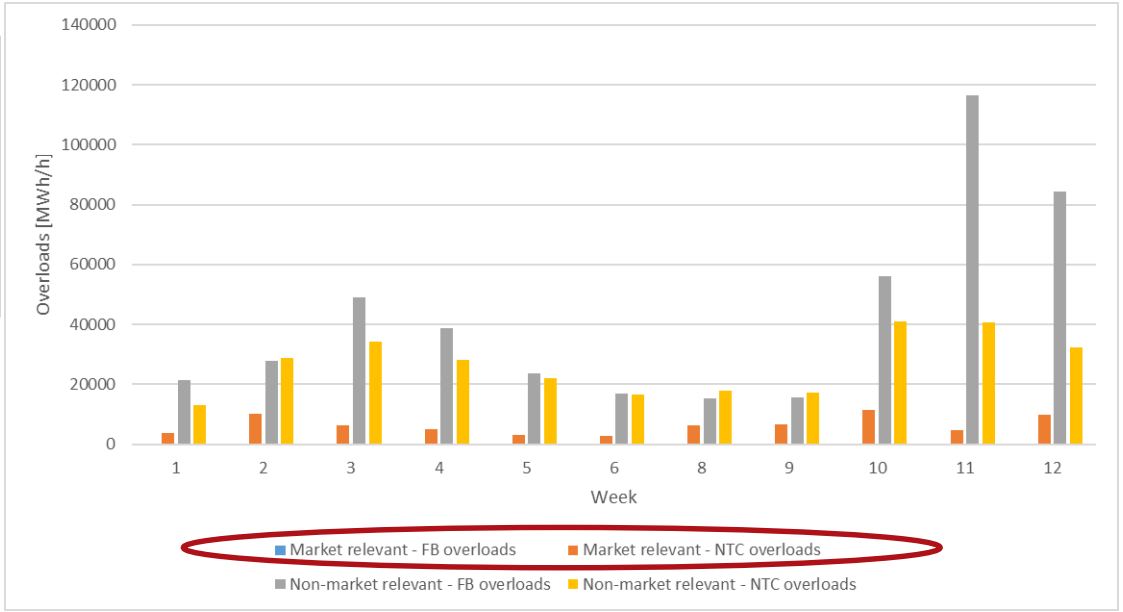
Power system impact analysis

- The previous results were related to the capacities, SEW and prices
- The next set of slides analyses the impact of a shift to FB on the poewr system security, defined as overloads on the monitored critical network elements

Power system security: Impacts on overloads

- Two types of network elements: market-relevant and non-market relevant
- Market-relevant network elements receives at least 15% of cross-border trades

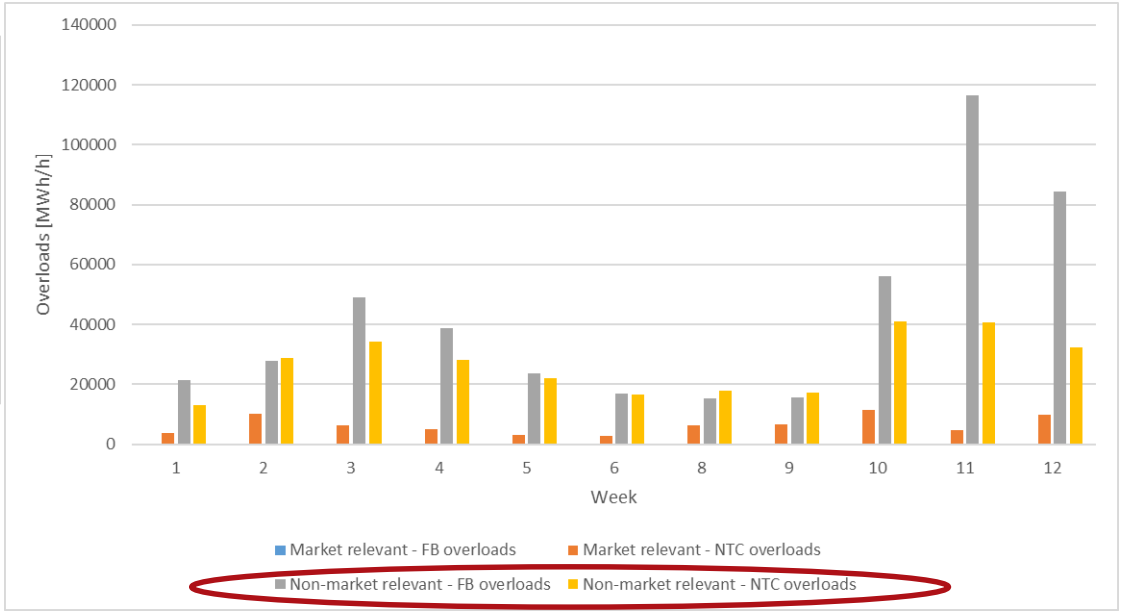
- Current NTC capacities are not always N-1 secure => Can create overloads on market-relevant network elements
- With FB, the market is aware of the market-relevant network elements => No overload on them



Power system security: Impacts on overloads

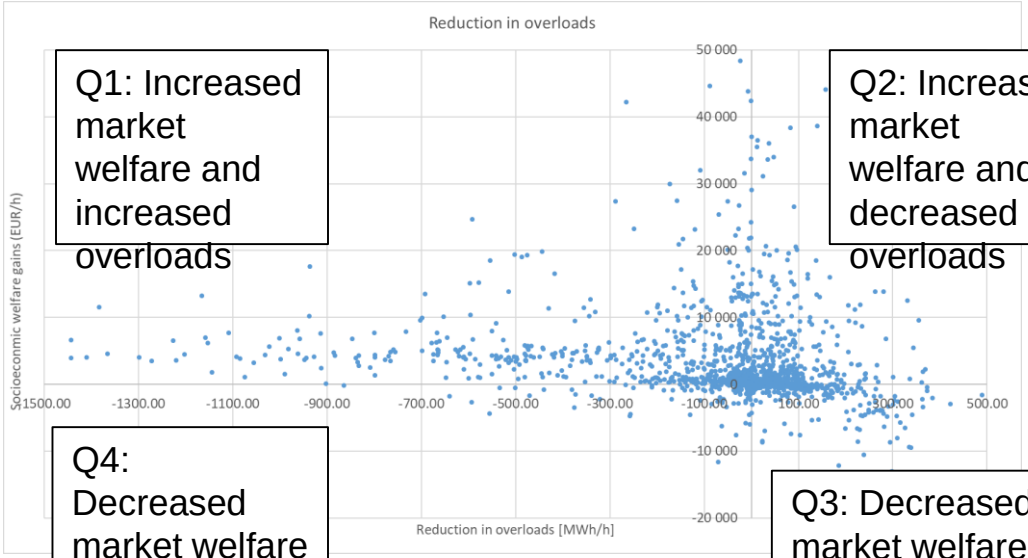
- Two types of network elements: market-relevant and non-market relevant
- Market-relevant network elements receives at least 15% of cross-border trades

- Non-market relevant network elements are not considered in FB
- Some of them may be considered in current NTC (no 15% threshold applied today in current CNTC)
- Increase of non-market relevant overloads indicate that the capacity in the system is used to a greater extent.



Power system security and SEW, hourly results

Average overloads NTC-FB [MW]	Average surplus FB-NTC [Euros]	Median overloads NTC-FB [MW]	Median surplus FB-NTC [Euros]
-73	3480	-5	1085

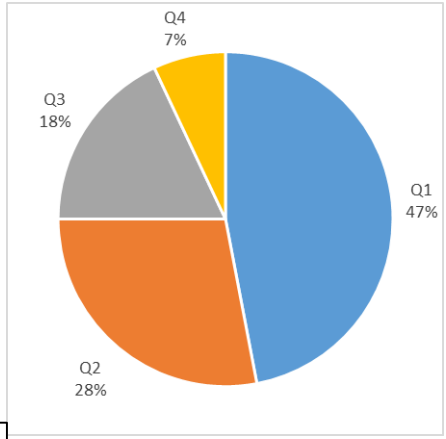


Q1: Increased market welfare and increased overloads

Q2: Increased market welfare and decreased overloads

Q4: Decreased market welfare and increased overloads

Q3: Decreased market welfare and decreased overloads



Statnett

Power system security and SEW, hourly results

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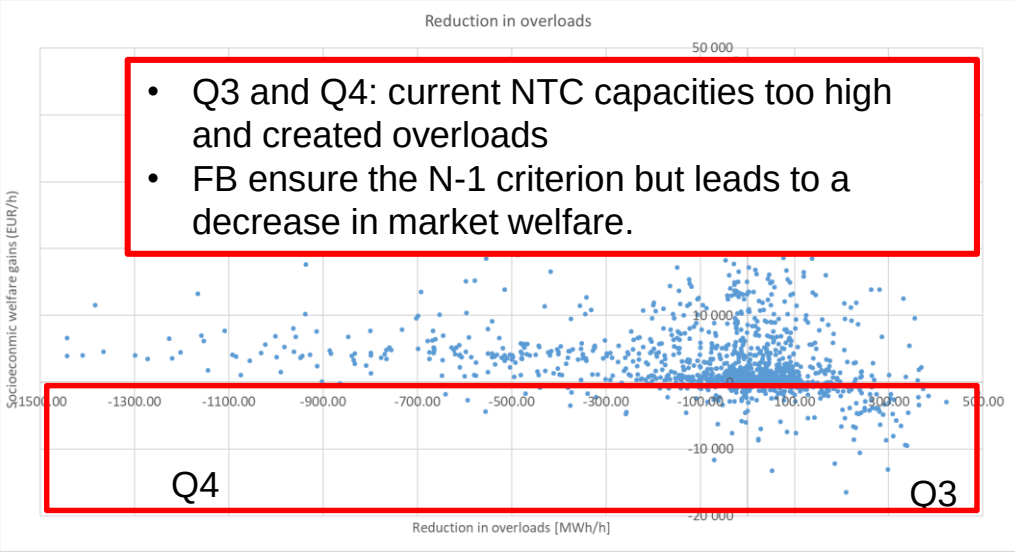
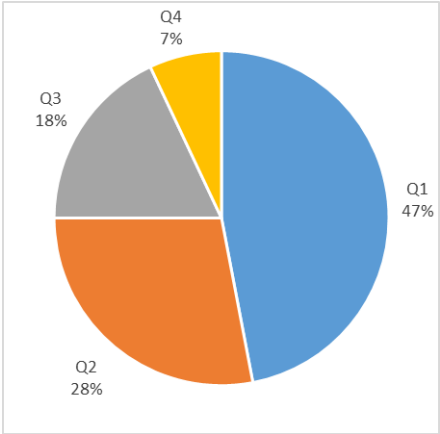


- Q3 and Q4: current NTC capacities too high and created overloads
- FB ensure the N-1 criterion but leads to a decrease in market welfare.



Statnett

Power system security and SEW, hourly results

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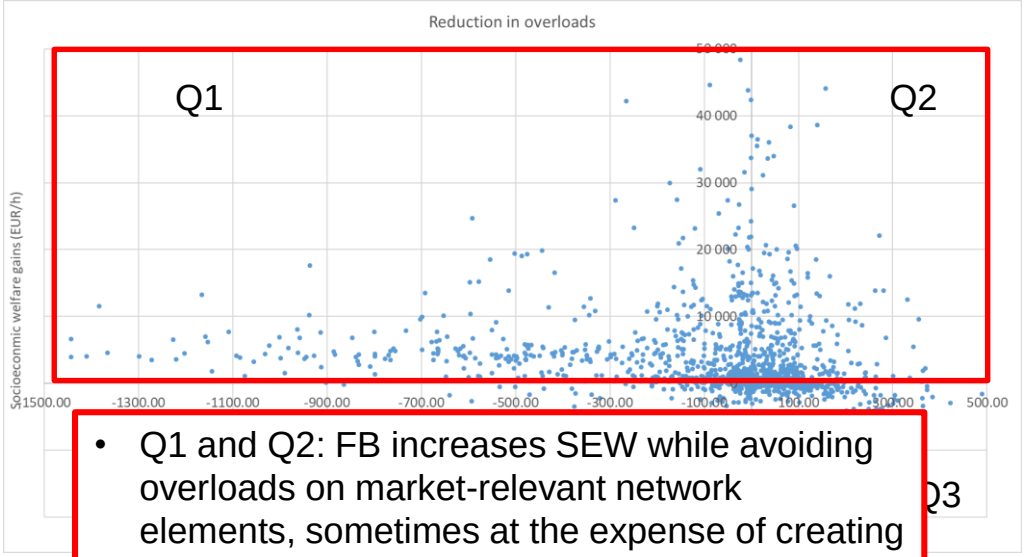
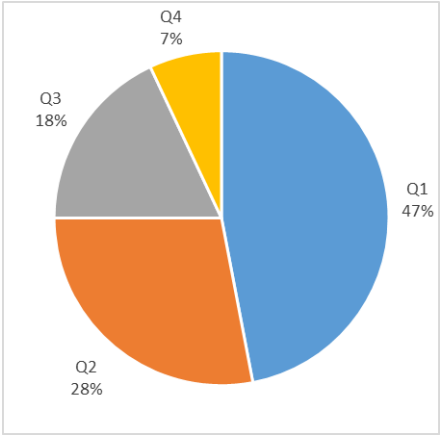


- Q1 and Q2: FB increases SEW while avoiding overloads on market-relevant network elements, sometimes at the expense of creating overloads on non-market relevant network elemets (Q1)



Statnett

Summary of the simulation results

Summary

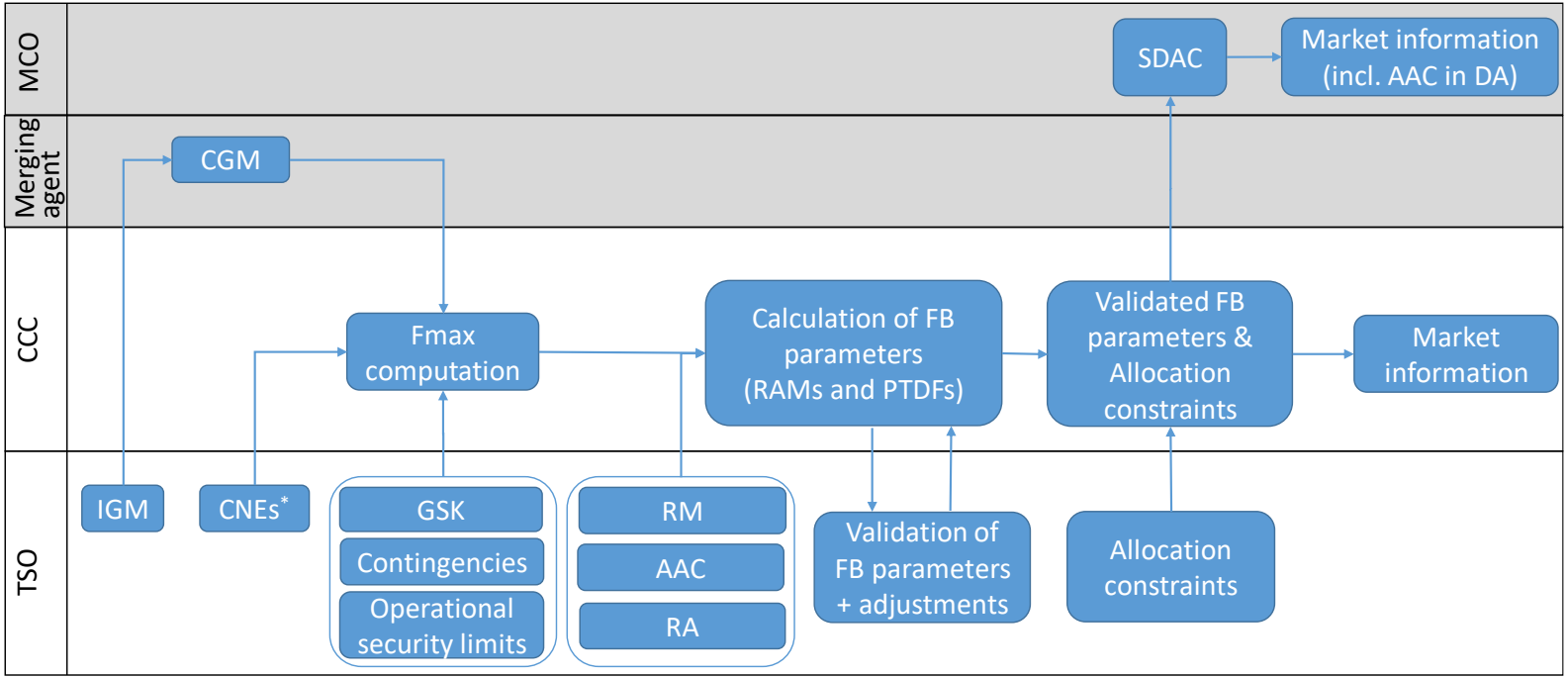
1. In average, welfare gains when changing to FB compared with current NTC
2. Welfare loss for some hours due to unsecure NTC capacities
3. Structural congestions such as West Coast corridor and export limitations in Norway dealt with in a more efficient way with flowbased:
   - No need to limit capacities ex ante.
   - Instead: full capacities + critical network elements given to the market => capacity allocated in the market in a more efficient way.

6. Implementation of new CCM in the Nordics

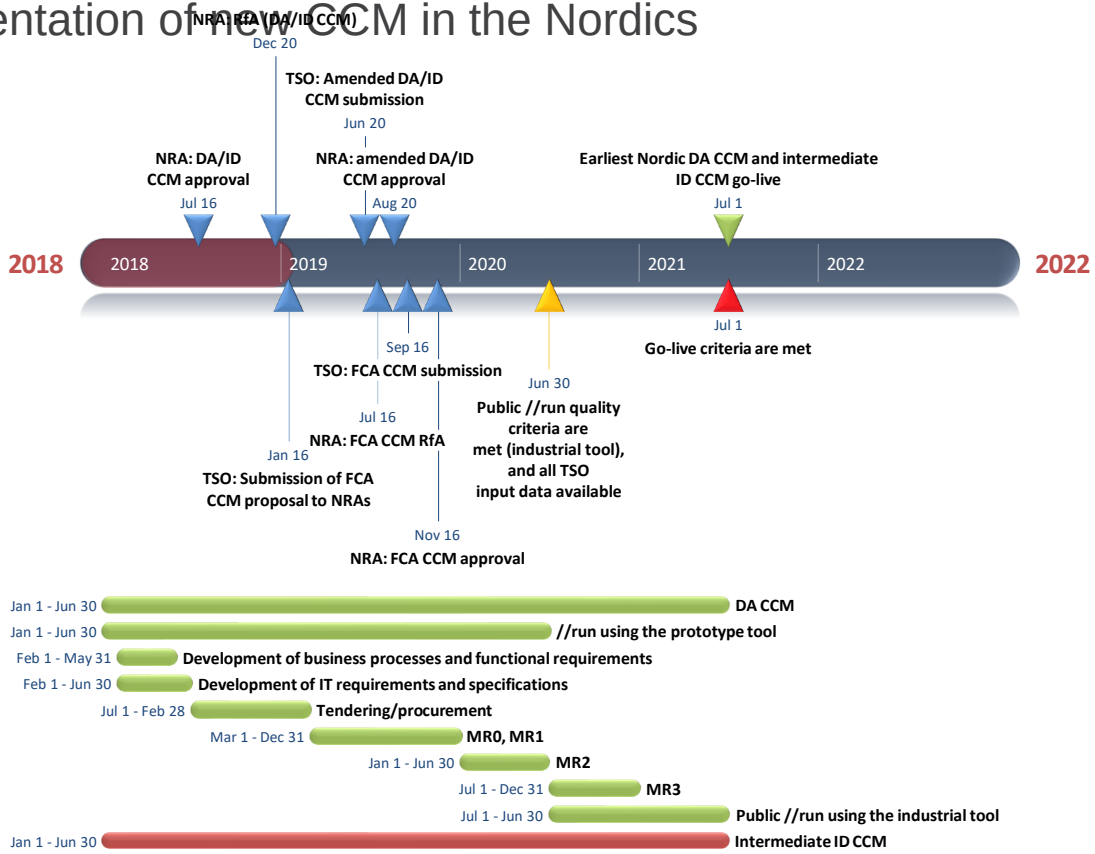
- Process diagram
- Timeline
- Further development (DSA)
- Key learning's from CWE FB operation

6. Implementation of new CCM in the Nordics

CCC - coordinated capacity calculator
MCO - Market Coupling Operator



6. Implementation of new CCM in the Nordics



6. Implementation of new CCM in the Nordics

Key learning's from CWE FB operation (from the 2018 visit to Tennet NL)

- Internal parallel run: information was published to the stakeholders
- Domain validation by the TSO operators: only important in the beginning. Trust has been built in the meantime, so that there is less need for the validation.
- FRMs are “operationally adjusted” (i.e. reduced when they are considered to be too large)
- Stakeholder involvement and transparency: leaflet / handbook, webinars
- Improvements ongoing on GSKs (important input parameter with a - potentially - large impact)
- Euphemia performance issues due to the DE-AT split (due to the virtual CNEs being applied for the LTA inclusion, the number of presolved CNEs increased to 500-800 with the DE-AT split)
- Relatively large welfare gains with the CWE going to FB compared to ATC.
- SPAIC analysis (Standard Process to communicate on and Assess the Impact of significant Changes) requires a lot of effort. A SPAIC analysis consists of a comparison of FB domains and market results for 12 typical “reference” days, commonly predefined by CWE TSOs, in order to estimate the impact of a change in grid topology or FB parameters.