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Openbaar besluit goedkeuring voorstel CWE FB DA updated package

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Samenvatting

TenneT TSO B.V. (hierna: TenneT) heeft op 25 juni 2018 een voorstel tot wijziging van (i) de flow-based capaciteitsberekeningsmethodologie voor Centraal-West Europa (hierna: het voorstel tot wijziging van CWE flow-based day-ahead), (ii) de methode voor verdeling van de inkomsten uit congestie en (iii) de capaciteitsberekeningsmethodologie voor het intraday tijdsbestek voor Centraal-West Europa (hierna: de CWE-regio) aan de Autoriteit Consument en Markt (hierna: de ACM) ter goedkeuring voorgelegd. TenneT heeft deze voorstellen ontwikkeld met de transmissiesysteembeheerders (hierna: TSB's) van de CWE-regio. TenneT is op grond van artikel 16, vijftiende lid, van de Elektriciteitswet 1998 (hierna: E-wet) verplicht om deze congestiebeheersprocedures aan de ACM ter goedkeuring voor te leggen. Deze congestiebeheersprocedures zijn eerder door de ACM goedgekeurd.

De aanleiding voor de indiening van deze voorstellen is de introductie van een biedzonegrens tussen Duitsland en Oostenrijk per 1 oktober 2018. Tevens hebben de regulerende instanties van de CWE-regio de TSB's van de CWE-regio verzocht om als hoofdregel op te nemen dat ten minste 20% beschikbare commerciële capaciteit (Remaining Available Margin (hierna: RAM)) wordt gegarandeerd op kritieke netwerkelementen (uitgezonderd situaties waarin er onvoldoende remediërende maatregelen zijn om de leveringszekerheid en systeemveiligheid te garanderen). Het doel daarvan is om tot een grotere hoeveelheid grensoverschrijdende capaciteit te komen dan de huidige CWE flow-based day-ahead marktkoppeling op momenten oplevert. Om dit te faciliteren dienen bestaande congestiebeheersprocedures te worden aangepast.

Het voorstel tot wijziging van CWE flow-based day-ahead bevat de opname van deze biedzonegrens in de flow-based marktkoppeling. Ook is de door de regulerende instanties van de CWE-regio gevraagde hoofdregel betreffende 20% minimale RAM in het voorstel opgenomen.

De voorstellen tot wijziging van de methode voor verdeling van de inkomsten uit congestie en de capaciteitsberekeningsmethodologie voor het intraday tijdsbestek voor de CWE-regio vloeien voort uit de voorgestelde introductie van de biedzonegrens Duitsland-Oostenrijk in de CWE flow-based day-ahead methodologie.

De ACM keurt de voorgestelde wijzigingen goed op grond van artikel 5, zesde lid, van de E-wet. Daaraan verbindt zij wel de voorwaarden (i) een studie te ontvangen naar selectie van de kritieke netwerkelementen en uitvalsituaties, (ii) overeenkomstig de uitkomsten van deze studie een gewijzigd voorstel voor CWE flow-based day-ahead, (iii) een verdere verduidelijking van het gebruik van de *external constraint on the global net position* en (iv) dat marktpartijen tijdig worden geinformeerd indien niet een minimale RAM van 20% kan worden gegarandeerd op een CNEC.

Belanghebbenden kunnen tegen dit besluit bezwaar maken bij de ACM.

1 Inleiding

1. TenneT TSO B.V. (hierna: TenneT) heeft op 25 juni 2018 een voorstel ingediend tot wijziging van (i) de flow-based capaciteitsberekeningsmethodologie voor Centraal-West Europa (hierna: de CWE-regio) voor het day-ahead tijdsbestek (hierna: voorstel tot wijziging van CWE flow-based day-ahead), (ii) de methode voor verdeling van de inkomsten uit congestie en (iii) de capaciteitsberekeningsmethodologie voor het intraday tijdsbestek voor de CWE-regio (hierna: de voorstellen). De flow-based capaciteitsberekeningsmethodologie voor de CWE-regio (hierna: CWE flow-based day-ahead), de methode voor verdeling van de inkomsten uit congestie en de capaciteitsberekeningsmethodologie voor de CWE-regio zijn eerder door de ACM goedgekeurd.

2. Aangezien het verzoek ziet op congestiebeheersprocedures heeft TenneT deze ter goedkeuring aan de ACM voorgelegd. Op grond van artikel 16, vijftiende lid, van de Elektriciteitswet 1998 (hierna: E-wet) is TenneT namelijk verplicht om congestiebeheersprocedures ter goedkeuring voor te leggen aan de ACM. Op grond van artikel 5, zesde lid, van de E-wet beslist de ACM over de goedkeuring.

3. De indeling van dit besluit is als volgt. Hoofdstuk 2 van dit besluit bevat de gevolgde procedure. Hoofdstuk 3 bevat het wettelijk kader. Het ontvangen voorstel is samengevat in hoofdstuk 4. Hoofdstuk 5 bevat de beoordeling van de aanvraag en hoofdstuk 6 het besluit.

4. Dit besluit bevat 4 bijlagen. Deze bijlagen zijn onderdeel van het besluit en bevatten de voorstellen en een position paper van de regulerende instanties van de CWE-regio.

2 Procedure van totstandkoming van dit besluit

5. Op 26 juni 2018 heeft de ACM van TenneT een verzoek ontvangen tot goedkeuring van het voorstel tot wijziging van (i) CWE flow-based day-ahead, (ii) de methode voor verdeling van de inkomsten uit congestie en (iii) de capaciteitsberekeningsmethodologie voor het intraday tijdsbestek voor de CWE-regio.

6. Om een zorgvuldige besluitvorming te waarborgen heeft de ACM de voorstellen ter inzage gelegd en gepubliceerd op haar internetpagina. Van de terinzagelegging is kennis gegeven in Staatscourant 38322 van 5 juli 2018. De ACM heeft hiermee belanghebbenden in de gelegenheid gesteld zienswijzen te geven.

7. Naar aanleiding van de terinzagelegging is geen zienswijze ontvangen.

8. De regulerende instanties van de landen in de CWE-regio hebben elkaar geraadpleegd en in nauwe coördinatie samengewerkt bij de beoordeling van de voorstellen. Naar aanleiding hiervan is een gezamenlijk position paper opgesteld. Dit position paper is als bijlage aan dit besluit gehecht.

3 Wettelijk kader

9. In dit hoofdstuk beschrijft de ACM de bepalingen die gezamenlijk het wettelijk kader vormen voor dit besluit.

Nationaal toetsingskader

10. Het verzoek van TenneT tot goedkeuring van de voorstellen betreft een wijziging van de congestiebeheersprocedures. Artikel 16, vijftiende lid, van de E-wet schrijft voor dat de netbeheerder van het landelijk hoogspanningsnet de congestiebeheersprocedures ter goedkeuring aan de ACM voorlegt, voordat de netbeheerder deze hanteert.

11. Artikel 5, zesde lid, van de E-wet bepaalt dat de ACM beslist over de goedkeuring van congestiebeheersprocedures voor landsgrensoverschrijdende netten.

12. Op grond van artikel 26a, eerste lid, van de E-wet dient TenneT voorwaarden te hanteren die redelijk, objectief en niet-discriminerend zijn.

Europees toetsingskader

13. Artikel 15, eerste en tweede lid, van Verordening (EG) nr. 714/2009 van het Europees Parlement en de Raad van 13 juli 2009 betreffende de voorwaarden voor toegang tot het net voor grensoverschrijdende handel in elektriciteit en tot intrekking van Verordening (EG) nr. 1228/2003 (hierna: Verordening 714/2009) luiden:

> “1. De transmissiesysteembeheerders voorzien in mechanismen voor coördinatie en uitwisseling van informatie teneinde in het kader van congestiebeheer in te staan voor de zekerheid van de netwerken.
> 2. De door de transmissiesysteembeheerders gehanteerde veiligheids-, operationele en planningsnormen worden openbaar gemaakt. Dit omvat tevens een algemeen model voor de berekening van de totale overdrachtcapaciteit en de transmissiebetrouwbaarheidsmarge, een en ander gebaseerd op de elektrische en fysieke eigenschappen van het netwerk. Dergelijke modellen moeten door de regulerende instanties worden goedgekeurd.
> (…)”

14. Artikel 16, eerste, tweede en derde lid, van Verordening 714/2009 luiden:

> “1. Congestieproblemen van het netwerk worden aangepakt met niet-discriminerende, aan de markt gerelateerde oplossingen waarvan voor de marktspelers en de betrokken transmissiesysteembeheerders efficiënte economische signalen uitgaan. Bij voorkeur dienen netcongestieproblemen te worden opgelost met van transacties losstaande methoden, d.w.z. methoden waarbij geen keuze tussen de contracten van afzonderlijke marktspelers behoeft te worden gemaakt.
> 2. Procedures om transacties te beperken worden slechts toegepast in noodsituaties, wanneer de transmissiesysteembeheerder snel moet optreden en redispatching of

conpensatiehandel niet mogelijk is. Dergelijke procedures worden op niet-discriminerende wijze toegepast. Behoudens in geval van overmacht worden marktspelers met een capaciteitstoewijzing voor een eventuele beperking vergoed.
3. Marktspelers krijgen de beschikking over de maximale capaciteit van de interconnecties en/of de maximale capaciteit van de transmissienetwerken waarmee grensoverschrijdende stromen worden verzorgd, zulks in overeenstemming met de voor een bedrijfszekere exploitatie van het netwerk geldende veiligheidsnormen.
(…)"

15. Bijlage I bij Verordening 714/2009 bepaalt onder meer het volgende:

"**Artikel 1.7:**
Bij het definiëren van passende netwerkgebieden waarop en waartussen congestiebeheer van toepassing is, moeten de transmissiesysteembeheerders zich laten leiden door de beginselen van rendabiliteit en minimalisering van de negatieve gevolgen voor de interne markt voor elektriciteit. Met name mogen transmissiesysteembeheerders de interconnectiecapaciteit niet beperken om congestie binnen hun eigen controlegebied op te lossen, behalve om de hierboven vermelde redenen en redenen van operationele veiligheid.[1] Indien een dergelijke situatie zich voordoet, moeten de transmissiesysteembeheerders ze beschrijven en alle systeemgebruikers hiervan op de transparante wijze in kennis stellen. Een dergelijke situatie wordt alleen getolereerd zolang geen oplossing op lange termijn is gevonden. De methoden en projecten waarmee zo'n oplossing kan worden bereikt worden door de transmissiesysteembeheerders beschreven en op transparante wijze aan de systeemgebruikers gepresenteerd."
(…)
"**Artikel 3.5:**
Ter bevordering van eerlijke en doeltreffende mededinging en grensoverschrijdende handel, dient de in punt 3.2 beschreven coördinatie tussen de transmissiesysteembeheerders binnen de gebieden alle stappen te bestrijken, gaande van capaciteitsberekening en optimalisering van toewijzing tot veilige exploitatie van het netwerk, en worden de verantwoordelijkheden duidelijk verdeeld. Deze coördinatie heeft met name betrekking op:
a) het gebruik van een gemeenschappelijk transmissiemodel dat doeltreffende omspringt met fysieke loop-flows en rekening houdt met de verschillen tussen fysieke en commerciële stromen;
b) de toewijzing en nominering van capaciteit om doeltreffend om te springen met onderling afhankelijke fysieke loop-flows;
(…)
g) de verificatie van de stromen om te voldoen aan de eisen inzake netwerkbeveiliging voor operationele planning en realtime-exploitatie;
(…)."

[1] Met "operationele veiligheid" wordt bedoeld: "het transmissiesysteem wordt binnen de overeengekomen veiligheidsgrenzen gehouden".

4 De voorstellen

16. Dit hoofdstuk beschrijft de aanleiding van en de gevolgde procedure voor het verzoek tot goedkeuring van de voorstellen. Vervolgens wordt de inhoud toegelicht.

4.1 Aanleiding voorstellen en gevolgde procedure

17. De elektriciteitsnetten van de CWE-regio zijn onderling verbonden, hetgeen handel in elektriciteit tussen de verschillende landen mogelijk maakt. Concurrentie tussen producenten van verschillende landen leidt tot een scherpere prijs op de groothandelsmarkten. De transportcapaciteit tussen de verschillende landen is echter beperkt en om deze reden moet de beschikbare capaciteit efficiënt worden benut. In april 2015 heeft de ACM flow-based marktkoppeling voor het day-ahead tijdsbestek voor de CWE-regio goedgekeurd.[2] Door de flow-based marktkoppeling wordt de maximale capaciteit op netwerkelementen berekend, terwijl het prijskoppelingsalogritme de capaciteit toe wijst aan transacties die een hoge financiële waarde vertegenwoordigen én een lage belasting op het net veroorzaken. Dit leidt tot een optimaal gebruik van het elektriciteitsnet.

18. Op 17 november 2016 heeft het Agentschap voor de samenwerking tussen energieregulators een besluit genomen over de capaciteitsberekeningsregio's, waarin een biedzonegrens tussen Duitsland en Oostenrijk is opgenomen. Met ingang van 1 oktober 2018 zal een dergelijke biedzonegrens tussen de twee landen zijn geïntroduceerd. Op deze grens dienen congestiebeheersprocedures te worden toegepast. De transmissiesysteembeheerders van de CWE-regio hebben voorgesteld om deze biedzonegrens op te nemen in CWE flow-based day-ahead. Aangezien dit leidt tot wijzigingen in de door de ACM goedgekeurde congestiebeheersprocedures, dient TenneT de voorstellen aan de ACM ter goedkeuring voor te leggen.

19. De voorstellen tot wijziging van de methode voor verdeling van de inkomsten uit congestie en de capaciteitsberekeningsmethodologie voor het intraday tijdsbestek voor de CWE-regio vloeien voort uit de opname van de biedzonegrens Duitsland-Oostenrijk in CWE flow-based day-ahead.

20. Tevens bevat het voorstel tot wijziging van CWE flow-based day-ahead het uitgangspunt van een minimale beschikbare commerciële capaciteit (hierna: minimale RAM[3]) van 20% van de fysieke capaciteit van een kritiek netwerkelement. Dit vloeit voort uit een verzoek daartoe van de regulerende instanties van de CWE-regio.

[2] Besluit ACM van 10 april 2015 in zaaknummer 13.0852.52.
[3] RAM staat voor *Remaining Available Margin*.

4.2 Omschrijving voorstellen

Voorstel tot wijziging van CWE flow-based day-ahead

21. In het voorstel tot wijziging van CWE flow-based day-ahead wordt de splitsing van de gezamenlijke biedzone Duitsland/Oostenrijk/Luxemburg geadresseerd door voor de biedzone Oostenrijk aparte inputs op te nemen in de methodologie. Voorbeelden van deze inputs hebben betrekking op de berekening van een *Generation Shift Key* (hierna: GSK) en op *Power Transfer Distribution Factors* voor Oostenrijkse kritieke netwerkelementen en uitvalsituaties (hierna: CNECs[4]).

22. Ook is in het voorstel tot wijziging van CWE flow-based day-ahead een aanpassing voorgesteld van de berekening om een minimale RAM van 20% te garanderen. Deze *adjustment for Min RAM* wordt uitgevoerd aan het eind van de berekening, waarmee wordt gegarandeerd dat er altijd minimaal 20% van de fysieke capaciteit van een netwerkelement aan de markt wordt aangeboden (uitgezonderd situaties waarin er onvoldoende remediërende maatregelen zijn om de leveringszekerheid en systeemveiligheid te garanderen). Wanneer blijkt dat er minder dan 20% RAM beschikbaar is, wordt de uitkomst van de capaciteitsberekening door deze toevoeging aan de methodologie gewijzigd naar de minimaal vereiste beschikbare capaciteit.

23. Het voorstel tot wijziging van CWE flow-based day-ahead bevat tot slot een aantal wijzigingen die niet samenhangen met de introductie van een biedzonegrens tussen Duitsland en Oostenrijk of de introductie van de 20% minimale RAM.

24. Er wordt voorgesteld om de Duitse external constraint uit de methodologie te verwijderen.

25. Ook wordt voorgesteld om gebruik te maken van een zogenaamde *external constraint on the global net position* voor de biedzones waarin nog wel van een external constraint gebruik wordt gemaakt. Momenteel worden voor enkele biedzones zogenaamde external constraints gebruikt. Voor Nederland geldt bijvoorbeeld momenteel een beperking (external constraint) van de import van 5000 MW.[5] Dit houdt in dat de netto importpositie niet hoger[6] mag zijn dan 5000 MW. De reden van deze beperking is de bescherming van de systeem- en voltagestabiliteit van het elektriciteitsnetwerk. Echter, deze beperking van 5000 MW geldt momenteel slechts voor de netto positie als gevolg van commerciële uitwisselingen met andere landen uit de CWE-regio, niet voor uitwisselingen met landen van buiten de CWE-regio.[7] De nieuw voorgestelde *external constraint on the global net position* werkt op een manier waarin de commerciele uitwisselingen met landen van buiten de CWE-regio ook worden betrokken. Deze constraint zal dan ook worden gebruikt om een limiet toe te passen op de som van alle grensoverschrijdende uitwisselingen van een biedzone.

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[4] CNEC staat voor *Critical Network Element and Contingency.*
[5] Maandag t/m vrijdag van 8:00 t/m 23:00 bedraagt de external constraint 5000 MW, daarbuiten 4250 MW.
[6] Een netto import voor een biedzone betekent een negatieve netto positie, een netto export betekent een positieve netto positie.
[7] Voor Nederland gaat dit om de uitwisselingen met Noorwegen en het Verenigd Koninkrijk.

Voorstel tot wijziging methode verdeling inkomsten congestie

26. In het voorstel tot wijziging van de methodologie voor verdeling van de inkomsten uit congestie is de biedzone Oostenrijk toegevoegd. Op deze manier wordt gegarandeerd dat de biedzone Oostenrijk een evenredig deel van de inkomsten uit congestie ontvangt.

Voorstel tot wijziging capaciteitsberekeningsmethodologie intraday

27. In het voorstel tot wijziging van de capaciteitsberekeningsmethodologie voor het intraday tijdsbestek voor de CWE-regio is een methodologie voor de biedzone Oostenrijk toegevoegd. Deze capaciteitsberekeningsmethodologie is van toepassing tot de implementatie van de eerder door de ACM goedgekeurde flow-based capaciteitsberekeningsmethodologie voor het intraday tijdsbestek voor de CWE-regio.[8]

[8] Besluit ACM van 15 september 2017 in zaaknummer 17.0105.52.

5 Beoordeling

28. In dit hoofdstuk beoordeelt de ACM de voorstellen van TenneT.

29. Voor de beoordeling van de voorstellen heeft de ACM in nauwe coördinatie samengewerkt met de regulerende instanties van de CWE-regio. Het position paper dat is voortgekomen uit deze coördinatie is als bijlage aan dit besluit toegevoegd en maakt er een integraal onderdeel van uit.

Voorstel tot wijziging van CWE flow-based day-ahead

30. De introductie van de biedzonegrens tussen Duitsland en Oostenrijk leidt enkel tot een toevoeging van de inputs voor Oostenrijk aan de methode, dit heeft geen gevolgen voor de methode van berekening van het capaciteitsdomein. In de documenten die TenneT heeft ingediend ter onderbouwing van het voorstel tot wijziging van CWE flow-based day-ahead, wordt gesteld dat er geen verslechtering van de prestaties van de marktkoppeling in de CWE-regio is voorzien. Er wordt voorzien dat door de introductie van de biedzonegrens de grensoverschrijdende handel in de CWE-regio zal stijgen, omdat flow-based marktkoppeling dan ook uitwisselingen tussen Oostenrijk en Duitsland kan optimaliseren. Immers, flow-based marktkoppeling kan louter uitwisselingen optimaliseren tussen biedzones. Uitwisselingen binnen biedzones krijgen automatisch capaciteit toegewezen. Op basis van het bovenstaande ziet de ACM geen aanleiding om de voorgestelde wijzigingen naar aanleiding van de opname van de Duits-Oostenrijkse biedzonegrens aan CWE flow-based day-ahead niet goed te keuren.

31. De introductie van de 20% minimale RAM garandeert dat ten minste 20% van de fysieke capaciteit van een kritiek netwerkelement aan de markt ter beschikking wordt gesteld. Deze introductie wordt door de regulerende instanties van de CWE-regio gezien als een tijdelijke maatregel om de discriminatie tussen interne en grensoverschrijdende stromen tegen te gaan binnen de operationele veiligheidseisen van het transmissienetwerk. Enkel in situaties waarin er onvoldoende remediërende maatregelen beschikbaar zijn om de leveringszekerheid en netveiligheid te garanderen mag worden afgeweken van het vereiste van een 20% minimale RAM. De ACM is van mening dat het uitgangspunt bij een afwijking van het vereiste van de 20% minimale RAM is dat het uitzonderlijke situaties dient te betreffen waarin geen andere mogelijkheden zijn om de netveiligheid te verzekeren. Naar het oordeel van de regulerende instanties van de CWE-regio leidt de 20% minimale RAM namelijk momenteel tot een vergroting van de mogelijkheden tot grensoverschrijdende handel, maar onvoldoende is onderbouwd waarom de minimale RAM niet hoger kan zijn dan de voorgestelde 20%. Ook twijfelt de ACM aan de mate waarin het voorstel non-discriminatie garandeert.

32. Gezien het voorgaande verbindt de ACM aan de goedkeuring van het voorstel tot wijziging van de flow-based capaciteitsberekeningsmethodologie voor het day-ahead tijdsbestek voor de CWE-regio de voorwaarde dat TenneT een verbeterde studie naar de CNEC-selectie dient te doen, waarbij de mogelijkheid van een verhoging van de minimale RAM en de optimaliteit van een

drempelwaarde voor PTDFs van 5% wordt onderzocht. Uiteindelijk moet gemotiveerd worden waarom de in de studie voorgestelde en te implementeren waarden voor de minimale RAM en de drempelwaarde voor de PTDFs non-discriminatie garanderen.[9] De resultaten van deze studie dienen tot de indiening van een dienovereenkomstig aangepast voorstel tot wijziging van de goedgekeurde methodologie voor CWE flow-based day-ahead te leiden.

33. Vanwege transparantieoverwegingen stelt de ACM tevens als voorwaarde aan de goedkeuring dat TenneT naast de regulerende instanties van de CWE-regio ook tijdig marktpartijen informeert indien niet op een CNEC een 20% minimale RAM wordt gegarandeerd.

34. Het voorstel om de Duitse *external constraint* uit de capaciteitsberekeningsmethodologie te verwijderen moet leiden tot een grotere beschikbaarheid van grenscapaciteit. Aangezien de huidige toepassing van deze *external constraint* frequent leidt tot een beperking van de beschikbare grensoverschrijdende capaciteit, is de verwachting dat deze verwijdering de mogelijkheden tot grensoverschrijdende handel zal vergroten.

35. De door de TSBs gecreëerde mogelijkheid om gebruik te maken van een *external constraint on the global net position* leidt tot een methode waarin de coördinatie verbetert in vergelijking met de eerder goedgekeurde methode. Momenteel wordt louter de netto positie als gevolg van uitwisselingen in de CWE-regio gelimiteerd bij overschrijding van de vastgestelde waarde van de *external constraint*. De netto positie als gevolg van commerciële uitwisselingen met landen van buiten de CWE-regio wordt hier niet in betrokken en dus niet door gelimiteerd. Met de *external constraint on the global net position* wordt de *global net position (*volgens de TSB's van de CWE-regio is dat de som van alle grensoverschrijdende uitwisselingen van een biedzone in de day-ahead marktkoppeling) gelimiteerd door een external constraint, in tegenstelling tot de huidige situatie met een limitering enkel op de uitwisselingen met landen uit de CWE-regio). Hiermee wordt tevens rekening gehouden met het effect van uitwisselingen met landen van buiten de CWE-regio op de systeemveiligheid. Op voorhand ziet de ACM geen bezwaar tegen toevoeging van de mogelijkheid van een *external constraint on the global net position* aan CWE flow-based day-ahead.

36. Momenteel bestaat echter nog enige onduidelijkheid met betrekking tot de *external constraint on the global net position*. Daarom verbindt de ACM een voorwaarde tot verduidelijking van deze *external constraint on the global net position* aan de goedkeuring van het voorstel. Deze verduidelijking dient ten minste te bestaan uit (i) de toe te passen waarde van de constraint voor de Nederlandse biedzone, (ii) een beschrijving hoe de *external constraint on the global net position* mee wordt genomen in het marktkoppelingsproces, (iii) een beschrijving hoe de toepassing van de constraint tussen de TSBs van de CWE-regio wordt gecoördineerd en hoe deze terug kan worden gevonden in de transparantie- en monitoringsdata van de flow-based

[9] Zoals in het door de regulerende instanties van de CWE-regio gezamenlijk geschreven Position Paper op pagina's 5 en 7 uiteen is gezet.

marktkoppeling en (iv) de datum vanaf wanneer gebruik zal worden gemaakt van de *external constraint on the global net position*.[10]

37. De ACM concludeert dat het voorstel tot wijziging van CWE flow-based day-ahead geen voorwaarden bevat die onredelijk, niet-objectief of discriminerend zijn zoals bedoeld in artikel 26a, eerste lid, van de E-wet. Daarnaast voldoet het voorstel aan de bepalingen uit Verordening 714/2009. Echter, naar het oordeel van de ACM dient het voorstel voor CWE flow-based day-ahead, voor zover van toepassing, in overeenstemming met de hierboven uiteen gezette overwegingen te worden aangepast. De ACM keurt daarom de voorstellen goed op grond van artikel 5, zesde lid, van de E-wet, onder de voorwaarden opgenomen in hoofdstuk 6.

Voorstel tot wijziging methode verdeling inkomsten congestie

38. De ACM concludeert dat het voorstel tot wijziging van de methode voor de verdeling van de inkomsten uit congestie geen voorwaarden bevat die onredelijk, niet-objectief of discriminerend zijn zoals bedoeld in artikel 26a, eerste lid, van de E-wet. Daarnaast voldoet het voorstel aan de bepalingen uit Verordening 714/2009. De ACM keurt het voorstel tot wijziging van de methode voor verdeling van de inkomsten uit congestie daarom goed op grond van artikel 5, zesde lid, van de E-wet.

Voorstel tot wijziging capaciteitsberekeningsmethodologie intraday

39. De ACM concludeert dat het voorstel tot wijziging van decapaciteitsberekeningsmethodologie voor intraday geen voorwaarden bevat die onredelijk, niet-objectief of discriminerend zijn zoals bedoeld in artikel 26a, eerste lid, van de E-wet. Daarnaast voldoet het voorstel aan de bepalingen uit Verordening 714/2009. De ACM keurt het voorstel tot wijziging van de capaciteitsberekeningsmethodologie voor intraday daarom goed op grond van artikel 5, zesde lid, van de E-wet.

[10] Zoals in het door de regulerende instanties van de CWE-regio gezamenlijk geschreven Position Paper op pagina's 5 en 8 uiteen is gezet.

6 Besluit

40. De Autoriteit Consument en Markt keurt het voorstel van TenneT TSO B.V. tot wijziging van de flow-based capaciteitsberekeningsmethodologie voor het day-ahead tijdsbestek voor de CWE-regio goed.

41. De Autoriteit Consument en Markt verbindt aan de goedkeuring de volgende voorwaarden:
    a. Uiterlijk op 30 juni 2019 dient de ACM van TenneT een studie naar de selectie van de kritieke netwerkelementen en uitvalsituaties te ontvangen, die in samenwerking met de overige transmissiesysteembeheerders van de CWE-regio is opgesteld. Hierin dient ten minste onderzoek te zijn gedaan naar:
        i. de mogelijkheden van een verhoging van de minimale *Remaining Available Margin*;
        ii. de optimaliteit van de huidige toegepaste drempelwaarde van 5% voor de *Power Transfer Distribution Factor;* en
        iii. een motivering waarom de door de studie voorgestelde en te implementeren minimale *Remaining Available Margin en Power Transfer Distribution Factor* non-discriminatie garanderen.
    b. In overeenstemming met de resultaten van de onder a. genoemde studie dient de ACM van TenneT TSO B.V. een voorstel tot wijziging van de flow-based capaciteitsberekeningsmethodologie voor het day-ahead tijdsbestek voor de CWE-regio te ontvangen.
    c. De ACM dient van TenneT TSO B.V. een verdere verduidelijking van het gebruik van de *external constraint on the global net position* ontvangen. Deze verduidelijking dient ten minste te bestaan uit:
        i. de toe te passen waarde van de constraint voor de Nederlandse biedzone;
        ii. een beschrijving hoe de *external constraint on the global net position* mee wordt genomen in het marktkoppelingsproces;
        iii. een beschrijving hoe de toepassing van de constraint tussen de TSBs van de CWE-regio wordt gecoördineerd en hoe deze terug kan worden gevonden in de transparantie- en monitoringsdata van de flow-based marktkoppeling; en
        iv. per biedzone de datum vanaf wanneer gebruik zal worden gemaakt van de *external constraint on the global net position*.
    d. Marktpartijen dienen tijdig te worden geïnformeerd indien op een CNEC niet een 20% minimale RAM wordt gegarandeerd.

42. De Autoriteit Consument en Markt keurt het voorstel van TenneT TSO B.V. tot wijziging van de methode voor verdeling van de inkomsten uit congestie goed.

43. De Autoriteit Consument en Markt keurt het voorstel van TenneT TSO B.V. tot wijziging van de capaciteitsberkeningsmethodologie voor het intraday tijdsbestek voor de CWE-regio goed.

‘s-Gravenhage,
Datum: 31 augustus 2018

Autoriteit Consument en Markt
namens deze,
w.g.

mr. P.C.M. Bijlenga
Teammanager Directie Energie

Als u rechtstreeks belanghebbende bent, kunt u bezwaar maken tegen dit besluit. Stuur uw gemotiveerde bezwaarschrift naar de Autoriteit Consument en Markt, Juridische Zaken, postbus 16326, 2500 BH Den Haag. Graag ontvangen wij uw bezwaarschrift ***binnen zes weken*** *na de dag waarop dit besluit bekend is gemaakt. In uw bezwaarschrift kunt u de Autoriteit Consument en Markt verzoeken in te stemmen met rechtstreeks beroep bij de bestuursrechter.*

Documentation of the CWE FB MC solution

June 2018 – version 3.0

Last updated: 30/05/2018

Note: this document is an update of the CWE FB MC approval package version 2.1. published on JAO website on 04.10.2017.

The main changes compared to the version 2.1 are the following:

1. Updates related to DE-AT bidding zone border
2. Inclusion of the Minimum RAM process
3. Removal of German External constraints
4. Application of the external constraint on the global bidding zone net position

Contents

1 Management summary

The purpose of this updated approval document is to provide all Regulators of the CWE region with complete and up-to-date information regarding the applied solution of the CWE Flow Based Marked Coupling (FB MC).

This document constitutes an update of the approval document dated September 25th 2017 ("Documentation of the CWE FB MC solution" V2.1) now including the bidding zone border split of the German and Austrian Hub and the implementation of the MinRAM process with the current value of 20%.

For the sake of consistency all provisions reflected in this document are without prejudice to methodologies and proposals, which will be implemented as required by Regulation 2015/1222 (CACM). This includes, inter alia, the interaction between TSOs and NEMOs as foreseen by the Multiple NEMO arrangement.

The CWE Market Coupling Solution

The specific CWE Flow Based Market Coupling solution is a regional part of the MRC Market Coupling Solution.

Similar to the CWE ATC MC, during the daily operation of Market Coupling the available capacity (final Flow Based parameters including the Critical Branches and the PTDF-matrix) will be published at 10:30. Market Parties will have to submit their bids and offers to their local PX before gate closure time. In case results cannot be calculated, the Fallback mechanism for capacity allocation will be applied at MRC level and there will be a Full or Partial Decoupling of the PXs, following the MRC Procedures.

The solution is operated via a set of connected systems. These systems are operated by RSCs, TSOs, jointly or individually, PXs, jointly or individually, JAO and clearing houses. Daily operations consist of three phases: provision of network data (Flow Based parameters), calculation of results, and post publication processes.

Fallback arrangement (capacity allocation)

In the CWE MC procedures, a Fallback situation occurs when the Incident Committee declares that, for any reason, correct Market Coupling results cannot be published before the Decoupling deadline.

The principle of the CWE Fallback arrangement is to allocate ATCs derived from the Flow Based parameters via; (1) a "shadow explicit auction" and a Full Decoupling of the PXs or (2) a CWE regional coupling (CWE-BritNed Coupling or CWE-only coupling). The first case means an isolated fixing, performed after having reopened order books. The second case means an implicit auction via a coupling of the CWE area and, if applicable, GB area.

The Algorithm

The Project Partners of the MRC-Project have selected Euphemia as the algorithm to calculate daily market results. Euphemia is a branch-and-bound algorithm designed to solve the problem of coupling spot markets with block orders. It handles all technical requirements set by the MRC and CWE projects, including step and interpolated orders, flow based network under PTDF representation, ATC links and DC cables (possible with ramping, tariffs and losses). Euphemia outputs net export positions and prices on each market and each hour, the set of accepted orders, and the congestion prices on each tight network element. These outputs satisfy all requirements of a feasible solution, including congestion price properties.

Capacity Calculation

The CWE TSOs have designed a coordinated procedure for the determination of Flow Based capacity parameters. This procedure consists of the following main steps

- Merging
- Pre-qualification
- Centralized Initial-Flow Based parameter computation
- Flow Based parameter qualification
- Flow Based parameter verification
- LTA inclusion check
- LTN adjustment

This method had been tested in the external parallel run since January 2013. TSOs developed the methodology from prototype to industrialization.

Any changes to the methodology during the parallel run were subject to change control, documented and published.

Economic Assessment

Extensive validation studies have been performed by the Project Partners, showing positive results. Among others, the studies show an approximate increase in day-ahead market welfare for the region of 95M Euro on an annual basis (based on extrapolated results of the average daily welfare increase, during the external parallel run from January to December 2013). Full price convergence in the whole region improves significantly, although some partial convergence is lost because of the intrinsic Flow Based price properties. The net effect though is that the spread between average CWE prices is reduced.

Impacts on price formation and volatility have also been observed (c.f. Annex 15.10).

These calculations were performed, using results of ATC MC and comparing them with simulated FB(I) MC. In order to further validate the results, the Project Partners have performed additional analyses, e.g. the domain reduction study (Annex 15.11)
Flow Based simulations can be found in the daily parallel run publication on JAO’s website.
The technical and economic impact of the bidding zone border split of the German and Austrian Hub on the CWE Flow Based Market Coupling has been analysed via the standard process to communicate on and assess the impact of significant changes (SPAIC). The results of this study are attached in Annex 15.28.

Intuitiveness
Based on the dedicated studies, the feedback during the public consultation and the eventual guidance of the CWE NRAs, the Project has started with FBI.

Transparency
The Project Partners publish various operational data and documents related to Flow Based Market Coupling, in compliancy with European legislation and having considered demands of the Market Parties and the Regulators. These publications support Market Parties in their bidding behaviour and facilitate an efficient functioning of the CWE wholesale market, including long term price formations and estimations.

Monitoring
For monitoring purposes the National Regulatory Authorities get additional (confidential) data and information. Based on national and EU-legislation, on reasonable request from the NRAs, the Project provides all Project related data for monitoring purposes. Publica-

tions of monitored information can be commonly agreed from case to case.

2 Introduction

After having signed the Memorandum of Understanding of the Pentalateral Energy Forum on Market Coupling and security of supply in the Central West European (CWE) region in 2007, the TSOs and PXs of CWE have put in place a project that was tasked with the design and implementation of the Market Coupling solution in their region. As a first step, the project partners have decided to implement an ATC based Market Coupling which went live on November 9th 2010. Parallel to the daily operation of the ATC-Based Market Coupling, the Project Partners worked on the next step which is the implementation of a Flow Based Market Coupling in CWE.

Work has progressed and the Flow Based Market Coupling solution was improved. Results of more than 16 months of the external parallel run, covering all seasons and typical grid situations, have shown clear benefits of the FB methodology. After the go-live of the Flow Based Market Coupling, APG has been integrated in the CWE procedures, following a stepwise process agreed with all CWE partners.

The purpose of the report at hand with all Annexes is to provide the Regulators of the CWE region with a complete set of documentation describing the Flow Based Market Coupling solution.

The following articles have been updated and are submitted for approval according to the national approval procedures to the competent CWE NRAs and in line with Regulation 714/2009:

1. German External constraints ➔ *4.1.9. Specific limitations not associated with Critical Branches (external constraints) – German External Constraints, to be operated after formal approval from 1st October 2018.*

2. DE/AT split (main changes compared to version 2.1 as published on the JAO website), to be operated after formal approval from 1st October 2018.
   - *Throughout the document: Inclusion of the additional border DE-AT and the separate hubs / bidding zones DE/LU and AT.*
   - *Section* ***Fout! Verwijzingsbron niet gevonden.****: Separation of the German/Austrian GSK/GShK.*
3. Application of the MinRAM process[1], section 4.2.5.
4. Application of the external constraint on the global bidding zone net position, section 4.1.9.

For the other parts of the document, CWE TSOs consider that the initial approval of the CWE NRAs on the implementation of CWE FB MC methodology remains valid.

The CWE FB MC Approval document is structured in the following chapters:

- General principles of Market Coupling
- Coordinated Flow Based capacity calculation
- CWE Market Coupling solution
- Fallback solution
- Functioning of the algorithm
- Economic validation
- Transparency / publication of data

[1] The MinRAM process is already applied as of April 24th (delivery date 26 April) 2018, on request of CWE NRAs.

- Monitoring
- Calculation of bilateral exchanges
- Contractual scheme
- Change control

3 General principles of Market Coupling

1.1. General principle of Market Coupling

Market Coupling is both a mechanism for matching orders on power exchanges (PXs) and an implicit capacity allocation mechanism. Market Coupling optimizes the economic efficiency of the coupled markets: all profitable deals resulting from the matching of bids and offers in the coupled hubs of the PXs are executed subject to sufficient Cross-Zonal Capacity (CZC) being made available for day-ahead implicit allocation; matching results are subject indeed to capacity constraints calculated by Transmission System Operators (TSOs) which may limit the exchanges between the coupled markets.

Market prices and Net Positions of the connected markets are simultaneously determined with the use of the available capacity defined by the TSOs. The transmission capacity made available to the Market Coupling is thereby efficiently and implicitly allocated. If no transmission capacity constraint is active, then there is no price difference between the markets. If one or more transmission capacity constraints are active, a price difference between markets will occur.

1.2. Day-Ahead Flow Based Market Coupling

Market Coupling relies on the principle that when markets with the lowest prices export electricity to markets with the highest prices, there is day-ahead market welfare created by these exchanges. The Market Coupling algorithm (described later on in the document) will optimize the day-ahead market welfare for the whole region, based on the capacity constraints (Flow Based capacity parameters; including the Critical Branches and the PTDF-matrix) and the energy orders. A general example of Market Coupling for two markets illustrates how FB MC works. Two situations are possible: the margin on the Flow Based capacities is large enough and the prices of both markets are equalized (price convergence), or the margin of capacities is not sufficient (leading to one or more active constraint(s)) and the prices cannot equalize (no price convergence)[2]. These two cases are described in the following example.

Sufficient margin, price convergence

Suppose that, initially, the price of market A is lower than the price of market B. Market A will therefore export to market B. The price of market A will increase whereas the price of market B will decrease. If the margin of capacities from market A to market B is sufficiently large, a common price in the market may be reached (PA* = PB*). This case is illustrated in **Figure 3-1**.

[2] The term "convergence" is used in the context of Market Coupling to designate a situation where prices converge up to their equalization. Although prices may get closer to each other too, one says that there is "no price convergence" in all cases where the transmission capacity made available to the Market Coupling is not sufficient to lead to price equalization.

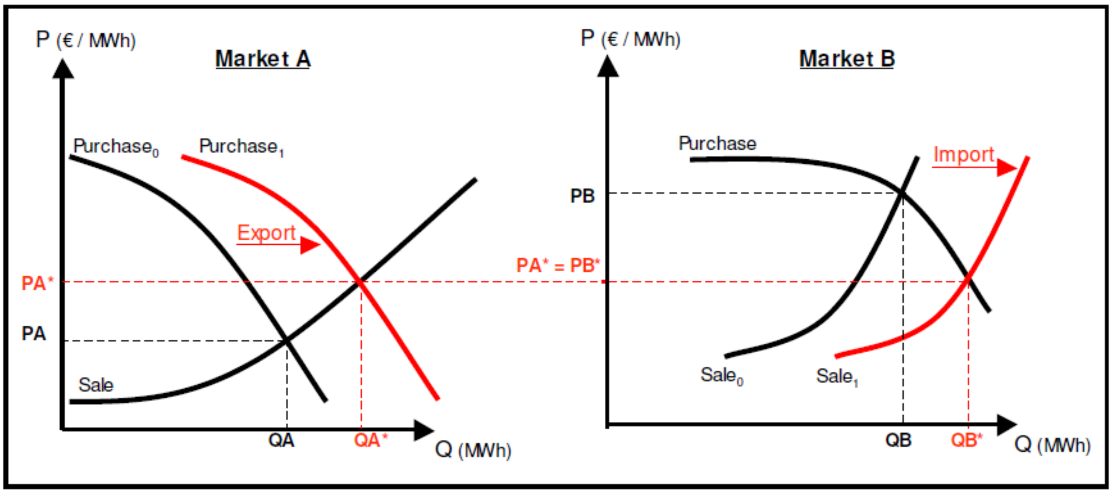

Figure 3-1: Representation of Market Coupling for two markets, no congestion.

Insufficient margin, no price convergence

Another situation illustrated in **Figure 3-2** happens when the capacity margin is not sufficient to ensure price convergence between the two markets. The amount of electricity exchanged between the two markets it then equal to the margin (or remaining capacity) on the active (or limiting) constraint, divided by the difference in flow factors (PTDFs) of the two markets.

The prices PA* and PB* are given by the intersection of the purchase and sale curves. Exported electricity is bought in the export area at a price of PA* and is sold in the import area at a price of PB*. The difference between the two prices multiplied by the exchanged volume between the two markets (bidding zones) is the congestion revenue.

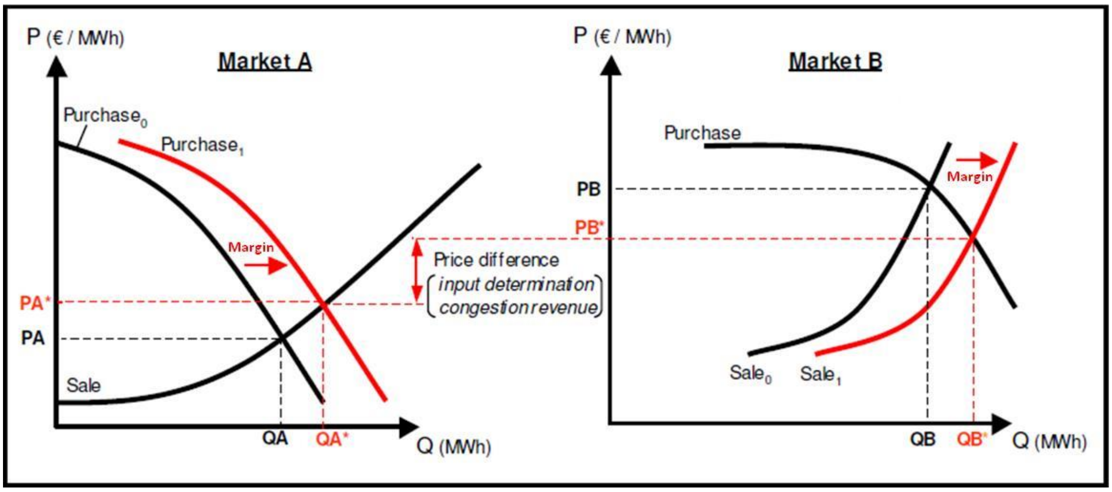

Figure 3-2: Representation of Market Coupling for two markets, congestion case

In “plain” Flow Based Market Coupling a non-intuitive exchange can occur (export from a high priced market to low priced markets), the welfare loss of this exchange is then to the benefit of a higher day-ahead market welfare gain for the whole region, which originates from other exchanges (c.f. chapter 8.3).

4 Coordinated Flow Based capacity domain calculation

The method for capacity calculation described below is fixed since the start of the external parallel run. Changes which were applied based on experience of the parallel run are documented in detail in Annex 0.
An educational, simplified and illustrative example, “How does Flow Based capacity calculation work?” can be found in Annex 15.2.
The high level business process for capacity calculation can be found in Annex 15.3.

4.1. Input data

To calculate the Flow Based capacity domain, TSOs have to assess different items which are used as inputs into the model. The following inputs need to be defined upfront and serve as input data to the model:

- Critical Branches / Critical Outages
- Maximum current on a Critical Branch (Imax)
- Maximum allowable power flow (Fmax)
- Final Adjustment Value (FAV)
- D2CF Files, Exchange Programs
- Remedial Actions (RAs)
- Generation Shift Key (GSK)
- Flow Reliability Margin (FRM)
- External constraints: specific limitations not associated with Critical Branches

4.1.1. CBCO-selection

A Critical Branch (CB) is a network element, significantly impacted by CWE cross-border trades, which is monitored under certain operational conditions, the so-called Critical Outages (CO). The CBCOs

(Critical Branches/Critical Outages) are determined by each CWE TSO for its own network according to agreed rules, described below. The CBs are defined by:

- A line (tie-line or internal line), or a transformer, that is significantly impacted by cross-border exchanges,
- An "operational situation": normal (N) or contingency cases (N-1, N-2, busbar faults; depending on the TSO risk policies).

Critical Outages (CO) can be defined for all CBs. A CO can be:

- Trip of a line, cable or transformer,
- Trip of a busbar,
- Trip of a generating unit,
- Trip of a (significant) load,
- Trip of several elements.

CB selection process

The assessment of Critical Branches is based on the impact of CWE cross-border trade on the network elements and based on operational experience that traced back to the development of coordinated capacity calculation under ATC:

Indeed, the TSOs developed the coordinated ATC methodology that was in daily operation from November 2010 until May 2015, based on FB ingredients. The so-called 16 corner check was based on a check on a limited number of grid elements: the Critical Branches. The advantage of this approach was that there is already significant operational experience with the application of Critical Branches as part of a grid security analysis, and that it facilitates a consistent transition from ATC to FB as well. Indeed, the Critical Branches that were applied within the 16 corner check, boiled down to relevant sets based on the operational ATC experience. The experienced gained in ATC operations therefore already provided a relevant set of initial Critical Branches for FB operations.

This set has then been updated according to the following process:

A set of PTDFs is associated to every CBCO after each Flow Based parameter calculation, and gives the influence of the net position of any bidding zone on the CBCO. If the PTDF = 0.1, this means the concerned hub has 10% influence on the CBCO, meaning that 1 MW in change of net position of the hub leads to 0.1 MW change in flow on the CBCO. A CB or CBCO is NOT a set of PTDF. A CBCO is a technical input that one TSO integrates at each step of the capacity calculation process in order to respect security of supply policies. CB selection process is therefore made on a daily basis by each TSO, who check the adequacy of their constraints with respect to operational conditions. The so-called flow based parameters are NOT the Critical Branches, they are an output of the capacity calculation associated to a CB or CBCO at the end of the TSO operational process. As a consequence, when a TSO first considers a CBCO as a necessary input for its daily operational capacity calculation process, it does not know, initially, what the associated PTDF are.
A CB is considered to be significantly impacted by CWE cross-border trade, if its maximum CWE zone-to-zone PTDF is larger than a threshold value that is currently set at 5%.
This current threshold has been set following security assessments performed by TSOs, by the iterative process described below:
TSOs have carried out some alternative computations of Flow Based parameters, using scenarios where only the threshold was set to different values. Depending on the threshold values, some Critical Branches were included or not in Flow Based parameters computa-

tion, resulting in a capacity domain more or less constraining for the market. Taking some extreme "vertices" of the resulting alternative Flow Based domains, TSOs assessed whether these domains would be safe, and more precisely to identify at which point the exclusion of CB not respecting the threshold would lead to unacceptable situations, with respect to CWE TSOs risk policies. If for one given threshold value, the analyses would conclude in unacceptable situations (because the removal of some constraints would allow an amount of exchanges that TSOs could not cope with as they would not respect standard SOS principles, like the standard N-1 rule), then this simply meant that the threshold was too high. Following this approach and assessing different values, CWE TSOs came to the conclusion that 5% was an optimal compromise, in terms of size of the domain versus risk policies.
TSOs want to insist on the fact that the identification of this threshold is driven by two objectives:

- Bringing objectivity and measurability to the notion of "significant impact". This quantitative approach should avoid any discussion on internal versus external branches, which is an artificial notion in terms of system operation with a cross-border perspective.

- Above all, guaranteeing security of supply by allowing as many exchanges as possible, in compliancy with TSOs risks policies, which are binding and have to be respected whatever the capacity calculation concept (ATC or Flow Based). In other words, this value is a direct consequence of CWE TSOs risk policies standards (which do not change with Flow Based), adapted to Flow Based principles.

It is important to keep in mind that these CB selection principles cannot be seen as a single standalone study performed by CWE TSOs. Rather, CWE TSOs have applied over time a continuous (re-assessment process that has started with the computations of bilateral capacities and been developed with FB, in order to elaborate a relevant CB set and determine afterwards an adequate threshold. The 5% value is therefore an ex-post, global indicator that cannot be opposed automatically, which means without human control, to an individual CB in a given timestamp.

CWE TSOs constantly monitor the Critical Branches which are fed into the allocation system in order to assess the relevance of the threshold over time. During the external parallel run, active Critical Branches, i.e. the CBs having actually congested the market, respected – with the exception of some rare cases – the threshold value of 5%, This would tend to confirm the adequacy of the current value.

Practically, this 5% value means that there is at least one set of two bidding zones in CWE for which a 1000 MW exchange creates an induced flow bigger than 50 MW (absolute value) on the branch. This is equivalent to say that the maximum CWE "zone to zone" PTDF of a given grid element should be at least equal to 5% for it to be considered objectively "critical" in the sense of Flow Based capacity calculation.
For each CBCO the following sensitivity value is calculated:
Sensitivity = max(PTDF (BE), PTDF (DE), PTDF (AT), PTDF (FR), PTDF (NL)) - min(PTDF (BE), PTDF (DE), PTDF (AT), PTDF (FR), PTDF (NL))
If the sensitivity is above the threshold value of 5%, then the CBCO is said to be significant for CWE trade.

A pre-processing is performed during the Flow Based parameter calculation which results in a warning for any CBCO which does not meet pre-defined conditions (that is, the threshold). The concerned TSO then has to decide whether to keep the CBCO or to exclude it from the CBCO file.

Although the general rule is to exclude any CBCO which does not meet the threshold on sensitivity, exceptions on the rule are allowed: if a TSO decides to keep the CBCO in the CB file, he has to justify it to the other TSOs, furthermore it will be systematically monitored by the NRAs.

Should the case arise, TSOs may initiate discussions on the provided justifications in order to reach a common understanding and a possible agreement on the constraints put into the capacity calculation process. TSOs know only at the end of the capacity calculation process the detailed and final PTDFs, while the Critical Branch is required in the beginning as an input of the capacity calculation process[3].

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[3] A frequent explanation for having eventually a CBCO associated to PTDFs not respecting the threshold is the usage of a Remedial Action. Indeed, if it happens that a CBCO is too limiting, the TSO owner will try to release some margin on this CB by implementing a Remedial Action (see dedicated section later in this document). The Remedial Action will have as an effect to decrease the sensitivity of the CB towards the cross-border exchanges: by decreasing the influence of the exchanges on the load of the line, more trades will become possible. In this situation, it is legitimate to "keep" the CBCO.

CWE TSOs therefore commit to critically assess their set of Critical Branches in two respects:

1. On the one hand with a "close-to-operations" perspective, considering the threshold as a fixed reference. In this framework, CWE TSOs operators and FB experts assess ex-post the relevance of the CBs against this threshold. Eventually, this assessment may result in discarding the CB from the FB computation, but in any case this will not happen on a daily basis, after just one occurrence, but rather after an observation and security analysis phase potentially lasting several months. On the contrary, upholding a CB that chronically violates the present agreed threshold shall be objectively justified and reported to NRAs in dedicated reports.
2. On the second hand, the threshold itself needs to be regularly, if not changed, at least challenged. This is more a long-term analysis which needs several months of practical experience with FB operations. Once this experience is gained, CWE TSOs will re-consider the relevance of the thresholds by looking at the following criteria with a focus on active CBs :
    - Frequency and gravity of the threshold violations
    - Nature of the justifications given to keep some CBs
    - Or, on the contrary, absence of threshold violation.

The main idea is therefore to assess the "distance" between the threshold and the set of active CBs. This distance can be inappropriate in two aspects:

- Either the threshold is too high, which will be the case if too many CB violate it while valid justifications are given
- Either it will be too low, which will be the case if all active CB systematically respect it over a representative period of time.

In both cases, the shadow price (> 0 when the CB becomes active), that is information provided to NRAs within the monitoring framework, can also be a useful indicator to assess market impact of the active CBs, especially when they are far from the agreed threshold.

4.1.2. Maximum current on a Critical Branch (Imax)

The maximum allowable current (Imax) is the physical limit of a Critical Branch (CB) determined by each TSO in line with its operational criteria. Imax is the physical (thermal) limit of the CB in Ampere, except when a relay setting imposes to be more specific for the temporary overload allowed for a particular Critical Branch-Critical Outage (CBCO).

As the thermal limit and relay setting can vary in function of weather conditions, Imax is usually fixed at least per season.

When the Imax value depends on the outside temperature, its value can be reviewed by the concerned TSO if outside temperature is announced to be much higher or lower than foreseen by the seasonal values.

Imax is not reduced by any security margin, as all margins have been covered by the calculation of the Critical Outage by the Flow Reliability Margin (FRM, c.f. chapter 4.1.8 and Final Adjustment Value (FAV, c.f. chapter 4.1.4).

4.1.3. Maximum allowable power flow (Fmax)

The value Fmax describes the maximum allowable power flow on a CBCO in MW. It is given by the formula:

Fmax = $Sqrt(3)$ *** Imax * U * cos(φ) / 1000 [MW],**

where Imax is the maximum permanent allowable current (in A [Ampere]) for a CB. The value for cos(φ) is set to 1, and U is a fixed value for each CB and is set to the reference voltage (e.g. 225kV or 400kV) for this CB.

4.1.4. Final Adjustment Value (FAV)

With the Final Adjustment Value (FAV), operational skills and experience that cannot be introduced into the Flow Based-system can find a way into the Flow Based-approach by increasing or decreasing the remaining available margin (RAM) on a CB for very specific reasons which are described below. Positive values of FAV in MW reduce the available margin on a CB while negative values increase it. The FAV can be set by the responsible TSO during the qualification phase and during the verification phases. The following principles for the FAV usage have been identified:

- A negative value for FAV simulates the effect of an additional margin due to complex Remedial Actions (RA) which cannot be modelled and so calculated in the Flow Based parameter calculation. An offline calculation will determine how many MW can additionally be released as margin; this value will be put in FAV.

- A positive value for FAV as a consequence of the verification phase of the Flow Based domain, leading to the need to reduce the margin on one or more CBs for system security reasons. The overload detected on a CB during the verification phase is the value which will be put in FAV for this CB in order to eliminate the risk of overload on the particular CB.

Any usage of FAV will be duly elaborated and reported to the NRAs for the purpose of monitoring[4] the capacity calculation.

4.1.5. D2CF Files, Exchange Programs

The 2-Days Ahead Congestion Forecast files (D2CF files), provided by the participating TSOs for their grid two-days ahead, are a best estimate of the state of the CWE electric system for day D.
Each CWE TSO produces for its zone a D2CF file which contains:

- Best estimation of the Net exchange program
- Best estimation of the exchange program on DC cables
- best estimation for the planned grid outages, including tie-lines and the topology of the grid as foreseen until D-2
- best estimation for the forecasted load and its pattern
- if applicable best estimation for the forecasted renewable energy generation, e.g. wind and solar generation
- best estimation for the outages of generating units, based on the latest info of availability of generators
- best estimation of the production of generating units, in line with outage planning, forecasted load and best estimated Net exchange program.

The PST tap position is usually neutral in the D2CF but well justified exceptions should be allowed.

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[4] Details on monitoring are given in the dedicated chapter 10. Besides, a template of the monitoring reports is available in Annex 15.17).

For each timestamp, the local D2CF file has to be balanced in terms of production and consumption, in coherence with the best estimated Net exchange program. The D2CF files will be merged together with DACF (Day-Ahead Congestion Forecast) files of non CWE-TSOs to obtain the base case according to the merging rules described in this document (c.f. chapter 4.2.1).

Individual procedures

Amprion:

For every day D there are 24 D2CF files generated by Amprion. These D2CF files describe the load flow situation for the forecasted business day as exactly as possible. In order to provide an adequate forecast Amprion generates the D2CF files in the following way:
The basis of a D2CF file is a "snapshot", (i.e. a "photo") of the grid from a reference day.
In a first step the topology is adjusted according to the business day. Here are all components put into operation (which were switched off in the snapshot) and all forecasted outages (for the business day) are included in the D2CF file. After that the generation pattern is adapted to the schedule of the exchange reference day.
In the next step the wind and solar forecasts are included in the D2CF file by using dedicated wind and solar GSKs. This process is based on local tools and uses external weather forecasts made available to Amprion.
As a next step the resulting net position is adapted to the one of the reference day. After this, the resulting so-called "slack deviation" (unbalance between generation and load) is determined and this deviation is spread over all marketbased generation units of Amprion by using GSKs.

To summarize, the provision of the Amprion D2CF data set is based on 5 main steps.

1. Take snapshot from the reference day as basis
2. Include topology for business day and adjust generation pattern
3. Include wind and solar forecast
4. Adapt net position of Amprion
5. Deviations (slack) are spread over all market based generation units

APG:

Using renewable generation-schedules, estimated total load and planned outages for the business day, and market driven generation-schedules and the load distribution from the reference day, 24 D2CF Files are being created as follows:

- Topology is adjusted according to the outage planning system
- Generation is adjusted according to the renewable schedules for the business day and the market driven schedules from the reference day
- Total load is adjusted to the forecast of the business day, and distributed according to the reference day
- Thermal rating limits are applied
- Exchange is distributed over tie-lines according to merged D2CF of the reference day

After these steps a load flow is being calculated to check for convergence, voltage- and reactive power limits.

Elia:

Load profile and cross-border nominations of the reference day are used. The topology of the grid is adjusted by use of the information of a local outage-planning-system (including generator maintenance) as known at time of preparation of D2CF, which is between 17:00 18:00. This includes possible preventive topology Remedial Actions needed for specific grid maintenance.

The load is automatically adjusted to account for the difference in the load of the reference day and the predicted load of the day D.

The best estimate is used to determine all production units which are available to run, with a determination of the Pmin and Pmax to be expected on the business day (depending on whether units are foreseen for delivery of ancillary services or not).

The production program of the flexible and controllable units is adjusted based on the calculated GSK, and on the Pmin and Pmax prepared in order to fit with the cross-border nominations of the reference day.

PST tap positions are put at 0 in order to make a range of tap positions available as Remedial Action, except if overloads can be expected in the base case in a likely market direction, in which case 2 to 4 steps could be made on some PST at Elia borders.

TransnetBW:

D2CF files are elaborated according to the following steps:

- Choose a proper snapshot (last available working-day for working-days; last weekend for the weekend) as a basis
- Adjust the topology by use of the information of a local outage-planning-system (including generator maintenances)
- Adjust generation in feed to the available generator-schedules. For generators with no schedules available adjust to the schedules of the reference day.
- Adjust the flow to the distribution grid by adapting the load and renewable generation with forecasts.

- Adjust the Net Exchange program to the forecasted of the Net Exchange program.
- After all changes are made the created files will be checked for convergence.

RTE:

French D2CFs are based on an automatic generation of 24 files, created with several inputs:

- Up to 24 snapshots if available for the 24 hours, less in other cases
    - These snapshots are selected in the recent past to be the best compromise possible between the availability of snapshots, generation pattern, load pattern and exchanges.
    - Topology is adapted to the situation of the target day (planned outages and forecast of substation topology)
- Depending on the reference exchange programs, topology can also be adapted to avoid constraints in N and N-1 situations.
- Estimation of net exchange program is based on reference days
- Load is adjusted based on load forecasts for the concerned time horizon.
- Generation is adjusted based on planned “D-1” patterns or realized “D-X” patterns (meaning: historical situations anterior to the day when the D2CF process is happening), with some improvements:
    - renewable generation (PV and wind generation) is updated based on forecasts available for the concerned time horizon,

  - for large units, generation is adjusted, based on maintenance forecast (provided on a weekly basis by producers, and adapted during the week).

➔ 24 hourly files are produced in this way.
For each file, an adjustment is performed on generation, to reach the estimation of net exchange program and produce the final 24 French D-2 grid models.
A loadflow is launched to check the convergence.

TenneT DE:

The D2CF data generation at TenneT DE starts after the day-ahead nominations are known.
As a first step TTG creates a grid model respecting the expected switching state in order to match the outage planning. The PST taps are always set to neutral position.
The second step involves the adjustment of the active power feed-in of each node to its expected value:

- Connections to the distribution grid are described by using D-2 forecasts of renewable feed-in, e.g. wind and solar generation, as well as load.
- Directly connected generation units are described by using D-2 production planning forecasts of single units in the first step. If necessary, the Net exchange program is adjusted to meet the D-2 forecast of the Net exchange program by using a merit-order list.

Finally, additional quality checks are made (e.g. convergence, voltages, active and reactive power).

TenneT NL:

TenneT starts the D2CF creation process with a grid study model. This model which represents the topology of the business day by making use of the information of the local outage-planning (including generator maintenances) as known at time of preparation of D2CF, which is between 17:00-18:00 at D-2.
The model is then adapted for the Load & Production forecasts (directly derived from the forecasts received from the market) and cross-border nominations of the reference day, which become available at 17:00.
After the forecasts have been imported TenneT starts to redistribute the production of all dispatchable units (which are not in maintenance) above 60MW (further called: GSK Units). This redispatch of production is done in order to match the GSK methodology as described in the GSK chapter of this document. All GSK units are redispatched pro rata on the basis of predefined maximum and minimum production levels for each active unit. The total production level remains the same.
The maximum production level is the contribution of the unit in a predefined extreme maximum production scenario. The minimum production level is the contribution of the unit in a predefined extreme minimum production scenario. Base-load units will have a smaller difference between their maximum and minimum production levels than start-stop units.

With Pi0 being the initial MW dispatch of unit i, and Pi1 being the new dispatch of unit i after the redispatch, then

$$P_{i1} = Pmin_i + (Pmax_i - Pmin_i)\frac{(\sum_k P_{k0} - \sum_k Pmin_k)}{(\sum_k Pmax_k - \sum_k Pmin_k)} \text{ (eq. 1)}$$

$$P_{i1} = Pmin_i + (Pmax_i - Pmin_i)\frac{(\sum_k P_{k0} - \sum_k Pmin_k)}{(\sum_k Pmax_k - \sum_k Pmin_k)} \text{ (eq. 1)}$$

PST tap position is put at 0 in order to make a range of tap positions available as Remedial Action, except if overloads can be expected in the base case in a likely corner, in which case 2 to 4 steps could be made on some PST
For the DC cables the Exchange programs of reference days are used. In case the cable is out of service on the target day, the program of the cable will be distributed over the loads.
Afterwards, production and load are redistributed and an AC load-flow is performed in which the grid is checked for congestions and voltage problems. During this process there is an automatic adjustment of loads to correct the difference in the balance between the reference program of the execution day and the data received in the prognosis of Market Parties for this day.

Remark on the individual procedures:
If one can observe methodological variants in the local parts of the base case process, it is to be reminded that the latter remains within the continuity of the currently applied process, and that reconsidering the Grid Model methodology (either in its local or common aspects) is not part of the CWE FB implementation project.

Currently, there exists an ENTSO-E initiative in order to align European TSOs practices towards the ACER capacity calculation cross-regional roadmap, but in any case the following sequence will have to be respected:

- Design of a CGM methodology by ENTSO-E according to CACM requirements
- Validation of the methodology by NRAs
- Design of an implementation plan.

4.1.6. Remedial Actions [5]

During Flow Based parameter calculation CWE TSOs will take into account Remedial Actions (RA) that are allowed in D-2 while ensuring a secure power system operation i.e. N-1/N-k criterion fulfilment.

In practice, RAs are implemented via entries in the CB file. Each measure is connected to one CBCO combination and the Flow Based parameter calculation software treats this information.

The calculation can take explicit and implicit RAs into account. An explicit Remedial Action (RA) can be

- changing the tap position of a phase shifter transformer (PST)
- topology measure: opening or closing of a line, cable, transformer, bus bar coupler, or switching of a network element from one bus bar to another
- curative (post-fault) redispatching: changing the output of some generators or a load.

Implicit RA can be used when it is not possible to explicitly express a set of conditional Remedial Actions into a concrete change in the load flow. In this case a FAV (c.f. chapter 4.1.4) will be used as RA.

These explicit measures are applied during the Flow Based parameter calculation and the effect on the CBs is determined directly.

[5] Didactic examples of different types of Remedial Actions (including explicit and implicit variants) can be found in Annex 15.4).

The influence of implicit RA on CBs is assessed by the TSOs upfront and taken into account via the FAV factor, which changes the available margins of the CBs to a certain amount.

Each CWE TSO defines the available RAs in its control area. As cross-border Remedial Actions will be considered only those which have been agreed upon by common procedures (for example limited number of tap position on CWE PST) or explicit agreement (as in ATC process). The agreed actions are assumed binding and available.

The general purpose of the application of RAs is to modify (increase) the Flow Based domain in order to support the market, while respecting security of supply. This implies the coverage of the LTA (allocated capacity from long term auctions) domain as a minimum target.

Some RAs, with a significant influence on elements of neighbouring grids – especially cross-border RAs – have to be coordinated before being implemented in the CB file. The coordination of cross-border Remedial Actions maintains the security of supply when increasing the capacity that can be offered to the market. Common procedures, indicating amongst others which Remedial Actions can be applied for the capacity calculation stage, have been implemented to facilitate this.

The guidelines[6] for the application of RAs imply that the RAs described in the CB files can change during the daily Flow Based process in the qualification and verification phase (e.g. as a result of a PST coordination process).

If needed, and in an effort to include the LTA domain, all possible coordinated Remedial Actions will be considered in line with the agreed list of Remedial Actions. Each TSO could, if this does not jeopardise the system security, perform additional RA in order to cover the LTA domain.

During the D-2 / D-1 capacity calculation process, TSOs have the opportunity to coordinate on PST settings. This coordination aims to find an agreement on PST settings which covers all the TSOs needs. The focus is to cover the LTA and if possible the NTCs[7]. This means that the LTAs/NTCs will not cause overloads on CBs within the Flow Based method. TSOs try to reach this by using only internal RAs as a first step. If this would not be enough the CWE wide PSTs are taken into account in order to mitigate the overloads.

The basic principle of the PST coordination is the following:

[6] These "guidelines" encompass the operators' expertise and experience gained over the years, combined with the application of operational procedures, and is neither translated nor formalized in documentation designed to external parties.

[7] NTCs were only available during the external parallel run period. After go-live, TSOs will use another reference Flow Based domain – based on the experience built during the external parallel run which will be communicated to Regulators and Market Parties.

- local calculation: TSOs try to cover the NTC/LTA domain using their own PSTs. If this is not sufficient, the TSO incorporate the PSTs of other TSOs in their local load flow calculations. In the end, every TSO comes up with a proposal for the PST tap positions in the CWE region, and the corresponding corners/situations in which the PST should be used.
- exchange of proposals: the proposal(s) is(are) shared between TSOs for review.
- review, coordination, confirmation: TSOs review the proposals and coordinate/agree on the final setting. This is to avoid that contradictory Remedial Actions are used in the same situation. The result is considered to be firm before the verification phase. The information (if necessary an updated CB file) must be transferred to the D-1 and D processes.

PSTs available for coordination are located in Zandvliet/Vaneyck, Gronau, Diele and Meeden. PST coordination is performed between Amprion, Elia, and TenneT (DE and NL). The PSTs in Austria (Tauern, Ternitz, Ernsthofen) are coordinated in a local process between German and Austrian TSOs and are further taken into account in the coordination as described above.

The coordination process is not necessarily limited to PST adjustment, but usual topology actions can also be considered at the same time and in the same way as the PST setting adjustment.

A prerequisite of a well-functioning coordination is that all involved parties have a dedicated timeframe to perform this coordination. This timeframe should be at best in the night between the initial Flow Based computation and the final Flow Based computation. The PST coordination should start before midnight.

4.1.7. Generation Shift Key (GSK)

The Generation Shift Key (GSK) defines how a change in net position is mapped to the generating units in a bidding area. Therefore, it contains the relation between the change in net position of the market area and the change in output of every generating unit inside the same market area.

Due to convexity pre-requisite of the Flow Based domain, the GSK must be linear.

Every TSO assesses a GSK for its control area taking into account the characteristics of its network. Individual GSKs can be merged if a hub contains several control areas.

A GSK aims to deliver the best forecast of the impact on Critical Branches of a net position change, taking into account the operational feasibility of the reference production program, projected market impact on units and market/system risk assessment.

In general, the GSK includes power plants that are market driven and that are flexible in changing the electrical power output. This includes the following types of power plants: gas/oil, hydro, pumped-storage and hard-coal. TSOs will additionally use less flexible units, e.g. nuclear units, if they don't have sufficient flexible generation for matching maximum import or export program or if they want to moderate impact of flexible units.

The GSK values can vary for every hour and are given in dimensionless units. (A value of 0.05 for one unit means that 5% of the change of the net position of the hub will be realized by this unit).

Individual procedures

GSK for the German bidding zone:

The German TSOs have to provide one single GSK-file for the whole German Hub. Since the structure of the generation differs for each

involved TSO, an approach has been developed, that allows the single TSO to provide GSK's that respect the specific character of the generation in their own control area and to create out of them a concatenated German GSK in the needed degree of full automation.
Every German TSO provides a reference file for working days, bank holidays and weekends. Within this reference file, the generators are named (with their node-name in the UCTE-Code) together with their estimated share within the specific grid for the different time-periods. It is also possible to update the individual GSK file each day according to the expectations for the target day. So every German TSO provides within this reference-file the estimated generation-distribution inside his grid that adds up to 1.
An example: Reference-file of TSO A for a working day

00:00 – 07:00:

GenA (Hard-Coal)	0,3
GenB (Hard-Coal)	0,3
GenC (Gas)	0,1
GenD (Hydro)	0,2
GenE (Hydro)	0,1

07:00 – 23:00

GenC (Gas)	0,3
GenD (Hydro)	0,5
GenE (Hydro)	0,2

23:00 – 24:00:

GenB (Hard-Coal)	0,2
GenC (Gas)	0,3
GenD (Hydro)	0,4

GenE (Hydro) 0,1

In the process of the German merging, the common system creates out of these four individual reference-files, depending on the day (working day / week-end / bank holiday), a specific GSK-file for every day. Therefore, every German TSO gets it individual share (e.g. TransnetBW: 15%, TTG: 18%, Amprion: 53%, 50HzT: 14 %). The content of the individual reference-files will be multiplied with the individual share of each TSO. This is done for all TSOs with the usage of the different sharing keys for the different target times and a Common GSK file for the German bidding zone is created on daily basis.

Example: Taking the reference-file above, assuming TSO A is TransnetBW, it leads to the following shares in the concatenated German GSK-file:

00:00 – 07:00:

GenA (Hard-Coal)	0,3*0,5 = 0,045
GenB (Hard-Coal)	0,3*0,15 = 0,045
GenC (Gas)	0,1*0,15 = 0,015
GenD (Hydro)	0,2*0,15 = 0,030
GenE (Hydro)	0,1*0,15 = 0,015

07:00 – 23:00:

GenC (Gas)	0,3*0,15 = 0,045
GenD (Hydro)	0,5*0,15 = 0,075
GenE (Hydro)	0,2*0,15 = 0,030

23:00 – 24:00:

GenB (Hard-Coal)	0,2*0,15 = 0,030
GenC (Gas)	0,3*0,15 = 0,045

GenD (Hydro) 0,4*0,15 = 0,060

GenE (Hydro) 0,1*0,54 = 0,015

With this method, the knowledge and experience of each German TSO can be brought into the process to obtain a representative GSK. With this structure, the nodes named in the GSK are distributed over the whole German bidding zone in a realistic way, and the individual factor is relatively small.

The Generation share key (GShK) for the individual control areas (i) is calculated according to the reported available market driven power plant potential of each TSO divided by the sum of market driven power plant potential in the bidding zone.

$$GShK\ TSO_i = \frac{Available\ power\ in\ control\ area\ of\ TSO\ _i}{\sum_{k=1}^{4} Available\ power\ in\ control\ area\ of\ TSO_k}$$

Where k is the index for the 4 individual German TSOs

With this approach the share factors will sum up to 1 which is the input for the central merging of individual GSKs.

Individual distribution per German TSO

TransnetBW:

To determine relevant generation units TransnetBW takes into account the power plant availability and the most recent available information at the time when the individual GSK-file is generated for the MTU:

The GSK factor for every power plant i is determined as:

$$GSK_i = \frac{P_{max,i} - P_{min,i}}{\sum_i^n \left(P_{max,i} - P_{min,i}\right)}$$

Where n is the number of power plants, which are considered for the generation shift within TransnetBW's control area.

Only those power plants which are characterized as market-driven, are put in the GSK if their availability for the target hour is known.

The following types of generation units for middle and peak load connected to the transmission grid can be considered in the GSK:

- hard coal power plants
- hydro power plants
- gas power plants

Nuclear power plants are excluded

Amprion:

Amprion established a regularly process in order to keep the GSK as close as possible to the reality. In this process Amprion checks for example whether there are new power plants in the grid or whether there is a block out of service. According to these changes in the grid Amprion updates its GSK.

In general Amprion only considers middle and peak load power plants as GSK relevant. With other words basic load power plants like nuclear and lignite power plants are excluded to be a GSK relevant node. From this it follows that Amprion only takes the following types of power plants: hard coal, gas and hydro power plants. In the view of Amprion only these types of power plants are taking part of changes in the production.

TenneT Germany:

Similar to Amprion, TTG considers middle and peak load power plants as potential candidates for GSK. This includes the following type of production units: coal, gas, oil and hydro. Nuclear power plants are excluded upfront.

In order to determine the TTG GSK, a statistical analysis on the behavior of the non-nuclear power plants in the TTG control area has been made with the target to characterize the units. Only those power plants, which are characterized as market-driven, are put in the GSK. This list is updated regularly. The individual GSK factors are calculated by the available potential of power plant i (Pmax-Pmin) divided by the total potential of all power plants in the GSK list of TTG.

Austrian GSK:

APG's method to select GSK nodes is analogue to the German TSOs. So only market driven power plants are considered in the GSK file which was done with statistical analysis of the market behaviour of the power plants. In that case APG pump storages and thermal units are considered. Power plants which generate base load (river power plants) are not considered. Only river plants with daily water storage are considered in the GSK file. The list of relevant power plants is updated regularly in order to consider maintenance or outages. In future APG will analyse the usage of dynamic GSK.

Dutch GSK:

TenneT B.V. will dispatch the main generators in such a way as to avoid extensive and not realistic under- and overloading of the units for extreme import or export scenarios. Unavailability due to outages are considered in the GSK.

All GSK units (including available GSK units with no production in de D2CF file) are redispatched pro rata on the basis of predefined maximum and minimum production levels for each active unit. The total production level remains the same.

The maximum production level is the contribution of the unit in a predefined extreme maximum production scenario. The minimum production level is the contribution of the unit in a predefined extreme minimum production scenario. Base-load units will have a smaller difference between their maximum and minimum production levels than start-stop units.

With Pi0 being the initial MW dispatch of unit i, and Pi1 being the new dispatch of unit i after the redispatch, then

$$P_{i1} = Pmin_i + (Pmax_i - Pmin_i)\frac{(\sum_k P_{k0} - \sum_k Pmin_k)}{(\sum_k Pmax_k - \sum_k Pmin_k)} \text{ (eq. 1)}$$

where "k" is the index over all active GSK units.

The linear GSK method also provides new GSK values for all active GSK units. This is also calculated on the basis of the predefined maximum and minimum production levels:

$$GSK_i = \frac{Pmax_i - Pmin_i}{\sum_k Pmax_k - \sum_k Pmin_k} \text{ (eq. 2)}$$

where "k" is the index over all active GSK units.

The 24-hour D2CF is adjusted, as such that the net position of the Netherlands is mapped to the generators in accordance to eq.1.

The GSK is directly adjusted in case of new power plants. TTB includes the outage information of generators daily in the GSK, which is based on the information sent by Market Parties.

Belgian GSK:

Elia will use in its GSK all flexible and controllable production units which are available inside the Elia grid (whether they are running or not). Units unavailable due to outage or maintenance are not included.
The GSK is tuned in such a way that for high levels of import into the Belgian hub all units are, at the same time, either at 0 MW or at Pmin (including a margin for reserves) depending on whether the units have to run or not (specifically for instance for delivery of primary or secondary reserves). For high levels of export from the Belgian hub all units are at Pmax (including a margin for reserves) at the same time.

After producing the GSK, Elia will adjust production levels in all 24 hour D2CF to match the linearised level of production to the exchange programs of the reference day as illustrated in the figure 4-1.

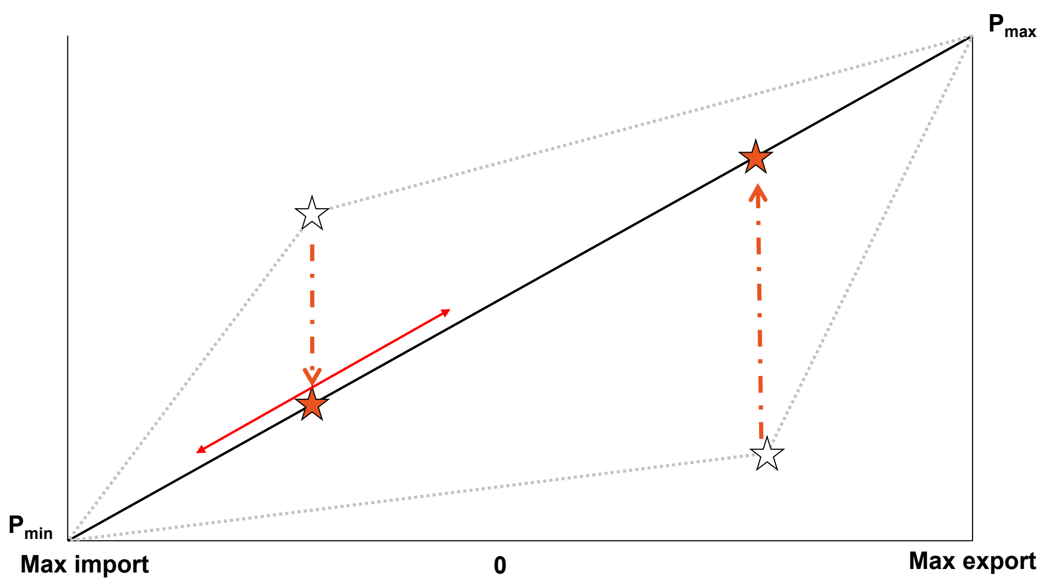


Figure 4-1: Belgian GSK.

French GSK:

The French GSK is composed of all the units connected to RTE's network.
The variation of the generation pattern inside the GSK is the following: all the units which are in operations in the base case will follow the change of the French net position on a pro-rata basis. That means, if for instance one unit is representing n% of the total generation on the French grid, n% of the shift of the French net position will be attributed to this unit.

About 50Hertz:
50Hertz sends its D2CF and GSK files which improves the quality of the German data set.

Due to the large distance of 50HZ to the CWE borders, not considering 50HZ Critical Branches within the CWE FB calculation is not considered a problem.

Summary and overview concerning the variability of the GSKs during the day:

- APG, Elia and TTB use GSKs according to their GSK concept, which means constant values over the day.
- The German TSOs have two GSKs for two different periods of a day as described above (peak, off-peak).
- Since RTE is using pro-rata GSK, the values in the French GSK file change every hour.

4.1.8. Flow Reliability Margin (FRM)

The origin of the uncertainty involved in the capacity calculation process for the day-ahead market comes from phenomena like external exchanges, approximations within the Flow Based methodology (e.g. GSK) and differences between forecasts and realized programs. This uncertainty must be quantified and discounted in the allocation process, in order to prevent that on day D TSOs will be confronted with flows that exceed the maximum allowed flows of their grid elements. This has direct link with the firmness of Market Coupling results. Therefore, for each Critical Branch, a Flow Reliability Margin (FRM) has to be defined, that quantifies at least how the before-mentioned uncertainty impacts the flow on the Critical Branch. Inevitably, the FRM reduces the remaining available margin (RAM) on the Critical Branches because a part of this free space that is provided to the market to facilitate cross-border trading must be reserved to cope with these uncertainties.

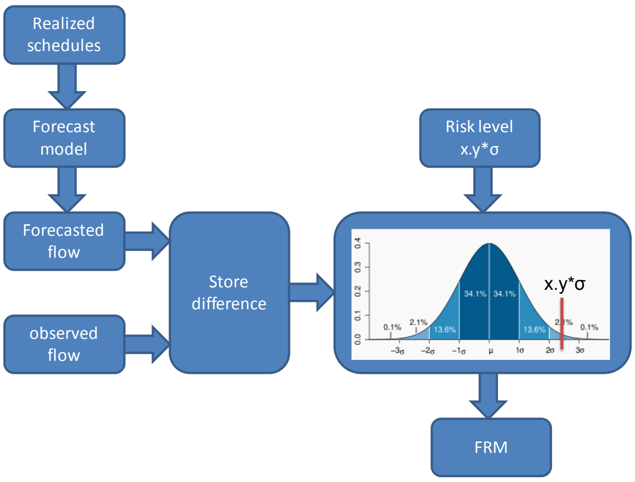


Figure 4-2: FRM Assessment Principle

The basic idea behind the FRM determination is to quantify the uncertainty by comparing the Flow Based model to the observation of the corresponding timestamp in real time. More precisely, the base case, which is the basis of the Flow Based parameters computation at D-2, is compared with a snapshot of the transmission system on day D. A snapshot is like a photo of a TSO's transmission system, showing the voltages, currents, and power flows in the grid at the time of taking the photo. This basic idea is illustrated in the figure 4.2.

In order to be able to compare the observed flows from the snapshot with the predicted flows in a coherent way, the Flow Based model is adjusted with the realized schedules corresponding to the instant of time that the snapshot was created. In this way, the same commercial exchanges are taken into account when comparing the forecast flows with the observed ones (e.g. Intraday trade is reflected in the observed flows and need to be reflected in the predicted flows as well for fair comparison).

The differences between the observations and predictions are stored in order to build up a database that allows the TSOs to make a statistical analysis on a significant amount of data. Based on a predefined risk level[8], the FRM values can be computed from the distribution of flow differences between forecast and observation.

By following the approach, the subsequent effects are covered by the FRM analysis:

- Unintentional flow deviations due to operation of load-frequency controls

[8] The risk level is a local prerogative which is closely linked to the risk policy applied by the concerned TSO. Consequently, the risk level considered by individual TSOs to assess FRM from the statistical data may vary. This risk level is a fixed, reference that each TSO has to respect globally in all questions related to congestion management and security of supply. This risk level is a pillar of each TSO's risk policies.

- External trade (both trades between CWE and other regions, as well as trades in other regions without CWE being involved)
- Internal trade in each bidding area (i.e. working point of the linear model)
- Uncertainty in wind generation forecast
- Uncertainty in Load forecast
- Uncertainty in Generation pattern
- Assumptions inherent in the Generation Shift Key (GSK)
- Topology
- Application of a linear grid model

When the FRM has been computed following the above-mentioned approach, TSOs may potentially apply a so-called "operational adjustment" before practical implementation into their CB definition. The rationale behind this is that TSOs remain critical towards the outcome of the pure theoretical approach in order to ensure the implementation of parameters which make sense operationally. For any reason (e.g.: data quality issue), it can occur that the "theoretical FRM" is not consistent with the TSO's experience on a specific CB. Should this case arise, the TSO will proceed to an adjustment.

It is important to note here that:
This adjustment is supposed to be relatively "small". It is not an arbitrary re-setting of the FRM but an adaptation of the initial theoretical value. It happens only once per CB during the FRM analysis (in other words, the TSO will not adjust its FRM at any Flow Based computation). Eventually, the operational FRM value is computed once and then becomes a fixed parameter in the CB definition.

This adjustment process is not expected to be systematic, but rather rare on the contrary, as much effort is put on the representativeness of the theoretical values.

The differences between operationally adjusted and theoretical values shall be systematically monitored and justified, which will be formalized in a dedicated report towards CWE NRAs (cf. Annex 15.5).[9]

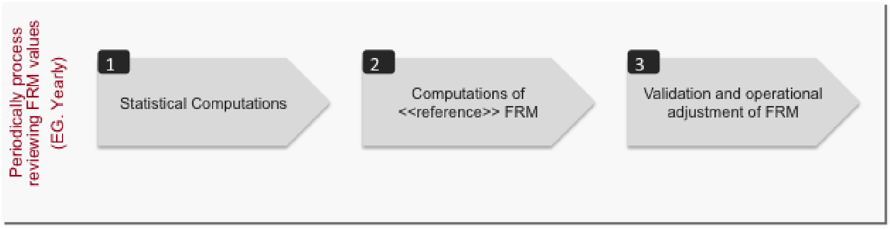
The theoretical values remain a "reference", especially with respect to any methodological change which would be monitored through FRM.

For matter of clarification, we remind here that for each CB (or CBCO for the N-1 cases), the FRM campaign leads to one single FRM value which then will be a fixed parameter in the CB definition. FRM is not a variable parameter.

However, since FRM values are a model of the uncertainties against which TSOs need to hedge, and considering the constantly changing environment in which TSOs are operating, and the statistical advantages of building up a larger sample, the very nature of FRM computation implies regular re-assessment of FRM values. Consequently, TSOs consider recomputing FRM values, following the same principles but using updated input data, on a regular basis, at least once per year.

The general FRM computation process can then be summarized by the following figure:

[9] A dedicated, confidential report on FRM (FRM values and operational adjustment for main active Critical Branches of the parallel run) is available in Annex 15.5.



Step 1: elaboration of statistical distributions, for all Critical Branches, in N and N-1 situations.
Step 2: computation of theoretical (or reference) FRM by applying of a risk level on the statistical distributions.
Step 3: Validation and potentially operational adjustment. The operational adjustment is meant to be used sporadically, only once per CB, and systematically justified and documented.
CWE TSOs intend a regular update, at least once a year, of the FRM values using the same principles. Exceptional events[10] may trigger an accelerated FRM re-assessment in a shorter time frame, but in all cases one should keep in mind that for statistical representativeness, the new context integrated into new FRM values needs to be encompassed in several months of data.

In practice, FRM values have been computed end of 2012 on the basis of the winter 2010-2011 and summer 2011 period. The graphical overview below displays the FRM values associated to the main

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[10] Exceptional events could be: important modification of the grid (new line, decommissioning of large generating units...), change in the capacity calculation method, enlargement of the coupled area, implementation of advanced hybrid coupling etc...

active CBs of the internal parallel run of 2012. One can basically notice here that:

- FRM values spread between 5% and 20% of the total capacity Fmax of the line, depending on the uncertainties linked to the flows on the CBCOs.
- Operational adjustments are performed in both directions (increase or decrease calculated FRM value), and essentially consist in correcting outliers, or missing, high reference values.

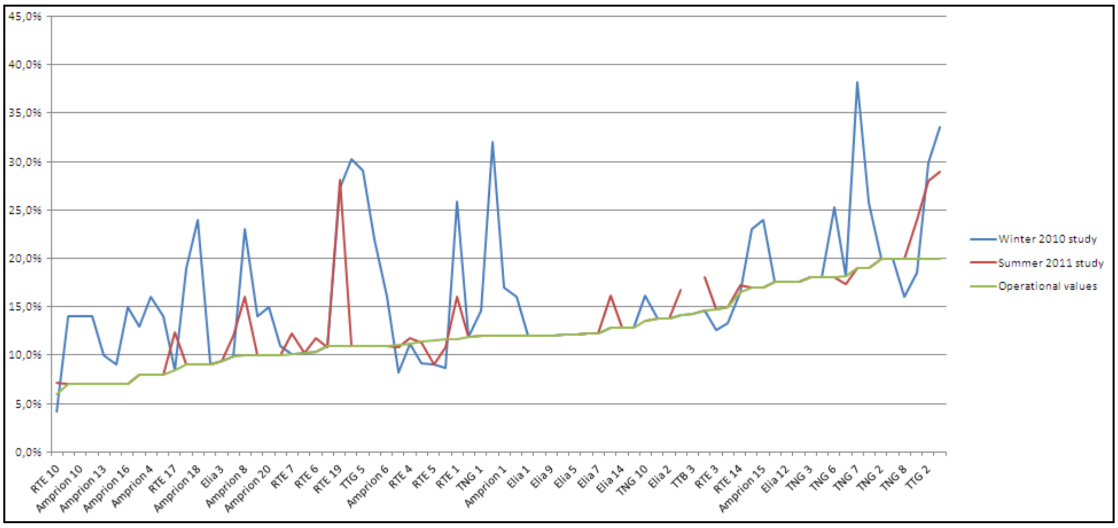

Figure 4-3: Graphical overview of the operational FRM values for the active CBs of the parallel run (CB labelling is purely arbitrary and does not correspond to the future fixed anonymization)

The values that will be used for go-live are currently being assessed on the basis of year 2013 data by CWE TSOs, and should be implemented by the end of May 2014. In this way, observation of new FRM values is guaranteed during the parallel run. A specific report will be communicated to the NRAs in this respect which will indicate for each active CB of the current parallel run:

- The reference FRM
- The operational adjustment11 and its justification.

4.1.9. Specific limitations not associated with Critical Branches (external constraints)

Besides electrical Critical Branches, other specific limitations may be necessary to guarantee a secure grid operation. Import/Export limits declared by TSO are taken into account as "special" Critical Branches, in order to guarantee that the market outcome does not exceed these limits. TSOs remind here that these constraints are not new, since already taken into account implicitly when computing NTCs[12]. With Flow Based, they appear explicitly and their usage is justified by several reasons, among which:

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11 Operational adjustment is not a daily operational step but a single adjustment possibly done on FRM values when the latter are computed.

[12] Discrepancies can be identified in some cases, for instance when the sum of export (respectively import) NTCs of a given hub are larger than the export (respectively import) EC of the same hub in FB. These discrepancies can have several reasons :

1. At implementation level, the ATC and FB model obviously differ, which could lead to slightly different results.
2. The NTCs belong to an « unlikely » situation (typically, the double Belgium export), therefore it is foreseeable that just summing up NTCs on borders and comparing them with ECs can lead to differences.

- Avoid market results which lead to stability problems in the network, detected by system dynamics studies.

Avoid market results which are too far away from the reference flows going through the network in the base-case, and which in exceptional cases would induce extreme additional flows on grid elements, leading to a situation which could not be verified as safe by the concerned TSO during the verification step (c.f. chapter 4.2.6). In other words, FB capacity calculation includes contingency analysis, based on a DC loadflow approach. This implies that the constraints determined are active power flow constraints only. Since grid security goes beyond the active power flow constraints, issues like:

- voltage stability,
- dynamic stability,
- ramping (DC cables, net positions),

need to be taken into account as well. This requires the determination of constraints outside the FB parameter computation: the so-called external constraints (ECs).

One also needs to keep in mind that EC are therefore crucial to ensure security of supply and are in this respect systematically implemented as an input of the FB calculation process. In other words, the TSO operator does not decide including or not an EC on a given day (or even hour), he will always integrate an external constraint whatever the current operational conditions are, in order to prevent unacceptable situations.

These external constraints may also be modeled as a constraint on the global net position (the sum of all cross border exchanges for a certain bidding zone in the single day-ahead coupling), thus limiting the net position of the respective bidding zone with regards to all

Capacity calculation regions (CCRs) which are part of the single day-ahead coupling. When modeled as such, the EC will not form part of the FB calculation and will thus not be modeled as a Critical Branch.

In the case that an external constraint is limiting the market, it receives a shadow price. Indeed, the shadow price indicates the welfare increase when the constrained element is marginally relieved. The shadow price, a useful indicator to assess the market impact of a given CB, will be part of the active constraint reporting towards NRAs.

External constraints versus FRM:

FRM values do not help to hedge against the situations mentioned above. By construction, FRMs are not covering voltage and stability issues which can occur in extreme cases, not only because FB is based "only" on a DC model, but also because as they are statistical values looking "backward", (based on historical data), they cannot cover situations which never happened. And this is exactly the purpose of external constrains, to prevent unacceptable situations (which by definition did not happen), like voltage collapses or stability issues on the grid.

Therefore, FRM on the one hand (statistical approach, looking "backward", and "inside" the FB DC model) and external constraints on the other hand (deterministic approach, looking "forward", and beyond the limitations of the FB DC model) are complementary and cannot be a substitute to each other. Each TSO has designed its own thresholds on the basis of complex studies, but also on operational expertise acquired over the years.

The advantage of FB in this respect is that it makes the design and activation of external constrains fully transparent. Not only are the EC explicit Critical Branches (while they are taken into account implicitly when computing NTCs) but also are they easily identifiable in the publication. Indeed, their PTDFs are straightforward (0;0;0;1 or -1, the margin being the import/export limit) and can be directly linked to its owner resp. country, since it relates to the 1 or -1 in the PTDF matrix. Therefore CWE TSOs consider that full transparency is already provided in this respect.

The following sections will depict in detail the method used by each TSO[13] to design and implement external constrains.

Austrian External Constraint

APG does not apply an import or export constraint.

German External Constraint:

German import or export constraints will not be applied any longer with the implementation of the German – Austrian BZ border going live 1st October 2018.

Dutch External Constraint:

TenneT NL determines the maximum import and export constraints for the Netherlands based on off-line studies, which also include

[13] Any time a TSO plans to change its method for EC implementation, it will have to be done with NRAs' agreement, as it is the case for any methodological change.

voltage collapse and stability analysis during different import and export situations. The study can be repeated when necessary and may result in an update of the applied values for the external constraints of the Dutch network.

Belgian External Constraint:

Elia uses an import limit constraint which is related to the dynamic stability of the network. This limitation is estimated with offline studies which are performed on a regular basis.

French External Constraint:

RTE does not apply the external constraints.

4.2. Coordinated Flow Based Capacity Calculation Process

4.2.1. Merging

Basis for the calculation process is a model of the grid, the Common grid Model (CGM) that represents the best forecast of the corresponding hour of the execution day (day D). Due to the timeline within the process, the creation of the CGM has to be performed two-days ahead of day D. The CGM is a data set created by merging individual grid models by a merging entity.

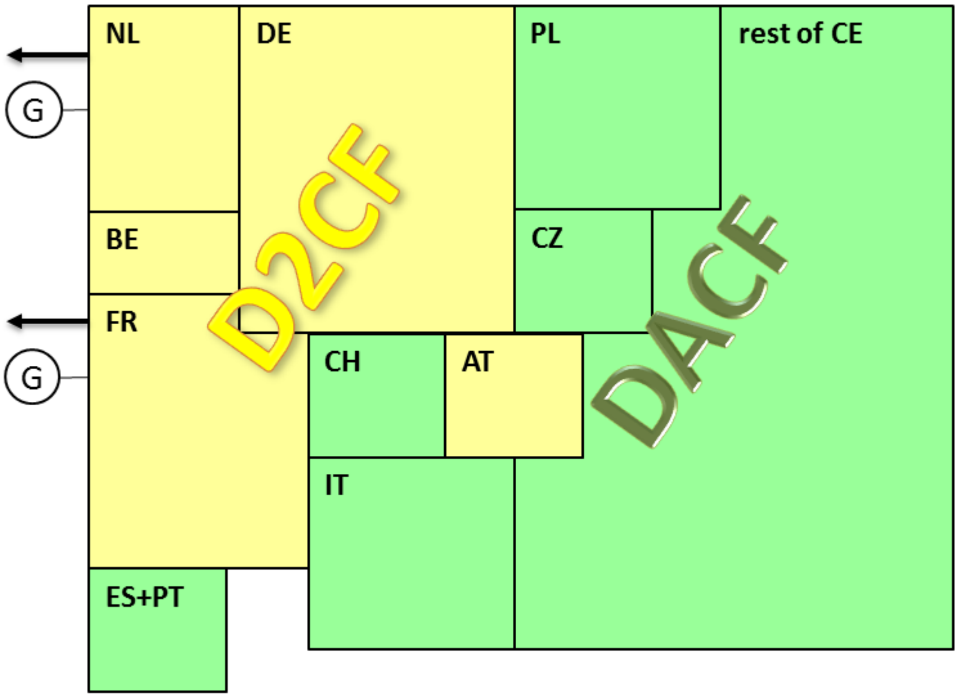
This data set contains

- the single D-2CF data sets from CWE TSOs: Elia (BE), RTE (FR), TenneT (NL), TenneT (DE), Transnet BW (DE), Amprion (DE), 50HzT (DE) and APG (AT)[14]
- the DACF data sets from the non-participating TSOs of continental Europe

The network of German Control Block (GCB) is composed of EnDK (DACF), TenneT DE, Transnet BW, Amprion, 50Hertz and CREOS in a pre-merge. DC cables linked to other control blocks are handled as injections in the model. The schedules on these cables are consistent with the forecasted exchange programs.

The DACF data sets of non-participating TSOs are needed to take the physical influences of these grids properly into account when calculating transfers between FR-BE-NL-DE-AT. In the figure below not shown zones are external zones, which are represented as positive or negative injections.

[14] It is also envisaged to include D-2CF data sets from Swissgrid (CH)



The merging process will be done in the following steps, according to the internationally agreed merging rules:

1. Check of individual data sets of the participating and non-participating TSOs:

    - Check for format
    - Check loadflow convergence

2. Balance check (import/export situation):

    In case of mismatch, balance adjustment according to the internal CWE Merging Guidelines.

3. Merging process:

    - Check interconnector status. If necessary adjustment according to the CWE Merging Guidelines
    - All CWE Control Blocks will be adapted by using their GSK in order to reach Balanced Day Net Positions, within a Feasibility Range provided by Control Blocks. This process, of merging by using GSK, allows CWE TSOs to

provide their best estimate (shaping Flow-Based domain) and allows a merge not impacting shape of Flow-Based domain when reaching Reference Day Net Positions.

Note: the merging activity is not a fully automatic one and comprises a sanity check (format compliance, tie-lines status, country balance) of each individual file with a specific operational procedure in case of inconsistencies.

4.2.2. Pre-qualification[15]

Before the first Flow Based parameter calculation the TSO checks the consistency of the applied CB-file with the forecasted grid-situation. Special attention is given to the Remedial Actions (RA) described in the CB-file. Every TSO has to check, if the described RAs are available in the forecasted grid situation, or if some adapta-

[15] Prequalification is a CB assessment phase available at any moment of the FB process, during which each TSO can assess the relevance of its CB set, with respect to the operating conditions at the moment of capacity calculations. Therefore, operational experience plays a major role. Concretely, this phase is facilitated by a tool which allows an efficient review of the Critical Branches, as well as a cross comparison of interconnectors and associated Remedial Actions. As such, prequalification is an introduction to qualification since it provides the first elements to be discussed and coordinated between TSOs later during the FB process, which is why it is presented here before qualification in the operational sequence. In practice, prequalification can be done before each FB common computation.

tions might have to be done. This pre-qualification step also contains, if necessary, the information sharing and coordination with adjacent TSOs.

4.2.3. Centralized Initial-Flow Based parameter computation

The Flow Based parameters computation is a centralized computation. As the whole grid is linearized, the calculation can be done with the much faster DC approach and delivers two main classes of parameters needed for the following steps of the FB MC.

i) Remaining Available Margin (RAM):

As the reference flow (Fref) is the physical flow computed from the common base case, it reflects the loading of the Critical Branches given the exchange programs of the chosen reference day. The RAM is determined with the formula:

RAM = Fmax – Fref – FRM – FAV - AMR

Out of the formula, the calculation delivers, with respect to the other parameters, the remaining available margin for every CBCO. This RAM is one of the inputs for the subsequent process steps. The adjustment for minimum RAM (AMR) is applied after the qualification step[16].

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[16] Please refer to paragraph 4.2.5 for more details.

ii) Power Transfer Distribution Factors (PTDFs):

The PTDFs are calculated by varying the exchange program of a zone (=market area), taking the zone-GSK into account. For every single zone-variation the effect on every CB loading is monitored and the effect on the loadflow is calculated in percent (e.g. additional export of BE of 100 MW has an effect of 10 MW on a certain CB => PTDF = 10%). The GSK for the zone has an important influence on the PTDF, as it translates the zone-variation into an increase of generation in the specific nodes.

The PTDF characterizes the linearization of the model. In the subsequent process steps, every change in the export programs is translated into changes of the flows on the CBs by multiplication with the PTDFs.

4.2.4. Flow Based parameter qualification

The operational Flow Based parameter qualification process is executed locally by each TSO, and covers amongst others the following action. For each non-redundant CB, limiting the Flow Based-domain, the TSO checks, if Remedial Actions (RA) are at hand, that could enlarge the Flow Based-domain. This is in coherence with the local capacity calculation procedures and risk policies. Depending on the nature and the complexity of the specific RA, the RAs could be applied explicitly in the CB-file by a detailed description or, if too complex and the effect is known or can be estimated, by adapting the Final Adjustment Value (c.f. chapter 4.1.4). Close coordination between CWE TSOs is needed for the application of the different RAs. A coordination of cross-border Remedial Actions enhances the security of supply and can increase the capacity that can be offered to the market. Information sharing among TSOs plays a key role in this respect. Common procedures indicating amongst others which Remedial Actions will be applied for this capacity calculation.

The aim is to qualify in this stage the maximum Flow Based domain that can be given, with respect to the TSO's risk policies. The following criteria and parameters can help and guide through this phase:

- The Flow Based domain should be comparable with the one of the previous day (i.e. max net positions comparison) if the environment did not change significantly (i.e. consumption forecast, outages, renewable energy forecasts)
- The Flow Based domain should be bigger than the LTA domain
- The current reference program has to be inside the Flow Based-domain, nor may there be violations of the formula: Fref < Fmax – FRM – FAV.

4.2.5. MinRAM process

The MinRAM process is applied to provide a minimal FB domain to the market. The MinRAM is applied using the AMR (Adjustment for minimum RAM) attribute of each affected CBCO which guarantees a minimal RAM per CBCOs. Currently, the value for MinRAM is set at 20%.

A TSO may decide to not apply the AMR in certain circumstances on specific CBCOs or the full set of the TSOs' CBCOs, justified to regulatory authorities. The exclusion can be performed:

a. before the initial flow based parameter computation when the TSO identifies the necessity when providing the CBCO

b. *at the qualification phase or* during the verification process

The exclusion of the application of AMR can be triggered in situations when there are insufficient available remedial actions, costly or not, in order to ensure the security of supply and system security.

The process of exclusion can be performed when the TSO identifies its necessity (for example in case of planned outage) when providing the CBCO list for the Flow Based calculation. It can also be performed at qualification phase or later during verification phase, based on the results of initial or intermediate computations.
The high-level calculation process is the following:

- CBCOs with a RAM of less than X% of Fmax at zero-balance are assigned an AMR value in order to ensure the "X% MinRAM" on hourly basis.
- Calculation of the AMR (negative value means increase in capacity same as for FAV):
  - AMR = Min(0; RAM-FMax*X)
    where RAM = FMax – Fref – FRM – FAV
- RAM provided in further calculations then includes also the computed AMR:
  - RAM = FMax – Fref – FRM – FAV – AMR

4.2.6. Flow Based parameter verification

After the qualification phase, the TSOs provide an updated CB file to the Common System. Based on this updated CB-file, a second Flow Based-parameter calculation is started. This next calculation delivers the largest possible Flow Based domain that respects the Security of Supply (SoS) domain. This domain is modified in order to take into account the "MinRAM". During the verification step, TSOs check whether the computed Flow Based domain is secure, with a possibility to identify constraints through an AC load flow analysis. Therefore, at this step of the process, TSOs have the possibility to ascertain the correctness of the Flow Based parameters generated by the centralized computation:

- TSOs can check the grid security in the relevant points (e.g. vertices) of the Flow Based domain by customizing the generation pattern to the commonly observed one for the corresponding vertex instead of using the linear GSK
- TSOs can perform a full AC load flow analysis of the relevant points, thereby taking into account reactive power flows
- TSOs can check if the voltage limits of the equipment are respected
- TSOs can assess voltage stability (voltage collapse)
- TSOs can investigate extreme net positions

If security issues are discovered, TSOs can update their Critical Branch files (by adding new CBs, that were not perceived upfront as being limiting (for instance in the case of combined and/or unusual scheduled outages), by adapting the Final Adjustment Value), or by excluding CBCOs from the "MinRAM" application).
After the verification step and possibly adaptation of the CB-file, the final Flow Based-parameter calculation can be performed, which includes adjustment to long-term nominations (c.f. chapter 4.2.8) and presolve (c.f. chapter 4.3.1) steps.

4.2.7. LTA inclusion check

Given that Programming Authorizations for long term allocated capacity (LTA) have already been sent out in D-2 Working Days (according to the current version of the Auction Rules), the long-term-allocated capacities of the yearly and monthly auctions have to be included in the initial Flow Based-domain which is calculated, before taking into account the cross-border nominations. This will avoid that the flow based domain provided to the day-ahead allocation (after taking into account the cross-border nominations) would not include the 0 hub-position point. This can be checked after each Flow Based-parameter-calculation. The fundamental reasons for designing this "LTA coverage" are explained in details in Annex 15.6.

The figure below illustrates the calculation that has to be done:

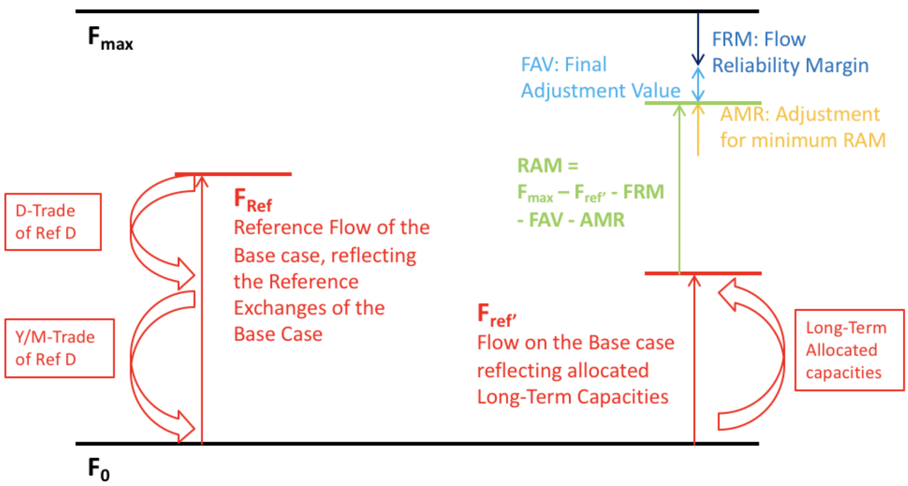
After each calculation a check can be performed if the remaining available margin after LTA adjustment is negative.

For every presolved CB the following check is performed

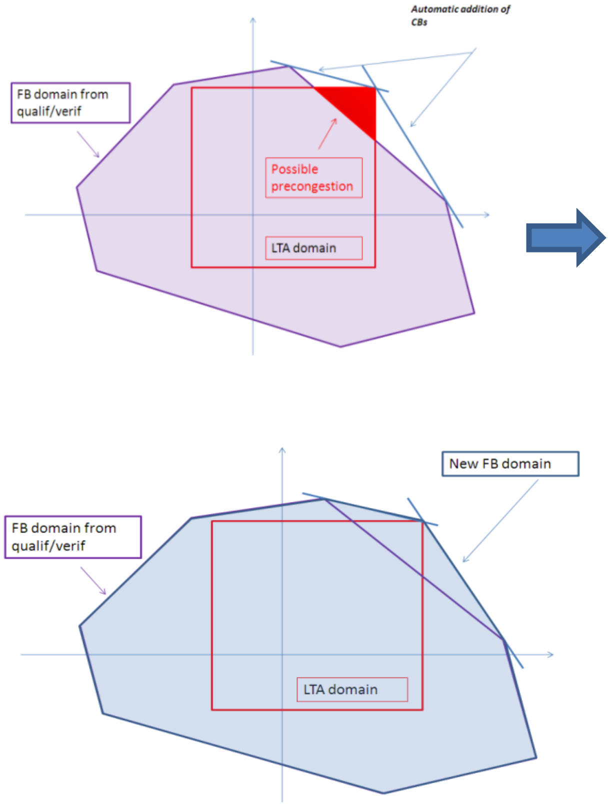
$$Fref^* = Fref - \sum_{i=hub} PTDF_i * [\![(Ref]\!]_{prog\ i} - LTA_i)$$

and then the following equation is checked

RAM* = Fmax – Fref* - FRM – FAV- AMR < 0



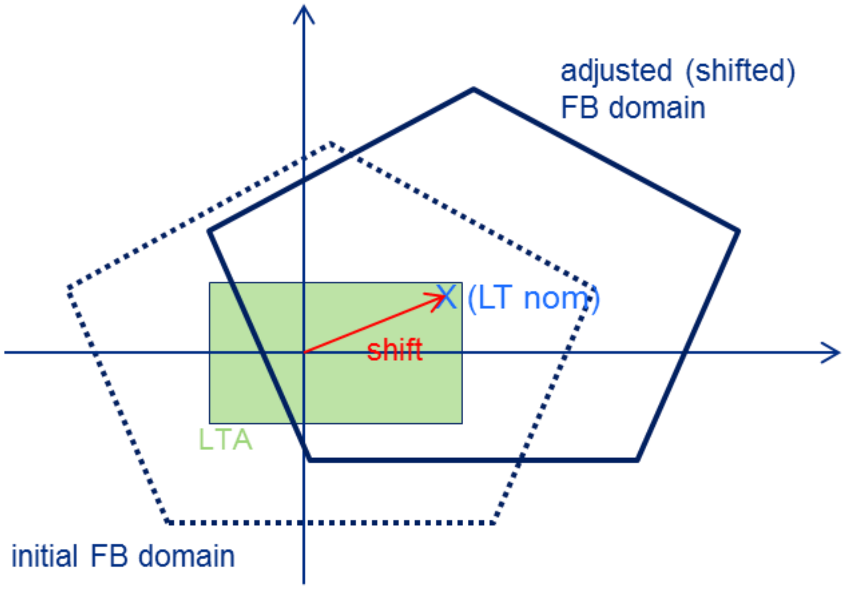
If the remaining margin is smaller than zero, this means the LTA is not fully covered by the Flow Based domain. In this case, a method is applied that enlarges the Flow Based-domain in a way that all LTA are included. Virtual CBs are created and introduced, which replace the CB for which RAM < 0, and that guarantee the inclusion of all LTA, as illustrated in the figure below.



Experience of the LTA inclusion can be found in Annex 15.19.

4.2.8. LTN adjustment

As the reference flow (Fref) is the physical flow computed from the common base case, it reflects the loading of the Critical Branches given the exchange programs of the chosen reference day. Therefore, this reference flow has to be adjusted to take into account only the effect of the LTN (Long Term Nominations) of day D as soon as they are known[17]. The effect on the domain is schematically visualized in the following figure.



For the LTN adjustment, the same principle has to be applied for every constraining element. A linear "backward-forward-calculation" with the LTNs multiplied with the PTDFs delivers the flow on the CBs affected by these LTNs. The remaining margin for the DA-allocation can be calculated by:

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[17] A description of the publication of the initial and final FB domain can be found in Annex 15.6.

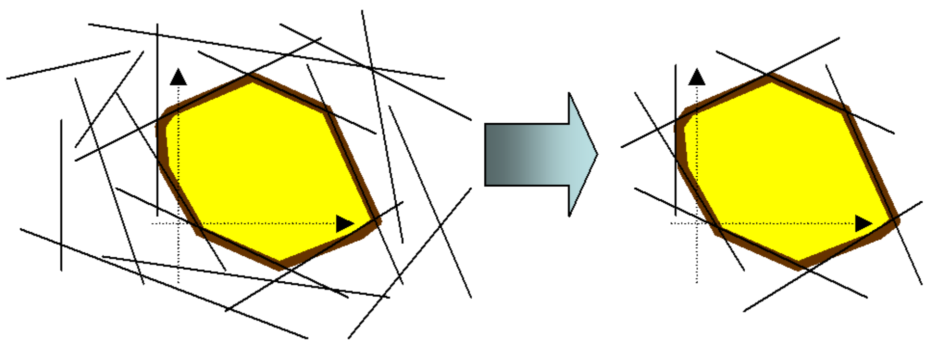
RAM = Fmax – Fref’ – FRM – FAV - AMR

*Fref’ = Fref + (LTN – RefProg)*PTDF*

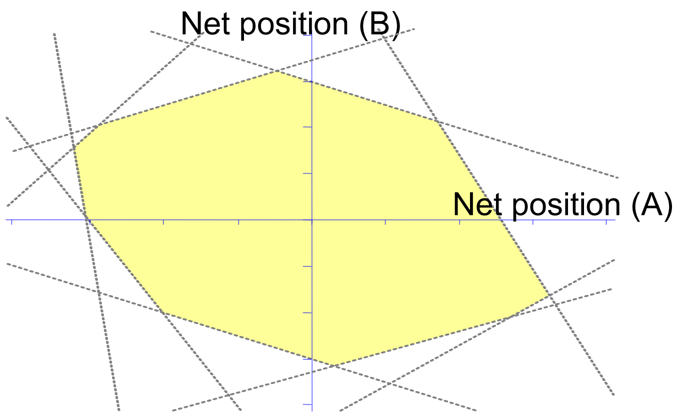
4.3. Output data

4.3.1. Flow Based capacity domain

The Flow Based parameters that have been computed indicate what net positions, given the Critical Branches that are specified by the TSOs in CWE, can be facilitated under the Market Coupling without endangering the grid security. As such, the Flow Based parameters act as constraints in the optimization that is performed by the Market Coupling mechanism: the net positions of the bidding zones in the Market Coupling are optimized in a way enabling that the day-ahead market welfare is maximized while respecting the constraints provided by the TSOs. Although from the TSO point of view all Flow Based parameters are relevant and do contain information, not all Flow Based parameters are relevant for the Market Coupling mechanism. Indeed, only those Flow Based constraints that are most limiting the net positions need to be respected in the Market Coupling: the non-redundant constraints. The redundant constraints are identified and removed by the TSOs by means of the so-called presolve. This presolve step is schematically illustrated in the two-dimensional example below:



In the two-dimensional example shown above, each straight line in the graph reflects the Flow Based parameters of one Critical Branch. A line indicates for a specific Critical Branch, the boundary between allowed and non-allowed net positions: i.e. the net positions on one side of the line are allowed whereas the net positions on the other side would overload this Critical Branch and endanger the grid security. As such, the non-redundant, or presolved, Flow Based parameters define the Flow Based capacity domain that is indicated by the yellow region in the two-dimensional figure above. It is within this Flow Based capacity domain (yellow region) that the net positions of the market can be optimized by the Market Coupling mechanism. A more detailed representation of a two-dimensional Flow Based capacity domain is shown hereunder.

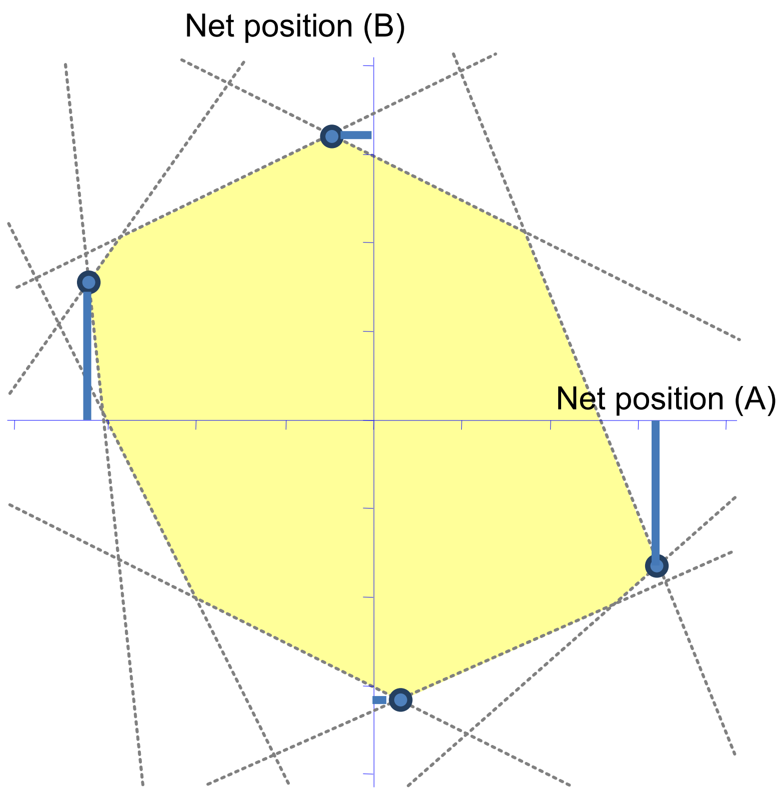


The intersection of multiple constraints, two in the two-dimensional example above, defines the vertices of the Flow Based capacity domain.

4.3.2. Flow Based capacity domain indicators

From the Flow Based capacity domain, indicators can be derived that characterize the Flow Based-domain and provide additional information of the domain. These indicators are published (see chapter 9) or monitored by the NRAs (see chapter 10)

- Flow Based-Volume: “volume” of the domain
  - The volume is computed in n-1 dimensions, where n is the number of hubs participating in the CWE FB MC (as the sum of the n net positions must be zero).
  - The volume can be compared with the volume of another domain, for instance the LTA domain (Long-Term Allocated capacity domain).
  - The intersection of different volumes can be computed, for instance the intersection of the Flow Based domain and the LTA domain.
- Flow Based-vertices: Net positions of the Flow Based-vertices
- Min-Max net positions: Minimum and maximum net position values for each hub, feasible within the Flow Based domain (by assuming that all other CWE hubs contribute to this specific Min-Max net position). An illustration of the Min-Max net positions feasible within the Flow Based domain for the two-dimensional example used so far, is shown in the figure below (the respective vertices are indicated by the blue dots, whereas the corresponding Min-Max net positions are highlighted by the blue lines).
- Min-Max bilateral exchanges between any two hubs, feasible within the Flow Based domain (by assuming that all other exchanges in CWE contribute to this specific Min-Max bilateral exchange).



4.4. ID ATC Computation

The methodology for capacity calculation for the Intraday timeframe, which is applied for the internal CWE borders since 30th March 2016 is attached as Annex 15.20 (context paper) to this document.

If an external constraint applies on the global net position of a hub, then this external constraint will not be reflected in the presolved Flow Based parameters sent to PXs. To ensure operational security an adapted external constraint is added as an additional FB constraint, the value is set to be the global constraint minus the allocated capacities after MC (in relevant import or export direction) on non-CWE borders and capacity calculated on non-CWE borders.

4.5. Capacity calculation on non CWE borders (hybrid coupling)

Capacity calculation on non CWE borders is out of the scope of the CWE FB MC project. CWE FB MC just operates provided capacities (on CWE to Non-CWE-borders), based on approved methodologies.

The standard hybrid coupling solution, which is proposed today, is in continuity with the capacity calculation process already applied in ATC MC. By "standard", we mean that the influence of "exchanges with non-CWE hubs" on CWE Critical Branches is not taken into account explicitly at capacity calculation phase (no PTDF relating exchanges CWE <-> non-CWE to the load of CWE CBs). However, this influence physically exists and needs to be taken into account to make secure grid assessments, and this is done in an indirect way. To do so, CWE TSOs make assumptions on what will be the eventual non-CWE exchanges, these assumptions being then captured in the D2CF used as a basis, or starting point, for FB capacity calculations. What's more, uncertainties linked to the aforementioned assumptions are integrated within each CB's FRM. As such, these assumptions will impact the available margins of CWE Critical Branches. However, strictly speaking, no margin is explicitly booked for non-CWE exchanges on CWE CBs.

CWE partners together with MRC are committed to study, after go-live, potential implementation of the so-called "advanced hybrid coupling solution", that consists in taking directly into account the influence of non CWE exchanges on CWE CBs (which means, practically, the addition of new PTDFs columns in the FB matrix and therefore less reliance on TSOs' assumptions on non CWE exchanges, since the latter would become an outcome of the FB allocation).

4.6. Backup and Fallback procedures for Flow Based capacity calculation

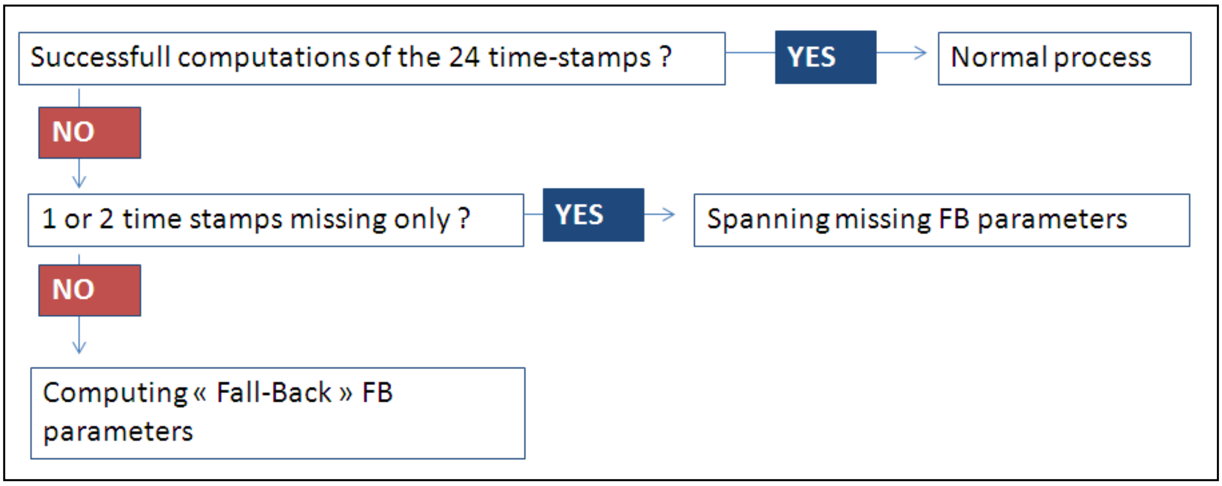
<u>Introductory disclaimer:</u> please note that this section is related to capacity calculation Fallback principles only. Therefore, its aim is neither to address operational Fallback procedures, nor to consider market-coupling Fallbacks (decoupling).

In some circumstances, it can be impossible for CWE TSO to compute Flow Based Parameters according to the process and principles. These circumstances can be linked to a technical failure in the tools, in the communication flows, or in corrupted or missing input data. Should the case arise, and even though the impossibility to compute "normally" Flow Based parameters only concern one or a couple of hours, TSOs have to trigger a Fallback mode in order to deliver in all circumstances a set of parameters covering the entire day. Indeed, market-coupling is only operating on the basis of a complete data set for the whole day (ALL timestamps must be available), mainly to cope with block orders.
The approach followed by CWE TSOs in order to deliver the full set of Flow Based parameters, whatever the circumstances, is twofold:

- First, TSOs can trigger "replacement strategies" in order to fill the gaps if some timestamps are missing. Because the Flow Based method is very sensitive to its inputs, CWE TSOs decided to directly replace missing Flow Based parameters by using a so-called "spanning method". Indeed, trying to reproduce the full Flow Based process on the basis of interpolated inputs would give unrealistic results. The spanning method is described in detail in the following section. These spanning principles are only valid if a few timestamps are missing (up to 2 hours). Spanning the Flow Based parameters over a too long period would also lead to unrealistic results.

- Second, in case of impossibility to span the missing parameters, CWE TSOs will deploy the computation of "Fallback Flow Based parameters". Their principles are described below in this paragraph.

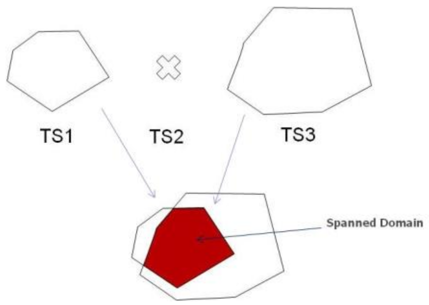
The sketch below will synthesise the general approach followed by CWE TSOs:



Spanning methodology

When Flow Based parameters are missing for less than 3 hours, it is possible to computed spanned Flow Based parameters with an acceptable level of risk, before using Fallback Flow Based parameters.
The spanning process is based on an intersection of previous and sub-sequent available Flow Based domains, after adjustment to 0 balance (to delete impact of reference program). At the end of the intersection process pre-calculated spanning margins are added.

Intersection Step: For each TSO, the active CBs from the previous and sub-sequent timestamps are compared and the most constraining ones are taken into consideration (intersection).



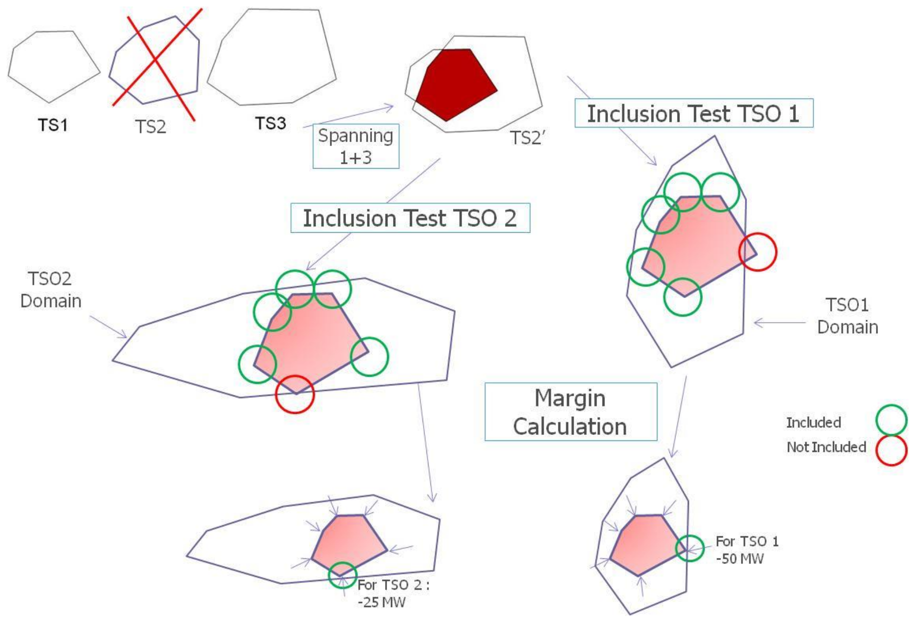
Spanning Margin calculation Step: The aim of this step is to define the spanning margin needed for each TSO to ensure the SoS in case that spanning is applied. This spanning margin is updated every day, after final Flow Based parameters calculation, based on a simulation of 'what could have been the spanned Flow Based parameters', compared to real Flow Based parameters (statistical analysis). To reduce the margin impact on the result, this process is performed per TSO (in this way, results of TSOs with Flow Based parameters that are more fluctuating from one hour to the other are not impacted by results of TSOs with more stable Flow Based parameters).

During this simulation, a raw spanned Flow Based domain is calculated, and a check is done to know if each vertex of the spanned domain is included in the real TSO Flow Based domain (inclusion test):

- If the spanning vertex is inside the original Flow Based domain, no extra margin is needed to ensure the SoS for this TSO.
- If the vertex is outside, an extra margin would have been necessary to keep the SoS. The size of this extra margin is calculated and stored.

- ⇨ After the full inclusion test, a new reference margin is defined as the maximum of all extra margins from the step before (for each TSO and each time stamp).

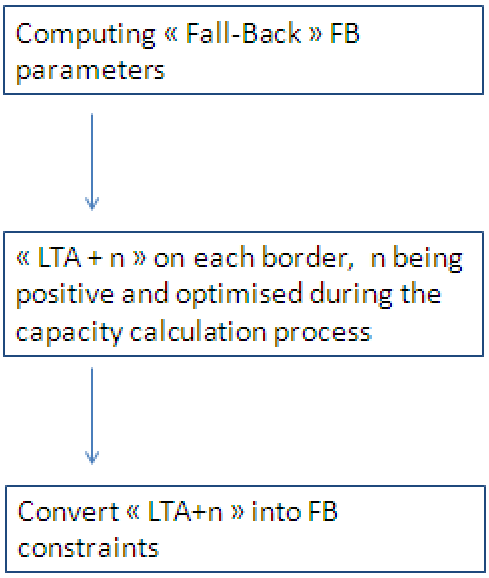
This reference margin is then added to the distribution of the already calculated reference margins from the past (for each time stamp and each TSO), in order to update (with a 90% percentile formula) the new spanning margin.



***Fallback** Flow Based parameters*

When Flow Based parameters are missing for more than 3 hours, CWE have to recompute them in a straightforward way. Indeed, they could be in a downgraded situation where fundamental inputs and/or tooling are missing. For these reasons, CWE TSO will base the Fallback FBParam on existing Long Term bilateral capacities. These capacities can indeed be converted easily into Flow Based external constraints (i.e. import or export limits c.f. chapter 4.1.9 for more details), via a simple linear operation. In order to optimize the capacities provided in this case to the allocation system, CWE TSOs will adjust the long term capacities during the capacity calculation process. Eventually, delivered capacities will be equal to “LT rights + n” for each border, transformed into Flow Based constraints, “n” being positive or null and computed during the capacity calculation process. CWE TSOs, for obvious reasons of security of supply, cannot commit to any value for “n” at this stage.

Principles are summarized in the sketch below:



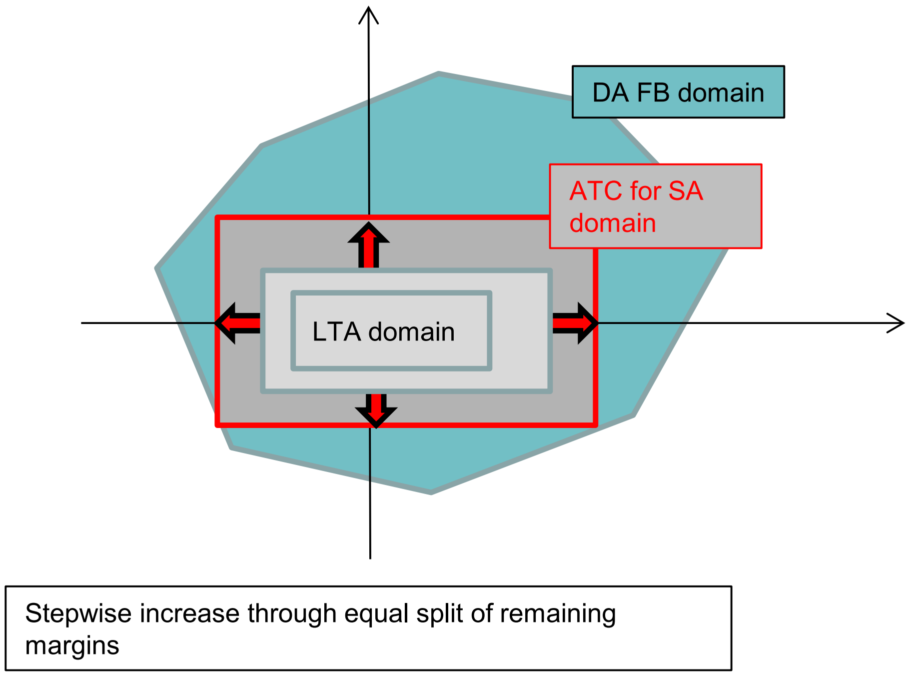
One can note that in all cases, CWE TSOs commit to deliver Flow Based constraints over the entire day to the Market Coupling system.

4.7. ATC for Shadow Auctions

Introduction: In case of a decoupling in CWE, explicit shadow auctions (SA) will be organized.

With the TSO CS daily running, 24 Flow Based domains are determined as an input for the FB MC algorithm. In case the latter system fails, the 24 Flow Based domains will serve as the basis for the determination of the SA ATCs that are input to the Shadow Auctions. In other words: there will not be any additional and independent stage of ATC capacity calculation.

As the selection of a set of ATCs from the Flow Based domain leads to an infinite set of choices, an algorithm has been designed that determines the ATC values in a systematic way. The algorithm applied for the determination of the SA ATCs is the same as the algorithm applied to compute the ID ATCs after the FB MC, though the starting point of the computation is a different one. Indeed, the iterative procedure to determine the SA ATC starts from the LTA domain [18]as shown in the graph below.



Input data:

Despite the two days per year with a long-clock change, there are 24 timestamps per day. The following input data is required for each timestamp:

[18] Keep in mind that that the LTA domain will systematically be included in the FB one, as explained in chapter 4.2.7.

- LTA
- presolved Flow Based parameters that were intended to be sent to the PXs. If an external constraint applies on the global net position of a hub, then this external constraint will not be reflected in the presolved Flow Based parameters sent to PXs. To ensure operational security an adapted external constraint is added as an additional FB constraint, the value is set to be the global constraint minus the ATCs (in relevant import or export direction) on non CWE borders.

Output data:

The calculation leads to the following outputs for each timestamp:

- SA ATC
- number of iterations that were needed for the SA ATC computation
- branches with zero margin after the SA ATC calculation

Algorithm:

The SA ATC calculation is an iterative procedure.

Starting point: First, the remaining available margins (RAM) of the presolved CBs have to be adjusted to take into account the starting point of the iteration.

From the presolved zone-to-hub PTDFs ($\mathrm{PTDF_{z2h}}$), one computes zone-to-zone PTDFs ($\mathrm{pPTDF_{z2z}}$)19, where only the positive numbers are stored:

$$\mathrm{pPTDF_{z2z}}(\mathrm{A} > B) = max?\,(0, PTD\mathrm{F_{z2h}}(\mathrm{A}) - \mathrm{PTDF_{z2h}}(\mathrm{B}))$$

with $\mathrm{A, B = DE/AT, FR, NL, BE}$ at the moment. Only zone-to-zone PTDFs of neighboring market area pairs are needed (e.g. $\mathrm{pPTDF_{z2z}}(\mathrm{DE/AT} > BE)$ will not be used).

The iterative procedure to determine the SA ATC starts from the LTA domain. As such, with the impact of the LTN already reflected in the RAMs, the RAMs need to be adjusted in the following way:

$$\mathrm{RAM = RAM - \ pPTDF_{z2z} * (LTA - LTN)}$$

Iteration: The iterative method applied to compute the SA ATCs in short comes down to the following actions for each iteration step i:

For each CB, share the remaining margin between the CWE internal borders that are positively influenced with equal shares.

From those shares of margin, maximum bilateral exchanges are computed by dividing each share by the positive zone-to-zone PTDF.

The bilateral exchanges are updated by adding the minimum values obtained over all CBs.

Update the margins on the CBs using new bilateral exchanges from step 3 and go back to step 1.

[19] Negative PTDFs would relieve CBs, which cannot be anticipated for the SA capacity calculation.

This iteration continues until the maximum value over all Critical Branches of the absolute difference between the margin of computational step i+1 and step i is smaller than a stop criterion.

The resulting SA ATCs get the values that have been determined for the maximum CWE internal bilateral exchanges obtained during the iteration and after rounding down to integer values.

After algorithm execution, there are some Critical Branches with no remaining available margin left. These are the limiting elements of the SA ATC computation.

The computation of the SA ATC domain can be precisely described with the following pseudo-code:

```
While max(abs(margin(i+1) - margin(i))) > StopCriterionSAATC

    For each CB

        For each non-zero entry in pPTDF_z2z Matrix

            IncrMaxBilExchange = margin(i)/NbShares/pPTDF_z2z

            MaxBilExchange = MaxBilExchange + IncrMaxBilExchange

        End for

    End for

    For each ContractPath

        MaxBilExchange = min(MaxBilExchanges)

    End for

    For each CB

        margin(i+1) = margin(i) – pPTDF_z2z * MaxBilExchange
```

```
        End for
End While
SA_ATCs = Integer(MaxBilExchanges)
```

Configurable parameters:

StopCriterionSAATC (stop criterion); recommended value is 1.e-3.

NbShares (number of CWE internal commercial borders); current value after DE/AT split is 5.

5 The CWE Market Coupling Solution / Daily schedule

This chapter describes the CWE Market Coupling Solution, embedded in and as part of the MRC Price Coupling Solution.
In the next sections the high level business process is further explained. They are devoted to:

- Terminology
- The operational procedures and the roles of the Parties

The high level functional architecture can be found in Annex 15.7.

5.1. Definitions related to MC Operation

Normal Procedure: procedure describing the actions to be taken by Agents to operate the CWE FB Market Coupling when no problem occurs.

Backup Procedure: procedure describing the actions to be taken by Agents in order to operate the CWE FB Market Coupling when a problem occurs (when for any reason, the information cannot be produced/exchanged or if a validation fails before the target time, or if it is known or may reasonably be expected that this will not happen before target time).

Fallback Procedure: procedure describing the actions to be taken by Agents in case the information cannot be produced/exchanged either by Normal or Backup Procedure or if a check fails before the Partial/Full Decoupling deadline, or if it is known that this will not happen before the Partial/Full Decoupling deadline.

Other procedures: procedure describing actions to be taken by an agent in certain specific situations, which are not directly associated to Normal procedures.

Target time (for a given procedure): estimated time to complete a procedure in a normal mode. If an incident occurs that does not allow applying the Normal procedure, and for which a backup exists, the Backup procedure is triggered.

Partial/Full Decoupling deadline: latest moment in time to complete some procedure in Normal or Backup mode. If an incident that does not allow applying Normal or Backup procedure (if any) occurs before this time, Fallback procedure is triggered.

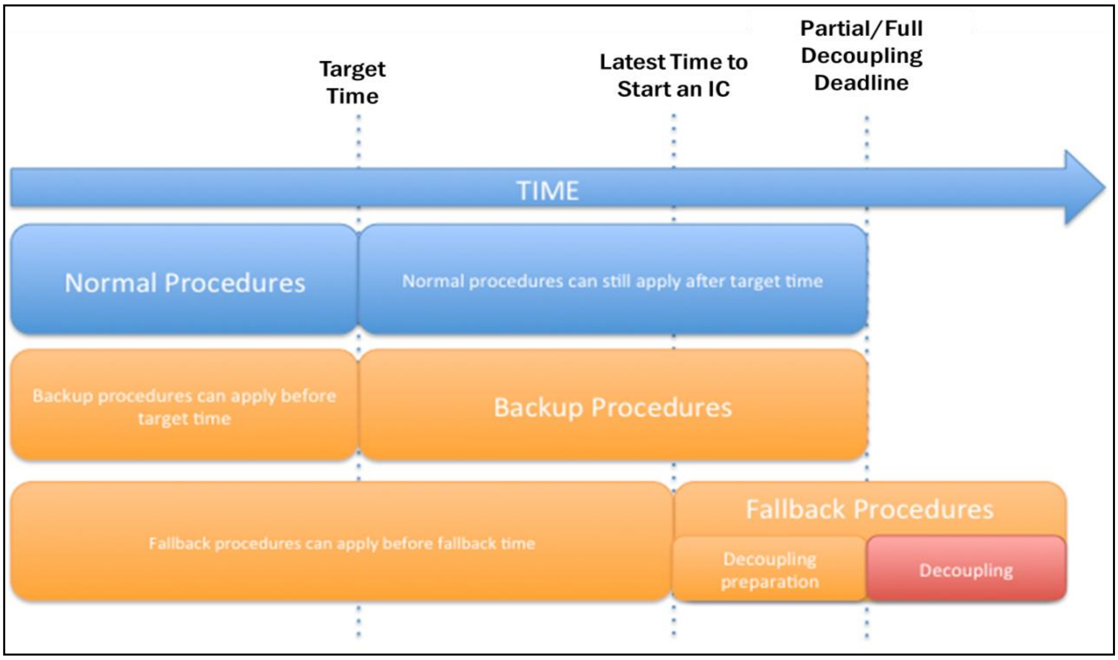


Figure 5-1: Interrelationship between Normal procedures, Backup, and Fallback.

5.2. High Level Architecture

The High Level Architecture is described in the final regulatory report of the MRC Day-Ahead Market Coupling Project (§3.1 resp. 3.7 of MRC Day-Ahead Market Coupling Project, Final Regulatory Report), which has been sent for approval to the MRC National Regulatory Authorities.

For completeness of the provided information, the above mentioned chapters of the MRC approval package are attached to this document (c.f. Annex 15.7).

5.3. Operational procedures

The Market Coupling process is divided into 3 different phases. During each phase, a number of common procedures will be operated under normal conditions. These procedures are called Normal Procedures and Backup Procedures. In addition there is a number of common procedures which are not associated to a specific phase. The procedures that belong to this category are Other, Special and Fallback Procedures. In this paragraph we describe them on a high level[20].

The following procedures are specific for the local CWE FB MC solution and are not part of the MRC-documentation and approval request.

[20] Please refer to Annex 15.8 for detailed procedures (to be provided later).

5.3.1. Phase 1: provision of the Cross Zonal Capacities and Allocation Constraints by the TSOs

Phase 1 starts with the sending of the Cross Zonal Capacities and Allocation Constraints to the PX Pre Coupling Module by the CWE TSO Common System and ends when the Cross Zonal Capacities and Allocation Constraints are successfully received by the PXs Pre-Coupling Module.

NOR_1: Cross Zonal Capacities and Allocation Constraints	This procedure describes the first phase of the business process dedicated to the sending of the Cross Zonal Capacities and Allocation Constraints by TSOs and their reception by PXs.
BUP_1: Cross Zonal Capacities and Allocation Constraints	Description of the actions to be performed by the operator in case the normal process described in NOR_1 does not work.

5.3.2. Phase 2: Final Confirmation of the Results

Phase 2 starts with the sending of the Price Coupling Results for the final confirmation to the CWE TSO Common System. This phase ends with the reception of the Global Final Confirmation of the results by the CWE TSO Common System. Hereby, the Price Coupling Results become firm.

NOR_2: Final Confirmation of the Results by the CWE TSO CS	This procedure describes the second phase of the business process dedicated to verify and validate the price coupling results in a normal mode.
BUP_2: Final Confirmation of	Description of the actions to be per-

the Results by the CWE TSO CS	formed by the operator in case the normal process described in NOR_2 does not work.

In case of a negative Global Final Confirmation, an Incident Committee will be triggered according to CWE_FAL_01. For a detailed description of the Fallback mechanism we refer to chapter 0.

5.3.3. Phase 3.1: Price Coupling Results and Scheduled Exchanges

This phase starts with the sending of Price Coupling Results by the CWE TSO Common System (Verification Module) to the CWE TSO Common System (Post Coupling Module). Then, the CWE TSO Common System (Post Coupling Module) will calculate the Scheduled Exchanges (c.f. chapter 11) and send them to the Cross-PX Clearing and Settlement System, the local TSOs and to the Congestion Revenue Distribution System (CRDS).This phase ends with the sending of MRC net positions and Prices from the Cross PX Clearing and Settlement System to the Congestion Revenue Distribution Systems.

NOR_3: Price Coupling Results and Scheduled Exchanges	This procedure describes the first part of the third phase of the business process regarding the steps that have to be performed in a normal mode.
BUP_3: Price Coupling Results and Scheduled Exchanges	Description of the actions to be performed by the operator in case the normal process described in NOR_3 does not work.

5.3.4. Phase 3.2: Trading Confirmation, Scheduled exchanges notification and Congestion Income

This phase starts with the sending of the Trading Confirmation from the Cross PX Clearing and Settlement System to the CCP Shipping System. It ends with the sending of the Scheduled Exchanges Notification from the CCP Shipping System to the TSO Back-End Systems.

NOR_4: Trading Confirmation, Scheduled exchanges notification and Congestion Income	This procedure describes the second part of the third phase of the business process regarding the steps that have to be performed in a normal mode
BUP_4: Trading Confirmation, Scheduled exchanges notification and Congestion Income	Description of the actions to be performed by the operator in case the normal process described in NOR_4 does not work.

5.3.5. Other Procedures

Other Procedures are not associated to a specific phase. They relate to certain situations, which need to be managed by a formalized procedure.

Other Procedures	Documents describing various actions to be performed by the PX operator under certain conditions which are not back up or Fallback actions
SPE_01 CWE Second Auction	Description of modified timeframe and actions to be performed by the PX operator in case of special or exceptional circumstances leading to a second auction

OTH_01 Glossary	Description of used terminology and abbreviations in order to facilitate the reading of procedures
OTH_02 Internal and External Communications	Description of messages that need to be sent in order to provide an official communication during some particular market situations or technical incidents
OTH_03 CWE Publications	Description of the different publications and associated timings
OTH_04 CWE Market Operator Tasks and Rotational Scheme	Description of the actions to be performed by CWE Market Operator in case of a switch of the CWE PMB Operator
OTH_05 Change control procedure	Description of the process to follow by all parties in case of change in one of the systems

5.3.6. Fallback procedures

Fallback procedures are applicable as soon as an incident occurs that prevents the timely allocation of the CZCs via the implicit allocation process and/or the timely publication of the Market Coupling Results. In this case an Incident Committee is convened where the issue is assessed and in case necessary, potential Fallback solutions will be assessed and agreed upon.

Fallback Procedures	Documents describing the actions that should be performed by the PX operator under Fallback conditions.
FAL_01 Incident Management	Description of the initiation of the Inci-

	dent Committee and the way discussions should be handled.
FAL_02 Full Decoupling	Description of the actions to be initiated by the operator in case Full Decoupling is declared by the Incident Committee.
FAL_03 Partial Decoupling	Description of the actions to be initiated by the operator in case Partial Decoupling is declared by the Incident Committee.

6 Fallback arrangement for Market Coupling (capacity allocation)

This chapter presents the description of the proposed CWE MC Fallback arrangement in case of a problem in the coupling process once the capacities (Flow Based parameters) have been received by PXs.
Regarding the Flow Based capacity calculation Fallback solution, please refer to chapter 4.6.
The Fallback arrangement is described in following sections:

- Fallback situations
- Fallback solutions
- Principle of the Fallback arrangement
- CWE-BritNed or CWE-only Coupling
- Description of explicit PTRs allocation
- Bids
- Database tool
- Sequence of operations
- Matching and price determination rules

6.1. Fallback situations

A Fallback situation occurs when the MRC price coupling has not given price coupling results at the time limit to trigger the Fallback. The Fallback solution for the CWE Region is described in the Fallback HLFAs of the approved MRC Price Coupling Solution documentation (§9.1 of MRC Day-Ahead Market Coupling Project, Final Regulatory Report), c.f. Annex 15.9.
The following paragraphs summarize the most important characteristics related to Fallback from the perspective of Market Parties, operating in the CWE region.

The Fallback is caused by the failure of one or more processes in the Market Coupling session, that affect the completion of the Business process phase 2 (see 5.3, operational procedures). In other words, the Fallback is pronounced if no Market Coupling result can be calculated and validated before the Partial/Full Decoupling deadline of phase 2. For instance:

- some market data may not be generated,
- the algorithm, or the system on which it runs may fail,
- technical validations may return a “non-compliant” result.

One can note that in all cases, CWE TSOs commit to deliver Flow Based Parameters over the entire day to the Market Coupling system.

6.2. Fallback solutions

The Incident Committee will assess and agree on the potential Fallback solution which can be either PCR partial or full decoupling according to the observed incidents and deadlines.
A Partial Decoupling is a situation where it is not possible, for a specific day, to allocate the capacities via the implicit allocation for one or several areas and/or interconnectors before the relevant Partial Decoupling Deadline. After the Partial Decoupling declaration by the Incident Committee, the process will be followed through the MRC Normal procedures, even though the timings are delayed accordingly for the remaining coupled areas and/or interconnectors. For the decoupled areas and/or interconnectors the Local procedures are followed accordingly. If, at the regular publication time, Market Coupling Results have not been published, a PCR external communication message informs Market Parties about a delay in the pro-

cess and the risk of Full Decoupling. In case the Full Decoupling has been declared by the Incident Committee, PXs and TSOs have three options to continue. The Fallback solution for CWE internal borders is shadow explicit auctions via JAO, described in the next paragraphs

1. The CWE-BritNed Coupling will be activated: the issue causing the MRC Full Decoupling came from a party outside CWE;
2. The CWE-only Coupling will be activated: The issue causing the MRC Full Decoupling came from GB2.
3. Local procedures for running the shadow explicit auctions will apply. No CWE(-BritNed) coupling can be activated if the issue causing the MRC Full Decoupling is:
   a) A critical technical issue on one of the CWE parties;
   b) A major failure of the coupling system (PMB) or the coupling algorithm (Euphemia).

The Fallback solution for CWE internal borders is shadow explicit auctions via JAO, described in the next paragraphs. In case 1 and 2 the Shadow Auctions results for the CWE internal borders will not be published by JAO.

A Full Decoupling known in advance can only be declared in case the previous Market Coupling Session has resulted in a Full Decoupling and the corresponding critical issue could not be solved until the target time for publishing the CZCs. In this situation no CWE-BritNed Coupling will be activated.

6.3. Principle of the CWE Fallback Arrangement

The principle of the proposed Fallback arrangement is to allocate the ATCs for shadow auctions derived from Flow Based parameters via a "shadow explicit auction" and a Partial/Full Decoupling of the

PXs. This means isolated local auctions by the PXs, performed after having reopened their order books. The shadow explicit auction consists of:

- maintaining a permanent data base where all pre-registered Market Parties (Fallback participants) may submit, amend or withdraw, bids for capacity. During normal operation, these bids are not used;
- should a Fallback situation be declared on a particular day in case of an incident during the daily session, the Shadow Auction System Operator (JAO) performs a Shadow Auction to allocate the Available Transmission Capacities based on the available valid bids; from the time of running the Fallback auction, the participants are not allowed to update their bids for the upcoming shadow auction.
- should a Fallback situation be declared in advance for the next sessions of CWE MC in case of any foreseen unavailability, the participants are allowed to update their bids according to the time schedule communicated by the Shadow Auction System Operator (JAO); the Shadow Auction System Operator (JAO) performs a Shadow Auction to allocate the available transmission capacities.

For the High-level Fallback Architecture, please refer to Annex 15.9. The publication of Shadow Auction ATCs is described in chapter 9.

6.4. CWE-BritNed Coupling

The CWE-BritNed Coupling is a regional coupling that will occur after an MRC Full Decoupling and certain criteria are met. In the event of an issue outside the CWE region (also not related to PMB and algorithm), which leads to a Full Decoupling, the CWE area can stay

coupled by a CWE-BritNed Regional Coupling. In case the above describes applies, but the issue is in the GB2 area, a CWE only Coupling will be activated.
The FB capacities will be used in a regional coupling via implicit auction (PMB and Euphemia are used).

6.5. Description of explicit PTRs allocation

The Shadow Auction allocates Physical Transmission Rights (PTRs) for each oriented bidding zone border and for each hour of the day. Using the ATC, provided by TSOs, and the auction bids from the Shadow Auction System, the Shadow Auction System calculates the PTRs allocated to the participants and the corresponding programming authorizations. The PTRs resulting from the auction may not exceed the ATCs. The unused PTRs are lost by the Fallback participants (UIOLI) if they are not nominated.
Since PTRs and programming authorizations are only options, the Fallback arrangement cannot take into account any netting of opposed capacities.

6.6. Bids in case of explicit PTR allocation

6.6.1. Content

A bid entered in the Shadow Auction System contains the following information:

- the bidding zone border for which the bid applies (Belgium-Netherlands, Netherlands-Germany, Germany -France or France-Belgium, Germany-Austria),
- the direction for which it applies (two directions for each country border),

- the hourly period for which it applies,
- a price to be paid for the capacity.

Bids inserted by the participants in the Shadow Auction System are unconditional and irrevocable once the Fallback mode has been declared in case of an unforeseen unavailability of the CWE FB MC or according to the new time schedule communicated in advance if an unavailability of the CWE FB MC is forecasted for the next daily sessions.

Bid(s) submitted by the participant to a Shadow Auction are submitted in a priority order according to their Bid Identification. Lowest ID number has the highest priority. When a Shadow Auction is run, bids are created according to the priority order until the Bids meet the available capacity. The last created bid that exceeds the Available Capacity is reduced so the total of Bids does not exceed the Available Capacity.

6.6.2. Ticks and currency

Bids contain whole MW units, and Bid Prices in Euros per MWh expressed to a maximum of two decimal places.

6.7. Shadow Auction System tool and bid submitters

The Shadow Auction System enables participants to submit bids, according to the conditions set out in the documentation available on the Shadow Auction System Operator's (JAO) website. In particular, bids must be submitted in accordance with the formats defined in the relevant documentation.

6.8. Sequence of operations in case of explicit PTR allocation

The sequence of operations is applicable after a decision to resort to Fallback after the Partial/Full Decoupling deadline or in case a Fallback situation is announced in advance at 10:30. The process and contractual basis remains the same as under CWE ATC MC.

1. At any time, Market Parties are invited to register by means of entering into an agreement with the Shadow Auction System Operator (JAO) through applicable Shadow Allocation Rules. From then on, they become "Fallback participants".
2. At any time, Market Parties are invited to register by means of entering into an agreement with the TSOs for the nomination part (meaning that the Market Parties should sign a nomination contract or designate their nomination responsible according to each country's regulation).
3. Fallback participants are allowed to enter bids into the Shadow Auction System and amend or withdraw them.
4. TSOs provide the Shadow Auction System Operator (JAO) with ATCs.
5. Should a Fallback situation be declared, Market Parties will be informed and can update their bids according to the new time schedule communicated.
6. The Shadow Auction System Operator (JAO) then performs the Shadow Auction: it determines the PTRs allocated to each Fallback participant and the corresponding programming authorizations.
7. The Shadow Auction System Operator (JAO) provides each Fallback participant with the results and prices resulting from the auction.
8. The Shadow Auction System Operator (JAO) provides each TSO/Fallback participant with all programming authorizations.

9. The Shadow Auction System Operator (JAO) publishes transparency data, as defined in chapter 9.4.
10. PX participants are allowed to change their position in the PX order books in function of the Fallback situation. The PXs then match and publish their results separately.
11. Fallback participants submit their nominations to TSOs according to the existing local processes.

6.9. Matching and price determination rules in case of explicit PTR allocation

The Shadow Auction is performed for each country border within CWE, each direction and each hour, by the following steps:
1. The bids are ranked according to the decreasing order of their price limit.
2. If the total capacity for which valid bids have been submitted is equal to or lower than available capacity for the auction in question, the marginal price is nil.
3. If the total capacity for which valid bids have been submitted exceeds the available capacity for the auction in question, the marginal price is equal to the lowest bid price selected in full or in part.
4. The highest bid(s) received for a capacity requested which does (do) not exceed the available capacity is (are) selected. The residual available capacity is then allocated to the participant(s) who has (have) submitted the next highest bids price, if the capacity requested does not exceed the residual capacity; this process is then repeated for the rest of the residual available capacity.
5. If the capacity requested under the next highest bid price is equal to or greater than the residual available capacity, the bid is selected either in full, or partially up to the limit of the residual available capacity. The price of this bid constitutes the marginal price.

6. If two (2) or more participants have submitted valid bids with the same bid price, for a total requested capacity which exceeds the residual available capacity, the residual available capacity is allocated in proportion to the capacity requested in the bids by these participants, in units of at least one (1) MW. The capacities attributed are rounded down to the nearest megawatt. The price of these bids constitutes the marginal price.

6.10. Daily schedule

A Fallback situation may be declared at any time before publication of FB MC results. However, the timing of procedures may depend on the moment it is triggered: if known sufficiently in advance the timing will be adapted to the prevailing conditions, this will be communicated to the market as early as possible. The timings presented in this document correspond to the worst case, which is when Fallback is triggered at the MC results publication deadline.
In the worst case, i.e. when the Fallback situation is declared at 13:50, the underlying hypotheses are:

- The delay between publication of the local PX market results and cross-border nominations is at least 45 minutes. In case the CWE-BritNed Coupling is activated, the delay between publication of the local PX market results and cross-border nominations is at least 35 minutes.
- 20 minutes are reserved for Market Parties to amend their orders on the PXs after the allocation of capacity via Shadow Auctions. 10 minutes are reserved for Market Parties to amend their orders on the PXs in case the CWE-Britned Coupling is activated.

- Sufficient time must remain for the TSOs to respect deadlines of the day ahead processes (e.g. ENTSO-E, Intra-day capacity calculation, margins calculation)

6.11. Opening hours

The access to the Shadow Auction System is open 24h a day and 365 days a year, except for system maintenance periods, announced by the Shadow Auction System Operator (JAO) generally 15 days in advance. In exceptional circumstances this notice may be shorter.

7 Requirements for and functioning of the Market Coupling algorithm

The introduction of Flow Based does not change the requirements for the Market Coupling algorithm (Euphemia). All details concerning the algorithm (except the intuitiveness constraint) can be found on MRC PXs' websites. Formal approval for using this specific and specified algorithm has been part of the approval of the NWE/MRC day-ahead MC project.

Intuitiveness constraint

Since the principle objective of the Market Coupling is to provide (day-ahead market) welfare maximizing solutions, such solutions need to fulfil optimality conditions. One can prove that under certain circumstances such optimal solutions exchange energy from high priced areas to low priced areas, i.e. the solution can be non-intuitive. This can be simply accepted and we label such a solution as "plain Flow Based solution".

However, from other perspectives, non-intuitive results may represent an unbalanced distribution of costs and benefits between markets, or even a perverse market. Consequently, in order to cope with the eventuality that such non-intuitive solutions may be determined to not be acceptable, the algorithm has an option to suppress non-intuitive solutions. More precisely when the "intuitive patch" is activated solutions should now fulfil an additional constraint:

For a solution that consists of net positions and market prices per bidding area a decomposition of the net positions into exchanges (following a pre-specified topology) should exist such that all exchanges are from a low priced area to a high priced area.

8 Economic Assessment

8.1. Results of the 2013 external parallel run

The economic impact of FB MC compared to ATC MC on market and prices was initially demonstrated in the feasibility report.

Based on the first year of the external parallel run an extensive study of the impact of FB(I) MC has been performed (Annex 15.10).

The study shows an approximate day-ahead market welfare increase of 79M€ (307 days simulated of 365) for 2013 with an average daily gain of 257 K€. Therefore a social welfare increase for the region of nearly 95M Euro on an annual basis can be expected (based on extrapolated results of the average daily welfare increase, during the external parallel run from January to December 2013).

The parallel run also showed some increases in price volatility and a limited correlation with prices under ATC Market Coupling, especially in the smaller markets.

Simulations comparing ATC, FB MC and FBI MC in 2013 gave furthermore the following results:

- Day-Ahead Market Welfare and Convergence indicators are significantly better with FB MC or FBI MC than with ATC MC.
- Non-intuitive situations were found. Enforcing intuitiveness through FBI MC deteriorates only very slightly the indicators. Moreover, non-intuitive situations represent a minor proportion of the analysed cases.

Notwithstanding the limitations mentioned in chapter 1.2.2 of the study in Annex 15.10, the market impact analysis concludes that FB MC and FBI MC have a positive impact on welfare, compared to ATC MC.

8.2. Sensitivity i.e. domain reduction study

The domain reduction study aims at providing some insights into the sensitivity of the market results to different FB parameters. The margin reduction is a simple tool to model impact, although it lacks a link with physical reality.

- The objective of this study was to answer what impact changes to the FB domain have on market results. A series of trivial qualitative results could be obtained by simple reasoning and was confirmed in our study: The level of price convergence increases with additional margin;
- The day-ahead market welfare increases with additional margin;

We tried to quantify the impact.

Impact on price

The annual average prices are little affected by the margin reductions. However once the isolated case is being approached the effects, especially for BE become more noticeable (e.g. for BE the average price under FB is € 44.44, but this would increase to € 57.83 when margins are reduced to only 10% of the current level. When margin is reduced to 90% of the current level the BE would increase to € 44.92).

Impact on welfare

The difference in welfare between the 100% scenario and the infinite scenario is 383k€ average per day. This suggests that under the current market conditions welfare could be further increased with additional margin.

When we consider the relative increase in welfare (distance from isolated scenario over distance between infinite scenario and isolated scenario) we observe that 90.3% of the welfare potential is realized. This would increase to 92.8% when margin is increased to 110%, or drop to 87.03% when margin is decreased to 90%.

There are limitations too: diminishing return to scales: each subsequent increase in margin will increase welfare by less than it increased by earlier margin increases. This means that increasing margin from 10% to 20% raises average daily welfare by 470k€, whereas increasing margin from 20% to 30% only raises welfare an additional 380k€. The increase from 90% to 100% only added 119k€ and from 100% to 110% 93k€. Realizing the full remaining welfare potential with the infinite scenario would likely require vast increases in margin.

Overall

Comparing the results from this study with the results from ATC, it appears that as long as margins are at least 90% of their current values the FB methodology still outperforms the ATC approach, both in terms of welfare and price convergence.

The domain reduction study can be found in Annex 15.11.

8.3. Decision on Intuitiveness

Buying at low(er) prices and selling at high(er) prices is an intuitive fundamental for all kinds of trading and business activities. However, for maximising total day-ahead market welfare under FB MC, it can happen that there is an exchange from a higher price area to a lower price area, which is non-intuitive.

Related to FB MC, a situation (a combination of market clearing prices and Net Export Positions) is said to be (bilateral-)intuitive, if there exists at least one set of bilateral exchanges that satisfies the

following property: “exchanges on each interconnector occur from the low price area to the high price area”.
In October 2013 the Project Partners published an update of the CWE Enhanced Flow Based MC Intuitiveness Report to explain all details related to intuitiveness. This version of this Intuitiveness Report is annexed to this approval document (c.f. Annex 15.12).
The economic assessment for the complete year 2013 of external parallel run indicates
421 non intuitive hours (5,7% of all hours and 8,2% of the congested hours).

The main outcome of the project’s assessment whether to go-live with plain or intuitive CWE Flow Based market coupling is presented in the following overview, assessing the differences between FB and FBI against a set of criteria.
The exhaustive study can be found in Annex 15.13.

Criterion	In favour of FB “plain”	In favour of FB “intuitive”
Volatility	inconclusive	
Price Signal	Negligible difference	
Liquidity	resilience analysis: inconclusive	
Welfare (global)	Unknown	Unknown
Welfare (DAMW)	X (though relatively small)	
Welfare repartition	No statistically significant difference	
ID	X (considering DA capacity should not be allocated to ID)	X (considering ID capacity is higher; mitigates DA welfare loss)
Investment	inconclusive	
SoS	inconclusive	
Communication to general public	Arguments against either alternative exist	

Based on the inconclusive outcome of the study, the Project initially has not been in a position to make a recommendation whether to start with FB or FBI. The outcome of the public consultation of the NRAs of June 2014 has given additional guidance for the decision.
Based on guidance by the CWE NRAs CWE FB MC has started with FB intuitive.
Regardless of this decision, the Project will monitor the Flow Based plain and keep the possibility to reassess the decision after go-live.
Key descriptions and confirmation related to Euphemia/the FBI-decision, requested by the NRAs after the June 2014 consultation can be found in Annex 15.18

9 Publication of data

This paragraph describes how the Project aims to provide the necessary data towards Market Parties of the CWE Flow Based Market Coupling, in order to facilitate the market and to comply with EU-legislation.

The issue of data publication (transparency) was a key issue in the responses of the first public consultation in May-June 2013 (c.f. Annex15.14). The results have been discussed with the CWE NRAs in expert meetings afterwards. Additionally there have been exchanges with MPs about transparency needs in Flow Based User Group meetings and Market Fora. To keep business secrets and confidentiality, the Project furthermore had bilateral discussions with some MPs to better understand processes and data needs on MPs' side.

As a result, an approach for data-supply and transparency, which covers the main needs of MPs has been defined. An overview over all data directly published by the project via the Utility Tool on the JAO website is provided in form of a publication handbook, which can be found on the JAO website[21] as well.

For monitoring purposes the National Regulatory Authorities get additional (confidential) data and information (further described in chapter 10). Based on national and EU-legislation, on reasonable request from the NRAs, the Project will provide all Project related data for monitoring purposes. Publications of monitored information can be commonly agreed from case to case.

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[21] http://www.jao.eu/cwemc_publicationhandbook

9.1. Relation to EU Regulations

Transparency obligations related to congestion management are currently mainly regulated by Regulation (EC) No 714/2009 and its Annex 1 § 5, and the Commission Regulation (EU) No 543/2013 on submission and publication of data in electricity markets and amending Annex I to Regulation (EC) No 714/2009 of the European Parliament and of the Council (entered into force in June 2013).

The transparency regulation and the abovementioned paragraphs of these CM-Guidelines oblige TSOs to publish a broad variety of data related to congestion management in general, and implicit FB MC in specific. Specifically for Flow Based, the transparency regulation foresees in its article 11 §1 that TSOs, for their control areas or, if applicable, transmission capacity allocators, shall calculate and provide the following information to the ENTSO for Electricity sufficiently in advance of the allocation process:

"b) The relevant flow based parameters in case of flow based capacity allocation".

Next, for transparency issues, there is the EC Regulation 1227/2011 on wholesale energy market integrity and transparency (REMIT) and the competition law, the Project has to comply with. To the opinion of the Project Partners, it is the responsibility of the individual PXs and TSOs to fulfil the requirements of all EU-regulations.

In this chapter we especially present the data which will facilitate the Market Parties in their bidding behaviour, as far as it concerns data produced by the common MC system and commonly published by the Project Partners. The publication of data via ENTSO-E as required by Commission Regulation (EU) No 543/2013, can be found on https://transparency.entsoe.eu.

9.2. General information to be published

The following general information is already covered within this document and will be updated and published when needed:

- Description of the coordinated Flow Based capacity calculation methodology,
- High-level business process of Flow Based capacity calculation
- A description of the CWE FB MC solution,
- Fallback arrangements in case of decoupling.

Furthermore, a description of the market coupling algorithm Euphemia is published by the MRC Project[22]. -

9.3. Daily publication of Flow Based Market Coupling data

It is the obligation of ENTSO-E to publish relevant data related to the cross border exchanges on the ENTSO-E platform. TSOs can mandate a third party, like JAO, to deliver the data on their behalf to the ENTSO-E Transparency platform. For the time being, the Project Partners have decided to provide easily accessible data as set out in the next two subsections on a common website (www.JAO.eu).

[22] This information is published on PXs' websites of MRC region.

9.3.1. Daily publication of data before GCT

Intitial Flow-Based parameters (without LT-nominations)

Based on requests from MPs' side, the Project provides for information and analysing purposes initial Flow-Based parameters at D-1 (8:00 target time) with random anonymized CBCOs.

For this set of FB-parameters all long term nominations at all CWE-borders are assumed as zero (LT-noms=0).

The technical provision is similar to the below mentioned, via the Utility Tool.

Final Flow-Based parameters

The TSOs will publish for each hour of the following day the Flow-Based parameters i.e. the fixed Critical Branches, Power Transfer Distribution Factors (PTDFs) and the Remaining Available Margin (RAM) on Critical Branches. In addition to the Remaining Available Margin values, the Adjustment for Minimum RAM (AMR) values that can be implemented in order to guarantee the 20% min RAM for each CBCO along with the information of exclusion of a CBCO from the 20% min RAM process if the exclusion has been done by the TSO, will be published. This publication shall comply with the obligations of Art. 11 (1b) of the transparency regulation.

The Flow Based parameters will be available at D-1 (10:30 CET – target time) via the Utility Tool, daily fed with new input data of the next day from the JAO website. The Utility Tool can be downloaded from JAO website.

The look and main features of the Utility Tool are presented in Annex **Fout! Verwijzingsbron niet gevonden.**.

Content	Where/ Who	When	Unit
fixed Critical Branches (CBs)	JAO/ ENTSO-E	D-1 (10:30 CET)	ID

PTDFs	JAO/ ENTSO-E	D-1 (10:30 CET)	-
RAMs	JAO/ ENTSO-E	D-1 (10:30 CET)	MW
AMRs	JAO/ ENTSO-E	D-1 (10:30 CET)	MW
Exclusion from min RAM process	JAO/ ENTSO-E	D-1 (10:30 CET)	-

Final Shadow Auction ATCs

The final Shadow Auction ATCs (border and direction) per market time unit will be published at D-1 (10:30 CET – target time) together with the FB parameters. The form of publication can be found in Annex 15.16.

9.3.2. Publication of data after Market Coupling calculation

The Project will comply with the respective obligations of Art. 12 (a) & (e) of the transparency Regulation.
Additionally, in the framework of separate CWE FB MC publications, the following data is published:

On JAO Website:

- Capacity allocated
- The total congestion income in the CWE area

In addition to the data above, the Project Partners publish the following data:

- PX market prices: the market prices for each market time unit of the day will be published on daily basis on the ENTSO-E platform (https://transparency.entsoe.eu/) by the individual PXs for their hub.

- Aggregated supply and demand curves for each market time unit of the day will be published by the individual PX for their hub.

These data will be published after Flow Based allocation for each market time unit (presently an hour) of the day.

Content	**Where/ Who**	**When**	**Unit**
Capacity allocated (used margin on Criti-cal Branches)	JAO/ ENTSO-E	13:00 CET	MW
Congestion income	JAO/ ENTSO-E	19:00 CET	€
Individual Hub prices	PXs' websites	13:00 CET	€/MWh
Aggregated supply and demand curves for each market time unit	PXs' websites	14:00 CET	-
Overview CWE-Hub prices	ENTSO-E	14:00 CET	€/MWh
Hubs net positions	JAO / ENTSO-E	13:00 CET	MW

9.3.3. Publication of additional CBCO information

CWE partners will publish, for each day with an hourly resolution, the list of all Critical Branches, disclosing the location aggregated by bidding zone or border ("BE", "DE", “AT”, "FR", "NL", “DE-AT”, "DE-NL", "FR-BE", "FR-DE", BE-NL").

In other words, CWE partners will publish the equivalent of the PTDF sheet of the utility tool, but will publish the Critical Branch and Outage Name, the EIC codes if applicable of the CB and CO, RAM, Fmax, Fref, FRM, FAV, AMR, presolved status, bidding area and the PTDF factors linked to the fixed CBCO labels

This additional publication will be realized at 10:30 AM in D-1 .

The content and style of this additional data supply related to the Critical Branches is the outcome of intensive exchange with Market Parties and NRAs.

Date: 2017-05-17

FileId	DeliveryDate	Period	Row	OutageName	EIC_Code	CriticalBranchName	EIC_Code	Presolved	RemainingAvailableMargin (MW)	Fmax	Fref	FRM	FAV	BiddingArea_Shortname	Factor
137	20170517	1	11351420000	11351420000	N/A	11351420000	N/A	FALSE	1,090	1385	11	284	0	BE	-0.05206
137	20170517	1	12796520000	12796520000	N/A	12796520000	N/A	FALSE	17311699	1.7E+07	124	0	0	BE	-0.15192
137	20170517	1	12332120000	12332120000	N/A	12332120000	N/A	FALSE	17311498	1.7E+07	325	0	0	BE	-0.02346
137	20170517	1	12875000000	12875000000	N/A	12875000000	N/A	FALSE	15143283	1.5E+07	232	0	0	BE	-0.15443
137	20170517	1	12361720000	12361720000	N/A	12361720000	N/A	FALSE	13847862	1.4E+07	211	0	0	BE	-0.19541
137	20170517	1	18179830000	18179830000	N/A	18179830000	N/A	FALSE	17394494	1.7E+07	459	0	0	BE	0.11523
137	20170517	1	18615060000	18615060000	N/A	18615060000	N/A	FALSE	15406610	1.5E+07	150	0	0	BE	0.07481
137	20170517	1	18432740000	18432740000	N/A	18432740000	N/A	FALSE	5034566	5034532	-34	0	0	BE	0.06222
137	20170517	1	18441840000	18441840000	N/A	18441840000	N/A	FALSE	5034560	5034532	-28	0	0	BE	0.07034
137	20170517	1	18410900000	18410900000	N/A	18410900000	N/A	FALSE	15406467	1.5E+07	293	0	0	BE	0.15217
137	20170517	1	11734810000	L 400kV N0 1DOEI	22T-BE-IN-LI0	L 400kV N0 1DOEL-AVELGE	22T-BE-IN-LI012	FALSE	694	1515	742	79	0	BE	-0.02802
137	20170517	1	12796523000	12796523000	N/A	12796523000	N/A	FALSE	1383	1731	124	224	0	BE	-0.15192
137	20170517	1	12332123000	12332123000	N/A	12332123000	N/A	FALSE	1147	1731	325	259	0	BE	-0.02346
137	20170517	1	11370900000	11370900000	N/A	11370900000	N/A	FALSE	1089	1385	12	284	0	BE	-0.05523
137	20170517	1	12875003000	12875003000	N/A	12875003000	N/A	FALSE	1109	1515	232	174	0	BE	-0.15443
137	20170517	1	12361723000	12361723000	N/A	12361723000	N/A	FALSE	980	1385	211	194	0	BE	-0.19541
137	20170517	1	11805750000	11805750000	N/A	11805750000	N/A	FALSE	768	1385	462	155	0	BE	0.05122
137	20170517	1	11763970000	11763970000	N/A	11763970000	N/A	FALSE	864	1515	463	188	0	BE	0.05130
137	20170517	1	11904290000	11904290000	N/A	11904290000	N/A	FALSE	1024	1385	211	150	0	BE	-0.19541
137	20170517	1	11624910000	11624910000	N/A	11624910000	N/A	FALSE	1253	1385	-18	150	0	BE	-0.16338
137	20170517	1	18879320000	18879320000	N/A	18879320000	N/A	FALSE	921	1385	293	171	0	BE	0.15217
137	20170517	1	18792890000	18792890000	N/A	18792890000	N/A	FALSE	903	1608	459	246	0	BE	0.11523
137	20170517	1	18470050000	18470050000	N/A	18470050000	N/A	FALSE	1063	1385	150	172	0	BE	0.07481
137	20170517	1	18230780000	18230780000	N/A	18230780000	N/A	FALSE	416	452	-34	70	0	BE	0.06222
137	20170517	1	18943680000	18943680000	N/A	18943680000	N/A	FALSE	407	452	-28	73	0	BE	0.07034
137	20170517	1	11899430000	11899430000	N/A	11899430000	N/A	FALSE	883	1385	336	166	0	BE	0.15217
137	20170517	1	11977170000	11977170000	N/A	11977170000	N/A	FALSE	708	1415	451	256	0	BE	-0.17539
137	20170517	1	11274580000	11274580000	N/A	11274580000	N/A	FALSE	1473	1415	-232	174	0	BE	0.15443
137	20170517	1	11276460000	11276460000	N/A	11276460000	N/A	FALSE	1010	1415	211	194	0	BE	-0.19541
137	20170517	1	11147700000	11147700000	N/A	11147700000	N/A	FALSE	639	1385	678	68	0	BE	-0.02562
137	20170517	1	11662200000	11662200000	N/A	11662200000	N/A	FALSE	634	1385	678	73	0	BE	-0.02562
137	20170517	1	11440870000	11440870000	N/A	11440870000	N/A	FALSE	694	1515	742	79	0	BE	-0.02802
137	20170517	1	11461120000	11461120000	N/A	11461120000	N/A	FALSE	1449	1385	-203	139	0	BE	0.02449
137	20170517	1	11190200000	11190200000	N/A	11190200000	N/A	FALSE	1573	1515	-200	142	0	BE	0.01380
137	20170517	1	11388110000	11388110000	N/A	11388110000	N/A	FALSE	1499	1515	-114	130	0	BE	0.01380
137	20170517	1	11644190000	11644190000	N/A	11644190000	N/A	FALSE	1121	1385	-11	275	0	BE	0.05206
137	20170517	1	12760700000	12760700000	N/A	12760700000	N/A	FALSE	17311947	1.7E+07	-124	0	0	BE	0.15192
137	20170517	1	12715160000	12715160000	N/A	12715160000	N/A	FALSE	17312148	1.7E+07	-325	0	0	BE	0.02346
137	20170517	1	12307420000	12307420000	N/A	12307420000	N/A	FALSE	15143747	1.5E+07	-232	0	0	BE	0.15443
137	20170517	1	12328020000	12328020000	N/A	12328020000	N/A	FALSE	13848284	1.4E+07	-211	0	0	BE	0.19541

Figure 9-1: All CBCO fixed label publication

9.4. Publication of aggregated information related to the D-2 common grid model

Daily ex-post (at D+2) the following aggregated hourly information related to the common grid model will be published:

1. Vertical Load
2. Generation

3. Best forecast Net Positions for BE, DE, AT, NL, FR, which represent the total Net Positions of each bidding zone, and not only the CWE Net Positions.

Information related to this data items are described in the chapter "D2CF Files, exchange Programs". Wind- and solar generation is taken into account (subtracted from) the vertical load.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
Date:	######	The data for 2018-02-22 has been retrieved successfully.													
	D2CF per Hub (in MW)														
	Vertical load					Generation					Best Forecast Net Positions				
imeStamp	AT	BE	DE	FR	NL	AT	BE	DE	FR	NL	AT	BE	DE	FR	NL
1	8849	41657	56722	9175	7800	47996	61393	11264	-1279	5238	3457	1910	7752	5993	-1848
2	8552	40101	54990	8796	7265	46363	59136	11270	-1510	5160	2938	2292	7483	5710	-1857
3	8486	39306	54196	8663	6976	45277	57920	11049	-1732	4851	2556	2201	7747	5655	-2170
4	8523	40137	51774	8601	6780	45605	56106	10727	-1964	4424	3245	1953	8148	5584	-2632
5	8550	40175	51255	8691	6799	44845	56674	11069	-1974	3626	4351	2217	7372	5657	-1798
6	8583	42563	53602	9132	7546	47248	58857	11932	-1262	3655	4192	2633	8052	5848	-2291
7	9751	50334	58256	10314	8093	54989	63548	12463	-1896	3745	4261	1958	9159	7053	-2211
8	10255	55858	62622	12164	9477	59317	68305	13333	-1031	2595	4571	955	10133	8367	-1891
9	10204	56160	64811	13019	9847	59761	69498	13305	-615	2755	3611	63	10459	8583	-2004
10	10039	53012	64643	13106	9836	57742	69762	13356	-459	3866	4018	27	10554	8507	-2174
11	9644	50140	63777	12584	9463	56206	68026	13411	-429	5123	3180	601	10582	8165	-2539
12	9467	48134	62838	11994	8982	55446	66583	13352	-726	6331	2719	1128	10541	7869	-2789
13	8988	45723	61263	11675	8787	54951	65854	13265	-438	8225	3582	1362	10329	7646	-2798
14	9016	45178	59652	11561	8569	54867	65707	13318	-682	8688	5080	1525	10256	7638	-2733
15	9083	45298	58101	11544	8569	54942	65183	13332	-750	8652	6133	1564	10164	7769	-2511
16	9327	45946	56586	11824	8561	55200	65224	13338	-1004	8280	7769	1298	10155	7969	-2305
17	9564	47530	56141	12506	8879	55673	65548	13437	-923	7205	8556	715	10297	8229	-2191
18	9925	52343	57606	12794	9220	57750	66333	13598	-949	4625	7762	592	10600	8957	-1777
19	10493	54792	62446	12523	9592	61695	68053	13658	-1154	6071	4580	916	10657	9088	-1705
20	10185	52945	66129	12243	9560	61898	70311	13665	-877	8102	2941	1187	10219	8961	-1392
21	9733	48144	62295	11590	9106	58332	68227	13006	-872	9323	4689	1189	9608	7994	-1734
22	9269	45272	59395	10896	8471	55144	64982	12398	-1035	8922	4312	1276	8980	6284	-2790
23	9483	43546	58503	10085	8072	53233	64190	11881	-1648	8710	4303	1585	8809	5744	-3151
24	9424	40100	60380	9470	7908	49618	65092	11405	-1751	8422	3351	1732	8261	5320	-3020

Figure 9-2: Aggregated hourly information related to the common grid model

In addition, Refprog Bilateral exchanges on the CWE-borders and the following non-CWE borders is published for every hour[23]:

AT=>CZ, AT=>HU, AT=>SI, BE=>NL, BG=>TR, CH=>AT, CH=>DE, CH=>FR, CH=>IT, CZ=>SK, DE=>AT, DE=>CZ, DE=>NL, DE=>PL, ES=>MA, ES=>PT, FR=>BE, FR=>DE, FR=>ES,

[23] Note that Refprog bilateral exchanges refer to exchanges between control blocks.

FR=>IT, GR=>AL, GR=>BG, GR=>IT, GR=>RS, GR=>TR, IT=>AT, IT=>SI, PL=>CZ, PL=>SK, RO=>BG,RO=>HU, SI=>HU, SK=>HU, RS=>AL, RS=>BG, RS=>HU, RS=>RO, RS=>SI, UA=>HU, UA=>RO, UA=>SK

9.5. Publication of data in Fallback mode

The Fallback solution for CWE FB MC is coordinated with the MRC-/PCR Fallback arrangements. It will be (1) ATC based explicit shadow auctions, or (2) a regional coupling; CWE-BritNed coupling These explicit auctions will be performed by the Shadow Auction System Operator (JAO The regional coupling will be performed by the PMB and Euphemia, operated by the CWE MO (EPEX SPOT).
The Shadow Auction System Operator (JAO) will publish and update when necessary the following general information on its website:

- Shadow auction rules;
- names, phone and fax numbers and e-mail addresses of persons to be contacted at the Shadow Auction System Operator (JAO);
- the forms to be sent by participants;
- the information related to the time schedule of the shadow auctions when they are decided in advance (auction specifications);
- the shadow auction results, including the anonymous complete Bid curves (amongst others the requested capacity, the capacity allocated, the auction clearing price and the auction revenue); the results should be published 10 min after the allocation.;
- Data of past days will be archived.

The CWE MO will publish and update in case of a regional coupling the following general information on its website and via e-mail:

- CWE-BritNed Coupling rules on the website;
- Contact details of the PX (phone, fax numbers and e-mail addresses) on the website;
- the information related to the time schedule of the CWE-BritNed Coupling are on the website and sent by e-mail at the moment of the activation of a regional coupling;
- results of the CWE-BritNed Coupling for the specific delivery day.

9.6. Cooperation with the Market Parties after go-live

A Flow Based User Group meeting (CWE Consultative Group) will be held on a regular basis to discuss all relevant issues related to FB MC operation from MPs' perspective and to further improve the FB MC solution.

10 Monitoring

10.1. Monitoring and information to the NRAs only

For monitoring purposes the CWE Project provides the following additional data-items on a monthly basis to the NRAs only:

Items related to the FB capacity calculation

1. Results of the hourly LTA checks
2. Results of the hourly NTC checks
3. Line Sensitivity Check
4. Hourly Min/Max Net Positions
5. Hourly Intraday ATCs for all CWE borders
6. AT - Max Bilateral Exchanges (hourly)
7. BE - Max Bilateral Exchanges (hourly)
8. FR - Max Bilateral Exchanges (hourly)
9. DE- Max Bilateral Exchanges (hourly)
10. NL - Max Bilateral Exchanges (hourly)
11. Volume of the Flow-Based domains (hourly)
12. Usage of the Final Adjustment Value FAV
13. External Constraints
14. Hourly Shadow Auction ATCs for all CWE-borders
15. Overview of timestamps where spanning is applied (per month)
16. Overview of timestamps for which default FB parameters were applied (per month)
17. Hourly non-anonymized presolved CBCOs, disclosing

    PTDF, FMAX, FRM, FAV, RAM, FREF, AMR
18. Key aggregated figures per bidding zone and border (weekly aggregations)

    Number of presolved CBs

    Number of precongested cases

Number of CBs exceeded by LTA

Number of CBs exceeded by ATC

Number of of presolved CBs with RAs applied

Number of presolved CBs without RAs applied

Number of presolved CBs, breaching the 5% rule

Number of hours using the FAV

Number of hours, spanning technology was applied

Number of hours, default FB parameters were applied

19. In case of occurrence: justification when FAV is used
20. In case of occurrence: justification when 5% is breached (of pre-solved CBs)
21. In case of occurrence: justification when a CBCO is excluded from the MinRAM process

Items related to the FB capacity allocation (after market coupling)

1. Active CBs (Hourly)
2. Shadow prices (Hourly)
3. Monthly top 10 of active constraints
4. Number of days or hours, allocation used Shadow Auction ATCs instead of FB parameters
5. Number of congested CBs
6. Number of congestions in the timestamps with non-intuitive prices (pending technical feasibility)
7. Price convergence indicator
8. Price convergence indicator: border-per-border price differences diagrams
9. Welfare loss compare to infinite capacity
10. Comparison FB-intuitive and FB-plain
11. CIA-Reporting (congestion income allocation)

The templates for the foreseen reporting towards the CWE NRAs are presented in Annex 15.20.

11 Bilateral Exchange Computation and Net Position Validation

Bilateral Exchange Computation

As a result of the Market Coupling process one gets several sets of net positions (one net position value for each participating Market Area per hour).

The net positions have to be transformed into bilateral exchange data in order to support the daily nomination process. This transformation is called the 'bilateral exchange computation' (BEC). In the course of the BEC, the routes and time series of all CWE cross-border schedules (reflecting the MC volumes) are determined.

In principle, an infinite number of solutions exist to determine these Bilateral Exchanges, so it was decide to take the same formula as in BEC for ATC, without the major constraint used in this case (respect of NTC on all borders).

This formula reads (with B = NetPosition of one country):

$$BEC\_ma_{BE=>FR} = -\frac{1}{4} * (3B_{FR} + 2(B_{DE} + B_{AT}) + B_{NL})$$

$$BEC\_ma_{FR=>DE} = -\frac{1}{4} * (3(B_{DE} + B_{AT}) + 2B_{NL} + B_{BE})$$

$$BEC\_ma_{DE=>NL} = -\frac{1}{4} * (3B_{NL} + 2B_{BE} + B_{FR})$$

$$BEC\_ma_{NL=>BE} = -\frac{1}{4} * (3B_{BE} + 2B_{FR} + (B_{DE} + B_{AT}))$$

$$BEC\_ma_{DE=>AT} = -B_{AT}$$

The output of the computation has to be provided per directed border, so the missing borders in the previous calculation are determined as follows:

$BEC\_ma\,FR=>BE = -BEC\_maBE=>FR$

$BEC\_maDE=>FR = -BEC\_maFR=>DE$

$BEC\_maNL=>DE = -BEC\_maDE=>NL$

$BEC\_maBE=>NL = -BEC\_maNL=>BE$

$BEC\_maAT=>DE = -BEC\_maDE=>AT$

Net Position Validation

After completing the Market Coupling Process, the MC System sends the net positions for validation to the TSO Common System, for formal approval.

As the MC system and the TSO CS use the same algorithm for validation of the net positions (with the only difference in the tolerance levels), the results will normally be the same. The output of this verification is a full acceptance or full rejection of results of the Market Coupling process.

Validation performed is based on simple principles:

- Abs(NPout * NPin) < Tolerance Margin

  2 Net Position per Market Area are produced by the process: one in and one out. Only one can be non-zero.

- (NPout - NPin) < Tolerance Margin

Global CWE Net position is zero.

- (($NPout_i$ - $NPin_i$) * $PTDF_i$) < Margin (CB_j) + Tolerance $margin_i$

All CBs, adjusted to NetPosition to be validated, are safe

The tolerance margins are parameters with small positive values.

If all these inequalities are correct, the result of the validation process is a "Go" message to the MC System as the confirmation of the acceptance of Net Positions.

12 Contractual scheme

In this chapter the contractual scheme put in place for the operation of CWE FB MC is presented.

CWE FB MC shall be seen in the context of the European Price Coupling. To that extend, the CWE agreements as regional arrangements of the CWE region shall be compliant with the principles set forth in the Day-Ahead Operations Agreement (DAOA).

In this chapter, we will focus in particular on the:

- Principles of the CWE Framework agreement
- Parties involved in the daily operation and their tasks
- Risk management

12.1. Principles of the Framework Agreement

The daily operation and maintenance of the CWE FB MC is governed by a number of contracts between subsets of parties. These contracts are governed by the CWE Framework Agreement: the overall contract between CWE PXs and CWE TSOs. The subsidiary agreements between subsets of parties must be compliant with the principles of the CWE Framework Agreement. The principles of the CWE Framework Agreement have been discussed with regulators.

12.2. Roles and responsibilities of the Parties

In order to operate Market Coupling to the required standards, the Parties have agreed to allocate the involved tasks and actions to certain individual Parties or a subset of Parties. By doing so, it is ensured that all tasks and actions are performed by the most competent body, and are executed in an efficient way. One can distinguish the following actors:

- Individual TSOs

- Joint TSOs
- Individual PXs
- Joint PXs
- Joint Parties
- External service providers

In this section we listed the legal entities having an operational role in the Market Coupling. In the next sections we will further explain the roles of these involved actors.

12.2.1. Roles of the individual/joint TSOs

The individual TSOs are responsible to calculate on a daily basis the day-ahead Cross-Zonal Capacities (CZCs) for the operation of Market Coupling. In the context of FB MC, CZCs are Flow Based parameters. Flow Based parameters are determined by the joint TSO pre-coupling system according to the method described in chapter 1.1 on capacity calculation. After their determination, the joint TSO pre-coupling system sends the Flow Based parameters to the local PX trading system which forwards them to the PMB. The joint TSO pre-coupling system is operated by all TSOs taking weekly shifts.
The joint TSOs are also responsible for the final validation of the net positions and of the calculation of bilateral cross border exchanges that result from the net positions. These cross border exchanges are necessary for the nomination of the cross border flows at each TSO. The calculation of bilateral cross border exchanges is performed by the joint TSO post-coupling system. JAO is the operator of that system on behalf of the TSOs.

12.2.2. Roles of the individual PXs

The individual PXs are responsible to collect all bids and offers from their participants, and to submit their aggregated and anonymous order books to the PMB, a joint PX system part of the PCR solution. The PX order books are transferred and injected directly into the Market Coupling database. The order books contain all the bids of the Market Parties in an aggregated and anonymous format. The PX currently involved is EPEX SPOT, after the business of APX/Belpex had been integrated into EPEX SPOT in the course of 2015/2016.

After the Market Coupling has been performed and the price has been set, the individual PXs are responsible for executing all orders placed by their participants that are within the calculated price, and to form the contracts with them.

12.2.3. Roles of the joint PXs

The joint CWE PXs are responsible for building, operation and maintenance of the PMB system together with PXs of the PCR cooperation. The PMB system is the system on which the price coupling algorithm, Euphemia, will run on a daily basis to calculate the net positions, market prices and accepted block bids on the different hubs. The involved PXs operate the PMB system according to a rotation scheme.

12.2.4. Roles of joint Parties

The CWE PXs and TSOs are together responsible for the management of the CWE FB MC solution. Decisions regarding the solution will be taken by all the parties. In order to perform this task, the Parties will set up a joint steering committee, an operational committee and an incident committee.

12.2.5. Roles of external service providers

In order to operate an efficient Market Coupling, the CWE Parties have decided to outsource a number of tasks to external service providers (e.g. JAO and Coreso). Other tasks to be performed by service providers are:

- Shipping agent activities (nomination of cross border exchanges, financial clearing and settlement). These tasks are performed by the clearing house of EPEX SPOT´, ECC, for the Belgium, Dutch, French, German and Austrian hubs.
- Reception of congestion rents and distribution to the individual TSOs. This task will be operated by JAO.

12.2.6. Summary of operational roles

Entity	Role
TSOs	• Determine CZCs
Coreso & TSCNET	• Operate the TSOs pre coupling system on behalf of TSOs
PXs	• Collection of bids and offers from their participants in their hub, and submission of their aggregated and anonymous order books to the PMB. • Operation of the PMB in shift
ECC	• Financial clearing and settlement in the EPEX SPOT Belgium, Dutch, French, German and Austrian hubs, nomination of cross border exchanges
JAO	• Operation of the TSO post-coupling sys-

	tem (calculation of bilateral exchanges) • Congestion revenue distribution among TSOs

Operational roles at the time of submission of the approval document.

12.3. Risk management

In order to mitigate risks related to changes to all components that make the Market Coupling solution work as it is supposed to, e.g. systems, procedures and interfaces, the Parties have implemented a change control procedure (c.f. chapter 131).

12.4. Other risks addressed prior Go Live

There were some risks on which the project worked further and whose resolutions are an integral part of the project's Go Live acceptance criteria:

- Negative welfare days and control of quality of FB solution with respect to the size of the FB domain when reference to ATC is not available anymore. This aspect was addressed in the second report on specific parallel run investigations available in September 2014).
- Risk of lack of coupling capacity (in particular for smaller hubs) due to a combination of possible changes to nomination behavior and FB domain sometimes just covering some critical LTA corners. This aspect were addressed by further analysis of the risk and mitigation measures.

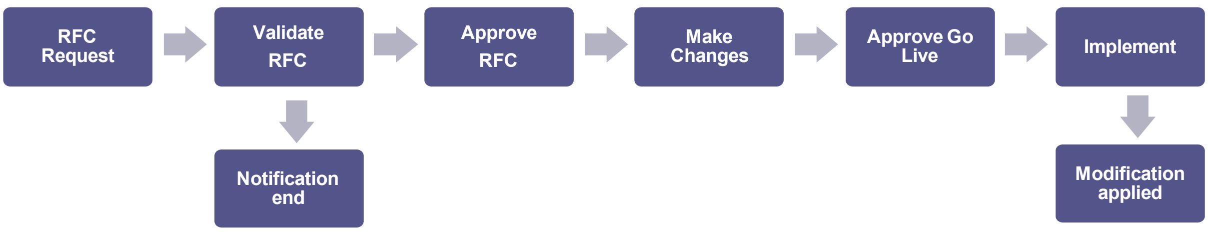
13 Change control

13.1. Internal change control processes of the Project

The change control procedure aims at tracking any change, small and large, in software, systems, procedures and in documents. Whilst the majority of changes are likely to be simple operational changes or small textual changes, it is still important that the procedure is robust to the processing of more complex changes. The relevant Steering Committee (e.g. CWE TSO Steering Group, CWE Joint Steering Committee) shall decide on the final approval of changes. Changes in the MRC coupling or PCR arrangements fall under the responsibility of the respective MRC Steering Committee or PCR Steering Committee.

In case a change is needed, a request for change document is filled. This document shall contain the details, the consequences such change could have for the other parties and any other relevant information on the requested change. Then, an impact assessment is performed in order to determine whether the requested change will have a material impact on the common operations and systems. The proposal is checked to see if it is correct. After approval, the change is performed.

Example given of a RFC Procedure control



Simple changes with a low-risk solution affect a small number of components owned by a single or joint party, and change only local items with no identified impact on common items. Project Partners are informed of such changes, with a fast track procedure if required.

All other changes which are more complex, of a higher risk category, affecting multiple components or components which are the responsibility of more than one project party are handled as real modifications, but can be managed in fast track if needed.

For simple changes, the change will be recorded on just one form. This will contain all the information required including the cause of the change, the proposed solution, its impact and the way in which the change will be implemented. In this case no other forms will be required to be completed.

13.2. Approval of changes of the CWE FB MC solution

Changes in the CWE FB MC methodology will be published. If needed, a formal approval request towards the NRAs will be started to be commonly approved. All changes will be documented and attached to the initial approval document.

14 Glossary

AC	Active constraint
AMR	Adjustment for Min RAM
ATC	Available Transfer Capacity
ATC MC	ATC Market Coupling
CB	Critical Branch
CBCO	Critical Branch Critical Outage
CCP	Cross Clearing Party
CEE	Central Eastern Europe
CET	Central European Time
CEWE	Central East West Europe
CGM	Common Grid Model
CO	Critical Outage
CS	Common System
CWE	Central Western Europe
CWE MO	CWE Market Operator
CZCs	Cross Zonal Capacities
D	Delivery Day
D-1	Day Ahead
D-2	Two-Days Ahead
D-2CF or D2CF	Two-Days Ahead Congestion Forecast
DA	Day Ahead
DACF	Day-Ahead Congestion Forecast
EC	External Constraints
ENTSO-E	European Network of Transmission System Operators for Electricity
FAV	Final Adjustment Value
FB	Flow Based
FB MC	Flow Based Market Coupling
FBI MC	Flow Based Intuitive Market Coupling
Fmax	Maximum allowable flow on a given Critical Branch

FRM	Flow Reliability Margin
GCB	German control block
GCT	Gate Closure Time
GSK	Generation Shift Key
HLA	High Level Architecture
IC	Incident Committee
ID	Intraday
IFA	Interconnexion France Angleterre
Imax	Maximum current on a Critical Branch
LT	Long Term
LTA	Allocated capacity from LT auctions
LTN	Long Term Nominations
MC	Market Coupling
MinRAM	Minimum RAM
MoU	Memorandum of Understanding
MP	Market Party
MRC	Multi Regional Coupling (successor of the former NWE project)
NA	Not applicable
NRA	National Regulatory Authority
PCR	Price Coupling of Regions
PLEF	Pentalateral Energy Forum
PMB	PCR Matcher and Broker (Joint PX IT System which embeds the PCR Algorithm calculating the MRC Net Positions, Prices and Scheduled Ex-changes on the non CWE interconnectors)
PCR Coordinator	PX operating the PMB system
PTDF	Power Transfer Distribution Factor
PST	Phase-Shifting Transformer
PX	Power Exchange
RA	Remedial Action

RAM	Remaining Available Margin
RSC	Regional Security Cooperation
SAS	Shadow Auction System
SoS	Security of Supply
TSO	Transmission System Operator
TYNDP	Ten-Year Network Development Plan
UCTE	(formerly Union for the Coordination of Transmission of Electricity (today integrated into ENTSO-E)

15 Annexes

15.1. Documentation of all methodological changes during the external parallel run

15.2. Educational example “How does Flow Based capacity calculation work?”

15.3. High level business process FB capacity calculation

15.4. Examples of different types of Remedial Actions (will be provided later)

15.5. Dedicated report on FRM (confidential)

15.6. Information regarding LTA inclusion

15.7. CWE High level architecture (confidential)

15.8. Technical Procedures (confidential)

15.9. CWE High level Fallback architecture (confidential)

15.10. Economic assessment

15.11. Domain reduction study

15.12. Intuitiveness report

15.13. Intuitiveness, Analysis for the FB/FB(I) selection

15.14. Results of the survey/ consultation in May/June 2013

15.15. Presentation of the Utility Tool

15.16. Publication of Shadow ATCs

15.17. Monitoring templates

15.18. Flow-based "intuitive" explained

15.19. Preliminary LTA inclusion statistics

15.20. Mitigation to Curtailment of Price Taking Orders

15.21. Implementation of FTR Options and temporary LTA+ solution

15.22. Methodology for capacity calculation for ID timeframe

15.23. Context paper CWE Intraday

15.24. Congestion income allocation under flow-based Market Coupling

15.25. Adequacy Study Report

15.26. Annex C_1_Transparency

15.27. Annex C_2_Transparency

15.28. Report on SPAIC results for the integration of the DE-AT border into CWE Flow Based

Note: The current status of the annexes of the CWE FB MC approval package listed above is available in the table below. It should be noted that most of the annexes listed have been published at the time of the Go-live (May 2015):

Name of the annex	Status of the document
Annex 15_1 Documentation of all methodological changes during the external parallel run	**Historically relevant**: description changes during parallel run
Annex 15_2 Educational example “How does Flow Based capacity calculation work”	**Valid**
Annex 15_3 High level business process FB capacity calculation	**Valid**
Annex 15_4 Example of different types of Remedial Actions	**Valid**
Annex 15_5 Dedicated report on FRM (**confidential)**	**Historically relevant**, data of 2013
Annex 15_6 Information regarding LTA inclusion	**Valid**
Annex 15_7 CWE High level architecture (**confidential)**	**Not up to date**
Annex 15_8 Technical procedures (**confidential)**	**Not relevant anymore**
Annex 15_9 CWE High level Fallback architecture (**confidential)**	**Not up to date**
Annex 15_10 Economic assessment	**Valid**

Annex 15_11 Domain Reduction Study	**Valid**
Annex 15_12 Intuitiveness report	**Valid**
Annex 15_13 Intuitive Analysis for the FB-FBI selection	**Valid**
Annex 15_14 Results of the survey-consultation in May_June 2013	**Not relevant** anymore
Annex 15_15 Presentation of the Utility Tool	Replaced by Publication Handbook: http://www.jao.eu/cwemc_publicationhandbook
Annex 15_16 Publication of shadow ATCs	**Valid**
Annex 15_17 Monitoring Templates	**Valid**
Annex 15_18 Flow-Based "intuitive" explained	**Valid**
Annex 15_19 Preliminary LTA inclusion statistics	**Historically relevant**, statistics before go-live 2014.
Annex 15_20 Mitigation to Curtailment of Price Taking Orders	**Valid**
Annex 15_21 Implementation of FTR Options and temporary LTA+ solution	**Historically relevant**, Temporary procedure in 2015 for 6 months.
Annex 15_22 Methodology for capacity calculation for ID timeframe	Updated in June 2018 in combination with the update of the main document CWE FBMC approval document (v3.0)

Annex 15_23 Context paper CWE Intraday	**Valid**
Annex 15_24 Congestion income allocation under Flow-Based Market Coupling	Updated in June 2018 in combination with the update of the main CWE FBMC approval document (v3.0)
Annex 15_25 Adequacy Study Report	**Valid**
Annex 15_26 Annex C_1_Transparency	**Not up to date**
Annex 15_27 Annex C_2_Transparency	**Not up to date**
Annex 15_28 Report on SPAIC results for the Integration of the DE-AT border into CWE Flow Based	**New**. Submitted in combination with the update of the main document

Methodology for capacity calculation for ID timeframe

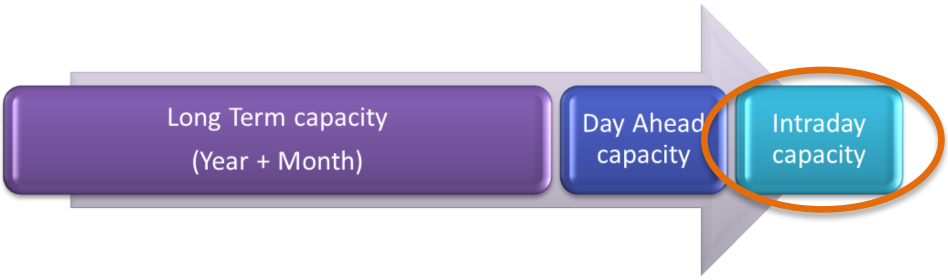
NRA approval package

Version	2.0	
Date	01-06-2018	
Status	☐ Draft	☒ Final

Contents

1 Introduction and purpose

This document gives a description of the calculation of the intraday (ID) capacity for the CWE internal borders. Pursuant to Regulation (EC) 714/2009 (+Annex 1) and based on regulatory approved splitting rules, TSOs allocate capacity in different market timeframes (long term, LT; day-ahead, DA; and intraday, ID). TSOs try to maximize available capacity in all time frames.



The scope of this methodology is strictly limited to the ID timeframe. This model is part of a coordinated approach by the TSOs involved in accordance with the ENTSO-E policies and assumes that the day-ahead capacity, allocated to the market, is the result of the CWE Flow Based Market Coupling.

Up to now no capacity is reserved for ID allocation. All ID capacity given to the market is a result of non-used DA capacity, increase processes after DA allocation, or due to the netting effect.

The target of the CWE Flow Based Market Coupling (FBMC) project was to increase efficiency of capacity allocation in the DA timeframe. This goal was achieved as the increase of DA net positions refering to higher market activity at the border with a higher trade volume. As FBMC is a process for the entire CWE region on all time frames for the capacity market (LT, DA, ID), an increase in the DA net position by default means a decrease in available capacity for the ID market.

The aim of this ID capacity calculation methodology is to have the possibility to release additional capacity to the market players after the flow based market coupling.

Note: this document is an update of the Methodology for capacity calculation for ID timeframe as submitted to CWE NRAs on 05.11.2015.

The main changes compared to the version 1.0 are the following:

- Updates related to the inclusion of the DE-AT bidding zone border

2 Definitions

- **CBCO**: Critical Branch Critical Outage
- **CMT**: Central Matching Tool. Central tool used for intraday increase/decrease process to consolidate the increase requests and the decrease notifications.
- **D2CF**: Two-Days ahead Congestion Forecast. Daily procedure to create a representative load flow model of the grid for the region of the participating TSOs for a specific hour. The dataset to create this model includes the best estimation for: the planned grid outages, the outages of generators, the representative load pattern, wind and solar generation and the load-forecast.
- **DA CGMs & ID CGMs** are the Day Ahead & Intraday Common Grid Models which are the result of the merging of the Individual Grid Models provided

by TSOs in day-ahead or in intraday as their best forecast of the topology, generation and load for a given hour of the Day D.

- **Day D**: delivery day for which capacity increases or rejection are considered.
- **Day D-1**: day before Day D, day ahead.
- **DACF**: Day-Ahead Congestion Forecast.
- **ID ATC**: Intraday Available Transfer Capacity.
- **Increase Feedback Deadline**: this is the latest time a CWE TSO may introduce a feedback for the request of increase on one of the borders for the applicable MTP: acceptance, partial acceptance or justified rejection.
- **Increase Request Deadline (IRD) and decrease Notification Deadline (DND)**: this is the latest time a CWE TSO may introduce a request for increase or a notification of decrease on one of his own borders.
- **Initial ID ATCs**: output results of Initial ID ATC computation (left-over capacities after DA FBMC).
- **Firmness**: arrangements to guarantee that capacity rights remain unchanged or are compensated.
- **Full acceptance**: situation in ID increase/decrease process when a TSO will fully accept the requested increase.
- **Market Coupling net positions**: sum of power flows per hub induced by the accepted orders.
- **MTP**: Market Time Period. This is a group of consecutive hours within the Day D.
- **Own border of TSO x**: bidding zone border within CWE across which TSO x has at least one (tie)-line.
- **Partial acceptance**: situation in ID increase/decrease process when a TSO will partially accept the requested increase on the borders on a non-discriminatory basis. This occurs when the requested capacity increases on different borders compete for available margin on the same network element.
- **Post-coupling process**: activities to check the DA MC result and to transform the Net Positions, computed as a result of the market coupling, into Bilateral Exchanges for further processes.
- **Pre- coupling**: activities to compute the DA capacities that will be sent to the MC system.
- **PTDF**: Power Transfer Distribution Factor. Factors showing the impact of the various bilateral exchanges on the overloaded branch.
- **RAM**: Remaining available margins on critical branches.
- **Rejection**: situation in ID increase/decrease process when a TSO will reject the increase requested because the consequences of the request cannot be fully nor partially accepted by the TSO.

3 General principles of ATC ID CC after FBMC

As it was the case in the former CWE DA capacity calculation (CC) process, the proposed ID ATC capacity calculation process combines different local processes with coordination on CWE level in different steps.

1. The starting point for the proposed ID CC methodology is the intitial calculation of the ID ATCs which have been described in the CWE Flow Based (FB) approval document in Chapter 4.4 “Initial ID ATC Computation”. This Initial ID ATC computed out of the DA FB domain

around the DA market clearing point is the result of a unique and common centralized computation.

2. The second step is a local evaluation by each involved TSO to request a possible increase (Basecase) or decrease (in special situations) on his own borders.
3. The third step is a merging step by a common system. The Central Matching Tool (CMT) consolidates the increase requests and the decrease notifications.
4. During the fourth step, based on this consolidated input, each involved TSO performs a local analysis that enables him to accept fully, accept partially or reject the requested capacity increases in a justified manner.
5. In the fifth step, these acceptance or rejection messages are then gathered and handled in a common way by the CMT. The System will distribute these consolidated acceptances and rejections back to the local TSOs.
6. In the last and sixth step, each TSO will then be able to use these common CWE ID ATCs and NTCs as input for the capacity allocation of their respective borders.

The steps 4 to 6 can be performed serveral times a day for a certain period of trading. For example, the assement can be done during the evening for the night hours and during the night for the day hours. The number of iterations depends on the border. For an overview of the proposed ID ATC capacity calculation process see Figure 1.

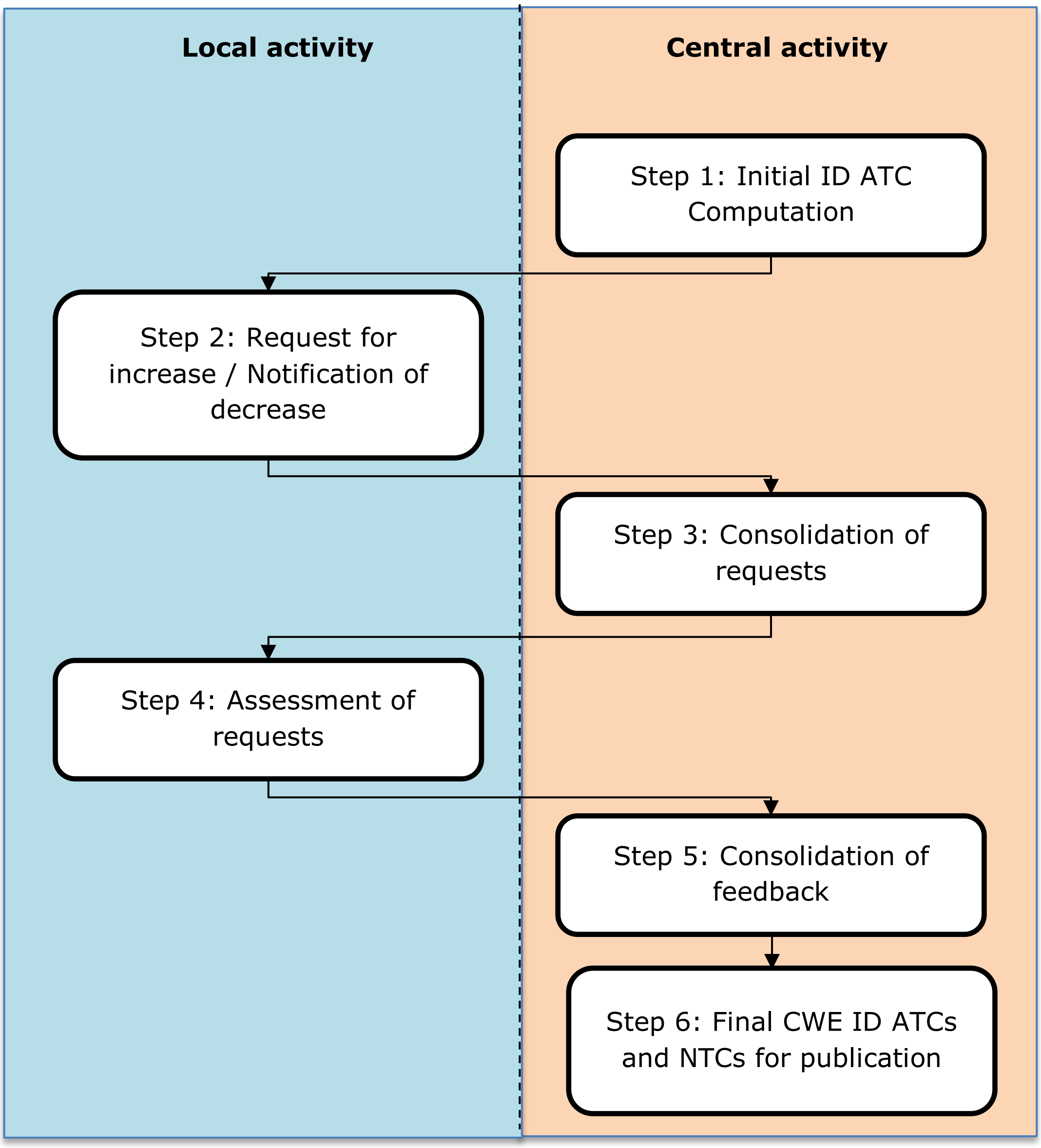


Figure 1: High-level process of ID ATC CC methodology.

4 Coordinated ID ATC CC after FBMC process

Important remark

This step is essential in the ID capacity calculation methodology but has already been presented to CWE NRAs in the context of the approval of the CWE FB Market Coupling.

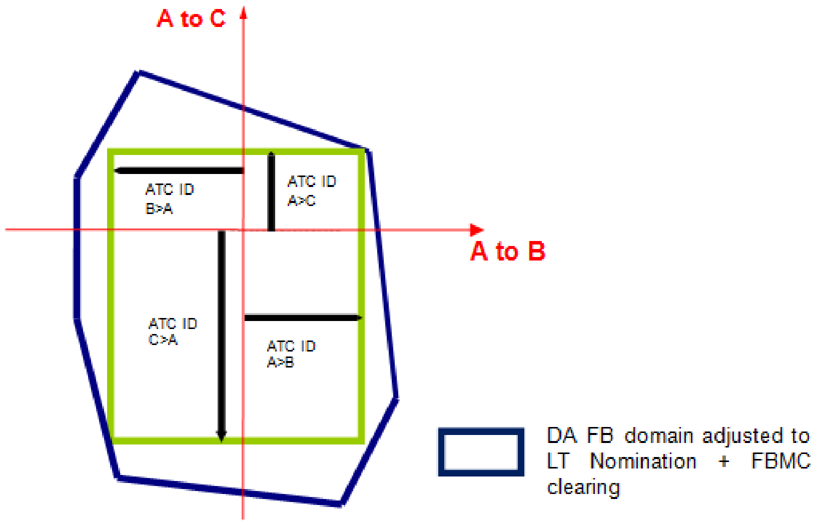
4.1 In addition to this first step, the coordinated increase process is described in paragraph 4.3~~4.2~~ "Re-computation of ID ATC during intraday timeframe

~~Re-computation of ID ATC during intraday timeframe~~" and is submitted for approval pursuant to Section 15.2 of the Regulation (EC) 714/2009 and Article 5.2 of the Guidelines (Annex 1 of Regulation 714/2009).

~~4.1~~4.2 Initial ID ATC Computation

~~4.1.1~~4.2.1 Introduction

The hereafter described procedure is an intermediate step, to make the D-1 Flow Based method compatible with the current ID ATC process. The aim is to assess ID ATC values deduced from the D-1 Flow Based parameters, which have been adjusted according to the D-1 FB MC results. The ID ATCs can be considered as a leftover of the D-1 Flow Based capacity as illustrated below. With that respect the initial ID ATC computation is not a new capacity calculation process.



The calculated ID ATCs are then used in the same way as the current ID ATCs. This chapter focuses on the process of the ID ATC computation. The input and output parameters are described and the iterative method is explained using a pseudo-code and an example calculation.

~~4.1.2~~4.2.2 Input data

Despite the two days per year with a long-clock change, there are 24 timestamps per day. The following input data is required for each timestamp:

- Market Coupling net positions.
- Presolved Flow Based parameters adjusted to LT nominations; curtailed to zero margins in case of a negative RAM.
- Tolerance margin (in MW), with the possibility to activate it for every country by the respective TSO (may be used in order to propose minimum ID ATC values).

~~4.1.3~~4.2.3 Output data

The calculation leads to the following outputs for each timestamp:

- initial ID ATC
- number of iterations that were needed for the ID ATC computation
- branches with zero margin after the ID ATC calculation
- indication if the tolerance margins were activated, and if so, which ID ATC was affected by this

~~4.1.4~~4.2.4 Algorithm

The ID ATC calculation is an iterative procedure and part of the so-called post-coupling process.

Starting point

First, the remaining available margins (RAM) of the pre-solved CBs, which were given to the DA market at the end of the pre-coupling process, have to be adjusted to the MC

results. The adjustment is performed using the net positions resulting from the day-ahead MC and the corresponding zone-to-hub PTDFs. The resulting margins serve as a starting point for the iteration (step i=0) and represent an updated Flow Based domain from which the ID ATC domain is determined.
From the non-anonymized presolved zone-to-hub PTDFs ($PTDF_{z2h}$), one computes zone-to-zone PTDFs ($pPTDF_{z2z}$), where only the positive numbers are stored[1]:

$$pPTDF_{z2z}(A > B) = \max(0, PTDF_{z2h}(A) - PTDF_{z2h}(B))$$

with $A, B = DE, FR, NL, BE, AT$. Only zone-to-zone PTDFs of neighbouring market area pairs are needed (e.g. $pPTDF_{z2z}(DE > BE)$ will not be used).

Iteration

The iterative method applied to compute the ID ATCs in short comes down to the following actions for each iteration step i:

1. For each CB, share the remaining margin between the CWE internal borders that are positively influenced with equal shares.
2. From those shares of margin, maximum bilateral exchanges are computed by dividing each share by the positive zone-to-zone PTDF.
3. The bilateral exchanges are updated by adding the minimum values obtained over all CBs.
4. Update the margins on the CBs using new bilateral exchanges from step 3 and go back to step 1.

This iteration continues until the maximum value over all critical branches of the absolute difference between the margin of computational step i+1 and step i is smaller than a stop criterion.

The resulting ID ATCs get the values that have been determined for the maximum CWE internal bilateral exchanges obtained during the iteration and after rounding down to integer values.

After algorithm execution, there are some Critical Branches with no remaining available margin left. These are the limiting elements of the ID ATC computation.

The computation of the ID ATC domain can be precisely described with the following pseudo-code:

```
While max(abs(margin(i+1) - margin(i))) > StopCriterionIDATC
        For each CB
                For each non-zero entry in pPTDF_z2z Matrix
                        IncrMaxBilExchange = margin(i)/NbShares/pPTDF_z2z
                        MaxBilExchange = MaxBilExchange + IncrMaxBilExchange
                End for
        End for
        For each ContractPath
                MaxBilExchange = min(MaxBilExchanges)
        End for
        For each CB
                margin(i+1) = margin(i) – pPTDF_z2z * MaxBilExchange
        End for
End While
ID_ATCs = Integer(MaxBilExchanges)
```

Configurable parameters:

- StopCriterionIDATC (stop criterion); recommended value is 1.e-3
- NbShares (number of CWE internal commercial borders); current value is 5.

Tolerance margin

The tolerance margin introduces minimum ID ATC values on borders between CWE market areas. This optional process step[2] comes after the original ID ATC determination and is therefore based on the results obtained before.

[1] Negative PTDFs would relieve CBs, which cannot be anticipated for the ID capacity calculation.

The tolerance margin can be activated by one or more CWE TSOs, which are neighbours to the border, by setting a non-zero value into a reference table. Such TSOs are here labelled with 'TSO_act'.

	TTG	TTB	Amp	TNG	RTE	Elia	APG
DE->NL	0	0	0				
NL->DE	0	0	0				
NL->BE		0				0	
BE->NL		0				0	
BE->FR					0	0	
FR->BE					0	0	
FR->DE			0	0	0		
DE->FR			0	0	0		
DE->AT	0		0	0			0
AT->DE	0		0	0			0

The value in the table is valid for the whole day (all timestamps) and remains unchanged until it is reset by the responsible TSO_act.
The tolerance margin is only accepted within the algorithm if it does not introduce overloadings on the CB of those TSO, which did not activate the tolerance margin (labelled with TSO_other). But the CBs of TSO_act can be overloaded with respect to this procedure.

The following procedure describes the calculation of the tolerance margin:
Define first the TSO(s)/countries having activated the tolerance margin in the ID ATC computation as 'TSO_act', whereas the other TSOs are identified as 'TSO_other'. Then perform the following check, which may result in an adjustment of the ID ATCs corresponding to the borders of TSO_act:

```
FOR all TSO_act DO
  Store the old ID ATC values of TSO_act
  IF the ID ATCs of TSO_act < tolerance margin THEN
              Set TSO_act ID ATCs to the tolerance margin value
  IF this leads to overloaded TSO_other CBs THEN
    Discard the new ID ATCs for TSO_act and retrieve the stored ones
ELSE
Store and apply the new set of TSO_act ID ATCs
```

The tolerance margin[3] used for the ID ATC calculation takes into account the level of uncertainty of the ID ATC calculation based on the D2CF grid model. Given the uncertainty level of these calculations in the D-2 stage, some TSOs have the possibility to put a minimum value on the ID ATC in order not to prematurely and maybe unnecessarily block the market. The initial value of the ID ATC will then not be initially lower than the tolerance margin, however security calculations performed after day-ahead market coupling (e.g.

[2] Since the CWE FB project considers the DA market only, the usage of the ID tolerance margin should be discussed in the current ID framework.
[3] The tolerance margin is one of the options currently being investigated by a dedicated workgroup and out of scope of this approval package.

using DACF) might still reduce or increase the ID ATC in line with system security requirements.

The ID ATC initially at zero might not be confirmed by the recalculation, therefrom the possible usage of the tolerance margin.

~~4.2~~4.3 Re-computation of ID ATC during intraday timeframe

After the first computation, the TSOs have the possibility to re-assess the new capacities. This chapter describes the process after the first computation.

~~4.2.1~~4.3.1 Requesting increase or notifying decrease of capacities on own borders

~~4.2.1.1~~4.3.1.1 Requesting increased capacities on own borders

Capacity increases can be requested by all CWE TSOs for each hour of the Day D on their own borders via the CMT. Please note that the inclusion of the border between Austria and Germany in the process is currently not foreseen. An extension of the process to this border might be applied in the future.

The starting point for the local analysis to launch an increase request is the already available initial ID ATCs. In order to maximize the acceptance of the requests, the TSOs should favour a request for the borders and directions where the available capacity provided to the market after the FB MC is low.

Every increase request is capped with a fixed value per border and direction. These fixed values are proposed by each TSO for their own borders and commonly approved by the involved CWE TSOs. After having gained experience with the increasing process TSOs will reevaluate the cap.

The requested capacity increase is an intention for a capacity increase. However, due to constraints identified during the local analysis (during the fourth step of the process cf §4.3.3~~4.2.3~~), it can be the case that a proposed capacity increase for a specific border is rejected by the same TSO who requested it.

The Increase Request Deadline is set for all MTP simultaneously to ensure a coordinated assessment on local side.

~~4.2.1.2~~4.3.1.2 Notification of a decrease of capacities on own borders

In line with the task to secure the grid, all TSOs have the possibility to take the necessary steps to guarantee this (just like today). Intraday capacity reduction is a pragmatic process that allows involved TSOs for any hour of the Day D to reduce Intraday ATCs, on their own borders, in cases operational security issues arise.

As the notification for decrease is an emergency process, a capacity reduction is an input to the assessment of capacity increases and cannot be rejected by other TSOs.

As firmness of the trades applies, only capacity that was not yet allocated will be reduced, even if a higher decrease is requested.

~~4.2.2~~4.3.2 Consolidation of the requests of increase and notification of decrease

When the Increase Request/Decrease Notification deadline is reached, the CMT will immediatly proceed for each hour of the Day D with the consolidation per border and direction of the received information respecting the following rules:

- In case only Increase Request have been sent, the CMT will take the maximum of the requests. If this value is higher than the fixed maximum increase authorized on this border, the CMT will cap the request to this maximum authorized increase.

- In case a Decrease Notification has been sent, the notification for decease will prevail over an increase request for the same hour. The CMT will consider the minimum value of the notified decrease[4].

The CMT will then send for each hour of the Day D and for each CWE border and direction (which is covered by the re-computation process) the resulting increase or decrease to the CWE TSOs.

~~4.2.3~~4.3.3 Assessing the feasibility of requested increases

After receiving the requests of increase and notification for decrease, the involved TSOs have to assess locally the feasibility of the requests.

A request for increase can be:

- **Fully accepted**
- **Partially accepted**

  There are situations when requested capacity increases on different borders compete for available margin on the same network element.

  In this case, the TSO will partially accept increases on the borders on non-discriminatory basis.
- **Rejected** in case the consequences of the requests cannot be fully nor partially accepted by the TSO.

After the assessment, the TSO will notify the CMT with the status of each request for each MPT before the Increase Feedback Deadlines.

~~4.2.3.1~~4.3.3.1 Local implementation

Amprion

Amprion checks upon the feasibility of capacity increases via a local simulation tool that models the effect of capacity increases of Amprion's network. The tool uses DA CGMs or ID CGMs and models the impact of capacity increases via linear sensitivities.

In case this tooling should not be available when the process goes live, a slimmer, intermediate method based on contingency analysis results will be applied for a limited time. For the borders BE-NL and BE-FR no rejections of increase requests are planned to be conducted with this slimmer, intermediate method.

Elia

ELIA assesses ATC around the clearing point in D-1 and in intraday on Belgian borders and in all directions based on DA CGMs or ID CGMs. Calculation will be performed for a given MTP on representative hour(s) for this period. In this assessment, realistic values in the direction of the likely corner(s) are considered for the non-Belgian borders. Based on this, ELIA defines for this period the (partial) increase ID ATC possible on the Belgian borders and motivated (partial) acceptances or rejections for other borders, if any.

For the assessment, the same set of acceptance criteria and remedial actions as the ones used locally at Elia for the DACF process is considered.

On request of ELIA, Coreso may be in charge for Elia of the assessment whether or not to increase capacity for the aforementioned time periods. Based on this information Elia's operator will decide about possible rejections of capacity increases.

In all cases, the notification of rejections will be provided to the CMT by Coreso.

RTE

[4] For example, the CMT will receive two requests for decrease (-100 MW and -200 MW) and one increase request (100 MW), in this case the CMT will consider the minimum value, namely –200 MW, as consolidated notification of decrease.

For each hour of the day, RTE checks the inclusion of the increased ATC domain into a flow-based domain.

The ATC domain is the initial ATC domain centrally computed increased by the requests on each border. If the resulting domain is larger than the normal behaviour of the market players in the intraday timeframe, the domain is reduced in this market direction.

The flow-based domain used for the inclusion is the flow-based domain with only the critical branches of RTE without the French external constraints. It also means that none of the branches of other CWE TSOs and none of the external constraints are in this domain.

TenneT TSO B.V.

For the Dutch-German and Dutch-Belgian borders harmonized procedures were already developed, meaning that the capacity analyses are running in parallel and use identical parameters for the decision making for the intraday capacity.

For both borders, several timeframes are used to analyse the capacity increases for the forthcoming hours. The analyses is in line with the feedback deadlines specified in HLBP of ID ATC after FBMC.

The current local assessment looks at the thermal loading of a predefined set of network elements under all relevant (n-1)-contingencies. If thermal loadings are below a certain threshold, the capacity increase is permitted. In addition, an NTC update is made using updated wind forecasts. In case operational security issues are expected/arise for the coming hours, operators can take these results into account when releasing intraday capacity. Consequently, a decision whether or not to accept an increase request is made hour-wise.

TenneT TSO GmbH

The increase requests are assessed starting from DA CGM and the D-1 clearing point. Maximum utilization of potential ID ATCs (total of initial ATCs, decrease notifications and increase requests) is simulated for the most likely combinations of simultaneous exchanges on all four borders. Security assessment is performed using AC load flow and CBCOs of TenneT TSO GmbH. If the network security assessment fails for at least one likely market direction, it is repeated with reduced increase requests in order to check for the possibility of partial acceptance.

The assessment of increase requests takes place for all MTPs simultaneously.

TransnetBW

TransnetBW assesses the increase requests with the help of local load flow tool that uses day ahead and intraday CGM as basis. The focus of increase assessment is on the CBCOs in the control area. Requests are checked in all possible market directions meaning simultaneous exchanges on all borders. In case full acceptance is not possible, the process is repeated with partial increase requests according to the common rules. The results of possible reductions of the local assessment are sent to CMT.

APG

As the border DE-AT is currently not foreseen to be involved in the increase/decrease process, no local activity is outlined here for the APG side.

~~4.2.4~~4.3.4 Consolidation of acceptances/rejections

When an Increase Feedback Deadline is reached, the CMT will immediatly proceed for each hour of the applicable MTP with the consolidation per border and direction of the received information respecting the following rule:

- In case justified rejections are received, the CMT will consider the lowest value as the result of the applicable increase.

The CMT will then send for each hour of the Day D and for each CWE border and direction to the CWE TSOs the resulting ID ATCs/NTCs as the sum of the initial ID ATCs and the consolidated increase/decrease for the applicable MTP.

~~4.2.5~~4.3.5 Providing ID ATCs for allocation

After receiving the updated capacity from the CMT, the responsible TSOs offer the capacity to the market players with the allocation rules and platforms.

Congestion income allocation under Flow-Based Market Coupling

CWE Market Coupling

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Document creation and distribution

Document Owner	CWE CIA WG
Distribution	CWE TSO SG

Disclaimer

For the revised document presented together with the approval package for the implementation of the DE-AT Bidding Zone (BZ) border, all basic principles of the currently used methodology for sharing congestion income (CI) between TSOs are kept in place. For instance, the sharing of CI in the revised document is again based on Cross border Clearing Price times Market Flows (CBCPM) considering physical flows (on internal borders by Additional Aggregated Flows (AAFs), and for hubs not balanced by those internal flows by external flows to a virtual Slack Zone).

Additionally, the principles for the compensation of Long Term Rights (PTRs with UIOSI or FTRs) including the socialization principle on a BZ border is kept. However, in accordance with the HAR, the compensation process is now named 'remuneration', thus replacing the term 'resale'.

To consider the more complex situation related to the calculation of external flows, the approach by implementing an additional, virtual Slack Zone is considered in the revised document. This approach was already proposed and described in Chapter 10 for the 'case of extensions' in the CWE CIA approval document dated 19-08-2014 on the one hand, and on the other hand this approach is also part of the approved ENTSO-E CID methodology document according to CACM Article 73.

Considering the fact that no real market results are available before the DE-AT BZB split is effective, it was not possible to evaluate this methodology in all details and quantify its potential impact.

Therefore, the proposed methodology will be analysed once respectively 6 and 12 months of CIA results following the go-live of the DE-AT split are available. CWE TSOs will report and update CWE NRAs about the new results, explaining main differences observed in comparison to historical congestion income while taking into account potential changes to the grids and/or flows.

Based on the analyses considering the congestion income results in the 6- and 12-month period referred above, CWE TSOs will assess if all of the criteria for sharing income, as detailed in section 2 of this document, are still achieved. A reassessment of the methodology will be triggered in case at least one TSO identifies that one of these criteria is no longer fulfilled, supported by numerical analysis.

If necessary, methodology changes will be assessed by CWE TSOs and proposed to CWE NRAs. In case the results are not in line with the objectives described in section 2, there could be retroactive application of the further improved methodology.

Introduction

The sharing of the congestion income under Flow-Based Market Coupling (FB MC) between the hubs of the CWE (Central-Western Europe) region is described in this document. This description is only valid for the standard hybrid coupling method. The treatment of remuneration costs resulting from Long-Term Capacity Rights is integral part of the methodology.

Due to the inclusion of the DE/AT border in CWE FB MC this document is updated especially with respect to the calculation of the external pot. The updates are based on the principles highlighted in section 10.1 of the final Congestion Income Allocation (CIA) approval document dated 19-08-2014, as published on the JAO website.

When updating the document, the principles of the Congestion Income Distribution Methodology (CIDM) related to CACM, Article 73, were taken into account.

CONTENT

1 General definitions

The overall congestion income (CI) can be calculated by the following formula:

$$CI = -\sum_{i=1}^{NH} netPOS_i \times CP_i \quad \text{(Eq. 1)}$$

Where:

$netPOS_i$: net position of hub i

CP_i: clearing price of hub i

NH: total number of hubs

The impact of commercial flows on the critical branches (CB) is given by the power transfer distribution factors (PTDF) which are organized in the so-called PTDF-Matrix. This matrix translates the net positions into physical flows on the critical branches. Hence, the additional aggregated flow - AAF_i - associated to network constraint i can be calculated by multiplying the according power transfer distribution factor $PTDF_{i,j}$, where j refers to the respective hub, by the net hub position, using the following equation. For clarification and delimitation issues it might be helpful to mention that for calculating the AAFs for Congestion Income Distribution (CID) - calculation the PTDF matrix differentiate from the PTDF matrix that is used for the calculation of the Flow Based Domain in such way, that for CID-AAFs only cross border network elements within the Flow Based Region (i.e. internal cross border lines) are taken into account in a base case (N) and no hub internal ones.

$$AAF_i = \sum_{j=1}^{NH} PTDF_{i,j} \times netPOS_j \quad \text{(Eq. 2)}$$

Where:

AAF_i: additional aggregated flow associated to network constraint *i*

$PTDF_{i,j}$: power transfer distribution factor of hub j on critical branch i

$netPOS_j$: net position of hub j

NH: total number of hubs

Definition of shadow price

In mathematical terms, the FBMC algorithm is an optimization procedure that generates so-called shadow prices on every Flow-Based (FB) constraint, i.e. on each modelled network element that is monitored under certain operational conditions (such as outages).

The shadow price represents the marginal increase of the objective function (Day Ahead (DA) market welfare) if the constraint is marginally relaxed. In other words: the shadow price is a good indication of the increase in DA market welfare that would be induced by an increase of capacity on the active network constraint. As a consequence, non-binding network constraints in the market coupling solution have a shadow price of zero, since an increase of capacity on those network elements would neither change the optimal market coupling solution nor the flow on the network element concerned.

The overall congestion income for flow-based market coupling can therefore also/alternatively be calculated on the basis of the shadow prices (*SP)* and the flows induced by the net positions resulting from the market coupling as well, using the expression

$$CI = \sum_{i=1}^{NC} AAF_i \times SP_i \quad \text{(Eq. 3)}$$

Where:

SP_i: shadow price associated to network constraint *i*

NC: total number of network constraints

Hence, equation (Eq. 3) represents the mathematical equivalent to equation (Eq. 1).

For explanatory purposes, this document uses a consistent set of market results that have been calculated by the Price Coupling of Regions (PCR) simulation facility for one example hour. These market results are displayed in figure 1. The same example is used throughout the document except in Annex 1.

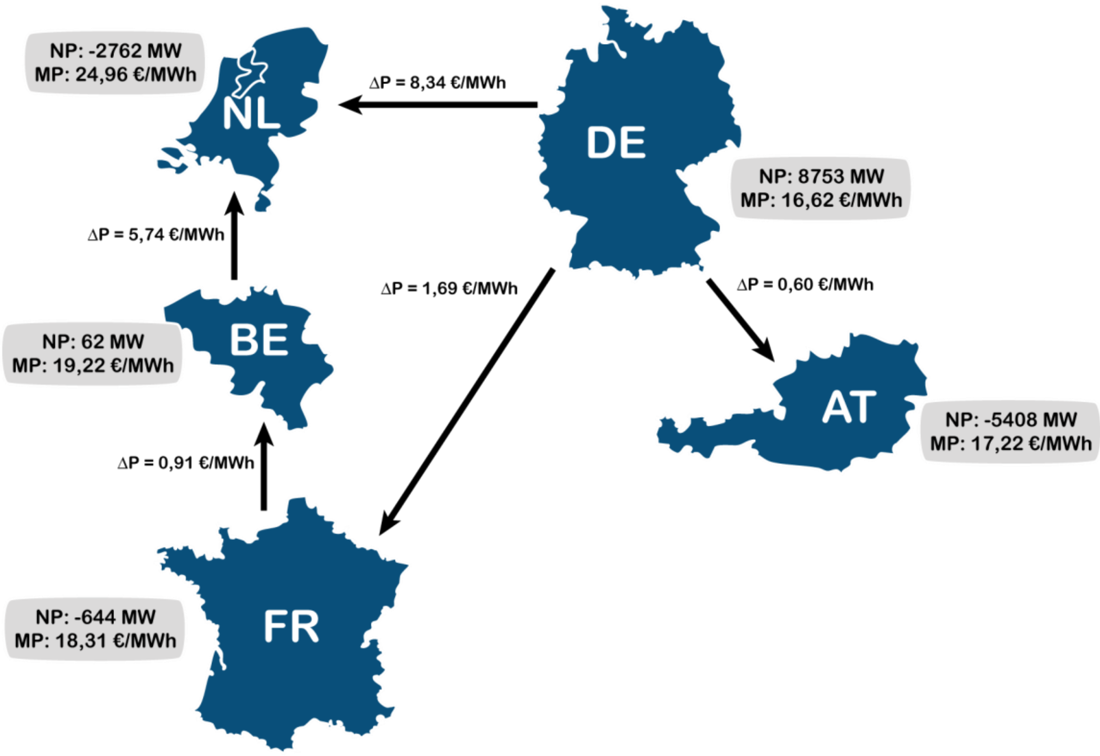


Figure 1: Flow-based market coupling results for the hour used in the example throughout this document.

Due to rounding, the sum of the net positions of the hubs does not sum up to zero. The simulated FBMC was constrained by one critical branch, having a shadow price:

CB RAM[1] (MW) shadow price (€/MW)

[1] In case of congestion, the Remaining Available Margin (RAM) is equal to the additional aggregated flow associated to the Network Constraint

CB1 829 MW 32,79 €/MW

The total congestion income equals:

CI = $829 \times 32{,}79 = 27.182{,}91€$

From the net positions and prices we can obtain the congestion income as well:

CI = $2762 \times 24.96 - 62 \times 19{,}22 + 644 \times 18{,}31 + 5408 \times 17{,}22 - 8753 \times 16{,}62 = €27.190{,}42$[2]

The numbers are equivalent to one another, besides some difference due to rounding effects in the numbers.

[2] The sum of the congestion income is negative, however this implies a positive revenue due to the fact that the importing countries are selling at higher prices than the exporting countries.

2 Criteria for sharing income

The qualitative criteria are depicted below in more detail.

2.1 Short & Long Term Incentive compatible

According to Article 6.1 of Annex 1 to EU Regulation 2009/714/EG the procedure for the distribution of congestion income shall not provide a disincentive to either reduce congestion nor to distort the allocation process in favour of any party requesting capacity or energy.

Objectives: Efficient use of existing and efficient investments in transmission assets.

2.2 Transparent and easy to understand

Objectives: The distribution of congestion income should be transparent and auditable, which means that very complex sharing keys are not preferred. It should be easy to show in which way the congestion income is shared by the hubs and how this is integrated in the total picture of the congestion income cycle.

2.3 Robustness against gaming

Objectives: The sharing key should not give room for optimisation of any individual hub's share of the congestion income by gaming on data manipulation.

2.4 Fairness and Non discriminatory

Objectives: The sharing key should be based on elements related to the management of capacity for cross-border transactions.

2.5 Predictability and Limited volatility

Objectives: The sharing key should allow a forecast of the financial outcome and should not lead to a higher volatility of each share compared to the status quo, in order to allow a reasonable financial planning and cash flow management.

2.6 Smoothness of transition

Objectives: the current congestion income distribution should not be changed in a radical way in the short term in order to limit the financial impact on all parties.

2.7 Positive income per hub

Objectives: As long as the long term allocated (LTA) capacity domain is included in the FB domain, the hourly individual net income of each hub remains positive.

2.8 Stability in case of extension

Objectives: The current congestion income distribution for the CWE hubs should not be changed in a radical way when new hubs are joining the FB region.

2.9 Positive Day-ahead market welfare gain compared to ATC MC

Objectives: The DA market welfare (producer surplus + consumer surplus + congestion income) gain for a hub should be positive compared to ATC MC.

Within the process of developing the sharing methodology for the congestion income, these criteria and objectives were taken into account. Therefore, the presented solution is one that fits the criteria best.

3 Nomination proof and additional aggregated flow calculation

The sharing of congestion income and remuneration costs of each hub is made independent of the actual nomination level on a border by the market participants that hold the long term rights. As such, the sharing key is made ´nomination proof´. To establish this, the hourly remuneration costs per hub border are calculated from the total volume of allocated long term rights multiplied by the hourly price difference that occurs on that border, instead of only considering the resold part of the LTA multiplied by the price difference. Furthermore, the net positions to derive the overall congestion income need to be corrected with the Long Term Nominations (LTN), such that the income is shared as if all LTA have not been nominated. These updated net positions are used throughout the whole calculation methodology, except for the calculation of the overall congestion income. The netted long term nominations on the CWE borders, for our example, are shown in Figure 2.

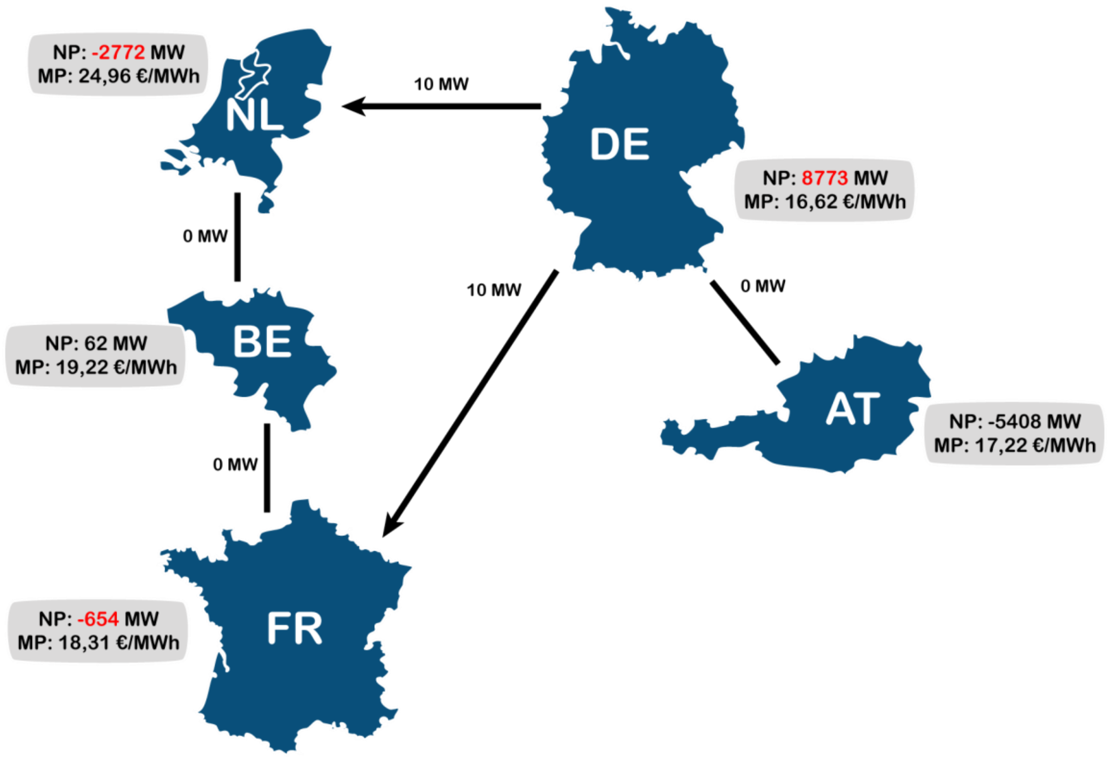


Figure 2: The netted long-term nominations on the internal borders and their effect on the net position of the bidding zones (changed net positions due to long-term nominations highlighted in red).

Since the net positions change, the AAFs change accordingly (Eq. 4), which is an adaptation of the earlier shown equation (Eq. 2). The flows on the critical branches on a border are aggregated on a hub border level.

$$AAF_i = \sum_{j=1}^{NH} PTDF_{i,j} \times netPOS(FBMC + LTN)_j \qquad \text{(Eq. 4)}$$

Where:

$PTDF_{i,j}$: power transfer distribution factor of hub *j* on critical branch *i*

$netPOS_j$: net position of hub *j*

NH: total number of hubs

FBMC: the part of the net position allocated through the daily flow-based market coupling (resold LTA and additional margin provided by the TSOs)

LTN: a correction of the net position due to the level of Long Term Nominations

The resulting net positions, additional aggregated flows and prices are depicted in the Figure 3 below. The adjusted CWE net positions of Germany, France and Austria do however not balance by the aggregated flows as part of the real physical flows leave and re-enter the CWE region through external borders. The concept of internal and external pot as discussed in Chapter 5 has been designed to address this issue.

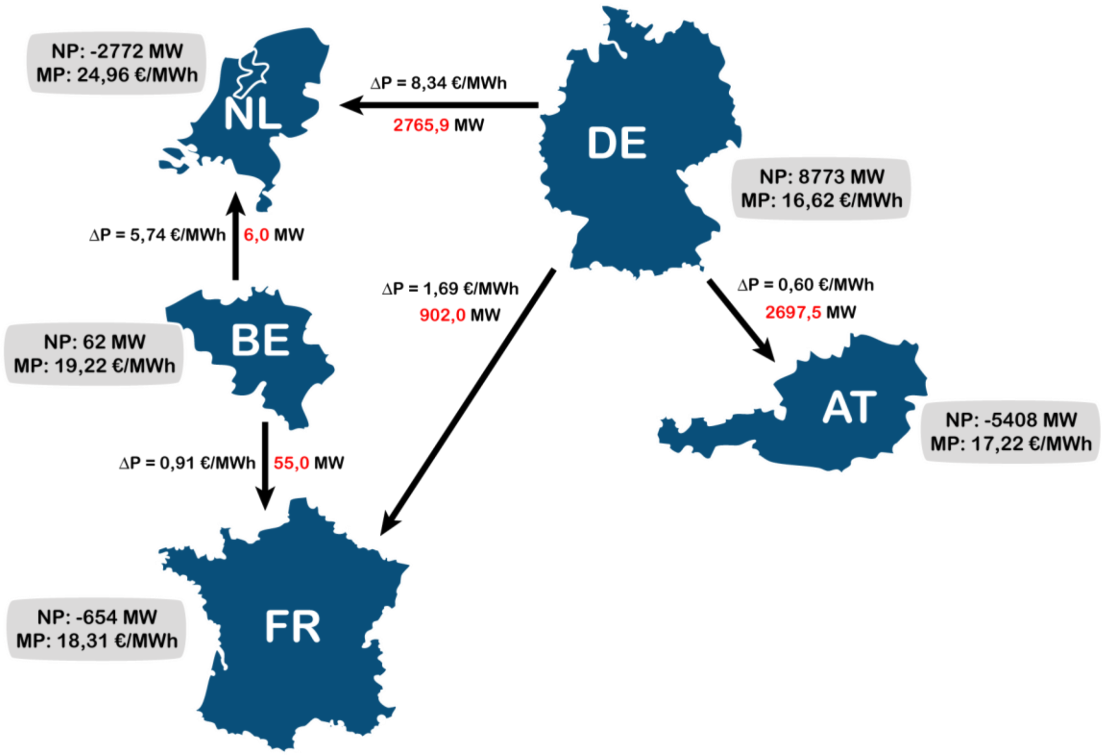


Figure 3: The calculated additional aggregated flows, based on the PTDFs and net positions (changed AAFs indicated in red).

4 Cross Border clearing price times market flows absolute (CBCPM abs)

The Congestion Income Allocation mechanism for CWE – which could serve as a blueprint for other FB coupled regions as well – takes up the fundamental characteristics of the well-known ATC scheme. Even though the results of CWE FB MC are hub net positions and clearing prices, the FB sharing key (CBCPM abs) – in a first step – assigns a Border Value to each individual hub-border in order to allocate the congestion income to the respective capacity holders. The idea is to share the congestion income based on economic indicators related to the allocation of cross-border capacity in zonal-markets, i.e. market price differences and allocated cross-border flows. However, the FB sharing key is also in line with the principle of price formation in FB (Eq. 5):

$$\frac{\Delta CP_{hub\ i\rightarrow j}}{\Delta PTDF_{hub\ i\rightarrow j,k}} = Shadow\ Price\ \geq 0 \qquad \text{(Eq. 5)}$$

Where:

$\Delta PTDF_{hub i\rightarrow j,k}$: power transfer distribution factor difference between hub i and j for critical branch k

$\Delta CP_{hub i\rightarrow j}$: clearing price difference between hub i and hub j

ΔPTDF of the limiting CB is proportional to ΔCP. The ΔPTDF between the hubs close to the limiting CB is larger than the ΔPTDF between the hubs far away. Therefore, the price difference between the hubs close to the limiting CB is larger than the price difference between hubs far away.

The aforementioned Border Value is calculated by multiplying the respective AAFs by the price difference of the neighbouring hubs.

Under FB MC negative Border Values might occur if AAFs are directed against the clearing price difference (the price difference of the neighbouring hubs is – in the direction of the AAF – negative)[3]. Those flows contribute to the maximization of day-ahead market welfare within the entire Region, therefore Border Values are always taken into account in absolute terms. Since the absolute value of the Border Values is taken into account, a rescaling to the original overall congestion income is required.

4.1 Calculations

For the calculation of the CBCPM ABS key, the absolute Border Value per hub is considered as shown below:

$$CI\_Hub_i^{CBCPM\ ABS} = \frac{1}{2} \times \frac{\sum_{j=1}^{NH} \left| AAF_{hub\ i\rightarrow j} \times \Delta CP_{hub\ i\rightarrow j} \right|}{\sum_{i=1}^{NH} \sum_{j>i}^{NH} \left| AAF_{hub\ i\rightarrow j} \times \Delta CP_{hub\ i\rightarrow j} \right|} \times CI \qquad \text{(Eq. 6)}$$

Where:

CI_Hub_i: congestion income associated to hub i

$AAF_{hub\ i\rightarrow j}$: sum of additional flows from hub i to hub j

$\Delta CP_{hub\ i\rightarrow j}$: clearing price difference between hub i and hub j

NH: total number of hubs

[3] This situation can also occur within FB Intuitive MC, since a situation is defined as intuitive if there exist at least one possible set of intuitive bilateral exchanges. The AAFs resulting from the FBI MC are different from this set of bilateral exchanges.

4.2 Properties of the proposed sharing key

The CBCPM abs sharing key can be seen as an "evolution" of the ATC sharing key principle to rationalize the sharing of congestion income. The basic idea of the CBCPM sharing key is transparency and easiness to understand.

The income is linked to congested CB(s) that set(s) the prices: the ΔPTDF close to the limiting branch is large and therefore, the price difference is also large. This means a large congestion income on the borders close to the congestion. So the price difference is an indication of the location of the congestion. As such, the congestion income is an indication of the criticality of a congestion.

The sharing key has a good stability in case of extensions. In case a hub with a border with recurrent congestions joins, the congestion income sharing is mainly attributed to that border and vice versa: if a hub without congestion on its borders joins, few congestion incomes will be attributed to this hub.

The absolute variant of the sharing key avoids negative net congestion income on a hub border.

5 Determination of the internal and external pot

As previously mentioned, the total congestion income is related to the shadow prices of the congested critical branches somewhere inside CWE. After adaption of the net positions with the Long-Term nominations and calculating AAFs, it is possible to divide this global income into an "internal" and an "external" pot. This external pot is related to the flows exiting and re-entering the CWE FB area through neighbouring hubs. The external flows are calculated as a complement to the internal flows in order to balance the net position of all hubs in the CWE CCR.

As not all CWE net positions can be balanced by internal flows (AAFs) the concept of an external pot was introduced and has to be updated with the implementation of DE-AT border. Without that border, there was only one external flow between FR and DE/LU/AT hubs, which was easy to calculate. Considering the DE-AT border, the situation became more complex and individual external flow components would be much more difficult to determine.

In accordance with the Congestion Income Distribution Methodology (CIDM) proposal based on CACM Article 73 and approved by ACER on December 2017, the so cold 'Slack Zone' approach was selected for the determination of external flow values. This approach was also prepared in this document by former Chapter '10.1.1 Determination of the unique price of the slack zone' for the case of extensions of the CWE-CCR. In Figure 4 the principle of this Slack Zone approach is illustrated. Therefore all external flow components between different hubs needed to balance the respective hubs in CWE (which are FR, DE/LU and AT) are substituted by only one virtual flow for each relevant hub and the Slack Zone. Of course the net position of the virtual Slack Zone is zero and a price of the Slack Zone has to be determined in an appropriate way.

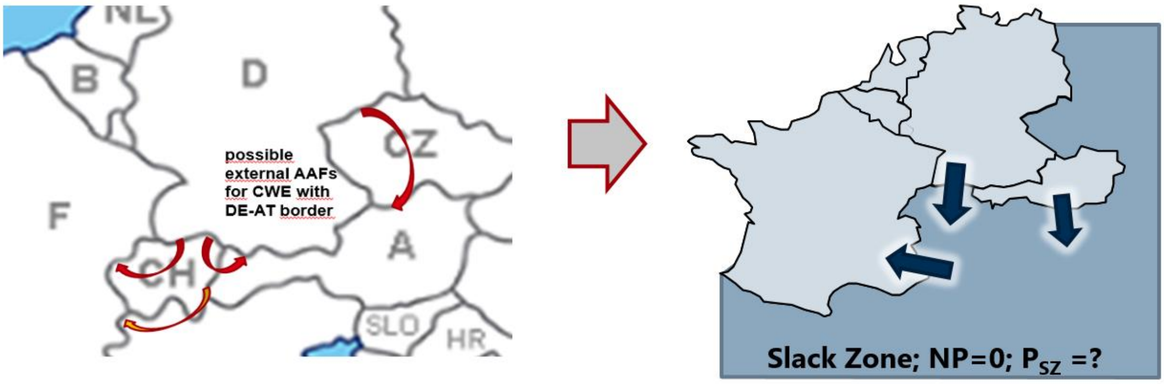


Figure 4: The principle of the Slack Zone approach.

Transferring this Slack Zone approach to the figure used before results in Figure 5, now also including the Slack Zone which acts as a source or sink for all the external flows. The external flow is calculated as the flow needed to balance the net positions in addition to the already calculated AAF.

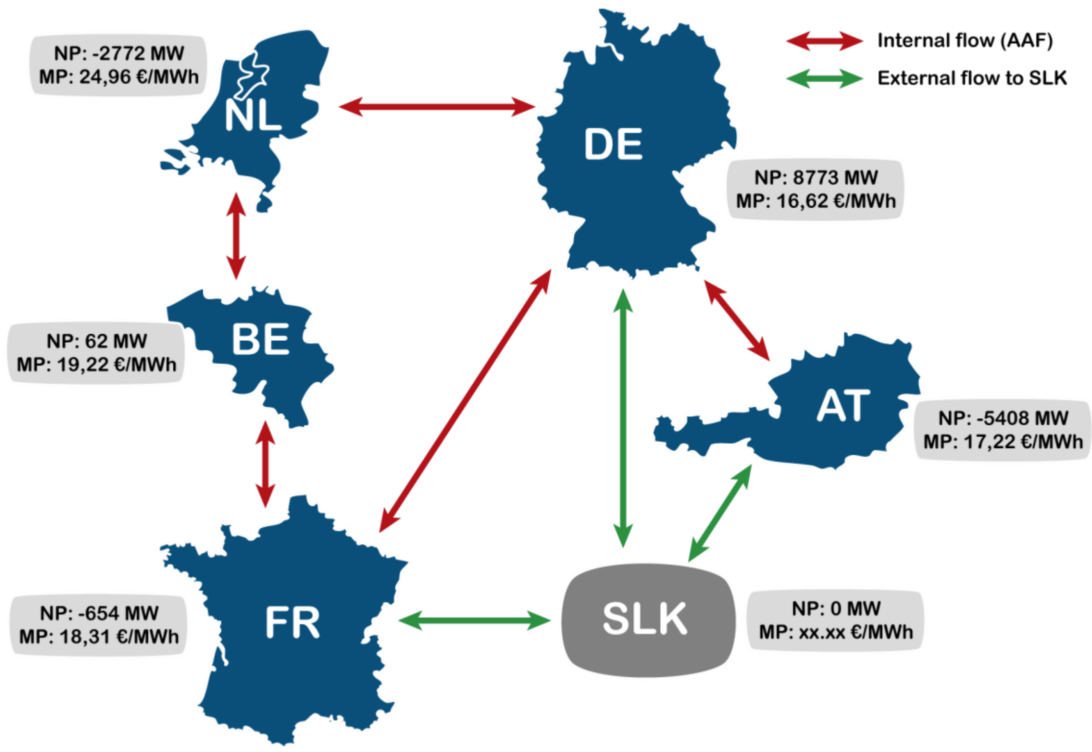


Figure 5: The principle of external flows towards the slack zone.

For bidding zones, where external flows are needed to balance the updated net position the market spread of such external flows are calculated as:

$$EMS_{j,SZ} = P_j - P_{SZ} \quad \text{(Eq. 7)}$$

And P_{SZ} is the price that minimizes the sum of external flows flowing in the opposite direction of EMS (i.e. non-intuitive external flows) using the following optimization:

$$P_{SZ} = \arg\min_{P} \sum_{j=1}^{n} (P_j - P_{SZ}) \times EF_{j,SZ} \quad \text{(Eq. 8)}$$

Where:

$EMS_{j,SZ}$ market spread for the external flow of a bidding zone j to the Slack Zone;

P_j clearing price of a bidding zone j resulting from SDAC (single day-ahead coupling);

P_{SZ} price of the virtual Slack Zone, which represents a common sink or source for all external flows;

$EF_{j,SZ}$ external flow of bidding zone j to Slack Zone;

n number of bidding zones having external flows.

If there is no unique solution for P_{SZ} then P_{SZ} shall be calculated as the average of the maximum and the minimum value from a set of P_{SZ} satisfying the formula above.

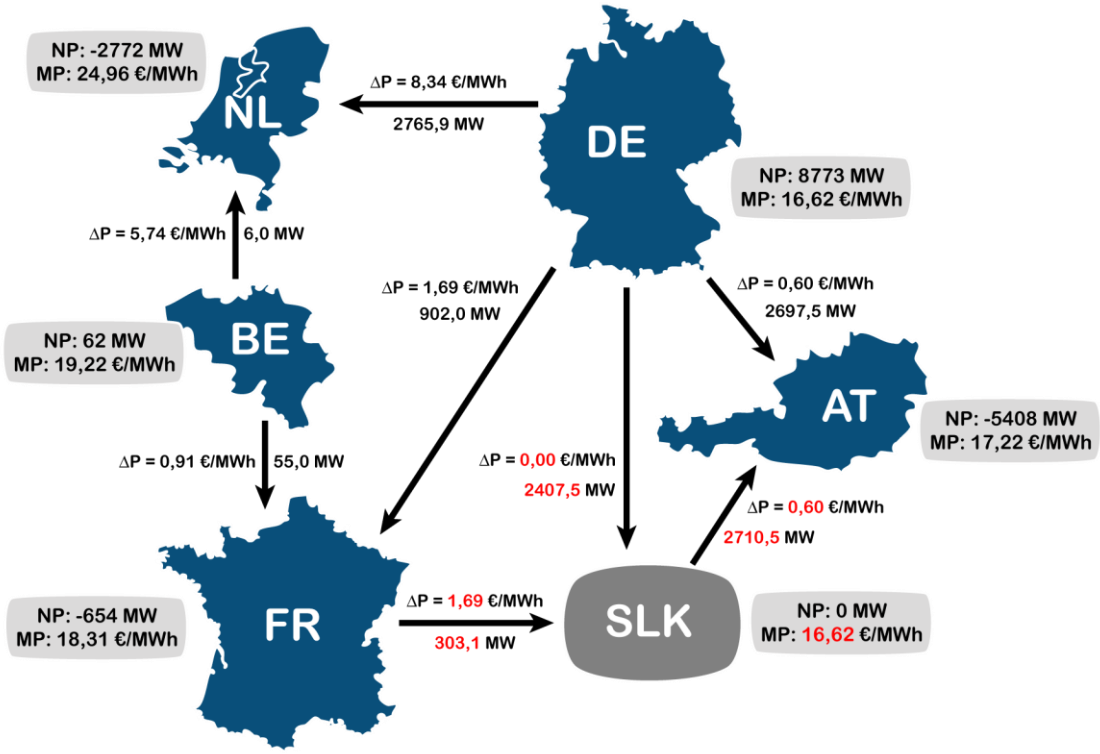


Figure 6: External flows towards the slack zone, based on the price optimization of the slack zone.

5.1 Calculation

For the computation of both the internal and external pot, we consider that all flows (AAFs) help to reach the optimum in CWE day-ahead market welfare, whatever the direction of the flow (with or against the price difference). This is in line with the choice of the CBCPM absolute key that was selected. It also ensures that both incomes are positive, which would not always be the case without considering absolute values. This means that we sum up the absolute Border Values for all internal and external hub borders respectively:

- Unscaled Internal pot = $\Sigma|(\text{AAF(internal hub borders)}\times\Delta P)|$ (Eq. 9)
- Unscaled External pot = $\Sigma|(\text{AAF(external hub borders)}\times\Delta P)|$ (Eq. 10)

The use of absolute values implies that the sum of the two pots may exceed the overall CWE congestion income. When sharing each of the pots, a pro-rata rescaling is then needed to correct this effect as shown in (Eq. 11) and (Eq.12).

- $internal\ pot = \frac{unscaled\ internal\ pot \times overall\ CI}{(unscaled\ internal\ pot + unscaled\ external\ pot)}$ (Eq. 11)
- $external\ pot = \frac{unscaled\ external\ pot \times overall\ CI}{(unscaled\ internal\ pot + unscaled\ external\ pot)}$ (Eq.12)

For the sharing of each of the pots keys based on the CBCPM absolute sharing key of internal flows (AAFs) or external flows are used:

5.2 Example

The updated net positions, market clearing prices and AAFs are already shown in Figure :

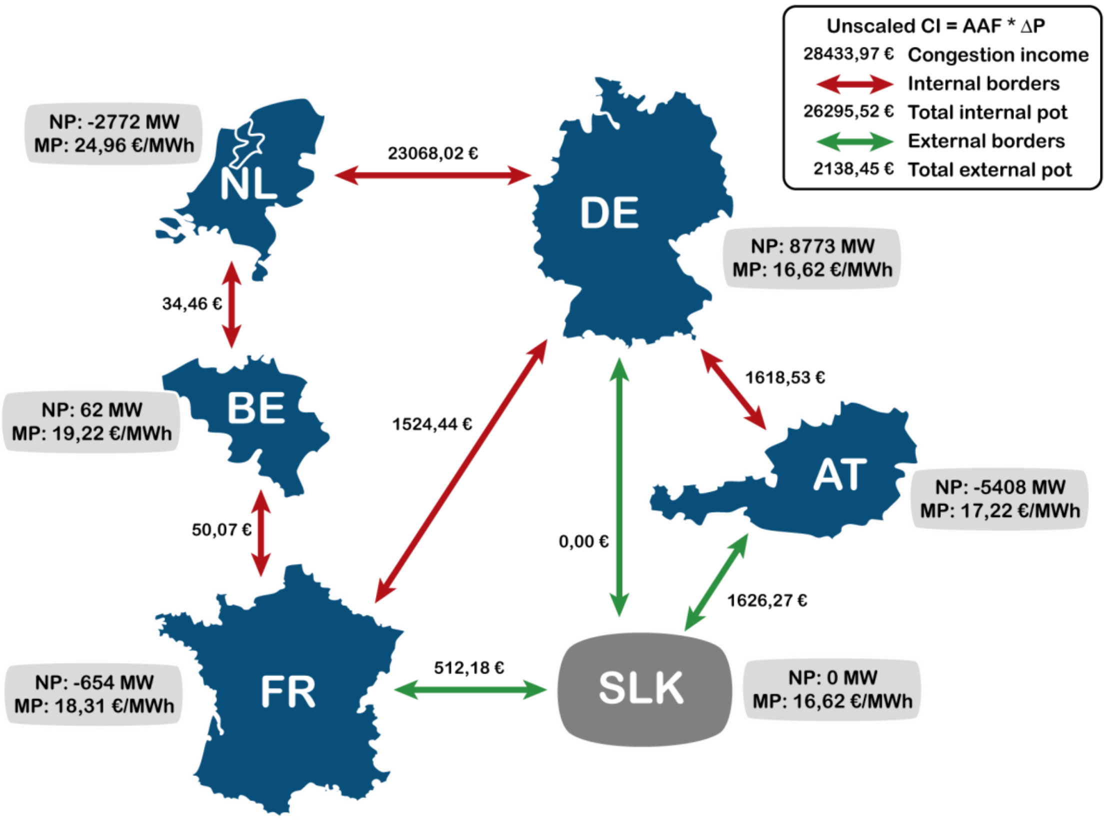


Figure 7: The unscaled congestion income per hub border, based on the market results as shown in Table 1

Applying these principles to our example leads to these computations (Table 1):

Unscaled internal pot = Σ │(AAF(internal)×ΔP)│ = 26.295,52€

Unscaled external pot = Σ │(AAF(external)×ΔP)│= 2.138,45€

Border	**Flow×│ΔP│**
DE-FR	902×1,69 = 1.524,44
DE-NL	2.765×8,34 = 23.068,02
BE-NL	6×5,74 = 34,46
BE-FR	55×0,91 = 50,07
DE-AT	2.697,5×0,60 = 1.618,53

Sum of absolute Border Values for all internal hub borders => **Unscaled internal pot**	**26.295,52**
FR-SZ	303,1 x 1,69 = 512,18
DE-SZ	2.407,5 x 0,00 = 0,00
AT-SZ	2.710,5 x 0,60 = 1.626,27
Sum of absolute Border Values for all external hub borders => **Unscaled external pot**	**2.138,45**

Table 1: Calculation of the border values

As the sum of the unscaled internal pot and unscaled external pot (28.433,97€) exceeds the overall CWE congestion income (27.190,42 €), a proportional rescaling is applied to unscaled CI amounts of the internal and external pot (Table 2) by a scaling factor of 27.190,42/28.433,97 = 0,9563

Border	**Rescaled Congestion Income**
DE-FR	1.524,44 x 0,9563 = 1.457,77€
DE-NL	23.068,02 x 0,9563 = 22.059,15€
BE-NL	34,46 x 0,9563 = 32,95€
BE-FR	50,07 x 0,9563 = 47,88€
DE-AT	1.618,53 x 0,9563 = 1.547,74€
Internal pot	**25.145,49€**
FR-SZ	512,18 x 0,9605 = 489,78€
DE-SZ	0€
AT-SZ	1.626,27 x 0,9605 = 1.555,15
External pot	**2.044,93€**

Table 2: Calculation of the rescaled congestion income on borders of the internal and external pot

Internal pot = 25.145,49€

External pot = 2.044,93€

The congestion income on the borders is shown in Figure .

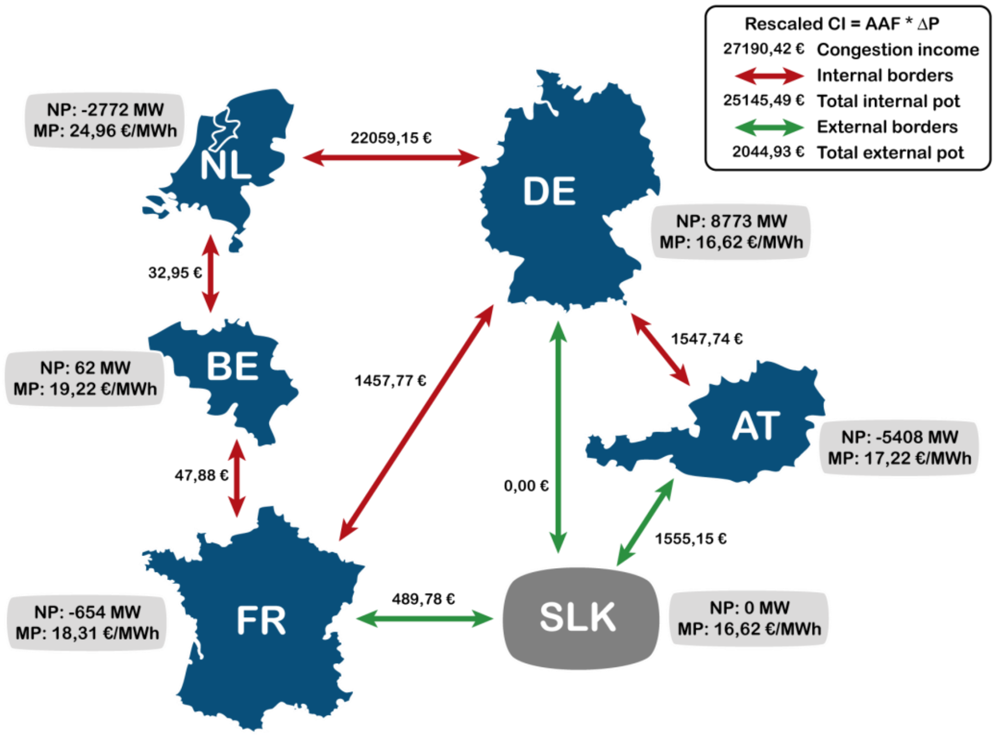


Figure 8: The scaled congestion income per hub border.

6 Sharing of the hub border income

The (rescaled) congestion income on the hub borders is shared equally (50/50) between the neighbouring hubs as shown in Figure 9.

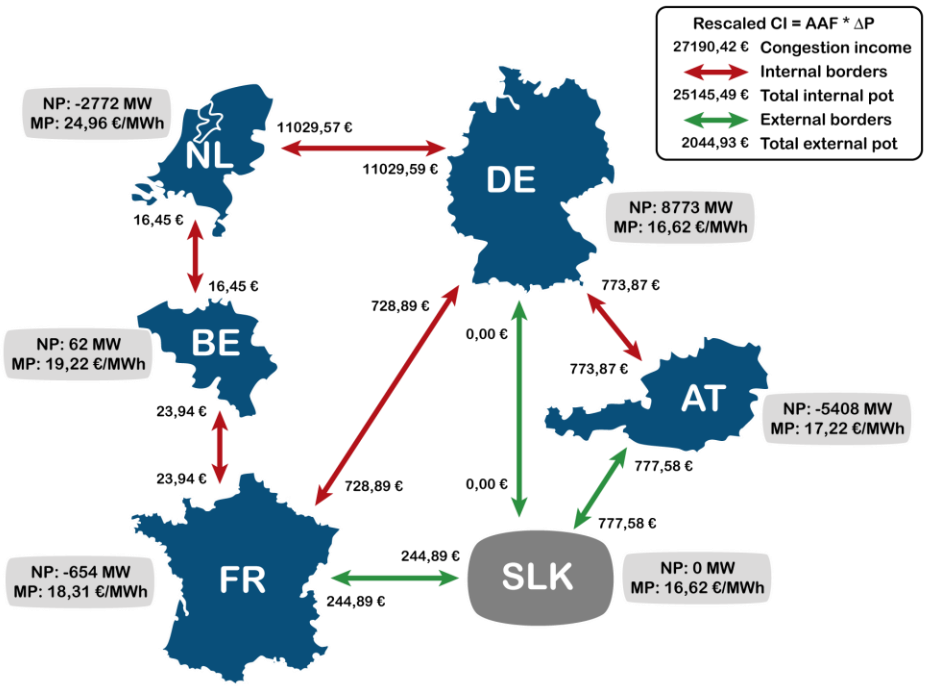


Figure 9: The scaled congestion income per hub border shared equally between each side of the border.

7 Principles of the remuneration of LTRs under Flow-Based MC

7.1 Cost for remuneration of Long-Term remuneration cost

The TSOs, through the "Use It Or Sell It" principle, enable the Market Participants that acquire some bilateral Long-Term capacities (based on ATC) in Yearly and Monthly auctions to automatically remunerate these capacities at the daily allocation in case they do not nominate these capacities in case of physical transmission rights (PTRs) on a border. In case of financial Transmission rights (FTRs) all allocated long-term rights are self-acting financially remunerated and no nomination is possible. Such remuneration will lead, in ATC but also in Flow-Based, to the payment of the positive price spread between the two hubs multiplied with the volume of Long-Term capacity remunerated. The remuneration costs in Flow-Based can be defined in 2 ways as shown in (Eq. 13) and (Eq.14);

$$Remuneration\ Cost = \sum_{i,j} (LTA_{i\rightarrow j} - LTN_{i\rightarrow j}) \times \max(0, \Delta CP_{hub\ i\rightarrow j}) \quad \text{(Eq. 13)}$$

$$Remuneration\ Cost = \sum_{NC} AAF_{rem,i} \times SP_i \quad \text{(Eq.14)}$$

<u>Where</u>:

$LTA_{,i\rightarrow j}$:	long term allocated capacity on the border in the direction from i to j.
$LTN_{,i\rightarrow j}$:	long term nominated capacity on the border in the direction from i to j.
$\Delta CP_{hub\ i\rightarrow j}$:	clearing price difference between hub i and hub j
$AAF_{rem,I}$	positive margin freed by the remuneration on critical branch i.
SP_i:	shadow price associated to network constraint *i*
NC:	total number of network constraints

7.2 Maximum amount available for remuneration of the return of LTRs

From (Eq.14), one can see that if the overall margin freed by all returns of LTRs to daily markets on each critical branch is lower than the margin made available by the TSOs to the Market Coupling, the congestion income from Flow-Based Market Coupling is higher than the remuneration cost as shown in Figure 10. We can conclude that if the Long Term ATC domain is included in the Flow-Based domain, the remuneration costs are covered by the hourly congestion income. The numerical proof that the remuneration costs are smaller or equal than the overall congestion income is assured because of the automatic LTA inclusion in the FB domain. An explanation can be found in Annex 1.

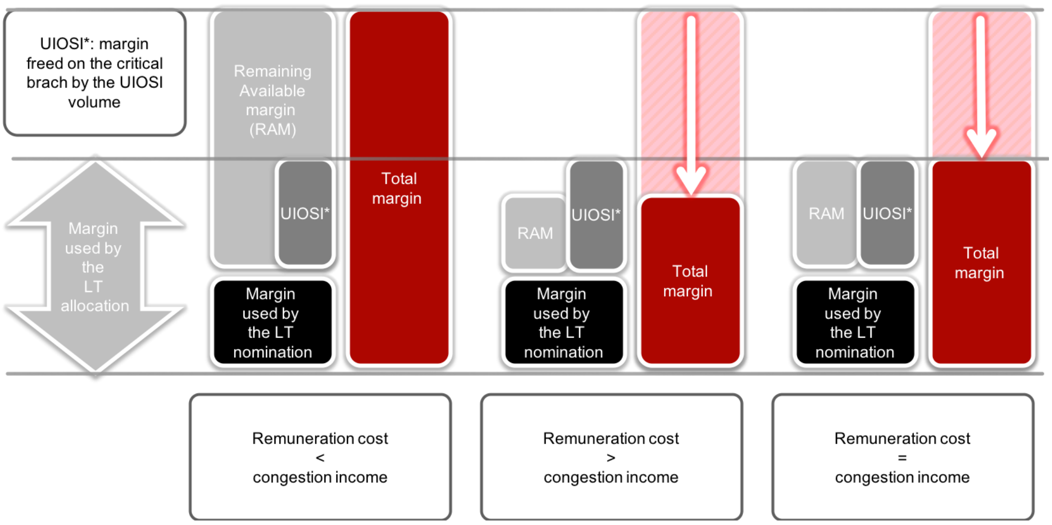


Figure 10: Relationship between overall congestion income, remuneration cost and margin on a critical branch

Following Eq. 13, the total remuneration cost can be calculated. This amount in total has to be remunerated to the market participants. Following the same calculation principle, also the remuneration cost per direction of a BZB respectively per BZB can be calculated (please be aware that remuneration costs only exist in case of positive market spread). For each BZB the resulting remuneration costs were shared 50% to 50% between the TSOs of a border and have to be remunerated to market participants by TSOs. Figure 11 is showing the netted (allocated minus nominated) LT-capacity relevant for remuneration, whereas Figure 12 is showing the effective remuneration cost per BZB considering market spread orientation.

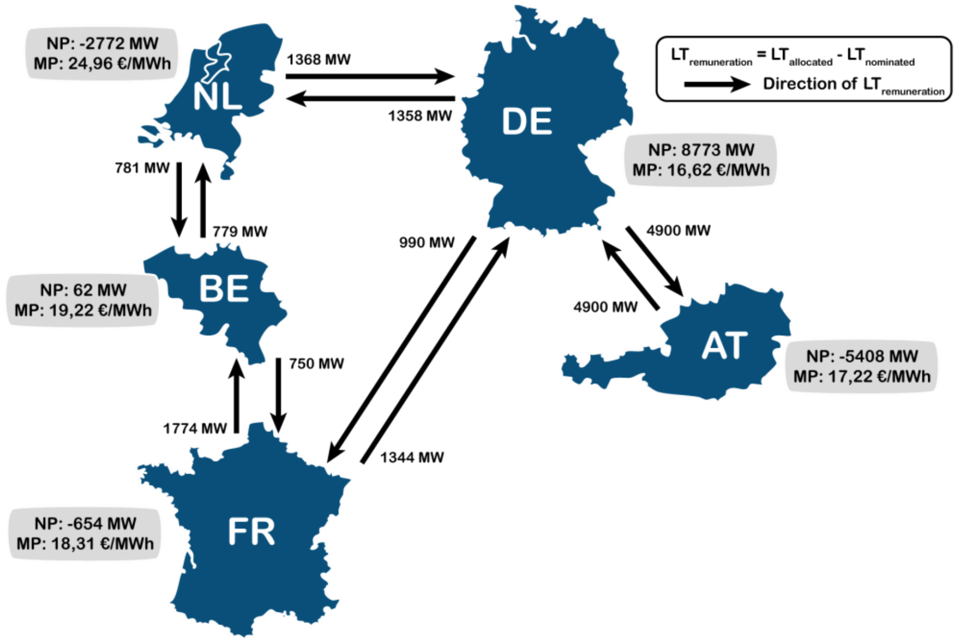


Figure 11: Amount of LT-Capacity for remuneration per BZB and direction

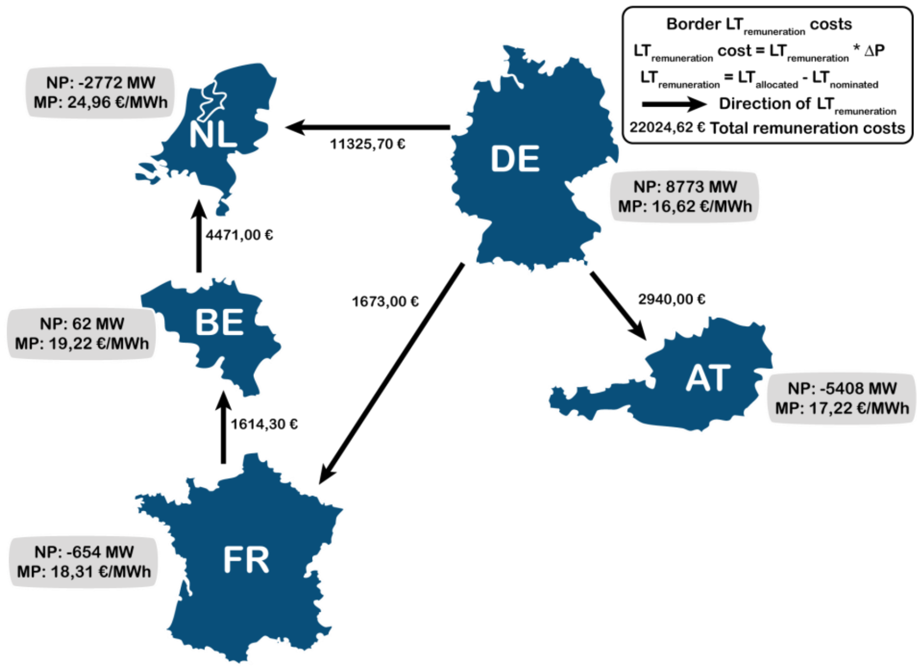


Figure 12: Effective remuneration cost per BZB caused by LT-remuneration

The total sum of remuneration cost according Eq. 13 is and as shown in Figure 12 is 22.024,62€. This is the amount which has to be paid to market participants for LT-remuneration.

7.3 Remuneration methodology in line with treatment of external pot

Remuneration costs for TSOs to market participants are based on a scheduled flow and resulting as already shown in Figure 12.

To make the remuneration cost independent of the nomination level (nomination proof; which is especially important if on a CCR PTRs with LT-nomination are in place on some borders in parallel to other borders based on FTR principle), in a first step theoretical remuneration cost are calculated again following Eq. 13 for each BZB, however without any nomination considered (remuneration cost based on allocated capacity and positive Market Spread).

On our Example this amount of remuneration without any nomination part over all BZBs is 22.124,92€ and rescaled again proportionally per BZB to the 22.024,62€, which has to be paid to market participants (Figure 13).

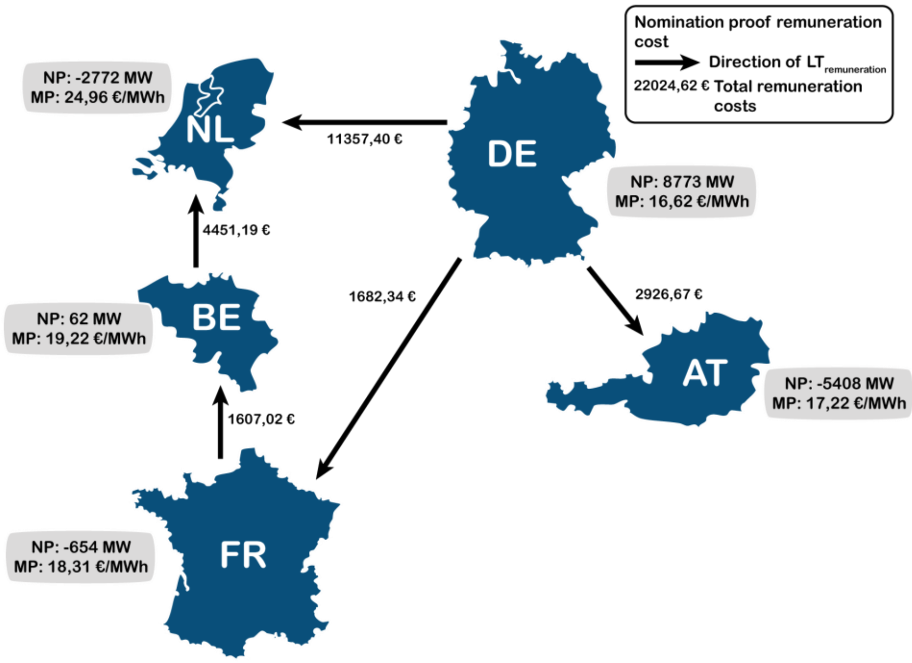


Figure 13: Nomination proof rescaled remuneration cost per BZB

In a next step the rescaled remuneration cost per BZB are further distributed because CI sharing key for TSOs is based on physical flows considering AAFs and external flows. To avoid an inconsistency between the remuneration methodology and the CI sharing principles, the remuneration cost shall also be assigned to internal and external borders (with external flows).

Therefore the following principle is applied:

- For a hub with closed borders the remuneration cost divided by two is assigned to its side of the respective closed border.
- For a hub with open borders, the part of the remuneration cost that is linked to the internal flow (AAF), divided by two, is assigned to its side of the closed border, whereas the part of the remuneration cost that is linked to the difference between the remunerated volume and the external flow, divided by two, is assigned to the open border to the Slack Zone. As a consequence, both sides of a border can have a different remuneration cost as shown in Figure 14

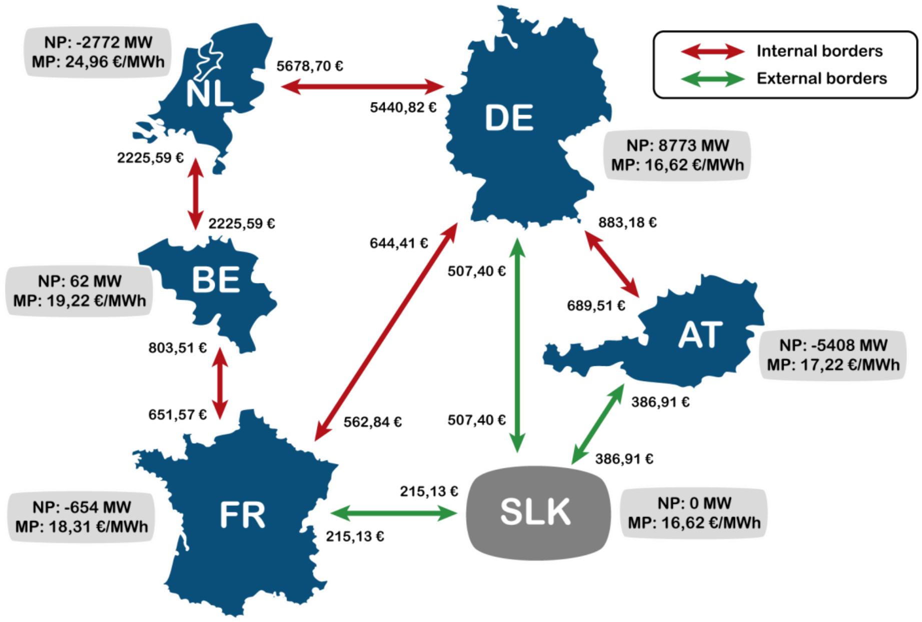


Figure 14: Assigned remuneration cost per border after distribution to internal and external borders

In Figure 14, between Belgium and the Netherlands the remuneration cost are equally at 2.225,59€, because both hubs have only closed borders (no external flows), whereas on all physical hubs with external flows (FR, DE/LU, AT) the remuneration cost on their BZB are different. The remuneration cost between those hubs with external borders and their SZ-border however is also equal, because the Net Position of the Slack Zone is always zero and therefore no flows relevant for remuneration are generated by this virtual hub.

7.4 Socialization methodology

The remuneration cost is calculated on a hub border basis; for internal and external borders. Each TSO is responsible for compensating the remuneration costs on its side of the border (based on hourly CI-income according distribution methodology). The steps to arrive at the remuneration cost per side of a hub border are reflected in the chart below (Figure 15).

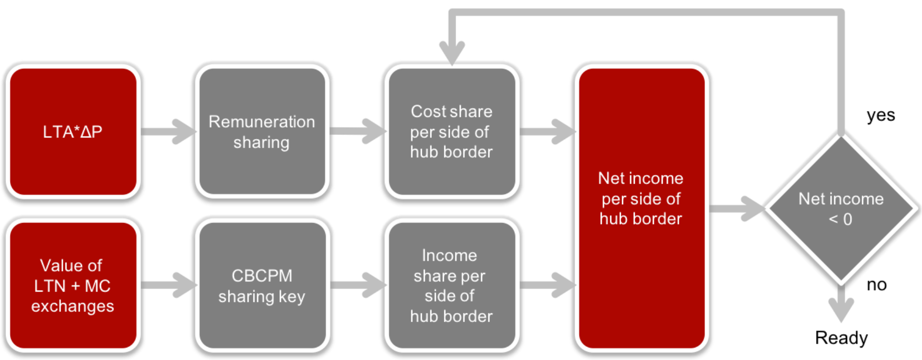


Figure 15: Socialization methodology principle

Figure 5 shows the congestion income per hub border on each side of the hub border and Figure 6 shows the remuneration costs on each side of the hub border. The difference between these values is the net congestion income per hub border (i.e. income after considering of cost for LT-remuneration) as shown in Figure 18.

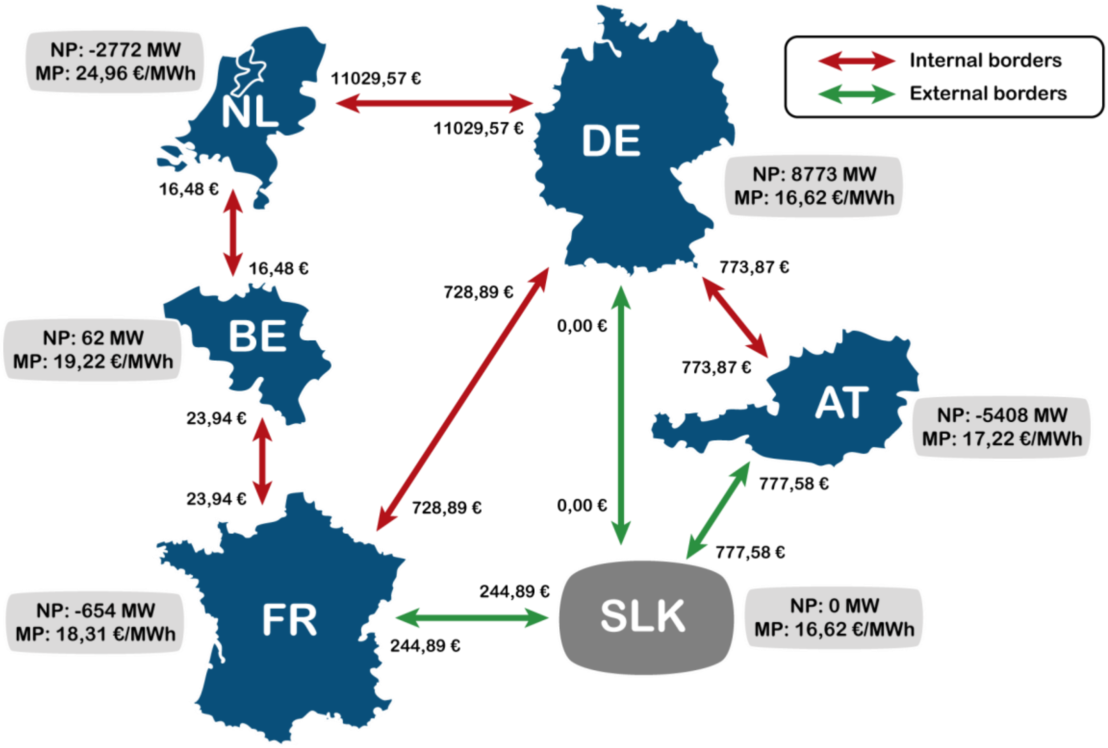


Figure 5: The congestion income per hub border on each side of the border, as calculated in paragraph 5.2.

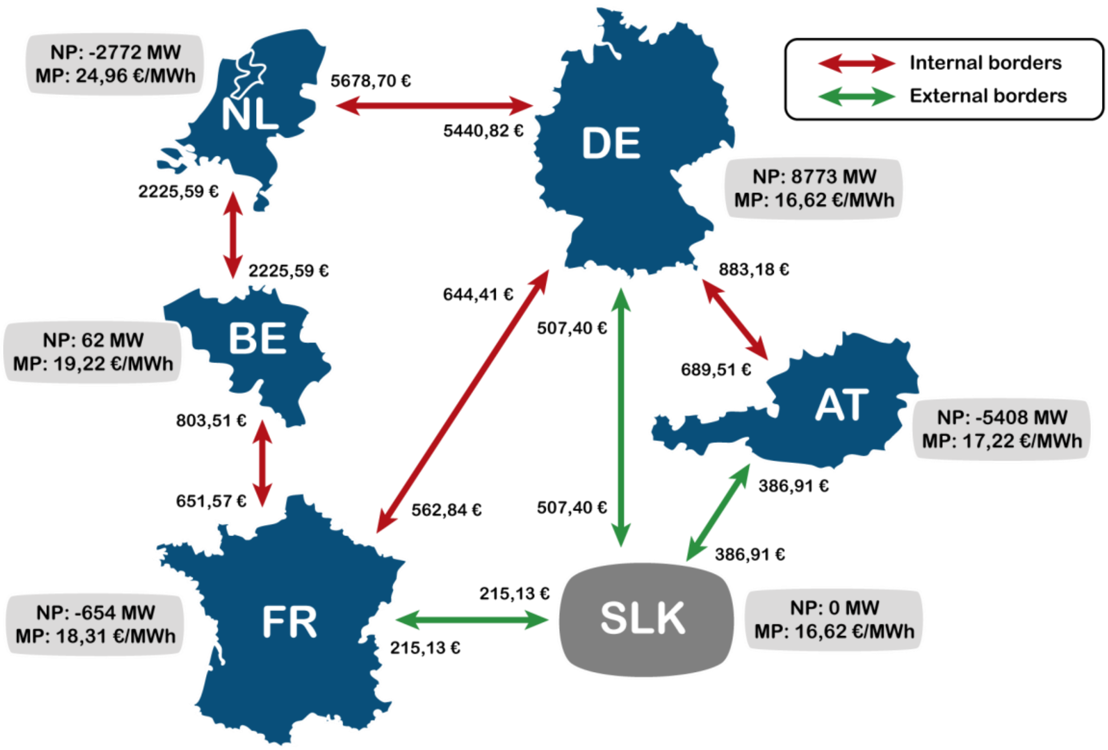


Figure 6: Long-term remuneration cost per hub border on each side of the border.

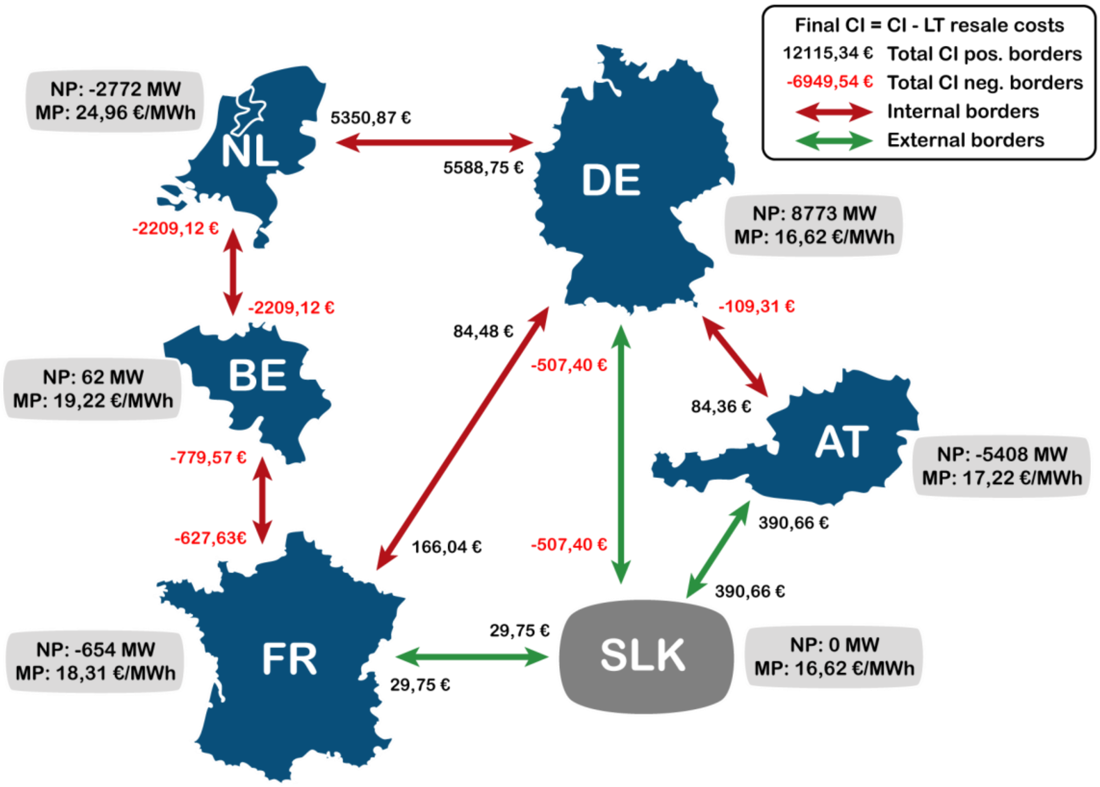


Figure 7: Combination of congestion income and long-term remuneration costs per hub border on each side of the border.

The hourly net income (income minus remuneration cost) should not lead to negative income per side of a hub border. In line with the remuneration methodology, the remuneration for any side of the hub border will initially be borne by its TSO. However, in case the income on a particular side of the hub border is not sufficient to cover these remuneration costs, these costs will be borne pro rata by the other hub borders (shown in the iteration of the cycle in Figure 15). This is referred to as 'socialization'.

In the given example only on the borders DE-NL, FR-SZ and AT-SZ the resulting CI for both directions are positive and also the border direction DE-AT:AT is positive. For all other borders, the amount of remuneration is larger than the CI. However the total CI of the positive borders with 12.109,11€ is larger than the outstanding remuneration cost of -6.943,31€ for negative borders and therefore the CI of the positive borders will be proportionally assigned to the negative borders to balance them to zero (in fact based on LTA-inclusion principle of the DA-FB domain, the total CI shall be always larger or at least equal to the total remuneration cost).

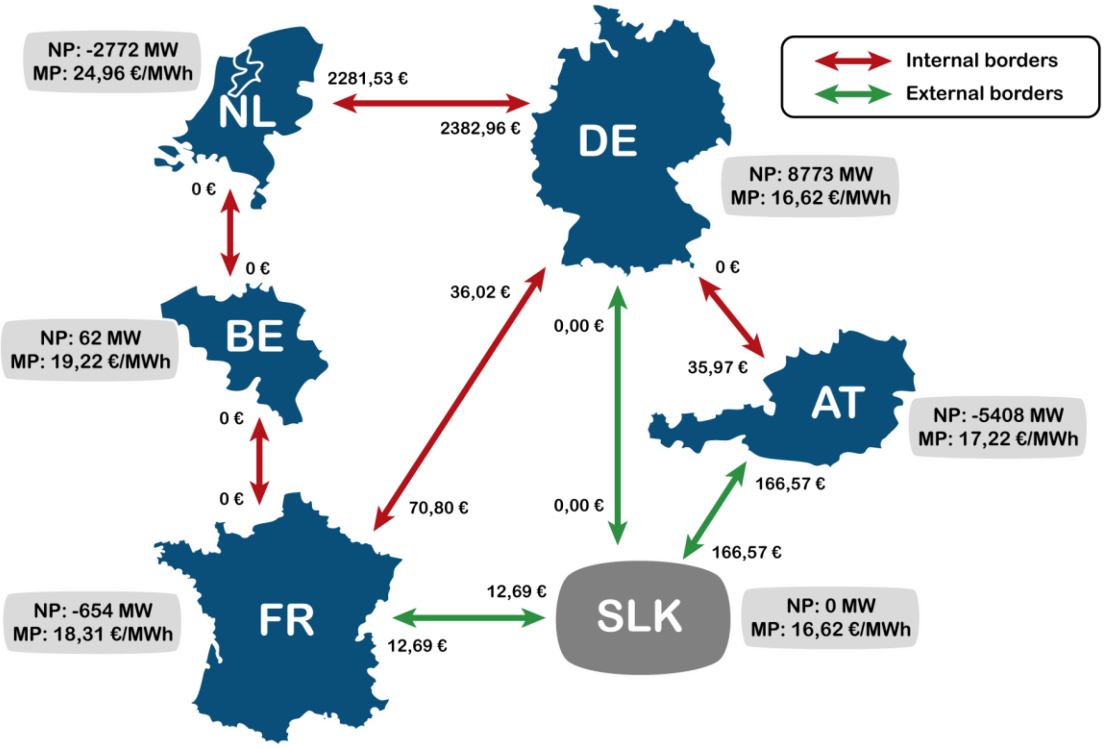


Figure 19: Net congestion income after socialization to all borders

After this socialization step it may be occur that some CI is also assigned to the Slack Zone. As this is only a virtual hub, this does not make sense and therefore in a last step the CI resulting for the Slack Zone (82,97€ in our example) is proportional to the AAFs distributed to the internal BZBs. Summing up this to the CI per direction of BZBs resulting after consideration of remuneration cost and socialization, the final CI per direction of BZB is calculated as shown in Figure 19 and in Table 3. For the example the CI for evaluated sample hour is equal to 5.165,80€. Based on the CI per side of BZB it is easy to sum up the CI per hub respectively per TSO(s).

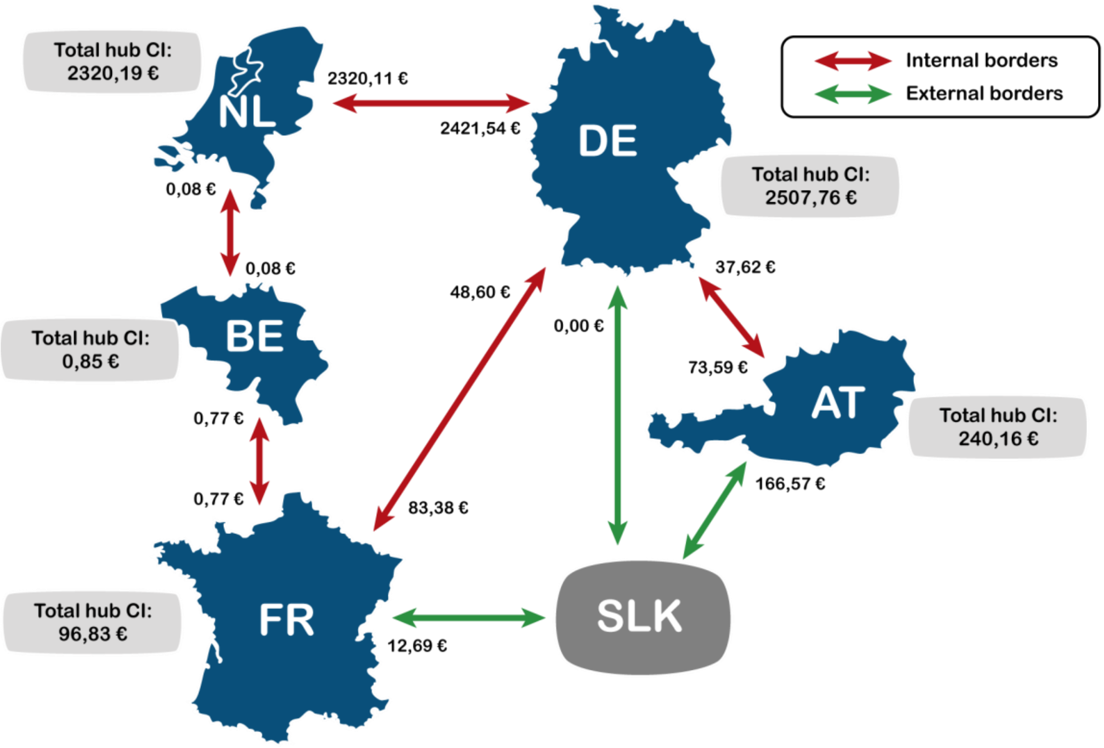


Figure **20: Net congestion income per hub border on each side of the border, after consideration of LT remuneration costs, socialization and sharing of the CI of the Slack Zone**

Border	**Final CI per side of BZB** **5.165,80€**
DE-FR.DE	48,60€
DE-FR.FR	83,38€
DE-NL.DE	2.421,54€
DE-NL.NL	2.320,11€
BE-FR.BE	0,77€
BE-FR.FR	0,77€
BE-NL.BE	0,08€
BE-NL.NL	0,08€
DE-AT.DE	37,62

DE-AT.AT	73,59
DE-SZ.DE	0€
FR-SZ.FR	12,69€
AT-SZ.AT	166,57€

Table 3: Final congestion income on each side of the BZB

7.5 Additional issue linked to the remuneration with Flow-Based daily allocation

In the previous chapters, we have already seen that there is a one-to-one relation between the Long Term ATC capacity and the available margins on day-ahead critical branches.

For the above mentioned reason, TSOs need to evaluate clearly what are the possible effects on the congestion income sharing, of the Long Term (non-harmonised) bilateral allocation of capacity on the one hand and of the fully coordinated Flow-Based allocation of capacity on the other.

Indeed, TSOs know that the Long Term allocation income will be received by the two TSOs issuing the capacity on that border. In line with the remuneration methodology, the remuneration will initially be borne by those TSOs. However, in case their income through the Flow-Based allocation is not sufficient to cover this, the costs for that border might be borne by other/all TSOs (socialization), therefore also the Long Term Rights need to be coordinated within the region.

8 Glossary

AAF	Additional aggregated flow
ATC	Available Transfer Capacity
ATC MC	ATC Market Coupling
BZB	Bidding Zone Border
CB	Critical Branch
CBCPM	Cross Border Clearing Price x Market flows
CI	Congestion Income (from day-ahead Market Coupling)
CIA	Congestion Income Allocation
CIDM	Congestion Income Distribution Methodology
CP	Clearing Price
CWE	Central Western Europe
D-1	Day Ahead
DA	Day Ahead
EF	External Flow
EMS	Market Spread of External Flow
FB	Flow-Based
FBI	Flow Based Intuitive
FBMC	Flow-Based Market Coupling
JAO	Joint Allocation Office
LT	Long Term
LTA	Allocated Long Term Transmission Capacity
LTN	Nominated Long Term Transmission Capacity
MC	Market Coupling
NP	Net Position (sum of commercial exchanges for one bidding area)
PCR	Price Coupling of Regions
PTDF	Power Transfer Distribution Factor
RAM	Remaining Available Margin
SLK/SZ	Slack Zone
SP	Shadow Price
TSO	Transmission System Operator
UIOSI	Use It or Sell It

Annex 1 Numerical example and proofs of remuneration costs versus flow-based income

1.1 Example: Remuneration costs higher than hourly congestion income in Flow-Based.

In order to understand better how the remuneration costs 'work' in Flow-Based, let's assume the following example, for illustration purpose:

- Critical Branch CB1: internal line with increasing flows for any export outside hub A - margin available 100MW
- Remuneration of capacity from Hub A towards Hub B: 200MW – influencing factor on CB1 = 20%
- Remuneration of capacity from Hub A towards Hub C: 250MW – influencing factor on CB1 = 30%
- The double export of energy from Hub A is unrealistic since there is not enough production in Market A for this configuration.

In this situation, we know that we have sold too much capacity simultaneously, on both interconnections, however there is no physical risk due to the constraint on the production availability in hub A.

Nevertheless, if the clearing result of Market Coupling leads to the congestion of the Critical Branch CB1, we will have the following situation (by assuming a shadow price on CB1 = 50€):

- Overall congestion income :
  Margin on CB1 × Shadow Price on CB1 = 100 × 50 = **5 000€**
- Remuneration cost linked to 200MW of capacity between Hub A and Hub B
  (Capacity resold × influencing factor CB1)[4] × Shadow Price CB1[5]= 200 × 20% × 50 = **2 000€**
- Remuneration cost linked to 250MW of capacity between Hub A and Hub C
  (Capacity resold × influencing factor CB1 × Shadow Price CB1[6] = 250 × 30% × 50 = **3 750€**

In this situation, we have a remuneration cost that is higher than the total hourly congestion income from the Flow-Based Market coupling. In addition, we have to point out the fact that the congestion of this Critical Branch might appear even if the market results is not a double export from Hub A.

1.2 Example (intuitive) for the remuneration proof

The example described in this section shows that the remuneration cost are covered by the hourly congestion income as long as the LTA domain is within FB domain. The three nodes (shown in Figure 8) are connected by three lines that have equal impedance. Node C acts as the swingbus / slacknode. Let's assume that the lines are unloaded and have a maximum capacity of 9MW.

---

[4] Margin freed by the resale of capacity on the critical branch

[5] Calculation linked to the high Level Property of Flow-Based allocation. In that respect, the Price in market A will be 2 000/200 = 10€ less expensive than in Market B.

[6] Calculation linked to the high Level Property of Flow-Based allocation. In that respect, the Price in market A will be 3 750/250 = 15€ less expensive than in Market C.

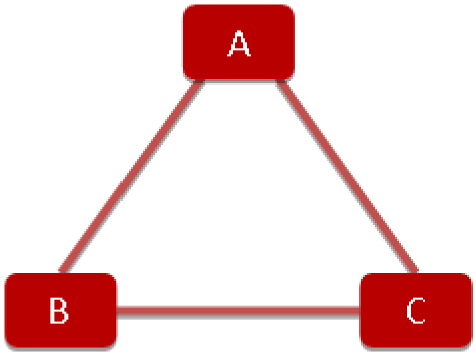


Figure 8: Example with three nodes

$$\begin{matrix} AB: \\ BC: \\ AC: \\ AB: \\ BC: \\ AC: \end{matrix} \begin{bmatrix} 1/3 & -1/3 \\ 1/3 & 2/3 \\ 2/3 & 1/3 \\ -1/3 & 1/3 \\ -1/3 & -2/3 \\ -2/3 & -1/3 \end{bmatrix} \begin{bmatrix} NP(A) \\ NP(B) \end{bmatrix} \leq \begin{bmatrix} 9 \\ 9 \\ 9 \\ 9 \\ 9 \\ 9 \end{bmatrix}$$

Figure 9: PTDF matrix

The FB domain is visualized in Figure 10.

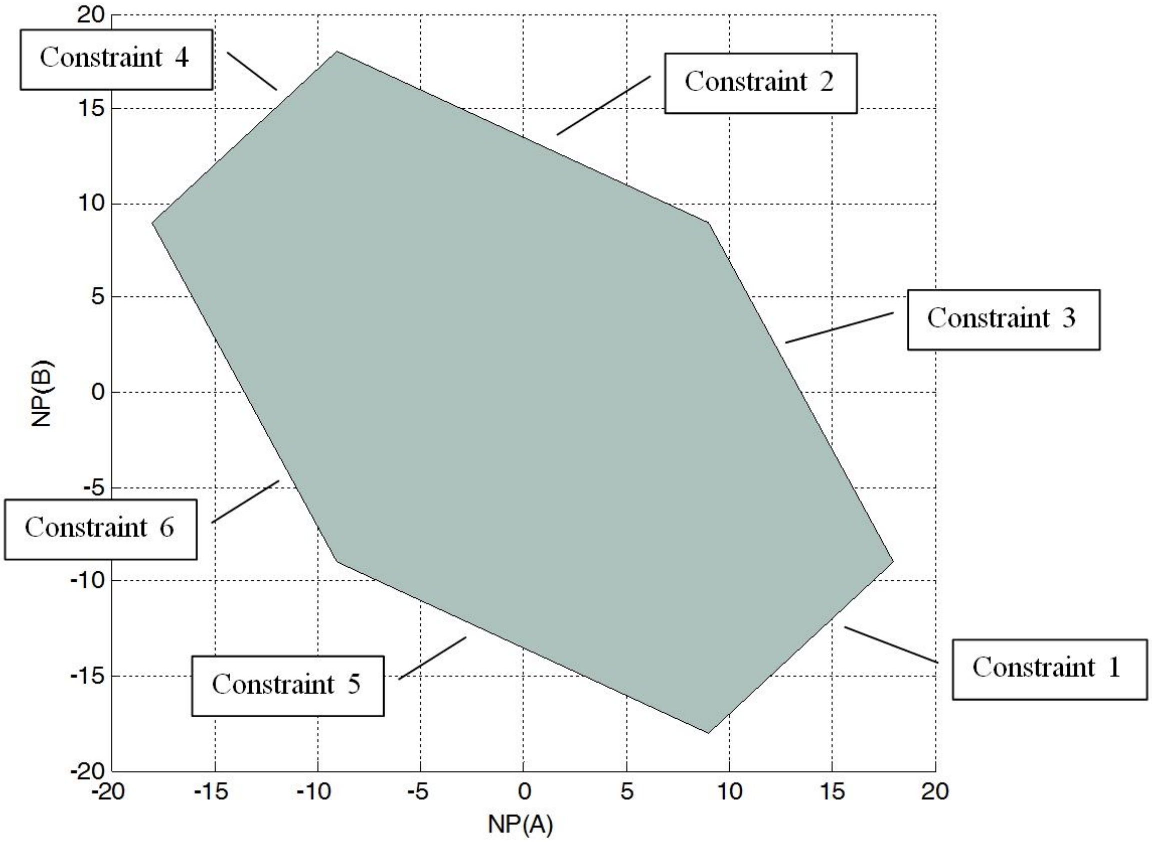


Figure 10: FB domain

The LTA are as follows: $\begin{bmatrix} A > B \\ A > C \\ B > C \\ B > A \\ C > A \\ C > B \end{bmatrix} = \begin{bmatrix} 13.5 \\ 0 \\ 13.5 \\ 0 \\ 13.5 \\ 0 \end{bmatrix}$

The LTA domain is shown, together with the FB one, in the following figure.

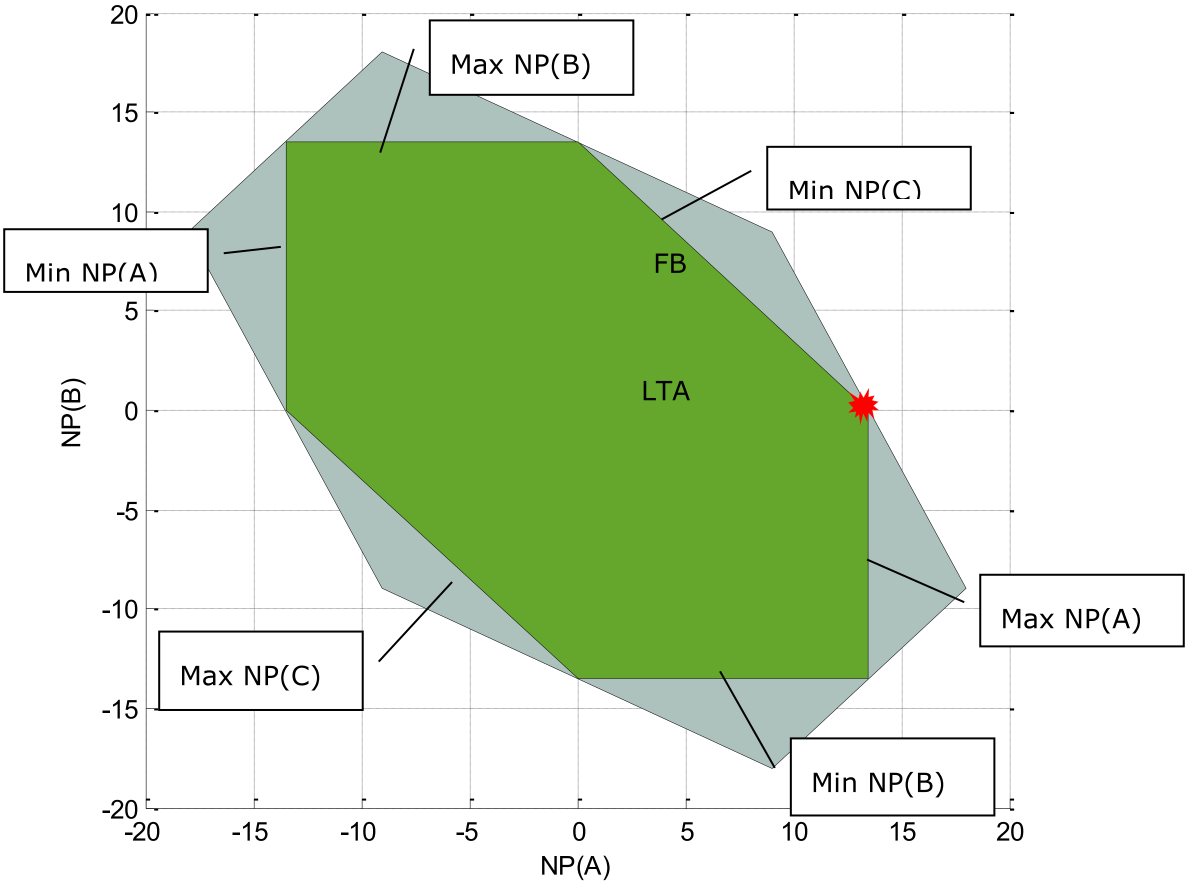


Figure 11: FB and LT domain

After the FBMC, a congested situation appears. Constraint 3 is hit ( ), and the following shadow price results: $\mu = 30$ €.

The resulting prices and net positions are:

$P_A = 10$ €, $NP_A = 13.5$

$P_B = 20$ €, $NP_B = 0$

$P_C = 30$ €, $NP_C = -13.5$

Maximum Remuneration Costs compensated at price spread is "Max RC":

$$\text{Max RC} = \sum_i \sum_{j \neq i} LTA_{i \to j} . \max\left((P_j - P_i), 0\right) = 13.5 * 10 + 13.5 * 10 + 0 = 270 \text{ €}$$

For each border i→j, a set of bilateral exchanges $BE_{i \to j}$ is:

$$\begin{cases} BE_{i \to j} = LTA_{i \to j} & \text{if } P_j > P_i \\ BE_{i \to j} = -LTA_{j \to i} & \text{if } P_j < P_i \\ BE_{i \to j} = 0 & \text{if } P_j = P_i \end{cases}$$

$BE_{A \to B} = 13.5$, $BE_{B \to A} = -13.5$

$BE_{A\to C} = 0$, $BE_{C\to A} = 0$

$BE_{B\to C} = 13.5$, $BE_{C\to B} = -13.5$

Consider Q'_i as the net position associated with this set of exchanges $BE_{i\to j}$:

$\forall i \;\; Q'_i = \sum_{j\neq i} BE_{i\to j}$ [b]

$\forall i,j \;\; BE_{i\to j} = -BE_{j\to i}$

$\sum_i Q'_i = \sum_i \sum_{j\neq i} BE_{i\to j} = 0$ [c]

$Q'_A = BE_{A\to B} + BE_{A\to C} = 13.5$

$Q'_B = BE_{B\to A} + BE_{B\to C} = -13.5 + 13.5 = 0$

$Q'_C = BE_{C\to A} + BE_{C\to B} = 0 - 13.5 = -13.5$

Indeed, $\sum_i Q'_i = 0$.

With [a] and [b], we are now able to rewrite:

$\text{Max RC} = \sum_i \sum_{j>i} BE_{i\to j} \cdot (P_j - P_i) = -\sum_i (Q'_i \cdot P_i)$ [d]

$\text{Max RC} = BE_{A\to B} * (P_B - P_A) + BE_{A\to C} * (P_C - P_A) + BE_{B\to C} * (P_C - P_B) = -P_A * (BE_{A\to B} + BE_{A\to C}) - P_B * (-BE_{A\to B} + BE_{B\to C}) - P_C * (-BE_{A\to C} - BE_{B\to C}) = -P_A Q'_A - P_B Q'_B - P_C Q'_C = -10 * 13.5 - 20 * 0 - 30 * -13.5 = 270$ €

Moreover the net position Q'_i is within the FB domain. Then:

$\forall l \in CB, \sum_i Q'_i \cdot PTDF_{i,l} \leq m_l$ [e]

Where CB is the group of all critical branches and m_l is the margin (available for DA MC) on the critical branch l. This margin is positive if the LT domain is included in the FB domain.

Indeed, the net positions are within the FB domain:

$$\begin{matrix} AB: \\ BC: \\ AC: \\ AB: \\ BC: \\ AC: \end{matrix} \begin{bmatrix} 1/3 & -1/3 \\ 1/3 & 2/3 \\ 2/3 & 1/3 \\ -1/3 & 1/3 \\ -1/3 & -2/3 \\ -2/3 & -1/3 \end{bmatrix} \begin{bmatrix} 13.5 \\ 0 \end{bmatrix} = \begin{bmatrix} 4.5 \\ 4.5 \\ 9 \\ -4.5 \\ -4.5 \\ -9 \end{bmatrix} \leq \begin{bmatrix} 9 \\ 9 \\ 9 \\ 9 \\ 9 \\ 9 \end{bmatrix}$$

The Congestion Income « CI » collected in D-1 can be written as :

$CI = -\sum_i (Q_i \cdot P_i) = \sum_{l \in CB} (\mu_l \cdot m_l)$ [f]

where μ_l is the shadow price of the critical branch l.

The Congestion Income in our example amounts

based on the computation with net positions and prices:

$$\mathrm{CI} = -10 * 13.5 - 20 * 0 - 30 * -13.5 = 270\ €$$

based on the computation with shadow price and margin:

$$\mathrm{CI} = 9 * 30 = 270\ €$$

Flow-Based clearing also has the following properties[7] :

$$\forall \mathrm{l} \in \mathrm{CB},\ \mu_{\mathrm{l}} \geq 0 \qquad [\mathrm{g}]$$

$$\exists \mathrm{P_{ref}} \text{ such that } \forall \mathrm{i}, \mathrm{P_i} = \mathrm{P_{ref}} - \textstyle\sum_{\mathrm{l}\in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}} \qquad [\mathrm{h}]$$

With [f] and [d], we finally have:

$$\mathrm{CI} - \mathrm{Max\ RC} = \sum_{\mathrm{l}\in\mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} - (-\sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \mathrm{P_i})$$

With [h],

$$= \textstyle\sum_{\mathrm{l}\in\mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} + \sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \left(\mathrm{P_{ref}} - \sum_{\mathrm{l}\in\mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}\right)$$

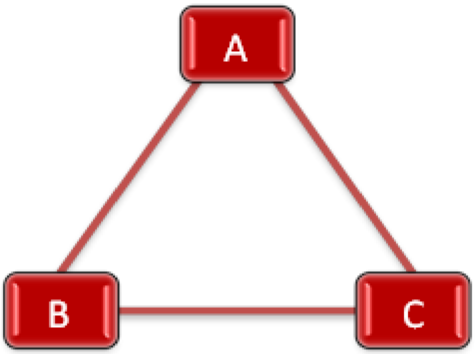
$$= \textstyle\sum_{\mathrm{l}\in\mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} + \mathrm{P_{ref}} \cdot \sum_{\mathrm{i}} \mathrm{Q'_i} - \sum_{\mathrm{i}}\left(\mathrm{Q'_i} \cdot \sum_{\mathrm{l}\in\mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}\right)$$

With [c],

$$= \textstyle\sum_{\mathrm{l}\in\mathrm{CB}} \mu_{\mathrm{l}} \left(\mathrm{m_l} - \sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \mathrm{PTDF_{i,l}}\right)$$

1.3 Example (non-intuitive) for the remuneration proof

The example described in this section shows that the remuneration cost are covered by the hourly congestion income as long as the LTA domain is within the FB domain. The three nodes are connected by three lines that have equal impedance as shown in Figure 12. Node C acts as the swingbus / slacknode. Let's assume that the lines are unloaded and have different maximum capacities.



$$\begin{matrix} AB: \\ BC: \\ AC: \\ AB: \\ BC: \\ AC: \end{matrix} \begin{bmatrix} 1/3 & -1/3 \\ 1/3 & 2/3 \\ 2/3 & 1/3 \\ -1/3 & 1/3 \\ -1/3 & -2/3 \\ -2/3 & -1/3 \end{bmatrix} \begin{bmatrix} NP(A) \\ NP(B) \end{bmatrix} \leq \begin{bmatrix} 14.67 \\ 9.67 \\ 15.33 \\ 3.33 \\ 8.33 \\ 2.67 \end{bmatrix}$$

[7] Based on the following FB equation: $\frac{P_j - P_i}{PTDF_i - PTDF_j} = \mu_l \geq 0$

Figure 12: Example with three nodes **Figure 13: PTDF matrix**

The FB domain is visualized in the graph hereunder.

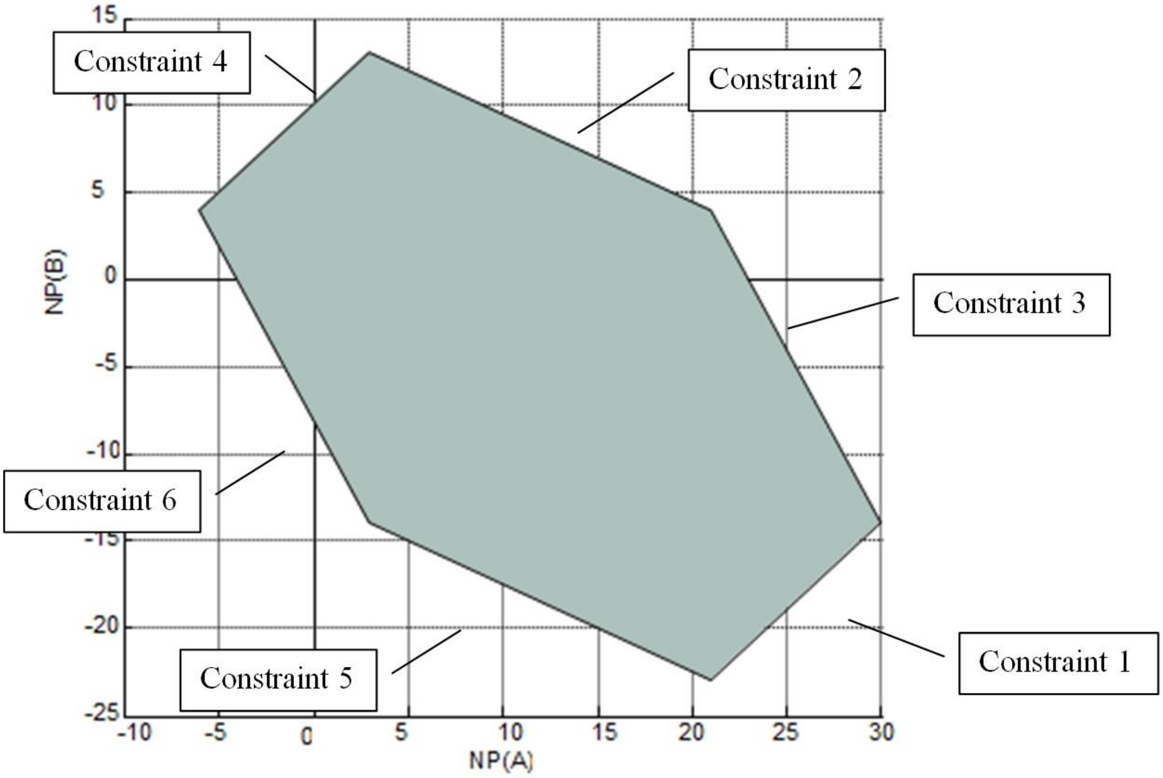


Figure 14: FB domain

The LTA are as follows: $\begin{bmatrix} A > B \\ A > C \\ B > C \\ B > A \\ C > A \\ C > B \end{bmatrix} = \begin{bmatrix} 7 \\ 8 \\ 10 \\ 0 \\ 0 \\ 8 \end{bmatrix}$.

The LTA domain is shown, together with the FB one, in the following figure.

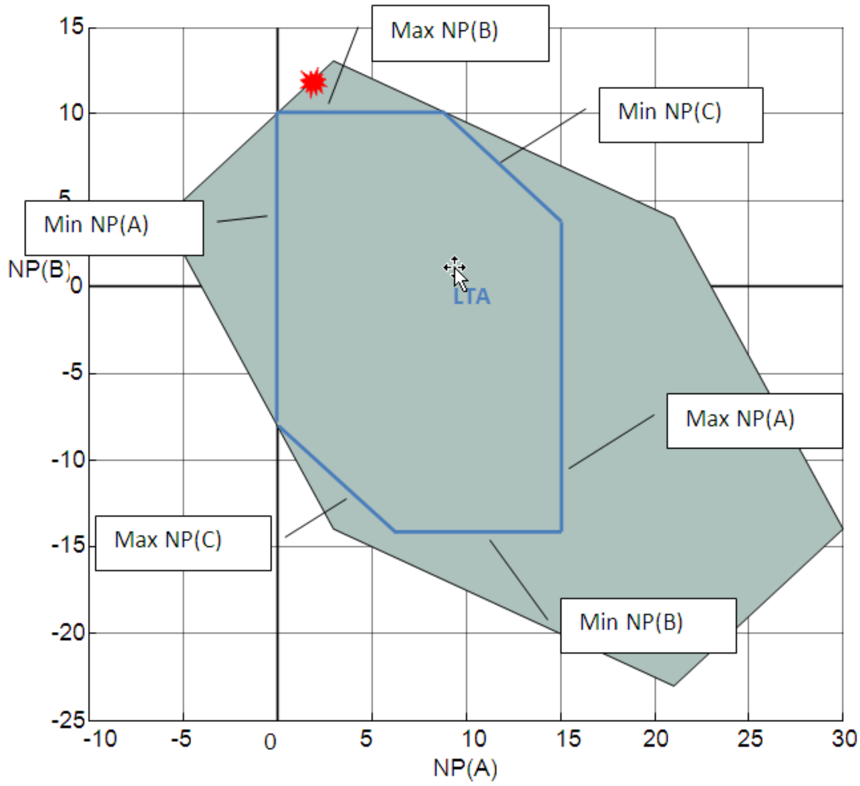


Figure 15: FB and LTA domain

After the FBMC, a congested non-intuitive situation appears. Constraint 4 is hit (✸), and the following shadow price results: $\mu = 30$ €.

The resulting prices and net positions are:

$P_A = 0$ €, $NP_A = 2$

$P_B = -20$ €, $NP_B = 12$

$P_C = -10$ €, $NP_C = -14$

Maximum Remuneration Costs compensated at price spread is « Max RC » :

$$\text{Max RC} = \sum_i \sum_{j \neq i} LTA_{i \to j} \cdot \max\left((P_j - P_i), 0\right) = 0 + 0 + 10 * (-10 + 20) + 0 = 100 \text{ €}$$

For each border i→j, a set of bilateral exchanges $BE_{i \to j}$ is:

$$\begin{cases} BE_{i \to j} = LTA_{i \to j} & \text{if } P_j > P_i \\ BE_{i \to j} = -LTA_{j \to i} & \text{if } P_j < P_i \\ BE_{i \to j} = 0 & \text{if } P_j = P_i \end{cases}$$

$BE_{A \to B} = 0,\ BE_{B \to A} = 0$

$BE_{A \to C} = 0,\ BE_{C \to A} = 0$

$BE_{B \to C} = 10,\ BE_{C \to B} = -10$

Consider Q'_i as the net position associated with this set of exchanges $BE_{i \to j}$:

$$\forall i \quad Q'_i = \sum_{j \neq i} BE_{i \to j} \qquad [b]$$

$$\forall i, j \quad BE_{i \to j} = -BE_{j \to i}$$

$$\sum_i Q'_i = \sum_i \sum_{j \neq i} BE_{i \to j} = 0 \qquad [c]$$

$$Q'_A = BE_{A \to B} + BE_{A \to C} = 0 + 0 = 0$$

$$Q'_B = BE_{B \to A} + BE_{B \to C} = 0 + 10 = 10$$

$$Q'_C = BE_{C \to A} + BE_{C \to B} = 0 - 10 = -10$$

Indeed, $\sum_i Q'_i = 0$.

With [a] and [b], we are now able to rewrite:

$$\text{Max RC} = \sum_i \sum_{j>i} BE_{i \to j} \cdot (P_j - P_i) = -\sum_i (Q'_i \cdot P_i) \qquad [d]$$

$$\text{Max RC} = BE_{A \to B} * (P_B - P_A) + BE_{A \to C} * (P_C - P_A) + BE_{B \to C} * (P_C - P_B) = -P_A * (BE_{A \to B} - BE_{A \to C}) - P_B * (BE_{A \to B} - BE_{B \to C}) - P_C * (BE_{A \to C} - BE_{B \to C}) = -P_A Q'_A - P_B Q'_B - P_C Q'_C = 0 * 0 - (-20 * 10) - (-10 * -10) = 200 - 100 = 100$$
€

Moreover the net position Q'_i is within the FB domain. Then:

$$\forall l \in CB, \sum_i Q'_i \cdot PTDF_{i,l} \leq m_l \qquad [e]$$

where CB is the group of all critical branches and m_l is the margin (available for DA MC) on the critical branch l. This margin is positive if the LT domain is included in the FB domain.

Indeed, the net positions are within the FB domain:

$$\begin{matrix} AB: \\ BC: \\ AC: \\ AB: \\ BC: \\ AC: \end{matrix} \begin{bmatrix} 1/3 & -1/3 \\ 1/3 & 2/3 \\ 2/3 & 1/3 \\ -1/3 & 1/3 \\ -1/3 & -2/3 \\ -2/3 & -1/3 \end{bmatrix} \begin{bmatrix} 0 \\ 10 \end{bmatrix} = \begin{bmatrix} -3.33 \\ 6.67 \\ 3.33 \\ 3.33 \\ -6.67 \\ -3.33 \end{bmatrix} \leq \begin{bmatrix} 14.67 \\ 9.67 \\ 15.33 \\ 3.33 \\ 8.33 \\ 2.67 \end{bmatrix}$$

The Congestion Income « CI » collected in D-1 can be written as :

$$CI = -\sum_i (Q_i \cdot P_i) = \sum_{l \in CB} (\mu_l \cdot m_l) \qquad [f]$$

where μ_l is the shadow price of the critical branch l.

The Congestion Income in our example amounts

based on the computation with net positions and prices:

$\mathrm{CI} = -0 * 2 - (-20 * 12) - (-10 * -14) = 240 - 140 = 100\,€$

based on the computation with shadow price and margin:

$\mathrm{CI} = 3.33 * 30 = 100\,€$

Flow-Based clearing also has the following properties[8] :

$\forall \mathrm{l} \in \mathrm{CB},\ \mu_{\mathrm{l}} \geq 0$ [g]

$\exists \mathrm{P_{ref}}$ such that $\forall \mathrm{i}, \mathrm{P_i} = \mathrm{P_{ref}} - \sum_{\mathrm{l} \in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}$ [h]

With [f] and [d], we finally have:

$$\mathrm{CI} - \mathrm{Max\ RC} = \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} - \left(-\sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \mathrm{P_i}\right)$$

With [h] $= \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} + \sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \left(\mathrm{P_{ref}} - \sum_{\mathrm{l} \in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}\right)$

$= \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \cdot \mathrm{m_l} + \mathrm{P_{ref}} \cdot \sum_{\mathrm{i}} \mathrm{Q'_i} - \sum_{\mathrm{i}} \left(\mathrm{Q'_i} \cdot \sum_{\mathrm{l} \in \mathrm{CB}} \mathrm{PTDF_{i,l}} \cdot \mu_{\mathrm{l}}\right)$

With [c], $= \sum_{\mathrm{l} \in \mathrm{CB}} \mu_{\mathrm{l}} \left(\mathrm{m_l} - \sum_{\mathrm{i}} \mathrm{Q'_i} \cdot \mathrm{PTDF_{i,l}}\right)$

With [g] and [e], ≥ 0

In our example, the Congestion Income is equal to the Remuneration Costs:

$$\mathrm{CI} - \mathrm{Max\ RC} = 100 - 100 = 0$$

[8] Based on the following FB equation: $\frac{P_j - P_i}{PTDF_i - PTDF_j} = \mu_l \geq 0$

Common position paper of CWE NRAs on the update of the Flow-based market coupling methodology

August 2018

Context

Flow-Based (hereafter FB) is a key element of the implementation of the target model for capacity calculation and allocation at day-ahead (hereafter DA) timeframe as described in the European Regulation on Capacity Allocation and Congestion Management (hereafter CACM Regulation)[1]. Its implementation in the Central West Europe (hereafter CWE) region started on the basis of the Annex issued end 2006 of Regulation 1228/2003[2] repealed later by Regulation 714/2009[3].

Its purpose is to improve the optimization allowed by Market Coupling (hereafter MC) based on a more precise capacity calculation which makes it possible to benefit from the interdependency between commercial flows on affected transmission network elements called "Critical Branches" (hereafter CB) by maximizing as much as possible their use by the most valuable exchanges. Commercial capacities do not have to be shared ex-ante between several borders as implemented with ATC[4] methods, leading to potential inadequacy between the needed and the possible exchanges.

Since 2007, CWE parties have committed themselves to work toward the development of FB Market Coupling (hereafter FB MC). The CWE FB methodology (principles and details) has thus been developed by the project partners (TSOs and PXs) under the supervision of CWE NRAs.

The methodology has been tested through an internal parallel run in 2012 and two years of external parallel run in 2013 and 2014.

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[1] CACM Regulation: Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management

[2] Regulation 1228/2003: Regulation (EC) N° 1228/2003 on conditions for access to the network for cross-border exchanges in electricity

[3] Regulation 714/2009: Regulation (EC) N° 714/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) N° 1228/2003

[4] Available Transfer Capacity

In 2015, the methodology was approved followed by go-live in May. However, at that time CWE NRAs recognized that there was room and a need for further improvements. These were summarized in a "Position Paper of CWE NRAs on Flow-Based Market Coupling", published in March 2015. Therefore some CWE NRAs approved the methodology conditional to the improvements set out in this common position paper.

Today not all requested improvements have been fulfilled yet. The request for fulfilling the improvements linked to this paper remain valid and CWE NRAs monitor the progress on these improvements.

One of the major requests for improvement was the completion of a Critical Branch Critical Outage (hereafter CBCO[5])-selection study to demonstrate the optimality of the 5% PTDF-threshold as CBCO selection criterion. End of 2017 this request had not been fulfilled. The need for an improved CBCO-selection methodology became however clear from the monitoring data, which indicated that cross-zonal exchanges were often strongly limited by the inclusion of CBCOs with low remaining available margin (RAM). Given the urgency to solve the problem of very low cross-zonal capacities, CWE NRAs agreed in December 2017 on the request for a minimum RAM requirement of 20% of the thermal capacity of the defined and applied CBCOs. This measure is operational since 26 April 2018 and is considered as a short-term solution awaiting a proper CBCO-selection study by CWE TSOs. CWE TSOs are still in the process of completing this study under the supervision of CWE NRAs. Therefore, it was agreed amongst CWE NRAs to meanwhile incorporate the so-called "20% minRAM" requirement in this updated CWE FB MC approval package.

Another main trigger for this updated CWE FB MC approval package is the request by E-Control and BNetzA to include their common bidding zone border in the CWE FB MC by 1 October 2018. The establishment of the DE/LU-AT border results in an additional bidding zone in the CWE FB MC. The Austrian bidding zone will be operated by the Austrian TSO APG who has been involved in the CWE FB MC from the early stage of the CWE processes by (1) inclusion of Austrian D2CF data into CWE Common Grid Model (hereafter CGM) in November 2014, (2) inclusion of Austrian Generation Shift Key (hereafter GSK) into CWE FB in December 2015 and (3) considerations of Austrian CBs in the FB process.

Upon request of E-Control and BNetzA, CWE NRAs agreed that CWE TSOs shall analyse the technical and economic impact of the inclusion of the German-Austrian bidding zone border into the CWE FB MC via the standard process to communicate on and assess the impact of significant changes (hereafter SPAIC). The principle of the SPAIC analysis is to, for representative days, compute as in real operations, the transmission capacity domain, and the resulting market outcomes. All these tests have allowed a better understanding and a greater confidence into the appliance of the methodology also on that border. After a positive outcome, TSOs prepared the inclusion of the DE/LU-AT border into the submission of the CWE FB MC approval package, in view on an implementation from 1 October 2018 on.

[5] CBCO means "critical branch critical outage". It corresponds to what is called CNEC (critical network element contingency) under the CACM Regulation

In order to prepare and transparently communicate the details of the inclusion of the DE/LU-AT border, meetings with market participants have been organized. The outcome of these meetings were made public[6] and taken on board for further improvements. Moreover, since 1 July 2018, an external parallel run is performed.

Legal basis

The legal basis under which the CWE FB MC methodology was developed and submitted for approval is Regulation 714/2009 and its Annex 1 as well as Directive 2009/72/EC[7]. This legal basis remains unchanged for the proposed changes to CWE FB MC. The legal framework provided by the CACM Regulation, which entered into force on 14 August 2015, builds further upon Regulation 714/2009 and foresees the combination of FB DA and intraday (hereafter ID) MC with adequate bidding zones as the European target model. However, as the relevant process under the CACM Regulation is ongoing within the Core region, this should not prevent from any progress in the CWE region before the wider coordinated Core FB MC is implemented[8].

These Regulations set out minimum harmonised rules for the single DA and ID coupling, in order to provide a clear legal framework for an efficient and modern capacity allocation and congestion management system. This shall facilitate Union-wide trade in electricity, allowing more efficient use of the network and increasing competition, for the benefit of consumers.

Description of the proposal

The updated CWE FB MC approval package includes the two main changes discussed in the Context section above, being:

- the inclusion of the DE/LU-AT-border; and
- the introduction of the 20% minRAM requirement.

[6]http://www.jao.eu/support/resourcecenter/overview?parameters=%7B%22IsDEATBZBProject%22%3A%22True%22%7D

[7] Article 37(6) of Directive 2009/72 of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity provides that regulatory authorities shall be responsible for fixing or approving sufficiently in advance of their entry into force the methodologies used to calculate or establish the terms and conditions for access to cross-border infrastructures, including the procedures for the allocation of capacity and congestion management.

[8] ACER decision n° 06/2016 of 17 November 2016 on the electricity transmission system operators' proposal for the determination of capacity calculation: "*the CACM Regulation does not prohibit the TSOs to propose the implementation of the requirements through a step-by-step approach and sub-regional projects, provided the latter are consistent with the common methodologies developed at regional level; the efforts and progress achieved already in the framework of the ongoing regional projects should actually foster the development of common methodologies at the level of the merged region*".

On top, CWE TSOs indicate the following major changes, being:

- the proposal not to apply external constraints to the DE/LU bidding zone; and
- for the bidding zones where external constraints are applied, the proposal to apply external constraints on the global net position instead of the currently used external constraints on the CWE net positions.

These changes are incorporated in the CWE FB MC approval package that consists of three parts:

- the DA methodology: this methodology includes the 4 changes described above;
- the ID methodology; and
- the congestion income allocation (hereafter CIA) methodology.

The two latter documents are only impacted by the inclusion of the DE/LU-AT border.

Besides these major changes, CWE TSOs proposed some smaller updates. Some of them are included in the analysis.

Analysis of the proposal

The scope of this common position paper is the evaluation of the new elements in the updated proposal. The requests for improvements linked to the CWE NRA common position paper of 2015 are still valid and the monitoring by CWE NRAs on the progress on these requested improvements is ongoing in a parallel process and which will be the scope of a separate CWE NRA position paper.

Through the Long-Term Allocation (hereafter LTA) inclusion patch implemented in the CWE FB MC, the type and the amount of long term allocated transmission rights on CWE borders influence the flow based domain. The evaluation of the type and value of long term allocated transmission rights are part of the scope of the evaluation of the 2015 CWE NRA Common position paper.

Day-ahead proposal

Regarding the inclusion of the DE/LU-AT border

CWE NRAs acknowledge the introduction of the DE/LU-AT border in the CWE capacity calculation as of 1 October 2018. Despite the uncertainty regarding the SPAIC analysis (due to the need to forecast proportionate share of locational bidding information in the historical order books of the joint bidding zone DE/LU/AT), the SPAIC analysis showed that there will be no deterioration of the current performance of the CWE DA FB MC and, on the contrary, increased capacities are expected. CWE NRAs expect that the introduction of the DE/LU-AT-border will increase the CWE cross-zonal exchanges, especially for the exchanges that are currently limited.

Regarding the introduction of the 20% minRAM requirement

The minimum RAM requirement of 20% of the thermal capacity of the network element at CBCO-level is applied since 26 April 2018 following the conclusion made in December 2017 amongst CWE

NRAs. This represents an improvement and should be included as a temporary solution awaiting the result of the CBCO-selection study.

The CBCO-selection study is still ongoing. A first version was submitted by CWE TSOs in presentation format on 1 May 2018, and CWE NRAs deem that additional explanations and analysis were required. From the feedback received by CWE TSOs, CWE NRAs understand that CWE TSOs propose to first gather experience with the split of the DE/LU/AT bidding zone in order to be able to further conduct a CBCO-selection study for this new bidding zone configuration. CWE NRAs therefore ask CWE TSOs to provide a timeline which they deem reasonable for conducting the analysis and proposing an improved CBCO-selection methodology that duly addresses the feasibility and non-discrimination aspect. This timeline is binding to CWE TSOs and should not be longer than 30 June 2019. CWE NRAs keep open the possibility to use their powers of enforcement in case CWE TSOs do not provide a CBCO-selection study of the required quality. Whilst an improved CBCO-selection in CWE is legally independent of the Core FB MC, it may provide useful lessons and could possibly serve as a building block for the Core FB MC. In any case, CWE TSOs shall ensure a smooth transition towards the Core FB MC.

CWE TSOs shall timely and duly justify any derogation from the minimum 20% RAM requirement towards NRAs for monitoring and towards market parties for transparency (see *Transparency* section). Derogations should be exceptional and only when no other means to secure grid security are available.

Regarding the external constraints

Some CWE TSOs currently use external constraints on the CWE net position to address grid security issues linked to voltage stability or dynamic stability.

CWE NRAs welcome the proposal of German TSOs not to apply external constraints for the DE/LU bidding zone. As the external constraints applied today for the DE/LU/AT bidding zone have been found to frequently limit the CWE FB domain, the decision not to apply any external constraints after the DE/LU/AT bidding zone split is thus expected to improve the opportunities for CWE cross-zonal exchange as an external constraint by means limits trading capacity.

CWE NRAs acknowledge the proposal of CWE TSOs to apply external constraints on the global bidding zone net position instead of an external constraint on the CWE net position. Nevertheless, CWE NRAs repeat that external constraint by means always limits trading capacity. Therefore, the functioning of these external constraints on the global net position need to be better explained. To improve transparency on the functioning and justify the need for such a global net position constraint, CWE NRAs expect from the corresponding CWE TSOs a report including:

- (a) the justification for the applied value,
- (b) a description of how a global bidding zone net position is taken into account in the market coupling process and how this is coordinated amongst CWE TSOs,
- (c) a description on how the application is going to be coordinated among CWE TSOs and traced in the CWE FB MC transparency and monitoring data,
- (d) the date of the switching from an external constraint on the CWE net position to one on the global net position.

The report shall be submitted to the CWE NRAs before the application of these global constraints instead of the current constraints. After approval by the relevant CWE NRA(s) the paper shall be published on the JAO website as soon as possible.

Regarding the additional changes related to minor updates

CWE NRAs agree on the following and expect these remarks to be taken into account if an amended proposal is submitted at a later stage:

- Local Phase Shifting Transformer (hereafter PST) coordination: CWE TSOs specified that the PST coordination of Zandvliet/Vaneyck, Gronau, Diele and Meeden on one side and Tauern, Ternitz, Ernsthofen on the other side is done locally with the involved TSOs. CWE NRAs underline that all remedial actions with cross-zonal impact, including PST coordination, have to be coordinated with all CWE TSOs. Even if for practical reasons not all CWE TSOs are involved in this local PST coordination process, CWE NRAs request respective TSOs to always act in the maximum transparent manner.
- D2CF of Swissgrid: Inclusion of D-2 forecasts of the Swissgrid is expected to provide more accurate D-2 forecasts for establishing the base case than with the current practice, which is the inclusion of the Swiss DACF-files of the reference day. Also from the point of grid security, CWE NRAs consider it important that CWE TSOs continue their active cooperation with non-CWE TSOs from all neighbouring bidding zones as to guarantee grid security in a most efficient way.
- Use of dynamic GSKs: CWE NRAs take note of the intention expressed by APG to investigate the use of dynamic GSKs. CWE NRAs however understand that the determination of GSKs on an hourly basis requires historical data for data-learning and therefore ask APG to launch the data-learning process from the start and request other TSOs not yet applying dynamic GSK to follow the same path. CWE NRAs underline that the use of dynamic GSKs by all TSOs is required in order to obtain the most accurate representation of the market coupling results.
- Explicit mentioning of EPEX SPOT: CWE NRAs recognize the role of EPEX SPOT as CWE FB MC project partner and their role in the development of the methodology. However, CWE NRAs underline that this explicit reference to EPEX SPOT can in no way hamper the possibility for other power exchange companies being Nominated Electricity Market Operators (hereafter NEMOs) to join the MC in the CWE region or be a source of discrimination between NEMOs.

Regarding transparency requirements

On the transparency side, CWE NRAs notice that the table of published information does not reflect the current status of transparency level at CWE level. CWE NRAs also notice that CWE TSOs did not propose any update with further improvements. In May 2018, CWE NRAs shared a list of short-term expected improvements on transparency and expressed their support to the requests by market parties.

First of all, CWE NRAs urge for completeness of the published data with unique physical names and EIC-codes of both CBs and COs before 15 October 2018.

At the same time, CWE NRAs request:

- the publication of the full RAM-breakdown, i.e. Fmax, Fref, FRM, FAV and the Adjustment for Minimum RAM (AMR) which is currently proposed by CWE TSOs to implement the 20% minRAM,
- the inclusion of the reference program of all CWE and non-CWE borders of the involved bidding zones,

- in the case of derogation from the min 20% rule, publication of the justification
- the publication PTDF and RAM-values before and after LTA-inclusion,
- the timely publication of all outages considered in the market coupling,
- the publication of up-to-date static grid models.

The above list is non-exhaustive. In the case of an updated or amended proposal, CWE TSOs are asked to update the transparency table accordingly.

Regarding regional coupling

CWE NRAs understand that the current FB MC approval document is notably focused on the introduction of the DE/LU-AT border and that the CWE regional coupling is still included as this process remains applicable after the go-live of the DE/LU-AT border.

However, CWE TSOs intend to remove the CWE regional coupling, once the CWE MNAs are implemented, as it is planned not to share order books between the NEMOs active in CWE.

ID proposal

CWE NRAs note that it is currently not foreseen to apply the increase/decrease process at DE/LU-AT border, which has been applied on all other CWE borders since 3 May 2017. Having in mind recent developments in the ID capacity calculations, CWE NRAs recommend CWE TSOs to investigate whether an improvement in the upcoming months is manageable and possible and if yes, request CWE TSOs to implement the inclusion of DE/LU-AT border in the increase/decrease process.

CIA

CWE NRAs notice updates to the methodology to reflect the addition of the DE/LU-AT border. This is especially the case for the determination and repartition of the external pot. CWE NRAs acknowledge the remark from CWE TSOs, indicating that CWE TSOs will analyse the applied methodology once respectively 6 and 12 months of CIA results following the go-live of the DE/LU/AT split are available and will report CWE NRAs about the results. CWE NRAs also acknowledge the possibility of a reassessment of the methodology.

Conclusion

CWE NRAs acknowledge the introduction of the DE/LU-AT-border in CWE FB MC. CWE NRAs expect that the introduction of the DE/LU-AT border in CWE FB MC will increase the CWE cross-zonal exchanges, especially for the exchanges which are currently limited.

CWE NRAs acknowledge the introduction of the 20% minRAM requirement for all CBCOs included in the CWE FB MC and expect that it also increases the CWE cross-zonal exchanges. This is considered as a temporary measure awaiting an improved CBCO-selection methodology. CWE NRAs therefore ask CWE TSOs to provide a timeline which they deem reasonable for conducting the analysis and proposing an improved CBCO-selection methodology addressing both the feasibility and non-discrimination aspect. This timeline is binding to CWE TSOs and should not be longer than 30 June 2019. CWE NRAs keep open the possibility to use their powers of enforcement in case CWE TSOs do not provide a CBCO-selection study of the required quality. Whilst an improved CBCO-selection in CWE is legally independent of the Core FB MC, it may provide useful lessons and could possibly serve as a building block for the Core FB MC. In any case, CWE TSOs shall ensure a smooth transition toward Core FB MC.

CWE NRAs acknowledge the decision not to apply external constraints at the DE/LU bidding zone level.

CWE NRAs expect the CWE TSOs who propose to apply external constraints on the global net position to improve transparency on these constraints and describe how these will be applied in the market coupling process. CWE NRAs expect from the corresponding CWE TSOs a report including:

a) the justification for the applied value,
b) a description of how a global bidding zone net position is taken into account in the market coupling process,
c) description on how the application is going to be coordinated among CWE TSOs and traced in the CWE FB MC transparency and monitoring data,
d) the date of the switching from an external constraint on the CWE net position to one on the global net position.

The report shall be submitted to the CWE NRAs before the application of these global constraints instead of the current constraints. After approval by the relevant CWE NRA(s) the paper shall be published on the JAO website as soon as possible.

CWE NRAs ask CWE TSOs to improve transparency and satisfy the transparency requirements as laid out in this common position paper. This includes amongst others the completeness of the published data, the publication of the RAM-breakdown, the EIC-codes of CBs and COs, the reference program of CWE and non-CWE borders and the PTDF and RAM-values before and after LTA-inclusion.

The comments of this position paper shall be taken into account if an amended proposal is submitted at a later stage.