Documentation of the CWE FB MC solution

July 2020 – version 5.0, applicable as of DD MM 2020

Last updated: 10/07/2020

Note: this document is an update of the CWE FB MC approval package version 4.1, dated 11 April 2019.

The main changes compared to the version 4.1 are the following:

1. Introduction of the ALEGrO-cable in CWE FB capacity calculation: detailing how the ALEGrO HVDC between Amprion and Elia will be included in the CWE FBMC
2. Evolved Flow-based: describing the methodlogy used for HVDC borders between two Bidding Zones
3. Extended LTA inclusion: explaining the updated methodology for LTA inclusion to keep the same precision and improve performance.
4. CEP MinRAM calculation methods: detailing how each TSO calculates mininimum levels of available capacity for cross-zonal trade according to Regulation (EU) 2019/943 of 5 June 2019 on the internal market for electricity (one of the regulations of the Clean Energy Package).
5. Removal of the intuitiveness patch: switch from Flow-Based intuitive to Flow-Based based plain.

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 11 April 2019, now including:

1. Introduction of the ALEGrO-cable in CWE FB capacity calculation: detailing how the ALEGrO HVDC between Amprion and Elia will be included in the CWE FBMC
2. Evolved Flow-based: describing the methodlogy used for HVDC borders between two Bidding Zones
3. Extended LTA inclusion: explaining the updated methodology for LTA inclusion to remain precision and improve performance.
4. CEP MinRAM calculation methods: detailing how each member state calculates minRAM according to the CEP.
5. Removal of the intuitiveness patch: switch from Flow-Based intuitive to Flow-Based based plain.

For the sake of consistency all provisions reflected in this document are without prejudice to further methodologies and proposals, which will be implemented as required by Commission Regulation (EU) 2015/1222 (CACM) or Regulation (EU) 2019/943.

The CWE Market Coupling Solution

The specific CWE Flow Based Market Coupling solution is a regional part of the Single Day Ahead Coupling (SDAC).

During the daily operation of Market Coupling the available capacity (final Flow Based parameters including the Critical Network Elements and the PTDF-matrix) will be published at 10:30. Market Parties will have to submit their bids and offers to one of the NEMOs in their

bidding zone before gate closure time. In case results cannot be calculated, the Fallback mechanism for capacity allocation will be applied at SDAC level and there will be a Full or Partial Decoupling of one or multiple NEMOs or bidding zones, following the SDAC Procedures.
The solution is operated via a set of connected systems. These systems are operated by RSCs, TSOs, jointly or individually, NEMOs, 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 general principle of the CWE Fallback arrangement is to allocate ATCs derived from the Flow Based parameters via a "shadow explicit auction" on decoupled borders. A bidding zone remains coupled, as long as cross zonal capacities can be provided to the market coupling algorithm for at least one border of that bidding zone. If all borders of a certain bidding zone are decoupled, the order books of the NEMOs in that bidding zone are removed from the market coupling algorithm and become decoupled.
Moreover, if one NEMO cannot submit its order book of a certain bidding zone to the market coupling algorithm, the remaining NEMOs in that bidding zone remain coupled. Decoupled NEMOs run their own local fallback auctions.

The Algorithm

Market results are calculated by a centralised market coupling algorithm, which 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 SDAC 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). The algorithm outputs net 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 14.10).

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 14.11).
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 14.28.

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.

The parallel computation of results with FBP takes place since May 2015.
The removal of the intuitiveness patch (switch to FBP) will take place as of the technical go-live of ALEGrO in Euphemia due to issues in terms of algorithm performance and optimisation possibilities with the Evolved Flow-Based approach as well as alignment with ACER’s

decision on algorithm methodology defined in the Article 37 of Commission Regulation (EU) 2015/1222 (CACM).

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. Publications 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 active at that time in 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 latest update of this documentation focuses on:

- Changes required in order to make the CWE Flow Based Market Coupling compliant with provisions on capacity calculation of the Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity, which applies from 1 January 2020.

The updated descriptions are submitted for approval according to the national approval procedures to the competent CWE NRAs and in line with Regulation (EU) 2019/943.

For the other parts of the document, CWE TSOs consider that the previous approvals of the CWE NRAs on these parts of the CWE FB MC methodology remain 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
- Economic validation
- Transparency / publication of data
- 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 Nominated Electricity Market Operators (NEMOs) 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 NEMOs 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 Network Elements 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)[1]. 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**.

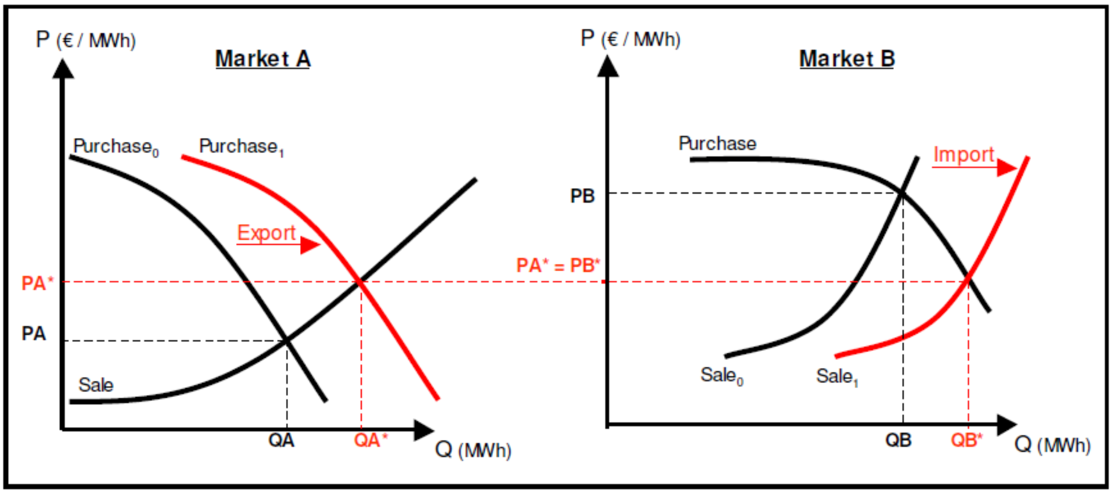

Figure 3-1: Representation of Market Coupling for two markets, no congestion.

[1] 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.

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.

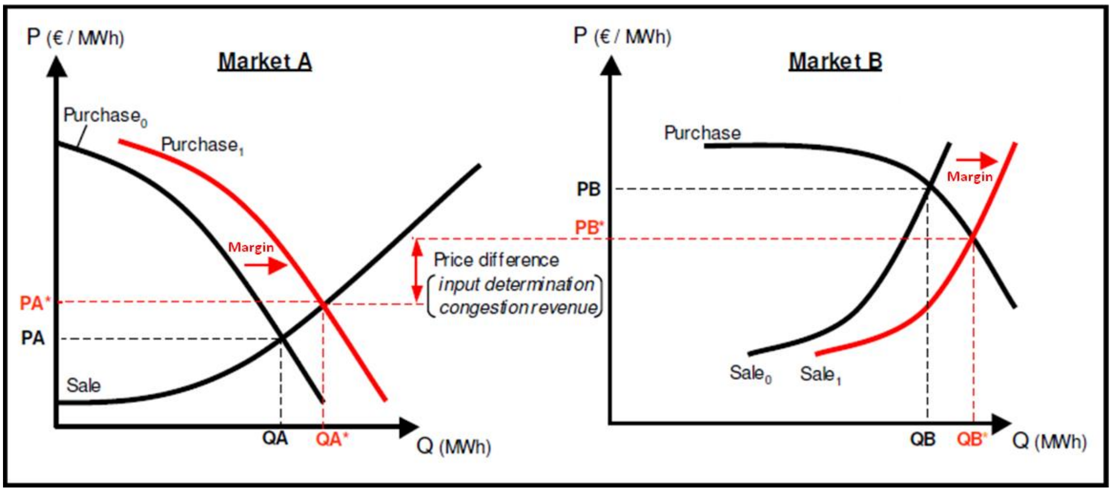

Figure 3-2: Representation of Market Coupling for two markets, congestion case

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 7.3).

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 14.2.

The high level business process for capacity calculation can be found in Annex 14.3.

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 Network Elements / Contingencies
- Maximum current on a Critical Network Element (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 Network Elements

4.1.1. CNEC-selection

A Critical Network Element (CNE) is a network element, significantly impacted by CWE cross-border trades, which is monitored under certain operational conditions, the so-called Contingency (C). The CNECs

(Critical Network Elements/Contingencies) are determined by each CWE TSO for its own network according to agreed rules, described below.

The CNEs 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).

Contingencies (C) can be defined for all CNEs. A C 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,
- Trip of an HVDC interconnector under Evolved Flowbased.

<u>CNE selection process</u>

The assessment of Critical Network Elements 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 Network Elements. The advantage of this approach was that there is already significant operational experience with the application of Critical Network Elements as part of a grid security analysis, and that it facilitates a consistent transition from ATC to FB as well. Indeed, the Critical Network Elements 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 Network Elements for FB operations.

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

A set of PTDFs is associated to every CNEC after each Flow Based parameter calculation, and gives the influence of the net position of any bidding zone on the CNEC. If the PTDF = 0.1, this means the concerned hub has 10% influence on the CNEC, meaning that 1 MW in change of net position of the hub leads to 0.1 MW change in flow on the CNEC. A CNE or CNEC is NOT a set of PTDF. A CNEC is a technical input that one TSO integrates at each step of the capacity calculation process in order to respect security of supply policies. CNE 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 Network Elements, they are an output of the capacity calculation associated to a CNE or CNEC at the end of the TSO operational process. As a consequence, when a TSO first considers a CNEC as a necessary input for its daily operational capacity calculation process, it does not know, initially, what the associated PTDFs are.

A CNE 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 Network Elements were included or not in Flow Based parameters computation, 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 CNE 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 CNE 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 CNE 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 CNE in a given timestamp.

CWE TSOs constantly monitor the Critical Network Elements 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 Network Elements, i.e. the CNEs 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 CNEC the following sensitivity value for AC borders is calculated:

Sensitivity_AC = max(PTDF (BE), PTDF (DE), PTDF (AT), PTDF (FR), PTDF (NL)- min(PTDF (BE), PTDF (DE), PTDF (AT), PTDF (FR), PTDF (NL))

If two bidding zones (A,B) are connected via HVDC connector, the sensitivity will be calculated as follows:

Sensitivity_DC = abs(PTDF(A) – PTDF(virtualhubA) + PTDF(virtualhubB) – PTDF(B))

where virtualhubs represent the sending or receiving end of an HVDC connector. More information on the treatment of DC interconnectors can be found in chapter 4.2.9.

If the sensitivity AC or DC is above the threshold value of 5%, then the CNEC 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 CNEC which does not meet pre-defined conditions (that is, the threshold). The concerned TSO then has to decide whether to keep the CNEC or to exclude it from the CNEC file.

Although the general rule is to exclude any CNEC which does not meet the threshold on sensitivity, exceptions on the rule are allowed: if a TSO decides to keep the CNEC in the CNE 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 Network Element is required in the beginning as an input of the capacity calculation process[2].

CWE TSOs therefore commit to critically assess their set of Critical Network Elements 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 CNEs against this threshold. Eventually, this assessment may result in discarding the CNE 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 CNE 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

[2] A frequent explanation for having eventually a CNEC associated to PTDFs not respecting the threshold is the usage of a Remedial Action. Indeed, if it happens that a CNEC is too limiting, the TSO owner will try to release some margin on this CNE 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 CNE 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 CNEC.

will re-consider the relevance of the thresholds by looking at the following criteria with a focus on active CNEs :

- Frequency and gravity of the threshold violations
- Nature of the justifications given to keep some CNEs
- 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 CNEs. This distance can be inappropriate in two aspects:

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

In both cases, the shadow price (> 0 when the CNE 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 CNEs, especially when they are far from the agreed threshold.

4.1.2. Maximum current on a Critical Network Element (Imax)

The maximum allowable current (Imax) is the physical limit of a Critical Network Element (CNE) determined by each TSO in line with its operational criteria. Imax is the physical (thermal) limit of the CNE in Ampere, except when a relay setting imposes to be more specific for the temporary overload allowed for a particular Critical Network Element-Contingency (CNEC).
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 Contingency 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 CNEC 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 CNE. The value for cos(φ) is set to 1, and U is a fixed value for each CNE and is set to the reference voltage (e.g. 225kV or 400kV) for this CNE.

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 CNE for very specific reasons which are described below. Positive values of FAV in MW reduce the available margin on a CNE 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 CNEs for system security reasons. The overload detected on a CNE during the verification phase is the value which will be put in FAV for this CNE in order to eliminate the risk of overload on the particular CNE.

Any usage of FAV will be duly elaborated and reported to the NRAs for the purpose of monitoring[3] 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

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[3] Details on monitoring are given in the dedicated chapter 9. Besides, a template of the monitoring reports is available in Annex 14.17).

- 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.

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 forecast 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

$$P_{i1} = \mathrm{Pmin}_i + (\mathrm{Pmax}_i - \mathrm{Pmin}_i)\frac{(\sum_k P_{k0} - \sum_k \mathrm{Pmin}_k)}{(\sum_k \mathrm{Pmax}_k - \sum_k \mathrm{Pmin}_k)} \text{ (eq. 1)}$$

$$P_{i1} = \mathrm{Pmin}_i + (\mathrm{Pmax}_i - \mathrm{Pmin}_i)\frac{(\sum_k P_{k0} - \sum_k \mathrm{Pmin}_k)}{(\sum_k \mathrm{Pmax}_k - \sum_k \mathrm{Pmin}_k)} \text{ (eq. 1)}$$

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 loadflow 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 [4]

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 CNE file. Each measure is connected to one CNEC 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.

[4] Didactic examples of different types of Remedial Actions (including explicit and implicit variants) can be found in Annex 14.4).

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 CNEs is determined directly.
The influence of implicit RA on CNEs is assessed by the TSOs upfront and taken into account via the FAV factor, which changes the available margins of the CNEs 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 CNE 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[5] for the application of RAs imply that the RAs described in the CNE files can change during the daily Flow Based process in the qualification and verification phase (e.g. as a result of a PST co-ordination 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[6]. This means that the LTAs/NTCs will not cause overloads on CNEs 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:

- local calculation: TSOs try to cover the NTC/LTA domain using their own PSTs. If this is not sufficient, the TSO incorporate the

[5] 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.

[6] 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.

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 CNE 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 Network Elements 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 dispatched 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

$$P_{i1} = \mathrm{Pmin}_i + (\mathrm{Pmax}_i - \mathrm{Pmin}_i)\frac{(\sum_k P_{k0} - \sum_k \mathrm{Pmin}_k)}{(\sum_k \mathrm{Pmax}_k - \sum_k \mathrm{Pmin}_k)}\ (\mathrm{eq.}\,1)$$

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:

$$\mathrm{GSK}_i = \frac{\mathrm{Pmax}_i - \mathrm{Pmin}_i}{\sum_k \mathrm{Pmax}_k - \sum_k \mathrm{Pmin}_k}\ (\mathrm{eq.}\,2)$$

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.

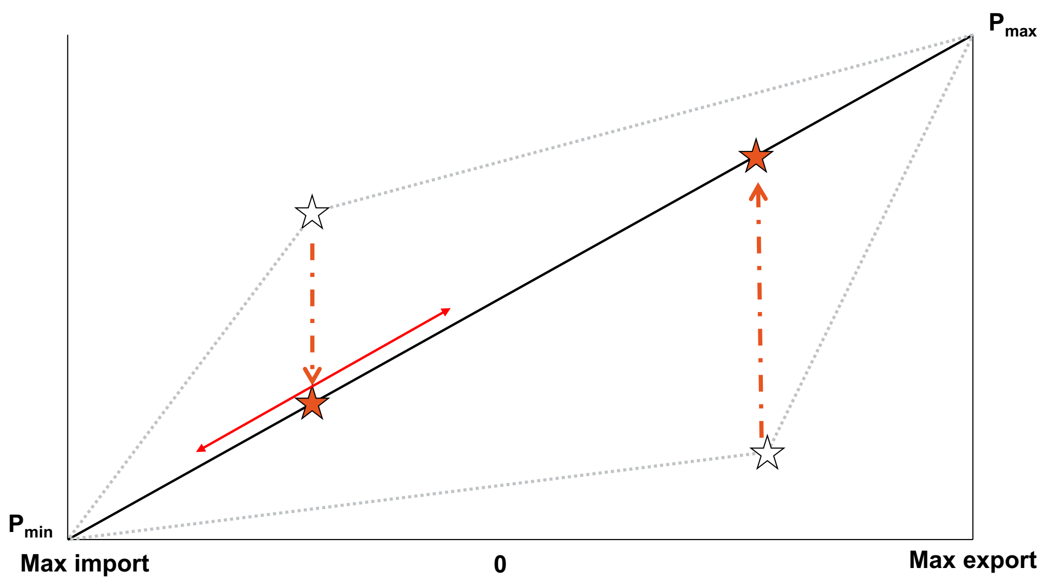

Figure 4-1: Belgian GSK.

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 Network Elements within the CWE FB calculation is not considered a problem.

Alegro GSK:

In order to integrate ALEGrOs Evolved Flow-Based approach, two virtual bidding zones (ALBE & ALDE) are defined as described in Article 4.2.9.

The two bidding zones (ALBE & ALDE) which model the ALEGrO interconnector possess a GSK equal to 1 on the nodes where the ALEGrO Interconnector converters are installed.

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 Network Element, a Flow Reliability Margin (FRM) has to be defined, that quantifies at least how the before-mentioned uncertainty impacts the flow on the Critical Network Element. Inevitably, the FRM reduces the remaining available margin (RAM) on the Critical Network Elements 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.

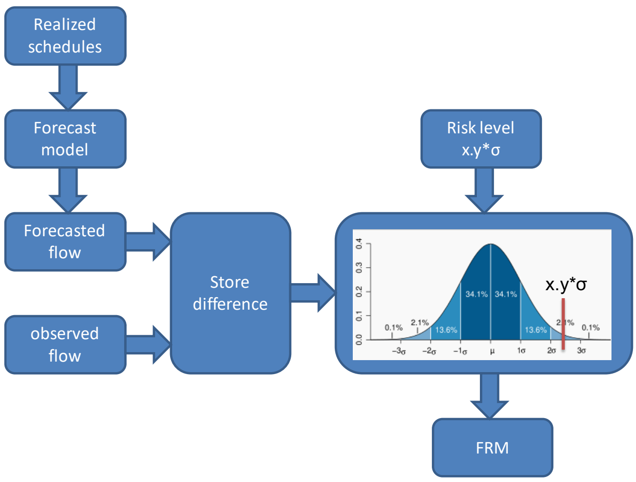

Figure 4-2: FRM Assessment Principle

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[7], 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:

[7] 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.

- Unintentional flow deviations due to operation of load-frequency controls
- 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 CNE 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 CNE. 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 CNE 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 CNE 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 14.5).[8]

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 CNE (or CNEC for the N-1 cases), the FRM campaign leads to one single FRM value which then will be a fixed parameter in the CNE 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.

[8] A dedicated, confidential report on FRM (FRM values and operational adjustment for main active Critical Branches of the parallel run) is available in Annex 14.5.

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

Step 1: elaboration of statistical distributions, for all Critical Network Elements, 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 CNE, 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[9] 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 active

[9] 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...

CNEs 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 CNECs.
- Operational adjustments are performed in both directions (increase or decrease calculated FRM value), and essentially consist in correcting outliers, or missing, high reference values.

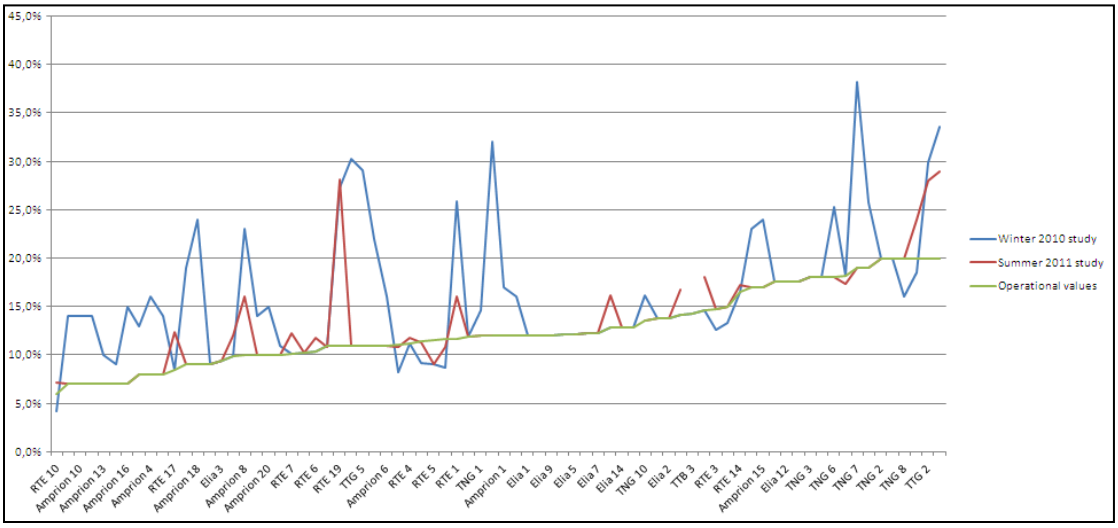

Figure 4-3: Graphical overview of the operational FRM values for the active CNEs of the parallel run (CNE labelling is purely arbitrary and does not correspond to the future fixed anonymization)

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 CNE of the current parallel run:

- The reference FRM

- The operational adjustment10 and its justification.

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

Besides electrical Critical Network Elements, 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 Network Elements, 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[11]. With Flow Based, they appear explicitly and their usage is justified by several reasons, among which:

- 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

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

[11] 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.

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 Network Element.

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 CNE, 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 Network Elements (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. bidding zone, 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[12] to design and implement external constrains.

Austrian External Constraint

APG does not apply an import or export constraint.

German External Constraint:

For the German-Luxembourgian Bidding Zone no import or export constraint is applied.

Dutch External Constraint:

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

[12] 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.

French External Constraint:

RTE does not apply 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.

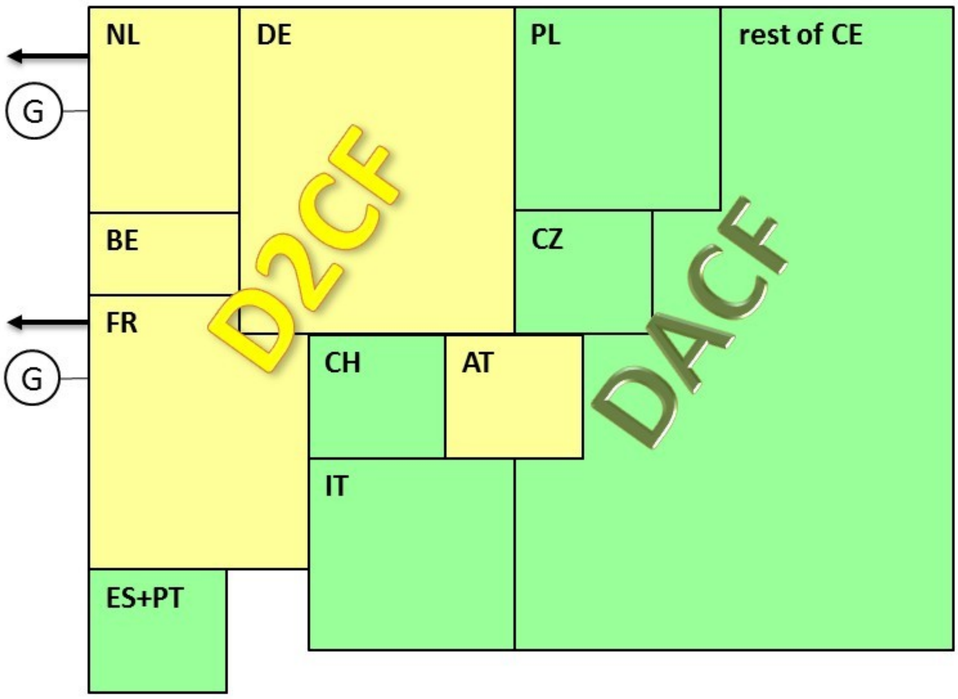
This data set contains

- 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)[13]
- 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.

[13] The nclusion of the D-2CF data from Swissgrid (CH) is ongoing.

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.



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, bidding zone balance) of each individual file with a specific operational procedure in case of inconsistencies.

4.2.2. Pre-qualification[14]

Before the first Flow Based parameter calculation the TSO checks the consistency of the applied CNE-file with the forecasted grid-situation.

[14] Prequalification is a CNE assessment phase available at any moment of the FB process, during which each TSO can assess the relevance of its CNE 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.

Special attention is given to the Remedial Actions (RA) described in the CNE-file. Every TSO has to check, if the described RAs are available in the forecasted grid situation, or if some adaptations 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 Network Elements 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 CNEC. This RAM is one of the inputs for the subsequent process steps. The adjustment for minimum RAM (AMR) is applied after the qualification step[15].

[15] 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 CNE 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 CNE => 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 CNEs 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 CNE, 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 CNE-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: $F_{ref} < F_{max} – FRM – FAV$.

4.2.5. MinRAM process

The MinRAM process is applied to provide a minimal FB domain to the market and to ensure that the capacity provided within the CWE region is compliant with the provisions of Article 16 of Regulation (EU) 2019/943.
The MinRAM process is applied using the minRAM factor attribute of each CNEC which guarantees a minimal RAM per CNEC.

The minRAM factor will be set between 20% and 200%[16] at CNEC level to comply with the minimum margin of 70% and possible national derogations and/or action plans following from the relevant provisions of article 14 to 16 of Regulation (EU) 2019/943[17].
In exceptional circumstances, the minRAM factor can be set below 20% by a TSO in case required to maintain operational security, in which case the TSO needs to justify this to the regulatory authorities.

It is the responsibility of the individual CWE TSOs to determine the appropriate values for minRAM which ensure compliance with the minimum margin of 70% and possible national derogations and/or action plans following from the relevant provisions of article 14 to 16 of Regulation (EU) 2019/943, this document does not specify which minRAM values will be applied per TSO. The responsibility for monitoring the compliance of the individual CWE TSOs, lies with their relevant NRA.

A TSO may apply his minRAM factor at different steps of the Flow based calculation process and may decide to not apply or reduce the minRAM factor in certain circumstances on specific CNECs or the full set of the TSOs' CNECs, justified to regulatory authorities. The reduction can be performed:

a. before the initial flow based parameter computation CNEC

[16] For the bidding zones which calculate the impact of non-CWE flows according to forecast, the impact of this forecast might lead to relieving flows leading to MinRAM applied higher than 70%.

[17] All derogations (AT, BE, FR & NL) can be found here. DE action plan can be found here. NL action plan can be found here.

b. at the qualification phase
c. during the verification process

The reduction of the minRAM factor 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 for any steps mentioned above.

The high-level calculation process is the following:

- CNECs with a RAM of less than the minRAM factor multiplied by Fmax at zero-balance are assigned an AMR value (adjustment for minRAM) in order to increase the RAM.
- Calculation of the AMR (negative value means increase in capacity same as for FAV):
  - AMR = Min(0; Fmax – Fref – FRM -FMax*X) and X = minRAM factor
- 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 CNE file to the Common System. Based on this updated CNE-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 Network Element files (by adding new CNEs, 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 CNECs from the "MinRAM" application).
After the verification step and possibly adaptation of the CNE-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

The LTA inclusion can be performed in the Flow Based common system or by Euphemia. The execution of the LTA inclusion by Euphemia is the target solution. The current solution is the execution in the Flow Based Common System with Virtual Branches. The switch towards the target solution will be notified to Market Participants in due time.

1. Implementation of LTA inclusion at Flow Based common system side

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 14.6.

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

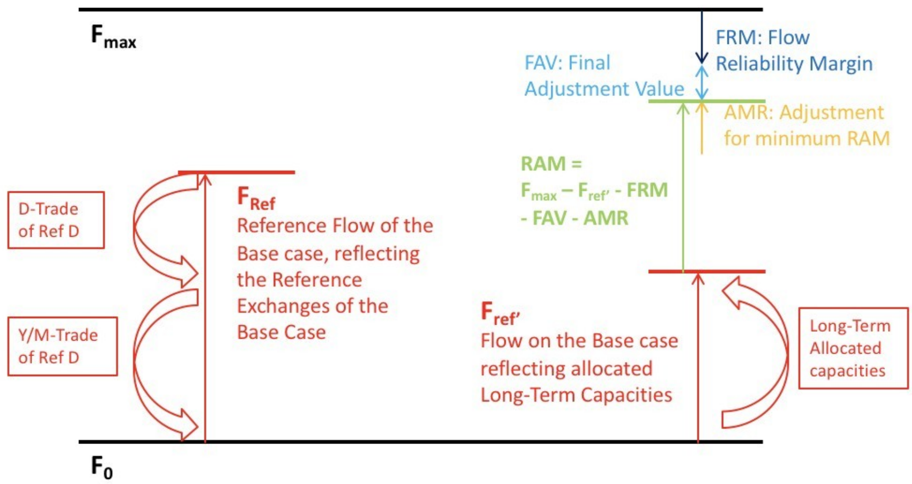
After each calculation a check can be performed if the remaining available margin after LTA adjustment is negative.

For every presolved CNE the following check is performed

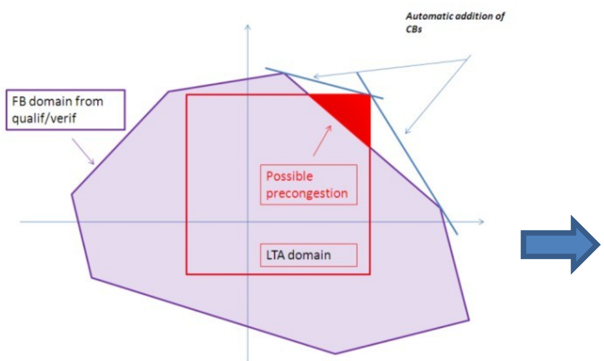
$$Fref^{*} = Fref - \sum_{i=hub} PTDF_i * \llbracket (Ref \rrbracket_{prog\ i} - LTA_i)$$

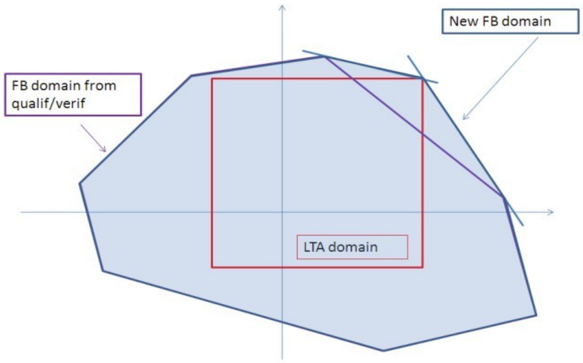
and then the following equation is checked

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 CNEs are created and introduced, which replace the CNE 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 14.19.

2. Implementation of LTA inclusion at Euphemia side ("Extended LTA")

The LTA inclusion can be performed at Euphemia side. In this case TSOs send a virgin domain with MinRAM applied and a LTA domain. Euphemia will be able to combine the two domains in order to simulate similar behavior as with the Virtual Branches approach. In other words, the concept is to allow the optimizer to use any linear combination of the LTA domain and the physical FB domain. The result is similar to the Virtual Branches domain (as presented in the approach above), just without any VB creation upfront. The set of feasible market clearing points should be the same as for the VB approach, the approach is just more efficient and scalable.

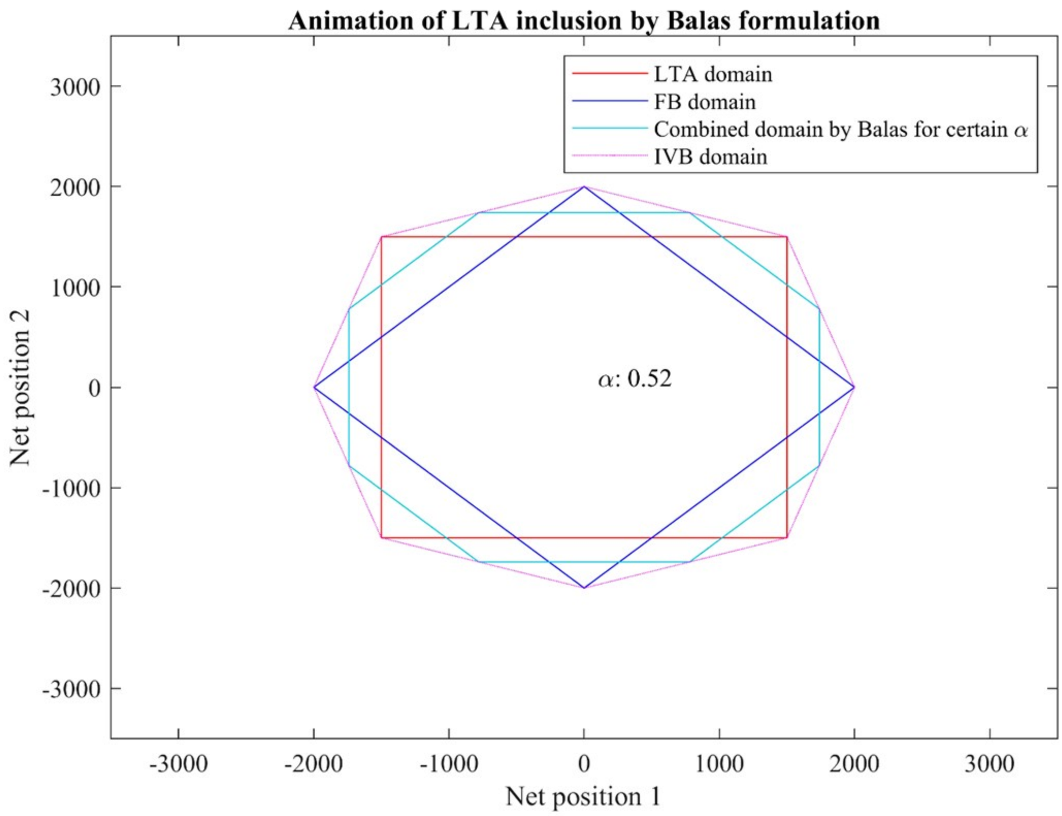
The mathematical description can be found in the Annex 14.29 while the comparison between the two approaches can be found in the Annex 14.30.

Please find a pedagogical example below. In this 2D example, you can find:

- A simplified physical FB domain in blue
- A LTA domain in red

- The alpha which represents the choice from the algorithm to choose for one domain or the other
- The Virtual Branches domain in purple

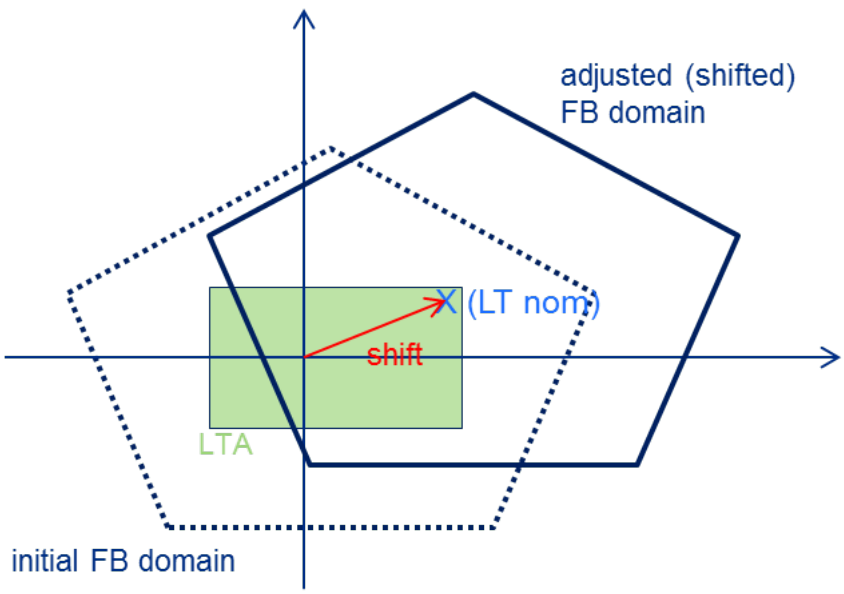
The three first inputs are used by the extended LTA approach and can model the cyan domain which can be similar to the LTA domain (alpha = 1), to the FB domain (alpha =0) or to any domain in between. Therefore, the set of feasible market coupling points will be the same as for the Virtual Branches approach.



Remark: Even if the operational solution will be switched to the Extended LTA approach, the computation of a Final FB domain with Virtual Branches as presented before will remain for the sake of transparency towards Market Parties, Shadow Auctions and Intraday ATC exctraction.

4.2.8. LTN adjustment

In case all CWE borders use FTRs, LTN adjustment can be skipped. As the reference flow (Fref) is the physical flow computed from the common base case, it reflects the loading of the Critical Network Elements 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[18]. 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 CNEs

[18] A description of the publication of the initial and final FB domain can be found in Annex 14.6.

affected by these LTNs. The remaining margin for the DA-allocation can be calculated by:

RAM = Fmax – Fref' – FRM – FAV - AMR
*Fref' = Fref + (LTN – RefProg)*PTDF*

4.2.9. Integration of HVDC interconnector on CWE bidding zone borders

1 The CWE TSOs apply the evolved flow-based (EFB) methodology when including HVDC interconnectors on the CWE bidding zone borders. According to this methodology, a cross-zonal exchange over an HVDC interconnector on the CWE bidding zone borders is modelled and optimised explicitly as a bilateral exchange in capacity allocation, and is constrained by the physical impact that this exchange has on all CNECs considered in the final flow-based domain used in capacity allocation.

2 In order to calculate the impact of the cross-zonal exchange over a HVDC interconnector on the CNECs, the converter stations of the cross-zonal HVDC shall be modelled as two virtual hubs, which function equivalently as bidding zones. Then the impact of an exchange between two bidding zones A and B over such HVDC interconnector shall be expressed as an exchange from the bidding zone A to the virtual hub representing the sending end of the HVDC interconnector plus an exchange from the virtual hub representing the receiving end of the interconnector to the bidding zone B:

$$PTDF_{A\rightarrow B,l} = (PTDF_{A,l} - PTDF_{VH\_1,l}) + (PTDF_{VH\_2,l} - PTDF_{B,l})$$

with

$PTDF_{VH\_1,l}$	zone-to-slack $PTDF$ of Virtual hub 1 on a CNEC l, with virtual hub 1 representing the converter station at the sending end of the HVDC interconnector located in bidding zone A
$PTDF_{VH\_2,l}$	zone-to-slack $PTDF$ of Virtual hub 2 on a CNEC l, with virtual hub 2 representing the converter station at the receiving end of the HVDC interconnector located in bidding zone B

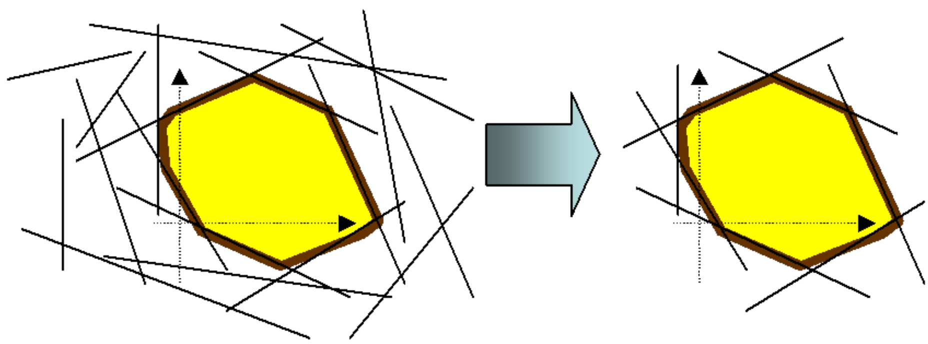
3 The PTDFs for the two virtual hubs $PTDF_{VH\_1,l}$ and $PTDF_{VH\_2,l}$ are calculated for each CNEC and they are added as two additional columns (representing two additional virtual bidding zones) to the existing $PTDF$ matrix, one for each virtual hub.

4 The virtual hubs introduced by this methodology are only used for modelling the impact of an exchange through a HVDC interconnector and no orders shall be attached to these virtual hubs in the coupling algorithm. The two virtual hubs will have a combined net position of 0 MW, but their individual net position will reflect the exchanges over the interconnector. The flow-based net positions of these virtual hubs shall be of the same magnitude, but they will have an opposite sign.

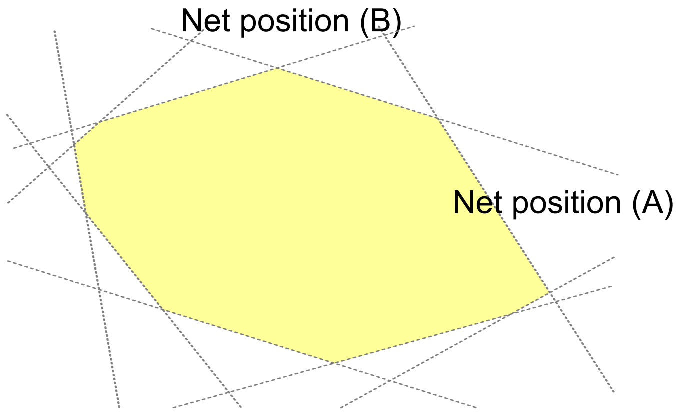
4.3. Output data

4.3.1. Flow Based capacity domain

The Flow Based parameters that have been computed indicate what net positions, given the Critical Network Elements 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 and virtual hubs 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 Network Element. A line indicates for a specific Critical Network Element, 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 Network Element 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. Outputs for extended LTA implementation

When the Extended LTA inclusion is considered, TSOs will send two files in order to compute the market coupling:

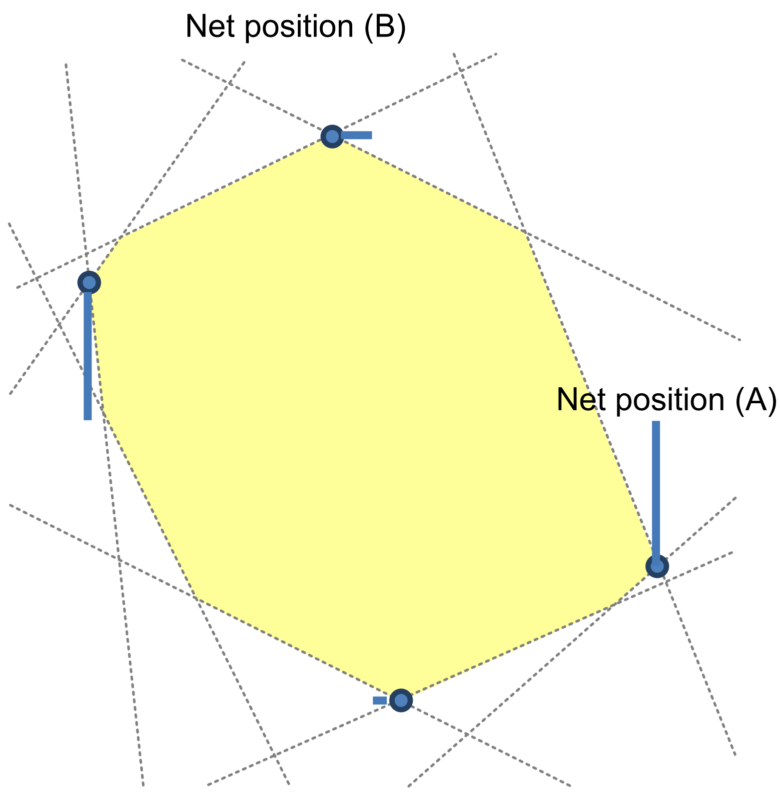
1. Virgin FlowBased domain with MinRAM applied
2. LTA domain

4.3.3. 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 8) or monitored by the NRAs (see chapter 9)

- 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 14.22 (Methodology for capacity calculation for ID timeframe) 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 Network Elements is not taken into account explicitly at capacity calculation phase (no PTDF relating exchanges CWE <-> non-CWE to the load of CWE CNEs). 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 CNE's FRM. As such, these assumptions will impact the available margins of CWE Critical Network Elements. However, strictly speaking, no margin is explicitly booked for non-CWE exchanges on CWE CNEs.

CWE partners together with relevant parties 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 CNEs (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

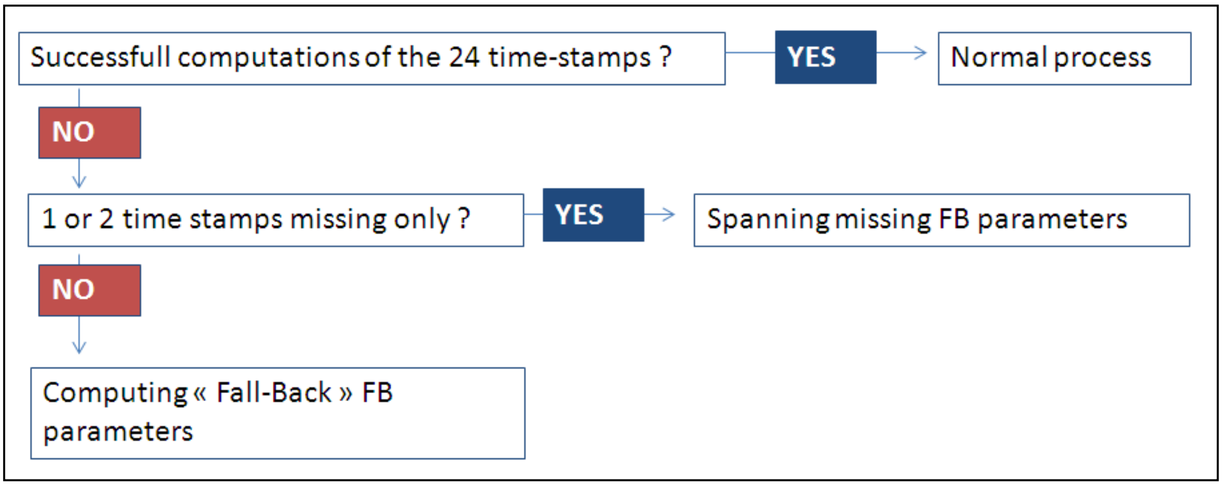
Introductory disclaimer: please note that this section is related to capacity calculation Fallback principles only. Therefore, its aim is neither to address operational Fallback procedures, nor to consider market-coupling Fallbacks (decoupling).

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.

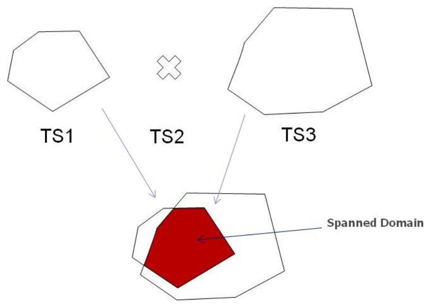
The sketch below will synthesise the general approach followed by CWE TSOs:



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 subsequent 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 CNEs from the previous and sub-sequent timestamps are compared and the most constraining ones are taken into consideration (intersection).



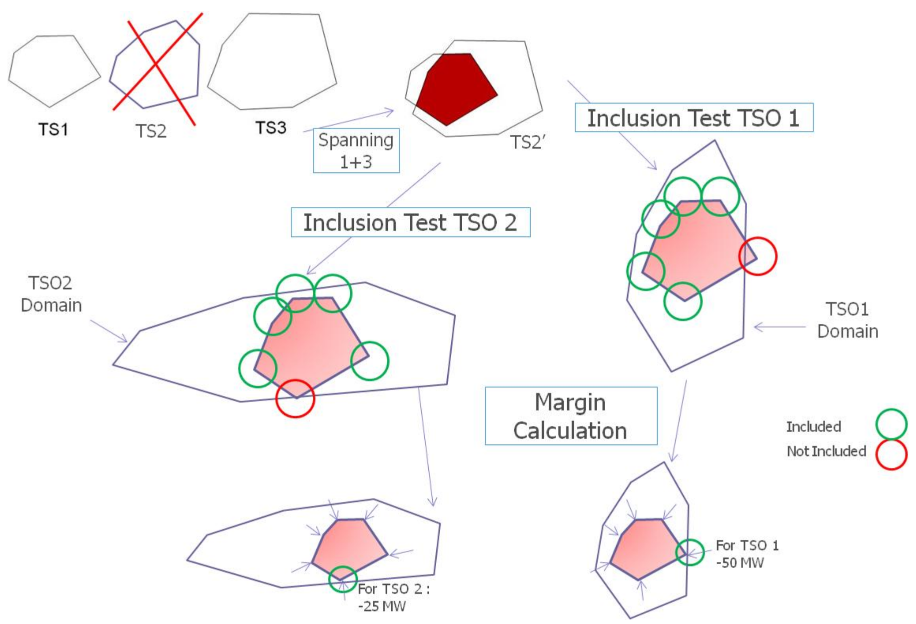
Spanning Margin calculation Step: The aim of this step is to define the spanning margin needed for each TSO to ensure the SoS in case that spanning is applied. This spanning margin is updated every day, after final Flow Based parameters calculation, based on a simulation of 'what could have been the 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).

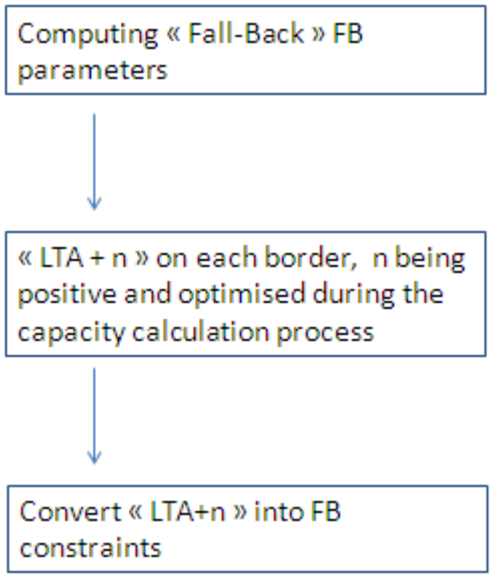
This reference margin is then added to the distribution of the already calculated reference margins from the past (for each time stamp and each TSO), in order to update (with a 90% percentile formula) the new spanning margin.



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:

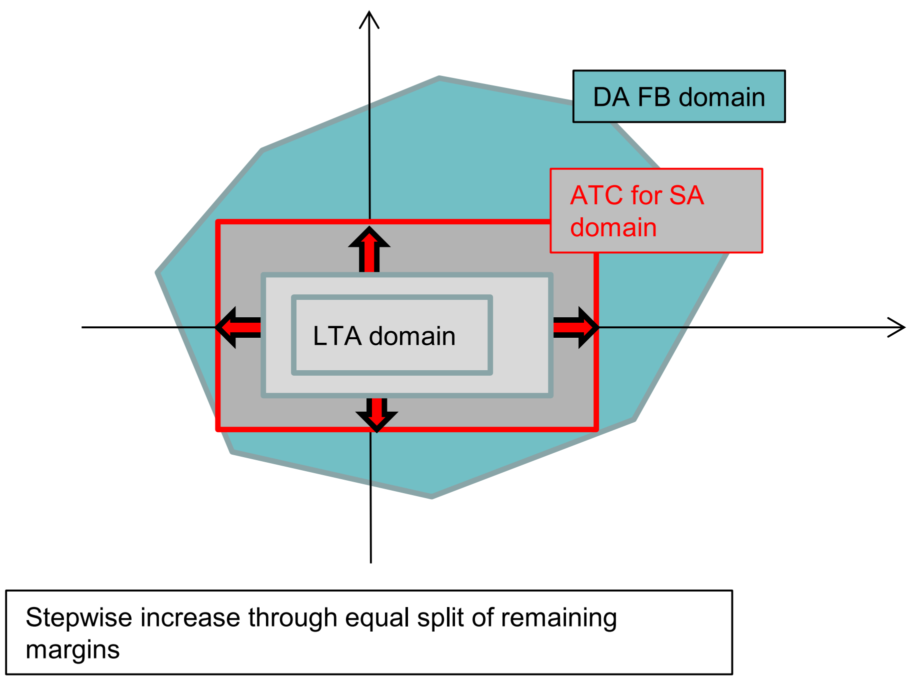


One can note that in all cases, CWE TSOs commit to deliver Flow Based constraints over the entire day to the Market Coupling system.

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 [19]as shown in the graph below.



Input data:

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

[19] 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 market coupling algorithm. 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 the market coupling algorithm. 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 CNEs have to be adjusted to take into account the starting point of the iteration.

From the presolved zone-to-hub PTDFs ($\mathrm{PTDF}_{\mathrm{z2h}}$), one computes zone-to-zone PTDFs ($\mathrm{pPTDF}_{\mathrm{z2z}}$)[20], where only the positive numbers are stored:

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

$$\mathrm{pPTDF}_{\mathrm{z2z}}(\mathrm{A} > B) = max?\,(0, PTD\mathrm{F}_{\mathrm{z2h}}(\mathrm{A}) - \mathrm{PTDF}_{\mathrm{z2h}}(\mathrm{B}))$$

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

In case neighbouring market areas within CWE are connected via HVDC links and the evolved FB methodology is used for the DA market coupling the zone-to-hub PTDFs ($PTDF_{z2h}$) of the virtual hubs can be considered for the calculation of the positive zone-to-zone PTDFs (pPTDF_z2z) between both market areas (e.g. pPTDFz2z(BEDC > DEDC) = max(0, PTDFz2h(BE) – PTDFz2h(ALBE) + PTDFz2h(ALDE) – PTDFz2h(DE) where ALBE and ALDE describe the virtual hubs).

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:

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

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 CNE, 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 CNEs.

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

This iteration continues until the maximum value over all Critical Network Elements 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 Network Elements 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 CNE
        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 CNE
        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 implementation of ALEGrO is 6.

For borders connected via HVDC links the bilateral exchanges cannot exceed the maximum transmission capacity of the HVDC links.

5 The CWE Market Coupling Solution / Daily schedule

This chapter describes the CWE Market Coupling Solution, embedded in and as part of the Single Day Ahead Coupling.

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 14.7.

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.

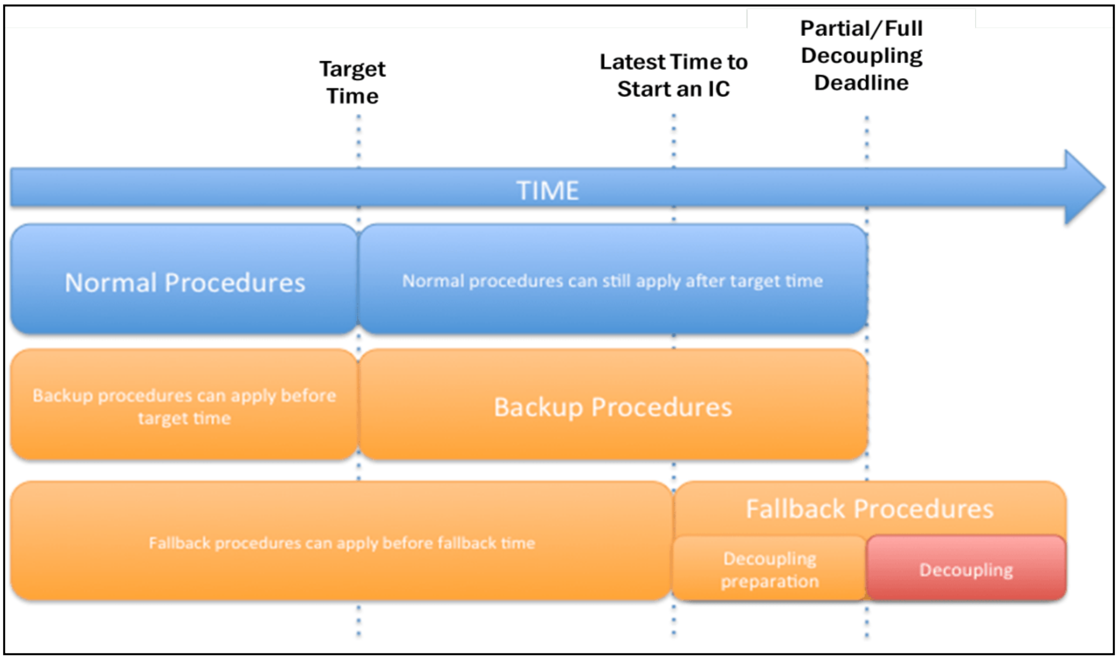


Figure 5-1: Interrelationship between Normal procedures, Backup, and Fallback.

5.2. High Level Architecture

The original High Level Architecture has been 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 14.7).

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[21].

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

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 NEMO ECP Endpoint by the CWE TSO

[21] Please refer to Annex 14.8 for detailed procedures.

Common System and ends when the Cross Zonal Capacities and Allocation Constraints are successfully received by the NEMOs 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 NEMOs.
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 the Results by the CWE TSO CS	Description of the actions to be performed 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: Market Coupling Results and Scheduled Exchanges Transfer

This phase starts with the sending of Market Coupling Results by the CWE TSO Common System (Verification Module) to the CWE TSO Back-End Systems. Then, the CWE TSO Common System (Post Coupling Module) will create programming authorizations. These are sent via the CWE NEMOs ECP Endpoint to the Cross NEMO Clearing and Settlement Support System, to TSO Back-End Systems and to the Congestion Revenue Distribution System (CRDS). Furthermore, Market Coupling Results are sent to the CRDS.

NOR_3: Market Coupling Results and Scheduled Exchanges Transfer	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: Market Coupling Results and Scheduled Exchanges Transfer	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: Local Hub Nomination, Cross-Border Nomination and Congestion Income

This phase starts with the creation of CCP information for local hub nomination and cross-border nomination by CWE NEMO back-end Systems and/or CCP/Shipping Systems and/or Cross-NEMO Clearing and Settlement Support Systems. It ends with data exchange on congestion rents from shipping modules to the CRDS.

NOR_4: Local Hub Nomination, Cross-Border Nomination 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: Local Hub Nomination, Scheduled Exchanges Notification, Cross-Border Nomination 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 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 in case of special or exceptional circumstances leading to a second auction
OTH_01 CWE Procedures Reading Instructions	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
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 under Fallback conditions.
FAL_01 Incident Management	Description of the initiation of the Incident 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 NEMOs.

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
- 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 no market coupling results are generated until 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 14.9.

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 declared 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 partial or full decoupling of SDAC 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 relevant 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, an external communication message informs Market Parties about a delay in the process and the risk of Full Decoupling. In case the Full Decoupling has been declared by

the Incident Committee, each NEMO will run its local backup auction. The Fallback solution for the allocation of capacity on CWE internal borders is shadow explicit auctions via JAO, described in the next paragraphs

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.

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". 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 14.9. The publication of Shadow Auction ATCs is described in chapter 8.

6.4. 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.

6.5. Bids in case of explicit PTR allocation

6.5.1. 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, France-Belgium, Germany-Austria or Germany-Belgium),
- the direction for which it applies (two directions for each bidding zone 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.

6.5.2. Ticks and currency

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

6.6. 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.

6.7. 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 0.
10. Market Participants submit their orders through the CWE NEMO Trading modules for day ahead market, per NEMO Trading Hub. . The NEMOs then match and publish their results separately.
11. Fallback participants submit their nominations to TSOs according to the existing local processes.

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

The Shadow Auction is performed for each bidding zone 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.

6.9. 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 timespan between publication of the local NEMO market results and cross-border nominations is at least 45 minutes.
- 20 minutes are reserved for Market Parties to amend their orders on the NEMOs after the allocation of capacity via Shadow Auctions..
- 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)

6.10. 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 Economic Assessment

7.1. 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 14.10).
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 14.10, the market impact analysis concludes that FB MC and FBI MC have a positive impact on welfare, compared to ATC MC.

7.2. 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 14.11.

7.3. 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 14.12).
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 14.13.

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 has monitored the Flow Based plain and kept the possibility to reassess the decision after go-live.
Key descriptions and confirmation related to the FBI-decision, requested by the NRAs after the June 2014 consultation can be found in Annex 14.18.

During Q4 2019, CWE NRAs requested CWE parties to update the report, taking into account 4 years of data, including one full year of data after DE/AT split. It was also required to include additional considerations related to performances. The full report can be found in Annex 14.31 while the main results are written below.

Main results

Non-intuitive situations occurred for 16.2% of the hours when the intuitivity patch is not applied.

The welfare loss related to the application of FBI over the investigated period is 26 Mio. € for the whole MRC region, or 18K € per day on average or 0.0002 % in relation to the welfare that would have been generated under FBP. In relations to total welfare, the impact appears quite small. Still it represents significant amount in absolute terms and the discussion on this difference appears to be relevant.

Some redistributive effects between countries and between producers and suppliers exist. When a bidding zone exports, its price will slightly increase under FBP and inversely. This denotes a better price convergence. As a consequence, the producers in the exporting zones and the consumers in the importing zones see an increase of their surplus.

The average time to first solution for the market coupling algorithm decreases by 14.1% in the latest bidding zone configuration after DE/AT split, which is the most demanding situation. This is an important consideration taking into account the challenges the algorithm will have to face for the upcoming developments (ALEGrO, Core FB, Nordic FB, market time unit of 15 min…).

The average welfare loss mentioned above is unevenly distributed. While for most days the differences between FBP and FBI are somewhat small (in terms of prices and volumes), some specific days are illustrating that import differences occur. In one example and for one bidding zone, a price difference of more than 200 €/MWh was observed between the price that would have been observed under FBP and the price that was actually observed under FBI. The price differences in the other bidding zones were not so significantly affected, leading to important price differentials between bidding zones. These rare but spectacular situations are not easily understood by market participants, which may in itself question the additional value in terms of intuitivity of the application of FBI.

The reduced utilization of the grid is illustrated by analyzing the impact on ALEGrO interconnector. This HVDC interconnector between Belgium and Germany will be implemented with the so-called Evolved Flow Based (EFB) approach where the flow on the interconnector is determined by the market coupling algorithm in order to maximize the welfare. FBI leads to set this flow to zero in 33.27 % more cases than under FBP, and these cases relate to situations with price differences. One may find counter-intuitive that the flow on a controllable HVDC interconnector is set to zero even when there is price difference.

Conclusions of the report

Considering that the removal of the intuitiveness patch will lead to higher welfare, a better price convergence, the avoidance of price spike situations, a higher utilization of the grid and better algorithm performances, CWE NRAs agreed to remove the intuitiveness patch as of the technical go-live of ALEGrO (CWE NRA EM 16th of March).

8 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. Annex 14.14). 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[22] as well.

For monitoring purposes the National Regulatory Authorities get additional (confidential) data and information (further described in chapter 9). 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.

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

8.1. 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.

8.2. 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 is published by the NEMOs operating this algorithm. -

8.3. 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).

8.3.1. 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. 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 Network Elements, Power Transfer Distribution Factors (PTDFs) and the Remaining Available Margin (RAM) on Critical Network Elements. In addition for each CNEC, the applied Adjustment for Minimum RAM (AMR) and the minRAMfactor values along with a justification of calculations behind the minRAMfactor based on derogations (if any) 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 **Error! Reference source not found.**.

Content	**Where/ Who**	**When**	**Unit**
Harmonized human readable name Critical Network Elements	JAO	D-1 (10:30 CET)	-
EIC codes of Critical Network Elements and Contingency	JAO	D-1 (10:30 CET)	-
Zonal PTDFs	JAO	D-1 (10:30 CET)	-
RAMs	JAO	D-1 (10:30 CET)	MW
Fmax	JAO	D-1 (10:30 CET)	MW
Fref	JAO	D-1 (10:30 CET)	MW
FRM	JAO	D-1 (10:30 CET)	MW
FAV	JAO	D-1 (10:30 CET)	MW
AMR	JAO	D-1 (10:30 CET)	MW

minRAM factor	JAO	D-1 (10:30 CET)	%
MinRAM Factor Justification	JAO	D-1 (10:30 CET)	-

Final Virgin Flow Based domain

The TSOs will publish for each hour of the following day the Flow-Based parameters similarly to the specifications mentioned above at D-1 10h30. The final virgin flow based domain should be interpreted as the final FB domain with MinRAM applied without LTA inclusion.

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 14.16.

8.3.2. 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:

- market prices: the market prices for each bidding zone and market time unit of the day will be published on daily basis on the ENTSO-E platform (https://transparency.entsoe.eu/).
- Aggregated supply and demand curves for each market time unit of the day will be published by the individual NEMO for their hub.

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

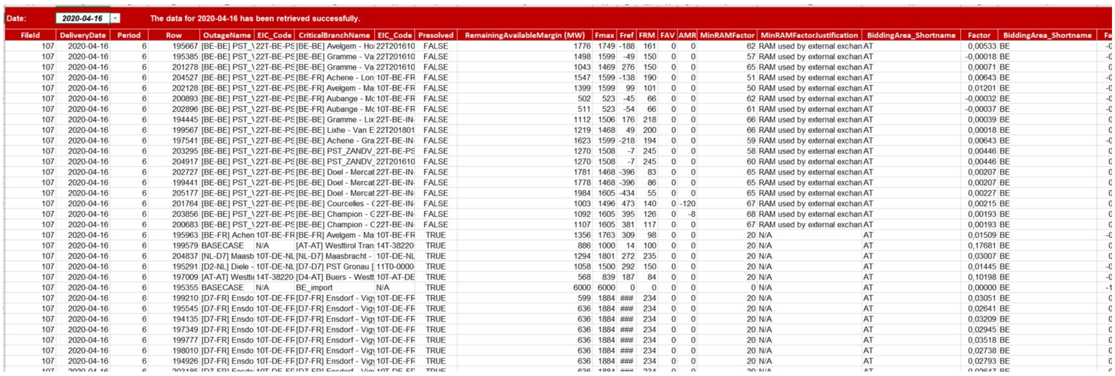
Content	**Where/ Who**	**When**	**Unit**
Capacity allocated (used margin on Critical Network Elements)	JAO/ ENTSO-E	13:00 CET	MW
Congestion income	JAO/ ENTSO-E	19:00 CET	€
Individual bidding zone prices	NEMOs' websites	13:00 CET	€/MWh
Aggregated supply and demand curves for each market time unit	NEMOs' websites	14:00 CET	-
Overview CWE bidding zone prices	ENTSO-E	14:00 CET	€/MWh
Net positions per bidding zone	JAO / ENTSO-E	13:00 CET	MW

8.3.3. Publication of additional CNEC information

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

In other words, CWE partners will publish the equivalent of the PTDF sheet of the utility tool, but will publish the Critical Network Element and Contingency Name, the EICs if applicable of the CNE and C, RAM, Fmax, Fref, FRM, FAV, AMR, MinRAMFactor, MinRAMFactorJustification, presolved status, bidding area and the PTDF factors linked to the CNEC harmonized human readable names (detailed in a next paragraph).

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 Network Elements is the outcome of intensive exchange with Market Parties and NRAs.



Date: 2020-04-16 The data for 2020-04-16 has been retrieved successfully.

FileId	DeliveryDate	Period	Row	OutageName	EIC_Code	CriticalBranchName	EIC_Code	Presolved	RemainingAvailableMargin (MW)	Fmax	Fref	FRM	FAV	AMR	MinRAMFactor	MinRAMFactorJustification	BiddingArea_Shortname	Factor	BiddingArea_Shortname	Fa
107	2020-04-16	6	195667	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Avelgem - Ho	22T201610	FALSE	1776	1749	-188	161	0	0	62	RAM used by external exchan	AT	0,00533	BE	-0
107	2020-04-16	6	195385	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Gramme - Va	22T201610	FALSE	1498	1599	-49	150	0	0	57	RAM used by external exchan	AT	-0,00018	BE	-0
107	2020-04-16	6	201278	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Gramme - Va	22T201610	FALSE	1043	1469	276	150	0	0	65	RAM used by external exchan	AT	0,00071	BE	0
107	2020-04-16	6	204527	[BE-BE] PST_\	22T-BE-PS	[BE-FR] Achene - Lon	10T-BE-FR	FALSE	1547	1599	-138	190	0	0	51	RAM used by external exchan	AT	0,00643	BE	-0
107	2020-04-16	6	202128	[BE-BE] PST_\	22T-BE-PS	[BE-FR] Avelgem - Ma	10T-BE-FR	FALSE	1399	1599	99	101	0	0	50	RAM used by external exchan	AT	0,01201	BE	-0
107	2020-04-16	6	200893	[BE-BE] PST_\	22T-BE-PS	[BE-FR] Aubange - Mc	10T-BE-FR	FALSE	502	523	-45	66	0	0	62	RAM used by external exchan	AT	-0,00032	BE	-0
107	2020-04-16	6	202896	[BE-BE] PST_\	22T-BE-PS	[BE-FR] Aubange - Mc	10T-BE-FR	FALSE	511	523	-54	66	0	0	61	RAM used by external exchan	AT	-0,00037	BE	-0
107	2020-04-16	6	194445	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Gramme - Lix	22T-BE-IN-	FALSE	1112	1506	176	218	0	0	66	RAM used by external exchan	AT	0,00039	BE	0
107	2020-04-16	6	199567	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Lixhe - Van E	22T201801	FALSE	1219	1468	49	200	0	0	66	RAM used by external exchan	AT	0,00018	BE	0
107	2020-04-16	6	197541	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Achene - Gra	22T-BE-IN-	FALSE	1623	1599	-218	194	0	0	59	RAM used by external exchan	AT	0,00643	BE	-0
107	2020-04-16	6	203295	[BE-BE] PST_\	22T-BE-PS	[BE-BE] PST_ZANDV_	22T-BE-PS	FALSE	1270	1508	-7	245	0	0	58	RAM used by external exchan	AT	0,00446	BE	0
107	2020-04-16	6	204917	[BE-BE] PST_\	22T-BE-PS	[BE-BE] PST_ZANDV_	22T201610	FALSE	1270	1508	-7	245	0	0	60	RAM used by external exchan	AT	0,00446	BE	0
107	2020-04-16	6	202727	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Doel - Mercat	22T-BE-IN-	FALSE	1781	1468	-396	83	0	0	65	RAM used by external exchan	AT	0,00207	BE	0
107	2020-04-16	6	199441	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Doel - Mercat	22T-BE-IN-	FALSE	1778	1468	-396	86	0	0	65	RAM used by external exchan	AT	0,00207	BE	0
107	2020-04-16	6	205177	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Doel - Mercat	22T-BE-IN-	FALSE	1984	1605	-434	55	0	0	65	RAM used by external exchan	AT	0,00227	BE	0
107	2020-04-16	6	201764	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Courcelles - (	22T-BE-IN-	FALSE	1003	1496	473	140	0	-120	67	RAM used by external exchan	AT	0,00215	BE	0
107	2020-04-16	6	203856	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Champion - G	22T-BE-IN-	FALSE	1092	1605	395	126	0	-8	68	RAM used by external exchan	AT	0,00193	BE	0
107	2020-04-16	6	200683	[BE-BE] PST_\	22T-BE-PS	[BE-BE] Champion - C	22T-BE-IN-	FALSE	1107	1605	381	117	0	0	67	RAM used by external exchan	AT	0,00193	BE	0
107	2020-04-16	6	195963	[BE-FR] Achen	10T-BE-FR	[BE-FR] Avelgem - Ma	10T-BE-FR	TRUE	1356	1763	309	98	0	0	20	N/A	AT	0,01509	BE	-0
107	2020-04-16	6	199579	BASECASE	N/A	[AT-AT] Westtirol Tran	14T-38220-	TRUE	886	1000	14	100	0	0	20	N/A	AT	0,17681	BE	0
107	2020-04-16	6	204837	[NL-D7] Maasb	10T-DE-NL	[NL-D7] Maasbracht -	10T-DE-NL	TRUE	1294	1801	272	235	0	0	20	N/A	AT	0,03007	BE	0
107	2020-04-16	6	195291	[D2-NL] Diele -	10T-DE-NL	[D7-D7] PST Gronau [	11T0-0000-	TRUE	1058	1500	292	150	0	0	20	N/A	AT	0,01445	BE	-0
107	2020-04-16	6	197009	[AT-AT] Westti	14T-38220-	[D4-AT] Buers - Westt	10T-AT-DE	TRUE	568	839	187	84	0	0	20	N/A	AT	0,10198	BE	-0
107	2020-04-16	6	195355	BASECASE	N/A	BE_import	N/A	TRUE	6000	6000	0	0	0	0	0	N/A	AT	0,00000	BE	-1
107	2020-04-16	6	199210	[D7-FR] Ensdo	10T-DE-FR	[D7-FR] Ensdorf - Vig	10T-DE-FR	TRUE	599	1884	###	234	0	0	20	N/A	AT	0,03051	BE	0
107	2020-04-16	6	195545	[D7-FR] Ensdo	10T-DE-FR	[D7-FR] Ensdorf - Vig	10T-DE-FR	TRUE	636	1884	###	234	0	0	20	N/A	AT	0,02641	BE	0
107	2020-04-16	6	194135	[D7-FR] Ensdo	10T-DE-FR	[D7-FR] Ensdorf - Vig	10T-DE-FR	TRUE	636	1884	###	234	0	0	20	N/A	AT	0,03209	BE	0
107	2020-04-16	6	197349	[D7-FR] Ensdo	10T-DE-FR	[D7-FR] Ensdorf - Vig	10T-DE-FR	TRUE	636	1884	###	234	0	0	20	N/A	AT	0,02945	BE	0
107	2020-04-16	6	199777	[D7-FR] Ensdo	10T-DE-FR	[D7-FR] Ensdorf - Vig	10T-DE-FR	TRUE	636	1884	###	234	0	0	20	N/A	AT	0,03518	BE	0
107	2020-04-16	6	198010	[D7-FR] Ensdo	10T-DE-FR	[D7-FR] Ensdorf - Vig	10T-DE-FR	TRUE	636	1884	###	234	0	0	20	N/A	AT	0,02738	BE	0
107	2020-04-16	6	194926	[D7-FR] Ensdo	10T-DE-FR	[D7-FR] Ensdorf - Vig	10T-DE-FR	TRUE	636	1884	###	234	0	0	20	N/A	AT	0,02793	BE	0

Figure 8-1: All CNEC fixed label publication

8.4. Harmonized human readable name convention

The following harmonized human readable name convention is used.

CNE publication name:

[hubFrom-hubTo] CNE name [Direction] (+ [TSO] if a tie-line)

- HubFrom, HubTo and TSO can be BE, NL, FR, AT, D2, D4, D7, D8.
- Direction can be DIR or OPP. DIR means that the CNE is monitored from firstly mentioned hub/substation to the secondly mentioned hub/substation. OPP inverts the order.
- The CNE name always has to include the human readable connected substation names divided by a hyphen. Substations could be listed in alphabetical order (TNG will do so. But I think it is not crucial to do so or harmonize this).
- TSOs use DIR and OPP to indicate the direction and do not change the order of substations.
- If there is a hyphen in a substation name, no spaces are used
- Examples:
  - [BE-FR] Achene – Lonny 19 [DIR] [BE]
  - [BE-BE] Avelgem – Horta 101 [DIR]

Tripods publication name:

[hubFrom-hubTo] Y - substation (- substation 2 - substation 3) [Direction] (+ [TSO] if a tie-line)

- Y stands for the node connecting all three branches of the tripod. [substation] defines the branch of the tripod that is monitored. If it is monitored from the Y-node to the substation the direction is DIR. Otherwise it is OPP.
- [hubFrom] indicates where the first node is located
- TSOs use DIR and OPP to indicate the direction and do not change the order of substations.
- If there is a hyphen in a substation name, no spaces are used

- Example: [D4-D4] Y - Engstlatt (- Oberjettingen - Pulverdingen) rot [DIR]

PSTs publication name:

[hubFrom-hubTo] PST name [Direction] (+ [TSO] if a tie-line)

- Each TSO does their best effort for the direction
- If there is a hyphen in a substation name, no spaces are used

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

Daily at D-1 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, ALBE, ALDE 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 8-2: Aggregated hourly information related to the common grid model

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

AT=>CZ, AT=>HU, AT=>SI, BE=>NL,BE=>DE (DC), 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, 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

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

8.6. Publication of data in Fallback mode

The Fallback solution for CWE FB MC is coordinated with the MRC-/PCR Fallback arrangements. It will be ATC based explicit shadow auctions. These explicit auctions will be performed by the Shadow Auction System Operator (JAO).

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.

8.7. 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.

9 Monitoring

9.1. 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 CNECs, disclosing

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

    Number of presolved CNEs

    Number of precongested cases

Number of CNEs exceeded by LTA

Number of CNEs exceeded by ATC

Number of of presolved CNEs with RAs applied

Number of presolved CNEs without RAs applied

Number of presolved CNEs, 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 CNEs)
21. In case of occurrence: justification when a CNEC is excluded from the MinRAM process

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

1. Active CNEs (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 CNEs
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. CIA-Reporting (congestion income allocation)

The templates for the foreseen reporting towards the CWE NRAs are presented in Annex 14.20.

10 Scheduled Exchanges and Net Position Validation

Scheduled Exchanges

Scheduled Exchanges are calculated according to the methodology for Calculating Scheduled Exchanges resulting from single day-ahead coupling in accordance with Article 43 of the Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.

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 Positions 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 (CNE_j) + Tolerance $margin_i$

All CNEs, 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.

11 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

11.1. 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 NEMOs 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.

11.2. 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 NEMOs
- Joint NEMOs
- 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.

11.2.1. 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 NEMOs active in CWE, which forward 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.

11.2.2. Roles of the individual NEMOs

The individual NEMOs 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 NEMO system. The NEMO 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.

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

11.2.3. Roles of the joint NEMOs

The joint CWE NEMOs are responsible for building, operation and maintenance of the PMB system and the market coupling algorithm together with further relevant NEMOs of the SDAC. NEMOs are responsible to calculate net positions and market prices for all bidding zones of the SDAC.

11.2.4. Roles of joint Parties

The CWE NEMOs 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.

11.2.5. 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).
- Reception of congestion rents and distribution to the individual TSOs. This task will be operated by JAO.

11.2.6. Summary of operational roles

Entity	Role
TSOs	• Determine CZCs
Coreso & TSCNET	• Operate the TSOs pre coupling system on behalf of TSOs
NEMOs	• Collection of bids and offers from their participants in their hub, and submission of their aggregated and anonymous order books to the PMB. •
Clearing Houses	• Financial clearing and settlement , nomination of cross border exchanges
JAO	• Operation of the TSO post-coupling system (calculation of bilateral exchanges) • Congestion revenue distribution among TSOs

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

11.3. 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 121).

11.4. 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.

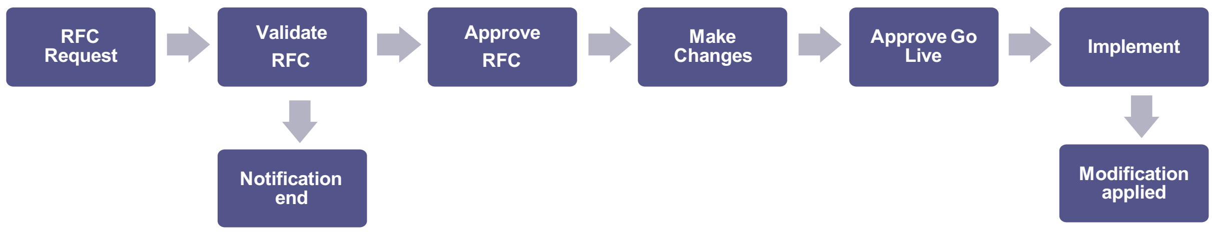
12 Change control

12.1. 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 SDAC or the market coupling algorithm fall under the responsibility of the respective steering committees.

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.

12.2. 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.

13 Glossary

AC	Active constraint
AMR	Adjustment for Min RAM
ATC	Available Transfer Capacity
ATC MC	ATC Market Coupling
CNE	Critical Network Element
CNEC	Critical Network Element Contingency
CCP	Cross Clearing Party
CEE	Central Eastern Europe
CET	Central European Time
CEWE	Central East West Europe
CGM	Common Grid Model
C	Contingency
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
EVB	Evolved Flow Based
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 Network Element
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 Network Element
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
NEMO	Nominated Electricity Market Operator
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 Exchanges 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
SDAC	Single Day Ahead Coupling
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)

14 Annexes

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

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

14.3. High level business process FB capacity calculation

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

14.5. Dedicated report on FRM (confidential)

14.6. Information regarding LTA inclusion

14.7. CWE High level architecture (confidential)

14.8. Technical Procedures (confidential)

14.9. CWE High level Fallback architecture (confidential)

14.10. Economic assessment

14.11. Domain reduction study

14.12. Intuitiveness report

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

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

14.15. Presentation of the Utility Tool

14.16. Publication of Shadow ATCs

14.17. Monitoring templates

14.18. Flow-based “intuitive” explained

14.19. Preliminary LTA inclusion statistics

14.20. Mitigation to Curtailment of Price Taking Orders

14.21. Implementation of FTR Options and temporary LTA+ solution

14.22. Methodology for capacity calculation for ID timeframe

14.23. Context paper CWE Intraday

14.24. Congestion income allocation under flow-based Market Coupling

14.25. Adequacy Study Report

14.26. Annex C_1_Transparency

14.27. Annex C_2_Transparency

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

14.29. Extended LTA formulation (*to be included May 2020)*

14.30. Pedagocical information on Extended LTA formulation (*to be included May 2020*)

14.31. CWE report: comparison flow-based plain and flow-based intuitive (2020)

14.32. Report on Congestion Income Distribution in Central Western Europe Flow Based Market Coupling after

Twelve Months of Operation of the Bidding Zone Border between Austria and Germany/Luxembourg (2020)

14.33. Evaluation of ALEGrO impact on CID results - 12 SPAIC Day assessment (2020)

14.34. Explanatory Note for ID Capacity Calculation (2020)

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 14_1 Documentation of all methodological changes during the external parallel run	**Historically relevant**: description changes during parallel run
Annex 14_2 Educational example “How does Flow Based capacity calculation work”	**Valid**
Annex 14_3 High level business process FB capacity calculation	**Valid**
Annex 14_4 Example of different types of Remedial Actions	**Valid**
Annex 14_5 Dedicated report on FRM (**confidential)**	**Historically relevant**, data of 2013
Annex 14_6 Information regarding LTA inclusion	**Valid**
Annex 14_7 CWE High level architecture (**confidential)**	**Not up to date**
Annex 14_8 Technical procedures (**confidential)**	**Not relevant anymore**
Annex 14_9 CWE High level Fallback architecture (**confidential)**	**Not up to date**
Annex 14_10 Economic assessment	**Valid**
Annex 14_11 Domain Reduction Study	**Valid**
Annex 14_12 Intuitiveness report	**Valid**
Annex 14_13 Intuitive Analysis for the FB-FBI selection	**Valid**
Annex 14_14 Results of the survey-consultation in May_June 2013	**Not relevant** anymore

Annex 14_15 Presentation of the Utility Tool	Replaced by Publication Handbook: http://www.jao.eu/cwemc_publicationhandbook
Annex 14_16 Publication of shadow ATCs	**Valid**
Annex 14_17 Monitoring Templates	**Valid**
Annex 14_18 Flow-Based "intuitive" explained	**Valid**
Annex 14_19 Preliminary LTA inclusion statistics	**Historically relevant**, statistics before go-live 2014.
Annex 14_20 Mitigation to Curtailment of Price Taking Orders	**Valid**
Annex 14_21 Implementation of FTR Options and temporary LTA+ solution	**Historically relevant**, Temporary procedure in 2015 for 6 months.
Annex 14_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 14_23 Context paper CWE Intraday	**Valid**
Annex 14_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 14_25 Adequacy Study Report	**Valid**
Annex 14_26 Annex C_1_Transparency	**Not up to date**

Annex 14_27 Annex C_2_Transparency	**Not up to date**
Annex 14_28 Report on SPAIC results for the Integration of the DE-AT border into CWE Flow Based	Updated in June 2018 in combination with the update of the main CWE FBMC approval document (v3.0)