Flow-based market coupling in the Central Western European region - on the eve of implementation -

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SUMMARY

The European target model for the Electricity market in 2014 is a single European price coupling for the day-ahead market. At the core of this single European price coupling, is the targeted coordinated capacity calculation by the TSOs. The coordinated capacity calculation process shall encompass the following steps:

- Setting up individual TSO's base cases (grid models),
- Merging of these individual files into a European-wide common grid model,
- Capacity calculation, on a regional basis,
- Validation of the results, to ensure the feasibility of the calculated capacities.

By optimizing the capacity calculation and allocation, the target model aims at promoting market integration, facilitating the European market functioning and efficiency, and improving the European social welfare while guaranteeing the Security of Supply.

In Central Western Europe (CWE) - a region consisting of the Netherlands, Belgium, France, Luxembourg, and Germany - a single price coupling was launched successfully as of November 9, 2010. At the origin of this market coupling (MC) process lies a coordinated ATC capacity calculation method that was designed and implemented by the CWE TSOs. For several years now, the CWE TSOs have been working on the 'next-step' coordinated capacity calculation method, the 'flow-based methodology' (FB), and reported on their work in 2008 [1]. The methodology, that was still in a theoretical stage at that time, has evolved by extensive experimentation and some theoretical improvements, and is now 'operationalized'. This means that the implementation of a flow-based market coupling (FBMC) in CWE, as a next (r)evolutionary step in the European market integration, is now envisaged [2].

In this paper, the CWE TSOs present the developments made since their CIGRE paper in 2008; the theory of the FB mechanism itself will not be touched upon as it is addressed in depth in [1].The focus in the paper is first on the properties of the FB capacity domain and the advantages that it brings compared to the ATC approach. This will be done not only from a theoretical perspective, but the theoretical claims will be proven on the basis of experimentally acquired results as well. Thereafter, the questions how remedial actions could be precisely taken into account during the capacity calculation process (using explicit remedial actions), and how to quantify the uncertainty, that the TSOs are faced with in the day-ahead market coupling, in the FB mechanism, are addressed.

KEYWORDS

CWE, Flow based, FB, Market Coupling, MC, ATC, PTDF, social welfare, remedial actions, day ahead, Flow Reliability Margin, FRM.

CWE FBMC WITHIN THE EUROPEAN FRAMEWORK / OTHER PROJECTS

The completion of the Internal Electricity Market by 2014 is divided into 4 main areas (LT allocations, Day-ahead market coupling, Capacity calculation and Intraday trading), each of these areas being itself addressed into cross-regional roadmaps, under the supervision of ACER, in order to identify key milestones, both at EU and regional level, and to increase consistency between and across the regions. For illustration purposes, the 2 roadmaps most relevant for the CWE FBMC are provided in Figure 1.

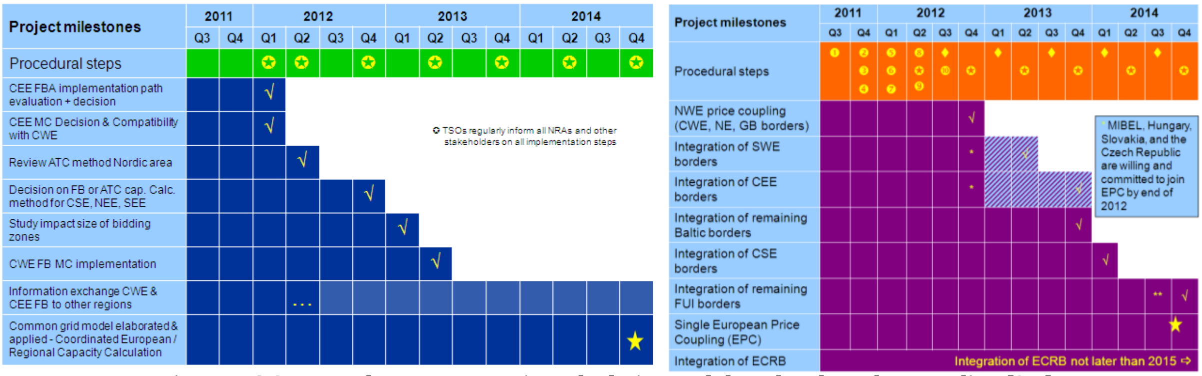

Figure 1 ACER roadmaps on capacity calculation and day-ahead market coupling [3,4]

Beyond the details of these roadmaps, the idea here is to show that within a European perspective, the CWE FBMC project is, as a matter of fact, just a single part of a consistent and complex set of intertwined projects. To this respect, the relationships and dependencies towards other European initiatives is an integral part of the CWE FBMC project. In practice, it means that CWE partners have designed, and are committed to implement, a flow based market coupling which ensures compatibility, both in terms of timescale (i.e. compatible with Long-Term allocation (year and month capacity products) and Intraday allocation) and geographical scope (i.e. compatible with any other coupling initiative, either in FB or ATC).

As a consequence, project partners prepare today the future integration of the CWE FB area within the single-price coupled “NWE” zone (CWE + Nordic Countries + GB), through a so-called “hybrid-coupling” which enables to manage FB and ATC links in and between bidding areas. Another example is the cooperative initiative, based on technical exchanges, between the FB Experts of the CWE and CEE (Central East Europe) regions.

CWE FBMC PROJECT STRUCTURE

CWE is a regional initiative which encompasses several aspects, from LT capacity calculation to operational “real-time” topics. Within this framework, FB MC is an entire project, of which an essential characteristic is a “Joint” initiative, involving both PXs (Power Exchanges) and TSOs. This fundamental “joint” perspective has been deployed within the project structure, which is composed of several working groups responsible for specific aspects of market integration: IT & testing, finance, legal/contracts... The whole project is driven by a Joint Steering Committee, co-chaired by a CWE PX and a CWE TSO. Given the need on the TSO side to settle specific processes and IT for a FB MC implementation, there exists in addition a dedicated TSO sub-project, with its own specialized working groups. The main groups of interest for this paper are the FBWG on the “TSO side”, the group responsible for designing and implementing the FB methodology within the TSO’s operations (and for drafting this paper), and the FB Validation Task Force (FBVTF) on the “Joint side”, responsible for assessing the market impact of FB.

The two groups have been working in coordination for several months, where the experimentally computed FB parameters (FBP) of the FBWG were provided to the FBVTF to run market coupling simulations. The promising results of this experimentation, described in a dedicated section, allowed the CWE partners to pursue the initiative and to start the operational implementation of FB.

In order to ease the paradigm shift when going from ATC to FB (not only for TSOs, but for all stakeholders: PXs, market parties, regulators), the project partners will organize a “parallel run” for probably a one year period, during which FBP are computed in parallel with ATCs, and are used to run market coupling simulations, on the basis of the same order books. The results will be published, in order to enable a continuous comparison between the 2 methods, and to allow all stakeholders to adapt smoothly to the new methodology. Eventually, it is assumed that FB will establish its own reference and that the ATCs will become obsolete at the end of the parallel run.

FROM ATC MARKET COUPLING TO FB MARKET COUPLING

Changing from ATC to FB constraints is a major step, not only for the TSOs in their daily operational processes and tools to determine the daily capacities for the day-ahead market and all interlinked processes, but also for the PXs, as the MC algorithm should be able to deal with this different type of constraints. Last but not least, the switch to FB is a major change for the market participants. As all cross-border trades that we have today are based on ATCs, the concepts of the ATC and its interpretation is well-established, well-understood, and embedded in the trading tools. The switch to flow-based should bring advantages to justify these changes. It is exactly those advantages of FB, compared to the existing ATC schemes, that will be touched upon in this section.

CWE Market Coupling

A power exchange is a market place where the demand and supply bids of a country, or group of countries, on a day ahead basis are collected and matched. In a market coupling of several countries, all bids of the (national) power exchanges are brought together in order to be matched. This will result in one price and a net import (demand) or export position (supply) per market area for all the coupled countries.
However, the results of the market coupling should be feasible in the grids of the TSOs of the countries involved. Therefore, the TSOs need to assess the capacity that they can provide to the day-ahead market coupling algorithm, to facilitate the market in the best feasible way, while safeguarding the Security of Supply. The market coupling algorithm solves therefore a constrained optimization problem, where the market welfare is maximized while respecting the security constraints provided by the TSOs. When one or more of the constraints is hit by the market coupling algorithm, different market prices are the result in the coupled markets. Congestion income, paid for the scarce capacity, is then collected by the TSOs. By contrast, when no constraint is hit, the market prices are identical for all countries and no congestion income is collected.

ATC versus FB constraints

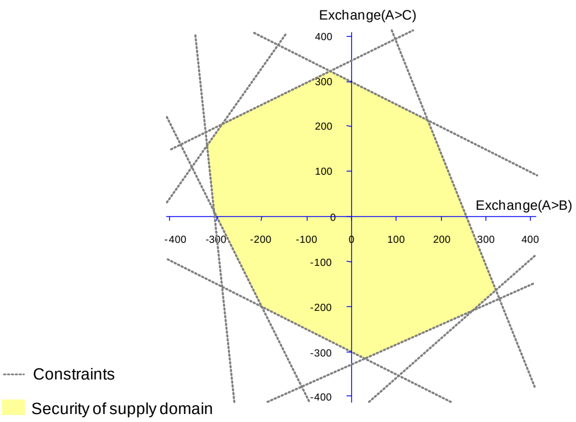

Figure 2 Simplified representation of a two-dimensional SoS domain

The constraints that are provided by the TSOs are either ATC or FB constraints, respecting the Security of Supply (SoS) domain. The SoS domain can be determined by making assumptions with regard to the foreseen grid situation and by performing contingency analyses. If we imagine a country A, that is interconnected with country B and country C, the SoS domain of country A could look like in Figure 2. On the x-axis the commercial exchange from country A to B is varied, while on the y-axis the commercial exchange from country A to C is varied.
In Figure 2, the SoS domain is coloured yellow and is bounded by several physical constraints. We can see from the figure that a 100 MW commercial exchange from A to B and a 100 MW commercial exchange from A to C is within the SoS domain; this combination of exchanges is feasible. A commercial exchange of 400 MW from A to B is always outside the SoS domain and is not allowed.

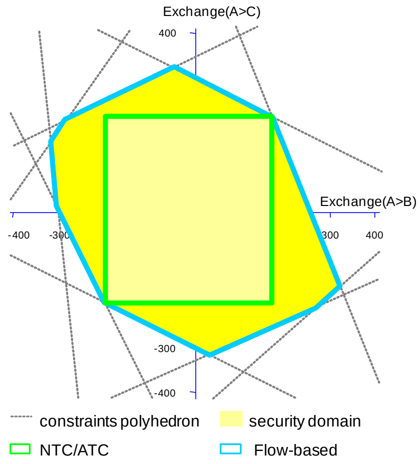

Figure 3 Example of one set of ATCs within the SoS domain and the FB domain

By providing FB constraints to the MC system, the TSOs provide the SoS domain as illustrated in Figure 3, as the domain itself is delimited by the FB constraints. When a TSO provides ATC constraints to the MC system, the TSO needs to make a choice on how to split the capacity among its borders (A to B and A to C). One of the possible choices is shown by the green rectangle in Figure 3, which represents the ATC domain. Thus, based on the figure, the ATC domain (or ATC search space) that can be provided to the MC system by the TSOs, without violating the SoS, is more restrictive than the represented FB domain. As such, the FB approach provides more trading opportunities and more flexibility to the market than the ATC.

In FBMC the final capacity split between borders is not a choice of the TSOs, but it is market driven (at the time of allocation). Indeed, this is another major advantage of the FB approach: it is up to the market to decide how to use the available capacity in the grid.

EXPERIMENTAL RESULTS – CONFIRMATION OF THE THEORY

The principles described above have been thoroughly experimented by CWE FB experts, both in terms of capacity and market impact. The principle of this experimentation was two-fold:

- TSOs computed FB parameters
- these FB parameters were used in market simulations with the FBMC algorithm, on the basis of historical order books, in order to assess the market impact of FB.

CWE TSO FB experts have run the experimentation during 17 months from March 2010 up to and including July 2011, computing FB parameters for one (and sometimes two) full week(s) each month. The market impact has been assessed jointly by TSOs and PXs as soon as implicit order books were available (from the start of the CWE ATCMC in November 2010). The length of the experimentation enabled to cover an exhaustive set of situations. The main outcomes of these "experimental runs" are presented in the two following sections[1].

Capacity Indicators

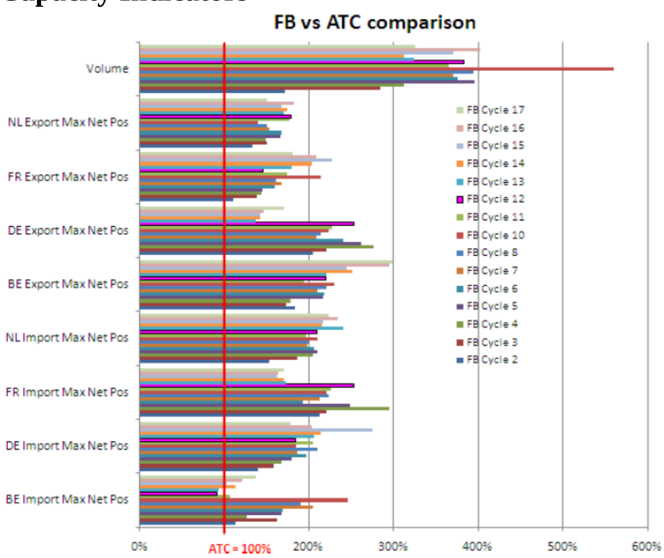

Figure 4 Capacity indicators obtained during the experimental cycles

Along the so called "experimental cycles", CWE TSOs have computed FB parameters and compared them to historical ATCs through a set of indicators (volume of the search space and non simultaneous import/export capabilities for each hub). The results are shown in Figure 4. In this graph, the red line represents the capacity indicators as obtained with the ATC methodology; all values have been normalized to this reference (100%) value for easy comparison. Even though these maximum net positions cannot be reached simultaneously, one can observe the significant increase in capacity provided by the FB methodology.

[1] The following results have been obtained without implementation of explicit remedial actions and with normative Flow Reliability Margins (FRMs) of 10% (see definitions below).

Market impact

In a second stage, the FBP computed during the experimental "cycles" were used in FBMC simulations. This started as soon as the CWE ATCMC went live in November 2010 (from cycle 11 of the experimentation onwards). The indicators used to assess the market impact of FB are, amongst others, the gain in social welfare and price convergence. Also from this perspective, the results of the experimentation clearly indicate that FBMC has a positive impact on the market, as shown in Figure 5 and Figure 6.

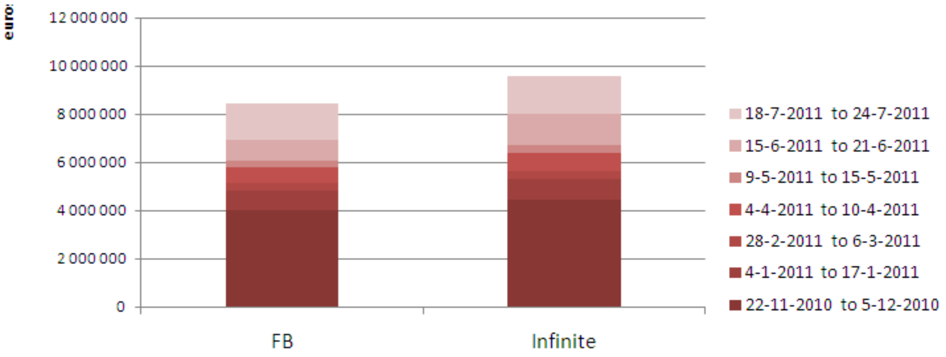

Figure 5 Additional social welfare gain of FBMC compared to ATCMC (based on 9 weeks)

Figure 5 shows the additional social welfare generated under a FBMC compared to the welfare generated under ATCMC. In addition the welfare that would have been generated in case no grid constraints were imposed to the MC system, the 'infinite capacity' or 'copper plate' scenario, is shown as well. In total, FBMC clearly generates a significant gain in welfare when compared to ATCMC. On average, the gain generated by FBMC even represents 83% of the maximum welfare gain feasible.

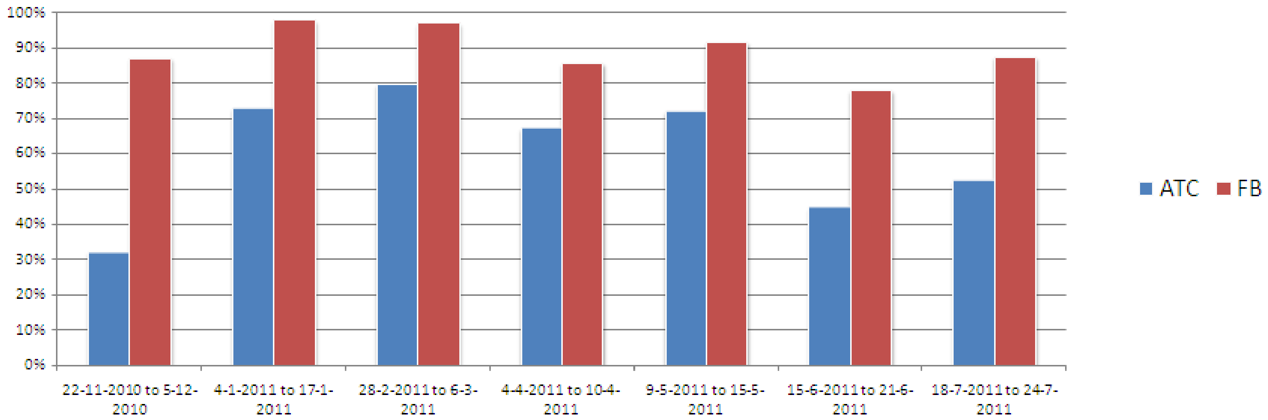

Figure 6 Price convergence under FBMC compared to ATCMC (based on 9 weeks)

Figure 6 shows that under a FBMC, the price convergence within CWE (i.e. one single price in NL, BE, DE, and FR) significantly improves compared to the results under ATCMC.

CWE FB PROCESS

A high-level flowchart of the CWE FB process is shown in Figure 7. Two functionalities have been added to the CWE FB process, compared to the approach described in the CIGRE 2008 paper [1], and will be elaborated upon hereunder. After the initial flow based parameters calculation, the following two processes are executed by each TSO: FB parameters qualification and FB parameters verification. Each process has its proper objective to ensure that the FB domain is as large as possible without jeopardizing the security of supply (SoS).

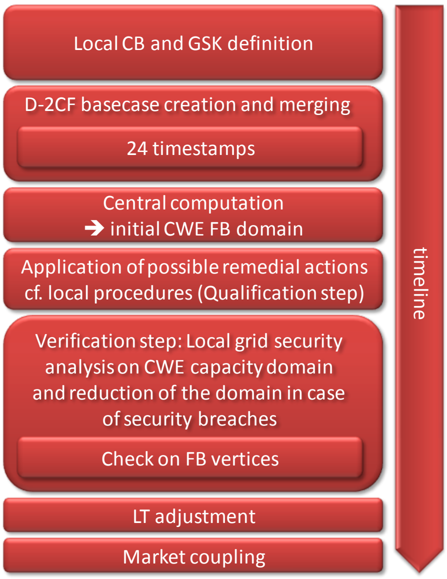

Figure 7 CWE FB process

Qualification step

In order to perform the qualification of the calculated FB domain, the TSO will observe the results of the first calculations. He can analyse the whole set of Critical Branches (CBs), or just those CBs which are limiting the domain. The TSO can also analyse the results of the calculation by comparing the maximum net positions (maximum import or export) of the hub through time. For each constraint, the TSO can incorporate additional remedial actions, such as he would perform in real-time. A check has to be performed to ensure the availability of the remedial action and the impact of this action on other branches in the CWE grid. The incorporation of remedial actions is executed by each individual TSO according to his own risk policies and local capacity calculation procedures.

Verification step

After the qualification phase of the FB domain, each TSO has the possibility to verify the FB domain. The FB domain is calculated on carefully selected branches, using a DC load flow computation and by applying linear generation shift keys (GSKs). In order to assess the different approximations in the FB calculation method, the TSO can perform a full AC load flow with his own grid analysis tools. The TSO can select certain vertices of the FB domain to verify the safety of the grid on a more detailed level; either for the twenty four hours of the day, or for a selection of timestamps, based on the experience of the operators (e.g. high load / low load). Different analyses can be made:

- analysis of the flows of reactive power throughout the grid in the AC load flow
- customization of the generation pattern, taking into account different generation patterns, instead of a linear GSK
- a check can be performed on the voltage limit for equipments on all nodes for specific situations
- the available margin before a voltage collapse (voltage stability check) can be determined

Currently, every TSO will perform this verification on his own set of CBs; the intersection of all locally verified domains will be proposed to the market as the common FB domain as shown in Figure 8. Because of operational timings, this is the best way to ensure the safety of the grid and the level of security of supply.

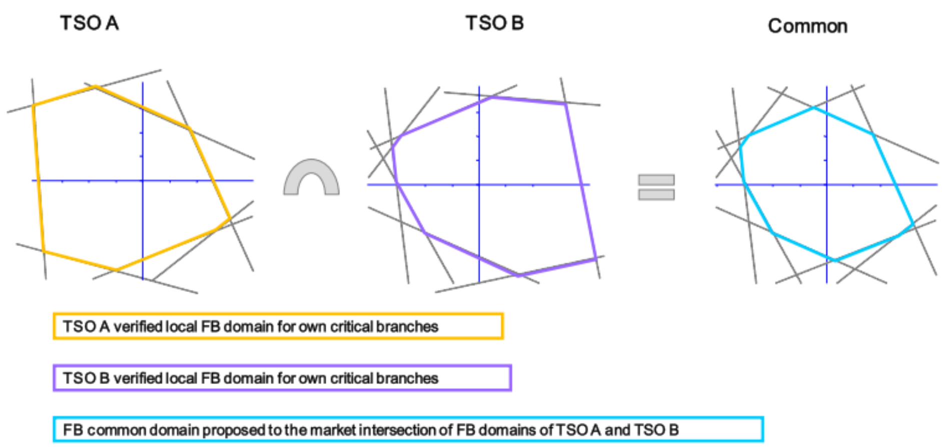

Figure 8 Composition of one common FB domain from two local FB domains

Therefore, for grid security reasons, it is possible that the FB domain could be decreased in the verification phase.

Summary
The qualification phase has got as main objective the incorporation of available remedial actions to optimise the given capacities. This is executed by each individual TSO according to his own risk policies and local capacity calculation procedures. The verification phase will provide an additional security check to verify the relevant extreme points of the FB domain (vertices).
The impact and incorporation of remedial actions within the FB methodology and FB process is elaborated upon hereunder.

Capacity calculation and remedial actions
The Flow-Based domain to be set up shall represent the full security domain itself. At a first glance, this means applying the well-known N-1 rule[2]. However, in operation, dispatchers have at their disposal specific counter-measures ("remedial actions") to secure the grid in case of unplanned outages ("contingencies"). Remedial actions (RA) can be classified either as "post-fault" or "pre-fault":

- A remedial action is said to be post-fault if it is applied after a fault, using the fact that branches can be overloaded for a short period of time
- By contrast, pre-fault remedial actions are applied in anticipation of an overload or a fault.
- In any case, the period of time needed for applying the remedial action is a key point when assessing the suitability of a remedial action.

The time available for putting in place the remedial actions affects largely their use. Namely, within CWE, lines and transformers are monitored with (at least) two different thresholds, "instant tripping" and "permanent limit":

1. The instant tripping threshold ($I_{instant}$) is the highest one; when this threshold is reached, the equipment is tripped off automatically and instantly; when this occurs, the dispatcher has no time to perform any manual action (only pre-fault remedial actions are possible to avoid such events).
2. By contrast, when the flow exceeds the permanent limit threshold ($I_{permanent}$), it results only in an alarm; based on the grid code, the dispatcher is then requested to put in place as soon as possible the necessary post-fault remedial actions to bring back the flow below its limit value.

In parallel, financial aspects come into play as remedial actions may be costly or non costly.
According to respective risk policies, in the CWE flow-based methodology, TSOs can make uses of:

- Non-costly counter measures like topological measures[3] including the application of phase-shifting transformer (PST) tap changes,
- and post-fault redispatching[4].

Those remedial actions are core elements of the TSOs' risk policies. Besides assessing N-1/n-k fulfilment, TSOs have the possibility to take into account remedial actions when computing cross-border capacities. As shown in the short example below, their impact can add up to a significant share of the total import/export capacities of a market area. Taking remedial actions into account when computing the flow-based domain similarly proves to be highly beneficial. In any case, TSOs remain cautious when considering remedial actions in the capacity calculation process, such in order to respect SoS standards as there could be a possible impact of remedial actions on neighbouring grids.

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[2] Different contingencies may appear: tripping of a single line or of a generation unit are the most probable events which could happen during operation. Busbar tripping or simultaneous tripping of several lines or loss of a whole substation is generally less probable. Dimensioning the system for all possible events, even those with very low probability of occurrence, would lead to very high costs. Therefore, it is a matter of system risk policy to take into account the probability of system failures, and their consequences, in order to find an acceptable trade-off between costs and level of security, respecting compliance with security criteria established in Network Codes.

[3] A topological remedial action generally comes down to changing the status of one (or several) busbar switch(es)

[4] Pre-fault redispatching (and pre-fault countertrading) is excluded since they are not economically efficient. Post-fault costly remedial actions, however, are efficient for the European social welfare, since the expected cost is low (N-1 probability times cost) compared to the hourly capacity gain.

Small example of the impact of remedial actions in bilateral capacity calculation

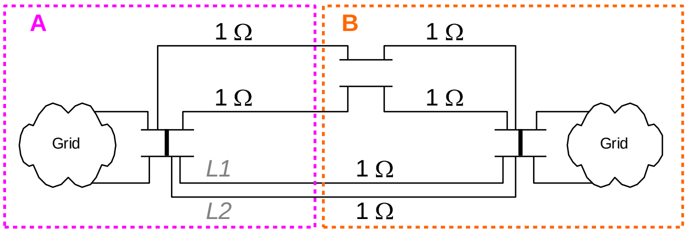

Figure 9: Nominal conditions

Let's consider a small example with two zones (A and B) linked by four parallel tie-lines (Figure 9).
When computing the cross-border capacity, the most restrictive N-1 shall be considered. The capacity is equal to the maximum exchange feasible in that condition.

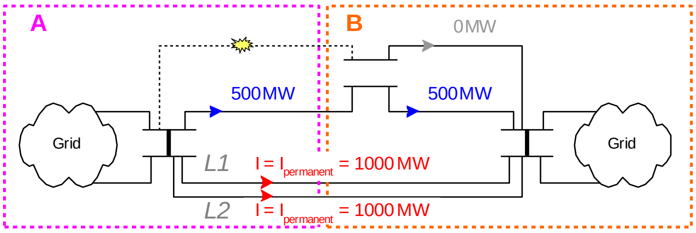

Figure 10: Limit case after N-1 without available remedial

Without any available remedial action, the flow in L1 and L2 may not exceed $I_{permanent}$ = 1000 MW.

Hence the import/export capacity is **2500 MW** (no reliability margin taken into account) (Figure 10).

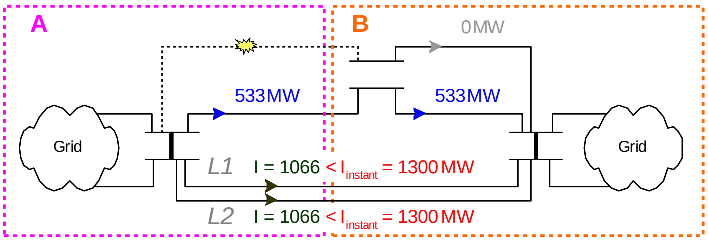

Figure 11: Limit case after N-1 with available remedial action

The physical flow in L1 or L2 may temporarily go up to $I_{instant}$ = 1300 MW, provided the dispatcher is able to quickly bring the flow back below the limit (Figure 11).

Then, after applying a topological remedial action (busbar switch, in green in Figure 12), the physical flow in L1 and L2 is reduced to $I_{permanent}$ = 1000 MW which is an acceptable level for the grid security.
Hence the import/export capacity is **2666 MW** (i.e ~7% above the initially computed value without remedial action).

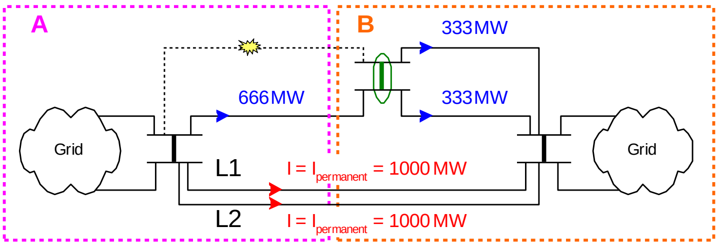

Figure 12: Situation after the remedial action

Implicit vs explicit remedial actions

In practice, remedial actions may alter largely the topology, hence the electrical distances, and at the same time the reference flows and the PTDFs. Depending on the respective weight of these effects, two ways of taking into account remedial actions may be envisaged:

- implicit remedial actions
  The impact in MW of a given remedial action on the associated monitored branch is estimated outside of the FB tool by an expert; when taking into account the remedial action in the FB tool, the physical margin of the monitored branch[5] is simply increased by the previous quantity (assuming this quantity was positive); the PTDFs are considered to remain constant;

[5] In practice, when the application of a remedial action increases the physical margin on a➔b by a given amount, it reduces at the same time the physical margin by the same amount on b➔a. This is the rationale for having oriented monitored branches, i.e. CB a➔b is distinct from CB b➔a. It enables to define:

- a CB a➔b with application of a given remedial action RA1
- and a CB b➔a with application of a given remedial action RA2 (with opposite influence with respect to RA1).

- explicit remedial actions
  Remedial actions are detailed and associated to the critical branches or critical outages definition; in this case the exact influence of the remedial action is determined by the FB parameter calculation tool; this allows taking into account PTDF modifications for topological remedial actions.

Graphically, the application of an implicit remedial action is a pure translation within the nomogram while an explicit remedial action can also alter the slope of the constraints, as shown in Figure 13.

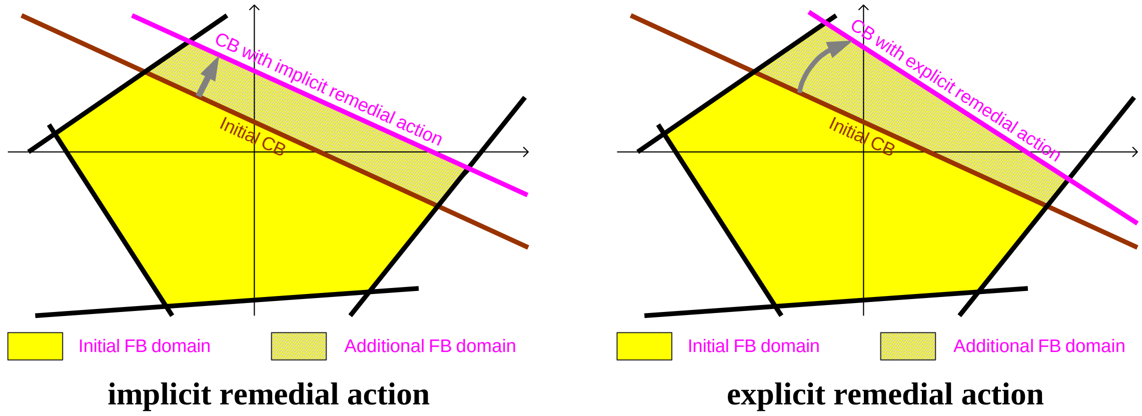

Figure 13 Different impact of implicit and explicit remedial actions on the FB domain

The CWE Flow-Based methodology enables both implicit and explicit remedial actions to be used. Nevertheless, explicit remedial actions have the following advantages:

- they facilitate the FB parameter computations as they are taken into account as input data, which mitigates the need for complex post-processing,
- they are more accurate (recomputation of the PTDF),
- and they provide transparency among TSOs.

Explicit remedial actions computation process
Fortunately, the practical computation of a critical branch with the application of one (or more) remedial action(s) is a straightforward process:

1. the initial base case is altered to reflect the outage(s) and the corresponding remedial action(s).
2. the reference flow and the PTDF for the monitored branch(es) are computed on the resulting grid state.

FLOW RELIABILITY MARGIN (FRM)

The uncertainty involved in the flow-based process must be quantified and discounted in the allocation process, in order to prevent that on day D the TSOs will be confronted with flows that exceed the maximum allowed flows in their grids due to phenomena that are out of their scope of responsibility[6].
Therefore, for each critical branch a Flow Reliability Margin (FRM) has to be defined, that reduces the remaining available margin (RAM) on the critical branches because a part of this free space must be reserved to cope with these uncertainties.
The basic idea behind the FRM determination is to quantify the uncertainty by comparing the 2 day ahead forecast, i.e. the FB model, with the observation of the corresponding timestamp in the real time, by making a snapshot (SN) of the transmission system. This is illustrated in Figure 14. In order to be able to compare the observed flows (from the SN) with the predicted flows, the FB model is fed with the realized schedules at the time of the SN. 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, the FRM values can be computed from the distribution of flow differences between forecast and observation.

[6] For instance, discrepancies between wind forecast and realized programs.

By following the approach in Figure 14, all uncertainties within the FB process are taken into account and monitored for the FRM determination. As such, it will provide a reference to monitor future changes/improvements in parts of the process and/or the input data.

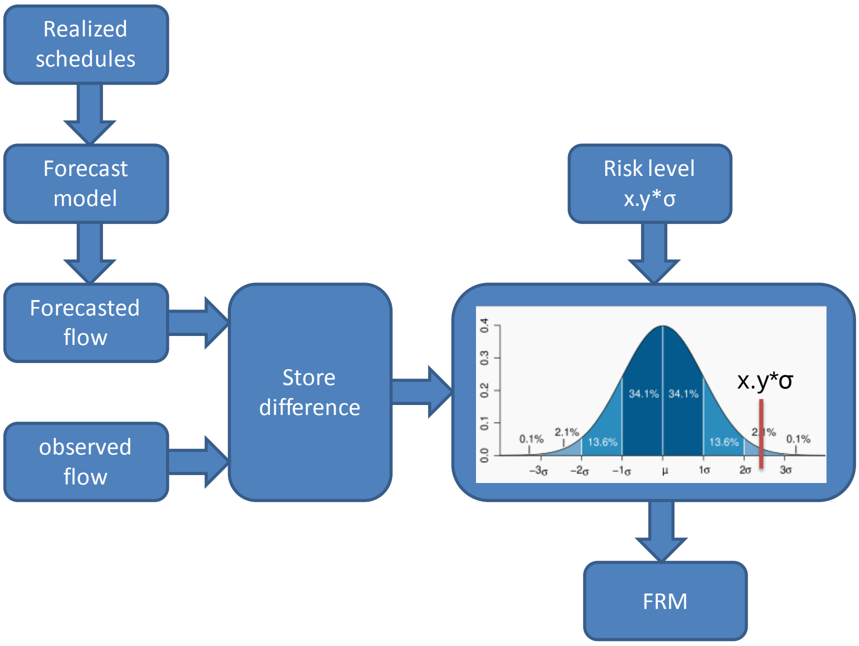

Figure 14 FRM assessment principle

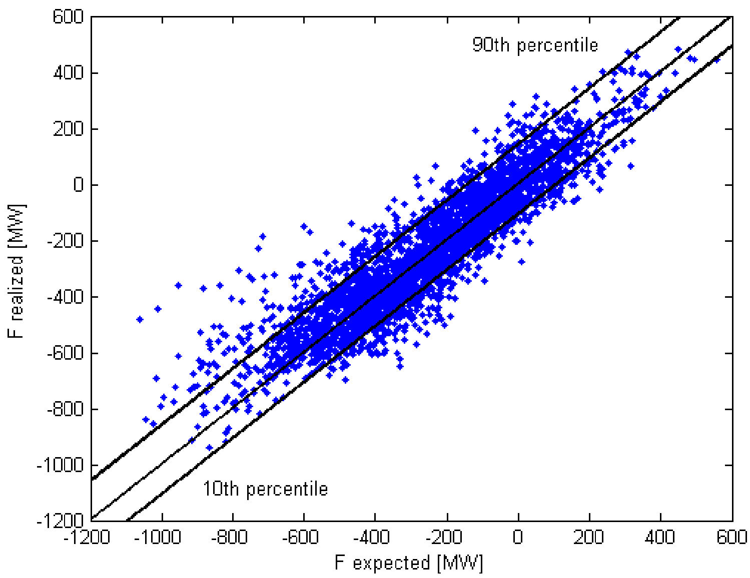

Figure 15 Preliminary results from the FRM analysis for one CB

In Figure 15, the expected flow on one critical branch (F expected) is shown on the x-axis, whereas the realized flow (F realized) for this specific branch is shown on the y-axis. The realized flow is the flow observed in real time (i.e. in the snapshots (SNs)). The expected flow is the flow computed from the FB model by taking the CWE realized schedules into account. In the graph three black lines are drawn. One line starts in the lower left corner and ends in the upper right one. As the x and y axis have the same scale, this line indicates the one-to-one relation between the expected and the realized flow. It is evident that due to all uncertainties involved, the actual numbers are scattered around this line, represented by the blue dots. The two remaining black lines, labelled with 10th percentile and 90th percentile, indicate the 10% of the blue dots where the difference between the realized and the predicted flow (F realized – F predicted) is the smallest and the largest respectively. CWE TSOs are currently analyzing the huge amount of data that they generated by means of the FRM assessment in order to determine the FRM values that would allow the grid security to be safeguarded.

CONCLUSIONS

In this paper, the CWE TSOs present the developments made on the flow-based capacity calculation since their CIGRE paper in 2008 [1].

With the start of the CWE ATC MC (November 2010), a major milestone was reached by the CWE TSOs, Power Exchanges (PXs), and Regulators. Not only did a three-year project materialize, it also triggered the start of the FB parallel run. With the ATC MC in operation, the FB MC could be simulated by using the same order books, while the CWE TSOs were able to provide operational FB constraints with the same level of SoS as the ATCs used in the ATC MC. These studies allow the TSOs and PXs to analyze the market impact - in terms of social welfare, price convergence, price volatility, resilience and more - of introducing the FB constraints instead of the ATC ones. It is demonstrated in this paper that the FB mechanism outperforms the ATC mechanism in terms of capacities provided to the market, and therefore also in terms of social welfare and price convergence.

Furthermore, the questions how remedial actions could be precisely taken into account during the capacity calculation process (using explicit remedial actions), and how to quantify the uncertainty, that the TSOs are faced with in the day-ahead market coupling, in the FB mechanism, are addressed in this paper.

BIBLIOGRAPHY

[1] Schavemaker, P.H., et al., 'Flow-based allocation in the Central Western European region', paper C5-307, CIGRE, 2008.

[2] CWE project, 'CWE Enhanced Flow Based Market Coupling Feasibility Report', October 2011, http://clients.rte-france.com/lang/an/clients_traders_fournisseurs/services_clients/initiatives_regionales.jsp

[3] ACER, Draft Cross-regional roadmap for Capacity Calculation, http://www.acer.europa.eu/portal/page/portal/ACER_HOME/Activities/Regional_Initiatives/Electricity_Regional_Initiatives/Regional%20Roadmaps/South-West/Meetings1/IG_Meetings/9th_IG_meeting_of_the_ERI_SW_region/Agenda_and_distributed_docs/Draft%20Cross-Regional%20roadmap%20for%20Capacity%20Calculation-FB_20110911_E-control%20_CREG.pdf

[4] ACER, Draft cross-regional roadmap for Day-Ahead Market Coupling, http://www.acer.europa.eu/portal/page/portal/ACER_HOME/Activities/Regional_Initiatives/Electricity_Regional_Initiatives/PROJECTS/Announcements/Draft%20Cross-Regional%20roadmap%20for%20Day-Ahead%20Market%20Coupling.pdf