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Improved TSO coordination in the Central West European region

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SUMMARY

The TSOs believe that there is room for an improvement in the congestion and security management in the CWE region by a better coordination of the use of its PSTs and HVDC interconnections. Therefore the Congestion and Security Management (CSM) group, being an operational platform of TSOs, has decided to create a dedicated task force to look at procedures for a better coordination around the use of PSTs and HVDC interconnectors for security of supply. The paper describes the basic principles of these new procedures for congestion management and improved information exchange among TSOs.

Investigations have been done on the possibility to coordinate the existing PSTs in the region as a cross-border remedial action. The use of HVDC lines is recognized to be an option for congestion management.

The CWE TSOs realize that the coordination of operation may also affect other regions within the European grid which creates other challenges to deal with. The use of operation policies for the regional group Central Europe as agreed within the European Network of TSOs for Electricity (ENTSO-E) is described. Furthermore, the issue of cost sharing mechanisms related to cross-border countermeasures among TSOs is addressed.

KEYWORDS

European Transmission Grid, Congestion Management, Market Coupling, System Security Analysis, Countermeasures

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REGIONAL INITIATIVES

TSOs in the Central West European (CWE) region for many years already have coordinated their system operations. Characteristic for this region is its highly meshed grid and that electricity markets have become more linked after the introduction of market coupling concepts. In the last few years the increasing development of both renewable and dispersed generation together with a boost of new conventional generation units created an extra need for new approaches for operations. Next to that TSOs have invested in recent years in Phase Shifter Transformers (PSTs) and HVDC interconnections, which may give them the opportunity to influence in a large range the power flow patterns as well. The PSTs are installed to overcome local bottlenecks in the grid or with the intention to increase cross-border capacity for the market and so far have been operated with a limited coordination.

Over the last years new service providers, like TSO Security Cooperation (TSC) [1], Coreso [2] and the Security Service Centre (SSC) for grid security coordination and the Capacity Allocation Service Company (CASC) for market related issues like cross-border trade nominations have been introduced in the CWE region. The coordination between these service providers, TSOs and Power Exchanges is crucial for a successful electricity market where the complexity of operation is increasing and where the system is run closer to the limits.

REGULATORY FRAMEWORK

TSOs have got to deal with the following regulatory framework:

- EU directive 2009/72 EC and regulation 714/2009
- EU Third Energy Package
- Multilateral Agreement (MLA) among TSOs and ENTSO-E Operation Handbook for the Region Central Europe
- Member states' legislation (rules & regulation)
- Memorandum of Understanding of the Pentalateral Energy Forum on market coupling and security of supply in central Western Europe
- Agency for the Cooperation of Energy Regulators' (ACER) framework guidelines development
- ENTSO-E's European Network Codes development.

INCREASING VOLATILITY

Electricity business' volatility has changed tremendously due to increasing cross-border trade and newly introduced market mechanisms such as market coupling, continuous intraday cross-border trade. On top of that the increasing volumes of renewable energy sources create an extra challenge for TSOs regarding balancing and congestion management mechanisms.

The next figures show how flow patterns have changed over the years. Figure 1 shows flow patterns around the CWE region where in 2003 a modest number of flow pattern changes

a week.

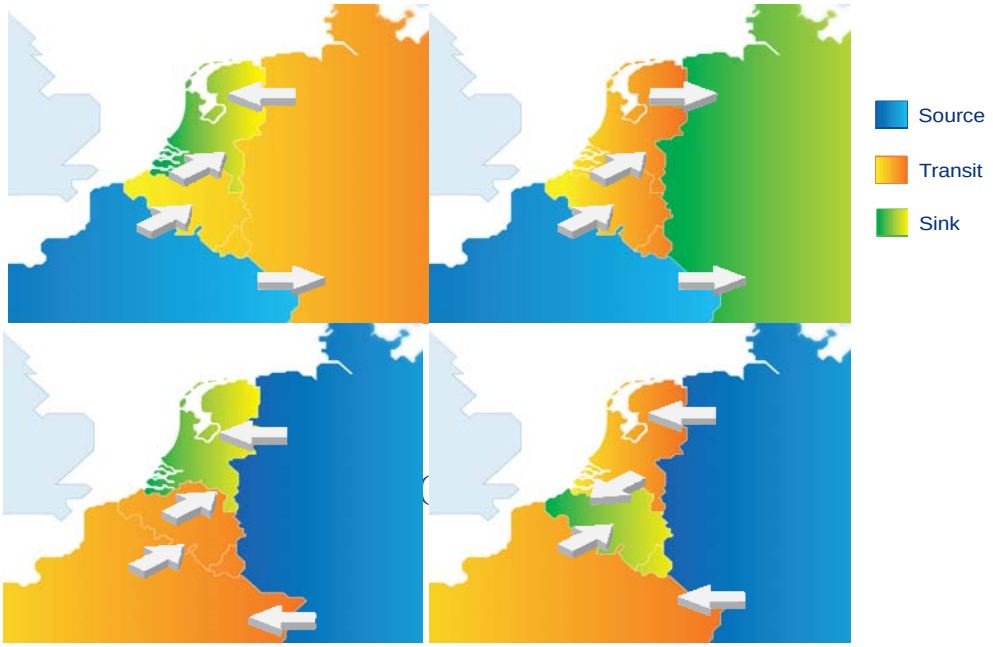

Fig. 1: Flow patterns 2003 (1 week)

As shown volatility was at a fair level in 2003.
This trend has changed dramatically as figure 2 shows. Flow patterns in 2010 changed and a large increase in different flow patterns was experienced. Even in one day different large flow pattern changes were being realized due to small differences in market prices per hour and vast volumes of generation from Renewable Energy Sources (RES), located especially in the Northern part of Germany. During most of the time the large cross-border programme changes are not 'synchronized' all over the European continent which also introduces possible large frequency changes in continental Europe.

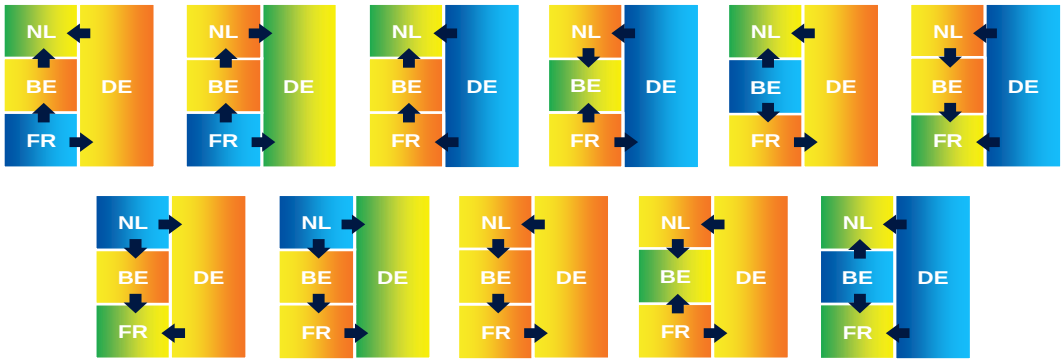

Fig. 2: Flow patterns 2010 (1 week): 11 configurations

RECENT DEVELOPMENTS

A new HVDC interconnection has been put in operation in April 2011 between UK and the Netherlands, operated by BritNed Development Ltd. This new interconnector with a transmission capacity of 1000 MW has further increased the volatility of physical flows in the CWE region. The TSOs have assessed the level of impact of the BritNed HVDC link's commissioning on grid operations. The advantage of the fact that HVDC lines are controllable is that they could be used to solve grid constraints. Discussions have started among the TSO of UK National Grid, the TSO of the Netherlands TenneT TSO B.V. and BritNed Development Ltd. on the possibility of having a congestion management scheme on this HVDC link and IFA (HVDC link between UK and France).

One important and striking event was the decision taken by the German Government on March 16, 2011 to start the phase out of nuclear power plants right after the Fukushima accident. Eight nuclear power plants were immediately shut down representing a total of around 8 GW. Based on that decision the German TSOs prepared an impact study incorporating also two worse case scenarios: a) highest load, no wind, no photovoltaic and b) high load, high wind, no photovoltaic. The calculated impact of shutting down the nuclear power plants are: a possible endangered power system adequacy (balance of load and generation), N-1 transmission and voltage violations due to high flows and lack of sufficient local power plants.
It is foreseen that the remaining nuclear power plants will be taken out of operation until end of 2022. The following immediate remedial measures are agreed among the German TSOs: redispatch of thermal and RES generation, rescheduling of maintenance and extension works in the grid, curtailing of NTCs to neighbouring countries and market interventions by TSOs.
The next short term focus for the German TSOs was to assess the risks for the coming Winter 2011/2012 period together with the surrounding TSOs around Germany.

PST COORDINATION

A PST coordination procedure has been developed for the CWE region, covering in total 8 400 kV PSTs: i.e. 3 PSTs from the Belgian TSO Elia, 1 PST from the German TSO Amprion, 2 PSTs from the German TSO TenneT TSO GmbH and 2 PSTs from the Dutch TSO TenneT TSO B.V. The procedure covers the time horizons from D-2 to real time (D). The French TSO RTE is also involved in the coordination process, due to the influence on its grid.
Because of the broad area concerned, the coordination initiatives (SSC and Coreso) are also part of the coordination process.

The following flowcharts shows the processes in a high level way. Some details have been omitted or simplified to keep the overview. Fig. 3 shows the D-2 process which deals with the determination of the available NTC.

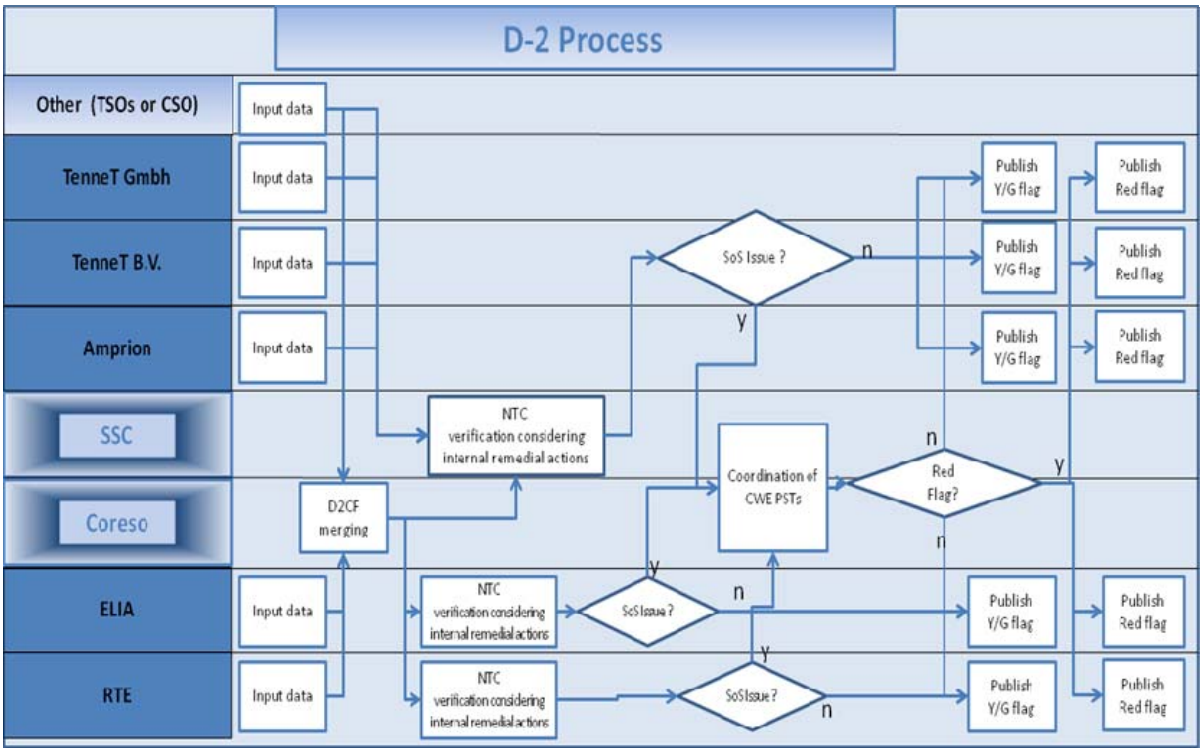

Fig. 3: PST coordination in the D-2 process

In case the NTC verification considering internal remedial actions doesn't result in grid security violations, a so-called green flag is published, pointing out that grid security is warranted. In case coordination of PSTs is applied, and grid security violations remain, a red flag is raised by the concerned TSOs. In case coordination of PSTs is applied, and no grid security violations remain a yellow flag could be raised. In case the PST coordination is applied, this will be confirmed to all involved TSOs. The TSOs take expected loop flows into account when determining the NTC values. Next to PST coordination also the usual topology actions should be considered.

On D-1 the Day Ahead Congestion Forecast is being performed, i.e. regional loadflow forecasts and grid security analyses are performed based on merged loadflow models for the region.
During the Daily Operational Telephone call (DOPT) the involved TSOs discuss the DACF results and in case of any detected N-1 violation determine which preparations for countermeasures should be taken such as PST coordination. In parallel, Coreso provides its partners which propositions of coordinated remedial actions and facilitates the agreement between impacted TSOs. Coreso speaks for its shareholders during the DOPT. This collaboration between TSC and Coreso has already proven its efficiency.

One of the major reasons several TSOs installed PSTs is to be able to solve N-1 violations and guarantee grid security, within the limits of existing grids. It is of utmost importance that a tap range can be exclusively reserved for this purpose. This also implies that even if the PST might appear to have some margin left, in fact this is not the case. Compared to the realization of a new transmission line or an upgrade of an existing transmission line, PSTs are cheaper in investments and are much shorter in commissioning and realization time. Nowadays the realization of a new transmission line sometimes takes about 8 – 10 years, depending on the tough licensing procedures.

Fig. 4 shows the PST coordination process for real time. In this case the coordination directly takes place among the involved TSOs, without interference of SSC and Coreso.

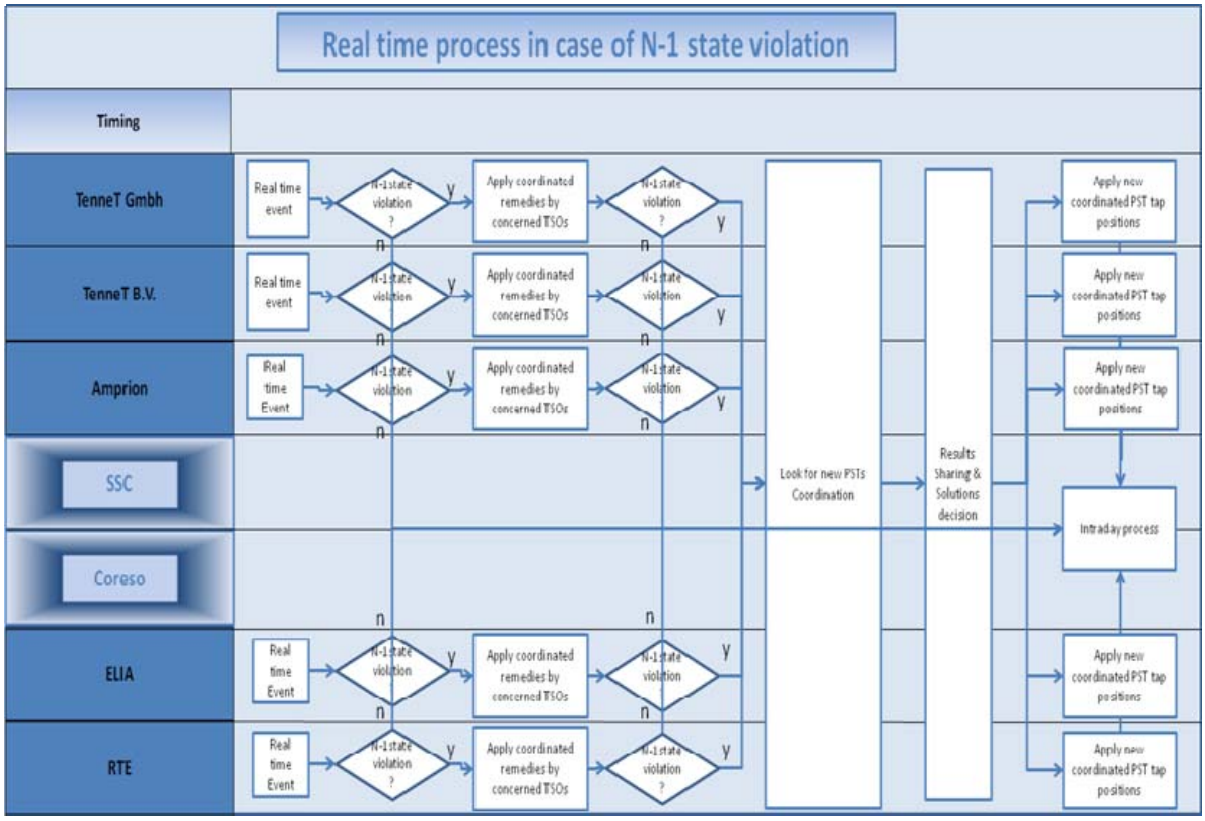

Fig. 4: PST coordination in the real time process

Within the coordination of remedial actions TSOs have to consider the efficiency and effectiveness regarding the constraint in the grid. It is also important to ensure that the constraint is not moved in another part of the grid as also is one of the rules in the Policy 3 of the ENTSO-E Operation Handbook for Central Europe [3]. The remaining grid security margins and remedies should also be sufficiently distributed in the grid to face the impact of the uncertainty in the flows or next possible N-1 violation. Due to the inherent volatile nature of phenomena affecting the TSOs business there is likely a need to rely on PST tapping steps in real-time to manage loop flows, N-1 violations and local congestions. At this stage, TSOs requesting steps on PSTs in other control areas can also contact their neighbours. In practice we see that such request can often be predicted in D-1. Experience tells us that it is very useful to have the indications of possible need for coordination as early as possible. This will prevent the TSO control engineers from being taken by surprise. Due to the increasing presence of HVDC links, remedial actions should not be limited to topology actions or the use of PSTs, but also include the possibility to control HVDC links to alleviate bottlenecks on the grid.

INFORMATION EXCHANGE

In practice for TSOs participating in regional coordination initiatives, it is common sense to already look into possible coordination needs at the D-2 and D-1 stage and to share this information with all TSOs involved. Those regional initiatives and coordination centres amongst themselves and in parallel with the involved TSOs are also best placed to coordinate

the different actions and propose combinations of tap settings of PSTs, due to their broader view of the grids in the region. ENTSO-E's Central Europe Operation Handbook also prescribes the methodology for determining the so-called observability area for each TSO. It also is necessary to have some important external contingencies incorporated in the real-time and off-line grid security analysis.

A common grid model is required to assess the coordinated use of the PSTs and HVDCs devices. The common grid model is generally built as follows: each TSO prepares the dataset for his own grid and these individual datasets are merged into one common grid model for the given time horizon. For the moment, the following dataset are available:

- D2CF for D-2
- DACF for D-1
- IDCF for intraday (under construction)
- snapshot for real time.

It is important that each TSO includes its best forecasts in these date, including of course foreseen PSTs' tap positions. These data can also be updated: in D-1, after delivering a first version of DACF, it could be valuable to deliver a second version in case grid security assessments show that PST tap changes are necessary. It is also of importance that each TSO shares the characteristics and operational principles and rules and objectives of his PSTs or HVDC links, including the PST tap range used dependent of the time horizon of the grid security analysis.
A sensitivity matrix with the influence of each controlling device like PST and HVDC link on a list of critical transmission lines could be useful information. This information can be computed based on the common grid model and a list of critical transmission lines provided by each TSO.

REMEDIAL ACTIONS

In general, a fixed ranking in remedial actions is difficult to impose and the following list just shows the different possibilities which are in use at TSOs:

- ATC/NTC reduction in the congested direction
  - Intraday: TSOs should prevent new intraday allocations that could increase the detected congestion
  - Week ahead: TSOs should coordinate regional daily NTC values taking the detected congestions into account
- Possible grid topology adjustments (preventive or curative):
  - Topology adjustments
  - Tap changing of PSTs with a local impact
- Redispatch of generation within one control area
- Tap changing of PSTs with a regional impact
- DC loop flows using HVDC cables
- Declaring emergency power reserves unavailable
  - Interruption of maintenance of grid elements
- Activation of inter-TSO emergency power reserves
- Tripping of tie lines, up to opening of a border in case of N-1violation
- Cross-border redispatch, i.e. redispatch within two or more control areas.

NEW CHALLENGES

The definition of a common objective function for the 'optimal PST coordination' for the whole CWE area is not a simple task and will for sure need further R&D effort. Effective use of optimization tools requires harmonization of starting points related to the operational processes such as objectives, constraints, and released control range of PST settings for the different time intervals.

Within the CWE region the so-called flow based allocation mechanism, see also Policy 4 of ENTSO-E [3], will be introduced within the next few years. TSOs together with Power Exchanges and market parties will jointly cooperate to achieve the right implementation level for this flow based allocation mechanism. One of the issues being discussed within the flow based allocation mechanism was whether or not to incorporate PSTs in the algorithm. The decision was taken not to do so due to the complexity of defining the common optimization target. The involved regulators will carefully evaluate the proposed rules and regulations and check whether indeed the expected benefits of the flow based allocation mechanism will be met.

There is an increasing need to strengthen the collaboration among the different TSO initiatives and at the moment successful first steps are taken in that direction regarding Coreso, SSC and TSC. Targets of such collaboration are: finding harmonized rules, improving quality and consistence of data, standardized processes and procedures, possibly also resulting in standardized common tools.
The TSC initiative includes a pilot phase of cross-border coordinated redispatch among TSOs, where the 'requester' principle is used, i.e. the one TSO requesting for redispatch measures, will pay the costs for these measures. One has to keep in mind such a principle should not lead to the situation that no one of the involved TSOs is calling for such measures and that all TSOs are waiting for each other, resulting in possible insecure grid situations.

Meanwhile in the new draft Network Codes the subject of a common grid model has been addressed. The right content and implementation details will still have to be defined and the practical use will have to support operations, market and long term investment processes.

It can be concluded that the European Commission's one Internal Electricity Market (IEM) is stepwise on its way of realization. In today's world several electricity markets are coupled and framework guidelines and target models for the electricity business are under development. One has to keep in mind that facilitating the market is one of the challenges to be met but this should not jeopardize the security of supply.

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