Current challenges for the European Interconnected System and Situation Awareness in Transmission System Operation

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During the past couple of years, the complexity of transmission system operation has increased significantly. Along with the liberalization of the electricity markets a broad range of new, varying tasks have arisen and with this a significant increase of interfaces which the operators in control centres have to cope with. Furthermore the substantial growth of volatile wind and PV energy sources and large-scale energy trades across wide-areas lead to frequently changing load flow situations. As a consequence of these huge load flows, the transmission system is more frequently operated ever closer to its security limits. This situation is further aggravated by recent developments as the so called Nuclear Power Plant (NPP) Moratorium in Germany came in effect as a reaction to the Japanese disaster in Fukushima. The following paper will provide an overview of the current challenges facing Amprion, a German Transmission System Operator in Central Europe, and will present examples of solution approaches, in which the European interconnected electricity system plays a major role and has to be taken into account.

One key challenge in the operation of the electric power systems is the ongoing integration of renewable energy sources (RES) and distributed generation, due to the fluctuating and intermittent behaviour of especially wind power and photovoltaic (PV) generation. Currently almost 30,000 MW of wind power and about 20,000 MW of PV are installed in Germany while conventional power plants sum up to about 100,000 MW and the peakload of Germany is about 85,000 MW. To integrate these large amounts of fluctuating and not controllable energy sources into the grid, accurate forecast systems are essential. Therefore the TSOs developed special prediction tools, transforming meteorological data into an electrical power forecast. To enhance the forecast accuracy an expert system was developed, combining several weather models to a combined prediction, a so called ensemble. The paper will show how the expert tool is used in day-ahead planning and real-time operation, leading to an optimal wind and PV energy forecast.

After the major disturbances 2003 in USA and 2006 in Central Europe, inter-Transmission System Operator (inter-TSO) coordination has increased. For the security analysis regional approaches such as “Wide Area View” (NERC) respectively “Observability Area” (ENTSO-E Region Continental Europe) were introduced (Figure 1) and several regional security initiatives have been founded. This reflects that the operator in the control room has to observe wider, external areas – with less operational experiences compared to the own grid – to fully evaluate system security. Along with the development of information technology and functionality of SCADA systems, the amount of on- and off-line data the operators have to observe has increased significantly. New visualization approaches to deal with the
significantly increasing amount of data are necessary in order to enhance situation awareness in wide area electrical power systems.

One major task of the control centres’ operators is to identify the overall operation state of the power system. This serves as basis for their decision making. The increasing complexity in the power system control centre poses new demands on the visualization concept according to cognitive principles. An analysis of current visualization approaches shows that in most cases these are stand-alone systems, separated from ordinary SCADA system in use. Furthermore the presentation types tend to suite better analysis rather than real-time operation objectives, so cognitive principles are often neglected. Therefore this paper describes an approach, how the increasing complexity can be prepared to assist the operator in the control centre. In addition to the detailed description of the visualization approach, the results of the implementation into the SCADA system of the German TSO Amprion and experiences gained by operators of the control centre will be presented to validate this concept.

In order to deal with the operational challenges in the highly meshed European transmission system, several TSO cooperations in form of security service centres (Coreso, SSC) or the TSO security cooperation (TSC) were established. The overall aim of the TSC initiative is the continual improvement of European transmission system security. TSC follows a decentralized approach, the initiative is illustrated in figure 2. Common IT-platforms were developed and will be presented within this paper.

In order to react quickly in cases of disturbance, a real-time information system with information about the status of the interconnected system was created. The regional real-time awareness and alarm systems (RAAS) - already bilaterally implemented in Central Europe - provides key data from each control area. A system status indicator in form of a traffic light can be set by each TSO.

In order to achieve better situation awareness and to allow alarming depending on the grid status in real-time, the European-wide real-time Awareness System (EAS) is currently under development by ENTSO-E.
In March 2011, the German federal government decided to shut down immediately seven nuclear plants (NPP), in total approximately 8,300 MW. The analysis of the German TSOs shows that in summer and most winter scenarios the additional challenges can be handled by taking additional measures such as: Redispatching of thermal and RES generation, Re-scheduling of maintenance and extension works in the grid, Curtailing of transmission capacities to neighbouring countries and Market interventions by TSOs.

On the other hand, in winter scenarios (cold weather, high load, no RES generation, no import possibility) serious problems may occur – as happened in February 2012: Power Adequacy (Balance of load and generation) for Germany can be endangered, High flows and low thermal generation capacity can lead to violations of current values on lines in (n-1) cases, Voltage problems which could lead to voltage collapse, No additional reserves in grid for common mode failures.

An example of a critical grid situation will be presented within this paper.

In order to improve reactive power supply in Southern Germany, a project was started to rebuild a NPP into a synchronous compensator (phase shifter) for VAR support. After successful implementation the Generator delivers approximately 900 MVAR inductive and 450 MVAR capacitive. The start of operation is February 2012. In this paper first operational experiences of the synchronous compensator in use will be shown.

In this context the TSO plays the key role for Security of Supply.