NAME : Peter Noglik
COUNTRY : Germany
REGISTRATION NUMBER : 5630

GROUP REF. : C6
PREF. SUBJECT : PS2
QUESTION N° : Q2.3

Answer to the question:

Are there any actual challenges or issues in the operation of the power system between the TSO and DSO due to the mass deployment of RES/DER? What were the causes or background consideration in dealing with such issues?
What were or are the proposed solutions to such challenges?

The energy transition from a fossil power plant dominated power system to a system with a high share of renewable energy resources has beside the obvious challenges of e. g. loosing inertia also challenges on the interconnection between TSO and DSO. One assumption, of course, is that the majority of RES will be connected to the DSO's grid, in particular to the medium voltage grid.

Starting from a classic scenario, where load is the dominated factor on the interconnection point, an increasing penetration of RES in the distribution grid will lead in a balance between load and generation inside the distribution grid. The consequence is an almost zero power exchange between DSO and TSO during times with high wind and PV generation. This is in a first glance not a problem for the TSO as the overall load of the transmission grid is reduced. On the other hand, system stability issues can arise in the scenario, when almost all DSO's do not exchange power. In this case conventional power plants connected to the transmission grid must be shut down because there is simply not enough load. This is a very extreme scenario, as usually for example cities will not be "self-powered" and still will be large loads. Other issues like short circuit capabilities, protection and so forth have to be addressed by the TSO.

During further evolvement of the energy transition, the penetration of RES will increase to the level, where a more or less constant revert load flow from the DSO to TSO is reached. Beside the system stability issue different overload scenarios, but not limited to, can be expected:

- DSO internal congestions like overvoltage and line overload
- Overload of the transformer between TSO and DSO because of overplanting
- Line overload in the transmission system

One solution for the first two problems is to control the RES in case of congestions. This redispatch of RES is basically a curtailment based on different rules depending on grid codes and regulation. This can lead in high costs under different regulation and markets. In Germany, for example, the curtailed amount of energy must be compensated by the TSO. The purpose of the law is to ensure that the owner of the RES does not suffer losses because the TSO has not expanded its grid. In recent years, this has led to costs of one billion EURO. To avoid additional cost for redispatch of conventional power plants, the redispatch itself should not be done in real time, but in a predictive manner. The DSO should run a predictive load flow for the next 24h or 48h. Based on this prediction, congestions are detected, and measures can be planed. The result is a schedule for all connected RES and the interconnection point. With this result the TSO can start his day ahead planning to avoid redispatch on short notice. In case of congestion inside the TSO-grid based on this forecast, the TSO can ask the DSO to adjust the schedule on the interconnection point. This feedback loop also tackles problem three. Controllable loads can also be considered. However, this strongly depends on the distribution of loads and renewables in the grid.

Another option to avoid transformer and line overloads on TSO side is to use a MVDC-Back-to-Back converter, which horizontal connects two medium voltage grids. With this converter the HV/MV-transformer and sub-transmission level are bypassed, and the energy flow between both grids is controlled by the MVDC-link. Another advantage is the possibility to inject reactive power into both grids to adjust voltage. Of course, this solution is only practical if the connection is between a generator and load driven grid and if there is already a MV-connection with a normal open point for N-1 safety reasons between both stations. In this case the grid expansion and therefore high costs on high voltage level can be avoided. In any case a cost benefit assessment (CBA) must be carried out as such converter have still high costs. This CBA must be done for each project separately and cannot be generalized like “If the sub-transmission line is longer than x km a MVDC is lower in price”. Things like landscape, existing lines, necessary power rating, etc. are playing an essential role as well as OPEX costs.