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Implementation of grid forecasting processes at TenneT: from strategic planning to after-the-fact analysis

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SUMMARY

The Dutch Transmission System Operator TenneT TSO B.V. is responsible for the Dutch electricity grids with voltages of 110 kV to 380 kV. The company is required to guarantee the Security of Supply at all times, and must comply with both national and international legislation and agreements.

Historically, the transmission system operator's tasks were to:

- guarantee the secure(according to the N-1 criterion) and efficient transmission of electricity across all grids;
- schedule outages;
- identify and resolve operational risks and constraints;
- maintain the power balance for the Dutch grid;
- control the voltage and reactive power;
- resolve disturbances in the transmission of electricity;
- compensate for grid losses.

Economic efficiency and market facilitation are prompting an increase in interconnection capacity between European countries, together with optimization of asset utilization. Besides operating their own networks, TSOs must collaborate and coordinate with each other. This includes managing network interconnections across different control areas, in particular neighbouring grids. The total capacity of connections with the Dutch grid has increased with the arrival of the NorNed (2008) and BritNed (2011) cables, and will increase still further once the planned additional interconnector to Germany comes in use. The connected grids make considerable use of renewable energy sources.

These developments have a significant impact on the operation of the transmission system. In recent years, therefore, the focus has shifted to:

- facilitating Central-West European (CWE) and North-Western European (NWE) market coupling;
- coordinating with other TSOs and exchanging information through integration into international processes as TSO Security Cooperation (TSC) and the European Awareness System (EAS).

Forecasting processes by means of offline grid analysis is one of the core business processes by which TenneT meets these requirements. Various computational tools and network models were used in the past. In 2008, projected future requirements and the integration of the Dutch 110 kV and 150 kV grids

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into TenneT triggered the development of a single offline power system analysis platform that combined all tools. Commercially available software was customized to create an environment dedicated to TenneT's forecasting processes.

The first step was to implement outage planning and day-ahead forecasting (load flow, N-1 contingency analysis and the creation of DACF files). Later functions included facilitating marked coupling (D-2CF), congestion management and grid losses calculations. The Intraday congestion forecast process (IDCF) became operational in 2012. This process provides operators with a fully automated network security forecast from h-1 to a configurable numbers of hours ahead. Simplification and automation were required, in order to give the operator enough time to access grid calculation results and prepare curative remedial actions (RAs) or to take preventive RAs. However, forecasting grid processes in a timeframe closer to real time increased the demands on the systems.

The aim of this paper is to provide an insight into the complexity of implementing and integrating these processes given the requirements, the IT infrastructure and the needs of the various user groups. The emphasis is on those processes close to real time, where the complexity of the solution increased. It addresses the most important design and implementation aspects from TenneT's demand-side perspective and provides an overview of best practices. The paper ends with a summary of future developments based on TenneT's roadmap.

KEYWORDS

Forecasting – Power System Analysis – Grid Model – Operational Planning – Capacity Assessment – Day Ahead Congestion Forecast – Intraday Congestion Forecast – Offline Calculation – Enterprise Service Bus – ESB.

OPERATIONAL PLANNING PROCESSES

TenneT distinguishes a number of forecasting processes (see Figure 1), each with a different time horizon. Predictions made in close to real time are more accurate as more details on outage schedules, load and generation forecasts and foreign grids are known. However, if predictions are obtained closer to real time there is less time for analysis and there are fewer options for remedial actions.

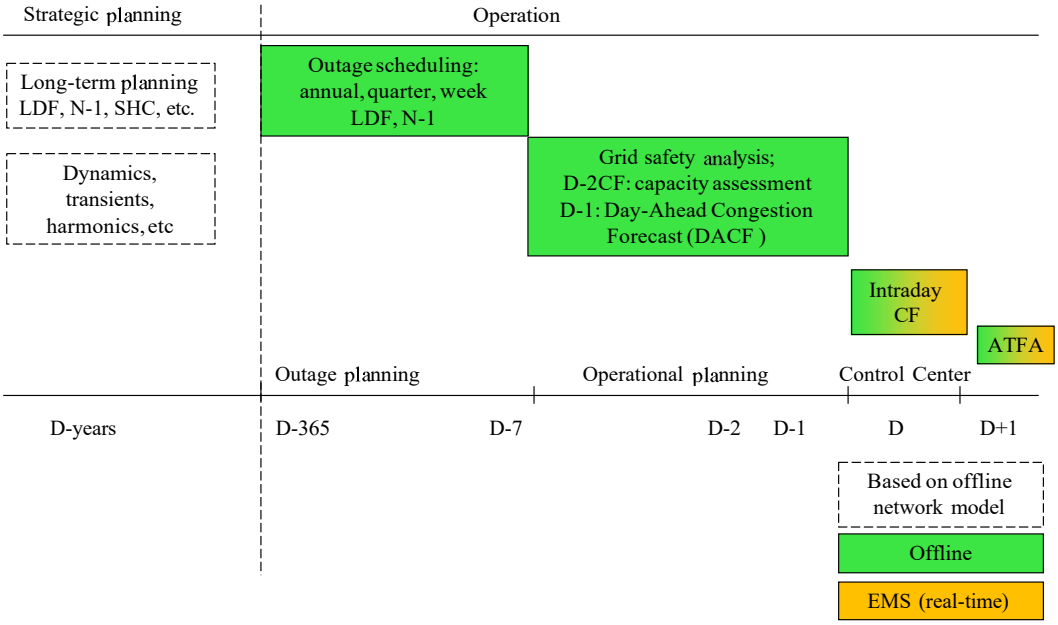

Figure 1: *Overview of TenneT grid analysis business processes. EMS is used for real-time calculations. Most processes are carried out by separate user groups.*

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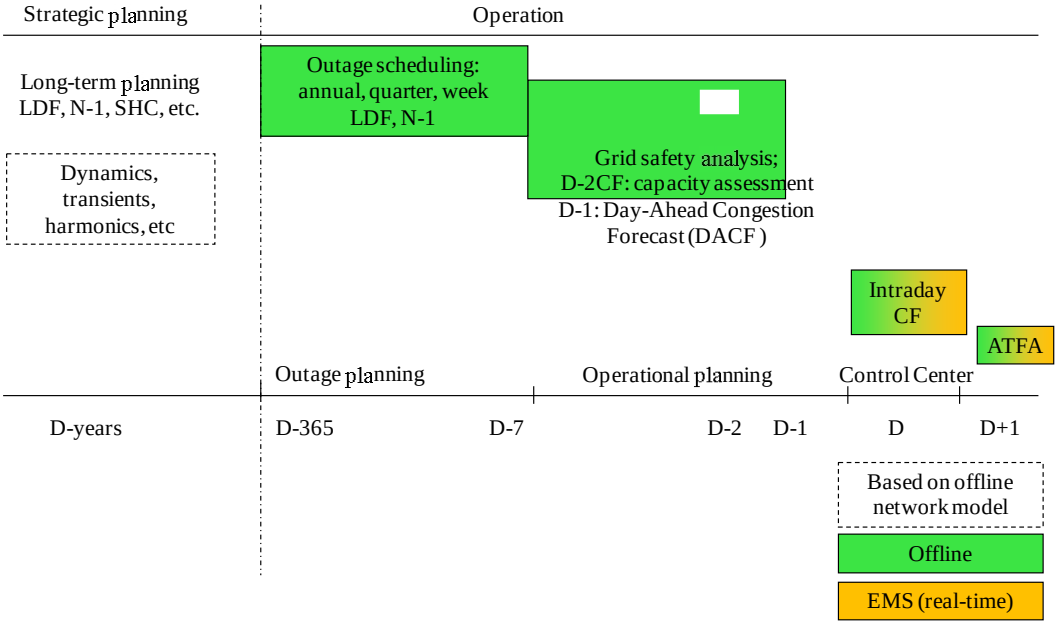

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