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Advanced inter TSO Voltage-VAR Scheduler for coordinated voltage control

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Voltage situations with extremely high voltages as well as highly volatile voltages mainly caused with integration of RES in the southeast European region are causing serious operational challenges in the Slovenian and Croatian transmission grids. In order to address those challenges ELES and HOPS have started a common SINCRO.GRID project. The project aim is to solve the problem of overvoltages and optimize operation in both grids in a coordinated and sustainable manner. It includes deployment of new voltage and reactive power control devices and implementation of a Virtual Cross-Border Control Center (VCBCC) for their control. The latter is important, because only by coordinated voltage control which enables full exploitation of new devices and efficient voltage regulation, system operation cost could be reduced. In addition to the newly installed voltage control devices, the VCBCC control scheme shall seamlessly integrate existing devices with voltage regulation capability already in operation at ELES and HOPS.

The main goal of the VCBCC project is bringing the voltage profile to a secure level allowing connection of more renewables, distributed generation and other critical users to the grid. The concept of the coordinated voltage control envisions three hierarchical levels of voltage control:

1. **Local device control**: primary voltage regulation performed by device controller (as automatic Q, U, tap or switch on/off control) at the grid connection point or on one of connecting nodes in case of transformer with OLTC.
2. **VVC (intra TSO Voltage-VAR Control)**: secondary voltage controller performing real-time local voltage optimization considering constraints from the VVS.
3. **VVS (inter TSO Voltage-VAR Scheduler)**: tertiary voltage control, providing coordination of regulating devices between multiple TSOs considering cross-coupling effects.

The discussion in this paper will focus on the VVS algorithm, which will have a superior role in optimizing ELES and HOPS grids. It will perform time coupled voltage optimization in a coordinated way by considering both forecasted grids models and a predefined set of constrains. The results will be calculated voltage profiles with respect to the requirements of ELES and HOPS at any given moment.

An optimization algorithm is the integral part of VVS. The core of the VVS optimization process will be Neplan's Multi Period Optimal Power Flow (MPOPF) module. Thanks to the time coupling characteristic of the MPOPF, it will be possible to find the optimal solution for the whole optimization period and not only for each time stamp individually. The MPOPF will enable to enforce time coupling constrains such as number of tap changer operations etc.

The optimization will be running on multiple grid models, each representing a grid condition at various (sequential) time instances (hours) in a selected timeframe in the future. For example, expected day-ahead operations consecution can be described by introducing 24 grid models with implemented topology/generation/load changes on hourly basis. The task of the VVS Optimization Process would be to optimize these 24 grid models with reference to a given set of optimization criteria. The optimization results will be checked in real-time by the VVS Validation process. Once validated, the results will be delivered to the local VVC algorithm for execution. While VVS optimization process will run just once per hour, the VVS validation will be performed more often (up to once every 5 minutes) with the most recent and accurate input data.