

Introduction

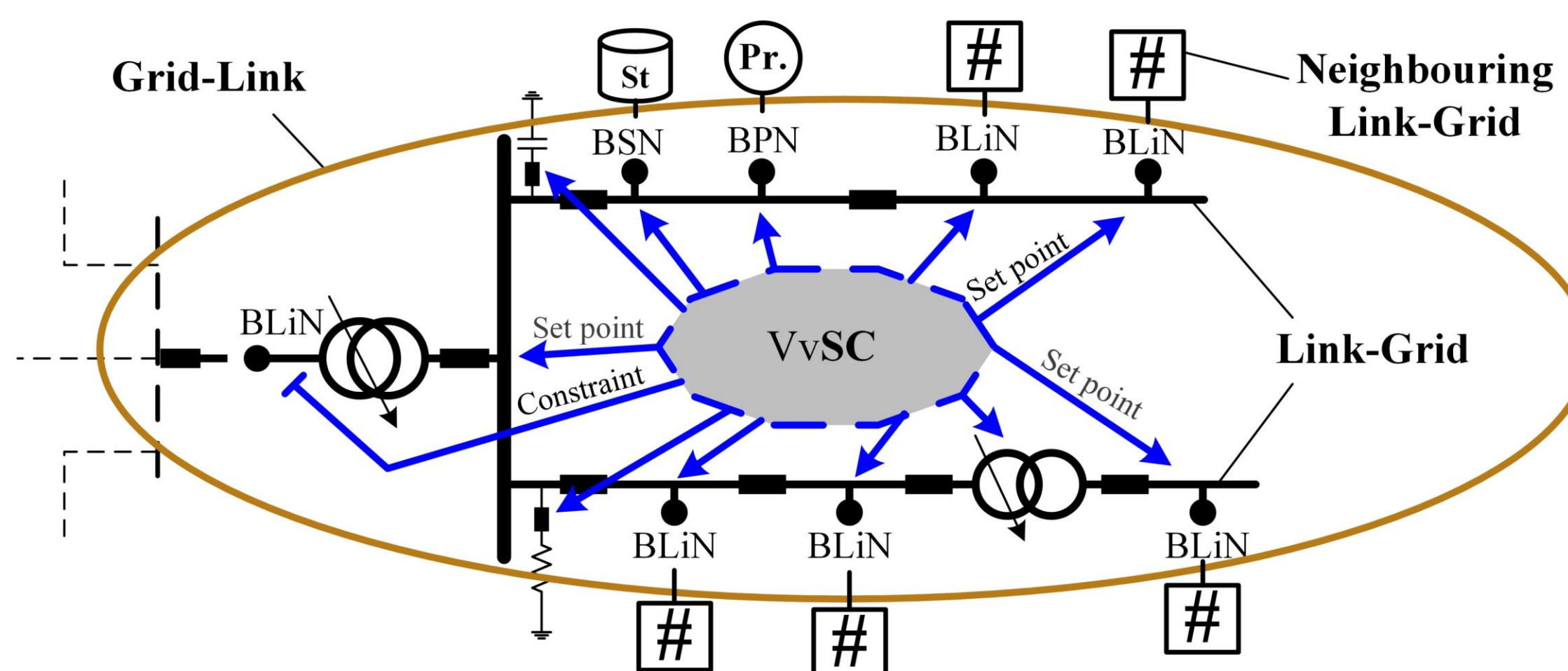
European DSOs have to maintain the voltages at the customer plants' (CP) connection points within $\pm 10\%$ around the nominal value. Smart Grids verify voltage limit compliance online by calculating the voltages at the MV level and checking them against constant limits. The limits are set to imply safety margins for the LV level.

Methodology

The *LINK*-based holistic architecture is used to extend the conventional lumped model of LV grids by a new parameter: the Boundary Voltage Limits (BVL).

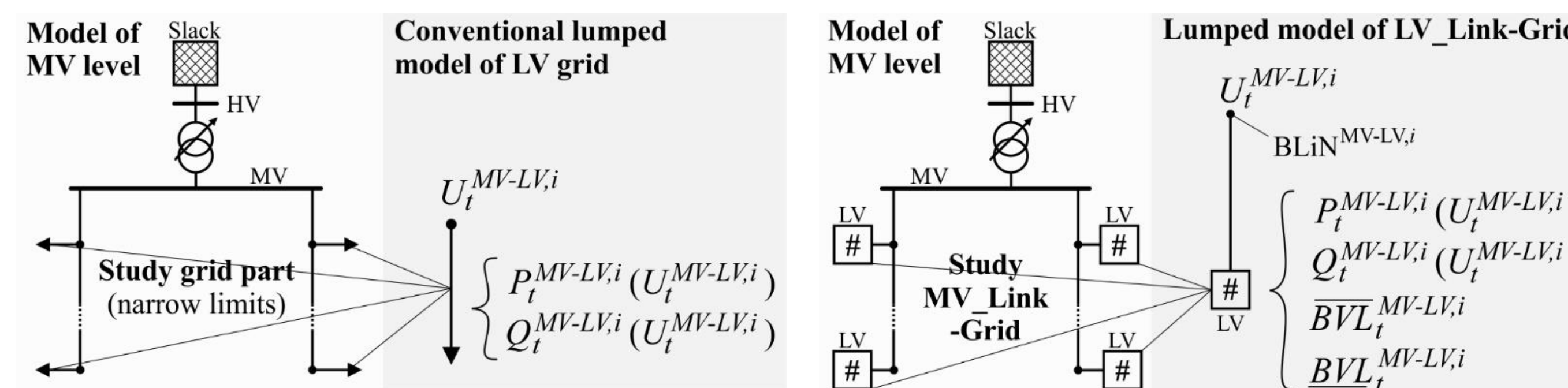
Modelling based on *LINK*-Architecture

LINK-Architecture divides the power system into chains of Grid-, Producer- and Storage-Links, interconnected via Boundary-Link- (BLiN), -Producer- (BPN), and -Storage-Nodes (BSN). The Grid-Link's Volt/var secondary control (VvSC) calculates set-points for the available control variables by respecting static and dynamic constraints.



Conventional lumped LV grid model

This model represents for each instant of time the corresponding $P_t(U_t)$ and $Q_t(U_t)$ behaviour. The voltage of each MV node is checked against time-constant limits to verify limit compliance at the LV level.

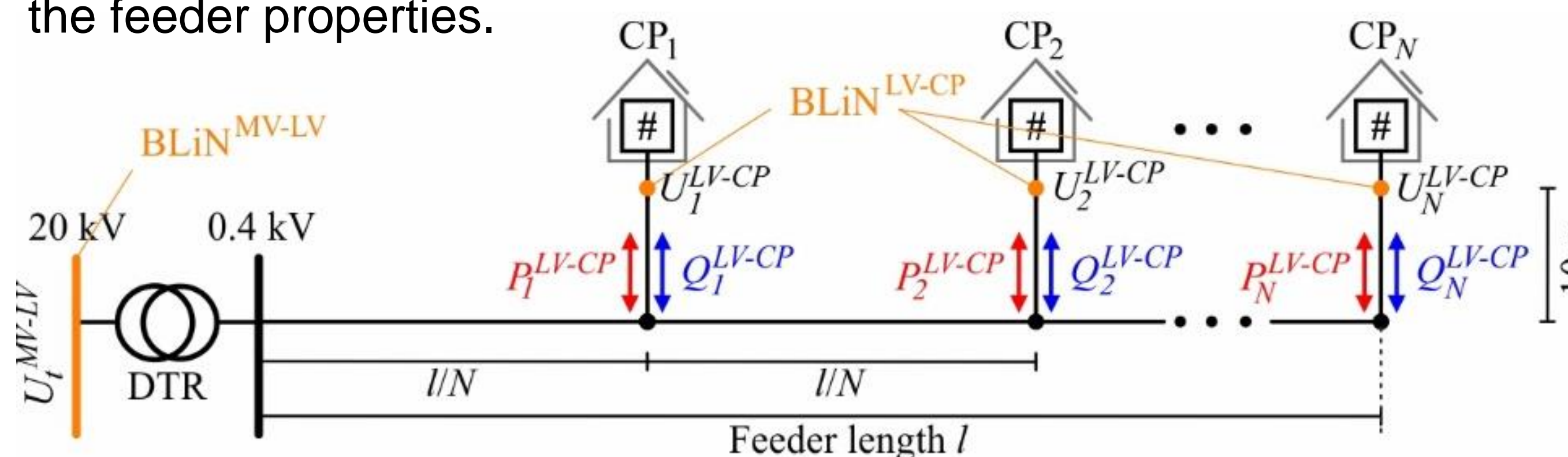


Lumped LV Link-Grid model

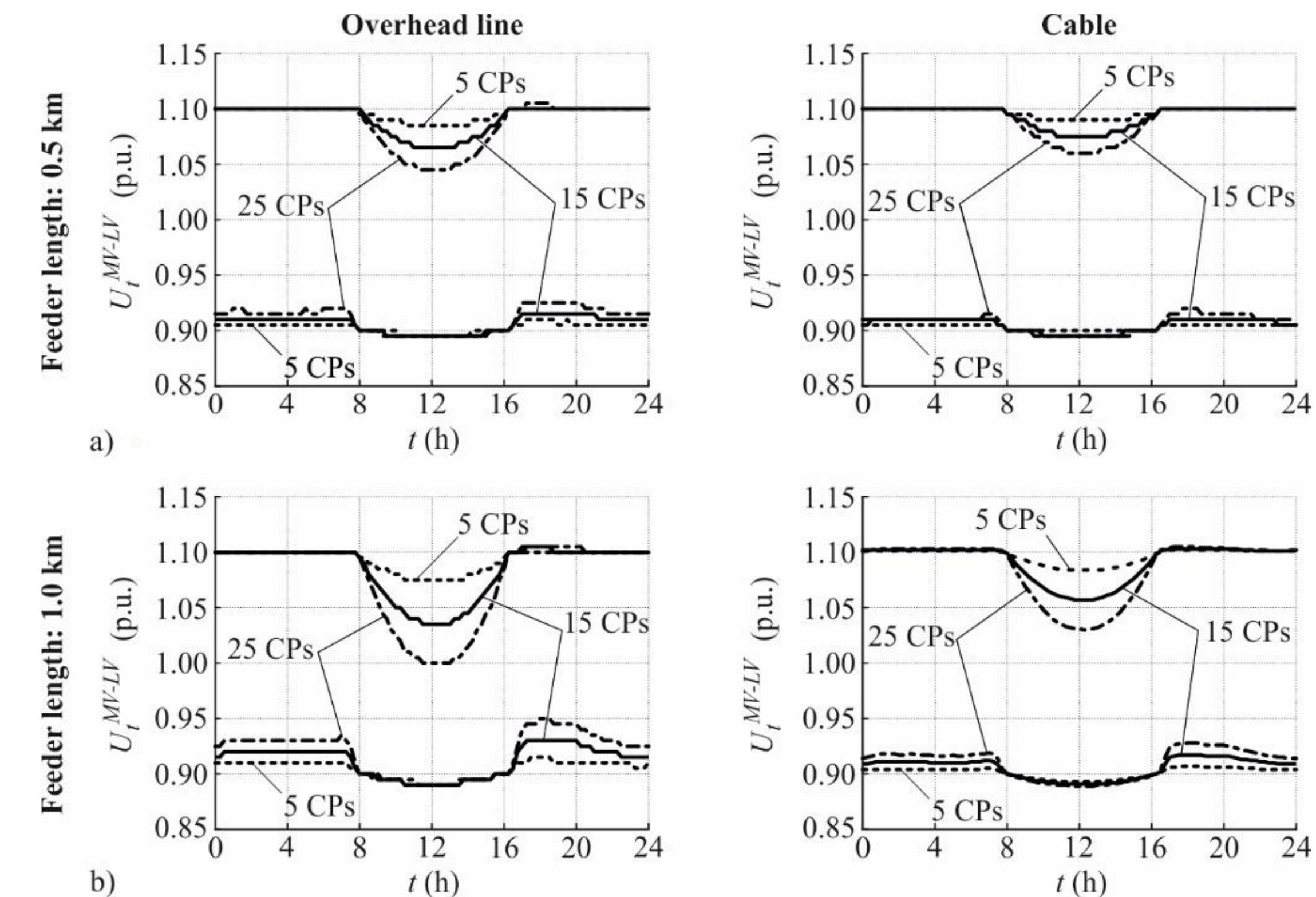
The conventional lumped model is extended by variable upper and lower BVLs that pertain to the corresponding BLiN. Their compliance guarantees that no limit violations occur within the represented LV-Link-Grid.

Impact of LV feeder properties on BVLs

The BVL^{MV-LV} of the test LV grid are calculated to analyse the impact of the feeder properties.

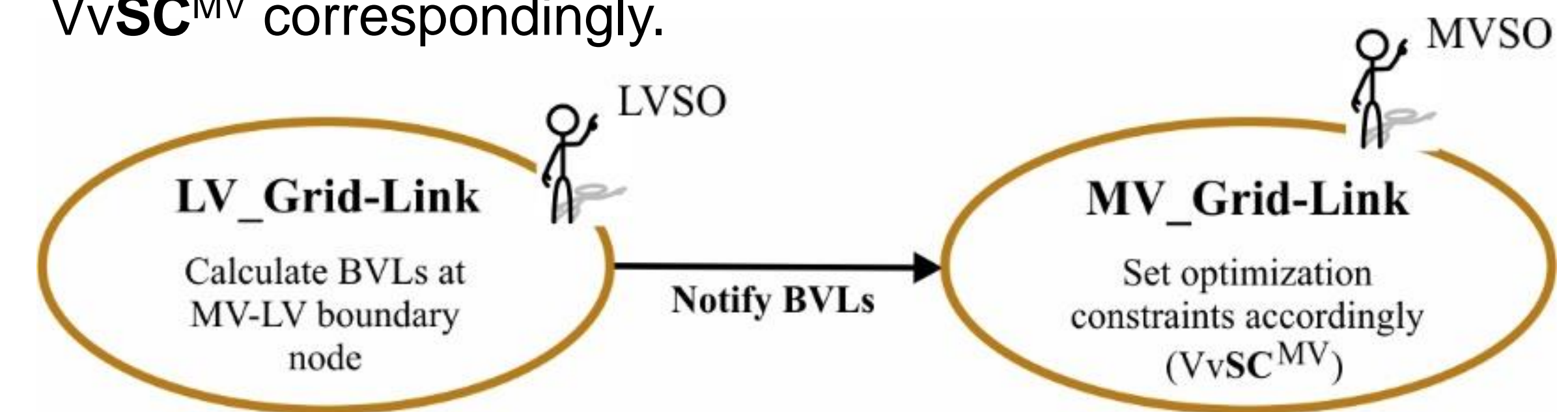


The greater the LV feeder's impedance and the more CPs are connected, the more intensive is the deformation of the BVL^{MV-LV} .



Use Case: Notification of Boundary Voltage Limits

The LV_System-Operator (LVSO) calculates the BVL^{MV-LV} , e.g. in real-time or day-ahead, and notifies them to the MVSO. The MVSO sets the optimization constraints of its $VvSC^{MV}$ correspondingly.



Conclusion

Using constant voltage limits to check the power flow results is inaccurate. Boundary voltage limits allow verifying voltage limit compliance in LV level by calculating load flows in MV level. They increase the Smart Grids' operational efficiency.