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Automated Optimal Placement of Distribution Substations for Future Supply Tasks

The necessary electrification of the mobility and heating sector and integration of distributed energy resources as part of the energy transition to achieve a zero-carbon society is causing frequent technical limit violations (TLV) in distribution networks. The capacity of existing distribution substations (DSS) is often exceeded, necessitating network separation. To optimize the network separation, this contribution introduces an automated approach for optimal placement of new DSS within large-scale low-voltage network areas. It minimizes total costs and civil engineering measures. It therefore also reduces the environmental impact of network expansion.

The approach identifies optimal DSS positions by combining spatial data and network conditions such as existing network topology and TLV (transformer overloads, line overloads and voltage violations). Initially, the spatial data is used to identify potential positions for placement of new DSS. The approximated costs for fixing TLV are determined for each DSS and feeder. The reduction in costs for each potential DSS position are determined considering the proximity to overloaded DSS and feeders. This cost-reduction is offset against the costs for construction and integration of the new DSS, resulting in net savings. After selecting the position with the highest net savings, remaining TLV are updated for all proximate DSS and feeders. This process continues iteratively until no positions with positive net savings remain.

After determining the optimal positions, DSS are integrated into the network topology by performing a reconfiguration that separates affected networks around the new DSS. Two setups of automated planning for the network area are compared regarding total costs and length of needed line measures: One using the base topology and another incorporating the new DSS. The results prove effectiveness in not only reducing total costs but also necessary civil engineering measures.

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Figure 1: Promotional Logo BMWK

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