Masterarbeit

UNIVERSITÄT DUISBURG ESSEN

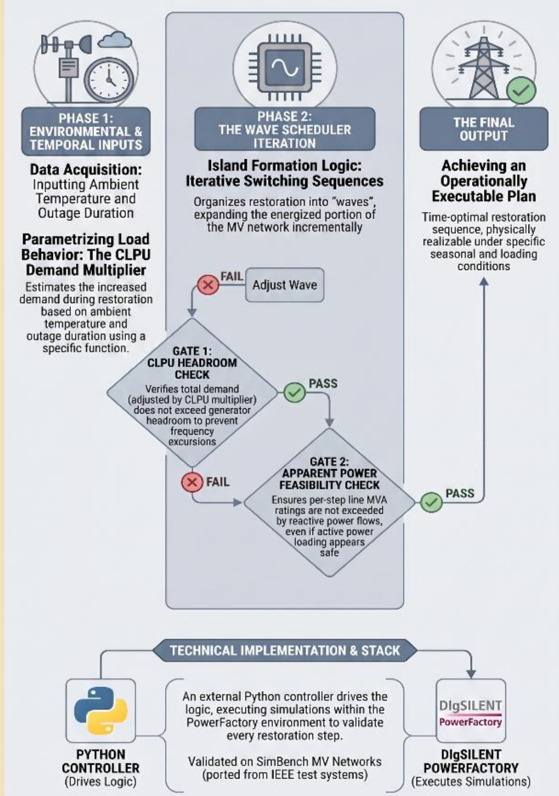
Offen im Denken

Fachgebiet für Elektrische Energiesysteme (EES)

Constraint-Aware Black-Start Restoration Planning for Medium Voltage Networks with High Renewable Penetration

The increasing penetration of distributed renewable energy sources in medium voltage networks introduces significant challenges for post-blackout restoration planning. Existing graph-based restoration algorithms optimize island formation and switching sequences primarily on the basis of active power availability and topological switching time. Two additional constraints need to be systematically considered: cold load pickup (CLPU), whereby thermostatically controlled loads reconnect simultaneously after a prolonged outage and demand power well above their rated steady-state values, risking generator overload and frequency excursions; and line apparent power limits, which can be violated during restoration due to reactive power flows even when active power loading appears within bounds.

This thesis extends an existing weather-adaptive, wave-scheduled black-start restoration algorithm by embedding the technically critical feasibility constraints directly into the switching sequence logic. A CLPU demand multiplier, parametrized as a function of outage duration and ambient temperature, is to be incorporated. A per-step apparent power feasibility check as extension to the power balance constraint is introduced to verify that line MVA ratings are not exceeded. SimBench medium voltage benchmark network, implemented in DIgSILENT PowerFactory with an externally interfaced Python controller is modelled and validated across multiple weather and seasonal loading scenarios.



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