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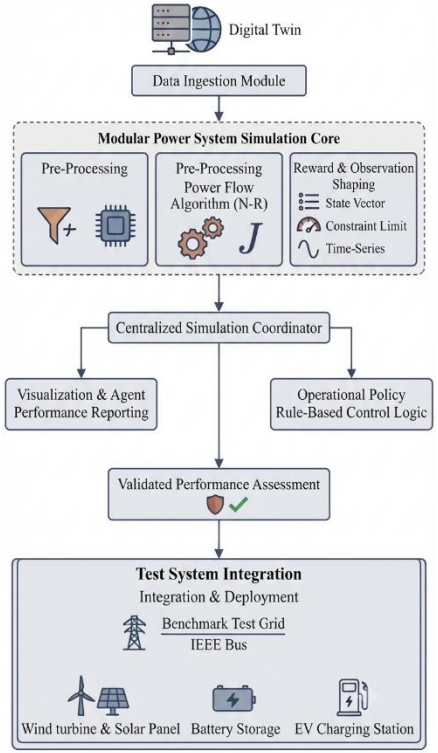
Offen im Denken

Fachgebiet für Elektrische Energiesysteme (EES)

Engineering a Modular Simulation Framework for Power Flow Analysis

The integration of decentralized energy resources and the increasing complexity of modern power grids have made accurate grid planning and operational management more critical than ever. In the context of *Smart Grids* and *Digital Twins*, power flow analysis serves as the core computational engine for ensuring system stability. Due to the non-linear nature of grid equations, numerical solvers—specifically Newton-Raphson and its variants—often face convergence challenges or yield physically infeasible solutions. Consequently, managing system stability under dynamic loading conditions has become a primary operational challenge.

This thesis aims to develop a robust, modular simulation environment to systematically analyze the behavior of these iterative methods. By leveraging Python and the pandapower framework, the environment integrates standardized datasets from SimBench to investigate how solvers respond to varying initial conditions and strict physical constraints, such as voltage bands and thermal limits. The final outcome is a validated simulation tool capable of rigorous algorithmic performance assessment across diverse grid topologies.



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