

Project Title: Fair and Efficient Optimization of Distribution Grid Interconnection Queues Using Flexible Connection Agreements

Project Type: Master Thesis or Semester Project

Project Description: Distribution grids are facing rapidly increasing connection requests from distributed energy resources such as solar PV, batteries, EV charging infrastructure, heat pumps, and electrified industrial loads. Many distribution system operators still rely on sequential or first-come-first-served interconnection processes, which can lead to long queues, inefficient use of grid capacity, and delays for technically viable projects. Recent policy and research discussions highlight the need for improved queue management [1], digitalized interconnection studies, hosting-capacity tools, and flexible/non-firm connection agreements [2]. This thesis will investigate how distribution-grid interconnection queues can be optimized by combining grid-impact assessment, project prioritization, and flexible connection agreements. Instead of granting only firm connections or processing requests strictly in queue order, the project will explore whether dynamic or curtailable connection rights can increase the number of connected projects while maintaining network security and fairness.

The main objective is to develop and test an optimization-based framework for managing distribution-grid interconnection queues under technical network constraints. The project will address the following research question: *How can a distribution system operator allocate scarce grid capacity among queued DER projects while balancing connection speed, network feasibility, curtailment risk, fairness, and upgrade cost?*

Key tasks during the project:

1. Literature review and problem formulation,
2. Simulation environment setup: IEEE test feeder,
3. Baseline queue management implementation,
4. Fair and efficient optimization scheme formulation and simulation,
5. Performance evaluation.

Useful skills software:

- Good knowledge of power-system analysis and distribution grids.
- Programming experience in Python.
- Interest in optimization, power-flow modelling, and DER integration.
- Familiarity with tools such as pandapower, OpenDSS, or Pyomo is desirable.

- Basic understanding of mathematical optimization, especially linear programming, mixed-integer programming, or optimal power flow, is an advantage.

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Reference:

[1]. From Backlog to Breakthrough Managing Connection Queues in Distribution Networks, <https://www.eurelectric.org/publications/from-backlog-to-breakthrough-managing-connection-queues-in-distribution-networks-vf2/>

[2]. Managing connection queues in distribution networks with flexible connection agreements <https://publications.jrc.ec.europa.eu/repository/handle/JRC140137>