Dynamic Management of Power Distribution System

Industrial Use Case

HEP ODS d.o.o.

Electric distribution grid

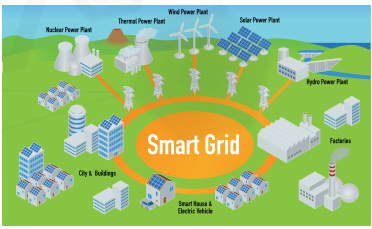
- Grid of the city of Koprivnica (Croatia)
- Cooperative management of consumers and producers
- Reduction of energy losses guaranteeing grid stability

Context

Electrical power distribution system:

- The increasing penetration of distributed generation and storage in electrical power distribution systems will have a significant impact on the power grid operation in the near future.
- If managed properly, distributed generation and storage can help to improve the security of energy supply and lead to a better operation of the overall system.

Objective: Optimal dynamic management of electrical power distribution systems with distributed generation and storage.



Determine the optimal power references for distributed generators and storages while satisfying all system constraints and taking into account the system dynamics.

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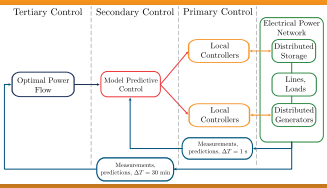
Challenge

- The underlying optimal power flow (OPF) problem is very difficult to solve due to its non-convex constraints.
- It can be solved via convex relaxation approaches but not fast enough to capture the generator dynamics.
- It needs to be extended to include slower power dynamics of storage units and to provide a coordinated system-wide actuation that is able to reconfigure the topology of the distribution network.
- The load invariability at the faster time-scale needs to be taken into account.

Proposed Solution

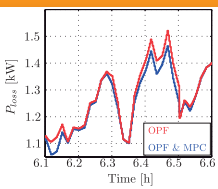
A three layer hierarchical control structure:



Centralized hierarchical control structure.

The proposed scheme works as follows:

- At the upper level a dynamic OPF solver with low sampling rate computes the optimal power references for distributed generators and storages.
- These references are transmitted to the intermediate level, where a faster model predictive control (MPC) algorithm computes deviations from power references given by the OPF solver taking into account the load variability at a faster time-scale than the upper level.
- Finally, the power references are forwarded to the primary level where local controllers track the power reference values computed by the upper layers.



The dynamic management generally results in smaller cumulative losses compared to classic OPF Management.