DTU Compute
Department of Applied Mathematics and Computer Science

# MSc Thesis Project: Optimized power grid operation with high shares of Renewable Energies

**Section for Dynamical Systems (DYNSYS)**

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**TAGS (projektbank.dtu.dk, section web-site):** DYNSYS, Poulsen, uGrip, Model Predictive Control, Stochastic Programming

**Primary study lines:** Mathematical Modeling and Computing, Optimal Control, Stochastic Programming & Dynamic Programming, Applied and Engineering Mathematics

## Possible Projects:

**Project background.** "The growing share of intermittent and partly predictable renewable energy sources (RES) requires a more flexible operation of the power system. Flexibility is a key to maximize the utilization of RES, while minimizing the negative impact of their associated variability and uncertainty. An effective way of increasing system flexibility is the integration of price-responsive microgrids" [ERA16].

*uGrip*[1] is an *European Research Area (ERA-NET)* project in the field of optimal grid operation at the lower voltage level (microgrids). *DTU* in this project focuses on the analysis of operating strategies, modeling of microgrid elements, modeling of uncertain parameters and simulations in the context of microgrids.

**Project description.** Price-responsiveness can be incorporated by means of a market entity managing the portfolio of e.g. energy producing units and participating in electricity markets utilizing the portfolio. This market entity is denoted as *Aggregator*, as this entity places lumped bids for the whole portfolio. As such the microgrid can be perceived as *Virtual Power Plant* (VPP).
Flexibility in operational means of a power system can be described as degrees of freedom. Given high shares of RES, we deal with systems that are to great extent driven by stochastic processes. We aim to drive the system within operational boundaries whilst optimizing its economical performance (operational costs, arbitrage, ...). Advanced control strategies such as Model Predictive Control and a control architecture designed for the rejection of disturbances at various levels are employed for achieving this goal.

This approach involves among others forecasts, stochastic programming techniques, activation of the demand side and optimal bidding. Furthermore, good knowledge of the current state of the system and its boundaries is needed in order to maximize the available flexibility within the system.

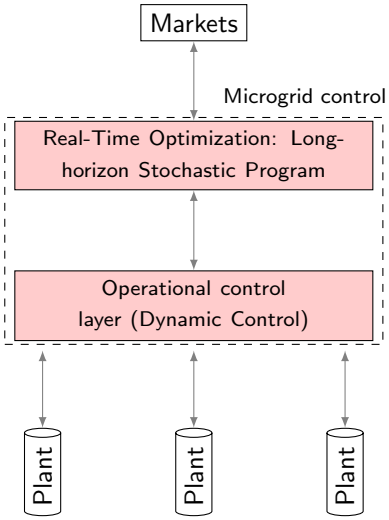


Figure 1: Simplified control structure: Lower control hierarchies receive set points decided upon information available to higher levels.

**Project aim.** The scope of the project may be in the areas of:

- Stochastic Programming for long-term optimal power grid operation (Real-Time Optimization layer)
- Model Predictive Control (Dynamic Control layer) with a focus on power system control
- Due to that this project naturally incorporates a broad range of aspects, other topics may be interesting as well.

**Collaborations.** *FER-UNIZG Zagreb* and other *uGrip* project member organizations.

## References

[ERA16] ERA-Net Smart Grids Plus. *Microgrid Positioning (uGrip) Project Description*. 2016.

[1] Compare: uGrip Homepage (http://www.ugrip.eu/uGRIPProject.html)