Project title: MPC of distributed energy storage for a smarter grid

Background

The distribution grid in most electricity markets face increasing challenges due to increasing intermittent power generation from renewable energy resources at the distribution grid level as well as to varying peak load demand. The challenges are related both to operational grid quality issues and to capacity investment issues. One mean to support the operation of the distribution grid and to minimize the investment costs can be to exploit distributed energy storage resources such as batteries in combination with intelligent power conversion and control. The Norwegian company Eltek is a global industrial solution provider for complete systems for power conversion, storage and control for applications especially related to telecom. A telecom operator can operate thousands of base stations with batteries for power back-up. By coordinating and controlling a large number of such storage sites for more intelligent charging and dis-charging, the owner of the distributed storage can obtain an economic benefit and the grid operator can get a support to a 'smarter' and more reliable grid.

This project would provide insight into a 'hot', global market opportunity related to smart grids and renewable energy where advanced control theory is essential and there are relevant Norwegian industrial technology providers.

Opportunity and challenge

The specific opportunity to explore in this project would be:

- How could a telecom operator exploit their distributed back-up power batteries to benefit from electricity tariff variations and other relevant incentives by: Optimizing the charging and dis-charging of the batteries subject to various constraints?

Challenges to solve could be:
- How to specify the economic objective function for the telecom operator?
- How to model the various constraints and cost functions,- e.g. the cost of charging and dis-charging cycles of the batteries?
- How to model the predictions of: the local telecom loads, and the incentives/tariffs
- How to develop a control strategy to manage up to 3000 sites to optimize the objective function? A Model Predictive Controller (MPC) is suggested.

Project tasks

- Describe the potential business opportunity of a telecom operator with distributed energy storage
- Describe the state-of-art of coordinated control of such distributed energy storage
- Develop an objective function, system model and relevant constraints
- Develop a control strategy to optimize the use of such distributed energy storage
- Analyse the suggested control strategy by simulations in the cases of:
    - Control of the charging of the batteries and dis-charging to local telecom load, only.
    - Control of the charging of the batteries and dis-charging also back to the grid, in addition to the local telecom load (i.e. a bi-directional power flow).

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