PHD THESIS

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Grid integration of variable speed hydro power plant

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Background

As the share of wind and solar energy production increases, more flexible production and loads are required to control the balance of the grid. A potential use of Variable Speed Hydro Power (VSHP) is to provide this flexibility and compensates the production of variable renewables. The hypothesis is that VSHP can offer additional ancillary services, contributing to the frequency regulation and improving the grid stability, allowing for higher penetration of renewables in the grid.

The advantages compare to conventional pumped-storage hydro power with constant rotational speed is better utilization of the rotation energy in the turbine and generator and improved power control in pumping mode. The efficiency and operating range of variable speed hydro power will also be higher and they can contribute in frequency control both in production and pumping mode.

The focus of the PhD work will be to investigate the interactions between the VSHP plant and the grid, and how variable speed operation can benefit the security and flexibility of the power system operation. The main research task will be to explore the control possibilities from a system perspective while considering the limitations given by the water/turbine system. This comprise development of non-linear time domain simulation models with limitations for water flows in the tunnel, turbine, governor, generator with magnetizing system, generator-side converter and grid-side converter, and a representatively test grid.

Different methods for virtual inertia control methods will be investigated for damping of power fluctuation. Also new control schemes for coordinated control of governor, synchronous generator and grid converter considering limitations given by the water and turbine system and will be developed and optimized for a system perspective.