The Modeling and Controller Design of a Microgrid

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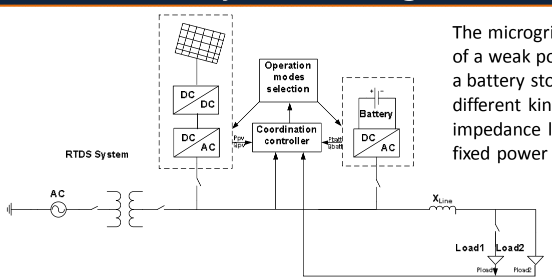
Introduction

The objective of this work is to assess the benefits of coordinating controller actions to the design of power electronics control systems under varying and uncertain conditions. Focus is on-

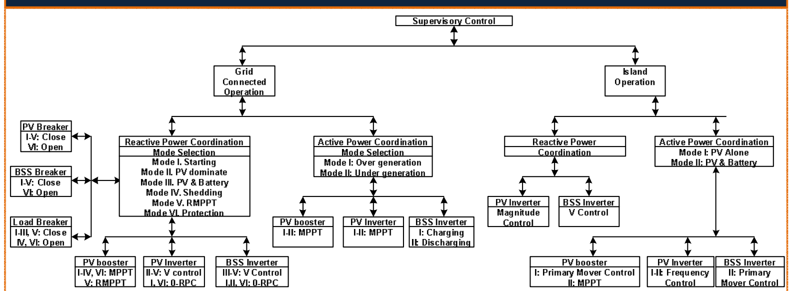
- The development of comprehensive control methodologies that will enable the GTC system to operate stably and reliably.
- The development of control tools for enabling non-synchronous connections. This work includes island operation with renewable sources and batteries.
- The development of MPC that will capture the maximum wind energy as well as provide desired reactive power

System Configuration



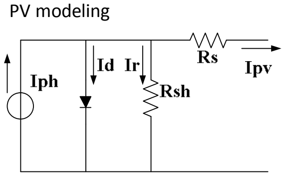
The microgrid system is consisted of a weak power grid, a PV system, a battery storage system, and two different kinds of loads: a fixed impedance load and a controllable fixed power load.

Coordinated Controller

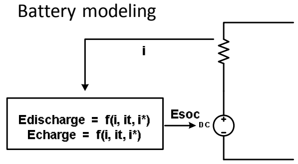


PV and Battery Modeling

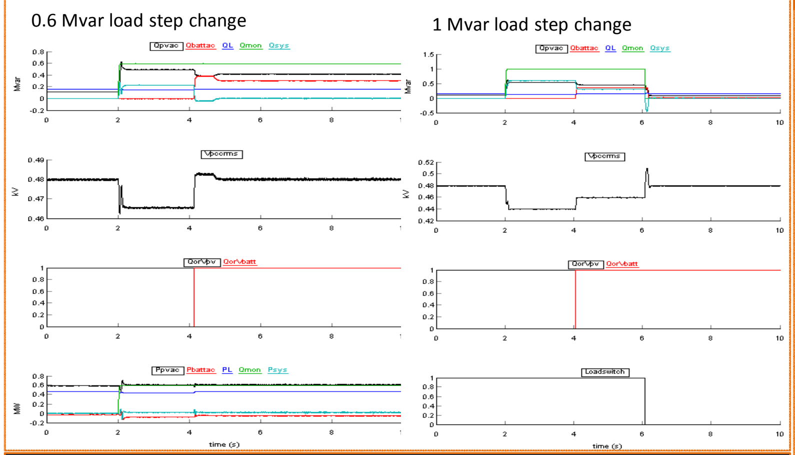
PV modeling



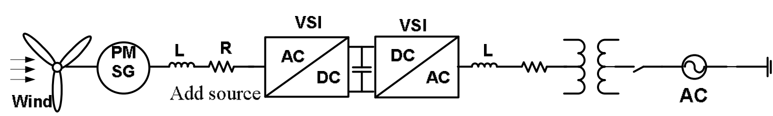
Battery modeling



Coordinated Controller Test in Grid-connected mode

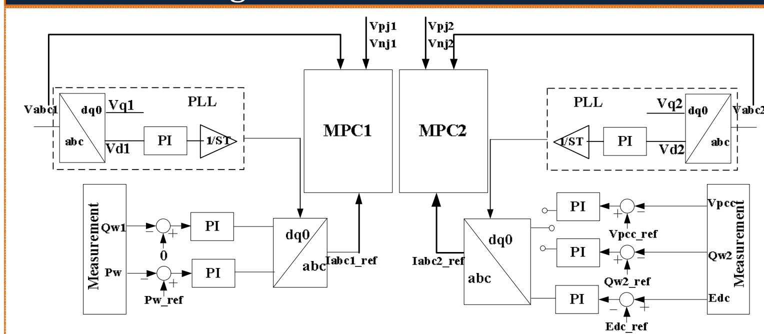


Direct Drive Wind Turbine Modeling



$[illegible] = \frac{1}{2} [illegible]$ $\quad [illegible] = \frac{[illegible]}{[illegible]} = \frac{1}{2} [illegible]$

MPC Design of Wind AC-DC-AC Converter

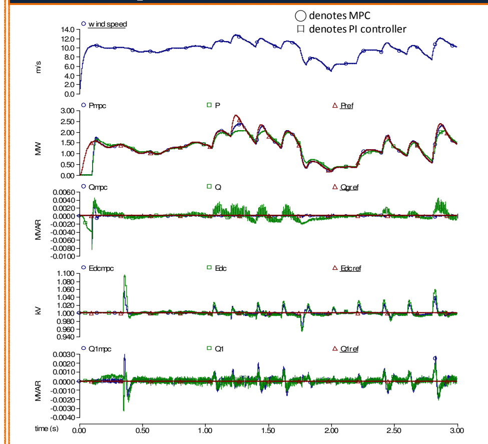


$$V_{jk} + L\frac{di_{jk}}{dt} + Ri_{jk} + V_{pjk} = \frac{E_{dc}}{2}$$

$$V_{jk} + L\frac{di_{jk}}{dt} + Ri_{jk} - V_{njk} = \frac{E_{dc}}{2}$$

[illegible] and [illegible] are the voltage and current of the VSI of wind converter respectively, [illegible] and [illegible] are the upper and lower bridge voltage respectively, jk denote phase-j of VSI-k, and [illegible] is the dc bus voltage.

Comparison Between MPC and Optimized PI Controller



Conclusion

- The proposed coordinated controller can mitigate both active and reactive power disturbances caused by the intermittency of renewable resources and load change.
- The MPC in wind converter increases the accuracy of maximum wind energy capture as well as minimizes the power oscillation.

Future Work

- Use genetic algorithm to find the optimum control parameters of the controllers of distributed generation inverters.
- Enhance coordinated control scheme to be predictive and adaptive to improve the performance of the system.

Reference: Junbiao Han, Sarika Khushalani-Solanki, "Modeling and Coordinate Controller Design of A Microgrid System in RTDS", PESGM, 2013

Software Ability

MILSOFT Utility Solutions, PSCAD, MathWorks SIMULINK, SIEMENS PSS®E, OpenDSS, PowerWorld Corporation