DEPARTMENT OF ELECTRICAL ENERGY, METALS, MECHANICAL CONSTRUCTIONS AND SYSTEMS

Nezmin Kayedpour, Narender Singh, Jeroen De Kooning, Guillaume Crevecoeur, Lieven Vandeveld

BEOWIND – OFFSHORE WIND FARMS AS AN ANCILLARY SERVICE PROVIDER

Introduction

- Global wind power capacity was estimated at 591 GW at the end of 2018 with 51.3 GW added in 2018 itself
- Wind energy attracts more investment than all other renewable energy sources combined
- Traditional power systems consisted of large synchronous generators. These machines use their rotating inertia to overcome deviations in system frequency
- Power systems with high renewable penetration tend to have low inherent capability for inertial response.
- As a result of low synchronous reserve, in 2016 South Australia witnessed a blackout that affected 1.7 million people alongside incurring huge economic loss
- In order to avoid such events, power utilities are now beginning to impose strict grid codes for wind parks grid integration
- Hydro-Québec, a power utility has set up ancillary requirements for wind parks such as: a wind park with rated output > 10 MW must be equipped with frequency control system

BEOWIND Objectives

- This project aims to investigate the possibility of offshore wind parks providing ancillary services such as:
  - Frequency Control Reserve (FR)
  - Automatic frequency restoration reserve (AFR)
  - Manual frequency restoration reserve (MFR)
  - Voltage regulation using reactive power
  - Dynamic grid stability support
- Model based and data driven approach to develop an advanced control system for wind turbines

Wind farm control structure with the prime research concern of the grid integration

- Wind farm control level decides the control strategies upon transmission system operator request and sets the wind turbines operating references based on the wind farm topology and wake interactions of wind turbines
- Local supervisor optimal control objectives are to track the optimized power reference and to alleviate the structural load on the wind turbine’s blade and tower
- Low level control units are responsible of slow dynamic control (control of speed and power, pitch control) and fast dynamic control (electrical control of generators/rectifier current) of the wind turbines

Physical modelling approach

Integration of detailed wind turbine models in FAST with advanced control schemes in Simulink

Data driven model-based optimal control and system identification

- The dynamic model of wind turbines can be identified using measured data
- The optimization algorithm can iteratively test control settings on the model to find the model-predicted optimal operation point

Future work

- Development of elaborate power system models based on the Belgian grid to study the behavior of offshore wind farms and their ability to provide ancillary services
- Developing wind farm control based on the classification of operating reserves
- Developing model-based optimal controller using nonlinear system identification
- Optimizing operating reserve using time series prediction of wind and load

Contact

nezmin.kayedpour@ugent.be
narender.singh@ugent.be

Universiteit Gent
@ugent
Ghent University

*The BEOWIND project is funded by the Energy Transition Fund of the Belgian federal government