Grid fault and design-basis for wind turbines - Final report

This is the final report of a Danish research project “Grid fault and design-basis for wind turbines”. The objective of this project has been to assess and analyze the consequences of the new grid connection requirements for the fatigue and ultimate structural loads of wind turbines. The fulfillment of the grid connection requirements poses challenges for the design of both the electrical system and the mechanical structure of wind turbines. The development of wind turbine models and novel control strategies to fulfill the TSO’s requirements are of vital importance in this design. Dynamic models and different fault ride-through control strategies have been developed and assessed in this project for three different wind turbine concepts (active stall wind turbine, variable speed doubly fed induction generator wind turbine, variable speed multipole permanent magnet wind turbine). A computer approach for the quantification of the wind turbines structural loads caused by the fault ride-through grid requirement, has been proposed and exemplified for the case of an active stall wind turbine. This approach relies on the combination of knowledge from complimentary simulation tools, which have expertise in different specialized design areas for wind turbines. In order to quantify the impact of the grid faults and grid requirements fulfillment on wind turbines structural loads and thus on their lifetime, a rainflow and a statistical analysis for fatigue and ultimate structural loads, respectively, have been performed and compared for two cases, i.e. one when the turbine is immediately disconnected from the grid when a grid fault occurs and one when the turbine is equipped with a fault ride-through controller and therefore it is able to remain connected to the grid during the grid fault. Different storm control strategies, that enable variable speed wind turbines to produce power at wind speeds higher than 25m/s and up to 50m/s without substantially increasing the structural loads, have also been proposed and investigated during the project. Statistics in terms of mean value and standard deviation have been analysed and rainflow calculations have been performed to estimate the impact over the lifetime of a variable speed wind turbine.