Abstract

The German government aims to install 6.5 GW of offshore wind power until 2020. Due to the large distances from shore, most of the windfarms will be connected to the German transmission system via High-Voltage Direct-Current Links (HVDC-Links). Electrical transient processes are potentially significantly more distinct if a windfarm is operated at a HVDC-Link than at an onshore grid connection point. Processes in wind farms nearby and in the system of the HVDC-Link influence the power quality of the grid connection as well as processes inside the windfarm, such as faults, switching operations done during maintenance and repair works or certain weather situations. Switching operations are identified to cause transients, which on short term can influence the production of the wind farms and on long-term may overstress the equipment. This stress can be of electrical or mechanical nature.

The aim of the thesis was to develop a suitable model of the offshore grid, as it is common in the German North Sea. The grid consists of the HVDC-Converter, the subsea cables, the switchgears, the transformers and shunt reactors. For the model, generic data about the equipment from the Trianel Windpark Borkum was used. The model is verified based on existing measurements done at Trianel Windpark Borkum. With the parametrized model, the switching transients during transformer energization are examined. Special focus is laid on the influence of the on load tap changer and the point on wave switching devices. To overcome the problem of an unknown remnant magnetization of the transformer core after de-energizing, different approached for a ‘smart de-energization’ are examined. The investigations show, that the transformers stray capacities as well as the connected substation cables, do not lead to a suitable swing circuit. The offshore specific grid connection consists of the connecting submarine high voltage cable, and a reactive power compensating shunt reactor. With this circuit, the time constants and frequency of the ring down transient are suitable to demagnetize the core sufficiently. Concluding it can be said, that the three measures to reduce the switching transients on transformer energization could successfully be analyzed with the developed model.

Keywords: Offshore grid, electromagnetic transients simulation, dynamic model, inrush current, switching transients mitigation, demagnetization.