Grid-connection of large offshore windfarms utilizing VSC-HVDC: Modeling and grid impact

Utilization of Voltage Source Converter (VSC) – High Voltage Direct Current (HVDC) systems for grid-connection of large offshore windfarms becomes relevant as installed power capacities as well as distances to the connection points of the on-land transmission systems increase. At the same time, the grid code requirements of the Transmission System Operators (TSO), including ancillary system services and Low-Voltage Fault-Ride-Through (LVFRT) capability of large offshore windfarms, become more demanding. This paper presents a general-level model of and a LVFRT solution for a VSC-HVDC system for grid-connection of large offshore windfarms. The VSC-HVDC model is implemented using a general approach of independent control of active and reactive power in normal operation situations. The on-land VSC inverter, which is also called a grid-side inverter, provides voltage support to the transmission system and comprises a LVFRT solution in short-circuit faults. The presented model, LVFRT solution and impact on the system stability are investigated as a case study of a 1,000 MW offshore windfarm grid-connected through four parallel VSC-HVDC systems each with a 280 MVA power rating. The investigation is carried out on a complete, validated model of the west Danish, with some elements of the north German, 400 kV, 220 kV and 150 kV transmission systems stage 2005–2006 using the DiSILENT PowerFactory simulation program. The use of such a complete, validated power system model is among novelties of this work on utilization of VSC-HVDC systems for grid connection of large offshore windfarms. In the investigation, a thermal power plant just south to the Danish border has been substituted by the 1,000 MW offshore windfarm with the VSC-HVDC system. The investigation has shown that the substitution of a thermal power plant by a VSC-HVDC connected large offshore windfarm should not have any negative impact on the short term stability of the west Danish transmission system. It is proposed to repeat the investigation applying updated system model stages and offshore wind power commissioning schedules in the North and Baltic Seas.