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Addressing intra-area oscillations and frequency stability after DC segmentation of a large AC power system

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Abstract-

Several events have shown that electromechanical oscillations are a major concern for large interconnected Alternating Current (AC) power systems. Segmentation of AC power systems with High Voltage Direct Current (HVDC) systems (DC segmentation, for short) turns large AC grids into a set of asynchronous AC clusters linked by HVDC links. It is a promising solution to mitigate electromechanical oscillations and other issues. In particular, an appropriate placement of DC segmentation can stop a selected inter-area electromechanical oscillation mode. However, without supplementary controllers, DC segmentation will not contribute to the damping of the intra-area oscillation modes in the remaining AC clusters and frequency stability of the overall system will deteriorate. This paper studies the use of DC segmentation with HVDC systems based on Voltage Source Converters (VSC-HVDC) with active and reactive power supplementary controllers in the converter stations. The former were tailored for frequency support among the asynchronous AC clusters and the latter for Power-Oscillation Damping (POD-Q) of the intra-area oscillation modes. The proposed supplementary controllers and their design will be presented, and their efficiency will be demonstrated on the Nordic 44 test system with DC segmentation by means of non-linear time-domain simulation and small-signal stability analysis.

Index Terms- HVAC/HVDC; Voltage source converter; VSC-HVDC; Power system stability; DC segmentation; Power-oscillation damping; POD-Q; Frequency control

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