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Generalized model of vsc-based energy storage systems for transient stability analysis

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Abstract-

This paper presents a generalized energy storage system model for voltage and angle stability analysis. The proposed solution allows modeling most common energy storage technologies through a given set of linear differential algebraic equations (DAEs). In particular, the paper considers, but is not limited to, compressed air, superconducting magnetic, electrochemical capacitor and battery energy storage devices. While able to cope with a variety of different technologies, the proposed generalized model proves to be accurate for angle and voltage stability analysis, as it includes a balanced, fundamental-frequency model of the voltage source converter (VSC) and the dynamics of the dc link. Regulators with inclusion of hard limits are also taken into account. The transient behavior of the generalized model is compared with detailed fundamental-frequency balanced models as well as commonly-used simplified models of energy storage devices. A comprehensive case study based on the WSCC 9-bus test system is presented and discussed.

Index Terms- Battery energy storage (BES), compressed air energy storage (CAES), electrochemical capacitor energy storage (ECES), energy storage system (ESS), power system dynamic modeling, superconducting magnetic energy storage (SMES), transient stability.

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