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A simplified algorithm to solve optimal power flows in hybrid VSC-based AC/DC systems

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Abstract— High Voltage Direct Current systems based on Voltage Source Converters (VSC-HVDC) are increasingly being considered as a viable technology with advantages, above all when using underground or submarine cables, for bulk power transmission. In order to fully understand how VSC-HVDC systems can be best used within existing power systems, it is necessary to adapt conventional tools to carry out system-wide studies including this technology. Along this line, this paper proposes a simplified algorithm to solve optimal power flows (OPFs) in hybrid VSC-based Alternating Current/Direct Current (AC/DC) grids with multi-terminal VSC-HVDC systems. The proposed algorithm makes it possible to seamlessly extend a previous large-scale AC case to which several multi-terminal VSC-HVDC systems must be added. The proposed approach combines two ideas used previously in two different modelling approaches: each VSC is modelled as two generators with a coupling constraint; and DC grids are modelled as notional AC grids, since, in per unit, the equations for the former are a particular case of the latter with resistive lines and no reactive-power injections. In the proposed approach, the hybrid VSC-based AC/DC system is transformed into an equivalent only-AC system. Therefore, the OPF solution of the AC/DC system can be found with the same tool used for the previous AC problem and a simple extension of the original case.

Index Terms— VSC HVDC; HVDC transmission; Multi-terminal; Optimal power flow; Power systems

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