Large-scale provision of frequency control via V2G: The Bornholm power system case

This paper assesses the impact of electric vehicles (EVs) providing primary frequency regulation via vehicle-to-grid (V2G) technology. The aim of the work is to define a set of recommendations in order to guarantee a stable large-scale deployment of EV fleets as primary reserve providers. A realistic fleet model is proposed, which emulates the aggregated response of a number of EVs characterized by V2G hardware response times derived in laboratory tests. The effects of primary frequency control via EV fleets replacing conventional generating units are assessed with a sensitivity study in a single-bus power system with growing fleet sizes and response times. Two recommendations are derived to guarantee safe and stable operation: Recommendation 1 requires the share of EVs providing primary reserve to be smaller than the reserve from conventional units; Recommendation 2 requires response times below a given limit value, calculated as a function of the following power system parameters: the system inertia, the total primary reserve over the rotating generation capacity, and the employed droop gain. The full 60kV power system of the Danish island of Bornholm is then employed to evaluate the validity of the proposed requirements on a real system with complex dynamics, non-linearities and voltage dependencies.

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