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An aggregate model of plug-in electric vehicles for primary frequency control

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Abstract— The penetration level of plug-in electric vehicles (PEVs) has the potential to be notably increased in the near future, and as a consequence, power systems face new challenges and opportunities. In particular, PEVs are able to provide different types of power system ancillary services. The capability of storing energy and the instantaneous active power control of the fast-switching converters of PEVs are two attractive features that enable PEVs to provide various ancillary services, e.g., primary frequency control (PFC). However, concurrently, PEVs are obliged to be operated and controlled within limits, which curbs the grid support from PEVs. This paper proposes a new model for PEV using a participation factor, which facilitates the incorporation of several PEV fleets characteristics such as minimum desired state of charge (SOC) of the PEV owners, drive train power limitations, constant current and constant voltage charging modes of PEVs. In order to reduce computational complexity, an aggregate model of PEVs is provided using statistical data. In the end, the performance of PEVs for the provision of PFC is evaluated in a power system. Results show that PEV fleets can successfully improve frequency response, once all the operating constraints are respected.

Index Terms— Battery chargers; electric vehicles; frequency control; modeling

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