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Evaluation of aggregate models of plug-in electric vehicles for primary frequency control

S. Izadkhast, P. García-González, P. Frías, P. Bauer, L. Ramírez-Elizondo

Abstract— This paper summarizes and evaluates in detail aggregate models of plug-in electric vehicles (PEVs) for primary frequency control (PFC) through dynamic simulations. A basic aggregate model of PEVs for PFC is introduced and then gradually developed in the following steps: i) technical characteristics of PEVs are incorporated into the model, ii) technical characteristics of distribution networks are formulated and added, and iii) a strategy is described to well-design the frequency-droop controller of PEVs for PFC. Moreover, from an economic point of view, a method is presented to assess the benefits which could result from PEVs for PFC. Four simulation scenarios are defined to evaluate the impact of: 1) different PEV's penetration levels, 2) PEV's operating modes and constraints, 3) power consumed in the network during the PFC, and 4) well-designed frequency droop controller, on the frequency response following a contingency event. Simulation results show that aggregate PEVs have a great potential not only to improve the frequency response, while preserving the overall stability, but also to save some costs associated with PFC.

Index Terms— Aggregation, Distribution Networks, Economic Assessment, Plug-in ElectricVehicles, Primary Frequency Control, Strategy, Technical Constraints,Well-Design Droop.

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