IEEE Transactions on Power Systems. Volume:32. Number: 6. Pages: 4241-4254. November 2017

Design of plug-in electric vehicle's frequency-droop controller for primary frequency control and performance assessment

S. Izadkhast, P. García-González, P. Frías, P. Bauer

Abstract— This paper describes a novel strategy to design the frequency-droop controller of plug in electric vehicles (PEVs) for primary frequency control (PFC). To be able to properly compare the frequency response of control system with and without PEVs, the design is done to guarantee the same stability margin for both systems in the worst case scenario. To identify the worst case, sensitivity analyses are conducted on a large set of system parameters performing eigenvalue analysis and bode plots. Three main contributions are included in this work: (i) we demonstrate that PEVs using the well-design droop controller significantly improve the PFC response while successfully preserving the frequency stability, (ii) since the fast response of PEVs may cause to mask the governor-turbine response in conventional units, a novel control scheme is developed to replace some portion of PEV's reserve after a certain time by the reserve of conventional units during PFC, and (iii) a method is proposed to evaluate the positive economic impact of PEV's participation in PFC. For the latter, the system PFC cost savings mainly through the avoidance of under frequency load shedding by PEVs are calculated. A large-scale power system and an islanded network are evaluated and compared through dynamic simulations, which illustrate the validity and effectiveness of the proposed methodologies.

Index Terms— Design strategy, economic performance, frequency-droop controller, plug-in electric vehicle (PEV), primary frequency control (PFC), stability margin, under frequency load shedding (UFLS).

Citation:
Izadkhast, S.; García-González, P.; Frías, P.; Bauer, P.; "Design of plug-in electric vehicle's frequency-droop controller for primary frequency control and performance assessment", IEEE Transactions on Power Systems, vol.32, no.6, pp.4241-4254.

November, 2017.