Accepted Manuscript

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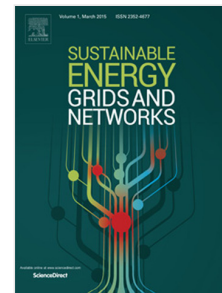Please cite this article as: Y.A. Alhazmi, M.M.A. Salama, Economical staging plan for implementing electric vehicle charging stations, *Sustainable Energy, Grids and Networks* (2017), http://dx.doi.org/10.1016/j.segan.2017.02.001

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Economical Staging Plan for Implementing Electric Vehicle Charging Stations

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Abstract— **This paper proposes an economical staging planning method that optimally matches Plug-in Electric Vehicle (PEV) charging demand with the installation of Fast Charging Stations (FCSs) in the distribution system. The proposed plan consists of two stages. The first stage evaluates the capability of distribution systems to supply PEV charging demands with the existence infrastructure. To investigate the influence of using different types of charging (i.e. Level 2, Level 3), PEV demand is distributed between residential and public charging facilities with different shares considering the travel patterns when modeling PEV loads. Optimal Power Flow (OPF) analysis is utilized to obtain the maximum penetration level of PEVs that the existing distribution system can adapt without any technical violations. In the second stage, the growth of public PEV demand is optimally matched by the installed FCS capacity using the economical staging plan model. By including the waiting and the service times of charging service, the proposed planning model considers not only the economic assessment of the FCS plan but also the quality of FCS service. A comprehensive case study for coupled transportation and electrical networks is examined. The results show that no major distribution system upgrades are required to serve public PEV demand, up to a 30% penetration level, during the early stage of adoption. The influence of using FCS to allocate and manage the PEV demand is illustrated, and the current work provides to FCS investors a means to evaluate the profitability of such a business.**

Keywords: **Plug–in Electric Vehicles; Fast Charging Stations; Penetration Level; Economical Staging Plan; Queuing System**