World Academy of Science, Engineering and Technology
International Journal of Energy and Environmental Engineering
Vol:11, No:09, 2017

Designing Ecologically and Economically Optimal Electric Vehicle Charging Stations

Authors : Y. Ghiassi-Farrokhfal

Abstract : The number of electric vehicles (EVs) is increasing worldwide. Replacing gas fueled cars with EVs reduces carbon emission. However, the extensive energy consumption of EVs stresses the energy systems, requiring non-green sources of energy (such as gas turbines) to compensate for the new energy demand caused by EVs in the energy systems. To make EVs even a greener solution for the future energy systems, new EV charging stations are equipped with solar PV panels and batteries. This will help serve the energy demand of EVs through the green energy of solar panels. To ensure energy availability, solar panels are combined with batteries. The energy surplus at any point is stored in batteries and is used when there is not enough solar energy to serve the demand. While EV charging stations equipped with solar panels and batteries are green and ecologically optimal, they might not be financially viable solutions, due to battery prices. To make the system viable, we should size the battery economically and operate the system optimally. This is, in general, a challenging problem because of the stochastic nature of the EV arrivals at the charging station, the available solar energy, and the battery operating system. In this work, we provide a mathematical model for this problem and we compute the return on investment (ROI) of such a system, which is designed to be ecologically and financially optimal. We also quantify the minimum required investment in terms of battery and solar panels along with the operating strategy to ensure that a charging station has enough energy to serve its EV demand at any time.

Keywords : solar energy, battery storage, electric vehicle, charging stations
Conference Title : ICRESS 2017 : International Conference on Renewable Energy Sources and Sustainability
Conference Location : Istanbul, Türkiye
Conference Dates : September 28-29, 2017