Chapter 16

Feasibility Study of Renewable Energy Integrated Electric Vehicle Charging Infrastructure

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ABSTRACT

This chapter presents a detailed study of renewable energy integrated charging infrastructure for electric vehicles (EVs) and discusses its various aspects such as siting requirements, standards of charging stations, integration of renewable energy sources for powering up charging stations and interfacing devices between charging facilities and smart grid. A smart charging station for EVs is explained along with its essential components and different charging methodologies are explained. It has been recognized that the amalgamation of electric vehicles in the transportation sector will trigger power issues due to the mobility of vehicles beyond the stretch of home area network. In this regard an information and communication technology (ICT) based architecture may support EVs management with an aim to enhance the electric vehicle charging and energy storage capabilities with the relevant considerations. An ICT based solution is capable of monitoring the state of charge (SOC) of EV batteries, health and accessible amount of energy along with the mobility of EVs.

INTRODUCTION

Concept of smart cities envisages diffusion of plug-in hybrid electric vehicles that utilize electric power to run. Electric vehicles have gained attention of various researchers and stake- holders evaluating their potential benefits such as zero carbon emission and reducing dependency on fuel for the greater penetration of plug-in hybrid electric vehicles. Penetration of PHEV/EVs will definitely help overcome likely shortage of oil resources due to tremendously increasing consumption of fuel. In order to have acceptable market of electric vehicles, charging infrastructure is required to be deployed optimally keeping focus
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on cost concerns. An economic deployment of charging stations added with low costs onboard power electronics along with vehicles’ battery technology may be the major certain factors in the success of electric mobility i.e. PHEV running. While building charging infrastructure, a care is to be taken that charging stations’ standards and power rating must be synchronized with the type of electric vehicle. It is estimated that the sale of EVs is expected to increase as high as 64% by 2030. As per the expectations, making diffusion of EVs practicable, in future, more focus is needed to be paid on the development of appropriate charging facility for EVs recharging. Concentration of the present research community is to reduce recharging time of vehicle’s battery by supplying fairly high voltage & current rating.

However, high power supply to charging station may cause grid stability problem during high demand hours so it may require additional power generation to satisfy the power demand during peak load hours (Gil & Taiber, 2014). Therefore, impact of charging station load on the power grid and rate of vehicle charging is to be taken into account carefully while designing the charging station. Additionally, in view of optimal development of charging infrastructure, various energy storage technologies such as batteries, super capacitors, flywheels and etc. are under evaluation contributing in optimization of EV charging station. Simultaneously, distribution power generation (DPG) has received wide attention because of its advantages in terms of attention cutting down transmission investment, decreased operating cost and less losses in transmitting electric power with the improved grid stability during peak hours (Begovic, Pregelj, Rohatgi & Novosel, 2001; Lasseter, 2006). However, DPG system must stop its operation in case a power system failure is determined otherwise it may add negative impact on the power grid (ISC Committee, 2003). In this regard, concept of micro-grid has emerged to ensure reliable operation of the power grid (Tuttle & Baldick, 2012). In order to support economic deployment of EVs, mileage of e-vehicles needs to be enlarged and utilities may be required to design power infrastructure around the recharging station rescheduling provision of supply offering high quality of service in terms of reliability, continuity, low delay, and security.

With the advent of EVs, will be a rising need for technologies that achieve an intelligent and improved management of all energy resources. Technologies based strategies such as demand based pricing are assumed to be effective in dynamic shapes of power usage. Demand based pricing of power is anticipated to become the typical mechanism for pricing in smart grids to uphold the system secure and unfailing at low cost. From the user’s viewpoint an EV is the most promising electric load in this assimilated optimization practice of energy resources due to its high power requirements and bidirectional (V2G) features. An accurate identification of EVs features such as parking status, location, and its energy storage capacity are vital to devise an efficient algorithm. In the residential consumers’ perspective, the key goal is cost reduction. Though, for the utilities, following objectives are of extreme importance; deployment and costs reduction, load balancing, mitigation of distribution losses and operation of grid reliability. In this wake, Information and Communication Technology (ICT) based solutions obtain and archives the relevant feature and objectives. All the information will be utilized in amalgamation with the dynamic tariffs, preferences of users and requirements of comfort in terms of operation of appliances through appropriate algorithms that will deliver optimized choices in a household energy management systems (EMS).

In view of limited EV driving range, a significant research is concentrated on EV wireless charging with an aim of extending the driving range of EVs. Assuming scenario of a highway that connects two main cities with one EV charging lane. This charging lane has many charging mats beneath the road. When an EV reaches a charging mat, it will be wirelessly recharged for that moment. In this regard, a few
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