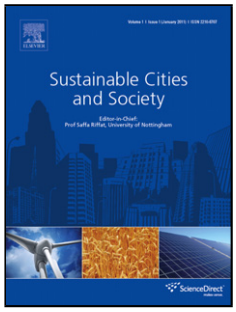

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Simultaneous Allocation of Electric Vehicles' Parking Lots and Distributed Renewable Resources in Power Distribution Network

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***Abstract*— Electric vehicles (EVs) and distributed renewable resources (DRRs) are introduced to achieve three of the most pivotal objectives of this century: using environmentally-friendly energy resources, reliable supply of the load demand, and sustainable development of power systems. To achieve the aforementioned goals, simultaneous utilization of DRRs and EVs should be implemented in a scheduled manner. In this paper, we propose a two-stage approach for allocation of EV parking lots and DRRs in power distribution network. Our method considers both the economical benefits of parking lot investor and the technical constraints of distribution network operator. First, the parking lot investor offers the candidate buses for installing the parking lot to the distribution network operator based on economic objectives. Then, the distribution network decision-making is obtained to reduce loss of system. The proposed framework not only improves the distribution network loss, but also ameliorates the availability of the parking lot from the economical point of view. In order to solve the formulated optimization problem, we utilize two optimization techniques. Genetic algorithm (GA) and particle swarm optimization (PSO) algorithm are used for the distribution network loss minimization purpose. Besides, we model the EV parking lot by expanding single EV probabilistic model. The performance of the proposed method is evaluated by allocating DRRs and EV parking lots simultaneously on the IEEE standard distribution test system. This system is bus 2 of Roy Billinton Test System (RBTS).**

Keywords: Distributed renewable resource, electric vehicle, power distribution network, parking lot investor, Genetic algorithm, particle swarm optimization algorithm.

I. Introduction

A. Motivation

Growing awareness of energy and environment, and the demand for a reliable, secure, and sustainable power grid, lead to the evolution of smart grid (SG) as a reliable means of electricity distribution. Novel technologies are introduced by SG, such as self-healing frameworks for smart distribution systems management [1], and smart buildings with vehicle-to-grid (V2G) capability [2]. In this context, electric vehicles (EVs) play a pivotal role [3]. Brady and O'Mahony proposed a charging profile modeling for electric vehicles in [4]. Their model is based on real-world EV charging data.

Additionally, the increasing load demand and the limits on energy resources involve incorporating renewable resources. Enabling the SG also revolutionizes the characteristics of distribution networks [5]. Based on US Energy Information Administration (EIA) assessment, energy demand will increase by 56% from 2010 to 2040 which is driven by economic development [6]. Therefore, governments have proposed distributed renewable resources (DRRs) and EVs as technological solutions for solving sustainability issues. Unscheduled and independent utilization of DRRs and EVs may bring irrefutable challenges for the smart distribution network. The future cities will require to deploy novel technologies such as electric vehicles and renewable resources to improve social welfare, reduce environmental emissions, and move toward electrified transportation networks. This also will lead to sustainable development of the power distribution networks.

B. Literature Survey

The effects of EVs and DRRs on the future power systems are investigated in several papers (e.g., references [7] -[12]). In [7], the effect of EV charging on a residential distribution grid was studied. However, the effect of simultaneous utilization of DRRs on the EV charging was not addressed. The value of using DRRs in distribution networks includes investments deferral, loss reduction, and improving the network reliability [8]. In [9], the advantages of scheduled aggregation of deferrable loads and storages were investigated. In [10], a general smart load management framework was introduced based on multi-agent systems considering DRRs and responsive demands. In [11], the potential benefits of EV's participation in different types of electricity markets such as regulation market and spinning reserves were studies. Alizadeh

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