International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)
ISSN: 0976-1353 Volume 20 Issue 3 – MARCH 2016.

LOAD MODELING AND IDENTIFICATION BASED ON ANT COLONY ALGORITHMS FOR EV CHARGING STATIONS

S.SANDHYA#1and Prof.R.KALPANA*2

#*Final year, M.E, Power systems Engineering, P.S.V College of Engineering and Technology, Krishnagiri (D.T) -635108*

**Assistant Professor, Electrical and Electronics Engineering, P.S.V College of Engineering and Technology, Krishnagiri (D.T) -635108*

Abstract— **Charging load modeling for electric vehicles (EVs) is a challenge due to its complexity. However, it serves as a foundation for related studies such as the impact assessment of EV charging behaviors on power system and power demand side management for EVs. The decisive factors affecting charging load profile include the power curve, the duration, and the start time of each charging process. This paper introduces the charging traffic flow (CTF) as a discrete sequence to describe charging start events, where CTF contains both spatial and temporal properties of a charging load. A set of equations are proposed to build a probabilistic load model, followed by simulation iteration steps using a flow chart. The proposed circuit deals with charging of EVs by using ant colony (AC) algorithm. This system gives a better conversion efficiency which is to be proved in simulation. The parameter identification method based on ant colony (AC) algorithms is then studied in depth, and the pheromone update and the state transition probability are used to implement route finding and city selection, respectively. Finally, an actual case of battery swapping station is applied to verify the proposed model in both identification and simulation. The results show that the model has satisfactory accuracy and applicability. The optimization is done with load flow based calculations. The objective function is to minimize both the real and the reactive power and better load dispatch based on online demand of EV in the queue.**

Index Terms—**Ant colony algorithms, charging station, electric vehicles, load model.**

INTRODUCTION

Nowadays, electric vehicle (EV) industries are rapidly developing. The large-scale application of EVs will come soon with improvements of power battery technologies. Thus, related research topics have been receiving great attention, whose spectrum includes impact analysis of EVs on a power system, power demand side management (PDSM) for EV charging load, and economic operation optimization of a micro grid involving EVs. In particular, modeling of EV charging loads becomes very important since it is a fundamental work to support the above studies. There are three charging modes for EVs: normal/slow, quick, and swap. The charging load in the last two modes has the following characteristics:1) higher superposition power values; 2) larger peak-valley differentials; 3) much more difficult to shift peak loads because the waiting time greatly affects the quality of charging service. Therefore, the load of a charging station will cause significant impacts on a power distribution network. It is necessary to assess these impacts. For this purpose, a highly resolved load model will be very helpful, as it can directly support power flow calculation involving EVs.

Generally, there are two traditional approaches in power load modeling: the component-based statistical synthesis and the measurement-based identification. For EV charging load, the former could have three steps: First, classify EVs as different groups according to the uses. Second, analyze the operational pattern and the proportion for each group. Last, forecast the total charging load. This approach was widely used for charging load forecasting. In most studies, the distribution of charging start time was considered a crucial factor for EV charging load profile. It was analyzed based on the four charging scenarios. In the EV plug-in time was represented by the normal distribution. It was obtained from the actual traffic flow measurement. It was controlled by the charging strategies. It was simulated based on the vehicle mobility patterns. It was assumed with the actual conditions.

It was estimated with the arrival time distribution of an EV. Thus, many different ways are presented to describe the EV plug-in time. Although charging load profiles can be simulated with these ways, its accuracy still depends on certain assumptions or the given scenarios. For the latter approach, the charging load model is built with unknown parameters. These parameters need to be identified based on actual measurement. An aggregation model was proposed, and the curve-fitting method was directly applied for parameter identification. However, its applicability is seriously limited because EV load profiles are significantly different from each other. A novel way was proposed to identify the number of charging EVs for the nationwide power system.

However, it did not consider the charging progress dependency and the spatial feature of traffic flow. Therefore, it is necessary to establish a generic EV charging load model with both spatial and time properties. This task has two key issues: how to describe charging start time with a universal parameter, and how to identify the parameter with an efficient algorithm based on measured data. Power-flow or load-flow studies are important for planning future expansion of power systems as well as in determining the best operation of existing systems. The principal information obtained from the power-flow study is the magnitude and phase angle of the voltage at each bus, and the real and reactive power flowing in each line.

An alternating current power-flow model is a model used in electrical engineering to analyze power grids. It provides a nonlinear system which describes the energy flow through each transmission line. The problem is non-linear because the power flow into load impedances is a function of the square of the applied voltages. Due to nonlinearity, in many cases the analysis of large network via AC power-flow model is not feasible, and a linear (but less accurate) DC power-flow model is used instead.

I. LOAD FLOW ANALYSIS

In power engineering, the power-flow study, or load-flow study, is a numerical analysis of the flow of electric power in an interconnected system. A power-flow study usually uses simplified notation such as a one-line diagram and per-unit system, and focuses on various aspects of AC power parameters, such as voltages, voltage angles, real power and reactive power. It analyzes the power systems in normal steady-state operation. Commercial power systems are usually too complex to allow for hand solution of the power flow. Special purpose network analyzers were built between 1929 and the early 1960s to provide laboratory-scale physical models of power systems. Large-scale digital computers replaced the analog methods with numerical solutions. In addition to a power-flow study, computer programs perform related calculations such as short-circuit fault analysis, stability studies (transient & steady-state), unit commitment and economic dispatch.[1] In particular, some programs use linear programming to find the optimal power flow, the conditions which give the lowest cost per kilowatt hour delivered. A load flow study is especially valuable for a system with multiple load centers, such as a refinery complex. The power flow study is an analysis of the system's capability to adequately supply the connected load. The total system losses, as well as individual line losses, also are tabulated. Transformer tap positions are selected to ensure the correct voltage at critical locations such as motor control centers. Performing a load flow study on an existing system provides insight and recommendations as to the system operation and optimization of control settings to obtain maximum capacity while minimizing the operating costs. The results of such an analysis are in terms of active power, reactive power, magnitude and phase angle.

A. *Load-Flow Model*

Usually analysis of a three-phase system is simplified by assuming balanced loading of all three phases. Steady-state operation is assumed, with no transient changes in power flow or voltage due to load or generation changes. The system frequency is also assumed to be constant. A further simplification is to use the per-unit system to represent all voltages, power flows, and impedances, scaling the actual target system values to some convenient base. A system one-line diagram is the basis to build a mathematical model of the generators, loads, buses, and transmission lines of the system, and their electrical impedances and ratings.

B. *Power-Flow Problem Formulation*

The goal of a power-flow study is to obtain complete voltage angle and magnitude information for each bus in a power system for specified load and generator real power and voltage conditions. Once this information is known, real and reactive power flow on each branch as well as generator reactive power output can be analytically determined. Due to the nonlinear nature of this problem, numerical methods are employed to obtain a solution that is within an acceptable tolerance. The solution to the power-flow problem begins with identifying the known and unknown variables in the system. The known and unknown variables are dependent on the type of bus. A bus without any generators connected to it is called a Load Bus. With one exception, a bus with at least one generator connected to it is called a Generator Bus. The exception is one arbitrarily-selected bus that has a generator. This bus is referred to as the slack bus. In the power-flow problem, it is assumed that the real power P_D and reactive power Q_D at each Load Bus are known. For this reason, Load Buses are also known as PQ Buses. For Generator Buses, it is assumed that the real power generated P_G and the voltage magnitude $|V|$ is known. For the Slack Bus, it is assumed that the voltage magnitude $|V|$ and voltage phase are known. Therefore, for each Load Bus, both the voltage magnitude and angle are unknown and must be solved for; for each Generator Bus, the voltage angle must be solved for; there are no variables that must be solved for the Slack Bus. In a system with N buses and R generators, there are then 2(N-1) – (R-1) unknowns .In order to solve for the 2(N-1) – (R-1) unknowns, there must be 2(N-1) – (R-1) equations that do not introduce any new unknown variables. The possible equations to use are power balance equations, which can be written for real and reactive power for each bus. The real power balance equation is:

$$0 = -P_i + \sum_{k=1}^{N} |V_i||V_k|(G_{ik}\cos\theta_{ik} + B_{ik}\sin\theta_{ik})$$

where P_i is the net power injected at bus i, G_{ik} is the real part of the element in the bus admittance matrix Y_{BUS} corresponding to the ith row and kth column, B_{ik} is the imaginary part of the element in the Y_{BUS} corresponding to the ith row and kth column and θ_{ik} is the difference in voltage angle between the ith and kth buses$(\theta_{ik}) = \delta_i - \delta_k$. The reactive power balance equation is:

$$0 = -Q_i + \sum_{k=1}^{N} |V_i||V_k|(G_{ik}\sin\theta_{ik} + B_{ik}\cos\theta_{ik})$$

where Q_i is the net reactive power injected at bus i.

Equations included are the real and reactive power balance equations for each Load Bus and the real power balance equation for each Generator Bus. Only the real power balance equation is written for a Generator Bus because the net reactive power injected is not assumed to be known and therefore including the reactive power balance equation would result in an additional unknown variable. For similar reasons, there are no equations written for the Slack Bus. In many transmission systems, the voltage angles θ_{ik} are usually relatively small. There is thus a strong coupling between real power and voltage angle, and between reactive power and voltage magnitude, while the coupling between real power and voltage magnitude, as well as reactive power and voltage angle, is weak. As a result, real power is usually transmitted from the bus with higher voltage angle to the bus with lower voltage angle, and reactive power is usually transmitted from the bus with higher voltage magnitude to the bus with lower voltage magnitude. However, this approximation does not hold when the voltage angle is very large.

C. *Newton-Raphson Solution Method*

There are several different methods of solving the resulting nonlinear system of equations. The most popular is known as the Newton–Raphson method. This method begins with initial guesses of all unknown variables (voltage magnitude and angles at Load Buses and voltage angles at Generator Buses). Next, a Taylor Series is written, with the higher order terms ignored, for each of the power balance equations included in the system of equations. The result is a linear system of equations that can be expressed as:

$$\begin{bmatrix} \Delta\theta \\ \Delta|V| \end{bmatrix} = -J^{-1} \begin{bmatrix} \Delta P \\ \Delta Q \end{bmatrix} \tag{3.3}$$

Where ΔP and ΔQ are called the mismatch equations:

$$\Delta P_i = -P_i + \sum_{k=1}^{N} |V_i||V_k|(G_{ik}\cos\theta_{ik} + B_{ik}\sin\theta_{ik}) \tag{3.4}$$

$$\Delta Q_i = -Q_i + \sum_{k=1}^{N} |V_i||V_k|(G_{ik}\sin\theta_{ik} + B_{ik}\cos\theta_{ik}) \tag{3.5}$$

$$J = \begin{bmatrix} \dfrac{\partial\Delta P}{\partial\theta} & \dfrac{\partial\Delta P}{\partial|V|} \\ \dfrac{\partial\Delta Q}{\partial\theta} & \dfrac{\partial\Delta Q}{\partial|V|} \end{bmatrix} \tag{3.6}$$

and J is a matrix of partial derivatives known as a Jacobian:

The linearized system of equations is solved to determine the next guess (m + 1) of voltage magnitude and angles based on:

$$\theta^{m+1} = \theta^{m} + \Delta\theta \tag{3.7}$$

$$|V|^{m+1} = |V|^{m} + \Delta|V| \tag{3.8}$$

The process continues until a stopping condition is met. A common stopping condition is to terminate if the norm of the mismatch equations is below a specified tolerance.

A rough outline of solution of the power-flow problem is:

a. Make an initial guess of all unknown voltage magnitudes and angles. It is common to use a "flat start" in which all voltage angles are set to zero and all voltage magnitudes are set to 1.0 p.u.

b. Solve the power balance equations using the most recent voltage angle and magnitude values.

c. Linearize the system around the most recent voltage angle and magnitude values

d. Solve for the change in voltage angle and magnitude

e. Update the voltage magnitude and angles

f. Check the stopping conditions, if met then terminate, else go to step b.

D. Objectives

a. To derive an objective function to minimize the real and reactive power losses and to improve the voltage profile of the overall EV charging stations.

b. To implement a 33 bus system and acquire the various fixed and binding constraints and to find the optimum place of source and its capacity need to maintain the minimum loss.

c. To reduce the number of iterations and make earlier convergence.

II. OPERATING PRINCIPLE

The proposed circuit deals with charging of EVs by using ant colony (AC) algorithm. This system gives a better conversion efficiency which is to be proved in simulation. The parameter identification method based on ant colony (AC) algorithms is then studied in depth, and the pheromone update and the state transition probability are used to implement route finding and city selection, respectively. Finally, an actual case of battery swapping station is applied to verify the proposed model in both identification and simulation. The results show that the model has satisfactory accuracy and applicability. The optimization is done with load flow based calculations. The objective function is to minimize both the real and the reactive power and better load dispatch based on online demand of EV in the queue. Calculation of BVSI matrix for load flow analysis to estimate the charging profile, swapping of batteries based on results obtained. Additional sources, are added to increase the voltage profile. Steps involved in improving the voltage profile algorithm for SOURCE Placement and Sizing

- Run the load flow without source placement.
- Find the Bus voltage sensitivity indices at each node using eqn. by penetrating the 10% of source value at respective node and rank the sensitivities of all nodes in ascending order to form priority list.
- Select the bus with lowest priority and place source at that bus.
- Change the size of source in small steps and calculate power loss for each by running load flow.
- Store the size of source that gives minimum loss.
- Compare the loss with the previous solution. If loss is less than previous solution, store this new solution and Discard previous solution.
- Repeat Step 4 to Step 6 for all buses in the priority list.
- End

A. Load Dispatch Flow

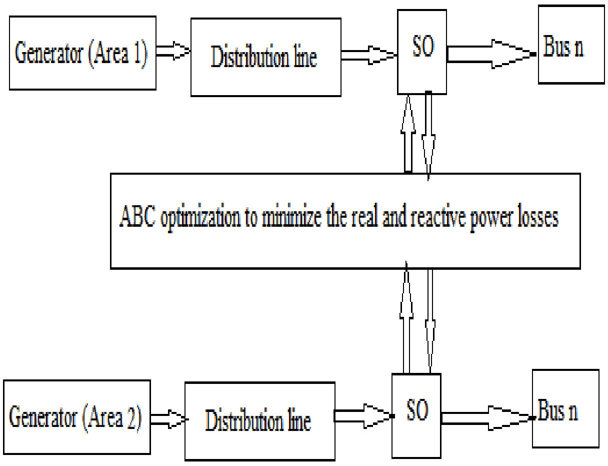

Fig. 2.1 Load Dispatch Flow

Block diagram shown above in figure 2.1 is load dispatch flow generally with ABC technology.ABC is a new swarm intelligence algorithm proposed by Karaboga in 2005, which is inspired by the behaviour of honey bees. Since the development of ABC, it has been applied to solve different kinds of problems. Artificial bee colony (ABC) algorithm is a recently proposed optimization technique which simulates the intelligent foraging behaviour of honey bees.

B. Intra Area System (Inside an Area)

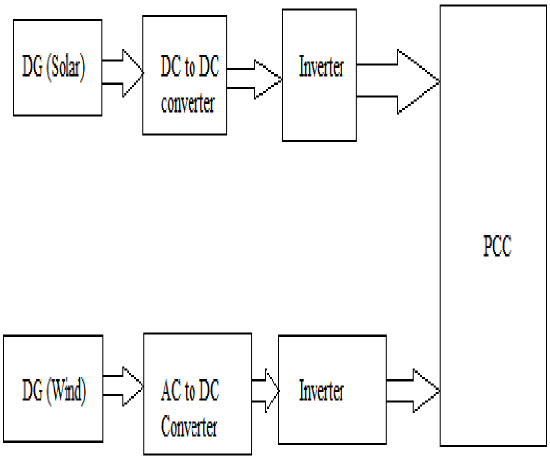

Fig.2.2 Intra Area System

The block diagram shown in figure 2.2 are inter area system of load dispatch. Consider two distribution generators, one from solar energy and other from wind generation. Its direct conversion of power system. The block diagram is for inside area of SO as shown in figure 2.1 of load dispatch flow. Here to generating station are consider for simplification. It shows general power flow diagram with SO. ABC optimization in used in between two OS of two generating station. An ABC technology is used to minimize the real power and reactive power losses. A power station generate the electrical power such as voltage, frequency, load etc. Most of power station are operated and connected to n bus. Depend on load demand the generation has to be controlled and also reactive power and real power losses also consider and it optimized by ABC optimization technology.PCC is point of common coupling for two distribution generation stations (DG).In this all power are converted in AC power for required load.

III. SIMULATION RESULTS

A. Without Improvement in V Profile

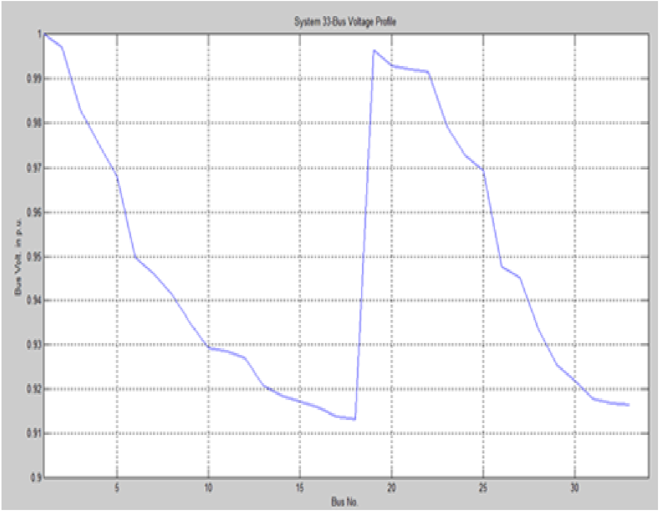

Fig.3.1Without Improvement in V Profile

The graph shown in figure 3.1 is voltage profile without improvement. In this voltage with respect to system are instable, at 15 only it gives the peak voltage and after that again it’s in decreasing and increasing. The voltage level should be in stable condition to provide continuous charging to the system are vehicles.

B. Voltage with improved profile at all buses

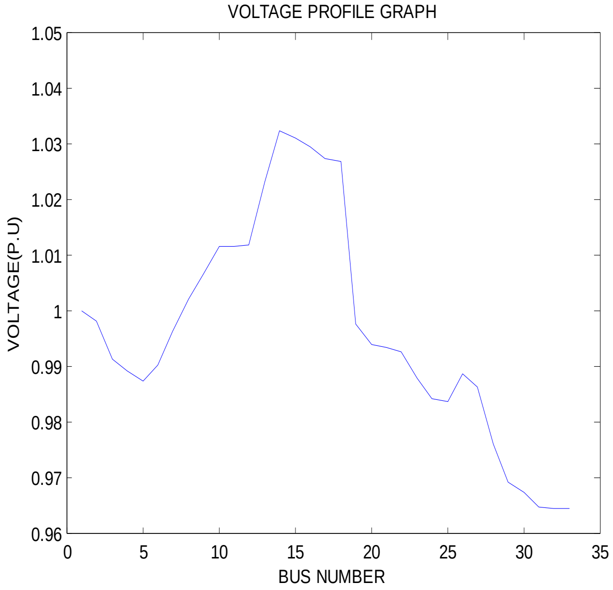

Fig.3.2 Voltage with Improved Profile at All Buses

The graph shown above is voltage profile after improving all buses.

C. Real Power Losses

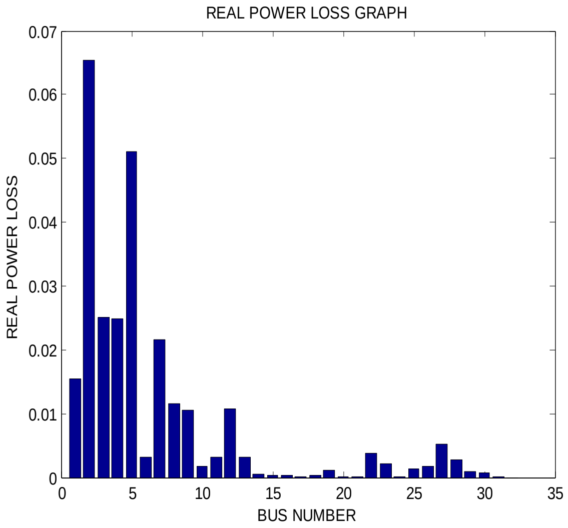

Fig.3.3Real Power Loss Graph

Real power accomplishes useful work while reactive power supports the voltage that must be controlled for system reliability. Reactive power has a profound effect on the security of power systems because it affects voltages throughout the system. Find important discussion regarding importance about Reactive Power and how it is useful to maintain System voltage healthy.

D. Reactive Power Losses

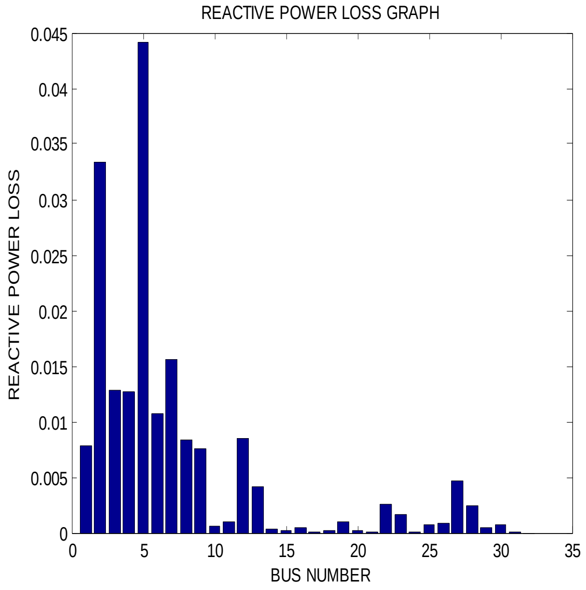

Fig. 3.4 Reactive Power Losses

We always in practice to reduce reactive power to improve system efficiency. This are acceptable at some level, if system is purely resistively or capacitance it make cause some problem in Electrical system. AC systems supply or consume two kind of power: real power and reactive power.

IV. CONCLUSION & FUTURE WORK

Since BVSI matrix based LF is analyzed, decisions taken faster. More vehicles are handled in one hour. Load power oscillations are minimized. Source battery is placed in location and determining the best location for best power quality. The optimization is done with load flow based calculations. The objective function is to minimize both the real and the reactive power and better load dispatch based on online demand of EV in the queue. Applicable in all micro, macro and hybrid grid power dispatch and EV charging stations. The decisive factors affecting charging load characteristics are the distribution of durations, the power profile of chargers, and the charging start time. The proposed CTF can be introduced to describe the charging start time. Furthermore, it contains the properties of both space and time. The proposed model provides flexible modes for simulation and parameter identification. In simulation, it can be used in both stochastic and deterministic situations. In parameter identification, provides a rapid calculation method to improve the efficiency by using BVSI matrix and voltage profiles have been sufficiently improved.

REFERENCES

[1] 1. J. A. P. Lopes, F. J. Soares, and P. M. R. Almeida, “Integration of electric vehicles in the electric power system,” Proc. IEEE, vol. 99, no. 1, pp. 168–183, Jan. 2011.

[2] 2. M. Etezadi-Amoli, K. Choma, and J. Stefani, “Rapid-charge electric- vehicle stations,” IEEE Trans. Power Del., vol. 25, no. 3, pp.1883–1887, Jul. 2010.

[3] 3. J. G. Vlachogiannis, “Probabilistic constrained load flow considering integration of wind power generation and electric vehicles,” IEEE Trans. Power Syst., vol. 24, no. 4, pp. 1808–1817, Nov. 2009.

[4] 4. G. Li and X.-P. Zhang, “Modeling of plug-in hybrid electric vehicle charging demand in probabilistic power flow calculations,” IEEE Trans. Smart Grid, vol. 3, no. 1, pp. 492–499, Mar. 2012.

[5] 5. K. Qian, C. Zhou, M. Allan, and Y. Yuan, “Modeling of load demand due to EV battery charging in distribution systems,” IEEE Trans. Power Syst., vol. 26, no. 2, pp. 802–810, May 2011.

[6] 6. Y. Cao, S. Tang, C. Li, P. Zhang, Y. Tan, Z. Zhang, and J. Li, “An optimized EV charging model considering TOU price and SOC curve,” IEEE Trans. Smart Grid, vol. 3, no. 1, pp. 131–138, Mar. 2012.

[7] 7. P. Papadopoulos, S. Skarvelis-Kazakos, I.Grau, L.M. Cipcigan, andN. Jenkins, “Electric vehicles’ impact on British distribution networks,” IET Electr. Syst. Transp., vol. 2, no. 3, pp. 91–102, Apr. 2011.

[8] 8. S. Shao, M. Pipattanasomporn, and S. Rahman, “Grid integration of electric vehicles and demand response with customer choice,” IEEE Trans. Smart Grid, vol. 3, no. 1, pp. 543–550, Mar. 2012.

[9] 9. Y. Zheng, Z. Y. Dong,Y.Xu, K.Meng, J.H.Zhao, and J.Qiu, “Electric vehicle battery charging/swap stations in distribution systems: Comparison study and optimal planning,” IEEE Trans. Power Syst., vol. 29, no. 1, pp. 221–229, Jan. 2012.

[10] 10. J. Lassila, V. Tikka, J. Haakana, and J. Partanen, “Electric cars as part of electricity distribution—Who pays, who benefits?,” IET Electr. Syst. Transp., vol. 2, no. 4, pp. 186–194, Feb. 2012