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INTREGATION OF EV CHARGING STATION WITH RENEWABLE ENERGY GENERATION WITH OPTIMAL SOLUTION

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ABSTRACT

As the vehicles are becoming the basic need of the human been for the transportation, importance of fuel increased to very high level, and research started on different types of fuels. With the fossil fuels like oil, natural gas, petroleum, coal are excepted to last a little longer, not for longer duration, and the high awareness on the protecting our environment, creates very high importance of Electric Vehicles (EVs). But, the use of EVs is not much as the use of Petrol or Diesel vehicles. One of the reason for this is the mesh of the charging stations is very poor cross the globe. Inappropriate siting and sizing of EV charging stations, the city traffic mesh, and a degradation in voltage profiles at some nodes could have negative effects on the development of EVs. This is due the commercial profit in a charging station. This paper discuss one of the solution for this issue. In this paper we first identify the optimal site of EV charging stations, for that two steps screening method is used in which first step considers environmental factors and second service radius of EV charging stations, using this method we are finding the an optimal cost to state up an EV charging station. Then, a mathematical model employed to find the optimal solution on fast charging. At the end, this paper have a demonstration of simulation results test feeder, which says developed model and method cannot only attain the reasonable planning scheme of EV charging stations, but also reduce the losses in network and enhance the voltage profile.

Keywords: *Electric Vehicles, EV Charging station, siting and sizing, Distribution system.*

1. INTRODUCTION

Nowadays the world is facing energy problems, global warming, and lack of energy supplies and environmental concerns as air pollution. To reduce these problems, fossil fuel replacement with renewable energy is proposed. In the last decade, electric vehicles (EVs) have grown rapidly in some countries, due to the good improvement in the batteries. The global electric vehicle market size is expected to grow from an estimate of 3 million units in 2020 to reach 30 million units by 2030. Electric vehicles appear to be the best alternatives for replacing the conventional

IC engine powered vehicles. However, there are certain critical aspects which need to be looked upon in order to make Electric Vehicles (EVs) a commercial reality. Range anxiety can be considered as the most important factor impeding the widespread acceptance and planning of EV charging station. Also, charging time reduction is considered to be a key goal in making electric vehicles (EVs) accessible to a larger population. In this perspective, fast DC charging provides a fascinating opportunity. DC fast charging reduces charging time . In this project, model of an electric vehicle charging station with fast DC charging is proposed. Power quality issues related to the source end harmonics are dealt with along with the implementation of a charging strategy using constant-current and constant-voltage modes. An optimal energy management scheme is presented in the end to reduce the load on utility grid by use of renewable energy systems.

2. RELATED WORK

Given the aforementioned background, the optimal planning of EV charging stations is becoming a big problem to be resolved. EVs cannot only increase energy utilization and reduce pollution emission, but also smooth the load curve by peak load shaving and, hence, enhance the safety and economics of the facility system concerned by coordinating with intermittent renewable energies, like wind power . However, inappropriate siting and sizing of EV charging stations could have negative effects on the event of EVs, the layout of the traffic network during a city concerned, and therefore the convenience of EV drivers. It could also cause a rise in network losses and degradation in voltage profiles at some nodes [2]. Now day's industry and academics paying exhaustion focus on the optimal planning of EV charging stations [3]- [8]. Many factors having impacts on the layout of EV charging stations, just like the charging demands, the method of energy provide, the performance and charging period of A battery, additionally as a result of the locations and setting of charging stations, are investigated in [4]. In [5], the event procedure of EV charging stations is split into 3 stages (i.e., the demonstration stage, public promotional stage, and business utilization stage). Then, associate degree improvement model for the planning of EV charging stations is planned with the interval distance magnitude relation, charging capability redundancy, and charging power redundancy thought of. In [6], the feasibleness of optimally utilizing the potential of the Ontario's grid for charging plug-in hybrid EVs (PHEVs) is analyzed for off-peak load periods by using a simplified zonal model of the Ontario's electrical transmission network and a zonal pattern of base-load generation capacities for the years from 2009 to 2025.

Environmentally and economically property integration of PHEVs into an influence system is self-addressed beneath a robust optimization coming up with method framework with the constraints of the power system and thus the transport sector taken intoaccount [6]. A smart load-management approach for coordinating multiple plug-in EVs chargers in distribution systems is planned, with the objectives of shaving peak demand, up voltage profile and minimizing power losses conjointly as a result of the impact of EVs charging stations and typical daily residential loading patterns thought-about as constraints [7]. In [3], a reduced price model for crucial the locations and capacities of charging stations for regional EVs is developed considering some constraints, just like the distances between the station and candidate locations of work unit charging substations, the number of EVs, and thus the put in prices of work unit charging stations.

The existing analysis work on the optimum coming up with of work unit charging stations does not consistently address all necessary factors having impacts on the candidate sites of work unit charging stations, just like the distribution options of the charging demands, the performance of battery packs, and thus the potential effects of the power system involved. With this background, a ballroom dance screening technique with the environmental factors and thus the service radius of work unit charging stations thought-about is initial bestowed to identify the optimum sites of work unit charging stations. Then, a mathematical model for the optimum size of work unit charging stations is developed and solved by a changed primal-dual interior-point algorithmic rule (MPDIPA). Finally, the IEEE 123- node take a look at feeder is employed as an example the essential options of the developed model and technique.

3. PROBLEM STATEMENT

Develop model and method, which can be provide reasonable planning scheme of EV charging stations, and also reduce the network loss and improve the voltage profile. Which include as the minimization of the total costs associated with EV charging stations to be planned, including the investment costs, operation costs, maintenance costs, and network loss costs in the planning period.

4. PROPOSED METHOD

4.1 Siting and sizing

The developed mathematical model for the optimal sizing of EV charging stations can be described as

$$\begin{cases} \min & f(\boldsymbol{x}) \\ \text{s.t.} & \boldsymbol{g}(\boldsymbol{x}) = 0 \\ & \boldsymbol{h}_{\min} \leq \boldsymbol{h}(\boldsymbol{x}) \leq \boldsymbol{h}_{\max} \\ & \boldsymbol{x}_{\min} \leq \boldsymbol{x} \leq \boldsymbol{x}_{\max} \end{cases} \quad \text{…. (1)}$$

Where $\boldsymbol{f}(\boldsymbol{x})$ is the objective function, $\boldsymbol{g}(\boldsymbol{x})$ is the vector of the equality constraints, $\boldsymbol{h}(\boldsymbol{x})$ is the vector of the inequality constraints, $\boldsymbol{h}_{max}$ / $\boldsymbol{h}_{min}$ is the vector of the maximal/minimal limits of $\boldsymbol{h}(\boldsymbol{x})$, $\boldsymbol{x}$ is the vector of continuous decision variables consisting of the capacities of all EV charging stations, and $\boldsymbol{x}_{max}$ / $\boldsymbol{x}_{min}$ is the vector of the maximal/minimal limits of $\boldsymbol{x}$.

The problem described by (1) is a typical nonlinear constrained programming problem. Up to now, many optimization algorithms are available for solving this problem in the field of operations research. In this paper, the modified primal-dual interior point algorithm (MPDIPA) is employed due to its fast convergence rate, strong robustness, and insensitive starting points. The calculation amount of the primal-dual interior algorithm mainly involves solving correction equations. To speed the solving procedure, the correction equations are simplified by taking full advantage of their sparse structures.

4.2 Optimization on fast charging

Fig. 1 show the proposed method. This system generates the power from different source like Solar i.e. PV, Wind turbine, Diesel engine etc., the generated power then stored in the storage and used as and when needed. Flowchart of given model as below.

The renewable energy sources of generation have been modeled as simple power sources in the system as the

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purpose of the investigation is to study system effects during step changes. The outputs of renewable generation will changes with respect to predefined tables to simulate its fluctuation characteristics. Based on which, the distributive fast charging stations will be controlled so as to optimize the operation of the network. AC charging is the simplest kind of charging to find – outlets are everywhere and almost all EV chargers you encounter at homes, shopping plazas, and workplaces are Level 2 AC chargers. An AC charger provides power to the on-board charger of the EV, conversion of AC power to DC in order to enter the battery. The acceptance rate of the on-board charger varies by brand but is limited for reasons of cost, space and weight. This means that depending on your vehicle it can take anywhere from four or five hours to over twelve hours to fully charge at Level 2 type charger.

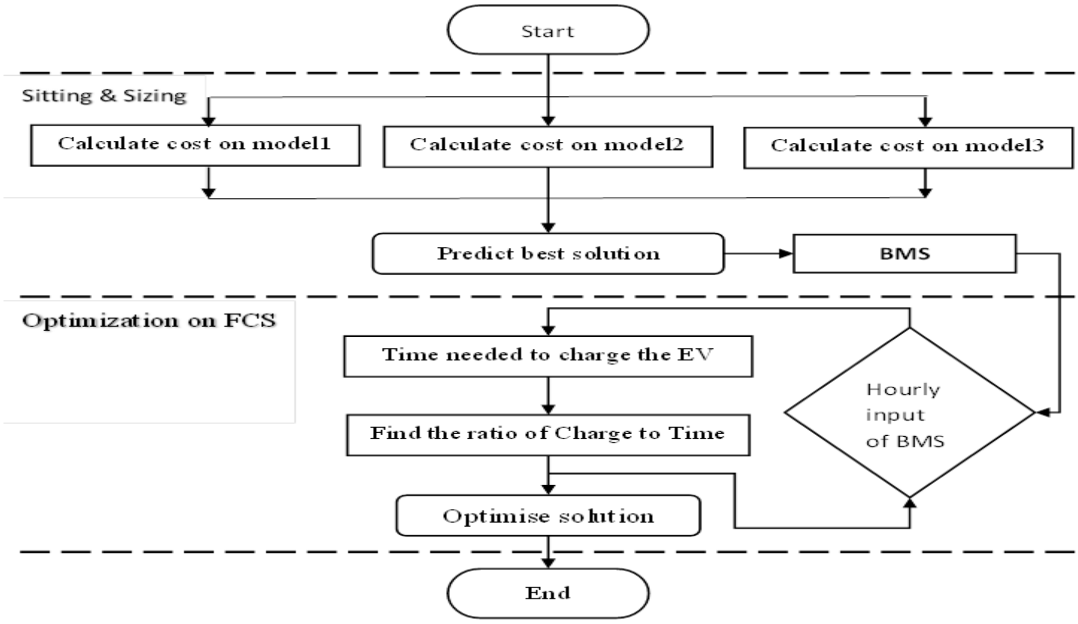
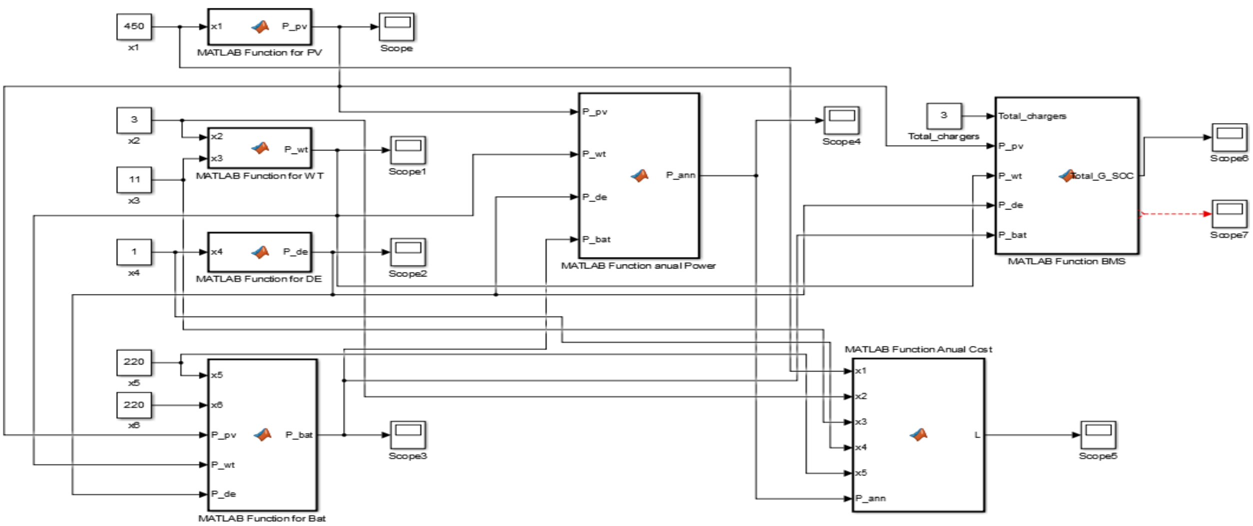


Figure : **1** Flowchart for Proposed Method for EV Charging Station integrated with Renewable Sources

5. SIMULATION MODEL



6. CASE STUDY

Optimizing the sizes of components of an system depends on various factors such as the resources, cost, drivetrain, load requirement, blackouts, and so on. Since in this problem, the loads and resources were known, the optimization was greatly dependent on the drivetrain. The variables considered in the code are:

1. The number of solar panels.
2. Number of wind turbines.
3. The radius of the Wind turbine blades.
4. The number of diesel engines required
5. The total battery loads.
6. The number of batteries.

In this problem, the demand and supply are considered for one year of 8640 hours, where there is Sunlight for half that time, and the rest of the time, the diesel engine is on so as to meet the load requirements.

There can be many approaches considered which are all logical in some sense or the other. The rationale behind this drive train is that solar PV will be unable to function during the night due to obvious reasons, and the deficit is filled by the use of diesel engines (which is why it remains off in the morning). Therefore, an if- else statement is used to switch on and off the diesel engines according to the load.

Although Irradiance and Wind velocities are variables that determine the power output of the system in an exponential fashion, they are taken as constants in the code. But each iteration yields a different value for each of these inputs, making it a little more volatile and practical. A random number between the mentioned values is generated so that each iteration can assume a different value, even though they are decide deterministically.

The solutions obtained are documented below. The Range of function value varied from 0.06 to 1.4 $/kW.

Soluions	No. of PV panels	No. of Wind turbines	Radius of the Wind Turbines	No. of diesel Engines	No. of Batteries	total Maximum instantaneous load on the batteries KW	Levelised cost of Energy $/Kwh
Solution 1	450	3	11	1	220	220	3.76
Solution 2	478	2	10	2	300	200	6.72
Solution 3	500	3	11	4	220	220	6.04

Table 1 : List of Solutions

number of wind turbines	radius of the wind turbine blades	number of Diesel Engines	total number of batteries	total instantaneous load on all the batteries	C_pv	C_wt	C_bat	C_de	C_ann	L $/Kwh
2	11	4	300	234	1138760	79620.52	600000	12032	1830412.52	17.12
3	12	4	222	232	1115520	195432.2	444000	12032	1766984.19	7.28
2	12	3	255	0	1162000	86858.75	510000	9032	1767890.75	20.4
3	11	1	220	220	1045800	179146.2	440000	3032	1667978.17	3.77

Table 2 : List of Solutions from Simulink Model

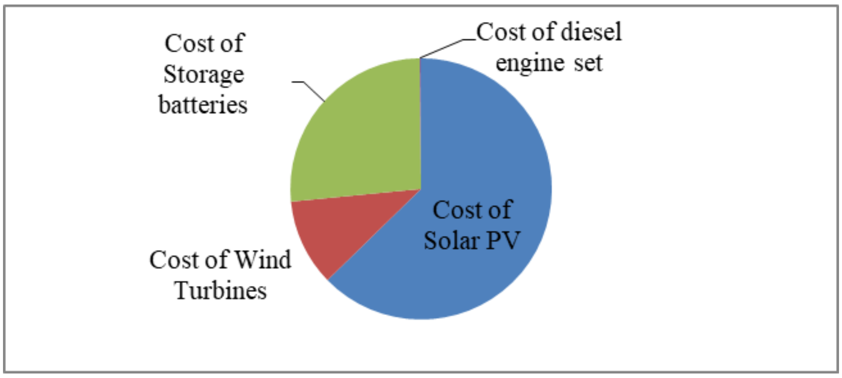


Fig. 2 Average size of components

7. RESULTS

The distance between the EVs in a charging service area and the EV charging station located in this charging service area is less than the distance between the EVs and the EV charging station located in any other charging service areas.

After the EV charging stations' optimal locations are determined by the two-step screening method, the MPDIPA is employed to solve the developed model for EV charging stations' optimal capacities. The convergence of MPDIPA is achieved when the complementarity gap tends to zero. This illustrates that the algorithm has good convergence characteristics.

8. CONCLUSIONS

To solve the problem of optimal placement of the EV charging station, this paper a method combining the two-step screening method and the modified primal-dual interior point algorithm (MPDIPA) is developed. In those two steps first identify the optimal site of EV charging stations, for that two steps screening method is used in which first step considers environmental factors and second service radius of EV charging stations. Then, a mathematical model for the optimal sizing of EV charging stations is developed with the minimization of total cost related to EV charging stations to be planned because the objective function and solved by a modified primal-dual interior point algorithm (MPDIPA).

At the end, this paper have a demonstration of simulation results test feeder, which says developed model and method cannot only attain the reasonable planning scheme of EV charging stations, but also reduce the network loss and enhances the voltage profile.

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