International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 05 | May 2020 www.irjet.net p-ISSN: 2395-0072

Electrical Vehicle Charging Station Planning in Distribution System with Optimum Solution

Prashant S. Gadhe[1], Prof.H.V.Takpire[2]

[1]*Department of Electrical Engineering, G.H.Raisoni University Amravati, Maharashtra, India*
[2]*Assistant Professor, Department of Electrical Engineering, G.H.Raisoni University Amravati, Maharashtra, India*

---***---

Abstract - *As the vehicles became the essential need of the human been for the transportation, importance of fuel increased to very high level, and research started on differing kinds of fuels. With the fossil fuels like oil, gas, petroleum, coal are excepted to last a touch longer, not for extended duration, and also the high awareness on the protective the environment, creates very high importance of electrical Vehicles (EVs). But, the use of EVs doesn't seem to be a great deal just like the employment of Petrol or Diesel vehicles. One in all the reason for this can be often the mesh of the charging stations is incredibly poor cross the planet. Inappropriate siting and sizing of EV charging stations, the town traffic mesh, and degradation in voltage profiles at some nodes could have negative effects on the event of EVs. This paper discusses one in all the solution for this issue. During this paper we first identify the optimal site of EV charging stations, for that two steps screening method is utilized during which commencement considers environmental factors and second service radius of EV charging stations.*

Key Words: **Electric Vehicles, siting and sizing, Distribution system.**

1. INTRODUCTION

In the last decade, electric vehicles (EVs) have grown rapidly in some countries, due to the good improvement in the batteries [1]. The global electric vehicle market size is projected to grow from an estimate of three million units in 2019 to succeed in 27 million units by 2030. BYD Auto Co., Ltd. (China), Nissan Motor Company Ltd. (Japan), Tesla Motors (US), and Volkswagen (Germany) are a number of the leading players within the electric vehicle market. These companies have launched electric vehicles in different segments to cater to the increased demand. Tesla Model S, Nissan Leaf, and BYD Tang are a number of the foremost successful models that have attracted customers toward electric vehicles. Additionally, Panasonic Corporation (Japan), Automotive Energy Supply Corporation (Japan), BYD Auto Co., Ltd. (China), and Samsung SDI (South Korea) are a number of the most important battery manufacturers that cater to the worldwide demand for EV batteries.

2. Related Works'

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 optimisation coming up with method framework with the constraints of the power system and thus the transport sector taken into account [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 Statements

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

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

5. Case Studies

The IEEE 123-node test feeder, as shown in Fig. 1, is employed to demonstrate the developed model and method. The road lengths, the states of three-phase switches, and therefore the original load data are shown in Tables I–III, respectively.

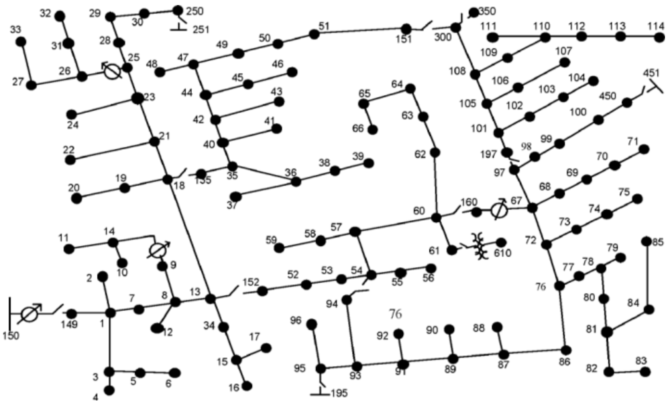

Figure 1 IEEE 123-node test feeder.

Table -I: LINE LENGTHS OF THE IEEE 123-NODE TEST FEEDER

Node A	Node B	Line Length/(m)	Node A	Node B	Line Length/(m)
1	2	175	58	59	250
1	3	250	60	61	550
1	7	300	60	62	250
3	4	200	62	63	175
3	5	325	63	64	350
5	6	250	64	65	425
7	8	200	65	66	325
8	12	225	67	68	200
8	9	225	67	72	275
8	13	300	67	97	250
9	14	425	68	69	275
13	34	150	69	70	325
13	18	825	70	71	275
14	11	250	72	73	275
14	10	250	72	76	200
15	16	375	73	74	350
15	17	350	74	75	400
18	19	250	76	77	400
18	21	300	76	86	700
19	20	325	77	78	100
21	22	525	78	79	225
21	23	250	78	80	475
23	24	550	80	81	475
23	25	275	81	82	250
25	26	350	81	84	675
25	28	200	82	83	250
26	27	275	84	85	475
26	31	225	86	87	450
27	33	500	87	88	175
28	29	300	87	89	275
29	30	350	89	90	225
30	250	200	89	91	225
31	32	300	91	92	300
34	15	100	91	93	225
35	36	650	93	94	275
35	40	250	93	95	300
36	37	300	95	96	200
36	38	250	97	98	275
38	39	325	98	99	550
40	41	325	99	100	300
40	42	250	100	450	800
42	43	500	101	102	225
42	44	200	101	105	275
44	45	200	102	103	325
44	47	250	103	104	700
45	46	300	105	106	225
47	48	150	105	108	325
47	49	250	106	107	575
49	50	250	108	109	450
50	51	250	108	300	1000
52	53	200	109	110	300
53	54	125	110	111	575
54	55	275	110	112	125
54	57	350	112	113	525
55	56	275	113	114	325
57	58	250	135	35	375
57	60	750	149	1	400

Table –II : STATES OF THREE-PHASE SWITCHES

Node A	Node B	Configuration
13	152	Closed
18	135	Closed
60	160	Closed
61	610	Closed
97	197	Closed
150	149	Closed
250	251	Open
450	451	Open
54	94	Open
151	300	Open
300	350	Open

Table III : ORIGINAL LOAD DATA

Node	P_{Li}/(kW)	Q_{Li}/(kVar)	Node	P_{Li}/(kW)	Q_{Li}/(kVar)
1	40	20	53	40	20
7	20	10	55	20	10
9	40	20	60	20	10
10	20	10	63	40	20
11	40	20	65	35	25
19	40	20	68	20	10
20	40	20	69	40	20
28	40	20	70	20	10
29	40	20	71	40	20
33	40	20	76	105	80
35	40	20	79	40	20
37	40	20	82	40	20
42	20	10	88	40	20
45	20	10	94	40	20
46	20	10	98	40	20
47	35	25	109	40	20
48	70	50	111	20	10
49	35	25	112	20	10
51	20	10	113	40	20
52	40	20	114	20	10

Note: The growth of active and reactive power at each node in every year of the planning period follows the normal distribution, i.e. $N(0.1P_{Li}, 0.02P_{Li})$ and $N(0.1Q_{Li}, 0.02Q_{Li})$.

The demonstration, expansion, and application planning of energy savings and new energy vehicles in China (the so-called Ten-city 1000-vehicle planning) are launched since January 2009, with the main goal of applying EVs to the general public service sectors as buses, business cars, taxis, and postal cars. With this background, a sort of electricity-powered bus named HFF6112GK50 is taken as an example here.

6. Result

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

7. Conclusion

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 associated with EV charging stations to be planned as 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 of the IEEE 123-node 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 improve the voltage profile.

REFERENCES

[1] C. G. M. K.-M. a. R. F. K. Schneider, "Impact assessment of plug-in hybrid vehicles on pacific northwest distribution," in Proc. IEEE Power Eng. Soc. Gen. Meeting-Convers. Del. Elect. Energy in 21st Century, Pittsburgh, PA, pp. 1 - 6, Jul. 20–24.

[2] K. C. a. J. S. M. Etezadi-Amoli, "Rapid-charge electric-vehicle stations," IEEE Trans. Power Del., vol. vol. 25, no. no. 3, p. 1883–1887, Jul. 2010.

[3] G. Q. Y. L. F. G. a. H. Z. F. Xu, "Tentative analysis of layout of electrical vehicle charging stations," Proc. East China Elect. Power, vol. vol. 37, no. no. 10, p. pp. 1677–1682, Oct. 2009.

[4] C. L. D. a. J. C. C. Y.Wu, "Amethod for electric vehicle charging infrastructure planning," Autom. Elect. Power Syst., vol. vol. 34, no. no. 24, p. pp. 36–39, Dec. 2010.

[5] C. A. C. M. W. F. a. A. E. A. Hajimiragha, "Optimal transition to plug-in hybrid electric vehicles in Ontario, Canada, considering the electricity-grid limitations," IEEE Trans. Ind. Electron, vol. vol. 57, no. no. 2, p. pp. 690–701, Feb. 2010.

[6] C. A. C. F. S. a. A. E. A. H. Hajimiragha, "A robust optimization approach for planning the transition to plug-in hybrid electric vehicles," IEEE Trans. Power Syst.,, vol. vol. 26, no. no. 4, p. pp. 2264–2274, Nov. 2011.

[7] S. D. P. S. M. M. A. S. M. a. A. A.-S. A. S. Masoum, "Smart load management of plug-in electric vehicles in distribution and residential networks with charging stations for peak shaving and loss minimisation considering voltage regulation," Inst. Eng. Technol. Gen., Transm. Distrib., vol. vol. 5, no. no. 8, p. pp. 877–888, Aug. 2011.

[8] Z. F. L. a. H. Z. L. F. Kou, "Modeling algorithm of charging station planning for regional electric vehicle," Modern Elect. Power, vol. vol. 27, no. no. 4, p. pp. 44–48, Aug. 2010.

BIOGRAPHIES

Prashant S. Gadhe[1]
Pursuing M.Tech Electrical Power System
[1]Department of Electrical Engineering, G.H. Raisoni University Amravati, Maharashtra, India