Optimizing slow-charging EV loads with a two-layer strategy to enhance split-phase voltage quality and mitigate issues in PDNs

Attada Durga Prasad[1], Manickam Siva[1], Alla Srinivasa Reddy[2]
[1]Department of Electrical Engineering, Annamalai University, Chidambaram, India
[2]Department of Electrical and Electronics Engineering, Sir C. R. Reddy College of Engineering, Eluru, India

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ABSTRACT

Power distribution networks (PDN) were mostly affected by the voltage imbalances created by the slow charging of electric vehicles (EV), were there random load into the PDN system, causing split-phase voltage quality (SPVQ) issues. Hence, to mitigate the problems associated with EVs' slow charge in distributed phases of the power system, a multi-layer charging strategy is proposed considering the following constraints in the system: voltage deviation (VD) and voltage harmonics (VH) in split phase (SP). Further multi-layer control is associated with an inner layer equipped with hybrid non-dominated sorting genetic algorithm (NSGA-II) to select the optimal phase for charging the EV and send it to the output layer where a SP current algorithm is utilized so that voltage quality can be fed in loop to inner layer so that iterations were performed to satisfy the convergence condition. Simulation results in MATLAB demonstrate a voltage unbalance (VU) reduction of up to 32.81%, a maximum VD reduction of 9.11%, and a VH reduction of 6.25% at key grid nodes. The proposed method significantly enhances PDN efficiency and maintains voltage quality within national standards across 1,000 to 5,000 EV connections. The generated results reflected the optimal improvement in SPVQ, and the harmonics content reduced further; PDN operational efficiency also improved to a greater extent.

Corresponding Author:

Attada Durga Prasad
Department of Electrical Engineering, Annamalai University
Chidambaram, Tamil Nadu 608002, India
Email: prasad.phdannamalai2019@gmail.com

1. INTRODUCTION

World adoption the carbon neutrality towards climate change makes a way for the electric vehicles (EVs) to be adopted to an extent of exponential adoption [1]. This level of expansion created a burden on the power distribution network's (PDN's) to withstand the sudden loads of EVs, as most of them were single-phase chargers used in civilian vehicles, creating an imbalance in the phase voltages and creating split phase voltage quality (SPVQ) issues in the power system [2]. In real-time operation, random load on a single-phase lead to unbalance in the three-phase system stability and increases the losses in the PDN system and further reducing the lifetime of the equipment used in PDNs [3]. To address the issues associated with single-phase slow chargers of civilian EVs and to address issues of SPVQ, there is a need for improved charging strategies for EVs [4].

Most of the EV charging trends focus on a particular time of peak load because of the common lifestyle of most people, such that PDN is not able to meet the demands of the load, resulting in the failure of the grid. Liang *et al.* [5] explored a variable tariff based on common load demand times with an algorithm of load peak to valley (PtV) differentials. Qu *et al.* [6] proposed a charging strategy for a valley with a renewable energy grid by proposing EV guides relatable towards time sharing options across the sub-regions from the peak to valley optimization objective. Both proposals discussed in [5] and [6] were not able to address the optimization objectives like voltage unbalance (VU), voltage deviation (VD), and voltage harmonics (VH) created by EVs connected to PDN. Advancing the voltage distribution algorithm with a new proposal of interconnected wind systems with economic load dispatch is presented in [7] for minimizing the effect of EV loads in a particular region. However, the authors failed in addressing the issues like optimization objectives VU, VD & VH. A similar type of research is presented in [8], where a dynamic pricing system according to the load scheduling makes the user opt for non-peak time charging. All the methods discussed so far considered the parameters of a PDN as the same and estimated the values based on EVs distributed equally to each phase, making them unsuitable for balancing the three-phase grid system and reducing the harmonics of voltage.

Most of the voltage quality problems can be solved by having access to control devices of the charging network through a controller [9]; however countries like India, it's difficult to achieve and implement in practical conditions [10]. Research is then shifted to the design of controllers in [11]. A voltage sag controller is proposed for mitigating the imbalances in voltage, but this model failed to address the voltage oscillations and optimization objectives like VD & VH. An algorithm for a controller is designed on the basis of adaptive notch filters (ANFs) to address the issues of current harmonics and provides a support condition in the algorithm for improving the reactive power component of PDN, as proposed in [12]. The approach in [13] proposed phase switching method is employed for balancing the VU; however, when there is more frequent connection of EV loads, then it suffers from oscillating frequencies, which is not desirable for the PDN system. An improved version is proposed in [14], similar to [15], but this model fails in addressing the commutation failures that occur during the phase shifting process. So far, the literature has addressed referencing the VU, but very less models have focused on VD and VD when operating the Split-phase voltage quality improvement.

To address the above-mentioned problems, this article proposes VU, VD, and VH constraints for allocating the optimal charging for EV loads so that losses and effective utilization of available power can be achieved, respectively. The main contributions of this article are as follows:

a. Improved voltage quality with split-phase charging: The article demonstrates that split-phase connection of EVs significantly enhances voltage quality by reducing three-phase VU, VD, and VH.
b. Optimization using NSGA-II algorithm: The study employs the NSGA-II algorithm to optimize the split-phase charging strategy, providing effective solutions for multi-objective optimization problems with faster convergence and improved results compared to traditional methods.
c. Effective integration of renewable energy: By coordinating EV charging with wind power output, the proposed strategy balances the load distribution, ensuring optimal utilization of renewable energy sources and reducing voltage quality issues.
d. Scalability and robustness: The article validates the effectiveness of the split-phase charging strategy across varying numbers of EVs (1,000 to 5,000), confirming its scalability and robustness in maintaining voltage quality within national standards, even with increasing EV adoption.

This paper is organized as: i) Section 2 describes the charging strategy; ii) Section provides insight into mathematical modelling; iii) Section 4 describes the algorithm supporting multilayer control; and iv) Section 5 with validation of simulation results and concludes.

2. CHARGING STRATEGY OUTLINE

With the growing prevalence of EVs, the unpredictability associated with single-phase charging is also increasing [16]. The introduction of single-phase loads further intensifies the existing imbalance within the originally unbalanced PDN [17]. At the same time, the distribution grid is progressively incorporating more single-phase connections for distributed wind energy. Given that wind power generation tends to peak during nighttime and decrease during daylight hours, it aligns well with the significant single-phase charging demands of private vehicles at night. Consequently, when developing an EV charging strategy, it is essential to take into account the split-phase connections and the synergistic relationship between EVs and wind energy [18]. Connecting more EV loads to the network during peak wind power output phases helps meet charging demands while balancing wind power output [19]. Additionally, the strategy must account for harmonics introduced into the system by wind power and EVs via power electronic converters, ensuring each phase's harmonic levels remain within acceptable limits. Given the PDN's heavy load, connecting an EV load can result in low node voltage, leading to VU, VD, and VHs. This research investigates electric vehicle (EV) charging techniques designed to enhance the voltage quality at PDN nodes, while taking into account the optimal and uncontrollable utilization of distributed wind energy generation [20]. By regulating the phase of single-phase EV load connections, we can mitigate voltage quality challenges arising from the integration of EVs and wind power, as well as rectify the imbalance issues stemming from PDN base loads [21].

Figure 1(a) depicts the split-phase charging process for EVs. The power system control center collects the total scheduled charging load from each station and utilizes this information to develop a phase-oriented charging model based on the overall charging requirements and wind energy production. Subsequently, the control center communicates the charging plan to each station, directing EV users to charge their vehicles according to the designated loads outlined in the charging scheme.

3. MATHEMATICAL MODELLING OF EV CHARGING STRATEGY

More decentralization of load demand makes it difficult to estimate the voltage quality in single-phase [22]. So more robust mathematical developed in the present study for making the system more efficient.

3.1. Voltage quality analysis

EV connected to PDN has been shown in Figure 1(b). In order to ease the mathematical computation, the EV connected to the grid is considered as node *k*, and the line constraints like losses were neglected, and the power factor is high for EV loads, so reactive power is neglected. Then the resultant voltage equation at node *k* is written as (1).

$$U_k = \left(U_h - \frac{\sum_{m=k}^{n}(P_{L,M}+P_{ev})R+\sum_{m=k}^{n}Q_{L,M}X}{U_h}\right) < \left(U_h - \frac{\sum_{m=k}^{n}P_{L,M}R+\sum_{m=k}^{n}Q_{L,M}X}{U_h}\right) \quad (1)$$

U_h is the voltage at *k*, P, and Q were the active and reactive components of the system, P_{ev} is the load, R is the line resistance, and X is the reactance.

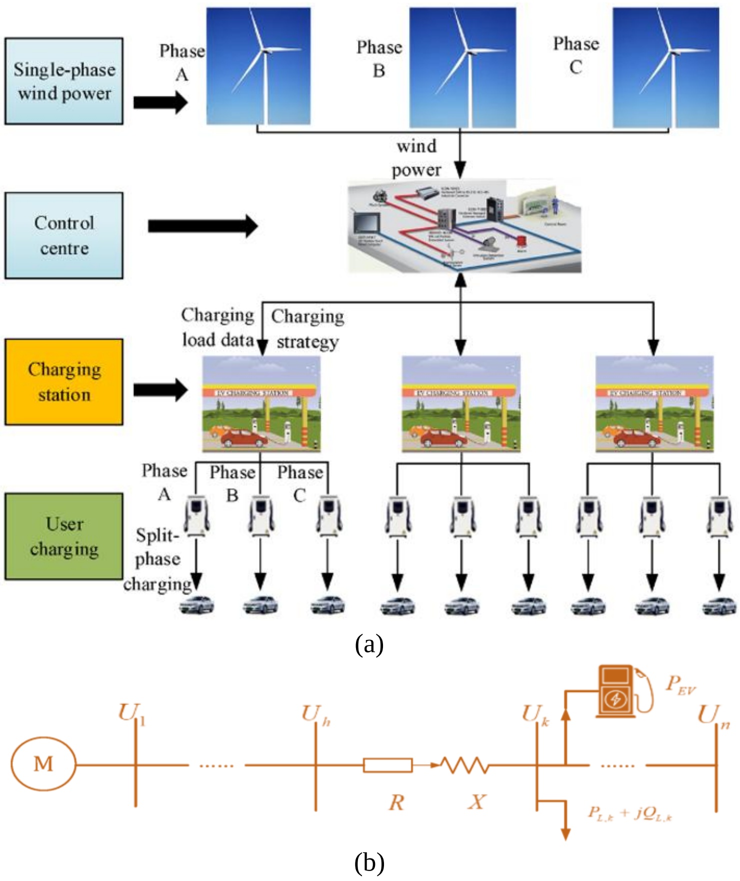

Figure 1. Schematic of (a) EV phase selection flowchart and (b) EV charging connection diagram

Further, for the above-derived equation, the optimizable variables like VU, VD, and VH components are chosen so that the final system will be robust. Firstly, let us consider the three-phase voltage unbalance VU condition, by assuming the symmetrical component approach for re-transforming the phase voltages in +ve, -ve and 0 components such that the function can be defined as (2) and (3).

$$f_1 = \sum_n^n \sum_i^m U_{VUF,i,t} \quad (2)$$

$$U_{VUF,i,t} = \left|\frac{U_{2,i,t}}{U_{1,i,t}}\right| = \left|\frac{U_{a,i,t}+\alpha^2 U_{b,i,t}+\alpha U_{c,i,t}}{U_{a,i,t}+\alpha U_{b,i,t}+\alpha^2 U_{c,i,t}}\right| \quad (3)$$

Where $U_{VUF,i,t}$ is VU at node *i*, and time *t*, further m and n represent the no. of nodes here constant $\alpha = e^{j120^0}$.

Now, the characterization equation for the VD condition for a phase system can be defined as (4).

$$f_2 = \delta U_{i,t} = \sum_n^n \sum_i^m max \frac{|U_{y,i,t} - U^*{}_{y,i,t}|}{U^*{}_{y,i,t}} \times 100\% \quad (4)$$

Here, U & U* represent the particular phase’s real-time and nominal voltages at that particular node and instant of time.

Considering the final objective of harmonics in voltage VH, the distortion rate is presented in (5) and (6). Considering the equations suggested by Ciuceanu *et al.* [21] same were incorporated for the present model for calculating harmonic current. Hence, a detailed explanation for the derivation is not provided here.

$$f_3 = THD_u = \sum_t^n \sum_i^m \sum_y \frac{U^H{}_{y,i,t}}{U^1{}_{y,i,t}} \times 100\% \quad (5)$$

$$U^H{}_{y,i,t} = \sqrt{\sum_{h=2}^{\infty} \left(U^h{}_{y,i,t}\right)^2} \quad (6)$$

Here, $U^H{}_{y,i,t}$ represents the VH of the three-phase system at a particular node and time.

The phase selection for the EV inside the grid can result in quality issues; hence, through analysis performed with the help of Pareto analysis, the highest degree function in membership will lead to a better outcome.

$$\delta_{i,j} = \begin{cases} 1, & \beta_{i,j} = \beta^{\min}{}_j \\ \dfrac{\beta_j^{\max} - \beta_{i,j}}{\beta_j^{\max} - \beta_j^{\min}} & \beta_j^{\min} < \beta_{i,j} < \beta_j^{\max} \\ 0 & \beta_{i,j} = \beta^{\min}{}_j \end{cases} \quad (7)$$

Here, the beta functions were the solution variables, min and max functions of beta are values of j on the Pareto front. Further, for deriving the optimal solution, the formula is redefined, and the membership function is represented with (8).

$$\delta_{i,best} = max\left(\sum_{j=1}^{N_j} \delta_{i,j}\right) \Rightarrow \beta_{i,best} \quad (8)$$

3.2. Constraint conditions

Three types of limitations must be incorporated in order to ensure the practicality of actual grid-connected EV charging: restrictions about EV charging, power flow mathematical balance, along additional constraints [23]. Firstly, the power flow balance constraints pertaining to active and reactive power balance equations were defined as (9).

$$\begin{cases} P_i{}^t = U_i{}^t \sum_{n=1}^N U^t{}_j\left(G_{ij} \cos\theta^t{}_{ij} + B_{ij} \sin\theta^t{}_{ij}\right) \\ Q_i = U_i{}^t \sum_{n=1}^N U^t{}_j\left(G_{ij} \sin\theta^t{}_{ij} + B_{ij} \cos\theta^t{}_{ij}\right) \end{cases} \quad (9)$$

Here, the U function represents the voltage amplitude, and the G function represents the line conductance. P & Q represent active and reactive power components.

Secondly, the EV charging constraints, which have sub-constraints like charging power, battery capacity, and power balance [24]. The charging power constraint can be defined as (10).

$$0 \leq \left(P_{EV_i}{}^{z,y}\right)_t \leq \left(\overline{P}_{EV_i}{}^{z,y}\right)_t \tag{10}$$

$$\left(\overline{P}_{EV_i}{}^{z,y}\right) = \begin{cases} P_{EV_i}{}^{z,y}, t \in [t^z{}_{in}, t^z{}_{de}] \\ 0, t \notin [t^z{}_{in}, t^z{}_{de}] \end{cases}, t \in D \tag{11}$$

In the above equation, P +ve and p -ve components were the power taken for charging and its maximum limit. Now the battery constraint has the issues included for the SOC status and levels of SOC as per (12).

$$SOC_i^{min_i{}_i{}^{max}} \tag{12}$$

Lastly, the power balancing constraint is defined as per (13), where the sub-constraints of the EV mixed and finalized the optimal equation.

$$\eta_i{}^{z,y} \sum_{t-t_n}^{t=t_{de}} \left(P_{EV_i}{}^{z,y}\right)_t \Delta T = E_i{}^{z,y} \left((SOC_i{}^{z,y})_T - (SOC_i{}^{z,y})_t\right) \tag{13}$$

Further, the other additional constraints were defined for voltage as per (14) and current as per (15), the total number of charging piles in the system is shown in (17).

$$U_i^{min_i(t)_i{}^{max}} \tag{14}$$

$$I_i(t) \leq I_i{}^{max} \tag{15}$$

$$0 \leq M_i{}^y \leq N_i{}^y \tag{16}$$

4. DESIGN OF A MULTILAYER ALGORITHM FOR EV CHARGING STRATEGY FOR VOLTAGE QUALITY

Voltage quality indices are obtained through power flow analysis. These indices rely on the calculation of three-phase unbalanced power flow, which must be performed at each instance of EV charging and grid connection to ensure precise voltage quality information via three-phase current assessments. The daily demand from EVs and the output from wind power are projected using the Monte Carlo simulation (MCS). After establishing the fundamental system parameters and constraints, the three-phase power flow is computed to evaluate voltage quality. This information is then integrated with the objective function in the inner layer, where the NSGA-II algorithm formulates various charging strategies. These strategies are subsequently returned to the outer layer for an assessment of their impact on voltage quality. Ultimately, the optimal split-phase charging strategy is identified through the affiliation function. The methodology of this two-layer algorithm is depicted in Figure 2(a), and the simulation environment in MATLAB version is provided in Figure 2(b).

4.1. The functionalities of the outer layer

The outer layer of the algorithm consolidates the EV loads from the inner layer and employs power flow analysis to assess the voltage quality of the PDN across various charging scenarios. Due to the inherent characteristics of the imbalanced PDN [22]-[24], including three-phase load imbalance and asymmetry in the three-phase factors, along with the uncoordinated grid-connected charging of single-phase EVs and wind energy, directly applying the equivalent single-phase trend calculation method to the three-phase network proves impractical [25]. In this study, the forward-backward generation technique [26] is implemented to evaluate both voltage quality and three-phase power flow.

Establishing the system initialization state, which consists of parameters like grid state, EV load state, wind power output, and grid connection diagram. Create admittance matrices for the three-phase system node points and further start number sequencing for each node or node k. The injection node current is defined with a predefined formula as shown in (17)-(19).

$$I_{k,it}{}^{1,2,0} = TI_{k,it}^{a,b,c} \tag{17}$$

$$I_{kd,it}^{a,b,c} = \frac{S^*y}{U^*y} \tag{18}$$

$$T = \frac{1}{3}\begin{pmatrix} 1 & \alpha & \alpha^2 \\ 1 & \alpha^2 & \alpha \\ 1 & 1 & 1 \end{pmatrix} \tag{19}$$

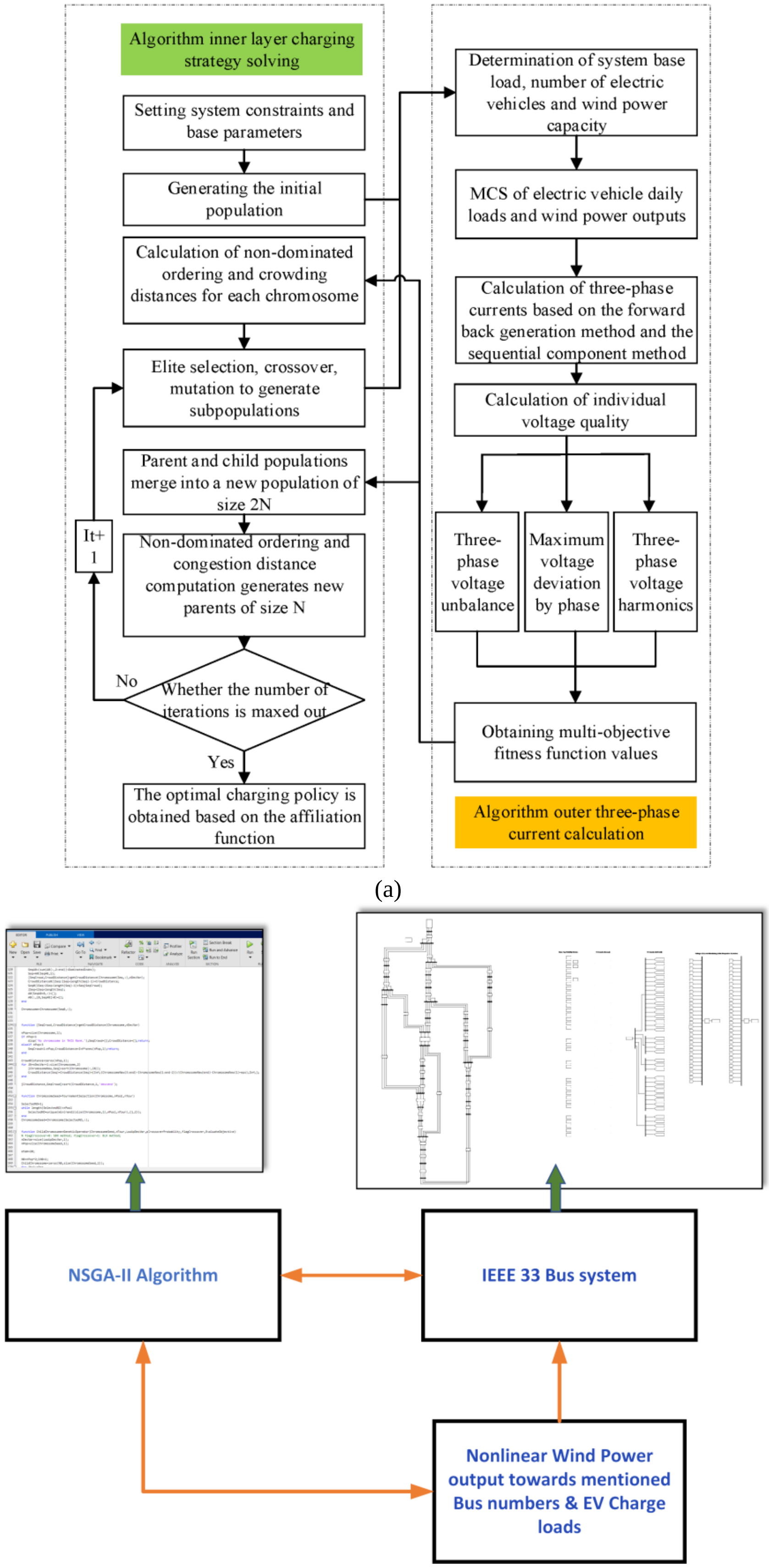

Figure 2. View of (a) bilayer algorithm and (b) simulation environment in MATLAB

Here, current vectors of +ve, -ve and 0 sequences represented as ${I_{k,it}}^{1,2,0}$ and S_y is the load matrix, and accordingly, U is the voltage matrix. Further, the updated injected current and power are expressed as (20).

$$ {I_{k,it}}^{1,2,0} = \sum I_{kd,it}^{a,b,c} + \sum I_{kl,it}^{a,b,c} \quad (20) $$

Here, the equation is a merger of load and line sequence currents.

$$ {S_{k,it}}^{1,2,0} = \sum S_{kd,it}^{a,b,c} + \sum S_{kl,it}^{a,b,c} \quad (21) $$

Iterations performance for voltage value generation using processes like single-phase forward-back generation, nodal voltage technique [24], such that the three-phase voltage obtained at the node is defined as (22).

$$ U_{it+1}^{a,b,c} = T^{-1} U_{it+1}^{1,2,0} \quad (22) $$

Now the convergences for the maximum point of voltage difference are done, and if satisfactory levels are not achieved, then steps 3 to 6 are repeated to achieve maximum convergence.

$$ \Delta U = max\left|U_{it+1}^{a,b,c} - U_{it}^{a,b,c}\right| < \varepsilon \quad (23) $$

Now, finally, the voltage quality is assessed and fed into the inner layer.

4.2. Functionalities of the inner layer

The inner layer of the algorithm optimizes the split-phase charging strategy using the NSGA-II algorithm, which enhances multi-objective optimization [20] with better speed and convergence than the traditional GA method [22]. The process involves:

i) Initialization: Assess the fitness of the multi-objective function utilizing initial data on EV accessibility and voltage quality from the outer layer.
ii) Genetic Evolution: Calculate crowded and non-dominated ordering distances, combine offspring with parents, and generate new populations through processes such as crossover, mutation, and elite selection.
iii) Selection: Preserve individuals ranked by quality in descending order, choosing the final subset with higher crowding distance to establish a new parent population.
iv) Iteration: Confirm the completion of iterations; if the criteria are not met, return EV charging strategies to the outer layer and repeat the procedure until the requirements are fulfilled.
v) Final Optimization: Employ the affiliation function to determine the optimal phase strategy within the Pareto solution set.

5. VALIDATION AND RESULT ANALYSIS

The simulation validation is presented in this section, and for simulation validation MATLAB environment is used, and for algorithm implementation convergence MATLAB script has been used, as shown in Figure 3(a). The various cases considered for the performance validation of the proposed method are as follows:

5.1. A standard basic power grid load testing

To validate the efficacy of the proposed system towards some basic standards, the IEEE-33 standard node architecture is utilized. An improvised IEEE-33 standard node architecture is used for the suggested case study towards the wind power system. The 12 nodes of PDN have a power input of 3.36 MW combined from various wind turbines. Nodes 17 to 31 have an approximate load from EVs ranging from 800 to 1200. These nodes have access to communications to the connected load, and a ratio of 6:4:5 is maintained towards the capacity levels. The phase-wise access for the load connected at the parallel points in Figure 3(b) presents the load access without the proposed algorithm, and Figure 3(c) presents the results with the proposed algorithm.

5.2. Performance analysis of phase selection

Figures 4(a) and 4(b) illustrate the phase-wise load access at the parallel connection points. Specifically, Figure 4(a) presents the system behavior without the proposed algorithm, whereas Figure 4(b) demonstrates the improvement achieved when the algorithm is applied. From the results, it can be observed that without an algorithm, the load is disordered as Phase C received more load and created the unbalance in the system. In contrast, the proposed algorithm effectively distributed the load to all phases equally with the split-phase algorithm.

Further wind power was generated, and the load line of EVs was shown in Figure 4(a). The 33-node base load, along with the connected sites of the grid, is shown in Figures 4(b) and 4(c). The PDN described above has the following rating: a capacity of 100 MVA power and a maximum voltage rating of 12.66 KV.

Further, a total of six scenarios were proposed to assess the performance of the proposed algorithm and how effectively the charging technique is implemented to enhance the system's voltage quality. Further proposed scenarios were listed in Table 1. Where the average and maximum values are taken into consideration for assessing the voltage quality under various conditions of the system

Examination of Table 2 shows that in Case Studies 1, 2, and 3, the indicators increase when EVs are associated with average and disordered access. This is because lack of offset for increased energy production and the exacerbation of three-phase load differences by the base grid load. Split-phase charging improves voltage quality, reducing system VU by a percentage of 24.56% compared with average access for EVs and 32.81% compared to disordered access. The max. SP-VD decreases by 4.89% when compared with the average access and 9.11% when compared with disordered access. VH at the grid point is reduced by 6.25% when compared with disordered access. In average and disordered access scenarios, three-phase unbalance and VD exceed national standards by more than 2% and 7%, respectively. The charging strategy in this work ensures voltage quality meets national standards. Careless selection of charging piles leads to significant voltage quality overruns, highlighting the need for split-phase charging to meet voltage quality standards.

The max. 3-phase VU, VD, and VH observed rates are 1.778%, 6.528%, and 0.286%, respectively. However, optimizing for a single voltage quality increases the other two to varying degrees. This paper's charging technique minimizes the overall target while achieving the best possible equilibrium for all three of the voltage attributes.

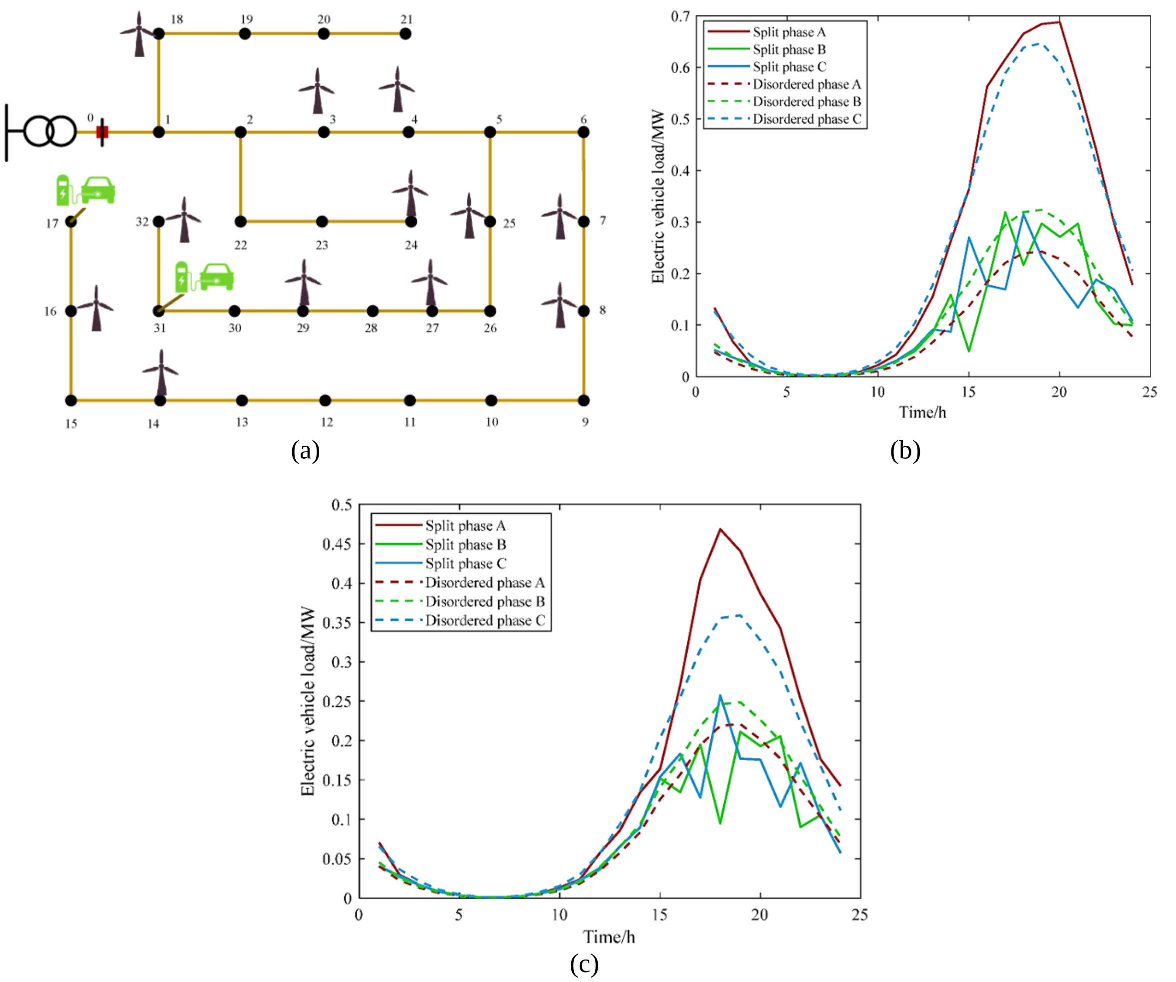

Figure 3. Structural view of (a) IEEE-33 standard node system and 3-phase harmonics, (b) load access without the proposed algorithm, and (c) load access with the proposed algorithm

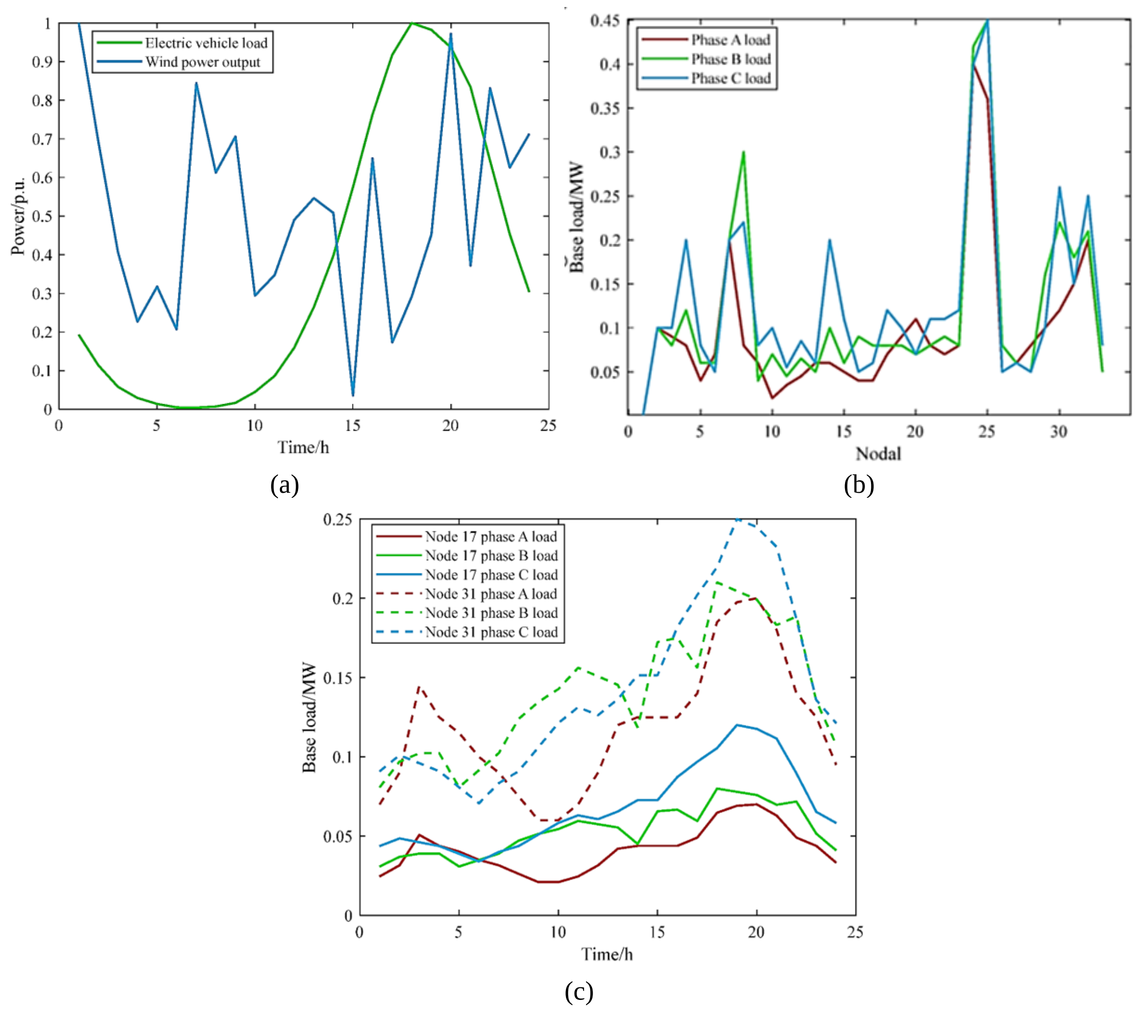

Figure 4. Representation of (a) generated wind power and load of EVs, (b) 3-ph base load for IEEE-33 systems, and (c) 3-ph base load at nodes 17 and 31

Table 1. PDN voltage quality under different scenarios

Scenario	3-phase VU %		VD per phase %		VH at grid node points %	
	Avg. value	Max. value	Avg. value	Max. value	Avg. value	Max. value
1. EV Avg. access to 3-phase charging	0.568	2.528	3.67	7.63	0.15	0.308
2. EV has disorderly access to 3-phase charging	0.65	3.35	4.06	9.40	0.15	0.457
3. Split Phase access with the goal of voltage quality	0.44	1.9	3.68	6.57	0.16	0.357
4. Only consider a minimum 3-phase VU	0.374	1.781	3.684	6.66	0.15	0.381
5. Considering the Min and Max of per-phase VD	0.423	1.884	3.634	6.521	0.15	0.408
6. parallel network point's minimum VH	0.465	1.91	3.762	6.584	0.15	0.29

Table 2. The comparative approach of the proposed method with the available literature

Literature referred	Intended regulation targeting	Optimization target			
		P t V	VU	VD	VH
Work in [5]	EV's	C	NC	NC	NC
Work in [6]	EV's	C	NC	NC	NC
Work in [7]	EV's	C	NC	NC	NC
Work in [8]	EV's	C	NC	NC	NC
Work in [11]	Embedded device tech.	NC	C	NC	NC
Work in [12]	Embedded device tech.	NC	NC	NC	C
Work in [13]	Embedded device tech.	NC	C	NC	NC
Work in [14]	Embedded device tech.	NC	C	NC	NC
Proposed method	EV's	C	C	C	C

Note: In the above table, C -represents the optimization target is considered, and as well as NC means Not Considered

Compared to methods in [7]–[14], which target single optimization objectives or rely heavily on static pricing models, the proposed strategy provides a more holistic approach by simultaneously addressing VU, VD, and VH through dynamic phase allocation. Unlike phase switching techniques [13], [14] which face operational issues like oscillation or commutation failures, the two-layer strategy here leverages NSGA-II to iteratively refine charging plans, making it suitable for scalable, real-time deployment. The improvements demonstrated—VU reduced by over 32%, VD by 9%, and VH by 6%—show strong advantages in both performance and robustness.

6. CONCLUSION

This study presents a multi-layer split-phase charging strategy for EV integration, effectively mitigating voltage quality issues such as VU, VD, and VH in PDNs. By strategically optimizing EV load distribution across three phases while leveraging wind power generation, the proposed methodology significantly improves voltage stability and ensures compliance with national voltage quality standards.

Simulation results demonstrate that the proposed split-phase access method achieves a VU reduction of up to 32.81%, a maximum VD reduction of 9.11%, and a VH reduction of 6.25% at grid node points compared to conventional EV charging strategies. Furthermore, optimization using the NSGA-II algorithm accelerates convergence, ensuring an effective balance of multi-objective voltage quality parameters. The study also validates the proposed strategy's scalability, maintaining voltage quality within permissible limits even as the number of connected EVs increases from 1,000 to 5,000, thereby reducing overall grid stress and enhancing PDN operational efficiency.

Future research may explore integrating more advanced forecasting algorithms for EV arrival times and wind energy variability, enabling proactive scheduling. Additionally, the scalability of this method could be enhanced by testing on urban-scale networks with real-time feedback mechanisms. Investigating integration with AI-driven demand response systems and addressing cybersecurity challenges in distributed EV communication are also promising directions.

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Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Attada Durga Prasad	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	
Manickam Siva		✓				✓		✓	✓	✓	✓	✓		
Alla Srinivasa Reddy	✓		✓	✓		✓			✓		✓		✓	

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

Data availability is not applicable to this paper as no new data were created or analyzed in this study.

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BIOGRAPHIES OF AUTHORS

Attada Durga Prasad is an Assistant Professor in the Department of Electrical and Electronics Engineering at Sir C. R. Reddy College of Engineering, Eluru, Andhra Pradesh, India. He received his B.Tech. and M.Tech. degrees in Electrical and Electronics Engineering in 2009 and 2012, respectively. He has been working as an assistant professor since 2012. He is, at present, the External Research Scholar of Annamalai University, Annamalai Nagar, Tamil Nadu, India. His research interests include power systems, power electronics, and renewable energy. He can be contacted at email: prasad.phdannamalai2019@gmail.com.

Manickam Siva is an Assistant Professor in the Department of Electrical Engineering at Annamalai University, Annamalai Nagar, Tamil Nadu, India. He received his B.E., M.E., and Ph.D. Degrees in Electrical Engineering in 1999, 2008, and 2019. He has been working as an assistant professor since 2002. He published 5 papers in International Journals. His research interests include power electronics, renewable energy, and power systems. He can be contacted at email: vasi.siva@gmail.com.

Alla Srinivasa Reddy was a Professor in the Department of Electrical and Electronics Engineering at Sir C. R. Reddy College of Engineering, Eluru, Andhra Pradesh, India. He received his B.Tech, M.Tech., and Ph.D. degrees in Electrical Engineering in 1998, 2000, and 2011, respectively. He has been working as a professor since 2012. He published 16 papers in International Journals. His research interests include power system dynamics, power electronics, and renewable energy. He can be contacted at email: eeehod@sircrrengg.ac.in.