A Review on Optimization Techniques for Electric Vehicles Planning in Distribution Networks

Bindeshwar Singh[1], Arvind Pratap[2], and Prabhakar Tiwari[2]
1Department of Electrical Engineering, Kamla Nehru Institute of Technology, Sultanpur, INDIA
2Dept. of Electrical Engineering, Madan Mohan Malaviya University, Gorakhpur, INDIA

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Abstract: This paper presents a study of various optimization techniques for electric vehicles (EVs) planning in distribution systems with load models for the minimization of the system's actual and reactive power losses to boost system performance. System performance such as available power transfer capability, system versatility, system loadability, system power factors, system protection, system reliability, voltage profile, system oscillations, system stability, power quality and greenhouse gas (GHG) environmental performance, etc. are achieved by planning electric vehicles (EVs) in distribution systems with load model. The authors strongly believe that this analysis paper would be very useful for researchers, designers, clinicians, academics and scientists to find appropriate references in the field of planning EVs in distribution systems with load models to improve system efficiency from various points of view of objective functions.

1 INTRODUCTION

In the present scenario of energy planning, the different types of EVs are having important roles. The power technology planning such as EVs planning, are studied and analyzed for future research. But in this article only considered the EVs planning in distribution systems with load models mainly focused.

The conventional optimization techniques such as Value-Based Control Technique (VBCT), Index Methods (IM), Adaptive Control Algorithm (ACA), Frequency Variable (FV), Static Voltage Stability Assessment Method (SVSAM), Sensitivity Based Methods (SBM), Eigen-Value Analysis (EVA), Optimal Power Flow (OPF), Power train Systems Analysis Toolkit (PSAT), SBM, and OPF, EVs planning have been studied in review.

The analytical optimization-based techniques such as Mixed-Integers (MI), Non Linear Programming (NLP), Analytical Approaches (AA), Optimization Algorithm (OA), Robust Optimization (RO), Linear Programming (LP), Dynamic Programming (DP), Dual Programming, Mix Integer Linear Programming (MILP), Stochastic Dynamic Programming (SDP), Sequential Quadratic Programming (SQL), and Ordinal Optimization (OO) approach EVs planning have been also studies in past literature.

The artificial intelligence computational techniques, Monte Carlo (MC) Algorithms, Emultion Based (EB) Method, Simulated Annealing (SA) Based Approach, Genetic Algorithms (GA), Particle Swarm Optimization (PSO) Techniques, Fuzzy Logic (FL) Based Method, Artificial Neural Network (ANN) Based Algorithms, Tabu Search (TS) algorithms, Cluster-Wise Fuzzy Regression (CWFR) Analysis, Artificial Bee Colony (ABC) Algorithms, Honey Bee Mating Optimization (HBMO), Fuzzy Logic, Particle Swarm Optimization, Monte Carlo, Heuristic Planning Algorithms (HPA), Genetic Alogithm, Artificial Neural Network, Ant Bees Colony and Search Algorithm EVs planning have been studied in past study. Hybrid optimization techniques (HOTs) for EVs planning have been also found in past research literatures.

The optimization-based techniques such as Mix Integer nonlinear Programming, Agglomerative Hierarchical Clustering (AHC) Method, Whale Optimization Algorithm, Optimal Power Flow , MINLP & NSGA-II, Generalized Nash Equilibrium Problem (GNEP) & Relaxation Algorithm (RA), Quadratic Roteted Conic Programming (QRCP) & Multi Stage Optimization Coordination Method

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(MSOC), Greedy Randomized Adaptive Search (GRAS) &Tabu Search, Karush-Kuhn-Tucker (KKT) conditions and Stochastic Framework (SF) for EVs planning are proposed for future research. Recent optimization techniques (ROTs) for EVs planning have been also found in recent research works of literature.

The literature survey, quoted in the review article, deals with the preparation of EVs in power systems with different load models, such as static and dynamic, using various optimization strategies to increase system performance from the perspective of different target functions. The literature review shows that in the open works of literature, the investigation of various system performances with EVs planning in power systems with different load models using existing optimization techniques such as Ant Lion optimization, Spider Monkey optimization, Whale optimization algorithm, Grey Wolf optimization, etc. has not been used.

A review article presents an impact assessment EVs planning in systems with different load models from different objective functions for enhancement of system performances. This article mainly focused on the impact assessment of EVs in distribution system with ZIP load models from different objective functions for enhancement of the system performances such as real and reactive power losses, system stability, system security, system reliability, system loadability, bandwidth of operation, system oscillation, greenhouse gases, etc. are not published any journals.

The main contributions of this review paper are as follows:

- System performance variations for EVs planning for different load models such as static, realistic, ZIP, composite, frequency-dependent load models, etc.
- Robustness of the proposed algorithms for EVs planning with load models.
- Practical system validity for EVs planning with load models.

The rest structures of the paper are as follows: Section 2 discusses EVs planning. The paper's findings and future scope of research are discussed in Section 3.

2 LITERATURE SURVEY FOR DGS WITH EVS PLANNING

A literature survey for EVs planning are discussed in sub-sections 2.1-2.3, subsequently. EVs Planning The different optimization techniques are discussed for EVs planning with load models are as follows:

2.1 Conventional Optimization Techniques

The conventional optimization techniques for EVs planning [1-10] are presented as follows: For improved system efficiency, Zhang et al. proposed charge-depleting control techniques and fuel optimization of blended-mode PHEVs. Sanjaka et al., presented a source-to-wheel analysis of PHEVs. Zhang et al., represented the impact of silicon carbide devices on hybrid electric and PHEVs. Seshadri and Alireza presented a possible factor for electrification: energy-based value proposition study of PHEVs for system efficiency improvement. Reza et al., presented an on the conversion of hybrid electric vehicles to plug-in for system performance enhancement. The architecture of a Bayesian network model for optimum site selection of electric vehicle charging stations was suggested by Seyed and Sarder. Yongxiu et al. proposed a production pattern design for Chinese EVs based on a life cycle cost study of the essential cost. Simone et al., presented socio-technical inertia: understanding the barriers to EVs. Harun and Seddik, presented an optimal minimization of PEVs charging cost with vehicle-to-home and vehicle-to-grid concepts. Hua et al., presented an ADMM-Based multiperiod OPF considering PEVs charging for system performance enhancement. The conventional optimization techniques for EVs planning are presented in Table 1.

2.2 Optimization Techniques

The EV planning optimization strategies are presented as follows: Gong et al., for system performance improvement, proposed trip-based optimal power control of PHEVs. Kristien et al., addressed the effect of charging PHEVs for system efficiency improvement on a residential delivery grid. Saber et al. addressed the resource scheduling of renewable and plug-in vehicles under instability in a smart grid. Micro turbine-powered PHEVs should be handled for energy management using the telemetry equivalent consumption minimization technique, according to Geng et al. Kum et al. suggested optimizing PHEV energy and catalyst temperature for low fuel consumption and pollution at the tailpipe. A two-stage energy management regulation of fuel cell PHEVs considering fuel cell durability was proposed by Geng et al. A description and analysis of control strategies for PHEVs for system performance improvement was proposed by Sanjaka and Ali. Linni et al. suggested a regulated charging of PHEVs to minimize load variance in the household smart microgrid. Justin et al., presented the optimum involvement of PHEVs in the power market pooled by distribution feeders. Wisdom and Chris, introduced hybrid electric vehicle modeling and control (a comprehensive review). The macroeconomic effects of fiscal subsidies for the development of electric vehicles in Iceland has been presented by Ehsan et al.: consequences for government and market prices.

Amir et al., proposed a RO approach to scheduling the transition to system performance improvement PHEVs. For the grid implementation of electric vehicles, Haddadian et al. suggested a safety-constrained schedule of power generation with thermal generating systems, variable electricity sources, and storage of electric cars. Hamed et al. addressed the long-term complex preparation of the extension of generation capacity and power transmission networks in multi-carrier energy systems. Raji and Noboru proposed a more precise dimensioning of RESs under the high degree of incorporation of electric vehicles. A multi-objective energy storage power delivery using PEVs in a smart-micro grid was proposed by Vitor et al. Stephanie et al., for real-world driving cycles, proposed an energy-optimal regulation of PHEVs. Menyang et al., proposed an AA for blended-mode PHEV power management. Luting and Chen suggested a consensus algorithm-based distributed control system for large-scale PEV charging. Weihao et al. suggested the best way to use PEVs in power systems with high wind penetration. In a microgrid, Peng et al. suggested a model predictive control system for matching uncertain wind generation with PEV charging demand. Maryam et al. suggested a decentralised, robust model for organizing smart delivery network and EV aggregator operation. Luis and Raquel, proposed a rigorous stochastic optimization approach for an EV aggregator bidding technique. Xiangning et al., proposed a distribution network scheduling integration of vehicle-to-grid EV charging stations for system efficiency improvement. Sheikhi et al., proposed a method of strategic charging for smart grid PHEVs; a game-theoretical approach. Junjie et al., presented smart grid EV fleet management: a study of facets of facilities, optimization, and regulation. Kumarsinh et al., proposed a coordinated EV charge with RESs for system efficiency enhancement for the commercial parking lot. Table 2 addresses the preparation of EVs by optimization techniques.

2.3 Ai Computational Techniques

AI estimation methods for planning EVs are discussed as follows: Li et al., introduced the power and battery control of a hybrid EV plug-in series using FL. A charging load profile on the grid attributable to plug-in vehicles was proposed by Soheil et al. A two-stage charging technique for PEVs at the residential transformer level was proposed by Genget al.. A smoothing of wind power using the demand response of EVs was proposed by Raoofat et al. A multi-objective optimal charging of PEVs in unbalanced distribution networks was introduced by Masoud and Ali. AI estimation methods for planning EVs are discussed as follows:

Ning et al. suggested a fuzzy chance-constrained unit interaction problem programme that took demand response, electric vehicles, and wind power into account. Naik et al. suggest a smart mass transportation network expansion and its link to the grid. Janjic suggested a two-step algorithm for optimizing an energy delivery company's fleet of vehicles. On the basis of FL, Qi et al. proposed an energy storage approach for fuel cell/battery/ultracapacitor hybrid vehicles. Saber et al. proposed a new smart charging system for EVs for smart grid frequency management. A fuzzy algorithm for EV parking lot service was suggested by Samy et al. Daya et al. addressed an investigation and numerical improvement of the wavelet controller for robustness in the electronic differential of EVs. In a regenerative braking mode, Joy and Ushakumari demonstrated the work of a three-phase H-bridge inverter feeding permanent magnet brushless direct current motor-generator drive in an electric bike. A real-time energy regulation solution was introduced by Suyang et al. for the smart home energy management framework. Liyeet al. proposed an estimation model for the economic operation of the energy-internet-oriented active distribution network. Reddy and Meikandasivam, using a water-filling algorithm for load flattening and vehicle prioritization using the adaptive neuro-fuzzy inference method, proposed an optimal distribution of PEV storage space. An automated failure analysis of electrical machinery was proposed by Awadallah & Morcos: a case study of permanent magnet brushless direct current motors.

To improve the stability of the PEV power system, Mitra suggested a wide-area control system. Saberet al. suggested a resource scheduling algorithm for a smart grid of renewables and plug-in electric vehicles that is unstable. Charging infrastructures, according to Huet al., should be strategically positioned to allow for large-scale integration of pure EVs into the grid. Yachao et al. suggested a multi-objective hydro-thermal-wind synchronization scheduling combined with large-scale EVs using improved multi-objective PSO. Chunyan et al. suggested optimal spatio-temporal scheduling for EVs and load aggregators, taking response efficiency into account. For robust monitoring of renewable energy, Saeid and Hosam proposed transport-based load modelling and sliding-mode PEV regulation. Casey et al. suggested an evaluation of state-of-charge constraints and drive signal energy quality on PHEV, vehicle-to-grid reliability, and economics. Yue and David suggested a Markov chain MC simulation of EV consumption for network integration studies. Pashajavid and Golkar suggested non-Gaussian multivariate modelling of PEV load production. Akashet al. suggested a stepwise power tariff model with a game theory focused on MC simulation and its implementations for household, agricultural, commercial, and industrial customers. Alireza et al proposed a stochastic characterization of the energy markets for electricity, including PEVs for optimizing device efficiency. Jun et al. addressed the modeling of large-scale charging market for EVs: a case study from New Zealand. Gray and Morsi addressed the effect of single-phase charging of PEVs and solar photovoltaic rooftops on the ageing of distribution transformers. Gray and Morsi addressed the role of prosumers (power producers and consumers) owning solar photovoltaic rooftops in reducing the effect of PEV charging on the ageing of the transformer. Leonardo et al, proposed EV models to determine supply security. Gray and Morsi presented an economic evaluation of the reconfiguration of phases to mitigate the disparity due to the charging of PEVs. An efficient secondary distribution system layout considering PEVs was proposed by Abdelsamad et al.. Gray and Morsi proposed a probabilistic quantification in secondary distribution systems of voltage difference and neutral current due to the charging of plug-in battery EVs. Nima and Peng have proposed a probabilistic approximation of the charging load profile of PEVs. In the face of load and generation instability, Wang et al. suggested an affine arithmetic-based direct current power flow for automatic contingency selection. On the distribution network, Zhou et al.suggested a probability model and EV charging load simulation approach. Jaber et al. proposed a modern charging demand model based on the accumulation of PHEVs. Nan et al. proposed a smart residential group optimal scheduling solution that took into account residential load uncertainties.

An HPA method evaluation of the effect of PEVs on distribution networks for system performance improvement was explored by Luis et al. Xiaohu et al., provided high-frequency resonance reduction with a broad variety of grid requirements for PHEVs incorporation. According to Navarro et al., an EV fast-charging station can be installed using clean energy and storage technology. Moein et al. suggested a novel Volt-VAR optimization engine for smart delivery networks using the vehicle for grid dispatch. Chen et al. presented a cost-benefit analysis of an energy storage system based on recycled EV batteries. Susana et al. proposed electrical and parallel-hybrid EV modeling using the Matlab/Simulink setting and charging station planning through a geographic information system and GA. The commercial EV fleet scheduling for secondary frequency management was proposed by Aleksandar et al.. Saeed et al. suggested simultaneous planning for PHEV charging stations and wind power generation in distribution networks, taking into account uncertainties. Online modelling and recognition of PEVs sharing a residential station was proposed by Abdoul et al. Guohai et al. suggested a neural network-based internal model decoupling control of the three-motor drive system. Panchal et al suggested a thermal and electrical performance assessment of lithium-ion battery modules for an EV under actual drive cycles. Rathore and Roy discussed the effect on transmission network extension planning of wind instability, PEVs and the demand response program. Tiago et al. proposed shared control of EVs in simulated annealing to cope with energy and ancillary services. The artificial intelligence computational techniques for EVs planning are presented in Table 3.

2.4 Hybrid Optimization Techniques

Hybrid optimization techniques for EVs planning are discussed as follows: A description and analysis of control methods for PHEVs was proposed by Wirasingha and Emadi et al. Nojavan and Zare proposed that an electricity retailer with BEVs could have an acceptable energy price for customers. Mehdi et al., proposed a risk-averse power planning look-ahead of heterogeneous BEV aggregations that allow vehicle-to-grid and grid-to-vehicle systems based on the theory of information gap decision. Reddy et al., proposed a novel approach for optimizing the use of PHEV storage for grid service with consumer flexibility in mind. John et al., discussed the coordination of localized charging PHEVs utilizing only local voltage magnitude measurements. Farahani et al., including PHEV, proposed a multi-objective clearing of the demand for reactive capacity. An estimate of voltage mismatch impacts of PHEV penetration in residential low-voltage delivery networks was proposed by Farhad et al. Arman et al, proposed an automatic regulation of generation that integrates BEVs. The effect of observability and multi-objective optimization on the efficiency of the extended Kalman filter for direct torque control of alternating current machines with PHEV was proposed by Ibrahim et al. Reza et al., discussed the conversion of hybrid EVs to plug-in for system performance enhancement. The hybrid optimization techniques for EVs planning are presented in Table 4.

2.5 Other Optimization Techniques

Other optimization techniques for EVs planning are presented as follows: Tara et al.proposed battery storage sizing for system efficiency enhancement in retrofitted PHEVs. Sara et al. proposed scheduling PHEV charging in smart grids in real-time to minimize power losses and increase the profile of voltage. Jose et al., addressed a rational configuration of the vehicle-to-grid control PHEVs aggregator. A network security-aware charging of PHEVs was proposed by Tian et al. Xu et al., introduced the EX-PHEV aggregator's decentralized charging control technique focused on the enhanced lagrangian process. Wolf et al., presented the use of PHEV capabilities with a new software platform for demand response optimization: Okeanos. In the imperfect energy markets, Schill addressed BEVs: The case of Germany. A QRTM of PHEVs charging for system efficiency improvement was proposed by Soares et al. Table 5 displays the other optimization methods for planning EVs.

Table 1: Conventional optimization techniques for EVs planning with load models

Ref. No.	System performances	Control parameters	Proposed methods	Load models	Future scopes
[1]	System power factor	Location & types	PSAT	STATLM	MOO
[2]	Environmental GHG	Size & types	PSAT	STATLM	RLMs
[3]	System oscillations	Location & coordination	PSAT	STATLM	RLMs
[4]	System flexibility	Location & types	PSAT	STATLM	HOTs
[5]	System security	Size & types	PSAT	STATLM	HOTs
[6]	System reliability	Size & location	SBM	RLMs	MOO
[7]	Frequency stability	Location & types	SBM	STATLM	HOTs
[8]	System loadability	Size & types	SBM	STATLM	HOTs
[9]	Voltage stability	Size & location	OPF	STATLM	RLMs
[10]	Frequency stability	Location & types	OPF	STATLM	RLMs

Table 2: Optimization Techniques for EVs Planning with Load Models

Ref. No.	Authors	Pub. year	System performances	Control parameters	Proposed methods	Load models	Future scopes
[11]	Li et al.	2011	Rotor angle stability	Location & types	FL	STATLM	RLMs
[12]	Soheil et al.	2012	Frequency stability	Size & types	FL	STATLM	RLMs
[13]	Geng et al.	2013	System flexibility	Location & coordination	FL	STATLM	HOTs
[14]	Raoofat et al.	2018	System security	Location & types	FL	STATLM	RLMs
[15]	Masoudet al.	2015	System reliability	Size & types	FL	STATLM	RLMs
[16]	Ning et al.	2015	Frequency stability	Size & location	FL	STATLM	HOTs
[17]	Naik et al.	2019	System loadability	Location & types	FL	STATLM	RLMs
[18]	Janjic	2015	Voltage stability	Size & types	FL	STATLM	RLMs

[19]	Qi et al.	2012	Frequency stability	Size & location	FL	STATLM	RLMs
[20]	Saber et al.	2016	Real power loss	Location & types	FL	STATLM	ROTs
[21]	Samy et al.	2017	System power factor	Size & types	FL	STATLM	ROTs
[22]	Daya et al.	2016	Rotor angle stability	Size & location	FL	STATLM	ROTs
[23]	Joy &Ushakumari	2018	Environmental GHG	Location & coordination	FL	STATLM	ROTs
[24]	Suyang Z et al.	2014	System oscillations	Location & coordination	FL	STATLM	RLMs
[25]	Liye et al.	2019	System flexibility	Size & types	FL	STATLM	ROTs
[26]	Reddy et al.	2018	Real power loss	Size & location	FL	STATLM	ROTs
[27]	Awadallah et al.	2005	System power factor	Size & types	FL	STATLM	ROTs
[28]	Mitra	2010	Environmental GHG	Size & location	PSO	STATLM	ROTs
[29]	Saber et al.	2012	System oscillations	Size & types	PSO	STATLM	ROTs
[30]	Xu et al.	2015	System flexibility	Location & coordination	PSO	STATLM	RLMs
[31]	Yachaoet al.	2018	Power system security	Location & types	PSO	STATLM	RLMs
[32]	Chunyan L et al.	2018	Reactive power losses	Location & types	PSO	STATLM	RLMs
[33]	Saeid et al.	2012	System power factor	Size & location	MC		RLMs
[34]	Casey et al.	2012	System oscillations	Location & types	MC	STATLM	RLMs
[35]	Yue et al.	2018	System stability	Size & types	MC	STATLM	RLMs
[36]	Pashajavid et al.	2014	System security	Size & location	MC	STATLM	RLMs
[37]	Akashet al/	2017	System reliability	Location & types	MC	STATLM	RLMs
[38]	Alirezaet al.	2019	Environmental GHG	Size & types	MC	STATLM	ROTs
[39]	Jun et al.	2017	System flexibility	Size & location	MC	STATLM	RLMs
[40]	Gray et al.	2019	System loadability	Location & types	MC	STATLM	RLMs
[41]	Gray et al.	2017	Voltage stability	Size & types	MC	STATLM	RLMs
[42]	Leonardo et al.	2014	Rotor angle stability	Location & types	MC	STATLM	RLMs
[43]	Gray et al.	2016	Frequency stability	Size & types	MC	STATLM	RLMs
[44]	Abdelsamad et al.	2016	System flexibility	Location & coordination	MC	STATLM	MOO
[45]	Gray et al.	2016	Environmental GHG	Location & types	MC	STATLM	RLMs
[46]	Nimaet al.	2015	System oscillations	Size & types	MC	STATLM	RLMs
[47]	Wang et al.	2014	Frequency stability	Size & location	MC	STATLM	HOTs
[48]	Zhou et al.	2014	System loadability	Location & types	MC	STATLM	HOTs
[49]	Jaber et al.	2017	Voltage stability	Size & types	MC	STATLM	HOTs
[50]	Nan et al.	2019	Frequency stability	Size & location	MC	STATLM	ROTs
[51]	Luis et al.	2011	Real power loss	Location & types	HPA	STATLM	RLMs
[52]	Xiaohu et al.	2012	System power	Size & types	GA	STATLM	HOTs

			factor				
[53]	Navarro et al.	2019	Rotor angle stability	Location & coordination	GA	STATLM	RLMs
[54]	Moeinet al.	2016	Environmental GHG	Location & types	GA	STATLM	RLMs
[55]	Chen et al.	2013	System oscillations	Location & types	GA	STATLM	HOTs
[56]	Susana et al.	2016	System flexibility	Size & location	GA	STATLM	RLMs
[57]	Aleksandaret al.	2017	Real power loss	Location & types	GA	STATLM	RLMs
[58]	Saeed et al.	2016	System power factor	Size & types	GA	STATLM	HOTs
[59]	Abdoulet al.	2019	Environmental GHG	Size & location	ANN	RLMs	ROTs
[60]	Guohai et al.	2012	System oscillations	Location & coordination	ANN	STATLM	RLMs
[61]	Panchal et al.	2018	System flexibility	Location & types	ANN	STATLM	HOTs
[62]	Rathore et al.	2016	System security	Size & types	ABC	STATLM	RLMs
[63]	Tiago et al.	2016	System reliability	Size & location	SA	STATLM	RLMs

Table 3: AI computational techniques for EVs planning with load models

Ref. No.	Authors	Pub. year	System performances	Control parameters	Proposed methods	Load models	Future scopes
[64]	Gong et al.	2008	Rotor angle stability	Size , types & location	DP	STATLM	RLMs
[65]	Kristien et al.	2010	Frequency stability	Size , types & location	DP	STATLM	ROTs
[66]	Saber et al.	2012	System flexibility	Size , types & location	DP	STATLM	ROTs
[67]	Geng et al.	2011	System security	Size & location	DP	STATLM	ROTs
[68]	Kum et al.	2013	System reliability	Location & types	DP	STATLM	ROTs
[69]	Geng et al.	2012	Frequency stability	Size & types	DP	STATLM	ROTs
[70]	Sanjaka et al.	2011	System loadability	Location & coordination	DP	STATLM	ROTs
[71]	Linni et al.	2013	Voltage stability	Location & types	DP	STATLM	ROTs
[72]	Justin et al.	2013	Frequency stability	Size & types	DP	STATLM	ROTs
[73]	Wisdom et al.	2017	Real power loss	Size & location	DP	STATLM	ROTs
[74]	Ehsan et al.	2018	System power factor	Location & types	DP	STATLM	ROTs
[75]	Amir et al.	2011	Rotor angle stability	Size & types	MILP	STATLM	RLMs
[76]	Haddadian et al.	2015	Environmental GHG	Size & location	MILP	STATLM	RLMs
[77]	Hamedet al.	2018	System oscillations	Location & types	MILP	STATLM	RLMs
[78]	Rajiet al.	2015	Frequency stability	Size & types	MILP	STATLM	RLMs
[79]	Vitoret al.	2016	System flexibility	Size & location	MILP	STATLM	RLMs
[80]	Stephanie et al.	2011	System security	Location & coordination	SDP	STATLM	RLMs

[81]	Menyang et al.	2012	System reliability	location & coordination	SDP	STATLM	RLMs
[82]	Luting et al.	2019	Frequency stability	Size & Types	SDP	STATLM	RLMs
[83]	Weihao et al.	2013	System loadability	Size & location	SQP	STATLM	RLMs
[84]	Peng et al.	2019	Voltage stability	Size & types	SQP	STATLM	RLMs
[85]	Maryam et al.	2019	Frequency stability	Size & location	RO	STATLM	RLMs
[86]	Luis et al.	2017	Real power loss	Size & types	RO	STATLM	RLMs
[87]	Xiangninget al.	2014	Voltage stability	Location & coordination	OO	STATLM	RLMs
[88]	Sheikhi et al.	2013	Frequency stability	Location & types	OA	STATLM	RLMs
[89]	Junjieet al.	2016	Reactive power loss	Location & types	OA	STATLM	RLMs
[90]	Kumarsinh et al.	2017	System power factor	Size & location	LP	STATLM	MOO

Table 4: Hybrid Optimization Techniques for EVs Planning with Load Models

Ref. No.	Authors	EVs	System performances	Control parameters	Proposed methods	Load models	Future scopes
[91]	Wirasingha & Emadi	PHEV	System security	Location & types	FL + ANN	STATLM	MOO
[92]	Nojavan et al.	BEV	System reliability	Size & types	FL + MILP	STATLM	RLMs
[93]	Mehdi et al.	BEV	Frequency stability	Location & types	PSO +GWO	STATLM	RLMs
[94]	Reddy et al.	PHEV	System loadability	Location & types	GA + FL	STATLM	RLMs
[95]	John et al.	PHEV	Voltage stability	Size & types	MC + MILP	STATLM	ROTs
[96]	Farahani et al.	PHEV	Real power loss	Size & location	PSO + FL	STATLM	MOO
[97]	Farhad et al.	PHEV	System power factor	Location & types	MC + SBM	STATLM	ROTs
[98]	Arman et al.	BEV	Environmental GHG	Size & types	PSO + GA	RLMs	ROTs
[99]	Ibrahim et al.	PHEV	System oscillations	Size & location	KFM + NSGA-II	STATLM	MOO
[100]	Reza et al.	PHEV	System flexibility	Location & types	FL +PSAT	STATLM	ROTs

Table 5: Other Optimization Techniques for EVs Planning with Load Models

Ref. No.	Authors	Pub. year	EVs	System performances	Control parameters	Proposed methods	Load models
[101]	Tara et al.	2010	PHEV	Frequency stability	Location & types	SBF	STATLM
[102]	Sara et al.	2011	PHEV	Real power loss	Size & types	RTSLM	STATLM
[103]	Jose et al.	2012	PHEV	System power factor	Size & location	LM	STATLM
[104]	Tian et al.	2018	PHEV	Rotor angle stability	Location & types	LM	STATLM
[105]	Xu et al.	2019	EX-PHEV	Environmental GHG	Size & types	LM	STATLM

[106]	Wolf et al.	2016	PHEV	System oscillations	Size & location	GTSF	STATLM
[107]	Schill	2011	BEV	System flexibility	Location & types	GTSF	STATLM
[108]	Soares et al.	2014	PHEV	Voltage stability	Size & types	QRTM	STATLM

3 SUMMARY OF THE PAPER

The advantages and disadvantages of different optimization techniques for EVs planning in distributions systems with load models are given in Table 6.

Table 6: Advantages and disadvantages of different optimization techniques for EVs planning in distributions systems with load models

Methods	Advantages	Disadvantages	Applications
GA	It just needs a rough idea of the objective function and does not impose any constraints on it, such as differentiability or convexity.	tremendously high time	DGs, EVs, FACTs, Capacitor, voltage/reactive power planning
PSO	Simple implementation	Slow convergence in refined search stage	Sensor network planning
ACO	Can be used in dynamic application	Convergence is guaranteed, but time to convergence is uncertain	Machine scheduling
GWO	Higher precision and more consist result	low solving precision, slow convergence, and bad local searching ability	DG and FACTS controllers planning
ABC	Few control parameters are required	Search space limited by initial solution	Power system DG and EVs planning
FL	It is simpler and more flexible	It requires a lot of data	Traffic control, improving the efficiency of automatic transmission
OPF	Able to run a parallel computation	Can be difficult to define initial parameters	Power system stability analysis
MC	Bypass the complexity of solving the problem by analytical method	High precision comes at a high computational cost	Power system DG, FACTS controllers and EVs planning
LP	Linear programming is adaptive and more flexibility to analyze the problem	Linear programming is work only with the linear variables	Power system operation and control
DP	They required much less computing resources	They do not always reach the global optimum solution	Bank of capacitor and FACTS controllers planning
KFM	Computationally efficient	Able to represent only Gaussian distributions	Bank of capacitor, DGs, EVs and FACTS controllers planning
GSA	Ability to solve highly nonlinear optimization problems	The difficulty for the appropriate selection of gravitational constant parameter	Power system DGs, EVs and FACTS controllers planning
SAA	Strong global search capacity	Convergence speed is slow and parallel computing is difficult	Power system DGs, EVs and FACTS controllers planning
TS	It is a meta-heuristic search to solve global optimization problems	It is relatively slow	Transmission planning, optimal capacitor placement, hydrothermal scheduling, reactive power planning
ALO	Ant Lion Optimization (ALO) is used to solved complicated optimization problems in engineering design particularly in electrical engineering	It is got a long run time due to the random walking process	Hyperspectral imaging, agricultural credit classification

This survey paper presented the analysis of literature reviewed for different EVs planning by using conventional, optimization, AI, hybrid, other, and recent optimization techniques for enhancement of system performances like available power transfer capacity, system flexibility, system loadability, system power factors, system security, system reliability, voltage profile, system oscillations, system stability, power quality, and environmental greenhouse gases (GHG), etc. from different objective functions viewpoints. This survey article is useful for researchers who are working in the field of EVs planning in the distribution system with load models.

4 CONCLUSIONS AND FUTURE SCOPE OF SURVEY ARTICLE

An exhaustive literature survey plays an important role in future system planning. This survey article represents optimization techniques used for the optimal setting of the system performance parameter of the system.

System parameters, such as actual and reactive power losses, etc., are often reduced by the optimum positioning, dimensioning and properly organized regulation of the various types of EVs, such as BEVs, FCEVs, PHEVs and Ex-PHEVs, in separate load models of delivery systems.

In the survey, the following potential scope of research study is also assumed.

Hybrid optimization strategies for the optimum positioning, dimensioning and properly organized regulation of the various forms of EVs in distribution systems with different load models can be implemented in the future.

Dynamic load modes, as well as static load modes, can be used by optimal alignment, dimensioning and properly organized control.

In the future, the environmental effect of the various forms of EVs in distribution networks with different load models which be accomplished by optimum positioning, dimensioning and properly organized regulation.

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