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A Taxonomical Review on Distributed Generation Planning

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ABSTRACT

This paper presents a taxonomical review on Distributed Generation (DG) planning in the distribution power network from different power system performances such as minimization of real and reactive power loss, enhance power system load ability, enhance power system stability, enhance power system reliability, enhance power system security, enhance available power transfer capacity, enhance power system oscillations, more flexible operation and bandwidth, enhance voltage profile, reduce short circuit capacity of line, more real and reactive power support and environmental friendly (green house gases) point of view. This paper also presents the current status of DG planning in a distributed power network. This survey article is very much useful for scientific persons, industrial persons and researchers in field of DG planning in distribution power system networks.

Key words: Distributed Generation Planning, Distribution Power Network, Power System Performances, Power Flow Analysis, Artificial Intelligence Technique

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INTRODUCTION

The distributed generations are basically real, and reactive power supported to distribution power system networks. The real and reactive power delivered to the system depends on the type of DGs are used. On the basis of real and reactive power delivery, the DGs are classified in four categories such as :(i) DG1 (ii) DG2 (iii) DG3 (iv) DG4. The details of different types of DGs are as follows [11]-[40]:

(i) DG1: DG1 only real power supported to system at unity power factor. For example, photovoltaic cell, solar systems, biogas, etc.
(ii) DG2: DG2 real and reactive power supported to system at 0.80 to 0.99 leading power factor. For examples wind, tidal, wave, geothermal etc.
(iii) DG3: DG3 only reactive power supported for the system at 0.00 power factor. For example, synchronous condenser, bank of inductor and bank of capacitors etc.
(iv) DG4: DG4 delivered reactive power to the system and absorb real power from system at 0.80 to 0.99 lagging power factor. For example doubly fed induction generators based wind etc.

The DG planning is a very important issue [41]-[80] with installation of DG in all over world for delivering real and reactive power to the system. The DG planning means the proper location as well as properly coordinated control of multiple DGs in the power system network. The various combinations of DG planning as follows: (i) size only (ii) location only (iii) size and location (iv) size, location and numbers, (v) size, location, number and type.

The various advantages of optimal DG planning [42]-[60] are as follows: (i) reduce real and reactive power loss (ii) reduces power system oscillations (iii) enhance power system stability, such as voltage, frequency and rotor angle stability (iv) enhance power system reliability and security (v) enhance power system load ability (vi) enhance available power transfer capacity (vii) reduce power conjunction of line (viii) increase band of operation of system hence system is more flexible operation.

The DG planning [81]-[130] are achieved by conventional and optimization techniques such as eigenvalues, eigenvector, modal index, residues, optimal power flow (OPF), sensitivity, linear programming (LP), nonlinear programming (NLP), mixed integer programming (MIP), ordinal optimization programming (OOP), dynamic programming (DYP), dual programming (DP) stochastic programming (SP) etc.

The DG planning [131]-[200] are also achieved by different artificial intelligence techniques such as genetic algorithm (GA), artificial neural network (ANN), fuzzy logic (FL), particle swarm optimization (PSO) technique, tabu-search (TS), simulated annealing (SA) algorithm, ant colony search (ACS), Monte Carlo algorithm (MCA), ant bee colony (ABC), hybrid techniques etc.

This paper organized as follows: Section II presents the taxonomical survey on DG planning. Section III presents the summary of the paper. Section IV presents conclusive and future scope of work.

A TAXONOMICAL REVIEW

Table -1 shows the taxonomical review of optimal DG planning in distribution power system network (Maintaining the Integrity of the Specifications).

Table -1 A Taxonomical Review of Optimal DG Planning in Distribution Power System Network

Ref no	Authors	Proposed Methods	Parameter enhance	Test System	Future Scope
[1]	D Singh *et al*	GA	Minimization of power loss	IEEE-16, IEEE-37	Hybrid techniques
[2]	AN Venkateswarlu *et al*	Repeated power flow	Voltage Stability Constrained Available Transfer Capability	IEEE- 14 Bus	Multi objective task
[3]	Hasan Hedayati *et al*	Continuation power flow	Yields Efficiency in improvement of Voltage profile and reduction of Power losses	Typical 34-Bus	Realistic load models
[4]	Devender Singh *et al*	Load flow Models	Real and Reactive Power intake at the main substation and MVA support		Multi objective task
[5]	Duong Quoc Hung *et al*	Analytical expressions for finding Optimal size and Power Factor	Requires less computation, but can lead optimal solution as verified by the exhaustive load flow		Realistic load models
[6]	LF Ochoa *et al*	Multi-objective performance index for distribution networks	Distributed generation is extensively located and sized	IEEE- 34 Bus	Hybrid techniques
[7]	MR Haghifam *et al*	Multi-objective model	The true Pareto-optimal solutions are found with a multi-objective genetic algorithm		Multi objective task
[8]	RA Jabr *et al*	ordinal optimization method	OO theory allows computing the size s of the selected subset		Realistic load models
[9]	LF Ochoa *et al*	Multi-objective performance index for distribution networks with time-varying	Better response to the natural behavior of loads and generation		Hybrid techniques
[10]	Rajendra Prasad Payasi *et al*	Distributed generation planning is optimal ie their site and size are selected optimally	Various objectives, different constraints as well as optimization based		Multi objective task
[11]	H Yassami *et al*	Partial Swarm Optimization	Minimization of power generation cost , active power loss and Maximization of reliability level		Hybrid techniques
[12]	Sami Repo *et al*	Ring operation of the distribution network and control of windmill active power	Increase the integration capacity of DG units without major network investments		Realistic load models
[13]	Gopiya Naik S *et al*	Voltage sensitivity index Analysis	Real power loss reduction, voltage profile improvement, substation capacity release	IEEE-33 Bus	Multi objective task
[14]	Gopiya Naik S *et al*	DG Technology	Improve technical, economical, and environmental factors both for the utility and customers		Hybrid techniques
[15]	Barry Hayes *et al*	A predictive database is created and applied to forecast future network states	Provide early warning of potential network issues and more optimal management of distributed energy		Realistic load models
[16]	Sami Repo *et al*	statistical planning approach	Voltage level management		Multi objective
[17]	Bindeshwar Singh *et al*	Optimally placed Distributed Generation (DG) & FACTS controllers in power Systems	Useful to the researchers for finding out the relevant references in the field of the enhancement of different performance parameters of power systems		Hybrid techniques
[18]	S Kumar Injeti *et al*	Fuzzy logic method	Improved voltage stability and loss reduction	12-Bus	Realistic load
[19]	Manoj Kumar Nigam *et al*	The impacts that were raised due to the connection of distributed generation	Active power losses as well as reactive power losses are almost reduced to zero	IEEE 30-Bus	Multi objective task
[20]	F Fatahian *et al*	Multi-objective Optimization Algorithm, Multi Objective Particle Swarm Optimization and Genetic Algorithm	Cost, power loss, voltage profile and environmental attributes	34- Bus radial system	Hybrid techniques
[21]	Satish Kumar Injeti *et al*	Fuzzy logic and new analytical method respectively	Minimize total power loss in radial distribution system	IEEE 33-Bus	Realistic load models
[22]	Mingxin Zhao *et al*	A new load forecasting method for distribution network Superposition method;	The volatility and seasonality of DG output power are contained in the net-load time-varying curve		Multi objective task
[23]	S Najafi Ravadanegh	Imperialist Competitive Algorithm as a new developed heuristic	Efficiency of the proposed method obtained by ICA, a sensitivity analysis for the effect		Hybrid techniques

		optimization algorithm	of ICA parameters on obtained results is applied		
[24]	Duong Quoc Hung *et al*	An improved analytical method	Optimal location, optimal power Factor, optimal size		Realistic load models
[25]	Dan Zhu *et al*	The optimum locations are sought for time-varying load patterns	Optimal location, power loss, power system efficiency, power system reliability		Multi objective task
[26]	N Khalesi *et al*	Dynamic programming	Minimize power loss of the system and enhance reliability improvement and voltage profile		Hybrid techniques
[27]	Gareth P Harrison *et al*	Genetic algorithms and Optimal power flow	Siting and sizing an assigned number of DG units		Realistic load models
[28]	Gareth P Harrison *et al*	Multi-objective optimal power flow is used to simulate	The costs, benefits and tradeoffs associated with DG in terms of connection, losses		Multi objective task
[29]	RS Al Abri *et al*	Mixed-Integer nonlinear programming	Optimum power flow, voltage profile, voltage stability		Hybrid techniques
[30]	CJ Dent *et al*	Optimal power flow	Load flow analysis, Power generation planning		Realistic load
[31]	A Zangeneh *et al*	Multi-objective optimization, Pareto set	Benefit–cost analysis		Multi objective
[32]	Victor H Mendez Quezada *et al*	Power injections from DGs change network power flows modifying energy losses	Reactive power control provide a better network voltage profile and lower losses		Hybrid techniques
[33]	MH Moradi *et al*	GA and PSO	Minimize network power losses, better voltage regulation and improve the voltage stability	33-Bus and 69-Bus	Realistic load models
[34]	Alireza Soroudi *et al*	Two-stage heuristic method, immune algorithm	Dynamic planning, Multi-objective optimization		Multi objective task
[35]	Alireza Soroudi *et al*	Fuzzy satisfying method, Immune algorithm	optimal schemes of sizing, placement and specially the dynamics of investments on DG units		Hybrid techniques
[36]	Pavlos S Georgilakis *et al*	Embedded generation ,ODGP	Best locations and sizes of DGs to optimize electrical distribution network operation and planning		Realistic load models
[37]	MF Akorede *et al*	GA, a fuzzy controller	Maximizes the system loading margin as well as the profit of distribution companies	IEEE 6-Bus and 30-Bus	Multi objective task
[38]	MM Aman *et al*	PSI	System losses, voltage profile	12-Bus	Hybrid techniques
[39]	Hugo A Gil *et al*	Approximation to the capacity deferral benefits brought about by DG is obtained	Financial performance of investments on these important technologies can be then improved		Realistic load models
[40]	Deependra Singh *et al*	Power loss minimization, System MVA minimization, System cost minimization and System Energy loss minimization	Optimal location and size of DG with compromise between Power loss, System MVA, System cost and System energy loss		Multi objective task
[41]	Julius Kilonzi Charles *et al*	PSO and GA	System loss reduction, voltage profile improvement		Hybrid techniques
[42]	Zeinab Ghofrani-Jahromi, *et al*	Based on the results of power flow and considers active and reactive power flows	Power loss allocated to the DGs		Realistic load models
[43]	Majid Davoodi *et al*	Optimal Capacitor placement and GA	loss reduction, voltage profile improvement and freeing up the power system capacity	IEEE 9-Bus	Multi objective task
[44]	Rajendra Prasad Payasi *et al*	Incremental power flow and exhaustive search method as deterministic approach	Mixed load model, types of DG, and power factor of DG have significant impact on size and location		Hybrid techniques
[45]	J B V Subrahmanyam *et al*	Voltage index analysis, variational algorithm	Power loss minimization and to improve the voltage profile of the system	25-Bus and IEEE 37-Bus	Realistic load models
[46]	SN Liew *et al*	EWG , Based on the passive operation of the distribution network	Advanced optimal power flow is used to quantify the benefits of alternative control		Multi objective task
[47]	YG Hegazy *et al*	Monte Carlo-based method for the adequacy assessment	Distribution system and the system margins and the average amount of unsupplied loads are estimated		Hybrid techniques
[48]	AA Chowdhury *et al*	Distribution capital investment deferral credit received by the IPP	The size, location and the reliability of the DG will be achieved		Realistic load models
[49]	Yiming Mao *et al*	The switch placement problem is formulated as a nondifferentiable, multi-objective optimization problem	Their results enable DG to support customers continuously in the event of fault	394-Bus	Multi objective task
[50]	Dragan S Popovic *et al*	Fuzzy decision-making and risk management	Reduction of expected costs due to undelivered energy during the process of supply restoration		Hybrid techniques
[51]	Vinit Gupta *et al*	Cold load pickup Method	Enhancing quality of power even in emergency conditions while minimizing the cost		Realistic load models

[52]	J Mutale *et al*	substitution method	Proposed loss allocation coefficients is that they can be positive or negative and therefore can recognize the presence of counter-flows such as those due to the presence of EG	265-node generic distribution system	Multi objective task
[53]	Pathomthat Chiradeja *et al*	General approach and a set of indices to assess some of the technical benefits in a quantitative manner	Line-loss reduction, voltage profile improvement	Simple 12-Bus test system	Hybrid techniques
[54]	Caisheng Wang *et al*	Analytical Method	Optimal Placement and minimize power loss		Realistic load models
[55]	Sukumar M Brahma *et al*	Phasor measurement unit, protective device coordination and suggests an adaptive protection scheme	Recloser, short-circuit analysis		Multi objective task
[56]	W El-Khattam *et al*	Fuel cell , Micro-turbine , Photovoltaic and Wind turbine	comprehensive survey by adding new classifications to relate the DG types, technologies and applications to each other		Hybrid techniques
[57]	Carlos A Coello Coello *et al*	PSO	Highly competitive and that can be considered a viable alternative to solve multi-objective optimization problems		Realistic load models
[58]	Paulo Moises Costa *et al*	On tracing the real and imaginary parts of the currents	EG incentives or to design tariffs for the use of the distribution network		Multi objective task
[59]	Yasuhiro Hayashi *et al*	N-1 contingencies, TA with strategic oscillation is proposed	Determine the loss minimum configuration effectively		Hybrid techniques
[60]	Walid El-Khattam *et al*	Heuristic approach	Cost-benefit analysis, peak demand planning		Realistic load models
[61]	In-Su Bae *et al*	Incorporating reliability worth evaluation of a distribution system	Determine the optimal operating decision for the DG		Multi objective task
[62]	Aleksandar Pregelj *et al*	Combination of clustering techniques and a convex hull algorithm	Reduce computational load and allowing accurate estimation of DG-enhanced feeder operation		Hybrid techniques
[63]	RC Bansal	Mathematical optimization, AI and hybrid AI	Optimal power flow		Realistic load models
[64]	Gianni Celli *et al*	GA and multi-objective programming	Optimal sitting and sizing of DG		Multi objective task
[65]	Walid El-Khattam *et al*	Binary decision variables are employed	Achieve optimal sizing and sitting of distributed generation		Hybrid techniques
[66]	Panagis N Vovos *et al*	Fault level constraints and OPF	Directly introduced to any optimization process performing the OPF	A 12-bus/15-line test	Realistic load models
[67]	G Pepermans *et al*	OPF and EG	Major benefits and issues of small scale electricity generation		Hybrid techniques
[68]	Manisa Pipattanasomporn *et al*	Impact of grid-connected DG on the reliability of on-site electric Power	Reliability and minimize the capital costs of DG units		Realistic load models
[69]	MA Kashem *et al*	Dynamics, eigenvalues and eigen functions	power generation control, sensitivity, voltage control		Multi objective task
[70]	Fabrice Demailly et	SP and MCA	Limited voltage regulation		Hybrid techniques
[71]	GP Harrison *et al*	Reverse load-ability, the approach models fixed-power facter	maximizes capacity and identifies available headroom		Realistic load models
[72]	Andrew Keane *et al*	LP	Optimal allocation of EG		Multi objective
[73]	M Padma Lalitha *et al*	FL and PSO	Reduce the real power losses and to improve the voltage profile	IEEE 33- Bus	Hybrid techniques
[74]	Panagis N Vovos *et al*	OPF which takes into account fault level constraints	Significantly higher new generation capacity than existing	Tested on a 12-bus LV	Realistic load models
[75]	G Carpinelli *et al*	OPF and double trade-off method	Optimal siting and sizing of EG		Multi objective task
[76]	DH Popovic *et al*	GA	Optimal siting is determined, power factor is formulated as a security constrained		Hybrid techniques
[77]	MPadma Lalitha *et al*	Real Coded GA	Reduce the real power losses and to improve the voltage profile	IEEE 33-Bus	Realistic load models
[78]	Soma Biswas *et al*	GA	Minimize the total power loss and to improve the voltage sag performance	34-node radial system	Multi objective task
[79]	M Padma Lalitha *et al*	FL and AIS	Reduce the real power losses and to improve the voltage profile	IEEE 33-Bus	Hybrid techniques
[80]	MFKotb *et al*	GA	Active and reactive power losses are minimized and voltage profile is improved		Realistic load models
[81]	A Rezazadeh *et al*	GA	Optimal siting and sizing of DG and also enhancing transient stability		Multi objective task
[82]	Priyanka Paliwal *et al*	OPF	Optimum allocation of DG and increase level of Reliability		Hybrid techniques

[83]	Amin Hajizadeh *et al*	PSO and weight method	Minimize the cost of power losses and energy not supplied	33-Bus	Realistic load models
[84]	Yamini Arora	OPF	Mitigating voltage sag and swell issues at distribution end		Hybrid techniques
[85]	Mohammad Javad Kasaei	ACA	power loss reduction and voltage profile improvement	33 and 10 buses	Realistic load models
[86]	MJ Kasaei	ACA	Power losses reduction and voltage profile improvement	IEEE 33-Bus	Multi objective task
[87]	Amir Bagheri *et al*	GA	Voltage and reactive power control in distribution network		Hybrid techniques
[88]	S Shan *et al*	OPF	Useful for power system analysis and operation planning		Realistic load models
[89]	S Chandrasekhar Reddy *et al*	GA	Total power loss is reduced , reliability and voltage profile of the system is improved	IEEE 30-Bus	Multi objective task
[90]	T Lajnef *et al*	OPF	Evaluate energy losses in the system during unit sizing process		Hybrid techniques
[91]	Rosnazri Ali *et al*	OPF	Multiple operations are achieved		Realistic load models
[92]	Masoud Farhoodnea *et al*	OPF	Improving power quality for different level of users		Multi objective task
[93]	S Sreejith *et al*	DE	Control real and reactive power		Hybrid techniques
[94]	Anoop Arya *et al*	CIT	Optimum power flow achieved		Realistic load models
[95]	Mozhgan Balavar *et al*	DFIG	Control active and reactive power		Multi objective task
[96]	Benjamin Kroposki *et al*	OPF	Improved power quality, compatibility by reducing fault contributions and flexibility		Hybrid techniques
[97]	Ma Mozaffari Legha *et al*	GA and ICA	Optimal allocation of DG units		Realistic load models
[98]	Deependra Singh *et al*	GA	Loss is obtained under voltage and line loading constraints	16, 37and 75 Bus	Multi objective task
[99]	Hussein A Attia *et al*	GPI	Modifying energy losses and voltage profile of the system		Hybrid techniques
[100]	M Sedighizadeh *et al*	GA	Reduce losses and improve voltage profile		Realistic load models
[101]	T Lantharthong *et al*	TS	Best network reconfiguration involving balancing of feeder loads	69-Bus	Hybrid techniques
[102]	C Ponce-Corral *et al*	MCA	Optimized criteria for the expansion of (DG)		Realistic load models
[103]	R Shivarudraswamy *et al*	Voltage regulation method	Determine the priority for individual generators in multiple DG environment		Multi objective task
[104]	A Safari *et al*	GA and PSO	Improvement in the optimization goal is achieved		Hybrid techniques
[105]	PVV Rama Rao *et al*	PGSA	smooth voltage profile, reduce total cost	33 Bus and 69 Bus	Realistic load models
[106]	Satish Kansal *et al*	PSO	Optimal size of DG is calculated by using exact loss formula and loss sensitivity factor	33-Bus	Multi objective task
[107]	MA Junjie *et al*	IA	Effectively resolve the DG planning	IEEE30-Bus	Hybrid techniques
[108]	Christopher Kigen *et al*	A coordinated network controller	Optimal voltage profile	IEEE 33-Bus and 69-Bus	Realistic load models
[109]	M Balasubba Reddy *et al*	PSO method is combined with Newton's method	Optimal power flow/volt-var optimization	IEEE 30-Bus	Multi objective task
[110]	D Issicaba *et al*	An optimal capacitor placement	Improve voltage regulation and reduce power losses		Hybrid techniques
[111]	P Umapathi Reddy *et al*	PSO	Cost of loss is reduce		Realistic load models
[112]	Dheeraj K Khatod *et al*	Evolutionary programming (EP) based technique	Minimize the computational burden, set a suitable location for DG placement	69-Bus	Multi objective task
[113]	Mohd Khairun N M Sarmin *et al*	Mixed-integer nonlinear programming and PSO	System voltage within operating limit and power loss also minimized		Hybrid techniques
[114]	K Valipour *et al*	BBO	Minimizing the power losses and voltage profile and THD improvement	33-Bus	Realistic load models
[115]	Rambabu CH *et al*	EP and PSO	Reduction in cost of power generation and active power loss	IEEE 14-Bu	Multi objective task
[116]	Amir Khanjanzadeh	CSA	Voltage profile improvement and minimizing loss		Hybrid techniques
[117]	Mohsen Rezaie Estabragh *et al*	Hybrid PSO	optimal location of the DGs	IEEE 14- and IEEE	Realistic load models
[118]	Maruthi Prasanna HA *et al*	GA	Reduction in line losses and considerable tail end node voltage improvement during peak load	IEEE 33 Bus	Multi objective task

[119]	Christopher Kigen *et al*	PSO	Greatly improve the voltage profile	IEEE 30-Bus	Hybrid techniques
[120]	MATaghikhani	MSFLA	Voltage Profile Improvement Index, Line Loss Reduction index are analyzed	IEEE-70 Bus	Realistic load models
[121]	Nasim Ali Khan *et al*	Novel Binary PSO	Improvement of total voltage profile and line loss minimization		Multi objective task
[122]	KVS Ramachandra Murthy *et al*	Direct Search Algorithm	Maximum reduction in active power loss		Hybrid techniques
[123]	Reza K-Nia *et al*	SP	Optimal placement of DSTATCOM	IEEE 69-Bus	Realistic load models
[124]	Nadim Makhol *et al*	GA and OPF	Optimal location of DG obtained	IEEE 15-Bus	Multi objective
[125]	Raj K Singh *et al*	GA	Optimal allocation of DGs		Multi objective ta
[126]	Deependra Singh et	GA	Minimization of losses	16,37-Bus	Hybrid techniques
[127]	Yuzuru Ueda *et al*	OPF	Avoids the overvoltage on the grid		Realistic load
[128]	Zdravko Jadrijev *et al*	OPF	Reliability indices and the daily load curve calculated on the real network		Multi objective task
[129]	A Alarcon-Rodriguez *et al*	Stochastic and controllable DER in the distribution grid	Multi-objective approach permits a better evaluation potential of active DER to support system operation		Hybrid techniques
[130]	P Ajay-D-Vimal Raj *et al*	PSO	Reduction in losses and improvement in voltage profile	IEEE-30 Bus	Realistic load models
[131]	Luis F Ochoa *et al*	multi-period steady-state analysis	maximising the connection of intermittent DG		Multi objective task
[132]	David Trebolle *et al*	OPF	Improving reliability of the system		Hybrid techniques
[133]	D Singh *et al*	Multi-objective function	Minimize the overall cost of MW, MVar and MVA intakes	33-Node test system	Realistic load models
[134]	S Porkar *et al*	Interface Heuristic approach	Validating the economical and electrical benefits of introducing DG		Multi objective task
[135]	Antonio Piccolo *et al*	OPF	Siting and sizing of DG installation are analyzed		Hybrid techniques
[136]	RK Singh *et al*	Nodal pricing	Loss reduction, and voltage improvement including voltage rise issue		Realistic load models
[137]	YM Atwa *et al*	Mixed integer NLP	Minimizing the system's annual energy losses		Multi objective task
[138]	Luis F Ochoa *et al*	OPF	Very high penetration levels of new variable generation capacity can be achieved		Hybrid techniques
[139]	HM Khodr *et al*	Problastic methodology	Optimal locaton of DG achieved		Realistic load models
[140]	Walid El-Khattam *et al*	MCA	Steady-state operating system parameters are evaluated to describe the DG behavier		Multi objective task
[141]	E Haesen *et al*	Mathematical optimisation	A robust planning methodology is formulated		Multi objective task
[142]	Luis F Ochoa *et al*	GA	Maximize the integration of distributed wind power generation		Hybrid techniques
[143]	David TC Wang *et al*	Elimination algorithm together	Network planning		Realistic load models
[144]	Haoyong Chen *et al*	PSO	Integrated Planning of Distribution Systems		Multi objective task
[145]	Ruifeng Shi *et al*	GA and PSO	Optimal allocation of DG		Hybrid techniques
[146]	T Nishi *et al*	Lagrangian decomposition and coordination technique	Solve the problem effectively within a reasonable computation time		Realistic load models
[147]	Vikash Mishra *et al*	TLBO	Optimal query plans using parameter less optimization technique		Multi objective task
[148]	Marta Maria de A Olivieri *et al*	OPF	DG in smart grid		Hybrid techniques
[149]	Alessandro Bosisio *et al*	OPF	Optimal active power production computed		Realistic load models
[150]	Giacomo Bruni *et al*	Hybrid Photovoltaic-Battery-Fuel cell	Cost reduction and components lifetime increase		Multi objective task
[151]	A Elmitwally	Heuristic techniques	Allocating multiple DG		Hybrid techniques
[152]	Dongxiao Niu *et al*	Cloud Model	Grid-connected distributed generation		Realistic load models
[153]	Huang Jiadong *et al*	Impedance current limiter	Feasibility of scheme is verified		Multi objective task
154]	K Balamurugan *et al*	OPF	Fault level of distribution system is studied		Hybrid techniques
155]	Nikzad Manteghi *et al*	Analytical hierarchal process	Optimal power flow		Realistic load models

[156]	Ionel Muscalagiu *et al*	DCP	Evaluation of distributed algorithms in conditions as similar as possible to the real situations		Multi objective task
[157]	Cristian-Drago Dumitru *et al*	OPF	Management of multiple energy production systems		Multi objective task
[158]	D Thukaram *et al*	Robust three phase power flow algorithm	Optimum power flow		Hybrid techniques
[159]	Petr Ya Ekel *et al*	FL	Optimal allocation		Realistic load models
[160]	Carlos A Coello Coello	Multi-objective optimization techniques	Optimization achieved		Multi objective task
[161]	IEEE Task Force *et al*	Load models	Verifying the load models		Hybrid techniques
[162]	Institut National Polytechnique de Grenoble, LEG *et al*	OPF	Maintaining distribution system		Realistic load models
[163]	JO Kim *et al*	Hereford ranch algorithm	Minimization of losses		Multi objective task
[164]	Ignacio J Ramirez-Rosado *et al*	GA	Optimal design		Hybrid techniques
[165]	WD Kellogg *et al*	Numerical algorithm	Unit sizing and reduction in cost		Realistic load models
[166]	Yu-Chi Ho *et al*	OPF	Optimal design		Multi objective task
[167]	P JOKane *et al*	EG loss of protection technique	Avoids nuisance tripping during an under-frequency transient		Hybrid techniques
[168]	C Concordia *et al*	OPF	Stability achieved		Realistic load models
[169]	IEEE Task Force *et al*	OPF	Dynamic performance achieved		Multi objective task
[170]	Kwang Y Lee *et al*	GA and LP	Optimal reactive power planning	IEEE 30-Bus	Hybrid techniques
[171]	Narayan S Rao *et al*	OPF	Optimal location		Realistic load models
172]	JAMomoh *et al*	FL	Basic procedure for FL		Multi objective task
[173]	James Kennedy *et al*	PSO	Application of PSO in power system		Multi objective task
[174]	IEEE DPWG Report	AI Technique	Radial distribution test		Hybrid techniques
[175]	Brion Stutt *et al*	OPF	Security analysis		Realistic load models
[176]	IEEE Task F *et al*	Load modeling and power flow	Transient stability , voltage stability		Multi objective task
[177]	William J Burke *et al*	Multi-objective planning with uncertainty	Extension of models		Hybrid techniques
[178]	T Ohya A W *et al*	Voltage dependence on composite loads	Synthesize loads		Realistic load models
[179]	MChis *et al*	Heuristic search strategies	Optimum capacitor placement and ratings for distribution systems		Multi objective task
[180]	S Civanlar *et al*	Real time control method	Primary feeders for loss reduction		Hybrid techniques
[181]	Mesut E Baran *et al*	General formulation and solution method	Loss reduction and load balancing		Realistic load models
[182]	D Das *et al*	Novel method	Easily handle different types of load characteristics		Multi objective task
[183]	Mesut E Baran *et al*	General formulation and solution method	Place of capacitor is determined		Multi objective task
[184]	Daniel S Shugar	OPF	PV generation to be a potentially cost effective alternative		Hybrid techniques
[185]	Jianxue Wang *et al*	Novel transmission expansion planning method	Flexible and economic transmission planning		Realistic load models
[186]	Haijun Xing *et al*	Multiple active management technique	Optimal coordination model of intermittent DG	Modified IEEE 123	Multi objective task
[187]	Alireza Fereidouni *et al*	PSO	Dynamic stability of power systems		Hybrid techniques
[188]	Arulmurugan R *et al*	Fractional order incremental conductance algorithm	Small tracking period and practicality in tracking of photovoltaic array		Realistic load models
[189]	Bong-Sang Jeong *et al*	OPF	Voltage stabilization		Multi objective task
[190]	Byung Chul Sung *et al*	Dynamic embedded optimization	Power system stabilize	IEEE 39 Bus	Hybrid techniques
[191]	Hyoungtae Kim *et al*	Generalized Bender's Decomposition method	Power systems for transmission expansion planning	IEEE 30-Bus	Realistic load models
[192]	Mi-Young Kim *et al*	Biomass method	Active power and frequency control		Multi objective task
[193]	V K Jadoun *et al*	Enhanced PSO	Fuel cost minimization		Multi objective task
[194]	Gihwan Yoon *et al*	OPF	Frequency control		Hybrid techniques

[195]	Dai-Zheng Huang *et al*	GA	more accuracy than BP ANN		Realistic load models
[196]	Hyewon Lee *et al*	Using frequency deviation loop	Improve the frequency drop for a disturbance by releasing more kinetic energy		Multi objective task
[197]	RMuthukumar *et al*	OPF	Capacitor placement		Hybrid techniques
[198]	Bo Zeng *et al*	Active distribution system	Renewable distributed generation		Realistic load models
[199]	Jinho Kim *et al*	Hierarchical voltage control scheme	Recovers the PCC voltage within a short time after a disturbance		Multi objective task
[200]	A El-Fergany *et al*	ABC	Capacitor allocation , loss reduction		Realistic load models

DISCUSSIONS

Table -2, 3, 4 and 5 are shows techniques for DG planning such as conventional technique, optimization technique, artificial intelligence and hybrid artificial intelligence respectively.

A. Conventional Techniques

Table -2 Conventional Techniques for DG Planning

S. No.	Conventional technique	No. of literatures reviewed	Percentage of literatures reviewed
1	Eigen value	1	0.5
2	Eigen vector	1	0.5
3	Residues	14	7
4	Modal index	4	2
5	OPF	100	50

It is concluded from table 2 that the survey regarding DG planning conventional techniques such as 0.5% eigen values, 0.5 % eigen vector, 7% residues and 2% modal index techniques used in various literatures respectively.

B. Optimization Techniques

Table -3 Optimization Techniques for DG Planning

S. No.	Conventional technique	No. of literatures reviewed	Percentage of literatures reviewed
1	LP	1	0.5
2	NLP	2	1
3	MIP	7	3.5
4	DYP	2	1
5	DP	2	1
6	SP	3	1.5
7	OOP	1	0.2

It is concluded from table 3 that the survey regarding DG planning optimization techniques such as 0.5% LP, 1 % NLP, 3.5% MIP, 1% DYP, 1% DP, 1% SP and 0.2% OOP techniques used in various literatures respectively.

C. Artificial Intelligence Techniques

Table -4 Artificial Intelligence Techniques for DG Planning

S. No.	Conventional technique	No. of literatures reviewed	Percentage of literatures reviewed
1	GA	18	9
2	FL	7	3.5
3	ANN	1	0.2
4	PSO	16	8
5	TS	1	0.2
6	ACS	2	1
7	ABC	1	0.2
8	SA	1	0.2
9	MCA	5	2.5

It is concluded from table 4 that the survey regarding DG planning artificial intelligence techniques such as 9% GA, 3.5 % FL, 0.2% ANN,8% PSO,0.2% TS,1 %ACS, 0.2% ABC, 0.2% SA and 2.5% MCA techniques used in various literatures respectively.

D. Hybrid artificial Intelligence Techniques

Table -5 Hybrid Artificial Intelligence Techniques for DG Planning

S. No.	Conventional technique	No. of literatures reviewed	Percentage of literatures reviewed
1	GA+FL	1	0.2
2	FL+AIS	1	0.2
3	FL+PSO	1	0.2
4	GA+OPF	2	1
5	GS+PSO	5	2.5

It is concluded that from table 5 the survey regarding DG planning hybrid artificial intelligence techniques such as 0.2% GA+FL, 0.2 % FL+AIS, 0.2% FL+PSO,1% GA+OPF and 2.5% GA+PSO techniques used in various literatures respectively.

CONCLUSION

The following conclusions made from this survey article as follows:

- AI techniques are more suitable as compared to conventional and optimization techniques for optimal DG planning in distribution power system networks from different power system performance point of view.
- Hybrid AI techniques are also more suitable as compared to conventional and optimization techniques for optimal DG planning in distribution power system networks from different power system performance point of view.

The following recommendation for future scope of research work as follows:

- Comparison of different types of DG planning with static as well as realistic load modals by AI techniques.
- Comparison of different types of DG planning with static as well as realistic load modals by hybrid AI techniques.
- Comparison of different types of DG and FACTS controller planning with static as well as realistic load modals by AI techniques.
- Comparison of different types of DG and FACTS controller planning with static as well as realistic load modals by hybrid AI techniques

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