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Conceptual Review on Demand Side Management, Optimization Techniques for the Improvement of PowerQuality in Smart Grids

D.Chandra Sekhar
Ph.D Research Scholar,Department of EEE
JNTUA
Anathapuramu, India
daram.sekhar@gmail.com

P V V Rama Rao
Professor in EEE
Maturi Venkata Subba Rao Engineering College
O.U,Hyderabad, India
pvvmadhuram@gmail.com

R.Kiranmayi
Professor in EEE
JNTUA
Anathapuramu,India
kiranmayi0109@gmail.com

***Abstract*—The Smart Grid (SG) is an anomalous emergence to move energy commerce in formative generation of modernized grid where all kinds of power systems operations are managed intellectually and harmoniously via two-way automation system. The pertinence to technology domains of smart grids variegating in functions and forms, shares prevailing prospects like smart energy reduction, structured amalgamation of demand response and distributed generation of renewable energy. This manuscript conferselectric review categorically on new-fangled progressions and anterior developments in SG paradigm research over the past years. The prelude of manuscript emphasizes concept and the architecture of SG. The trail bestows in depth, the modern advances in managementof energy testimony in grid, forms of tariffing in rejuvenated electricity grid, and the predominant components of smart grid. Smart cities reliance on radical communication infrastructures advocates, greater agitates in connection with data integrity, featuring emerging developments in pricing mechanisms, highlights multi-objective optimization problem that has high reliability, low user end price, sustainability, and algorithms used in smart grid. Multi-Objection Co-Operative Schedule (MOCSF) depreciates power yield at peak loads, beneath an impediment environment. SG abilities are used to comprehend harmonious containment, where MOCSF is augmented to set consumers issue affiliations if user demands load stable,actuate on start and end time, the power utilization groove and mode of exertion are correlated. In this review the concepts of Demand Side Management (DSM), and the optimization techniques of SG are highlighted.**

***Index Terms*—Power generation, Energy data, Pricing mechanism, Data integrity, multi-objective optimization, reliability, sustainability**

I. INTRODUCTION

For a few decades, prevalent power generation is grooved to load pivots via long distances. The involvement of framework of longer transmission lines [1] fetched enormous cost. Longer lines have stability issues managing voltage profile for veracious and formable operation. Penetration of distribution generation network from renewable sources has facilitated postponing construction of new transmission lines [2], reducing infrastructure costs, and network problems. With SG applied science, SG schema has been propounded to correlate DG's with conventional electrical grid.

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Creating SG by reconciling local renewable sources [3], accustomed generators, and loads are the clear steps pointing to SG. In contempt of momentous assets, the hassle in the view of system outline are adequate power storage capacity requirements, power management, reserve power allocation, and control. The critical dispense is superlative systematization of hybrid power sources in SG with the main grid [4]. Inexpensive delivery of smart grids will affect the operational efficiency. The central controller power management is responsible for assuring optimal power generation in SG [5]. A new energy scheming technique is conferred for economic dispatch in microgrids with assimilation of RES [6] at the operating cost of MG. The "Smart Grid Energy Management (SGEM)" [7] problem enfolds management of supply, demand, the commitment of unit (UC) [8], while gratifying impediments of system, to bring about economic, sustainable, reliable action of SG. SGEM offers many advantages from generating promptness to energy saving, from frequency regulation to support, from fidelity to expenditure decrease, from energy equivalence to reduction of greenhouse gas emissions [9] from customer's conception to customer concealment. The aspiration is to depreciate operating cost of microgrid, and prominent aspirations like minimization of gaseous emissions, line losses can be considered. Typically, in such a system, knowledge such as DG parameters, ESS availability, expected load demand, renewable generation productions, and market price of electricity for nextday, must be acknowledged foremost. This data act as input parameters to SGEM [10] optimization algorithm, outputs parade foremost generation schedule for all hours of day to come. The SG is connected to the main public network via common point of coupling (PCC) which is the rear control of SG. SGEM is entrusted with inconvenience for EM [11] of discrete SG units. Two-way communication is a requisite for superior SG power management. Each SG unit encompasses battery storage device, DG setup, and wind turbines. Each SG agent propagates with SGO [12] in optimal power distribution. In SG, battery energy storage systems are mandatory for: instant power supply, excess RES energy storage, charge curve smoothing, backup support, optimal power distribution.

With proper ESS battery, SG network becomes solid, stable networkendorsed to operate PV, and WT at ultimate operating points to super late lens function. The BES retention [13] is elected to conserve energy impartial in SG, to stash excess energy more than RES. The smart grid DG set enact as a backup. DG sets are sized judiciously to power emergency, critical loads during predicament situation, when main grid and RES are not obtainable. The smart grid operator must accurately calculate load, generation inconsistency for flawless power delivery to micro grids. In SGEM model, State of Charge (SOC) of ESS in exclusive hourhinges on SOC in the former hour [14]. The SOC of ESS is interacted every two successive hours. Optimization crunch is subjectto dynamic repression. The rubrics are centralized energy management (CEM) and decentralized energy management (DEM) that are contemplated in populated publications to reveal the problem of EMS [15]. The CEM encompasses central controller expounds comprehensive optimization problems with respect to preferred objectives, constraints, but DEM focuses on multi-agent entities. Assorted SG CEM optimization standardizations are submitted. These standardizations are intended at lessening the regulating costs, and detract emissions. Goals like load shedding ratio, voltage drift, energy losses, fuel consumption, fluctuations in grid energy profile are mediated as an objective function of SGEM problem.

The unbiased function of EM obstacle [16] adds many objectives, like minimization of network voltage deviations, power losses, safety margins, and imported energy from main network. The straight function comprehends four intentions of minimizing costs for the customer, emissions, maximum load, and fluctuations of load curve. Intended SG configuration exists in renewable energy, electric vehicles [17], controllableDG, and ESS that are not mediated. The justifiable function is evolved in mode of weighted sum of objectives, and SG configuration is evaded. The scarcity of intensified functions, limits in existing engravings regarding accuracy and forcefulness of SGEM results. Despite citation accomplishments, applications are not skillful [18], and do not compute to settlements with ESS. Dynamic mode of SGEM obstacles are that UC of controllable DG's are not established in them, and the inscribed economic dispatch predicament. A comprehensiveexemplary for SGEM is desired.

Contrasting optimization executions are used to solve CEM perplexity in SGs which are linear, nonlinear, dynamic, stochastic programming, inquisitive approach evolutionary approach, model predictive control approach, and robust optimization [19]. A postulated architecture contemplated for EM is SG hinged on MA entity. Multi period despotic emulation approach alerted the EM in SG to keep down the price of generation. In hybrid power system with PV, WT-hinged ES, and ESS are intended to relax the load generation curve. The composed control advent is propounded to adapt power variations in HPS [20]. In each SG, EM predicament is untangled; that synchronously merge with contiguous SG clusters. The complication of economic reserving on multi-time struggle with PV, wind stationed RES seeing derivable loads are dissertated in energy reciprocation for reserve allotment [21].

EM amidst multiple SGs admitting heat and electricity ES are debated in proving conversed optimization algorithm. DR program is encompassed in optimization scrape. Budgetary blueprint for power expedition to deflate managing price in AC-DC hybrid SG [22] is conferred in view of uncertainty of load demand, RES.The budgetary dispatch crisis is illustrated using the combination of PSO, FLC schema. EM in community SG is discussed in the view of distribution generation, electrical load demand to reduce absolute price. PV and BSS [23] unified to grid coupled SG is the formulated dispatch problem like MILP with aspiration of escalating PV fabrication. Genetic algorithm [24] adapted for power expedition in grid allied SG for diminishing the manufacturing cost of PV, WT, FC, MT, grid. Economic dispatch is disposed as quadratic prioritizing in grid connected SG to limit the price of grid, DG, and BSS. Dynamic computing is positioned economic dispatch in grid coupled SG for minimization administering cost. Budgetary schedule of grid linked SG with HES is interpreted on estimating control device, the untangled proving MILP.

Power promptness proposal of island SG dwells of DG, PV, BESS is to reduce the transacting price. Two-stage min-max-min prosperous optimal expedition schema is conferred in island hybrid SG considering inconclusiveness of RES customer loads [25]. The first juncture framework ascertains start-up/closure state of DG, managing state of bidirectional converter of SG. Thesecond notch upgrades power dispatch of singular units inSG. A decomposition-hinged prospective is intended to figure out the issue of devised planning of BESS beneath confusion to depreciate net equivalence [26]. A dichotomy technique is offered for vigorous power dispatch in isolated SG with MT, ESS endorsing DSM. In the primary plan, control based ablutionary algorithm is adapted to catch optimal revelations of issues. The foremost solution is derived decision analysis in the secondary phase. The Smart Grid Energy Management System (SGEMS) is flourished with the ability to file, reserve, and evaluate power dispersion data of dominant appliance in domicile and industries. The power devastation data is attainable via Web portal and handheld gadgets [27]. The three extensive systems are smart infrastructure scheme, smart management entity, and smart protection arrangement [28]. The intentions in smart management system elaborates energy capability, delineating demand, expanding utility, regulating emission probe to integrate home, architecting EM systems (HEMS, BEMS), solar PV, and ES with SG.

II. Smart Grid Energy Management Systems (SGEMS)

A. Demand Side Management (DSM)

Energy management means to optimize complex, important technical creations energy systemhaving surge ofdiscernment in improving energy generation, distribution, and demand side receiving proliferating obsession by investigating factory to revamp energy entity at the view of dissipation [29] elaborating energy proficiency by sophisticated staples, over bright energy custom with attraction for dispersion markings, and disappointed real-time limitation of distributed energy resources [30]. The demand response program is divided into many categories which are shown in fig.3.

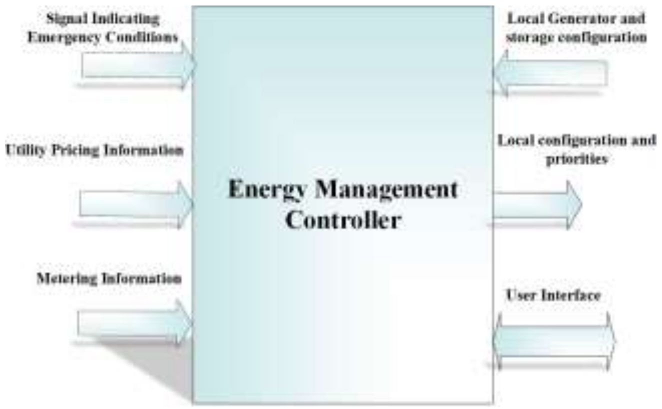

Fig. 1. Functions of Energy Management Controller [14].

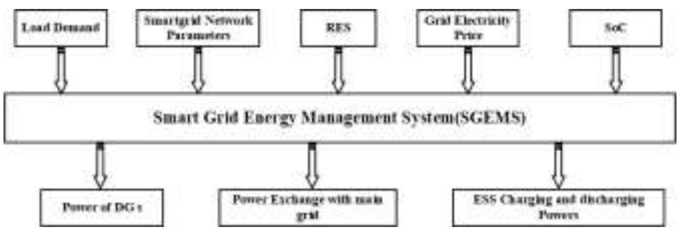

Fig. 2. Functions of Smart Energy Management System [12].

The SG has significant recognition due to the features, like distributed generation, self-mending, digital communication, and self-supervising [31]. The SG can govern, manage electricity market, construct infrastructure, and manage disseminated power resources. DSM upholds SG features to estimate brief term prominence of electricity vend, clinching cost- emphatic option for energy supply, and delineating entity load. The capacity of SG is mended to match thriving energy trade [32] desired positioning of energy generation transmission framework. The evolution of modern foundation enhances not only complexity of SG plexus but increases significant schema financially. The adequate pursuits of DSM programs in SG overwhelmed development, causes huge recompensesby governing predisposing energy demand [33].

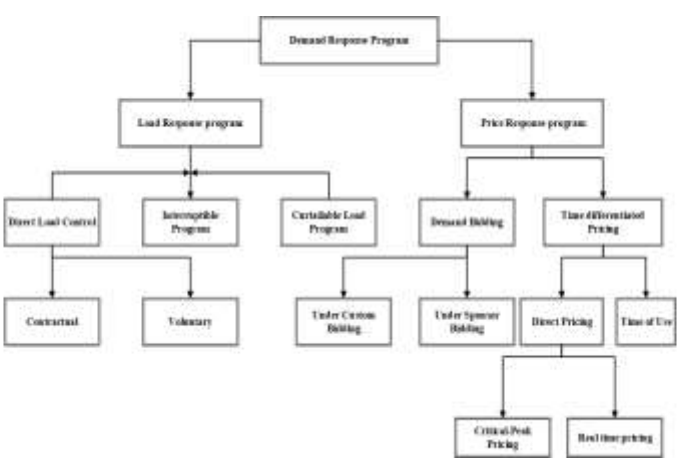

Fig. 3. Classification of Demand Side Management Programs [29].

The DSM is classified into six categories compromising to daily, seasonalpractice of electricity.

B. Demand Response (DR)

A swift response by the essence of DR is sound. Signal transmission is done by distribution, transmission system operator (DSO/TSO). This signal encompasses cost, command for load shedding/shifting. Classical Direct Load Control (DLC) speculates loads beneath control. An intelligent controller is anticipated in adopting load models to assemble verdicts. The main components of DR are

- DR Automation Server (DRAS)
- DRAS Clients at customers' sites
- The Internet as communication framework

The client-side elucidation study adopted by controls fabricators to invent confection Open ADR, is efficient. Clients can recommend to "DR programs," as critical crest costing, demand injunction, DRAS deals like market platform, and subscription manager. A utility operator announces crisis intimation to DRAS, server ahead directive to clients compete in "crunch chores" and transactions are documented [34].

Distributed Spinning Reserve (DSR): DSR attempts to fortify conventional purchasers of subsidiary indulgences by emulating exploits. The command side is decreased or escalated if grid frequency falls or rises. Two accomplishments of method are Integral Resource Optimization Network (IRON), and "grid friendly controller". The diversity is IRON box- extraneous communication associates (GSM/3G modem) licenses cooperative algorithms [35].

III. OPTIMIZATION ALGORITHMS

Optimization of grid entangles observance of optimal counterweights amidst obtainability, price, constancy, and productiveness. Optimization of grid is accomplished by surveying load convention, agitating mountain time electricity market into off peak, fast stimulating of power collapse [36], assisting in forging power stockpiles to context adjunct demand, extension of PHEV, converging consumer statistics, chunks with utility firms, entrenches efficacious communication network amid passive consumers, utility, exhilarates amalgamation of RES to consummate green energy, fabrication of SG to transfigure streamlined power grid into DG interface, and perspective costing control [37] to transport enhance customers to follow intelligent power system. The advancements are actualized by re-vamping grid such as, power transmission, distribution, utilization losses are abridged, authenticity of grid is enacted, ejection of hazardous gases are disapproved and minimization of energy cost [38]. With amalgamation of RES, progress optimization dispositions [39] stationed on wisdom algorithms posture protest over the existing grid. With inclusion of unfamiliar loads, PEVs, charging stations-busses, electricity market are exalted briskly. The evaluation analyses of SG are optimization algorithms like genetic, firefly, and PSO [40]. They suggested meld, brilliant combination of diversified algorithms like fuzzy ARTMAP wavelet transform adopting firefly optimization in applied science.

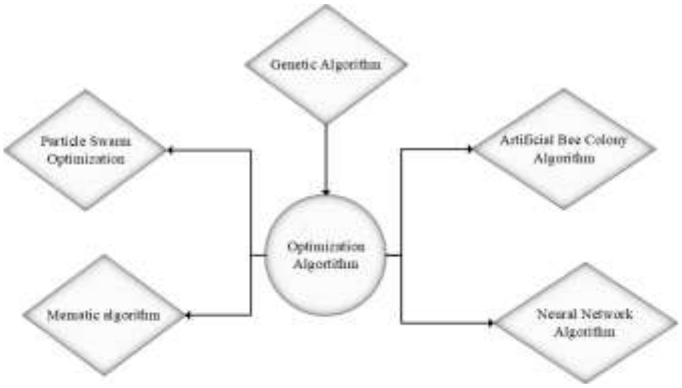

Fig. 4. Optimization Algorithms [41].

The optimization procedures to monitor foremost variable from initial parameter(s) optimizes the given function. The obstruction of conventional techniques is complex to perceive leading value if storage space size improves. The swarm algorithms are PSO, artificial bee colony, and ant colony optimization. The interpretation algorithms have exertion on natural crossover, mutation, selection, and adaption. The apprehension algorithms are Genetic Algorithm (GA), genetic, evolutionary programming, and differential evolution [1].

A. Genetic Algorithm (GA)

GA is environment galvanized appraisement algorithm, that intercedes to ameliorate non-linear function. In SG user, electricity market variegates with climate [1].GA engrosses searching of solution from one dwellers of solvents to another, and the foremost explication is obtained. Solution to enigma is implied by cord of chromosomes. Genes manifest in chromosomes clinches drifts of optimization function. Optimum chromosomes invert data amid crossover and mutation to crop offspring. Offspring is screened beside week fellow [42]. GA plays indispensable role in proficient retention of SG. GA in SG entail's fault detection in SG, to supersede energy extortion, lessen electricity distribution price, and methodize substation voltages [43].

B. Memetic Algorithm (MA)

MA is to adobe non-linear function in SG. Energy intensification in SG is the crucial factor highlighted [41]. MA retains the similarities of GA in view of awaiting assured solution. Meme in MA yields adventure locally before involvements of evolutionary usages. Initial situla pursuit is enforced in random variable to acquire experience, and vernacular optimum nostrum is achieved. Random reproduced variable is passed via mutation and crossover phase to furbish offspring [44]. One of the MA is Memetic Slap Swarm Algorithm (MSSA). Slaps are marine brutes that features jellyfish in body format dynamism and is consistently merged end to end to form chain called as slap chain. The pioneer is positioned at the front end of chain, outstanding discernment of environment. The resting slaps are supporters, who follow the previous one.

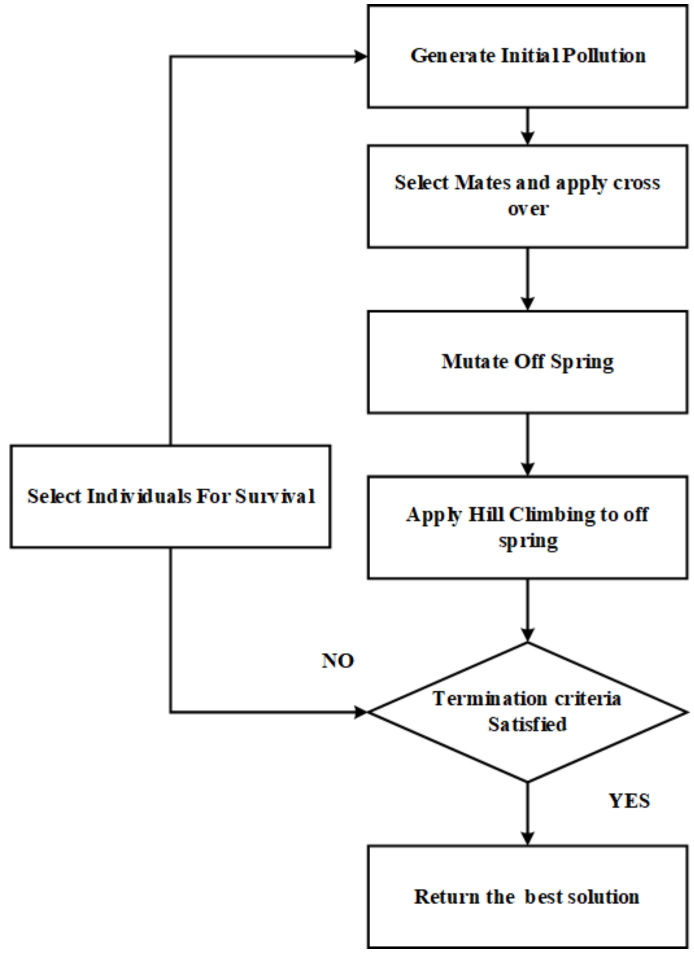

Fig. 5. Flow Chart of Memetic Algorithm [44].

This movement phase is tending to accelerate integrated movement, nourishing to slaps congregate [1]. The flow chart of MA is laid out in Fig5.

C. Particle Swarm Optimization (PSO)

PSO is a metamorphic scheme related to GA facets. PSO is elated by the congregation of flying birds' inscription towards unspecified destination. Each bird in brood characterizes blends in PSO, flock implies particle. Flying birds transmit collectively and recognize bird in supreme location. After encompassing optimum location, they glance for additional birds to strategy. The formation keeps until bird's reach target [45]. The PHEVs, affluent power load will influence SG. PSO prudently controls PHEV's by designating energy to PHEVs charging station skillfully. PSO is adapted to encounter optimal locations for deployment of sensor that gives best coverage range, and used to optimize substation which intercedes of Phaser Measurement Units (PMU's)[46].

D. Artificial Bee Colony Algorithm (ABCA)

ABCA is an expounding dispute by spotting accurate value. ABCA has three types of honeybees that are adapted for food piercing.

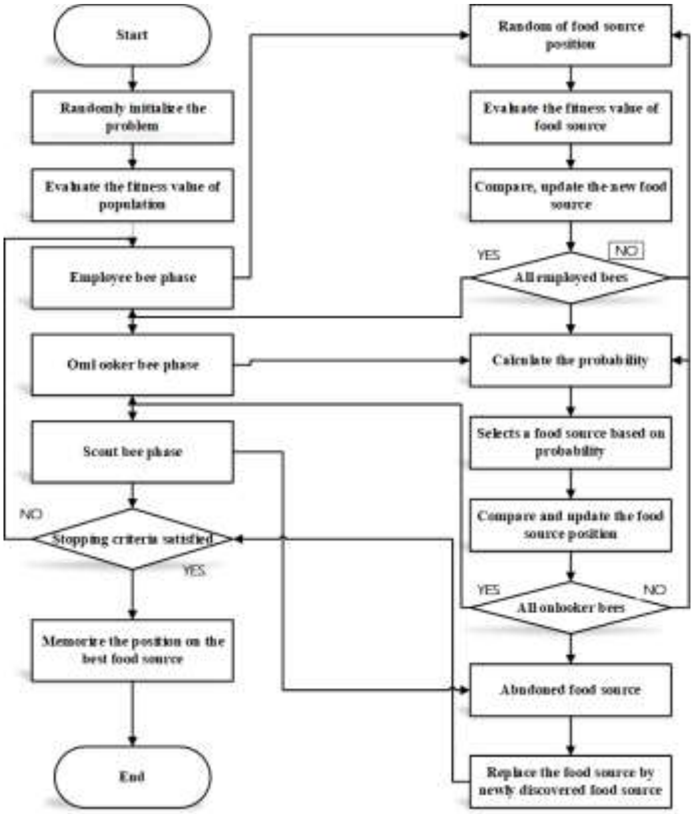

Fig. 6. Artificial Bee Colony Algorithm [49].

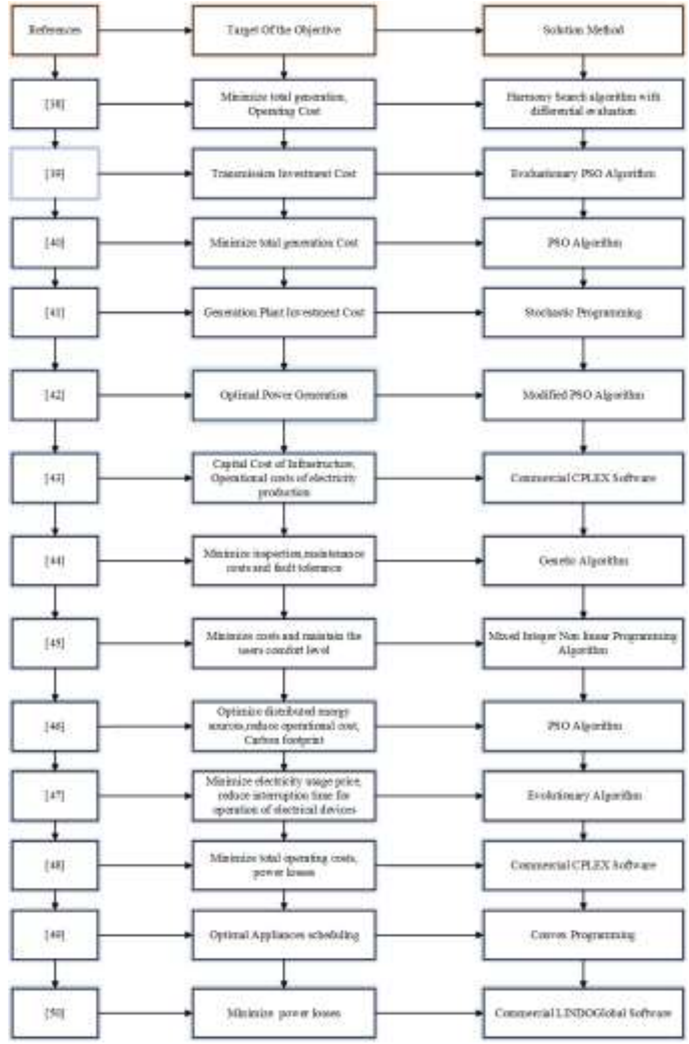

Fig. 7. Application of different optimization techniques[14].

ABC algorithm concurs steadily to fall into confined optimum. Exalted by Opposition-Based Learning (OBL), investigators advised amended ABC i.e., Opposition-Based Learning ABC (OLABC). In OLABC, initially, population is embarked adopting OBL [47]. Besides, to make certain assortment of occupants in iterative undertakings, solution equation working to bee mode is customized. If fitness value of contemporary generated solution has less current solution, opposite solution is generated and greedy choosing scheme is sued to upgrade solution. Adaptive weight method is dynamically regulating weight, stabilizing global exploration, and locally exploits. OLABC has superior convergence speed and optimization precision [48]. ABCA is a group brilliant algorithm that simulates affairs of bee colonies gathering honey. The bees in ABCA may be: employed, scout, onlooker bees. The three bees' perform with each other to settle variety stages of functions in honey mining methods such as, recognize locale of optimal nectar source by accumulating, and dividing nectar sources. Optimal nectar source condition coincides to optimal emulsion of dispute, and nectar restrained in nectar source correlate to fitness charge of the result [49]. After ample configuration, employed bees seek neighborhood of cognate known nectar source or pridemodern nectar source. The scout bees sort the nectar source stationed on nectar in each source. The scout bees explore privileged nectar source, ascertain position of new nectar source per formula. They approach to choose or not pick- up new nectar source, allied to nectar-congregation bees to actuate replacement of old nectar source with one.

E. Neural Network Algorithm (NNA)

NNA is ecologically energized learning prototype algorithm, akin to human brain. NNA enrolls from encounters like human brain. NNA have skill to extract data from compound markings that are not remarked by human or computer [50]. In NNA processing units (PUs) are conjugated mutually through convoluted communication networks [51]. Each PU is carved to mimic real neutron which is accountable for allocating data amidst diversified nodes united in a schema. To propagate logical accord in energy distribution, electricity price and load are the preconditional contentions. Input attribute of NNs is hingedon knowledge gathered in form of previous aridity, cost, and calendar testimonies. Output aspect gathered immediate effects on the view of report is rendered [52]. Pricing data attained from consumer's domain with ANN schema is applied for charge anticipating.

F. Optimal Energy Management (OEM)

Optimal energy management is the framework of primary control of SG operating in grid-connected mode.

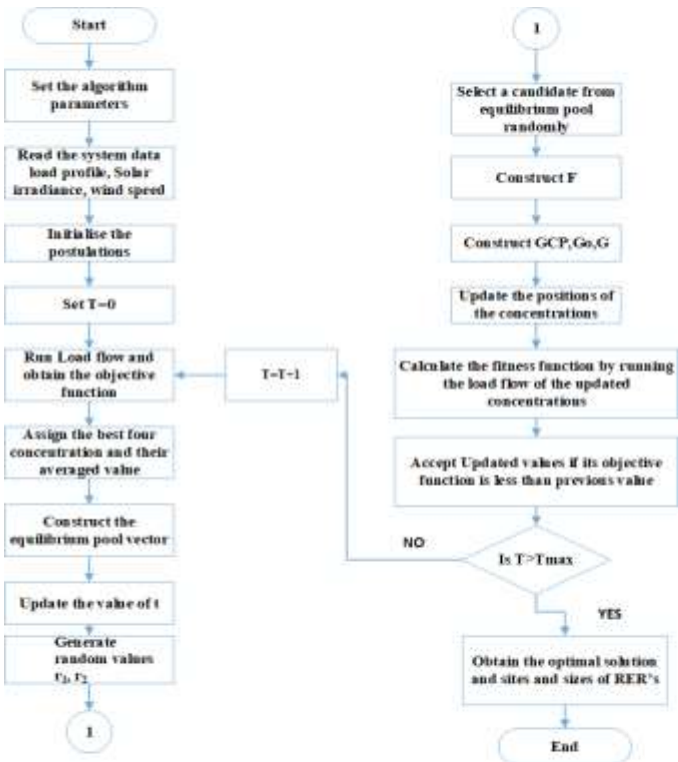

Fig. 8. Flow chart of Optimal Energy Management [54].

The optimal energy management problem is untangled by using Optimal Power Flow (OPF). The essentials regarded in SG are PV panel, WT, EV, storage system, and PCC with grid. ESS is significant for energy peak relocating, peak load cutting in SG, optimal battery conceptualization, EM in use of ESS, and schema of taking account of battery attributes in cognitive stage. Optimal battery deployment for SG system with Li- ion batteries is investigated as lifespan supplement [53]. The battery option is the implication for optimal battery exertion dispute of OEM. The battery feature of SG system is with distributed battery entity for grid frequency control with deliberation of distributed restraint. Optimal controllers for distributed battery integral to diminish battery load and for the expansion battery life is designed [54].

IV. Conclusion

This manuscript confers visionary review of DSM optimization techniques in improving power quality of SG. The intention posterior contemplation of SG apart from farther grids is to designate grids in forthcoming, to bestow surpass customer service, to deflate harmonize cost, and to equate demand curve. This paper exemplifies how budgetary is significant for grid. For that, DR line-ups are imported which allows end use purchasers to depreciate their electricity practice over period of greater power prices. They can abate electricity consumption if extensive fares are immense or reliability of grid is risked, gathering payments for reductions, to harmonies supply, demand etc.

The alteration from centralized grid to distributed electrical system via SG pinched astounding has been fixed. SG's acquaints technological abstractions desires affiliation between sensitive electrical and electronic components. Realization of SG's, crave offset between two main trade-offs: potency and reliability. Reliability is given priority though is not always attested. Power quality is one of the important aspects responsible for SG reliability that should not be lapsed. Mending power quality modern optimization algorithms are popularized in this paper which will boost the performance of grid.

References

[1] P. Wang, E. Du, N. Zhang, X. Xu, and Y. Gao, "Power system planning with high renewable energy penetration considering demand response," *Global Energy Interconnection*, vol. 4, no. 1, pp. 69–80, 2021.

[2] J. Chakravorty and J. Saraswat, "Improving power flow capacity of transmission lines using dpfc with a pem fuel cell," *Engineering, Technology & Applied Science Research*, vol. 9, no. 6, pp. 4883–4885, 2019.

[3] E. Himabindu and M. G. Naik, "Energy management system for grid integrated microgrid using fuzzy logic controller," in *2020 IEEE 7th Uttar Pradesh Section International Conference on Electrical, Electronics and Computer Engineering (UPCON)*, IEEE, 2020, pp. 1–6.

[4] T. R. Ayodele, A. Jimoh, J. L. Munda, and A. J. Tehile, "Challenges of grid integration of wind power on power system grid integrity: A review," *International journal of renewable energy research (IJRER)*, vol. 2, no. 4, pp. 618–626, 2012.

[5] O. M. Butt, M. Zulqarnain, and T. M. Butt, "Recent advancement in smart grid technology: Future prospects in the electrical power network," *Ain Shams Engineering Journal*, vol. 12, no. 1, pp. 687–695, 2021.

[6] I. Alotaibi, M. A. Abido, M. Khalid, and A. V. Savkin, "A comprehensive review of recent advances in smart grids: A sustainable future with renewable energy resources," *Energies*, vol. 13, no. 23, p. 6269, 2020.

[7] S. K. Rathor and D. Saxena, "Energy management system for smart grid: An overview and key issues," *International Journal of Energy Research*, vol. 44, no. 6, pp. 4067–4109, 2020.

[8] M. Håberg, "Fundamentals and recent developments in stochastic unit commitment," *International Journal of Electrical Power & Energy Systems*, vol. 109, pp. 38–48, 2019.

[9] O. H. Mohammed, Y. Amirat, and M. Benbouzid, "Particle swarm optimization of a hybrid wind/tidal/pv/battery energy system. application to a remote area in bretagne, france," *Energy Procedia*, vol. 162, pp. 87–96, 2019.

[10] B. Hartono, S. P. Mursid, and S. Prajogo, "Home energy management system in a smart grid scheme to improve reliability of power systems," in *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, vol. 105, 2018, p. 012 081.

[11] Y. Ma and B. Li, “Hybridized intelligent home renewable energy management system for smart grids,” *Sustainability*, vol. 12, no. 5, p. 2117, 2020.
[12] M. Eissa, “First time real time incentive demand response program in smart grid with “i-energy” management system with different resources,” *Applied energy*, vol. 212, pp. 607–621, 2018.
[13] M. Gaber, A. M. Atef, A. El Zawawi, and M. Salah, “Availability and feasibility of demand side management projects in egypt,” *The Academic Research Community publication*, vol. 2, no. 4, pp. 379–386, 2019.
[14] H. B. ELURI and M. G. Naik, “Challenges of res with integration of power grids, control strategies, optimization techniques of microgrids: A review,” *International Journal of Renewable Energy Research (IJRER)*, vol. 11, no. 1, pp. 1–19, 2021.
[15] D. E. Olivares, C. A. Cañizares, and M. Kazerani, “A centralized optimal energy management system for microgrids,” in *2011 IEEE Power and Energy Society General Meeting*, IEEE, 2011, pp. 1–6.
[16] N. Javaid, I. Ullah, M. Akbar, *et al.*, “An intelligent load management system with renewable energy integration for smart homes,” *IEEE access*, vol. 5, pp. 13 587–13 600, 2017.
[17] H. Zakaria, M. Hamid, E. M. Abdellatif, and A. Imane, “Recent advancements and developments for electric vehicle technology,” in *2019 International Conference of Computer Science and Renewable Energies (ICCSRE)*, IEEE, 2019, pp. 1–6.
[18] Z. Guo, W. Wei, L. Chen, Z. Wang, J. P. Catalão, and S. Mei, “Optimal energy management of a residential prosumer: A robust data-driven dynamic programming approach,” *IEEE Systems Journal*, 2020.
[19] O. A. Omitaomu and H. Niu, “Artificial intelligence techniques in smart grid: A survey,” *Smart Cities*, vol. 4, no. 2, pp. 548–568, 2021.
[20] A. Sathesh, “Metaheuristics optimizations for speed regulation in self-driving vehicles,” *Journal of Information Technology and Digital World*, vol. 2, no. 1, pp. 43–52, 2020.
[21] A. S. Nair, T. Hossen, M. Campion, *et al.*, “Multi-agent systems for resource allocation and scheduling in a smart grid,” *Technology and Economics of Smart Grids and Sustainable Energy*, vol. 3, no. 1, pp. 1–15, 2018.
[22] S. Sarangi, B. K. Sahu, and P. K. Rout, “Distributed generation hybrid ac/dc microgrid protection: A critical review on issues, strategies, and future directions,” *International Journal of Energy Research*, vol. 44, no. 5, pp. 3347–3364, 2020.
[23] A. Z. A. Shaqsi, K. Sopian, and A. Al-Hinai, “Review of energy storage services, applications, limitations, and benefits,” *Energy Reports*, 2020.
[24] D. Krishna, M. Sasikala, and V. Ganesh, “Fractional order fuzzy logic based upqc for improvement of power quality in distribution power system,” *International Journal of Recent Technology and Engineering*, vol. 7, no. 6, pp. 1405–1410, 2019.
[25] A. Bashar, S. Smys, *et al.*, “Integrated renewable energy system for stand-alone operations with optimal load dispatch strategy,” *Journal of Electronics*, vol. 3, no. 02, pp. 89–98, 2021.
[26] D. M. Rosewater, J. Lamb, J. C. Hewson, *et al.*, “Grid-scale energy storage hazard analysis & design objectives for system safety.,” Sandia National Lab.(SNL-NM), Albuquerque, NM (United States), Tech. Rep., 2020.
[27] D. P. Karuppusamy *et al.*, “Integrated renewable energy management system for reduced hydrogen consumption using fuel cell,” *Journal of Electrical Engineering and Automation*, vol. 3, no. 1, pp. 44–54, 2021.
[28] K. Liu, K. Li, Q. Peng, and C. Zhang, “A brief review on key technologies in the battery management system of electric vehicles,” *Frontiers of mechanical engineering*, vol. 14, no. 1, pp. 47–64, 2019.
[29] E. Sarker, P. Halder, M. Seyedmahmoudian, *et al.*, “Progress on the demand side management in smart grid and optimization approaches,” *International Journal of Energy Research*, vol. 45, no. 1, pp. 36–64, 2021.
[30] G. H. Philipo, Y. A. Chande Jande, and T. Kivevele, “Clustering and fuzzy logic-based demand-side management for solar microgrid operation: Case study of ngurudoto microgrid, arusha, tanzania,” *Advances in Fuzzy Systems*, vol. 2021, 2021.
[31] J. Ahmad and M. Abrar, “Demand side management based optimal energy management technique for smart grid,” *Iranian Journal of Science and Technology, Transactions of Electrical Engineering*, vol. 41, no. 2, pp. 81–91, 2017.
[32] S. Ahmed, A. Raza, S. Shafique, *et al.*, “Rpsmdsm: Residential power scheduling and modelling for demand side management,” *KSII Transactions on Internet and Information Systems (TIIS)*, vol. 14, no. 6, pp. 2398–2421, 2020.
[33] D. Krishna, M. Sasikala, and V. Ganesh, “Adaptive flc-based upqc in distribution power systems for power quality problems,” *International Journal of Ambient Energy*, pp. 1–11, 2020.
[34] H. J. Jabir, J. Teh, D. Ishak, and H. Abunima, “Impacts of demand-side management on electrical power systems: A review,” *Energies*, vol. 11, no. 5, p. 1050, 2018.
[35] H. Zhang, H. Sun, Q. Zhang, and G. Kong, “Microgrid spinning reserve optimization with improved information gap decision theory,” *Energies*, vol. 11, no. 9, p. 2347, 2018.
[36] D. Krishna, M. Sasikala, and V. Ganesh, “Mathematical modeling and simulation of upqc in distributed power systems,” in *2017 IEEE International Conference on Electrical, Instrumentation and Communication Engineering (ICEICE)*, 2017, pp. 1–5. DOI: 10. 1109 / ICEICE.2017.8191886.

[37] ——, “Fuzzy based upqc in a distributed power system for enhancement of power quality,” *International Journal of Pure and Applied Mathematics*, vol. 118, no. 14, pp. 689–695, 2018.

[38] M. M. Islam, H. Shareef, and A. Mohamed, “Optimal location and sizing of fast charging stations for electric vehicles by incorporating traffic and power networks,” *IET Intelligent Transport Systems*, vol. 12, no. 8, pp. 947–957, 2018.

[39] M. Jain, V. Singh, and A. Rani, “A novel nature-inspired algorithm for optimization: Squirrel search algorithm,” *Swarm and evolutionary computation*, vol. 44, pp. 148–175, 2019.

[40] S. Mohammed, K. Alsafadi, I. Takács, and E. Harsányi, “Contemporary changes of greenhouse gases emission from the agricultural sector in the eu-27,” *Geology, Ecology, and Landscapes*, vol. 4, no. 4, pp. 282–287, 2020.

[41] L. Jian, G. Feng, Z. Ming, C. Liuning, and L. Weiyao, “Research on optimal inspection strategy for overhead transmission line based on smart grid,” *Procedia computer science*, vol. 130, pp. 1134–1139, 2018.

[42] C. Bharathi, D. Rekha, and V. Vijayakumar, “Genetic algorithm based demand side management for smart grid,” *Wireless Personal Communications*, vol. 93, no. 2, pp. 481–502, 2017.

[43] L.-M. Ionescu, N. Bizon, A.-G. Mazare, and N. Belu, “Reducing the cost of electricity by optimizing real-time consumer planning using a new genetic algorithm-based strategy,” *Mathematics*, vol. 8, no. 7, p. 1144, 2020.

[44] M. Papadimitrakis, N. Giamarelos, M. Stogiannos, E. Zois, N.-I. Livanos, and A. Alexandridis, “Metaheuristic search in smart grid: A review with emphasis on planning, scheduling and power flow optimization applications,” *Renewable and Sustainable Energy Reviews*, vol. 145, p. 111 072, 2021.

[45] H. Karimi and S. Jadid, “Optimal energy management for multi-microgrid considering demand response programs: A stochastic multi-objective framework,” *Energy*, vol. 195, p. 116 992, 2020.

[46] M. Samadi, J. Fattahi, H. Schriemer, and M. Erol-Kantarci, “Demand management for optimized energy usage and consumer comfort using sequential optimization,” *Sensors*, vol. 21, no. 1, p. 130, 2021.

[47] K. Garifi, K. Baker, D. Christensen, and B. Touri, “Convex relaxation of grid-connected energy storage system models with complementarity constraints in dc opf,” *IEEE Transactions on Smart Grid*, vol. 11, no. 5, pp. 4070–4079, 2020.

[48] P. Kettunen and N. Mäkitalo, “Future smart energy software houses,” *European Journal of Futures Research*, vol. 7, no. 1, pp. 1–25, 2019.

[49] Y. jie, “Application of artificial bee colony algorithms in smart grid,” in *Journal of Physics: Conference Series*, IOP Publishing, vol. 1453, 2020, p. 012 083.

[50] V. Balasubramaniam, “Fault detection and diagnosis in air handling units with a novel integrated decision tree algorithm,” *Journal of Trends in Computer Science and Smart Technology*, vol. 3, no. 1, pp. 49–58, 2021.

[51] H. M. Rouzbahani, H. Karimipour, and L. Lei, “An ensemble deep convolutional neural network model for electricity theft detection in smart grids,” in *2020 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*, IEEE, 2020, pp. 3637–3642.

[52] Z. Hameed, N. Raza, M. R. K. Sial, Z. Ghafoor, and F. Ahmad, “Smart grid optimization by implementing the algorithm of artificial neural network,” in *2021 National Computing Colleges Conference (NCCC)*, IEEE, 2021, pp. 1–7.

[53] V. V. Murty and A. Kumar, “Optimal energy management and techno-economic analysis in microgrid with hybrid renewable energy sources,” *Journal of Modern Power Systems and Clean Energy*, vol. 8, no. 5, pp. 929–940, 2020.

[54] M. M. Ismail and A. F. Bendary, “Load frequency control for multi area smart grid based on advanced control techniques,” *Alexandria engineering journal*, vol. 57, no. 4, pp. 4021–4032, 2018.