

# Power Quality Enhancement with Involvement of RES and Power Converters in Micro Grids using Metaheuristic Algorithms: A Literature Review

T.Srikanth<sup>1</sup>, A.S.Kannan<sup>2</sup> and B.M.Chandra<sup>3</sup>

<sup>1</sup>Research Scholar, <sup>2</sup> Associate Professor, Annamalai University, Chidambaram, Tamil Nadu, India

<sup>3</sup>Professor, QIS College of Engineering & Technology, Ongole, Andhra Pradesh, India

E-mail:srikanthummala1988@gmail.com, askannan.aup@gmail.com, bmoulichandra@gmail.com

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**Abstract** - Micro Grids are going to replace the traditional concept of electrical networks in order to satisfy the increasing needs in terms of flexibility, accessibility, reliability, and quality of the power supply. Economy and energy efficiency are the paradigms followed to exploit the available distributed energy resources (DERs), guaranteeing technical and environment-friendly standards. Obviously, the path to Micro Grids is complicated by the increasing heterogeneity of Micro Grid components, such as renewable, storage systems, fossil-fueled generators, and controllable loads [1]. Fortunately, the synergic interaction between DERs and information and communication technologies (ICT) foster the coordination among different infrastructures, promoting the development of Smart Grids at both theoretical and practical levels. The major highlights of utilizing micro grid are the capacity to self-heal from power quality (PQ) issues, efficient energy management, incorporation of automation based on ICT and smart metering, integration of distributed power generation, renewable energy resources, and storage units [2]. The advantages contribute to maintain good PQ and to maintain the reliability. In this regard, the concept of micro grid is brought to the stage as one of the main building blocks of the future smart grids [3].

**Keywords:** RES-Renewable energy sources, PQ-Power Quality, OT-Optimization Techniques

## I. INTRODUCTION

Power quality alludes to the capacity of electrical hardware to burn-through the energy being provided to it. Various force quality issues including electrical sounds, helpless force factor, voltage flimsiness and irregularity sway on the proficiency of electrical gear. This has various results including: Higher energy use and costs, higher upkeep expenses and Equipment unsteadiness and disappointment. Electrical power is the principle component that needed in any capacity in the business and modern areas in this manner it ought to be accessible consistently. Force quality is a bunch of boundaries that characterize the attributes of the force supply as conveyed to the purchasers in typical working conditions as far as coherence of supply and qualities of voltage, for example, recurrence, size, waveform and balance. As of late, power quality isn't just a specialized issue yet in addition a difficult that prompts monetary issues. Numerous reviews have been indicated that helpless force quality makes huge monetary misfortunes modern areas.

PQ has arisen as a champion among the most basic issues of savvy network [4]. In spite of the fact that PQ has been a notable worry of the ordinary force network, it has obtained extraordinary worry in savvy frameworks transcendently due to the accompanying reasons: a) Expanding usage of sensitive loads and control shapes starting late. b) Expansion of different nonlinear and single-stage loads which may unfairly impact the PQ. c) Accessibility of forefront metering, distinguishing and control functionalities in keen networks which can be utilized to give a charming PQ level for buyers. The term power quality is utilized to depict the nonstationary unsettling influences, which cause the major breaking down of the electrical types of gear. Activity of the electric burdens without the appropriate force makes the electrical gadgets or burdens breakdown, bomb rashly, or not work by any stretch of the imagination. Along these lines, PQ examination pulls in numerous multidisciplinary specialists in this provocative field [5].

The PQ events which significantly happen in a circulation framework can be characterized into moderate voltage varieties, brief length under voltages, quick voltage changes, symphonious twists, and exchanging homeless people [6]. These are talked about to comprehend their belongings in a brilliant lattice. The PQ issues with the infiltration of sustainable power sources incorporated to the conveyance framework as far as microgrids are clarified. The microgrids which are grouped into AC microgrids and DC microgrids are additionally talked about. The PQ worries in each sort of microgrids are talked about. The most widely recognized reasons for unsettling influences at clients side are: Faulty hardware and Improper establishing to secure against flood, while the most well-known aggravations at utility side are brought about by: Sags and swell is appeared in fig.1

In recent many years, research in the metaheuristic and transformative space has developed quickly. Various writing have been distributed on famous methodologies like hereditary calculations, memetic calculations, reproduced strengthening, Tabu pursuit, developmental calculations, subterranean insect province calculations, molecule swarm improvement, cuckoo search, and so on This book is an assortment of these methodologies in a solitary volume.

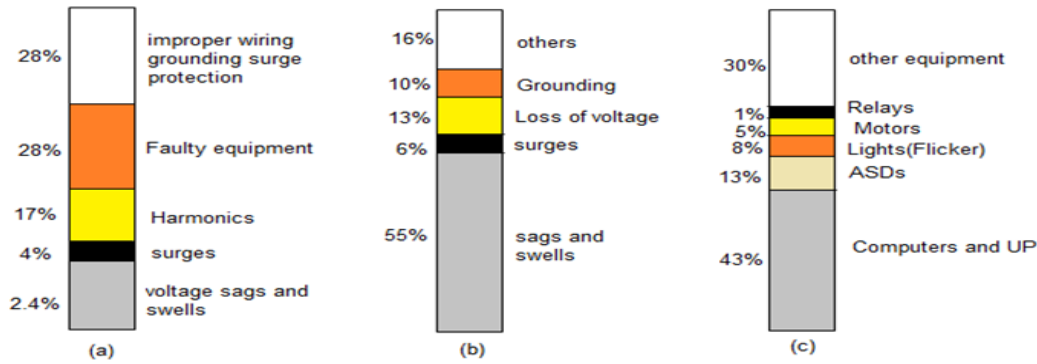


Fig.1 a) Customer side b) Utility side c) Affected Equipment

Not at all like deterministic strategies starting with one arrangement, the metaheuristic techniques actuate with a few practical arrangements (both for single-and multi-target streamlining issues) disseminated arbitrarily over the whole hunt space. These techniques are likewise exceptionally favored for taking care of multi-target improvement issues where more than one clashing target capacities are included. The technique is relied upon to unite to a solitary ideal arrangement usually alluded to as worldwide arrangement in writing for single-target improvement issues and a bunch of arrangements framing a Pareto ideal front for multi-target advancement issues. The metaheuristic approach utilized ought to assemble to the genuine Pareto front with high enhancement in the arrangement set on the Pareto front. The decision for a well-suited methodology for a given issue relies upon a few components like the number and sort of choice factors (persistent, spasmodic) and the idea of choice variable space; kind of target capacities (minimization, expansion) and nature of target space; nonlinearity and solidness of model conditions; kind of imperatives (uniformity and imbalance); a capacity of calculation to deal with the inquiry spaces of destinations and choice factors. Metaheuristic approaches are arranged into a few classifications dependent on the accessibility of information, estimations of factors, imperatives included, number of target capacities, on the web/disconnected, and so on. However some normal highlights unmistakably show up in many metaheuristics, for example, the utilization of

investigation (enhancement) and misuse (strengthening). Investigation is the capacity of a way to deal with research all encouraging districts of the arrangement space, while abuse is the ability of improving the arrangement. Two being the foundations for an issue, at first, investigation is thorough and in later ages misuse is more stressed. Another closeness is the memory use for filing the best arrangements over the iterations. One basic deficiency of most metaheuristics is the fragile tuning of various boundaries; the hypothetical outcomes accessible are not sufficient to help the client confronting another, troublesome enhancement issue.

## II. OPTIMIZATION TECHNIQUES

An enhancement issue comprises of amplifying or limiting a genuine capacity by deliberately picking input esteems from inside a permitted set and figuring the estimation of the capacity. The speculation of enhancement hypothesis and strategies to different definitions establishes an enormous zone of Applied Mathematics. All the more for the most part, streamlining comprises of discovering best accessible estimations of some target work given a characterized area including a wide range of sorts of target capacities and various kinds of areas. Quite possibly the main patterns in the field of streamlining is the constantly expanding accentuation on the interdisciplinary nature.

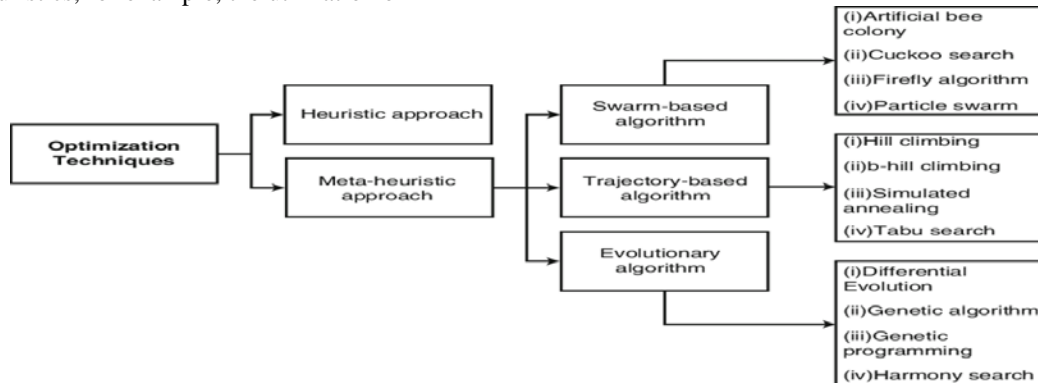


Fig.2 Metaheuristic algorithms Classification

Improvement has been a fundamental instrument in every aspect of Applied Mathematics, Engineering, Economics, Medical Science and other field of Sciences.

Most of present day optimization techniques incorporates metaheuristic calculations. Metaheuristic algorithms, for example, Particle Swarm Optimization, Ant Colony Optimization, Artificial Bee Colony, Genetic Algorithm, Simulated Annealing, Cuckoo Search, Differential Evolution, Biography Based Optimization and Harmony Search and so forth are getting extremely incredible in taking care of hard enhancement issues and they have been applied in practically all significant territories of science and designing just as modern applications. The characterization of the metaheuristic calculations appeared in the Fig.2.

### III. APPLICATION OF METAHEURISTIC ALGORITHMS IN MICROGRIDS

Power electronic converters and regulators contribute a significant job in force transmission and dispersion. The rising infiltration of discontinuous environmentally friendly power frameworks into the matrix further incited not just the mass utilization of intensity gadgets converters in force framework yet additionally ascend in a few force quality issues. The exchanging activity of intensity converter gadgets and symphonious created by the nonlinear burden in force framework raises the issues of intensity quality, for example, voltage mutilation, helpless force factor, voltage droop and swells, glimmer, and voltage lopsidedness. restorer (DVR), brought together force quality regulator (UPQC), PWM regulators, staggered inverters (MLIs) in circulation organization of intensity framework.

The interference of power and transients in voltage hold the significant offer in PQ issues followed by voltage plunge, sounds and different issues [6]. In India, some application, for example, footing, concrete plants, projecting plants, synthetic ventures are discovered significant reason for symphonious contamination. The different metaheuristic methods are being applied in addressing PQ issues. The effect of power electronics in present day power framework is significant. The lattice combination of conveyed ages (DGs) including sustainable power frameworks (RESs) utilizes the force electronic converters. For the monetary activity of intensity framework, the improvement is needed to diminish its number of parts, intricacy, establishment cost, running cost, electrical misfortunes, and consonant substance and so forth A few traditional iterative techniques were applied in these improvement issues. Nonetheless, they experience the ill effects of different disadvantages, for example, combination to nearby minima, multifaceted nature in programming, huge computational time, necessity of appropriate beginning supposition and instinct and so forth Despite the fact that there are different strategies proposed to take care of the improvement issue, the metaheuristics then again have demonstrated their abilities in taking care of the issues identified with advancement in

many designing fields. In force hardware, the enhancement is needed in circuit configuration, channel plan, keen regulators plan, boundaries calculation, displaying of new geographies, symphonious relief, misfortunes assessment, finding of safe working zones of influence electronic segments and so on In lattice associated applications, metaheuristics have likewise demonstrated their greatness, as they improve the nature of intensity alongside advancement of cost, size, and productivity of intensity framework organization.

### IV. DIFFICULTIES IN TRANSMISSION AND DISTRIBUTION USING FACTS

In present day power framework, the consistently expanding electrical burden request has pushed the current dispersion and transmission organizations as far as possible. The utilization of FACTS and HVDC transmission framework is favored for guaranteeing dynamic and static dependability. The FACTS regulators are ordinarily utilized in guideline of voltage, consistent and dynamic state control in force framework, and improvement of intensity stream capacity of transmission lines [2–4]. Be that as it may, there are a few issues as recorded beneath:

1. Low-voltage ride-through (LVRT) ability in PV frameworks and wind power change frameworks.
2. Dynamic soundness of intensity framework.
3. Association of converters to high-voltage organization.
4. The issue of adjusting the voltage of dc-connect capacitors.
5. Exact control of dynamic/responsive force for matrix adjusted/uneven conditions.
6. Utilization of new converter geographies.

### V. DIFFICULTIES IN RENEWABLE ENERGY SYSTEMS

The environmentally friendly power frameworks, for example, photovoltaic (PV) and wind energy transformation framework (WECS) utilize the force converters for change from dc to dc and ac to ac. Sea energy, geothermal energy, atomic energy, biomass, hydrogen power modules and so on are other significant assets of sustainable power [6]. Following are the difficulties in environmentally friendly power frameworks.

1. To achieve proficient greatest force point following (MPPT) in PV and WECS.
2. Irregular nature of sustainable power assets.
3. Significant expense of support and activity.
4. Infusion of sounds to network.
5. Issue of dependability of framework during network shortcoming condition.
6. Islanding impact.
7. Ideal setting and measuring of intensity electronic converters.
8. In sea energy framework, to keep up activity under cruel climate conditions.

9. To improve the prerequisite of energy stockpiling gadgets.

## VI. DIFFICULTIES IN ENERGY STORAGE SYSTEMS

The instances of energy stockpiling framework are batteries, compacted air energy frameworks, power modules, flywheel energy stockpiling frameworks, thermoelectric energy stockpiling, and superconductive attractive energy stockpiling framework and so on. The power electronic converters are utilized in the energy stockpiling frameworks [8]. The difficulties in energy stockpiling frameworks are as per the following:

1. To encourage the interconnected local networks.
2. To coordinate harmony among burden and age.
3. The energy stockpiling framework ought to cut down the fuel cost in transportation area. Likewise, ecological risks ought to be diminished.
4. To screen the effect of energy stockpiling on strength of lattice.
5. Advancement of framework coordinated/independent EVs/PHEVs.
6. Improved usage of environmentally friendly power sources.

The rising portion of discontinuous environmentally friendly power assets into lattice has pushed the idea of microgrid. It comprises combination of distributed resources such as wind, solar, fuel cells, micro hydro, combined heat and power (CHP) etc. with superior control and coordination [9]. There are a few boundaries of microgrid like productivity, designation of sources, booking, cost, size, and area of parts and so on which must be advanced.

## VII. RENEWABLE ENERGY SYSTEMS (RES)

The commitment of RES in present day framework is expanding these days attributable to their few ecological, specialized, and conservative advantages. A portion of the advantages of RES to conveyance networks are as per the following:

1. Reduced transmission misfortune.
2. Voltage profile improvement.
3. Increased efficiency
4. Reduction in power bills.
5. Reduction in ozone harming substance emanation.
6. To achieve the abovementioned advantages of RES systems, it is desirable to optimize the sizing and allocation of generation units. Farh *et al.* [13] proposed the application of a crow search algorithm (CSA) based swarm optimization to solve for the objectives such as:
  7. Minimization of cost and power loss,
  8. To find the optimum number of units required,
  9. To obtain the optimal allocation and sizing of RES,
  10. To find the optimum number of generation units.

They follow the other crows to theft the hidden foods from the hiding locations once the other crows left the places. The crows also take care of their food from being stolen which is based on the probability. To obtain better results, CSA was hybridized with PSO and was implemented on IEEE-30 bus system to solve the problem of optimal power flow with RES. The proposed algorithm showed its excellent performance as compared to other metaheuristic methods for minimization of power loss and total cost of system. The incorporated the integration of tidal energy into a solar and wind energy based RES. For the economical operation of the proposed system, optimalizing of generators, converters and other components is required. In this context,

a novel CSA technique was proposed. The power extraction from the tides is more anticipated and can be extracted with the help of tidal barrage or ocean current. Its working is similar to that of wind energy system. The important outcomes of the research work are as follows.

1. CSA efficiently found the optimum size of components of PV/wind/tidal microgrid
2. CSA holds the superiority in terms of better rate of convergence, accuracy, and time saving as compared to PSO and GA.
3. Optimum cost and high reliability of the system with battery storage.

In Yahiaoui *et al.* [14], the use of grey wolf optimizer (GWO) for the optimization of design and total cost of hybrid RES. The proposed RES consisted of diesel generator, PV panels and energy storage devices. GWO algorithm imitates the hunting behavior of grey wolves. In the hierarchy, the  $\alpha$  wolves lead the group followed by  $\beta$ ,  $\delta$ , and  $\omega$  wolves. The hunt for prey is steered by  $\alpha$ ,  $\beta$  and  $\delta$  wolves while  $\omega$  wolves follow these wolves and change their positions according to positions of their leaders. The important findings of the proposed strategy are as follows:

1. GWO converges faster than the PSO.
2. The optimal size of hybrid RES was obtained using GWO. Number of components for optimal operation were as follows: PV panels = 33, batteries = 90, diesel generators = 2. These numbers were found lower than that obtained by PSO, hence GWO resulted in least cost of the system.
3. GWO minimized the annual cost of system.

In Eltamaly *et al.* [15], the application of new bat algorithm (BA) for MPPT considering partial shading in PV systems. In this study, the optimum number of agents were computed and found to be inversely proportional to the number of maxima in power-volt curve of PV system. Ram *et al.* [16] emphasized on the mixture of conventional P&O and bio-inspired metaheuristic method. The author proposed this idea to effectively utilize the robustness and simplicity of P&O to enhance the reliability and efficiency of MPPT.

Flower pollination algorithm (FPA) mimics the biotic and abiotic transfer process of pollens. Steps involved in FPA-P&O are as follows:

1. Initialization of variables such as duty cycle, increment in duty cycle, probability.
2. Initialization of swarm position.
3. Find the best duty ratio corresponding to the global maximum power.
4. Update the duty cycle, if the criterion  $G_{best}(t+1) \approx 0.05 G_{best}(t)$  is not met, continue with FPA else switch to P&O.

Oshaba *et al.* [17] proposed the MPPT for PV system driven motor drive. In their work, authors implemented the use of BAT algorithm for optimum tuning of parameters of PI controller. Simulation results showed the better performance as compared to that of PSO. Nunes *et al.* [18] proposed the use of hybrid metaheuristic method. In the study, a combination of three metaheuristics namely wind driven (WD), whale optimization (WO) and PSO was tested on PV systems for various scenarios including partial shading. The advantages of this methodology is to utilize the beneficial characteristics of each algorithm for achieving global optimum solution. Raha *et al.* [19] proposed the hybrid solution involving capacitors and superconductors together. CSA was applied for optimal sizing and optimal allocation of VAR compensators in the IEEE-118 bus system. Rahman *et al.* [20] presented the review of metaheuristics used in electric vehicle (EV) and plug-in hybrid EVs.

### VIII. POWER CONVERTERS

The power conversion devices are principal component in power system which are used to interface RES to power grid. Koch *et al.* [21] presented a new procedure of designing current controllers in grid connected application. GA was used to automatically tune the parameters of controller, improve the dynamic response of controller and to reduce the time in design stage. In Singh *et al.* [22], applied the firefly algorithm on the problem of power system stability. The firefly technique minimized the oscillations, overshoot and settling time of power system controller. Convergence rate of proposed controller was faster than that of conventional controller. Duman [23] presented the application of new moth swarm (MS) algorithm for the optimum power flow control in HVDC system. The objectives achieved were as follows:

1. Reduction in total cost of fuel,
2. Improvement in the voltage regulation,
3. Improvement in voltage stability.

Mohapatra *et al.* [24] applied GA based compensation technique for voltage and reactive power control. In Li *et al.* [25], discussed the role of metaheuristics in the optimization of weight in aircraft's power converter design application. GA, PSO and simulated annealing (SA) were applied in the weight reduction of 2 kW inverter and the minimum weight

was found to be 420 g only. Shayeghi *et al.* [26] proposed the application of quantum PSO in UPFC for tuning the parameters of damping controller. The results showed the improvement in the transient stability, effective damping of low switching frequencies, and superior performance as compared to PSO based power stabilizers. Sarkar *et al.* [27] proposed an ACO metaheuristic scheme for the control of switched shunt capacitors. Results showed that the proposed technique was superior from the point of view of memory required, time of response, and dynamics. P.C. See *et al.* [28] discussed the application of ACO in wave energy conversion systems. The ACO reduced the computation time which helped to reduce the oscillations in output power. Abd-Elazim and Ali [29] applied the CSA for optimal design of STATCOM and finding their locations in distribution network. The proposed technique reduced the damped oscillations and improved the voltage profile.

### IX. CONCLUSION

In the utilizations of metaheuristic calculations in the different zones of intensity hardware were examined. The benefits of metaheuristics have underscored their materialness in different power electronics applications, for example, in microgrids, in RES, and in power conversion devices. When all is said in done, metaheuristics are utilized in measuring, assignment, planning, cost and loss decrease, harmonics reduction, MPP tracking, voltage profile improvement, economic load dispatch problem, quick charging of batteries and various different issues. Later on, it is normal that few metaheuristics methods might be utilized in tackling the different complex issues identified with power electronics.

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