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# A Review on Microgrid Power Management Approaches for A Distributed Power Generation Units

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## Abstract

Since the potential benefits are resulting from the use of renewable energy sources, Microgrid and Distributed Generation (DG) are becoming a significant research area. Microgrid can generally be composed of renewable microsources placed close to the load centre. In order to have control over the real and reactive power of individual DG, Voltage-Frequency control, Power management strategy is required in microgrid. Hence the main motivation of this article is to make a comprehensive survey on challenges over power management in microgrid. Different approaches are reviewed in detail for AC, DC and hybrid AC/DC microgrid.

***Keywords:*** *Renewable Energy; Micro Grids* Distributed Generation; AC; DC.

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## 1. Introduction

In the literature there is a long past of batteries integration within the grid and has Over the last decade, economical and reliable communication and management technologies, in addition to a rise in smarter electrical facilities, like electrical vehicles and smart energy meters, have resulted in an increasing variety of customers taking part in demand response management (DRM) [1-5]. In what follows, this paper provides a comprehensive review of available solutions for the operation of a microgrid which is able to concurrently dispatch real and reactive power throughout each grid-connected and islanded operations, atoning for complete harmonics with the variation of load currents, and perform peak saving power consumption shedding for completely different operative conditions. The present analysis is additionally centered on achieving a smarter version of grid through demand-side management (DSM), increasing energy reserves and improves the continuity of power quality of the distribution system, like harmonic compensation for nonlinear energy load [5-8].

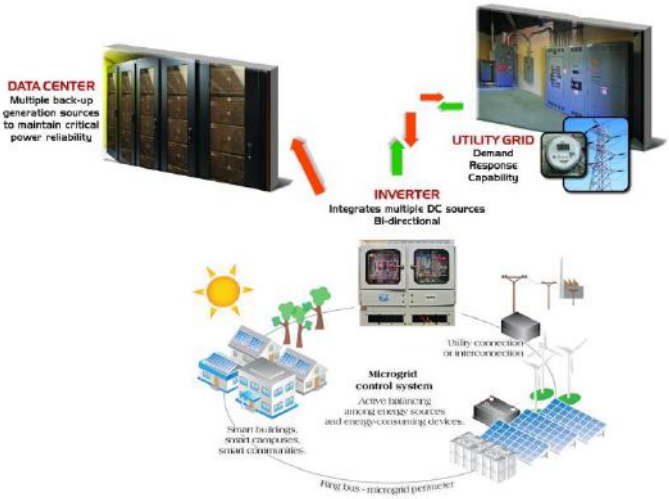


Figure 1. Sample Illustration of the Smart Microgrid.

The power storage batteries is employed for peak saving throughout grid-connected operation, and to provide power for any shortage in generated power throughout islanded operation and to take care of performance stability of the power distribution network. These new trends alter higher levels of penetration of renewable generation, like wind and solar energy into the grid [9-14]. The following energy-management algorithmic program is meant for the small grid to coordinate the sharing of power among completely different weight units. However, these renewable sources square measure intermittent in their generation and may compromise the responsibleness and stability of the distribution network. Thus, the mixing of renewable sources will supplement the generation from the distribution grid. The projected controller for the inverters of metric weight units relies on a recently developed model based predictive control (MPC) algorithmic rule, that optimizes the steady-state and therefore the transient power management issues individually [15-18]. As a result, energy storage devices, like batteries and ultra-capacitors, square measure needed to catch up on the variability within the renewable sources. The incorporation of energy-storage devices is additionally essential for managing peak demands and variations within the load demand.

## 2. Literature Review

Bourakadi et. al. (2020), presented the microgrid (MG) depended on two important and very useful renewable energies combined together to increase the efficiency of the system. Using batteries as a storage unit is suggested for this system. A MASwas proposed as EMS. Each component of MG is represented by an autonomous agent able to interact with other agents according to its current state and specific goals. The power generated from renewable sources was predicted using the ELM algorithm to overcome problems related to complex mathematical modeling.

Murty and Kumar (2020), presented microgrid energy management (MGEM) is formulated as mixed- integer linear programming and a new multi-objective solution is proposed for MGEM along with demand response program. Demand response is included in the optimization problem to demonstrate its impact on optimal energy dispatch and techno-commercial benefits. Fuzzy interface has been developed for optimal scheduling of ESS.

Simulation results are obtained for the optimal capacity of PV, WT, DG, MT, FC, converter, BES, charging/discharging scheduling, state of charge of battery, power exchange with grid, annual net present cost, cost of energy, initial cost, operational cost, fuel cost and penalty of greenhouse gases emissions.

Vera et. al. (2019), multi-objective management/optimization model when it simultaneously presents a solution to the technical, economic, and environmental problems. Based on the literature, different authors have addressed the problem and provided solutions using methods such as the classic ones with linear and nonlinear programming, heuristic methods, predictive control, dynamic programming, agent-based methods, and artificial intelligence. These methods are chosen based on their practicality, reliability, and resource availability in the microgrid environment.

Khatibzadeh et al. (2017), developed a hierarchical MAS (HMAS) and a distributed algorithm for HMAS to increase the speed of decision making in a hybrid MG. In them, the main energy sources are the renewable energy sources like wind and solar energy. The integration of the forecast of weather data and output power is necessary, and there are many proposed works for predicting wind and solar power.

Motevasel et. al. (2013), An IEMS (intelligent energy management system) is proposed for an optimal CHP-based micro grid in [3], and the IEMS aims to find the optimal set points of renewable distributed units, the CHP unit and energy storage systems.

Moghaddam et. al. (2011), a hybrid PSO algorithm based on a CLS (chaotic local search) mechanism and FSA (fuzzy self-adaptive) structure is utilized to improve the optimization process.

Marnay et. al. (2007), a DER-CAM (distributed energy resources customer adoption model) optimization technique is proposed to minimize the cost of a microgrid with CHP system. The energy storage system (ESS) is designed to store energy when production exceeds demand and to make it available at the user's request. Much research focusing on the modelling and scheduling of storage facility in microgrids has been carried out.

Ye Q et. al. (2012), a typical dispatch model is proposed to minimize the total operation cost of the microgrid. An energy management system for ESS in microgrids is presented. Furthermore, the optimal charging schedule of EVs has attracted much research attention.

Zhou et. al. (2014), Monte Carlo simulation of the particle swarm optimization (MCS-PSO) algorithm is employed to study the uncertainty of multidimensional network operation optimization scheduling. However, it is proven that the PSO algorithm is apt to fall into local optima in the optimization process. This paper proposes the MTPSO algorithm, which has a stronger global and local search ability, faster convergence and higher accuracy to solve the dispatch optimization issue in micro grid.

Niraj et. al. (2016), Position of the load and the DGs may or may not play a crucial role in active and reactive power management in a micro-grid. Further as has been discussed with extensive analysis using simulation result, that even though all DGs are of equal capacity in their generation but when the load is either increased or decreased this doesn't essentially guarantee in a microgrid that all DGs will equally share the active and reactive power demand of the loads.

Jordan et. al. (2015), is presents an efficient algorithm based on particle swarm optimization (PSO) for energy and operation management (EOM) of a microgrid including different distributed generation units and energy

storage devices. The proposed approach employs PSO to minimize the total energy and operating cost of the microgrid via optimal adjustment of the control variables of the EOM, while satisfying various operating constraints. Owing to the stochastic nature of energy produced from renewable sources, i.e. wind turbines and photovoltaic systems, as well as load uncertainties and market prices, a probabilistic approach in the EOM is introduced.

Ganesh et. al. (2015), This project gives a microgrid made up of distinctive Distributed Generation (DG) models that are connected with the submission lines. A vitality administration model is connected to arrange the highlights of the distinctive DG models in the microgrid for framework associated and islanded highlights. This paper proposed microgrid have PV array as a DG unit. Since power generated by a PV array is not constant. In order to maintain stability of grid a proton exchange membrane fuel cell is used to support the grid.

Katiraei et. al. (2008) a centralized system is developed that coordinates parallel operations of various DPG inverters among a microgrid. The associated overall energy management system is additionally developed for the microgrid to coordinate load sharing among completely different DPG units throughout each grid-connected and islanded operations. The simulation results of this model show that the operations of the DPG units among the microgrid may be coordinated effectively underneath the given system to confirm stable operation of complete microgrid. The planning idea of the projected system is evaluated through simulation studies during completely different sets of test situations.

Jenkins et. al. (2009), concluded the impact of the magnified penetration of DPG units on the distribution grid is additionally investigated within the conferred model of microgrid.

Chowdhury et. al. (2009) presented a unique power flow management methodology was developed for a hybrid AC-DC microgrid with integration of solar based alternative energy reserve, and energy storage is projected for the combination of a pulse load. Simulation results verify that the presented topology is coordinated for power management in each of the mutual AC and DC sides, when subjected to significant power loads with high performance efficiency, dependability and robustness in islanding mode of operations.

Yazdani and Dash (2009), The PV farm is connected to the DC bus through a DC-DC boost convertor with maximum power point tracking (MPPT) operability. The system is tested with a pulse load connected to the AC facets whereby electric battery bank is connected to the DC bus through a duplex DC-DC converter.

Zamora and Srivastava (2010), in order to enhance microgrid resilience within the moments of succeeding islanding, during this context innovative functionalities to run on-line, where area unit is able to manage microgrid storage considering the combination of electrical vehicles power lead responsiveness.

Li and Kao (2009), Microgrids are assumed to be established at the low voltage distribution level, wherever distributed energy sources, storage devices, manageable power loads and electrical vehicles are integrated within the system and want to be properly managed. The utilization of such storage devices in microgrids are expounded to the supply of some variety of energy buffering throughout autonomous operative conditions, so as to balance load and energy generation. However, frequency variations and restricted storage capability would possibly compromise microgrid autonomous operation.

Braithwait (2010), Microgrids comprise of numerous DPGs that are normally incorporated by means of power electronic inverters. In this context, the researchers take the consistent and transient move of grid interfacing and disengaging of the micro-grid to exhibit reparation on voltage reference. Also, voltage and recurrence coordination control can well perform critical administration of grid connected infrastructure, as well as manage the auxiliary direction of voltage and recurrence when micro-grid isolates from the primary grid.

Lasseter et. al. (2010) a control methodology for three stage voltage source inverters to coordinate the three-stage load, and in addition utility grid into the dc microgrid (DCMG), under different working situations, has additionally been developed.

Mohsenian-Rad et. al. (2010), the calculation for facilitated control plays a crucial role for the circulation and power generators coordinated to a DCMG, in islanded and grid associated methods of operation. While in island mode, the control of Voltage and recurrence will have the spot. In grid associated mode, energy administration is the control objective [27]. Thusly, such methodologies infuse in microgrids can endure variation in power load as the working conditions differ because of sudden mode changes and varieties in transport voltages and framework recurrence.

Tan et. al. (2010) The general control methodology for the microgrid comprises of the voltage reference pay would limit the unfaltering state mistake on the designated operation point; the organize control of voltage and recurrence with the help of feed-forward control of the voltage and recurrence deviation added to power references could accomplish auxiliary direction of the voltage and frequency [28]. Numerical reenactments are done to check the strength of the developed calculation and control technique under various working conditions including deficiency situation and its viability in keeping up the dc voltage of the microgrid.

Charkhgard and Farrokhi (2010) The traditional droop control can play out the critical administration in grid-associated mode, however may not all that compelling when micro-grid switches between grid-associated mode and island mode. Double relative necessary controllers for air conditioning voltage control and internal device current control have been taken a factor in two pivoting direct-and quadrature hub synchronous reference outlines for controlling the individual positive and negative succession segments.

Agrawal and Mittal (2011) with the imported external power for on time utilization (OTU) value, an interior element price based renewable and request side coordinative energy administration model is developed in light of load and PV power estimating results to augment the benefit of the renewable energy parks with a microgrid. Energy Management System for microgrid in this context depends on Smart Grid Dispatching Technical Support System (SGDTSS) which has been broadly utilized as a part of dispatching arrangement of common or territorial power grid.

Shi and Wong (2011) A secluded renewable DC microgrid having developed components and energy administration framework has been recreated utilizing MATLAB/SIMULINK. By utilizing the developed advancement calculation, the EMS will guarantee that power adjustment in the multi-microgrid framework is accomplished through energy exchanging between various interconnecting microgrids. Another renewable and request side coordinative energy administration framework is developed for microgrid with request response-based model.

Lidula and Rajapakse (2011) Microgrid (MG) is a planned power framework that addresses the renewable energy technical innovations (RETI) going with important developing sending of distributed energy reserves (DER) and little scale renewable energy sources (RES). Mixed-integer linear programming (MILP) which thinks about numerous imperatives is utilized to get the ideal measure of power that will be produced, sold, or put away for the Energy Management System (EMS) of the multi-microgrid framework at various time interims.

## 3. Problem Identification

Microgrids are receiving tremendous attention due to increasing need to integrate Distributed Power Generation Unit (DPGU) and to provide reliable power to critical loads. The problem those we tried to solve in this research work are mentioned as follows:

(i) Integration of renewable energy resources with grid.
(ii) Dynamic load management and proper control of power distribution
(iii) Avail seamless transition from grid to renewable energy reserves and vice-versa.
(iv) Quality power.
(v) Load prediction and reduction of power consumption thereby leading to cost reduction.

## 4. Conclusion

Proper power management in microgrid is required to regulate the system voltage and frequency, maintain power quality, and manage DPGGs. This study intends to solve the problem by presenting a computational technique for microgrid system, which bridges the integration of energy storage device, renewable and non-renewable power sources. The DPGUs will be modeled in detail using Fuzzified Analytic Hierarchy Process and the practical constraints of the components will be considered. In addition, with this the proposed design method to computationally control microgrid, other aspect of power distribution will also be modeled; such as power demand analysis, response characteristics measurement of power sources and forecast model of power usage. The proposed technique will be applicable to adaptively regulate the active and reactive power of each module in order to manage the power distribution system. The operability of cooperative power distribution system will be explored for to improve the system efficiency.

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