"MICROGRID WITH RENEWABLE ENERGY SOURCES AND ENERGY STORAGE SYSTEM"

[1]PRAJAKTA M. PALHADE
M. E. Scholar, G.H. Raisoni College of Engineering and Management, Amravati, India
prajaktapalhade1612@gmail.com

[2]PROF. C. M. BOBADE
Head, Department of Electrical Engineering, G.H. Raisoni College of Engineering and Management, Amravati, India
chetan.bobade@raisoni.net

ABSTRACT: *Renewable energy sources have emerged as an alternative to meet the growing demand for energy, mitigate climate change, and contribute to sustainable development. The integration of these systems is carried out in a distributed manner via microgrid systems; this provides a set of technological solutions that allows information exchange between the consumers and the distributed generation centers, which implies that they need to be managed optimally. Energy management in microgrids is defined as an information and control system that provides the necessary functionality, which ensures that both the generation and distribution systems supply energy at minimal operational costs.*

Keywords: Renewable Energy Sources, Microgrid Systems, Solar Energy

1. INTRODUCTION

Renewable Energy Sources are now recognize globally as important alternative options in supplying the electrical loads of microgrids [1]. Renewable energy based design and development of microgrids have attained a greater attention of power researchers and electric energy experts. Operating costs of renewable sources like wind, solar PV, fuel cells, biomass etc. are lesser than conventional energy sources (Nuclear, coal, oil and gas based) comparatively. Renewable energy sources are clean and pollution free and therefore are the prior options for the designers and planners of smart and microgrids. Microgrids not only provide onsite power to the local users but may sell surplus energy to power utility grid during light loads or surplus generation. As energy demands are increasing rapidly worldwide due the economic developments and gradual growth in rate of populations, requiring energy resources to meet the daily energy demands [2]. The significant issues that have made hard to grow renewable energy sources for large power generation are the unreliability and huge capital costs. It relates voltage and frequency fluctuations of renewable energies availability (e.g. from wind, solar, micro hydro and biomass etc.) and the amount of these energies depends on the environmental impacts (like climate and weather), place and time [3]. The optimal renewable technology unit size is the other main constraint in the design and planning of smart and microgrids.

The characteristics of renewable energy sources are quite different from traditional thermoelectric generator, which brings many difficult challenges to grid connection of renewable energy. The main concerned problems are:

a) Active power variation;
b) Power quality;
c) Low voltage ride through.

Currently those three problems are treated separately:

a) Energy storages to smooth active power variation;
b) Power quality conditioners to improve power quality;
c) Low voltage ride through requirement for grid connected converters.

2. LITERATURE REVIEW

Zaheeruddin et. al. [1] proposes an authentic renewable energy management algorithm for retaining sustainable energy stability within the microgrid below consideration. This paper establishes the need of considering the popularity of numerous renewable electricity resources and battery backup in a synchronized manner for the design of a microgrid imperative controller this is used to enforce the proposed strength management set of rules. The MGCC has been developed primarily based on multi agent system (MAS) idea wherein facts acquisition system (DAS) for the renewable assets and masses. To make the energy control machine extra reliable, battery electricity manipulate mechanism is carried out here. For the safe and dependable operation of the battery, its SOC is kept as an vital constraint i.e. We do no longer rate it above 80% of SOC nor can we extract battery power to satisfy the load while its SOC is below 20%.

S. Abu-Elzait et. al. [2] Studied to focus on the economic superiority of renewable energy-primarily based microgrids over the traditional microgrids, using most effective conventional fossil-fuel-based strength assets. This is in addition to the ensuing environmental advantage of warding off large amounts of CO2 emissions. Simulation effects for the 4 case research show the economic feasibility of renewable-based totally microgrids over diesel- generator-based microgrid in all cases. The financial analysis indicates that inclusive of renewable electricity systems inside the microgrids decreased the Net gift fee (NPC) of the conventional microgrid on this study by as much as 44%. The chosen disparate locations for the smart microgrids are

Yuma/AZ/USA, Boston/MA/USA, Ma'an/Jordan, and Plymouth/England.

Yimy E. García Vera et. al. [3] gives a literature evaluation of electricity management in microgrid systems the use of renewable energies, alongside a comparative evaluation of the one of a kind optimization goals, constraints, answer techniques, and simulation gear carried out to each the interconnected and remoted microgrids. To control the intermittent nature of renewable strength, electricity storage generation is taken into consideration to be an attractive option due to accelerated technological maturity, power density, and capability of presenting grid services together with frequency response. Finally, destiny directions on predictive modeling especially for electricity storage systems also are proposed.

M. Haripriya et. al. [8] studied is to minimise the transients in the power system when a renewable energy source is synchronised with electrical power grid. In the growing demand of electrical power, alternate resources such as renewable source are inevitable. Renewable source power plants such as solar power plants (microgrid) (Photovoltaic cells) operate in both off grid and on grid modes. Grid Synchronisation (GS) is a necessary operation to connect the renewable source to the micro grid. Communication between the controllers on both the side using Controller Area Network (CAN) protocol is proposed in this study. CAN protocol is chosen over Ethernet and GPS assisted GS since Ethernet has transmission delays and GPS assisted GS is costlier. CAN is an efficient and low cost protocol which helps in reducing the synchronisation time. Whenever the renewable source has to connect to the grid, the required information is shared among the main and local controllers via CAN. The voltage templates from the grid are obtained and transmitted through CAN to the local controller. To match the parameters such as voltage amplitude and frequency, a Voltage Source Inverter is used which is connected with the local controller. Whenever there is switching to on-grid mode, VSI produces the required controlled output. A DC-AC converter circuit is added to get an AC output from the PV cells. The proposed technique thus provides faster and transient less transition between modes.

3. BASICS OF MICROGRIDS

A microgrid in the most general sense can be viewed as a certain community of distributed generation sources, accumulation and redundancy systems and consumers of electrical energy, united into a single network. However, there is still no unified opinion on the parameters characterizing the microgrid, such as, in particular, the aggregated power of the connected generation sources, the size of the area on which the microgrid is implemented, the number of connections to the centralized network, etc.
A microgrid is actually a subset of electric power system. It is a power distribution network of that consists of several local distributed generation resources (DER) or generators with energy storage system and controllable loads and can operate both in an island mode (off-grid) and in parallel with utility grid (on-grid). The local generating sources may be conventional fossil fuels or then renewable energy sources.

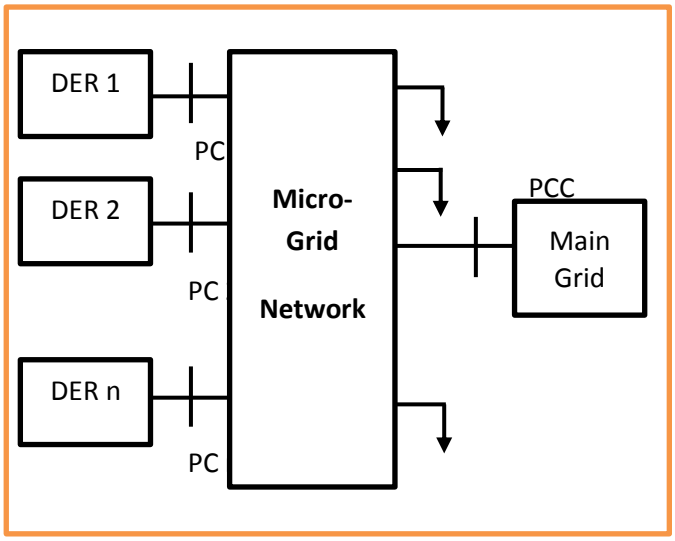

Figure 1: Simple model of microgrid [10]

A. Common features of Microgrid

• Operate in both the islanded mode and grid connected

• Presentation to the microgrid as a single controlled entity has a large number of induction motors and DC motors. Voltage buses are selected as most microgrid have both AC and DC main buses. For the load and power system parameters measurements, C.Ts, P.Ts, Voltmeters, Wattmeter

• Combination of co-located power generation sources and inter-connected loads

• Provide different levels of the power quality and supply continuity (reliability) for the end users

• They are designed to accommodate the total system energy requirement

B. Microgrid enabling Technologies

The key feature and capability of a designed microgrid is the ability to operate in an island mode (off-grid) when the power supply from the distribution system of utility's grid is suddenly interrupted or then blackouts for longer duration. The microgrid should be designed so that it may satisfy the load demand [8]. There should be an intelligent control and protective system to handle and operate the microgrid with dynamic behavior of load. The control system will control the bus voltages, reactive power in peak load duration and maintained the frequency within standard limits while protective system avoid the MG from faults and overloading.

However to operate the microgrid in an island mode in expected manner following technologies will be required:

• Distributed generation (DG)
• Distribution Automation (DA)
• Smart energy meters and other measuring meters
• Islanding and bi-directional inverters
• Substation Automation (SA)
• Microgrid control system (voltage, frequency etc.)
• Smart transfer and change over Switches
• Advanced energy storage system (batteries/super capacitors)

C. Backup Energy Storage System

The energy storage system is essential part of the microgrid since during peak loads and sudden interruptions the priority load is normally feed from batteries or other storage system (UPS). The proper selection of capacity of energy storage devices is one of the main constraints in design of the microgrid. If the generation is lightly more than demand then it is uneconomical to install huge number of batteries system. The batteries are selected normally for lightening and computer laboratories in institutes instead of running air conditioners or heating load

4. MICROGRID OPTIMIZATION TECHNIQUES

Energy management of a microgrid involves a comprehensive automated system that is primarily aimed at achieving optimal resource scheduling [4]-[5]-[6]. It is based on advanced information technology and can optimize the management of distributed energy sources and energy storage system [7]. The microgrid optimization problem typically involves the following objectives:

- Maximize the output power of the generators at a particular time
- Minimize the operating costs of the microgrid
- Maximize the lifetime of energy storage systems
- Minimize the environmental costs.

Some of the classic optimization methods include mixed integer linear and non-linear programming. The objective function and constraints used in linear programming are linear functions with real-valued and whole-valued decision variables. Dynamic programming methods are used to solve more complex problems that can be discretized and sequenced. The problem is typically broken down into sub-problems that are optimally solved. Then, these solutions are superimposed to develop an optimal solution for the original problem.

Metaheuristics is another important alternative in microgrid optimization. Heuristic techniques are combined to approximate the best solution using genetic algorithms, biological evolution, and statistical mechanisms for achieving optimal operation and control of microgrid energy.

Predictive control techniques are used in applications where predicting the generation and loading is necessary to guarantee effective management of stored energy. This typically combines stochastic programming and control. The most remarkable among these techniques are the ones to predict the deterioration of elements of the grid, mainly storage systems.

Optimization methods based on a multi-agent used on microgrids allow a decentralized management of the microgrid and consist of sections having autonomous behavior to execute the tasks with defined objectives. These agents, which include loads, distributed generators and storage systems, communicate with each other to achieve a minimal cost.

Stochastic methods and robust programming are used to solve the optimization functions when the parameters have random variables, particularly in artificial neural networks, fuzzy logic, and game theory.

A few more methods can be derived from a combination of the aforementioned techniques such as stochastic and heuristic methods and enumeration algorithms are used to solve more complex problems that can be discretized and sequenced. The problem is typically broken down into sub-problems that are optimally solved. Then, these solutions are superimposed to develop an optimal solution for the original problem.

5. CONCLUSION

Nowadays, microgrids are a progressive branch of the electric power industry, they have a number of advantages over conventional networks. Their modeling is an integral part of the study of the processes taking place in the microgrids. It is necessary to carry out physical modeling on laboratory equipment that repeats real equipment in a microgrid, but on a reduced scale, and mathematical modeling, since not all the processes can be traced on a physical model.

6. REFERENCES

[1] Zaheeruddin, Munish Manas "Renewable energy management through microgrid central controller design: An approach to integrate solar, wind and biomass with battery" Energy Reports 1 (2015) 156–163

[2] S. Abu-Elzait and R. Parkin, "Economic and Environmental Advantages of Renewable-based Microgrids over Conventional Microgrids," 2019 IEEE Green Technologies Conference (GreenTech), Lafayette, LA, USA, 2019, pp. 1-4. doi: 10.1109/GreenTech.2019.8767146

[3] Yimy E. García Vera, Rodolfo Dufo-López,and José L. Bernal-Agustín, "Energy Management in Microgrids with Renewable Energy Sources: A Literature Review" Appl. Sci. 2019, 9, 3854; doi:10.3390/app9183854

[4] Ahmad Khan, A.; Naeem, M.; Iqbal, M.; Qaisar, S.; Anpalagan, A. A compendium of optimization objectives, constraints, tools and algorithms for energy management in microgrids. Renew. Sustain. Energy Rev. 2016.

[5] Gamarra, C.; Guerrero, J.M. Computational optimization techniques applied to microgrids planning: A review. Renew. Sustain. Energy Rev. 2015.

[6]Fathima, A.H; Palanisamy, K. Optimization in microgrids with hybrid energy systems-A review. Renew. Sustain. Energy Rev. 2015.

[7] Suchetha, C.; Ramprabhakar, J. Optimization techniques for operation and control of microgrids-Review. J. Green Eng. 2018.

[8] M. Haripriya and C. Vasanthanayaki, "CAN based grid synchronisation technique of a micro grid with Renewable source," 2017 International Conference on Innovations in Green Energy and Healthcare Technologies (IGEHT), Coimbatore, 2017, pp. 1-4.
doi: 10.1109/IGEHT.2017.8094058

[9] P. Molotov, A. Vaskov and M. Tyagunov, "Modeling Processes in Microgrids with Renewable Energy Sources," 2018 International Ural Conference on Green Energy (UralCon), Chelyabinsk, 2018, pp. 203-208. doi: 10.1109/URALCON.2018.8544313

[10] A. U. Rehman, S. Zeb, H. U. Khan, S. S. U. Shah and A. Ullah, "Design and operation of microgrid with renewable energy sources and energy storage system: A case study," 2017 IEEE 3rd International Conference on Engineering Technologies and Social Sciences (ICETSS), Bangkok, 2017, pp. 1-6. doi: 10.1109/ICETSS.2017.8324151

[11] C. Yuan and X. Xiao, "A unified access conditioner for microgrid with renewable energy sources," 2014 IEEE Energy Conversion Congress and Exposition (ECCE), Pittsburgh, PA, 2014, pp. 1919-1923. doi: 10.1109/ECCE.2014.6953653

[12] L. I. DULĂU and D. BICĂ, "Economic Analysis of a Microgrid Considering Energy Markets," 2019 8th International Conference on Modern Power Systems (MPS), Cluj Napoca, Romania, 2019, pp. 1-4. doi: 10.1109/MPS.2019.8759709

[13] J. G. de Matos, L. A. d. S. Ribeiro and E. d. C. Gomes, "Power control in isolated Microgrids with renewable distributed energy sources and battey banks," 2013 International Conference on Renewable Energy Research and Applications (ICRERA), Madrid, 2013, pp. 258-263. doi: 10.1109/ICRERA.2013.6749762