Review On Sharing Energy Storage Between Transmission and Distribution System

Pooja Shaileshbabu Gajbhiye[1], Prof. S.S.Kamble[2]

[1] *Department of Electrical Engineering, People's Education Society College of Engineering, Nagsenvana, Aurangabad, India*

[2] *Department of Electrical Engineering, People's Education Society College of Engineering, Nagsenvana, Aurangabad, India*

---***---

Abstract - Micro grids often use dispersed energy resources such as wind turbines and solar photovoltaic modules. When several dispersed generating resources with varying characteristics are deployed in micro grids, controlling these resources becomes a significant challenge. sun photovoltaic modules and wind turbines used in micro grids create electricity that varies in response to sun irradiation and wind speed. Because renewable energy resources are transitory and unreliable, energy storage technologies are commonly used in micro grids. Energy management systems are used to govern distributed energy resources and energy storage units, maintain supply and demand balance within the micro grid, and deliver long-term and dependable energy to loads. Many approaches are utilized to implement and optimize energy management in micro grids. This review article compares and evaluates energy management technologies used in micro grids. The energy management system may be customized for a variety of reasons, which are also covered in depth. Furthermore, numerous uncertainty measuring methodologies are summarized to address the unpredictability and intermittency of renewable energy sources and load demand. Finally, some suggestions on possible future paths and practical applications are presented.

Key Words: Transmission, Distribution, Micro grid, Solar, Wind, Load

1. INTRODUCTION

Fossil fuels, such as coal, oil, and natural gas, are among the most efficient energy sources. Recent scientific study has shown that these energy sources have negative consequences on both human health and the environment, in addition to their economic effects. Along with these consequences, scientists are looking into alternative energy supplies for a variety of reasons, including increased energy consumption, rising energy prices, reliance on energy sources, and more. Renewable energy resources and distributed generation have traditionally been used to meet the needs of reducing the negative effects of electrical energy production on the environment, meeting the ever-increasing demand for electrical energy, and improving the quality, reliability, and stability of power systems.

Increasing the capacity of electrical networks and extending transmission lines to supply distant electrical loads raises the cost of producing electrical energy as well as transmission-distribution losses caused by rising electricity demand. Distributed generation, which mostly uses renewable resources such as solar and wind power, provides an excellent chance to address these issues. Micro grids, which are miniature electricity grids, are also being considered for this purpose. A micro grid can use both conventional and renewable distributed energy resources. With these resources, micro grids may power local and regional demands as well as the main power grid. As a result, neighboring loads can get electrical energy from energy sources spread around a certain region.

They can also operate in island (off-grid) or grid-connected (on-grid) mode. From these perspectives, micro grids provide several benefits for the future of electricity systems. Micro grids powered by renewable energy sources are used to minimize yearly electricity bills, grid energy purchases, and greenhouse gas emissions in the traditional power system. Micro grids can help to improve the sustainability of energy supply and reduce poverty in developing nations. Large power generators have high inertia moments, which help to control voltage and frequency oscillations that occur in traditional power systems. Distributed generating units in micro grids are more unstable than traditional generators due to system voltage and frequency fluctuations since they are connected to the grid via power electronic converters.

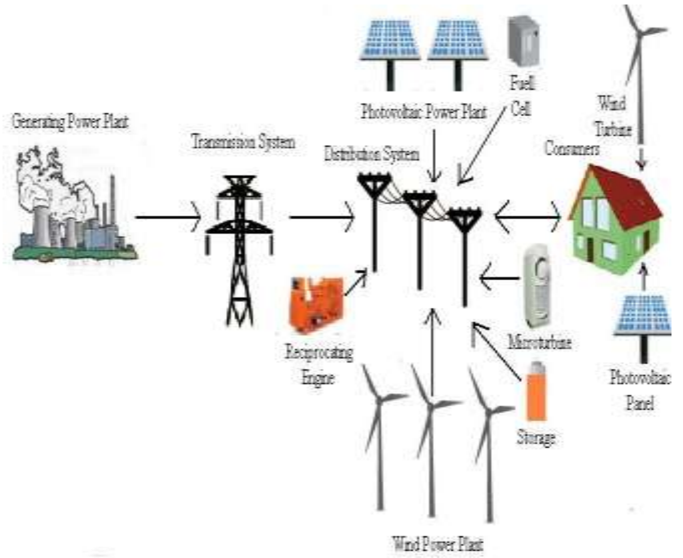

Fig 1 : A bidirectional system with distributed generation

To ensure that micro grids operate consistently, efficiently, and in accordance with standards, a control system must be established. This control system should tackle a variety of difficulties, including voltage-frequency regulation, correct load sharing, synchronization with the main grid, power flow management between the micro grid and the main grid, and operational cost optimization. Energy management is critical for the dispersed energy supplies that micro grids rely on to function efficiently.

The efficient, safe, and intelligent utilization of distributed energy resources by micro grid components is critical for power quality and supply-demand balance in the system. This may be accomplished by implementing energy management systems in micro grids. There are several methodologies, such as multi-agent systems, model predictive control, artificial intelligence techniques, meta-heuristic-based methods, and stochastic and resilient programming methods.

2. Literature Review

Energy sources that use fossil fuels to generate electricity have a negative impact on the environment; hence distribution network architects have turned their focus to the utilization of renewable energy sources [1].

On the other hand, developments in technology for connecting renewable energy sources to the grid have increased the importance of dispersed generating resources connected to the grid. Installing distributed generation resources in the right location and size can provide numerous economic and technical benefits, including reduced power losses, improved power quality, increased reliability, reduced distribution density, and economic benefits for the power grid [2].

Integrating renewable energy sources is difficult due to its intermittent and unpredictable character. Intermittent power implies that distributed renewable energy cannot supply power constantly and might fluctuate drastically in the short term. Forecasting renewable energy sources is challenging due to uncertainty [3].

As a result, this condition may induce changes in energy losses as well as an unexpected drop or rise in voltage. The increasing influence of these resources, along with the unpredictable nature of their output power, has presented several issues in the functioning of distribution networks [4].

Distributed generation injects electricity into distribution networks, affecting the flow magnitude and direction. In recent years, there has been a lot of discussion about integrating dispersed renewable energy sources into distribution systems. The notion of smart grids emerged as dispersed generation became more common in distribution networks [5].

Distributed energy sources are an essential component in the development of smart grids. Large distribution systems can be separated into a number of micro grids to improve control and operational infrastructure capabilities in future distribution systems [6].

These resources are critical in the development of micro grids. One method for maximizing the potential advantages of distributed renewable generating and energy storage batteries is to optimize their allocation and size within a distribution system [7].

In this case, integrating energy storage devices such as energy storage batteries into distribution networks is one viable method for facilitating the penetration of large levels of distributed renewable generating in the power system [8].

Distributed generation sources are classified into two types based on their applicability in micro grids [9]: traditional sources, which are rotating units with electric machines serving as the connection interface to the network, and resources, which inject power into the network via power electronic devices.

The control and operation of resources, where the interface with the micro grid is made up of power electronic devices, differs from energy generating sources, where electric machines serve as the interface [10].

The presence of dispersed generating sources in a distribution network affects current and voltage, potentially impacting system performance [11].

Its benefits include increased dependability, improved power quality, a better voltage profile, and lower losses. On the other side, the most significant issue caused by the installation of dispersed generating sources in distribution networks is an increase in the level of short circuit [12].

The power grid's mission is more than just supplying energy to users with as few outages as possible. The quality of electricity given to customers, as well as high dependability, clean energy generation, and cost reduction at all levels, is critical [13].

As a result, the concept of a micro grid, which generates electricity from a variety of energy sources, was presented. A micro grid is a component of a power system that contains one or more dispersed generating units that will continue to function even if the system is disconnected [14]. A grid-connected power storage device can alternatively be classed as a DER system, or distributed energy storage system (DESS) [15].

3. Body of Paper

The main controller is in charge of guaranteeing the micro grid system's dependability while also improving the performance and stability of each converter's local voltage control system. This control level also governs the reference voltage necessary for the internal voltage and current loops, ensuring that active and reactive power is distributed optimally amongst the dispersed generating sources. The most popular approach for the primary controller is droop control, which attempts to adjust for the imbalance etween generated power and demand. Based on this need, the droop control provides a reference voltage signal for the source, and the internal control loop (voltage and current) guarantees that the real voltage matches the reference value. In actuality, in grid-connected mode, a micro grid's central controller controls the active and reactive powers of each DG unit, as well as the voltage and frequency in island mode. Several methods of primary control have been developed, particularly for the inverter voltage source interface of distributed energy sources. The majority of these techniques make use of an inner/outer control loop based on the PI controller. An intelligent load approach using a three-phase-single-phase AC-DC converter as a virtual synchronous machine is presented to eliminate frequency variations in the island micro grid. This method can also do grid support activities. Increasing the sources of distributed generation in a micro grid minimizes the system's inertia. In the event of load fluctuations or generation failure, the primary frequency controller encounters a high-frequency change rate. The employment of solid-state transformers as virtual synchronous machines in island operating mode is a novel technique to boost system inertia. Solid-state transformers can help improve the frequency of an island micro grid. Electric vehicles can significantly impact the load profile of micro grids, according to much research. The authors demonstrated that high electric car adoption may significantly reduce primary frequency variations in micro grids. An adaptive droop controller for efficient power distribution in the DC micro grid is described.

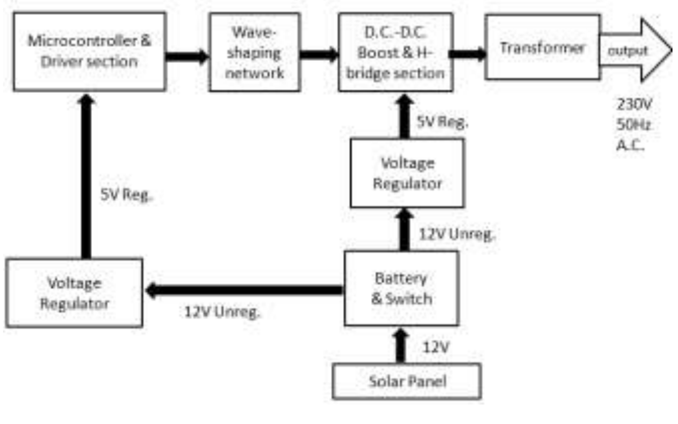

Fig2: Block Diagram of Microcontroller based energy storage system

Distributed hierarchical control has been presented to address the economic distribution of micro grids. The droop controller gets reference values from the economic regulator and outputs the necessary power while keeping the system stable. The traditional droop control method is a decentralized approach that is mostly used to operate parallel-connected converters in a DC micro grid. One of the drawbacks of the traditional droop control approach is inaccurate power sharing and voltage fluctuation in the DC bus. The tiny signal stability in a hybrid micro grid was investigated by taking into account variations in renewable energy sources. Wind speed fluctuations affect the active output power of DGs, causing power sharing to alter.

4. CONCLUSIONS

This article provides an overview of energy management systems and their applications in established micro grids. A thorough and critical review of energy management techniques and solution approaches has been conducted. The energy management system for sustainable development aims to optimize system dependability, energy planning, and operation in micro grids that can function both on the island and on the grid. As a result, a micro grid energy management system serves several purposes by addressing financial, environmental, and technological challenges. Although there are several approaches for managing energy in micro grids, artificial intelligence technologies have lately gained popularity and have significant promise in the future. Artificial intelligence technologies have enormous potential for revolutionizing micro grid operations and allowing the widespread integration of renewable energy supplies. In addition to allowing for real-time decision-making and greater resource utilization, machine learning, deep learning, and other artificial intelligence algorithms can improve micro grid predictive analytics, optimization, control, and monitoring. Although artificial intelligence technologies offer many benefits, they also pose several challenges, such as interpretability, privacy, and data quality. To encourage widespread usage of artificial intelligence technology in micro grids, future research and development should address these difficulties and propose new tactics and answers.

REFERENCES

1. Mozina, C.J. Impact of green power distributed generation. IEEE Ind. Appl. Mag. 2010, 16, 55–62.

2.Wang, C.; Nehrir, M.H. Analytical approaches for optimal placement of distributed generation sources in power systems. IEEE
Trans. Power Syst. 2004, 19, 2068–2076.

3.Ochoa, L.F.; Padilha-Feltrin, A.; Harrison, G.P.Evaluating distributed generation impacts with a multiobjective index. IEEE Trans.
Power Deliv. 2006, 21, 1452–1458.

4.Ochoa, L.F.; Padilha-Feltrin, A.; Harrison, G.P.Evaluating distributed time-varying generation through a multiobjective index.
IEEE Trans. Power Deliv. 2008, 23, 1132–1138.

5.Abu-Mouti, F.S.; El-Hawary, M. Optimal distributed generation allocation and sizing in distribution systems via artificial bee
colony algorithm. IEEE Trans. Power Deliv. 2011, 26, 2090–2101.

6.Dent, C.J.; Ochoa, L.F.; Harrison, G.P. Network distributed generation capacity analysis using OPF with voltage step constraints.
IEEE Trans. Power Syst. 2009, 25, 296–304.

7.Atwa, Y.; El-Saadany, E.; Salama, M.; Seethapathy, R. Optimal renewable resources mix for distribution system energy loss
minimization. IEEE Trans. Power Syst. 2009, 25, 360–370.

8.Celli, G.; Mocci, S.; Pilo, F.; Soma, G.G. A multi-objective approach for the optimal distributed generation allocation with
environmental constraints. In Proceedings of the 10th International Conference on Probablistic Methods Applied to Power

Systems, Rincon, PR, USA, 25–29 May 2008; pp. 1–8.

9.Haddad, R.J.; Guha, B.; Kalaani, Y.; El-Shahat, A. Smart distributed generation systems using artificial neural network-based event classification. IEEE Power Energy Technol. Syst. J. 2018, 5, 18–26.

10.Krishan, O.; Suhag, S. An updated review of energy storage systems: Classification and applications in distributed generation power systems incorporating renewable energy resources. Int. J. Energy Res. 2019, 43, 6171–6210.

11. Bahramara, S.; Mazza, A.; Chicco, G.; Shafie-khah, M.; Catalão, J.P. Comprehensive review on the decision-making frameworks referring to the distribution network operation problem in the presence of distributed energy resources and microgrids. Int. J. Electr. Power Energy Syst. 2020, 115, 105466.

12.Sarangi, S.; Sahu, B.K.; Rout, P.K. Distributed generation hybrid AC/DC microgrid protection: A critical review on issues, strategies, and future directions. Int. J. Energy Res. 2020, 44, 3347–3364.

13. Bajaj, M.; Singh, A.K. An analytic hierarchy process-based novel approach for benchmarking the power quality performance of grid-integrated renewable energy systems. Electr. Eng. 2020, 102, 1153–1173.

14.Razmjoo, A.; Kaigutha, L.G.; Rad, M.V.; Marzband, M.; Davarpanah, A.; Denai, M. A Technical analysis investigating energy sustainability utilizing reliable renewable energy sources to reduce CO2emissions in a high potential area. Renew. Energy2021,164, 46–57.

15.Guerrero, J.; Gebbran, D.; Mhanna, S.; Chapman, A.C.; Verbiˇc, G. Towards a transactive energy system for integration of