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Controlling of Micro-Grid by Sources Generating from Renewable Energy

Dr. Rajesh B. Mapari
Associate Professor, Anuradha Engineering college Chikhli 443201
aecedc@gmail.com

Abstract

Electric distribution networks are getting old, and the cost of building new substations and networks is going up a lot. It's getting harder to get electricity to remote places because the cost of fuel is going up, making it sometimes impossible to do. On the other hand, places that aren't in the middle of nowhere are having other issues, like not having enough electricity because demand is rising and the quality of power and service is getting worse. In the last few decades, both the production and use of energy have grown dramatically. These days, the rise in spending has caused a shortage of supplies. So, we need to find a way to fix both the lack and the buildup of greenhouse gases. Renewable energy sources can be thought of as an alternative to the usual power sources that use fossil fuels. Micro-grids are a new concept in the energy industry that has a bright future and many benefits. Micrograds are like the main grid, but smaller. They are made up of a number of loads and scattered generation sources, most of which are likely renewable sources. These loads can get electricity and heat from nearby sources easily. This thesis suggests a way for micro-grids to control their energy. Using the ant colony method in Matlab to create an optimization algorithm for the combined economic and emission dispatch problem is how the suggested energy management system is put into action. Additionally, this study suggests a different, less expensive way to fix micro-grid problems: putting in a battery system instead of load shedding for times when the source can't meet the demand for power. There is a comparison between the cost of KWh of the battery and the cost of energy at the time of the cutoff to find the most efficient system.

KeyWords: *Emissions, Micro-grids, Consumption, Distributed, Microstations*

I. INTRODUCTION

There are many places in the world that are very far away and don't have power. Additionally, there are many places that are connected to the grid but don't get power for up to 10 to 12 hours a day. This makes it hard for people to do business there. There are a lot of green energy (RE) sources in many of these places, like wind, sun, and biomass. A self-sufficient power system that uses renewable energy sources that are available in the area can greatly lessen the need for grid power, which is mostly fossil fuel-based. It is better to use wind and sun energy than bio-mass-based systems because the latter can have problems with the supply chain. However, wind and solar energies have a high amount of power variability, a low capacity utilization factor, and are subject to changes in the weather. These things mean that firm power can't be given for autonomous system. Battery energy storage (BES) can help by reducing power fluctuations and making things more predictable. However, the efficiency factor can be raised by making sure that each energy source is working at its best. To get the most electricity from an input source, the optimal working point, which is also known as maximum power point tracking (MPPT), needs to be controlled in terms of the speed and voltage of the wind energy generator and the solar PV (photovoltaic) array. Control based on power electronics (PE) can make the MPPT happen. BES can also better handle its energy with the help of control based on PE.

A. Problem Statements

Concerns about climate change and environmental damage are growing, and the world's need for energy keeps going up. We need to switch to sustainable and renewable energy sources for making power right away. However, there are still some problems that need to be fixed before green energy sources can be widely used and efficiently.

Important Problems:

- Variability and intermittency: Renewable energy sources like solar and wind change and intermittency based on the time of day and the weather. This lack of certainty makes it harder for the grid to stay stable and reliable.
- Grid integration and management: Adding renewable energy to existing power grids needs improvements to infrastructure and the creation of complex management and control systems that can balance supply and demand and allow power to move in both directions.
- Storage of energy: The lack of efficient and cost-effective storage options for energy makes it harder for renewable energy generation to grow and be reliable. Technologies for energy storage are very important for getting rid of extra energy when it's not needed and saving it for later use.
- Land use and environmental effects: Putting up a lot of green energy infrastructure, like solar farms and wind turbines, can have effects on the environment, such as conflicts over land use, damage to habitats, and noise and visual pollution.
- Policy and regulatory barriers: Subsidies, incentives, and regulatory frameworks that aren't consistent or aren't strong enough can slow the growth of green energy markets and make investors and developers nervous.
- Progress in technology: More research and development is needed to make green energy technologies more reliable, efficient, and affordable. It is also needed to come up with new ways to deal with technical problems like energy storage and grid integration.
- Socioeconomic factors: When switching to renewable energy, we need to think about things like creating jobs, making sure everyone has access to energy, and making sure that the benefits are shared fairly so that weaker groups don't get left behind.
- Overall, lawmakers, industry stakeholders, researchers, and communities need to work together to solve these problems. They need to speed up the use of renewable energy sources and lead the way to a more sustainable and reliable energy future.

B. Objectives

- It should work automatically while taking into account all the real-world circumstances.
- To give the battery charging help from an outside source without any extra work being needed.
- Designing a simulation model of the system is done in the Matlab/Python environment, and results for different situations are simulated.
- To make a model of the system that will be tested with a 5 kW solar PV array computer and a 3.7 kW wound rotor induction machine.

II. LITERATURE SURVEY

In this paper, Arulampalam et. al. states that 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. [1]

In this paper, Bharanikumar et. al. mentioned the importance of stability and resilience on increasingly distributed and renewable energy systems, DOE is heavily invested in advancing microgrids for remote communities and critical infrastructure applications. Out of DOE’s close engagement with partnering organizations and governments, we have identified research needs for each of the two microgrid areas covered under the request. [2]

In this paper, Bragard et. al. states that due to the rising cost of fossil fuels and environmental pollution, renewable energy (RE) resources are currently being used as alternatives. To reduce the high dependence of RE resources on the change of weather conditions, a hybrid renewable energy system (HRES) is introduced in this research, especially for an isolated microgrid. [3]

In this paper, Bull et. al. states that the flexibility in connecting/disconnecting from the electrical grid, increased system reliability, lower investment cost, great visibility in the green effect because of the integration of renewable sources, the energy-quality improvement of a system, and the reduction of losses in the distribution grid, among others. [4]

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III. MICROGRID

At point of common coupling between the micro-grid and the main grid, micro-grids have the ability to autonomously island themselves from the main grid at the times of disturbances and outages. They can supply their loads with minimum or no load disturbance. Feeders A, B, and C are considered as critical load feeders, so micro-sources were installed next to their loads, Feeder D is considered as a non critical load feeder therefore no micro-sources were installed on this feeder. At any undesired or unplanned occurrence such as power outage or low voltage levels, by using the static switch; Feeders A, B and C can be easily islanded from the main grid and depend totally on the micro-sources installed next to their loads. On the other hand, feeder D is cut out during islanding. When the main grid is up for service again, the static switch closes and power flows through all feeders supplying all loads [13].

A. Micro-Grids Operation and Control:

Micro-grids have two operation modes which are the grid connected mode and the island mode. In the grid connected mode, micro-grid remains connected to the grid whether it's totally or partially supplying certain loads. In the Island mode, micro-grid islands itself from the main grid supplying its priority loads and in other cases supplying all of its loads. The micro-grid control system must ensure the supply of electrical energy and heat energy as well to the required loads, participation in the energy market.

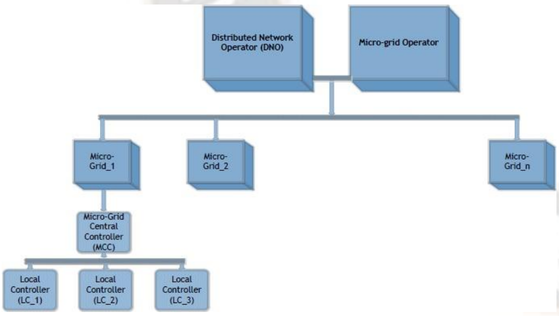

Figure 1 Micro-Grid Control Architecture

B. Energy Management Module:

Provides set points for active and reactive power output, voltage and frequency levels for micro-sources. It must maintain continuous supply of electricity and heat to customers. Ensure operation in optimum modes with minimum cost and minimum emissions. Ensure operation at highest efficiency with minimum losses.

- **Protection Co-ordination Module**
- **Micro-Grid Control Schemes**
- **Energy Management**
- **Economic Dispatch**

Several classical techniques were previously used to address the economic dispatch problem such as homogeneous Linear Programming Algorithm. Nowadays, Modern computational intelligence techniques are emerging to substitute the classical techniques such as Particle-Swarm-Based-Simulated Annealing. The economic dispatch problem was solved using the Ant Colony technique and results showed better cost savings and high effectiveness. The combined economic and emission dispatch problem was addressed using three methods; Genetic Algorithm, Classical Ant Colony, and Lambda technique. All results were compared and it showed that the Classical Ant Colony algorithm presented the best solution in minimizing the cost and the thermal emissions. The combined economic and emission dispatch problem was examined using evolutionary computation methods such as the genetic algorithm and evolutionary programming.

IV. PROPOSED SYSTEM

These renewable energy sources offer numerous environmental, economic, and social benefits, including reduced greenhouse gas emissions, energy security, job creation, and decentralized energy production. As technology advances and economies of scale improve, renewable energy is becoming increasingly competitive with fossil fuels, driving the global transition towards a more sustainable and resilient energy system.

Microgrids can be powered by distributed generators, batteries, and/or renewable sources like solar panels or wind turbines. The primary purpose is to ensure a reliable and continuous power supply, potentially improve efficiency, and enable the integration of renewable energy sources.

A. Energy Generation: Renewable energy sources like solar panels and wind turbines generate electricity. These sources are often intermittent, meaning they depend on weather conditions, so the microgrid may need energy storage solutions like batteries to store excess energy for use when generation is low.

B. Energy Management: A control system manages the flow of electricity within the microgrid. It decides when to use energy from renewable sources, when to store excess energy, and when to draw from the main grid (if connected).

C. Load Management: The control system also manages the distribution of electricity to different loads within the microgrid, prioritizing critical loads if necessary. It can also optimize the use of electricity based on demand and availability of renewable energy.

D. Grid Connection: A microgrid can be connected to the main grid or operate in isolation, depending on the situation. When connected, it can export excess energy to the main grid, and when disconnected, it can operate independently.

E. Islanded Operation: If there's a power outage or other reasons to disconnect from the main grid, a microgrid can continue to operate autonomously, providing electricity to its loads using its own generation and storage resources.

F. Control and Monitoring: A key aspect of a microgrid is its control and monitoring system, which constantly monitors the status of the grid, adjusts energy flow based on demand and availability, and ensures the stability and reliability of the system.

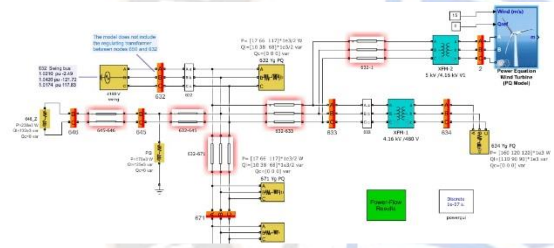

Fig. 2 Simulink model for the proposed system

V. RESULT

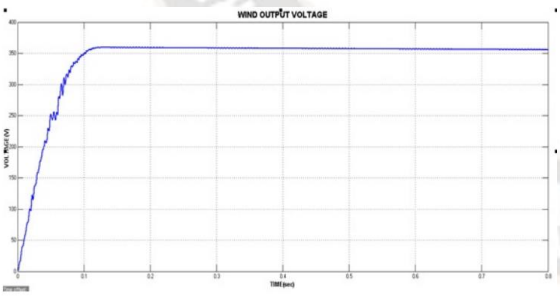

Fig. 3 Wind power output voltage waveform

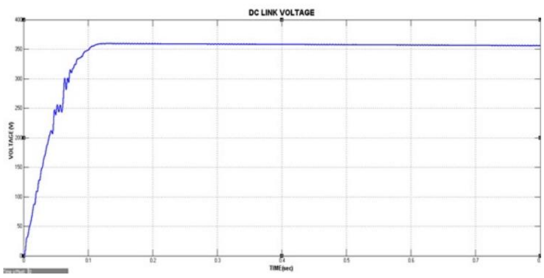

Fig. 4 DC link output voltage waveform

VI. CONCLUSION

In order to verify the effectiveness of the proposed energy management system are carried out and results were presented in this chapter. First case study was carried out on a micro-grid with conventional energy sorces. The second case study was carried out on a hybrid micro-grid containing renewable sources alongside with conventional sources. Various scenarios were studied to promote for the integration of the renewable based sources such as PV and WT in micro-grids. Moreover, renewable energy certificates are taken into consideration which eventually saves a large amount of cost. Finally, a feasibility study is carried out to decide upon the integration of battery system in the micro-grid if it is cost effective or not.

VII. FUTURE SCOPE

The future scope of Microgrid Control Systems powered by renewable energy encompasses several areas of development, innovation, and implementation. Here are some potential future directions:

A. Advanced Control Algorithms
B. Blockchain Technology
C. Internet of Things (IoT) Integration
D. Energy Storage Advancements
E. Hybrid Renewable Energy Systems
F. Grid-Interactive Buildings
G. Cybersecurity Measures
H. Policy and Regulatory Support

References

[1] Arulampalam, A., Barnes, M., Engler, A., Goodwin, A., Jenkins, N., 2004. Control of power electronic interfaces in distributed generation microgrids. Int. J. Electron. (91), 503–523.

[2] Bharanikumar, R., Kumar, A.N., 2010. Analysis of wind turbine driven PM generator with power converter. Int. J. Comput. Electr. Eng. 2 (4), 766–769.

[3] Bragard, M., Soltau, N., Thomas, S., De Doncker, R., 2010. The balance of renewable sources and user demands in grids: Power electronics for modular battery energy storage systems. IEEE Trans. Power Electron. 25 (12), 3049–3056.

[4] Bull, S.R., 2001. Renewable energy today and tomorrow. Proc. IEEE 89 (8), 1216–1226.

[5] Chen, M., Rincon-Mora, G., 2006. Accurate electrical battery model capable of predicting

runtime and I-V performance. IEEE Trans. Energy Convers. 21 (2), 504–511.

[6] Chen, Y.-K., Wu, Y.-C., Song, C.-C., Chen, Y.-S., 2013. Design and implementation of energy management system with fuzzy control for DC microgrid systems. IEEE Trans. Power Electron. 28 (4), 1563–1570.

[7] Dogger, J., Roossien, B., Nieuwenhout, F., 2011. Characterization of li-ion batteries for intelligent management of distributed grid-connected storage. IEEE Trans. Energy Convers. 26 (1), 256–263.

[8] Jiani, Du, Youyi, Wang, Changyun, Wen, 2013. Li-ion battery SOC estimation using particle filter based on an equivalent circuit model. In: Proc. 10th IEEE International Conference on Control and Automation, ICCA, Held in Hangzou China from 12–14 June, pp. 580–585.

[9] Gaonkar, D.N., 2010. Investigation on electromagnetic transients of distributed generation systems in the microgrid. Electr. Power Compon. Syst. 38, 1486–1497.

[10] Hledik, R., 2009. How green is smart grid? Electr. J. 22 (3), 29–30. labVIEW Software Signal Express, 2012. National Instruments, Texas, USA 2012.

[11] Xu, Ling, Miao, Zhixin, Fan, Lingling, 2012. Control of a battery system to improve operation of a Microgrid. In: Proc. IEEE on Power and Energy Society General Meeting held in San Diego, California, USA, During 22–26 July, pp. 1–8.

[12] Mishra, S., Mallesham, G., Jha, A.N., 2012. Design of controller and communication for frequency regulation of a smart Microgrid. IET Renew. Power Gener. 6 (4), 248–258.

[13] Prajapati, V., Hess, H., William, E.J., Gupta, V., Huff, M., Manic, M., Rufus, F., Thakker, A., Govar, J., 2011. A literature review of state of-charge estimation techniques applicable to lithium poly-carbon monoflouride (LI/CFx) battery. In: 2010 India International Conference on Power Electronics, IICPE, pp. 1–8, 28–30 January.

[14] Soloveichik, G.L., 2011. Battery technologies for large-scale stationary energy storage. Annu. Rev. Chem. Biomol. Eng. 2 (1), 503–527.

[15] Sovacool, B.K., 2008. Renewable energy: Economically sound, politically difficult. Electr. J. 21 (5), 18–29.

[16] Valenciaga, F., Puleston, P.F., 2005. Supervisor control for a stand-alone hybrid generation system using wind and photovoltaic energy. IEEE Trans. Energy Convers. 20 (2), 398–405.

[17] Vazquez, S., Lukic, S., Galvan, E., Franquelo, L., Carrasco, J., 2010. Energy storage systems for transport and grid applications. IEEE Trans. Ind. Electron. 57 (12), 3881–3895.

[18] Xiong, Xiaofu, Ouyang, Jinxin, 2011. Modeling and transient behavior analysis of an inverter-based microgrid. Electr. Power Compon. Syst. 40, 112–130.

[19] Zhengming, L., Mingzong, C., 2010. Small stand-alone wind turbine device characterstics analysis, vol. 35 (M.S. thesis), Electrical Engineering, Southern Taiwan University of Science and Technology, Tainan, Taiwan. Miao, Zhixin,

[20] Xu, Ling, Disfani, V.R., Fan, Lingling, 2014. An SOC-based battery management system for microgrids. IEEE Trans. Smart Grid 5 (2), 966–973.