

Review of Estimating the Stability of an AC-DC Hybrid Micro Grid with Multilayer Power Flow Using an Interconnected Converter

Ms. P. S. Yadav

Dattakala Group Of Institutions Faculty Of Engineering And Management , Tal-Daund, Dist-Pune, India

Dr. P. V. Paratwar

Dattakala Group Of Institutions Faculty Of Engineering And Management , Tal-Daund, Dist-Pune, India

Abstract— Regionalized networks known as micro grids must be able to operate independently by severing their connection to the main grid in order for a system to stay stable. Customers' dependability can be improved by providing a more robust power supply. Due to reversed energy flow from distributed generator units, regional fluctuations, transitory micro grid modes, significant frequency discrepancies in electrically isolated mode operation, and supply and demand uncertainties, the primary problems with micro grids are, in fact, consistency, dependability, and security. Although their main objective is to increase the hybrid micro grid's stability, delivering electrical energy from the AC side to the DC side and from the DC side to the AC side makes the system more unstable. As a result, a variety of circuit breakers, buck boost converters, grid bidirectional converters, and intermediate IC (interlinking converter) are employed to preserve the stability of the hybrid micro grid. This article explains how to build a bidirectional power flow through an interactive converter using MATLAB stability evaluation. For the best outcomes, simulation may improve the circuit's performance. The results of the best hybrid micro grid stability were shown. This study uses an interlinking converter, which improves micro grid stability when power flows through the AC and DC grids in both directions. A MATLAB simulation may be utilized to acquire the results. This strategy also has the advantage of reducing the amount of time required for the system to stabilize, hence improving system reliability and providing a high-quality supply.

Keywords — interlinking converter, distributed generators, bidirectional power flow, and hybrid micro grids (HMGs) are some related terms.

I. INTRODUCTION

The hybrid micro grid is powered by a variety of power generation sources, such as diesel engines, photovoltaic solar panels, wind power, and any additional power source. The hybrid energy source can power multiple power plants. This covers both renewable energy production facilities and non-renewable energy sources. One of the key advantages of employing a hybrid micro grid such as this one is the ability to preserve power supply continuity. Give customers access to a superior energy supply. The ability of the grid-connected photovoltaic system to continue operating normally or stably in the event of an interruption is referred to as stability. On the other hand, is Destabilization is a state that exhibits a lack of synchronism or a slipping out of synchronization. The importance of electrical grid factors in grid integration has long been recognized. As interconnected grids grow larger and cover large geographic areas, it becomes increasingly difficult to keep the many parts of a power grid in sync. Despite the lack of connectivity, HMG consistency has already been recognized as essential to location during working hours. Numerous power rails are connected by different networks

in the power grid. There are many devices on the grid that are capable of continuous operation. Such equipment is protected by various circuit breakers. Before the hybrid micro grid was introduced, there was only one grid available. If a fault arises, the entire grid will be shut down. Consequently, the grid cannot supply continuous power. Once the hybrid micro grid is implemented, problems of this nature will be resolved. The HMG is equipped with numerous tools.

Due to the expanding electricity market and environmental concerns, decentralized electricity generating technologies have made significant strides in recent years. The AC/DC connected micro grid, which also has a distinct power generation structure, combines the benefits of the micro grid based on the AC micro grid. The AC/DC connected power plants in the micro grid can simultaneously satisfy multiple demands. The method maximizes dispersed renewable energy sources and improves the efficiency of electricity distribution. In an AC/DC mixed system, a converter of electricity known as a "compound converters" (IC) regulates the power conversion between the AC and DC grids. In order to properly align and optimize the transfer of electricity among the AC sub-micro grid and the DC sub-micro grid, the IC must handle the reversible active power connection between the two sub-micro grids.

In contrast, the IC for the sub-micro grids must simultaneously display two distinct energy and demand parameters at both grid ends. The integrated distributed generation is still being developed and can be used to carry electricity between AC and DC networks. The combination converter (IC) of the HMG sub-grids uses a dual power flow to switch power between the alternating current (AC) and DC electrical systems. With or without electricity, the HMG can be distributed or managed centrally. a badly run company. There are various ways to use the attributes of energy that are used for participation and collaboration. Even though de-centralized management is used in both AC and DC sub grids, de-centralized organizational methods are still in use. Despite the lack of connectivity, it was already recognized that HMG's dependability is essential for the site during working hours. The operation of the micro grid in islanding mode, as well as the transmission of power from AC to the sub grid's DC and AC, present a number of challenges that the multipurpose power converter architecture seeks to address. It enhances the power quality while also enhancing the power flow through a variety of auxiliary services. It can improve the power supply and reduce the harmonics and transients of the system. As a result, the system is more stable than other systems (literature review).

The standard droop models utilized by the causers coupled to the DC and AC sub-micro grids are thoroughly examined in this research. To guarantee the voltage stability of autonomous interconnected micro grids, connected converters should employ a unidirectional sliding mode control method based on PI. This approach considers the properties of connected generators, which need to maintain reversible power exchange, DC bus voltage stability, and AC bus frequencies. Supporting power is sent between the AC and DC modules together. When one module deviates from the required system standards, the impact on the other systems can be mitigated [1]. Photovoltaic (PV) production and storage technologies are essential for controlling system stability and generating electricity in islanded micro grids. The generating and storage systems must be coordinated to prevent overcharging and over discharging, as well as an increase in the DC link voltage. of areas used for storage.

This paper develops a distributed method based on DC bus voltage signaling for synchronizing power generators and storage devices. First, a new state-of-charge (SOC) dependent buffer control technique is created for storage regions to enable the DC bus voltage and balance their SOC. Overcharging a storage unit can be avoided with this technique. When the power generating units are not operating at their maximum power point tracking capacity, power generation can be continuously regulated with an enhanced power control approach. It is possible to effectively combine these two approaches for collaboration between generators and storage units by employing DC voltage signaling. Additionally, the dependability of the relevant control mechanism is investigated. [2] A grid-connected interconnected grid DC/AC consisting of a photovoltaic DC/DC converter, a multimodal lithium battery (LB)-based DC/DC converter, and a grid-connected DC/AC inverter topology can be controlled by proposing linear regression compensators integrated into the internal dynamics of the two energy converters used.

An appropriate compensation architecture is used in the suggested energy converter control procedures to simultaneously associate these power supply variations with a few other control loop elements.

The largest overall result for the compensation elements is obtained by evaluating the natural The system variables' amplitude and frequency as calculated from the suggested management-based control loops. [3] Although the output of rooftop solar power generation is inconsistent, it is beneficial to the environment. By managing the process of charging and discharging, energy storage systems may make up for the difference between solar power production and consumer energy consumption. Thus, the management and control of micro grids using parallel hybrid converters and photovoltaic inverters has become one area of growth. Each combination inverter in a grid has a varying ability to produce energy because to variations in solar module storage, lighting conditions, storage capacity, and SOC. To successfully regulate the electrical output, it is essential to understand the real power capability of each inverter. These studies analyze the basic characteristics of parallel inverters in micro grids, which depend on control, and develop a method to determine the dynamic power status of each inverter. They study the effects of DC link voltage DC and adjust the decaying process factors to control the energy output of the inverters. The simulation and experimental results show that by gradually changing the electrical power of each inverter according to its actual performance, the

power demand of the loads can be met. This method can achieve the power dynamics of the hybrid system [4].

A crucial component of the stability of these grids under islanding situations is the bidirectional power flow in the interconnected inverters (IC) of hybrid ac/dc micro grids (HMGs) made up of distributed energy resources (DGs) with shuttle devices. This study looks into how energy flow direction affects the HMGs with islanding control's modest dependability. Making a linearized state space model of an HMG is the initial step. The dominant modes are represented by the equations in the upper right and are obtained using Eigen analysis. The network of variables and control factors that have the highest effects on stability are found using principal component evaluation, which is the third approach that can be used. The most significant changes in dependence and stabilization are then identified using the evaluation. According to the evaluation and vulnerability analyses, the HMGs' dominant modes stabilize when more energy is moved from the DC sub grid to the AC sub grid. Any enhancement to the AC to DC sub grid's power transfer decreases the HMGs' overall reliability. In order to understand how variations in ac and dc drop gain affect the methods under research, it is also examined how susceptible the dominant modes are to these changes. Power is transferred through the IC while this is being done [5].

The power transfer between the ac and dc sub grids may always be achieved properly for combination ac/dc micro grids coupled by one type of compound transformer (IC). The use of several ICs together with their respective AC and DC sub-networks may cause power circulation and overload the ICs owing to the influence of line opposition numbers. This research effort suggests an individual exchanging power strategy for composite micro grids connected by a number of ICs by producing clashing frequencies inside the DC sub grid 4. The power control system between the ICs and the DC and AC generators is referred to as a genuine filtering system.

As a result, there is no power circulation or IC overloading, and there is sufficient DC power and even power distribution. [6] An electrical system's primary objective is to safely and economically supply society with renewable energy sources. There has been a transition to low- or zero-carbon power generation as a result of several countries adding a second target to this one: using sustainable materials to meet all energy needs. This change is happening quickly all around the world, and distributed generation (DER), inverter-based resources (IBR), and differentiated alternative energy sources (AER) are becoming more prevalent. [7]

research is required to enhance the stability of dc micro grids [8]-[9].

In dc micro grids, the harmonic components of load currents can significantly affect the performance of the power sharing controller. In the conventional current sharing methods, the oscillatory current is shared among DG units based on the impedance of lines between the DG units and the oscillatory loads. The conventional droop control methods may, therefore, cause some DG units to inject oscillatory currents higher than the others, which can lead to the current crowding phenomenon. This phenomenon severely deteriorates the reliability of system, particularly when DG units operating at their maximum capacity are required to provide load oscillatory current demand [8].

Apart from the oscillatory current sharing in dc microgrids, some control strategies have been developed to attenuate the voltage fluctuation component of dc-bus voltage. A conventional method is to increase the capacitor size of the dc-bus. The dc-bus capacitor plays the role of a low-pass filter for conducting the oscillatory currents of loads [9].

However, as the capacitor size increases, the cost and the bulk of converters are unfavourably increased. An efficient method to design the PI controller of dc-bus for a single-phase renewable source has been presented in [9]. A phase-shift determination method has been used to minimize the double-frequency ripples [10]. In [11], a droop-controlled superconductive dc system catering to a small zone is analyzed. Effect of interconnecting cable resistance is neglected in the dc systems. It may be noted that this effect becomes significant for the low-voltage dc system.

A power management strategy for dc system in more electric aircraft (MEA) is given in [12]. This method assumes a centralized generator and does not address the issues pertaining to unequal load sharing in distributed sources. Analysis on the effect of interconnecting cable given in [13] is limited to the one-source one-load system. Therefore, it does not demonstrate the effect of unequal load sharing in the distributed generation system.

IV. CONCLUSION

The convergence analysis addressed in this study aims to emphasize the importance of caution rather than concentrating on the possibility that power exchanges across one sub grid towards another might possibly be disrupted. In the near future, more study should be conducted on the energy variation component of AC/DC hybrid micro grid ICs.

REFERENCES

- [1] K. Li, J. Zhang and J. Zhang, "Research on the Control Strategy of AC/DC Interlinking Converters in Islanded Hybrid Microgrid," 2021 *IEEE 4th International Conference on Electronics Technology (ICET)*, 2021, pp. 479-483, doi: 10.1109/ICET51757.2021.9450958.
- [2] Y. Xia, M. Yu, P. Yang, Y. Peng and W. Wei, "Generation-Storage Coordination for Islanded DC Microgrids Dominated by PV Generators," in *IEEE Transactions on Energy Conversion*, vol. 34, no. 1, pp. 130-138, March 2019, doi: 10.1109/TEC.2018.2860247.
- [3] A. Zafari, M. Mehrasa, K. Rouzbehi, M. S. Sadabadi, S. Bacha and A. Hably, "DC-Link Voltage Stability-Based Control Strategy for Grid-Connected Hybrid AC/DC Microgrid," 2020 *2nd Global Power, Energy and Communication Conference (GPECOM)*, 2020, pp. 268-273, doi: 10.1109/GPECOM49333.2020.9247892.
- [4] F. Zhang and J. Kang, "A Power Sharing Control Method of Parallel Hybrid Inverters to Preserve Microgrid Stability," 2019 *22nd International Conference on Electrical Machines and Systems (ICEMS)*, 2019, pp. 1-4, doi: 10.1109/ICEMS.2019.8921699.
- J. Park, Y. Sim, G. Lee and D. -H. Cho, "A Fuzzy Logic Based Electric Vehicle Scheduling in Smart Charging Network," 2019 *16th IEEE Annual Consumer Communications & Networking Conference (CCNC)*, 2019, pp. 1-6, doi: 10.1109/CCNC.2019.8651730
- [5] A. A. Eajal, H. Muda, A. Aderibole, M. A. Hosani, H. Zeineldin and E. F. El-Saadany, "Stability Evaluation of AC/DC Hybrid Microgrids Considering Bidirectional Power Flow Through the Interlinking Converters," in *IEEE Access*, vol. 9, pp. 43876-43888, 2021, doi: 10.1109/ACCESS.2021.3066519
- [6] S. Peyghami, H. Mokhtari and F. Blaabjerg, "Autonomous Operation of a Hybrid AC/DC Microgrid With Multiple Interlinking Converters," in *IEEE Transactions on Smart Grid*, vol. 9, no. 6, pp. 6480-6488, Nov. 2018, doi: 10.1109/TSG.2017.2713941.
- [7] F. Zhang and J. Kang, "A Power Sharing Control Method of Parallel Hybrid Inverters to Preserve Microgrid Stability," 2019 *22nd International Conference on Electrical Machines and Systems (ICEMS)*, 2019, pp. 1-4, doi: 10.1109/ICEMS.2019.8921699.
- [8] A. Azizi, S. Peyghami, H. Wang and F. Blaabjerg, "Risk Evaluation of Hybrid Microgrids Considering DC-Link Voltage Stability," 2022 *IEEE 13th International Symposium on Power Electronics for Distributed Generation Systems (PEDG)*, 2022, pp. 1-6, doi: 10.1109/PEDG54999.2022.9923273.
- [9] M. O'Malley et al., "Enabling Power System Transformation Globally: A System Operator Research Agenda for Bulk Power System Issues," in *IEEE Power and Energy Magazine*, vol. 19, no. 6, pp. 45-55, Nov.-Dec. 2021, doi: 10.1109/MPE.2021.3104078.
- [10] Y. Li and L. Fan, "Stability Analysis of Two Parallel Converters With Voltage-Current Droop Control," in *IEEE Transactions on Power Delivery*, vol. 32, no. 6, pp. 2389-2397, Dec. 2017, doi: 10.1109/TPWRD.2017.2656062H.
- [11] A. A. A. Radwan and Y. A. -R. I. Mohamed, "Networked Control and Power Management of AC/DC Hybrid Microgrids," in *IEEE Systems Journal*, vol. 11, no. 3, pp. 1662-1673, Sept. 2017, doi: 10.1109/JSYST.2014.2337353.
- [12] E. Alizadeh, M. Hamzeh and A. M. Birjandi, "A Multifunctional Control Strategy for Oscillatory Current Sharing in DC Microgrids," in *IEEE Transactions on Energy Conversion*, vol. 32, no. 2, pp. 560-570, June 2017, doi: 10.1109/TEC.2016.2633459.
- [13] E. Alizadeh, M. Hamzeh and A. M. Birjandi, "A Multifunctional Control Strategy for Oscillatory Current Sharing in DC Microgrids," in *IEEE Transactions on Energy Conversion*, vol. 32, no. 2, pp. 560-570, June 2017, doi: 10.1109/TEC.2016.2633459.
- [14] S. Leitner, M. Yazdani, A. Mehrizi-Sani and A. Muetze, "Small-Signal Stability Analysis of an Inverter-Based Microgrid With Internal Model-Based Controllers," in *IEEE Transactions on Smart Grid*, vol. 9, no. 5, pp. 5393-5402, Sept. 2018, doi: 10.1109/TSG.2017.2688481
- [15] S. Peyghami, H. Mokhtari and F. Blaabjerg, "Autonomous Operation of a Hybrid AC/DC Microgrid With Multiple Interlinking Converters," in *IEEE Transactions on Smart Grid*, vol. 9, no. 6, pp. 6480-6488, Nov. 2018, doi: 10.1109/TSG.2017.2713941.
- [16] Microgrids," in *IEEE Transactions on Power Electronics*, vol. 32, no. 10, pp. 8089-8099, Oct. 2017, doi: 10.1109/TPEL.2016.2632441.