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FUZZY LOGIC CONTROLLER BASED AC/DC INTERLINKING CONVERTERS IN ISLANDED HYBRID MICROGRID

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ABSTRACT:

By minimizing repeated power conversions in individual AC or DC microgrids, hybrid AC-DC micro grids offer highly distributed generation receiving capacity. In a hybrid AC-DC microgrid, the impact of negative sequence components and incorrect frequency transients make it difficult to control grid variables.The AC/DC Hybrid MicroGrid (HMG)'s bidirectional transfer of power via the Interlinking Converter (IC) is the subject of the analysis. As opposed to past attempts made for simply ac or dc microgrids in the main challenge is regulating power flows between all sources situated on the two types of sub-grids. The study that utilized this wider range of control has not received much attention. For it to work properly, converters, dc sources, and ac sources must all operate in synchronism. Converters may switch the flow of electricity from an AC sub-microgrid to a DC sub-microgrid. In a sub-microgrid composed up of Distributed Generators (DGs) with droop controllers, which are essential to the system's stability during islanding, this converter enables load requirements to be met despite a lack of power. According to this work, the small-signal stability of islanded droop-based HMGs is influenced by the power flow direction. A linearized state-space model of an HMG is being developed by it. Increased generation on the dc subgrid enhances the HMG stability margin overall during islanding, based on time-domain simulations conducted in MATLAB/Simulink.

Keywords: Interlinking Converter (IC), Hybrid Micro Grid (HMG), Photovoltaic (PV), Wind turbine, Fuzzy controller are some of the keywords.

I.Introduction

Microgrids use new energy quite successfully. DC hybrid microgrids, that combine the greatest qualities of DC and AC microgrids, are the subject of more and more study. The capacity for islanded AC-DC hybrid microgrids is constrained, therefore converters typically support bus voltages. It indicates that reliable operation of AC-DC hybrid microgrids depends on the connecting of the converters. lately the concept of connecting isolated ac and dc microgrids with bidirectional ICs to create a hybrid microgrid has been put out. For there to be power transmission between the two systems in hybrid systems, an interlinking converter (IC) that operates in both directions works in conjunction with the ACS and DCS.Both grid-connected and islanded power control modes can be used to manage ACS or DCS for each sub-grid. Numerous companies employ decentralized management techniques based on common droop characteristics.

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Because of the rising population, increasing living standards, and infrastructure development over the last few decades, there has been a dramatic increase in the need for energy. A widespread use of conventional generating units and increased system efficiency are therefore necessary. However, a system that cannot be preserved due to the depletion of fossil resources, high rate of consumption, environmental effects of old energy sources, inefficiency, and aging of power systems.The acceptance of sources of clean energy in this setting has grown over time [1].The readily available and emission-free renewable energy sources include solar, wind, tidal, biofuel, fuel cells, and small hydroelectric facilities. Given the fact that they frequently interact at the distribution level, they are also known as distributed energy resources. A reliable, cost-effective integration of distributed energy resources with a utility grid is still a challenge, but it is an appealing alternative. A particularly viable option is the smart grid, a next-generation electricity infrastructure made up of groups of linked micro-grids [2].

A low the voltage distribution system comprising distributed generating, energy storage devices, and loads is known as a microgrid.The most ideal method for decentralized a power grid, in my opinion. A microgrid's inherent capacity to connect to and disconnect from the main grid results in an improved system with reliability, lower investment costs, the green benefit from using renewable energy sources, better power quality for a system, and a reduction in distribution network losses. According to its topology, a microgrid can be categorized into three main categories: AC, DC, and hybrid. The most common structure that uses the protection, technologies, and electrical network already in place is an AC microgrid. However, its disadvantages includes the requirement for synchronizing distributed generation (DG) units and losses brought on by reactive power circulation [3].

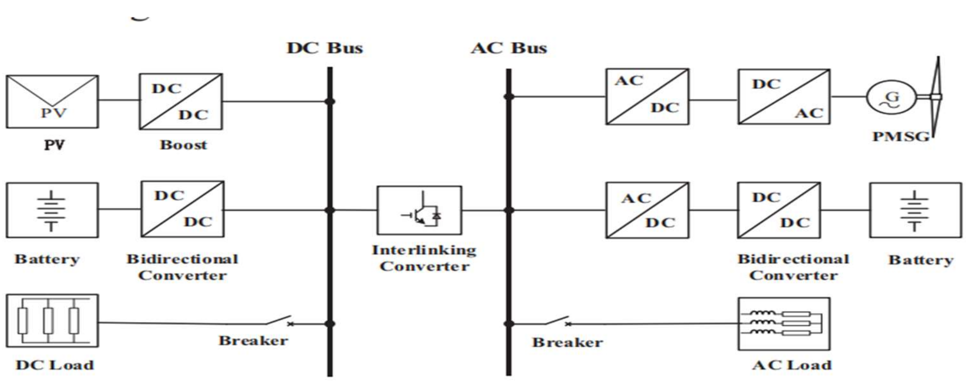


Fig 1: A Structure of AC/DC hybrid micro-grid

Additionally, the use of converters to convert DC sources into AC creates an issue and reduces overall efficiency. DC micro grids have been made possible by the rising adoption of DC-based distributed energy resources such as PV and fuel cells, energy storage systems, and loads. It will however necessitate a significant adjustment to the existing electrical network. Many DC/DC, AC/DC, and DC/AC conversions make individual DC and AC microgrids inefficient[4].An excellent way to implement smart grids in conventional distribution networks is through the use of hybrid microgrids. It combines advantages of AC and DC microgrids, enabling direct integration of AC and DC-based distributed energy resources, energy storage systems, and loads. Additional advantages include the lack of synchronization, straightforward transformation, and economic viability [6]. Among numerous definitions of a hybrid microgrid, we often refer to one as "a hybrid low-voltage microgrid, unless otherwise specified," or "an integrated AC/DC low voltage microgrid system."As the world's attention has recently shifted to the high penetration of renewable power sources like solar and wind at the customer's site, the traditional energy network is becoming significantly decentralized.This serves as an alternative to fuel-fired generators, which produce significant levels of carbon dioxide. To attempt to address issues like reliability and energy loss in the transmission network, a combination of these micro-sources known as clustered generation units was created along with the advancement of recent scientific work. Distributed renewable energy sources, also known as distributed generators (DGs), are typically connected to the nearby low voltage portion of the local AC utility grid to power local loads, doing away with the requirement for elevated voltage transmission. [17]. The term "Microgrid" (MG) refers to this combined system of AC and DC micro-sources, power controllers, and loads. A new set of issues are brought about by the compactness of this system and the low voltages at their points of connection, necessitating novel methods for controlling the operation of the DGs. As a result, different control topologies for the MG have recently been developed with the help of numerous recent in-depth research studies.

I. METHODLOGY

The below simulation diagrams shows the structure of AC/DC hybrid micro-grid.

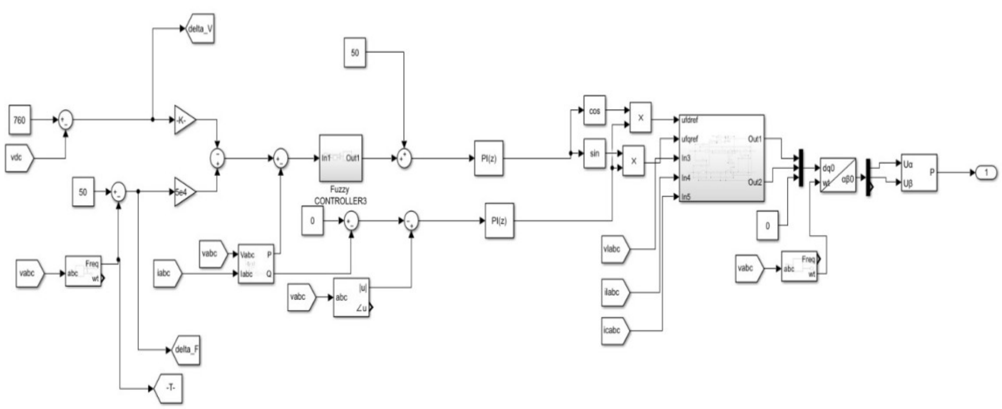


Fig. 2 shows a simulation of a controller.

A utility grid, connection stage, AC network, and DC network make up a typical hybrid microgrid structure. Through various interfaces phases, a hybrid AC/DC microgrid integrates both separate AC and DC microgrids. The hybrid microgrid can be split into three topologies, such as AC coupled, DC linked together, and AC-DC coupled, based on the connection of distributed generators and energy storage systems to the main bus and linkage of the main bus with the utility grid.Distributed generators, energy storage devices, and utilities are all connected to the main AC bus in an AC coupled microgrid. Bidirectional interface converter are used to connect the energy storage system and DC loads. Due to its ease of use as well as the availability of AC generation systems, it is the topology that is utilized the most frequently worldwide. integrating converters, however, take into consideration the current inefficiency.

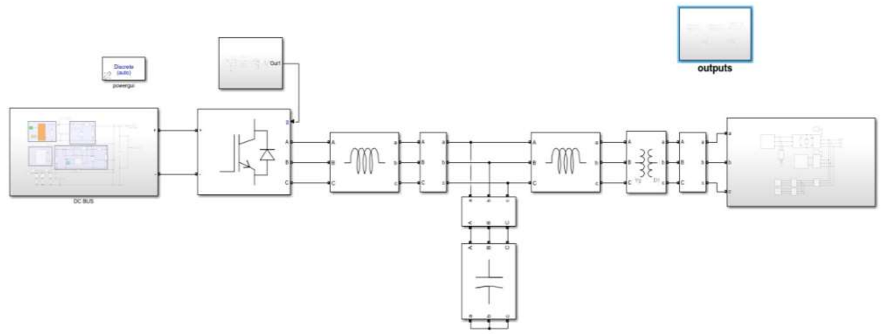
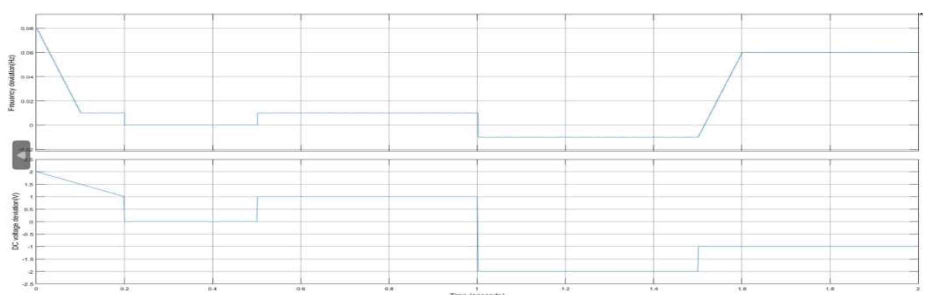


Fig. 3: Proposed structure of the simulation diagram for an AC/DC hybrid micro-grid

II. RESULTS ANALYSIS

Simulink is a computer add-on for Matlab, a mathematical tool created by the Natick-based business called Math Works (http://www.mathworks.com). It is used in this outcome analysis simulation findings. Large-scale numerical analytic capabilities underpin Matlab, which is Simulink is a tool for visually programming and examining the outcomes of dynamic systems (those controlled by differential equations). Using the common building blocks found in the the Simulink Libraries, any logic circuit or control system for a dynamic system can be created. Simulink offers a variety of arsenals for various techniques, such as fuzzy logic, neural networks, dsp, statistics, etc., which increases the tool's processing capability.The key benefit is the availability of templates and building blocks, which eliminate the need for minor mathematical operations to be coded.



Waveform diagrams of frequency and voltage deviation amount are shown in Figure 4.

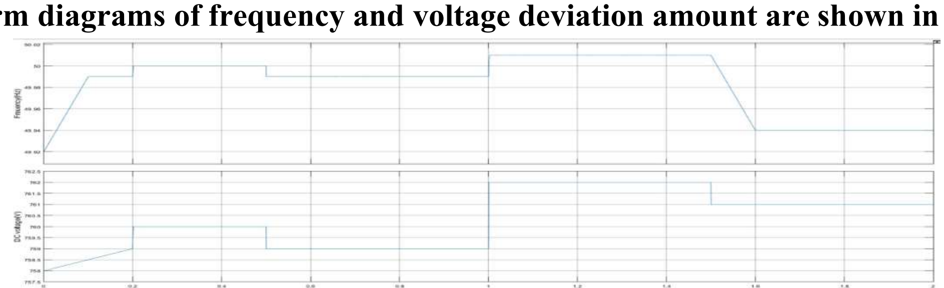


Fig.5: The Waveform Diagrams Of AC Bus Frequency And DC Bus Voltage

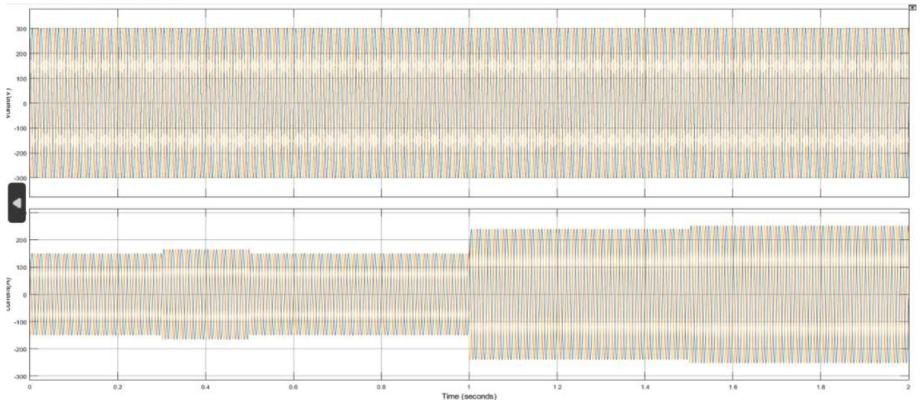


Fig 6: The Waveform Diagrams of IC.

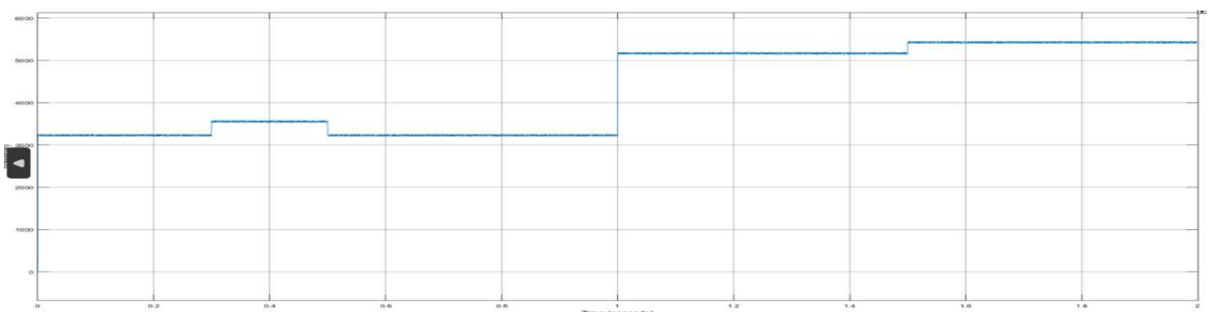


Fig.7: The Waveform Diagrams of IC.

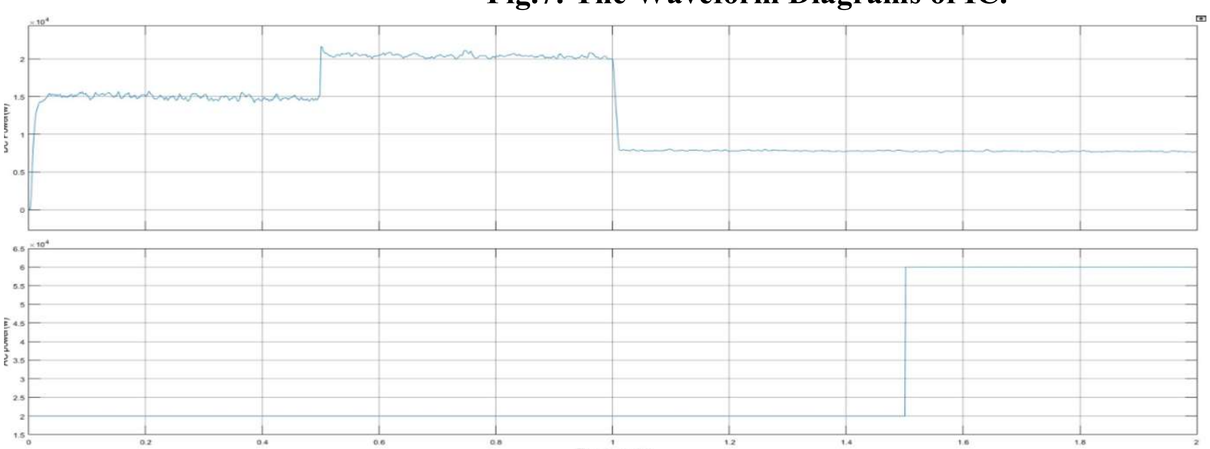


Fig.8: The waveform diagrams of DC and AC load output power.

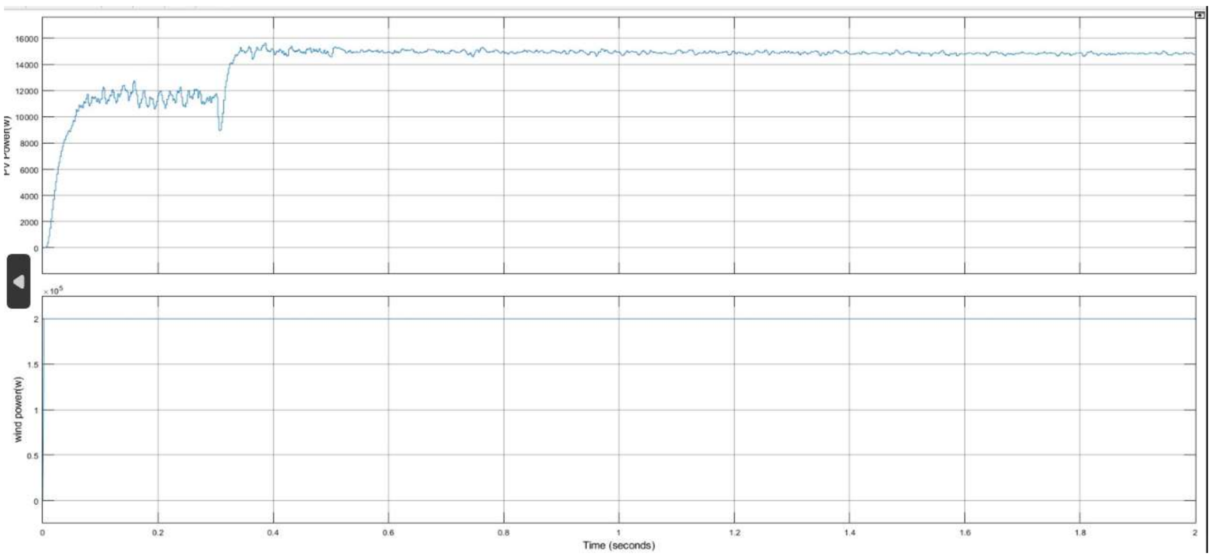


Fig.9: The Waveform Diagrams Of Photovoltaic And Wind Turbine Output Power

S.NO	Controller	Harmonics	Fundamental(50Hz)
1	PI Controller	3.49%	299.7
2	Fuzzy logic controller	0.70%	300

IV. CONCLUSION

How an HMG's power flow between its ac and dc subgrids affects the system's stability. It has been discovered that the stability margin of the HMG may be decreased as the power flow from the ac to dc subgrid grows. This can be due to the dynamics of the ac subgrid having a bigger impact on the HMG stability than those of the dc subgrid when power is switched from the ac to the dc subgrid. Additionally, if the ac subgrid's generation capability is increased, more power would be transferred to the dc subgrid to power the dc loads, which could reduce the HMG's stability.The simulation findings demonstrate that even though the DGs in the ac subgrid exhibit distinct droop characteristics, droop-based HMGs wobble in the direction of ac to dc power flow. Therefore, changing the values of the droop controller won't maintain the system. In this research, fuzzy control preserves the oscillator's remarkable performance while dampening its behavior.

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