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Modified Voltage Control Strategy for DC Network with Distributed Energy Storage using Fuzzy Logic Controller

[1]Jaideep Singh, [2]Kiranpreet Kaur
[1]M.Tech Scholar, [2]Assistant Professor
[1,2]Department of Electrical Engineering,[1]Desh Bhagat University (Punjab) India 147301

ABSTRACT: This research provides an extraordinary distributed energy storage (DES) technique for DC distribution networks. Under exhibited virtual inertia and capacitances, the parameters of the AC and DC networks are briefly assessed. The proposed control approach for DES is based on many interactive features, which allows the DES to respond to both DC network voltage variations and make use of AC grid frequency changes. To reduce the burden of DC network voltage degradation, a cascade droop management approach with fuzzy is proposed for DES in DC microgrid. The simulation outcomes give a response that is fruitful for improving the voltage stability in DC distributed network as compared to other existing techniques.

INDEX TERMS: Distributed energy storage, flexible voltage controlstrategy, AC and DC networks, fuzzy,voltage stability.

1. INTRODUCTION

Cost-effective and efficient networking methods are being researched, developed, and implemented. Offshore wind is a critical component of Europe's ambitious renewable energy goals. The current trend in offshore wind integration research and commercial applications is voltage source converter (VSC) high voltage direct current (HVDC) transmission [1].VSC-HVDC offers significant control and design advantages over traditional Line Commutated Converter (LCC) technology. The traditional AC distribution network faces considerable challenges in terms of plug-and-play performance and operating stability as the usage of renewable energy and microgrids grows, whereas DC alternatives thrive. The medium voltage DC (MVDC) distribution network is gaining popularity in the future smart grid design as a consequence of increased demand for power system operation and the success of DC technology in some specialized applications, such as large-scale data centers and shipboard systems [2], [3]. Because reactive power and phase synchronization do not exist, the DC voltage is critical to the system's operating stability.

This control approach may achieve great operation precision since all of the power source converters are regulated according to the condition of the system. [4], [5]. The master-slave control system, on the other hand, is reliant on high-speed, high-bandwidth communication. As a result, with this control system, redundancy is essential. Furthermore, this technique is incompatible with access to new generation sources, as the control frame must be updated properly. Droop control is a communication-free approach that regulates the output power of controlled converters using a voltage signal [6],[7]. For multi-terminal DC (MTDC) systems, a coordinated droop control approach is proposed that allows for proportional power dispatch among grid-side HVDC units. An adaptive droop control strategy is investigated to address the voltage mismatch, which employs a figure of merit index to decrease the voltage drop and load current sharing disparity. In and a hierarchical control technique is presented, in which distinct control targets are assigned to separate levels to govern more involved aspects and limit the impact of droop control. This research provides a revolutionary distributed energy storage (DES) technique for DC distribution networks.

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2. VOLTAGE CONTROL STRATEGY OF DC DISTRI- BUTTON NETWORK

The DC network may be classed into three forms, similar to the AC distribution network: 1) radial structure, 2) ring structure and 3) dual or multi-terminal structure. To provide good fault ride-through capability, the isolation transformers and the voltage source converter (VSC), which have electric isolation capabilities and work together to scale down the voltage and transfer AC power into DC format, are attached to the 4 kV DC network at the terminal. The network is connected to the following three components through DC cables.

2.1 ***AC/DC microgrid****:* Distributed generators (DGs), energy storage systems (ESs), and local loads comprise this type of element, the power of which is altered regularly in response to changes in natural environment components such as wind speed or sun irradiation. The microgrid regulates the amount of electricity absorbed from the DC network when power demand is low. On rare occasions, the microgrid might be utilized to modify the voltage of the distribution network.

2.2 AC/DC loads: The aggregative loads have a one-way power flow and are therefore difficult to consider for voltage management. Except in rare emergencies, loads can be shed passively to relieve the network's stress.

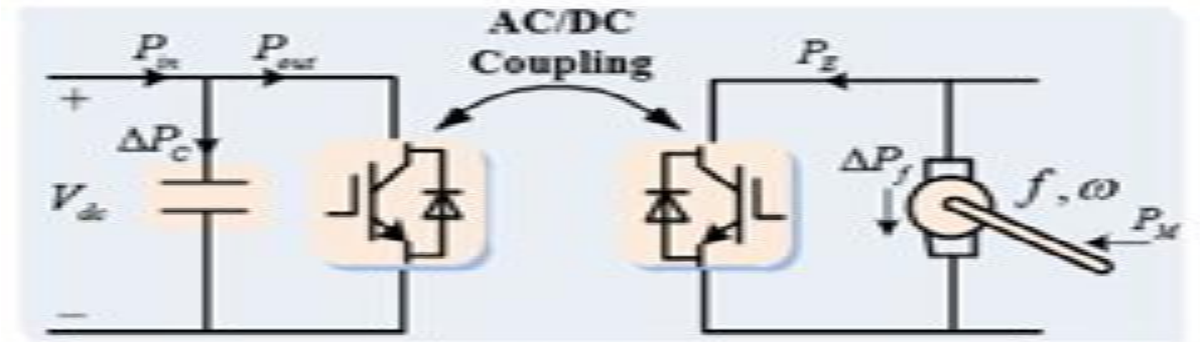

Fig.1 The power relationship betweenAC and DC.

2.3 Independent ES unit: It may be deployed at any node and provides DC voltage supplementary or backup assistance. To adjust for voltage variations, the node voltage signal is collected as an input for the ES unit controller.

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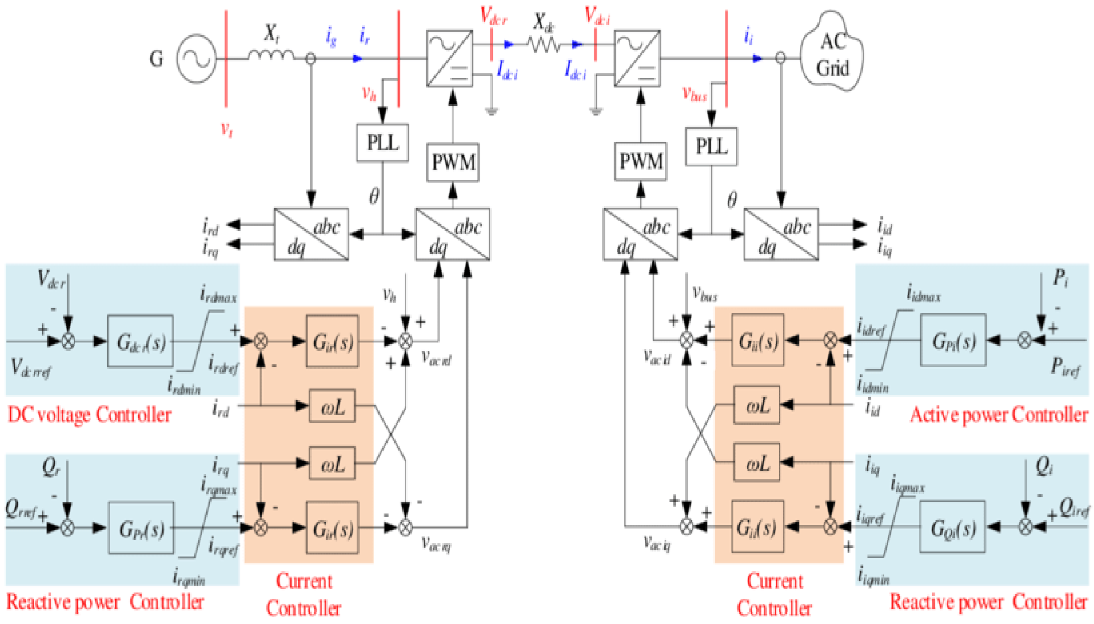

Fig.2 Independent ES unit

3. CONTROL STRATEGY: Traditional Voltage Control Strategy for Network Buses: According to the above-mentioned network element classification, nodes linked to various types of elements exhibit distinct operational characteristics.

Flexible voltage control using DESS: The whole spectrum of operational parameters and control objectives for various interfaces is considered in this study. The inner characteristics explain the electrical attributes of things interfaced with the DC network, such as the frequency of the AC grid and the voltage of the DC grid.

4. FUZZY METHOD: The quantity and diversity of fuzzy logic applications have grown dramatically in recent years. Consumer electronics including cameras, camcorders, washing machines, and microwave ovens to industrial process control, medical equipment, decision-support systems, and portfolio selection are among the uses. There are two main interpretations of fuzzy logic. In a broader sense, however, fuzzy logic (FL) is essentially identical to the idea of fuzzy sets, which deals with classes of objects with unsharp borders and membership determined by degree. In this perspective, fuzzy logic in its narrow sense is a branch of fl. Even in its more narrow definition, fuzzy logic differs both in concept and substance from traditional multivalve logical systems. Fuzzy logic should be regarded as FL in the fuzzy Logic Toolbox program, which means fuzzy logic in its broadest definition. The essential notions that drive fuzzy logic are explained simply and plainly in Foundations of Fuzzy Logic. It's worth noting that FL is based on the notion of a linguistic variable, which is a variable whose values are words rather than numbers. Much of FL may be seen as a means of computing with words rather than numbers. Even though words are intrinsically less exact than numbers, their application is more intuitive. Furthermore, computing with words takes use of the tolerance for imprecision, lowering the solution cost.

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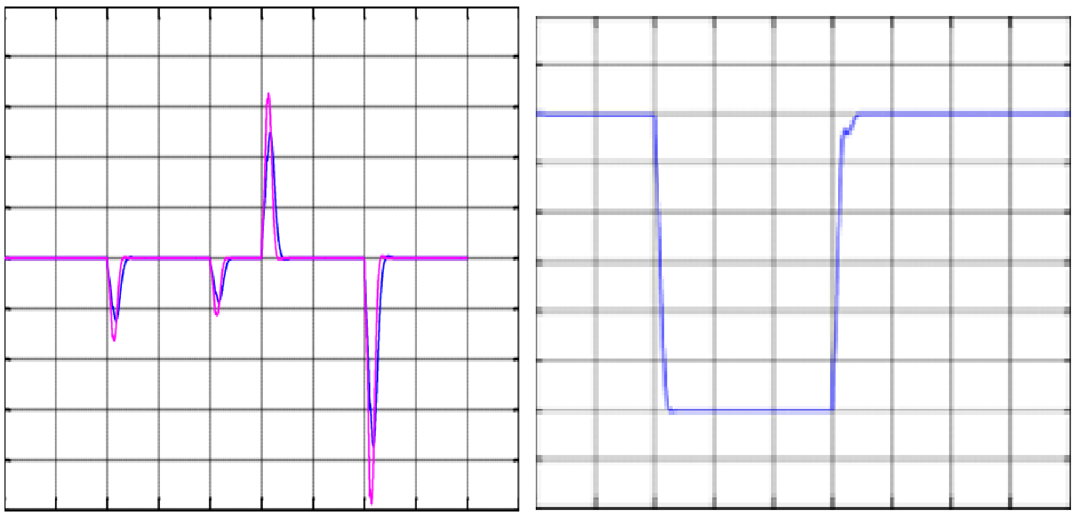
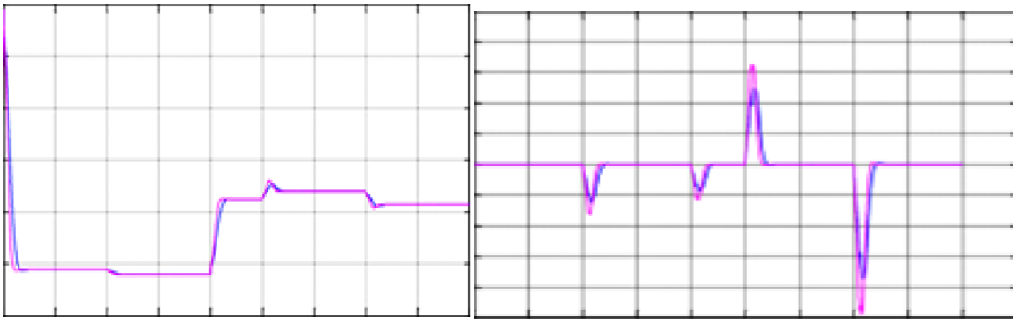
Fig.3 The Primary GUI Tools of theFuzzy Logic Toolbox

5. SIMULATION OUTCOMES

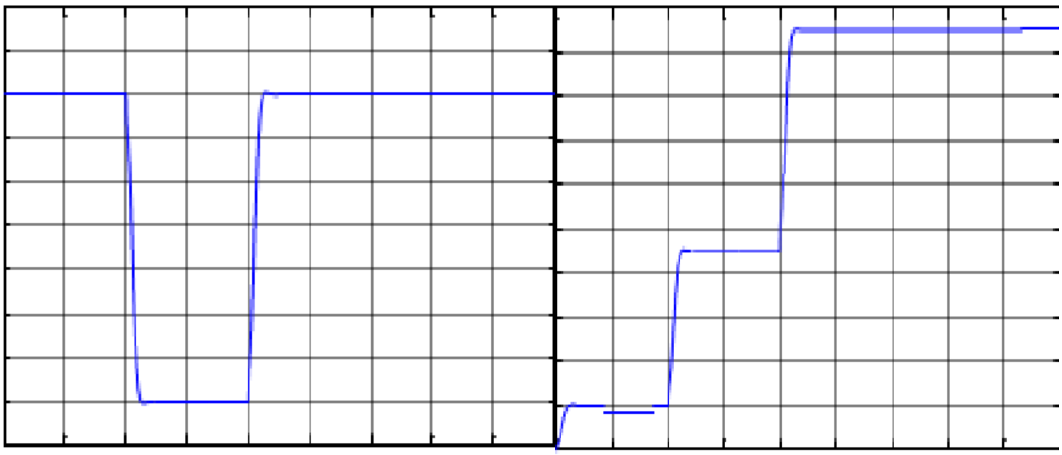


(a) Voltage (b) Frequency



(c) Net Power (d) DC-link Voltage

Fig.4 Simulation results of the DCmicrogrid for case 1with fuzzy



(a) Voltage (b) Power

Fig.5 Simulation results of DC bus #1for case 2 with fuzzy

6. CONCLUSION

In this study, the suggested flexible voltage control strategy is found to have improved ability in regulating DES units in a DC distributed network. The suggested strategy was tried on a variety of networks, and it produced effective results in every case. The characteristics of the AC and DC networks are also briefly examined under the demonstrated virtual inertia and capacitances. The proposed control technique for the DES, which is located at the AC microgrid or network terminal bus, is based on interactive characteristics that allow the DES to respond to both DC network voltage fluctuations and utility AC grid frequency changes. In comparison to other existing methodologies, the simulation results yielded a successful response for enhancing voltage stability in DC distributed networks.

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