

SIMULATION ANALYSIS OF POWER CONTROL USING DROOP CONTROL METHOD IN AC-DC MICROGRID

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ABSTRACT - Due to the fast proliferation of distributed generators (DGs) in power systems, managing the power of different DGs and the grid has become crucial, and microgrid provides a promising solution. Therefore, focus on ac and dc microgrids has grown rapidly with their architectural, modeling, stability analysis and enhancement, power quality improvement, power sharing control, and other issues. Most developments mentioned above on micro grids are, however, directed at DG control mainly within one microgrid.

Enforcing ac and dc microgrids inter tied by an interlinking power converter is a promising topology in future power networks, and has in fact been discussed recently due to some benefits, such as greater security and reliability, and reduced transmission and distribution losses. Autonomous operation and modified droop control schemes of such hybrid microgrids were discussed in and extended in and by integrating an energy storage system to the dc microgrid. Another droop control scheme was followed in for bidirectional power flow between the inter-tied microgrids. In, hierarchical control of multiple parallel ac-dc converter interfaces between ac and dc buses was proposed to achieve proportional current sharing. Despite the progress mentioned above, some drawbacks of the previous methods can also be found. (i) The majority of the existing inner loop control techniques are greatly dependent on mathematical model. These techniques cannot give satisfactory results when suffering poor model. Uncertainty dynamics and disturbances widely exist in inverter based microgrids, and it is difficult to obtain the accurate model. Although robust control, predictive control, variable-structure control, and neural network based control have been proposed for power converters, some challenges still exist.

In the proposed work, investigates the coordinated power sharing issues of interlinked ac/dc microgrids. An appropriate control strategy is developed to control the interlinking converter (IC) to realize proportional power sharing between ac and dc microgrids. Using the proposed scheme, the IC, just like the hierarchical controlled distributed generator units, will have the ability to regulate and restore the dc terminal voltage and ac frequency. Simulation results can be validating using MATLAB/Simulink environment.

1. INTRODUCTION

The guarantee of the smart grid (SG) is round the corner. Be that as it may, research and society can't sit tight for the endorsement of numerous measures and grid codes, especially when these codes can confine more the freedom of the power clients from the providers. In this sense, the interest side administration can be fulfilled by utilizing nearby vitality stockpiling and age systems, along these lines performing little grids or microgrids. Microgrids ought to have the capacity to locally take care of vitality issues and thus increment adaptability. Power hardware assumes a vital job to accomplish this progressive innovation. We can envision the future grid as various interconnected microgrids in which each client is in charge of the age and capacity part of the vitality that is devoured and to impart the vitality to the neighbors [1].

Thus, microgrids are key components to coordinate inexhaustible and appropriated vitality resources just as disseminated vitality stockpiling systems. In this sense, new power electronic gear will rule the electrical grid in the following decades. The pattern of this new grid is to end up increasingly dispersed, and thus, the vitality age and utilization territories can't be imagined independently. These days, electrical and vitality engineers need to confront another situation in which little appropriated power generators and scattered vitality stockpiling gadgets must be coordinated together into the grid. The new electrical grid, additionally named SG, will convey power from providers to purchasers utilizing advanced innovation to control apparatuses at buyer's homes to spare vitality, diminishing expense and expanding unwavering quality and straightforwardness. In this sense, the normal entire vitality system will be progressively intuitive, savvy, and appropriated. The utilization of conveyed age (DG) looks bad without utilizing appropriated capacity (DS) systems to adapt to the vitality adjusts.

Ongoing developments in little scale circulated power age systems joined with mechanical progressions in power electronic systems prompted ideas of future network innovations, for example, microgrids. These little self-ruling locales of power systems can offer expanded unwavering quality and effectiveness and can help incorporate sustainable power source and different types of dispersed age (DG) [1]. Numerous types of dispersed age, for example, energy components, photograph voltaic and micro-turbines are interfaced to the network through power electronic converters [2]- [5]. These interface gadgets make the sources increasingly adaptable in their task and control

contrasted with the ordinary electrical machines. Be that as it may, because of their unimportant physical latency they likewise make the system conceivably defenseless to swaying coming about because of network unsettling influences.

A microgrid can be worked either in grid associated mode or in remain solitary mode. In grid associated mode, the majority of the system-level elements are managed by the fundamental grid because of the moderately little size of micro sources. In remain solitary mode, the system elements are managed by micro sources themselves, their power regulation control and, to an unordinary degree, by the network itself.

2. DISTRIBUTION GENERATION SOURCES

2.1 INTRODUCTION

This part gives a review of grid associated dynamic converter system. All together for the system to be acknowledged comprehensively, it is imperative to realize the common standard utilized by the business. The accompanying areas talk about the general converter structure and the control system structure which will be the primary focal point of this postulation. In the last segment, diagram of the different channel topologies which is associated between the converter and load system are introduced. This part will investigate the different segments capacity and techniques in detail which comprise of controller's sort, controller enhancement, control flag reference outlines, beat width modulator (PWM), and converter which are on the whole generally executed in this theory work and industry.

2.2 PHOTOVOLTAIC SYSTEM

Extensive measure of power is saddled from PV modules associated in a cluster setup. PV systems are entirely trustworthy as it produces steady DC voltage. The PV design comprise of power gadgets to interface with the grid, the inverter circuit changes the DC to required AC voltage (50 Hz). Be that as it may, the power generation shifts with changes in climate conditions and in this way it is important to control the yield to accomplish greatest productivity conceivable. In this manner, greatest power point following (MPPT) procedure is utilized to separate most extreme power created by different PV modules under different climate conditions [2].

2.2.1 Solar Radiation

PV cells are semiconductor gadgets being able to ingest sun based vitality and convert it into usable electrical power. The essential development comprises of P-N intersection diodes that convert the light occurrence on its surface into electrical vitality. As the vitality produced in PV cells is specifically corresponding to occurrence radiation.

The working of PV cell is shown in figure below:

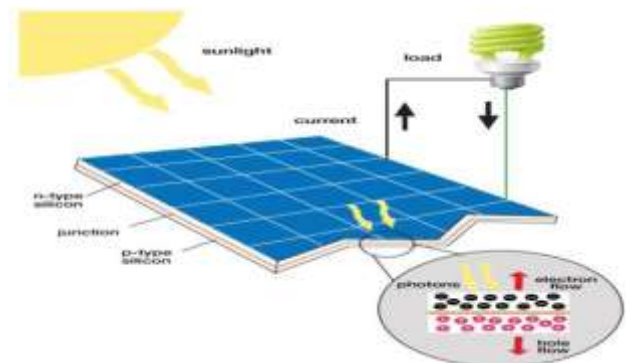


Fig.1: Working of Photovoltaic

4.2.2 Working of PV

The isometric view of PV module is as shown below:

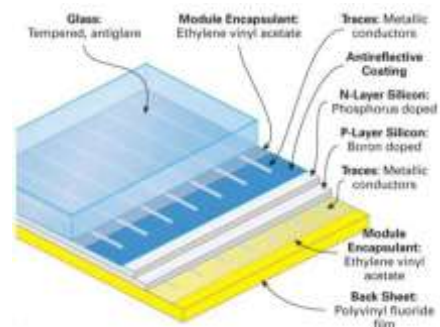


Fig. 2: Module of PV

It comprises of two silicon layers; a positive and negative layer separately. So when daylight falls on the silicon semiconductor and the vitality assimilated surpasses the band hole vitality of the material utilized for semiconductor, at that point the development of electrons into conduction band from valence band happens. Subsequently electron opening sets are shaped and the electrons move freely in conduction band. Thus this stream of electron makes electric flow stream. This power can be utilized to supply the heap.

As observed the PV module comprise of number of PV cells, encased inside back sheet and front board. The quantity of PV modules relies upon the producer however for the most part a module comprises of either 36 or 72 PV cells.

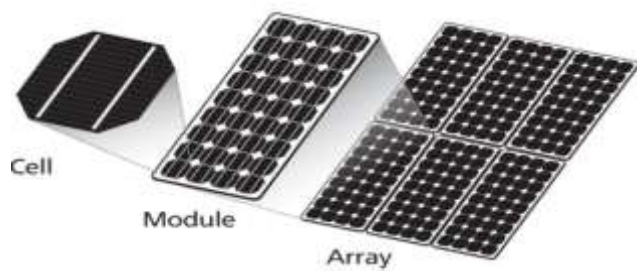


Fig. 3: Solar cell

The progression from cell to exhibit is as appeared in figure above. The cluster arrangement is done as a solitary cell can't deliver enough vitality to create power. For all intents and purposes, there are different misfortunes happening in this sort of arrangements and so as to get greatest effectiveness MPPT is connected to each string. Applying this control method, it is conceivable to remove most extreme measure of power created from the PV modules.

Techniques connected so as to create MPPT calculation are [5]:

- "Perturbation and perception calculation"
- "Progressive conductance"
- "Parasitic capacitance"
- "Maximum power following using voltage"
- "Maximum power following using Current"

As PV system makes utilization of daylight, it's for all intents and purposes free, accessible in plenteous and effectively available.

- These boards are amazingly dependable and needs low support.
- PV systems are flexible as they can be worked off grid just as in grid associated mode or even half and half mode.
- These systems are less expensive for remote application and the expense of use is less as transmission cost of contemporary system can be kept away from.
- This system is affordable as it lessens framework cost and can without much of a stretch meet the pinnacle requests.
- As they are developed in particular plans, extra creating limit can be effectively added to this system
- It has a long working productivity just about 30 years of continuous administration, with no commotion or contamination.

Impediments:

- The introductory expense of development and get together is high when contrasted with numerous other extensive scale power systems.
- The daylight achieving the earth is all that could possibly be needed to get the job done the vitality prerequisite of the globe, its thickness is generally low.
- The yield of the PV system is subject to the accessibility of radiation from sun. Additionally the overcast cover and brief days will affect the effectiveness of sunlight based boards.
- As this vitality is put away in batteries, it further expands the support cost.
- PV cells are just 13-18% proficient and therefore have low effectiveness and is the purpose behind surprising expense.

3. SIMULATION RESULTS

3.1 INTRODUCTION

This Chapter presents nitty gritty recreation aftereffects of the proposed control system. The reproduced system is appeared in Fig. 5.1. Reenactment thinks about are completed in the MATLAB/SIMULINK condition.

3.2 PROPOSED TOPOLOGY

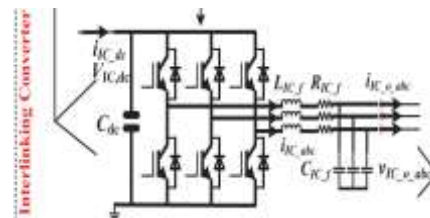


Fig. 4: Proposed topology

To approve the execution of the proposed control plot for the interlinked air conditioning/dc micro grids, the interlinked system, delineated in Fig.5.1 has been reenacted in MATLAB/Simulink condition. The air conditioner and dc microgrids have its own DGs and stacks, and are imitated with a dc-air conditioning inverter and a lift converter, separately. A six-switch dc-air conditioning converter with LC channels filling in as the interlinking converter is embraced to interface the air conditioner and dc microgrids.

3.3 SIMULATION RESULT ANALYSIS

Case I:

For this situation, both the air conditioner and dc microgrids are at first encountering a heap request of 2 kW every; this implies the wo microgrids are at first working in

light load condition. As indicated by the proposed control system alongside the equivalent estimated per-unit estimates ($V_{dc,pu} = \omega_{ac,pu} = 0.6$) of the voltage at dc side and the recurrence at air conditioning side, no dynamic power (PIC, $t_k = 0$ kW) is exchanged by the interlinking converter in this condition. The interlinking converter works in mode-3. Fig. 5.2 demonstrates the power reactions and the per unit estimations of the dc side voltage and the air conditioner side recurrence. After $t = 2$ s, stacks in the air conditioner and dc microgrids are expanded to 5 kW and 7 kW, separately. In this condition, both the air conditioner and dc microgrids are working in typical load condition. Along these lines the per-unit estimations of the air conditioner side recurrence and dc side voltage drop to 0 p.u and -0.4 p.u, individually. As indicated by (13), $\eta_e > \eta = 0.2$, the dynamic power exchanged by the interlinking converter is refreshed to -1 kW, which implies the interlinking converter exchanges 1 kW from the air conditioner microgrid to the dc microgrid. The task mode is changed from mode-3 to mode-1. After achieving unfaltering state, the air conditioner and dc source generations are noted to be the equivalent at around 6 kW each. What's more, the air conditioner and dc microgrids have the equivalent standardized estimation of -0.2 p.u ($V_{dc,pu} = \omega_{ac,pu} = -0.2$), bringing about relative power sharing of the all out load between the two microgrids.

Case II:

Like case I, for this situation, the underlying burden conditions are set to 5 kW for the air conditioner microgrid and 7 kW for the dc microgrid. The interlinking converter exchanges 1 kW from the air conditioner microgrid to the dc microgrid in the unfaltering state portrayed in the event that 1 to accomplish corresponding power sharing. At $t = 3$ s, the heap requests of the air conditioner and dc microgrids are changed to 8 kW and 6 kW, separately. At that point standardized estimations of the air conditioner side recurrence and dc side voltage are changed to -0.6 p.u and -0.2 p.u, separately. After detecting the bungle in standardized qualities, the measure of the dynamic power to be exchanged by the interlinking converter is refreshed to 1 kW bringing about the interlinking converter to invert the power stream with 1 kW moved from the dc to air conditioning microgrid.

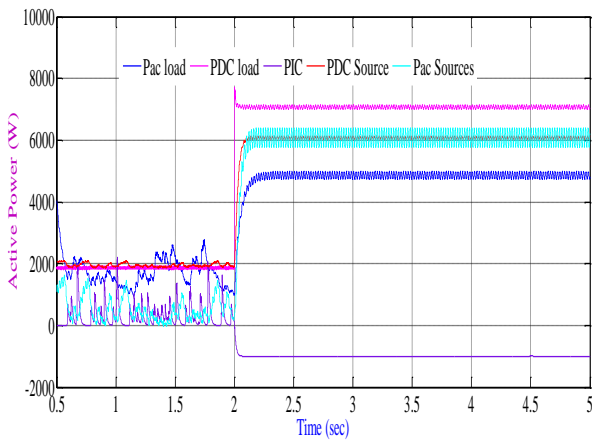


Fig.5: Power responses under case-I

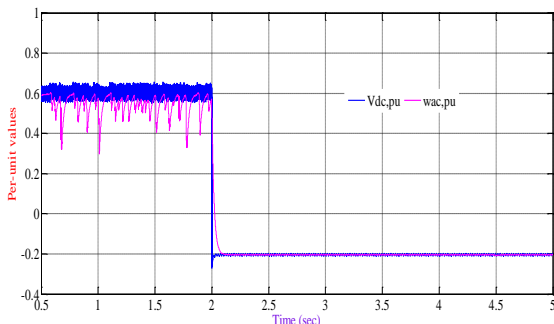


Fig.6: Per unit values under case-I

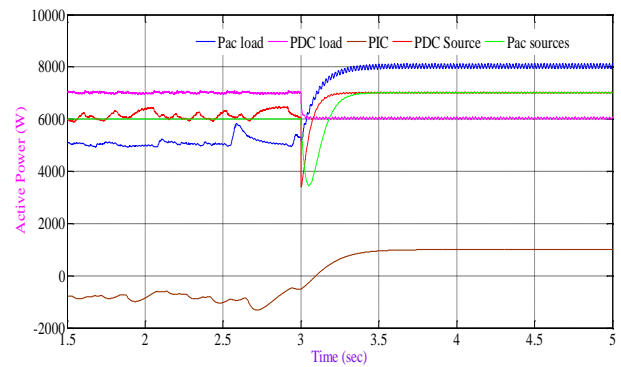


Fig.7: Power responses under case-II

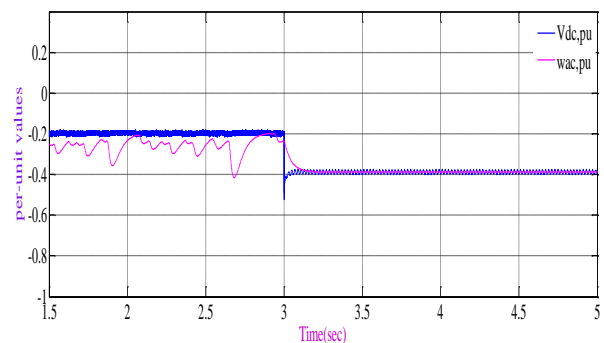


Fig.8: Per unit values under case-II

Consequently the $\omega_{IC,pu} - P$ hang is chosen and refreshed to control the recurrence. The task mode of the interlinking converter is changed from mode-1 to mode-2 now. Fig.5.3 demonstrates the power reactions and the standardized estimations of the air conditioner side recurrence and the dc side voltage. It tends to be seen that the absolute load is relatively shared between the air conditioner and dc microgrids. In the unfaltering state, the air conditioner and dc source generations are noted to be the equivalent at around 7 kW each. Furthermore, the air

conditioner and dc microgrids have the equivalent standardized estimation of - 0.4 p. u. as appeared in Fig.8.

Case III:

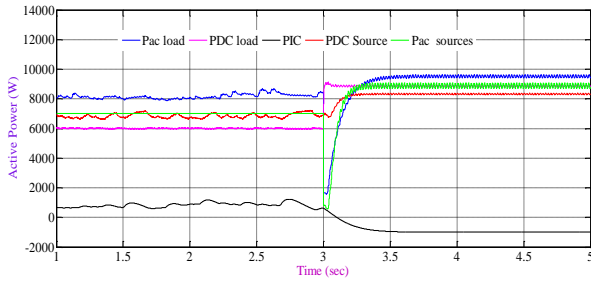


Fig 9: Power responses under case-III

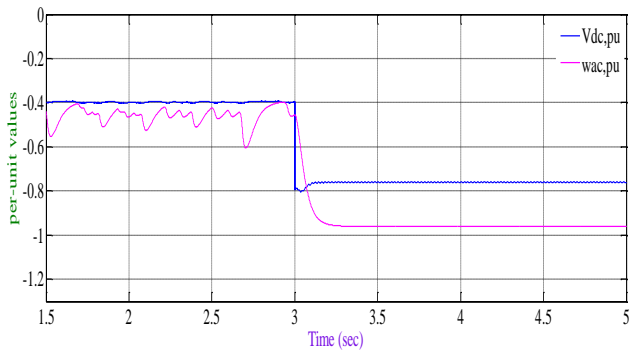


Fig.10: Per unit values under case-III

The over load state of both the air conditioner and dc microgrids is considered for this situation. The underlying conditions are set to 8 kW for the air conditioner microgrid and 6 kW for the dc microgrid, separately. That implies the air conditioner microgrid is at first working in over load condition while the dc microgrid is working in typical load condition. In the relentless express, the interlinking converter exchanges 1 kW from the dc microgrid to the air conditioner microgrid, which is talked about on the off chance that 2 in detail. At t=3 s, the air conditioner and dc microgrids are changed to 9.5 kW and 9 kW, individually, which makes both the air conditioner and dc microgrids over stacked. This can likewise be shown by the deliberate standardized qualities (- 0.9 p. u and - 0.8 p. u). The dynamic power to be exchanged by the interlinking converter is refreshed to 0 kW, which implies the interlinking converter, exchanges nopower and each microgrid is in charge of the power partaking in this heap condition. Fig. 5.6 and Fig.5.7 demonstrates the power and the standardized estimations of the air conditioner side recurrence and the dc side voltage.

Case IV:

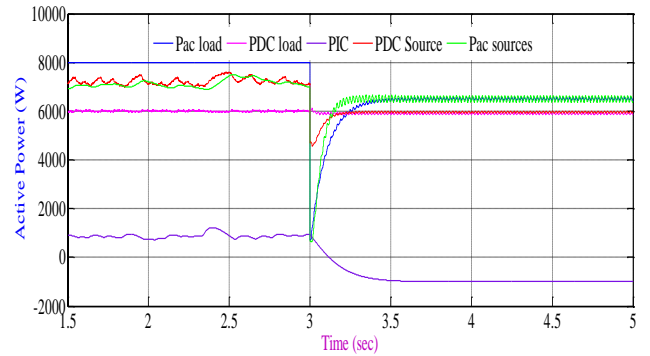


Fig.11: Power responses under case-IV

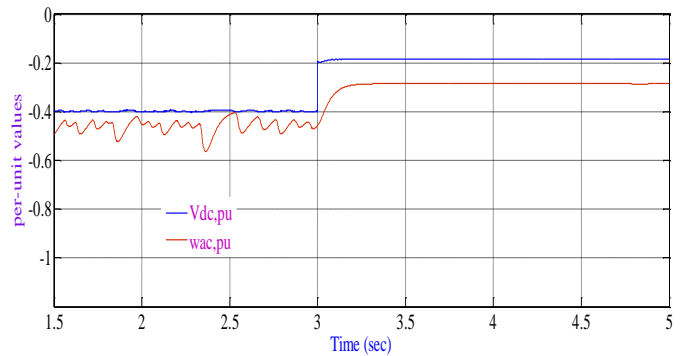


Fig.12: Per unit values under case-IV

For this situation, the underlying conditions are set to 8 kW for the air conditioner microgrid and 6 kW for the dc microgrid, separately. That implies the air conditioner and dc microgrids are at first working in over load and ordinary load condition, separately. In the relentless express, the interlinking converter exchanges 1 kW from the dc microgrid to the air conditioner microgrid. At t=3s, the air conditioner microgrid is changed to 6.5 kW and the dc microgrid remains 6 kW. Despite the fact that the air conditioner and dc microgrids are working at ordinary load condition, the dynamic power to be exchanged by the interlinking converter is refreshed to 0 kW (PIC,tk =0 kW) since the deviation is not exactly the edge ($\eta_e < \eta$), which implies the interlinking converter exchanges no power and each microgrid is in charge of the power partaking in this heap condition. Fig.5.8 and Fig.5.9 demonstrates the power and the standardized estimations of the air conditioner side recurrence and the dc side voltage.

Case V:

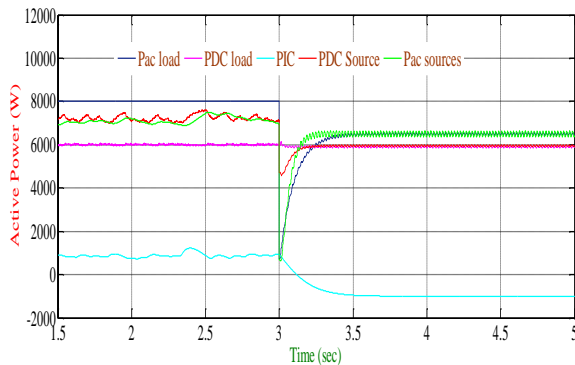


Fig.13: Power responses under case-V

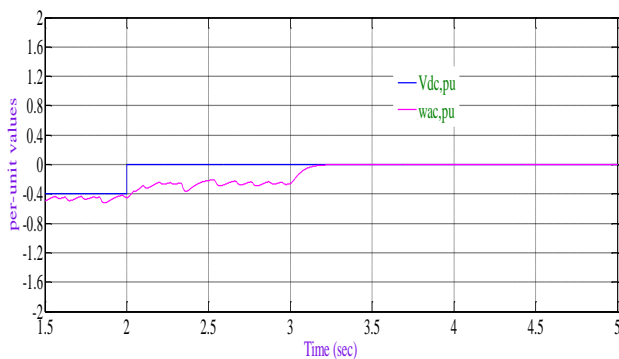


Fig.14: Per unit values under case-V

In view of case 4, the auxiliary control conspire is included this case. The heap conditions considered in this recreation is equivalent to that on the off chance that 4. Fig.5.11 demonstrates the reproduction results, from which it very well may be seen that the per unit estimations of the air conditioner recurrence and dc voltage are reestablished to zero relating to their ostensible qualities with help of the auxiliary controllers. At $t=3$ s, the air conditioner microgrid is changed to 6.5 kW and the dc microgrid remains 6 kW. In this heap condition, no dynamic power is exchanged by the interlinking converter since the deviation is not exactly the edge ($\eta_e < \eta$), which implies each microgrid is in charge of the power sharing. In this way, the auxiliary controller of the interlinking converter is halted to work and the optional controllers in every air conditioner and dc microgrid stay working.

CONCLUSIONS

6.1 CONCLUSIONS

In this postulation, explores on facilitated power sharing issues of interlinked air conditioning and dc microgrids. To acknowledge relative power sharing among air conditioning and dc microgrids, a novel essential controller including a double hang controller and a data-driven model-free adaptive voltage controller has been right

off the bat proposed in this work. Following, an auxiliary control conspire has likewise been proposed to collaborate with each microgrid to reestablish the dc voltages and the air conditioner recurrence to their ostensible qualities.

Utilizing the proposed plan, the interlinking converter, much the same as the various leveled controlled DG units, will be able to manage and reestablish the dc terminal voltages and the air conditioner recurrence while keeping corresponding power sharing. Recreation results have been given to check the proposed power sharing procedure.

6.2 FUTURE SCOPE

In the future, the proposed scheme can be possible to validate through experimental studies.

REFERENCES

- [1]. J. M. Guerrero, M. Chandorkar, T.-L. Lee, and P. C. Loh, "Advanced control architectures for intelligent microgrids—Part I: Decentralized and hierarchical control," *IEEE Trans. Ind. Electron.*, vol. 60, no. 4, pp. 1254–1262, Apr. 2013.
- [2]. C. Jin, P. Wang, J. Xiao, Y. Tang, and F. H. Choo, "Implementation of hierarchical control in DC microgrids," *IEEE Trans. Ind. Electron.*, vol. 61, no. 8, pp. 4032–4042, Aug. 2014.
- [3]. N. Pogaku, M. Prodanovic, and T. C. Green, "Modeling, analysis and testing of autonomous operation of an inverter-based microgrid," *IEEE Trans. Power Electron.*, vol. 22, no. 2, pp. 613–625, Mar. 2007.
- [4]. Q. Sun, Y. Zhang, H. He, D. Ma, and H. Zhang, "A novel energy function based stability evaluation and nonlinear control for energy Internet," *IEEE Trans. Smart Grid*, to be published.
- [5]. N. Bottrell, M. Prodanovic, and T. C. Green, "Dynamic stability of a microgrid with an active load," *IEEE Trans. Power Electron.*, vol. 28, no. 11, pp. 5107–5119, Nov. 2013.

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