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Microgrid Control With Droop Method

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Abstract— **Nowadays, application of DG in microgrid has been developed regarding to increasing need of more energy production especially the green one. In this paper the control of microgrid is studied by using Droop Method. At first the microgrid and controlling methods in network is introduced and the latter analyzed in network connected and in islanding state. At the end, the simulation results are presented.**

***Keywords-** DG; Microgrid; Droop Method; Connected state; Islanding state*

I. INTRODUCTION

Renewable energy emerges as an alternative way of generating clean energy. As a result, increasing the use of green energy benefits the global environment, making it a global concern. This topic relies on a variety of manufacturing and installation industries for its development. As a solution, continuously small and smart grid energy systems appear including renewable energy resources, microg-enerators, small energy storage systems, critical and non-critical loads, forming among them a special type of distributed generation system called the microgrid(MG) [1, 2].

Advantages of microgrids are; i) MG can operate independently without any support from the upper stream of the network. It is of advantageous as the MG would not be affected, but rather separated from the upper stream where the fault occurs, and thus at islanding state [1]. ii) MG has “plug-and-play” features. This means that it can always be connected or disconnected to the MV network [2]. iii) They are clean sources of energy that have very little environmental impact on the community compared to those conventional energy technologies.

A microgrid can operate in grid-connected mode or islanded mode and hence increase the reliability of energy supplies by disconnecting from the grid in the case of network faults. Now a considerable research has been undertaken on the control strategy of the microgrid. Flexible and fast controls of real and reactive power are important requirements during transient and steady-state operation of a microgrid system in both grid-connected and islanded modes [3].

A microgrid when subjected to disturbances can experience angle instability and poor voltage quality due to the presence of DG units with slow response rotating machines and DG units with power electronic converters as the interface to the utility system. To ensure stable operation during network disturbances while maintaining power quality in the islanded mode of operation, a more sophisticated control strategy for microgrid needs to be developed. In order to warranty both quality of supply and ensuring power management supervising critical and non-critical loads. Also, the basic issue on small grids is the control of the number of microsources. Microgrid concept allows larger distribution generation by placing many microsources behind singles interfaces to the utility grid. Some key power system concepts based on power vs. frequency droops methodology, voltage control and can be applied to improve system stability, enhance active and reactive support

This paper is organized as follows. In Section II, we describe the basic of the droop control method. Section III shows the microgrid simulation and experimental results. In Section IV, the conclusions of this paper are given.

II. MICROGRID CONTROL

In a microgrid, the DG supply can be connected to a network by using an inverter. An inverter can be tuned by frequency and voltage control.

For controlling the inverters usually the drop method is used. The active and reactive power of inverter can be controlled by means of this method in order to control the frequency and to produce voltage in a specific level.

The control method Analysis:

A. Active power control versus frequency

In this method frequency changes is affected by changing in active power. Fig. 1 shows the Droop of power versus frequency changes.

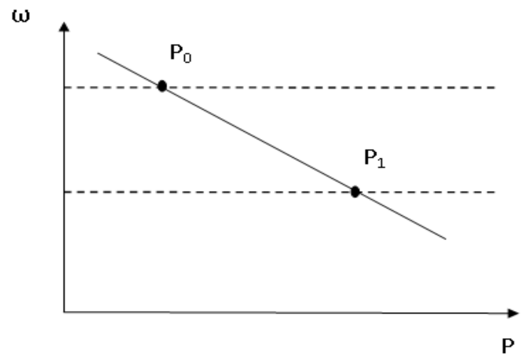


Figure1. Droop power versus frequency

According to Fig. 1 it can be deduced that whenever frequency decreases in a network, controllers make the supplies to increase their production and it means the production level changes from p0 to p1.

This state will happen to a microgrid whenever a fault occurs and it changes a microgrid status into islanding state. The microgrid reconnects to principle network meanwhile the frequency increases then controllers make the DG to decrease the production level.

"Equation 1 represents this controlling structure"

$$\omega = \omega^* - m.(P - P^*) \qquad (1)$$

B. Reactive power control versus voltage

This control mode, changes in voltage have an interaction with changes in reactive power. According to Fig. 2, this controlling mode is represents by "2"

$$E = E^* - n.(Q - Q^*) \qquad (2)$$

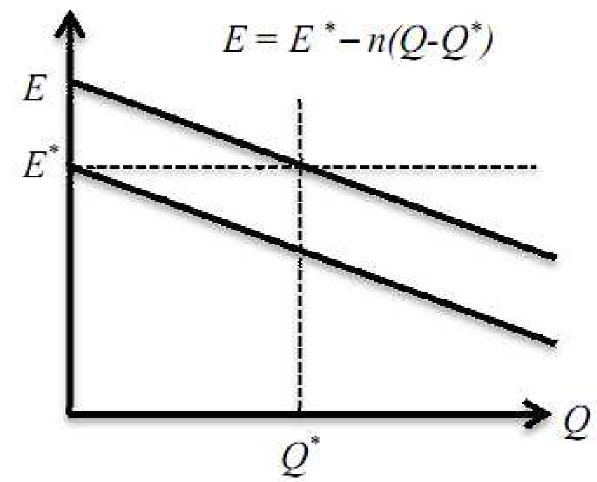


Figure2. Droop reactive power versus voltage

Where E is the amplitude of the inverter output voltage; is the frequency of the inverter; $\omega^*$and E^* are the frequency and amplitude at no-load, respectively; and n is the proportional droop coefficient.

III. The Studied System And Simulation Results

Fig. 3 shows a single-line diagram of the system used to investigate typical micro-grid operational scenarios. The basic system configuration and parameters were extracted from the benchmark system of the IEEE Standard 399-1997, with some modifications to allow for autonomous micro-grid operation. The system is composed of a 13.8-kV, three-feeder distribution subsystem which is connected to a large network through a 69-kV radial line. The 13.8-kV distribution substation is equipped with a three-phase 1.5-MVAr, fixed shunt-capacitor bank. The 13.8-kV substation busbar is radially connected to the main grid through the substation transformer and a 69-kV line. The network at the end of the 69-kV line is represented by a 69-kV, 1000-MVA short-circuit capacity bus. Combinations of linear and nonlinear loads (L1 to L5) are supplied through three radial feeders of the subsystem. Loads L1 to L4 are composed of linear RL branches. Load L5 is a three-phase diode-rectifier load. The aggregate of L4 and L5 constitutes a sensitive load within the distribution subsystem.

The system also includes two DG units, i.e., DG1 (5-MVA) and DG2 (2.5-MVA) on feeders F1 and F3 respectively. DG1 is a synchronous rotating machine equipped with excitation and governor control systems. It may represent either a diesel-generator or a gas-turbine-generator unit. DG2 utilizes a voltage-sourced converter (VSC) as the interface medium between its source and the power system. DG2 Represents a dispatchable source with adequate capacity to meet the real/reactive power commands, within pre-specified limits, subsequent to disturbances. Such a dispatchable source may also include energy storage interfaced at the converter dc bus. DG2 provides control on its output real and reactive power components independently [4].

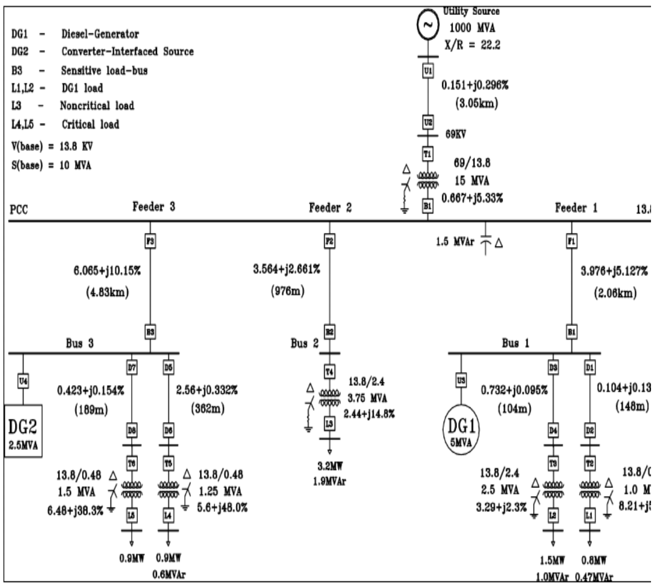
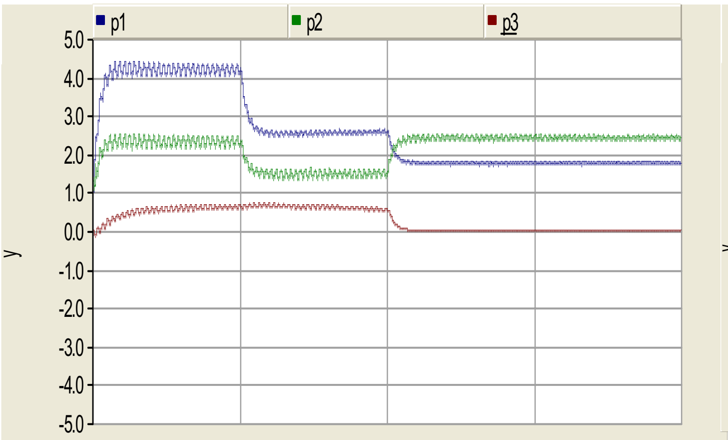


Figure3. Studied System

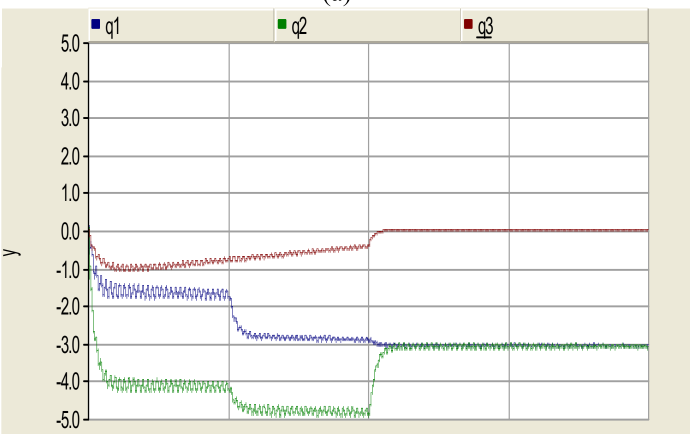
1) Case Study-1:

Load number 3 is disconnected in 0.5 second and microgrid state changes to islanding state in 1 second. As it has been shown in Fig.3 p1 and p2 is decreased 0.5 second in result of load descent and both microgrids change in 1 sec in islanding state and p1 and p2 increase their power generation in order to supply the loads.

In islanding state, the process is the same for Q but the difference is the increase of parameter V to compensate the Q.

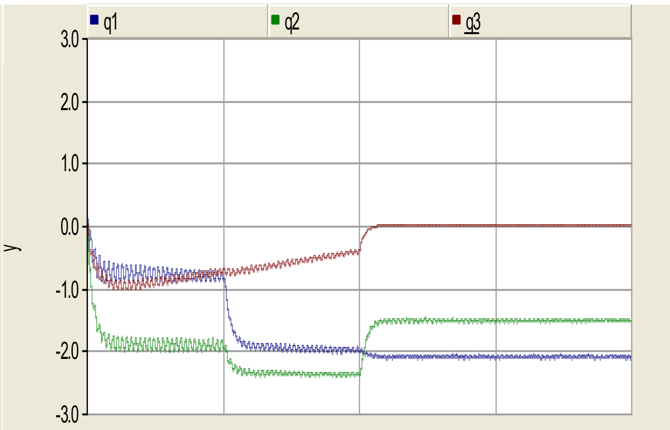


(a)

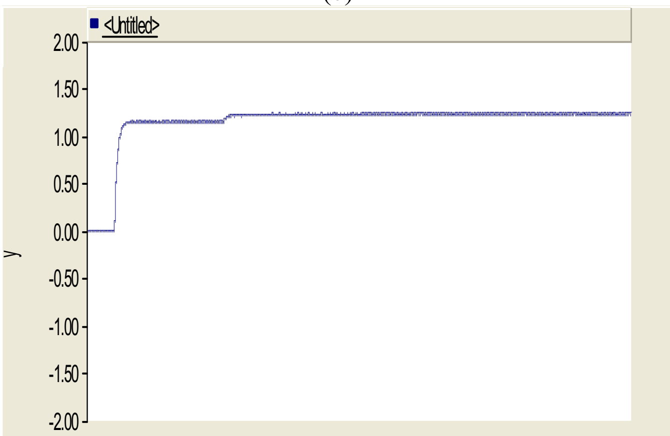


(b)

Figure4. Case Study-1. a) active power changes. b) reactive power changes



(b)

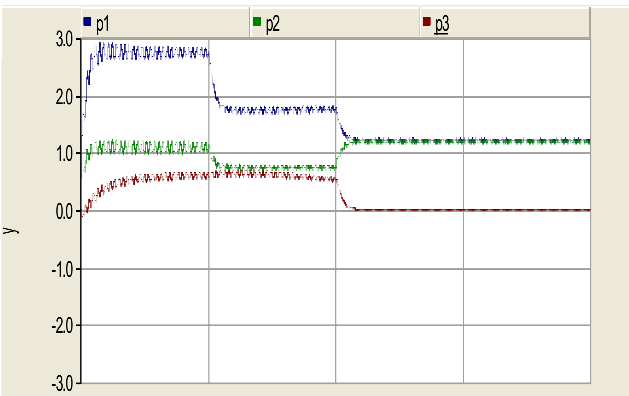


(c)

Figure5. Case Study-2. a) active power changes. b) reactive power changes. c)Value of voltage(P.u.)

2) Case study-2:

In this state, the network sends energy in the first 0.5 second and after that the network receives energy. After 1 second the network is disconnected . This process has been shown in Fig.5.



(a)

IV. CONCLUSIONS

In this paper the effect of drop method in voltage and frequency control has been discussed. As shown in Section III .in result of disconnection between network and microgrid, the active power generation level increases, if microgrid received energy before disconnection. If microgrid sends power to the network then active power generation level will reduce.

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