

# Control Strategies for Microgrid with Multiple Distributed Energy Resources

***Sumaiya Rahman**<sup>1</sup>, Hasimah Abdul Rahman<sup>2</sup>, Mohamad Shukri Bin Abdul Manaf<sup>1,2</sup>*  
*<sup>1,2</sup>Centre of Electrical Energy Systems (CEES), Institute of Future Energy, Fakulti Kejuruteraan Elektrik, Universiti Teknologi Malaysia (UTM), 81310 Johor Bahru, Johor, Malaysia*  
*Phone No.: 0167448236, Email: sumaiya\_r@yahoo.com*

## **Abstract**

Microgrid is considered as a smart solution to the global energy crisis and environmental issues these days for employing green technology. This is a small scale, usually renewable energy based distributed generation system which basically serves local users and does not require transmission lines. However, Microgrid needs a suitable control system to improve its efficiency and reliability to work as a standalone unit or as parallel connected unit with the main utility grid. For instance, renewable energy sources such as, Solar Photovoltaics and Wind Turbine depend on weather conditions thus result in output power fluctuation. In this case, a storage unit is essential that can provide back up during low generation period and can store outstanding energy at the time of less demand. In addition, integration of multiple distribution energy resources raises the energy generation of Microgrid sufficiently but increases complications in operations as well. Besides, a communication network is also vital in this case for information transfer within the sources and other components of the structure. Hence, a study related to advance control system to maintain a smart energy management incorporation with fault detection and self-healing aspects of Microgrid is presented in this research. The purpose of this project is to find out the most advantageous control techniques for Microgrid with multiple distributed energy resources which need to be user-friendly as well. Research shows that, Droop control techniques are beneficial for above requirements performing Decentralized control method where communication networks are not essential. Moreover, in this paper some MATLAB/SIMULINK based simulations are presented. Where a Microgrid is modelled that consists of distributed energy resources namely Photovoltaic, Wind turbine and Fuel cells. Finally, simulation results of different droop control techniques are presented and some discussions regarding tested techniques are enclosed.

## **Introduction**

Today's power system development has already closely integrated with modern control theory. Power grid is developing toward two distinct directions: a large capacity, long-distance, high pressure, even UHV AC and DC transmission level and a large grid interconnection; the other is small capacity and relatively independent micro-grid. For these two directions, there are still some common problems such as the optimization of operation, coordinated scheduling and control, etc.) to be resolved. Micro grid (MG) can be combined with the loads, generators, control devices and energy storage devices in to a manageable unit, with a lot of non-linear distributed power. It can not only solve the problem of large-scale distributed power access, but also bring the user and the system many benefits. Thus microgrid research is useful supplement of the existing backbone network .It is of great significance whether for the use of new energy from the environmental point of view, or considering increasing the supply of quality and reliability of power supply from the backdrop of power grid interconnection.

Among them, one of the key problems of the study of micro-grid is coordination and control technology and energy management systems research.

## Droop Control

### Droop Control Method Operating Principle

Droop control is in essence the voltage source inverter voltage-controlled method, by adjusting the Voltage amplitude and phase to achieve control of the transmission power. In the inductive transmission line, active power mainly depends on the power angle. Reactive power depends on the voltage difference. So Power angle can be used to control active power and voltage difference can be used to control reactive power. In the micro-grid, the droop control strategy simulates the droop characteristics of traditional power system, by changing the output of active and reactive power to control the frequency and amplitude of the output voltage, so that micro-grid system can work on stabilize voltage point in island operation mode. And it is less different with the network mode voltage. Transition is smooth when switching, that can guarantee the load undisturbed to normally work. The figure below shows the frequency - the active and voltage - reactive droop curve. The  $f_N$  is the nominal frequency. The  $f_{min}$  is minimum frequency for the power quality permission. The  $P_N$  is nominal active power output. The  $P_{max}$  is maximum power output. The  $V_{max}$ ,  $V_{min}$  is the maximum and minimum voltage of the system. The  $V_N$  is rated voltage. The  $Q_{min}$ ,  $Q_{max}$  is the minimum and maximum output reactive power. The control strategy: To get the output current and voltage by current and voltage sensors detecting. Then the micro-power active and reactive power output is calculated at this time to obtain voltage frequency and amplitude reference values in accordance with the droop curve setting, and then to control the inverter output current and voltage. Entire droop control system consists of the power calculate unit, droop control unit, voltage and current double closed loop control unit and modulation unit and other units.

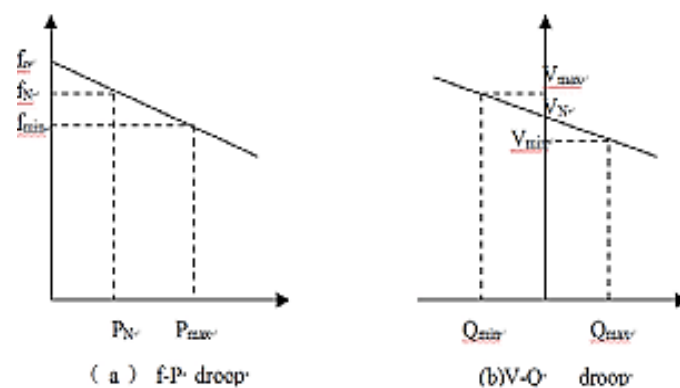


Figure 1. Drooping curve :(a) f-P droop (b) V-Q Droop

## **Acknowledgment**

The authors wish to acknowledge the support from Ministry of Science, Technology and Innovation (MOSTI) Malaysia and Universiti Teknologi Malaysia UTM), for the award of

the grant that has enabled the research, leading to this article under the E-Science grant (vote No: R.J130000.7923.4S068).