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Comparative Analysis of Droop and Advance Droop Control Strategy for Micro Grid

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Abstract: *With the rapid increase in the demand of electricity all over the world, proper control, utilization of power and load sharing is required. Micro grid is the future solution for compensating the requirement of power. In this paper, a comparative analysis of the two controlling techniques that is conventional droop control (CDC) and advance droop control (ADC) is done for controlling and load sharing in micro grid. The paper proposes an advance droop control technique which is the improved version of conventional droop method. Conventional method use grid parameters like voltage and frequency to change real and reactive power. But advance droop control scheme controls the output power without effecting frequency and voltage. The result show the better and improved effects by adopting ADC scheme for controlling in micro grid.*

1. INTRODUCTION

As we know that the demand for electric power is increasing, the current power needs some drastic changes. We require changes not only in industrial applications, but also in home appliances, since they affect the aging power system. The other problem that we face is that generators are incapable of reacting to sudden changes of load and this fluctuation in load can lead to higher generation cost of electricity .Thus in order to meet these demands, there is an urgent need of Distributed Generation. [1] The very idea of DG decreases the feeder loss, the reliability is enhanced and also thus the overall efficiency is increased. Wind , hydro and solar power are the most important renewable micro sources which are linked to DGs. Economically, solar and wind power are more suitable. The very advantage of DG is that it can be placed near to the end-users [2].

Several efforts have been initiated in developing and improving current power networks so that reliable and sufficient power could be delivered to the customers. Not only the advancement is required in generation technologies, but advancements in electricity delivery system is a must to ensure increased reliability. Micro-grid is one of the ways by which advancements could be implemented since it integrates conventional & non-conventional energy sources, energy storages and loads in a power network [5].

A micro-grid consists of Renewable Energy Sources such as wind power, photovoltaic array connected to serve the demand of small areas. A distributed generation (DG) network provides energy by either working in group or individually. Micro-grid has multiple distributed power, energy storage devices, and local loads. Micro-grid could be either connected to the power grid or it could also operate in islanding mode. Micro-grid can be of two types: AC and DC. The AC micro-grid is more popular however the idea of DC micro-grid is also on the cards. In comparison with AC micro-grid, DC micro grid offers some advantages such as: fewer energy conversion links, higher efficiency, lower line losses. Also, in case of the DC micro-grid, there is no need to keep a track on the phase and frequency of the voltage, which greatly enhances the reliability of the system, and thus DC micro-grid is considered more suitable for the distributed power.

A micro grid can work in two operating environments. When the micro grid is in connection with the macro-grid at the Point Of Common Coupling, then it is in grid-connected mode. When the micro grid is disconnected from the macro grid, then it is in island mode. In case if any problem occurs in micro grid it will switch automatically to island mode, so there won"t be any interruption in the supply to the local area [6].

SYSTEM STRUCTURE

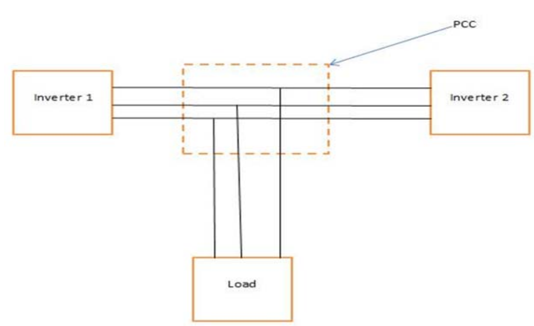

Fig. 1: System Model

The above block diagram represents the model of the system. The transmission line is taken simply as a three phase inductance without any coupling effect. Here the inverters taken are of same rating and same parameters so that system should be balanced. Inverter used here is a 3-level PWM based inverter having 5 KHz switching frequency. There is no communication between the inverters.

2. CONVENTIONAL DROOP TECHNIQUE

Droop control is used in power sharing to control the real and reactive power on the basis of frequency and voltage magnitude. Droop control is basically a control technique used in complex power systems, when multiple DGs are connected in a micro grid to share power among them properly and to disconnect and reconnect the system as per the load requirement In a transmission line, the real and reactive powers are designed as:

$$P=\frac{V_1V_2\sin\delta}{X} \quad .. (1)$$

$$Q=\frac{V_1^2}{X}-\frac{V_1V_2}{X}\cos\delta \quad (2)$$

Here we are neglecting the resistance(R) for an overhead transmission line as it is much lower than inductance(L). Also, considering power angle to be less so that sinδ = δ and cosδ = 1. These assumptions are true only for lines having high X/R ratio which is considered in this paper.

$$\delta=\frac{XP}{V_1\ V_2} \quad (3)$$

$$V_1-V_2 \cong \frac{XQ}{|V_1} \quad (4)$$

From the above equations, it is seen that the power angle can be controlled by the real power „P".

Dynamicaly, the frequency can regulate the power angle and this can result in controlling the real power flow. Also the voltage can be controlled through reactive power[]. The voltage and frequency control can be determined as :

$$\omega_1 = \omega_{01} - D_{p1}P_1 \quad .(5)$$

$$E_1 = E_{01} - D_{q1}Q_1 \quad (6)$$

Where w_1, E_1 = the frequency and voltage at operating point; P, Q = Active and reactive power at operating point; w_{01}, E_{01} = Base frequency and voltage and D_{p1}, D_{q1} = Droop constant.

2.1 Real Power Control

Studying the working of VSC1 (inverter 1) delivering power to common load bus. Here the assumption is made the load voltage magnitude is constant and fixed due to the negligible effect of load voltage variation on the real power flow. The relation between real power of VSC and phase angle δ [] is as follows :

$$(\delta_1 - \delta_{\text{com}}) = \int(\omega_1 - \omega_{\text{com}})dt \quad . (7)$$

$$P_1 = \frac{E_1 V_{\text{com}} \sin(\delta_1 - \delta_{\text{com}})}{X_1} \quad . (8)$$

magnitude of the VSC output voltage, magnitude of the infinite bus voltage, interface reactance.

In this, the angular frequency serves as a control quantity to the nonlinear equation and generates the output real power.

2.2 Reactive Power Control

According to the laws given by [], the voltage of the VSC are made as a function of reactive power output with droop coefficient.

$$E_1 = E_{01} - D_{q1}Q_1 \quad .9$$

Where E_{01} and E_{02} are the voltage magnitude references and D_{q1} and D_{q2} are the voltage droop coefficients.

Studying the working of VSC1 (inverter 1) delivering reactive power to common load bus. Here the assumption is made the load voltage magnitude is constant and fixed due to the negligible effect of load voltage variation on the reactive power flow. The relation between reactive power of VSC and voltage magnitude (E_1) [] is as follows :

$$Q_1 = \frac{E_1^2 - E_1 V_{\text{com}} \cos(\delta_1 - \delta_{\text{com}})}{X_1}. \quad 10$$

3. ADVANCE DROOP CONTROL

The Conventional droop control can be achieved by above equations. But to have better dynamic response as suggested in various papers[][], the addition of a derivative term in the conventional droop equation.

$$W=w_{01} - D_{p1}.P - n_p\ dP/dt \quad .11$$

The above equation can further written as

$$\int w.dt=\int w_{01}.dt - D_{p1}\int P.dt - n_p\int dP \quad ..12$$

or

$$\theta=w^*t - D_{p1}\int P.dt - n_p.P \ . \quad .13$$

The last equation has two term (ɵ) constant frequency and instantaneous phase.

Now introducing the new coeficient mp to replace

D_{p1} as:

$D_{p1} \alpha P$

$D_{p1} = mp^* P$

With only proportional term, the equation become

$W=w01 -mp.P^2$ 14

control since requency is not varying too much on power output of inverter.. Further more in steep zone frequency drop is very rapid so that inverter can avoid overloading.

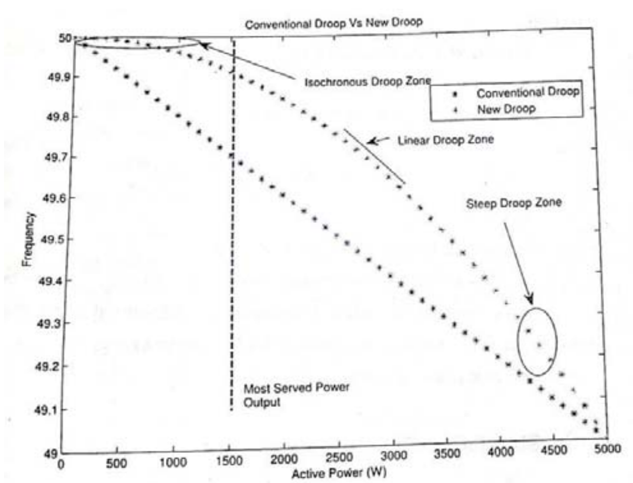

Fig. 2: Plot of w v/s P

Now rewritting equation 11

$W=w_{01} - mp.P^2 - n_p\, dP/dt$ .15

Similaly , Q droop can be written as

$E=E_{01} - mq.P^2 - n_q .Q.dQ/dt$

4. SIMULATION RESULT

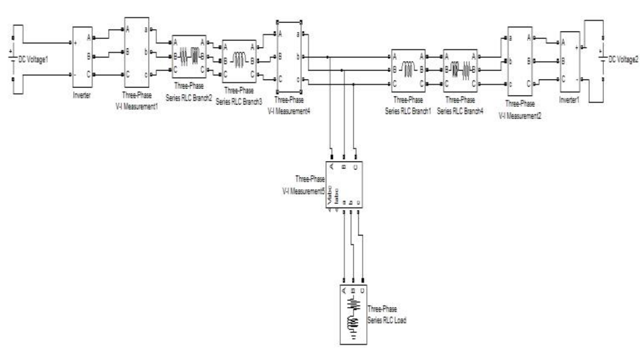

Fig. 3: Matlab Model of System

The graph between w and P with advanced droop coefficient is shown in Fig. 2[]. The result show that for a same frequency power is more in advenced

There are following conditions which are significant with the simulation

1. It is assumed in the paper that the inverters are synchronised before connecting, that is there is not enough phase and amplitude difference between the inverters.

2. Both the inverters must run in connected modefor zero pase difference.

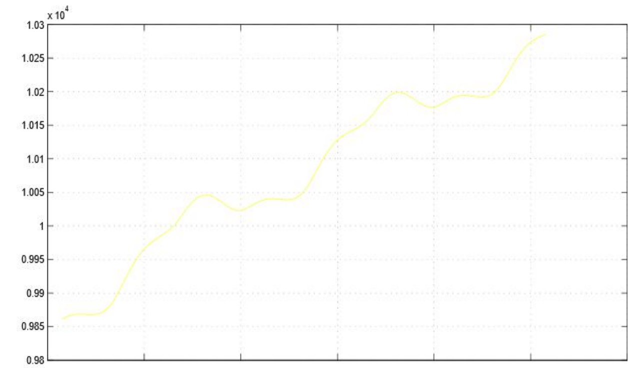

Fig. 4: Real Power waveform at PCC

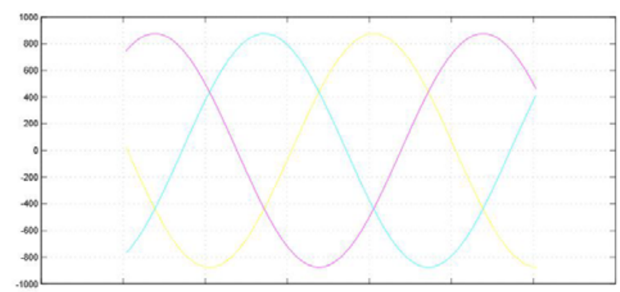

Fig. 5: Voltage waveform at PCC

5. CONCLUSION

The VSI with droop and advanced droop controller system has been properly described in this paper. In a micro grid, small sources must have a control system so that they can communicate with other sources and thus indulge in inter-connected mode. On the basis of the research paper that we have studied and analyzed, we came to a conclusion that the with the use of droop and advanced droop control technique, the ageing power system could be made more reliable and efficient and appropriate load sharing could be implemented.

The proposed advanced droop controlling technique has several advantages over conventional method. The advanced technique has the ability to increase high effective droop on peak loading and thus it becomes more advantageous. The active power is proportional to the frequency of the system where R/X ratio is very low. On the other hand, the reactive power is proportional to voltage magnitude of such system. But in smaller systems, it is difficult obtaining low R/X ratio, so response and functionality of droop controller is not so smooth..

Future Scope

For high R/X ratio, the droop relation needs to be changed. So in future, an adaptive droop controlling technique which changes its characteristics w.r.t changes in R/X ratio is well desired. So that it can be used in small areas and society separately supplying power efficiently, independently with lesser risk of faults.

REFERENCES

[1] Y. A. R. I. Mohamed and E. F. El-Saadany, “Adaptive decentralized droop controller to preserve power sharing stability of paralleled inverters in distributed generation microgrids,” IEEE Transactions on Power Electronics, vol. 23, no. 6, pp. 2806-2816, 2008.

[2] K.-L. Nguyen, D.-J. Won, S.-J. Ahn, and I.-Y. Chung, “Power sharing method for a grid connected microgrid with multiple distributed generators,” Journal of Electrical Engineering & Technology, vol. 7, no. 4, pp. 459-467, 2012.

[3] C. K. Sao and P. W. Lehn, “Control and power management of converter fed microgrids,” IEEE Transactions on Power System, vol. 23, no. 3, pp. 1088-1098, 2008.

[4] M. Griffiths and C. Coates, “Modelling and performance of low voltage distributed generation systems,” in Proc. 6th AUPEC Conference, Australia, 2006, pp. 10-13. 55

[5] PSERCR. H. Lasseter, “Control and design of microgrid components,” Final Project Reports.

[6] P. Piagi and R. H. Lasseter, “Autonomous control of microgrids,” in Proc. Power Engineering Society General Meeting, Montreal, QC, Canada, 2006, pp. 8.

[7] J. M. Guerrero, J. Matas, L. G. de Vicuna, M. Castilla, and J. Miret, “Decentralized control for parallel operation of distributed generation inverters using resistive output impedance,” IEEE Transaction Ind. Electron., vol. 54, no. 2, pp. 994–1004, April 2007.

[8] Nandar, Cuk Supriyadi Ali, "Design of SMES controller to enhance stability of microgrid system taking coil size into consideration." Engineering Journal, Vol. 14, no. 4, 11-20, 2010.

Autonomous Load Sharing of Voltage Source Converters Charles K. Sao, *Student Member, IEEE,* and Peter W. Lehn*, Member, I*EEE TRANSACTIONS ON POWER DELIVERY, VOL. 20, NO. 2, APRIL 2005