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A Study on the Microgrid Controller

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A B S T R A C T

Several renewable energy sources available to generate electricity at present and many of them are known too such as solar, wind, fuel cell, geothermal, biomass, etc. Some of the techniques are new and there controlling is not so developed still a lot of work to perform in this field. The microgrid is a combination of such renewable energy sources and local area loads. The electronic inverters are used to control the performance of a micro-grid. The Micro-grid can be connected and disconnected to the grid according to our requirements for transmitting or receiving power.

Keywords: Micro-grid, Modes of Micro-grid, Micro-grid Control, Photovoltaic.

Introduction

Microgrid consists of loads, small sources, and automatically controlled systems. We can define micro-grid as a load cluster with DGs and energy storage units. The small scale or micro-sources also called distributed energy resources (DER), increases the quality and the effectiveness of power system networks. They are placed near to loads, also can be connected to another electrical system. The micro-grid concept has opened the way for renewable energy sources to enter into the mainstream of power generation, without any direct connection through components of the grid.[1]

The reason behind it is that it happens because of the matchless strait of a micro-grid, which permits to operate in the grid-connected mode as well as in islanded mode where the power grid is not available or some contingencies in the grid. The idea of micro-grid gives the method to attach small scale generation to the main grid without creating disturbances. Some of the system parameters such as voltage can also be controlled using microgrid.[2]

In case there are some contingencies in the main grid, microgrids can supply the load solely that improves the power quality and customer satisfaction. Customers can avail from a micro-grid because it is designed and convened in order to fulfill and curtail losses on the feeder. Micro-grid includes storage units and load controlling units. The ability of micro-grid to share the load of the grid and also supply the load in the absence of grid supply is an important characteristic. As the frequency controlling method applied in a synchronous generator, in the same way, droop control strategy is applicable in micro-grid for frequency and voltage control.[3]

These days lighting load frameworks and automatic types of gears (for example PCs and supporting specialized gadgets, televisions among others) are in charge of around thirty-five percent of power utilization for household and industrial loads. The control of bus voltage at DC and its static and variable behavior researched. Objective framework in the investigation is the dependence of distributed generation on sources.

Modes of Operation of Microgrid

The micro-grid system ought to work for both modes grid connected as well as stand-alone mode and ceaselessly supply energy to loads when there are faults at grid recognized. Moreover, after latitude of faults at grid, the micro-grid needs to be synchronized again to the connection at main grid.[3]

Grid-Connected Mode

The micro-grid system ought to work for both modes grid-connected as well as the stand-alone mode and

ceaselessly supply energy to loads when there are faults at grid recognized. Moreover, after the latitude of faults at the grid, the micro-grid needs to be synchronized again to the connection at the main grid.[3]

Islanded Mode

Also called stand-alone mode, the Static Transfer Switch (STS) micro-grid from the utility, distributed generators supply power to the total power requested by the load. When any variation in the load observed, every distributed generator have to vary its frequency and voltage magnitude to fulfill the requirement of the current load of pre-decided droop characteristic.

Control of Microgrid

Micro-grids had composed by keeping in mind the objective to make the system more reliable and robust by connected it to the main grid. The upcoming developed controller and technique for controlling and designing the refreshed the assimilation of huge range of sustainable power sources to the grid also enhanced the dispersed demand of supply. Besides it capacity of the DGs to fulfill impressive measure of request of supply had significantly diminished the strain from the centrally connected utility.

In this manner, micro-grid networks comprising of these DGs are now ready to keep up a continuous power supply for its loads, even when grid is not supplying power. By the prudence of this unique feature, micro-grid in islanded mode keeps up a similar request of load when associated with utility however provides energy by restricted sources. Loss of a micro source, increment in request of load or existence of a non-linear or unequal load forms it much more challenging to keep up the steadiness of micro-grid. The orthodox methods for controlling could easily be connected by keeping in mind the end goal to check the stability issues. However, because of the varying stability issues, control procedures particular to each issue should be developed.

Some of the challenges may also occurs in microgrid control can be enumerated as both ways flow of power, forming the system to connect with utility and low inertia of the distributed generators. There may be variation practices when small unit synchronized with the utility. The expectations from the system that it poses a constant power load not certainly hold. There must be typical coordination among the several distributed energy resources connected to the system.[3]

Grid Connected Photovoltaic Power System

The PV system which supplies power directly to the grid is known as grid connected system. In it two cases are possible. Either the whole generated power supplied to grid or some power utilized by local loads and then the remaining power transmitted to grid. Before feeding power to grid the generated power which is in DC converted to AC and then transmission takes place. The DC to AC conversion is done by synchronizing grid tie inverters. High voltage is permitted at DC side for limiting ohmic losses. The modules are connected parallel and series both to get the desirable output. As we know that by connecting in series voltage level increased and in parallel case current level increased so this is to be done. The series connected set of modules is called string.

The main characteristics of solar prediction with predicted horizon and variables are explained here. Solar energy forecasters are developed after calculation of indices standardized performance.[4]

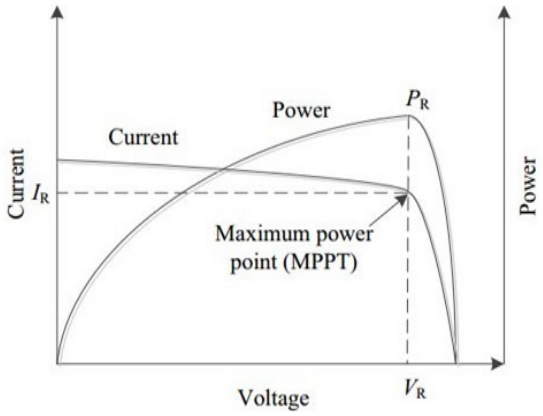

Figure 1.Power Characteristics of PV Array

Output of PV generated power forecasting exaggerated by several elements comprising the system still it is not bounded by the irradiance of solar measurements, reflection factor and estimate of temperature of PV cell with inverter efficiency.

For improving the efficiency of photovoltaic system maximum power point tracking plays a major role. Under the given values of irradiance and temperature the voltage and current are calculated such that to get the maximum generation from a PV array is performed by this technique as shown by Figure 1.

The calculated generated power is given as:

$$P_R = \eta * S * I [1 - 0.05(t_0 - 25)] \quad (1)$$

Where,

η = conversion efficiency (%) of the solar cell array
S = the array area (in m^2)
I = solar radiation (in kW/m^2)
t_0 = temperature of air ($^{\circ}C$)

The sources are renewable energy sources in which solar energy is converted to get power. The solar power is generated by using MPPT technique for controlling the irradiance.

Each PV solar generated DC power but we require AC power therefore the generated DC power is converted to AC by using inverter.

Results

The voltage and current waveforms without controller are depicted in Figure 2 which are initially distorted but reach to almost sinusoidal form later but still some harmonics are present. As we observe in the graphs there are transients much clearly visible at switching.

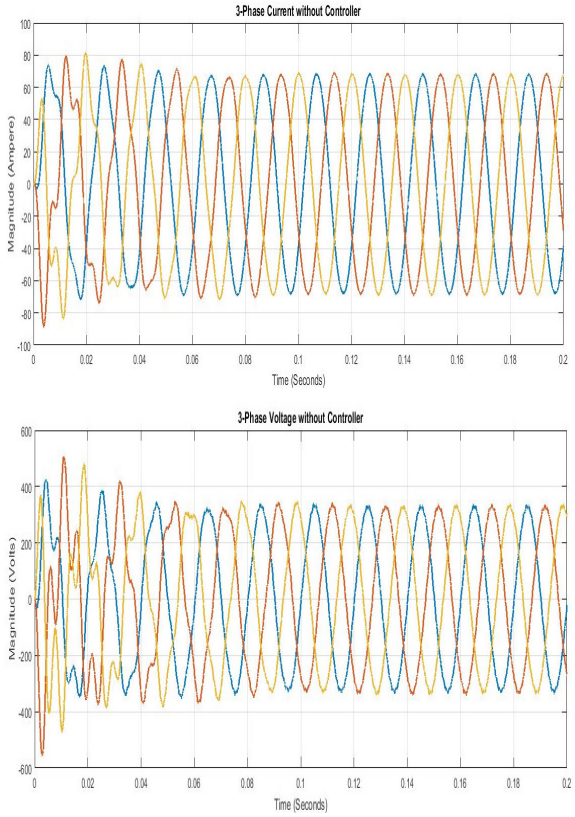

Figure 2.Voltage and Current Waveforms without Controller

In voltage curve magnitude of all the three phases get distorted. The highest positive peak for a phase is 506 Volts at 10.9msec.and highest negative peak is 555 Volts at 2.8 msec. After 76 msec. the curves shows nature close to sinusoidal with harmonics having peak value of 335 Volts.

In current curve also the magnitude of all the three phases get distorted. The highest positive peak for a phase is 81 Amperes at 19.7 msec. and highest negative peak is 88.3 Amperes at 3.87 msec. After 61 msec. the curves become almost sinusoidal with peak value of 68 Amperes.

Now the graphs of real and reactive power graphs without controller are shown in Figure 2. Both the curves become stable in a particular range of following overshoots. The peak overshoot of real power curve has magnitude of 61.84 KW at 3.23 msec. and become stable in range 28 KW to 30 KW after 102msec. And the peak overshoot of reactive power curve has magnitude of 43.54 KVAr at 4.8 msec. and become stable in range 16.4 KVAr to 18.5 KVAr after 103 msec.

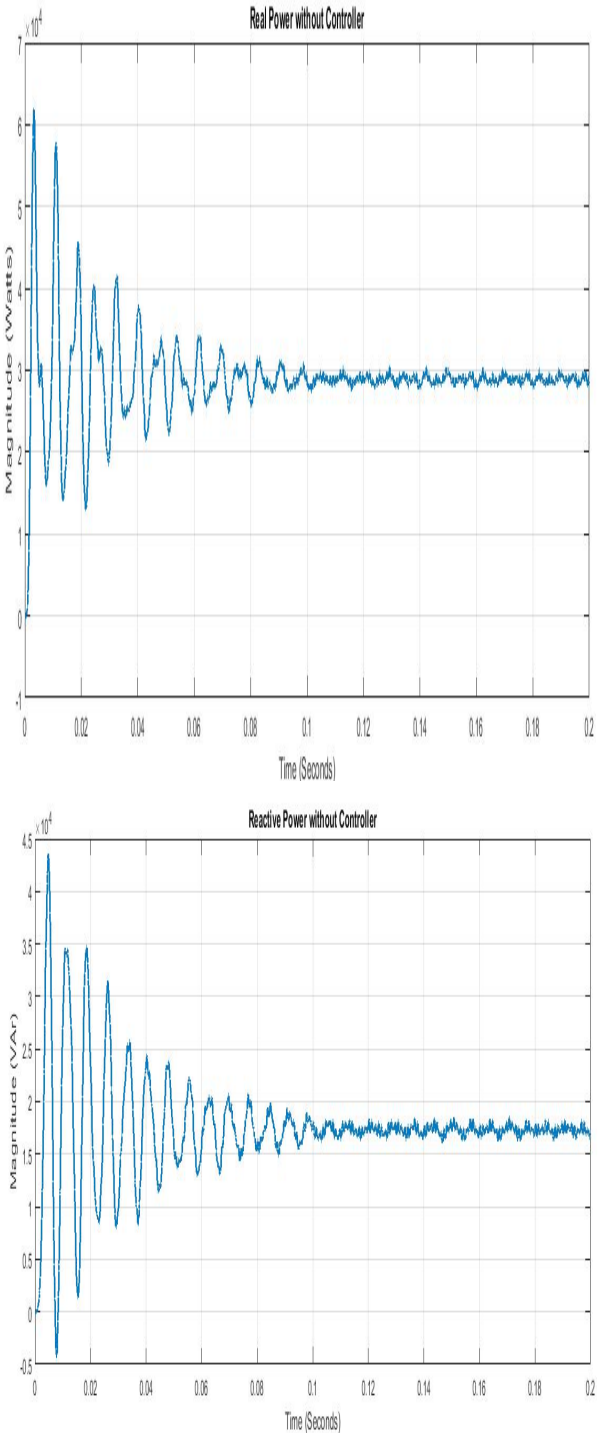

Figure 3.Real and Reactive Power without Controller

The frequency in this case is depicted in Figure 4 where we observe that the magnitude is continuously varying with time. These oscillations in frequency create problems to system.

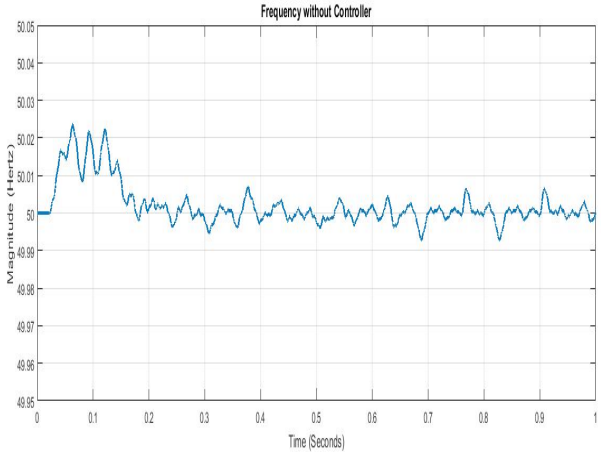

Figure 4.Frequency Waveform without Controller

Table 1.The Values of different Parameters observed in the above results

Parameters	Peak Overshoot	Steady State
Real Power	61.84 KW (At 3.23msec)	28-30 KW (After 102 msec)
Reactive Power	43.54KVAr (At 4.8msec)	16.4-18.5KVAr (After 103msec)

Conclusion

With this work we conclude that the observed parameters show a system which need a controller to get stable power and frequency. So, we have to apply a controller technique to control the voltage and frequency of a micro-grid and get stable real and reactive power signals.

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