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# Design of A Micro-Grid Including Wind Turbine and Photovoltaic Systems Connected To the State and Isolated From the Main Grid

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***Abstract— Due to the rapid increase in global energy consumption and the diminishing of fossil fuels, the customer demand for new generation capacities and efficient energy production, delivery and utilization keeps rising. The micro grid concept has the potential to solve major problems arising from large penetration of distributed generation in distribution systems. Increasing concerns regarding global warming caused by greenhouse gases, which are mainly generated by conventional energy resources, e.g., fossil fuels, have created significant interest for the research and development in the field of renewable energies. Such interests are also intensified by the finitude availability of conventional energy resources. To take full benefit of renewable energy resources, e.g., wind and solar energy, interfacing power electronics devices are essential, which together with the energy resources form Distributed Generation (DG) units. If properly controlled and coordinated, the optimal and efficient operation of DG units, which are the main building block of rapidly emerging microgrid technologies, can be ensured. In fact, the optimal and efficient operation of any energy conversion systems, e.g., microgrids, traction networks, etc., necessitates some sorts of control strategies.***

***Keywords— microgrid, wind turbine, Photovoltaic,***

## I. INTRODUCTION

Microgrid, which is formed by grouping a cluster of distributed energy resources, storage devices and controllable loads in a common local area, has attracted widespread attentions [1]. The control strategy in both the grid connected and islanding modes of a microgrid can be found in literature [2]. A microgrid is defined as a part of an electric power distribution network that embeds an appreciable number of distributed generators and energy storage devices, in addition to regional loads; it may be disconnected from the rest of the power system, under emergency conditions or as planned, and operated as an island.

A small scale system and located near the consumer is called the Micro Grid system. The interconnection of small generation to low voltage distribution systems can be termed as the Micro Grid. Micro Grids can be operated with and without a connection to the main power network. Small Capacity Hydro Units, Ocean Energy and Biogas Plants ,wind, diesel-generation, PV, energy storage etc are the various energy resources in MG for electrification of areas mainly rural areas where there is no possible access to grid electricity due to poor access of remote areas to technical skills. The micro grid has to be designed in such a manner so that there is ease in installation, commissioning, operation and maintenances. The micro grid helps in reducing the Expenditure by reducing network congestion &line losses and line costs and there by higher energy efficiency [1-3].

A microgrid can be a residential neighborhood, an industrial or commercial facility, a university campus, a hospital, an off-grid remote community, etc. Microgrids should widely utilize renewable energy resources such as wind, sunlight, and hydrogen1, to play a significant role in the electric power systems of the future, for cleaner air, reduced transmission and distribution costs, and enablement of energy efficiency enhancement initiatives. The economical and environmental benefits of microgrids have motivated extensive research and development efforts towards resolving the technical challenges of this new and fast growing technology[3].

## II. MICROGRID CONCPT

The microgrid concept assumes a cluster of loads and microsources operating as a single controllable system that provides power to its local area [4, 5]. Microgrids offer solutions to implementing distributed energy resources such as diesel generators, wind turbines, photovoltaic cells etc. at or near the point of load. This decreases the stress on the electrical transmission system and offers a significant increase in power system reliability as power can be generated locally. From a grid perspective, the microgrid concept is attractive because it recognizes the reality that the traditional grid structure is old and has to change[4]. Microgrids may or may not be connected to the main distribution grid that is maintained and operated by the distribution network operators. Microgrids can also provide premium power through the ability to smoothly move from dispatched power mode while connected to the main utility grid to load tracking while in island mode [5]. The microgrid concept is made possible by the recent advances in reliable small scale generators, power electronics and digital controllers. The majority of the present day micro sources are power electronics based. As a result, they can provide the required flexibility to ensure controlled operation as a single system.

A basic microgrid model is shown in Figure 1. This microgrid consist of different DGs and a collection of loads.

 

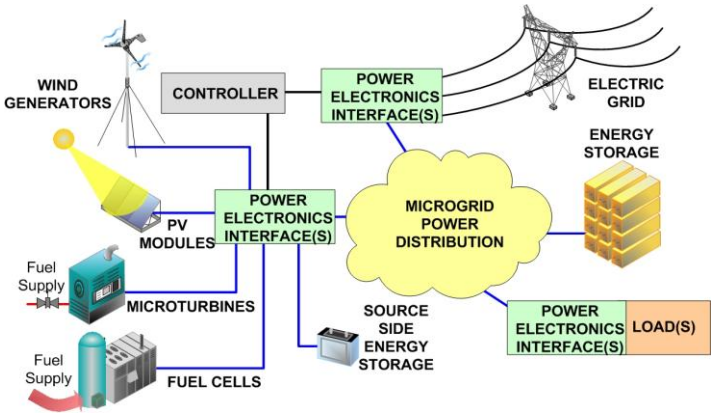


Figure 1: Microgrid Model

### *A. Wind turbine*

Wind turbines are packaged systems that include a rotor, a generator, turbine blades, and a drive or a coupling device. As wind blows through the blades, the air exerts aerodynamic forces that cause the blades to turn the rotor. As the rotor turns, its speed is altered to match the operating speed of the generator. Most systems have a gearbox and a generator in a single unit behind the turbine blades. As with photovoltaic (PV) systems, the output of most wind generators is processed by an inverter that changes the electricity from DC to AC so that the electricity can be used.

A wind turbine operates by extracting kinetic energy from the wind passing through its rotor. The power developed by a wind turbine is given by [6]:

$$P_{\omega} = 0.5\rho AV^3 \tag{1}$$

Where
P power (W),
Cp power coefficient,
Vw Wind velocity (m/s),
A swept area of rotor disc(m2),
density of air (1.225 kg=m3).

The force extracted on the rotor is proportional to the square of the wind speed and so the wind turbine must be designed to withstand large forces during storms. Most of the modern designs are three-bladed horizontal-axis rotors as this gives a good value of peak Cp together with an aesthetically pleasing design [7].

The power coefficient Cp is a measure of how much of energy in the wind is extracted by the turbine. It varies with the rotor design and the relative speed of the rotor and wind (known as the tip speed ratio) to give a maximum practical value of approximately 0.4 [7]. The power coefficient Cp is a function of the tip speed ratio, and the pitch angle , whichwill be investigated further. The calculation of the performance coefficient requires the use of blade element theory [8]. As this needs knowledge of aerodynamics and the computations are rather complicated, numerical approximations have been developed [8]. Here the following function will be used:

$$C_P(\lambda,\beta) = c_1\left(\frac{c_2}{\lambda_i} - c_3\beta - c_4\right)e^{\frac{-c_5}{\lambda_i}} + c_6\lambda \tag{2}$$

$$\frac{1}{\lambda i} = \frac{1}{\lambda + 0.008} - \frac{0.035}{\beta^3 + 1} \tag{3}$$

Figure 2 shows Cp($\lambda$, θ) versus $\lambda$ characteristics for various values of $\beta$. Using the actual values of the wind and rotor speed, which determine $\lambda$, and the pitch angle, the mechanical power extracted from the wind can be calculated from equations (2)-(3). The maximum value of Cp (cpmax=0.48) is achieved for $\beta$ = 0 and for $\lambda$ = 8.1. This particular value of $\lambda$ is defined as the nominal value ($\lambda$ nom).

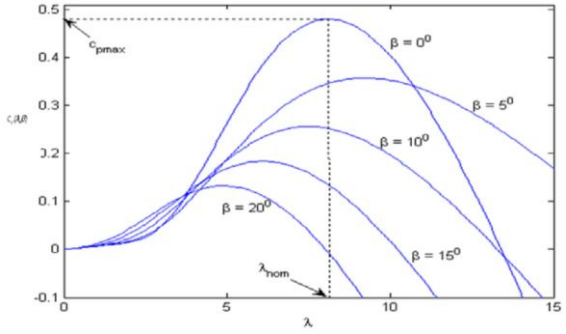


Figure 2: Performance coefficient Cp as a function of the tip speed ratio $\lambda$ with pitch angel $\beta$ as a parameter.

 

The working principles of the wind turbine can be described in two processes, that are carried out by its main components: the rotor which extracts kinetic energy from the wind passing it and converts it into mechanical torque and the generating system, which converts this torque into electricity. Figure 2 illustrates the working principles of a wind turbine.

Basically, a wind turbine can be equipped with any type of a three phase generator. Several generator types may be used in wind turbines, but here three types of wind turbine generators are discussed: Squirrel cage induction generators, Doubly fed induction generators, Direct drive synchronous generators, that in this article Squirrel cage induction generators is the base wind turbine for simulations.

### *B. Photovoltaic*

The photovoltaics (PVs) are an attractive source of renewable energy for distributed urban power generation due to their relatively small size and noiseless operation. Their applications are expected to significantly increase all over the world. PV generating technologies have the advantage that more units can be added to meet the load increase demand [9]. Photovoltaic cells can be divided into four groups: crystalline cells, thin-film cells, dyesensitised solar cells and multilayer cells. The latter can also be considered as several layers of thin-film PV cells. The different types are described in [10]. An initial understanding of the performance of a solar cell may be obtained by considering it as a diode. The light energy, which is in the form of photons with the appropriate energy level, falls on the cell and generates electron-hole pairs. The electrons and holes are separated by the electric field established at the junction of the diode and are then driven around an external circuit by this junction potential. There are losses associated with the series and shunt resistance of the cell as well as leakage of some of the current back across the p-n junction[11]. This leads to the equivalent circuit shown in Figure 3.

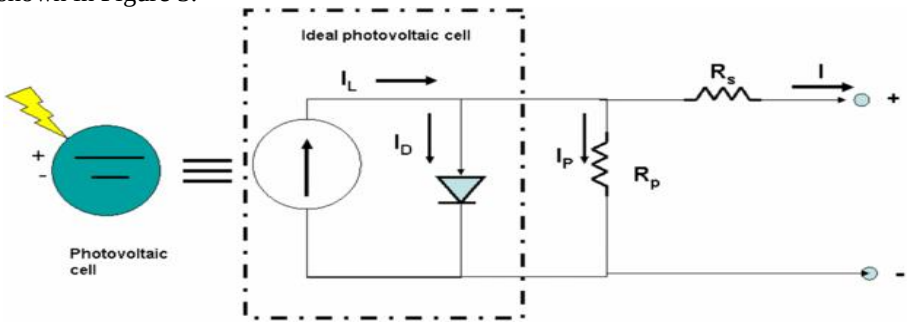


Figure 3: The circuit of Photovoltaic cell

The photo current (Iph) is a function of the solar irradiation. A series resistor Rs and a parallel resistor represent respectively the voltage loss and the leakage current of the cell. The diode D characterises the non linear behavior of the cell and the dependency of its performance on ambient temperature.

## III. RESULTS AND DISCUSSION

The traditional energy generation and distribution has an alternative today, named Micro Grid. And with the use of smart grid technologies, integrated control of distributed power generation can be achieved. Fig-1 depicts a normally operated MG in a grid-connected mode through the substation transformer via Point of common coupling (PCC). PCC is the point in the electric circuit where a micro grid is connected to a main grid. The converters play a vital role firstly by connecting DG systems in parallel with the grid or other sources, and secondly to continue unctioning in stand-alone mode, when critical loads don't get supply from other sources [12].

The system can disconnect from the utility in case of faults and voltage collapses, and when the power quality from the grid reduces below certain standards. A centralized model controller is set in the micro-grid with the control logic optimization of main power for unplanned and planned mode conversion. When micro-grid works in grid-connected mode, the main power works in PQ mode and when the micro-grid works in islanding mode, the main power works in V-F mode so the control of the micro-grid is "master and slavery" control. The micro-grid work mode can be detected from the micro-grid information such as current, voltage etc [13]. Control strategy is shown in Figure 4.

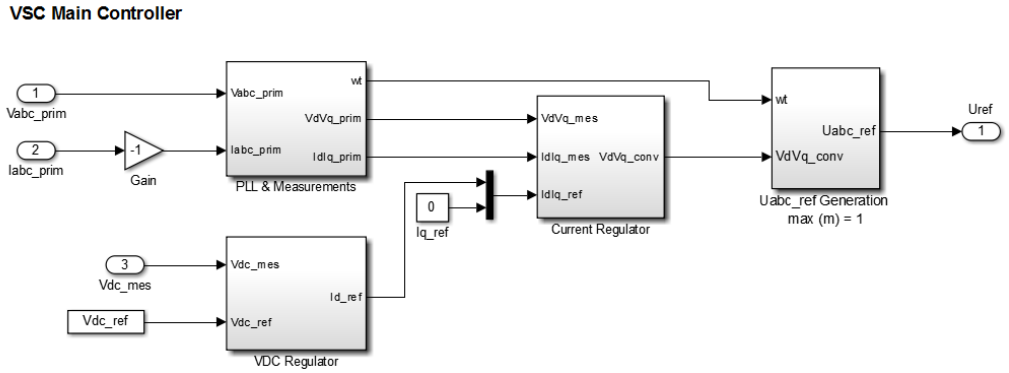


Figure 4: Control strategy for microgrid

 

## IV. RESULT

The power system in a State of persistent work in balance between production and consumption to take over, and if the balance of the event stir welding between the nominal value of the microgrid parameters go, will go away. This article is for voltage control and other parameters of the microgrid is used. If not, the control system of the swing can be a lot of damage, even to a production unit shutdown also happens. The output be and other parameters are also two modes of presence and absence of DGs have been analyses.

The following changes to the overall voltage shows a microgrid. The first case related to the presence of the Photovoltaic cell and second mode the presence of Wind turbine shown in Figure 5,6.

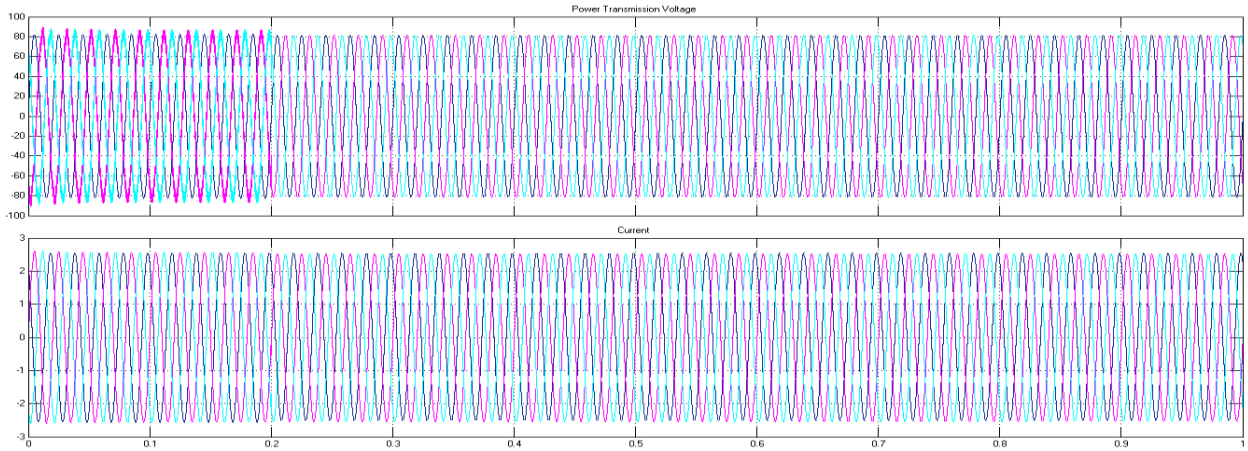


Figure 5: Microgrid effective voltage and current in the presence of Photovoltaic cell

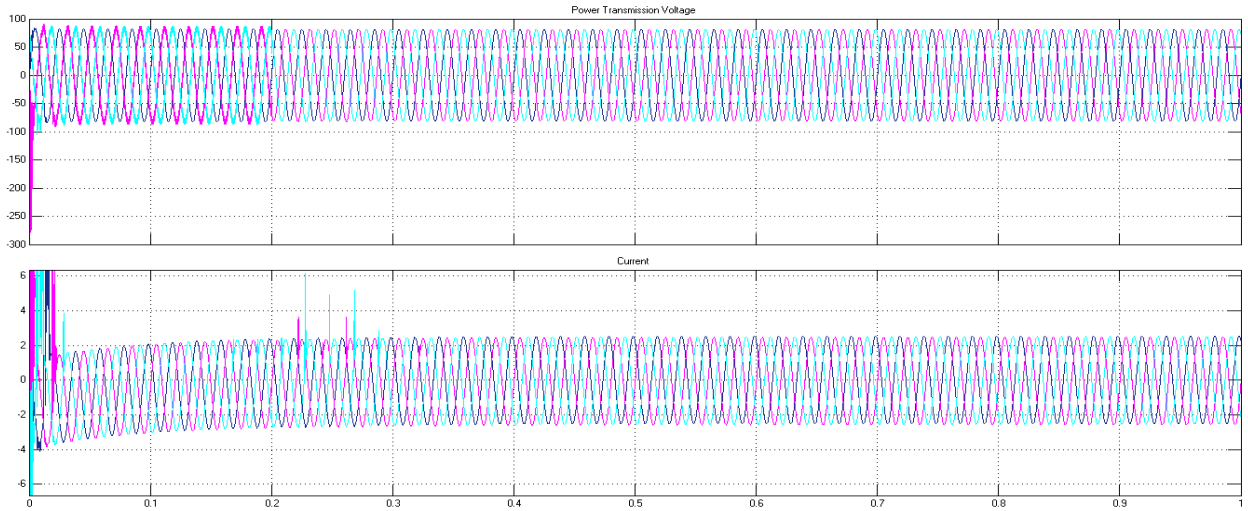


Figure 6: Microgrid effective voltage and current in the presence of Wind turbine

Figure 7 the active and reactive power injection in the presence of Photovoltaic cell and Figure 8 active and reactive power injection in the presence of a showing of Wind turbine. As mentioned in the previous section as well as in other instruments of DGs can play an role in improving the quality of be have.

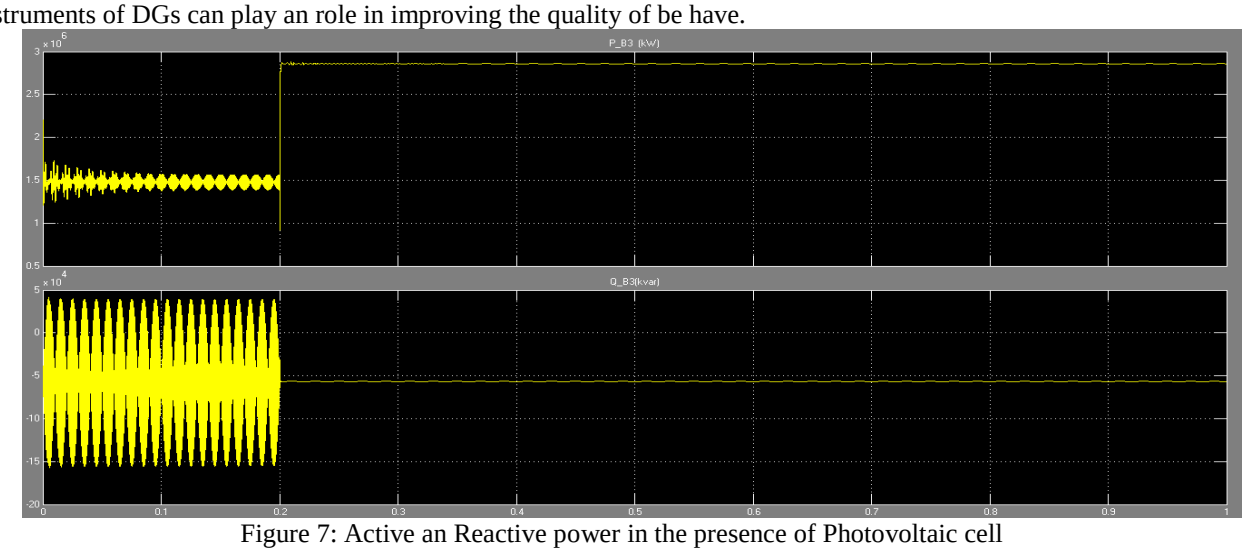


Figure 7: Active an Reactive power in the presence of Photovoltaic cell

 

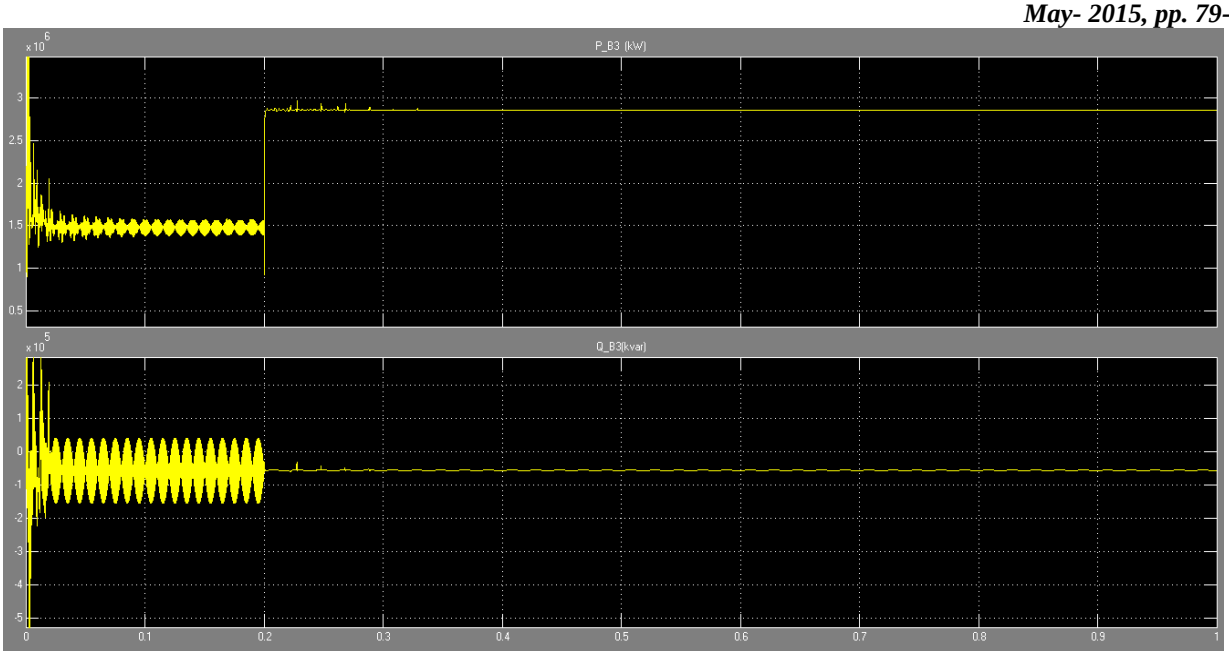


Figure 8: Active an Reactive power in The presence of Wind turbine

## V. CONCLUSIONS

After going through this review based on the given title, it has been concluded that issues of unreliable power quality, increased focus on renewable energy, need for rural electrification, and focus on higher efficiency have resulted in more emphasis on developing micro grid infrastructure. The ability of MG to island generation and loads together has a potential to provide a higher local reliability than that provided by the power system. Regarding distributed generation , the distribution systems have undergone the changes over the recent decades, along with the fact that many of these sources can be connected to form independent micro grids, have challenged this protection perspective.

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