REVIEW ON POWER MANAGEMENT ANALYSIS OF THE HYBRID GRID INTEGRATED SYSTEM

Author 1: D. Dharani Lakshmi, Research Scholar, EEE Dept, JNTUA.

Author 2: Dr. K. Jithendra Gowd, Assistant professor, EEE Dept, JNTUA.

Abstract:

The recent global need is to have a sustainable and low carbon living when there are issues pertaining to environmental degradation which have adversely affected the quality of living. This is possible only by adopting to green generation using renewable energy sources in place of conventional power generation.Every day we rely on energy to provide us with electricity, hot water, and fuel for our cars. Most of this energy comes from fossil fuels, such as coal, oil, and natural gas. Because fossil fuels can run out and are bad for the environment, it is important that we start switching to other energy sources, like renewable energy sources. The variable speed wind turbine is made to deliver constant output power by using pitch angle control very effectively, which is proved from the simulation results. The main objective of this research is to develop a dynamic model of photovoltaic, wind energy and fuel cell as sources in a distributed generation (DG) system. The above mentioned distributed generation is a part of a Micro grid. Mathematical modelling of PV, FC, wind energy system, converters and controllers were carried out using Matlab / Simulink software. The control section of this work is planned to make the Micro grid system to share the power effectively and efficiently. The grid integrated hybrid system mainly works in two states of operation namely DG control mode (DGCM) and grid control mode (GCM).

Index Terms: Micro grid, Power controller, PV cell, MPPT controller, boost controller.

1. Introduction:

Renewable power generation using a solar PV system or a wind energy system is nota reliable power supply since it depends upon the weather and other atmospheric conditions. This has led to the necessity of combining all renewable sources into a concept called distributed generation and the resulting system is known as hybrid system. The major player of any hybrid renewable energy generation system is the solar photovoltaic system. The simulation output of the mathematically modelled PV system is presented in this chapter whereas the contribution of the PV system in the overall hybrid system is presented in preceding chapter. A fuel cell is an electrochemical cell that converts a source fuel into electricity. It generates electricity inside a cell through reactions between a fuel and an oxidant, triggered in the presence of an electrolyte. The reactants flow into the cell, and the reaction products flow out of it, while the electrolyte remains within it. Fuel cells can operate continuously as long as the necessary reactant and oxidant flows are maintained. There are two types of FCs mostly preferred, they are the low-temperature Proton-Exchange Membrane Fuel Cell (PEMFC) and high- temperature Solid Oxide Fuel Cell (SOFC).Both of them show great potential in hybrid energy system applications.

2. STRUCTURE OF THE HYBRID SYSTEM

The overall arrangement of the hybrid system is shown in Figure 1.1. Thesystem consists of a PV array having a maximum generation of 90 kW connected through a DC-DC boost converter to a 500 V DC link-bus. MPPT (P&O) method is used to extract the maximum power from the PV array and controlling the gate pulse of the boost converter.

A 75 kW PEMFC is connected through a DC-DC boost converter to the same 500V DC link-bus. For FC a pulse controller similar to MPPT controls the boost converter gate pulses. A wind power system having maximum capacity of 25.2 kW AC after conversion to DC through a rectifier is connected to the 500 V DC bus through a DC-DC converter to regulate the DC voltage near togrid through an inverter responsible for DC-AC conversion and a coupling transformer as shown in Figure 2.1. Under light load conditions the surplus power of hybrid DG source (Pms) is exported to grid so that grid power (Pgrid) is positive and during heavy load condition, deficit power of load is supplied by grid so Pgrid500V. The DC bus is integrated parallel to the 33 kV load and 33/220 kV ACbecomes negative. However if the load (Pload) exceeds a certain threshold value.

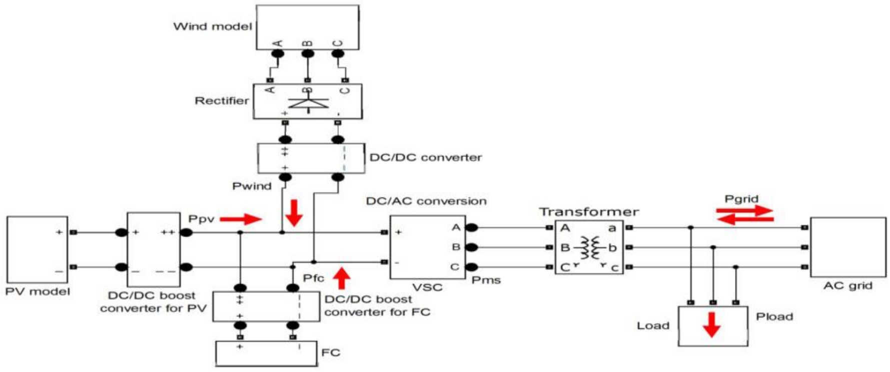


Figure 2.1 Overall configuration of grid integrated hybrid system

3. Literature Survey:

In this Research work(1) a comprehensive study of a hybrid AC/DC micro-grid for power system reconfiguration is analyzed Mathematical models and control schemes containing MPPT control are provided for the all the converters, which are boost converter, battery converter, main converter and AC/DC/AC converter of DFIG. In this (2) The thermal model of PV module has been provided with consideration of energy sources, heat capacity of materials and heat exchange paths, then from correspondence thermal and electric elements the equivalent electric circuit has been introduced. In this (3) investigated the dynamic circuit model and the dynamics characteristics of solar cells in order to provide academic support for studying the stability of PV generation systems. In this (4) a new proposal was put forward to develop the conventional distribution networks into hybrid AC/DC microgrids through the utilization of the capacity of the DC microgrid and modification of the designs of series and parallel controllers. In this (5), presented a simulation tool for PV grid connected generation systems suitable for large scale systems studies for both steady state and transient analysis. In this (6) the stability of small signal stability analysis for the hybrid microgrid to analyzed. In order to reduce system equations and for the better analysis of the proposed droop controller, the dc sources and their individual droops are aggregated to form one combined dc source. In this (7) A hybrid micro grid structure for grid connected micro grid through B2B is proposed. The proposed control scheme can provide an isolated, reliable system connection with improved power flow management. In this (8), the diesel generator works as the sole voltage source all along under islanding mode and the HES cooperates to achieved the power balance of the system.

4.RENEWABLE ENERGY SOURCES

Solar Energy **-**The solar energy is an unlimited source of energy which is originated from the sun. When the light and heat from the sun are used directly without changing the form, then the technology refers as a direct or passive technology of solar energy and when it used by converting the form of energy, that is called indirect or active technology of solar energy. The photovoltaic technology is the renowned indirect way and the solar thermal system is the direct way to harvest the abundant energy. There are different options for producing electricity from renewable energy sources. Consequently, there are several ways of connecting the gained electricity with the existing grid.

Wind Energy -Wind energy is the energy which is extracted from wind. For extraction we use wind mill. It is renewable energy sources. The wind energy needs less cost for generation of electricity. Maintenance cost is also less for wind energy system. Wind energy is present almost 24 hours of the day. It has less emission. Initial cost is also less of the system.

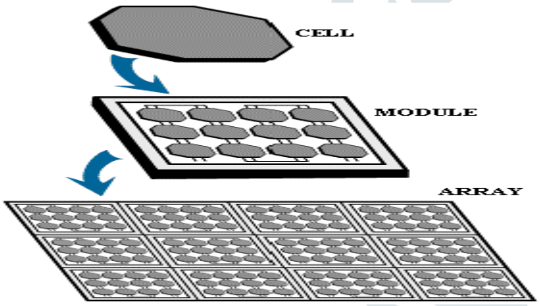
5.Modeling of PV and FC systems:

5.1 Photovoltaic module

Because of the low voltage generation in a PV cell (around 0.5 V),several PV cells are connected in series for high voltage and in parallel for highcurrent, to form a PV module for desired output. In case of partial or total shading and at night there may be requirement of separate diodes to avoid reverse currents. The p-n junctions of mono-crystalline silicon cells usually have adequate reverse current characteristics and hence separate diodes are not necessary.

5.2 PV array:

A PV panel is constructed using individual solar photo voltaic cells and solar cells are made from layers of silicon semiconductor materials. One layer of silicon is treated with a substance to create an excess of electrons. This becomes the negative or N-type layer. The other layer is treated to create a deficiency of electrons, and becomes the positive or P-type layer similar to transistors and diodes. When assembled together with conductors, this siliconarrangement becomes a light-sensitive PN-junction semiconductor. Because of the low voltage generation in a PV cell, several PV cells are connected in series for high voltage and in parallel for high current, to form a PV module. The Modelling of the PV array can be done by using MPPT and DC/DC Boost controller.



5.3.Proton Exchange Membrane Fuel Cells:

In proton exchange membrane fuel cell (PEMFC) a proton-conducting polymer membrane which acts as the electrolyte separates the anode and cathode. At the anode end, hydrogen diffuses to the anode catalyst where it later gets dissociated into protons and electrons. These protons often react with oxidants forming multi-facilitated proton membranes. The protons are conducted through the membrane to the cathode, but the electrons are forced to travel in an external circuit (supplying power) as the membrane is electrically insulating. On the cathode catalyst, oxygen molecules react with the electrons and protons to form water.

In thepresent research work FC of type PEMFC is being used. Pulse controller is used to track the maximum voltage and current points at the varying output of FC stack and accordingly apply the gate pulses to the boost converter based on MATLAB. By varying the FC module output voltage based on voltage feedback provided by power controller to achieve the desired power from FC stack to maintain the output of the hybrid DG sources at a certain reference level.

6.MODELLING OF WIND ENERGY SYSTEM:

The main objective is to derive a mathematical model of a wind energy system (WES) consisting of variable speed wind turbine with drive train, pitch angle controller, permanent magnet synchronous generator (PMSG), rectifier and DC-DC converter.the extraction of maximum power from WES, the turbine is operated at a constant speed ratio (SR), which means the rotational speed is made proportional to the wind speed. The constant-SR region is achieved by regulating the mechanical power input through pitch angle control or the electrical power output by the power electronic control.

7.CONTROL STRATEGIES OF THE GRID INTEGRATEDHYBRID SYSTEM:

7.1.Model of MPPT Controller:

The role of MPPT in PV system is to automatically find the voltage or current at which a PV array operated to obtain the maximum power output under a given temperature and irradiance. It is noted that under partial shading conditions, in some cases it is possible to have multiple local maxima, but overall there is still only one true MPP. Most MPPT techniques respond to changes in both irradiance and temperature, but some are specifically more useful if temperature is approximately constant.

7.2.Model of DC-DC Converter:

The boost converter for PV/ FC or DC-DC converter for WES is responsible for maintaining the output DC voltage constant at 500V with admissible variation of + 2% . The mathematical modelling of the DC-DC converter is given in Equations (5.1) to(5.2),

The reference DC voltage is given by,

m = [Scale changer (1-D)] (5.1)

Vref= (m+1)*Kmf*Vdc (5.2)

Where, D is the duty cycle ratio for the boost converter which is provided by MPPT algorithm.

7.3. **MODEL OF INVERTER CONTROLLER**

The inverter controller with PWM is responsible for controlling the gate pulses of the three phase, three level IGBT bridge which is responsible for DC/AC conversion and vice-versa so as to enable the desired power management between DG's consisting the hybrid system, load and AC grid. In present work inverter controller mathematical modelling is based on feed forward control (FFC) technique.

74.Current controller:

Current controller is responsible for generating the d-q reference component of Voltage. This reference signal generation block is based on FFC technique using a PI controller.

7.5. POWER CONTROLLER:

The power controller is mainly responsible for varying the FC output power in controlled operational mode so that PV-FC-WES hybrid power is maintained at a certain reference level during DGCM mode of operation and to operate FC at its low generation level in GCM. The power controller (PC) is implemented using MATLAB codes. The output power of FC is varied by varying the partial pressure.

8.Conclusion:

This work presented modelling and control strategies to improve the power management of the grid integrated hybrid system. The hybrid system composed of a PV array, PEMFC and WES is considered.Mathematical modelling of various components of PV, FC, and wind energy system including inverter controller, powerSimulink software platform to validate the desired power as well as load management

of the hybrid system under varying load conditionscontroller, load controller and mode selector is carried out using MATLAB.

9. Future Scope:

This work as a further research, the mathematical modelling can be doneconsidering Micro turbines, modelling of super capacitor as energy storage device and their integration to the hybrid system and fault ride through analysis using Neural Network can be considered. Flywheel energy storage system which is becoming a popular power conditioner can also be considered. Moreover, the application of the control strategies to a microgrid with multiple DGs can also be studied in detail.

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