ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Power Management Strategies for Optimal Operation of AC and DC Micro Grids

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ABSTRACT

In this paper, a micro-grid hybrid renewable energy system is integrated and operational controls, DC Micro-grids within the hybrid (solar, fuel cell, supercapacitor and battery) are designed to support the integration of power. And to ensure that the operation of wind and hydro power sources connected to the C-held applications. And the control scheme considering the available power, PV, must be generated by the fuel cell and / or the SC or the battery storage system to store power, the electric utility grid and the state of charge is determined by the SC, the battery's (SOC). AC microgrid Wind energy is one of the most accessible and dangerous forms of renewable energy. Variable Speed Wind Energy Conversion System is based on PMSG (WECS) at a power factor improved as the squirrel cage induction generators Stator output compared to a fixed speed operation provides many advantages, no operating cost, weight reduction gearbox (direct drive) and losses, higher efficiency and capacity run at low speed. Clean source of renewable energy, hydro power is an effective and reliable format. From small rivers and streams, which is an excellent method of harnessing renewable energy. Hydro Power Plant in the three divisions, "the governor (controller), water and a water turbine is servo system. This section of the turbine is converted into mechanical energy to electrical energy so utterly drive shaft is coupled to a synchronous generator, which is known as hydro turbine governor. This system has a simple parallel RLC load power three-phase power supply. Speed governing the operation of the control system ensures a constant speed at the time of load variation. Generator voltage, current and transient behavior of the rotor speed also captured. Models, MATLAB / Simulink simulation on. The results of the financial commitments to be very low, hence the use of renewable resources, more environmentally friendly low-carbon footprints are less technical skills required to operate and had to rely on automation.

INTRODUCTIONTO MICROGRID

A microgrid distribution generator used to supply loads and have a network of storage devices. A distributed generator (DG) as a microgrid combined heat and power (CHP) of photovoltaic (PV), wind turbine, or a small diesel generator, usually a renewable resource. DGS are usually located near the loads, so there is little risk of a microgrid that line. Host a microgrid grid connection or in islanded mode can work. When connected to the grid, DGS to support the main grid during peak demand. However, if there is a disturbance in the grid, a microgrid load can be supplied without the support of the main grid. Moreover, a microgrid connected to the main grid can be wrong. Yet, like any technology, microgrid technology faces many challenges. Several considerations voltage, current, frequency, power, and network protection control strategies based on the need to take into account.

1.1 The need for a MICROGRID

A microgrid is used for many reasons. It is a new paradigm in the world can meet the increase in demand for power. It also DGS are usually small-scale, renewable, or backup diesel generator use, increase energy efficiency and reduce carbon emission. By using a microgrid, to supply the critical loads will be

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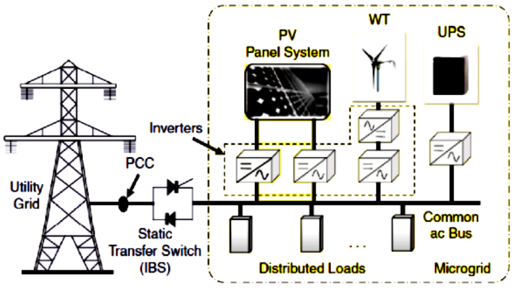
ensured all the time. Economically, the main grid spanning more expensive, so a microgrid instead be used to supply the load. Moreover, the grid is supported by the DGS; Therefore, to increase the total power quality and reliability. Also, using a microgrid, the main generators of low power supply grid. With less fossil fuels is useful to have a generator that runs the main grid. DGS load and are located near another economic reason, is kept to a minimum so that the line losses. A microgrid is hosted in remote areas or places where the power supply to the grid can be used both inefficient and difficult to install. For example, in some areas, the load is completely supplied by DGS is a small-scale low load demand. Therefore, the demand for the supply of a microgrid is loaded. Moreover, in some areas, making it difficult to connect to the main grid, rough terrain features. Using a microgrid power to provide the best solution for this. In summary, microgrid technology, the most important issues that are important:

- Load the demand has increased all over the world.
- Microgrids use of renewable sources, so they have less impact on the environment.
- Extending the grid is not only expensive, but also difficult.
- A microgrid is disconnected from the main grid can supply the critical loads.

1.2 STRUCTURE AND COMPONENTS MICROGRID

Figure 1.1. Shows the structure of a microgrid. During the microgrid is connected to the main grid with a common loop. Each microgrid load depending on demand, a different structure (DGS and DGS types No). A microgrid is able to supply the critical load. Thus, DGS should be enough to supply the load if the grid should insure disconnected. Microgrid microsources, power electronic converters, distributed storage devices, local loads, and the common coupling (PCC) consists of the point. Due to the medium voltage grid to a voltage transformer or an electronic converter that is similar to the output voltage from DG reduced using either. microgrid of the components are as follows.



1.3 MICROSOURCE

Microsource the weight of the energy source is located near a small scale. It is a dispatchable or in a microgrid network could be a non-dispatchable energy resource. dispatchable and non-dispatchable, because you can control the amount of output of the voltage difference between the voltage source is a dispatchable unit. In contrast, non- dispatchable unit-level control of the output voltage, which is considered as a current source. Non- dispatchable unit is an example of a PV panel. PV energy production will stop if there is no sun. However, in a voltage source, the amount of voltage control (ie, on / off) or increased / microgrid is reduced, depending on the voltage required for the load. The speed can be controlled by controlling the voltage from the generators generators. Microsources usually small, less than 50 MW. They are renewable source in the device in the form of CHP, solar PV, wind turbine, or a fuel cell will be present.

1.4 Power Electronics Converters

A power electronics converter is a device used to control and DG voltage and frequency control. From MW to GW, which is powered by the act. In a microgrid, power electronic converters and voltage output from DG DG depending on the type of the output voltage, to change the DGS is linked to another form. For example, DG, if the PV panel, is in the form of DC output voltage. Therefore, the voltage to match the type of microgrid load voltage must be converted from AC to DC. Another example is the AC voltage generated by the wind turbine, but not in the desired size and stage. Therefore, the voltage AC to DC and DC to AC should be converted to an acceptable size and stage. Terms inverter and converter should not be used interchangeably. However, changes in the size of the inverter to convert AC voltage, AC voltage, DC voltage changes. DGS to step up or step down converters, the output voltage. Voltage and frequency converter power electronics also control the use of DGS acts as a control device. Thus, by adjusting the voltage and frequency of the converter can be produced at a certain value.

INTRODUCTION TO ENERGY SYSTEMS

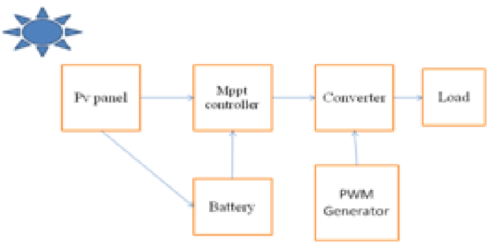
2.1 INTRODUCTION TO DC MICROGRID SOURCES

2.1.1 Solar energy

Solar energy is an important source of renewable energy. It regulates the heat from the sun and bright light. Solar thermal energy is used for space heating, solar energy can be harnessed from. Solar energy can be converted to electrical energy which can then be used in a wide variety of applications. It is an additional cost of the initial installation, the long-term benefits are rewarding.

2.1.2 photovoltaic array

PV cells are primarily powered by a photovoltaic energy system. PV system configuration described below, as shown in Figure 2 below.



It is in the form of solar radiation into electrical energy, which can convert solar energy PV panel, have. The maximum power point tracking system collects the maximum electric power. Interleaved boost converter, DC, the value that is generated from the back to the grid synchronization purpose.The DC / DC converter does not change the value of the input voltage for the inverter is given a pair of the entire system. The DC / DC boost converter, buck or buck-boost voltage level required and available to be contingent. Here is interleaved boost converter with the technique. The battery is used to store the energy.

2.1.3 PV panel

A solar cell or photovoltaic cell, light energy directly into electricity by the photovoltaic effect to convert an electrical device. Its electrical properties, such as current, voltage, or resistance, is defined as a device that is subject to change when exposed to light, a form of photoelectric cell is. Otherwise known as solar cells, solar panels, photovoltaic modules are the building blocks.

Photovoltaic solar cells, regardless of the source of sunlight or artificial light are described. They are near the visible range of light or other electromagnetic radiation to detect, or to measure the intensity of light to a photo detector (for example, infrared detectors) is used as.

- A photovoltaic (PV) cell operation requires 3 basic features:
- light, electron-hole pairs, but the absorption of the product.
- distinguish among the different types of charge carriers.
- A special extraction of the outer ring of the vehicle.

2.1.4 MPPT controller

They have given conditions for a power output of a PV system to increase the maximum power point trackers (MPPTs) of photovoltaic (PV) power systems plays an important role, and thus increase the range of EF-fi ciency. Therefore, to reduce the cost of the entire system is a MPPT. MPPTs fi nd and using an MPPT algorithm, to perform the operation at the maximum power point.

PV array under constant uniform irradiance has a current–voltage (I–V) characteristic like that shown in Figure 1.

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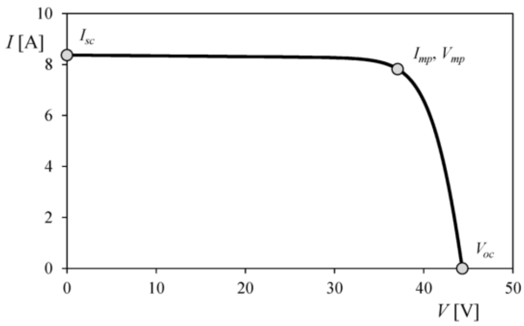
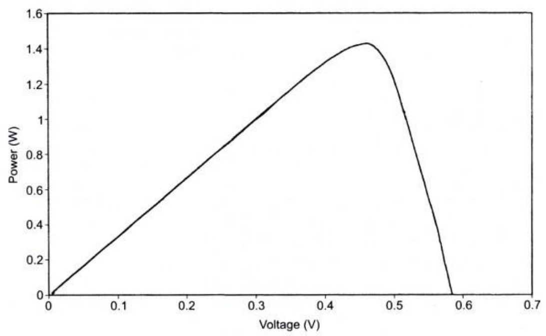
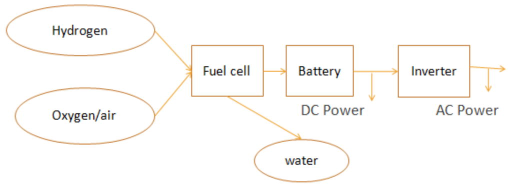


With a maximum range of EF-fi ciency and maximum output power of a single point of the curve, the maximum power point (MPP) is called. A PV array is loaded directly (a so-called "direct-coupled" system) to when the operating point of the system is shown in Figure 1 PV array and load the line is at the mutilation of the I-V curve. In general, the operating point is clearly a direct-coupled system, and so can be seen in Figure 1. The MPP of PVarray not, PVarray generally to ensure that the bulk of the load must be able to supply the power requirements. This will lead to an overly expensive system. To overcome this problem, a switch-mode power converter, the maximum power point tracker (MPPT) at the PV array's operating point to be used to perform MPPT. MPPT PV array by controlling the voltage or current of this is independent of the load. If not properly controlled by the MPPT algorithm, MPPT PV spot MPP of the array can be tracked. It is the model calculations or by a search algorithm, either, to be located. The situation is further complicated by the fact that the MPP depends in a nonlinear way on irradiance and temperature, as illustrated in Figure 2.



Note the change in the array voltage at which the MPP occurs. A number of MPPT control algorithms have been proposed. One algorithm, the perturb-and-observe (P&O) algorithm, is by far the most commonly used in commercial MPPTs.

BLOCK DIAGRAM



DC-DC CONVERTER BASICS:

A DC- to-DC converter accepts a DC input voltage and a device that produces a DC output voltage. Is different than the input voltage range is usually produced. In addition, DC- DC converters Two- noise isolation, leading DC- to-DC converter of the power to take control of the bus topologies are used to provide a summary of some of the conditions.

1 buck converter to step-down converter

Turning on the transistor circuit inductor and put an end voltage Vin. Inductor current will tend to cause the voltage to rise.

When the transistor is turned off, the current through the inductor continues, but now flowing through the diode. We present the first inductor, and therefore do not reach the zero voltage at VX is just the voltage across the diode is conducting now assume that at the time of completion. The average voltage of the transistor at an average of VX depends on the amount of time provided by the continuous flow inducement.

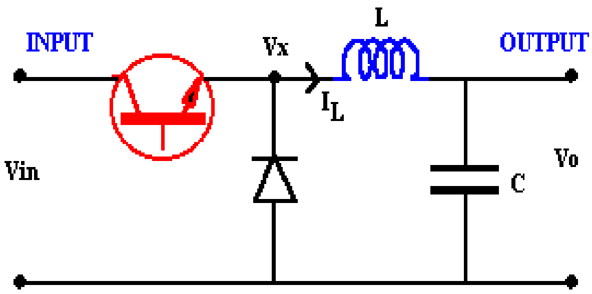


Fig-20:Buck Converter

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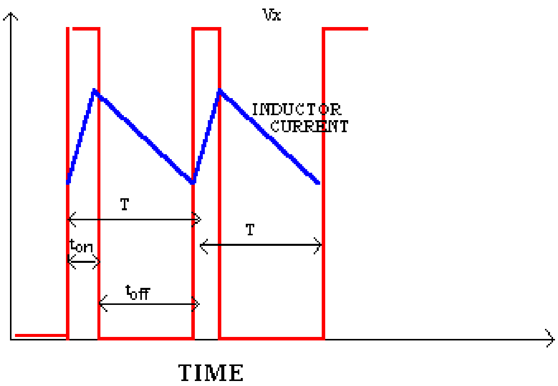

Fig-21:Voltage and current changes

2 BOOST CONVERTER STEP-UP CONVERTER

The schematic in Fig. 22 shows the basic boost converter. This circuit is used when a higher output voltage than input is required.

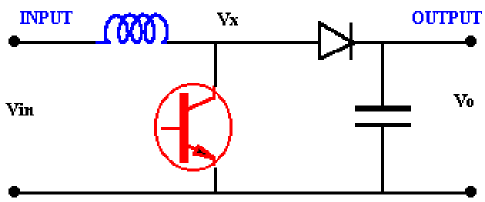

Fig-22: Boost Converter Circuit

While the transistor is ON $V_x = V_{in}$, and the OFF state the inductor current flows through the diode giving $V_x = V_o$. For this analysis it is assumed that the inductor current always remains flowing (continuous conduction). The voltage across the inductor is shown in Fig. and the average must be zero for the average current to remain in steady state

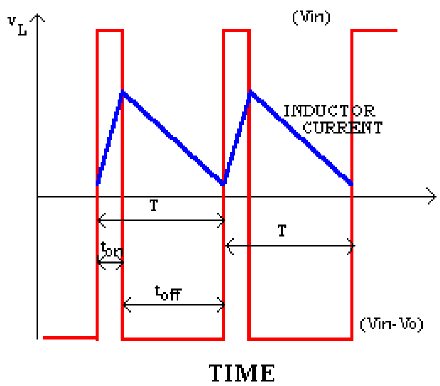

Fig 23:Voltage and current waveforms (Boost Converter)

Since the duty ratio "D" is between 0 and 1 the output voltage must always be higher than the input voltage in magnitude. The negative sign indicates a reversal of sense of the output voltage.

3 BUCK-BOOST CONVERTER

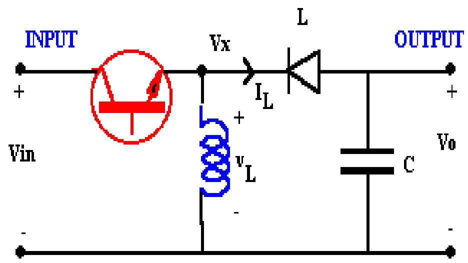

Fig-24:Schematic for buck-boost converter

With continuous conduction for the Buck-Boost converter $V_x = V_{in}$ when the transistor is ON and $V_x = V_o$ when the transistor is OFF. For zero net current change over a period the average voltage across the inductor is zero

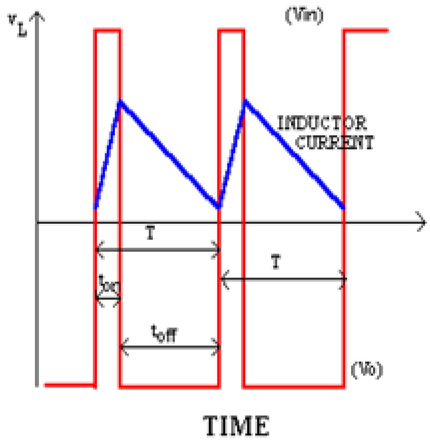

Fig 25:Waveforms for buck-boost converter

INTTRODUCTION TO AC MICRO GRID SOURCES

1 WIND ENERGY

So we can say that wind energy is a form of solar energy.

Wind power, like energy using wind turbines to make electricity in a useful form of energy, wind energy is converted to mechanical energy and air pumps for water pumping windmills for.

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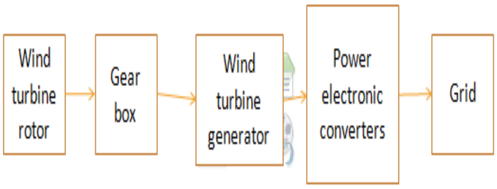
2 BLOCK DIAGRAM OF WECS



2.1 Turbine Model

A nacelle of a wind turbine and an electric generator mechanically connected to the two or more blades, a tower, a rotor is mounted. Mechanical Assembly on the high rotational speed gearbox and an electric generator wind turbine transforms the slow rotational speeds. The rotation of the shaft of the electric generator whose output is handled by the control system generates electricity. There are two types of wind turbines design models. The classification is made on the basis of their axis turbines which ro- tate: Horizontal Axis Wind Turbine (HAWT) and Vertical Axis Wind Turbine (VAWT). VAWT its [6], the inventor is named after the Darrieus rotor. HAWT time of day and the season, and their blades to collect the maximum amount of wind energy capacity can be adjusted to avoid a high wind storm. Operate in two modes, namely a fixed or variable speed wind turbines. For turbine at a constant speed, regardless of the rotor angular velocity of the wind is constantly changing variations.

ENERGY MANAGEMENT SYSTEM OF PROPOSED DC MICRO GRID

A 261 kW PV system at the power supply used in this study is the best radiation and temperature. Battery bank, SC PV module is operated in parallel. SC module and function of the battery bank to store extra power from the DC bus and then deliver it back in case of need. In addition, mismatches and the load of PV module and battery replacement SC tracking problems. A control scheme based on the exchange as shown in Figure 8. The music during the day, PV / SC / battery HRPS after sunset, using the development of the demands of the track

The algorithm controls the energy measure. Listed in Table 2 is based on the required investment, the proposed energy management system, power converter for the command signals to produce a pair of inputs / outputs of the components used in HRPS.

Table 1: Inputs/Outputs of proposed PMS

Symbol	Description
P_L	Residential Load Power
P_G	Grid Power
P_B	Battery Power
P_S	Super-capacitor Power
P_{PV}	PV Power
S_B	SOC of Battery
S_S	SOC of Super-capacitor
P_{BDR}	Battery Discharging Reference Power
P_{BCR}	Battery Charging Reference Power
P_{SDR}	Super-capacitor Discharging Reference Power
P_{SCR}	Super-capacitor Charging Reference Power
P_{GR}	Grid Reference Power

The operating strategies employed in the power management system are based on certain algorithm. This algorithm is described below.

Generalized Algorithm

1. All parameters are observed, i.e., PPV, PG, PL, PB, PS, SB and SS.
2. Check the condition , if it is true, then goto 1, otherwise goto next step.
3. Check the condition PL>PPV, if it is true, then goto next step else goto step 9.
4. Check TB>20%, if true, then discharge the battery and goto next step else goto 6.
5. Check the condition , if true, then goto next step, otherwise goto 1.
6. Check TS>20%, if true, then discharge SC and goto next step else goto 8.
7. Check the condition , if true, then goto next step, otherwise goto 1.
8. Apply all the remaining deficient power reference to grid and goto 1.

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9. Check TB>90%, if false, then charge the battery and goto next step else goto 11. 10. Check the condition, if true, then goto next step, otherwise goto 1.
11. Check TS>90%, if false, then charge the SC and goto next step else goto 13.
12. Check the condition , if true, then goto next step, otherwise goto 1.
13. Deliver all the remaining excess power to the grid and goto 1.

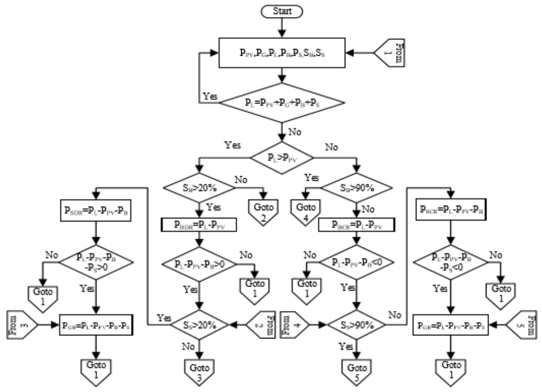

Fig. Flow Chart of proposed algorithm

SIMULATIONS AND RESULTS

All the simulations are carried out in MATLAB/Simulink environment.Figure 5.1 shows the simulation model of dc energy system. The model depicts the PMSG based wind energy conversion system in which a 9MW wind farm designed by using six 1.5MW wind turbines.The simulation configurations of both conventional and proposed techniques are depicted in the next coming figures.

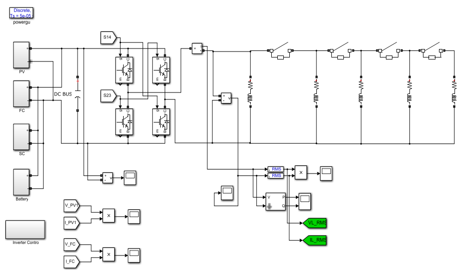

Fig. 5.1 Simulation of Dc Micro Grid

Figure 5.2 shows the simulation circuit of existed Individual Pitch Control technique for controlling the pitch angle.

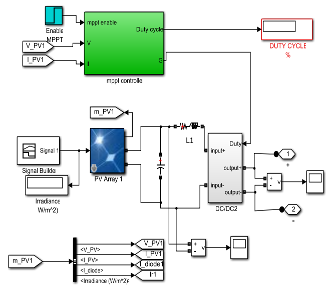

Fig. 5.2 Simulation of PV System

Figure 5.3 shows the proposed fuzzy logic controller based strategy to control the pitch angle of wind turbine

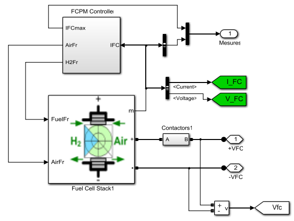

Fig. 5.3 Simulation Of Fuel Cell

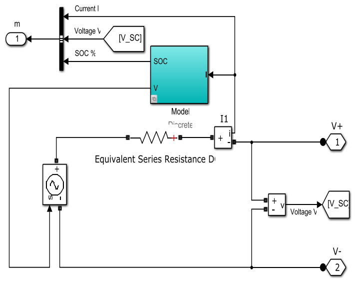

Fig.5.4 Simulation of Super Capacitor

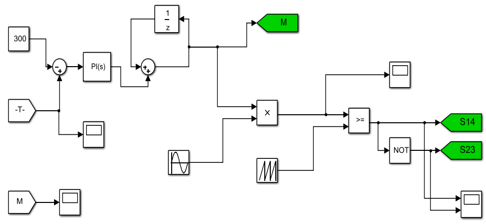

Fig.5.5 Inverter Control Simulation

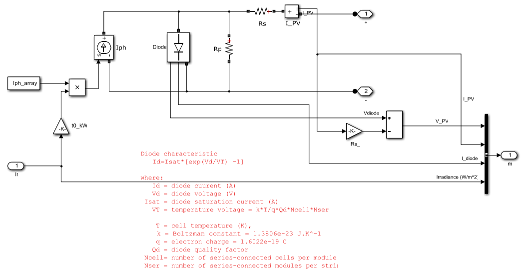

Fig.5.6 Simulation Of PV Array

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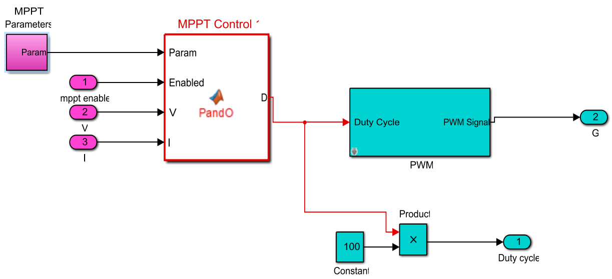

Fig.5.7 Simulation Of MPPT Controller

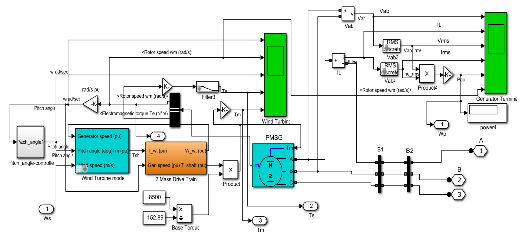

Fig. Wind Turbine Simulation Model

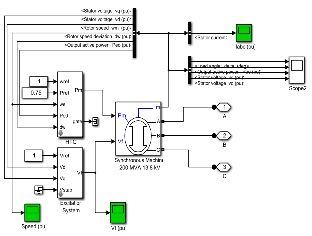

Fig. Hydro system Modeling

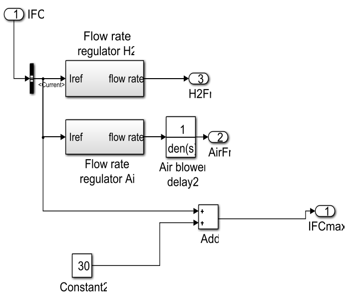

Fig.5.8 Fuel Cell Flow Rate Model Simulation

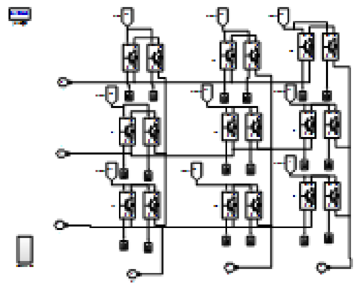

Fig. Matrix Converter Simulation Model

Fig. 5.4 Pitch angle, Active Power, Reactive Power, Rotor Speed, Grid Voltages and Currents with IPC

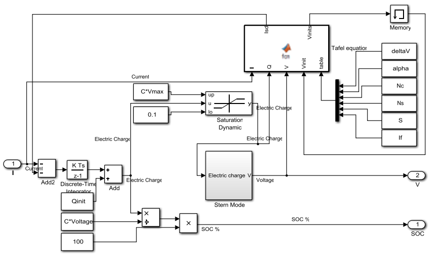

Fig.5.9 Super Capacitor (sub system)

Figure 5.4 shows the simulation results of Pitch angle, Active Power of PMSG based wind generator, Reactive Power of PMSG based wind generator, Rotor Speed and Grid Voltages and Currents with the conventional Individual Pitch Control.

Figure 5.5 shows the simulation results of Pitch angle, Active Power of PMSG based wind generator, Reactive Power of PMSG based wind generator, Rotor Speed and Grid Voltages and Currents with the proposed Fuzzy Logic Controller based control technique.

SIMULATION RESULTS OF AC GRID

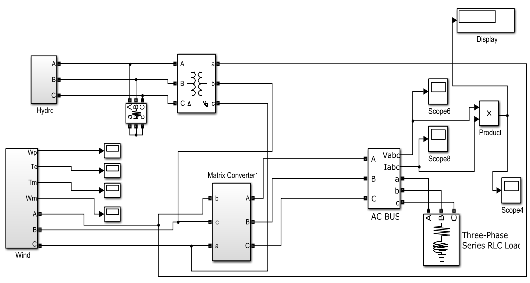

Fig. Ac Grid Simulation Model

SIMULATION RESULTS

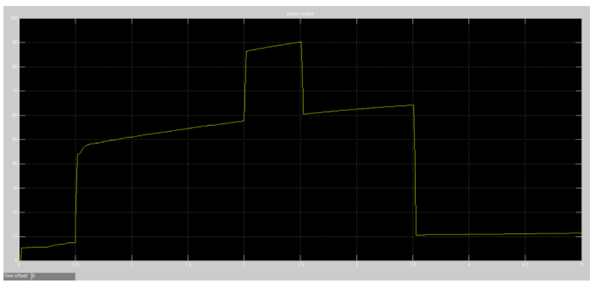

Fig. Power Output Of Dc Microgrid

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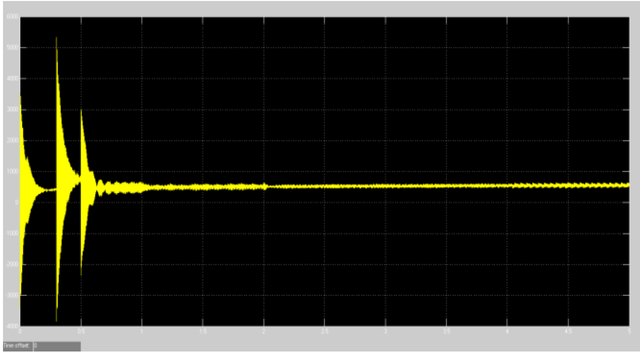

Fig. Output Power OfPv System

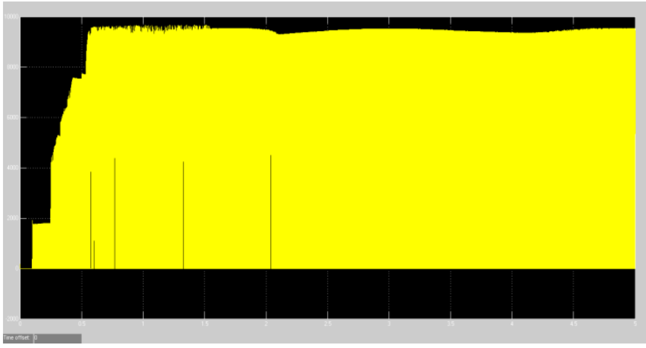

Fig.Output Power Of Fuel Cell

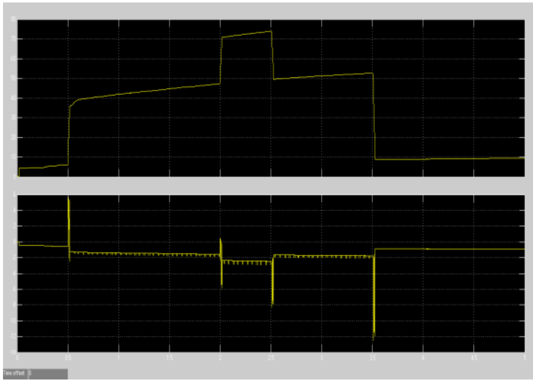

Fig. A)Real Power and B)Reactive Power

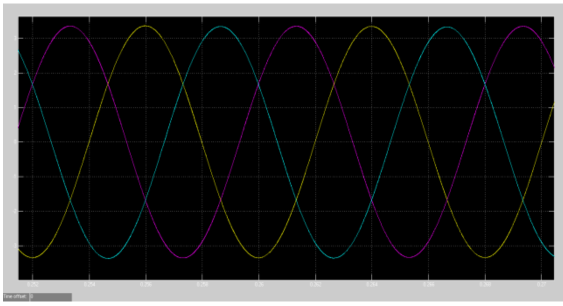

Fig.Three Phase Current Output Of Ac Microgrid

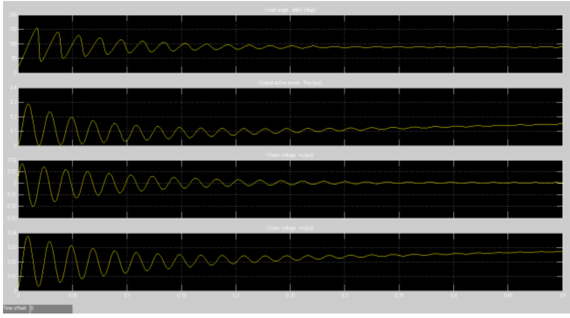

Fig. a)Load angle(deg) b)Output Active Power(pu) c)Stator Voltage(v_d) (pu) d)Stator Voltage(v_q) (pu) of hydro power system

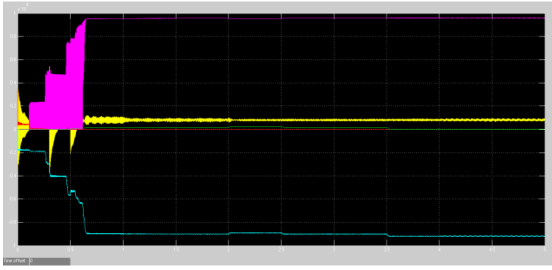

Fig. Power Output Of Pv, Fc, Sc,Battery And Load Power

CONCLUSION AND FUTURE SCOPE

Conclusion

This thesis was a comparison between two different methods to control the pitch. The traditional individual pitch control, pitch control, a technique based on fuzzy logic controller has been replaced by. To reduce flicker emission, the IPC is a control scheme in the past. This paper DFIG-based wind energy conversion fuzzy logic control for the pitch angle of the implementation of the proposed regulation.

Fuzzy logic control is mamdani 25 design rules, which effectively controls the angle of the pitch to get a good response and voltage of power generation is maintained constant value. Simulation and modeling of the proposed model Matlab / Simulink software is designed. Simulation results show the fuzzy controller effectively controls the angle of the wind turbine pitch. And it is also observed that the proposed fuzzy controller is more effective than the traditional IPC scheme.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Future Scope

- The work presented in this thesis, the following extensions DFIG-based wind energy systems, as more and more activities to be undertaken in relation to the description of unbalanced load conditions to operate them DFIG-based wind energy systems with a focus on the development of control strategies for each component.
- Other types of renewable energy systems (eg solar photovoltaic) Integration of DFIG-based wind energy to the stem.

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