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Analysis of Energy Management System with Connected DC Micro Grid

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Abstract – Microgrid is the combination of distributed energy resources (DER), distributed storage (DS) and load. The growing need of electrical energy can be fulfilled by harnessing energy from renewable energy sources (RES) along with conventional sources of energy. By understanding need of electricity and available energy sources and storage, energy management can be done. The task of Energy Management System (EMS) is to manage the energy between source and load. Micro grids are able to integrate distributed renewable energy, take advantage of renewable sources, provide higher power reliability, reduce electricity transmission loss, and decrease greenhouse gas emissions. The study considers solar power, wind power, fuel cell generators, power storage and electricity demand in micro grid system. An optimization model of the micro grid system is proposed and the optimal operating strategy of the system is presented.

Keywords: Microgrid, Distributed energy resources, energy management system, solar power, wind power, matlab7.8

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1. INTRODUCTION

An electric power industry is in the mid of a critical period in its evolution. Large scale changes in both transmission and distribution levels are expected to occur in the near future. Power generation is the key factor to determine the economic growth and industrial development of any country. Indian power sector is facing number of challenges and despite significant growth in generation over the years; it has been suffering from shortages and supply constraints. To meet the energy challenge and create a 21st century energy economy, we need a 21st century electric grid. In distribution levels, many smaller renewable generators are connected to the network. Fossil fuels are non-renewables, they draw on finite resources that will eventually dwindle, becoming too expensive or too environmentally damaging to retrieve. This forces the use of many types of renewable energy resources – such as wind and solar energy. Renewable energy sources are used so as to reduce the pressure on the current sources of energy. At the moment, the use of renewable sources will prevent destruction of the environment.[3]

1.1 Components of Micro Grid

1. Distributed Energy Resources.

Distributed energy resource (DER) systems are small-scale power generation technologies accustomed give an improvement of the conventional power system [2] Distributed Energy Resources (DER), with distributed generation (DG) in addition to distributed storage (DS), be the springs of energy situated near local loads then can give a variety of profit together with superior reliability. If they are appropriately worked during the Electrical distribution system micro grids are system that has a minimum of one distributed energy resource plus associated load create intentional islands within the electrical distribution system. Within small grids, loads and energy sources may be disconnected after and reconnected to the area or native electrical power system with smallest disruption to the local loads.[5]

2. Distributed Generation (DG)

DG technologies usually embrace photovoltaic (PV), wind, fuel cells, small turbines, and reciprocator combustion engines with generators. These systems perhaps driven by any fossil otherwise renewable sources some sorts of DG

may give combined heat plus power by recovering a number of the waste heat generated by the supply like the small turbine .this cab considerably rise the useful of the DG unit.

3. Distributed storage (DS)

Distributed storage technologies are used in micro grid application where the generation with loads of the micro grid cannot be accurately coordinated. Distributed storage offers a link in gathering the power and energy desires of the micro grid .storage capability is outlined in terms of the time that the small energy capability can cover the load at rated power. Storage ability can be then characterized in relations of energy density needs (for middle- as well as long-standing needs) otherwise in terms of power density requirements (for little- and very little-term needs). [6]

4. Power Electronic Interface

Most of the DG technologies need a power electronics interface so as to transform the energy into grid-well-matched ac power. The power electronics interface contains the required electronic equipment to transform power from one kind to a different. These converters could contain in cooperation of rectifier plus an inverter or an inverter. The essential output filters are also present the power electronics interface alsocan contain protecting functions for each the distributed energy system and also the local electrical power system that enable paralleling and disconnection from the electrical power system. These offer a distinctive capability the DG units and can improve the actions of a micro grid.[4]

5. Power Flow Controller

Controller is the greatest important component in micro grid to have controlled power flow. It is obligatory to match load with generation in together islanded mode and grid connected mode. It plays significant part in optimizing integration with dispatching plus control of DER and loads.[8]

6. Communication Interfaces

Communication interfaces along with power flow controllers, are obligatory to have optimized operation in addition to control of DERs and loads. Monitoring of real time network status requires fast and secure communication.

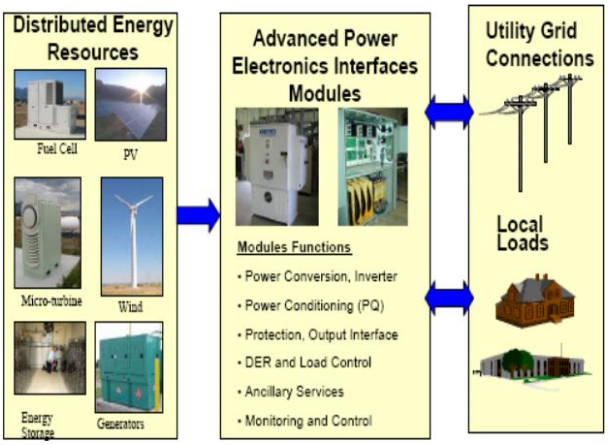

Figure 1.1 Components of Microgrid

II. PROBLEM IDENTIFICATION AND METHODOLOGY

2.1 Problem Identification

The multiplicity of micro grid distributed sources is increasing and their positions are also getting huge and huge decentralized, which resulted in the monitoring of the micro grid is big and big complex. At present, have multiplicity of issues with the micro-grid energy management system.[7]

Since there are so many intermittent power supply in the distributed power , for example solar energy, wind energy, tidal whose generation are affected by the weather and season apparently, they presents lots of unpredictable problems which is bad for micro grid to provide power steadily. The involvement of renewable in total electricity demand is around 20.8 percent worldwide according to International Energy agency.

III. SIMULATION MODEL OF DC MIGROGRID

The simulation of dc micro grid containing following components which essential to be simulated first,

1) PV model

2) WTGS model

3.1 PV Model

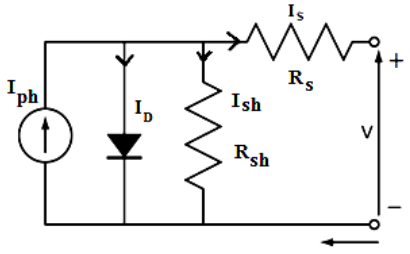

Fig. 3.1 circuit of solar cell

The photovoltaic cell is denoted by one-diode model, as shown in dia. 3.1. The one diode model contains a current spring, and series resistance. The operating equation relating the I-V features of a PV cell derived from figure is written as the dissimilarity between the photocurrent with the normal diode current

3.2 Wind Turbine Generator System Model in Simulink

Shows the simulation model of wind turbine generator system, which consist of permanent magnet dc generator (PMDC) for dc output. The evaluation of the machine is 36 V, 1000 Watt. Here also the physical model transformed addicted to an electrical equivalent by using voltage sensor and controlled voltage source.

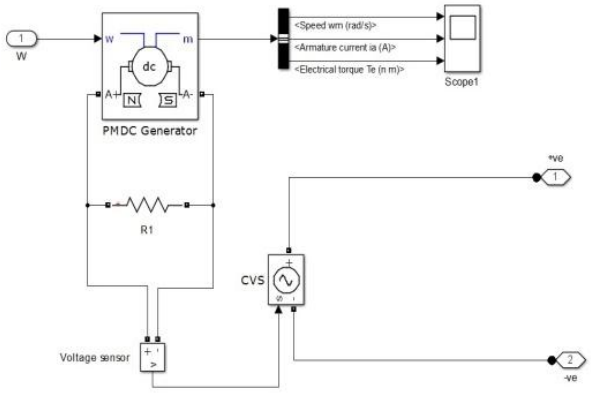

Fig. 3.2 Developed Wind Turbine generator model

3.3 Micro grid Model

As shown in Fig. the whole simulation model of dc micro grid which is made up of a string of photovoltaic array, wind turbine generator (PM DC generator), Battery storage system, grid plus load. PV array plus wind turbine generator each of 1kW in addition to constant voltage blocked loop boost converter to facilitate step up the PV array voltage as of 24V to 48V are coupled to the dc bus of 48V. Lithium ion battery of 180 Ah, 48V is used on behalf of energy storage space using charging .discharging controller. The rectified voltage of grid is allied to the dc bus throughout static switch to provide power at any time needed. Resistive load of 2kW is provided from dc bus beyond which 500W of critical load.

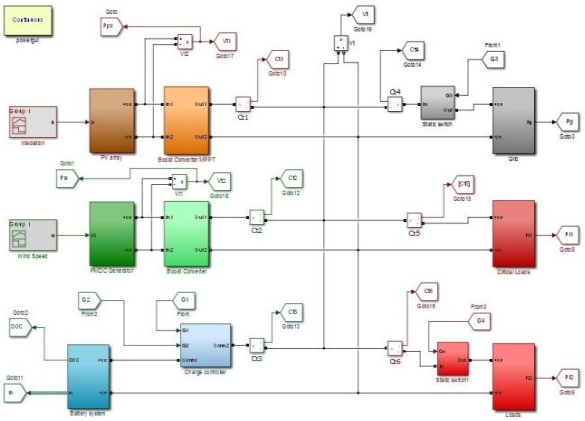

Fig. 3.3 Simulation model of micro grid

IV. SIMULATION RESULTS

Simulation results are illustrated for variable generation and load, in which the forecasting data of solar irradiation also wind, are expected to be changeable for the day. The generated power from PV and WTGS are plotted on the same axis, with solar radiation changesfrom500 to 1000W/m^2 plus wind speed changes between 30 to 60 rad/sec of angular speed moreover approximately 2 to 5 m/sec linear speed. The simulation is run for 0.1 s

4.1 Condition: 1 Battery Charging

Condition 1, is for battery charging in which the SOC of battery is considered to be 0.3 (30 percent) and variable load coupled to the scheme is between 400W to 1200W. Whenever the load is fewer than generation battery will charge by triggering stationary button of charge controller, additional power generated by the renewable sources will charge the battery. Fig.4.1 shows generated power plus load and Fig.4.2 shows battery parameters that is SOC, battery voltage along with current. From 0.05 s battery force initiate charging because required voltage will develop at this point.

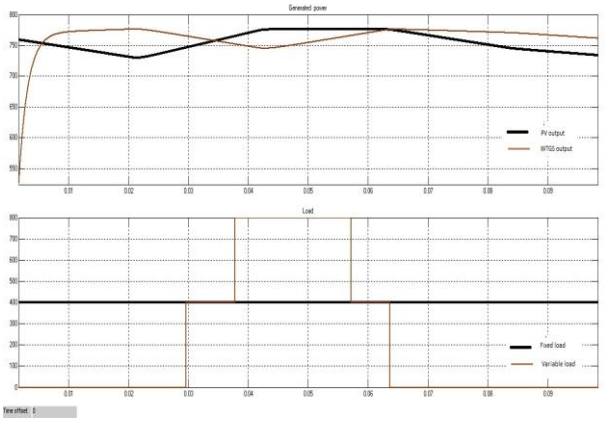

Fig.4.1 Condition 1 Generated power and load while battery charging

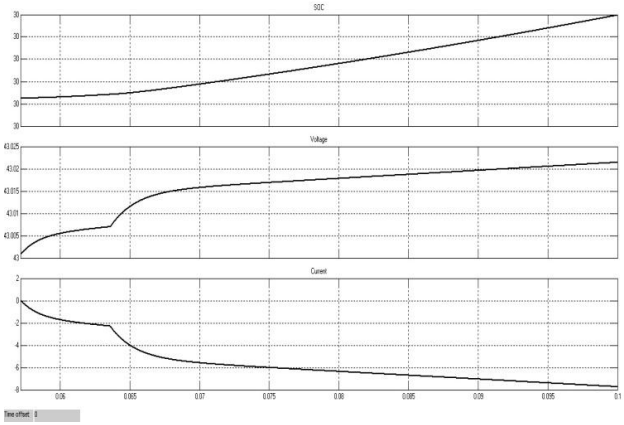

Fig.4.2 Condition1 battery parameters while charging

4.2 Condition: 2 Battery Discharging

Condition 2, is for battery discharging in which the SOC of battery is considered to be above 0.5 (50 percent). Whenever load is higher the generation needs an additional power to complete the load that extra power is getting from the battery. The generated power since renewables is 200 watts to 900 watts and connected load is around 1700 watts. Therefore the additional power needed to supply load is now taken from battery.

Fig.4.3 shows the graph of generated power along with load and Fig.5.4 shows Battery parameters. At simulation time 0.01 seconds, the load increase that is exceeds the generation then battery supplies extra power.

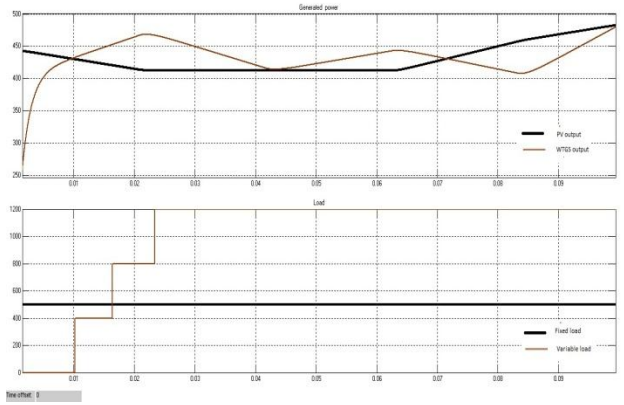

Fig.4.3 Condition 2 generated power and load while battery discharging

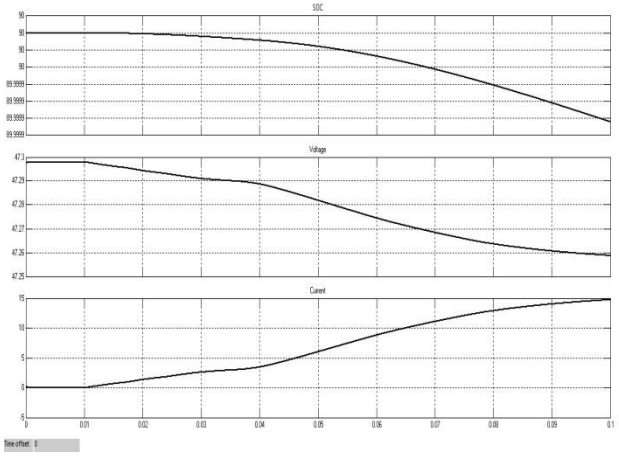

Fig.4.4 Condition 2 battery parameters while discharging

4.3 Condition: 3 Supply Taken From Grid

In condition 3, load is greater than generation and battery SOC isfewer than 0.5 (50 percent), then to supply load power is taken from grid by triggering motionless key connected between dc bus and utility grid whose resultant is dc 48 V.The generated power at this condition is 100 watts to 1400 watts and connected load is from 500 watts to 1700 watts.

At simulation time from 0.015 seconds the connected load is higher the generated power, renewables and battery is insufficient to supply increased load, so the required power is suppled by enableing grid. Fig. 4.5 shows generated power along with load and Fig.5.6 shows battery parameters. 7.

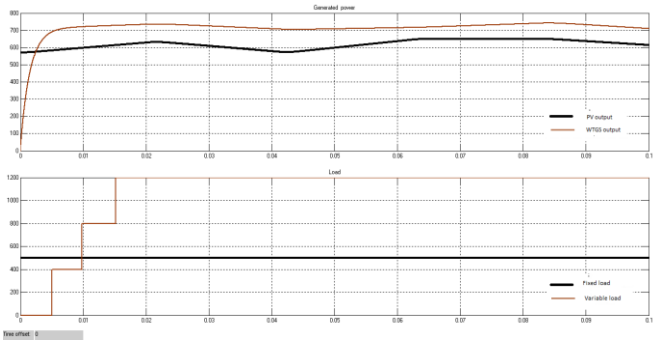

Fig.4.5 Condition 3 generated power and load while supply taken from grid

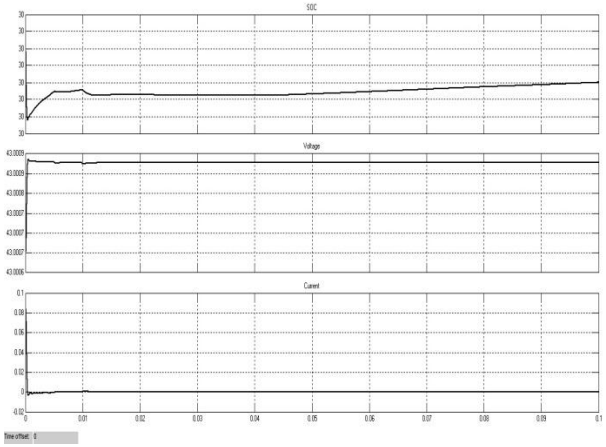

Fig.4.6 Condition 3 battery parameters while supply taken from grid

V. CONCLUSION AND FUTURE SCOPE OF WORK

The following conclusions can be tense from the simulation results:

The Simulation is accomplished for following conditions:

1) PV and WTGS both maximum and battery charging

2) PV and WTGS both minimum and battery discharging

3) PV and WTGS both average and power taken from grid

4) PV maximum and WTGS minimum

5) PV minimum and WTGS maximum

6) PV and WTGS both minimum and grid inadequate to supply, shut down some load.

From the results obtained it is concluded that,

1) The proposed system is capable to supply power to load with effective consumption of renewable energy sources such as PV and WTGS.

2) If sum of power obtainable from renewable energy sources is insufficient, then the required power is taken from grid to given the connected load.

3) Also if grid power is not sufficient, some of loads is switched off by the EMS automatically and only critical load is supplied.

The future scope in the area can be as follows,

4) Investigation of Safety and shield of micro grid

5) Development of micro grid in addition to bidirectional power flow with grid

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