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Hybrid Energy Management System based on Fuzzy Logic Controller for Power Distribution

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Abstract: The Paper presents a Energy Management System based on Fuzzy Logic Controller designed for the online operation of an small grid equipped with four power supplies: Wind Mill Power, Photovoltaic emulator, Fuel Cell and Electric Power these connected to small grid. The connections of the energy sources to the common dc bus make use of power inverters with specific functionalities. The DC voltage is inverted to AC node. The AC node feeds electric active and reactive load. The automatic energy management system provides based on load basis. In this system load is not enough means that time load shared with other power supplies. This paper describes the structure and functionalities of the EMS and dynamic performance of the small grid with load sharing conditions.

Key Words: Wind Mill, Photovoltaic Emulator, Fuel cell, Electric Power, Fuzzy Logic Controller, Energy Management System.

I. INTRODUCTION:

The Distributed Generation is continuity of service and in increased customer participation to the electric market. The Literature on the subject defines the energy management system is fully depended on load basis. The additional researches efforts appear to be needed in order to develop automotive system suitable for residential applications able to take into account the specific technical characteristics and constraints.

An Energy Management System is a system of Computer Aided tools used by operators of electric utility grids to monitor, control and Optimize the performance of the generation and / or transmission system. The Monitor and control functions are known as SCADA. The computer technology is also referred to as SCADA/ EMS , the EMS is suited for power network application and to the generation of control and scheduling applications. The EMS are also often commonly used by individual commercial entities to monitor, measure and control their electric building loads .

Electric Power Transmission is the bulk transfer of electrical energy, from generating power plant to electrical substations. The Combined transmission and distribution network is known as the power grid. Distributed Generation allows collection of energy from many sources and may give lower environmental impacts and improved security of supply.

An Energy management system has been developed and implemented in to a fuzzy logic controller for the power scheduling based on load. This paper aims to describing the above mentioned EMS with particular focus on its implementation into a dedicated fuzzy logic controller with load sharing based on load. The structure of the paper includes five sections , Section-II describes the circuit and section-III describes three phase measurement , section-IV is the experimental result , section-V presents the conclusion of the paper.

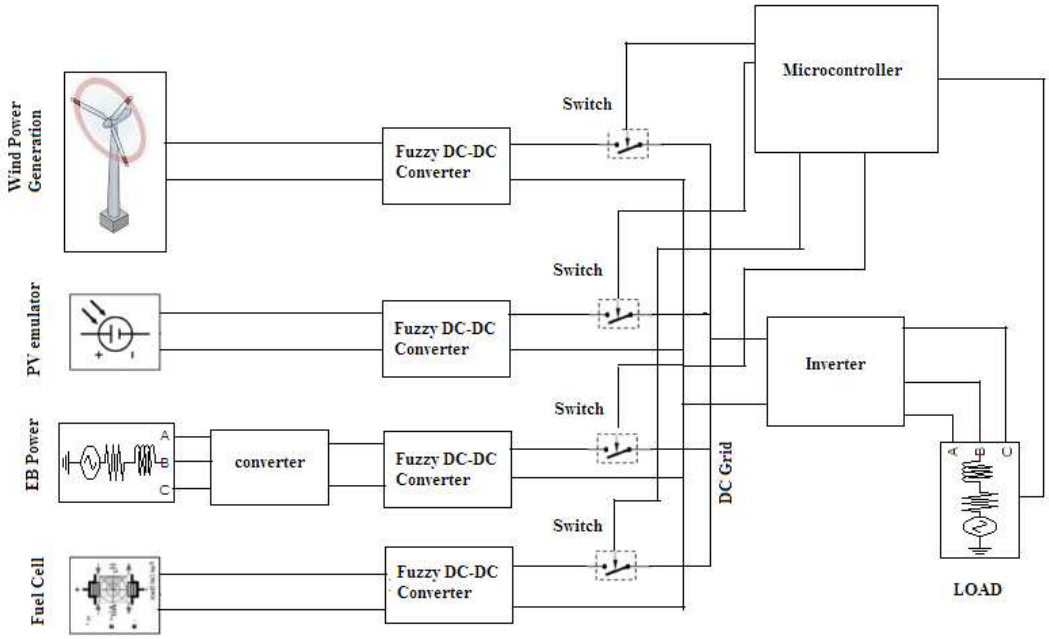


Fig.1. shows the block diagram of energy management system

II. CIRCUIT DESCRIPTION:

Wind Power:

Wind power is the conversion of wind energy into a useful form of energy, such as using wind turbines to make electricity . Large wind farms consist of hundreds of individual wind turbines which are connected to the electric power transmission network. Wind is an inexpensive source of electricity comparable with other energy sources, it is an renewable energy and occupy small space , wide distributed and does not produce the green house gas emission during the operation . 83 countries around the world are using wind power to supply the electricity grid.

World wide wind generation capacity more than quadrupled between 2000 and 2006, doubling about every three years. The development of wind power in india began in the 1990s, and has significantly increased in the last few years. India has the fifth largest installed wind power capacity in the world . In 2009-10 India's

growth rate was highest among the other top four countries . With the peak wind power generation at close to 7000MW, Tamilnadu is one of the wind power hubs of south Asia. Tamil Nadu generates 40% of india's wind power . Small onshore wind specialties are used to provide electricity to isolated locations and utility companies increasing by back surplus electricity produced by small domestic wind turbines. Fig.2.shows the wind power generations.

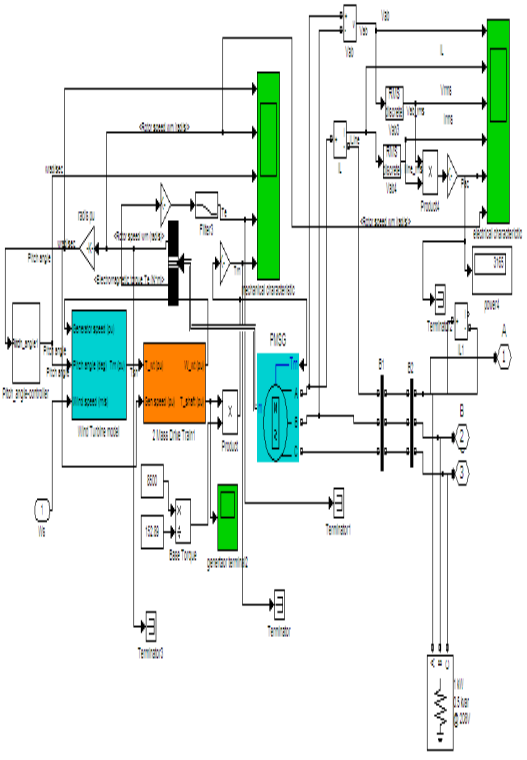


Fig.2.Wind power generations

In this system torque value is T=12 are given manual input to the wind turbine. Fig.3.shows the wind power electrical characteristics output.

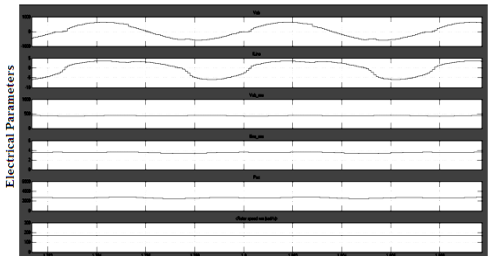


Fig.3.Wind power electrical characteristics

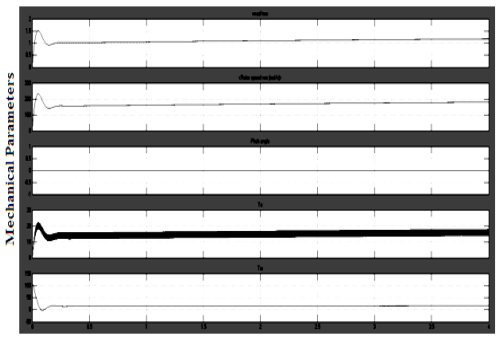


Fig.4.Wind power mechanical characteristics

Photovoltaic System:

Photovoltaic system use solar panel to convert sunlight into direct current electricity . A system is made up of one or more solar photovoltaic panel, a DC/AC power a tracking system that holds the solar panels, electrical interconnections and mounting for other components . Optionally it may include a maximum power point tracker (MPPT), battery system and charger. The number of modules in the system determines the total DC watts capable of being generated by the solar array, however the inverter ultimately governs the amount of AC watts that can be distributed for consumption. A Small PV system is capable of providing enough AC electricity to power a single home . Large grid-connected photovoltaic power system are capable of providing an energy supply for multiple consumers. The electricity generated can be stored , used directly fed into a large electricity grid powered by central generation plants . Systems are generally designed in order to ensure the highest energy yield for a given investment . Fig.5. shows the voltaic system .

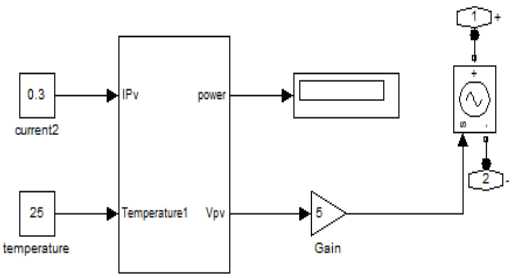
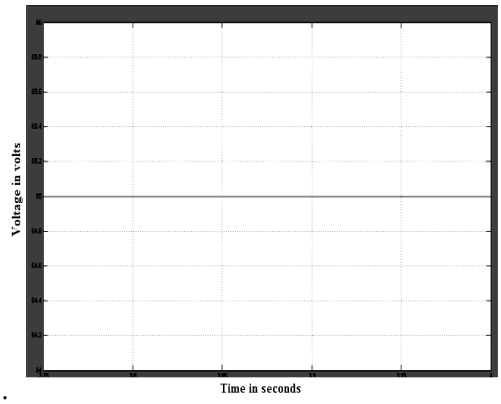


Fig.5. Circuit diagram for PV System

Fuel Cell:

A fuel cell is a device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent .Hydrogen is the most common fuel, but hydrocarbons such as natural gas and alcohols like methanol are sometimes used. Fuel cells are different from batteries in that they require a constant source of fuel and oxygen to run, but they can produce electricity continually for as long as these inputs are supplied .

There are many types of fuel cells, but they all consist of an anode (Negative side) a cathode (Positive side) and an electrolyte that allows charges to move between the two sides of the fuel cell. Electrons are drawn from the anode to the cathode through an external circuit, producing direct current electricity . Fig .6. Shows the fuel cell output voltage



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Fig;6 Fuel Cell voltag

III. THREE PHASE V&I MEASUREMENT:

The three phase V&I Measurement block is used to measure instantaneous three – Phase voltages and currents in a circuit. When connected in series with three – phase elements , it returns the three phase –to-ground or phase –to- phase peak voltages and currents . The block can output the voltages and currents in per unit(Pu) values or in volts and amphere.

If you choose to measure phase-to-ground voltages in per unit, the block converts the measured voltages based on peak value of nominal phase-to-ground voltage .

$$V\,abc(Pu) = \frac{V\text{phase to ground }(V)}{V\text{base }(V)}$$

Where

$$V\text{base} = \frac{V\text{norm}(V\text{rms})}{\sqrt{3}} . \sqrt{2} \qquad (2)$$

If you choose to measure phase –to-phase voltages in per unit, the block converts the measured voltages based on peak value of nominal phase-to-phase voltage .

$$Vabc(pu) = \frac{Vp - to\ p(V)}{Vbase(V)} \quad (3)$$

Where

$$Vbase = Vnorm(Vrms).\sqrt{2} \quad (4)$$

If you choose to measure currents in per unit, the block converts the measured currents based on the peak value of the nominal current .

$$Iabc(pu) = \frac{Iabc(A)}{Iphase(a)} \quad (5)$$

Where

$$Vbase = Vnorm(Vrms).\sqrt{2} \quad (6)$$

Vnorm and Pbase specified in the three –phase Vand I Measurement block dialog box.

The steady state voltage and current phasors measured by the three phase V-I measurement block can be obtained from the powergui block by selecting stedy – state Voltages and currents . The Phasor magnitude displayed in the powergui stay in peak or RMS values even if the output signals are converted to pu.

IV.EXPERIMENTAL RESULTS

This section presents the experimental results of the proposed circuit in order to illustrate the energy management system by using fuzzy logic controller. In this system used hybrid system based Energy management system. All systems are connected in DC grid. Finally the dc voltages is converted the AC voltages.AC power is act as a load. Here load sharing operations is activated. That experimental result is given,

Fig.7.shows the results for particular time availability of load is 1000 watts, at the time current and voltage value becomes 0.65 and 240V respectively.

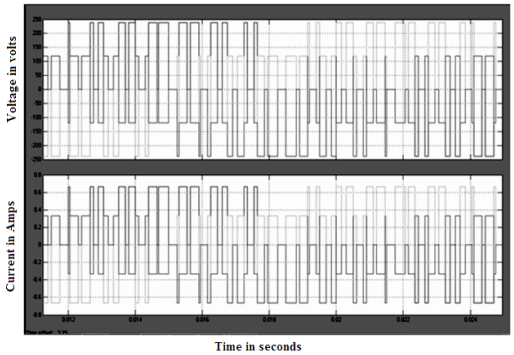

Fig.7.Output Result (1000w)

Fig.8.shows the results for particular time availability of load is 2000 watts, at the time current and voltage value becomes 1.4A and 240V respectively.

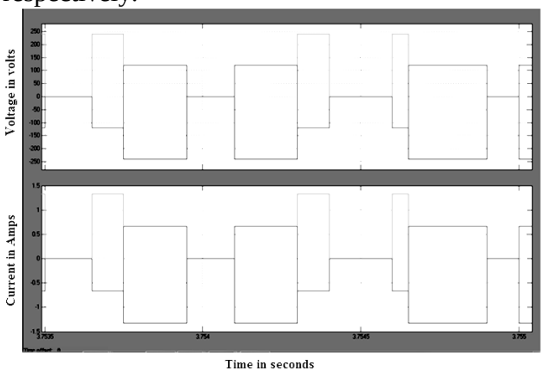

Fig.8.Output Result (2000w)

Fig.9.shows the results for particular time availability of load is 3000 watts, at the time current and voltage value becomes 2A and 240V respectively.

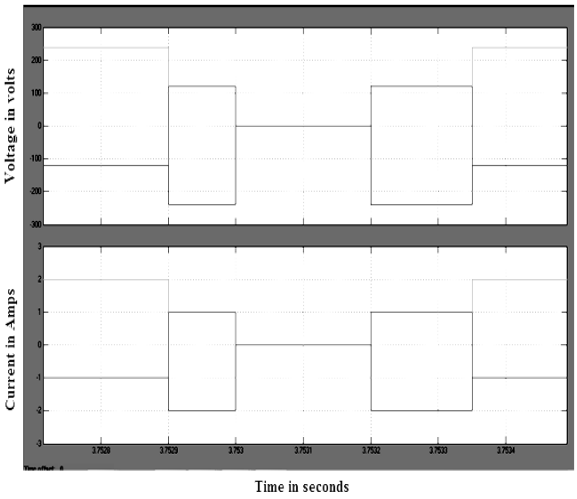

Fig.9.Output Result (3000w)

It depends on the load based energy management system.

V.CONCLUSION

The energy management is fully depends on load basis. Primary side all energy sources are connected together to form a small grid. If the solar power is not enough to the load means, the other energy sources (Wind Energy, Fuel Cell, Three phase) distribute the power to the load based on fuzzy logic controller. Hence no power wastage is occurred in this technique.

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