

## Hybrid Integrated Solar and Wind System Connected With Grid Comparison of Fuzzy and Pi Controller

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**Abstract:** The rising concern of global warming and the depletion of fossil fuel reserves, many are looking at the sustainable energy solutions to preserve the earth for the future generations. Eco-friendly solutions are becoming more prominent than ever as a result of regarding the state of our deteriorating planet. In this paper one of the alternate ways for the power generation, this is clean and economical for the future generation. The two sources which are used for power generation are solar and wind. DC output of photovoltaic panel and rectified dc output of Wind energy conversion system (WECS) is fed to the boost converter which is operating in closed loop in-order to maintain constant output power in any environmental condition. It consists of wind turbines with permanent magnet synchronous generator (PMSG). The output of boost converter is feed to the common dc link which is connected to the three phase Sinusoidal pulse width modulation (SPWM) inverter, which converts its dc input to three phase AC output. Simulation work or result obtained by MATLAB/simulink.

**Keywords:** PMSG-wind-solar-hybrid-boost converter-fuzzy controller-PI controller

### I. Introduction

The critical condition of industrial fuels which include oil, gas and others, the development of renewable energy sources is continuously improving. This is the reason why renewable energy sources have become more important these days. Few other reasons include advantages like abundant availability in nature, eco-friendly and recyclable. many renewable energy sources like solar, wind, hydro and tidal are there. Among these renewable sources solar and wind energy are the world's fastest growing energy resources. With no emission of pollutants, energy conversion is done through wind and PV cells. The main motivation of our work is to generate Electricity in eco-friendly way. The electricity is generated from either thermal power station or hydro power plant. In thermal power plant coal is used as a prime source of generation and we also know about the degradation in the production of coal in recent year and their chances of extinction in near future, and also this method of electricity generation generates a lot of pollution and contributes to the global warming. Talking about the hydro power plant this kind of power plant has very high initial cost and a lot of risks in this kind of generation. Energy demands day by day due to the increasing population and industrialization but we have limited resources, in this critical stage of energy crisis. We have to look for alternative way of power generation. Solar and wind are clean and renewable energy sources and also there installation is not that costly, there is only one time investment and we can save a lot of money and prevent global Warning. A hybrid system is more advantageous as individual power generation system is not completely reliable. When any one of the system is shutdown the other can supply power.

### II. Existing System

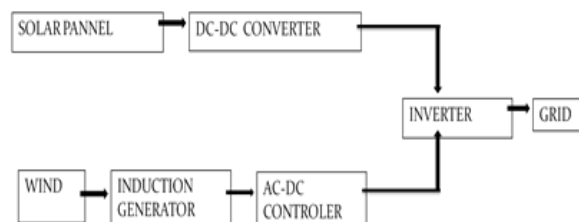


Figure: 2.1 Block diagram of existing system

### III. Proposed System

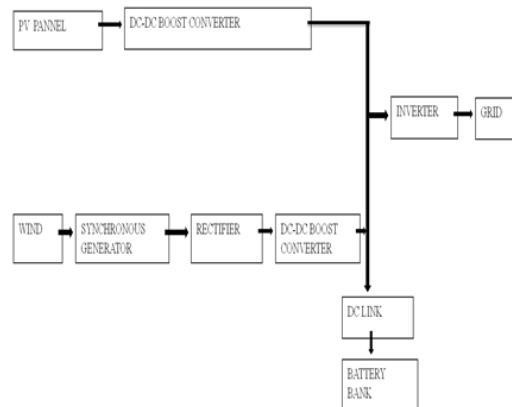


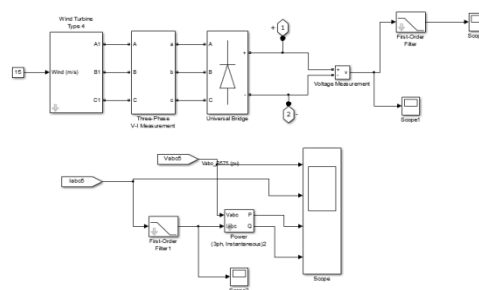
Figure: 3.1 Block diagram of proposed system

A **permanent magnet synchronous generator** is a generator where the excitation field is provided by a permanent magnet instead of a coil. The term synchronous refers here to the fact that the rotor and magnetic field rotate with the same speed, because the magnetic field is generated through a shaft mounted permanent magnet mechanism and current is induced into the stationary armature. In the permanent magnet synchronous generator, the magnetic field is obtained by using a permanent magnet, but not an electromagnet. The field flux remains constant in this case and the supply required to excite the field winding is not necessary and slip rings are not required. All the other things remain the same as normal synchronous generator.

It consists of 1kW PMSG based wind energy conversion system and 2kW solar array. The individual boost converters are used to control the flow of power to the load. Two sources are connected in parallel to a common DC bus line. The output of this common DC link is connected to a three Phase SPWM Inverter. Power will be generated with the help of both photovoltaic & wind energy and will be supplied to the same bus bar from where power is supplied to the load. Power flow scheme can be observed as PV array to DC/DC Boost converter to Common DC link. And for wind energy, Power flow can be observed as Wind energy to Turbine to PMSG to Rectifier to Boost Converter to Common DC Link. Common DC link voltage is given as an input to the 3 phase SPWM Inverter. Boost converter is operating in a closed loop to maintain the constant DC output voltage.

### IV. Simulation Circuit And Results

#### 4.1 Circuit Simulation for Wind Energy System



This is outline line diagram of wind energy conversion system. The wind turbine is rotate at constant speed, the constant speed maintained at 15(ms). The voltage measurement is used to measure the voltage. The first order filter is used to filter the unwanted signals in the current. The rectifier is used to convert AC current to DC current, this dc current is mingle with output DC current of solar energy

### 4.2 Circuit Simulation for Solar Energy System

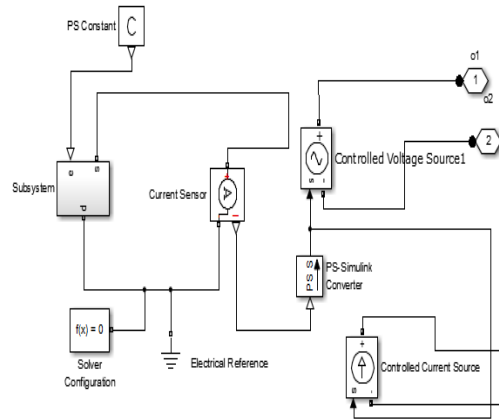


Figure: 4.1 Circuit diagram for solar energy

This diagram shows how the solar array produces dc current. Then the dc current is fed to the boost converter.

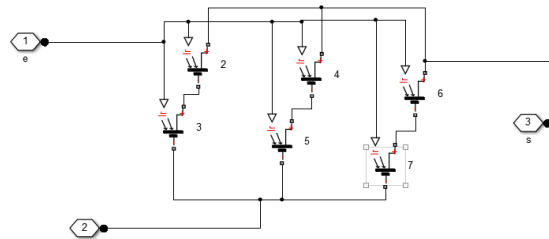


Figure: 4.2 circuit diagram for solar cell

### 4.3 Circuit Simulation for Boost Converter

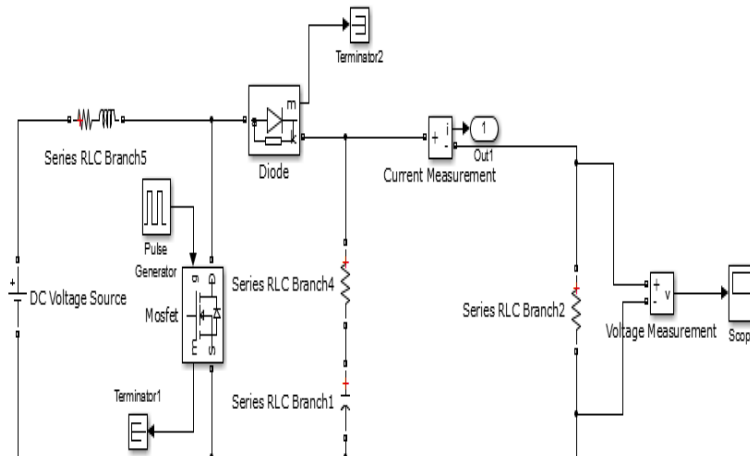


Figure: 4.3 Circuit diagram for boost converter

#### 4.4 Circuit Simulation for Spwm Inverter

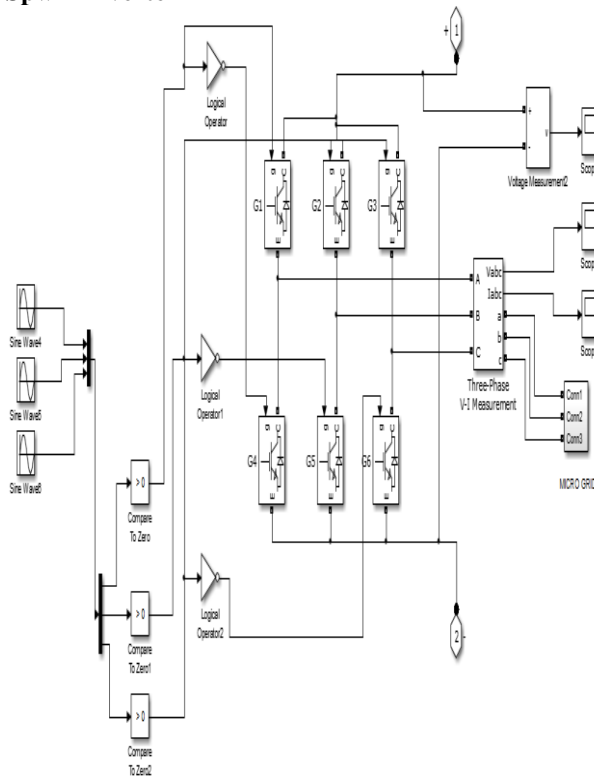


Figure: 4.4 circuit diagram for SPWM inverter

#### 4.5 Circuit Simulation for Proposed System with Pi Controller

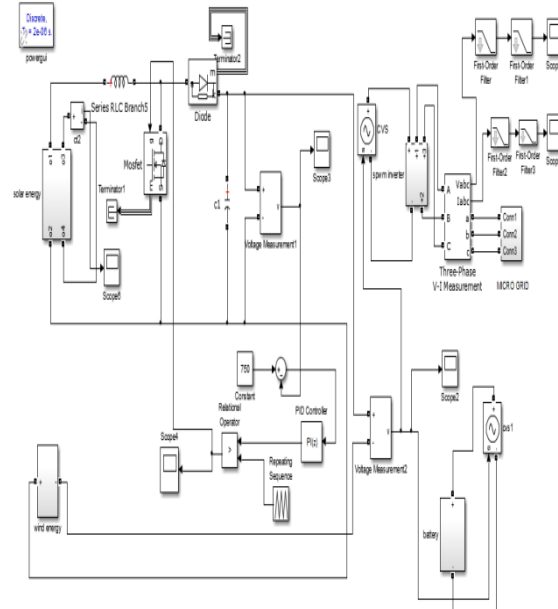


Fig 4.5 circuit diagram for proposed system using pi controller

4.6 Circuit Simulation for Proposed Systems with Fuzzy Controller

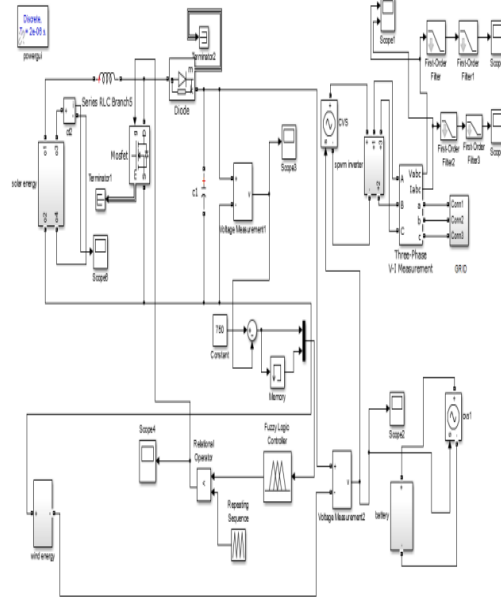


Fig 4.6 circuit diagram for proposed system using fuzzy controller

V. Results

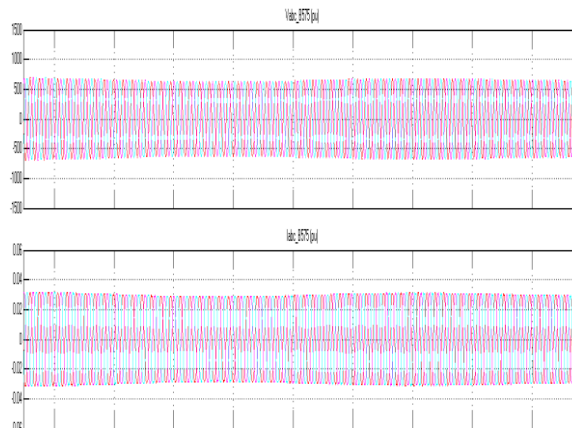


Figure: 4.7 AC Voltage and current waveform for wind

This waveform shows that the output voltage of the wind is 0.5kw, and the output current is 0.3ams in (pu). Then the ac current is converted into dc current.

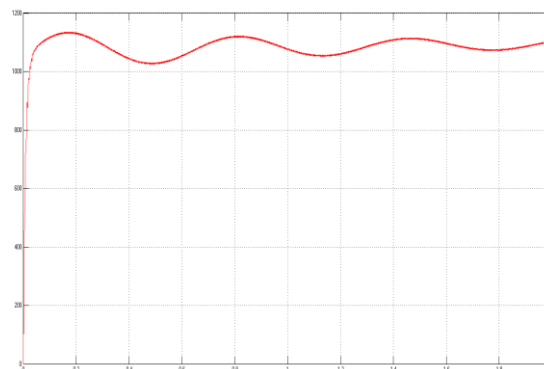


Figure: 4.8 DC voltage wave form for wind

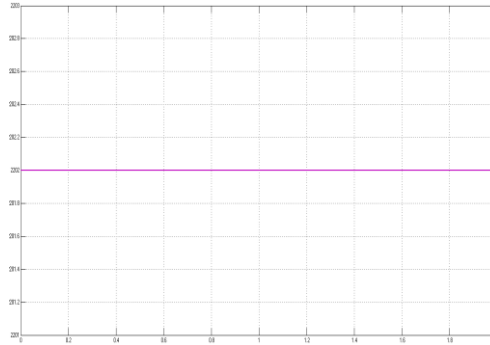


Figure: 4.9 solar output waveform

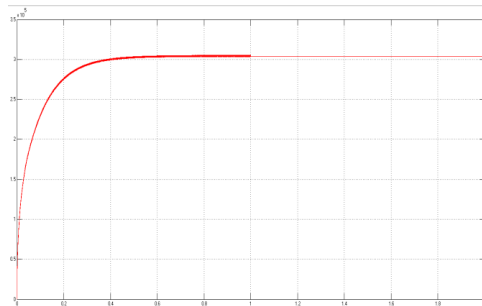


Figure: 4.10 boost converter output waveform

This waveform shows that it produces 300kw voltage from the input of common dc link of solar and wind energy. Then this dc current is fed to the SPWM inverter to convert the ac current.



Figure: 4.11 voltage and current output waveform for SPWM inverter

This waveform shows that the voltage and current values of the SPWM inverter, the obtained voltage is 200kw and the obtained current is 20kw. Then this output is supply to the micro grid.

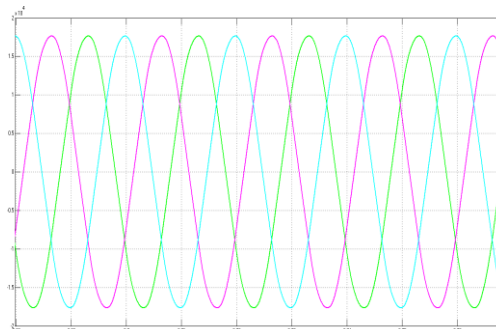


Figure: 5.12 proposed system using pi controller voltage output waveform

This waveform shows that the output waveform of voltage for proposed system, the obtained voltage is 20kw. This voltage is supply to the micro-grid

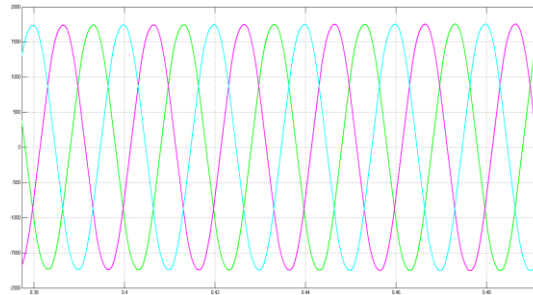


Figure: 4.13 proposed system using pi controller current output waveform

This waveform shows that the output waveform of current for proposed system, the obtained current is 2kw. This voltage is supply to the micro-grid.

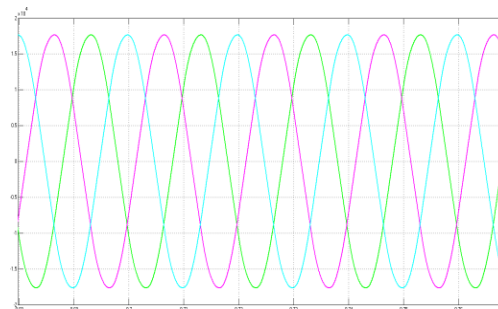


Figure: 4.14 proposed system using fuzzy controller voltage output waveform

This waveform shows that the output waveform of voltage for proposed system, the obtained voltage is 20kw. This voltage is supply to the micro-grid

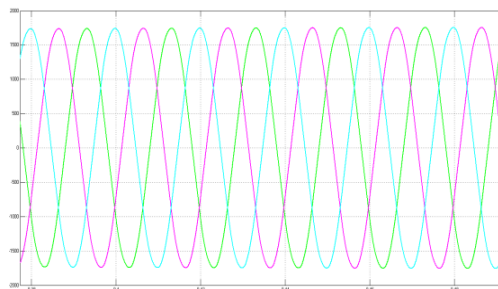


Figure: 4.15 proposed system using fuzzy controller current output waveform

This waveform shows that the output waveform of current for proposed system, the obtained current is 2kw. This voltage is supply to the micro-grid.

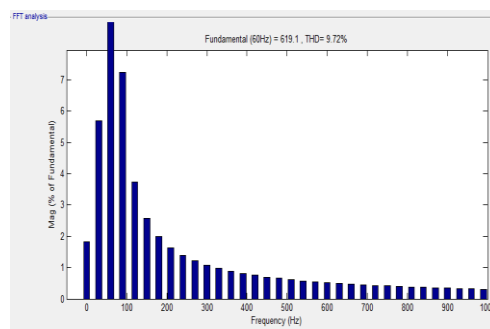


Figure: 4.16 FFT analyses for proposed system using pi controller

FFT analysis value for output voltage (Vabc) (ie)  
THD = 0.097  
Therefore, Total Harmonic Distortion (THD) = 9.7%

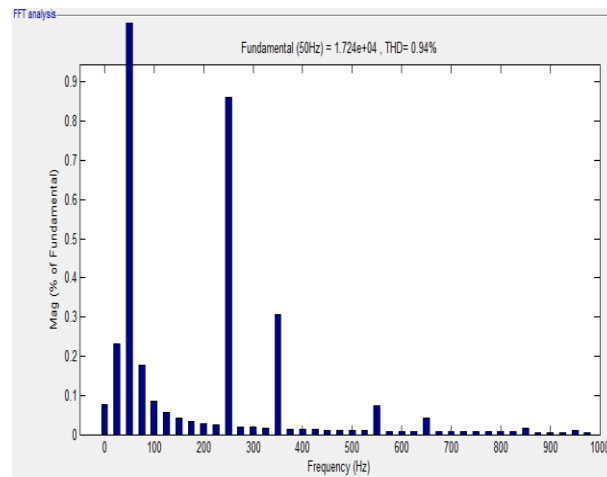


Figure: 4.17 FFT analysis of voltage for proposed system using fuzzy controller

FFT analysis value for output voltage (Vabc) (ie) THD = 0.0094  
Therefore, Total Harmonic Distortion (THD) = 0.94%

## VI. Conclusion

This project proposed that the Hybrid of PV and WECS connect with micro-grid by using PMSG. The PMSG is used to increase the efficiency of the systems. The design of PV module, WECS and Boost converter were done with the help of their general equations, and simulated in MATLAB. The wind turbine design is based on constant speed rotation, the PMSG was maintained the constant speed rotation. The output voltage of PV and rectifier voltage of WECS are fed to the boost converter. A control mechanism is developed that changes the duty cycle of the boost converter so as to obtain the desired or fixed output in spite of variations in the wind speed. An inverter was designed with the help of GTO's working in SPWM inverter. Triggering sequence was obtained and accordingly pulse generation was done for each GTO. The output produced by the inverter is a square wave which is then fed to a first order filter to obtain a sinusoidal wave. Then the sinusoidal wave is connected with micro-grid.

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