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Smart Power System with Integration of Biomass, Wind and Solar Power Sources

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Abstract: Renewable energy can generate power directly from environmental resources it embodies various features like efficient power generation, affordable and eco-friendly. The interconnection of Renewable resources provides efficient uninterrupted power supply. The generated energies from resources can be combined and integrated with adaptable technology. The system uses three renewable energy sources (Solar, Wind, and Biomass) for power generation. These Sources generate power separately and it is integrated by the driver circuit and provided to the controller. Microcontroller (ATmega328p) receives information about the generated power, it gives pulse to the MOSFET driver circuit and the current is stored in the battery using a battery charging circuit and it supplies energy to the load. The buck-boost converter operates to provide an appropriate supply to the load.

Keywords: Arduino, MOSFET, Buck-Boost converter

I.INTRODUCTION

Industrialists and consumers require a continuous power supply for production and services. The uninterrupted power supply provided by renewable energies leads to the conservation of electric power from non-renewable energy sources it helps to develop the nation's economic growth. These energy resources can be used repeatedly and reproduced naturally and can be utilized in any period. Hybrid renewable energy production is effective it can be used to manage power demand that increases the reliability and efficiency of power. Biomass, solar PV and wind are used for long term energy production. The system uses these three resources for providing stable power supply to load. Mainly, biomass can produce energy in a non-hazardous manner besides climatic conditions. The uninterrupted power supply can be achieved by this system. The value of the generated power is fed to a microcontroller leads the entire controlling section of the system which has a PWM controller pins, is used for triggering pulse to the MOSFET, microcontroller (ATmega328p) based programming circuit helps to facilitate an automatic shift of power between available sources is used in the system. MOSFET driver and four ports supply the power to the load. The boost converter is used to increase the voltage and buck converter reduces the voltage range of the power which is to be supplied as per the requirement of load. MOSFET act as a switch and also helps us for automatic switching. GSM is used for indicating the available power resources and it sends a message to theuser mobile phone.

II.PROPOSED SYSTEM

The power supply system consists of several elements and they are divided into generation section (solar, wind and biomass) and control section (MOSFET, a microcontroller).The generated current flows through the diode, which allows only the forward current from the source and does not allows the reverse current. It is connected to the resistor which acts as feedback line and is given to the Arduino which produces a pulse. MOSFET gate should be made active and charges the battery from the sources based on the power generation and it flows to the line that is directly connected to the battery cutoff circuit, it automatically stops charging when the battery gets fully charged. The availability of power in the battery leads Arduino to decide whether to supply the load directly from the battery or either from the source. The power has been supplied to the four-port that recognizes the load level automatically with the help of the Arduino that provides a command to buck or boost the voltage based on load range. The generation data and load data is sent through SMS to the mobile phone using GSM.

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III.BLOCK DIAGRAM

The auto power supply controlling system block diagram is shown in figure 1. The block diagram consists of a microcontroller interfaced with four sources, MOSFET, buck-boost converter and GSM.

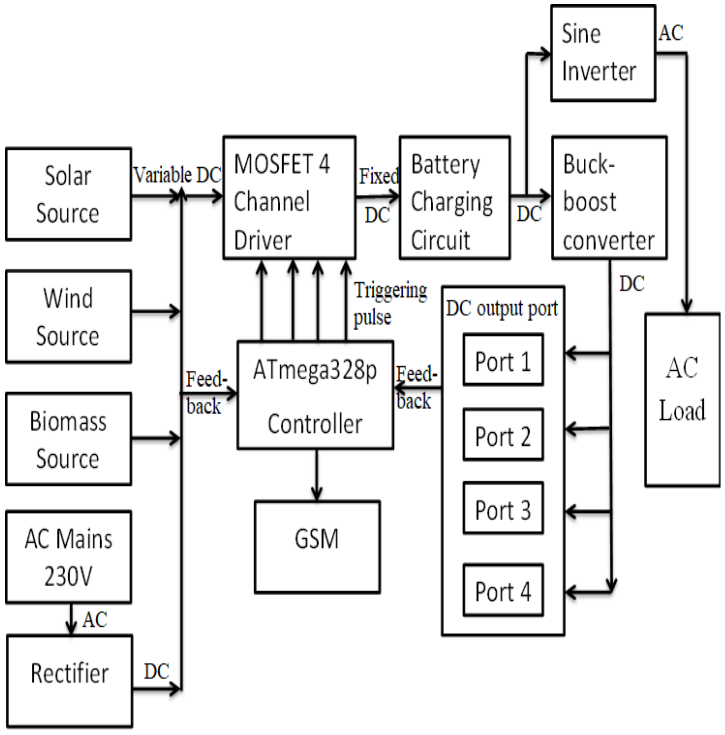

Fig.1. Block diagram of Proposed System

IV.FLOW CHART

Generation of power in solar panel, DC wind dynamo, plastic cylinder (biomass) starts the process in the system. The generated DC power range is fed in a resistor feedback line which is connected to the ATmega328p microcontroller. The microcontroller is connected to the gate terminal of MOSFET which activates the conductivity using the pulse. If pulse 1, the current is stored in the battery else pulse 0, it activates AC conductivity in the circuit. Before supplying to the load the required load (watts, volts) are read by feedback line which is connected to the

ATmega328p microcontroller and it generates a pulse. If the pulse 1, the battery current supplies to the load else pulse 0, the gate terminal of the MOSFET activates which leads to the buck-boost converter.

The buck-boost converter steps up or steps down the source voltage based on load requirement and supplies the load. The generation process is continued and stored in the 12V lead-acid battery it cuts off automatically through a battery charging circuit. As a standby supply for load the AC mains are used in case the generation of renewable energy fails to deliver required load power. The AC mains 230V is rectified into DC by using a single-phase bridge rectifier stored in the battery and delivered to the load. The information about generated power value, load value and the total capacity of power stored in the battery is transmitted as messages to the user mobile phones through GSM with the help of Arduino pins at required intervals. The process is stopped temporarily based on load requirement, battery availability and source power generation. The flow is terminated.

The system has been analyzed and surveyed for a minimum value of DC output load port. If it has to be supplied for domestic consumers and industries the same process flow involves power generation but after the battery charging circuit the system includes sine inverter which converts constant DC into a variable AC. It is preferred for its advantages like low harmonic distortion, efficient power utility, inductive loads are operated at high speed with low noise and also reduce noise in fans, audio amplifiers, and fax. After the inversion of generated DC to AC, they are

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supplied to AC load. The system has a great advantage like the conservation of electric energy, reduction of electricity bills, efficient power production at a low cost.

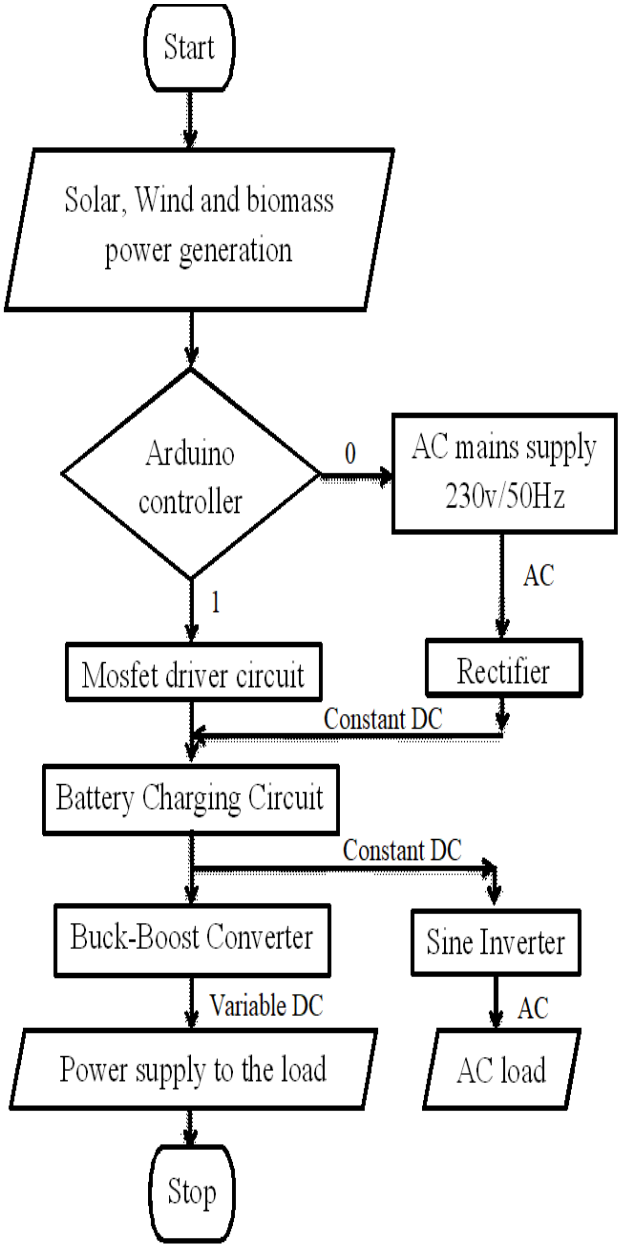

Fig.2.Flow chart of proposed system

A.**SOLAR**

Solar energy is the radiation from the sun, capable of producing heat and generates electricity. The system uses 25cm*35cm solar panel it generates 9.6watts. The process starts by sunlight conversion into electricity by using the solar panel. It works by the principle of the photovoltaic effect. The polycrystalline panel consists of many fragments of silicon layers in a single PV cell. The silicon crystal in the panel functions as a semiconductor device. The PN junction in the panel absorbs photons and it transfers the energy to the electrons in the solar cell. The electrons are knocked and cause the flow of electrons that produces electricity. The generated power is given to Arduino through the feedback resistor line; it activates the gate pulse which leads to current flow.

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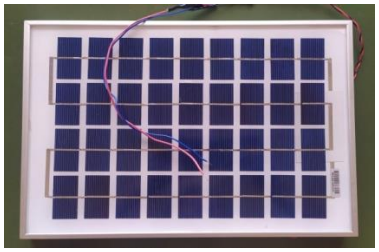

Fig.3.Polycrystalline solar panel (9.6 W)

B.WIND TURBINE:

The propeller used in this project with the size of 10cm*2.5cm it generates 1.5watts power. The generated power is fed to the Arduino and stored in the battery. The brushed DC motor is used to generate power. Wind produces the power by rotating the propeller blades of the turbine which spins the electromagnets of the brushed DC motor. The magnetic field is produced around the armature and causes rotation. The torque becomes zero and it tends to reverse the direction of the magnetic field which produces the current and the brushes are used to deliver current. High quality brushed DC motor has high efficiency and it does not require any gearing and the battery gets charged by the light wind.

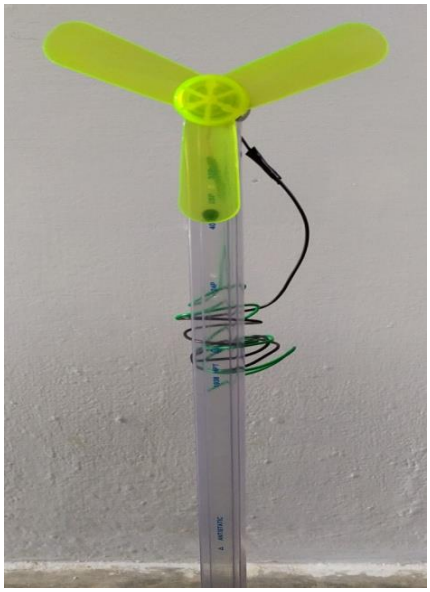

Fig.4.Wind DC motor (1.5 W)

C.BIOMASS

Biomass is carbon-neutral energy produced by organic wastes. The project system uses aplastic cylinder with the diameter of 20cm*35cm which generates 2watts. The power generation starts by collecting food and animal wastes and storing them in plastic cylinder for 10 days. The decomposition (hydrolysis) of plant or animal matter takes place and it converts decomposed matter into organic acids which are then converted into methane gas the process is called as anaerobic digestion. The gas is burned to produce heat which is used to rotate the turbine and produce electricity. The generated power is given to feedback line and conductivity flows at MOSFET and leads to storage in battery.

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Fig.5.Biomass cylinder (2 W)

D.AC MAIN SUPPLY

The power generated from the power station and distributed to the consumers for utilization. If the renewable sources are unable to supply the amount of power required to the load, then the AC mains act as a substitute which activates gate pulse to the MOSFET connected with it. The AC power is rectified and stored in the battery and it supplies power to the load either in bucked or boost state based on the requirement of the load.

E. ARDUINO

The Arduino UNO is based on ATmega 328p. It is a high-performance 8-bit controller based on AVR RISC architecture and it operates at frequency of 5volts. It has 14 digital I/O pins of which 6pins are used as PWM signals and operate at 5 volts. The analog pins A0, A1, A2, and A3 are the source feedback lines. These pins read the amount of power generated from the sources using feedback lines. The digital pins 3,5,6,9 are connected to the PWM signals which provide a high pulse signal to the gate terminal of MOSFET that activates the current in drain and source of MOSFET. The analog pins A4 and A5 are the load feedback lines that lead to reading the load range. Based on load range the Arduino pins 2,4,7,8 gives high pulse to the buck-boost circuit either to buck or boost the voltage. The 10,11,12 and 13pins are used for controlling the system and providing information through GSM.

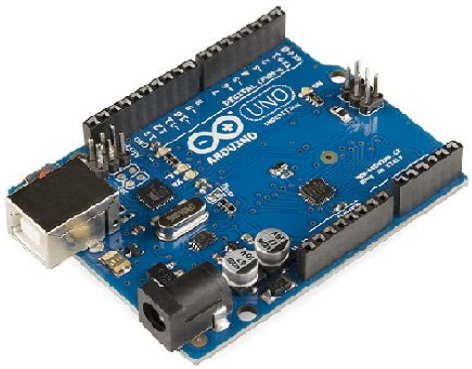

Fig.6.Arduino UNO (ATmega328p)

F.MOSFET DRIVER CIRCUIT

MOSFET driver circuit is a power amplifier that operates at low input power and produces a high pulse to the gate terminal. So, this can be incorporated with the Arduino pulse pins (which reads generated source range through feedback lines) and activates the gate terminal and it determines the conductivity of current flow and this current is stored in the battery.

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IRF540N is an N channel type MOSFET and it can dissipate up to 50W. The gate terminal is activated from Arduino pulse (i.e., provided from PWM converter to the Arduino pins) after activation of the drain and the source terminal is closed and current flows to the battery charging circuit. If there is no activation of gate terminal the source and drain terminal remains open which means no applied voltage.

IRFZ44 is an N channel type MOSFET and has 175 degrees Celsius operating temperature. It has fast switching characteristics and leads to the advantage of using them in the buck-boost circuit. The transistor has a high drain current of 49A, it usually starts conducting on small value and gives full conduction on high gate pulse value. So, the buck-boost circuit decides to either buck or boost based on the range of pulse received from Arduino pins.

G. BATTERY CHARGING CIRCUIT

The generated power from the four sources is stored in the battery by battery charging circuit. The circuit consists of a PNP transistor where the base of the transistor is connected to the battery.The PNP transistor is in reverse biased state which allows the battery to charge. Once the battery gets fully charged the state of the battery gets forward biased and the circuit gets cut-off automatically.

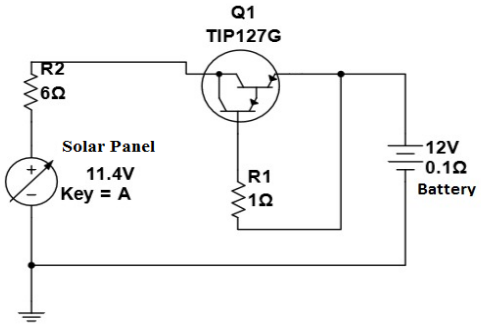

Fig.7. Battery charging circuit

The project consist of battery storage unit at capacity of 7.5Ah Lead Acid Battery it stores the generated power from the three sources and the rectified power from the AC mains. In this battery, lead peroxide and sponge lead is used for the conversion of chemical energy into electrical energy. It has a higher cell voltage. If the battery gets fully charged, the battery cut-off circuit automatically disconnects the connection between the transistor source and battery. The energy stored in the battery is given to the load. If there is the unavailability of power in battery either the source or AC mains is supplied directly to the load.

H. BUCK-BOOST CONVERTER

It is a DC-DC converter, also known as chopper. The magnitude of the output voltage is greater or lesser than the input voltage. The polarity of the input voltage is opposite to that of the output voltage. It operates as a step up DC-DC converter or a step down DC-DC converter depends on the duty cycle. The PWM is used to turn on and off the controlled switch. PWM can be frequency or time based. In on-state the inductor is directly connected to the input voltage. This accumulates energy in the inductor and the capacitor supplies it to the load. While, in off-state the capacitor and the output is connected with the inductor, so the energy is transferred from the inductor to capacitor and the load. If the battery has more sufficient amount of power to supply the load then gate pulse of MOSFET is activated leading to buck circuit it bucks and saves the available energy and provides accurate supply to the load.

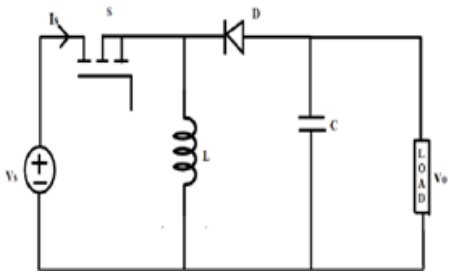

Fig.8. Buck-Boost Converter circuit

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I.OUTPUT PORTS

The DC four-port terminal is used to charge the load. In an electric circuit or network, a port is defined as a connection for a point of input signals or the output signals with an external circuit. The port has 5v, 12v, 18v and 24v terminals which are connected with the load. The four different loads are connected with the port it either buck or boosts the voltage based on the requirement of the load.

J.GSM MODULE

GSM (Global System for Mobile Communication) is a digital cellular technology used for transmitting and receiving power generation and distribution to load. It is wireless telephony widely used by mobile phone users. The subscriber identity module (SIM) is a detachable smart card contains the user's subscription. The GSM is connected with the Arduino. It transmits the data of the power source and the load which is connected with the port. The message received by the GSM from the controller is transmitted to the mobile phone which indicates the user about the status of power every 3 hours.

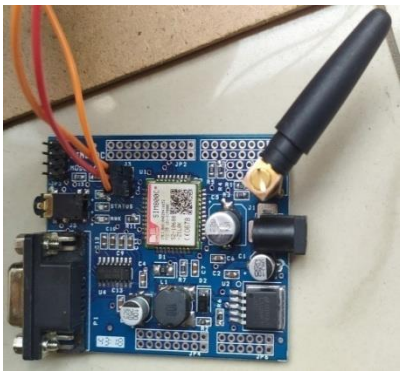

Fig.9.GSM module

V.HARDWARE

The hardware module consists of generation source (solar, wind and biomass) which is connected with resistor feedback line leading to battery charging circuit and those are connected to buck boost converter it supplies power on the basis of load. The positive red lines are used for load connection, resistors are connected as feedback line, MOSFET gate terminal are left to connect with Arduino and the inductor, diode, capacitor and mosfet module near to load side indicates buck boost converter circuit.

Generation of power in solar panel, DC wind dynamo, plastic cylinder(biomass) starts the process in the system. The generated DC power range is fed in a resistor feedback line which is connected toATmega328p microcontroller.The microcontroller is connected to the gate terminal of MOSFET which activate

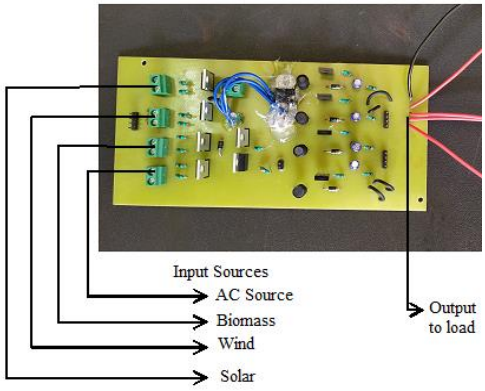

Fig.10. Hardware switching module

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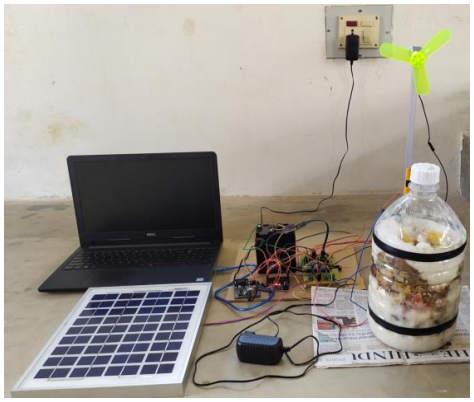

Fig.11.Hardware module

VI. RESULT ANALYSIS

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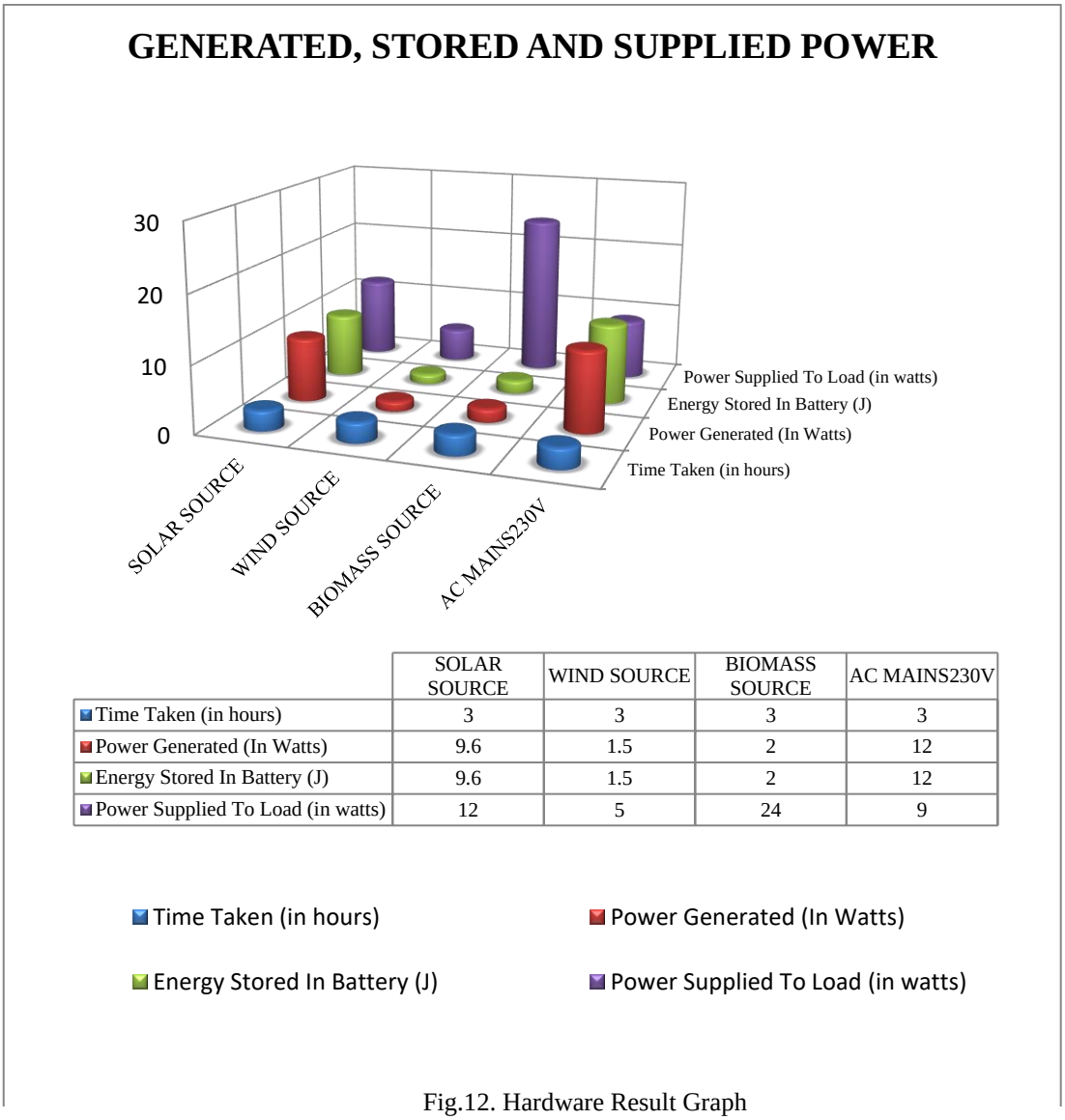

	SOLAR SOURCE	WIND SOURCE	BIOMASS SOURCE	AC MAINS230V
Time Taken (in hours)	3	3	3	3
Power Generated (In Watts)	9.6	1.5	2	12
Energy Stored In Battery (J)	9.6	1.5	2	12
Power Supplied To Load (in watts)	12	5	24	9

Fig.12. Hardware Result Graph

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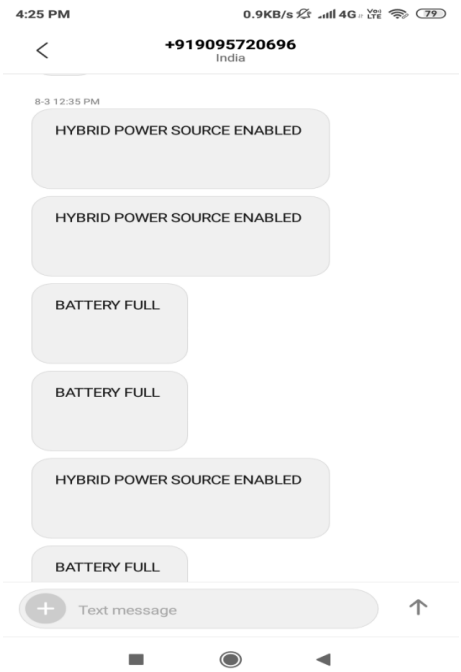

Fig.13.GSM output

VI.CONCLUSION

The dependency of EB's main supply is reduced and the implementation of hybrid renewable energy sources is enhanced. Hence, it can be concluded that this project can play a great contribution in supplying continuous power by automatic switching between different sources.As concluding, the energy consumption problem can be easily cleared and the system is in economical manner. The developed system results in excess of power generation and has wide application in the society. The uninterrupted power supply is very much useful in industrial sectors, hospitals and residential usages. Here lies the use of such a model in which green resources are used that are inexhaustible.

VII. FUTURE SCOPE

The future scope helps in providing an uninterrupted power supply by storing the power in the battery and supplying it to the load. The system effectively helps industries, hospitals, and research labs. Biomass will play a major role in the future, as it produces power by using organic waste materials such as plants and animals and municipal waste which is available in the environment at a low cost.

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