IOT Based Controlling of Hybrid Energy System using ESP8266

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***Abstract*— In this paper, authors have focused on controlling of hybrid energy system using IOT. There is various combination of energy and all of them are alternative to each other like solar energy, wind energy, bio fuel, fuel cell, etc. But the need of controlling of hybrid energy system arises when it is installed for domestic or commercial purpose. At this point IOT plays an important role in controlling system. The main criteria being switching between the two sources of energy i.e. solar and wind energy without any inconvenience through a website using ESP8266 Wi-Fi module. The data is transmitted wirelessly through website to ESP8266 module which controls the sources of energy. The transmitted data is controlled remotely using IOT. This enables user to have flexible control mechanism remotely through a secured internet web connection. This system helps the user to control the sources of energy, manually and remotely using smart phone or personal computer. This system is very efficient, cheaper and flexible in operation.**

Keywords: IOT, Controlling of Hybrid System, Home Automation, ESP8266, Router, Arduino IDE

I. INTRODUCTION

Energy is the basic need for development and the requirement of energy is more due to the rapid increase in world population, technology and other political and economic condition. Now a day's electrical energy is generated by the conventional energy resources like coal, diesel, and nuclear etc. and these are depleting day by day. So, there is an urgent need to switch on to non-conventional energy resources. Solar and wind are easily available in all condition can be good alternative source. With the rise in the demand of renewable energy resources the need of better utilization of these systems has aroused [1]. This in turn has given rise to the hybrid energy system. Hybrid Energy System is the combination of the two or more energy systems. Here, two sources are used solar and wind energy [2]. In order to control the hybrid system IOT can be used. IOT (Internet of Things) is the inter-networking of physical devices embedded with electronics, software, sensors and network connectivity that enable objects to collect and exchange data [3]. IOT is used to switch the power supply i.e., wind energy and solar energy of a house through secure website when the grid supply is off. A prototype is designed to control the switching between these two sources of energy. With the advancement in technology provide sensors, metering, transmission, Distribution, and flexibility to consumers of electricity, it can be possible to control the sources of energy of a house by this prototype.

II. SOLAR-WIND HYBRID ENERGY SYSTEMS

Energy resources are classified into two ways:

- **Non-renewable Energy**: Resources which are limited in quantity and can be depleted after few years. Example: Petroleum, Natural gas, Coal etc.
- **Renewable Energy**: Resources which are abundantly available in nature. Example: Solar energy, Wind energy, Tidal energy etc. [4].

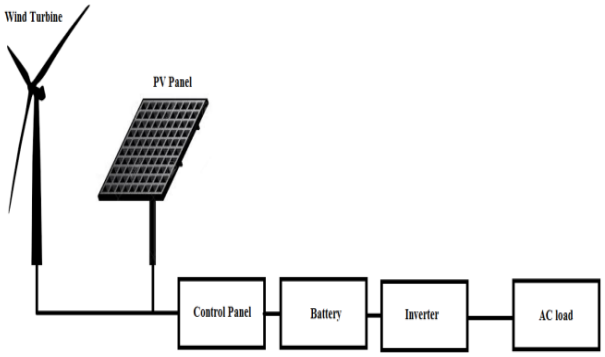

Fig.1. Hybrid electricity generating system

A. Solar PV cell

Photovoltaic cell absorbs light energy (photons) from the Sun and converts it into electricity by the photovoltaic effect. Lots of modules are used to make wafer-based crystalline silicon cells or thin-film cells. The load contained number of modules that can either be the upper layer or the lower layer. It must be shielded from mechanical harm and humidity. Nearly modules are rigorous, but on the basis of thin-film cells, semi- malleable ones are feasible. All cells are connected in series electrically to each other. Apparently, MC4 connector types are used in nearly all photovoltaic modules to expedite simple weatherproof connections to other system. Individual solar module can generate less power; almost all connection consists of multiple

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modules. A photovoltaic cell usually associated of bundle of photovoltaic modules, an inverter and a storage battery, connection of wiring and alternatively a solar tracking mechanism [5].

B. Wind Mill

A windmill is a machine that converts the wind energy into rotational energy with support of vanes called blades. Wind turbines are the evolutions of the typical windmills that can be observe in more rural areas of the world. Their purpose is to lessen reliance on fossil fuels to create energy and also to create energy in a less wasteful manner. They function by using the kinetic energy of the wind, which pushes the blades of the turbine and spins a motor that transform the kinetic energy into electrical energy for consumer use. They supply clean and renewable energy for both home and office. Wind Turbines are a way to save money and make the environment clean and green. Essentially, there are two types of wind generators; those are vertical axis and horizontal axis. They can be used to generate electricity both onshore and offshore. We are using vertical axis wind generator to control [6].

III. PROPOSED IOT SYSTEM

The structure of the design and development of the proposed system is provided in the following sections. Fig.4 and Fig.5 describes the working description of developed system. ESP8266 module is used to transmit and receive the electrical data wirelessly, which is collected from internet through designed website and the control system. The ESP8266 transmitter is interfaced with various sensing devices and reliable data reception at a receiver side of ESP8266 module. The ESP8266 receiver has been interfaced through router which is connected to the internet. The Load can be monitored and controlled remotely. The controlling operation is performed in two ways. Those are manual controlling and remote controlling.

- Manual control: An on/off and source change switch is provided directly to the system. In this mode user can manually operates the load without following remote control. Manual control is very adaptive.
- Remote Control: In remote control user can interact with the load remotely with smart phone or personal computer using secured internet web connection. User can control and operates the system when he is away from the home. This feature also reduces manual efforts and time by controlling the system from one place.

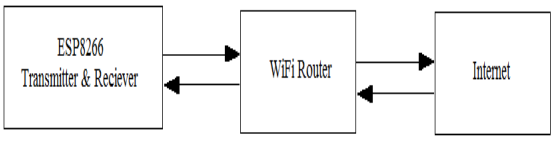

Fig.2. Receiver Section of smart controlling system

A. ESP8266 WiFi Module

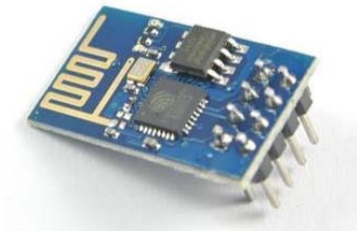

Fig.3. Esp8266

ESP8266 is a system on chip (SOC) and Wi-Fi network that can carry software applications. It also has TCP/IP protocol that permits to access Wi-Fi network. The ESP8266 is efficient to host an application or remove all Wi-Fi networking functions from another application processor. The flash memory can be started straightly from an external move. In-built cache memory will help upgrade system performance and curtail memory requirements. Another condition is when wireless Internet access considers the task of Wi-Fi adapter, you can integrate it to any microcontroller-based design, and the connection is uncomplicated, just by SPI / SDIO interface. The module has very good processing and storage capability. This allows it to integrate via GPIO ports sensors and other application specific machine with the lowest development in early and least loading during runtime.

The ESP8266 allows very less external circuitry due to the highly integrated chip. It includes antenna switch and front-end module, including the entire designed to minimize PCB area. The system of ESP8266 supports the following features: energy saving VoIP applications and Bluetooth interference. It has self-generated RF allow it to work on the operating condition with no external RF parts. The input voltage of the module is 3.3 V, with 8 pins, which have two pins of 1 TXD and 1 RXD, 2 GPIO pins i.e. GPIO 0 and GPIO 2, RST is Reset, VCC and GND is Ground. The module is very cheap and transforming it into an IOT solution is a unique thing [7].

B. ROUTER

A router is networking gadget designed to receive, analyze and transfer incoming packets to another network. It is a networking device which forwards the data packets and performs the "traffic directing" functions on the Internet. A data packet is usually forwarded from one router to another over the networks that establish the inter-networking until it enters its destination node [8].

C. Voltage Regulator [AMS 1117-3.3]

This is a flexible and immovable voltage regulators are designed to provide up to 1A output current and is operated on 5V input. The dropout voltage of the device is guaranteed maximum 1.3V, decreasing at lower load currents. Power source circuitry and regulator in both to lessen the stress under overload

situation to limit current. Low current drop. It converts 5V, 0.7A into 3.3 V for ESP8266 module. There are three pins,

- Ground
- Output (3.3 V)
- Input (5 V)

D. OP-AMP [AP 358]

It consists of two independent, high gains; internally frequency compensated operational amplifiers that are designed specifically to work from a single power supply over a wide range of voltages. The rating is ±15V power supply with 1 A current. The output voltage is +5V.

E. Sofware [Arduino IDE]

The program code written in Arduino IDE is known as a sketch. The Arduino IDE software used for developing sketches for ESP8266. This IDE contains the following parts in it [9]:

- **Text editor:** This is where the interpreted code can be written using a simplified version of C++ programming language.
- **Message section:** It shows error and also gives a feedback on saving and exporting the code.
- **Text:** The soothe displays text output by the Arduino environment along with complete error messages and other information
- **Console Toolbar:** This toolbar encompass various buttons like Verify, Upload, New, Open, Save and Serial Monitor. On the bottom right hand corner of the window there displays the Development Board and the Serial Port in use.

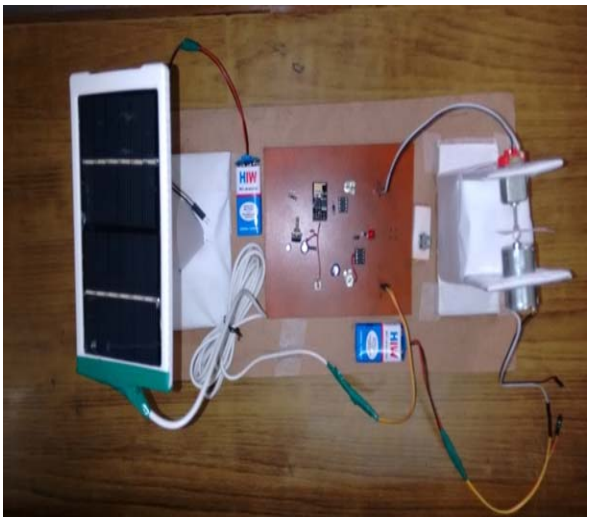

Fig.4. Prototype of the Controlling of hybrid Energy system

IV. IMPLEMENTATION

A. Flow chart for solar-wind hybrid Energy systems and esp8266 :

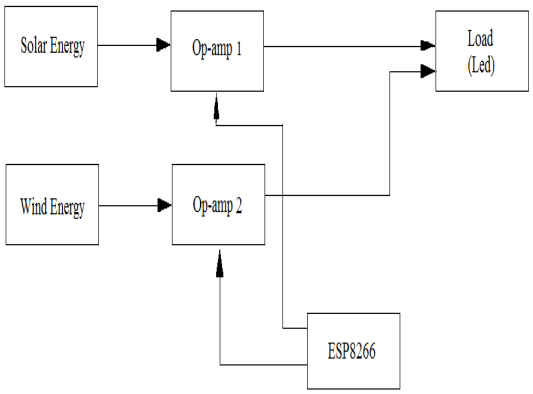

Fig.5. Block diagram of the control system

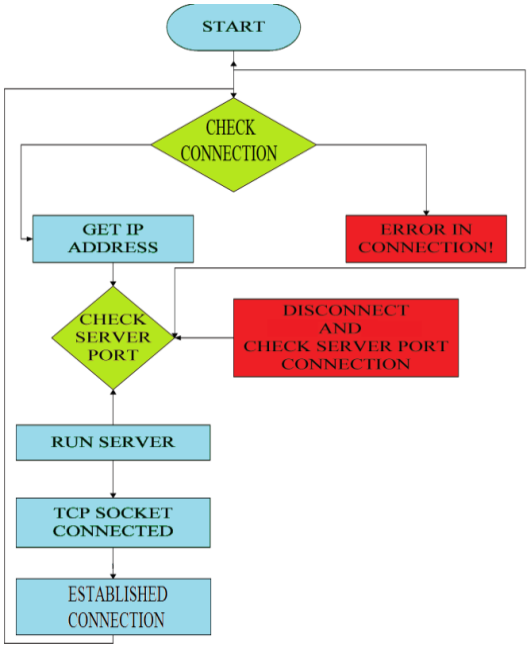

Fig. 6. Flow chart [10]

The main power supply is 220V AC and an adapter is used to convert 220V AC into 9V dc to charge a battery. The battery is connected to the system and it is of 9V. This 9V is supplied to AMS1117. AMS1117 is a voltage regulator, it is used to convert 9V into 3.3V for ESP8266 WiFi module. Since ESP8266 Wi-Fi module will only work on 3.3V supply above this voltage, it will burst out or not work properly. There are two capacitors used with the AMS1117 voltage regulator, one is of 0.1µF and other is of 100µF. The application of these capacitors is to filter the

current because all components work on DC current. Therefore, there is a need of smooth and clean supply of DC current, so that modules and ICs which are used in the system work properly without any fluctuating components of current.

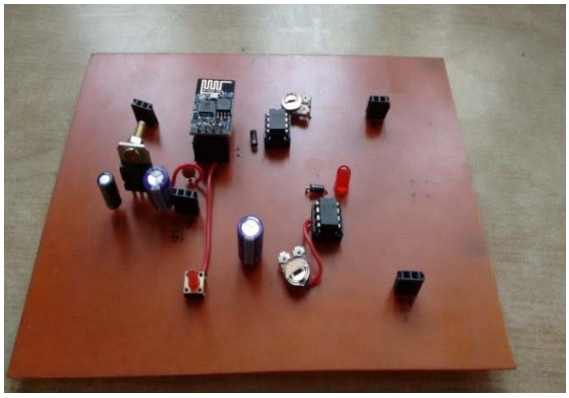

Fig.7. Electrical circuit model of the control system

ESP8266-01 Wi-Fi module is used to connect to the internet and it is linked to the website through which we can operate our supply from anywhere in the world. ESP8266 has 8 pins, which have two pins of 1 TXD and 1 RXD, 2 GPIO pins i.e. GPIO 0 and GPIO 2, Reset, VCC and Ground. TX and RX pins are used to flash the embedded code, after uploading the program into the module GPIO pins, Reset, VCC and Ground pins are used. There is no use of TX and RX after flashing, so it remains open. AMS1117 will supply 3.3V to the ESP8266 Wi-Fi module.

Two GPIO pins are connected as an output pin to the two ICs AP358 will take it as an input. When we give signal or select an option from website i.e., solar on or wind on then from website a signal is sent through the internet to the ESP8266 Wi-Fi module to turn ON solar connection or to turn ON wind connection or to turn OFF external supply. The signal received from user will be manipulated by the ESP8266 and it will give output signal to the input of AP358. AP358 is the two-sided op-amp IC and used to control the supply, to glow the LED (load). It contains 8 pins VCC, Ground, 2-input receiver, 2-set point pin and 2-output. We are using two of the separate supplies to control LEDs. The solar panel is used as the power supply of one IC and dc generator (wind mill) is connected to another IC for power supply.

Two PN-junction diodes are used, which is connected to the output of the AP358 IC. And these diodes are connected to the LED. Diodes are used, because when one supply is ON then another IC and their component will not affect. Red LED is used. It is used as a load. When power supply is ON, ESP8266 is blue light will start blinking and after few seconds it is connected to the internet. A website is used to control the supply of solar and wind. When light is gone, then there are two type of supply one is solar and second is wind. We can operate it from a website from anywhere in the world. When website is open then there are three options,

1.) Solar ON

2.) Wind ON

3.) OFF

Fig.8. Switching Options webpage

V. RESULTS AND DISCUSSION

A. Experimental setup

The whole system is organized as shown in the Figure 4. The system consists of two nodes. Two nodes are Solar panel and wind mill power. Nodes connected with two Op-amps AP358 respectively and interfaced to Esp8266. An LED bulb is controlled using this Op-amp.

B. Data transfer

Using Arduino IDE C++ program is uploaded and a variable is created to store data, which is getting by clicking the button in the website, it send data directly to ESP8266 module through internet. The data received from the internet is stored in the ESP8266 module. For each signal to be analyse module gives a domain id and API key. Domain id and API key are uploaded in the module and then code is executed in order to update the values in Esp8266. The outputs in serial monitor can be seen in Fig.9.

C. Client server Communication

The client-server communication is done by using HTTP communication protocol. The commands and arguments are passed in between client and server. The output of sending and receiving data can be figured out in Fig.8.

D. Web Server for controlling Hybrid energy system

When module is interfaced with internet, it generates a unique IP address. The webpage is designed so that when IP address is provided in the URL to the control page as shown in Fig.8 opens and user can control power supply by selecting buttons solar on, wind on or off. Internally when user selects the these button internally, Remote procedure call (RPC) commands are initiated for controlling op-amp. When power supply is cut-

off, person can switch power to another power supply(either solar or wind, which is more feasiable). With just a single click the whole system could be controlled. Operating time from Virtual button to output is minimum 3 seconds.

By changing the module to ESP-12 module and increasing the number of Op-amp AP 358 IC, more energy sources could be added. By using relay, system can be used in houses for the controlling of power supply.

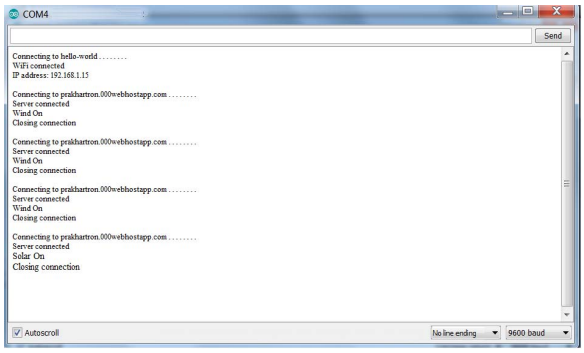

Fig.9. Output of the Esp8266

VI. CONCLUSION

This combination of solar-wind energy source will be highly effective in commercial areas. It is eco-friendly at the same time prevents accidents due to lightening. It is used to cut short power charge. By this system electricity charge could be saved as very less maintenance charge is required for equipment. Moreover there is no power cut or load shedding at any times. In addition to this, the system is controlled by INTERNET OF THINGS as site manager is able to receive detailed information of facility at site, efficient maintenance for regular checkup and failure could be performed conveniently. It is the most reliable and cost efficient. This research is at an underdeveloped stage and may take years to bring it into market. We encourage the scientific community to consider this technology along with others when contemplating efforts and resources for renewable energy.

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