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ORIGINAL ARTICLE

Hybrid power plant with wind and solar energy using IoT

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Abstract

Due to the fact that the connection is neither economically feasible nor supported by the key players, it is now impossible to reach the rural population that is not electrified by expanding the grid. Furthermore, conventional energy options, such as fuel-based systems, are gradually being dropped from the agendas for rural development due to the rise in oil costs and the intolerable effects of this energy source on consumers and the environment. Utilizing “hybrid power generation using solar and wind energy" can solve this issue. Hybrid systems are the most effective method of providing "high quality" power. The suggested system generates energy using solar and wind sources. Based on its intensity, a 6V solar panel absorbs sunlight and uses the photoelectric process to transform solar energy into electrical energy. A windmill converts wind energy into electric energy via a dynamo motor. We refer to a solar-wind energy system combination as a hybrid energy system. The produced energy is used to power further AC and DC usage after being stored in a 9V rechargeable battery. It uses an ESP8266 NodeMCU to transmit data over WiFi. A Blynk programme is used to remotely and manually control loads. The CPU and WiFi module are both Node MCUs.

1. Introduction

The hybrid power plant is highly adaptable to various distant power requirements and a fully functional electrical supply system. The system's three essential parts are the power supply, the battery, and the power management hub. A fully functional electrical supply system, the hybrid power plant is highly adaptable to various distant power requirements [1]. The system's three essential parts are the power supply, the battery, and the power management hub. Hybrid systems can overcome restrictions on fuel flexibility, dependability, efficiency, emissions, and economics. The Internet of Things (IoT) is a network of interconnected, internet-accessible physical items. The use of solar and wind energy has been chosen to increase dependability and help reduce pollution emissions. The system's internet connectivity is provided by the Node MCU module [2].

Thus, this project has incorporated electricity production using sustainable resources like wind and solar. Due to their availability, quantity, and ease of use in producing electricity [3]. When solar and wind energy resources are combined, reliability is increased, system energy service is improved, and pollution emissions are reduced. IoT is the term used to describe physical objects connected to the internet that are located all over the world. IoT offers more efficiency, which enables quick and accurate results. The IOT devices (NODE MCU) WiFi module is used to share information to the internet because automation is now a must [4].

2. Overview

Due to the overuse of non-renewable resources and their rising costs, demand for renewable energy has been rising recently. Besides hydropower, solar and wind energy have the most

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potential to satiate our energy needs. Wind energy alone can generate large amounts of power, but it is highly unpredictable because it might appear one second and disappear the next. Similarly, solar energy is available all day long. Still, the amount of solar irradiation varies due to the sun's intensity and the unpredictably shaped shadows created by clouds, birds, trees, etc. Because they are intermittent and unreliable, wind and photovoltaic systems share this fundamental disadvantage. However, merging these two sporadic sources can considerably increase the system's power transfer efficiency and dependability [5]. The alternative energy source can make up the difference if a source is unavailable or not enough to fulfil the demands of the load. The suggested system generates power using solar and wind energy sources. Based on its intensity, a 6V solar panel absorbs sunlight and uses photoelectric. We refer to a solar-wind energy system combination as a hybrid energy system [6]. The generated energy is used to power additional AC and DC usage after being stored in a 9V rechargeable battery. It uses an ESP8266 Node MCU to transmit data over WiFi. A Blynk programme is used to remotely and manually control loads. The processor and WiFi module are both Node MCUs [7].

3. Problem Formulation

As we know, our devices or appliances need an electric power source. Thus, as technology develops, people are using more electrical and electronic gadgets, which raises the need for electricity. As a result, several methods for producing electric power are employed to fulfil the load requirement. Furthermore, traditional energy options, such as fuel-based systems, are gradually being dropped from the agendas for rural development due to the rising costs of oil and the unpleasant effects of this energy source on its consumers and the environment. Renewable energy sources like solar, wind and other similar sources are increasingly being utilised for power generation to reduce pollution and save non-renewable energy resources like coal, petroleum, and so forth. But the major problem is the continuous power supply in all seasons and in any situation [8]. This issue may be solved by employing "hybrid power generation using solar and wind energy." Hybrid systems have been shown to be the most effective means of delivering "high-quality" power. The Hybrid power plant is an entire electrical supply system that may be readily adjusted to satisfy various distant power requirements. The system consists of three main components: the power source, the battery, and the power management centre. Hybrid systems can handle fuel flexibility, dependability, efficiency, emissions, and economic constraints [9]. Before we can comprehend how solar cells function, we must first understand how solar panels transform solar energy into electrical energy. Devices that use the photovoltaic effect to convert solar energy into electrical energy are known as solar cells or solar photovoltaic cells. Real-time applications using these cells include distant telephony systems, home lighting systems, street lighting systems, and railroad signaling systems. Large wind turbines are designed to revolve around the wind, generating power. Solar and wind energy are utilised to create leverage, so we added some IoT and computer programming to control the panel via a smartphone app. Because we've entered the virtual realm, we'll need some more code to handle it portably [10]. The Internet of Things (IoT) is an ecosystem of interconnected physical things that can be accessed over the internet. Solar and wind energy have been selected to increase dependability and contribute to pollution reduction. The Node MCU module is used to connect the system to the internet.

4. Materials and Method

Table 1: Hardware requirement

Components	Specification	Quantity
Solar panel	6V, 0.5A	1
Wi-Fi Module	ESP8266	1
Dynamo DC motor	5V	1
Transformer	Step-up transformer	1
Battery	Li-ion 9V	1
Resistors	1k Ω, 10kΩ, 330Ω	7
Transistors	BC547	3
PCB	-	1
LED	5mm	3
Relay Module	Generic	1
Adaptor	AC 100, 240V-50/60Hz 0.3 A	1

4.1 Block Diagram

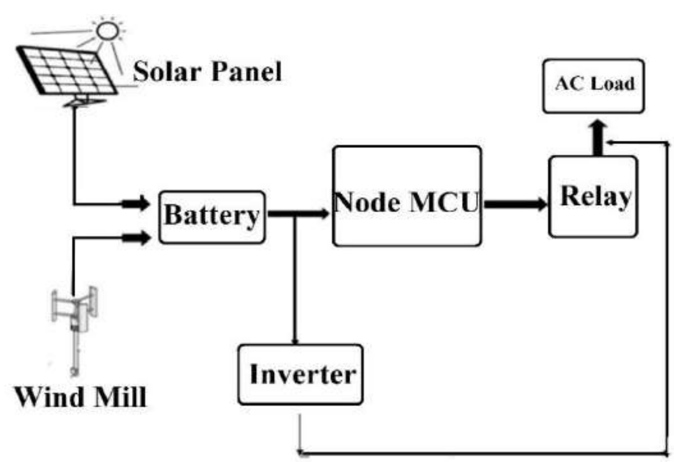

Figure 1: Block Diagram

In this Section, a brief discussion on the methodology used for this project is discussed.

- This system consists of a solar panel, a wind turbine, and an inverter.
- The power source, in this case, is a solar panel and a windmill.
- An inverter converts DC to AC for domestic usage.
- When there is enough wind to move the windmill, it generates enough electricity to store energy in a battery.
- Similarly, the solar module panel is positioned to

maximize sun exposure to create energy to store in the battery.
- The system is also built on IOT (NODE MCU), which intelligently monitors voltage and controls the inverter and load.
- As a result, this project exemplifies how natural resources may be efficiently exploited to create power at a faster rate.

4.2 Circuit Diagram

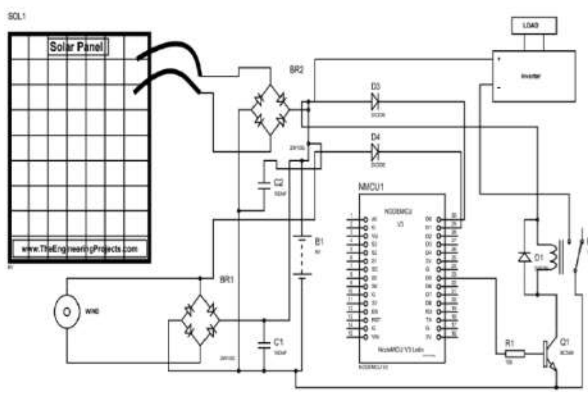

Figure 2: Circuit Diagram

For circuit connections, start by connecting the positive solar panel terminal to the positive terminal of the voltage sensor and the negative solar panel terminal to the negative terminal of the voltage sensor. The NodeMCU ESP8266's A0 will be connected to the voltage sensor's OUT pin, and the ground of the voltage sensor will be connected to the NodeMCU Module. This section will measure the voltage before joining the relay module, allowing us to connect the inverter or battery. The sensor's VCC pin will be linked to the NodeMCU's 3V. Based on its intensity, a 6V solar panel absorbs sunlight and uses the photoelectric process to convert it into electrical energy. A windmill connected to a battery and a single glowing LED works with a DC gear motor to convert wind energy into electrical energy.
A solar-wind energy system is referred to as a hybrid energy system. The generated energy is kept in a 9-volt rechargeable battery and may be utilized in both AC and DC applications later. On the blynk application, an ESP8266 NodeMCU is utilized to deliver data through Wi-Fi. The processor and Wi-Fi module are housed in the Node MCU. The following is the entire circuit diagram.

4.3 PCB fabrication and drilling

A PCB is used to connect electronic components electrically. This is accomplished by etching tracks from copper sheets bonded onto a non-conductive substrate to provide conductive channel ways for circuit connections. A PCB is made up of a conductive layer made up of tiny copper coils. PCB by directing electrical signals, it brings electronics to life. PCBs are mainly made of composite materials such as epoxy and fibre glass. PCBs are available in a variety of layers and designs [12].

4.3.1 PCB fabrication process

PCB manufacturing is the process or operation that converts a specified circuit board into a physical structure based on the parameters in the design package. This usually consists of three stages: manufacturing, assembly, and testing.

4.3.2 PCB manufacturing

- This is the process of building our board design. The procedure consists of two steps: board fabrication and printed circuit board assembly.
- This covers the design process, layout printing, substrate cleaning, etching, and drilling process [13].
- The design is printed on photo gloss clear paper.
- Ferric chloride and cupric chloride are used for etching.

4.3.3 PCB assembly

- It is the second step of PCB fabrication, in which the board components are soldered onto the board. Soldering is described as the process of adding components to the board, which is the next stage of assembly.
- The soldering equipment will be used in the manufacturing process. When using wave soldering, no solder paste is needed because the wave soldering equipment provides the solder [14].

4.3.4 PCB testing

- After manufacturing, it is the third stage of PCB development. During this, testing is done; any mistakes or problems and the location of the fault or whether it is working correctly or not is checked .and another cycle is started to include the design modifications.

4.4 Layout of PCB

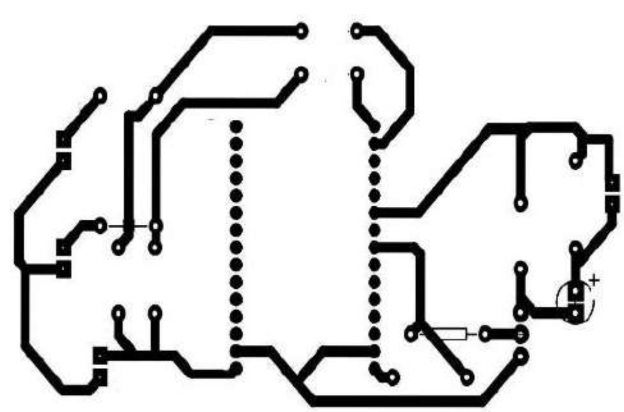

Figure 3: layout

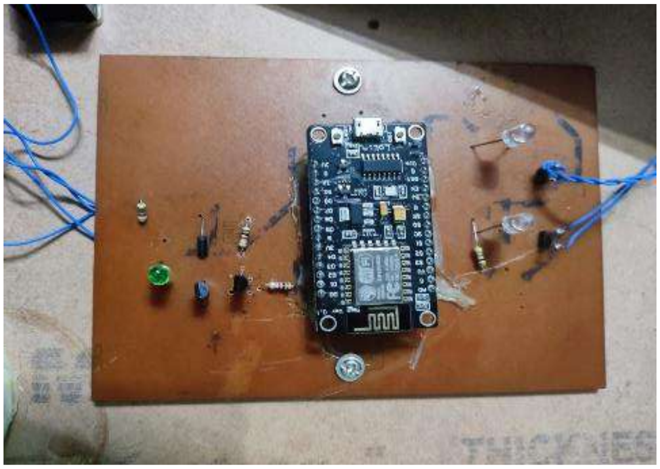

Figure 4: Components mounted on PCB

4.5 Project Implementation

Figure 5: Final Project Implementation

5. Software tools used

5.1 Arduino software IDE

It is an open-source Arduino software that does code writing for IoT and compiles it quickly, and we can attach and connect the devices to the cloud using this software. It has built-in methods and various libraries used for multiple applications main core code is the sketch, which will be written on the IDE platform. We have used the blynk app and written code in this software. After this, we have to connect the wifi module to the ide and compile or flash the code to the device using this software.

5.2 Easyeda

EasyEda is an online EDA tool package that allows electrical and electronics engineers to create, model, exchange, and open simulations and print circuit boards. Other features pick and placing files and documentary outputs in PDF, PNG, and SVG formats.

5.3 Blynk application

Blynk app is used for connecting smart devices to the cloud so we can interact and communicate with it, allowing us to develop great interfaces for our project. It has many widgets through which we can choose which to apply in our project, like buttons, led etc.
Start working on your app. Then, on whichever Blynk-compatible device you're using, use the Blynk library you downloaded in step 2 to create code that instructs the machine what to do when a user interacts with the widgets on the new app you're developing in the Blynk app on their phone.

6. Results and Discussion

6.1 Solar Energy Output

Solar panels get energy from sunlight, as dc is generated and converted to ac through a rectifier and now its energy gets stored in the battery, battery output is dc it will be passed to an inverter where it will convert into ac consumption, the load we are using is zero-watt bulb. As the Solar panel gets energy from sunlight, it will start storing energy in the battery, and this process is indicated by the red LED bulb glow mounted on the PCB. As we manually switch on the plug, energy stored in the battery will be passed to the inverter for further dc to ac consumption, and for load, we take zero watts' bulb, so we can glow the bulb by consuming energy through solar.

Figure 6: Energy generated is consumed by bulb

For wind energy, when the dynamo motor rotates in an alternate direction, it will act as a generator, so as wind energy is passed to the windmill, it will generate dc energy. The power generated is low so that it will generate energy only for the Led bulb, and as the windmill rotates bulb will glow. Output is shown in below images. When there is enough wind to rotate the shaft, the Windmill will generate enough power to glow a bulb.

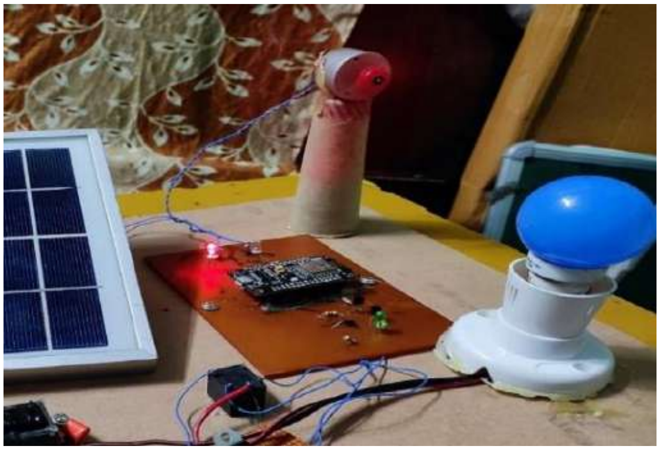

Figure 7: Led bulb glow due to wind energy

6.2 Output on Blynk app

As solar panels get energy from sunlight and, after that, will charge the battery and charging indications using a gauge, we will get on the Blynk app through Wi-Fi-module. Also, we can control the load on the cloud from anywhere; we can turn on/off the bulb as it is part of home automation. The results are shown below.

Figure 8: *Output for on state in blynk app*

Figure 9: On/off button and charging/intensity indication for solar energy

7. Conclusions

A hybrid solar-wind power plant generates electricity using both wind and solar insolation. Since wind and solar systems operate at their busiest throughout various seasons and times of the day. When we require power, hybrid systems are more likely to produce it. Indeed, by improving energy supply security, renewables are already helping to realize significant economic, environmental, and social goals. One of the best options for supplying electricity in dispersed locations or at specific distances from the grid is renewable energy if there are others. Indeed, by improving energy supply security, reducing greenhouse gases and other pollutants, and generating local employment that improves overall social welfare and living circumstances, renewable energy sources are already helping to realize significant economic, environmental, and social goals. Hybrid systems are the best solution to provide "high quality" community energy services to rural regions at the lowest possible cost and with the most significant potential social and environmental advantages. Developing nations can reduce their CO2 emissions while growing consumption due to economic growth by utilizing renewable energy.

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