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Prototype Output from Renewable Energy Power Sources and Its Application to Some Electrical Equipment Controlled Using IoT

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Abstract: A device that can combine many power sources into a bigger source of electricity was created on this project. At the moment, our planet is running out of coal to provide power. Coal is a major source of electricity. As a result, renewable energy should be employed to limit the consumption of coal. Coal combustion can also result in air pollution and climate change. Furthermore, the energy created by the three renewable sources kept in the rechargeable battery. This battery will power the inverter, which will convert voltage direct current to voltage alternative current. While the load employed in the project is an alternating current load. The usage of IoT has been introduced in this project to regulate the activation of the load. The ESP 32 WiFi microcontroller was utilised. It serves as the project's central processing unit. It could only be controlled using a smartphone and can be controlled from a considerable distance. All the connection of power sources such as solar panel, wind turbine and mini hydro power generator turbine was connected in series connection as the method to gain the result. The solar charger controller functioned well by regulating the incoming voltage and current from renewable energy to prevent from battery overcharge. The activation of the lamp was successfully made by controlling it via smartphone. all data have been successfully recorded according to objective requirements. Data has shown that solar energy is the largest energy successfully produced

Keywords: Renewable Energy, Solar Energy, Wind Energy, Hydro Energy, ESP 32 WiFi, Rechargeable Battery, IoT

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1. Introduction

In everyday human activity, weather conditions are frequently changeable and unexpected. The use of only one renewable source of power will be ineffective during rainy weather or in prolonged cloudy weather [1]. There is a need for a device that can offer varied power depending of the weather. The following challenges may be resolved by the combination of renewable energy sources present on Earth. If just a single renewable energy source is employed to create electricity, there will be difficulties to overcome the problem. Engineers have constructed solar farms in hot and expansive regions, depending on the earth's topography, as one of the strategies for getting big quantities of power [2]. However, the solar farm would have difficulties if it rains in the region. When it is raining, the location of the clouds will prevent sunlight from reaching the solar panel farm. Therefore, electricity generation is forbidden.

Not only that, the use of wind turbines alone in producing results will also face problems. Mountain peaks and mountain valleys are optimal locations for wind turbine installation [3]. The wind will usually blow at high altitudes because the area is not developed skyscrapers. The movement of the wind will be stunted and split if going through tall buildings. That is one example of a problem encountered in laying a wind turbine. The low power generation by the wind turbine is also due to the presence and speed of the wind passing through the blades. A wind turbine is a device that generates electricity by converting the kinetic energy of wind into usable mechanical energy [4]. Horizontal axis wind turbines and vertical axis wind turbines are the two primary types of wind turbines.

The generation of electricity or the operation of mechanical devices may be accomplished via the use of hydropower, which is sometimes referred to as water power. Producing electricity from a supply of water may be done by dipping into either the gravitational potential or the kinetic energy of the water. [5] Producing electricity with hydropower is a way that is environmentally friendly. In addition to its role in the production of electricity, hydropower also plays a role in the prevention of flooding, the support of agricultural irrigation, and the provision of potable water [6]. Hydropower is inexpensive. In comparison to other energy sources, hydropower generates electricity at a lower cost while maintaining its reliability over time. However, hydropower generation may have an effect on the quality and flow of water. Low amounts of dissolved oxygen in the water may be caused by hydropower plants. This is an issue that is hazardous to riparian (riverbank) ecosystems and can be remedied by the use of a variety of aeration methods, which oxygenate the water [7].

This research puts a great focus on the design of machinery that is able to combine many sources of power into a single source of energy that is not only more powerful but also more efficient. This is due to the fact that the electricity produced may feed AC equipment found in homes [8]. Solar, wind, and hydropower, when combined, have the potential to reduce a household's reliance on the electricity it already has. In order to preserve the energy that was created and use the energy that was gathered to power some electrical equipment, making a rechargeable battery as a tool to store energy. The battery voltage value used in this project is 12 V with 12AH. And then the stored energy will supply to the inverter. Besides that, the research is to create a system that, by use of an embedded system and the Internet of Things, allows for the remote control of electrical equipment.

These studies reduce the focus by claiming that sunlight sources also known as solar energy, wind sources (wind energy), and water sources are the three sources that may be used to create electricity [9] (hydroelectric energy). The three sources that are set are the most easily obtained sources for humans if they want to produce such power. In addition to this, the research has narrowed the radius of the scope by storing the energy that is produced in a storage battery that can be recharged, and then using that battery to power certain electrical devices that can be controlled by an embedded system. This has resulted in the energy that is produced being used in a more efficient manner. Other than the systems are created that allow mobile phones to operate devices utilising a microcontroller and WiFi. The ESP 32 can be controlled in various distance [10].

Therefore, the creation of a device that is able to combine many sources of power into a single, more powerful source of energy is the expected outcome that can be accomplished as a consequence of this work. In addition, the desired outcome may be accomplished if energy is collected and put to good use by operating a variety of electrical appliances. A portion of the power energy that is available from the rechargeable battery storage will be directed toward certain pieces of electrical equipment. In addition, users will be able to command the system via their mobile phones which indicates that it will be coded on a microcontroller. A microcontroller equipped with WiFi will be programmable and controlled through a smartphone, which will make it possible to activate a large number of relays connected to various pieces of electrical equipment.

2. Materials and Methods

2.1 Literature

Based on previous project 1, there are several advantages and disadvantages that can be discuss [11]. Both descriptions can make a huge impact on human life, environment and animals. Because with renewable energy technology, it can ensure the environment is always safe and clean without using fossil fuels. Not only that, the author also used some hardware in the project 1. For the wind turbine, the model type is FZY-3KW. The authors stated the specification of the wind turbine in their paper. The solar panel type is KMO120 PV module and for the hydro the authors construct it as Micro hydro power plant. Furthermore, the author uses some software such as The RainWise WindLog to obtain the results of such data and the use of AutoCAD to draw 3D models. For the project 1, the authors using hybridizing technique as a technology used.

Solar Energy Technology as the title for project 2 is about the innovation in solar energy concept [12]. The advantages and disadvantages allow the authors to improve the quality of solar energy in the solar field. There are a few technologies used that were discussed in their paper such as optical rectenna concept, concentrated photovoltaic technology (CPV) and micro-heat-pipe arrays system. All the technology mentioned bring a good result for the future plan.

The aim of project 3 is to develop a solar wind hybrid street light [13]. The optimization of the design of a Hybrid Renewable Energy System (HRES) of solar wind energy to power a 160W streetlight is presented in this research. The components that were used are solar panel, controller, inverter, wind energy generator, battery, LED street lamp and wind turbine. The solar PV cells were built in such a way that they could be easily tilted during maintenance to enable for self-cleaning. The example of software that authors were used is Excel, HOMER and Inventor Professional.

The advantages of project 4 show that solar energy has a lot of potential for being converted into electricity, solar energy is completely free and solar energy is adaptable [14]. To improve efficiency, a solar system's power production should be maximized. But despite the advantages, there are also disadvantages for this project. The disadvantages are this project cannot control by remotely and it works well in sunny conditions. Electricity cannot be generated after sunset, according to conventional solar cells. Under the anti-solar cell concept, electricity can be generated using solar cells at night. The hardware used in this project such as stepper motor, motor driver, LCD, RTC, charging control module, day/night sensor relay and microcontroller. The microcontroller is the most important component of the system. It controls all the operations.

The proposed system uses an Arduino Uno microcontroller integrated directly through a controller and a voltage divider circuit to monitor and store solar energy. This project explains that it can utilize both solar and wind renewable energy to the domestic household in the remote area and it is the most effective choice to deliver high quality power [15]. In this project, it consists of Arduino Uno, Arduino

Uno MPPT, LCD (Liquid Crystal Display), solar panel, wind turbine and battery. Arduino Uno MPPT, Maximum Power Point Tracking is a charge controller mechanism that extracts the maximum possible power from a PV module under particular conditions. Last but not least, the authors using Proteus software to create connection diagram of proposed system.

This research reveals how a sun tracking photovoltaic (PV) array system and a Wind Hybrid Electric Power System (HEPS) interface to the grid may be designed using renewable resources [16]. In this research, coordinated generation of electricity is shown to improve the system's power quality. In most low radiation PV array systems, the inverter outputs a lower voltage than the specified voltage, lowering the power quality. As an end, the combined generation of electricity by wind and solar energy is considered in this article, taking into consideration all radiation, temperature, wind speed, and variations in load demand throughout the day. The design and analysis of a PV/Wind Hybrid Electric Power System in MATLAB are presented in this study.

2.2 Flowchart

The system starts with solar, hydro and wind source. The sources were obtained by using different kind of methods. The solar source obtains from solar panel. Solar panel is a device that captures the sun’s rays and converts them to power or heat. Wind turbines transform the wind's kinetic energy into mechanical energy. A generator is a device that converts mechanical energy into electrical energy. Hydroelectric power is generated by turbines that transform the potential energy of flowing water into mechanical energy, resulting in electricity. As the power sources obtained, it will be channeled to the Digital Voltmeter, Ammeter and Watt meter. It is a device that will show and measure the voltage and current obtained from the collected sources.

After that, the power will flow through the controller. By controlling the voltage and current flowing from the solar panel to the battery, a solar charge controller prevents the battery from overcharging. The function of battery storage is to store the energy. From the battery storage, the supply can be used to generate the home appliances. Turn back to the controller, the power will channel to the inverter. Inverter is a type of electrical converter which converts the variable direct current (DC) into a alternating current (AC). Before the electric power flows to AC home appliances, the circuit is controlled by a microcontroller which is WiFi microcontroller and relay. The microcontroller will be programmed to allow the relay to act as switch in the circuit. As the WiFi controller has been set up, the user can control to ON or OFF the circuit and allow the current flows to the C home appliances.

2.3 Block Diagram

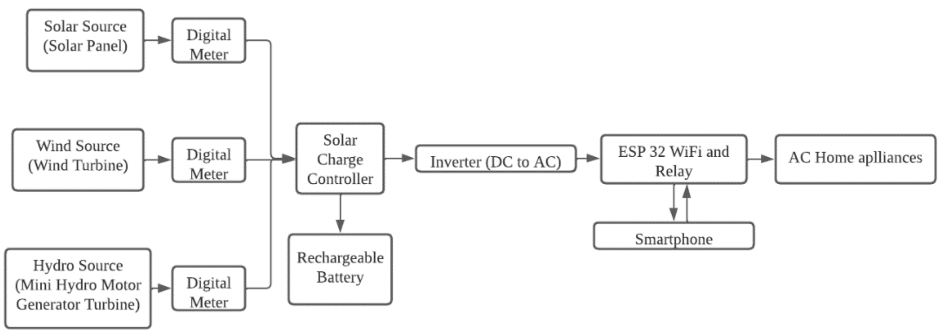

Figure 1: Block Diagram

As shown in the Figure 1, solar panel is use to absorb sunlight energy and produce power. The aerodynamic force of the rotor blades converts wind energy into electricity in a wind turbine meanwhile hydro mill. The kinetic energy of flowing water is converted into mechanical energy by a turbine. The mechanical energy from the turbine is then converted into electrical energy via a generator. The use of meters such as voltmeter, ammeter and wattmeter for the purpose of measuring the value of energy obtained. Send a signal to the user the current, voltage, power, battery capacity and cumulative total watts are all monitored in real time.

The controller will be used to control the power generated by renewable energy. Solar charger controller will be used for solar panels. The specification of product is battery voltage is 12V/24V auto, the USB output will be 5V/3A and working temperature can be said is -35°C to +60°C. Inverter is function to convert direct current electricity to alternating current electricity. Electricity is kept at a constant voltage in one direction in DC. When the voltage in the circuit changes from positive to negative, electricity flows in both directions in AC. Inverters are part of a group of devices known as power electronics that regulate the flow of electricity. Both components will act as a switch for home appliances.

Wi-Fi microcontrollers allow devices to connect to the internet and send and receive data as well as accept commands. The ESP8266 specifications are can operate for 2.4 GHz Wi-Fi, supporting WPA/WPA2). Serve as an output in this project. The power obtained from the renewable energy will be used to operate home appliances. AC input voltage can operate in range: 100 - 240 VAC while AC input line frequency is 50 to 60 Hz (nominal). Battery storage functions to store power obtained and allow stored power to be channeled to home appliances. The specification is input specific, DC 12V/10A while the AC output, 220V/ 50 Hz.

3. Results and Discussion

3.1 Hardware

Figure 2: Top View of Product

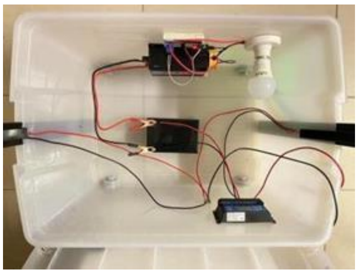

Figure 3: Top View of Product (Inside)

Figure 4: Side View of Product

Figure 5: Front View of Product

The Figure 5 above shows the hardware and equipment that has been used in the project. Renewable energy equipment such as solar panels, wind turbines, and mini hydro motor turbine generators have been installed to collect energy sources from the sunlight, wind, and water. In Figure 2, the solar panels, it has been placed on top of the container and facing upwards. Wind turbines are also used in this project. The hardware position is placed on the side of the container with a wooden stick as shown in Figure 4. The wind will blow and the blade will rotate and the voltage will be produced. For hydro energy, the mini hydro motor turbine generator is placed on the side of the container opposite the position of the wind turbine. To produce hydro energy, it has been equipped with bottles, valves, mini hydro motor generator turbines and water pipes. Inside the container box, it has contained with solar charge controller, rechargeable battery, inverter, AC load, ESP 32 WiFi, and relay as shown in the Figure 3.

3.2 Result of each testing, graphs & explanations

3.2.1 Power Sources Are Generated from Sunlight Sources (Solar Energy) In 3 Days A Row

Table 1: Power gained by solar energy in day 1

Day	Time	VoltageGained (V)	Current (A)	Power (W)
1	6 a.m	0	0.0	0
	7 a.m	3.0	0.11	0.33
	8 a.m	8.5	0.24	2.04
	9 a.m	9.7	0.28	2.72
	10 a.m	10.4	0.33	3.43
	11 a.m	11.9	0.42	4.99
	12 p.m	12.8	0.45	5.76
	1 p.m	12.5	0.43	5.38
	2 p.m	13.5	0.50	6.75
	3 p.m	12.3	0.44	5.41
	4 p.m	11.9	0.39	4.64
	5 p.m	11.1	0.34	3.77
	6 p.m	10.8	0.31	3.35
	7 p.m	6.6	0.22	1.45

Table 2: Power gained by solar energy in day 2

Day	Time	VoltageGained (V)	Current (A)	Power (W)
2	6 a.m	0.12	0.0	0
	7 a.m	5.8	0.24	1.39
	8 a.m	7.3	0.23	1.68
	9 a.m	10.3	0.32	3.29
	10 a.m	11.6	0.45	5.22
	11 a.m	12.6	0.49	6.17
	12 p.m	12.9	0.52	6.71
	1 p.m	13.4	0.55	7.37
	2 p.m	13.5	0.55	7.42
	3 p.m	12.6	0.51	6.43
	4 p.m	12.3	0.45	5.54
	5 p.m	12.5	0.47	5.88
	6 p.m	11.2	0.34	3.81
	7 p.m	9.4	0.22	2.07

Table 3: Power gained by solar energy in day 3

Day	Time	Voltage Gained (V)	Current (A)	Power(W)
3	6 a.m	0	0.0	0
	7 a.m	4.1	0.20	0.82
	8 a.m	8.7	0.26	2.26
	9 a.m	10.5	0.33	3.47
	10 a.m	11.8	0.44	5.19
	11 a.m	12.3	0.45	5.54
	12 p.m	12.5	0.45	5.63
	1 p.m	13.1	0.50	6.55
	2 p.m	13.0	0.49	6.37
	3 p.m	12.8	0.41	5.25
	4 p.m	11.9	0.39	4.64
	5 p.m	10.5	0.32	3.36
	6 p.m	9.3	0.31	2.88
	7 p.m	8.3	0.23	1.91

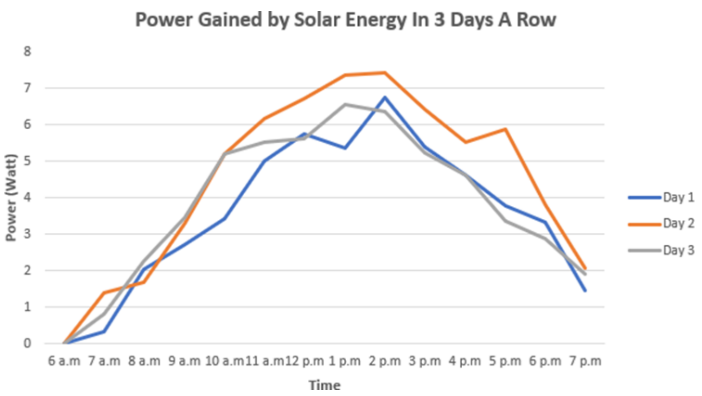

Figure 6: Line graph of power gained by solar energy

According to the Table 1, Table 2 and Table 3 it shows the findings that were acquired for the power gathered by solar energy for three days in a row, the results for the first day revealed that the maximum power that was successfully recorded was 6.75 watts. At two o'clock in the afternoon, data were successfully captured. At that point in time, the value of the voltage was 13.5 V, while the value of the current was 0.50 A. In Table 2, the greatest wattage reading that could be obtained satisfactorily on the second day was 7.42 watts. The wattage in Figure 6 reached its maximum at two in the afternoon since the solar panel was exposed to the most amount of sunshine at that time. The value of the increased current is 0.55 A, while the value of the gained voltage is 13.5 V. Based on Figure 6, on the third day of the investigation, researcher resumed the efforts to determine the power value of solar energy. According to Table 3, the wattage value was 6.55 W at one o'clock in the afternoon. On that particular day, the sky was clear and bright, and the solar panels had successfully soaked up all of the sun's rays and energy. 13.1 volts and 0.50 amperes are the values of the voltage and current that must be present in order to produce one watt of electricity. With a reading of 4.1 volts for the voltage and 0.2 amperes for the current, the lowest wattage that could be correctly measured is 0.82 W. The sun rises toward the east, therefore at seven in the morning, the light from the sun is not yet at its maximum intensity. This type of occurrence may thus occur. A contrast can be made by looking at Figure 6, which shows that Day 2 yields the greatest power value, with a measurement of 7.42W. This can be seen by looking at the graph. On that particular day, the position of the sun that produces its light is positioned in such a way that it is directed straight at the solar panel, and the position of the cloud does not block the route that the sunlight takes.

3.2.2 Power Sources Are Generated from Sunlight Sources (Solar Energy) During Rainy Day

Table 4: Power gained by solar energy during rainy day

Time	Voltage Gained (V)	Current (A)	Power (W)
6 a.m	0.5	0.02	0.01
7 a.m	3.3	0.16	0.53
8 a.m	8.7	0.22	1.91
9 a.m	9.2	0.28	2.58
10 a.m	10.9	0.42	4.58
11 a.m	11.5	0.45	5.18
12 p.m	12.8	0.48	6.14
1 p.m	13.7	0.50	6.85
2 p.m	11.3	0.44	4.97
3 p.m	9.6	0.29	2.78
4 p.m	8.2	0.23	1.89
5 p.m	7.5	0.21	1.58
6 p.m	6.7	0.20	1.934
7 p.m	5.6	0.17	0.95

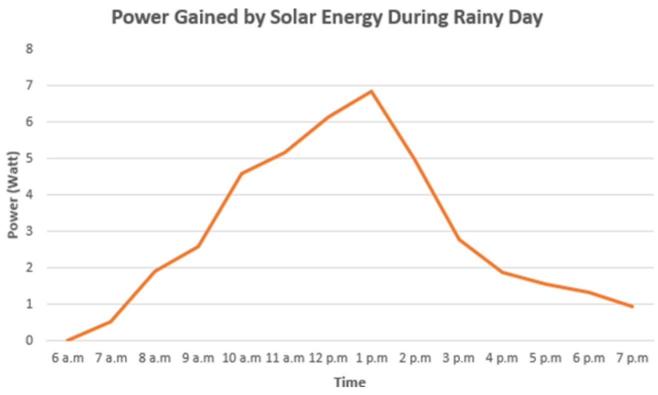

Figure 7: Line graph of power gained by solar energy during rainy day

According to the Figure 7, it shows the line graph of power gained by solar energy during rainy day. The power value was determined to be 6.85W as a result of the experiment that was carried out at one in the afternoon, and the result is the highest power value that was recorded. In the Table 4, at two in the afternoon, the sky started to turn gloomy, and by three in the afternoon, it started to rain. However, on that particular day, the operation did not take place since it was raining out. At 2 p.m., the recorded power reading value was 4.97W and drastically decreased to 5 p.m. compared to the other day.

3.2.3 Power Sources Are Generated from Sunlight Sources (Solar Energy) During Cloudy Day

Table 5: Power gained by solar energy during cloudy day

Time	Voltage Gained (V)	Current (A)	Power (W)
6 a.m	0	0.0	0
7 a.m	2.8	0.13	0.36
8 a.m	4.1	0.22	0.90
9 a.m	8.5	0.26	2.21
10 a.m	8.4	0.23	1.93
11 a.m	8.2	0.22	1.80
12 p.m	8.1	0.21	1.70
1 p.m	8.5	0.23	1.96
2 p.m	8.3	0.25	2.1

3 p.m	9.6	0.29	2.8
4 p.m	11.9	0.45	5.36
5 p.m	11.4	0.43	4.90
6 p.m	11.1	0.43	4.77
7 p.m	8.6	0.26	2.24

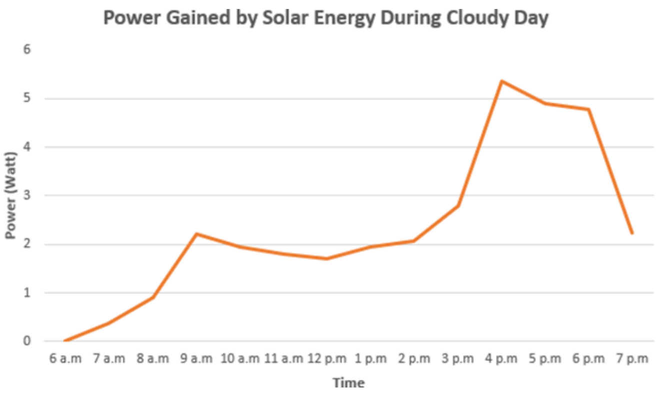

Figure 8: Line graph of power gained by solar energy during cloudy day

According to the Table 5, the value of power increasing starting from 6 a.m until 9 a.m. Unfortunately, the values become decreasing starting from 9 a.m. until 2 p.m. According to the Figure 8, the weather became cloudy and caused the process of generating power by solar panels to be less. During the 5 hours between 9 a.m. and 2 p.m., the lowest value that was successfully taken was 1.7 W. The power value was taken at 12 noon. This is because at that time, the position of the clouds has changed. At 3 pm, the reading for the power value had changed to increasing. At 3 o'clock, the power value is 2.8 W.

3.2.4 Power Sources Are Generated from Sunlight Sources (Solar Energy) During Sunny Day

Table 6: Power gained by solar energy during sunny day

Time	Voltage Gained (V)	Current (A)	Power(W)
6 a.m	0.8	0.03	0.03
7 a.m	3.1	0.15	0.47
8 a.m	9.5	0.28	2.66
9 a.m	10.2	0.41	4.18
10 a.m	10.9	0.42	4.58
11 a.m	11.4	0.44	5.01
12 p.m	12.5	0.45	5.63
1 p.m	13.7	0.55	7.54
2 p.m	13.4	0.46	6.16
3 p.m	13.5	0.46	6.21
4 p.m	12.3	0.45	5.54
5 p.m	11.7	0.44	5.14
6 p.m	11.4	0.43	4.90
7 p.m	9.9	0.30	2.97

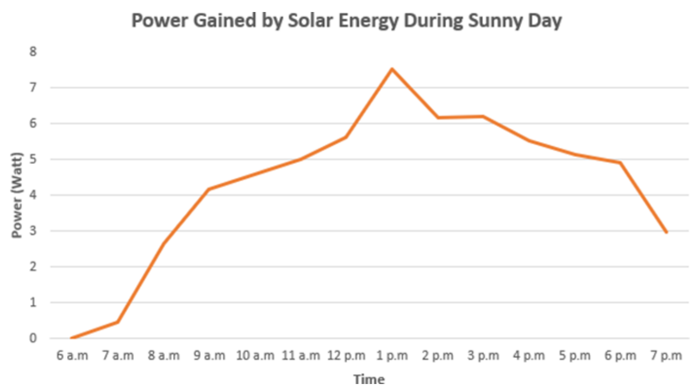

Figure 9: Line graph of power gained by solar energy during sunny day

According to the Figure 9, the maximum power gained that the solar produce is 7.54 Watt. This is because during 1 p.m. the solar panel generated 13.7 V and the current is 0.55A. While in the 6 a.m., the power generated is the lowest among the others. The sunlight at that moment is not as bright and hot when compared to 1 p.m. The sun will rise from the east in the morning and will set in the evening towards the west. The sunlight plays a very important role during the process of absorption of solar energy. The more sunlight is emitted, the more energy the solar panel will produce. The voltage value generated by the solar panel was taken using a digital multimeter.

3.2.5 Power Sources Are Generated from Wind Sources (Wind Energy) In 3 Days A Row

Table 7: Power gained by wind energy in 3 days a row

Day	Time	Voltage Gained (V)	Current (mA)	Power(mW)
1	8 a.m.	0	0.00	0
	10 a.m.	0.2	0.00	0
	12 p.m.	1.1	0.03	0.033
	2 p.m.	1.3	0.08	0.104
	4 p.m.	1.8	0.10	0.180
	6 p.m.	0.6	0.02	0.012
2	8 a.m.	0.9	0.03	0.027
	10 a.m.	0.0	0.00	0
	12 p.m.	1.0	0.07	0.070
	2 p.m.	0.4	0.01	0.004
	4 p.m.	0.7	0.02	0.014
	6 p.m.	0.0	0.00	0
3	8 a.m.	0.0	0.00	0
	10 a.m.	0.5	0.01	0.005
	12 p.m.	0.4	0.01	0.004
	2 p.m.	3.2	0.21	0.672
	4 p.m.	0.8	0.03	0.024
	6 p.m.	0.9	0.03	0.027

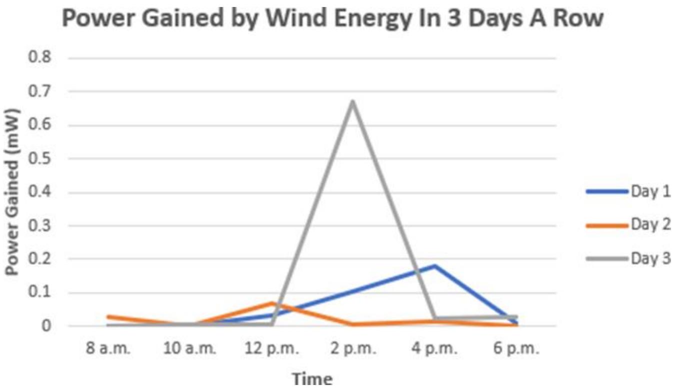

Figure 10: Line graph of power gained by wind energy in 3 days a row

Based on the Figure 10, the study was conducted starting at 8 a.m. until 6 p.m. On the first day, the highest power value successfully recorded was 0.180 mW while the lowest power value was 0.120 mW. For the highest power value recorded was at 4 p.m. with a voltage reading of 1.8 VDC and a current value of 0.10 mA. Next, on the second day the highest power reading is 0.070 mW. The lowest power reading was also recorded as low as 0.004 mW. For the highest power value recorded, the voltage value taken is 1 VDC and the current value is 0.07 mA. From the line graph above in Figure 10, the second day has a low power reading if compared to the first day. The study was continued again on the third day to obtain the value of power gained by wind energy for 3 days consecutively. On the third day, the highest power reading recorded was 0.672 mW at 2 p.m. The voltage value for the highest power is 3.2 VDC and the current value is 0.21 mA. The lowest power reading is at 12 p.m with a value of 0.004 mW. Among the three days, the data can be concluded that the highest power value successfully recorded was on the third day. The blades of the wind turbine will rotate according to the speed of the wind that passes through it. The faster the blade rotates, the higher the resulting voltage value. Next, the second highest reading on the first day with a reading of 0.180 mW. This shows that the wind that was blowing at that time was not as fast as the third day.

3.2.6 Power Sources Are Generated from Wind Sources (Wind Energy) During Rainy Day

Table 8: Power gained by wind energy during rainy day

Time	Voltage Gained (V)	Current (mA)	Power(mW)
8 a.m.	1.1	0.07	0.077
10 a.m.	0.3	0.01	0.003
12 p.m.	5.1	0.46	2.346
2 p.m.	4.8	0.39	1.872
4 p.m.	0.9	0.05	0.045
6 p.m.	1.0	0.07	0.070

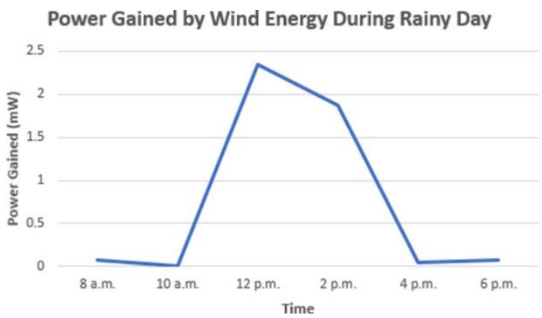

Figure 11: Line graph of power gained by wind energy during rainy day

According to the Table 8, the data was taken from 8 a.m. to 6 p.m. The data recorded in the table is taken every 2 hours. Starting at 10 a.m., the data showed the power value increasing at 12 noon. The power value reading recorded at 12 p.m was 2.346 mW. At that hour, it had rained and caused the wind to blow on the wind turbine. The power value recorded is the result from the voltage value taken which is 5.1 VDC and the current value is 0.46 mW. However, the power value found in Figure 11 decreases at 2 pm. This is because the wind blow is not as strong as it was at 12 p.m. The value continued to fall until 4 p.m., but there was a very slight increase at 6 p.m. The value at 6 pm is 0.070 mW. From here, it can be said that the highest power value is 2.346 mW and the lowest is 0.003. The difference value between the two readings is 2.343 mW.

3.2.7 Power Sources Are Generated from Wind Sources (Wind Energy) During Cloudy Day

Table 9: Power gained by wind energy during cloudy day

Time	Voltage Gained (V)	Current (mA)	Power(mW)
8 a.m.	0	0	0
10 a.m.	0.9	0.07	0.063
12 p.m.	0.3	0.01	0.003
2 p.m.	1.6	0.10	0.160
4 p.m.	4.3	0.33	1.419
6 p.m.	2.5	0.15	0.375

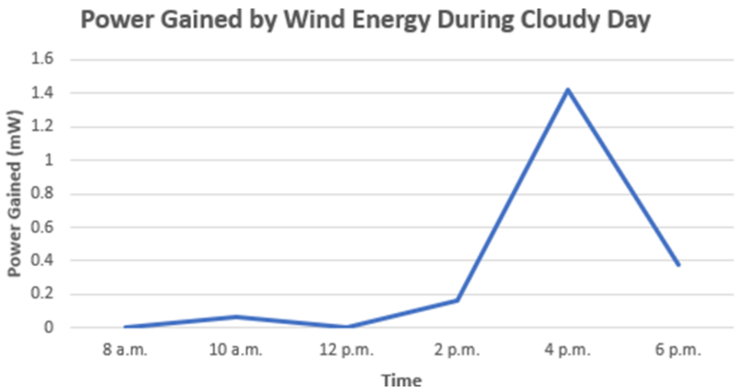

Figure 12: Line graph of power gained by wind energy during cloudy day

Table 9 shows the data for power gained by wind energy during cloudy days. The readings for voltage and current were taken using a digital multimeter in every 2 hours. The values of voltage and current taken are due to obtain the value of power (watts). At 8 a.m to 2 p.m, the reading for the resulting power is small, which is below 0.2 mW. At that point, sunny weather prevailed throughout that period. The wind blows slowly causing the wind turbine to produce a small amount of power. However, at 4 p.m, the readings show the highest power reading produced by a wind turbine is 1.419 mW. On that day, the clouds had darkened as they were filled with water and a strong wind was blowing at 4 p.m. The wind speed increased until 4 p.m., causing the wind turbine to produce a high-power value compared to other times. The graph pattern becomes drastically inclined from 2p.m to 4p.m.

3.2.8 Power Sources Are Generated from Wind Sources (Wind Energy) During Sunny Day

Table 10: Power gained by wind energy during sunny day

Time	Voltage Gained (V)	Current (mA)	Power(mW)
8 a.m.	0	0	0
10 a.m.	0	0	0
12 p.m.	0.5	0.02	0.01
2 p.m.	1.3	0.08	0.104
4 p.m.	0	0	0
6 p.m.	2.9	0.12	0.35

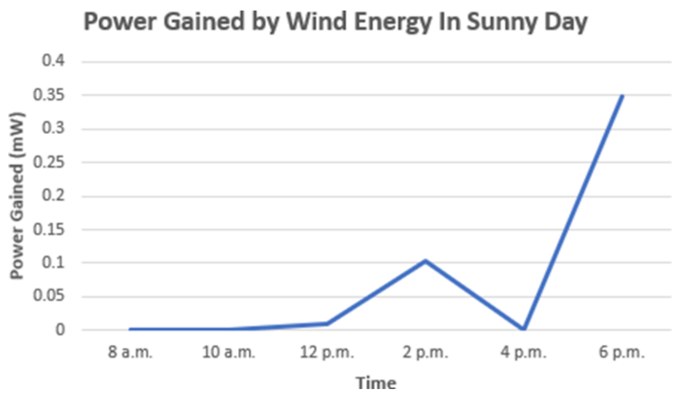

Figure 13: Line graph of power gained by wind energy during sunny day

Based on the Table 10, the highest power successfully generated was at 6 p.m. This is because, the wind at that time was blowing quite strong. The power value has been calculated based on the voltage and current value. To obtain the voltage value, a digital multimeter was used and installed in a parallel connection while the current value was taken which multimeter will be connected in series connection. The series connection has been installed with a load which is a battery. Meanwhile, the lowest power that has been produced based on the experiment is at 12 pm. At that point, the wind was blowing slowly but the sunlight was shining very brightly and was able to charge the battery. The value of the resulting voltage at that time is 0.5 VDC and the value of the resulting current is 0.02 mA. Both of these values play a role in determining the value of power.

3.2.9 Power Sources Are Generated from Hydro Sources (Hydro Energy)

Table 11: Power gained by hydro energy

Repetition	Voltage Gained (V)	Current (mA)	Power (mW)
1	3.6	0.68	2.448
2	3.1	0.57	1.767
3	2.9	0.55	1.595
4	3.2	0.58	1.856
5	3.8	0.64	2.432
6	2.9	0.55	1.595
7	3.0	0.53	1.590
8	3.7	0.63	2.331
9	3.9	0.65	2.535
10	3.5	0.66	2.310

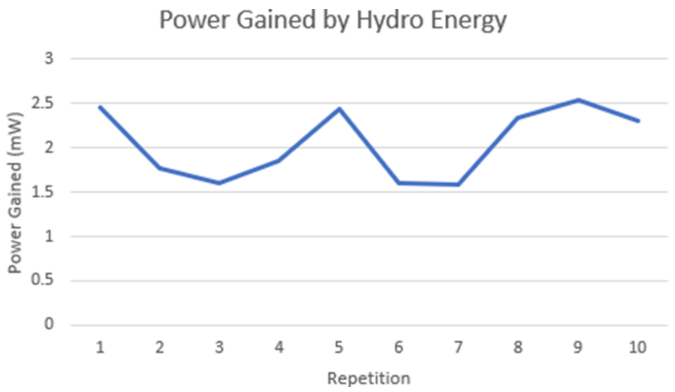

Figure 14: Line graph of power gained by hydro energy

According to the Table 11, it was indicated that the experiment was carried out a total of ten times. The bottle is now being filled with tap water until it is completely full. After reaching capacity, the pipe valve will be opened in order to release the water. The water will flow through the turbine of the mini hydro generator, which will cause the generator to produce electricity. According to the findings, the maximum power value that could be effectively recorded was 2.535 mW. After utilizing the solar charge controller that was linked to the battery as a load during the experiment, the current value (in milliamperes, or mA) was determined. While the least amount of power possible is just 1.590 milliwatts. The difference between the greatest and lowest power levels is not very significant. In Figure 14, after ten cycles, the average reading reveals that 3.36 volts have been generated. In the meanwhile, the power that may be stated on average is 2.046 milliwatts. If a mini hydro generator turbine is installed on a waterfall rapid, the voltage value may be enhanced to a greater extent. This occurs as a result of the torrential nature of the water that is rushing over the waterfall rapids. The purpose of the bottles in this experiment is only to serve as a model for the actual circumstance. In a real-world scenario, a mini hydro motor turbine generator will be installed in the route of a stream or water rapid where the speed of the water going through is quite fast. This will allow the generator to take advantage of the high-water velocity. As a result, gaining the process of high power has become much simpler.

3.2.10 Power Sources Are Generated from A Combination of 3 Power Energy (Solar, Wind and Hydro) Energy

Table 12: Power gained by combination of 3 power energy (solar, wind and hydro)

Time	Voltage Gained (V)	Current (A)	Power (W)
6 a.m	2.6	0.03	0.078
7 a.m	9.3	0.25	2.325
8 a.m	12.5	0.38	4.750
9 a.m	13.4	0.40	5.360
10 a.m	13.7	0.42	5.754
11 a.m	13.6	0.40	5.440
12 p.m	15.4	0.53	8.162
1 p.m	15.5	0.54	8.370
2 p.m	15.5	0.54	8.370
3 p.m	15.5	0.54	8.370
4 p.m	14.1	0.45	6.345
5 p.m	13.9	0.42	5.838
6 p.m	13.2	0.40	5.280
7 p.m	10.9	0.21	2.289

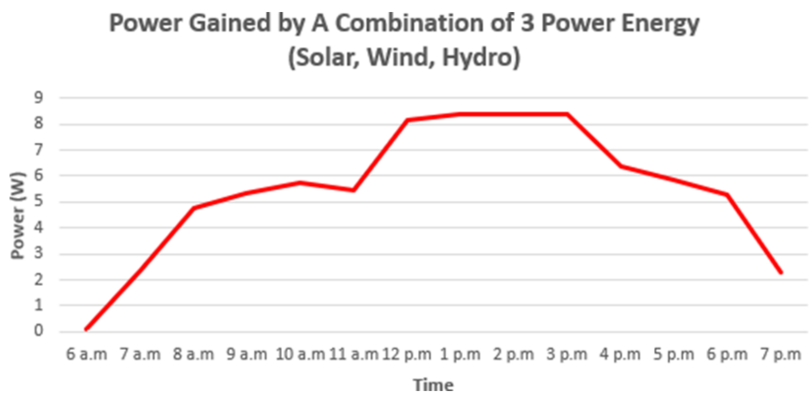

Figure 15: Line graph of power gained by a combination of 3 power energy

In addition to the data that is collected from solar, wind and hydropower, the data is also obtained from a mix of these three different types of power sources. In this endeavor, the power gained from solar energy is the greatest, followed by the power acquired from hydro energy. The data for the voltage, ampere, and power values that were correctly recorded are shown in Table 12 above. Readings of the data were obtained from six in the morning till seven in the evening. As can be observed, the power values are at their peak at one o'clock, two o'clock, and three o'clock in the afternoon, with a reading value of 8.37 W. The value of the current is 0.54 A, and the value of the voltage is 15.5 VDC as it is indicated in the table above. The smallest value of power that was measured was 0.078 W. This occurs because around six in the morning, the sun has just risen in the east, which prevents the solar panel from being able to take in the sun's rays and convert them into usable energy. In addition, the wind turbine that had been installed next to the storage container did not get any airflow from the wind at that period. The resultant voltage value comes from a hydropower source and has a value of 2.6 volts. Water was poured into the bottle until it was full and then the valve pipe was opened to flow water through the mini hydro motor generator turbine. While based on Figure 15, the graph pattern shows starting from 6 a.m to 10 a.m line graph become increase but around 11 a.m graph pattern slightly decreasing. In the evening, the pattern graph shows that the line graph is declining. The power value at 7 p.m. is 2.289 W.

3.2.11 Time Taken to Charge Battery by Using Combination of 3 Power Sources (Solar, Wind and Hydro)

Table 13: Time taken to charge battery using combination of 3 power sources

Day	Time	Time Taken to Charge 12V Battery (Hours)	Voltage (V)
	9 a.m.	0	10.4
	10 a.m.	1	10.6
	11 a.m.	2	10.9
	12 p.m.	3	11.3
1	1 p.m.	4	11.7
	2 p.m.	5	12.1
	3 p.m.	6	12.5
	4 p.m.	7	12.8
	5 p.m.	8	13.1
	6 p.m.	9	13.3
	9 a.m.	10	13.5
2	10 a.m.	11	13.8
	11 a.m.	12	14.1
	12 p.m.	13	14.4
	1 p.m.	14	14.4 Discharge

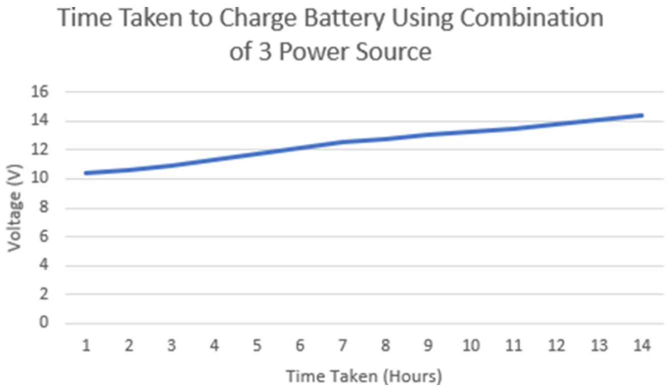

Figure 16: Line graph of time taken to charge battery

Referring to the Figure 16, the total time taken to charge battery is 14 hours. Starting from 10.4 Volts, the battery will be charged up to 14.4 V. In this project, the battery used is 12 V 12 AH Battery Matrix Rechargeable Sealed Lead Acid. The process to charge the battery starts from 9 am to 6 pm. According to Table 14, the value of the battery that was successfully charged on the first day was 13.3 V. The next day, the battery was connected to charge to get a full charge. When the process of charging the battery takes place, the process has been controlled by the solar charge controller. A solar charge controller prevents overcharging of the battery by limiting the voltage and current flowing from the solar panel, wind turbine and mini hydro generator turbine to the battery. In this project, the value that has been set to prevent from over charging is 14.4 V. Therefore, after the battery is fully charged, the solar charge controller will not allow voltage to flow to the battery. At 12 noon, the solar panel provides a lot of voltage and current to charge the battery. This is because, solar panels are the largest source of energy to be stored in the battery while wind and hydro provide less energy. However, the energy produced by wind and hydro is small, it still contributes to charging the battery.

3.2.12 Supplying Energy to Load Control by IoT

Table 14: Activation of load control by IoT

Distance (Meter, m)	Activation ofLoad				
1	1	1	1	1	1
	1	1	1	1	1
10	1	1	1	1	1
	1	1	1	1	1
100	1	1	1	1	1
	1	1	1	1	1
1000	0	0	0	0	0
	0	0	0	0	0

In this project, the ESP32 gets its supply from the USB port of the inverter, where the USB port supplies 5 VDC. The input voltage for the ESP32 is 5V to turn it on. According to the Table 14 results, the ESP 32 WiFi's maximum distance for connecting to the internet through smartphone is 100 meters. This mean that the microcontroller must place within 100 meters from the smartphone. A total of 10 trials were performed with different distances to identify the ability to turn on the load by being controlled by a smartphone. By using the Blynk application, all settings and interfaces have been done. While the coding to activate the ESP 32 WiFi and relay is programmed using Arduino IDE software. The building structure and signal strength between the smartphone and the ESP 32 are among the obstacles when conducting this experiment. Without a stable signal, it is not able to activate the ESP 32 to control the relay which it is acts as a switch in this project. Within a distance of 10 meter between the smartphone and the ESP 32 WiFi, all the data showed that the activation of load was successfully turned on. This is because ESP 32 has a distance specification that can accommodate a distance of 10 meter. Within 1 meter, load activation was successfully turned on without any problems. 1 meter is a very close distance compared to other distances. However, even though it was just 1000 meter away, the ESP 32 WiFi was unable to turn on the lights since the distance was too far. Normally, users will only turn on the light at a distance of 10 to 100 meters if they are controlling it from a distance. Therefore, a distance of 1000 meters was disregarded in the course of this research.

4. Conclusion

After successfully obtained results, it can be said that renewable energy can keep our environment clean and healthy. In addition, by using renewable energy, the depletion of the ozone layer can be reduced by not having to burn coal to produce electricity. Therefore, air pollution can be curbed while keeping our earth in good condition. The main objective of electrical power generators from renewable energy power sources which are solar, wind, and hydro is to combine all these sources of power into a larger source of electricity. The result shows the voltage and current generated become larger when compared to the existing source. So, the combined resources become large, and thus, the process of charging the battery becomes fast and saves time. As well as that, the energy that is generated and apply the obtained energy to some electrical equipment. The power obtained by the system is faster than the usual device. It comes from three renewable energy that was combined to become one device. It also can be used by the component that has high voltage. Along with that, a system that remotely controls the electrical equipment by using an embedded system is controlled by IoT. This will make the system more efficient and easier to use. It can monitor through a phone or other technology that is connected to IoT. The application of the IoT can activate the load of the control. This project can be improved in many ways. The tail fin which changes the direction of the wind turbine and accommodates variations in the approaching wind direction can be added. This will make the blade rotate faster with the tail fin. The voltage and current generated become larger when compared to the existing source. So, the combined resources become large, and thus, the process of charging the battery becomes fast and saves time.

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