

# East West University



**B. Sc. Engineering Thesis**

## **Solar and Wind Connected Hybrid Renewable Energy System for Small Scale Applications**

---

**Authors:**

Joya Roy

2018-2-55-007

Md. Masudur Rahman Emon

2018-1-55-013

Abdullah Sakib Shishir

2018-2-55-012

**Supervisor:**

**Sarwar Jahan**

Assistant professor

Department of Electronics and  
Communication Engineering

A thesis submitted to the Department of Electronics & Communication Engineering  
in partial fulfillment of the requirements for the degree of Bachelor of Science in  
Electronics & Telecommunication Engineering

Fall 2022



# Letter of Acceptance

The thesis/project titled “Solar and wind connected hybrid renewable energy system for small scale applications” submitted by Joya Roy (2018-2-55-007), Md. Masudur Rahman Emon (2018-1-55-013) and Abdullah Sakib Shishir (2018-2-55-012) of Electronics and Communications Engineering, East West University, Dhaka-1212, Bangladesh has been accepted as satisfactory in partial fulfillment of the requirement for the degree of Bachelor of Science in Electronics & Telecommunication Engineering.

---

**Mohammad Arifuzzaman, PhD**

Associate Professor and Chairperson

Department of Electronics and Communications Engineering

EAST WEST UNIVERSITY

---

**Sarwar Jahan**

Assistant Professor,

Department of Electronics and Communications Engineering

EAST WEST UNIVERSITY

# Declaration

It is hereby declared that, the thesis submitted is my/our own original work while completing degree at East West University. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution. I/We have acknowledged all main sources of help.

---

Md.Masudur Rahman Emon

2018-1-55-013

---

Abdullah Sakib Shishir

ID-2018-2-55-012

---

Joya Roy

ID-2018-2-55-007

# Acknowledgement

With the significant judgment skills and strongly appreciation, we take this prospect to express our sincere thanks to Almighty ALLAH for giving us strength and might to accomplish this stage of life. We moreover thank our guardians who gave us incredible ethical bolster at each step. We would like to extend our true appreciation to our supervisor Sarwar Jahan Assistant Professor, Department of Electronics & Communication Engineering, EWU, for his direction, persistent support, significant opinion and recommendations during the whole process of research which made a difference lead us in completing this thesis. We are grateful to EWU for giving us with all the vital materials required for the successful completion of the thesis.

# Abstract

This paper represents a miniature project on hybrid renewable system using solar and wind energy. As Bangladesh is the 8th most populous country in the world, so the demand of electricity is always at peak. Because of this disruption of electricity, houses-medical centers, primary schools in those affected areas suffer from a lot of problems due to lack of proper treatment and other basic needs. To minimize this problem, we came out with an innovative project- idea of building a miniature hybrid renewable energy system based on solar and wind energy. To build this project, we used Arduino as microcontroller chip and for simulating the system we used PROTEUS simulation model. We are also adding an alternative USB cable as back-up energy supplement for our project in case of either wind or solar is not available/broken or in case of any failure in the main system. We believe the combination of wind, solar and battery will be enough to fulfill the demand of electricity which we have shown in the miniature project.

Keywords: Renewable Hybrid Energy, LED light, Wind Turbine, Solar panel, Pump, Arduino, Proteus.



# Table of contents

<b>1</b>	<b>INTRODUCTION</b>	<b>1</b>
1.1	Outline of Renewable Energy.....	2
1.2	Wind Energy.....	2
1.3	Solar Energy.....	3
1.4	Statistics of Wind and Solar System in Bangladesh.....	3
1.5	Objectives.....	4
1.6	Social Impact of the Project.....	4
1.7	Thesis Outline.....	5
<b>2</b>	<b>SOLAR AND WIND ENERGY SYSTEM</b>	<b>6</b>
2.1	Wind Energy Systems.....	7
2.2	Introduction and Background.....	7
2.3	Working of Wind Energy System.....	7
2.4	Types of Wind Turbine.....	8
2.5	Site Selection for Installing Wind Turbine.....	9
2.6	Solar Energy Systems.....	10
2.7	Introduction and Background.....	10
2.8	Working Principles of Solar System.....	11
2.9	Different Kinds of Solar Panel.....	11
<b>3</b>	<b>METHODOLOGY</b>	<b>14</b>
3.1	Required Components.....	15
3.2	Hardware Module.....	15
3.3	Circuit Setup.....	20
3.4	Explanation of Circuit Setup.....	20



3.5	Planning.....	20
3.6	Implementation.....	22
<b>4</b>	<b>CIRCUIT DIAGRAM AND EXPLANATION</b>	<b>23</b>
4.1	Introduction of Charge Controller.....	24
4.2	Systemic Block Diagram.....	25
4.3	Block Diagram.....	25
4.4	Flow Chart.....	26
4.5	Circuit Diagram.....	27
4.6	Explanation and Implementation.....	30
<b>5</b>	<b>RESULT AND ANALYSIS</b>	<b>32</b>
5.1	Load Profile.....	33
5.2	Discussion.....	33
<b>6</b>	<b>CONCLUSION AND FUTURE WORK</b>	<b>34</b>
6.1	Conclusion.....	35
6.2	Future Work.....	35
	Appendix.....	36
	References.....	42

# List of Figures

Fig2.1: Horizontal Wind Turbine.....	8
Fig2.2: Various Axial Types of Wind Turbine.....	9
Fig2.3: Operating Principle of Solar Panel.....	11
Fig2.4: Monocrystalline Solar Panel.....	12
Fig2.5: Polycrystalline Solar Panel.....	12
Fig2.6: Cast-Polysilicon.....	13
Fig3.1: Arduino Board .....	16
Fig3.2: 1-ChannelRelayModule.....	17
Fig3.3: LDR Sensor.....	17
Fig3.4: Pump motor.....	18
Fig3.5: Servo motor .....	18
Fig3.6: DC Motor.....	19
Fig3.7: Circuit Setup.....	20
Fig 3.8: Complete Circuit Setup View.....	22
Fig4.1: Systemic Block Diagram.....	25
Fig4.2: Block Diagram.....	25
Fig4.3: Flow chart of the System.....	26
Fig4.4: Proteus Simulation of Full Circuit.....	27
Fig4.5: Solar Panel ON Mode .....	28
Fig4.6: Wind Turbine ON Mode.....	29
Fig4.7: Wind Turbine and Solar Panel ON Mode.....	30
Fig4.8: Voltage Divider Circuit Diagram.....	31



# **Chapter 1**

## **Introduction**

### 1.1 Outline of Renewable Energy

Over a period of time, any energy that is directly reproduced from the sun such as thermal energy, photovoltaic energy and photochemical energy indirectly from the sun such as wind power, hydroelectricity or other movements is naturally reproduced from nature and natural resources [1]. Renewable energy does not include fossil fuels, waste from fossil sources or waste from inorganic sources.

Some common forms of renewable energy:

- Wind power
- Hydropower
- Biomass
- Solar energy
- Geothermal energy
- Biofuel

We will purposefully concentrate on the wind and solar section as they make up a large portion of this hybrid project.

### 1.2 Wind Energy

To drive wind turbines, air currents can be used. Modern wind turbines have a nominal output between 600 kW and 5 MW; however, turbines with a nominal output of 1.5 to 3 MW are commonly used for commercial use. The performance of the turbine depends on the third power of the wind speed [2]. Productivity will increase drastically as wind speed increases. Typical flow rates are around 20-40%, which is particularly advantageous at higher ranges. Globally, wind energy potential is estimated to be more than five times the current global energy production. Using wind turbines will require large areas, especially in areas with high wind reservoirs. Marine resources have average wind speeds that are 90% higher than land, so marine resources can deliver significantly more energy [3]. Wind energy is renewable and does not produce greenhouse gases.

### 1.3 Solar Energy

As solar energy, we receive solar radiation from the sunbeam. Solar power generation is primarily based on heat engines and photovoltaics. Other solar applications include cooling with solar buildings, daylight, hot water, and so on. Solar cooking and high temperature processes are heated for industrial purposes. Solar technology is frequently referred to as either indirect or direct solar [3]. It is determined by how they absorb, compress, and transmit solar energy. Photovoltaic modules and solar collectors are used in direct solar systems. Utilize energy. Aligning buildings with the sunbeam, using materials with good thermal quality scattering properties, and designing spaces with natural air circulation are all examples of indirect solar technology [4].

### 1.4 Statistics of Wind and Solar System in Bangladesh

The small portion of Asian country energy demand is filled by star electrical phenomenon (PV) system and thus the point read of Bangladesh in terms of radiation 241 0' 0" N ranges and 901 0' 0" E line of longitude. Bangladesh has a gross alternative energy production of 500 MW and a total renewable energy percentage of 39.5 percent [6]. Bangladesh's state-owned infrastructure development company limited (IDCOL) has already installed 3 million solar home systems (SHS), providing clean energy to thirteen million farmers. Bangladesh receives an average daily radiation of 4-5 kWh/m. The Prime Minister's electricity enforced the new mega electricity project vision 2021. According to the International Post, Asian countries have installed over 50,000 SHS (Solar Home System), and Bangladesh is the world's fastest growing nation [6].

Renewable wind energy is rapidly expanding around the world, and turbines are being used to convert wind energy into electrical energy. Bangladesh has produced 900 kW of wind power at the Sonagazi Mukhuri Dam in Feni, as well as a 1,000 kW hybrid power plant on Kutubdia Island; Grameen Shakti, Bangladesh Advanced Research Center (BCAS), BRAC, Bangladesh Army, and IFRD are among the organizations involved. In total, 19.2 kilowatts of electricity have been installed in Bangladesh's coastal areas. Further feasibility studies are needed in Bangladesh for wind turbine electrification. BPDB, on the other hand, recently identified 22 wind power and onshore wind farm

locations in Bangladesh's coastal districts. Furthermore, BPDB has built a 50,200 MW Anawara wind farm in the Chittagong region, as well as a 15 MW wind farm at Feni Mukhuri Dam, Mognamaghat Cox's Bazar, Anwara Beach Parks in Chittagong, Kepupara in Borguna, and Kuakata in Patuahali [6].

### 1.5 Objectives

The use of hybrid renewable energy systems is critical for the globe since global energy consumption is increasing every day, but existing energy sources are insufficient to fulfill power demand [4]. A hybrid renewable energy system, which combines renewable energy sources (solar, wind), may be extremely efficient and is viewed as a great explanation for the problem. Renewable energies will account for more than 30% of the global energy mix by 2040, according to the Sustainable Advancement Situation [2]. We can examine the breakdown of renewable technologies by their separate components –hydropower, solar, wind, and others - in our planet in data.

A quick rental power station project in Bangladesh cannot be sustained for a lengthy period of time. As a result, it has become unavoidable for us to develop new methods of producing power in order to meet demand. In Bangladesh, a hybrid energy system is being developed on St. Martin Island, but we intend to use it at a more basic level [1]. During the day, there is abundant of sunlight, which is a tremendous blessing for Bangladesh because it average, around 4.5 KW/Year and the yearly average wind speed is 3.10 m/s [2]. As a result, the hybrid system is one of the greatest options for meeting future power demands.

### 1.6 Social Impact of the Project

The power supply system is primarily intended to provide maximum dependability for the future of the power sector. As with hybrid renewable energy power, power delivery is dependent on alternate energy sources and backups such as energy storage sub-units. The term hybrid refers to a combination of two or more separate units that provide similar outcomes for a certain purpose. A hybrid solar renewable energy source is always suitable for supplying a small community with long-term stable electricity [3]. Hybrid resources

may be enhanced by connecting energy storage devices so that the energy converters are protected by energy storage devices and a loss energy supply from zero is achieved. As we want to implement this in various sectors thus some impacts can be are:

- This is a one-time installation. Once established, it may be utilized for a long period without spending more than 20-25 years [4].
- This implementation can help rural regions who have been without energy for more than a month due to natural disasters.
- Because this concept is built on hybrid renewable energy, electricity may be generated from both sun and wind. If one of them becomes weakened or damaged, the other can be utilized as a backup complement.
- It is environmentally friendly and safe to use.

### 1.7 Thesis Outline

- This thesis is divided into five chapters, which are as follows:
- Chapter 1 provides an overview of renewable energy, its goals, and the project's societal impact.
- Chapter 2 provides a detailed overview of the literature on general adequacy evaluation, as well as an introduction to wind turbines and solar panels.
- Chapter 3 discusses the circuit diagram and project description. This chapter introduces the block diagram, flow chart, circuit diagram, and project description.
- Chapter 4 features a methodology section that details the components used in the project, an introduction to the hardware module, a block diagram, a circuit setup, an explanation of the circuit configuration, and a load profile.
- Chapter 5 is the conclusions and summary of this thesis project are highlighted, and some future works are also included at the end.



## **Chapter 2**

# **Solar and Wind Energy Systems**

### 2.1 Wind Energy Systems

### 2.2 Introduction and Background

Power issues are one of the most important threats to the world's environment. A substantial number of publications on renewable energy resources and demanding components for the emerging energy industry are neatly grouped in the Washington Archive [5]. Wind energy was included in that collection as the fastest expanding renewable energy industry. Some analysts feel that this trend will need a significant amount of research and development, as well as a national commitment, in order to give the technology an economic foothold. Wind energy was at its peak in the late 1970s, with the first wind turbines appearing in California in the 1980s. Today, the sector is expanding on a global scale [3]. "It is growing because it has become the most economical renewable energy source due to the tremendous growth in the market," he said. Now, the costs range between a few cents per kilowatt-hour, indicating that wind costs have been steadily maintained over the past decades "to bring them into a competitive range with some conventional technologies."

### 2.3 Working Principle of Wind Energy System

Almost all wind turbines are composed of three rotor blades set on a tubular steel tower. Less frequent variants include two wings or concrete or steel lattice towers. The tower, which is 100 feet or more above ground, permits the turbine to move. Take advantage of the increased wind speeds at higher altitudes. Turbines use propeller blades that behave like airplane wings to capture wind energy. When the wind blows, a low-pressure airbag forms on one side of the blade and the low-pressure airbag pulls the blade inward, forcing the rotor to spin. This is known as a lift. Lift is substantially stronger than drag, which is the force of the wind against the face of the blade. The rotor turns like a propeller due to the combination of lift and drag. A collection of gears is employed to boost the rotor's speed, and the substantial speed of the rotor allows the turbine's generator to create alternate current.

## 2.4 Types of Wind Turbine

Wind turbines are mainly two types:

- A. Horizontal axis
- B. Vertical axis

### A. Horizontal Axis

In wind turbines with a horizontal axis, the rotor shaft rotates horizontally. This system consists of a mounted rotor with more than two blades facing the wind, rotating around a horizontal axis, and an electric spinning generator. The blades are made of composite material and reinforced fiber plastic due to their heavy strength and low weight. Windmills are also built in other European countries with outputs ranging from a few kilowatts to several megawatts [10].

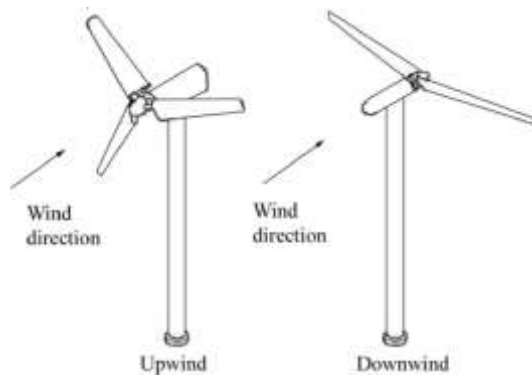


Fig2.1: Horizontal Wind Turbine [14]

### B. Vertical Axis

The rotor shaft of vertical-axis wind turbines travels vertically [4]. The tower's construction function is simple here since pieces may be found near the ground below.

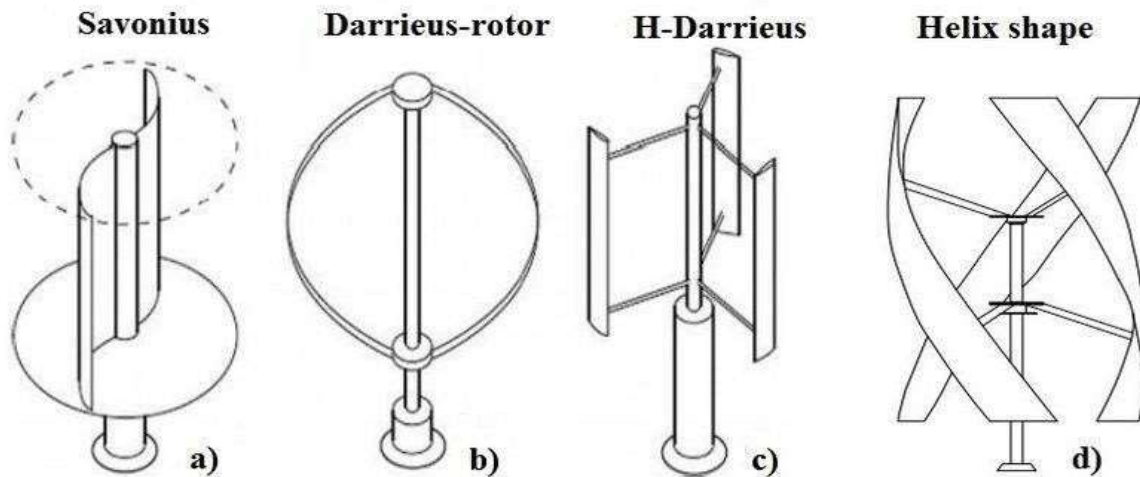


Fig 2.2: Various Axial Types of Wind Turbine [14]

Vertical axis can be divided into two types:

- i. Darrieus
- ii. Savonius

**i. Darrieus Rotor**

This turbine requires less area. It mainly shaped as an egg beater with two or three blades shaped.

**ii. Savonius Rotor**

From the top, the Savonius turbine looks more like a S. It rotates slowly, yet has a lot of torque for grinding.

## 2.5 Site Selection for Installing Wind Turbine

Many turbines are linked together in a wind turbine farm to create power for the public grid. Transmission and distribution factors provide electricity to customers. A wind turbine should be installed in a region with regular high winds. On a worldwide scale, NREL will develop wind maps based on wind speed data collected at monitoring sites throughout the year [7]. Wind energy will be calculated for some places based on average

wind speed. This wind energy computation assigns a limited geographical region to wind energy categories ranging from one to seven. This data will aid in determining the optimal locations for wind farm development. Plots having a wind energy rating of 3 or above are ideal for wind farm construction. Small wind turbines can be placed on ground that is at least level 2. The major elements in WECS site selection are its economic, social environment, and other concerns. The following are some prominent site selection criteria:

Because the power created is proportional to the cubic of wind speed, the location should have accessible high average wind speeds ranging from 6m/s to 30m/s all year. The minimum wind speed at the chosen location must be more than 3.5 to 4.5 m/s, which is the lowest limit at which the present wind turbine begins to revolve and is referred to as wind speed.

- Because buildings and woods restrict air movement, WECS should be located distant from towns and forests. Within 3 kilometers of the installation location, there should be no towering structures.
- To decrease foundation expenses, the soil surface must have strong soil strength.
- The installation should be far away from residential areas to prevent the noise generated by wind mills from affecting resident in the surrounding areas.

## 2.6 Solar Energy Systems

### 2.7 Introduction and Background

A solar panel is a direct solar energy structure that is used to explain how solar panels utilize sun energy. Solar panels capture the sun's rays and convert them directly into electrical energy [11]. Solar cells, also known as PV cells, are arranged in a grid pattern on the upper surface of a solar panel. The solar panel collects the sun's rays and stores them in batteries, which are then converted to electrical energy. PV panels are often constructed of crystalline silicon, which may be utilized in industries such as computer manufacture as well as the more demanding Ga. Dedicated to the production of arsenic compounds for photovoltaic (solar) cells.

## 2.8 Working Principles of Solar System

Solar panels immediately capture and convert solar radiation into electrical energy. The solar panel is made up of several individual solar cells. These solar cells operate similarly to big semiconductors and employ large-area p-n junction diodes. P-n diodes convert solar energy into useful electrical energy when exposed to sunlight [4]. The energy created by photons striking the solar panel's surface causes electrons to escape from their orbits and be released when the solar cell's electric field pulls them out. The free electrons in the directed current of the solar cell's metal contacts can be utilized to create power. The more the number of PV cells in a solar panel, the better the attribute of the solar cell and the greater the amount of power the PV panel shall create. The photoelectric effect refers to the transformation of solar energy into useable electrical power energy [9]. Because the solar panel has no moving parts, the photoelectric effect is created by the p-n diode's properties.

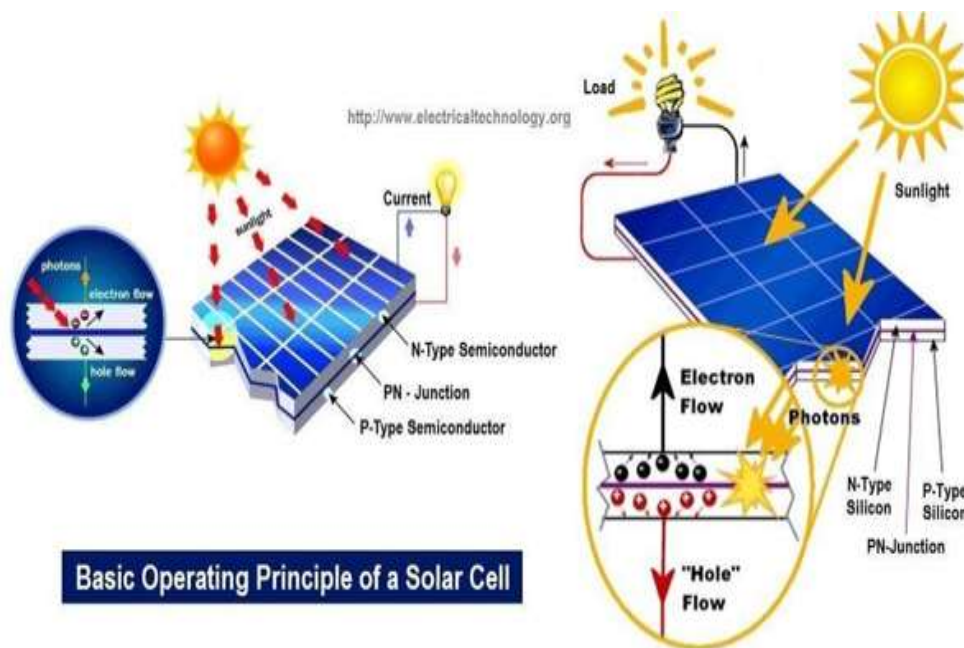


Fig2.3: Operating principle of solar panel [11]

## 2.9 Different Kind of Solar Panel

### A. Monocrystalline Panel

Monocrystalline plates are made of crystalline silicon, which comes from a large sheet that has been cut into different plate shapes, forming a single cell. Metal strips are placed

throughout the cell and act as a conductor that traps electrons. Mono panels are slightly smaller and more efficient than polycrystalline panels, but no more expensive than polyethylene panels [11].

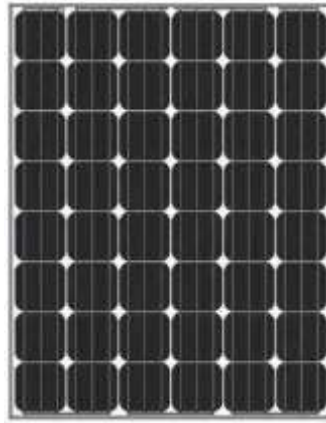


Fig2.4: Monocrystalline Solar Panel [15]

### **B. Polycrystalline Panel**

Polycrystalline plates made of small cells instead of one large cell. Poly is said to be less efficient than mono panels and cheaper to manufacture than mono, although they are very similar. There are several ways to make polycrystalline silicon cells [11].

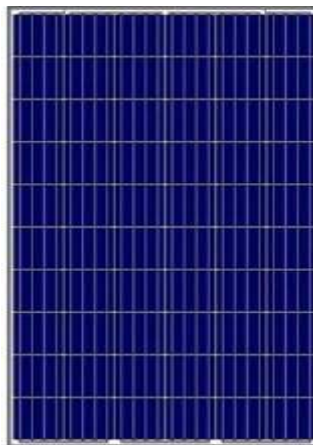


Fig 2.5: Polycrystalline Solar Panel [15]

### C. Cast-Polysilicon

This method incorporates silicon into a huge block that, after cooling, may be sliced into tiny layers for use in solar cells. These cells are arranged on a plate, and then conductive metal strips are put over the linked cells to generate a continuous electrical current across the plate [11].



Fig2.6: Cast-Polysilicon [15]



# **Chapter 3**

## **Methodology**

### 3.1 Required Components

This part offers the detailed estimation of our project's components. To complete this project effectively, we planned to create a hardware module that was also a software component. We created a circuit module that incorporates a variety of gadgets and a microcontroller chip. The components that we utilized to build our hybrid renewable energy system project are as follows:

Table3.1: Required Components List

<b>Name of the Components</b>	<b>Rating</b>	<b>No. of the Components</b>
Arduino UNO	Operating Voltage 5V	1
Relay	Maximum Load: AC 250V/10A,DC30V/10A	1
Voltage Divider	Min0.01V Max50V	2
LCD Display	5V	1
LED	Input 1-3V	2
LDR Sensor	Max Power 18V	2
DC Motor	Input Voltage 12V Rated Power 10watts	1
Battery	12V,1.3Ah/20HR	1
Switch	Max Voltage 250V	1
Display	Max 5.3V Mini 4.7V	1
Pump Motor	5v	1
Servo motor	4-6 V	1

### 3.2 Hardware Module

Here we will discuss many of the components that we used to build this project. Some of the main components are discussed below:

### A. Arduino:

Arduino Uno is basically a microcontroller card using Microchip ATmega328P. It helps in creating electronic projects [13]. A physical programmable circuit board (called a microcontroller) and software or IDE (Integrated Development Environment) are used to operate an Arduino UNO.

People, who are starting to use electronic projects, are very interested in using the Arduino platform for several reasons. It is popular among them due to its uniqueness as it does not require any kind of standalone hardware to write new code. We can only use USB cable. A simplified version of C++ is used in the Arduino IDE for programming learning. Finally, Arduino provides a traditional type issue that will divide management the microcontroller is in another package. [14].



Fig3.1: Arduino Board [15]

### B. 1-Channel Relay Module:

The relay is used as an electrical switch that can be turned on or off when current is flowing and can be monitored with a voltage as low as 5V provided by the Arduino pin. It consists of one channel. There are different models with one, four and eight channels. It must be powered by a suitable voltage which is 5V for the Arduino card. So, in our project, we can use a 1-channel relay module to make our work easier [13].

It is a 5-volt relay interface board with four channels. Each channel requires 15 to 20 mA of electricity to function. It regulates a wide range of high-current devices. This is built with a high current relay that can handle 250V AC 10A or 30V DC 10A. It can be immediately monitored by a microcontroller due to its good interface feature [21].



Fig 3.2: 1-Channel Relay Module [15]

### C. LDR Sensor:

Light Dependent Resistor is known by the abbreviation LDR. LDRs, often referred to as photo resistors, are minuscule light-sensing components. An LDR is a resistor whose resistance alters in response to variations in the quantity of light hitting it. Light intensity increases are accompanied by a decrease in LDR resistance, and vice versa. We can utilize them to create circuits for light sensing thanks to this characteristic [22].

We must always create a voltage divider circuit in order to use an LDR. The voltage across an LDR increases when its value of resistance rises relative to its fixed resistance. [14]. A sensor is a device that detects certain types of electrical or optical signals and responds to them.



Fig 3.3: LDR Sensor [15]

### D. Pump Motor:

A motor pump is a mechanical tool that uses mechanical motion to transport liquids or gases from one location to another. The water pump's basic mechanism is converting mechanical motor energy into fluid flow. Based on the method they employ to deliver the liquid, such as direct, gravity, and displacement, these are divided into different sorts. A pump uses a rotational or reciprocating mechanism to move liquid, and this mechanical effort requires energy to be performed. Pumps operate using a variety of energy sources,

including manual labor, electricity, engines, wind energy, etc. Depending on their intended use, from the medical to major sectors, these come in a variety of shapes [23].

This DC 3-6 V Mini Micro Submersible Water Pump is a compact, inexpensive submersible pump motor that runs from a 2.5 – 5V power source. It can use up to 120 liters per hour and only use 220 mA of current. The motor outlet must only be connected to the tube pipe before being powered and submerged in water. [14]



Fig3.4: Pump Motor [15]

### E. Servo Motor:

A servo motor is a kind of motor that has extremely precise rotational capabilities. This type of motor typically has a control circuit that gives feedback on the motor shaft's present location. This feedback enables the servo motors to rotate very precisely. A servo motor is used to rotate an object at predetermined angles or distances [24]. It consists of a straightforward motor that drives a servo mechanism. A motor is referred to as a DC servo motor if it is powered by a DC power source, and an AC servo motor if it is driven by an AC power source. We will solely talk about the operation of the DC servo motor in this lesson [15].



Fig3.5: Servo Motor [15]

### F. DC Motor

The DC motor is the device that transforms direct current into mechanical power. It operates under the principle of Lorentz Law, which states that "the current-carrying conductor put in a magnetic and electric field experiences a force." And the Lorentz force is that force. A current-carrying conductor receives a mechanical force every time it enters the magnetic field; this is the basic operating principle of a DC motor. No energy conversion is conceivable before there is anything to oppose the conversion, according to the fundamental rule of nature [25]. This opposition is produced by magnetic drag for generators, but back-electromagnetic field is provided for dc motors. A DC motor becomes "self-regulating" in the presence of the back electromagnetic field.



Fig 3.6: DC motor [15]

### 3.3 Circuit Setup

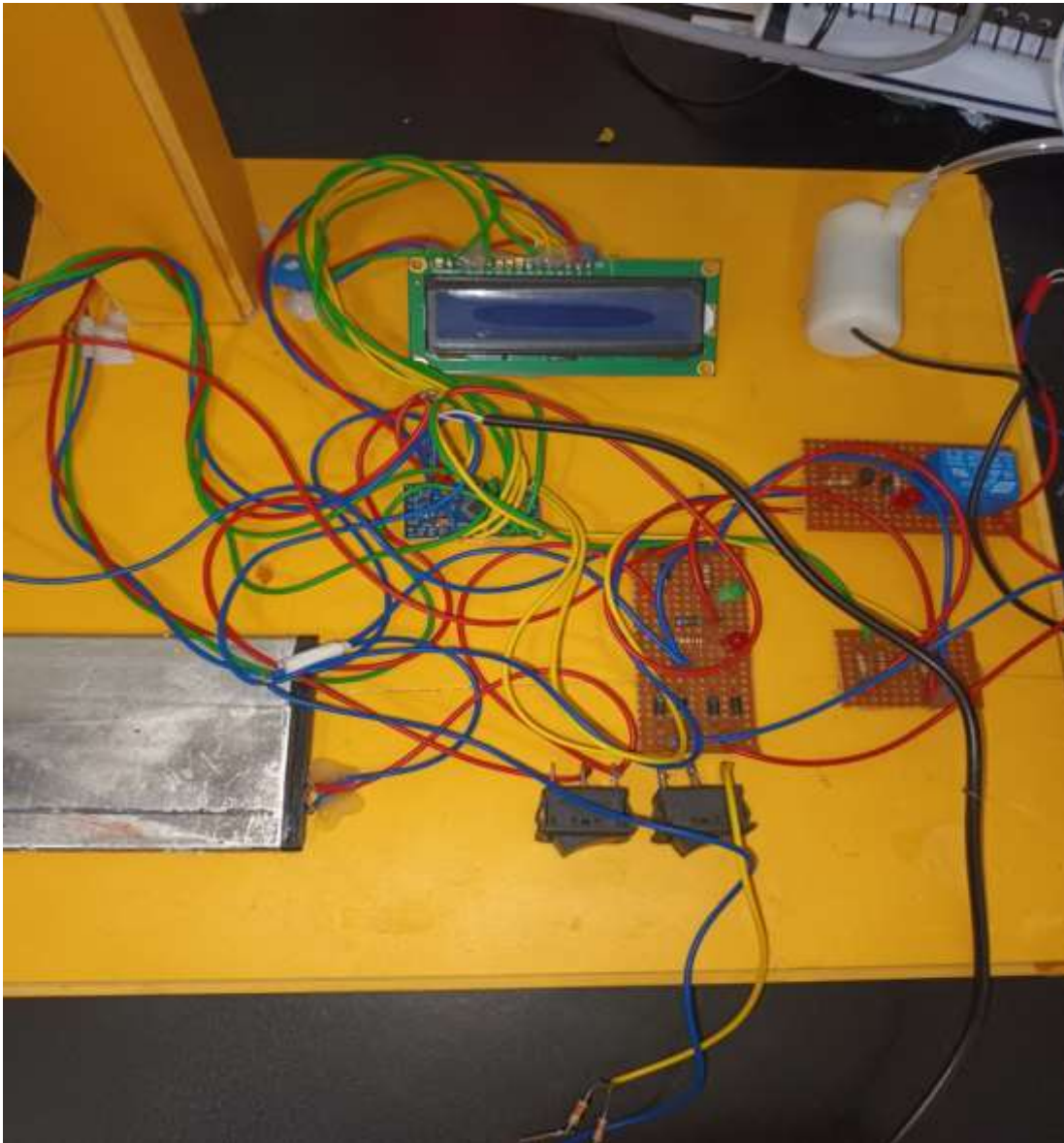


Fig3.7: Circuit Setup

### 3.4 Explanation of Circuit Setup

### 3.5 Planning

We planned to perform a project on renewable energy systems using wind and solar for our thesis project work. However, because the scenario does not suit us, we are reducing

this massive project to a tiny scheme that may then be expanded to various more sectors in Bangladesh. We purchased the above-mentioned components to complete this small project. However, because a wind turbine was not accessible for use in this little project, we transformed mechanical energy to electrical energy, which we employed as a wind turbine.

Table3.4.1: Price of the Components Used

<b>Components</b>	<b>Total Number of Components</b>	<b>Price (Taka)</b>
I. Arduino UNO	1	780
II. LDR Sensor	2	50
III. 1-ChannelRelay	1	160
IV. Voltage Divider	2	190
V. Solar Panel	1	480
VI. Wind Turbine	1	20
VII. Battery	1	580
VIII. LCD Display	1	380
IX. Switch	3	15*3=45
X. LDR Sensor	2	50
XI. PVC board	3FT	380
XII. Pump motor	1	190
XIII. Servo Motor	1	270
XIV. WIND TURBINE	1	20
XV. DC Motor	1	280
XVI. LED	4	10
<b>Total Cost:</b>		<b>5005</b>



### 3.6 Implementation

On a PVC board, the circuit configuration is built. Wires in the board were used to link the wind turbine and solar panel. 5v rechargeable batteries are used to store the energy produced by the solar and wind turbines. We may utilize the Arduino Pro Mini microcontroller because this project is a smart project system. While electricity is being provided from the battery to the load, this microcontroller lets us keep track of whether the battery is charging or draining. For switching, we utilize a 1-channel relay module. We employed two voltage divider circuits, one for the solar panel and one for the wind turbine. To follow the sun, we adjusted two LDR sensors with solar panels. For the battery charger, wind turbine, and solar panel, we linked a charge-controlling system circuit. A potentiometer allows you to change the brightness and contrast of the LED display, which will indicate the voltage that was generated by the solar and wind turbine. [17].

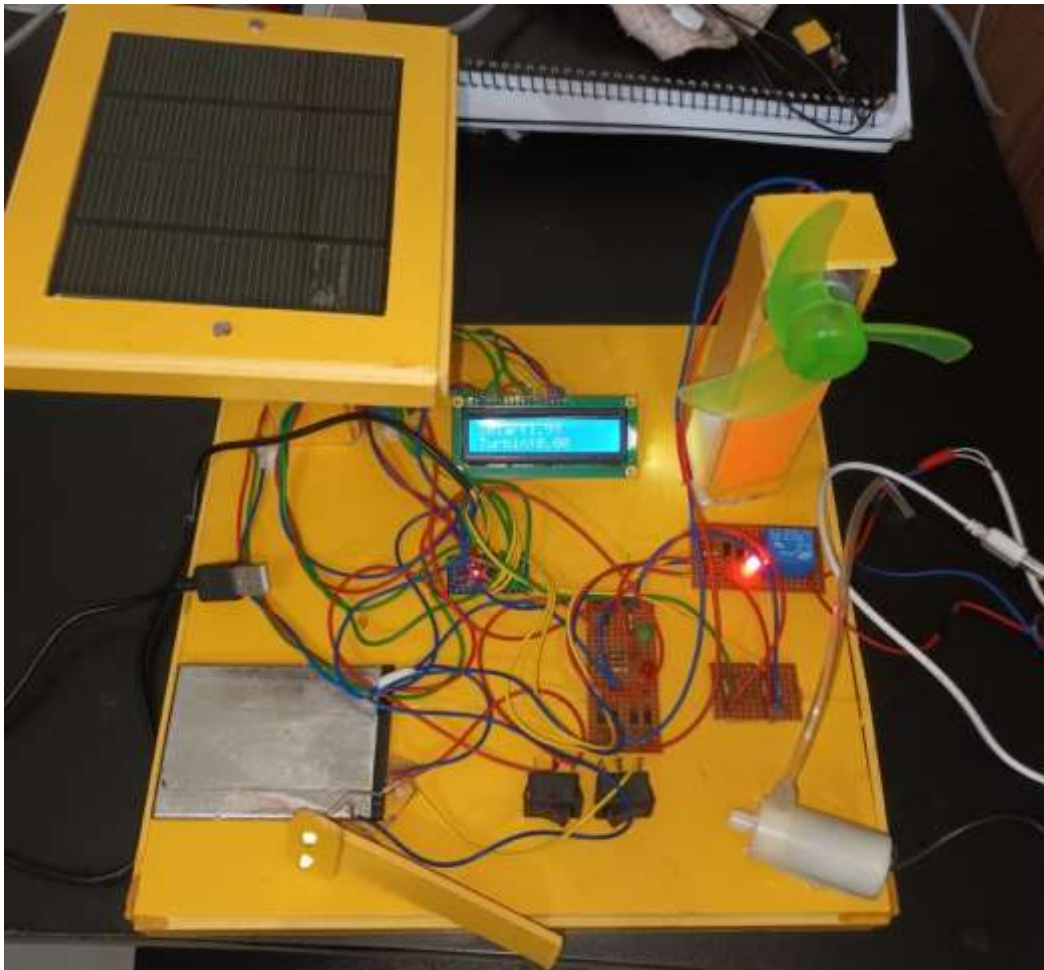


Fig3.8: Complete Circuit Setup View

## **Chapter 4**

# **Circuit Diagram and Explanation**

### **4.1 Introduction of Charge Controller**

Nearly all solar-powered systems have a battery that must be charged using solar energy before its stored energy is utilized to power the loads. There are several options for charging a lithium battery; however, we have already constructed a straightforward circuit for charging lithium batteries. However, the maximum power point tracker architecture, which offers significantly superior accuracy than alternative techniques like PWM controlled chargers, is the most widely used solution when using a solar panel to charge a battery. Commonly seen in solar chargers is the MPPT algorithm. The charge controller analyzes the output voltage from the panels and the battery voltage. Using this information, it compares the two measurements to determine the greatest amount of power the panel can deliver to charge the battery. Whatever the circumstance, whether in good or bad sunlight conditions, the MPPT charge controller takes this maximum power output factor and transforms it to the optimal charge voltage and current for the battery. The battery charge current also drops whenever the solar panel's production of electricity does.

Thus, the battery continues to be charged even when there is little sunshine, depending to the solar panel's output. Normal solar chargers often don't operate like this. Since each solar panel has a short circuit current and maximum output current rating, respectively. When a solar panel is unable to provide enough current, the voltage drops noticeably, the load current remains constant, and the short circuit current rating is crossed, resulting in zero output voltage from the solar panel. As a result, under low light settings, charging is entirely stopped. By regulating the battery charge current, MPPT, however, enables the battery to charge even in dimly lit areas.

The battery voltage is continually monitored by a conventional wind turbine charge controller. The controller activates a dump load, also known as a shunt, such as an immersion heating element, an electric heater, or automobile headlight bulbs to dissipate any surplus power and prevent the batteries from being overcharged if the voltage reaches a user-set maximum.

### 4.2 Systemic Block Diagram

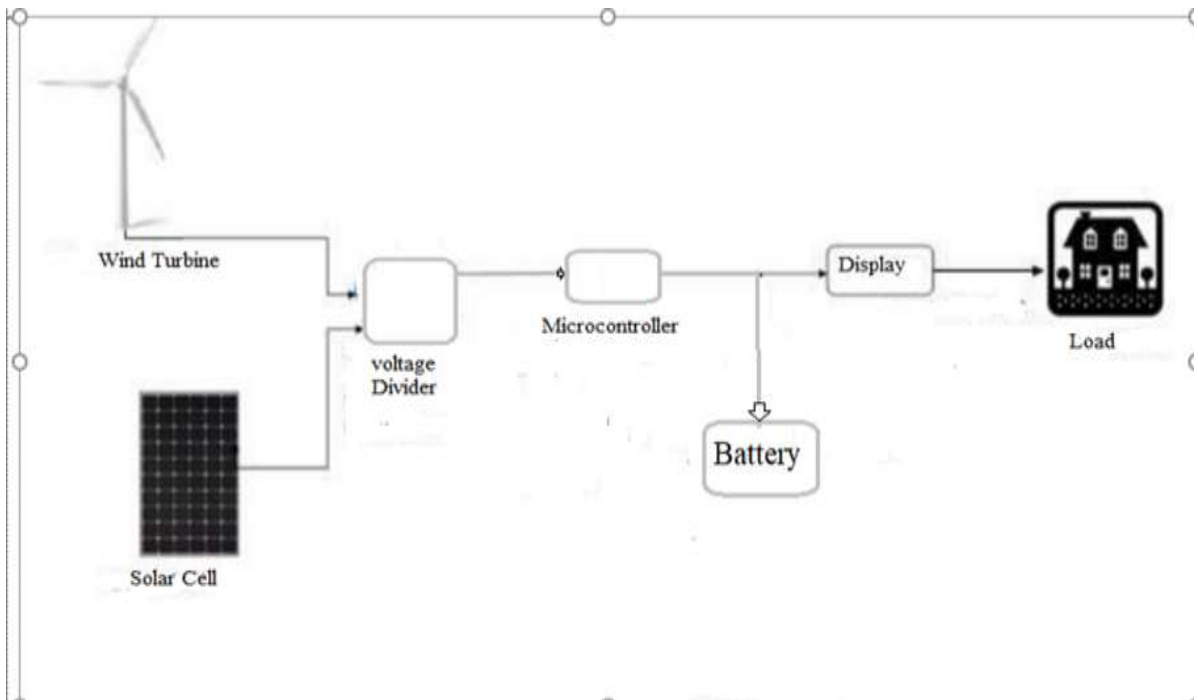


Fig4.1: Systemic Block Diagram

### 4.3 Block Diagram

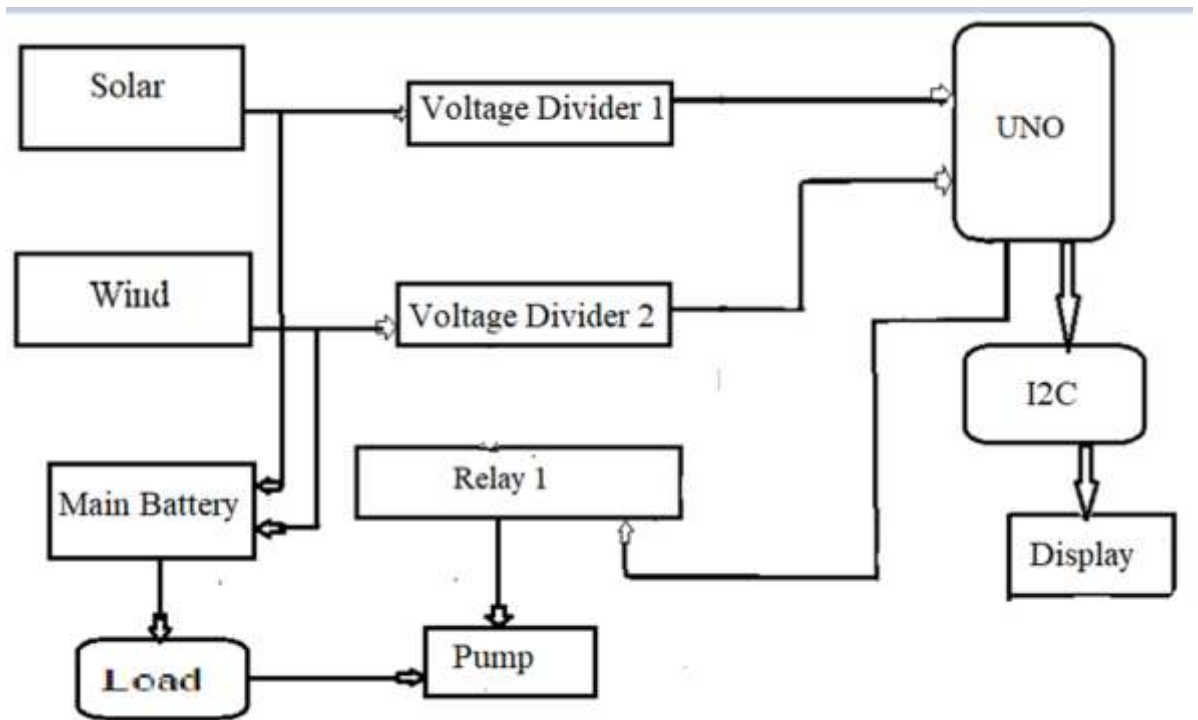


Fig4.2: Block Diagram

#### 4.4 Flow Chart

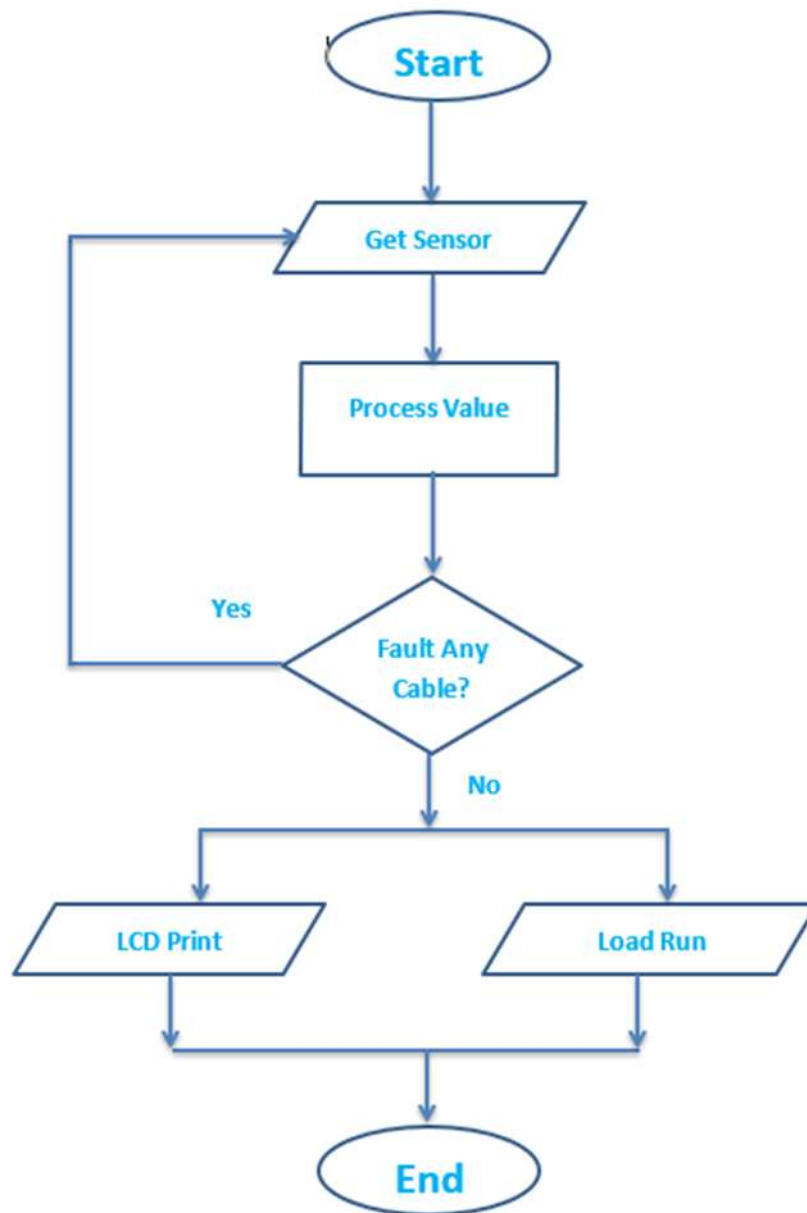


Fig4.3: Flowchart of the System

4.5 Circuit Diagram (Simulation):

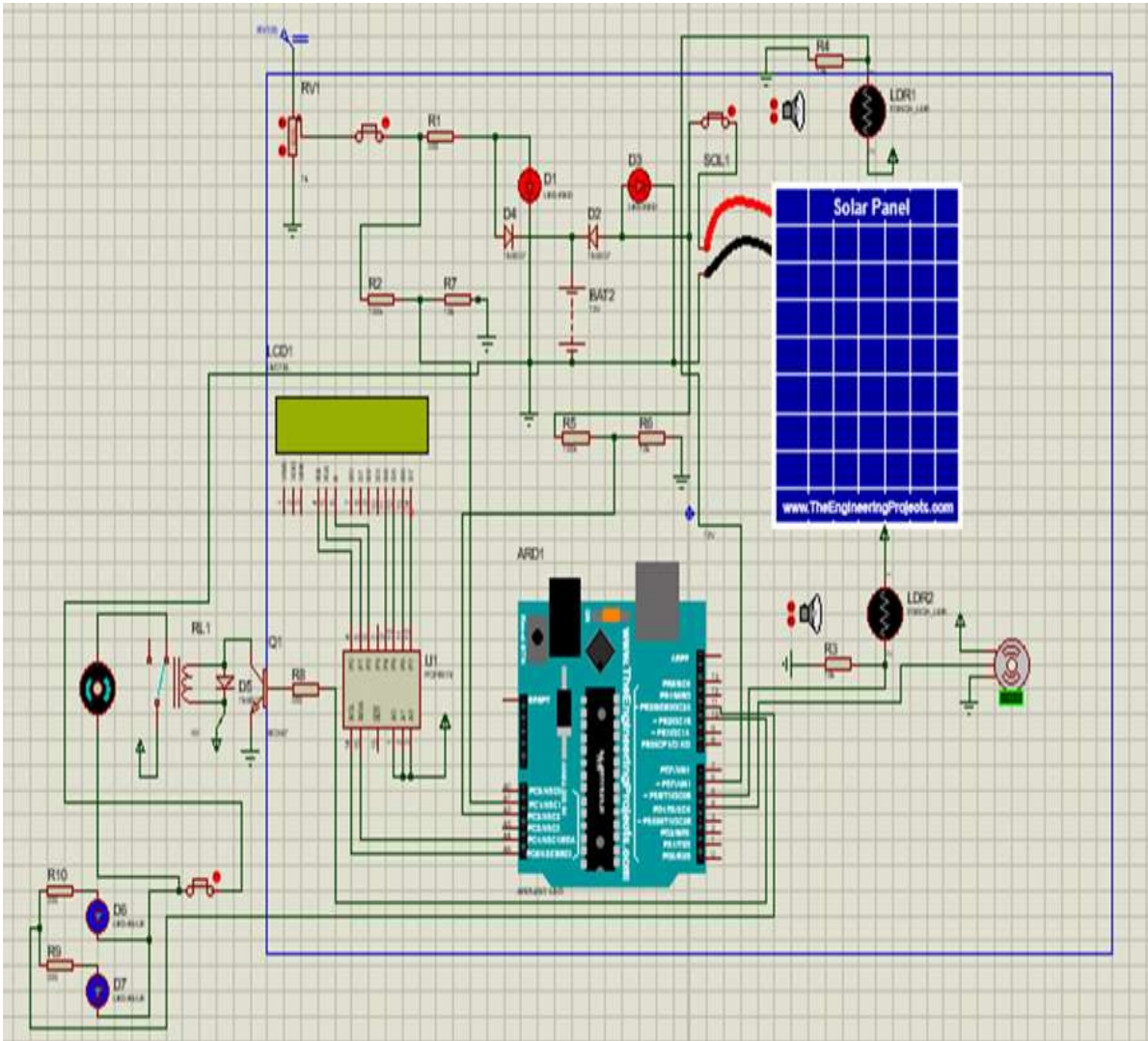


Fig4.4: Proteus Simulation of Full Circuit

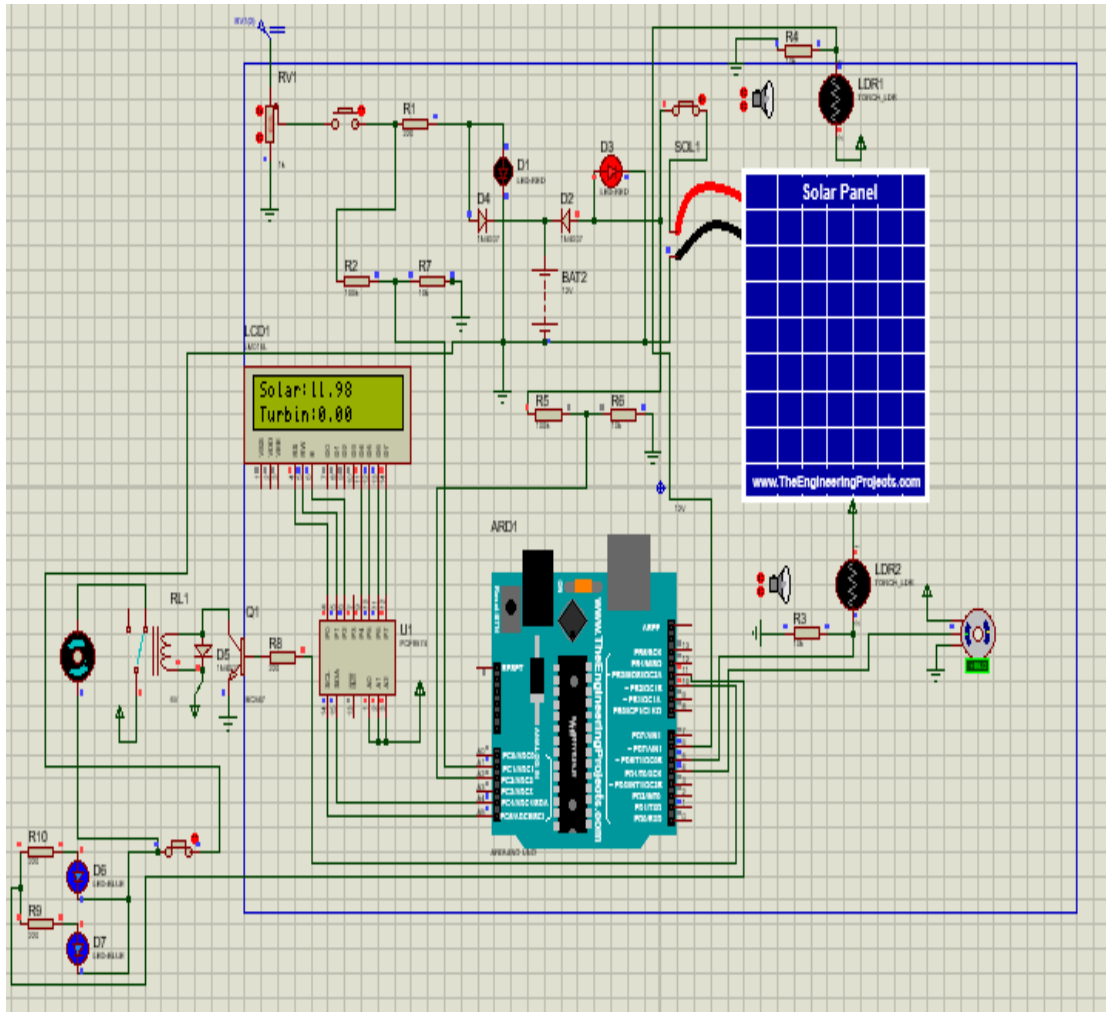


Fig4.5: Solar Panel ON Mode

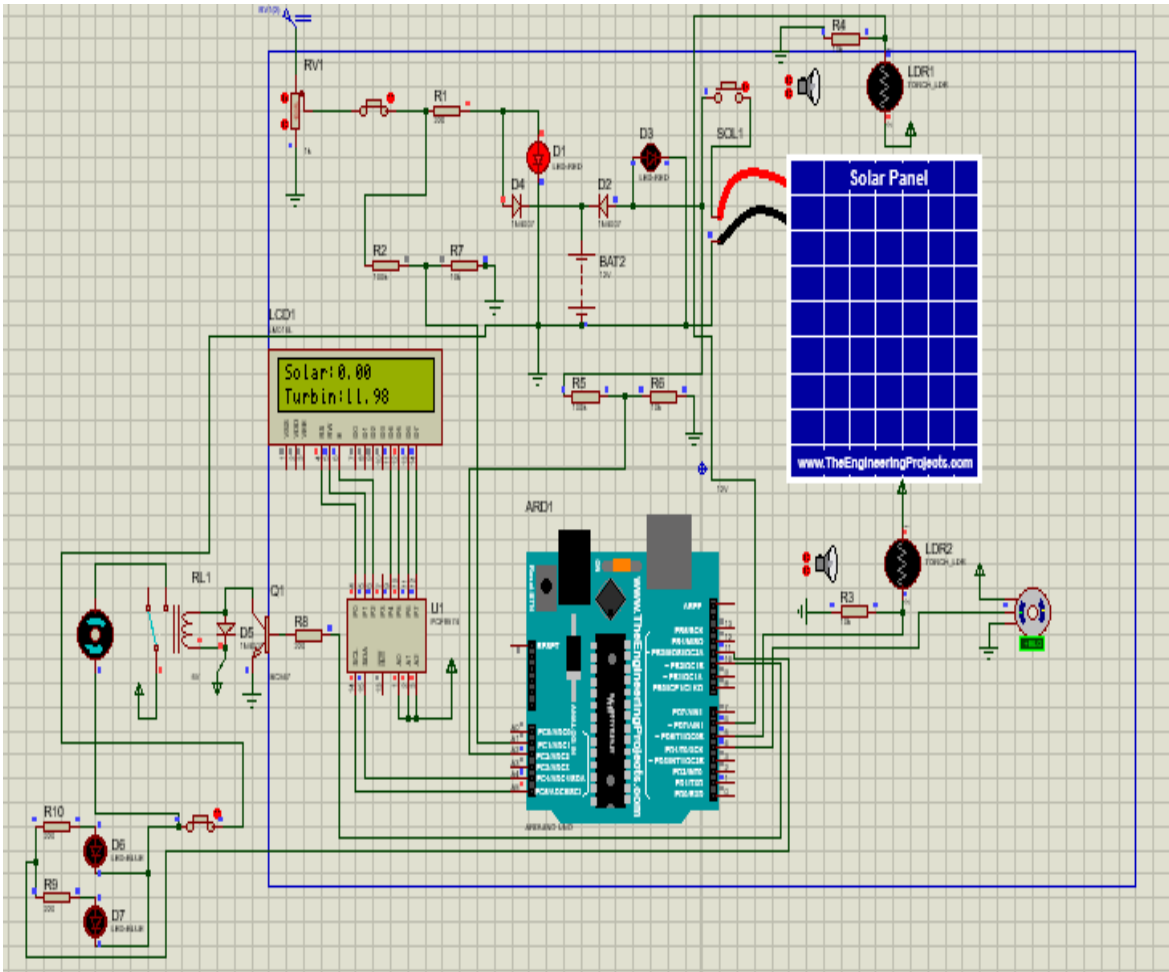


Fig 4.6: Wind Turbine ON Mode



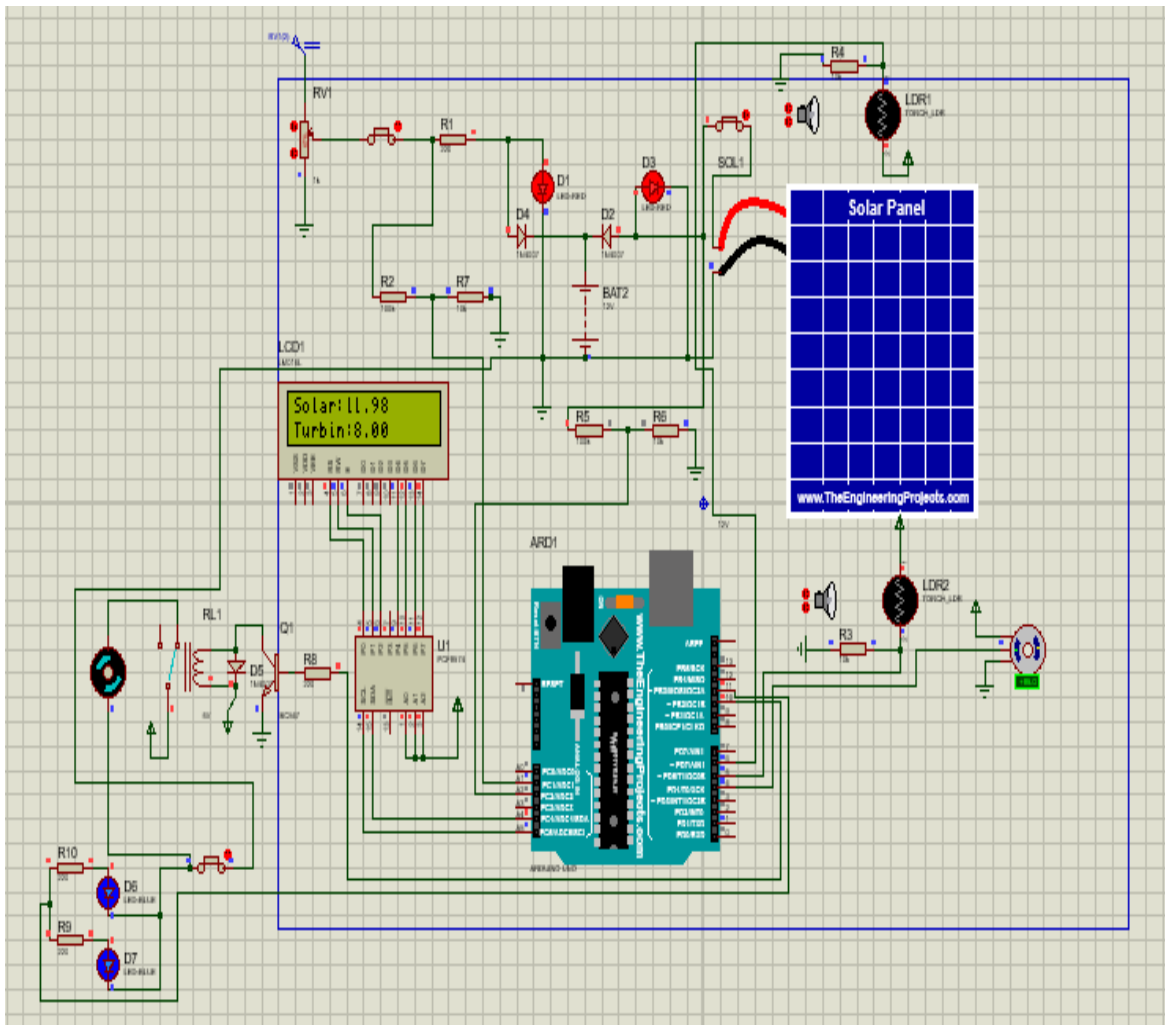


Fig4.7: Wind Turbine and Solar Panel ON Mode

#### 4.6 Explanation and Implementation

Starting with our modeling phase, we set out to build a hybrid renewable energy system that used both solar and wind energy. First, using Proteus simulations with both wind and solar turbines, we attempt to construct the scene. Since we needed to illustrate the simulation's current condition for both the wind and the turbine, we employed an LCD display. Now that the solar panel is turned on, the ammeter will now show positive volts and the status ON in the display, indicating that solar energy is being used to charge our main battery. Now, since the voltage we receive from the wind is not constant, if we switch on the wind turbine, we will also notice variance in the ammeter. Finally, if we turn on the turbine and solar panels simultaneously, the battery will be continually charged and

## Circuit Diagram and Explanation

---

the status will be shown on the display. To manage the battery charging system for the water pump, we employed the relay as a switch or charge controller.

As our primary board, we utilized an Arduino microcontroller. We used a resistor to connect two LDR sensors to the solar panel. And a servo motor to assist the operation of the axis mode. In our simulation design, we included two buttons for the solar and wind turbine sections' on and off states. For indicating if it is truly charging or not. For one-way flow from solar and the turbine to the battery, we also employed diodes. For the wind turbine and solar panel, we put two voltage divider circuits into place. To print the output from our microcontroller for display, we also created a display driver. A time-sensitive relay module that is connected to a water pump was employed.

```
temp2 = (analog_value2 * 5.0) / 1024.0;
```

```
Input_voltage2 = temp2 / (r2/(r1+r2));
```

The coding phase follows the Proteus simulation phase and ensures a flawless simulation run. We can carry on with our code on the Arduino, and for the LCD display, we linked it to the Arduino pins using the liquidcrystal.h library (2-7). We may specify two int values for the relay and link to the Arduino pin for the sun, wind, and main battery. Additionally, we may add a switch using the variable "sw" for the load section and attach it to another Arduino pin. To obtain the Voltage value for wind and sun, we can now use the voltage sensor interface in the loop.

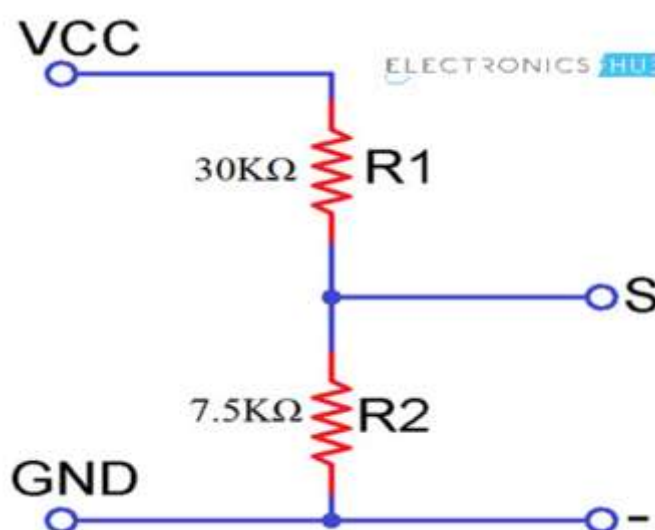


Fig4.8: Voltage Divider Circuit [6]

# **Chapter 5**

## **Result and Analysis**

## 5.1 Load Profile & Load Calculation

Table5.1: Solar Panel Rating

<b>Specification</b>	<b>Value</b>
Model	T-16P
Maximum watt power	7W
Short circuit current	0.50A
Open circuit voltage	12V
Maximum power current	50A
Maximum power voltage	10V
Weight of panel	2.5gm

Table-5.2: Wind System Rating

<b>Specification</b>	<b>Value</b>
Rotor blade diameter	4inch
Number of blades	3blades/horizontal axis
Input Voltage	12V
Input Current	480Amps

## 5.2 Discussion

We have used a 10V Battery with 1.5 Ah rating, which gives 18-watt power supply per hour. This battery will give backup for 20 hours. In our project we use a relay AC250V/10A, DC30V/10A estimated timer 5seconds well. We used a voltage divider Min 0.01 V Max 50V. We used LDR sensor in solar panel which has maximum power 18 volt. We considered two LED Light 1-3 voltages, a pump motor as load. As loads we examined a water pump and two LED lights. These are connected with a timer also. And we also did show the wind and solar power to our LED display. Details load profile is given in above mention table tables.

## **Chapter 6**

### **Conclusions and Future Work**

### 6.1 Conclusion

Hybrid systems are thought to provide a practical substitute for conventional fuel-based energy in remote places of the world. The demand for sophisticated alternative energy technologies and clean energy sources, however, has a significant impact on how widely such systems are used. In order to assure the broad acceptance of this new technology, hybrid power systems' costs must be decreased by ongoing development and advancement of solar photovoltaic and wind energy technologies.

For the project to begin, we must first produce power. We need solar and wind power in order to produce this energy. Arduino may be used as a microcontroller to regulate the circuits on and off states. To demonstrate that the project can be used on a wide scale, we may also provide thorough load estimates from the smaller project.

During the hex file creation process, we encountered certain coding problems. Since the load we anticipated was so great, we also had trouble distributing the loads. We made do with the limited load that could be created in order to solve the problem. After overcoming all the challenges, we were successful in finishing the task. The upcoming initiatives down below have also been briefly discussed.

### 6.2 Future Work

By expanding on this small-scale experiment, we want to put it into practice in any of Bangladesh's coastal regions, including Khulna, Patuakhali, Barisal, Noakhali, and Chittagong. This initiative is an excellent answer for the shelters in this coastal region that have endured prolonged power outages as a result of natural disasters. A possible solution in this case is an integrated power system (IPS), however if the power outage lasts long enough, the IPS will not be able to deliver adequate power in the long run. Now of doing it at schools, hospitals, and other significant locations in coastal areas, as we originally planned, we will instead conduct this project just within shelters. Where we may expect the highest output, we want to add hydropower to our clever hybrid renewable energy system. We included a water pump in our project to help farmers in rural areas where the soil is dry and they are unable to adequately water their crops.

Since it would use renewable energy to water the land, it will be advantageous to those in need.

## Appendix:

```
/* Comment this out to disable prints and save space */
```

```
#include <LiquidCrystal.h>
```

```
LiquidCrystalled(7,6,5,4,3,2);
```

```
#include <Servo.h>
```

```
int sensor1=A1;
```

```
int sensor2=A0;
```

```
int val1;
```

```
int val2;
```

```
intpos=0;
```

```
int angle=44;
```

```
int t=0;
```

```
int pump=10;
```

```
int light=11;
```

```
int count=0;
```

```
intval=0;
```

```
Servo servo;
```

```
int analogInput = A2;
```

## Appendix

---

```
int analogInput2 = A3;

float input_voltage = 0.0;

float temp=0.0;

float input_voltage2 = 0.00;

float temp2=0.0;

float r1=100000.0;//Bat +
float r2=10000.0;//gnd and junction for out

void setup() {

Serial.begin(9600);

lcd.begin(16,2);

pinMode(sensor1,INPUT);
pinMode(sensor2,INPUT);
pinMode(analogInput,INPUT);
pinMode(analogInput2,INPUT);
pinMode(pump,OUTPUT);
pinMode(light,OUTPUT);

servo.attach(9);
```



## Appendix

---

```
servo.write(angle);  
lcd.setCursor(0,0);  
lcd.print("  Welcome  ");  
delay(2000);  
lcd.clear();  
}  
  
void loop()  
  
{  
  
int analog_value = analogRead(A2);  
    temp = (analog_value * 5.0) / 1024.0;  
input_voltage = temp / (r2/(r1+r2));  
  
    if (input_voltage < 0.1)  
    {  
input_voltage = 0.0;  
    }  
  
int analog_value2 = analogRead(A3);  
    temp2 = (analog_value2 * 5.0) / 1024.0;  
input_voltage2 = temp2 / (r2/(r1+r2));
```

## Appendix

---

```
if (input_voltage2 < 0.01)
{
    input_voltage2=0.0;
}
```

```
Serial.print("v= ");
Serial.println(input_voltage);
```

```
val1=analogRead(sensor1);
Serial.print("val1 is: ");
Serial.println(val1);
val2=analogRead(sensor2);
Serial.print("val2 is: ");
Serial.println(val2);
```

```
if (val1>=850)
{
    servo.write(angle);
    angle++;

    if(angle>=179)
    {
        angle=180;
    }
}
```

## Appendix

---

```
delay(1);

}

if (val2>=850)
{
servo.write(angle);
angle--;
if(angle<=1)
{
angle=0;
}
delay(1);

}

if(t==0)
{
lcd.setCursor(0,0);
lcd.print("Solar:");
lcd.print(input_voltage);
lcd.print(" ");
lcd.setCursor(0,1);
lcd.print("Turbin:");
lcd.print(input_voltage2*1.99*9.21);
lcd.print(" ");
```

## Appendix

---

```
}  
  
t++;  
  
if(t>=10)  
{  
    t=0;  
}  
  
count++;  
  
if(count<=100 && count>=0)  
{  
    digitalWrite(pump,LOW);  
    digitalWrite(light,LOW);  
}  
  
else  
{  
    digitalWrite(pump,HIGH);  
    digitalWrite(light,HIGH);  
}  
  
if(count>=200)  
{  
    count=0;  
}  
  
delay(5);  
}
```

## References

- [1] Twidell. J & Weir.T. Renewable Energy Resources. Routledge, London: 23 November 2005.
- [2] Khare. V, Nema. S, Baredar. P, Solar–Wind Hybrid Renewable Energy System: A Review. May 2016.  
<https://www.sciencedirect.com/science/article/abs/pii/S1364032115016068?fbclid=IwAR3-CovMMZvEK1Gxnv3EIsiY4vh3NMFZ3GnVyFZUUCDBEi v BX76M1i4dw>
- [3] A.T.D. Perera and A. Wijesiri, Designing Smart Hybrid Renewable Energy Systems with V2G, Colombo, Sri Lanka, 30 March 2015.  
<https://ieeexplore.ieee.org/abstract/document/7069612?fbclid=IwAR2RHbcava6zrfAMIJRBuujv1KCXMYRW0AjASn4uqwD23y1iXpgY0Bxn0u8>
- [4] M.K. Deshmukh, S. S. Deshmukh, Modeling of Hybrid Renewable Energy Systems, January 2008.  
<https://www.sciencedirect.com/science/article/abs/pii/S1364032106001134?fbclid=IwAR0h9s5xbhfJUIJWlwF96RBXmn4OcC33YqWSxuxseHbmXyIs vSPeO1CFCw#>
- [5] R. Sunil, Switch gear Protection and Power Systems, 13<sup>th</sup> Edition, Khanna Publishers, Delhi, 2008.
- [6] Uddin MN, Renewable Energy in Bangladesh: Status and Prospects, ICEP2018.
- [7] P.M. Anderson, Power System Protection.1<sup>st</sup> Edition, IEEE press, New York, 1999.
- [8] Bangladesh-Power & Energy | export.ov (2018, October 12). Retrieved December 19, 2019, from <https://www.export.gov/article?id=Bangladesh-Power-and-energy>
- [9] Z. Zhao, M. Xu, Q. Chen, J. Lai and Y. Cho, "Derivation, Analysis, and Implementation of a Boost–Buck Converter-Based High-Efficiency PV Inverter," in IEEE Transactions on Power Electronics, vol. 27, no. 3, pp. 1304-1313, March 2012, doi: 10.1109/TPEL.2011.2163805.
- [10] S. Sarkar and V. Ajjarapu, "MW Resource Assessment Model for a Hybrid Energy Conversion System with Wind and Solar Resources, "in IEEE Transactions

## References

---

- on Sustainable Energy, vol. 2, no. 4, pp. 383-391, Oct 2011, doi: 10.1109/TSTE.2011.2148182.
- [11] Melgar. E. R, Diaz.C.C. Arduino and Kainect Projects, New York, NY, 2012.
- [12] S. M. Alzahrani, "Sensing for the Internet of Things and Its Applications," 2017 5<sup>th</sup> International Conference on Future Internet of Things and Cloud Workshops (FiCloudW), 2017, pp. 88-92, doi: 10.1109/FiCloudW.2017.94.
- [13] T. C. Green, M. Prodanovic. Control of Inverter-Based Micro-Grids. London SW72AZ, United Kingdom, 28 September 2006. <https://doi.org/10.1016/j.epr.2006.08.017>
- [14] M. Mirhosseini, J. Pou and V. G. Agelidis, "Single- and Two-Stage Inverter-Based Grid-Connected Photovoltaic Power Plants with Ride-Through Capability Under Grid Faults, " in IEEE Transactions on Sustainable Energy, vol. 6, no. 3, pp. 1150-1159, July 2015, doi:10.1109/TSTE.2014.2347044.
- [15] A.Urtasun, J. Samanes, E.L.Barrios, P. Sanchis and L. Marroyo, "Control of a Photovoltaic Array Interfacing Current-Mode-Controlled Boost Converter Based on Virtual Impedance Emulation, "in IEEE Transactions on Industrial Electronics, vol. 66, no. 5, pp. 3496-3506, May 2019, doi: 10.1109/TIE.2018.2856192.
- [16] Kreider. J. F, & Kreith. F. Solar Energy Hand book. United States.
- [17] Bahnall.D.M,Boreland.M, Photovoltaic Technologies, December 2008. <https://doi.org/10.1016/j.enpol.2008.09.070>
- [18] J.F.Manwell, J. G.McGowan, Anthony L, Wind Energy Explained, 2009.
- [19] Prajukti. D, National Database of Renewable Energy, Dhaka, 2021.
- [20] Apogeeweb, Working Principle and Development of Solar Cell, 2007
- [21] <https://www.electronicshub.org/what-is-relay-and-how-it-works/>
- [22] <https://thestempedia.com/tutorials/what-is-ldr-photoresistor/>
- [23] <https://store.roboticsbd.com/robotics-parts/949-5v-dc-mini-water-pump-micro-submersible>
- [24] <https://circuitdigest.com/article/servo-motor-working-and-basics>
- [25] <https://www.electricaltechnology.org/2012/01/simple-dc-moter-electrical-project.html>