DESIGN AND IMPLEMENTATION OF SOLAR-HYDRO HYBRID POWER STATION

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Declaration

This is to certify that the project titled “Design and Implementation of Solar-Hydro Hybrid Power Station” is the result of our study in partial fulfillment of the B.Sc. Engineering degree under the supervision of Rudaina Tasnuva, Lecturer, Department of Electrical and Electronic Engineering (EEE), Sonargaon University, Bangladesh. It is also hereby declared that this project or any part of it has not been submitted elsewhere for the award of any degree.

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<u>Certificate of Approval</u>

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First of all, we would like to say thanks to almighty “ALLAH” for giving us the strength to finish the project as a partial fulfillment for the requirements for the Degree of B. Sc. In Electrical and Electronic Engineering.

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This thesis work would not have been possible without the encouragement, logical help and advice from our friends. We are grateful to them.

Finally, we must acknowledge with due respect the constant support and patience of our parents.

ABSTRACT

As the demand increases for electricity these day requires more power generation which cannot be able to produce by conventional energy sources due to environmental conditions and depletion of fossil fuels. To overcome this, we have to switch from conventional to non-conventional energy resources. In our project, combination of two renewable energy source takes place i.e. solar and hydro energy, which never have been used by anyone to generate hybrid power using this source simultaneously. This process gives the enduring energy resource without damping the nature. We can give sustained power by using hybrid energy system. We have made the integration of two energy system which will give a regular power supply. Solar panel is utilized to transform solar radiation into electricity. Hydro generator is used to convert hydro energy into electricity. This electrical power can be deploying residential, or commercial purposes. In this paper, we are showing that how we have combined two renewable energy source to generate electricity continuously without harming the nature, less maintenance and at a lower cost.

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LIST OF ABBREVIATIONS

A	Ampere
AC	Alternative Current
AFH	Adaptive Frequency Hopping
C	Capacitance
CDI	Capacitor Discharge Ignition
CMOS	Complementary Metal Oxide Semiconductor
CT	Current Transformer
DC	Direct Current
EDR	Enhance Data Rate
EEPROM	Electrically Erasable Programmable Read-Only Memory
EN	Enable
F	Farad
FTDI	Future Technology Devices International
GHz	Giga Harz
GND	Ground
GSM	Global System for Mobile Communication
IC	Integrated Circuit
I/O	Input Output
IRLED	Infrared Light Emitting Diode
IoT	Internet of Thinks
K	Kilo
KB	Kilo Byte
LCD	Liquid Cristal Display
LDR	Light Dependent Resistor
LED	Light emitting Diode
mA	Mile Ampere
MAC	Media Access Control
Mbps	Mega Byte per Second

MCU	Microcontroller Unit
MHz	Mega Harz
MPU	Microprocessor Unit
N/O	Normally Open
N/C	Normally Close
PCB	Printed Circuit Board
PT	Potential Transformer
PWM	Pulse Wide Modulation
R	Resistance
RAM	Random Access Memory
RSR	Reset
RX	Receiver
RXD	Received Serial Data
R/W	Read Write
S/I	International System
SPDT	Single Pull Double Throw
SPP	Serial Port Protocol
TTL	Transistor-Transistor Logic
TX	Transmitter
TXD	Transmitted Serial Data
USB	Universal Serial Bus
V	Voltage
VCC	Voltage Common Collector
Vin	Input Voltage

LIST OF SYMBOLS

Ω	ohm
uF	Microfarad
nF	Nano farad
Ωt	Time Phase
°C	Degree Celsius
Q	Charge

CHAPTER I
INTRODUCTION

1.1 Introduction

The solar-hydro hybrid power system combines SPV cells with hydroelectric power generation to create a hybrid renewable energy system. The system uses solar and hydro energy resources to generate power, providing a reliable and sustainable power supply. Excess electricity generated can be used to pump water into the higher reservoir (tank) for storage during high sunshine when solar energy production is very high. The stored water can then be used to generate hydroelectric power during periods of low sunlight where solar energy production is low, allowing for efficient use of resources and maximizing energy capture. Also, the energy obtained from solar photovoltaic. during sunny weather can be stored in batteries and the batteries will then be used to power the water pump to produce a high-velocity fluid jet to strike the turbine blades. The two systems that make up the hybrid system can run concurrently to maximize power generation, or each system can work as a stand-alone system where the resources sunlight or water are largely available.

Hybrid renewable energy systems are becoming the new normal for maintaining operational reliability. Research on a grid-connected solar hydropower system to complement inadequate power supply in Ado-Ekiti, Ekiti State, Nigeria shows that a small hydropower system generated 2.21 MW and a solar PV power system produced 6.69 MW. The system was able to inject 8.90 MW into the 11 kV distribution networks, thereby increasing and improving power supply quantity and quality in the city.

The power generated from the hybrid system can be integrated or transmitted to the grid distribution network and sold as electrical energy to conventional energy providers. The goal is to complement the deficiencies of the conventional power supply system. As a stand-alone system, the hybrid system can be used in residences at night when power consumption is at its peak, thereby reducing the cost of electricity during this period.

For the stability of the hybrid system, energy storage is required to supplement the generator when the SPV and hydropower system cannot generate sufficient electricity, especially at night. Therefore, the significant concerns of the battery storage system are the performance, longevity and durability of the hybrid system. The paramount importance of the solar-hydro hybrid power system is the ability of each constituent power system to complement the deficiencies of each other, thereby ensuring regular and reliable power supply.

This study was carried out due to erratic or irregular power supply, which is frequently experienced in Nigeria, high energy cost, especially in areas where grid electricity is unavailable or unreliable and environmental concerns, which are familiar with fossil fuel power generation as they emit greenhouse gases and cause climate change. This study aims to design and construct a solar-hydro hybrid power system for power generation which addresses the challenges of over-dependence on national grid power by integrating two sources of renewable energy, of which the solar energy source is the primary source, thereby overcoming the limitations of over-dependence on the national power grid. Furthermore, this study harnesses renewable energy and reduces the environmental impact of conventional energy sources, including the reduction in emission of greenhouse gases, energy diversification and reduction in the cost of energy generation using conventional energy sources.

Solar energy is generated from the sun or derived through solar radiation. It is the most common source of renewable energy along with hydropower. Renewable energy emanates from natural resources and replenishes as they get used. They do not get depleted over time and are environmentally friendly as they do not emit any greenhouse gases. The word hydro means water. Hydro energy is the energy generated from fast-moving water. It is the power derived from kinetic energy of fast-moving water. It is referred to as hydroelectricity or hydroelectric power. A hybrid solar system is a combination of two or more sources of energy. It is typically a combination of solar power and another renewable energy source. It also has a mini battery which stores the generated power for controller or system use when solar energy or hydro energy is in limited supply.

The Earth's population has grown over time, which is proportional to the amount of energy consumed. Energy is required for the operation of all conceivable devices, machinery, and equipment. Finding sustainable sources of renewable energy that can lessen reliance on fossil fuels is becoming more important as fossil fuel reserves are depleting. Solar energy is the most abundant form of energy available to us. It is estimated that 1000 W/m2 of solar energy is incident on Earth's surface each day. There has been a minimal increase in energy consumption every year, with approximately 1 to 1.5 percent growth per year. By 2040, there will be a 56% increase in global energy consumption.

1.2 Background Study

After reading various literature papers and visiting some power station, we got only single power station like solar power station or hydro power station or fossil fuel power station. We got only one paper about hybrid power station, which is developed in Ekiti State in Nigeria. After reading this paper we decide to make a hybrid power station or combined power station with solar and hydro generator. Solar power station can generate electricity only 6-8 hour in day, where another 16 hours is remaining. Other side hydro power station or hydro generator need a lot of water to generate electricity. But in our country's there is only one water damn, and this damn was using for Karnafuli Hydropower station. In this case we can store water on overhead tank by using solar power for generate hydro-electricity. We use an external water pump for loading water on reservoir in day time. And we use this water in night time for generate electricity by using hydro generator. We can use this electricity for residential area or in industry or in a factory. Now we can easily safe our fossil fuel by using this station.

1.3 Problem Statement

Generally, we are depending on fossil fuel for generating electricity, but fossil fuel is limited in earth. On other hand wind mile is a renewable energy source but it's not suitable for our country, because in our country's weather is no appropriate for wind mile. There is also some limitation to generating electricity by using solar power station. Because solar panel can generate electricity only in day time. Now we can solve this all kind of problem by making a hybrid power station. That mean we can make a solar-hydro power station for solving this situation. This solar plant can deliver electricity in day time and also store extra electricity in a reservoir by converting electricity to water. This water can be used for generating hydropower by using hydro generator.

1.4 Objectives

The main objective of the project is making a hybrid power station by using solar-hydro combined power station. Because solar is a renewable energy source. We can safe fossil fuel by using this technic. And it's a green energy source it does not pollute our environment. We can get a lot of energy from this station.

1.5 Scopes

The recent rapid rise in the growth of solar PV and wind based power generation capacity is not only to gradually replace the conventional power supply system but also to meet the obligations of global climate protection. The developing countries China, India, and Bangladesh which are still struggling to produce enough power for their growing industrialization as well as other sectors are focusing on power supplement from the alternative sources. Given the rapid decline of conventional fuels, countries round the globe have devised supportive policy strategies in order to enhance RES exploitation. Among the new renewable solar, wind, modern biomass, geothermal heat etc. the installed capacity of wind based power generation is dramatically rising in some of the developed. However, the installed capacity in solar PV systems takes place mostly in the developed countries. Until the end of 2008, the global capacity of solar PV systems is just less than 17 GW, while grid connected system accounts for 13 GW and off-grid system is 4 GW. Until now (2010, Germany alone has already achieved an installed capacity of 7 GW, which is more than the existing power demand (5-6 GW) of Bangladesh. In Bangladesh until 2010, the exploitation of RES mainly applies solar home systems in the rural areas, a few wind based power generation plants and biogas plants.

Bangladesh has an enormous potential in solar-hydro energy, and therefore the installations of small and large-scale PV and hydro systems can help to reduce its current share of GHG emission. One family using a typical solar-hydro home system can save yearly 290 liters of kerosene by using solar lighting technology and can prevent the emission of 0.76-ton CO 2 per year. It can also save coal and LPG burning in power station. Which is a biggest benefit for our country's.

1.6 Benefit of the project

A key benefit of the hybrid solar-hydro system over a traditional one is that it delivers continuous power. Because the hydro generator connected to hybrid solar systems, they provide continuous power without interruption. During power outages, the hydro generator work as a battery to provide you with backup power for your home and important appliances. When the sun goes down or when there's a power outage, hydro generator provide backup power to keep things running smoothly.

Renewable Sources is the Best way, Because the hydro generator with water reservoir are connected to a specially designed system that stores excess solar energy, there is no waste of unused power. So, these systems make use of the renewable energy in the best way, store energy on sunny days and utilize that stored power on cloudy days or at night.

Unlike traditional generators, which can waste fuel under certain conditions, hybrid solar-hydro energy systems work more efficiently and sustainably. Hybrid solar-hydro systems generate power efficiently in all types of weather, storing extra energy for later use without wasting fuel.

Traditional generators provide high output only when they are turned on. On the other hand, hybrid solar-hydro power systems store energy during the day and distribute it at night. A hybrid solar-hydro system may have technology that automatically adjusts the energy supply according to the power requirements of specific devices, whether it’s an air conditioner or a fan.

1.7 Project Outline

This project is organized as follows:

Chapter 1 Introduction.

In this chapter we discus about this project.

Chapter 2 Analysis of the system component.

In this chapter we discus about all component, which component we used in this project. like Arduino Nano, Solar panel, Hydro generator, Li-Po controller, Boost converter, LCD display, etc.

Chapter 3 Hardware development.

In this chapter we discus about hardware developing. how we develop our project, how we make this project.

Chapter 4 Result and discussions.

In this chapter we discus about project output, we check our panel and hydro generator by using a sun-light and water flow, we got a perfect result.

Chapter 5 Conclusions.

CHAPTER II
ANALYSIS OF THE SYSTEM COMPONENT

2.1 Introduction

The proposed system is a solar-hydro hybrid power system. The system ensures to generate more power from the sun rays, using solar panel and hydro generator. This system is stores 50-56 percentage more energy for night time or when sun is hidden in cloud. This is fully automatic controlled with power monitoring system. The system will bear following functionalities:

A. It can convert solar energy to hydro energy for night using.
B. It will produce 50-56 percentage more energy from storing hydro power.
C. Its fully MPU controlled automatic system.

2.2 Required Component

The Controller has the following main components.

i. Arduino Nano.
ii. Hydro generator.
iii. Solar panel.
iv. Water pump.
v. Reed sensor.
vi. Voltage Regulator IC.
vii. Li-Ion Charge controller.
viii. Li-Ion Battery.
ix. Boost Converter.
x. LCD Display.
xi. Power Switch.
xii. Diode.
xiii. Resistor.
xiv. Capacitor.
xv. Transistor.

xvi. Vero-board.

xvii. Water tank.

xviii. Pipe fittings.

xix. Connecting wire.

xx. Arduino IDE.

2.3 Arduino Nano

The Arduino Nano is a MPU based developer board. It is a small, complete, and breadboard-friendly board based on the ATmega328P released in 2008. It offers the same connectivity and specs of the Arduino Uno board in a smaller form factor. The Arduino Nano is equipped with 30 male I/O headers, in a dip-30 like configuration, which can be programmed using the Arduino Software integrated development environment (IDE), which is common to all Arduino boards and running both online and offline. The board can be powered through a type-b micro-USB cable, or through a 9V battery.

In 2019, Arduino released the Arduino Nano Every, a pin-equivalent evolution of the Nano. It features a more powerful ATmega4809 processor, and twice the RAM.

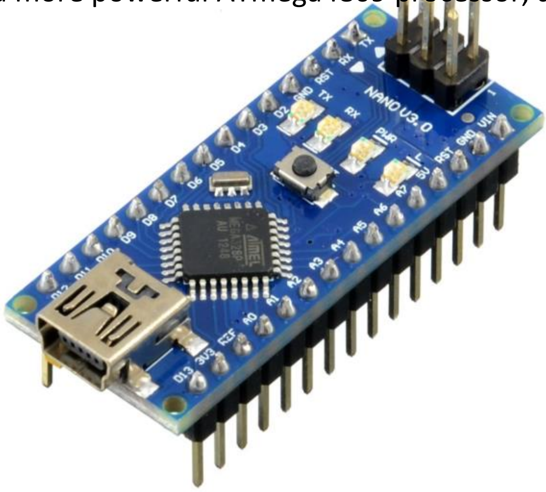

Fig: 2.1 Arduino Nano.

The Arduino Nano has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provide UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An FTDI FT232RL on the board channels this serial communication over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Nano's digital pins. The ATmega328 also support I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

2.3.1 Specification of Arduino Nano

Table: 2.1 Specification of Arduino Nano

Arduino Nano	
Microcontroller	Microchip ATmega328p
Operating Voltage	5V
Input Voltage	6-20V
Digital I/O Pins (DIO)	14
Analog Input Pins (ADC)	8
DC Current per I/O	40mA
SPIs	1
I2Cs	1
Flash Memory	32 KB
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
USB	Mini type B
Reset Button	YES
Serial LED	2 pcs
Load LED	1 pcs (pin 13)

Length	45 mm
Width	18 mm
Weight	7 gm

2.3.2 Pin Function of Arduino Nano

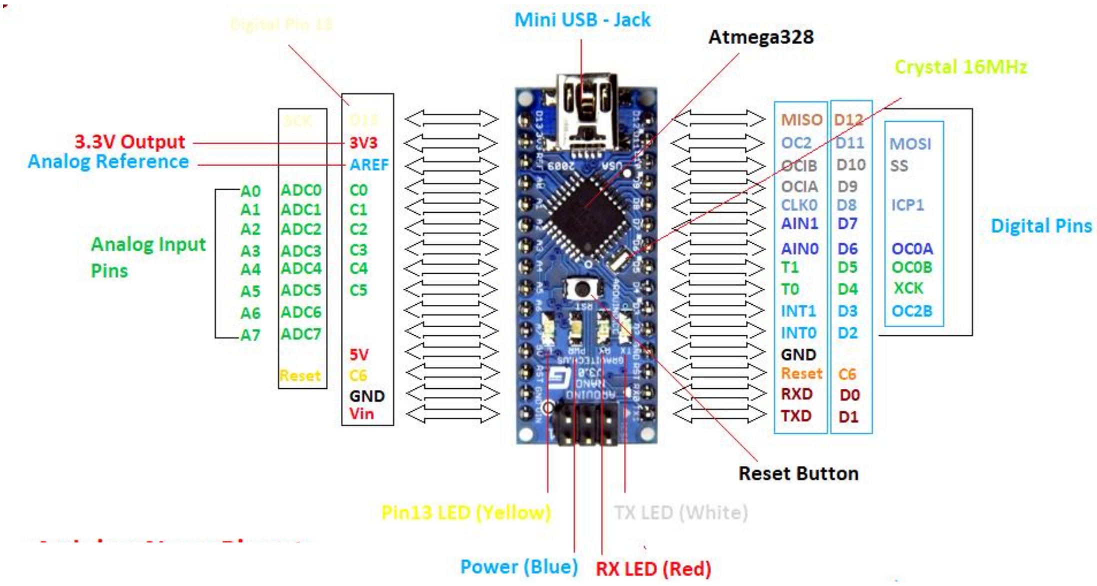

Fig: 2.2 Pin Function of Arduino Nano.

Table: 2.2 Pin function of Arduino Nano.

Level	Data Pin(D)	Notes
A0-A7		Analog to Digital Converter (ADC)
Reset		Reset Pin
D0-D13		Data Pin
RX	0	Serially Receiving Pin
TX	1	Serially Transmitting Pin
INT0	2	Interrupt Pin 1
INT1	3	Interrupt Pin 2
PWM	3, 5, 6,9,10,11	Pulse Wide Modulation Pin
SPI	10, 11, 12, 13	SS, MOS1, MOS0, SCK
GND		Ground

3V3		3.3V Output
LED	13	Inbuilt LED
RST		Reset
GND		Ground
Vin		Raw input Voltage
2IC	A4, A5	Serially data transmit

2.4 Hydro Generator

Hydro generator is a machine, which is used for generate hydro electricity from moving water. This machine is connected to a hydro turbine. Hydro turbines are devices used in hydroelectric generation plants that transfer the energy from moving water to a rotating shaft to generate electricity. These turbines rotate or spin as a response to water being introduced to their blades. These turbines are essential in the area of hydropower the process of generating power from water.

Generally, the construction of turbines is the same. A row of blades is fitted to some rotating shaft or plate. Water is then passed through the turbine over the blades, causing the inner shaft to rotate. This rotational motion is then transferred to a generator where electricity is generated. There are a variety of different types of turbines that are best used in different situations. Each type of turbine is created to provide maximum output for the situation it is used in.

The type of turbine selected for any given hydropower project is based on the height and speed of the incoming water known as the hydraulic head and the volume of water that flows known as the hydroelectric discharge.

Fig: 2.3 Hydro Generator.

2.4.1 Technological Background of Hydro Generator.

Hydro power plant has always operated according to the same fundamental principle, they capture the energy of flowing water and use this to generate electricity. Water in the hydro power plant flows over the turbine runners whose movement drives the generator. The generator is turn converts kinetic energy into electricity by contact free induction

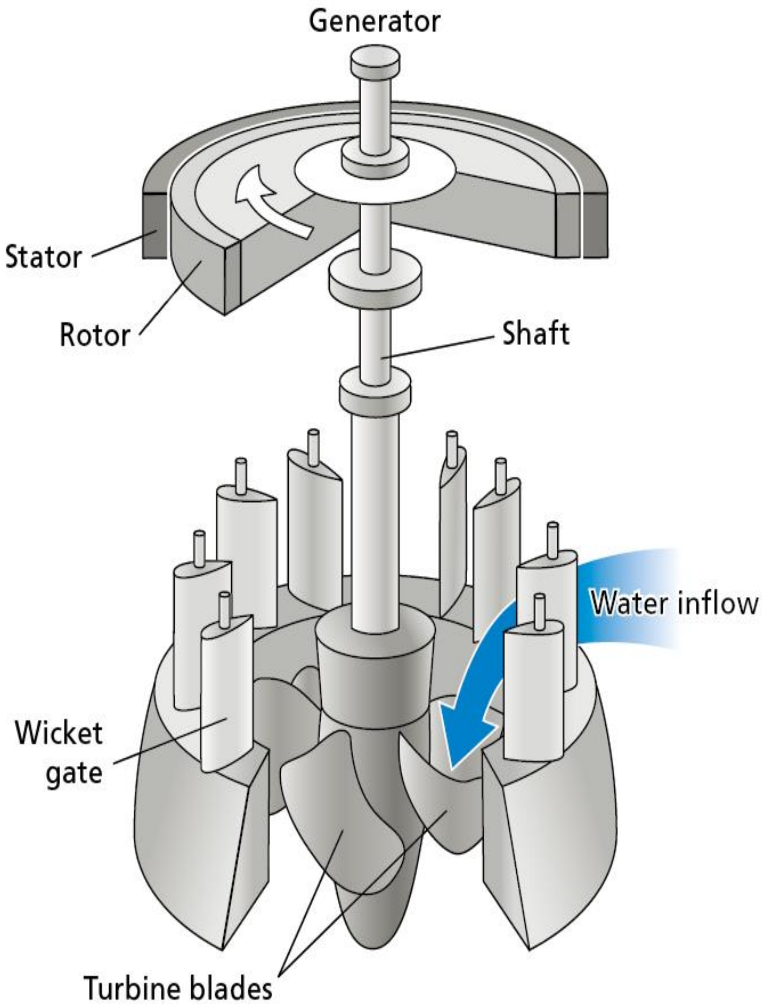

Fig: 2.4 Illustration of a hydroelectric turbine.

Usually, there is very low wear or the turbine, and little or no wear on generator, which means the average service life of the electro-mechanical equipment is between 60 to 80 years. This is far longer than the life time of other type of power generating equipment. The efficiency gains from improved materials and design tools over the past 100 years have amounted to only a few percent and efficiency is now near the theoretical upper limit of 100%, with turbines already reaching 95% efficiency and generator often exceeding 98% efficiency.

2.4.2 Efficiency of Hydropower Plant.

In addition to being a very economical viable technology in terms of maintenance and operation cost and a long service life, hydropower has among the best conversion efficiencies of all energy source energy flows are concentrated and can be controlled. Mean-while the conversion process capture kinetic energy and turn it directly into electric energy, with little or no losses through heat or inefficient processes. The total conversion efficiency of a hydropower plant typically ranges between 90-95%.On average, a hydropower plant generates between three and five gigawatt-hours of electricity per megawatt of installed capacity per year, which is around two to three time as much as a solar PV system. Hydropower also exhibits the highest peak load hours within the renewable energy subset, which indicates the degree of utilization of a power plant.

2.5 Solar panel

A solar cell panel, solar electric panel, photo-voltaic (PV) module, PV panel or solar panel is an assembly of photovoltaic solar cells mounted in a usually rectangular frame, and a neatly organized collection of PV panels is called a photovoltaic system or solar array. Solar panels capture sunlight as a source of radiant energy, which is converted into electric energy in the form of direct current (DC) electricity. Arrays of a photovoltaic system can be used to generate solar electricity that supplies electrical equipment directly, or feeds power back into an alternate current (AC) grid via an inverter system.

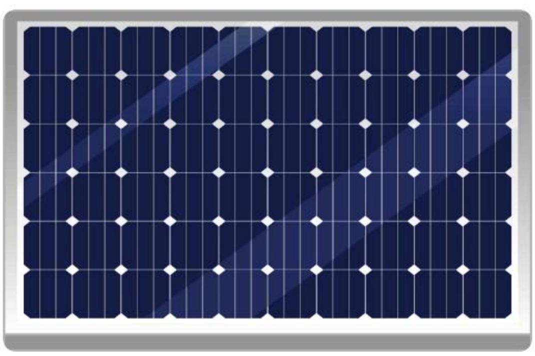

Fig: 2.5 Solar panel.

In 1839, the ability of some materials to create an electrical charge from light exposure was first observed by the French physicist Edmond Becquerel. Though these initial solar panels were too inefficient for even simple electric devices, they were used as an instrument to measure light.

The observation by Becquerel was not replicated again until 1873, when the English electrical engineer Willoughby Smith discovered that the charge could be caused by light hitting selenium. After this discovery, William Grylls Adams and Richard Evans Day published "The action of light on selenium" in 1876, describing the experiment they used to replicate Smith's results.

In 1881, the American inventor Charles Fritts created the first commercial solar panel, which was reported by Fritts as "continuous, constant and of considerable force not only by exposure to sunlight but also to dim, diffused daylight. However, these solar panels were very inefficient, especially compared to coal-fired power plants.

In 1939, Russell Ohl created the solar cell design that is used in many modern solar panels. He patented his design in 1941. In 1954, this design was first used by Bell Labs to create the first commercially viable silicon solar cell.

Solar panel installers saw significant growth between 2008 and 2013. Due to that growth many installers had projects that were not "ideal" solar roof tops to work with and had to find solutions to shaded roofs and orientation difficulties. This challenge was initially addressed by the re-popularization of micro-inverters and later the invention of power optimizers.

Solar panel manufacturers partnered with micro-inverter companies to create AC modules and power optimizer companies partnered with module manufacturers to create smart modules. In 2013 many solar panel manufacturers announced and began shipping their smart module solutions.

2.6 Water Pump

A water pump is a machine that is used to transfer water from one location to another. This can be used to transfer water from one place to be used for drinking water or irrigation, or it can be used to remove water from an area to prevent damage. There are many types of water pumps available, and you can choose the best option for your needs.

Water pumps are a type of impulse turbine that works using a spinning wheel to convert potential energy from pressure into kinetic energy. The water is pumped from a lower elevation to a storage area, where it is collected until it is needed. The water is then released from the storage area at a higher elevation, allowing the water to travel to its desired location. Hydroelectricity water pumps can be used to pump water from a lower elevation to a higher elevation. This can create hydroelectricity, a renewable source of energy.

Fig: 2.6 Water Pump.

2.7 Reed Switch

WS01 Magnetic Float switch for water level sensing, can be used to design a water tank overflow alarm and control system. This sensor has a moving ring on a cylindrical body. A reed switch is housed inside the central cylinder which senses the movement of the outer ring under the influence of the buoyant force of raising water level. This is a NO (Normal Open) type switch that closes on sensing of rising water level.

Fig: 2.7 WS01 Reed Sensor.

2.8 Voltage Regulator IC

Voltage sources in a circuit may have vacillations bringing about not giving settled voltage yields. A voltage controller IC keeps up the yield voltage at a consistent esteem. 7805 IC, an individual from 78xx arrangement of settled straight voltage controllers used to keep up such changes, is a mainstream voltage controller IC. The xx in 78xx demonstrates the yield voltage it gives. 7805 IC furnishes +5 volts controlled power supply with arrangements to include a warmth sink.

2.8.1 Specification of LM7805

i. Input voltage range 7V to 35V.

ii. Output Current 1 A.

iii. Output voltage range V_{Max} = 5.2V, V_{Min} = 4.8V.

2.8.2 Pin Function of LM7805

Table: 2.3 Pin Function of 7805 IC.

Pin NO	Pin Name
1	Input pin
2	Ground pin
3	Output pin

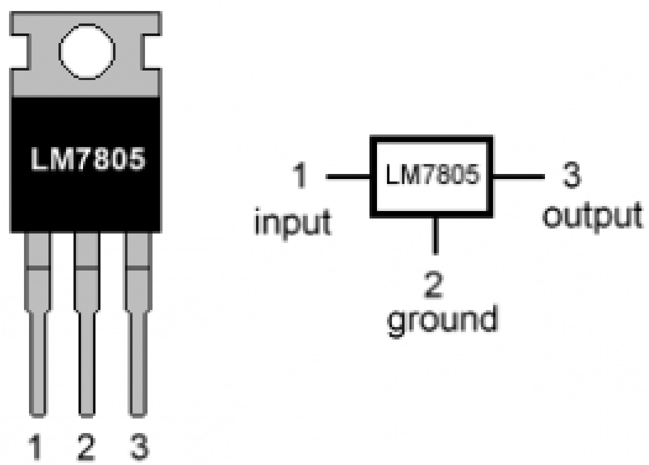

Fig: 2.8 Voltage Regulator IC.

2.9 Li-Ion Charge Controller

A charge controller, charge regulator or battery regulator limits the rate at which electric current is added to or drawn from electric batteries to protect against electrical overload, overcharging, and may protect against overvoltage. This prevents conditions that reduce battery performance or lifespan and may pose a safety risk. It may also prevent completely draining ("deep discharging") a battery, or perform controlled discharges, depending on the battery technology, to protect battery life. The terms "charge controller" or "charge regulator" may refer to either a stand-alone device, or to control circuitry integrated within a battery pack, battery-powered device, or battery charger.

The TC4056A is a complete single-cell Li-Ion battery with a constant current and constant voltage linear charger. Heat sink on the bottom. The ESOP8/DIP8 package and fewer external components make the TC4056A ideal for portable applications. TC4056A can be used for USB The source and adapter power supplies work.

Fig: 2.9 Li-Ion Charge controller.

2.9.1 Protection Features of TP4056

This module uses the TP4056 or TC4056 Li-Ion charge controller IC and a separate protection IC. There are other types of modules on the market that use the TP4056 or TC4056 but lack any protection circuits or ICs to provide the necessary protection needed with lithium batteries. This module uses both the TP4056 or TC4056 and the

DW01A Li-Ion battery protection IC, which together in combination provide the following protection features:

- Manage the constant current to constant voltage charging of a connected lithium battery
- Over-discharge protection - keeps your battery from being discharged below 2.4V, a healthy minimum voltage level for your battery.

  If a connected battery has been discharged below 2.4V the module will cut output power from the battery until the battery voltage has been re-charged above 3.0V (the over-discharge release voltage), which at that time the module will again allow discharge of power from the battery to a connected load. Although the module cuts output power from the battery during an over-discharge situation, it still allows charging of the battery to occur through the parasitic diode of the discharge control MOSFET (FS8205A Dual MOSFET).

- Overcharge protection - the module will safely charge your battery to 4.2V
- Overcurrent and short-circuit protection - the module will cut the output from the battery if the discharge rate exceeds 3A or if a short-circuit condition occurs
- Soft-start protection limits inrush current
- Trickle charge (battery reconditioning) - if the voltage level of the connected battery is less than 2.9V, the module will use a trickle charge current of 130mA until the battery voltage reaches 2.9V, at which point the charge current will be linearly increased to the configured charge current.

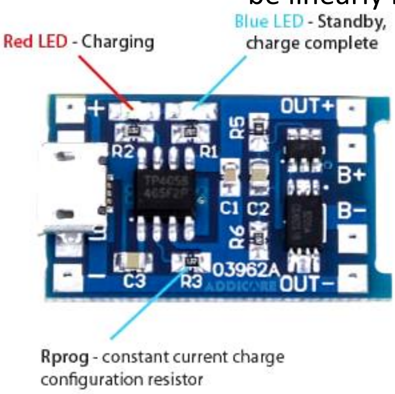

Fig: 2.10 TP4056 Indicator’s.

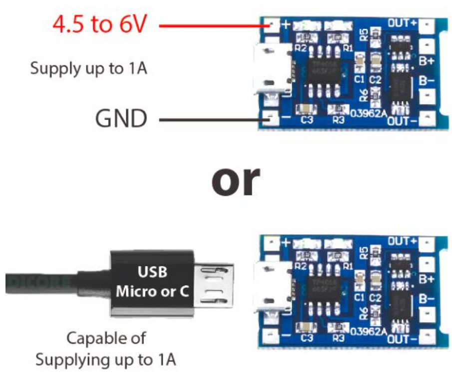

Fig: 2.11 Li-Ion Charge Controller Power IN.

It can be powered, for charging, from a USB cable (USB Micro or USB C) or the (+) and (-) connections, see Power Supply Options Diagram below. The power source needs to be able to provide at least 1A for the charger to correctly charge a connected battery. Most modern phone/USB chargers can provide 1A or more; refer to the label on your phone charger to verify. If you use a USB cable, make sure that it is made to carry at least 1A.

Includes two indicator LEDs. Red LED indicates charging. Blue LED indicates charge complete.

The charge current can be configured externally with the Rprog resistor. The datasheet for the TP4056 includes a table and equation for what resistor values to use for configuring different charge currents.

The module uses a very small amount of current (in the micro amps) whenever it is connected to a battery. It is fine to leave it connected to a battery for long periods, but if you plan to not charge the battery within four months then we recommend disconnecting the module from the battery.

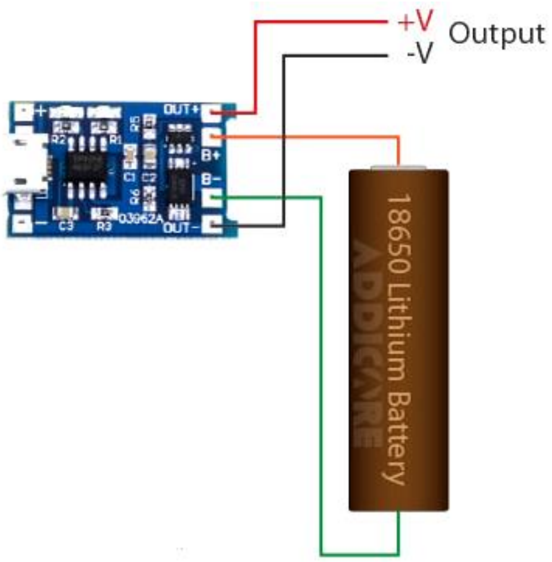

Fig: 2.12 TP4056 Battery Connection.

You can connect two lithium battery cells in parallel to form an equivalent single cell battery with a total capacity of twice that of the individual single cells, but we do not recommend connecting more than two cells at a time to this module. Refer to the Two

Parallel Cell Connection diagram below. Care must be taken when setting up this type of configuration; refer to Precautionary Note 1 concerning precautions to connecting parallel cells.

2.10 Li-Ion battery

An 18650 battery is a rechargeable lithium-ion battery. They tend to have a nominal voltage of 3.6V and range in capacity from 1800mAh to 3600mAh. In all honesty.

Popular in flashlights and portable electronic devices such as laptops, lithium-ion batteries are used extensively for a variety of reasons - they have a higher capacity, give higher output and do not leak over longer periods of time. They also have built-in safety features.

Lithium is the lowest density metal which also has the greatest electrochemical potential and energy to weight ratio. This means that lithium has excellent energy storage capacity. These high energy density and low weight density properties make it the ideal material to act as a power source for when high power and low weight is needed.

Batteries containing lithium were first experimented with in 1912 and then first sold in the 1970's. They were used in industries looking for powerful, long lasting batteries which were also lighter in weight. Other types of battery including nickel-cadmium and lead acid are slowly being replaced with li-ion cells. Not to be confused with lithium-metal batteries which are non-rechargeable, lithium-ion batteries can be recharged many times over.

Fig: 2.13 Li-Ion Battery.

18650 batteries are a popular choice in EDC and tactical flashlights because of their size which allow the flashlight to have a good balance of runtime, output and portability.

For all li-ion batteries, their approximate physical dimensions, in mm determine the name of them. The first two digits indicate the approximate diameter and the following two indicate the approximate length. These two sets of numbers are then followed by a zero. So for an 18650 battery, the first two digits are 18, meaning every 18650 battery has about 18mm diameter, the next two digits are 65, meaning they have around 65mm length.

There are actually a number of different chemical compositions for li-ion 18650 batteries which are listed below. It is worth finding out the composition of the 18650 battery because each of the various ones are slightly more suited for different tasks. These different types of li-ion chemical compositions are listed in order from the least volatile to the most volatile. Volatility is measure of how prone to overheating and exploding the battery is:

- **LiFePO4**: Lithium iron phosphate abbreviated to IFR or LFP or Li-phosphate.
- **LiMn2O4**: Lithium manganese oxide abbreviated to IMR or LMO or Li-manganese
- **LiNiMnCoO2**: Lithium manganese nickel abbreviated to INR or NMC
- **LiNiCoO2**: Lithium nickel cobalt oxide abbreviated to NCO
- **LiCoO2**: Lithium cobalt oxide abbreviated to ICR or LCO Li-cobalt.

2.11 Boost Converter

A boost converter is a DC to DC power converter that steps up voltage from its input to its output. It is a class of switched-mode power supply (SMPS) containing at least two semiconductors and at least one energy storage element: a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors are normally added to such a converter's output and input.

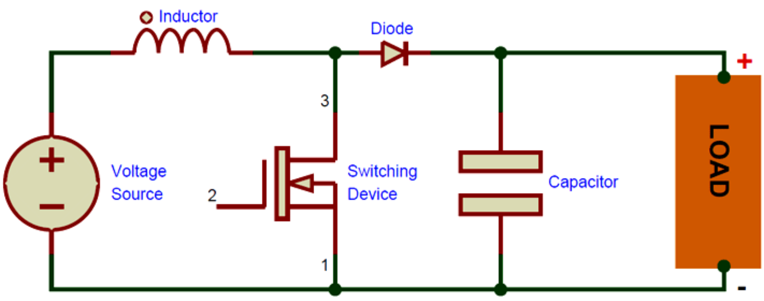

Fig: 2.14 Boost Converter.

For high efficiency, the switched-mode power supply (SMPS) switch must turn on and off quickly and have low losses. The advent of a commercial semiconductor switch in the 1950s represented a major milestone that made SMPSs such as the boost converter possible. The major DC to DC converters were developed in the early 1960s when semiconductor switches had become available. The aerospace industry's need for small, lightweight, and efficient power converters led to the converter's rapid development.

Switched systems such as SMPS are a challenge to design since their models depend on whether a switch is opened or closed. R. D. Middlebrook from Caltech in 1977 published the models for DC to DC converters used today. Middlebrook averaged the circuit configurations for each switch state in a technique called state-space averaging. This simplification reduced two systems into one. The new model led to insightful design equations which helped the growth of SMPS.

XL6009 module is a non-isolated step-up boost voltage converter featuring adjustable output voltage, high efficiency. It converts input voltage of 5-32V DC to an output voltage of 4-38V DC.

Fig: 2.15 XL6009 Booster.

2.11.1 Features of Boost Converter

1. Wide input voltage 3V ~ 32V, optimum operating voltage range is 5 ~ 32V;
2. Wide Output voltage 5V ~ 35V;
3. Built-4A efficient MOSFET switches enable efficiency up to 94%; (LM2577 current is 3A)

4. High switching frequency 400KHz, can use a small capacity filter capacitor that can achieve very good results, the ripple smaller and smaller. (LM2577 frequency only 50KHz)

2.11.2 Booster Test Results

Formula of XL6009 Boost converter: Vin * Iin * Efficiency = Vout * Iout

1. Input 3V Output 12V 0.4A 4.8W
2. Input 5V Output 12V 0.8A 9.6W
3. Input 7.4V Output 12V 1.5A 18W
4. Input 12V Output 15V 2A 30W
5. Input 12V Output 16V 2A 32W
6. Input 12V Output 18V 1.6A 28.8W

2.11.3 Technical Parameters of XL6009

1. Module Properties: Non-isolated boost.
2. Rectification: Non-Synchronous Rectification.
3. Input Voltage Range: 3V ~ 32V.
4. Output Voltage: 5V ~ 35V.
5. Input Current: 4A.
6. Conversion efficiency: <94%.
7. Switching frequency: 400KHz.
8. Output Ripple: 50Mv.
9. Load Regulation: ± 0.5%.
10. Voltage Regulation: ± 0.5%.
11. Operating Temperature: -40 ~ +85 Degree Celsius.
12. Dimensions: 43mm * 21mm * 14mm (L * W * H).

When using these modules remember that the output current will be a lot less than the input current, (remember - W = VA). For example, if you have a 10V output at 1A from a 5V input, the input current will be around 3.6A. The real-life maximum amount of power you can get out of these things is around 10W.

2.12 LCD Display

A liquid-crystal display is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly. Here, in this able we're going to use a monochromatic 20x4 alphanumeric LCD. 20x4 means that 20 characters can be displayed in each of the 4 rows of the 20x4 LCD, thus a total of 80 characters can be displayed at any instance of time.

This 20x4 Character LCD Display is built-in with RW1063 controller IC which are 6800, 4 line SPI or I2C interface options. The WH2004G 20x4 LCD Display have the same AA size and pin assignment as existing WH2004A and WH2004B character LCD modules but with smaller outline and VA size.

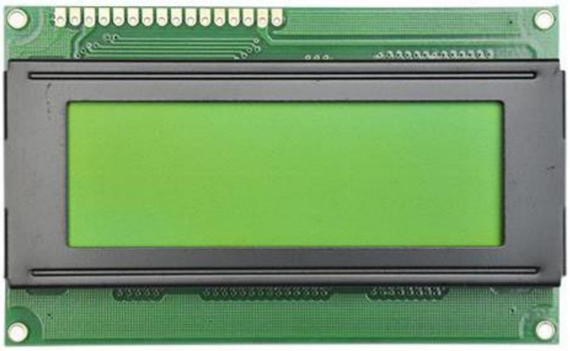

Fig: 2.16 16x2 LCD Display.

2.12.1 Specification of LCD Display

Table: 2.4 Specification of LCD Display.

Pin No	Symbol	Description
1	V_{SS}	Ground
2	V_{DD}	Power Supply
3	V_0	Contrast Adjustment
4	RS	Data / Instruction select signal
5	R/W	Read / Write Signal
6	E	Enable Signal
7-14	D0-D7	Data Bus line
15	A	Back kit LED Anode pin
16	K	Back kit LED Cathode pin

2.13 Power Switch

In electrical designing, a switch is an electrical segment that can "make" or "break" an electrical circuit, interfering with the flow or redirecting it starting with one conduit then onto the next. The system of a switch expels or reestablishes the directing way in a circuit when it is worked. A switch will have at least one arrangements of contacts, which may work at the same time, successively, or on the other hand. Switches in powerful circuits must work quickly to counteract ruinous arcing, and may incorporate unique highlights to aid quickly intruding on a substantial current. [15]

Fig: 2.17 Power Switch.

2.14 Power Connector

Barrel connectors are ordinarily found on minimal effort purchaser hardware which can be connected to divider control by means of massive AC divider connectors. Divider connectors are generally accessible, in an assortment of intensity evaluations and voltages, making barrel connectors a typical means for interfacing capacity to little tasks. The female barrel connector can be obtained in a few assortments: PCB mounted link mount, or board mount. A portion of these connectors will have an extra contact that enables the application to identify whether a power supply is connected to the barrel jack or not, in this manner enabling the gadget to sidestep batteries and spare battery life when running on outside power. [16]

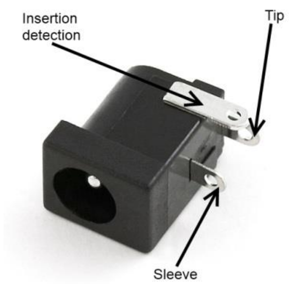

Fig: 2.18 Power Connector Port.

2.15 Diode

Diode, an electrical component that allows the flow of current in only one direction. In circuit diagrams, a diode is represented by a triangle with a line across one vertex. The most common type of diode uses a *p-n* junction. In this type of diode, one material 'N' in which electrons are charge carriers abuts a second material 'P' in which holes (places depleted of electrons that act as positively charged particles) act as charge carriers. At their interface, a depletion region is formed across which electrons diffuse to fill holes in the *P*-side. This stops the further flow of electrons. When this junction is forward biased (that is, a positive voltage is applied to the *P*-side), electrons can easily move across the junction to fill the holes, and a current flows through the diode. When the junction is reverse biased (that is, a negative voltage is applied to the *P*-side), the depletion region widens and electrons cannot easily move across. The current remains very small until a certain voltage (the breakdown voltage) is reached and the current suddenly increases.

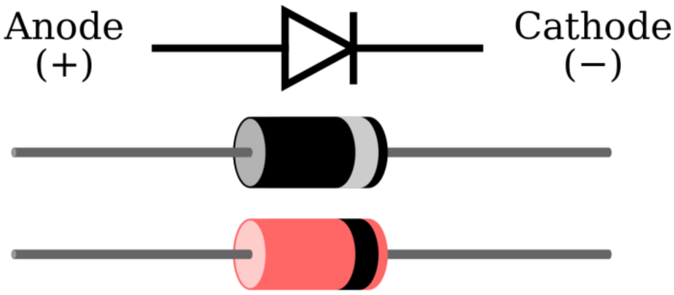

Fig: 2.19 Diode.

2.16 Resistor

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat, may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits. The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. The nominal value of the resistance falls within the manufacturing tolerance, indicated on the component.

Fig: 2.20 Fixed Resistor Symbol.

Fig: 2.21 Fixed Resistor Symbol (ANSI).

2.16.1 Type of Resistor

i. Fixed Resistor.
ii. Variable Resistor.
    a. Potentiometer.
    b. Rheoter.
    c. Trimpot.
iii. Resistance depend on a physical quantity.
    a. Thermistor.
    b. Photo Resistor.
    c. Varistor.
    d. Magneto Resistor.
    e. Strain Gauges Resistor.
iv. Material base.
    a. Carbon composition.
    b. Carbon film.
    c. Metal film.
    d. Metal oxide film.
    e. Wire-wound. f. Foil.

2.16.2 Resistor's Color Code

The obstruction esteem and resistance are shown with a few hued groups around the segment body. This stamping method of electronic segments was at that point created in the 1920's. Printing innovation was as yet not far created, what made printed numerical codes excessively troublesome on little segments. These days, the shading code is as yet utilized for most hub resistors up to one watt. In the figure a precedent is appeared with four shading groups. In this precedent the two first groups decide the noteworthy digits of the obstruction esteem, the third band is the duplicating factor and the fourth band gives the resistance. Each shading speaks to an alternate number and can be gazed upward in a resistor shading code table.

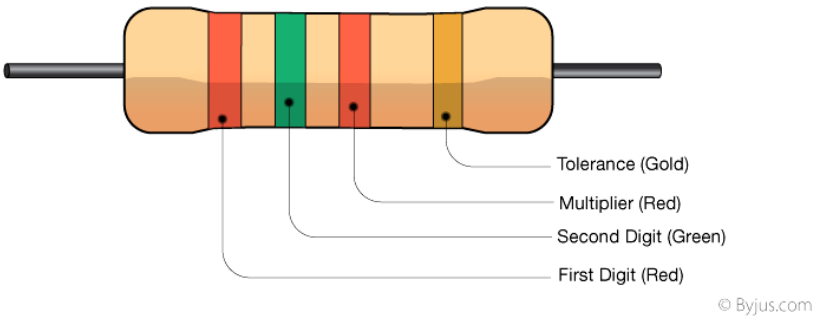

Fig: 2.22 Resistor Color Code.

Table: 2.5 Resistor color code table.

Color	Value	Multiplier	Tolerance
Black	0	1 Ohm	
Brown	1	10 Ohm	1%
Red	2	100 Ohm	2%
Orange	3	1 K Ohm	
Yellow	4	10 K Ohm	
Green	5	100 K Ohm	0.5%
Blue	6	1 M Ohm	0.25%
Violet	7		0.1%
Grey	8		
White	9		
Gold			5%
Silver			10%

No Color			20%

2.17 Capacitor

A capacitor is a device that stores electrical energy in an electric field. It is a passive electronic component with two terminals. The effect of a capacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser. This name and its cognates are still widely used in many languages, but rarely in English, one notable exception being condenser microphones, also called capacitor microphones.

Fig: 2.23 Symbol of Capacitor.

The physical form and construction of practical capacitors vary widely and many types of capacitor are in common use. Most capacitors contain at least two electrical conductors often in the form of metallic plates or surfaces separated by a dielectric medium. A conductor may be a foil, thin film, sintered bead of metal, or an electrolyte. The non-conducting dielectric acts to increase the capacitor's charge capacity. Materials commonly used as dielectrics include glass, ceramic, plastic film, paper, mica, air, and oxide layers. Capacitors are widely used as parts of electrical circuits in many common electrical devices. Unlike a resistor, an ideal capacitor does not dissipate energy, although real-life capacitors do dissipate a small amount. When an electric potential, a voltage, is applied across the terminals of a capacitor, for example when a capacitor is connected across a battery, an electric field develops across the dielectric, causing a net positive charge to collect on one plate and net negative charge to collect on the other plate.

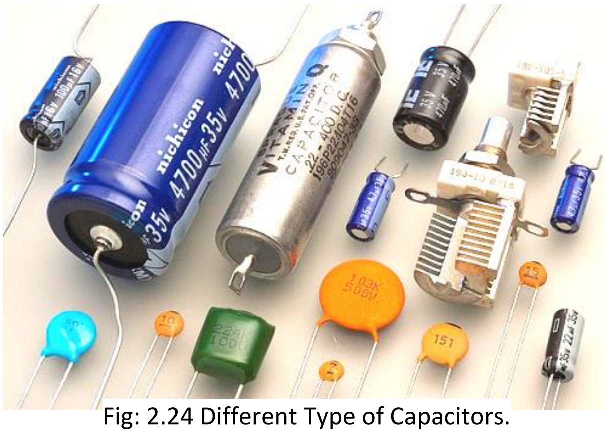

Fig: 2.24 Different Type of Capacitors.

No current actually flows through the dielectric. However, there is a flow of charge through the source circuit. If the condition is maintained sufficiently long, the current through the source circuit ceases. If a time-varying voltage is applied across the leads of the capacitor, the source experiences an ongoing current due to the charging and discharging cycles of the capacitor.

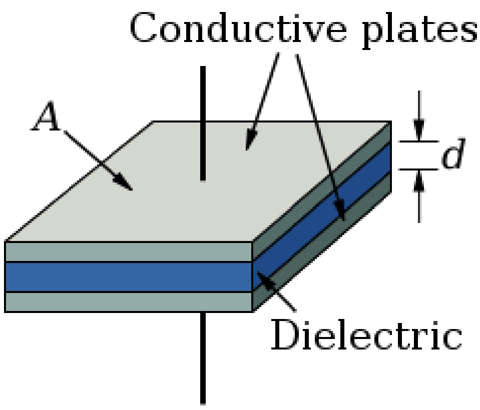

Fig: 2.25 Internal Architecture of Capacitor.

Capacitance is defined as the ratio of the electric charge on each conductor to the potential difference between them. The unit of capacitance in the International System of Units (SI) is the farad (F), defined as one coulomb per volt (1 C/V). Capacitance values of typical capacitors for use in general electronics range from about 1 pico-farad (pF) (10^{-12} F) to about 1 mille-farad (mF) (10^{-3} F).

$$C = \frac{Q}{V}$$

An ideal capacitor is characterized by a constant capacitance C, in farads in the SI system of units, defined as the ratio of the positive or negative charge Q on each conductor to the voltage V between them.

A capacitance of one farad (F) means that one coulomb of charge on each conductor causes a voltage of one volt across the device. Because the conductors are close together, the opposite charges on the conductors attract one another due to their electric fields, allowing the capacitor to store more charge for a given voltage than when the conductors are separated, yielding a larger capacitance. In practical devices, charge build-up sometimes affects the capacitor mechanically, causing its capacitance to vary. In this case, capacitance is defined in terms of incremental changes.

$$C = \frac{dQ}{dV}$$

2.18 Transistor

A transistor is a semiconductor device used to amplify or switch electronic signals and electrical power. It is composed of semiconductor material usually with at least three terminals for connection to an external circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled (output) power can be higher than the controlling (input) power, a transistor can amplify a signal. Today, some transistors are packaged individually, but many more are found embedded in integrated circuits.

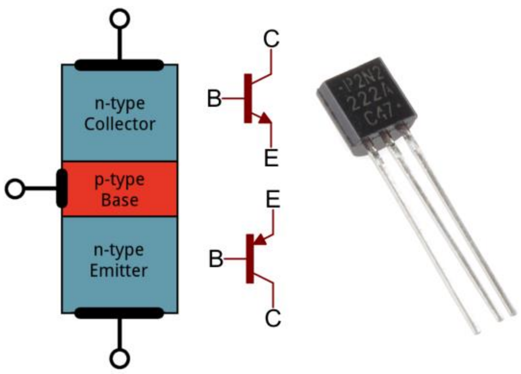

Fig: 2.26 Symbol & Internal Layer of Transistor.

Austro-Hungarian physicist Julius Edgar Lilienfeld proposed the concept of a field-effect transistor in 1926, but it was not possible to actually construct a working device at that time.[1] The first working device to be built was a point-contact transistor invented in 1947 by American physicists John Bardeen and Walter Brattain while working under William Shockley at Bell Labs. They shared the 1956 Nobel Prize in Physics for their achievement.[2] The most widely used transistor is the MOSFET (metal–oxide–semiconductor field-effect transistor), also known as the MOS transistor, which was invented by Egyptian engineer Mohamed Atalla with Korean engineer Dawon Kahng at Bell Labs in 1959.[3][4][5] The MOSFET was the first truly compact transistor that could be miniaturized and mass-produced for a wide range of uses.Transistors revolutionized the field of electronics, and paved the way for smaller and cheaper radios, calculators, and computers, among other things. The first transistor and the MOSFET are on the list of IEEE milestones in electronics. The MOSFET is the fundamental building block of modern electronic devices, and is ubiquitous in modern electronic systems. An estimated total of 13 sextillion MOSFETs have been manufactured between 1960 and 2018 (at least 99.9% of all transistors), making the MOSFET the most widely manufactured device in history.[11]

Most transistors are made from very pure silicon, and some from germanium, but certain other semiconductor materials can also be used. A transistor may have only one kind of charge carrier, in a field-effect transistor, or may have two kinds of charge carriers in bipolar junction transistor devices. Compared with the vacuum tube, transistors are generally smaller, and require less power to operate. Certain vacuum tubes have advantages over transistors at very high operating frequencies or high operating voltages. Many types of transistors are made to standardized specifications by multiple manufacturers.

2.19 Vero Board

Strip board is the generic name for a widely used type of electronics prototyping board characterized by a 0.1 inch (2.54 mm) regular (rectangular) grid of holes, with wide parallel strips of copper cladding running in one direction all the way across one side of the board. It is commonly also known by the name of the original product Vero board, which is a trademark, in the UK, of British company Vero Technologies Ltd and Canadian company Pixel Print Ltd. In using the board, breaks are made in the tracks, usually around holes, to divide the strips into multiple electrical nodes. With care, it is possible to break between holes to allow for components that have two pin rows only one position apart such as twin row headers for IDCs.

Strip board is not designed for surface-mount components, though it is possible to mount many such components on the track side, particularly if tracks are cut/shaped with a knife or small cutting disc in a rotary tool.

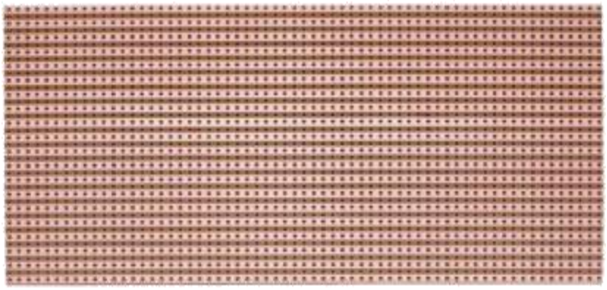

Fig: 2.28 Vero Board.

2.20 Connecting Wire

A wire is a single, usually cylindrical, flexible strand or rod of metal. Wires are used to bear mechanical loads or electricity and telecommunications signals. Wire is commonly formed by drawing the metal through a hole in a die or draw plate. Wire gauges come in various standard sizes, as expressed in terms of a gauge number. The term *wire* is also used more loosely to refer to a bundle of such strands, as in 'multi stranded wire', which is more correctly termed a wire rope in mechanics, or a cable in electricity.

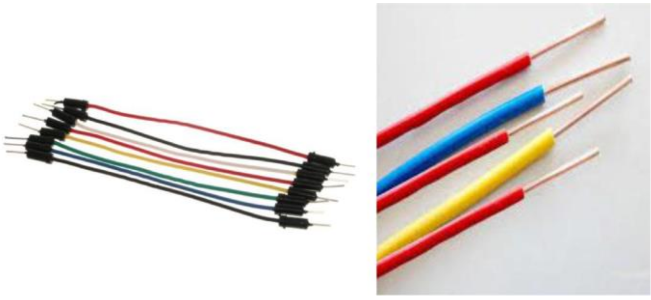

Fig: 2.29 Connecting Wire.

2.21 Arduino IDE

The Arduino Integrated Development Environment or Arduino Software (IDE) contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

Programs written using Arduino Software are called sketches**.** These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software, including complete error messages and other information. The bottom right-hand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

2.21.1 How to use Arduino IDE

- *New*
  Creates a new instance of the editor, with the bare minimum structure of a sketch already in place.
- *Open*
  Allows to load a sketch file browsing through the computer drives and folders.
- *Open Recent*
  Provides a short list of the most recent sketches, ready to be opened.
- *Sketchbook*
  Shows the current sketches within the sketchbook folder structure; clicking on any name opens the corresponding sketch in a new editor instance.
- *Examples*
  Any example provided by the Arduino Software (IDE) or library shows up in this menu item. All the examples are structured in a tree that allows easy access by topic or library.
- *Close*
  Closes the instance of the Arduino Software from which it is clicked.
- *Save*
  Saves the sketch with the current name. If the file hasn't been named before, a name will be provided in a "Save as." window.
- *Save as...*
  Allows to save the current sketch with a different name.
- *Page Setup*
  It shows the Page Setup window for printing.
- *Print*
  Sends the current sketch to the printer according to the settings defined in Page Setup.
- *Preferences*
  Opens the Preferences window where some settings of the IDE may be customized, as the language of the IDE interface.

- *Quit*
  Closes all IDE windows. The same sketches open when Quit was chosen will be automatically reopened the next time you start the IDE.

2.22 Proteus

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing printed circuit boards.

It was developed in Yorkshire, England by Lab-center Electronics Ltd and is available in English, French, Spanish and Chinese languages.

The first version of what is now the Proteus Design Suite was called PC-B and was written by the company chairman, John Jameson, for DOS in 1988. Schematic Capture support followed in 1990, with a port to the Windows environment shortly thereafter. Mixed mode SPICE Simulation was first integrated into Proteus in 1996 and microcontroller simulation then arrived in Proteus in 1998. Shape based auto-routing was added in 2002 and 2006 saw another major product update with 3D Board Visualization. More recently, a dedicated IDE for simulation was added in 2011 and MCAD import/export was included in 2015. Support for high speed design was added in 2017.

2.24 Summary

The components used are studied individually. Their purpose in the system is explained along with their ratings, pinouts and connections.

CHAPTER III
HARDWARE DEVELOPMENT

3.1 Introduction

This chapter will be explaining about the construction of Hybrid Solar and Hydro power generation system.

We explain how to design a Hybrid solar and hydro power station, how can we generate power from solar and hydro generator and also we will be explaining how to combined this two power to a single grid line.

In this chapter we be will discuss about block diagram and circuit diagram of Hybrid Solar and Hydro power station.

3.2 Block Diagram:

Solar-hydro Hybrid power generation system's block diagram are shown in blew:

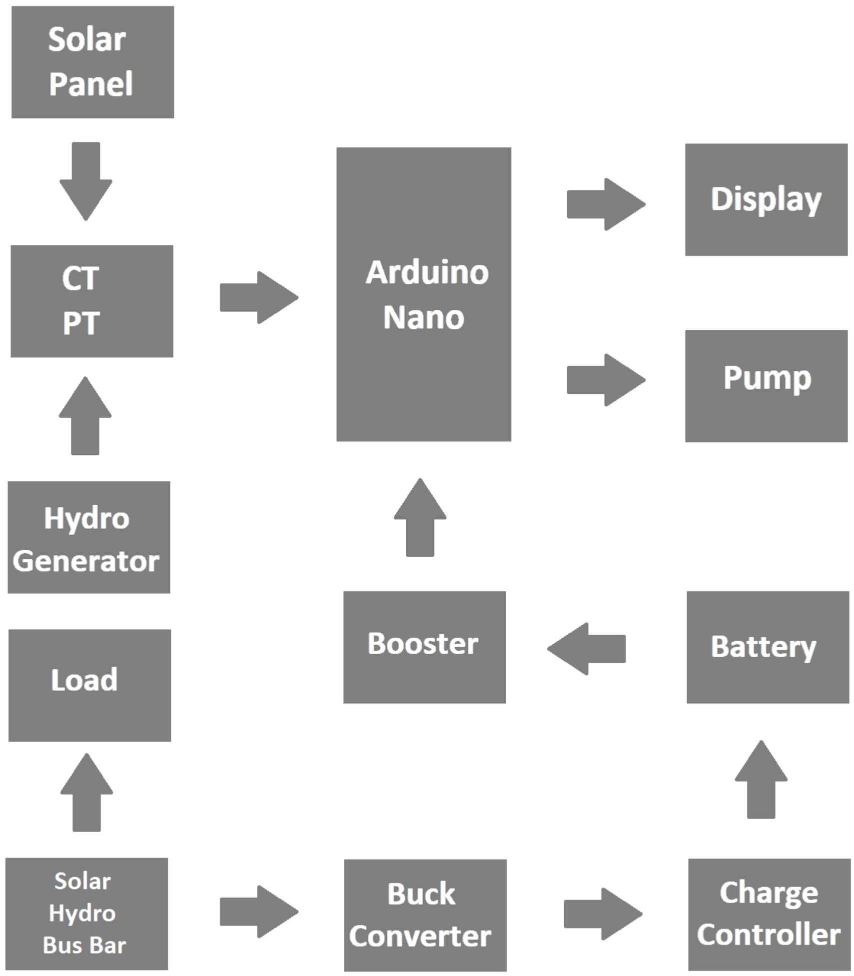

Fig: 3.1 Block Diagram of Hybrid power station.

3.3 Circuit Diagram

Solar-hydro hybrid power generation system's circuit diagram are shown in blew:

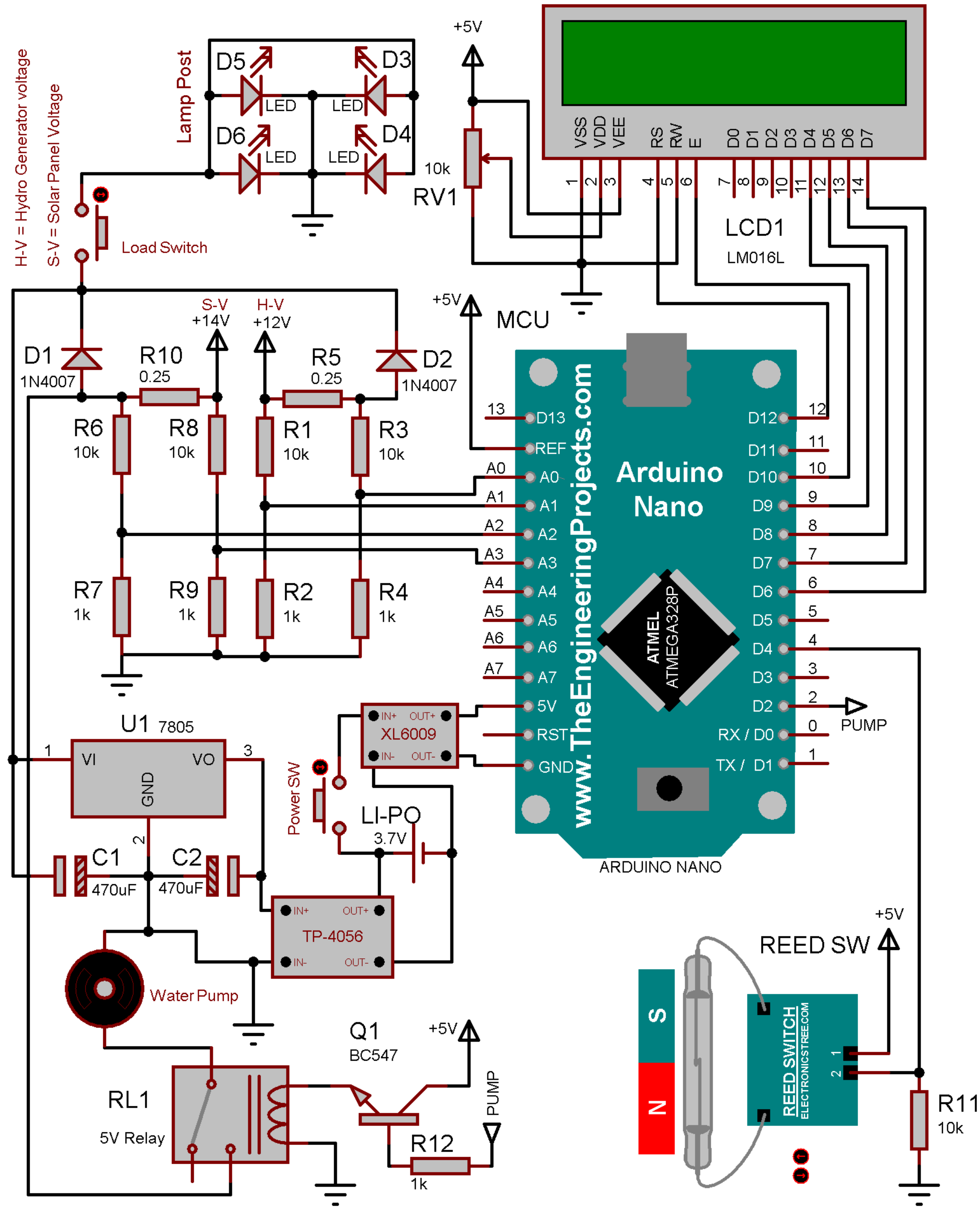

Fig: 3.2 Circuit Diagram of Hybrid Power Station.

3.4 Construction of Circuit

At first we need to collect all equipment for solar-hydro hybrid power station, which is listed in chapter 2.2. Then we need to connect as shown in figure 3.2.

We use arduino nano for measure and control all connected component, that's mean all kind of input data such as solar voltage, solar current, hydro generator voltage, generator current etc. we use a 15-watt poly film solar panel as a solar power station, which is connected with 12-volt bus bar voltage. We also use a micro hydro generator as a hydro power station, and we connect this generator with 12V bus-bar line. We separate this two voltage by using D1 and D2 1N4007 diode. We also use R10 and R5 0.25-ohm resistor as a shunt resistor for measuring solar current and hydro generator current. We make 4 voltage divider circuit for measuring voltage and current. In figure: 3.2 there is R8 and R9 resistor is make a voltage divider role, for measure solar voltage, similarly R6 and R7 is measure solar current. We can also see there is another resistor pair R1 and R2 is make voltage divider roles for measure hydro generator voltage, similarly R3 and R4 is for measure hydro generator current.

We connect a simple LED with bus-bar voltage for showing as load device. Our total system is design for 12v circuit, but arduino is operate by only 5-volt DC. In this case, we convert this 12v DC to 5v DC by using LM7805 voltage regulator IC. We also use two filter capacitor with LM7805 for filter converted DC voltage. Then we connect a TP4056 li-Po charge controller with this 5v DC. This charge controller is connected with Li-Po battery for controlling over charge and over discharge protection.

Now it's time to power on our controller, we connect a XL6009 boost converter between li-Po battery and arduino. We use this XL6009 boost converter for boost 3.7v battery to 5v battery source. We also connect a power switch between battery and boost converter.

In figure-3.2 we can see a relay, which is connected with arduino for controlling water pump. This relay has 5 pins. pin 1 and 2 for biasing voltage. And there is a common pin which is connect with 12v- bas-bar, and NO pin is connected with water pump. We control this relay by using a BC547 NPN transistor which is connected with Arduino's digital pin number 2.

We can see a REED switch in fig:3.2 which is control water over flow in overhead water tank. This switch is magnetic flood type switch. That mean when overhead tank is fill-up by water than this switch is automatically triggered. This switch is connected with Arduino's digital pin number D4.

Finally, we connect a 16x2 LCD display with arduino. This display has 16 pins, Pin number 1 is GND pin, which is connect with common GND. Pin number 2 is VCC pin, which is connected with 5v dc. Pin number 3 is display contrast pin, which is connected with a 10k potentiometer. Pin number 4 is display reset (RS) pin, which is connected with arduino's digital pin number 12. Pin number 5 is Read Write (RW) pin, which is connected with GND. Pin number 6 is Enable (E) pin, which is connected with arduino's digital pin number 10. Pin number 7 to 10 is D0-D3 pin, which is not connected. Pin number 11 is data pin D4, which is connected with arduino's digital pin number 9. Pin number 12 is data pin D5, which is connected with arduino's digital pin number 8. Pin number 13 is data pin D6, which is connected with arduino's digital pin number 7. Pin number 14 is data pin D7, which is connected with arduino's digital pin number 6. Pin number 15 is backlight LED's Positive pin, which is connected with 5v dc by using a 100-ohm resistor. And last pin 16 is backlight GND pin, which is connected with common GND.

3.5 Working Principle

After assembling the system, at first we turn on the power switch, we can see this circuit is working. Our LCD display is showing welcome texted (Sonargaon University). We set out solar panel to under sunlight. Now display is showing solar panels voltage and current. Its 14.3 volt and 0.81 ampere. Our controller start checking overhead tank condition, now it's in low condition. We can see in LCD display, now showing Tank condition is LOW and Pump states is ON. That mean overhead tank is empty that's why pump is automatically turn on for loading water in overhead tank. After few minutes' pump is automatically turn off, because overhead water tank is fill-upped by water. Now is time to check micro hydro generator. We imagine it's night time, we cover our solar panel with a paper or cloth and turn on water ball-valve for starting water flow on micro hydro generator. It's miracle, our generator is generation some power. Now our display is showing hydro voltage and current. We check our load with solar voltage a generator voltage. This load is glowing with this two voltage. We also check battery condition; it is showing on charge mode.

3.5.1 Flowchart

Solar-hydro hybrid power station's flowchart are shown in blew:

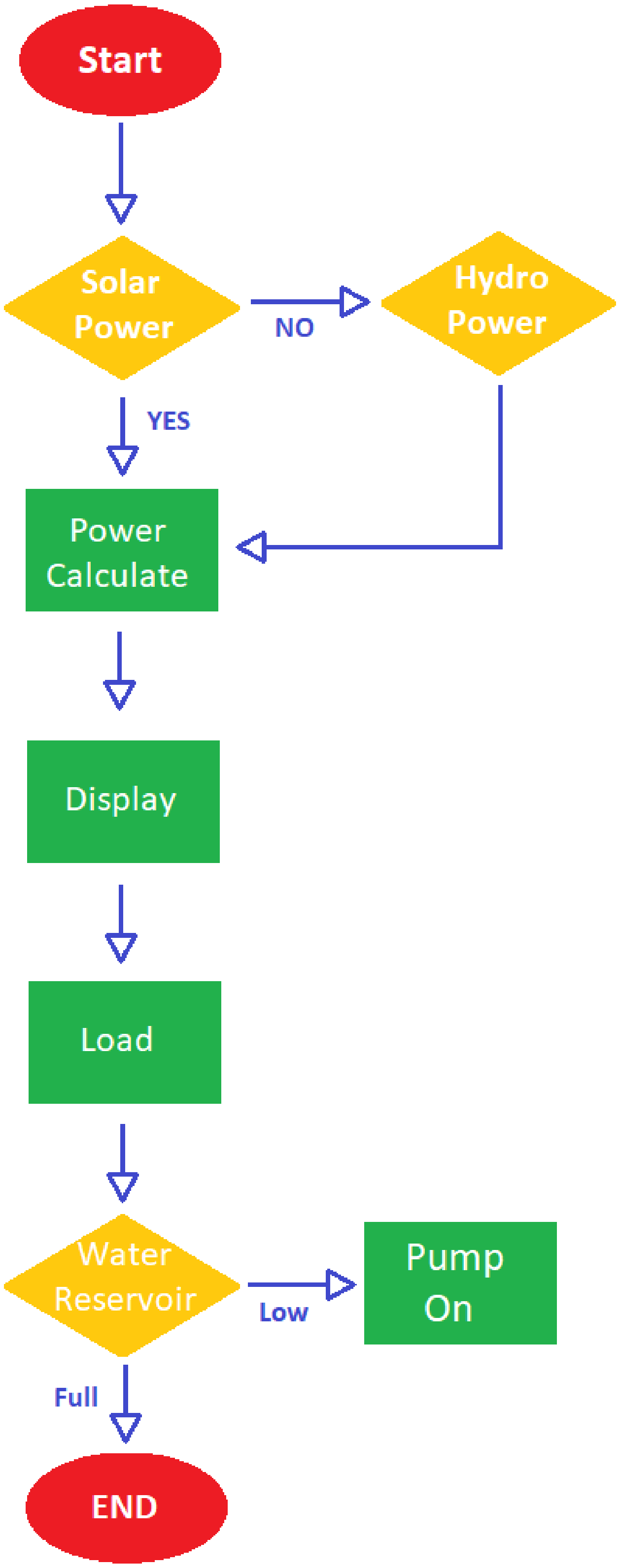

Fig: 3.3 Flowchart of Hybrid Power Station.

3.5.2 Step by step operation

The flowchart shown in the figure 3.3 explain the workflow of system.

1. When we turn on the power switch, our controller will detect power source.
2. After detection, controller will calculate voltage and current.
3. In this step's, we can watch some information in LCD display, like solar voltage, solar current, hydro voltage, hydro current, power consumption, and energy consumption.
4. If solar power is available, then water sensor will check overhead water tank condition.
5. If overhead tank is in low condition, then our water pump will turn on automatically.
6. If solar power is not available, then our hydro generator will turn on automatically, and continue power supplying.

3.6 Hardware image

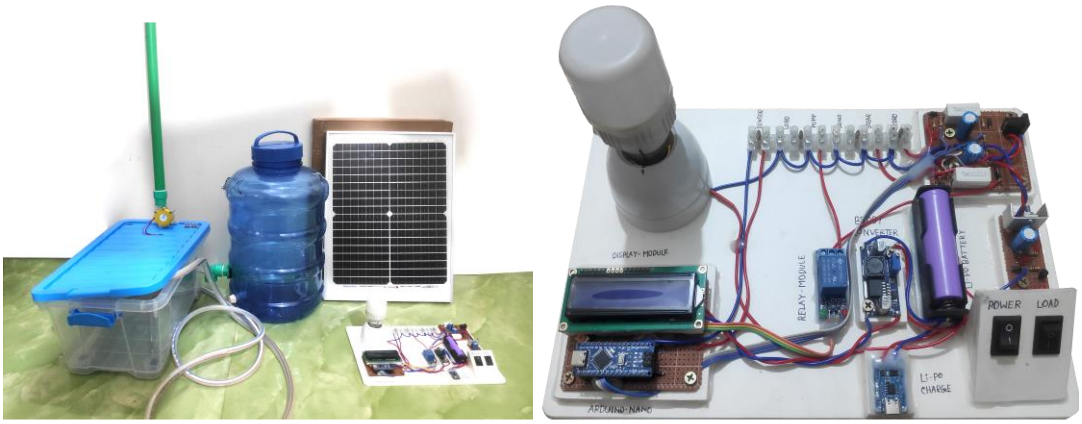

Fig: 3.4 Solar-hydro hybrid power plant hardware image.

3.7 Summary

A circuit diagram (electrical diagram, elementary diagram, electronic schematic) is a graphical representation of an electrical circuit. A pictorial circuit diagram uses simple images of components, while a schematic diagram shows the components and interconnections of the circuit using standardized symbolic representations. The presentation of the interconnections between circuit components in the schematic diagram does not necessarily correspond to the physical arrangements in the finished device.

CHAPTER IV
RESULT AND DISCUSSION

4.1 Introduction

Most power station has only one-way generation system. However, we make a combine or hybrid power station for more power generation. Normally, solar power station can work only in daytime. about 8 hour in a day. Another 16 hour is remain. We design a solar station with hydro generator; this hydro generator can generate electricity from kinetic energy, like water flow. In this case, we use exes' generated solar energy to store water in an overhead tank for hydro generator.

This chapter will present all the results, calculations, and relevant discussions.

4.2 Result

The experimental model was made according to the circuit diagram, and the results were as expected. When solar energy available all kind of load work correctly. And water pump loading water to overhead tank. When sun light is absent or nighttime, then hydro generator start automatically and continue power supplying. Our controller and display was working perfectly, our display showing all kind of data like, voltage, current, power and consuming energy. In addition, our display is showing pump condition and tank condition.

4.3 Advantage of Solar-Hydro Hybrid Power Station

1. This type of power station can generate 56% more energy.
2. It has water-recycling system.
3. Maintaining cost is very low.
4. It dies not pollute environment, like battery wastage.
5. Fully automatic system.
6. This kind of station can be install in a small area.

4.4 Disadvantage of Solar-Hydro Hybrid Power Station

1. Initial cos high.
2. Installation process is difficult.
3. Solar panel is effect by dust.
4. Solar panel is effect by weather, like rain session.
5. Programing can also take longer time to accomplish than circuit analysis.
6. Error in the programming is possible.

4.5 Application of Solar-Hydro Hybrid Power Station

1. Hybrid Power station.
2. Home purpose.
3. Industry.
4. Factory.
5. School, Collage, University.
6. All kind of farm.

4.6 Summary

The conventional solar system can generate electricity in 1/3 time in a day. But our designed solar-hydro hybrid system can generate electricity full time in a day. And it can reduces weather wasted like battery wastage.

CHAPTER V
CONCLUTION

5.1 Conclusions

1. It can be first priority for getting electric energy.
2. Less power consuming and more energy generator.
3. This system can use as a power plant in future.

The goal of the solar-hydro hybrid power station is produce more energy than previous solar system. Its produce green energy and its does not pollute our planet. It can be first choice to make energy for our electricity backup. It is safer then all electricity generator. It does not consume any fuel like other power generator.

5.2 Future Scopes of Modification

In this paper we have discussed about developing a "Solar-Hydro Hybrid power station: A Next Generation Smart power generator" by incorporating many features like live monitor, storing data, water recycling that are lacked in the conventional hybrid power system. Especially this system is designed for generate more green energy in same time and same area. And reducing battery wastage.

We practically check this solar-hydro hybrid power system, and we get perfect result from solar and hydro generator, we can easily observe this system by checking display data. Finally, we satisfied to our solar-hydro hybrid power generation system.

1. It can be implement with dual axis sun tracking mood.
2. We can add wind turbine with this system.

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APPENDIX

Controller Code:

```
#define t1 700  //heading time
#define t2 750  //running display time
#define t3 100  //display delay time
#define t4 10   //for loop time
#define sm_no 10

#include <LiquidCrystal.h>
LiquidCrystal lcd(12,10,9,8,7,6);

int RW = 11;
int backlight = 3;
float R = 0.25;
float power = 0;
float energy = 0;
float energy_KWh = 0;

int solar_pt_pin = A3;
int solar_pt_val = 0;
float solar_volt = 0;

int solar_ct_pin = A2;
int solar_ct_val = 0;
float solar_shunt_volt =0;
float solar_amp = 0;

int hydro_pt_pin = A1;
int hydro_pt_val = 0;
```

```
float hydro_volt = 0;
int hydro_ct_pin = A0;
int hydro_ct_val = 0;
float hydro_shunt_volt = 0;
float hydro_amp = 0;

int over_sw = 4;
int over_sw_val = 0;
int pump_pin = 2;

int i = 0;
int j = 0;
int k = 0;

void setup()
{
        pinMode(RW, OUTPUT);
        digitalWrite(RW, LOW);
        pinMode(backlight, OUTPUT);
        analogWrite(backlight, 220);

        lcd.begin(16, 2);
        lcd.clear();
        delay(t3);
        lcd.setCursor(4, 0);
        lcd.print("Sonargaon");
        lcd.setCursor(1, 1);
        lcd.print("University (SU)");
        delay(t2);

        lcd.clear();
        lcd.setCursor(1, 0);
```

```
    lcd.print("Department Of");
    lcd.setCursor(6, 1);
    lcd.print("EEE");
    delay(t2);
    lcd.clear();
    lcd.setCursor(1, 0);
    lcd.print("Solar & Hydro");
    lcd.setCursor(1, 1);
    lcd.print("Power Station");
    delay(t2);

    pinMode(solar_pt_pin, INPUT);
    pinMode(solar_ct_pin, INPUT);
    pinMode(hydro_pt_pin, INPUT);
    pinMode(hydro_ct_pin, INPUT);
    pinMode(over_sw, INPUT);
    pinMode(pump_pin, OUTPUT);
}

void loop()
{
    long milisec = millis();
    long time = milisec/1000;
    //***************Solar Voltage****************
    for(i=0; i<sm_no; i++)
    {
        j = analogRead(solar_pt_pin);
        k = (k + j);
        delay(t4);
    }
    solar_pt_val = (k/sm_no);
```

```
solar_volt = (((solar_pt_val*5.0)/4096.0)*11.0);
i=0; j=0; k=0;
//****************Hydro Voltage****************
for(i=0; i<sm_no; i++)
{
        j = analogRead(hydro_pt_pin);
        k = (k + j);
        delay(t4);
}
hydro_pt_val = (k/sm_no);
hydro_volt = (((hydro_pt_val*5.0)/4096.0)*11.0);
i=0; j=0; k=0;
//****************Solar Current****************
for(i=0; i<sm_no; i++)
{
        j = analogRead(solar_ct_pin);
        k = (k + j);
        delay(t4);
}
solar_ct_val = (k/sm_no);
solar_shunt_volt = (solar_volt-(((solar_ct_val*5.0)/4096.0)*10.8));
if(solar_shunt_volt < 0) {solar_shunt_volt = 0;}
solar_amp = (solar_shunt_volt/R);
i=0; j=0; k=0;
//****************Hydro Current*****************
for(i=0; i<sm_no; i++)
{
        j = analogRead(hydro_ct_pin);
        k = (k + j);
        delay(t4);
}
```

```
hydro_ct_val = (k/sm_no);
hydro_shunt_volt = (hydro_volt-(((hydro_ct_val*5.0)/4096.0)*11.0));
if(hydro_shunt_volt < 0) {hydro_shunt_volt = 0;}
hydro_amp = (hydro_shunt_volt/R);
i=0; j=0; k=0;
power = ((solar_volt*solar_amp)+(hydro_volt*hydro_amp));
energy = (power * time)/3600; //watt to watt houre
energy_KWh = (energy_KWh + energy);
pump();
//***************Solar Panel Section***************
lcd.clear();
lcd.setCursor(2, 0);
lcd.print("Solar Panel");
lcd.setCursor(0, 1);
lcd.print("V=");
lcd.print(solar_volt);
lcd.setCursor(9, 1);
lcd.print("A=");
lcd.print(solar_amp);
delay(t1);
pump();
//***************Hydro plant Section***************
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Hydro Generator");
lcd.setCursor(0, 1);
lcd.print("V=");
lcd.print(hydro_volt);
lcd.setCursor(9, 1);
lcd.print("A=");
lcd.print(hydro_amp);
```

```
delay(t1);
pump();
//*****************Total Energy***************
lcd.clear();
lcd.setCursor(1, 0);
lcd.print("Power: ");
lcd.print(power);
lcd.print(" W");
lcd.setCursor(0, 1);
lcd.print("Energy: ");
lcd.print(energy_KWh);
lcd.print(" Wh");
delay(t1);
pump();
//**************Pump condition****************
if(over_sw_val==HIGH)
{
	lcd.clear();
	lcd.setCursor(0, 0);
	lcd.print("Water Tank: Full");
	lcd.setCursor(0, 1);
	lcd.print("Pump Status: OFF");
	delay(t1);
}
else
{
	lcd.clear();
	lcd.setCursor(0, 0);
	lcd.print("Water Tank: LOW");
	lcd.setCursor(0, 1);
	lcd.print("Pump Status: ON");
```

```
        delay(t1);
    }
}
void pump()
{
    over_sw_val = digitalRead(over_sw);
    if(over_sw_val == HIGH)
    {
        digitalWrite(pump_pin, LOW);
        delay(10);
    }
    else
    {
        digitalWrite(pump_pin, HIGH);
        delay(10);
    }
}
```