VOCATIONAL INDUSTRIAL TRAINING ON

"Off-grid Rooftop Solar System Solution in Building"

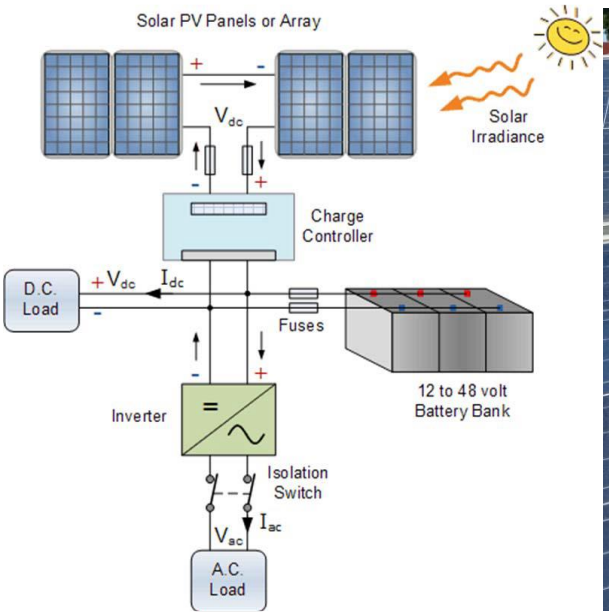
Duration of Training: 01.07.2023- 20.07.2023

At

Research Development & Training Unit

Navonis Automation And Renewable Power Solutions Pvt. Ltd

(Registered under MSME, Govt. OF India)



Name: Rafayal Nathanial

B.Tech In Electrical Engineering

4th YEAR

University Roll No: 23601621015

Greater Kolkata College Of Engineering And Management

ACKNOWLEDGEMENT

I am most obliged and grateful to my guides at Navonis Automation And Renewable Power Solutions Pvt. Ltd(Regd. Under MSME,Govt of India), Mr. Reeak Ari(Founder, Director & Trainer) and Mrs. Jeenia Dey(Director), for giving me the opportunity to do the training and giving me proper guidance in completing this project successfully.

I am also grateful to Dr. Anubrata Mondal, HOD, EE Dept, GKCEM for his guidance, and pleasant manner in helping me for this project.

I am most obliged and grateful to our principal, Dr Mahuya Das for supporting and encouraging us throughout the course of study,

Finally I Acknowledge with gratitude and unflagging support and patience of my parents for their guidance and encouragement during this dissertation work.

Rafayal Nathanial

Electrical Engineering

GKCEM

NAVONIS AUTOMATION AND RENEWABLE

POWER SOLUTIONS PRIVATE LIMITED

(Registered under MSME, Govt of India)

This is to Certify that the Student has completed Vocational Industrial Training on "Off-grid Rooftop Solar System Solution in Building" for 15 Working Days from 01.07.2023 to 20.07.2023 At Research Development & Training Unit of our Company under our Hands and Seal.

The Student was exposed in the fields of Solar System Installation, Design, Simulation, Maintenance and Commissioning.

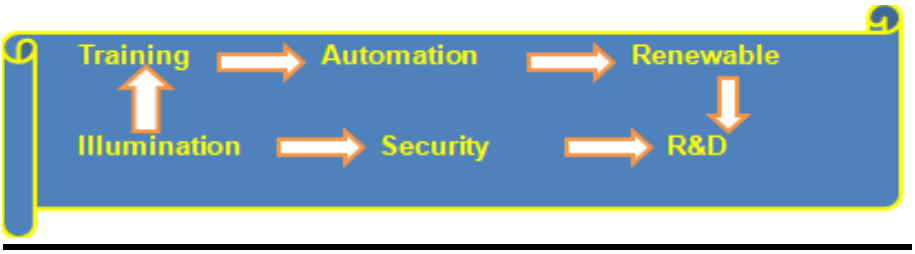
Name: Mr. Reeak Ari	**Mrs. Jeenia Dey**
Founder & Director	**Director**
Navonis Group	**Navonis Group**

Off Address: 76, Khudiram Bose Lane, Gouripur Road, Mahajati Nagar BL-4, Birati, Kolkata: 700051. Ph No: 8583869902, 9903497420 Email id: navonis.solution@gmail.com

Contents

About The Company

- Company is incorporated under MCA Act 2013 (Ministry of Corporate Affairs, Govt. of India) as private limited company.
- The company is An **Automation and Renewable Research & Development company cum training institute.**
- **Company is registered under MSME, Govt. of India.**



We provide **Corporate/ Industrial training / Workshops to technical students and working professionals to make them industry /job ready focusing on renewable(Basic & Advanced)(Solar, hydel), automation, IOT, Robotics, PLC, firmware design, lighting design, Autocad, Solidworks, Catia, Ansys , Electric Vehicle, Electrical maintenance , 3D printer which is the present trend and future of this globe.**

We serve both domestic and commercial sectors by:

- **Renewable (Solar & Hydro) power solutions**
- **Engineering consultancy(Electrical connection, maintenance, panel board connections, solar, automation solutions)**
- **EPC, Energy audit**
- **Energy efficient illumination designs (Indoor, Outdoor, Office, Road, Facade, Area, Sports)**
- **Small scale security systems (installing commissioning and maintenance).**
- **Automation system design and implementation**

- **Design and development of logic and sensor modules, PLC and automation products**

Our Vision:

- To make students industry ready by providing them in-hand practical training.
- To provide best energy efficient renewable power solutions.
- To contribute society by designing the best energy efficient renewable eco friendly products.
- To design and implement energy efficient illumination design.
- To Implement cost effective security system.
- To reduce human effort by designing the technologically upgraded modern automation schemes.
- To contribute society by designing safe secure best Panel boards for use in various systems.
- To be the leading automation and renewable R&D Company.

Our Mission:

- To create sustainable ecosystem.
- To create energy efficient products and design for betterment of society.
- To retrofit machines by intelligent logic control.
- To offer technologically advanced solutions.
- To listen to our customers and continually strive to provide perfect service, distribute quality products.
- To satisfy our customers and achieve manufacturing excellence by delivering the right automation solutions.

- To continue with research and development of products that will serve the nation according to future needs across the globe.
- To provide excellence in solutions and capturing the essence of what customer need with ease.
- To propel towards being the leading choice across various industries.
- To be the Leader in Automation and Process Control Systems, by providing Professional and Customized solution exceeding Customer delight through innovation and continuously upgrading our process & technical skill sets to meet the needs of customer.

Our Service Areas:

I. . *Corporate Training/ Industrial Training/ Workshop*

- We provide in-hand practical training/workshop to ITI, diploma, B.Tech students as well as working professionals on various technical courses (**Automation, PLC, lighting design, robotics, embedded system, Ansys, Catia, Solid works, Autocad, Renewable energy system design, IOT, Electric vehicle, Solar system design & software, Panel board connection, Electrical Wiring, 3D printer**).
- We provide Industry ready certificate (MSME Registered R&D company) after

completion of the training.

- We train students with modern lab facility and present industry criteria.
- Being an R&D company, we engage students in product development as

part of their internships during training.

- We provide entrepreneurship guidance to students so that they can set up their own venture.
- We make students industry ready by directly providing them with practical exposure and work culture followed in industries.
- We provide training to students and make them skilled trainer ready for industry.
- We conduct workshops/ hands on training in technical institutions in above courses for 30days, 5days, 15days

- Trainings / hands on practical / workshops / short term courses are also conducted in company R&D laboratory for 15days, 3months, 6months.
  - ❖ Certificate with industrial experience after Workshop/training
  - ❖ Live projects with original software
  - ❖ Job guidance/scope after training
  - ❖ Students are guided for entrepreneurship
  - ❖ Students are made skilled trained ready for present industry needs and future need of the world.
  - **We Provide Laboratory Setup With Industry Standard And Aicte Curriculum In Technical Institutions**

II. ***Renewable (Solar and Wind) power solutions:***

We are one of the leading Renewable Energy Solution Company based on West Bengal. We have excellent facility for supply, installation, maintenance and commissioning of solar as well as small hydropower system of multiple capacities We design, build and commission Off-grid, On grid, Hybrid solar power plants, Pico hydro power plants, Micro hydro power plants in suitable for a diverse profiles of customer catering from residential, institutional, Commercial and Community power solutions. We further provide guidance and training to engineers, DIY enthusiasts, Environmentalist for proper

maintenance and operations of our installed systems also provide data sheet with case studies for designing efficient and cost-effective systems.

We offer:

1. **Solar panel(OFFGRID, ONGRID, HYBRID) and Hydro power plant (PICO, NANO)installation, operation, maintenance and Commissioning in all sectors.**
2. **Solar and Hydro EPC project developer.**
3. **Raw material Supplier and Distributor.**
4. **Renewable energy consultancy service provider.**
5. **Hands on Training provider and Conducts awareness program PAN INDIA.**
6. **Energy Auditing.**
7. **DIY friendly Scalable design for future upgradation.**
8. **Solar and Hydro hybrid systems design, installation and commissioning.**

Renewable Energy Solutions under one roof.

9. **Installation of solar water pump**

III. Research And Development Unit – Automation

- **Design and development of IOT Relay modules, logic module with microcontrollers (8bit, 32bit), Zigbee module interface, Automation products, PLC products, lithium power bank (upto 5KVA)as per customer's need or requirement.**

- **IOT weather station(portable), Automatic power door, Automatic drip irrigation system, Automated security, Automated product assembly line control and predictive maintenance, custom sensor modules, solar products.**
- **Installing and Commissioning of Automation projects**
- **Automation system design and implementation.**
- **Design and development of logic and sensor modules.**
- **Design and development of Custom IOT, automation, PLC products(for technical college purpose).**
- **We Design and Develop and set up laboratory according to course curriculum for students in technical colleges.**
- **Design and prototype manufacturing going on *" 3D Printer"***

IV. ILLUMINATION DESIGN

We are passion for making great lighting environments that brings a sense of warmth, comfort and joy. Whether it be residential, healthcare, commercial or institutional, we are devoted to developing innovative, exceptional quality lighting solutions with state of the art designs. Our passion for great lighting began with a desire to bring tranquility and well-being by bringing a little more light into people's lives.

- We provide energy efficient , environmentally safe, healthy lighting design in domestic an all sorts of commercial sectors.
- The sectors include

✓ Indoor lighting

✓ Outdoor lighting

✓ Facade Lighting

- ✓ Area lighting
- ✓ Sports lighting
- ✓ Office, restaurant

V. SECURTY SYSTEM

- Small scale security systems (installing commissioning and maintenance).
- We provide small scale CCTV camera installation, commissioning and maintenance in : domestic buildings , Home , Commercial sectors (offices, hotels, restaurant, banks, and in all sectors)
- We provide custom embedded security systems in domestic and commercial sectors.

VI. Electrical Wiring & Panel board connections

- Electrical wiring, connections and maintenance in all domestic and commercial sectors.(low, medium and high voltages)
- Electrical Panel board connection, erection, wiring

Solar PV System Basics

Electricity from solar energy;

When the sun shines onto a solar panel, energy from the sunlight is absorbed by the PV cells in the panel. This energy creates electrical charges that move in response to an internal electrical field in the cell, causing electricity to flow. Solar panels are usually made from silicon, or another semiconductor material installed in a metal panel frame with a glass casing. When this material is exposed to photons of sunlight (very small packets of energy) it releases electrons and produces an electric charge.

This PV charge creates an electric current (specifically, direct current or DC), which is captured by the wiring in solar panels. This DC electricity is then converted to alternating current (AC) by an inverter. AC is the type of electrical current used when you plug appliances into normal wall sockets.

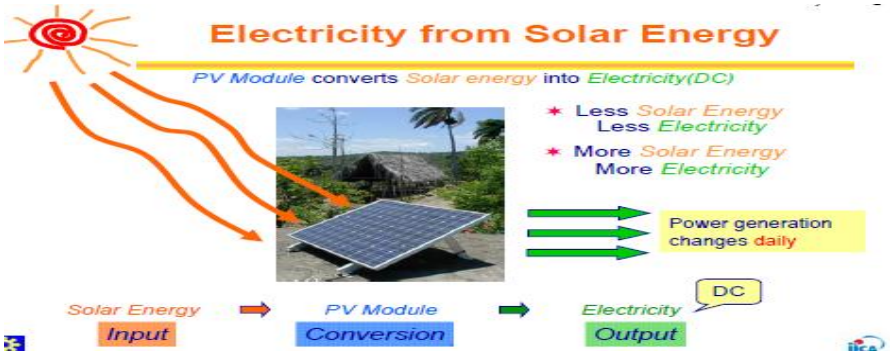


Fig: Electricity from Solar Energy

Components Of Solar PV System:

1. ***Battery:*** Battery stores electricity mainly during night time. Easily damaged if over discharged. A battery bank ensures that no excess energy is wasted by storing the energy produced by the PV array and not immediately consuming it.

2. ***PV module:*** Converts solar energy into electricity. Power generation is only during daytime. Long life for 20years. A solar module is made up of several solar cells having semiconductor qualities that are enclosed within a material to protect them from the elements. These characteristics allow the cell to catch light, or more particularly, photons from the sun, and

transform their energy into usable power via a process known as the photovoltaic effect. A layer of conducting material "collects" the electricity created on each side of the semiconductor.

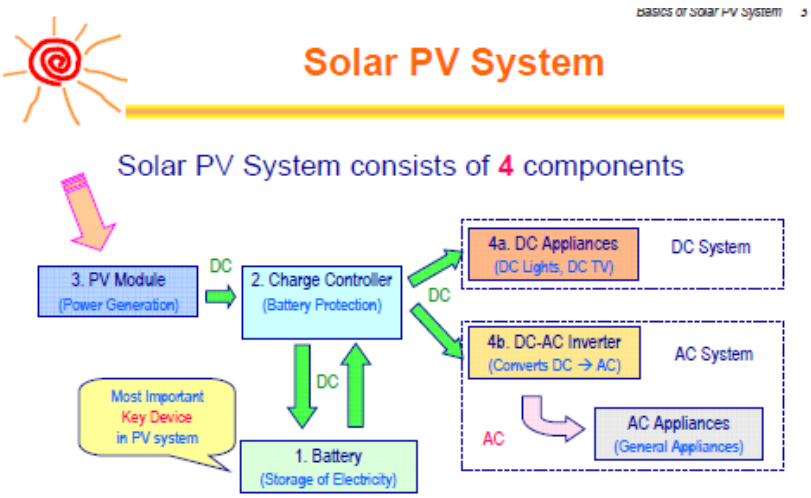


Fig: Components of Solar PV System

3. ***Charge controller:***

It protects battery from over charge and over discharge. A charge controller may detect when the batteries are completely charged and halt the current flow to protect the batteries from harm.

4. ***DC AC Inverter-*** Inverter converts dc to ac system. It I not necessary for dc system. Ac system is most convenient for users but less efficiency.

5. ***Cables and Accessories:***

All the cables shall be supplied conforming to IEC 60227/IS 694 & IEC 60502/IS 1554 shall be of 1.1 kV grade as per requirement. Only PVC copper cables shall be used. The size of the cables between array interconnections, array to junction boxes, junction box to PCU, PCU to AC Distribution Box etc shall be selected to keep the voltage drop and losses to the minimum. Permissible Wire Drop on DC side shall be <= 1%

Types of solar PV system design:

1. ***Solar PV On Grid System-***The most popular form of solar system; the home is linked to the grid so that it may utilize utility electricity when the solar panels do not produce enough energy to power the home.

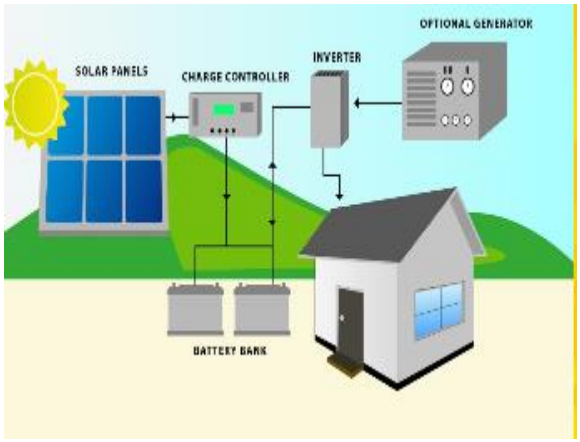


Fig: Solar Off- grid system

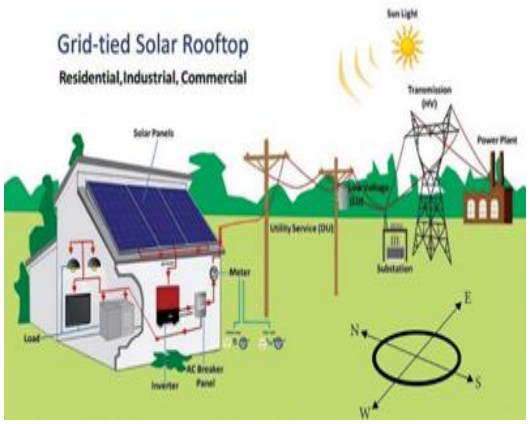


Fig: Solar On grid system

2. ***Solar PV Off Grid System***-they have no grid connection and rely only on energy generated and stored on site

Fig: Solar Hybrid system

3. ***Solar PV Hybrid System***-Hybrid systems, often known as 'solar-plus-storage systems,' combine solar panels with a solar battery to store energy for later use or during a power outage, and the house is also connected to the grid.

There are two types solar home system(SHS):

1. ***SHS(DC) :*** SHS is small, independent DC system. It is most efficient and economical system. Dc fluorescent lights ae not available in local markets.

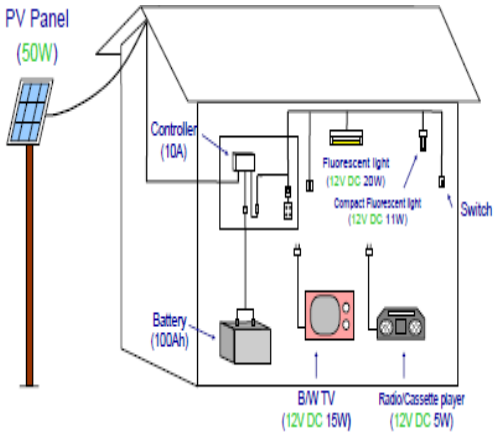


Fig: Solar SHS DC system

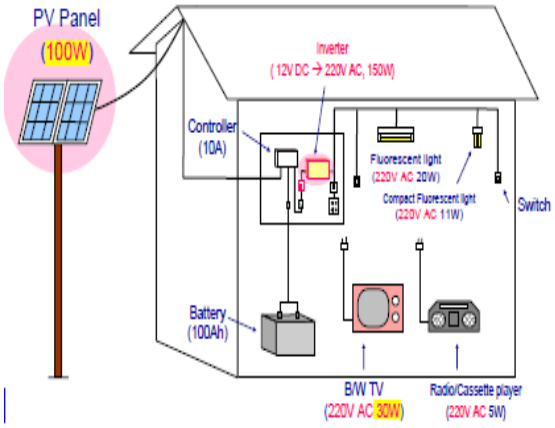
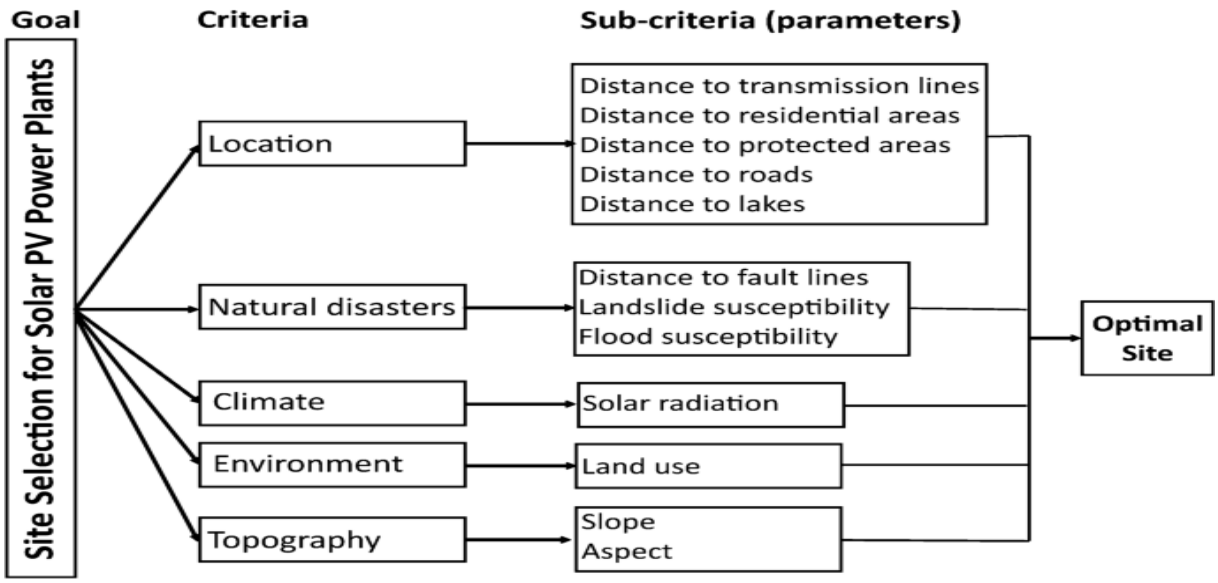


Fig: Solar SHS AC system

2. ***SHS(AC TYPE):*** AC system is convenient to users because of easy availability to users.it is less efficient and higher cost than DC system

Site selection for solar PV system:



Features of solar PV system:

- **Durability**: Solar PV modules are made of high-quality materials and are designed to withstand harsh weather conditions, making them highly durable. They are resistant to extreme temperatures, wind, and hail, making them ideal for use in any climate.

- **Efficiency**: Solar PV modules have high efficiency ratings, which means they can convert more sunlight into electricity. The higher the efficiency of the module, the more energy it can produce, making it an ideal choice for residential and commercial applications.

- **Portability**: Solar PV modules are lightweight and easy to install, making them ideal for use in remote locations. They can be used for off-grid applications, where there is no access to the electricity grid.

- **Cost-effective**: Solar PV modules are cost-effective, as they do not require any fuel or other inputs to generate electricity. They also come with long-term cost savings, as they reduce the need for expensive power plants and reduce the amount of energy that needs to be purchased from the grid.

Factors That Affect Solar Panel Efficiency

- **Solar Cell Quality**: The quality of the solar cells in a panel plays a big role in its efficiency. High-quality cells will produce more energy than lower quality cells.

- **Cell Arrangement**: The arrangement of the solar cells in a panel can also affect its efficiency. A well-arranged panel will produce more energy than a poorly arranged panel.

- **Panel Size**: The size of a panel can also affect its efficiency. Larger panels will produce more energy than smaller panels.

- **Angle and Orientation**: The angle and orientation of a panel can also affect its efficiency. Panels that are positioned at the right angle and orientation to the sun will produce more energy than those that are not.

- **Temperature**: The temperature of a panel can also affect its efficiency. Higher temperatures can reduce the efficiency of a panel, so it is important to keep panels cool.

Solar energy:

The sun is a source of energy and is known as **solar energy**. The portion of solar energy which reaches the outer parts of the earth's atmosphere in a rectangular angle is called solar constant. The solar constant at the outer earth atmosphere averages per year at approx. 1,037W/m2. About 1,000W/m2 of this power reach the earth's surface. The energy accumulated by this radiation is about 2,200kWh/m2 at the equator and 800kWh/m2 at the polar circles.

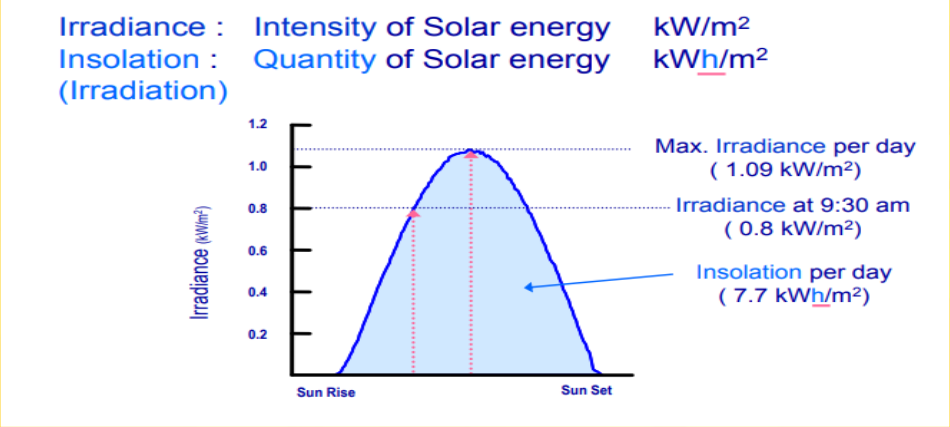


Fig: Irradiance and Insolation

Solar Resource:

Irradiance is power (unit: watt/m2); irradiation is energy (unit: watt-hour/m2/day or watthour/ m2/year). **Solar irradiance** is the sun's radiant energy incident on a surface of unit area expressed in units of kW/m2. Diffuse could be considered "scattered" light; direct light is non scattered light reaching the device directly from the sun. Peak sun is the irradiance when it is 1000 W/m2; peak sun hours are equivalent to the number of hours that the solar irradiance would be at a peak level/power of 1kW/m2

Solar Irradiation or Insolation (kWh/m2):

Solar irradiation (energy) or solar insolation is equal to total solar irradiance (power) over time. Solar irradiation is the sun's radiant energy incident on a surface of unit area expressed in units of kWh/m2 expressed on an average daily basis for a given month or year referred to as solar insolation or peak sun hours

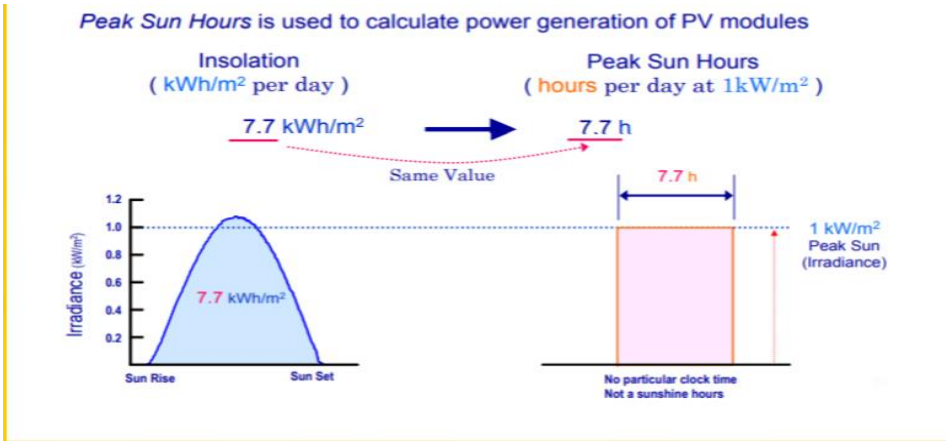


Fig: Peak Sun hours

Peak sun hours (PSH) is the average daily amount of solar energy received on a surface. PSH are equivalent to the number of hours that the solar irradiance would be at a peak level/power of 1 kW/ m2. 1000 W/ m2 is a typical average globally at noon on a clear day. Modules are rated at 1000 W/ m2.

PV Array Orientation

The orientation of PV arrays is defined by two angles with respect to the PV surface

- The PV array **azimuth angle** represents the angle between true north and the direction the array faces (in Marsabit, magnetic north is 0-3° west of true north).
- The PV array **tilt angle** represents the angle the array surface makes with the horizontal plane/earth

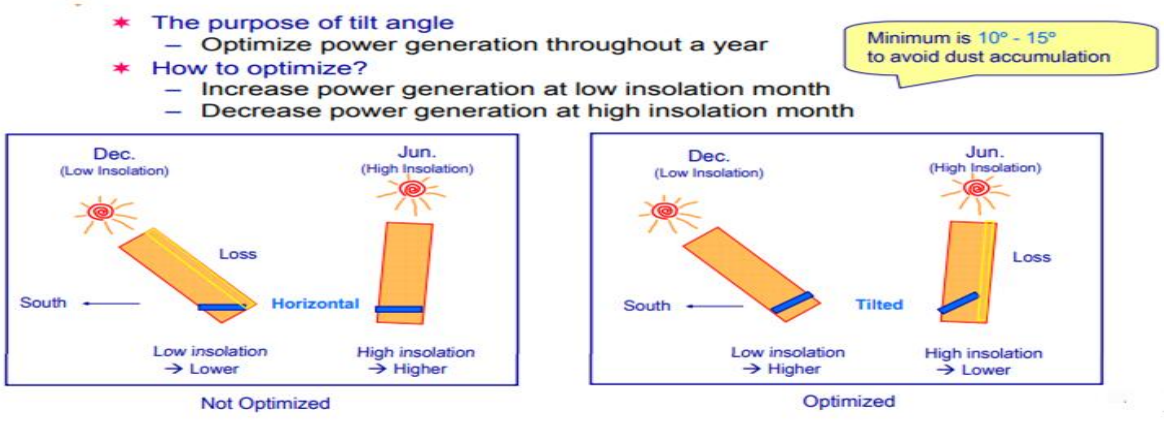


Fig: Tilt angle

PV Module:

Solar PV modules are made by connecting together photovoltaic (PV) cells or solar cells. They are manufactured from semiconductor materials like crystalline silicon. Solar modules convert the light energy captured from the sun into electric energy. The electric energy so produced is used for lighting residential and commercial establishments.

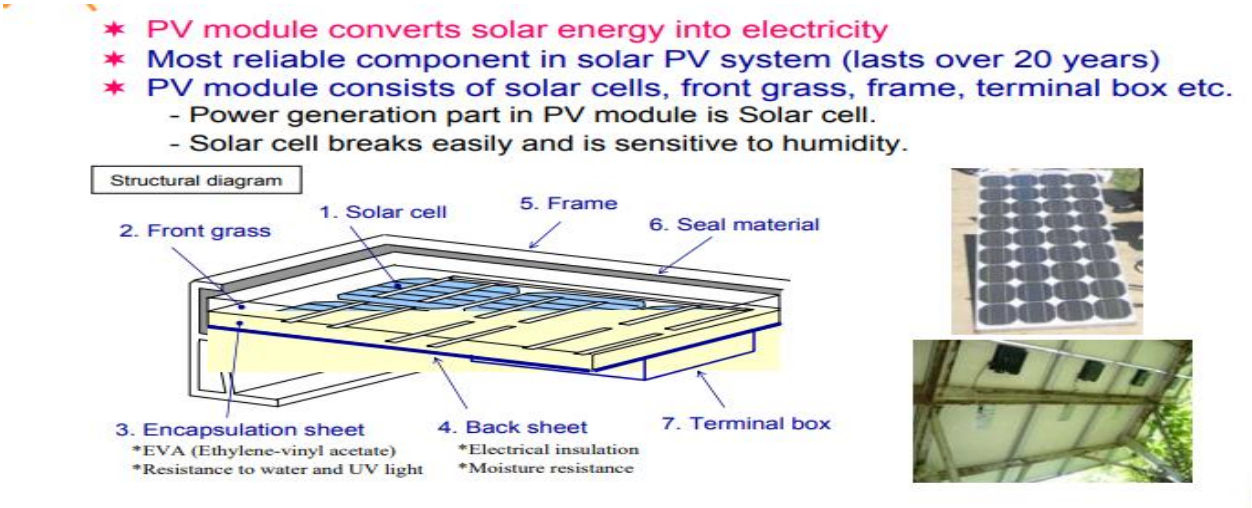


Fig: PV Module

Types of solar PV modules:

1. **Mono crystalline solar panels**
2. **Polycrystalline solar panels**

- **1. <u>MONOCRYSTALLINE SOLAR PANELS</u>**
- As the name suggests in monocrystalline solar panels, the solar cells are made up of single silicon crystal. To make solar cells for monocrystalline solar panels, silicon is formed into cylindrical bars called as 'Silicon Ingot'. Then the silicon ingot is cut into squares with chamfered edges know as silicon wafers. These silicon wafers are solar cells which are then assembled in rows and columns to form a solar panel. Monocrystalline solar cell manufacturing process is called ' Czochralski Process'. It is a complex and expensive manufacturing process which results in lot of wastage of silicon crystals, which makes them more expensive than polycrystalline solar panels. Monocrystalline solar panels can be easily distinguished by their black color appearance, they are normally used in places where the

area available is less and power requirement is more or places where there are few sunny days or less sun hours.

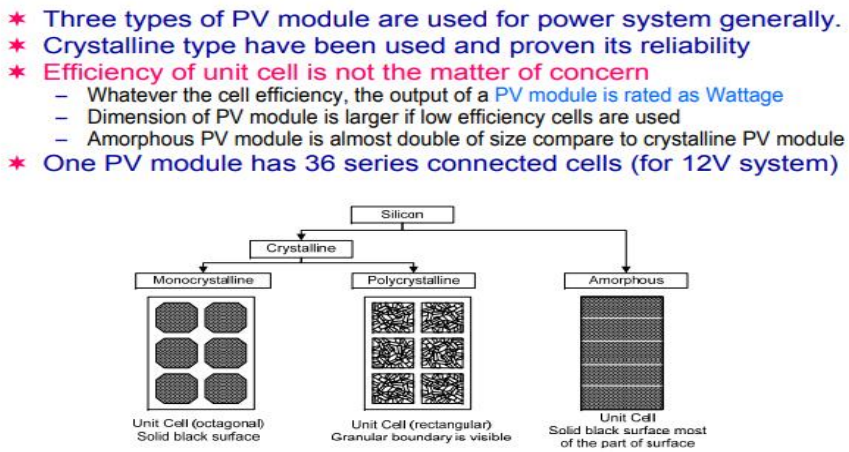


Fig: Types of PV modules

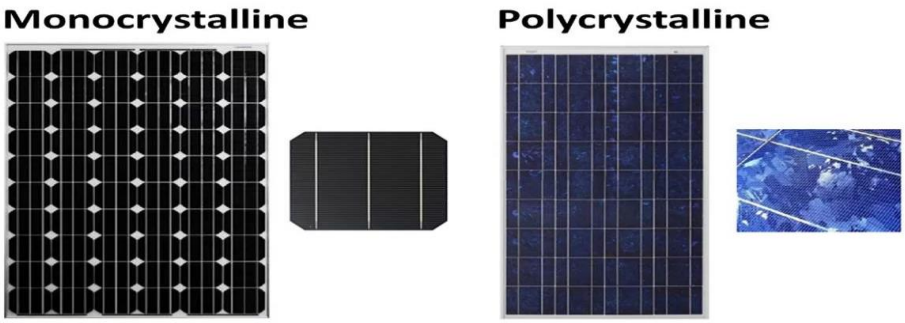


Fig: Polycrystalline and Monocrystalline PV module

2. **Polycrystalline Solar Panels**

Polycrystalline solar panels are the most widely used solar panels in the world today. We have seen a roof with solar panels on it then chances are it is polycrystalline.

Polycrystalline solar cells are made by melting fragments of different silicon crystals, pouring it in a mold and then cutting it in square shape to form a solar cell also called as wafers. These solar cells are then arranged in rows and columns to form a solar panel, which are then arranged in series and parallel arrangement to form solar array and thus a solar power plant.

IV Characteristics Of Solar PV Module:

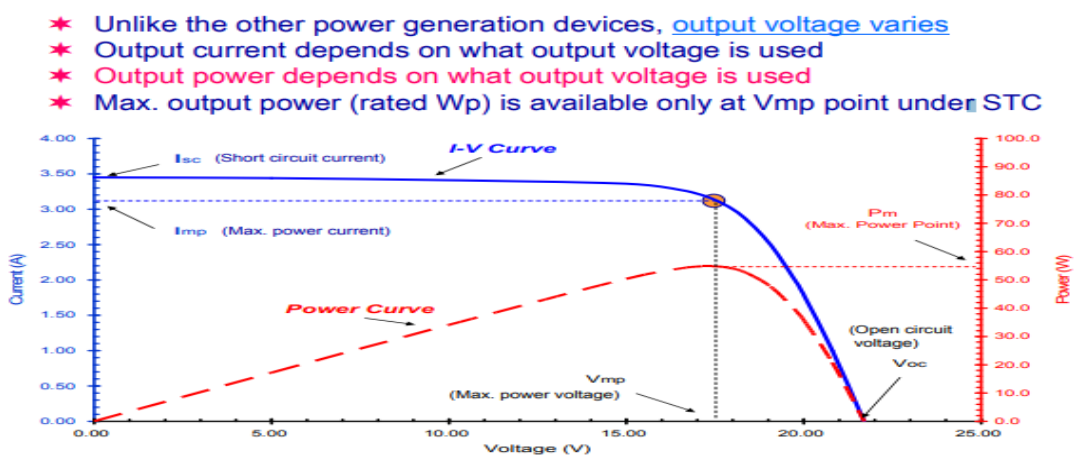


Fig: IV Characteristics Of Solar PV Module:

PV Module Output

- Higher temperature reduces output voltage
  approx. – 2.2 mV / °C per Cell
  approx. – 80 mV / °C per 36-cell PV module
- Higher irradiance increases output current
- Rated output (Wp) does not mean actual output power at the site
  - Maximum power (P = I x V) depends on Irradiance (I) and Temperature (V)
  - Maximum power changes approx. – 0.5 % / °C,
    100Wmp at 25 °C → 85Wmp at 55 °C

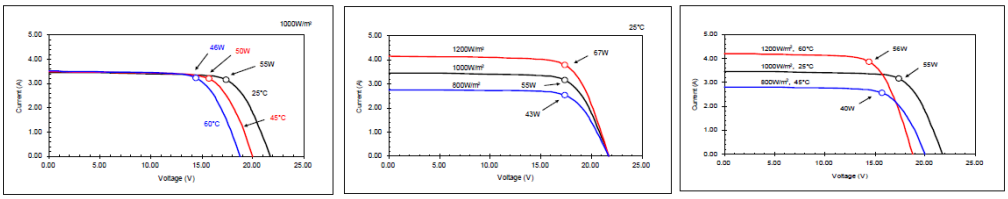
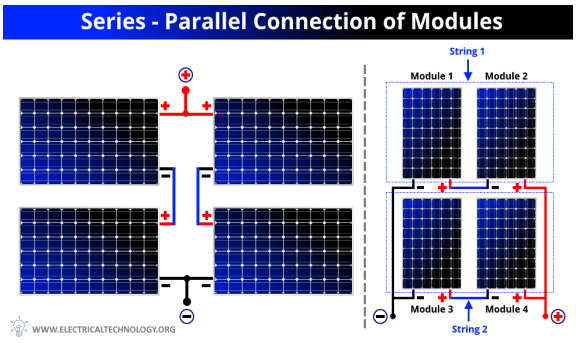
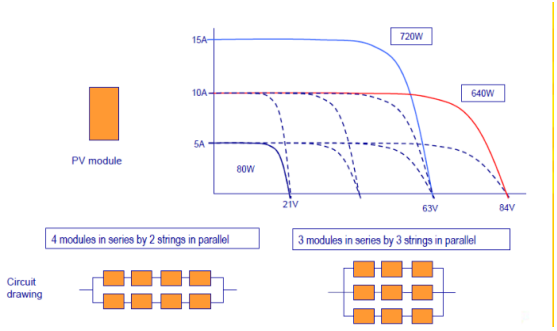


Fig: PV Module output

Types of Connection of Solar Panels:

1. **Series Connection** : To wire solar panels in series, connect the positive terminal on the first panel to the negative terminal on the next, and so on. The resulting voltage will be the sum of all of the panel voltages in the series. However, the total current will be equal to the output current of a single panel .

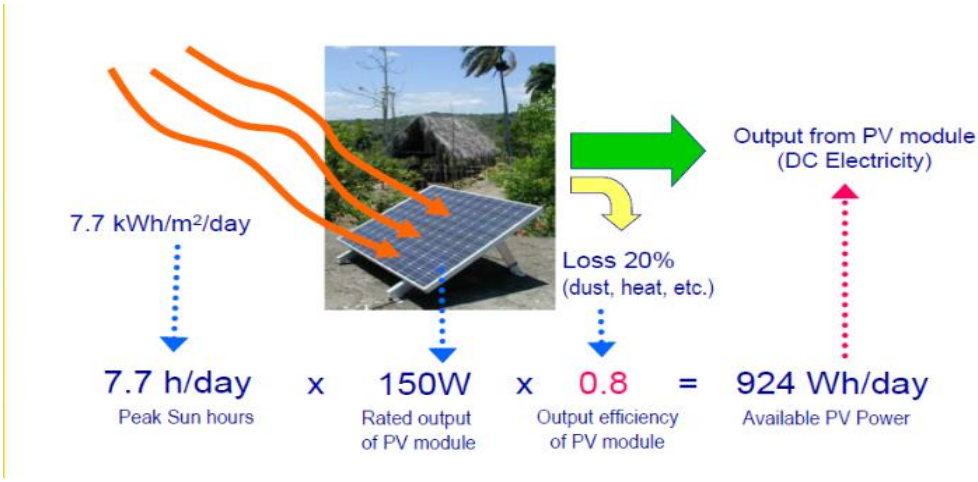




2. **Parallel Connection:** To wire solar panels in parallel, connect all of the positive terminals on each panel together and then do the same for the negative terminals. The resulting current will be the sum of all of the panel amperages in the parallel array. However, the total voltage will be equal to the output voltage of a single panel.

Output power from solar panel:

Most solar panels on the market in 2022 produce between 250 and 400 watts of power. You might come across these solar panel output numbers from your solar installation quote, which will typically include “245W”, “300W”, or “345W” next to the name of the panel. They are all referring to a solar panel’s wattage, capacity and power output.



Lead Acid Battery:

- Battery stores electrical energy in DC
- Mainly used during night time and charged during the day. Unit cell for a battery is 2V. Which is the nominal voltage. Voltage range is around 1.85V to 2.40**V**
- 12V battery has 6 unit cells in series connected**.**
- 6V battery has 3 unit cells in series connected.

The main type of battery used in Solar PV systems are the Lead Acid type and they can either be flooded type of the maintenance free type.

- Battery stores electricity
  - It does NOT generate electricity
- Most important key device for Solar PV, Wind systems
- Maintenance is very easy in theoretically because no mechanical maintenance such as lubrication, overhaul, etc.
  → Maintenance is extremely difficult in reality
- Technical maintenance

  Problem!

  1. Maintain electrolyte level (Topping up of distilled water)
     → Always forget. Use of unsuitable water (tap water, mineral water, well water, etc.)
  2. Maintain homogeneous electrolyte (Avoid stratification)

     Problem!
  3. Maintain healthy electrode (Avoid sulfation)
     → If no charge controller, easily over discharged because users want to use more power
  4. Maintain equal cell voltage (Periodical equalization)
     → Normally automatic by charge controller
- General maintenance
  - Maintain clean environment (Cleaning of terminals, cover, floor and air ventilation)

HVD, LVD are example only

Forget about the terms "Deep Cycle type" and "Shallow Cycle type".
These will confuse you. The operation of solar PV system is *shallow cycle* operation.

	Automotive Type	Industrial Type
Flooded (Liquid) • Need to top up distilled water • Durable • Relatively strong against overcharge (HVD ~14.4V)	• Available • Low cost • Acceptable for small application • Limited range of capacity (~150Ah) • LVD: ~11.7V , HVD: ~14.4V	• Available • Durable • Wide range of capacity (~2000Ah, 2V unit) • LVD: ~11.5V , HVD: ~14.4V
Maintenance free (Liquid) • Easy to handle • Weak against over charge • Need to use lower HVD than flooded type (~14.1V) • No boost charging • Limited range of capacity (~150Ah)	• Available • Acceptable for small application • Good for maintenance free system • Need good charge controller to avoid overcharge • LVD: ~11.7V , HVD: ~14.1V	• Available • Recommended for small application • Good for maintenance free system • Need good charge controller to avoid overcharge • LVD: ~11.5V , HVD: ~14.1V
Maintenance free (Gel) • Sealed • Easy to handle • Weak against over charge • Need to use lower HVD than flooded type (~14.1V) • No boost charging • Limited range of capacity (~150Ah)	N/A	• Available • Recommended for small application • Good for maintenance free system • Need good charge controller to avoid overcharge • LVD: ~11.5V, HVD: ~14.1V

Charge controller:

The functions of charge controller are as follows:

– **Charge controller protects batteries from Overcharge and Over discharge**

- Over charge protection :
- Sense battery voltage
- Battery voltage is high (fully charged, ~14.4V : High Voltage Disconnect, HVD)

-Disconnect PV module from battery (Stop Charging)

– While battery voltage is not high (not fully charged, below 13.5V : High Voltage Reconnect, HVR)

- Always connect PV module to battery (Normal status for charging)
- Over discharge protection :
- Sense battery voltage
- While battery voltage is not Low (ordinary status, above 12.5V : Low Voltage Reconnect, LVR)
- Always connect Load to battery (Normal status for discharging
- Battery voltage is Low (close to empty, below 11.5V : Low Voltage Disconnect, LVD)
- **Disconnect Load from battery (Stop Discharging)**
-

Generally two types of charge controller are used in industrial purposes:

Fig: MPPT charge controller

Fig: PWM charge controller

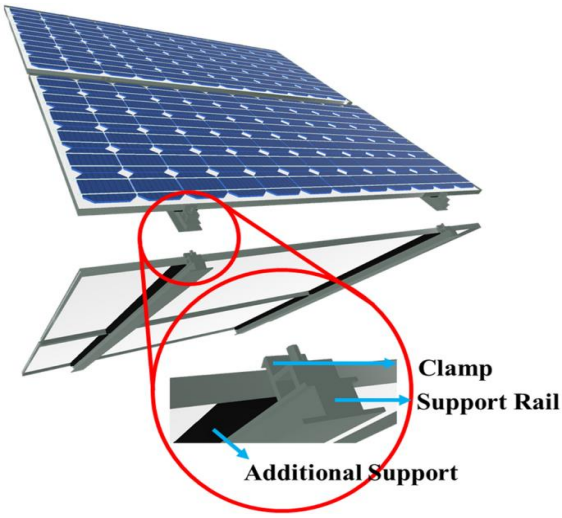
Inverter:

The inverter converts the DC power produced by the solar panel and stored into the batteries into AC power to feed to the AC loads.
Inverters range from small inverters of 100 Watts to large ones of 100kWatts. All inverters from reputable manufacturers should be accompanied with a data sheet.
Inverters produce different waveform, rectangular, modified and pure sine waves. It is however recommended to use pure sine wave inverters.

Fig: Inverter

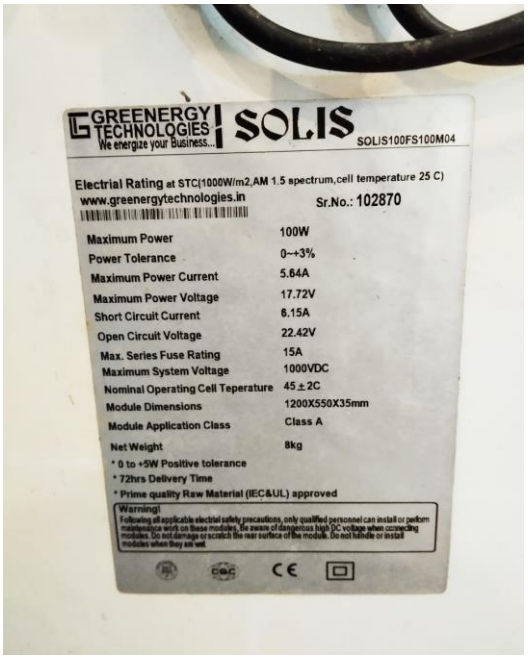
Mechanical supports of solar panels:

The structures are based on the same principle as pole mounted ones. The only difference is that all solar panels are laid in a single horizontal line (instead of being separated).This means that the solar system can be horizontally extended as much as desired with additional vertical pipe supports. The advantage over other solar ground mounting systems is that these structures allow the installation of bigger systems with great and simpler tilt variability, needing only one adjustment for all the panels, unlike pole mounted which require adjustment for each set of panels, and do not require as many soil perforations as other traditional systems.**These systems are also ideal for carports or for shading purposes . Basically the structures include materials like MS L-Channel , U-Channel , hollow square bars with flanges and stud bolts for foundation .The frame is installed making all the provisions for solar panel mounting and DC Cable routing. The nut and bolts used are stainless steel in nature.**



Experimentation and study on solar panel using inverter and MPPT circuit

The monocrystaline solar panel used for experimemtation purposein shown bewlow along with its specification:



The following inverter circuit was used for experimentation purpose:

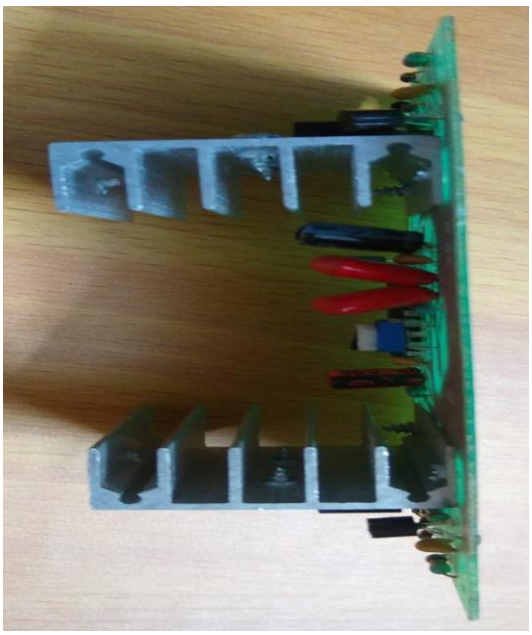


Fig: 100 W full bridge inverter

The components in the inverter circuit are as follows:

SL no	Component Name	Quantity
1	MOSFET	14
2	Resistance	4
3	Zener diode	9
4	Transistor	4
5	Capacitor	8
6	IC SG3524N	1
7	Potentiometer	1
8	Diode	5
9	Heat sink	2

Experimentation and data collection for grid power supply :

Measurements was taken and respective waveform was seen in **Oscilliscope**

SL NO	Input voltage (V)	Output transformer voltage (V)	Frequency(Hz)	Duty cycle
1	**230**	**4.77**	**49.9**	**+98.2 %** **- 1.8%**
2	**231**	**4.8**	**48.9**	**+1.2 %** **- 98.8%**
3	**229**	**4.53**	**49.99**	**+49.4%** **- 50.6%**

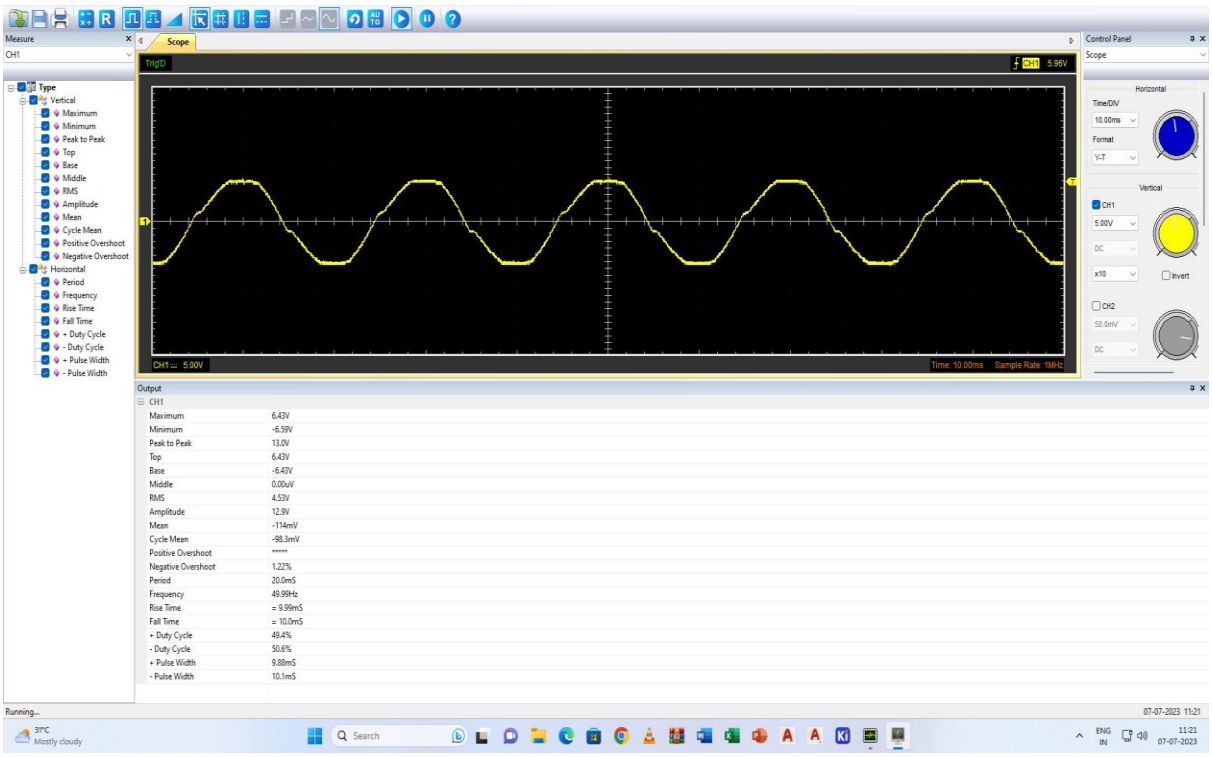


Fig: Waveform of grid power

<u>Experimentation for off grid power supply using inverter circuit:</u>

SL NO	Input voltage (V)	Output transformer voltage (V)	Frequency(Hz)	Duty cycle
1	230	4.93	50	+50 % - 50%

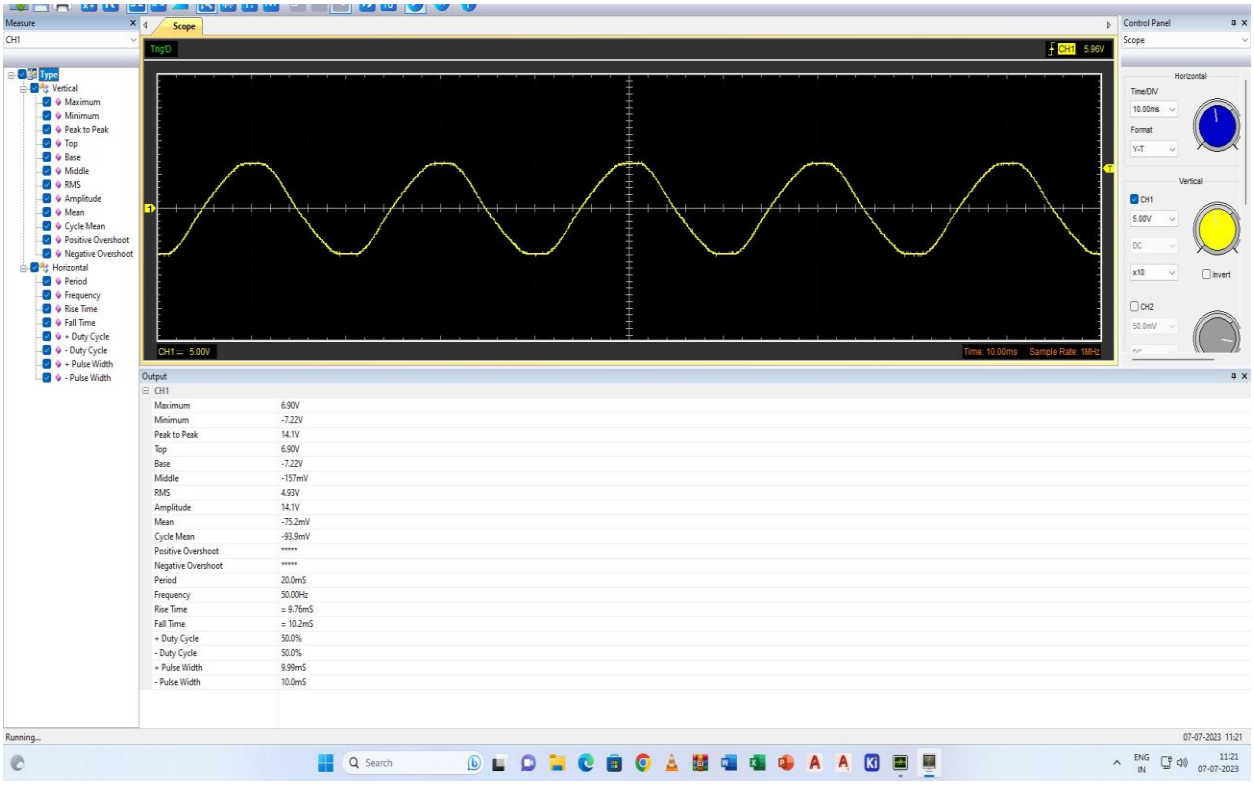


Fig: Waveform of inverter circuit in off grid mode

Experimentation for off grid power supply using MPPT circuit:

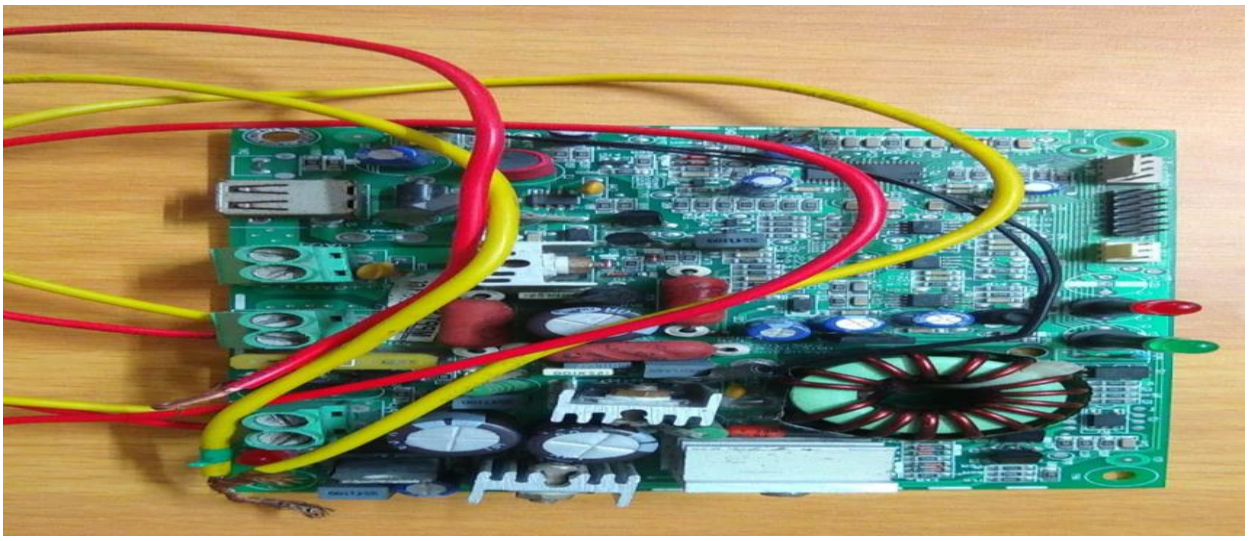


Fig: internal circuit of MPPT charge controller

Waveform as retrieved from MPPT charge controller while under load :

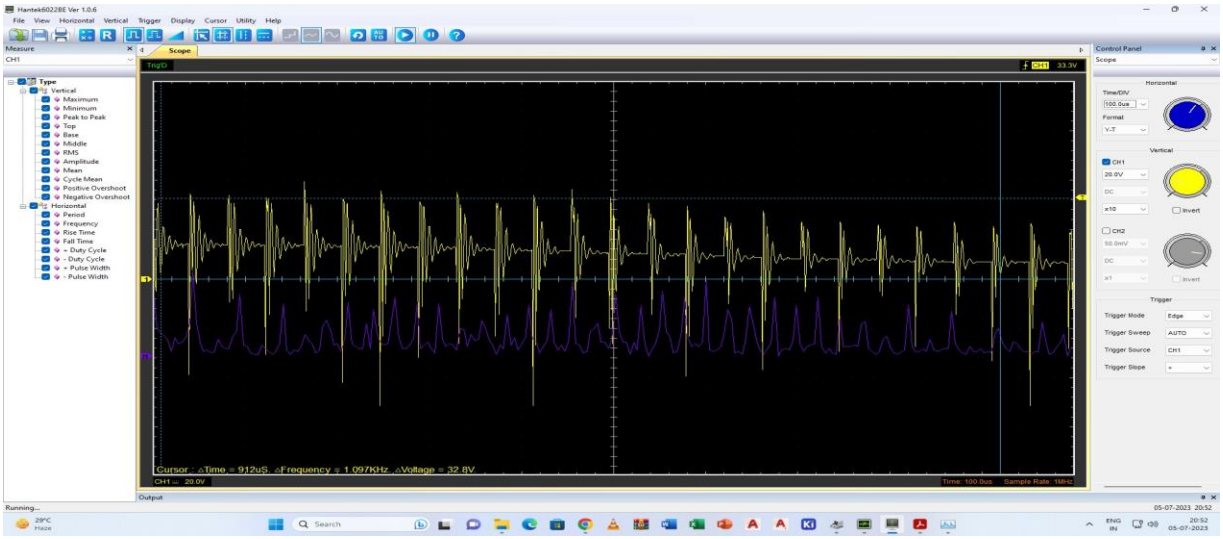


Fig: Switching frequency of the MOSFETs under load

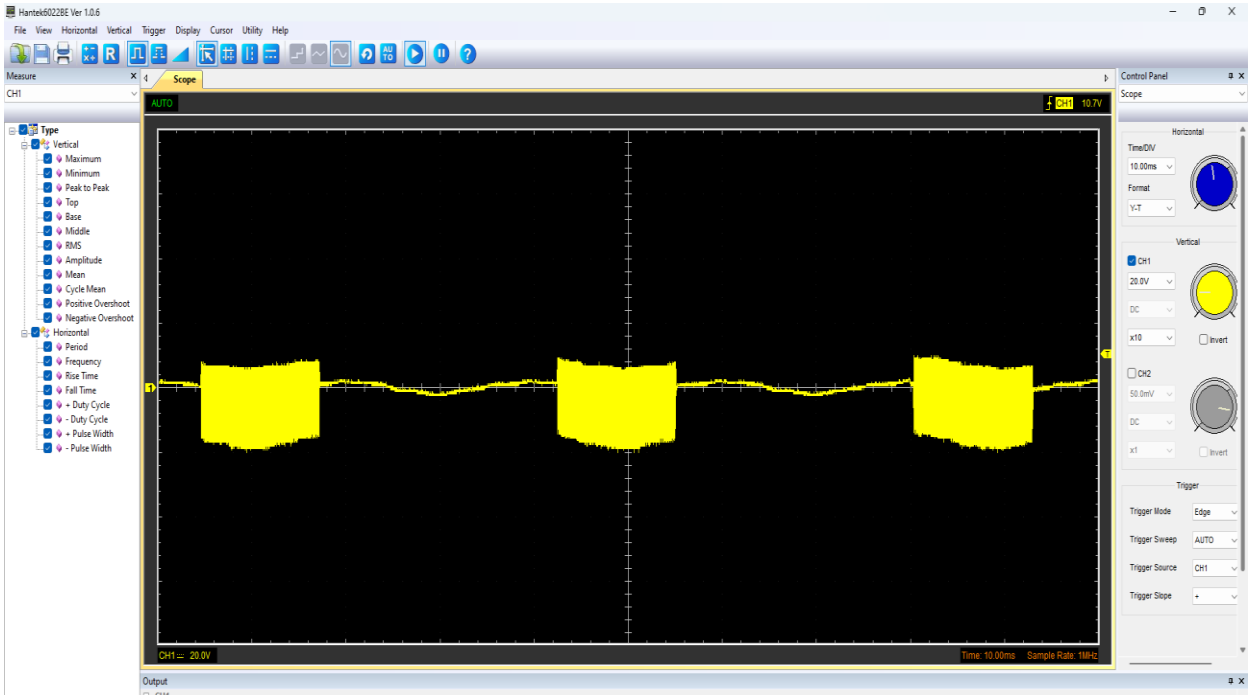


Fig: Battery charging sequence as shown by the switching activity of the charge controller

Tally on grid system and off-grid system:

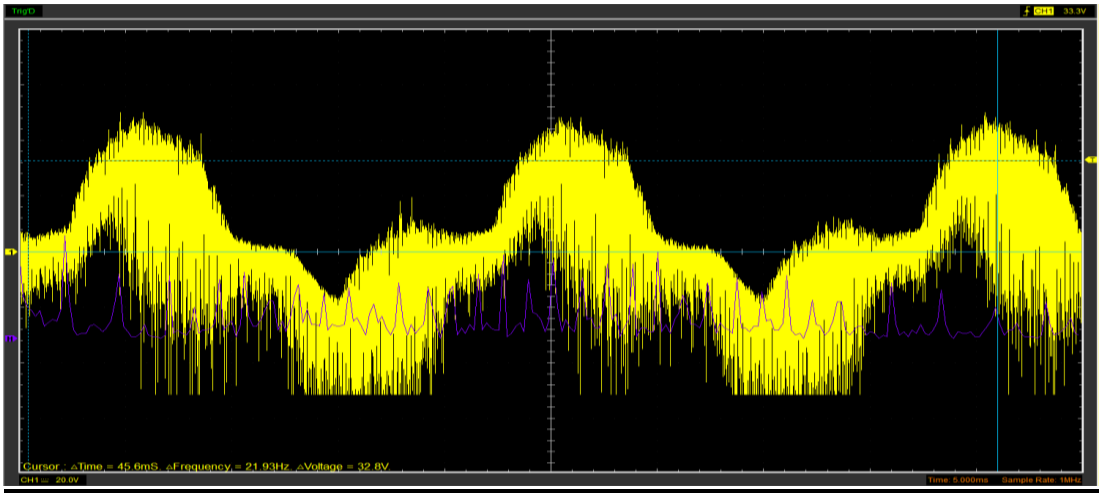


Fig: Waveform indicates the RMS as well as noise in grid power

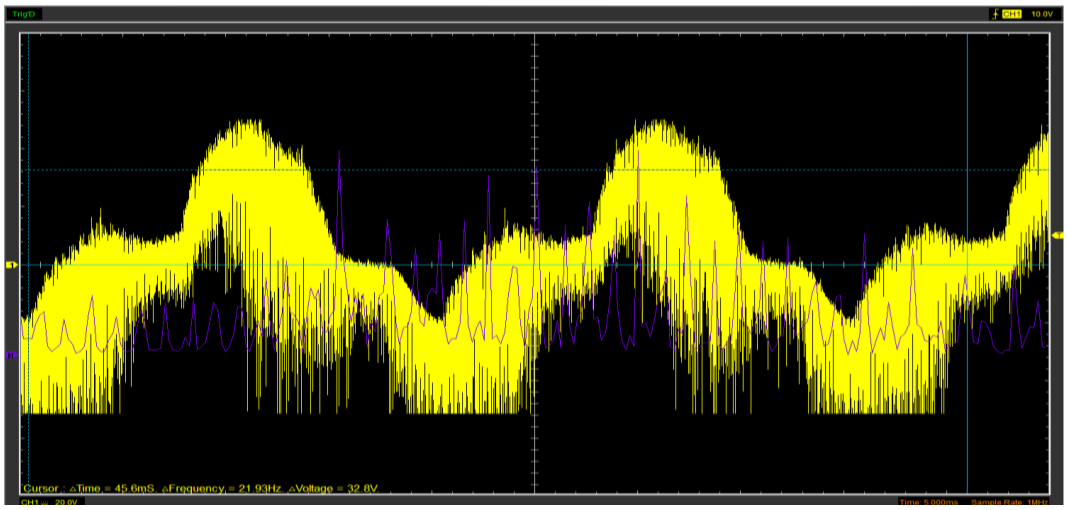


Fig: Waveform indicates the RMS as well as noise in off grid power

Conclusion: The source is equivalent in all parameter frequency , amplitude, duty cycle and hence can replace grid supply

Instruments used:

1. **Digital signal oscilloscope**
2. **Clampmeter**
3. **Sensing transformer**
4. **Multimeter**

Case Study :

We Will Design Solar PV SYSTEM FOR Our Own Residential Building

The following data was collected for designing solar PV system of our building:

Sl no	Overall Load (KW)	System voltage (V)	Inspected Area (Sqft)	Back up timing(hours)
1	**1000**	**12**	**60**	**3.5**

Design of Mechanical Section:

For designing Solar PV System, the Solar frames was installed in rooftop. The design was done using **Autodesk software** which is shown below:

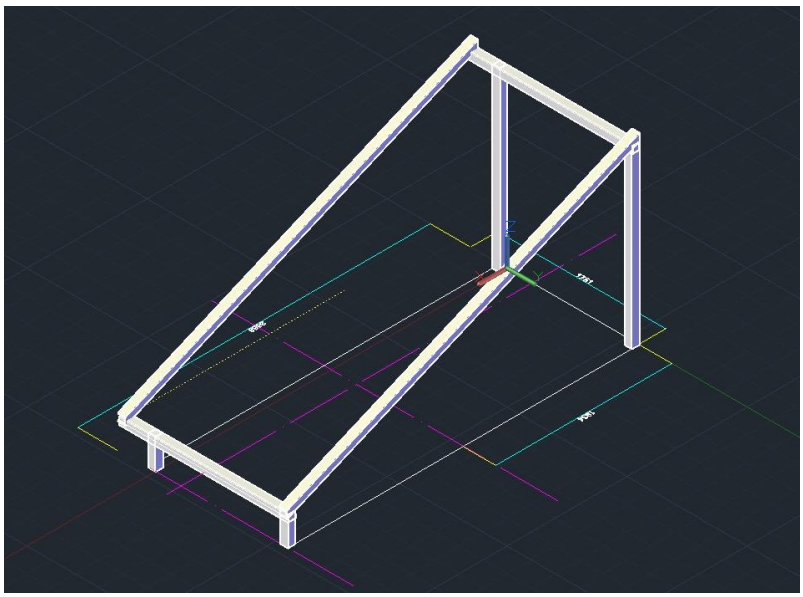
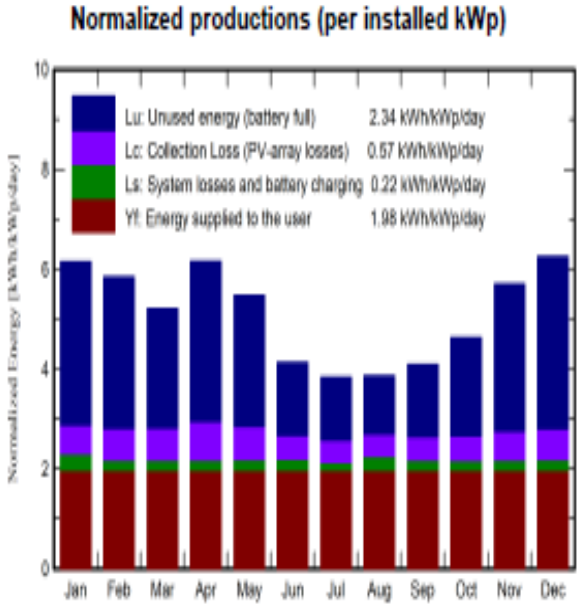


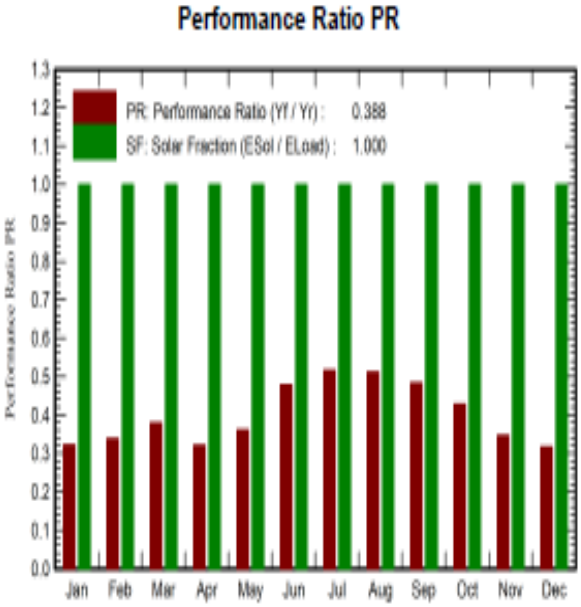
Fig: Solar frame design

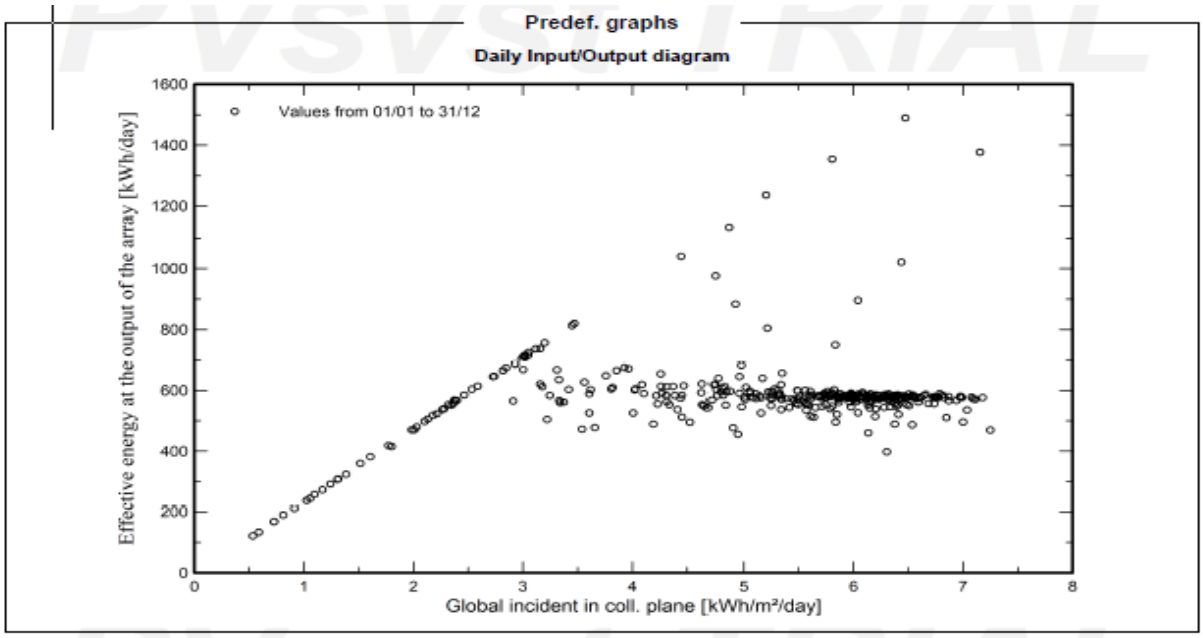
Bill of Materials for Solar Off-grid PV System Design:

SL NO	Name of component	quantity	specifications
1	Solar panels	5	200W
2	Inverter	1	1KW
3	Lead -acid Battery	3	12V 600Ah
4	MPPT SCC	1	83Amps, 12V
5	MC4 Connector	10	
6	DC wires	2pair 60ft each	4 sq mm
7	AC Wire	As reqd.	2.5sq mm
8	MS Rods for frame	As reqd.	2.5 sq inch
9	SS nut bolt	10	As per mounting hole requirement
10	MCB	1	220V 5Amps
11	RCCB	1	220V 5Amps
12	DC Surge Protector	1	

<u>Simulation of Solar Off-grid PV system for building was done using PVsyst software shown below:</u>





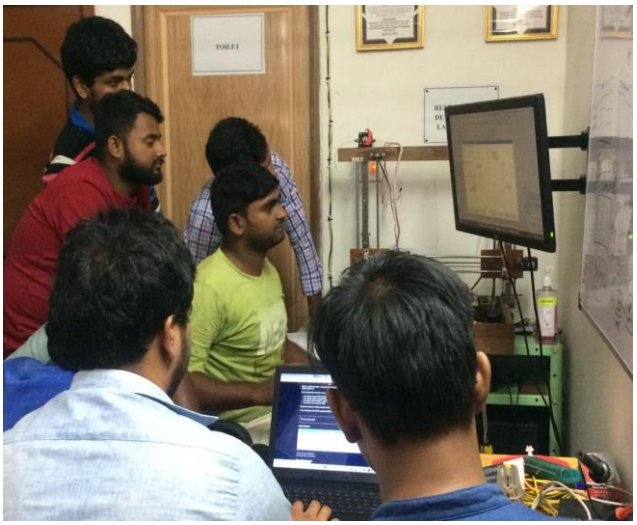


Output :

1 Kw solar system has 5 super high efficiency PV modules. It generates 6 units of power everyday.1800 units per year.

Month	Per day generation (in units)
January	**4.49**
February	**5.51**
March	**6.37**
April	**6.87**
May	**6.57**
June	**5.77**
July	**5.08**
August	**5.44**
September	**5.82**
October	**5.52**
November	**4.86**
December	**4.46**

Few Moments of Our Training Are Shared below:



Conclusion:

Solar power is an immense source of directly useable energy and ultimately creates other energy resources: biomass, wind, hydropower and wave energy.

Direct use of solar energy is the only renewable means capable of ultimately supplanting current global energy supply from non-renewable sources, but at the expense of a land area of at least half a million km^2.

The Indian solar industry has been growing rapidly over the past few years , and 2023 is expected to be a game-changing year for the sector. With Indian Government's ambitious target of achieving 100GW of solar capacity by 2022, the industry is set to witness significant growth in the coming years.

As of October 2022, India's installed renewable energy capacity (including hydro) stood at 165.94 GW, representing 40.6% of the overall installed power capacity. The country is targeting about 450 Gigawatt (GW) of installed renewable energy capacity by 2030 – about 280 GW (over 60%) is expected from solar.

The rooftop solar segment is expected to grow significantly in 2023, driven by the government's push towards promoting decentralized solar power generation. The government has set a target of achieving 60GW of solar rooftop capacity by 2023, and this segment is expected to contribute significantly to the overall solar capacity in the country.

We are grateful and thankful to Navonis Automation And Renewable Power Solutions Pvt Ltd (Registered under MSME, Govt of India) for giving us opportunity to do training in solar rooftop site and teach us useful practical concepts and gain knowledge in the respective sector.