

5MW SOLAR POWER PLANT -BAP

INTRODUCTION

Energy is the driving force for almost everything including the economy, society and technology all around the world. This makes energy generation an important and ever increasing responsibility. Energy generation, however, is mainly done by fossil fuels and is also used in a way that society will not be able to sustain for long, as fossil fuels are limited. There is an ever increasing effort in commercializing the alternative sources, which are practically never ending and are also difficult to harness. Among the major ones are Solar power, Wind energy, Bio-fuels, geothermal and nuclear. Among these, most available is the solar power.

A solar power plant is based on the conversion of sunlight into electricity, either directly using photovoltaic (PV), or indirectly using concentrated solar power (CSP). The following report deals with the layout, set up, maintenance, power balancing, conditioning and transmission of solar energy of 5MW solar plant of the Boiler Auxiliaries Plant of Bharat Heavy Electricals Limited in Ranipet. The generated power is connected to TNEB grid via SIPCOT substation. Our Solar Plant consists of 2MW of Fixed Panel, 1MW of Auto Tracking Panel and 2MW of Seasonal Tilt Panel.



REASONS TO USE SOLAR ENERGY

- ❖ **Green** – “Solar is green. Green is the new black.” Well said. Green energy is totally the new rage, but it is also a way to look out for the future of our planet and reduce our impact.
- ❖ **Renewable** – Solar is a renewable energy source. The sun is always present and even the cloudiest days, there is a bit of insolation available for the solar panels to soak up.
- ❖ **Availability**– Solar energy is available abundantly, hence can be installed anywhere. No matter what the circumstance, if there is a sunny spot nearby, the solar power can be harnessed and used off grid. There is even technology today turning roof top or windows into photovoltaic sources.
- ❖ **Durability**– Since silicon wafer is not durable by itself, a glass support is used. Best of all, as technology increases, the durability of the glass increases. Other protection, such as protective panel backs, can be used to increase the durability of free standing solar power systems.
- ❖ **Eco-Friendly** – No harmful gases are emitted and zero wastage.
- ❖ **Cost Savings** – Solar provides cost savings by not having to pay for electricity, as electricity cost continues to rise. Cost savings also can be calculated by eliminating the need to trench in grid power, disturbing surrounding landscapes and hardscapes, repairing areas, etc.
- ❖ **Easy Installation** – Solar panels are easy to install, when compared to any other power plant. Solar utilizes lower voltage, typically 12 or 24 Volts DC, which means safer usage and installation.
- ❖ **Energy Savings** – Solar utilizes lower powered appliances such as LED / CFL lamps. By using DC power for LEDs, they are able to operate more efficiently by providing more light and less heat.
- ❖ **Tax Credits / Grants**– Government provides credits and grants to help with the purchase of solar, to enhance the use of renewable energy.

LAYOUT AND WORKING OF SOLAR POWER PLANT

Solar electricity is a renewable source of energy that has been in.

Scientists have come up with a good and reliable way of tapping the energy from the sun.

Solar energy is captured through solar panels and converted to solar electricity using Photovoltaic (PV) technology.

Silicon is the most widely used semiconductor material for constructing photovoltaic cell.

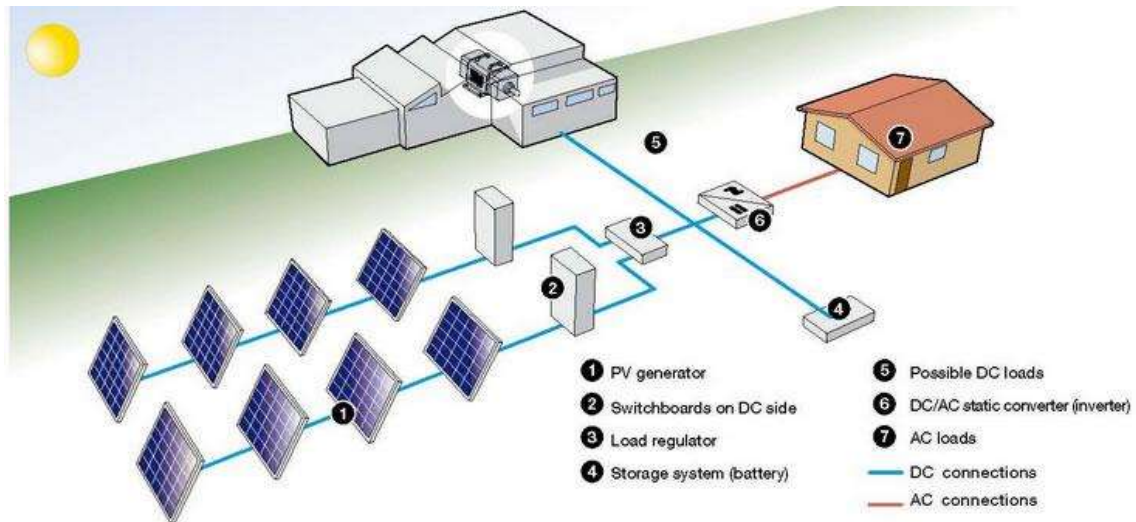
As light incident on the solar panels, the solar radiation is converted into Direct current (DC). The Direct current is converted into Alternating current (AC) via inverter.

The obtained AC is stepped up to utility voltage using step up transformer, which is then connected to grid.



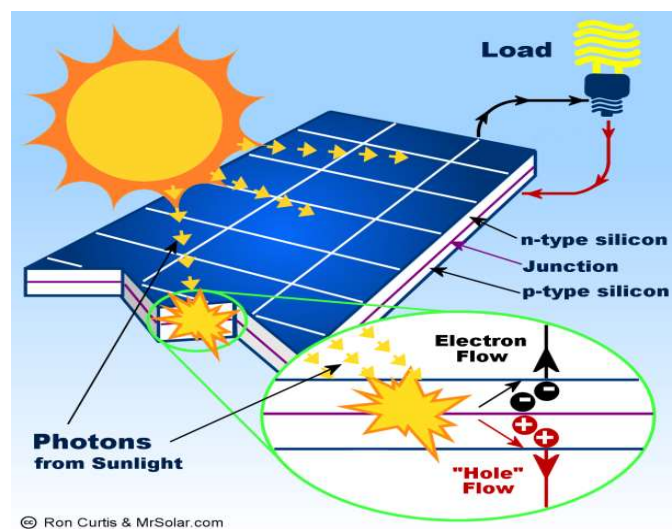
COMPONENTS OF SOLAR POWER PLANT SYSTEM:

A Solar Power Plant consists of the following units such as



1. SOLAR PANEL:

The following diagram describes the working of solar panels in solar power plant.



- Solar panel converts photons to electrons to generate current by making use photovoltaic cell. When bank of photovoltaic cells are connected together, they are collectively known as a solar panel.
- Photovoltaic cells are made up of semi conductive materials such as silicon. They work by allowing photons, or particles of light, to knock electrons free from atoms, generating a flow of electricity.
- Within each cell, there is an electric field which is used to streamline the flow of electrons in a particular direction. When these electrons meet a metal contact placed on the photovoltaic cell, it can be used to power devices.

Types of solar panels:

1. Fixed Solar Panel:



2. Seasonal Tilt Solar Panel:



3. Auto Tracking Solar Panel:

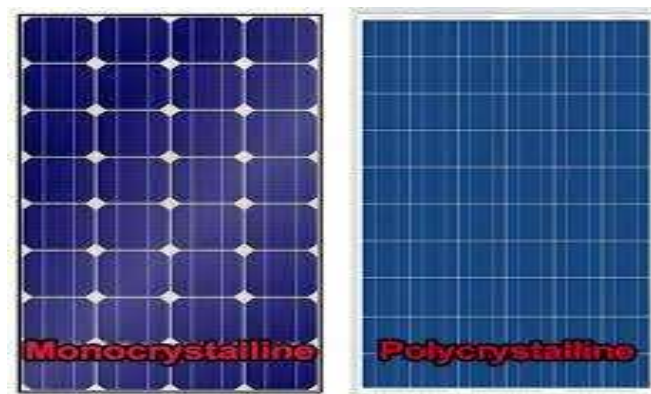


Types of silicon crystals:

All the types of solar panels used in our BHEL-BAP are made of both Mono and Polycrystalline form of Silicon. Mono-Crystalline form lasts longer and it contains 60 cells (6 X 10), whereas Poly –Crystalline form contains the same number of cells with some impurities and hence it is preferred for low budget solar power plant.

Mono-Crystalline Silicon lasts for 25 years whereas Poly- Crystalline Silicon lasts for 20 years. Mono- Crystalline Silicon uses 230 volts of power supply.

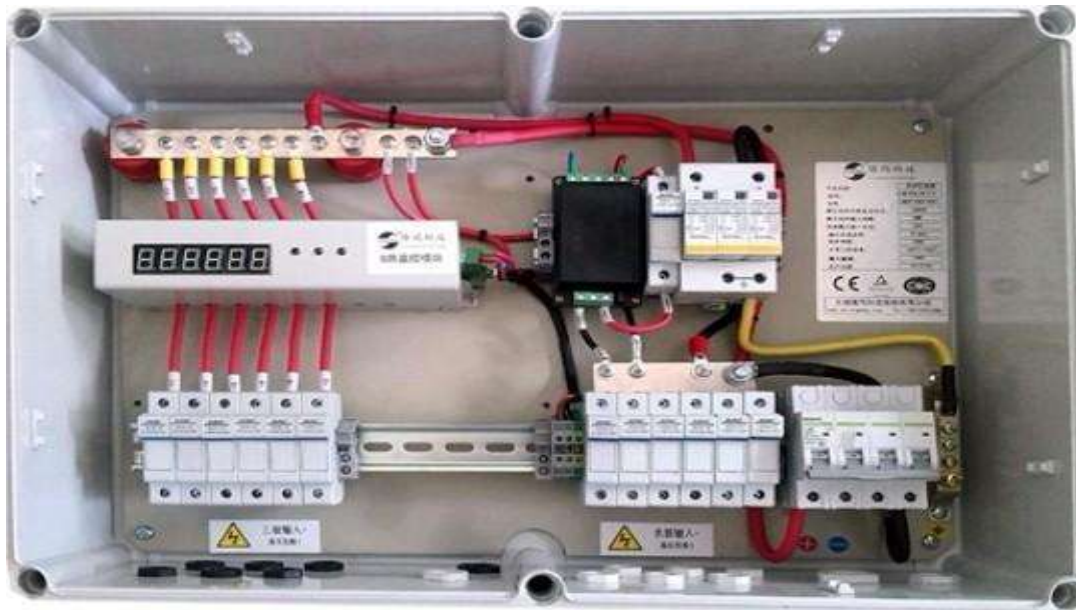
- Mono-Crystalline Silicon, 24 panels = 1 String.
- Poly-Crystalline Silicon, 20 panels = 1 String.



2. STRING MONITORING BOX (SMB):

- The String Monitoring box provides high level of system performance monitoring and also ensures system safety.
- SMB monitors various parameters such as electrical parameters of input strings, temperature, fuse status, SPD status, and disconnect switch status.
- The String Monitoring box combines multiple DC input coming from the panel termination and converts them into single DC output.

- The output of the String Monitoring box is connected to the inverter.
- Replaceable fuses are used per string input in the String Monitoring box.



3. POWER CONDITIONING UNIT:

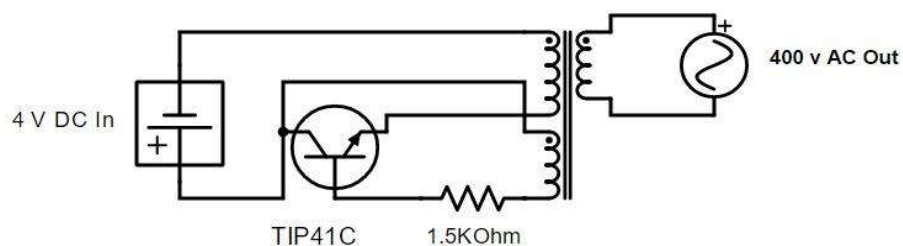
- Solar Power Conditioning unit (PCU) is an integrated system consisting of a solar charge controller, inverter and a Grid charger.
- It provides the facility to charge the battery bank through either a Solar or Grid/DG set.
- The PCU continuously monitors the state of battery voltage, solar power output and the load.
- Due to constant usage of power, if the battery voltage goes below a set level, the PCU will automatically transfer the load to the Grid/DG power and also charge simultaneously.
- Once the batteries are charged to the preset level, the Solar Power Conditioning unit cuts off the Grid/DG Power from the system and feeds the load from battery bank.

- PCU always give preference to solar power and will use Grid/DG power only when the solar power / battery charger is unable to meet the load requirement.



4. DC-AC CONVERSION SYSTEM:

A Solar inverter or PV inverter, converts the variable direct current (DC) output of a photovoltaic (PV) solar panel into utility frequency alternating current (AC) that can be fed into a commercial electrical grid or used by a local, off-grid electrical network.



5. CIRCUIT BREAKERS:

Circuit breaker is an automatically operated electrical switch designed to protect electrical circuit from damage caused by excess current, typically resulting from an overload or short circuit. Its basic function is to interrupt current flow after a fault is detected. There are two types of Circuit breakers.



I. Air Circuit Breakers:

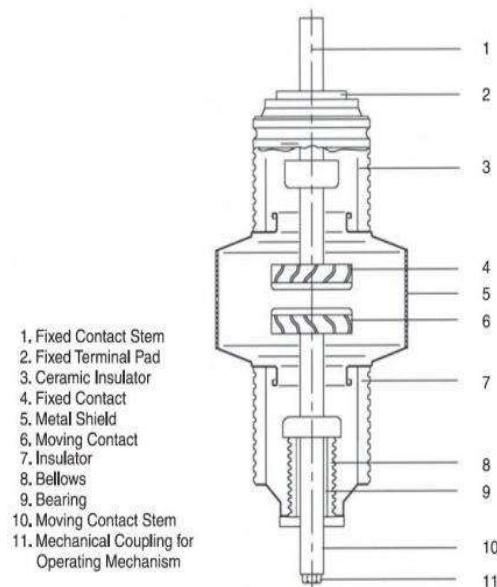
Air Circuit Breaker is a device used to provide overcurrent and short circuit protection for circuits ranging from 800 Amps to 10000 Amps. The type of circuit breaker, which operates in air at atmospheric pressure, is known to be an Air Circuit Breaker. Air circuit breaker has completely replaced by oil circuit breaker. In many countries, Air circuit breaker is preferred up to 15KV as there is no chance of oil fire like in an oil circuit breaker.



II. Vacuum Circuit Breakers:

Vacuum circuit breakers are circuit breakers that are used to protect medium and high voltage circuits from dangerous electrical situations. Like other types of circuit breakers, they literally break the circuit so

that energy cannot continue flowing through it, thereby preventing fires, power surges, and other problems which may emerge.



6. TRANSFORMERS:

Transformer is static electrical equipment which transforms electrical energy (from primary side windings) to the magnetic energy (in transformer magnetic core) and again to the electrical energy (on these secondary transformer side). In solar plant, step up transformer is used, to boost voltage levels so as to decrease line losses during transmission. The HV windings contains larger number of turns compared to LV windings. LV winding wire has bigger cross-section than HV wire because of higher current value on the LV side. Usually, LV windings are placed close to the transformer core whereas HV windings are wound over LV windings.

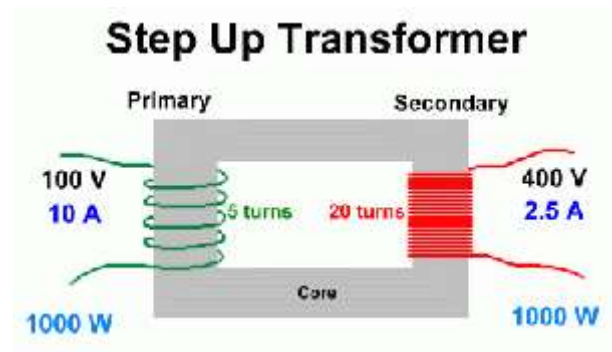
1. Step Up Transformers:

A step-up transformer is used when the secondary voltage is greater than the primary voltage. It has more wire turns in the secondary. The common usage of it is a starter of an electric motor. It takes a lot of voltage to initially start the motor's turning.

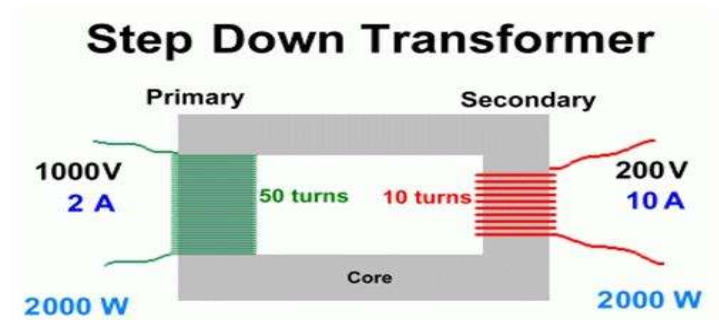
A step up transformer is also needed to use a 220v product in a country with 110v supply. In other words, the voltage has been “stepped up”. As you can see in the diagram, input is 110V and output is 220V. That is the main purpose of a Step-up Transformer.



II. Step Down Transformers:



Step- down transformers are designed to reduce electrical voltage. It has less wire turns in the secondary. Thus, decreases voltage. For instance, here in the Philippines, we have 220V electric supply. But since we have relatives or friends abroad who send us appliances that requires 110V supply, there is a need to use a Step down Transformer. Using a step-down transformer actually means that the voltage has been “stepped down”.



7. PYRANOMETER:

Pyranometer is a solar radiation sensor. It is a type of actinometer used for measuring solar irradiance on a planar surface and it is designed to measure the solar radiation flux density (W/m^2) from the hemisphere above within a wavelength range $0.3 \mu\text{m}$ to $3 \mu\text{m}$.



8. SCADA CONTROLLERS:

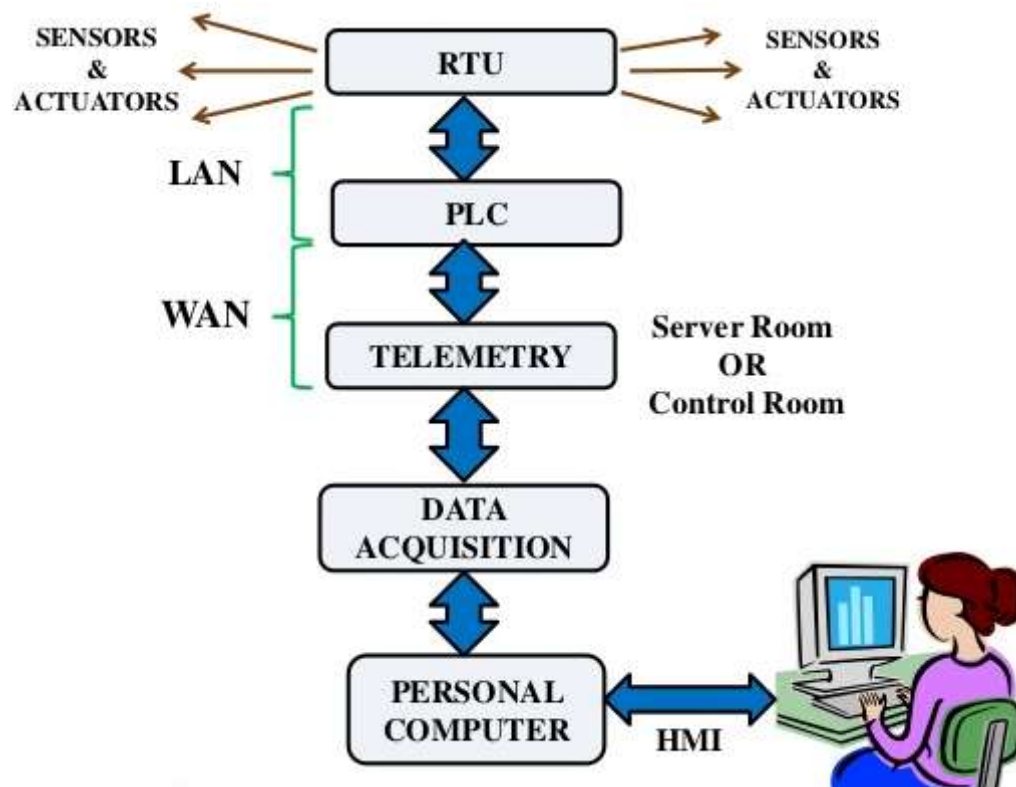
SCADA system is a common industrial process automation system which is used to collect data from instruments and sensors located at remote sites and to transmit data at a central site for either monitoring or controlling purpose. The collected data from sensors and instruments is usually viewed on one or more SCADA host computers that are located at the central site.

Based on the information received from the remote stations, automated or operator-driven supervisory commands can be pushed to remote station control devices, which are often referred to as field devices.

The figure shown below is a simple SCADA system with single computer. The computer receives data from remote terminal units through the

communication interface. One or more CRT terminals for display is controlled by operator. With this system, it is possible to execute supervisory control commands and request the display of data in alphanumerical formats.

The I/O SCADA programming is used to change the supervisory software. In the basic SCADA system, all the data and programs are stored in the main memory. The more complicated version of SCADA has additional secondary memories in the form of magnetic disc units.



BHEL-BAP SOLAR PLANT DETAILS

Each solar panel produces a voltage of 29 volts.

To produce the required voltage, temperature and tilt angle must be 25°C and 15° respectively.

The total capacity installed is 5MW.

They produce maximum output of 3.6 MW and 25,000 units per day.

The current of 7.6 Ampere is maintained for conditioning purpose.

The total cost of the plant is 43Crores.

The average selling cost of per unit is Rs.6.25 for SIPCOT and is providing 62 lakhs units per month.

The average DC input voltage is 633 V & 369 A.

The output will be 309 V & 420A, 310 V & 427 A, 309 V & 429 A for 3phases.

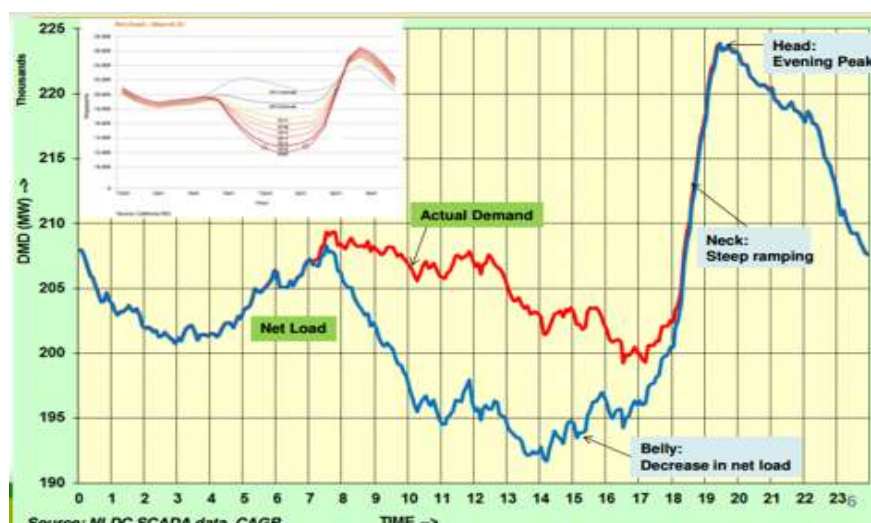
The average frequency will be 49.8 Hz and power factor of -0.99.

The internal power generation will be 2055.95 MWh (avg) and the power generation output is 1943 KWh per day.

The efficiency of the plant is 97.4% during the time of visit.

The solar modules of 280Wp, quantity of 3600 No's and with 90 No's of structure for mono and poly types.

The power generation is monitored via SCADA and the daily load graph appears as shown below.



CONCLUSION

As a result of this solar power plant visit, we came through the working, layout and maintenance of BHEL unit's 5MW solar power plant and how it satisfies the needs of the people around Ranipet and SIPCOT, etc.

This visit to our BHEL unit's 5MW Solar Power Plant gave us an opportunity to correlate theory we have learnt with actual site working conditions. We got an insight into generation, control & transmission of 5MW renewable energy and practical problems on site. The whole process was explained with detailed description of equipment's with their specification. Explanation was carried out in the control room.

Since protection and conservation of the environment is the need of the hour, let us Go Green by using renewable energy sources.