

Subject: SPIM (Solar panel installation and maintenance)

Unit-1 Check site conditions, collect tools and raw materials.

1.1 Basics on solar energy and power generation systems.

1.2 Use and handling procedure of solar panels.

1.3 Energy storage, control and conversion.

1.4 Basic electrical system and functioning.

1.5 Mechanical equipment and its functioning.

1.6 Maintenance procedure of equipment

1.7 Site survey, design and evaluation of various parameters.

1.8 Tool involved in installation of system.

1.9 Quality and process standards.

1.10 Occupational health and safety standards.

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* Basics of solar energy - When energy has a large number of different forms, and there is a ~~for~~ formula for each one. These are gravitational energy, kinetic energy, heat energy, elastic energy, electrical energy, chemical energy, radiant energy, nuclear energy, mass energy, mechanical energy etc. If we total up the formulas for each of these contributions, it will not change except for energy going in and out.

Energy is never produced but always converted from one form to another. The form of energy may change in time, but the total amount does not change. If we want to utilise energy to work for us, we usually convert it from one form to another more useable form. An example is the electric motor, in which we convert electrical energy to mechanical energy. Modern society is very much based on the capability of us humans to convert energy from one form to another form.

Country	Energy consumption (kwh/capita)	Average power use (w/capita)
U.S.A.	81642	9319
Netherlands	53963	6160
Germany	44310	5058
China	23608	2695
India	6987	797

Table - Total primary energy consumption per capita and average power used per capita in some countries in 2011

Solar power has historically been more expensive than other energy options, but that's changing fast because of government investment in technologies, as well as the simple fact that many more people are investing in solar, which results in economies of scale. Solar energy equipment increases your financial standing in basically two ways -

- * Savings on your monthly bills.
- * Appreciation of your's home values.

Solar energy is a powerful source of energy that can be used

to heat, cool, and light homes and businesses. more energy from the sun falls on the earth in one hour than is used by everyone in the world in one year.

Primary and secondary energy—primary energy consists of unconverted or original fuels. Secondary energy includes resources that have been converted or stored, for example—primary energy sources include petroleum, natural gas, coal, biomass, flowing water, wind and solar radiation. These are the fuels that can be mined, reaped, extracted, harvested or harnessed directly. Secondary energy cannot be harnessed directly from nature, rather, secondary energy is energy that has already been converted, for example: electricity cannot be mined or harvested, though it is available in quick bursts on ~~an~~ occasion from lightning. It is generated as a secondary form from primary fuels, like natural gas.

Commercial and non-commercial energy.

Energy that is available in the market for a definite price is known as commercial energy. The most important forms of commercial energy are electricity, coal, refined petroleum products and natural gas. Any kind of energy which is sourced within a community and its surrounding area, and which is not normally treated in the commercial market is termed as non-commercial energy such as firewood, cattle dung, agriculture waste etc.

Renewable and nonrenewable energy

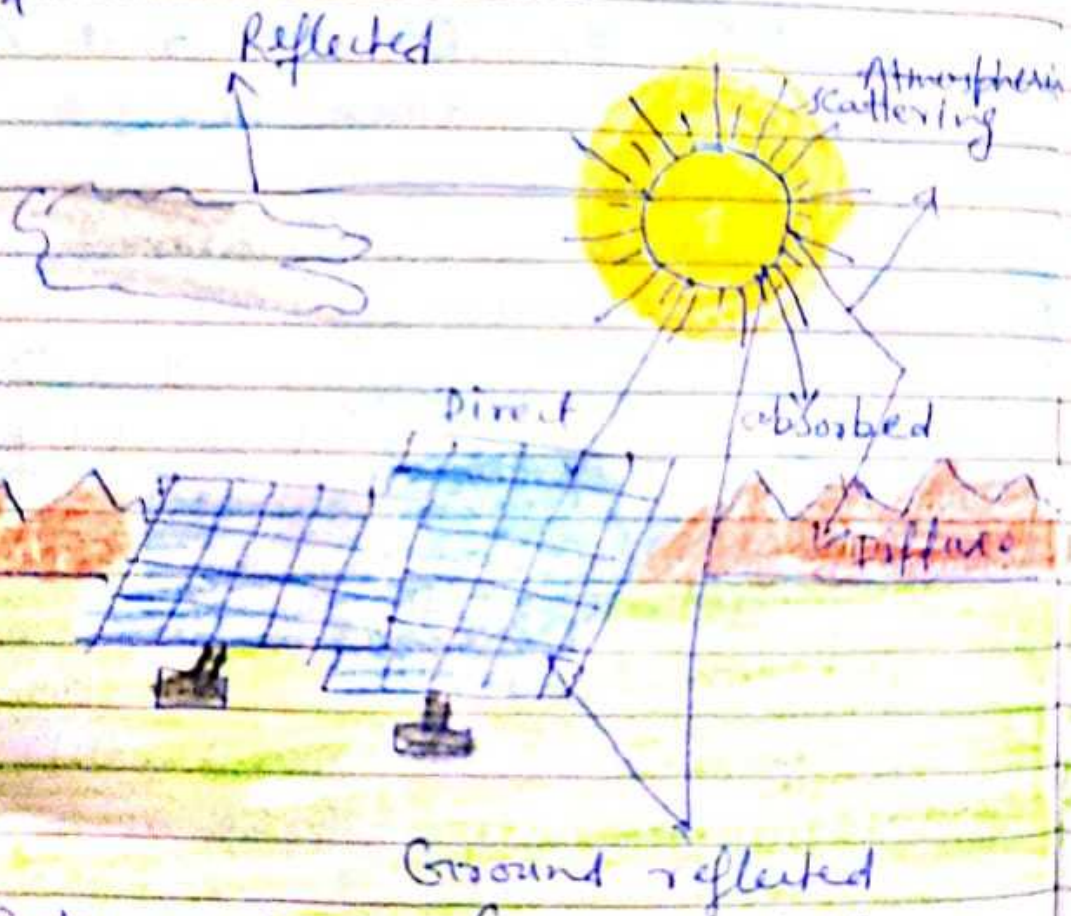
Renewable energy is obtained from natural sources. These resources can be used to produce energy again and again, for example: Solar energy, wind energy, tidal energy etc. Non renewable resources cannot be replaced once they are used, for example: coal, oil, gas etc. These energy resources are limited.

Solar energy and solar radiations -
solar energy (radiant energy emitted by the sun) Solar panels The earth receives the solar energy in the form of solar radiations. These radiations comprising of ultra-violet, visible and infrared radiation. The amount of solar radiation that reaches any given location is dependent on several factors like geographic location, time of day, season, land scope and local weather. Because the earth is round, the sun rays strike the earth surface at different angles (ranging from 0° to 90°). When sun rays are vertical, the earth's surface gets maximum possible energy. Most of the part of India receives 4 to 7 kWh of solar radiation per square meter per day. Solar panels convert the sun's light into usable solar energy using N-type and P-type semiconductor material. When sunlight is absorbed these materials, the solar

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energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (Photons) to electricity (voltage) is called the Photovoltaic (PV) effect.



Solar radiation (Direct, diffuse, and total solar radiations)

The solar radiation that reaches the surface of the earth without being diffused is called direct beam solar radiation. It is measured by instrument named as Pyrheliometer. As sun light passes through the atmosphere, some part of it is absorbed, scattered and reflected by air molecule, water vapours, clouds, dust and pollutants. This is called diffuse solar radiations. The sum of the direct and diffuse solar radiations is called total radiation or global solar radiations.

Sun angle - Sun angle is the angle of incidence at which sunlight strikes the earth at a particular time and place. The angle controls the amount of heat energy received at this place, so summer days are usually warmer than winter nights.

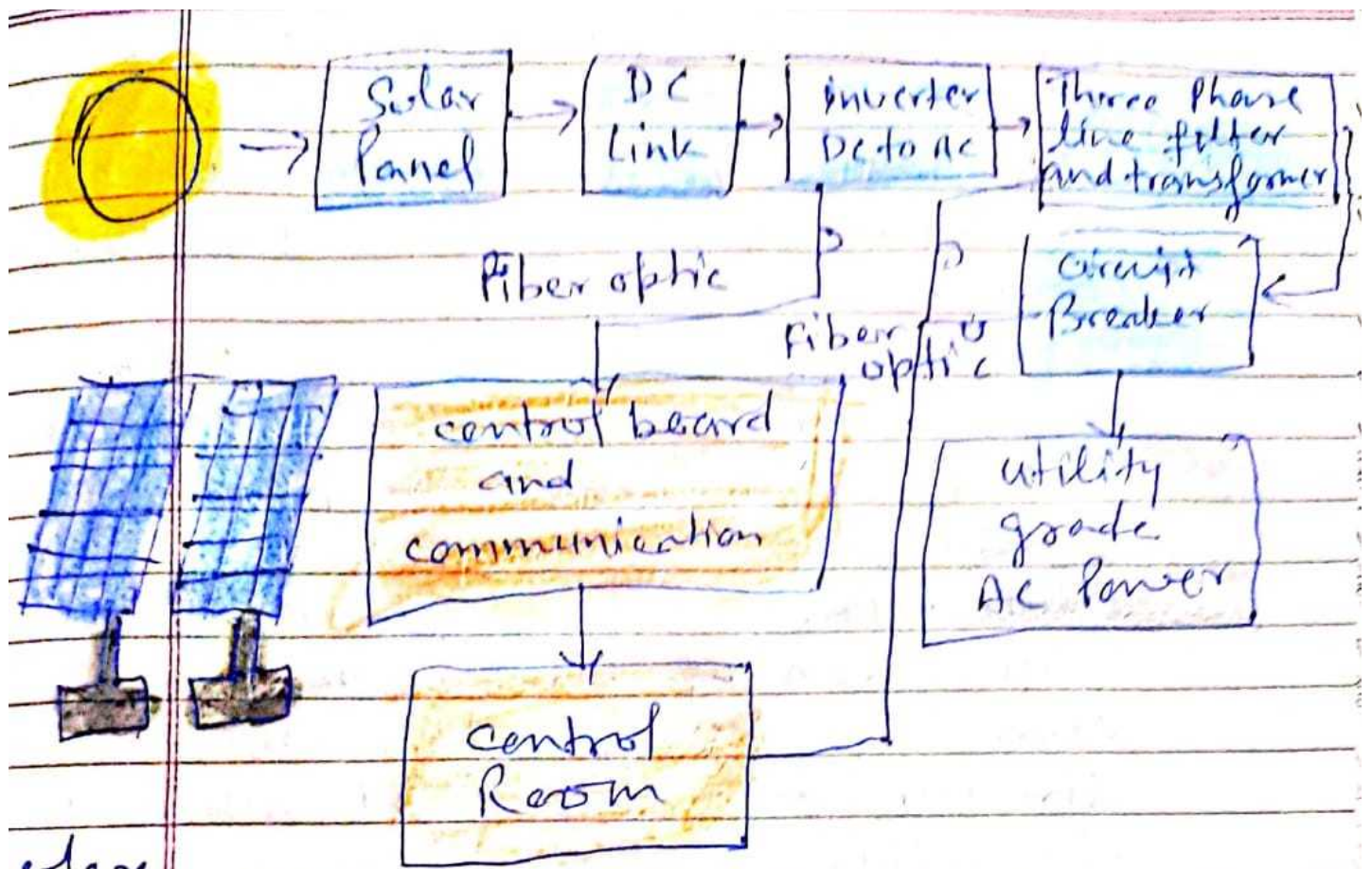
Applications -

1. Heating and cooling of residential building.
2. Solar water heating.

3. Solar drying agricultural and animal products.
 4. Solar distillation on a small community scale.
 5. Salt production by evaporation of seawater or inland brines.
 6. Solar cookers.
 7. Solar engines for water pumping.
 8. Food refrigeration.
 9. Bio conversion and wind energy, which are indirect source of solar energy.
 10. Solar furnaces.
 11. Solar electric power generation
- * Solar power generation system -

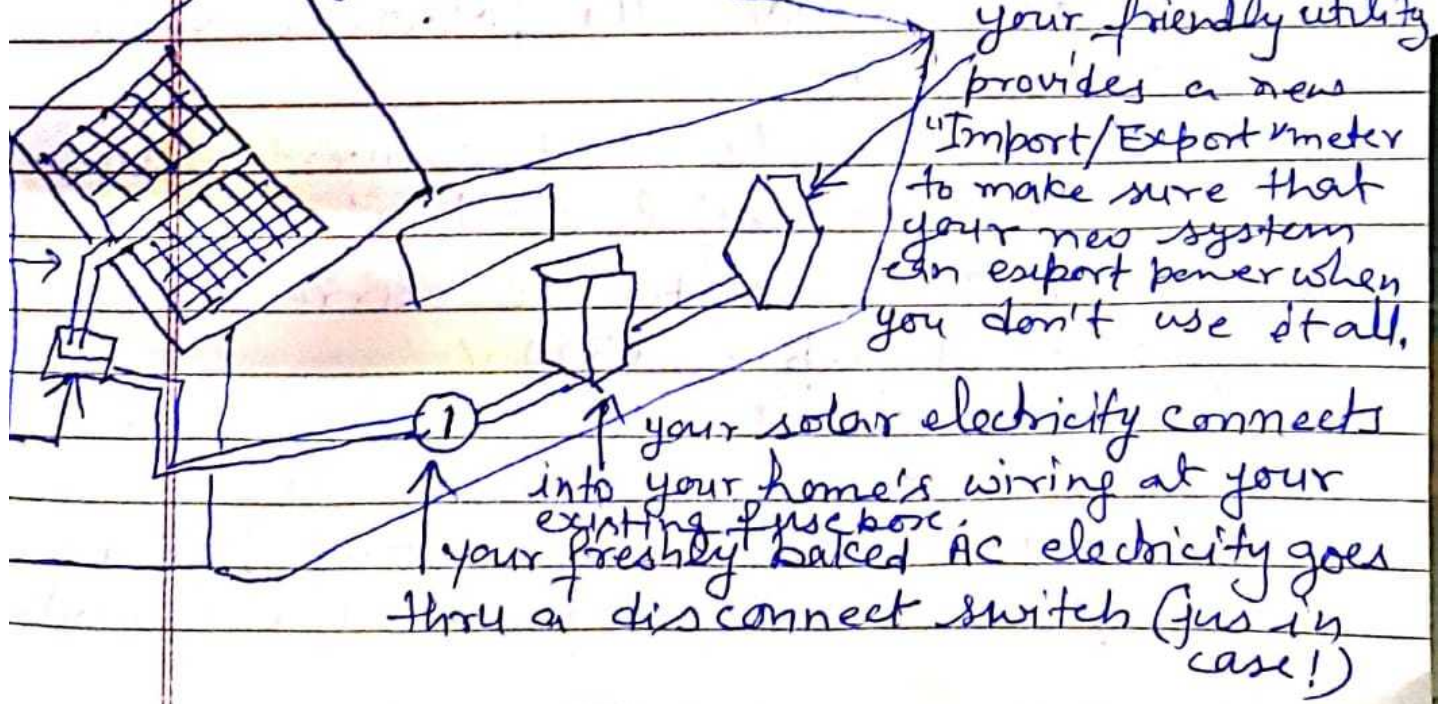
Sun goes in to the panels. DC (1) ———
electricity comes out

A box of electronics called an (2) inverter takes the not-very useful DC electricity and converts it into 240 V AC power that is compatible with our appliances.



solar

Power System =



A solar power plant is any type of facility that converts sunlight either directly, like photovoltaics, or indirectly, like solar Thermal plants, into electricity.

They come in a variety of 'flavors' with each using discretely different techniques to harness the power of the sun.

Photovoltaics power plants use large areas of photovoltaic cells, known as PV or solar cells, to directly convert sunlight into usable electricity.

These kind of power plant tends to have the following basic components :-

- * Solar panels that convert sunlight into useful electricity. They tend to generate DC current with voltages upto 1500 V.
- * These plants need invertors to transform the DC into AC.
- * They usually have some form of a monitoring system to control

and manage the plant.

- * They are directly connected to an external power grid of some kind.
- * If the plant generates in excess of 500 kW they will usually also employ step-up transformers.

How does a solar PV power plant work?

Solar PV Power plants work in the same manner as small domestic-scale PV panels or the tiny one on your calculator but on steroids.

Most Solar PV panels are made from semiconductor materials, usually some form of silicon. When photons from sunlight hit the semiconductor materials free electrons are generated which can then flow through the material to produce a direct electrical current. This is known as the photo-effect in physics. The DC current then needs to be converted to AC current using an inverter before it can be directly used or fed into the electrical grid.

PV panels are distinct from other solar power plants as they use the photo-effect directly without the need for other processes or devices. For example, no liquid heat-carrying agent like water, is needed as in solar thermal plants.

Solar thermal power plant on the other hand, focus or collect sunlight in such a manner as to generate steam to feed a turbine and generate electricity. Solar thermal power plants can also be subdivided into a further three distinct types -

* linear, Parabolic through solar thermal and solar Dish power plants

1. Parabolic through system
2. Linear concentrating system
3. Solar Dishes and ~~st~~ engines

Solar Power Towers are an interesting method in which hundreds to thousands of flat sun-tracking mirrors (heliostats) reflect and concentrate solar energy onto a central tower. This method is able to concentrate sunlight as much as 1500 times than would normally be possible from direct sunlight alone.

Solar pond - solar power plants make use of a pool of saltwater that collects and stores solar thermal energy. It uses a technique called salinity-gradient technology.

Solar ponds use a large body of saltwater to collect and store solar thermal energy. Saltwater naturally forms a vertical salinity gradient, known as a halocline, with low salinity water on the top and high salinity water at the bottom.

Salt concentrations levels increase with depth and, therefore, density also increases from the surface

to bottom of the lake" until the solution becomes uniform at a given depth.

The principle is fairly simple. Solar rays penetrate the pond and eventually at a given depth reach the bottom of the pool.

In a normal pond or body of water, water at the bottom of the pond is heated, becomes less dense and rises setting up a convection current. Solar ponds are designed to impede this process by adding salt to the water until the lower levels become completely saturated.

Use and handling procedure of solar panels —

Uses - There are many applications for the use of solar panels or photovoltaics. It can first be used in agriculture as a power source for irrigation. In health care solar panels can be used to refrigerate medical supplies. It can also be used for infrastructure. PV modules are used in photovoltaic systems and include a large variety of electric devices:

- * Photovoltaic power stations.
- * Rooftop solar PV systems
- * Standalone PV systems
- * Solar hybrid power systems
- * Concentrated Photovoltaics
- * Solar planes
- * Solar powered water purification
- * Solar pumped lasers
- * Solar vehicles
- * Solar panels on spacecrafts and space stations.

solar power generation system

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Batteries - Except the grid-connected system, all other solar energy power generation systems use batteries to store the energy generated from solar panels. Since the amount of solar power generated depends on the strength of the sunlight, batteries provide a constant source of power supply once it is fully charged. Mostly lead acid batteries are used in solar electric systems. Like solar panels, batteries can be connected together to form a battery bank. These can be connected either series or parallel as similar to solar panels to achieve desired voltage, current and power ratings. The type of battery chosen depends on the energy requirements of a system and its budget.

Controller - It regulates the flow of current into & out of the battery. If the generated current overcharges

the battery, it leads to the damage in the battery. Hence, the Solar Controller prevents the batteries to undergo these conditions.

Inverter:- The electricity generated from the Solar panels is a Direct Current (DC) whereas the most electrical appliances work on Alternating Current (AC) & hence a Converter is needed to convert DC to AC, nothing but an inverter. As a recent invention, most individual Solar panel are connected with micro inverter that provide a high AC Voltage. These are suitable only for grid-connected system and are not suitable with battery backup system.

Different Types of Solar Electric System:-
There are different Configuration of Solar Electric system & are Discussed below.