

PROFESSIONAL TRAINING REPORT

at

Sathyabama Institute of Science and Technology

(Deemed to be University)

BY

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS

SCHOOL OF ELECTRICAL AND ELECTRONICS

SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY

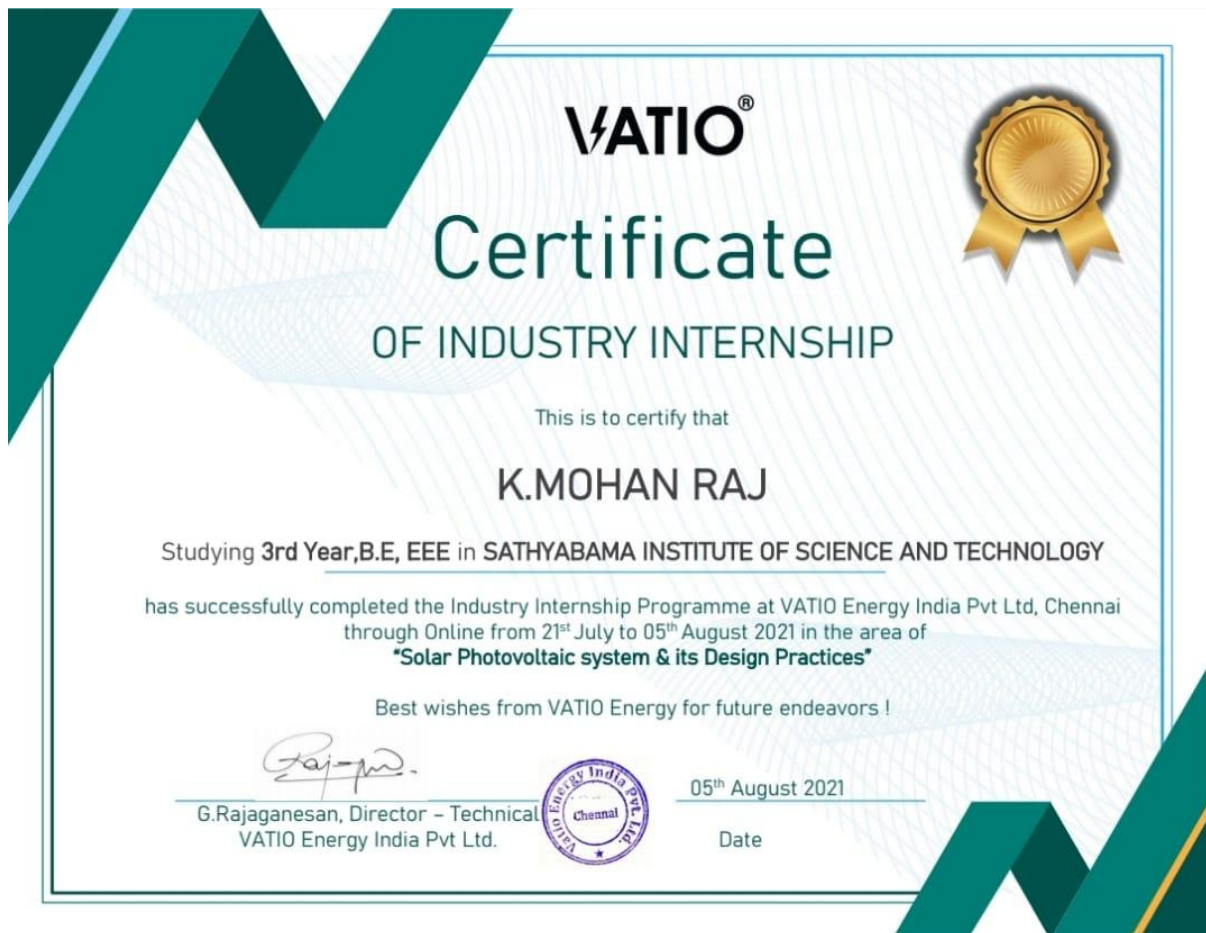
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VATIO ENERGY INDIA PRIVATE LIMITED

VATIO Energy is an efficiency-driven entrepreneurship inspired by a vision of creating a greener tomorrow by harnessing the power of solar energy. In doing so, we seek to improve our customers' daily lives by significantly reducing your electricity bills.

VATIO has provided solar panels and inverters to large corporations and government agencies, and has also helped thousands of individual homeowners with tailor-made solar and energy system.



PHOTOVOLTALIC SYSTEM



Photovoltaics directly convert **solar energy into electricity**. They work on the principle of the photovoltaic effect. When certain materials are exposed to light, they absorb photons and release free electrons. This phenomenon is called as the photoelectric effect. Photovoltaic effect is a method of producing direct current electricity based on the principle of the photoelectric effect.

Based on the principle of photovoltaic effect, solar cells or photovoltaic cells are made. They convert sunlight into direct current (DC) electricity. But, a single photovoltaic cell does not produce enough amount of electricity. Therefore, a number of photovoltaic cells are mounted on a supporting frame and are electrically connected to each other to form a photovoltaic module or **solar panel**. Commonly available solar panels range from several hundred watts (say 100 watts) up to few kilowatts (ever heard of a 5kW solar panel?). They are available in different sizes and different price ranges. Solar panels or modules are designed to supply electric power at a certain voltage (say 12v), but the current they produce is directly dependent on the incident light. As of now it is clear that photovoltaic modules produce DC electricity. But, for most of the times we require AC power and, hence, **solar power system** consists of an inverter too.

How Solar Power Works?

Electrical energy can be harvested from solar power by means of either photovoltaics or concentrated solar power systems.

Photovoltaic Solar Power System

According to the requirement of power, multiple photovoltaic modules are electrically connected together to form a PV array and to achieve more power. There are different types of PV systems according to their implementation.

- PV direct systems: These systems supply the load only when the Sun is shining. There is no storage of power generated and, hence, batteries are absent. An inverter may or may not be used depending on the type of load.
- Off-grid systems: This type of system is commonly used at locations where power from the grid is not available or not reliable. An off-grid solar power system is not connected to any electric grid. It consists solar panel arrays, storage batteries and inverter circuits.
- Grid connected systems: These solar power systems are tied with grids so that the excess required power can be accessed from the grid. They may or may not be backed by batteries.

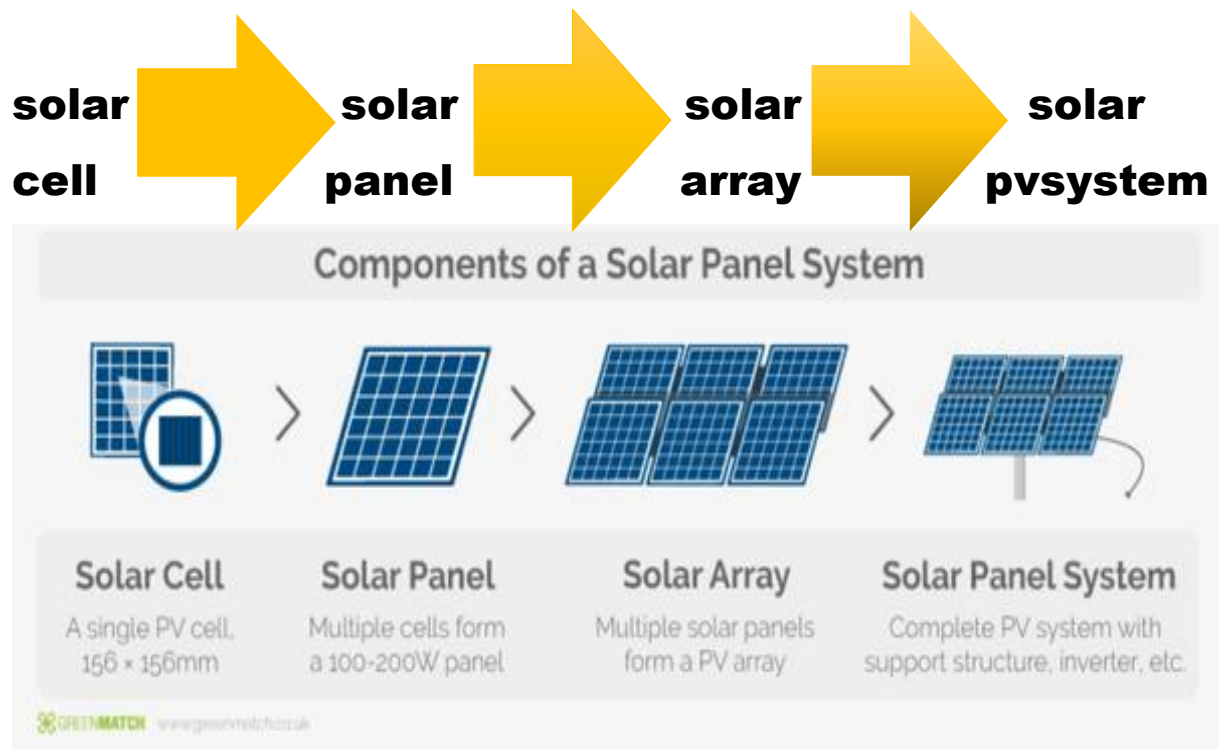
SOLAR ENERGY



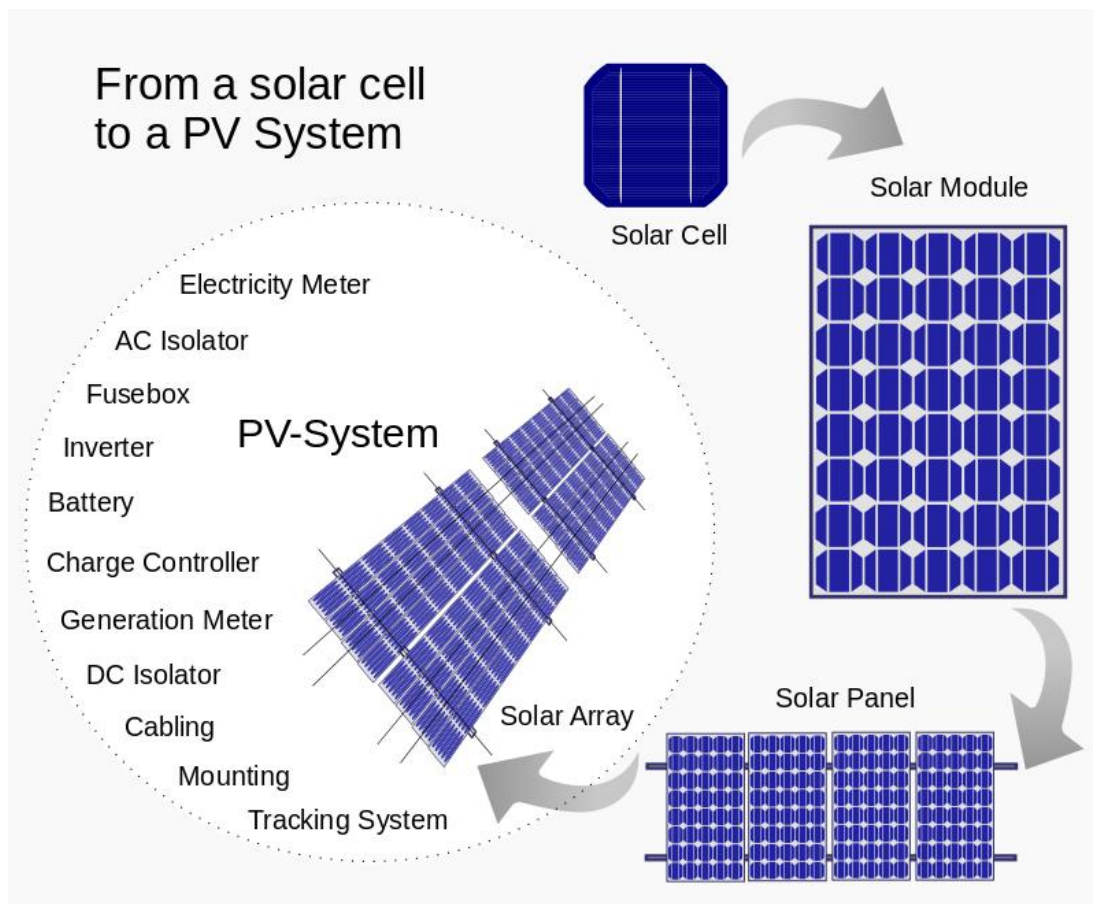
Solar energy is **the transformation of heat**, the energy that comes from the sun. It has been used for thousands of years in many different ways by

people all over the world. The oldest uses of solar energy is for heating, cooking, and drying.

COMPONENTS OF SOLAR PANEL SYSTEM

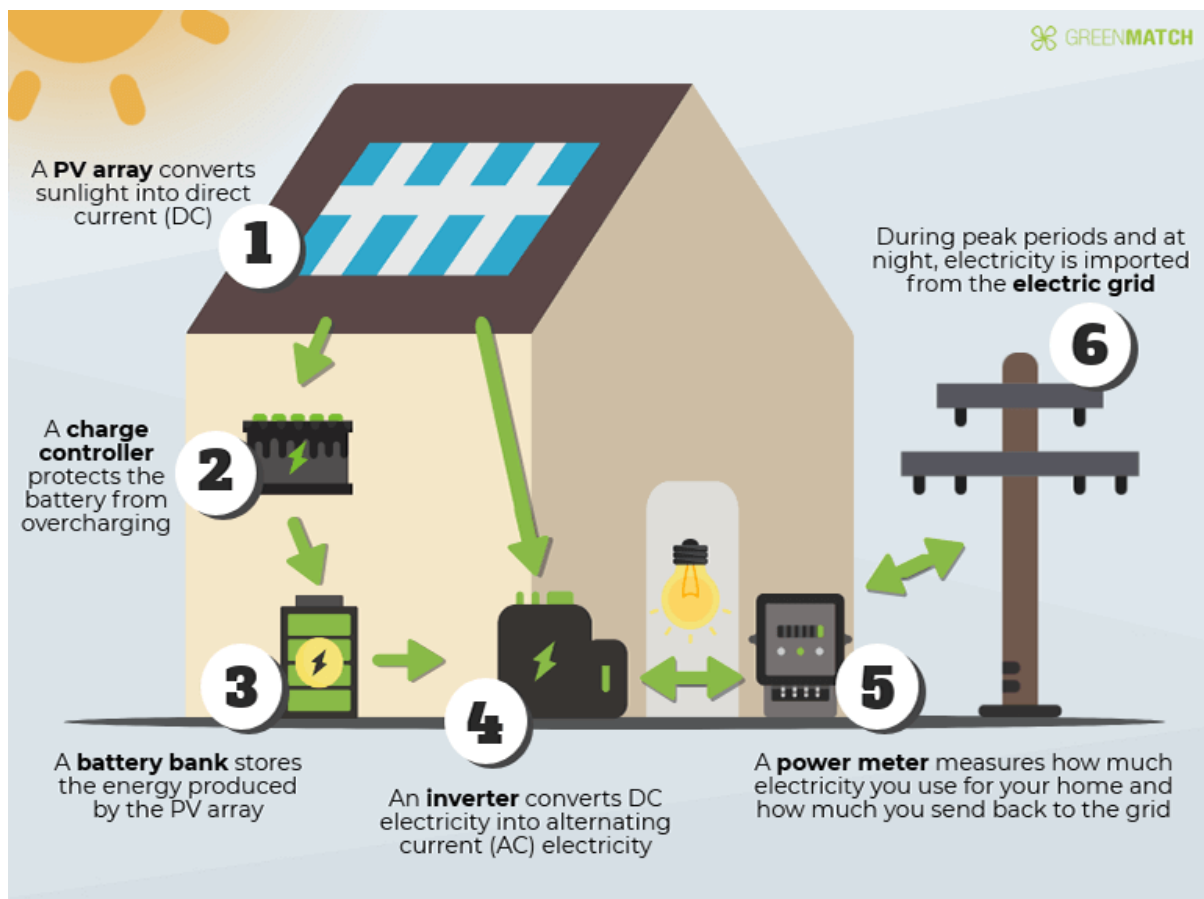


SOLAR CELL TO PV:



➤ OTHER COMPONENTS OF PHOTOVOLTAIC SYSTEM

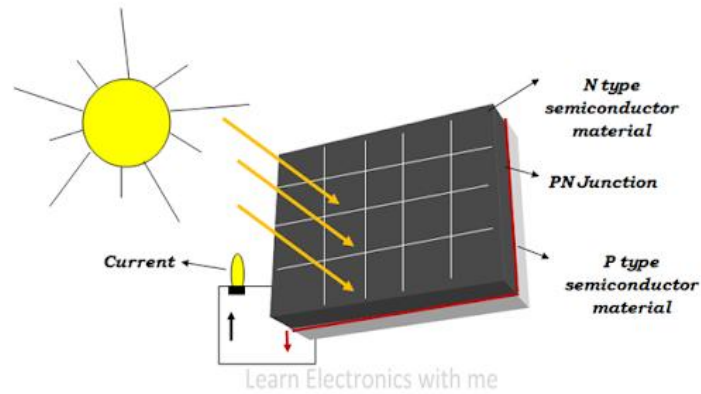
- *Cabling*
- *Tracker*
- *Inverter*
- *Battery*
- *Monitoringmetering*



What is Solar cell?

Solar cell is also called as photovoltaic cell and this is a device which converts light energy into electrical energy by using photovoltaic effect. Solar cell is basically a normal PN Junction diode.

Construction of Solar cell:



Construction of Solar cell

It consists of N type and P type semiconductor material. N type is highly doped and P type is lightly doped. Top and bottom is of conducting electrode to collect the current. The bottom is fully covered with the conductive layer and top layer is not fully covered because the sun rays should not be fully blocked. Since semiconductors are reflective in nature, antireflective coating is used. The whole arrangement is kept inside a thin glass to avoid mechanical shock.

Applications of Solar cell:

- i. It is used in calculators and in wrist watches
- ii. Used in storage batteries
- iii. Street lights
- iv. Portable power supplies
- v. Satellites

Advantages of Solar cell:

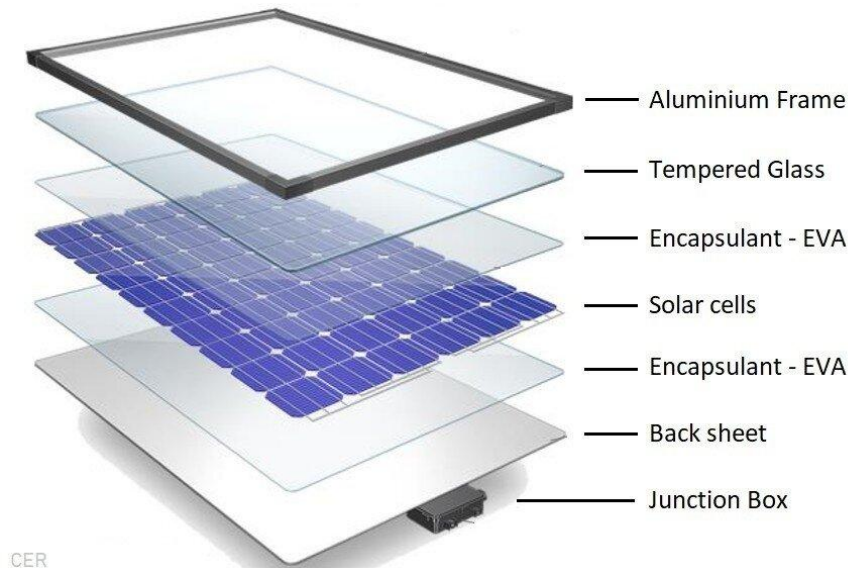
- i. It is very easy to operate compare to other power sources of renewable type.
- ii. It does not produce any noise as it does not have any moving parts.
- iii. It does not generate emissions or radiations.
- iv. It does not require fuels or water to produce electricity.

Disadvantages of Solar cell:

- i. It can not be used in absence of the light from any source.

- ii. It incurs very high initial cost for installation.
- iii. During cloudy weather, less power is being generated.
- iv. Very large geographical area is needed in order to deploy solar panels or cells

SOLAR PANEL



A **solar cell panel**, **solar electric panel**, **photo-voltaic (PV) module** or just **solar panel** is an assembly of photo-voltaic cells mounted in a framework for installation. Solar panels use sunlight as a source of energy to generate direct current electricity. A collection of PV modules is called a PV panel, and a system of PV panels is called an *array*. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

How Are Solar Panels Made?

Solar panels are made using the six main components described in detail below and assembled in advanced manufacturing facilities with extreme accuracy. In this article we will focus on panels made using **crystalline silicon solar cells** since these are by far the most common and best performing solar technology available today. There are other solar PV technologies available such as thin film and screen printed cells, but we will not be discussing these as they have limited use or are still in development.

Six Main Components Of A Solar Panel

I. Solar photovoltaic cells

- II. **Toughened Glass - 3 to 3.5mm thick**
- III. **Extruded Aluminium frame**
- IV. **Encapsulation - EVA film layers**
- V. **Polymer rear back-sheet**
- VI. **Junction box - diodes and connectors**

Many well known solar panel manufacturers are '**vertically integrated**' which means the one company supplies and manufactures all the main components including the silicon ingots and wafers used to make the solar PV cells. However many panel manufacturers assemble solar panels using externally sourced parts including cells, polymer back sheet and encapsulation EVA material. These manufacturers can be more selective about which components they chose but they do not always have control over the quality of the products so they should be sure they use the best suppliers available.

Solar array



A **photovoltaic array** is a linked collection of **photovoltaic modules**, one of which is shown in the picture to the right. Each photovoltaic (PV) module is made of multiple interconnected **PV cells**. The cells convert solar energy into direct-current electricity.

Applications of a Solar Array

- A solar array harnesses solar power that can be used for solar heating, electrical power generation, lighting of spaces, etc. in homes, offices, malls, factories, industrial setups, etc.
- When used with solar thermal collectors or hot water panels, solar arrays are useful for generating hot water that can be used in light industrial applications and domestic spaces.

- An energy system backed by a solar array can be used in building design and architecture for ventilation and heat control. This is possible in case of passive and active solar designs alike.
- Large sized solar arrays are useful for powering solar satellites, updraft towers, large-scale renewable energy systems, industrial units and processes, etc.

What Factors Affect Solar PV System Efficiency

It is important to note that the process of producing electricity from solar energy is not 100% efficient. Environmental factors—such as temperature, soiling, and shading—as well as losses in the electrical components, can affect the efficiency of a PV system. Typical loss categories include:

Temperature: Solar panel efficiency varies with temperature. High temperatures have a negative impact on performance.

Soiling: Material that accumulates on the surface of PV panels can block light from reaching the solar cells, thereby reducing the generated power. The power loss due to soiling is highly variable, depending on the type of soiling (such as dust or snow), and how frequently the panel is cleaned.



Soiling, such as dust, on PV modules reduces power output.

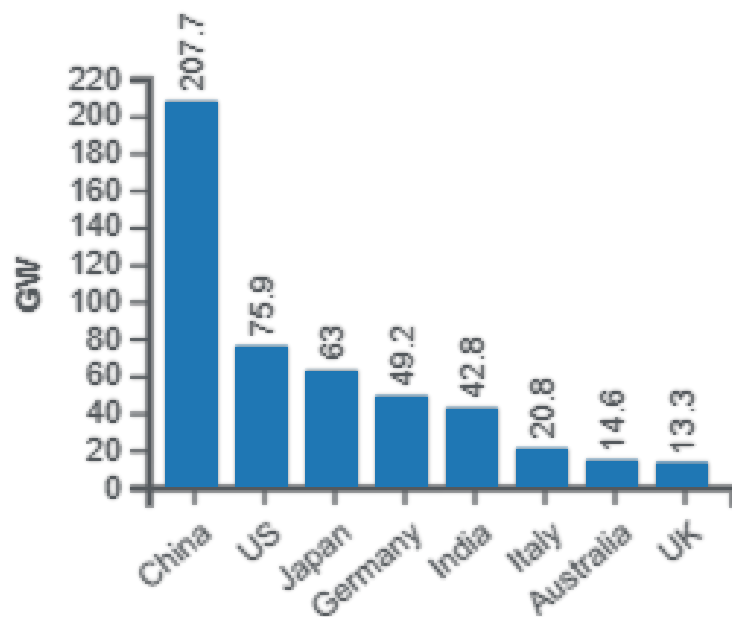
- **Shading:** Shading is the obstruction of irradiance due to trees, buildings, terrain, and other objects in the environment. The effect of shading on the power output of a solar installation is highly variable. (To learn more about the causes and consequences of shading, this article and this section of our PV system losses series are great resources.)

- **Wiring and connections:** Resistance in the electrical connections of a solar installation typically results in energy losses of a few percent.
- **Mismatch:** Due to manufacturing variations, modules of the same type can have slightly different electrical characteristics. This mismatch between modules can lead to a performance loss.
- **Inverter Efficiency:** Converting DC into AC current via an inverter is typically around 96-97% efficient. Inverters typically have higher efficiency when the DC input power is high. The conversion efficiency takes a big hit when the input power is much less than the inverter's rated power.
- **Age:** Solar panels produce less energy the older they get. Typically the decrease in performance is assumed to be around 0.5% per year.

Solar power in India

Solar power in India is a fast developing industry as part of the renewable energy in India. The country's solar installed capacity was 44.3 GW as of 31 August 2021.

The Indian government had an initial target of 20 GW capacity for 2022, which was achieved four years ahead of schedule. In 2015 the target was raised to 100 GW of solar capacity (including 40 GW from rooftop solar) by 2022, targeting an investment of US\$100 billion. India has established nearly 42 solar parks to make land available to the promoters of solar plants. The Ministry of New and Renewable Energy had stated that a further 36.03 GW (as of January 31, 2021) of solar projects are under various stages of implementation and 23.87 GW are in the tendering process.



Electricity generation

Year	Solar power generation (TWh)
2016–17	12.09
2017–18	25.87
2018–19	39.27
2019–20	50.13

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