SOLAR ENERGY – The Prime and fastest growing pillar of Renewable Energy

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1. Renewable Energy: Renewable Energy is energy from sources that are naturally replenishing but flow-limited; renewable resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time.

The Major Types of Renewable Energy sources are

- Solar energy is the radiant light and heat from the sun that has been harnessed by humans since ancient times using a range of ever-evolving technologies.
- Wind energy harnesses the kinetic energy of moving air by using large wind turbines located on land (onshore) or in sea- or freshwater (offshore). Wind energy has been used for millennia, but onshore and offshore wind energy technologies have evolved over the last few years to maximize the generation of electricity with taller turbines and larger rotor diameters.
- Biomass is renewable organic material that comes from plants and animals Biomass has been in use since people first began burning wood to cook food and keep warm. Wood is still the largest biomass energy resource today .
- Geothermal energy is the heat produced deep in the Earth's core. (Geo means "earth," and thermal means "heat" in Greek.) Geothermal energy is a clean, renewable resource that can be harnessed for use as heat and electricity.
- Hydropower, electricity produced from generators driven by turbines that convert the potential energy of falling or fast-flowing water into mechanical energy.

2. Why Renewable Energy!

- **Renewable energy sources are all around us**
  About 80 percent of the global population lives in countries that are net-importers of fossil fuels -- that's about 6 billion people who are dependent on fossil fuels from other countries, which makes them vulnerable to geopolitical shocks and crises.

  In contrast, renewable energy sources are available in all countries, and their potential is yet to be fully harnessed. The International Renewable Energy Agency (IRENA) estimates that 90 percent of the world's electricity can and should come from renewable energy by 2050.

- **Renewable energy is cheaper**
  Renewable energy actually is the cheapest power option in most parts of the world today. Prices for renewable energy technologies are dropping rapidly. The cost of electricity from solar power fell by 85 percent between 2010 and 2020. Costs of onshore and offshorewind energy fell by 56 percent and 48 percent respectively.

- **Renewable energy is healthier**
  According to the World Health Organization (WHO), about 99 percent of people in the world breathe air that exceeds air quality limits and threatens their health, and more than 13 million deaths around the world each year are due to avoidable environmental causes, including air pollution. Switching to clean sources of energy, such as wind and solar, thus helps address not only climate change but also air pollution and health.

- **Renewable energy creates jobs**
  Every investment in renewables creates three times more jobs than in the fossil fuel industry. The IEA estimates that the transition towards net-zero emissions will lead to an overall increase in energy sector jobs: while about 5 million jobs in fossil fuel production could be lost by 2030, an estimated 14 million new jobs would be created in clean energy, resulting in a net gain of 9 million jobs.

3. The Paris Agreement – To achieve net zero CO2 emission:

It is a landmark in the multilateral climate change process because, for the first time, a binding agreement brings all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects. India has updated its stand to adopt a climate friendly and a cleaner path than the one followed hitherto by others at corresponding level of economic development, to reduce Emissions Intensity of its GDP by 45 percent by 2030, from 2005 level and To achieve about 50 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030.

4. SOLAR ENERGY

- Solar PV and wind are set to contribute two-thirds of renewables growth. China alone should account for almost half of the global increase in renewable electricity in 2021, followed by the United States, the European Union and India.
- 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
- China is the leading country in terms of renewable energy. It has installed capacity of more than 1020 GW.
- India stood 4th in terms of renewable energy with installed capacity of more than 147 GW.

5. SOLAR CELL: It is a photovoltaic device that converts the light energy into electrical energy based on the principle of photovoltaic effect.

Photovoltaic Effect: A Built-in-potential barrier in the cell acts on these electrons to produce a voltage (the so-called photo voltage), which can be used to drive a current through a circuit.

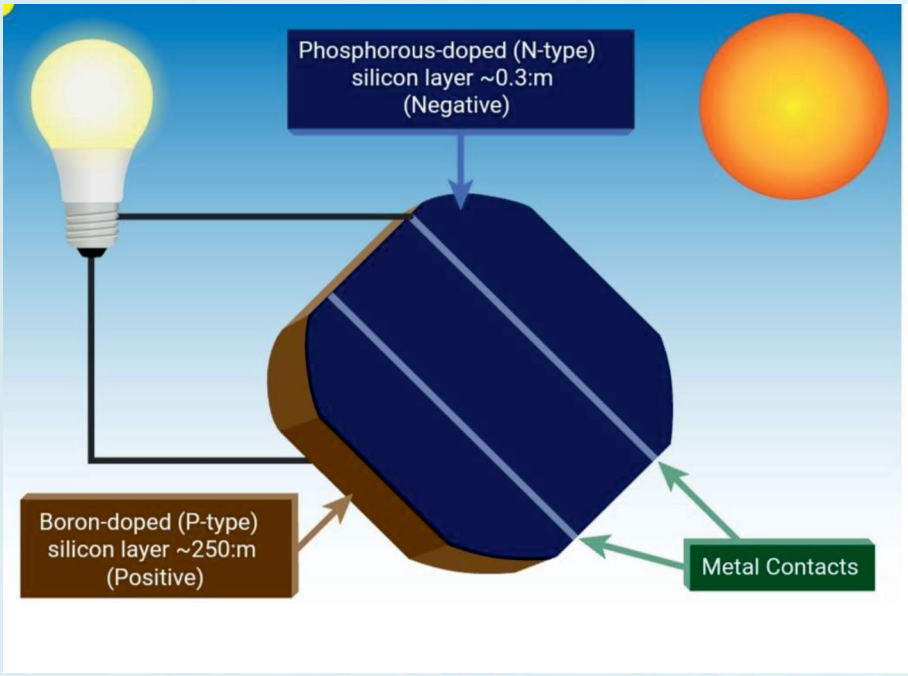

Fig 1: Diagram of a Photovoltaic cell

There are three Generation of solar cell.

1st Gen Solar cell - consist of large-area, high quality and single junction devices.

- Ex: Silicon Wafer based solar cell.

2nd Gen Solar cell - developed to address energy requirements and production costs of solar cells.

- Ex: Thin-film solar cell technology.

3rd Gen Solar cell - developed to address production costs and efficiency of solar cell.

- Ex: Advanced thin-film solar cell technology.

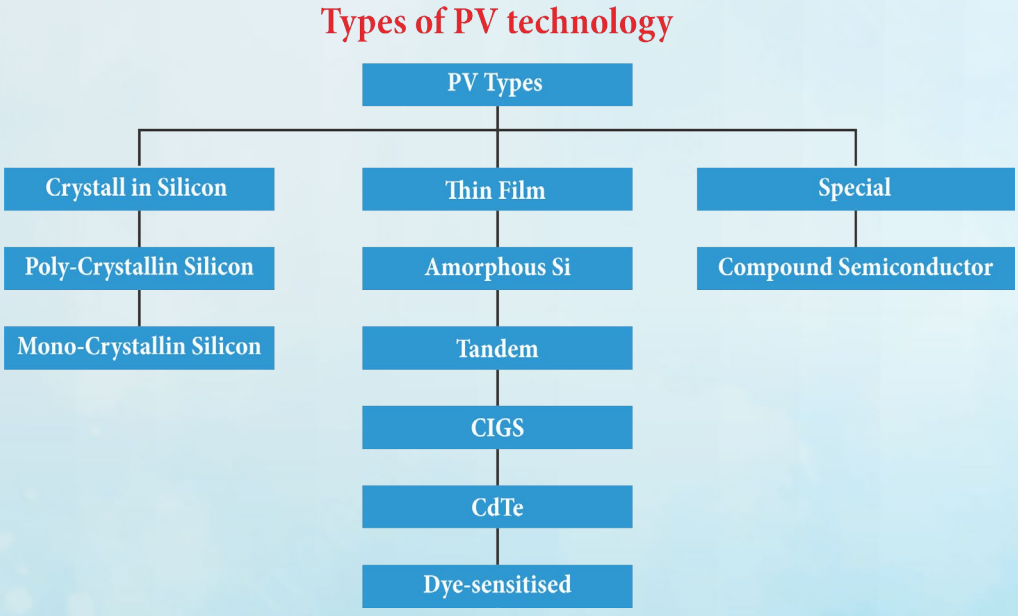

Fig 2: Types of PV Technology

Conversion Efficiency of Technology

Technology	Conversion Efficiency
Mono – crystalline silicon	12.5 -15%
Poly – crystalline silicon	11-14%
Copper indium gallium selenide	10-13%
Cadmium Telluride	9-12%
Amorphous silicon	5-7%

Cells, Modules and Array

- Photovoltaic cells are connected electrically in series and/or parallel circuits to produce higher voltages, currents and power levels.
- Photovoltaic modules consist of PV cell circuits and are the fundamental building blocks of PV Systems.
- Photovoltaic panels include one or more PV modules assembled as a pre-wired, field-installable unit.
- A photovoltaic array is the complete power-generating unit, consisting of any number of PV modules and panels.

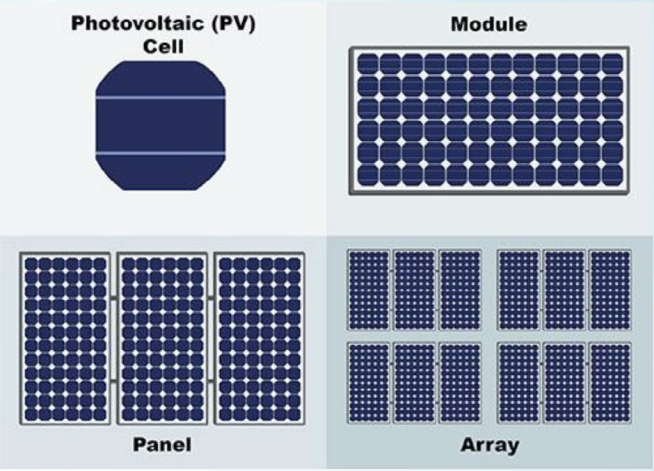

Fig 3: Different Elements of Solar System

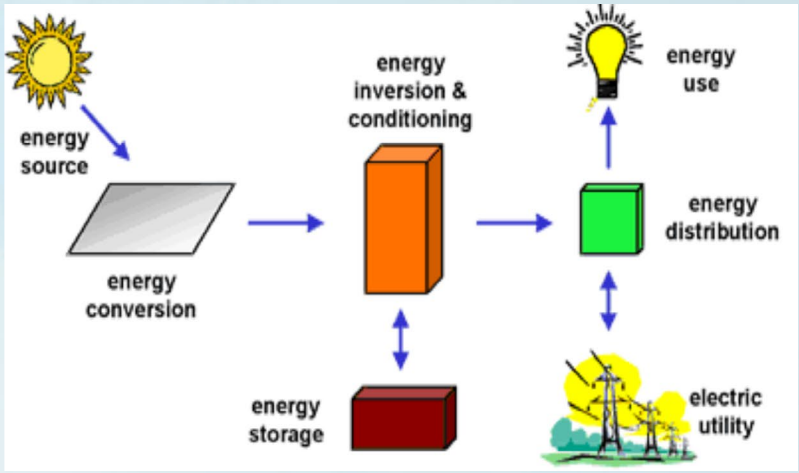

Fig 4: Operational Diagram of PV system

Advantages of solar cell.

- Can be used for either centralized or distributed power generation.
- PV systems have no moving part.
- Energy independence and environmental compatible.
- The fuel (sunlight) is free, and no noise or pollution is created from operating PV systems.
- Minimal maintenance and have long servicelifetime.

Disadvantages of solar cell.

- High cost.
- More surface area requirement.
- Efficiency depends upon availability of sunlight.

6. Conclusion

Renewable capacity expansion in the next five years will be much faster than what was expected just a year ago. Over 2022-2027, renewables are seen growing by almost 2400 GW in the main forecast by IEA, equal to the entire installed power capacity of China today. That is an 85% acceleration from the previous five years, and almost 30% higher than what was forecast in last year's report, making it our largest ever upward revision. Renewables are set to account for over 90% of global electricity capacity expansion over the forecast period. The upward revision is mainly driven by China, the European Union, the United States and India, which are all implementing existing policies and regulatory and market reforms, while also introducing new ones more quickly than expected in reaction to the energy crisis.

Solar PV has been the fastest growing technology by capacity additions in recent years; however, even the record 150 GW added in 2021 is only about one-third of the average annual additions during 2022-2030 in the Net Zero Scenario milestones.The number of households relying on solar PV grows from 25 million today to more than 100 million by 2030 in the Net Zero Emissions by 2050 Scenario (NZE Scenario). At least 190 GW will be installed from 2022 each year and this number will continue to rise due to increased competitiveness of PV and the growing appetite for clean energy sources.