1. Renewable Energy in India

- India stands **4th globally in Renewable Energy Installed Capacity** (including Large Hydro), **4th in Wind Power capacity** and **4th in Solar Power capacity** (as per REN21 Renewables 2022 Global Status Report).
- The country has set an enhanced target at the COP26 of **500 GW of non-fossil fuel-based energy by 2030.** This has been a key pledge under the Panchamrit (climate commitments by India). This is the world's largest expansion plan in renewable energy.
- India's installed non-fossil fuel capacity has **increased 396% in the last 8.5 years** and stands at more than 179.322 Giga Watts (including large Hydro and nuclear), **about 43% of the country's total capacity** (as of July 2023).

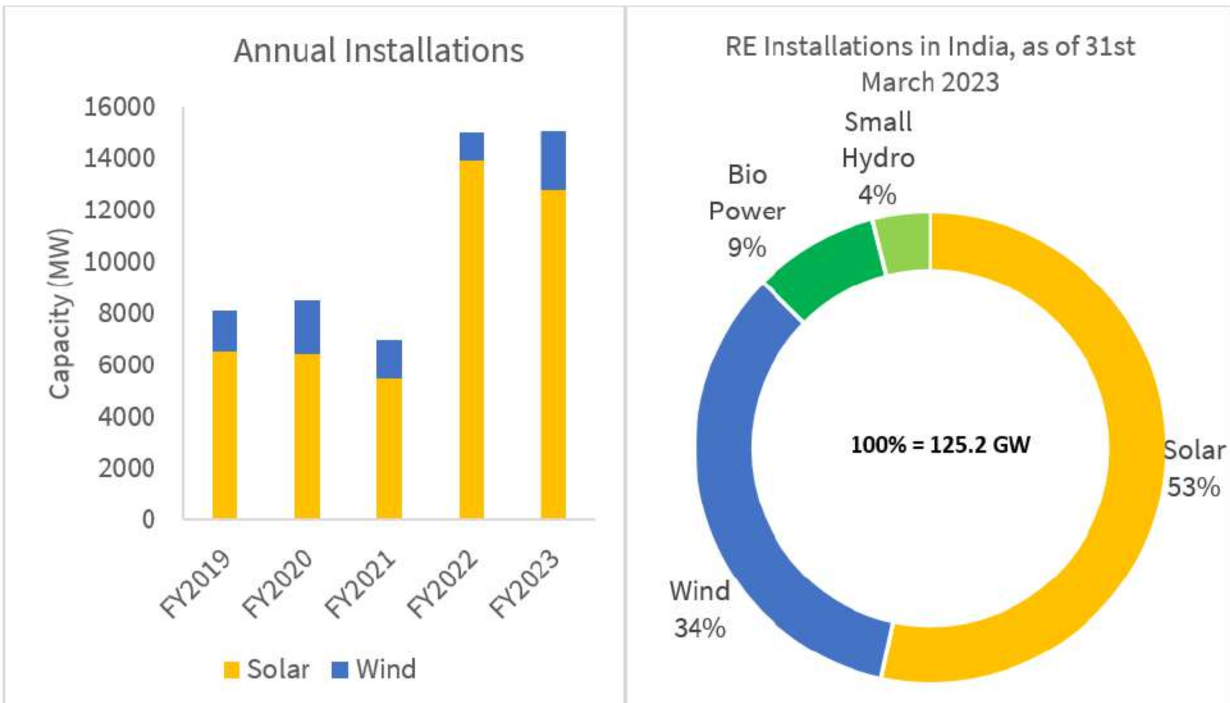

Figure.1. Renewable Energy in India

- India saw the highest year-on-year growth in renewable energy additions of 9.83% in 2022. The installed **solar energy capacity has increased by 24.4 times** in the last 9 years and stands at 67.07 GW as of July 2023.
- **Up to 100% FDI** is allowed under the automatic route for renewable energy generation and distribution projects subject to provisions of The Electricity Act 2003.
- India is the market with the fastest growth in renewable electricity, and **by 2026, new capacity additions are expected to double.**
- As per the Central Electricity Authority (CEA) estimates, by 2029-30, the **share of renewable energy generation would increase from 18% to 44%,** while that of thermal power is expected to reduce from 78% to 52%.

1.1. Energy Capacity

- India has a total renewable **energy capacity of 168.96 GW** (as on 28th February 2023) with about 82 GW at various stages of implementation and about 41 GW under tendering stage. This includes 64.38 GW Solar Power, 51.79 GW Hydro Power, 42.02 GW Wind Power and 10.77 GW Bio Power.
- India has set a target to reduce the carbon intensity of the nation's economy by less than 45% by the end of the decade, achieve 50 percent cumulative electric power installed by 2030 from renewables, and achieve **net-zero carbon emissions by 2070.**
- 57 solar parks with an aggregate capacity of 39.28 GW have been approved in India. Wind Energy has an off-shore target of 30 GW by 2030, with potential sites identified.

2. Nuclear Energy

- Nuclear energy is a form of energy **released from the nucleus,** the core of atoms, made up of protons and neutrons.
- This source of energy can be produced in two ways: **fission** – when nuclei of atoms split into several parts – or **fusion** – when nuclei fuse together.

2.1. Types of Nuclear Reactions: Fission and Fusion

2.1.1. Nuclear Fission

- In 1938, German scientists **Otto Hahn and Fritz Strassman** discovered that when a uranium nucleus is bombarded with a neutron, it breaks up into two fragments of comparable masses with the release of energy.
- The process of **breaking up the nucleus of a heavier atom into two fragments** with the **release of a large amount of energy** is called nuclear fission. The fission is accompanied by the release of neutrons. The fission reactions with ${}_{92}U^{235}$ are represented as:
    - ${}_{92}U^{235} + {}_{0}n^{1} \rightarrow {}_{56}Ba^{141} + {}_{36}Kr^{92} + 3\ {}_{0}n^{1}$ + Energy

2.1.1.1. Chain Reaction

- Consider a neutron causing fission in a uranium nucleus producing three neutrons. The three neutrons in turn may cause fission in three uranium nuclei producing nine neutrons. These nine neutrons in turn may produce twenty seven neutrons and so on.
- A chain reaction is a **self propagating process** in which the **number of neutrons goes on multiplying** rapidly almost in a geometrical progression.
- Two types of chain reactions are possible:
    - In the **uncontrolled chain reaction,** the **number of neutrons multiply indefinitely** and the entire amount of energy is released within a fraction of a second. This type of chain reaction takes place in atom bombs.
    - In the **controlled chain reaction,** the number of **fission producing neutrons is kept constant** and is always equal to one. The reaction is sustained in a controlled manner. Controlled chain reaction takes place in a nuclear reactor.
- When a thermal neutron bombards the U^{235} nucleus, it breaks into two fission fragments and three fast neutrons. One neutron may escape and one neutron may be captured by U^{238} which decays to Np^{239} (Neptunium-239) and then to Pu^{239} (Plutonium-239). One neutron is available for carrying out chain reactions.

- The chain reaction is possible, only when the loss of neutrons is less than the neutrons produced.

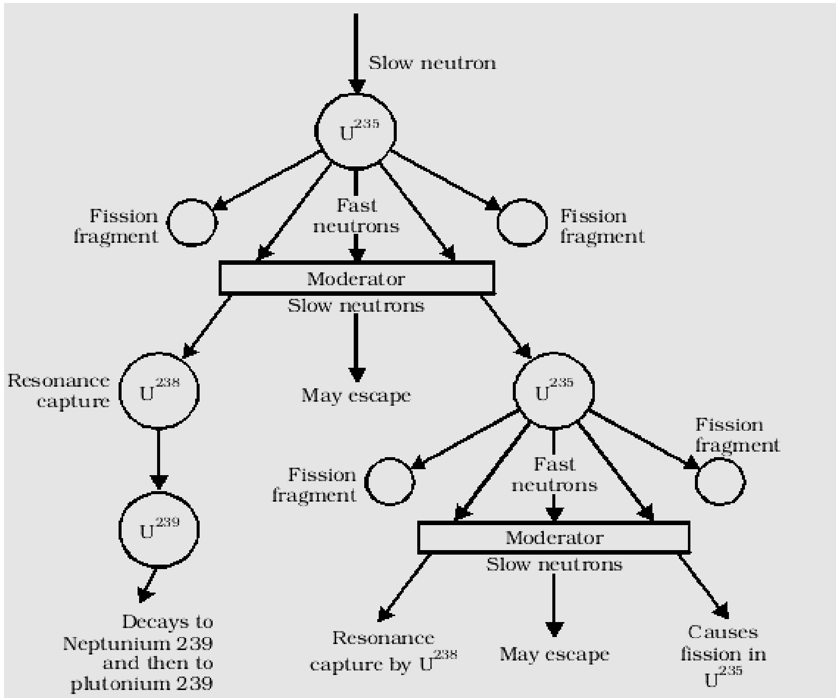

Figure.2. Controlled Chain Reaction

2.1.1.2. Nuclear Reactor

- A nuclear reactor is a device in which the nuclear fission reaction takes place in a self sustained and controlled manner. The **first nuclear reactor was built in 1942 at Chicago, USA.**
- Depending on the purpose for which the reactors are used, they may be classified into research reactors, production reactors and power reactors.
- Research reactors are used primarily to supply neutrons for research purposes and for production of radio-isotopes. The purpose of production reactors is to convert fertile (non-fissile but abundant) material into fissile material.
- The power reactor converts nuclear fission energy into electric power. The power reactors can be further classified into boiling water reactor, pressurized water reactor, pressurized heavy water reactor and fast breeder reactor depending upon the choice of the moderator and the coolant used.
- Numerous reactors of different designs have been constructed all over the world for a variety of purposes, but there exists a number of general features common to all the reactors.

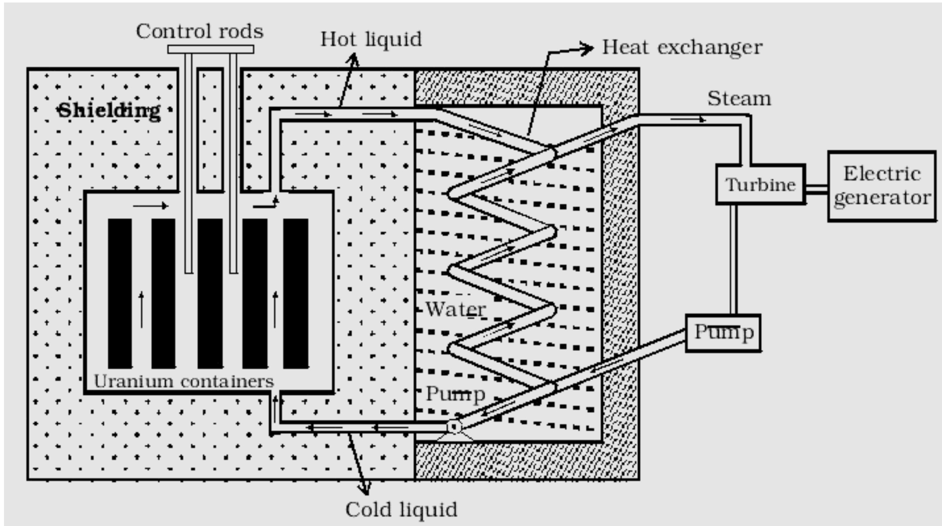

Figure.3. Schematic Design of a Nuclear Reactor

Fissile Material

- The fissile material or nuclear fuel generally used is $_{92}U^{235}$. But this exists only in a small amount (0.7%) in natural uranium.
- **Natural uranium is enriched with more** $_{92}U^{235}$ (2 – 5%) and this low enriched uranium is used as fuel in some reactors. Other than $_{92}U^{235}$, the fissile isotopes U^{233} and Pu^{239} are also used as fuel in some of the reactors.
- In the pressurized heavy water reactors (PHWR) built in India, natural uranium oxide is used as fuel. Tiny pellets of uranium oxide are packed in thin tubes of zirconium alloy and sealed to form a fuel rod. Nineteen such rods are tied together to form a fuel bundle.
- The reactor vessel which goes by the name 'Calandria' has about three hundred tubes passing through it. The fuel bundles are placed in these tubes. The part of the reactor vessel which contains the fuel rods is known as reactor core.

Moderator

- The function of a moderator is to **slow down fast neutrons** produced in the fission process. Ordinary water and heavy water are the commonly used moderators.
- A good moderator slows down neutrons by elastic collisions and it does not remove them by absorption. The moderator is present in the space between the fuel rods in a channel. Graphite is also used as a moderator in some countries.
- In fast breeder reactors, the fission chain reaction is sustained by fast neutrons and hence no moderator is required.

Neutron source

- A source of neutrons is required to initiate the fission chain reaction for the first time. **A mixture of beryllium with plutonium or radium or polonium** is commonly used as a source of neutrons.

Control Rods

- The control rods are used to control the chain reaction. They are very good absorbers of neutrons. They take up neutrons without fissioning. Lowering them into the reactor core will slow down the reaction.

- They are **held on electromagnetic clamps** so that if there is a dangerous increase in core temperature they can be dropped into the reactor and so shut down the chain reaction.
- The commonly used control rods are made up of elements like boron or cadmium. By pushing them in or pulling out, the reaction rate can be controlled.

Cooling System

- The cooling system removes the heat generated in the reactor core. Ordinary water, heavy water and liquid sodium are the commonly used coolants. **A good coolant must possess a large specific heat capacity and high boiling point.**
- The coolant passes through the tubes containing the fuel bundle and carries the heat from the fuel rods to the steam generator through heat exchanger. The steam runs the turbines to produce electricity in power reactors.
- The coolant and the moderator are the same in the PHWR and PWR. In fast breeder reactors, liquid sodium is used as the coolant. A high temperature is produced in the reactor core of the fast breeder reactors.
- Sodium is solid at room temperature but liquefies at 98°C. It has a wide working temperature since it does not boil until 892°C.
- That brackets the range of operating temperatures for the reactor so that it does not need to be pressurized as does a water-steam coolant system. It has a large specific heat so that it is an efficient heat-transfer fluid.

Neutron Reflectors

- Neutron reflectors **prevent the leakage of neutrons** to a large extent, by reflecting them back. In pressurized heavy water reactors the moderator itself acts as the reflector.
- In the fast breeder reactors, the reactor core is surrounded by depleted uranium (uranium which contains less than 0.7% of $_{92}U^{235}$) or thorium ($_{90}Th^{232}$) which acts as a neutron reflector. Neutrons escaping from the reactor core convert these materials into Pu^{239} or U^{233} respectively.

Shielding

- As a protection against the harmful radiations, the reactor is surrounded by a concrete wall of thickness about 2 to 2.5 m.

2.1.1.3. Different Types of Nuclear Reactors

Pressurized Water Reactors (PWRs)

- Most common type of Nuclear Reactor deployed to date.
- PWRs use **natural Uranium** as fuel.
- Ordinary water is used as both neutron moderators and coolant. In a PWR, the water used as moderator and primary coolant is separate to the water used to generate steam and to drive a turbine.
- In order to efficiently convert the heat produced by the nuclear reaction into electricity, the water that moderates the neutron and cools the fuel elements is contained at pressures 150 times greater than atmospheric pressure.

Boiling Water Reactors

- These are the second most commonly used types of reactors.
- Ordinary light water is used as both a moderator and coolant, like the PWR.

- However unlike the PWR, in a Boiling Water Reactor there is no separate secondary steam cycle. The water from the reactor is converted into steam and used to directly drive the generator turbine.

High Temperature Gas Cooled Reactors

- High Temperature gas cooled reactors operate at significantly higher temperatures than PWRs.
- They **use a gas as the primary coolant.**
- The nuclear reaction is mostly moderated by carbon.
- These reactors can achieve significantly higher efficiencies than PWRs but the power output per reactor is limited by the less efficient cooling power of the gas.

Heavy Water Reactors

- Heavy Water reactors are similar to PWRs but **use water enriched with the deuterium isotope** of Hydrogen as the moderator and coolant.
- This type of water is called "heavy water" and makes up about 0.022 parts per million of water found on Earth.
- The advantage of using Heavy water as the moderator is that natural, unenriched Uranium can be used to drive the nuclear reactor.

Uranium Fast Breeder Reactors

- These reactors **use the unmoderated "fast" neutrons** directly produced via the fission process.
- These reactors "breed" 239Pu from 238U and so produce more fuel than they consume.
- The use of fast-breeder technology makes it possible to increase the efficiency of Uranium use by over a factor of 50.
- In addition, the excess neutrons can be used to transmute the long-lived transuranic waste from current Nuclear Power reactors to ever-heavier isotopes until they eventually fission. Thus these reactors can be used to "burn" the most troublesome component of nuclear waste.
- This type of reactor is more costly to construct and more difficult to operate than a conventional second-generation Power Reactor.

Thorium Breeder Reactors

- Thorium is an element that is 3 times more abundant than Uranium on earth. It has a single stable isotope 232Th.
- In a nuclear reactor this isotope **can capture a neutron and be converted to 233U.** 233U undergoes fission like 235U and 239Pu.
- However when 233U fissions it releases more neutrons than either 235U or 239Pu.
- Consequently it is possible to construct a breeder reactor that utilizes thermal neutrons to both generate energy and to breed 233U from Thorium given sufficient initial quantities of 233U mixed with 232Th.
- A further advantage of Thorium breeders is that the **amount of transuranic waste is vastly decreased** compared to Uranium or Plutonium based reactors.

2.2.2. Nuclear Fusion

- Nuclear fusion is a process by which nuclear reactions between **light elements form heavier elements** (up to iron).

- In cases where the interacting nuclei belong to elements with low atomic numbers (e.g., hydrogen [atomic number 1] or its isotopes deuterium and tritium), substantial amounts of energy are released.
- Fusion is the process that **powers active stars.** The energy released from nuclear fusion reactions accounted for the longevity of the Sun and other stars as a source of heat and light.
- The prime energy producer in the Sun is the **fusion of hydrogen to form helium.** It takes four hydrogen atoms to fuse into each helium atom. During the process some of the mass is converted into energy.

2.2.2.1. Fusion Reaction

- An important fusion reaction for practical energy generation is that between deuterium and tritium (the D-T fusion reaction). It produces helium (He) and a neutron (n) and is written:
  - $\mathbf{D + T \rightarrow He} + \boldsymbol{n}$
- Fusion reactions between light elements release energy because of the mass difference between the Z protons and N neutrons considered separately and the nucleons bound together (Z + N) in a nucleus of mass M.
- M is less than (Z + N). The mass difference is converted into energy under the equation ($e=mc^2$).

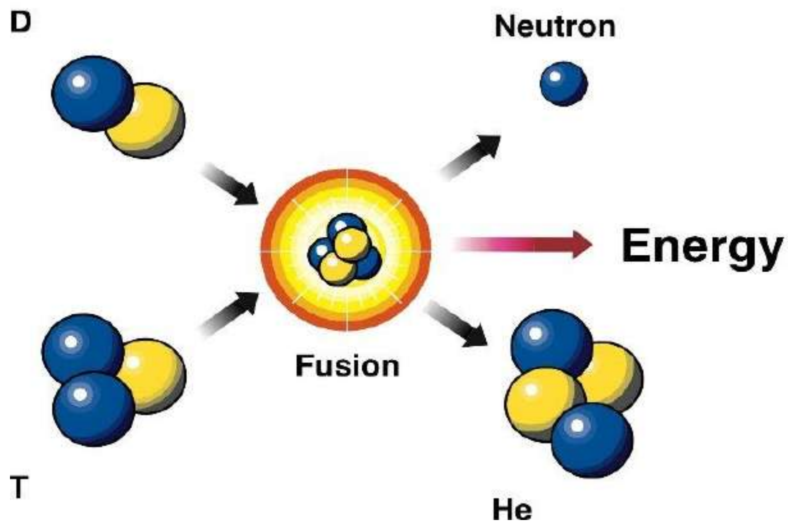

Figure.4. Nuclear Fusion

Two Basic Types of Fusion Reactions

- Those that preserve the number of protons and neutrons: Most important for practical fusion energy production.
- Those that involve a conversion between protons and neutrons: Crucial to the initiation of star burning.

Principle

- Fusion reactions are inhibited by the electrical repulsive force, called the **Coulomb force,** that acts between two positively charged nuclei.

- For fusion to occur, the two nuclei must approach each other at high speed in order to overcome their electrical repulsion and attain a sufficiently small separation (less than one-trillionth of a centimetre) so that the short-range strong force dominates.
- For the production of useful amounts of energy, a large number of nuclei must undergo fusion; that is to say, a gas of fusing nuclei must be produced.
- In a gas at extremely high temperatures, the average nucleus contains sufficient kinetic energy to undergo fusion.
- Such a medium can be produced by heating an ordinary gas beyond the temperature at which electrons are knocked out of their atoms. The result is an ionized gas consisting of free negative electrons and positive nuclei.
- **This ionized gas is in a plasma state,** the fourth state of matter. Most of the matter in the universe is in the plasma state.

2.2.2.2. ITER (International Thermonuclear Experimental Reactor)

- ITER (meaning "the way" or "the path" in Latin) is an international nuclear fusion research and engineering megaproject **aimed at creating energy through a fusion process** similar to that of the Sun.
- It is being built next to the Cadarache facility in southern France.
- It is the **world's largest tokamak,** a magnetic fusion device that has been designed to prove the feasibility of fusion as a large-scale and carbon-free source of energy.
- The primary objective of ITER is the investigation and demonstration of burning plasmas—plasmas in which the energy of the helium nuclei produced by the fusion reactions is enough to maintain the temperature of the plasma, thereby reducing or eliminating the need for external heating.
- ITER will also test the availability and integration of technologies essential for a fusion reactor (such as superconducting magnets, remote maintenance, and systems to exhaust power from the plasma) and the validity of tritium breeding module concepts that would lead in a future reactor to tritium self-sufficiency.
- Thousands of engineers and scientists have contributed to the design of ITER since the idea for an international joint experiment in fusion was first launched in 1985.

ITER Organization

- The ITER Organization is an intergovernmental organization that was **created by an international agreement signed in 2006,** and formally established on 24 October 2007 after its ratification by all Parties.
- The Parties to the ITER Agreement (the ITER Members) are China, the European Union (through Euratom), India, Japan, Korea, Russia and the United States of America (**35 countries** in total).
- The purpose of the ITER Organization is to provide for and promote cooperation among its Members for the benefit of the ITER Project, an international collaboration to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes.
- It acts as the **overall integrator of the project** and nuclear operator of the ITER facility.

What is Tokamak?

- Construction of the ITER complex in France **started in 2013,** and assembly of the tokamak began in 2020.

- The tokamak is an experimental machine **designed to harness the energy of fusion.**
- Inside a tokamak, the energy produced through the fusion of atoms is absorbed as heat in the walls of the vessel. Just like a conventional power plant, a fusion power plant will use this heat to produce steam and then electricity by way of turbines and generators.
- The heart of a tokamak is its doughnut-shaped vacuum chamber. Inside, under the influence of extreme heat and pressure, gaseous hydrogen fuel becomes a plasma—the very environment in which hydrogen atoms can be brought to fuse and yield energy.
- The charged particles of the plasma can be shaped and controlled by the massive magnetic coils placed around the vessel; physicists use this important property to confine the hot plasma away from the vessel walls.
- The term "tokamak" comes to us from a **Russian acronym** that stands for **"toroidal chamber with magnetic coils."**
- First developed by Soviet research in the late 1960s, the tokamak has been adopted around the world as the most promising configuration of magnetic fusion device.

3. Nuclear Energy in India

- Nuclear energy is the **fifth-largest source of electricity** for India which contributes about 3% of the total electricity generation in the country.
- India entered the atomic age, more correctly the nuclear age, on 4th August 1956 when **Apsara, India's first nuclear reactor,** went into operation. This reactor was designed and built by India with the nuclear fuel supplied from the United Kingdom under a lease agreement.
- India's second reactor for research purposes, CIRUS, was built with cooperation with Canada and went into operation in the early 1960's.
- India entered into a collaboration with the former Soviet Union in 1988 to build two 1000 MW reactor power units using enriched uranium as fuel.
- In 1998, India and Russia decided to embark on this project, and work at the site commenced in 2003. The first unit at Kudankulam went into operation in 2014 and the second in 2016.
- India now has 22 reactors in operation (as of 2021), with a combined capacity of 6780 MW. Twelve more reactors are being built.
- In 2021, the government stated in the Parliament that nuclear power generation capacity would increase to 22,480 MW by 2031. This figure was reiterated in the Parliament in 2022.
- The **Nuclear Power Corporation of India Limited,** or NPCIL, is an Indian government-owned corporation with headquarters in Mumbai that is in **charge of producing electricity using nuclear energy.**
- The Department of Atomic Energy (DEA) is responsible for running NPCIL.

3.1. List of Operational Nuclear Power Plants in India

Name	Operational Year	Location	Capacity (MWe)
Kakrapar Atomic Power Station	1993	Gujarat	440

(Kalpakkam) Madras Atomic Power Station	1984	Tamil Nadu	440
Narora Atomic Power Station	1991	Uttar Pradesh	440
Kaiga Nuclear Power Plant	2000	Karnataka	880
Rajasthan Atomic Power Station	1973	Rajasthan	1180
Tarapur Atomic Power Station (oldest nuclear facility)	1969	Maharashtra	1400
Kudankulam Nuclear Power Plant (Largest)	2013	Tamil Nadu	2000

3.2. India's Nuclear Energy Programme

- India's 3 stage Nuclear Power Program was **devised by Dr. Homi J Bhaba,** the father of India's Nuclear program, in 1954.
- The main aim was **to capitalize on India's vase thorium reserves** while accounting for its low uranium reserves.
- India has only about 2% of the global uranium reserves but 25% of the world's thorium reserves.
- The three stages are:
    - Natural uranium fuelled Pressurized Heavy Water Reactors (PWHR)
    - Fast Breeder Reactors (FBRs) utilizing plutonium based fuel
    - Advanced nuclear power systems for utilization of thorium

Stage 1

- The first stage involved **using natural uranium to fuel Pressurized Heavy Water Reactors** to produce electricity and producing plutonium-239 as a byproduct.
    - U-238 → Plutonium-239 + Heat
- Using Pressurized Heavy Water Reactors rather than Light Water Reactors was the best choice for India given its infrastructure. While Pressurized Heavy Water Reactors used unenriched uranium, Light Water Reactors required enriched uranium.
- Also, the components of PWHR could be domestically manufactured in India, as opposed to LWRs, which would need some components to be imported. Furthermore the byproduct plutonium-293 would be used in the second stage.

Stage 2

- The second stage **involves using plutonium-239 to produce mixed-oxide fuel,** which would be used in Fast Breeder Reactors.
- These reactors have two processes. Firstly plutonium 293 undergoes fission to produce energy, and metal oxide is reacted with enriched uranium reacts with mixed-oxide fuel to produce more plutonium-239.
- Furthermore once a sufficient amount of plutonium-239 is built up, thorium will be used in the reactor, to produce Uranium-233. This uranium is crucial for the third stage.

Stage 3

- The main purpose of stage-3 is to achieve a sustainable nuclear fuel cycle. The advanced nuclear system **would use a combination of Uranium-233 and Thorium.** Thus India's vast thorium would be exploited, using a thermal breeder reactor.
- Currently this stage is still in the research stage. Thus India is looking to simultaneously use its thorium in other technologies.
- The options include Accelerator Driven Systems (ADS), Advanced Heavy Water Reactor (AHWR) and Compact High Temperature Reactor (CHTR).

4. Solar Energy

- Solar energy is the most abundant & cleanest energy resource on earth. The amount of solar energy that hits the earth's surface in an hour is almost the same as the amount required by all human activities in a year.
- Solar energy can be used mainly in three ways one is direct conversion of sunlight into electricity through PV cells, the two others being concentrating solar power (CSP) and solar thermal collectors for heating and cooling (SHC).

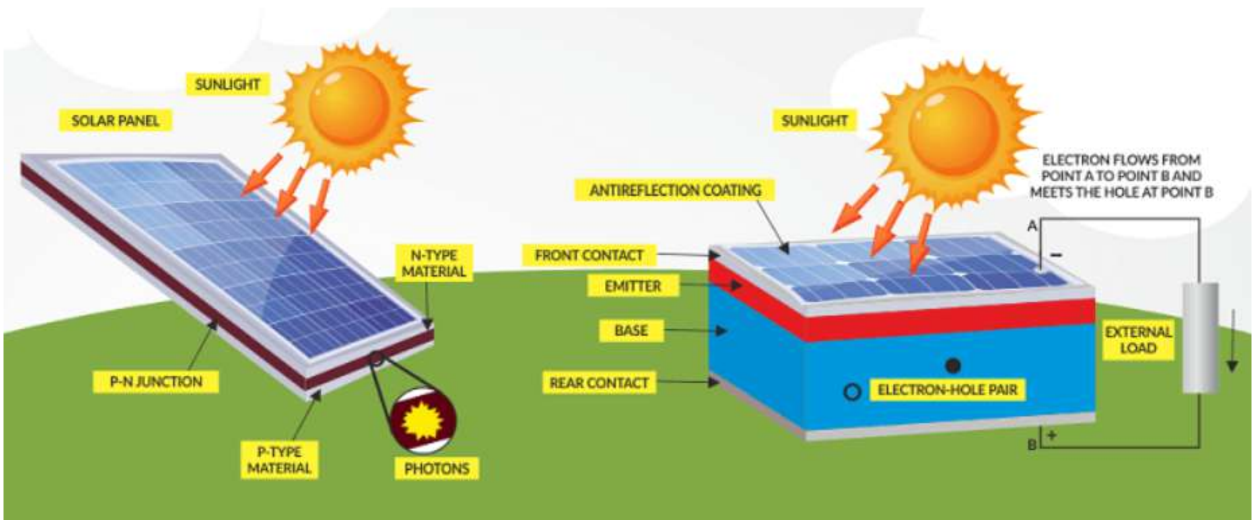

Figure.5. Working of Solar Panels

4.1. Role of Solar Panels

- Solar panels are responsible for generating electricity and in most cases they are located on the roof of any building.
- These solar panels also known as the **modules** are usually southern faced for maximum potential and electricity production.
- Each of these solar panels is made up of a special **layer of silicon cells,** a metal frame, a glassed casing which is further surrounded by special film and wiring.
- For maximum electricity production, the solar panels are **arranged together into "arrays".** Through these solar cells also known as photovoltaic cells, the sunlight is absorbed during the daylight hours.

4.2. Conversion of Absorbed Solar Energy into Electrical Energy

- Installing solar cells or photovoltaic cells is the first initial step to convert solar energy.

- Each Solar cell has a thin semiconductor wafer which is made up of two layers of silicon. Silicon semiconductors **can act as both conductors as well as insulators.**
- One silicon layer is positively charged known as the **N-type** and the other silicon layer is negatively charged known as the **P-type.**
- N-type gives away electrons easily while on the other side P-side semiconductor receives the extra electrons in the electric field. This positive and negative layer hence compliments the formation of an electric field on the solar panel.
- Energy from the sun comes on the earth in the form of **little packets called photons** When the sunlight strikes these photovoltaic cells already forming an electric field, the photons of sunlight startle the electrons inside these cells activating them to start flowing.
- These loose electrons that start flowing on the electric field further create the electric current.
- The electrical energy which we get from the solar energy through the photovoltaic cells is normally known as the Direct current (DC) electricity.
- To convert DC into alternating current (AC) special solar inverters need to be installed. The inverter turns DC electricity to 120 volts AC that can be further put into immediate use for the home appliances.

5. Solar Energy in India

- India is among the Tropical countries which receive ample solar insolation throughout the year. About **5,000 trillion kWh per year energy** is incident over India's land area with most parts receiving 4-7 kWh per sq. m per day.
- India ranks fourth globally in terms of solar power generation. Total solar power capacity installed in the country as on June 30, 2023 is **70.10 GW and in addition, 55.90 GW is under installation.**
- The top seven states in terms of highest installed capacity include Rajasthan (17.83GW), Gujarat (10.13 GW), Karnataka (9.05 GW), Tamil Nadu (6.89 GW), Maharashtra (4.87 GW), Telangana (4.69 GW) and Andhra Pradesh (4.55 GW).
- **National Institute of Solar Energy,** an autonomous institution of MNRE (Ministry of New and Renewable Energy) is the apex institute for research and development in the field of Solar Energy.

5.1. List of Largest Solar Power Plants In India

Sr.No.	Name	Installed Capacity (MW)
1.	Bhadla Solar Park, Rajasthan (world's largest solar park)	2,245
2.	Pavagada Solar Park, Karnataka	2,050
3.	NP Kunta Ultra Mega Solar Park, Andhra Pradesh	1500
4.	Kurnool Ultra Mega Solar Park, Andhra Pradesh	1,000
5.	Rewa Ultra Mega Solar, Madhya Pradesh	750

5.2. Government Schemes, Policies and Initiatives

Solar Parks Scheme

- To facilitate large scale grid-connected solar power projects, a scheme for "Development of Solar Parks and Ultra Mega Solar Power Projects" is under implementation with a **target capacity of 40 GW capacity by March 2024.**
- The scheme was launched by the Ministry of New & Renewable Energy in December 2014.
- Solar Parks provide solar power developers with a **plug and play model,** by facilitating necessary infrastructure like land, power evacuation facilities, road connectivity, water facility etc. along with all statutory clearances.
- As on 31-10-2022, **56 Solar Parks** have been sanctioned with a cumulative capacity of 39.28 GW in 14 states.
- Solar power projects of an aggregate capacity of over 10 GW have already been commissioned in 17 parks and the remaining parks are at various stages of implementation.

PM-KUSUM Scheme

- Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahaabhiyan (PM-KUSUM) was launched by MNRE in 2019 to provide energy and water security, de-dieselise the farm sector and also generate additional income for farmers by producing solar power.
- The Scheme consists of three components:
    - **Component A:** Installation of 10,000 MW of Decentralized Grid Connected Solar Power Plants each of capacity up to 2 MW
    - **Component B:** Setting up of 20 lakh standalone Solar Powered Agriculture Pumps
    - **Component C:** Solarisation of 15 Lakh existing Grid-connected Agriculture Pumps
- The Scheme aims to add 30.8 GW of solar capacity with central financial support of over Rs. 34,000 Crore.

Rooftop Solar Scheme

- To generate solar power by installing solar panels on the roof of the houses, the Ministry of New and Renewable Energy is implementing the Grid-connected Rooftop Solar Scheme.
- It aims to achieve a cumulative capacity of **40,000 MW from Rooftop Solar Projects** by the year 2022.
- This scheme is being **implemented in the state by distribution companies (DISCOMs).**
- The major objective of the programme includes:
    - To promote the **grid-connected SPV rooftop and small SPV power generating plants** among the residential, community, institutional, industrial and commercial establishments.
    - To mitigate the dependence on fossil fuel based electricity generation and encourage environment-friendly Solar electricity generation.

    - To create an **enabling environment for investment** in the solar energy sector by the private sector, state government and the individuals.
    - To create an enabling environment for the supply of solar power from rooftop and small plants to the grid.
- The programme has been extended till 31.03.2026 and therefore, subsidy under the programme will be available until the target under the programme is achieved.

International Solar Alliance (ISA)

- The International Solar Alliance is a **common platform for cooperation among sun-rich countries** lying fully or partially between the Tropics of Cancer and Capricorn who are seeking to increase solar energy, thereby helping to bend the global greenhouse emissions curve whilst providing clean and cheap energy.
- The ISA was conceived as a **joint effort by India and France** to mobilize efforts against climate change through deployment of solar energy solutions.
- It was conceptualized on the sidelines of the **COP21** of the UNFCCC which was held in Paris in 2015.
- With the amendment of its Framework Agreement in 2020, **all member states of the United Nations are now eligible** to join the ISA.
- At present (September 2023), **116 countries are signatories** to the ISA Framework Agreement, of which 92 countries have submitted the necessary instruments of ratification to become full members of the ISA.
- The ISA is **headquartered in Gurugram,** Haryana, India.
- Key focus areas include
    - Promote solar technologies, new business models and investment in the solar sector to enhance prosperity.
    - Formulate projects and programmes to promote solar applications.
    - Develop innovative financial mechanisms to reduce cost of capital.
    - Build a common knowledge e-Portal.
    - Facilitate capacity building for promotion and absorption of solar technologies and R&D among member countries.

National Solar Mission (NSM)

- It was **launched in January 2010.**
- The initial target of NSM was to install 20 GW solar power by 2022. This was upscaled to **100 GW** in early 2015.
- The objective of the National Solar Mission is to establish India as a global leader in solar energy.
- The Mission adopts a **three-phase approach,** Phase 1 (up to 2012 -13), Phase 2 (2013 - 17) and Phase 3 (2017 - 22).
- The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralized and decentralized level.