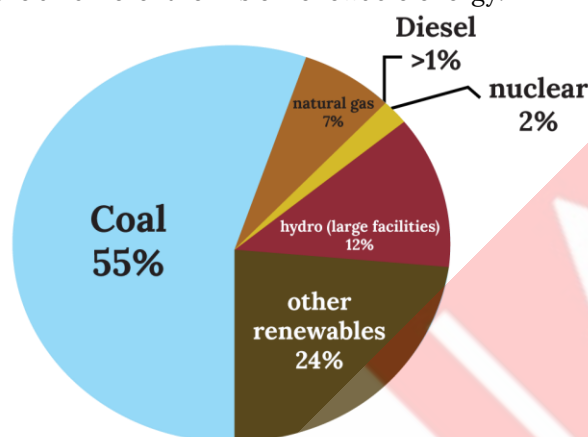


CHAPTER 4

SUSTAINABLE DEVELOPMENT

4.1 RENEWABLE ENERGY

Renewable energy refers to the energy that is generated from natural sources that are continuously replenished. Solar energy, hydel energy, biomass, geothermal energy, ocean thermal energy, co-generation and fuel cells are all different forms of renewable energy.



India's installed power capacity by fuel, June 2020

4.1.1 Solar Energy

Solar energy refers to the radiation that is received from the sun and utilized in the form of electricity and thermal energy by using various available technologies like photovoltaic cells and solar thermal technology.

1. **Photovoltaic electricity:** Uses photovoltaic cells that absorb direct sunlight to produce Direct Current (DC).
2. **Concentrated Solar Power (CSP) or solar thermal technology:** Uses a solar collector that has a mirrored surface. The mirrored surface reflects sunlight onto a receiver which in turn heats up a liquid. Steam is then generated from this heated-up liquid, which in turn is used to produce electricity.

India's current installed solar power capacity, according to Central Electricity Authority, is 34% of total renewable energy sources. India's Intended Nationally Determined Contributions (INDC) commitment to UNFCCC includes 100 GW of solar power out of 175 GW renewable energy by 2022.

International Solar Alliance (ISA): It was conceived as a coalition of solar-resource-rich countries (lying completely or partly between the Tropic of Cancer and the Tropic of Capricorn) to address their special needs. ISA membership has been recently extended to all member states of the UN, including those lying beyond the tropics.

1. Launched in COP 21 climate conference in Paris, 2015 by India and France.
2. The ISA's major objectives include globally deploying over 1,000GW of solar generation capacity as well as mobilizing investment of over US \$1000 billion into solar energy by 2030.
3. It is headquartered in Gurugram, India.

One Sun, One World, One Grid (OSOWOG) initiative was proposed by India to set up a framework for facilitating global cooperation which aims at building a global ecosystem of interconnected renewable energy sources that can be easily shared. Ministry of New and Renewable Energy (MNRE) is the parent body.

The term “**Surya Putra**” was coined by the Indian Prime Minister for all the nations which fall between the Tropic of Cancer and the Tropic of Capricorn.

Green Energy Corridor Project, launched by MNRE, aims at synchronizing electricity produced from renewable sources like solar and wind with conventional power stations in the grid.

Solar Charkha Mission is an initiative of Ministry of Micro Small and Medium Enterprises (MSME). Khadi and Village Industries Commission (KVIC) is the implementing agency.

Global Solar Council is an international non-profit association of the national, regional and international associations in solar energy and the world's leading corporation. It was founded in the 2015 Paris Climate Conference.

International Renewable Energy Agency (IRENA) is an intergovernmental organization that supports countries in their transition to a sustainable energy future. It is headquartered in Abu Dhabi.

National Solar Energy Federation is a founding member of the Global solar Council.

Solar Park scheme has been launched by Solar Energy Corporation of India (SECI). SECI is a Central Public Sector Undertaking under MNRE.

Association of Renewable Energy Agencies of the States (AREAS) has been formed at MNRE initiative to interact and learn from each other's experiences and also share their best practices and knowledge regarding technologies/schemes. The AREAS is registered under Society Registration Act. Union Minister for New and Renewable Energy is the patron of the Association and Secretary, MNRE is the ex-officio President.

PM Kisan Urja Suraksha Evam Utthaan Mahabhiyan (PM KUSUM) scheme has been launched recently by MNRE. The scheme aims to provide energy security along with financial and water security to farmers. It will encourage farmers to generate solar power in their farms. The target is to add decentralised solar power capacity of 25,750 MW by 2022. Components of KUSUM Scheme are:

1. Component A: 10,000 MW of decentralised ground mounted grid connected renewable power plants.
2. Component B: Installation of 2 million standalone solar pumps.
3. Component C: Solarisation of 1.5 million grid connected solar powered agricultural pumps.

Farmers can sell surplus solar power generated off-grid to DISCOMS, thereby increasing their incomes.

4.1.2 Wind Energy

Wind energy refers to the energy generated using the kinetic energy of wind. Wind turbines convert this kinetic energy into mechanical energy, further converting to electric power to generate electricity.

Wind farm consists of a group of wind turbines in the same location which is used for production of electricity. A wind farm can be located onshore as well as offshore.

India is the world's fourth largest onshore wind market by installations, with 37.5 GW of capacity as of 2019 and has the potential for more than 695 GW at 120 metres. As per the National Institute for Wind Energy (based in Chennai), western states have larger potential in terms of a stable, steady and a speedy wind flow starting from Gujarat, Maharashtra, Karnataka to Tamil Nadu and Andhra Pradesh.

National Offshore Wind Energy Policy-2015 is aimed at exploring and promoting deployment of offshore wind farms in the Exclusive Economic Zone (EEZ) of the country, including those under Public Private Partnership.

National Institute of Wind Energy (NIWE) has been authorized as the nodal agency for the development of offshore wind energy. India's first 1 GW offshore wind project is to be installed in **Gulf of Khambhat**.

Solar-Wind Hybrid Policy was issued to provide a framework for promotion of large grid connected wind-solar photovoltaic hybrid system for optimal and efficient utilization of wind and solar resources, transmission infrastructure and land.

The wind - solar PV hybrid systems will help in reducing the variability in renewable power generation.

4.1.3 Hydro power

Hydraulic power is generated when water flows from a higher elevation to a lower elevation. This is used to turn the turbine, thereby converting the kinetic energy of water into mechanical energy to drive the generator. **Small Hydropower** is defined as any hydropower project which has an installed capacity of less than 25 MW.

India is endowed with a large hydropower potential of 1,45,320 MW of which only about 45,000 MW has been utilized so far. Only about 10,000 MW hydropower has been added in the last 10 years. Hydropower sector is facing several challenges and the share of hydropower declined has from 50.36% in 1960s to around 13% in 2018-19.

Cabinet approved the following **measures to promote hydropower sector**:

1. Large hydropower projects were declared as renewable energy source (As per the earlier practice, only hydropower project projects less than 25MW were categorized as renewable energy).
2. Hydro Purchase Obligation (HPO) were declared a separate entity within non-solar Renewable Purchase Obligations.
3. Tariff rationalization measures were taken, including flexibility to developers to determine tariff by back loading of tariff after increasing project life to 40 years.
4. Budgetary support was provided for funding flood moderation component of hydropower projects on case-to-case basis.
5. Budgetary support was provided for funding cost of enabling infrastructure i.e., roads and bridges on a case-to-case basis.

4.1.4 Other forms of renewable energy

1. **Ocean Thermal energy**: It uses the temperature difference between the surface of the ocean and the depths of about 1000 m to operate a heat engine, which produces electric power.
2. **Co-generation**: It involves producing two forms of energy using one fuel. One of the forms of energy is heat and the other may be electricity or mechanical energy.

“Scheme to support promotion of biomass-based cogeneration in sugar mills and other industries in the country” has been launched by Ministry of New and Renewable Energy. It will provide Central Financial Assistance (CFA) for projects utilizing biomass like crop residues, bagasse, weeds, wood waste produced in industrial operations etc. However, municipal solid waste is not covered under the programme.

3. **Waste to Energy Technology (WtE)**: WTE technologies convert non-recyclable waste into usable forms of energy. The heat from the combustion of waste generates superheated steam in boilers. This steam drives turbogenerators and produces electricity. This technology can help reduce the amount of waste available for disposal and at the same time help generate electricity from it.

- a. Some of the techniques at WtE are incineration, gasification, pyrolysis and bio-methanation.
- However, high costs, choice of technology and improper segregation of waste remain a major challenge in its effective use.
4. **Geothermal Energy:** It refers to harnessing the geothermal energy or the vast reservoir of heat stored in the earth's inner core.
 - a. Potential Sites for Geothermal energy are Puga Valley (J&K), Tattapani (Chhattisgarh), Manikaran (Himachal Pradesh), Bakreshwar (West Bengal), Tuwa (Gujarat), Unai and Jalgaon (Maharashtra).

ONGC has planned to implement **India's first Geothermal Energy Project** at Ladakh.

5. **Fuel Cells:** Fuel cells generate electricity through an electrochemical process. The fuel cell combines hydrogen and oxygen to generate an electric current, water being the only by-product. There are no moving parts in fuel cells, so they are more efficient and reliable by comparison. Fuel cells have efficiency of 55% compared to 35% of conventional power plants.
6. **Bio-methanation:** It is a scientific process whereby anaerobic microorganisms in an anaerobic environment decompose biodegradable matter producing methane-rich biogas and effluent.
7. **Pyrolysis:** It refers to heating of an organic material, such as biomass, in the absence of oxygen.

4.1.5 Miscellaneous

Pointers for prelims:

1. **Bio Jet Fuel** is a blend of jatropha oil and aviation turbine fuel
 - a. Jatropha is a plant of Latin American origin.
 - b. It is a drought resistant perennial plant.
 - c. Jatropha oil is directly used in diesel engines.
 - d. Jatropha seed cakes make an excellent organic fertilizer with a high nitrogen content. It can also be used as a livestock feedstock.
 - e. It is also used as an insecticide and fungicide.
2. **Biofuels:** It is any hydrocarbon fuel that is produced from organic matter in a short period of time.
 - a. **First Generation (1G) biofuels:** It uses food crops like wheat for making ethanol.
 - b. **Second Generation (2G) biofuel:** It uses non-food crops like wood, grass, organic waste.
 - c. **Third Generation (3G) biofuel:** It uses specially engineered algae.
 - d. **Fourth Generation biofuel:** It aims at only producing sustainable energy but also a way of capturing and storing CO₂.

However, requirement of high levels of technology and the resultant high cost is a major impediment in its adoption.
3. **Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)** is the International Civil Aviation Organization (ICAO) resolution for a global market-based measure to address CO₂ emissions from international aviation from 2021 to 2035.
4. **Methane Hydrate** is a solid clathrate compound in which a large amount of methane is trapped within a crystal structure of water, forming a solid similar to ice.
 - a. Large amounts of methane are frozen in Arctic Tundra soils and in Marine Sediments including gas hydrates. As earth's climate warms, the methane is vulnerable to possible release into the atmosphere.

5. **“Net Metering”** is a billing mechanism that credits solar energy system owners for the electricity they add to the grid.

PM JI-VAN scheme under Ministry of Petroleum and Natural Gas (MoP&NG) will provide financial support to integrated Bioethanol Projects using lignocellulosic biomass and other renewable feedstock. 2G ethanol projects will be provided viability gap funding support over the next six years.

The ethanol produced will be mandatorily supplied to Oil Marketing Companies (OMCs) to further enhance the blending percentage under Ethanol Blended Petrol Programme. The government has fixed a target of 10% ethanol blending by 2022 and 20% by 2030.

Centre for High Technology (CHT), a technical body under the aegis of MoP&NG will be the implementing agency for the scheme.

SATAT (Sustainable Alternative Towards Affordable Transportation) initiative was launched by MoP&NG. It is aimed at setting up Compressed Biogas (CBG) production plants and make it available in the market for use in automotive fuels.

GOBAR-DHAN (Galvanizing Organic Bio-Agro Resources) Scheme has been launched to convert cattle dung and solid waste in farms to Compressed Biogas (CBG) and compost.

REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors from governments, international organizations and industry associations.

International Energy agency (IEA) was founded in 1974 to help countries collectively respond to oil supply disruptions. It is an autonomous body within OCED.

It is an international non-profit association and its secretariat is based at UN Environment in Paris, France.

Only OCED member states can become members of IEA. Accordingly, India is not a member of IEA but is an associate member.

Indian Renewable Energy Development Agency Limited (IREDA) is a Public Limited Government Company. It was established as a Non-Banking Financial Institution in 1987 and lies under the administrative control of MNRE. It is engaged in promoting, developing and extending financial assistance for renewable energy and energy efficiency/conservation projects with the motto “ENERGY FOR EVER”.

National Policy on Biofuels, 2018 was made by MNRE. Its major points include:

1. It categorizes biofuels into:
 - a. Basic Biofuels: First Generation (1G) bioethanol and biodiesel
 - b. Advanced Biofuels: Second Generation (2G) ethanol, Municipal Solid Waste (MSW) to drop-in fuels, Third Generation (3) biofuels, bio-CNG etc.
2. Viability Gap Funding (VGF) scheme for 2G ethanol bio refineries.
3. Expands the scope of raw materials for ethanol production by allowing use of sugarcane juice, sugar containing materials like sugar beet, starch containing materials like corn and cassava, damaged food grains like wheat and rotten potatoes unfit for human consumption for ethanol production.
4. Allows use of surplus food grains for production of ethanol.
 - a. However, it needs the approval of National Biofuel Coordination Committee headed by the Minister, Petroleum and Natural Gas.