Thermal Power Projects

CHARACTERISTICS OF ENERGY RESOURCES

- NATURE OF AVAILABLITY
- ENVIRONEMENTAL IMPACT
- CLEAN AND GREEN, LESS EXPLORED RENEWABLE SOURCES

CLASSIFICATION OF ENERGY RESOURCES

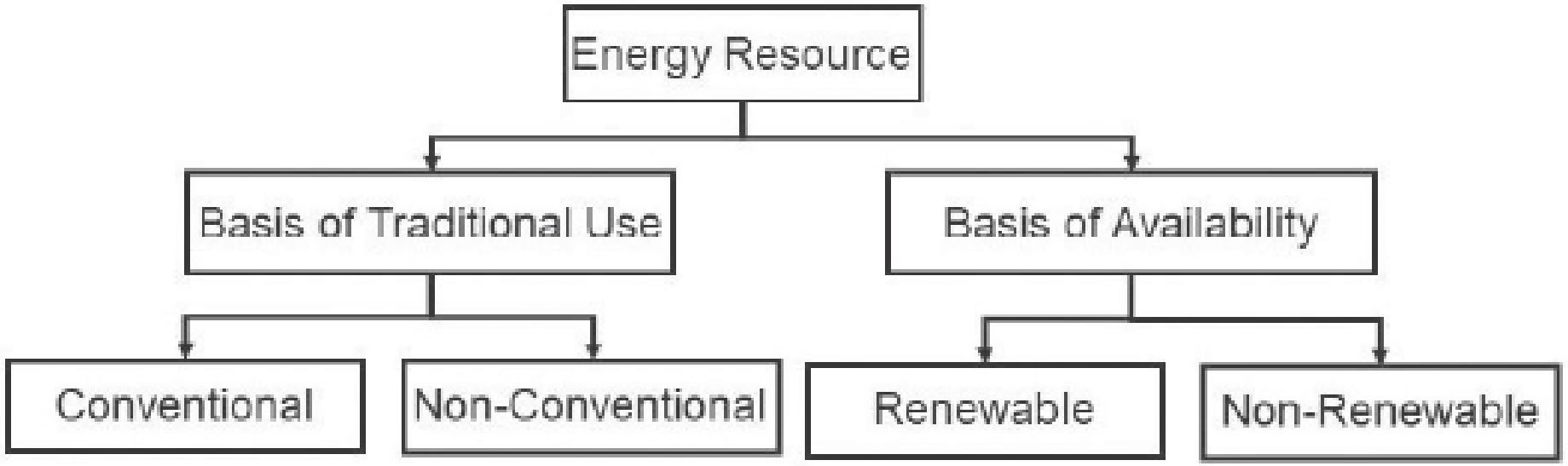


Fig. 10.1: Classification of sources of energy.

A) Classification based on Traditional Use

On this basis, energy resources are divided into two types namely conventional and non-conventional.

(i) **Conventional sources of energy:** Coal, oil, and natural gas are the examples of the conventional sources of energy. The conventional sources of energy are non renewable by any natural process. These resources are available in a limited quantity. Conventional sources of energy can also be further classified as commercial and non-commercial energy resources.

(ii) **Non-conventional sources of energy:** Solar, wind, bio-fuel, bio-mass, tidal, and ocean energy are the examples of non-conventional energy resources. They are renewable and eco-friendly in nature. These resources are available in an unlimited quantity and considered as clean fuel.

Feature	Commercial Energy Resources	Non-Commercial Energy Resources
Market exchange	Bought and sold	Not typically traded
Scale of production	Large-scale production	Smaller-scale production
Economic value	High economic value	Lower economic value
Regulation	Subject to government regulations	May not be subject to strict regulations

Conventional vs. Non-Conventional Energy Sources

Conventional Energy Sources are traditional sources that have been used for centuries. They are widely available and relatively inexpensive, but often have significant environmental impacts.

Non-Conventional Energy Sources are newer and alternative sources that are gaining popularity due to their potential for cleaner energy production.

Key Differences

Feature	Conventional Energy Sources	Non-Conventional Energy Sources
Availability	Abundant and widely available	Limited or intermittent availability
Cost	Generally less expensive	Often more expensive due to initial investment
Environmental Impact	Significant pollution and greenhouse gas emissions	Lower environmental impact, but may have specific concerns
Technology	Mature and well-established	Emerging and evolving technologies
Examples	Fossil fuels (coal, oil, natural gas), hydroelectric power	Solar power, wind power, geothermal energy, tidal power, biomass

B) Classification based on Availability

On this basis, energy resources are divided into two types namely renewable and non-renewable.

(i) **Renewable sources of energy**: Renewable source of energy are those energy resources which can replenish themselves at the rate those resources are used. Examples of renewable resources include wind, solar, tidal, and geo-thermal.

(ii) **Non-Renewable sources of energy:** Non-renewable resource has a limited supply. These resources are finite in nature. Non-renewable resources include coal, oil, and natural gas.

In India, coal-based thermal power plants are the most common type. While the exact percentage can fluctuate over time, coal-fired power plants typically contribute between 60% and 70% of India's total electricity generation.

(i) Coal

Coal is broadly divided into four types based on their origin, carbon content, and other characteristics. These are peat, lignite, bituminous and anthracite. Let us discuss them in brief.

(a) **Peat**: This is the lowest grade coal as far as carbon content is concerned. It contains up to 30% carbon. This type of coal is rarely found in India.

(b) **Lignite**: This is also known as brown coal. This is regarded as the second stage of coal formation after peat. It contains about 35% carbon and lots of moisture. Therefore, it produces more smoke and less heat. Lignite are generally found in the state of Tamil Nadu, Rajasthan and Gujarat.

(c) **Bituminous**: Its carbon content is higher than the other two types. It varies between 40 to 80 %. Moisture and volatile content varies between 15 to 40 %. Bituminous coal can further be subdivided into two types: sub- bituminous and bituminous.

(d) **Anthracite**: This is the best quality of coal in which carbon content is highest. This is mostly used by the thermal power plants and industries.

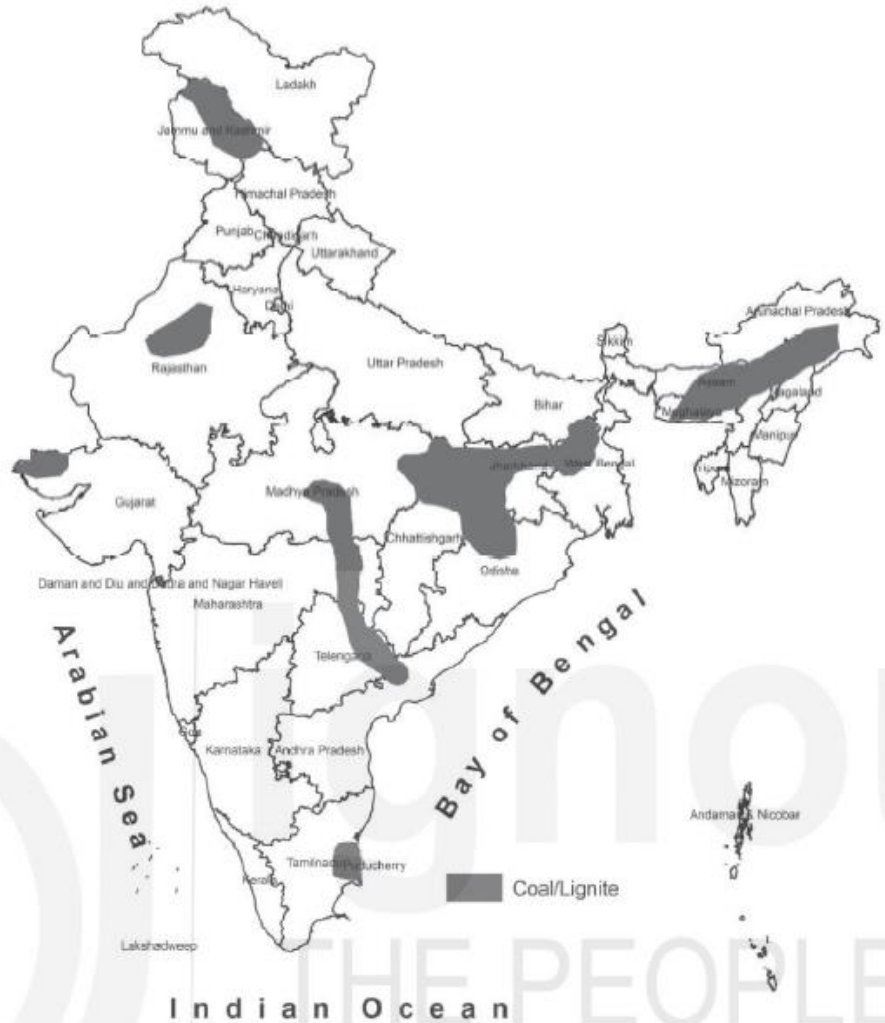


Fig. 10.2: Distribution of Coal in India.

Gondwana Coal: The coal fields of Gondwana origins are associated with the river valleys. Some of the major coal bearing river valleys located in different states are as follows:

(a) Damodar - Jharkhand and West Bengal
(b) Sone - Bihar, Madhya Pradesh and Uttar Pradesh
(c) Mahanadi - Chhatisgarh and Odisha
(d) Godavari-Wardha – Maharashtra, Andhra Pradesh and Telangana
(e) Pench-Kanha-Tawa-Madhya Pradesh (Fig. 10.2).

Tertiary Coal: As mentioned in the beginning of this section, this type of coal is generally found in the tertiary rocks of the Eocene-Oligocene geological period. This type of coal is generally found in the north-eastern states of Assam, Meghalaya, Nagaland, Arunachal Pradesh, and Jammu and Kashmir.

Lignite: Over 90% of the lignite reserves are found in the state of Tamil Nadu. Within the state of Tamil Nadu, major reserves are located in Neyvelli areas of Cuddalore district. Other important mining areas in the state are Jayamkonda-Cholapuram of Trichy district, Manargudi and East of Veeranam. Apart from Tamil Nadu, other important states where lignite is found are Rajasthan, Gujarat, Jammu and Kashmir, and Kerala.

(ii) Petroleum

This is an important source of energy which is much in demand to accelerate the economic development. As you know petroleum provides lubricants and raw materials for a number of chemical industries apart from an important fuel resource. It includes diverse products namely kerosene, diesel, petrol, aviation fuel, synthetic rubber, synthetic-fiber, thermoplastic resins, benzene-methansol, polystreteen, acrylates, detergents, aromatics, gasoline, carbon-blacks, dyes, colours, food colours, pigments, explosives, printing ink, film-photography, greases, cosmetics, paints, lubricant oils, paraffin and wax.

Petroleum is a naturally occurring inflammable fluid. It is a mixture of liquid and gaseous hydrocarbons. It also contains solid bitumens in soluble state and a soluble admixture of organic compounds of oxygen, sulphur and nitrogen. The hydrocarbons found in petroleum are of the methane, naphthalene, and aromatic series. Do you know how petroleum has originated? It is commonly agreed that its origin is linked to shallow water planktons and diatoms and associated rocks are marine sediments namely shales, silts and limestone of the Mesozoic and Tertiary times.

Distribution of Petroleum in India: Petroleum is generally found onshore as well as offshore in India. India's highly prospective basin for petroleum and natural gas are Bombay High, Khambat, Upper Assam, Krishna-Godavari delta region, Assam-Arakan and Cauvery basins (Fig. 10.3). Do you know why do we get petroleum and natural gas in this region? This is because most of the occurrences are associated with anticlines and fault traps in the rock formations of the lower and middle tertiary period.

Petroleum accounts for about 30% of India's total energy production. Oil consumption in the country was approximately 1.93 million barrels per day (bpd) in 1999 and now it is about 4.7 million bpd in 2017. In 2017, India imported about 198 million tonnes of crude oil and its products. Oil reserves are estimated at 4.7 billion barrels. The Bombay High oil Field is India's largest producing oilfield. It generated 250,000 barrel per day in 1998 and 210,000 barrel per day in 1999. However, if we compare production with consumption, it has been observed that there has been a huge gap between production and consumption. Consumption of petroleum products rose from 57 million tons in 1991-1992 to 196 million tons in 2016. The India Hydrocarbon Vision 2025 report estimates future refinery demand at 368 million tons by 2025. Thus, India is becoming a major global market for petroleum products.

What is thermal energy?

- **Thermal energy** is a form of energy that results from the movement of atoms and molecules in a substance. It's essentially the internal energy of a substance, related to its temperature. The faster the atoms and molecules are moving, the higher the thermal energy.
  - **Heat transfer:** Thermal energy is transferred from a hotter object to a colder one in a process called heat transfer. This can happen through conduction (direct contact), convection (movement of fluids), or radiation (emission of electromagnetic waves).
  - **Temperature:** Temperature is a measure of the average kinetic energy of the particles in a substance. A higher temperature means the particles are moving faster.

Types of Thermal Power Plants

Coal-fired Power Plants: 206404.50 MW

Dominant Type: Coal-fired plants are the most prevalent type in India, accounting for a substantial portion of the country's power generation capacity.
Fuel Source: **Coal** is a relatively abundant and affordable fuel source, making it a popular choice for thermal power plants.
Environmental Concerns: Coal combustion releases significant amounts of **greenhouse gases**, contributing to climate change. Efforts are underway to mitigate these impacts through technologies like carbon capture and storage (CCS).

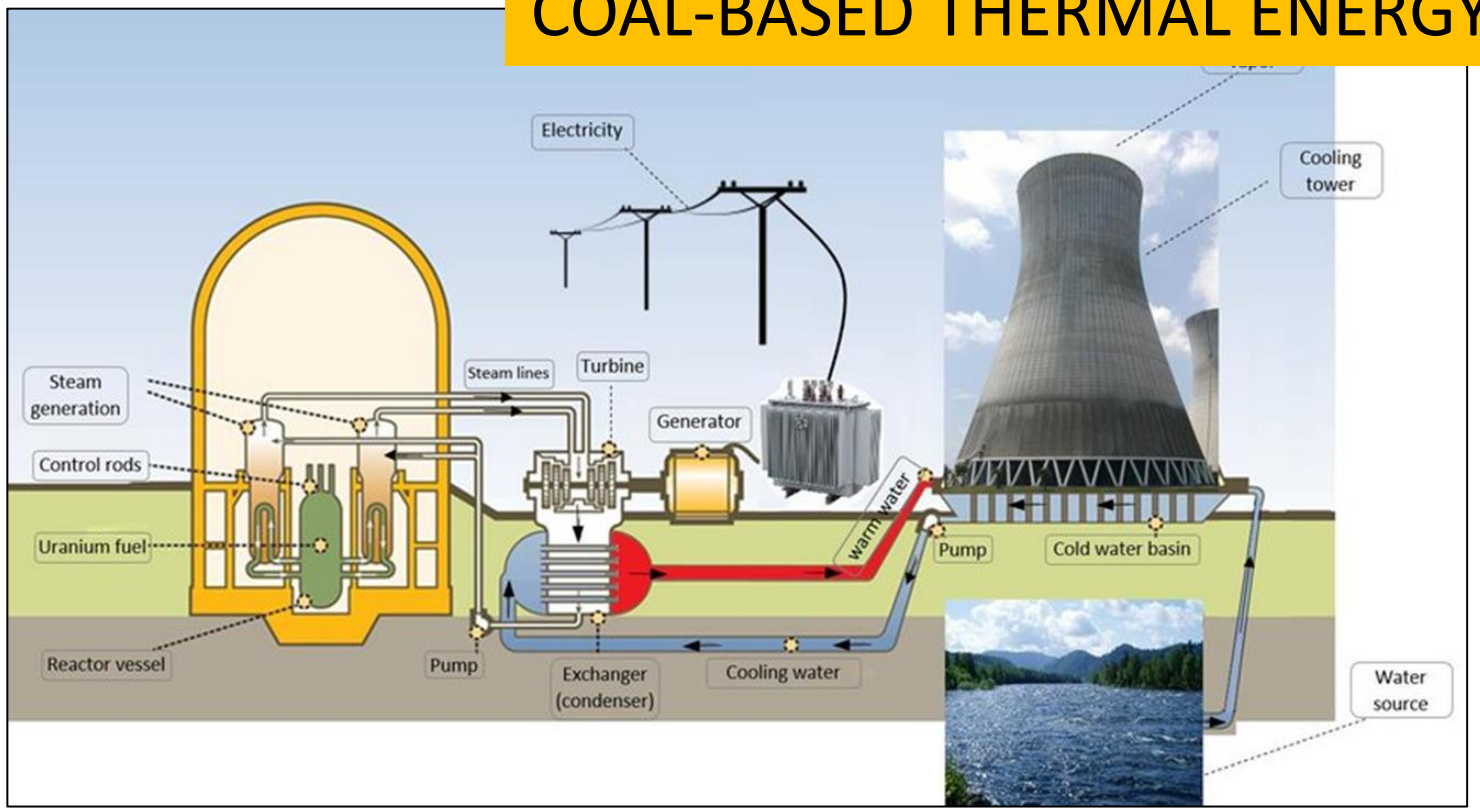
Oil-fired Power Plants: 509.71 MW

Flexibility: Oil-fired plants offer **greater flexibility** compared to coal-fired plants, allowing for **rapid load changes**.
Fuel Cost: **Oil prices can be volatile**, affecting the operational costs of these plants.
Environmental Impact: Oil combustion also contributes to air pollution and **greenhouse gas emissions**.

Gas-fired Power Plants: 24956.51 MW

Efficiency: Gas-fired plants are generally **more efficient** than coal-fired plants, resulting in **lower fuel consumption** and **emissions**.
Cleaner Fuel: Natural gas, a primary fuel for these plants, emits **fewer pollutants compared to coal and oil.**
Peak Load Management: Gas-fired plants are well-suited for **peak load management due to their quick start-up and shutdown times**.

COAL-BASED THERMAL ENERGY IN INDIA



Thermal power plants have been a cornerstone of India's energy infrastructure for decades, providing a significant portion of the nation's electricity. These plants convert thermal energy, primarily derived from fossil fuels, into electrical energy through a series of processes.

The Power Generation Process

1. **Fuel Combustion**: The fuel is burned in a boiler to produce heat.
2. **Steam Generation**: The heat converts water into high-pressure steam.
3. **Turbine Rotation**: The steam drives a turbine, converting thermal energy into mechanical energy.
4. **Generator Operation**: The turbine is connected to a generator, which converts mechanical energy into electrical energy.

Challenges and Opportunities

- **Environmental Concerns:** Thermal power plants contribute to air pollution, water pollution, and greenhouse gas emissions. Addressing these concerns requires stringent environmental regulations, technological advancements, and a shift towards cleaner fuels.
- **Dependence on Fossil Fuels:** India's reliance on fossil fuels for power generation poses a significant challenge. Transitioning to renewable energy sources can help reduce dependence on fossil fuels and mitigate climate change.
- **Grid Integration:** Integrating renewable energy sources into the existing power grid requires careful planning and management. Thermal power plants can play a vital role in providing baseload power and balancing fluctuations in renewable energy generation.
- **Technological Advancements:** Clean coal technologies and CCS offer potential solutions to reduce emissions from coal-fired power plants. However, the commercial viability and widespread adoption of these technologies remain to be seen.

Major Thermal Power Plants in India

Tata Power Mundra Ultra Mega Power Project: Located in Gujarat, this is one of the largest thermal power plants in India.

NTPC Dadri: Located in Uttar Pradesh, this is another major thermal power plant.

Adani Power Mundra: Located in Gujarat, this is a gas-based thermal power plant.

Neyveli Lignite Corporation (NLC): Located in Tamil Nadu, this is a lignite-based thermal power plant.

National Thermal Power Corporation (NTPC): NTPC operates several thermal power plants across India**.**

1. **What is the largest thermal power plant in India by installed capacity?**

Answer: The largest thermal power plant in India by installed capacity is the **Tata Power Mundra Ultra Mega Power Project**.

2. **In which state is the Tata Power Mundra Ultra Mega Power Project located?**

Answer: The Tata Power Mundra Ultra Mega Power Project is located in **Gujarat**.

3. **What type of fuel is used in the Neyveli Lignite Corporation thermal power plant?**

Answer: The Neyveli Lignite Corporation thermal power plant uses **lignite**, a type of low-grade coal.

4. **Which public sector company operates the most thermal power plants in India?**

Answer: The **National Thermal Power Corporation (NTPC)** operates the most thermal power plants in India.

5. **What is the approximate percentage of India's electricity generation that comes from thermal power plants?**

Answer: Approximately **60-70%** of India's electricity generation comes from thermal power plants.

CONSERVATION OF ENERGY RESOURCES

(i) Improving Efficiency of Energy Resources: Looking at the finite nature of various energy resources namely coal, petroleum, natural gas, atomic minerals etc. it is very much essential to increase efficiency of these resources so that we can get more benefit out of a fixed amount. How can we do it? This is possible by following certain technological upgradation. Some of the measures in this direction are given below.

- Using LED lights instead of incandescent lights. This is because LED lights save about 25% of energy as compared to incandescent lights which save only 10%.
- Using CNG enabled vehicles to avoid causing air pollution.
- Replacing conventional coal plants with supercritical ones as the latter are 45% more efficient than their counterparts.

(ii) **Prevention of Wastage**: This is an utmost need of the hour. India is one of the few countries where we lose a substantial amount of electricity during transmission. Similarly, we are not using energy resources judiciously. Therefore there is a need for awareness and practice it in our use. Some of the suggestive measures are as follows:

- Switching off electricity and appliances when not in use.
- Substituting old sockets with new ones.
- Using smart grid technologies.
- Prefer commuting through public transports and opt for carpooling to reduce air pollution.

(iii) **Optimum Utilization of Energy Resources:** This is another effective measure for energy conservation. Some of the important measures under this category are:

- Appropriate infrastructures of industrial, office, or private buildings.
- The right selection of building materials.
- Green buildings optimization for renovating residential areas and environmental surroundings.
- Reduction in energy and water usage via green building initiative.

(iv) **Use of Clean Technologies:** Energy conservation can be achieved through the following technological advancements namely cogeneration, off-grid renewable power and Perform, Achieve and Trade (PAT). Let us discuss this technological advancement in brief:

- Cogeneration refers to the industrial process of utilizing the processed steam out of the electricity generation plants. This steam can be reused for heating purposes.
- Off-grid renewable power refers to the use of wind, biomass, and hydel energies for conservation.
- Perform, Achieve, and Trade (PAT) refers to financial service that allows industries to trade energy saving certificates and increase their cost-effectiveness.

(v) Use of Renewable Sources of Energy: To conserve energy, it is best to use energy resources that can be iteratively reused and replenished. According to energy statistics provided by Government of India (Refer Energy Statistics 2020, Ministry of Statistics and Programme Implementation). India plans to set up 175 GW of renewable energies in the country which includes 100 GW of solar power plants, 60 GW of wind power plants, 10 GW for biomass efficient energies and 5 GW for small hydropower plants.

Try the following SAQ to see what you have understood of the various non-conventional sources of energy. Compare your answers with those given 'at the end of this unit.