UNIT 1 ENERGY AND DEVELOPMENT NEXUS

Structure

1.1 INTRODUCTION

Man is surrounded by an ocean of energy but he has been able to tap only a fraction of it. The source of all energy is the sun, an unimaginable vast powerhouse that affects everything on earth. But then, why do we hear about an energy crisis? We know that energy can be converted from one form to another, and that energy can neither be created, nor destroyed. But in all processes, whether it is a physical process or a chemical one, we observe that energy, in its usable form, is dissipated to the surroundings in less usable forms. Hence, any source of energy we use, to do work, is consumed and cannot be used again.

After studying this unit, you should be able to:

- discuss about energy and its classification
- differentiate between conventional and non conventional sources of energy
- describe the energy distribution system, initiatives taken by India and other countries in the energy sector
- have an extensive knowledge of thermal and hydropower, advantages and challenges in the sector

1.2 THE MEANING OF ENERGY AND TYPES OF ENERGY

Energy is the ability to do work. Energy is the capacity of a physical system to perform work. Energy exists in several forms such as heat, kinetic or mechanical energy, light, potential energy, electrical, or other forms. So energy is power, without which nothing can survive on Earth. The term, energy, used here, has a slightly different meaning. Energy actually means, useful energy, or, the energy that we can use; for cooking, operating machines, to run vehicles, and so on. And we get this useful energy only from specific sources, which we call, sources of energy. A good source of energy should have the following characteristics.

It should do a large amount of work per unit mass or volume. This means that the output energy must be more than the input energy. It should have high calorific value.

It should be easily accessible. The energy source should be able to provide energy over a long period of time. Examples: coal and petroleum.

It should be easy to store and transport. The most common sources of energy such as coal, petrol, and LPG need to be transported to users from their points of production. They also need safe and economical storage and transportability. Safe and convenient to use. Energy sources should be safe as they are used by a large number of people, and they should be convenient. Example: nuclear energy from a nuclear power plant is too hazardous to be used at homes.

1.2.1 Types of Energy

Broadly, there are two types of energy: i) conventional energy ii) non conventional energy.

i) Conventional sources of energy:

Conventional sources of energy include fossil fuels, thermal energy and hydroelectric energy. Fossil fuels include fuels that are most commonly used, such as wood, coal, and petroleum. These fossil fuels are non renewable sources of energy and we need to conserve them.

Wood

Wood is a major source of energy for man; it is widely used for cooking and heating. It is a primary fuel which can be used directly to produce heat. A major portion of heat produced by burning wood is lost to the surroundings and only 8 per cent of the total heat is actually used for cooking food, leading to significant wastage of fuel. It produces a lot of smoke due to incomplete combustion, which leads to pollution and health hazards.

Coal

Coal varies in quality according to the amount of pressure and heat to which it is subjected to during its formation. It consists largely of carbon, hydrogen, oxygen, and small amounts of sulphur and nitrogen. Coal is formed in layers called seams and takes millions of years to be formed. The oxides of carbon, nitrogen and sulphur are acidic oxides, and are released when coal and petroleum are burned. This leads to acid rain which affects our water and soil resources.

Non renewable resources of energy in India are the natural resources of energy that cannot be produced, regenerated, re-grown, or reused on a large scale. These non renewable resources exist in a fixed amount and are consumed much faster than nature can recreate them. Fossil fuels including coal, petroleum, and natural gas are some examples of non renewable resources of energy in India. On the other hand, resources such as timber, which can be recycled, are known as the renewable resources of energy in India. A non renewable resource is always strained down with anabolic procedures that use up energy.

Non renewable resources of energy in India such as coal, petroleum, oil and natural gas require millions of years to form naturally and cannot be replaced as quickly as they can be consumed. Eventually natural resources will become too costly to reap, and mankind will have to find other sources of energy. At present, the main sources of energy used in India are non renewable sources of energy.

ii) Non-conventional sources energy

Non conventional sources of energy include wind, tides, solar geo-thermal heat, and biomass including farm and animal waste, as well as human excreta. All of these sources are renewable or inexhaustible. They are inexpensive in nature.

Wind Energy

It can be used for pumping water, a prime need in irrigating farms in the countryside. Also, it can be used for generating electricity. The states of Gujarat, Tamil Nadu, Maharashtra, and Orissa are better places in regard to this energy. Areas with constant and high speed winds are suitable for the purpose. Besides windmills, there are also wind farms.

Tidal Energy

This is another unlimited and inexhaustible source of energy. The Gulfs of Kutch and Cambay are ideally suited to develop electricity from the energy produced by high tides entering into narrow creeks.

Solar Energy

The most abundant and inexhaustible source of energy is the sun. It is a universal source and has huge potential. A notable achievement has been the invention of solar cookers. They help in cooking food almost without any cost. Small and medium sized solar power stations are being planned for deployment in rural areas. The successful applications of the solar energy, so far, have been for cooking, heating water, water desalination, space heating, and crop drying. It is going to be the energy of the future when fossil fuels, namely coal and oil, are totally exhausted.

Thermal Energy

India is not rich in this source. However, efforts are on to utilize natural energy from the hot springs at Manikaran in Himachal Pradesh. Energy so produced can be used for running cold storage plants.

Biomass

The efforts are being made in India to make use of biomass in an efficient and scientific manner. The two main components of the biomass programme are production and utilization of biomass.

Energy Plantation

Waste and denuded lands are being used for plantation of fast growing shrubs and trees with high calorific value. These, in turn, provide fuel wood, charcoal, fodder, power, and also scope for rural employment. Through the gasification system, these energy plantations over 8,000 hectares were producing nearly 1.5 MW of power, annually.

Energy from Urban Waste

A pilot plant for demonstration purposes has already been set up in Delhi to treat solid municipal waste for conversion into energy. It produces nearly 4 MW of energy every year. Sewage in cities is used for generating gas and electricity.

Biogas Based Power Plants

It is estimated that sugar mills in India can generate 2,000 MW of surplus electricity during crushing season. Out of every 10 MW of energy produced by a mill of a given size, 4 mw would meet its own power requirements and the rest, 6 MW of energy, can be utilized to irrigate fields by feeding it into the local grid. Like biogas, several other farm wastes such as rice husks are also being used to produce electricity.

Farm, Animal, and Human Wastes

By using farm and animal wastes as well as human excreta, *gobar gas* plants are being set up in villages to make them self sufficient in their power requirements. The power so produced, is used for cooking, lighting homes and streets, and meeting the irrigation needs of villages. The plants are being set up both at individual, community, and village levels. Sewage from large cities can be used for generating biogas.

1.3 ENERGY DISTRIBUTION

The planet earth is a complicated system. The energy source for its movement and living process is the sun, directly or indirectly, but the energy distribution is distinct inhomogeneous at temporal and spatial scales due to Earth's movement and different latitude, so that the importance of this effect excesses the effect of solar activity on the Earth's system, these are:

i) Temporal and spatial distribution

Every type of land surface has a distinct way of energy distribution and mass exchange. Change of land surface feature impacts the balance of energy, momentum, and mass between land and atmosphere, thereby affecting local, regional, and even global climate changes. Therefore, research on temporal and spatial distribution of the energy of the land surface is important.

It is necessary to build data bases of land surface types in order to provide prior knowledge for a global climate model (GCM) and to analyze the land surface energy distribution due to differences of its physical characteristics and its role in exchanges of energy, momentum and mass. This is also prerequisite condition for the inversion of albedo, land surface temperature and land surface roughness. Albedo and temperature of the land surface reflects information about the structure in vegetation and energy distribution.

ii) The Water and Energy Cycle

The Water and Energy Cycle Focus Area studies the distribution, transport and transformation of water and energy within the Earth System. Since solar energy drives the water cycle and energy exchanges are modulated by the interaction of water with radiation, the energy cycle and the water cycle are intimately entwined. It takes energy to move energy. Whether renewable or non renewable, energy is harvested in certain locations and must be distributed for use. Currently, pipelines, ships, trains, and trucks carry fossil fuels from point to point, while power lines carry electricity from the generation point to homes and businesses. Significant energy is expended in transporting or pumping energy-containing materials, while the power grid suffers from electrical resistance and load unpredictability.

More efficient distribution networks will require new materials and advanced logistical systems. Large scale utilization of distributed and intermittent renewable resources (e.g., solar, wind) will require intelligent, networked grids to deliver power efficiently over long distances. The introduction of new energy carriers may present both difficulties and new opportunities for energy distribution. Research can address these technical barriers and help shape a future energy distribution system aiding energy use with much lower greenhouse gas emissions.

iii) Electricity transmission and distribution systems

Electricity transmission and distribution systems are among the most important technologies serving the world today, bringing clean and useful energy to meet the demands of end users in many parts of the world. However, in the light of concerns on energy security and access, environmental impacts of energy use (especially the threat of climate change) and depletion and rising costs of non renewable energy resources, these existing energy distribution systems (built primarily around large, centralized power generation plants) have begun to show signs of age, inflexibility, vulnerability, high costs, and inefficiencies. Much has to be done to address the challenges facing centralized and large scale power transmission and distribution.

At the same time, distributed energy resources (including renewable energy systems, distributed power generation, and integrated energy systems) are becoming increasingly widespread and important, and entail the development and use of new and innovative approaches and technologies for energy supply and distribution. Distributed energy resources are smaller in capacity and output (and, therefore, much greater in numbers) compared to existing centralized power and energy conversion systems. They are based on a variety of different alternative and renewable energy resources with different technical and economic characteristics (including intermittency in output, in the case of many forms of renewable energy resources).

The design, control, management, and optimization of these new distributed energy resources and technologies, and their integration into existing energy transmission and distribution networks, pose significant technological challenges to ensure their reliability and safety, and to improve and maximize their efficiency and cost competitiveness. Micro grids and other smaller scale power networks can make important contributions to the wider application of distributed energy resources. They enable distributed energy technologies to be safely and reliably integrated with centralised networks (where they exist), or to operate on their own (in islanded mode) in remote locations not served by centralised power grids. They offer opportunities to improve energy efficiency and can ease the strain on, and cost of developing centralised power grid infrastructure.

By embedding the necessary 'intelligence' into energy distribution systems (through the use of smart sensor and communication technologies, controllers and intelligent agents), they will be able to utilize, integrate and optimize diverse energy resources, and provide reliable, cost competitive, and environmentally sustainable energy and power to residential, commercial, industrial, and transportation needs.

Such intelligence will enable flexible and interactive exchange of energy and power between distributed systems and centralised energy systems. They will enable price awareness and price sensitivity to be shared with energy suppliers and users across time and space dimensions, creating a sophisticated real time energy marketplace that is robust, adaptive, interconnected, and interactive.

iv) DG (distributed generation)

DG (distributed generation) is defined as installation and operation of small modular power generating technologies that can be combined with energy management and storage systems. It is used to improve the operations of the electricity delivery systems at or near the end user. These systems may or may not be connected to the electric grid. A distributed generation system can employ a range of technological options from renewable to non renewable and can operate either in a connected grid or off-grid mode. The size of a distributed generation system typically ranges from less than a kilowatt to a few megawatts.

DG options can be classified either on the basis of the prime movers used – (engines, turbines, fuel cells) or, on the basis of fuel resources used (renewable and non renewable). In India, many renewable energy technologies are being employed in a number of distributed generation projects. The technologies include biomass gasifiers, solar, thermal, and photovoltaic systems, small wind turbines (aero generators), and small hydropower plants.

Check Your Progress 1

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit.

1) What are the characteristics of good sources of energy?

Answer:..

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2) Briefly, write about various energy sources?

Answer:..

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3) What are the contributions of micro grids?

Answer:..

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1.4 THE RELEVANCE AND DISTRIBUTION OF POWER GENERATION IN INDIA

In India, there are three distinct markets for distributed power generation has found.

a) Small power generation back up systems, including diesel generators that are being used in the domestic and small, commercial sectors.

b) Stand-alone, off-grid systems or mini-grids for electrification of rural and remote areas.

c) Large, captive power plants, such as those installed by power intensive industries.

Distributed power generation systems are needed to address the following issues.

High peak load shortages

With a deficit of 12.3 per cent in peak demand, distributed generation systems that can reduce the peak demand is seen as the most effective solution to the problem.

High transmission and distribution losses

Current losses amount to about 35.03 per cent of the total available energy. Distributed power generation systems can greatly reduce these losses and improve the reliability of the grid network.

Remote and inaccessible areas

In many parts of the country, extension of the grid may not be economically feasible. In such cases distributed generation can play a major role.

Rural electrification

The Government of India has identified rural electrification as a priority for rural development. Wherever grid extension is not feasible, the government has directed that decentralized distribution generation facilities with local distribution network be provided.

Faster response to new power demands

The modular nature of distributed generation system coupled with low gestation period enables the easy capacity additions when required.

Improved supply reliability and power quality

Disruptions, such as grid failure, can be prevented as electricity is produced close to the consumer.

Possibility of better energy and load management

Distributed generation systems offer the possibility of combining energy storage and management systems.

Optimal use of the existing grid assets

Inadequacies in distribution networks have been one of the major reasons for poor supply of power. Distributed generation facilitates an optimal use of the grid that improves the reliability of the grid network and reduces the congestion.

1.5 ENERGY INITIATIVES

India's energy requirements are enormous and the demand is growing. Our resources, however, are limited both in physical and financial terms. It is a long term imperative that these resources need to be exploited optimally. India is attracting significant attention from major overseas project developers, equipment suppliers, and financiers. However, there remain difficult issues to be resolved before these projects become a reality.

i) Initiatives in the renewable energy sector

Despite the economic slowdown, the renewable energy sector registered a global growth rate of 5 per cent, according to the World Institute of Sustainable Energy (WISE), an institute based in Pune, which spearheads the cause of renewable energy. Investment in India grew by 12 per cent. Out of the $3.7 billion investment in the renewable energy sector in India in 2008, the largest portion, amounting to $2.6 billion, went to the wind sector. The investment in solar sector was to the tune of $347 million in 2008. Much of this investment is being utilized for the manufacture of solar cells and modules.

Small hydro investment grew nearly four-fold to $543, while investment in biofuels fell by 80 per cent to $49 in 2008. Energy with Synergy Gujarat accounts for 54 per cent of India's onshore crude oil production; 50 per cent of India's natural gas production; 46 per cent of India's installed refining capacity, and 60 per cent of India's total crude oil import facility. It is Gujarat that has given India its largest natural gas discovery of 20 TCF at the KG basin. Out of this, a 750 km network is already operational, and another 650 km pipeline is being implemented. In the next two to three years, the Gas Grid is expected to reach all 25 districts of Gujarat and cater to the requirements of industrial, commercial, and domestic sectors.

ii) International energy initiatives

Access to modern and affordable energy services is a prerequisite for achieving the Millennium Development Goals, in particular for poverty eradication. The European Union (EU) Energy Initiative for Poverty Eradication and Sustainable Development (EUEI) was launched at the 2002 World Summit for Sustainable Development in Johannesburg as a joint commitment by the EU Member States and the Commission to give priority to the important role of energy in poverty alleviation, and is a catalyst for action. The Initiative will raise political awareness among high level decision makers, encourage the coherence and synergy of energy related activities and attract new resources (capital, technology, human resources) from the private sector, financial institutions, civil society, and end users. The Initiative is a framework for policy dialogue with developing countries and other partners, and also for specific actions and partnerships, supported by the commission and member states, and developed in close collaboration with developing countries.

iii) US-India Energy Dialogue: Coal Working Group

On May 31, 2005, U.S. Secretary of Energy at the time, Dr. Samuel W. Bodman and Dr. Montek Singh Ahluwalia, Deputy Chairman Planning Commission of India, launched a new Energy Dialogue. The Energy Dialogue builds upon the broad range of existing energy cooperation between India and the United States, as well as develops new avenues of collaboration. The Energy Dialogue includes working groups in the areas of coal, oil and gas, nuclear and renewable resources, electric power generation, and energy efficiency.

The U.S. Department of Energy's Office of Fossil Energy and India's Ministry of Coal chair the Coal Working Group. The objectives of the CWG are as follows.

Enhance the understanding of coal-related energy issues and promote the exchange of information on policies, programs and technologies with special emphasis on coal utilization for power generation and clean fuels production.

- Promote the efficient and environmentally responsible use of coal.
- Promote increased trade and investment in the coal and coal power sectors.
- Encourage India's active participation in the Carbon Sequestration Leadership Forum, and Methane to Markets Partnership.
- Work with the private sector to identify areas of cooperation and collaborate with the business community on joint activities.
- Since its inception, the Coal Working Group has had several meetings. In addition, the CWG has developed a high level work plan that identifies the priority items of interest that will be pursued by the group.

1.6 THERMAL POWER

The modern world is well aware of hydroelectricity. It is derived from a source, which is plentiful, and above all, renewable. Thermal power plants, on the other hand, use coal, petroleum and natural gas to produce thermal electricity. These sources are of mineral origin. They are also called fossil fuels. Their greatest demerit is that they are exhaustible resources and cannot be replenished by humans. Moreover, they are not pollution free as is hydroelectricity. However, electricity, whether thermal, nuclear, or hydro power is the most convenient and versatile form of energy. It is in great demand by industry agriculture, transport, and domestic sectors and its use is closely related to productivity and the standard of living of the people.

i) Solar thermal energy

Energy is considered a prime agent in the generation of wealth and a significant factor in economic development. Limited fossil resources and environmental problems associated with them have emphasized the need for new sustainable energy supply options that use renewable energies. Solar thermal power generation systems also known as Solar Thermal Electricity (STE) generating systems are emerging renewable energy technologies and can be developed as viable option for electricity generation in future.

ii) India's power scenario

India's current electricity installed capacity is 135 401.63MW. Currently there is peak power shortage of about 10 per cent and overall power shortage of 7.5 per cent. The 11th plan target is to add 100 000 MW by 2012 and the Ministry of Non Conventional Energy (MNRE) has set a target to add 14500 MW by 2012, from new and renewable energy resources, out of which 50 MW would be from solar energy. The Integrated Energy Policy of India envisages electricity generation installed capacity of 800,000 MW by 2030, and a substantial contribution would be from renewable energy. This indicates that India's future energy requirements are going to be very high and solar energy can be one of the efficient and eco-friendly ways to meet the same.

India is located in the equatorial sun belt of the earth, thereby receiving abundant radiant energy from the sun. The India Meteorological Department maintains a nationwide network of radiation stations, which measure solar radiation, and also the daily duration of sunshine. In most parts of India, clear sunny weather is experienced 250 to 300 days a year. The annual global radiation varies from 1600 to 2200 KWh/m^2, which is comparable with radiation received in the tropical and subtropical regions. The equivalent energy potential is about 6,000 million GWh of energy per year. In our country, solar radiation levels vary in different parts or region of the country. It can be observed that although the highest annual global radiation is received in Rajasthan, northern Gujarat and parts of the Ladakh region, the parts of Andhra Pradesh, Maharashtra, Madhya Pradesh also receive fairly large amount of radiation as compared to many parts of the world especially Japan, Europe and the US where development and deployment of solar technologies is maximum.

iii) Concentrating solar collectors

Solar collectors are used to produce heat from solar radiation. High temperature solar energy collectors are basically of three following types

a) Parabolic trough system: the receiver can reach 400° C and produce steam for generating electricity.

b) Power tower system: the reflected rays of the sun are always aimed at the receiver, where temperatures well above 1000° C can be reached.

c) Parabolic dish systems: parabolic dish systems can reach 1000° C at the receiver, and achieve the highest efficiencies for converting solar energy to electricity.

iv) Solar thermal power generation program of India

In India the first Solar Thermal Power Plant of 50 KW capacities has been installed by MNES following the parabolic trough collector technology (line focusing) at Gwalpahari, Gurgaon, which was commissioned in 1989 and operated till 1990, after which the plant was shut down due to lack of spares. The plant is being revived with the development of components such as mirrors and tracking system.

A solar thermal power plant of 140MW at Mathania in Rajasthan has been proposed and sanctioned by the state government in Rajasthan. The project configuration of 140MW integrated solar combined cycle power plant involves a 35MW solar power generating system and a 105MW conventional power component and the GEF has approved a grant of US$ 40 million for the project. The German government has agreed to provide a soft loan of DM 116.8 million and a commercial loan of DM 133.2 million for the project. In addition, a commercial power plant based on solar chimney technology was also studied in the north western part of Rajasthan. The project was to be implemented in five stages.

v) Solar thermal technologies for power generation -global scenario

Solar energy, among various renewable energy sources, provides an inexhaustible source of energy. The amount that can be readily accessed with existing technology significantly exceeds the world's primary energy consumption. The size of world's solar energy resources is truly enormous, and the amount that can be readily accessed with existing technology greatly exceeds the world's primary energy consumption It has been predicted that the power plants based on solar thermal technologies in 2020 are expected to produce from 60,000 to 90,000 MW electricity per year. Solar power plants, particularlythose installed in regions of high insulation, are a promising option for environmentally compatible technology for electricity generation. At present, approximately 80 per cent of the solar generated electricity is provided by power plants based on solar thermal technologies.

All solar thermal technologies are based on four basic systems: collector, receiver transport storage, and power conversion. There are five major varieties of solar thermal technologies for electricity generation, as listed below.

1.7 HYDROPOWER DEVELOPMENT - A KEY GOVERNMENT INITIATIVE

To boost economic growth and human development, one of the Government of India's top priorities is to provide all of its citizens with reliable access to electricity by 2012. To ensure that the uncovered 40 percent of Indian homes get electricity by 2012, and to serve the rising demand from those already being served by the power grid, the government estimates that the country will need to install an additional 100,000 Megawatts (MW) of generating capacity by 2012, expanding grid-based generation to about 225,000 MW. Given that India added about 23,000 MW during the last Five Year Plan of 2002-2007, this will be quite a quantum jump.

The Government of India has decided to acquire an increasing portion of this additional power from the country's vast untapped hydropower resources, only 23 per cent of which has been harnessed so far. India's energy portfolio today depends heavily on coal-based thermal energy, with hydropower accounting for only 26 per cent of total power generation. The Government of India has set the target for India's optimum power system mix at 40 percent from hydropower and 60 percent from other sources.

i) Advantages of hydropower

When developed in accordance with good environmental and social practices, hydropower plants have the advantage of producing power that is both renewable and clean, as they emit less greenhouse gases than traditional fossil fuel plants, and do not emit polluting suspended particulate matter (from the high ash content of indigenous coal). Hydropower plants can also start up and shut down quickly and economically, giving the network operator the vital flexibility to respond to wide fluctuations in demand across seasons and at different times of the day. This flexibility is particularly important in a highly populated country like India where household electricity demand is a significant portion of total demand and this demand in concentrated in a short period of time (usually in the evening). As an illustration, if the approximately 150 million households in India were to turn on two 100 watt light bulbs at 7 pm, the power system would experience an instantaneous surge in demand of about 30,000 MW! Today, households turning on small gasoline and diesel generation units, which, in addition to being polluting, are a serious health hazard in congested areas, often meet this peak demand. And, with rising wealth, households are switching on a lot more than two light bulbs. Although hydropower plants are subject to daily and seasonal variations in water flows (which affects the production of electricity at that point in time), they are not subject to the fluctuations in fuel costs that trouble thermal power plants.

While hydropower plants have large up-front capital costs, they also have long and productive lives, which significantly help reduce costs over time. For example, the Bhakra Nangal plant, now more than 40 years old, has operating costs of only Rs 0.10 or US$ 0.002 per unit. Hydropower plants are, thus, generally cheaper in the long run than natural gas-based plants, which are constantly at risk from fuel price increases in the global market.

ii) The challenges of hydropower development

While hydropower plays an important role in the energy and development strategies of India, such natural resource projects are inherently challenging. Environmental and social impacts are inevitable but they can be mitigated. Hydropower development in India has seen significant strides in understanding and addressing these impacts and the lessons learned from past engagements are now being incorporated in project selection and design. These lessons, coupled with suggestions from civil society, have resulted in changes to the laws and regulations that govern hydropower development today. As a result, there have been improvements on the ground, including greater public consultation with people affected by such projects; better monitoring of the environmental and social aspects of projects; and improvements in resettlement policy and practice. The government has also ensured that the methodology used by central power agencies to select sites has improved, as has the capacity of various hydropower developing agencies to deal with complexities in project identification, engineering, and design.

iii) Proposed hydropower projects in India

At the request of the Government of India, the World Bank is evaluating two hydropower projects in the country - the Rampur Hydropower Project,, downstream from Nathpa Jhakri on the River Satluj in Himachal Pradesh, and the Vishnugad Pipalkoti Hydropower Project on the River Alaknanda, in Uttarakhand. While the Rampur Project is in the project appraisal stage, the Vishnugad-Pipalkoti project is in the early stages of preparation. The World Bank is also assisting the state governments of Himachal Pradesh and Uttarakhand to adopt a river basin approach in the planning and development of cascaded hydropower systems. The two mountain states that have made hydropower generation a significant development priority, and asked for Bank assistance in initiating a River Basin Development Optimization Study that uses the Satluj and Alaknanda rivers as case studies. The study aims, also, at forging an effective and equitable system of cost and benefit sharing among all stakeholders, including developers and operators, affected local communities, and host states.

Check Your Progress 2

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit.

1) Write three major objectives of Coal Working Group (CWG)?

Answer: ....

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2) What are the three markets found for the distributed power generation in India?

Answer: ....

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1.8 LET US SUM UP

In this chapter you have studied the various concepts, sources, types and classification of conventional and non conventional energy. You have also studied the energy distribution systems, and various types of initiatives taken in India and other countries including advantages and challenges of various types of energy. The various issues relating to harnessing, management, and conservation of conventional sources of energy and non conventional sources. This unit has also described various energy initiatives under thermal and hydropower sector.

1.9 REFERENCES AND SUGGESTED READINGS

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1.10 CHECK YOUR PROGRESS – POSSIBLE ANSWERS

Check Your Progress 1

1) What are the characteristics of good sources of energy?

Answer: A good source of energy should have the following characteristics.

i) It should do a large amount of work per unit mass or volume - which means that the output energy must be more than the input energy. It should have high calorific value.

ii) It should be easily accessible.

iii) It should be able to provide energy over a long period of time. Examples: coal and petroleum.

iv) Should be easy to store and transport, like, coal, petrol and LPG.

v) Energy sources should be safe as they are used by a large number of people and should be convenient. Example: Nuclear energy from a nuclear power plant is hazardous to be used at homes.

2) Briefly, what are the various energy sources?

Answer: Energy sources are of two types: a) conventional sources of energy, and b) non conventional sources of energy. Wood and coal are the best sources of conventional energy. On the other hand wind energy, tidal energy, solar energy, thermal energy, biomass, energy plantation, energy from urban waste, and biogases are the main sources of non conventional energy.

3) What are the contributions of micro grids?

Answer: Micro grids and other smaller scale power networks can make important contributions to the wider application of distributed energy resources. They enable distributed energy technologies to be safely and reliably integrated with centralised networks or to operate on their own in remote locations not served by centralised power grids. They offer opportunities to improve energy efficiency and can ease the strain on, and cost of developing centralised power grid infrastructure.

Check Your Progress 2

1) Write three major objectives of Coal Working Group (CWG)?

Answer: The objectives of the CWG are:

i) enhance the understanding of coal-related energy issues and promote the exchange of information on policies, programs and technologies with special emphasis on coal utilization for power generation and clean fuels production

ii) promote the efficient and environmentally responsible use of coal

iii) promote increased trade and investment in the coal and coal power sectors.

2) What are the three markets found for the distributed power generation in India?

Answer: In India, distributed of energy generation has found three distinct markets.

a) Small, back up power generation systems including diesel generators that are being used in the domestic and small-commercial sectors.

b) Stand-alone off-grid systems or mini-grids for electrification of rural and remote areas.

c) Large, captive power plants, such as those installed by power intensive industries.