UNIT 2 ENERGY IMPACT ANALYSIS

Structure

2.0 INTRODUCTION

The Energy impact analysis conveys about the energy consumption at global level and its associated impacts to inform policy, standards and decision-making for better environment and society. Shortage of energy resources occur due to the enhancement in consuming energy resources. Instead of reducing the consumption of energy resources, public officials have extended their import. This results in increased dependency on the import of energy resources. Besides, researchers are finding the substitute for the energy resources. Determining the significance of impacts can be one of the most difficult aspects of an impact assessment. Quantifying the magnitude of impacts on scientific lines is the major objective. After determining the magnitude of impact, an analyst must conclude on the importance of impacts. While making a final decision on the project, a decision maker should consider major impacts along with alternatives. Considering the major impacts may be helpful for the mitigation measures and also for adjusting the characteristics of the project.

2.1 OBJECTIVES

After reading this unit, you should be able to:

- understand the concept of energy and load inventory along with energy balance;
- understand the supply and demand scenario; and
- describe the procedure of energy audit followed in various industries.

2.2 ENERGY AUDITING

Dear Learners, let us now read about energy auditing in the following sentences:

2.2.1 Energy Inventory

The expanding energy deficiency and increased specialization in enhancing alternative sources of energy e.g. wind and nuclear energy are main features of energy policy of India. India ranks at eighty one position in overall energy self-reliance of 66 % in 2014. In last one hundred years, world population has enlarged by manifolds. Life expectancy has been enhanced by 70%. The real per-capita Gross domestic product (GDP), which is the measurement of productivity of the world's individuals has risen by 600 %. At a similar time, we have consumed over 340 billion barrels of oil, nearly sixty billion short tons of coal and quite 1,090 trillion cubic feet of natural gas (CIPEC, 2009).

All the above mentioned stuffs are interconnected. Lots of outstanding human, social and technological achievements are still feasible by a crucial factor i.e. cheap and reliable energy. Today's world receives larger retrievable supplies of coal, natural gas and oil, even with constant increasing rates of economic and population growth, as well as increasing energy consumption, than at any other period in its recorded history. This should be conveyed to new and prolonged innovations in investigation and production technology, there's every reason to assume that today's approximation of reserves are solely a fragment of what is going to be fabricate and delivered tomorrow over the world. An Energy Inventory is meant as a primary step towards the goal of energy inventions.

Data gathering is the most significant activities under the process of energy auditing for measuring the utilization of energy use and energy inventory. To accomplish the energy data effective collection of adequate and and right data are needed. Few data are easily available and their collection completely diverse divisions of the plant to be audited. Collection of additional data may be done by recording and measurement. Energy audit team should be well-resourced with all essential instruments for measurements. Instruments used for measurements are often portable or installed in certain equipment.

Commonly used data for the measurements in the process of auditing are:

- Liquid and gas fuel flows
- Electrical measurements, like the current intensity, voltage, power and power factor
- Temperatures of liquid and solid surface
- Pressure of fluids in pipes, furnaces or vessels
- Emissions of exhaust gases (CO_2, CO, O_2 and smoke)
- Ratio of relative humidity
- Brightness

The rest of this section will focus on the sort of measurement that should be conducted and therefore the analyses that may be made from those measurements in each electrical and thermal utility. This helps the energy auditors and may assist them to follow a systematic way so as to evaluate the consumption of energy and performance in an industrial plant. The important tools used by an energy auditor for the evaluation are the load inventory and demand profile. These two tools are complementary since they both make available quantitative detail of the systems that consume energy during a facility.

The energy auditor must understand the exact point where energy to be consumed and about what proportion of energy is utilized by each and every system and what

is the collective load

of all the systems together. It is helpful to understand how the overall energy load is distributed among various systems.The load inventory may be a systematic means of assembling and organizing this kind of information. It's a great tool for undertaking "what if" assessments of proposed measures i.e. estimating the impact of retrofits technological or operational change.

The Electrical Load Inventory

There are two important questions which should be answered by making a list or inventory of electricity used.

- Where?
- How much and how fast?

Magnitude of the loads is a technique to prioritise for electricity saving opportunities. Therefore, distinguishing and categorizing completely different loads in a plant may be helpful, as the demand is quantified (i.e. how fast electricity is used) by the inventory of the loads related to each and every load or group of loads, which is useful for further understanding of demand profile. Waste is easily identified by the process of categorization and this frequently leads to economic savings opportunities. The best savings opportunities are considered by identification of high consumption loads.

1. Thermal energy use inventory – Identification of Energy Flows

An energy flowchart as shown in Figure 1 is useful for distinguishing thermal energy flows. All vital energy flows among the facility, into the facility and all outgoing flows from the facility to the environment are represented in energy flow chart.

The aim of energy flowchart isn't to explain a method well. Specific devices and equipment, which are used in various sub systems not usually shown in flowchart. The total of 14 energy outflows must equal energy inflows. It's usually feasible to visualize opportunities for energy saving and recovery with above information.

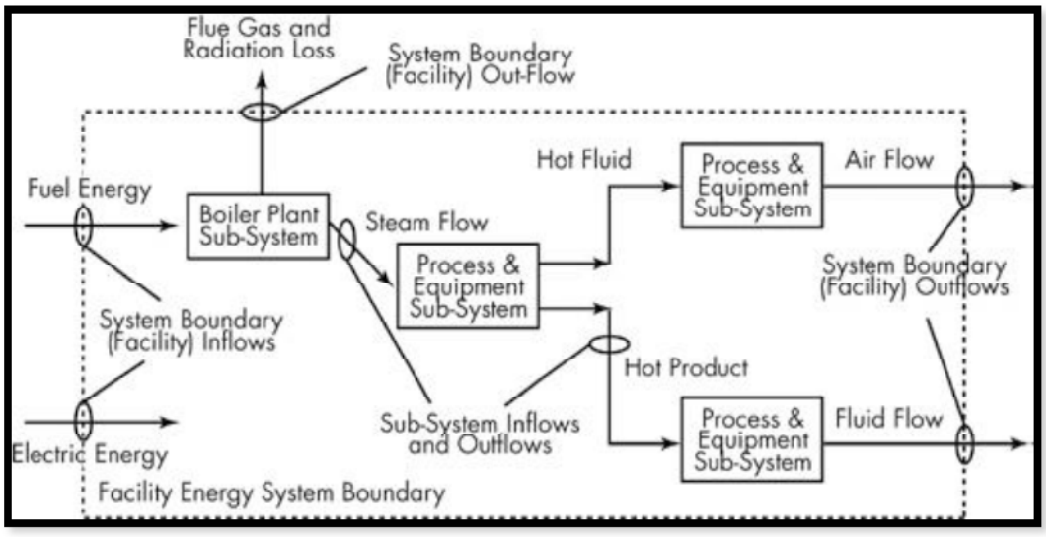

Fig. 2.1: Energy Flow diagram

The thermal energy outflows from a subsystem or a facility are identified and provided by checklist (Morvay and Gvozdenac, 2008). Calculations for estimating energy flows can be done by using an energy flow diagram, we can start to quantify the inflows of energy regarding rate (kW) and amount (GJ per day, month or year). In many cases, energy calculations are easily available for pieces of equipments and for several processes (EERE, 2004).

2. Energy Inventories and the energy balance.

The implications of the energy balance principle underlying the audit is that we can quantify all energy inputs and balance them against all energy outputs. The energy flow diagram for the industrial food-processing plant is balanced – the energy inflow equals the energy outflows. The Sankey diagram is a convenient graphical representation of energy balance. The Sankey diagram summarizes the energy balance for a given system, indicating (1) the magnitude of all energy inputs and outputs by the size of the arrows and (2) the approximate sequence in which outputs occur along the energy flow path. Another example of a thermal energy balance is the analysis of heat loss from the envelope of a building. This involves calculating heat loss through windows, doors, walls, roofs and ventilation and exhaust systems.

Check Your Progress 1

Note: a) Write your answer in about 50 words.
b) Check your progress with possible answers given at the end of the unit.

1. How can we use audit for quantifying energy inputs and outputs?

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2.2.2 Supply Demand Scenario

Resources and Demand

As the world population is increasing day by day, natural resources are becoming limited. So it is the need of hour to switch on to the alternative resources for meeting the demands of population. The present estimated reserves of hydrocarbon may not provide enough amount of energy. For meeting the increasing demand, we have to move to all the resource based reserves which can be increased use of non fossil resources i.e. nuclear and non conventional energies, for generation of electricity maximum hydro potential can be harnessed, explore additional fossil fuel, competitive import of energy. Gaps in the ratio of energy demand and supply can be reduced by exploring the potential of nuclear fuel resources.

Renewable and Nonrenewable Energy

There are various forms of energy on earth which can be regenerated with time span. They are said to be non depletable or renewable. Alternatively, other forms of energy which exists on earth are in limited quantities and are thus said to be depletable or nonrenewable. If the production (i.e. supply) of an energy form is more than its demand (i.e. consumption) than the energy form is considered to be non depletable.

Energy form is said to be depletable if the demand (in BTU per year) is such that the total supply is consumed within a finite time span for instance several hundred years or less.

Resources and Reserves

The terms reserves and resources can be used to discuss supply of the various nonrenewable energy sources. The concept of these two can be distinguishing with the criteria i.e. the level of certainty of their existence (from assurances by geologists) and the profitability (economic feasibility) of their recovery. The identification of quantity by detailed exploration is referred as reserves. With the implementation of existing technology, the reserves can be recovered economically and represent the existing quantity of energy source. On the sure estimation of geologists they are classified as proved, probable or possible. On the other hand, resources are a lot larger. It is referred to the amount of energy resource that exists or even known to be present regardless of the expenditure or the technique required for recovering it. For instance, recovery of the conditional resources which are known to exist, the cost becomes too high with existing technology and at current price.

Population and Energy Demand Growth

An intense debate is still going on about how fast the population, the economy and our energy consumption will grow in the years and decades to come. For instance, with increase in population, energy demand also increases although GDP per capita will decrease if GDP growth does not meet with population growth (as in developing nations). In context to population, the safely made statement is that the growth will be larger in the less developed countries than in the developed countries. From century and a half, the improvement in the living conditions in the developed countries has led to steady decrease in their death rate. The birth rate is also declining at the same rate, so that today the population growth (the difference between birth rate and death rate) is about 0.4% per year in the industrialized world. Population growing at increasing pace consume more energy. Moreover availability of energy also allows populations to grow. Consumption of energy exerts demands on energy resources creating shortage of them and they become harder to extract.

Check Your Progress 2

Note: a) Write your answer in about 50 words.
b) Check your progress with possible answers given at the end of the unit.

1. Differentiate between Resource and Reserve?

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2.2.3 Energy Auditing in industries

For reducing the consumption of energy, sustainable and energy efficient industrialization, timely energy audits are required. In comparison to non-residential buildings, industrial buildings have larger thermal loads, ventilation losses and pollution control requirements. Indian Energy Conservation Act of 2001 defines energy audit as: "The verification, monitoring and analysis of the use of energy and submission of technical report containing recommendations for improving energy efficiency with

cost-benefit analysis and an action plan to reduce energy consumption." This is a powerful tool to accomplish appealing energy savings.

Process of Energy Audit

The steps included in energy audit process are mentioned in Figure 2.2.

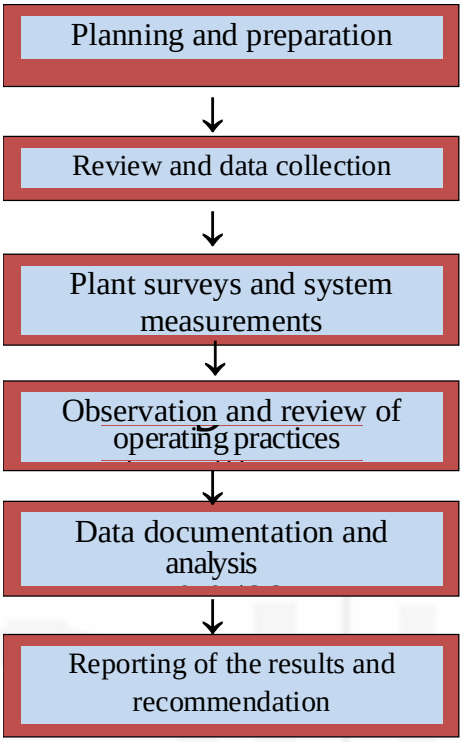


Fig. 2.2: Process of Energy Audit

Objectives

Industries with their defined objectives discover many ways for better development of the system and also for saving energy by conducting energy audits.

Types of energy audits

The form of how the energy audit conducted is mainly depended on the type, utility and size of the industry. There are two types:

1) **Preliminary audit**

   In this audit data available can be used mainly for analysis of energy consumption performance of the plant. Preliminary audit takes a comparatively short time. Results are much generalized. Economic analysis is usually limited to calculation of the simple payback period.

2) **Detailed audit**

   Data collection and measurements are usually done and assessment of various energy systems in detail. So, detailed audit needs longer time to be conducted. Results are much comprehensive and useful as they provide exact picture of the energy performance of the plant and more specific suggestion for improvements.

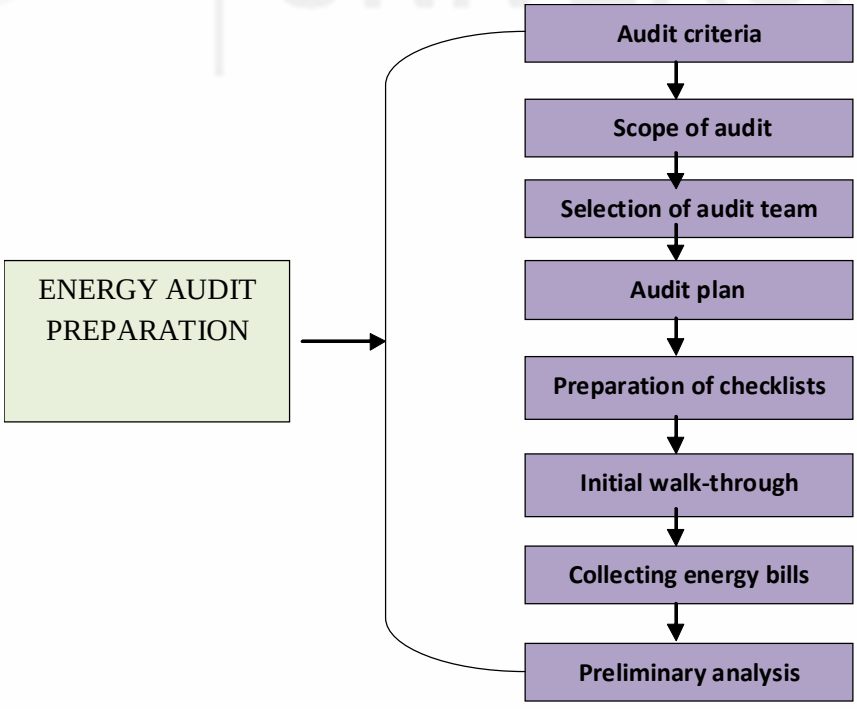
Measurement of Energy Use

The measurements of common data used for auditing process are elaborated in Figure 4.

Fig. 2.3: Common data measured during the auditing process

Overview of energy audit procedures

Procedure followed in detailed industrial energy audit is shown in Figure 2.4.



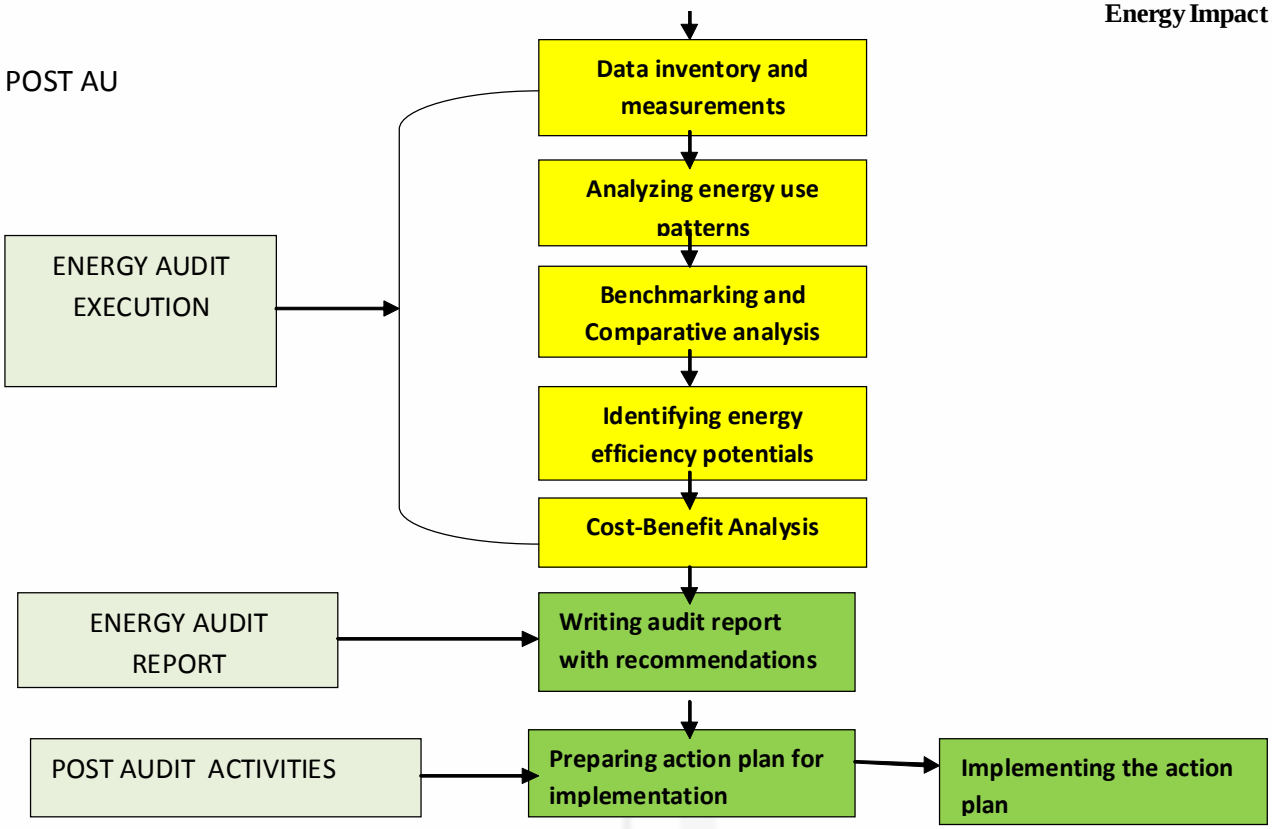


Fig.2.4: Overview of an industrial energy audit

Preparing an audit checklist

The audit checklist helps the auditor to conduct the work in a systematic and consistent way (Figure 2.5).

- Collection of data and information
- Existing measurement instrument and the data recorded
- Measurements required during the energy audit process and parameters enlisted for the - measurement
- Major equipment to be assessed in more detail
- major concerns and considerations
- Steps followed during the process of energy audit

Fig.2.5: Main components of the results section of the audit report

Check Your Progress 3

Note: a) Write your answer in about 50 words.
b) Check your progress with possible answers given at the end of the unit.

1. Mention the objectives and types of energy audit?

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2.3 ENERGY IMPACT ANALYSIS

Dear Learners, let us now read about energy impact analysis in the following sentences:

2.3.1 Impact Analysis of Fossil Fuel Usage

India ranks sixth in the world in terms of energy demand. In every sector such as commercial, domestic, economy, agriculture, transportation etc, we need input of energy. Consequently the use of energy is being slowly rising in the country. The increase in energy usage has resulted in dependency on fossil fuels such as coal, oil and gas. Formation of fossil fuels is a slower process which takes million years. As fossil fuels are formed from the organic material, their burning can contribute to climate change as they release carbon which goes back into the atmosphere. This changing climate causes the melting of glaciers and ice caps, which raises the risk of sea level rise and submergence of continents. Cases of phenomenon like acid rain and oil spills are increasing due to the increase of fossil fuel usage in many sectors. Burning of coal such as in thermal power plants releases sulphur dioxide, as coal has maximum concentration of sulphur in it and this forms acid rain. Coal burning releases harmful particulate matter which leads to formation of smog. Particulate matter causes lung and other diseases in human beings. Transporting fuels from the mine or well causes air pollution and lead to serious accidents and spills. Changes in weather conditions may affect precipitation patterns, which may affect agricultural outputs and influence energy needs that can create increasing economic instability.

2.3.2 Impact Analysis of Hydroelectricity Production

Hydroelectricity production is producing electricity from hydropower. A hydroelectric complex produces no direct waste, and has a considerably lower output level of greenhouse gases, but building of large dams to hold water can damage the environment. Hydroelectricity production may have huge environmental impacts by changing the environment and affecting land use, homes, and natural habitats in the dam area. Flooding land for construction of a hydroelectric reservoir has an extreme environmental impacts as it destroys forest, wildlife habitat, agricultural land, and scenic lands. Loss of habitat on account is a potential threat to the flora and fauna, as much land would be utilized for the dam construction. Deforestation will result in loss of plant species found in project area. A loss in plant species means that there would be a reduction in avifauna, since plant species are the nesting grounds of a large number of species. Construction in migratory route of the animals, vibration of the machines and increase in noise also results in species population loss. Acquisition of land for construction of hydroelectric dam causes change in land use and habitat destruction. The use of diesel generator to supply electricity causes emissions and releases gases such as nitrogen dioxide and sulphur dioxide. A construction activity causes noise pollution, which can develop high blood pressure in older people.

2.3.3 Impact Analysis of Nuclear Energy

Energy that holds together neutrons and protons, we called it as nuclear energy. This nuclear energy produced, can be used to generate electricity and is also used in various sectors such as environmental, medical and wartime (atomic bomb). Electricity generation by nuclear energy reduces the amount of energy generated from fossil fuels, less use of fossil fuels means lowering greenhouse gas emissions. Management of nuclear waste is difficult; it takes many years to eliminate its radioactivity and risks. Nuclear power plants releases gaseous and liquid radiological effluents. Nuclear accidents emit a certain level of radiation, which harms public health and environment as a byproduct of the chemical volume control system. Water discharged from the plant is hotter than the ambient temperature of water bodies that will lead to mortality of marine species.

2.3.4 Impact Analysis of Solar and Wind Energy Usage

Solar energy

Solar power is energy from the sun, which is a vast energy source. Solar energy is considered as a vast source of energy for many years because of the vast amounts of energy that is made freely available, if harnessed by modern technology. Large arrangements of solar cells are useful for powering road signs, and even much large arrangements are needed to power satellites in orbit around Earth. For photovoltaic power generation, large areas are required for central systems, which reduce the cultivable land. Solar panels in solar thermal power plants are used to heat up water into steam that further turns the turbines for the production of electricity. Setting up solar power stations requires much space to capture the sun's energy in high amount. Coolant is a potential environmental pollutant produced from the coolant change. Accidental leakage of coolant systems can create fire and release of gases from vaporized coolant affects public health and safety.

Wind energy

The terms "wind energy" or "wind power" describe the process by which the wind is used to generate mechanical power or electricity. Further this generated electricity can be used for particular tasks like grinding and pumping. In weather radars, wind turbines may lead to the misidentification of thunderstorm features and to the erroneous characterization of meteorological phenomena. Wind turbine may cause a scattered signal of dynamic nature which is both amplitude and frequency modulated due to the rotating blades. In comparison to fossil fuel using power plants, wind energy generation power plants have comparatively less impact on ecosystem. Wind energy does have aesthetic impacts also. Distress over the noise created by the rotor blades can harm the ecology. Setting up wind mill in migratory routes of birds causes killing of birds by flying into the rotors and also changes the micro climate of the region. Unlike as in case of traditional power plants, wind power plants/wind mills do not pollute the air and there is no emission of greenhouse gases.

2.3.5 Impact analysis of Biofuel Usage

Biofuel is a good source of renewable energy, produced using bio-based materials. It's a good substitute for petroleum fuels. Ethanol from corn, wheat or sugar beet and biodiesel from oil seeds are the finest biofuels. Biofuels are produced from classic food crops that need high-quality agricultural land for their growth. Bioethanol used as a fuel in cars are designed only to run on pure ethanol. Biofuels make availability of more efficient combustion and cleaner emission so reduces

environmental pollution. Bio-based fuels produce less air pollution, as they have high oxygen content. There is high emission of nitrogen oxide, but less sulfur and carbon dioxide. Biofuels have less efficiency due to their lower energy content. The economic impacts of using biofuels as energy source includes development in agriculture sector, augmentation of rural manufacturing jobs, competitiveness at international level and most important one is reducing the dependency on petroleum. As it is a clean fuel, it reduces the release of greenhouse gases, improved land and water use and higher combustion efficiency.

Check Your Progress 4

Note: a) Write your answer in about 50 words.
b) Check your progress with possible answers given at the end of the unit.

1) Analyze the impact of hydroelectricity production on environment.

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2) Discuss the aesthetic impacts caused during generation of wind energy.

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2.4 LET US SUM UP

Let's compile the chapter by studying the basics of noise, rating methods and scale of noise, prediction and estimation of transportation noise. By studying above chapter you will be able to understand noise and their effects on environment and human health. By understanding the noise prediction and estimation methods you will be able to know that how road transportation and noise plays vital role in daily life. You will be able to discuss about intake and exhaust engine noise. Sound plays role in our routine life but excessive exposure to noise can leads to the hindrance in human health. Psychological health is greatly affected by noise pollution. So by understanding the noise scale you will be able to interpret suitable noise exposure.

2.5 KEY WORDS

Energy : Is the capacity to do work. Different forms of energy may include potential, kinetic, thermal, nuclear, electrical, and chemical and various other forms.

Audit : Is an objective investigation and assessment of the financial statements of an organization to make sure that the records are fair and accurate representation of the transactions they claim to represent. It's an official inspection of an organization's accounts, typically by an independent body.

Inventory : May be defined as a detailed list of all the stuff in a place or a detailed, often descriptive, list of articles, giving the code number, quantity and value of each catalog.

Natural Resource : A resource is anything comes naturally for the use of people. A natural resource include water (seas and fresh water), land, soils, rocks, forests, animals (including fish), fossil fuels and minerals and are considered valuable in their natural form.

Renewable energy : Includes sunlight, wind, rain, tides, waves, and geothermal heat which can be replenish and are clean source of energy and energy obtained from the renewable sources of energy are called renewable energy.

Non Renewable energy : Is obtained from the non-renewable sources of energy such as fossil fuels, such as coal, oil, and natural gas which cannot be recycle within the time of their formation.

Efficiency : Is defined as the quality of being able to do a task successfully with a minimum amount of effort, without wasting time or energy.

Data : Is a set of values of qualitative or quantitative variables data exists in a variety of forms, like text on paper or bytes stored in electronic memory. Data facts and statistics are collected together for reference or analysis.

2.6 REFERENCES AND SUGGESTED FURTHER READINGS

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2.7 ANSWERS TO CHECK YOUR PROGRESS

Your answers should include the following points:

Answers to Check Your Progress 1

1. Audit is the verification, monitoring and analysis of the use of energy. Through the process of audit we can quantify all energy inputs by analyzing the heat losses through thermal energy balance. One of the advantages of an energy balance is that all energy inputs can be quantified and balanced against all energy outputs. With the help of sankey diagram we can represent the energy losses/ outflows, the energy gains/inflows, as well as the useful energy in a given energy system quantitatively and in proportion to the total energy inflow. Presenting the energy flows visually with the aid of the Sankey diagram helps to locate the more critical energy-consuming areas of the energy system and, at the same time, to identify the sources that lead to energy losses.

Answers to Check Your Progress 2

1. The term resource refers to the total amount of a material or primary energy flow that exists. This includes fuel that is both discovered and undiscovered, economically recoverable or not economically recoverable. Conversely, reserves are deposits of fossil fuels that are known to exist with a reasonable level of certainty based on geological and engineering studies. These reserves are also recoverable economically with the technologies that already exist.

Check Your Progress 3

1. The objectives of an energy audit can vary from one plant to another. However, an energy audit is usually conducted to understand how energy is used within the plant and to find opportunities for improvement and energy saving. Sometimes, energy audits are conducted to evaluate the effectiveness of an energy efficiency project or program.

Types of energy audits

The form of energy audit conducted is mainly depended on the type, utility and size of the industry. There are two types:

Preliminary audit

In this audit available data are used mainly for analysis of energy consumption performance of the plant. Preliminary audit takes a comparatively short time. Results are more common. The economic analysis is usually limited to calculation of the simple payback period.

Detailed audit

Measurements and data are usually collected and different energy systems are assessed in detail. So detailed audit needs longer time to be conducted. Results are much comprehensive and useful as they provide exact picture of the energy performance of the plant and more specific suggestion for improvements.