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Nadar Saraswathi College of Engineering & Technology

NSCET E-LEARNING PRESENTATION

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

III YEAR / V SEMESTER

EE8591 – Digital Signal Processing

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UNIT 04

BIOMASS ENERGY

"Intellectuals solve problems, geniuses prevent them."

—ALBERT EINSTEIN

BIOMASS ENERGY

Introduction
Bio mass resources
Energy from Bio mass: conversion processes
Biomass Cogeneration
Environmental Benefits.
Geothermal Energy: Basics
Geothermal Electricity.
Mini/micro hydro power: Classification of hydropower schemes
Classification of water turbine
Turbine theory
Essential components of hydroelectric system.

Introduction

Biomass is fuel that is developed from organic materials, a renewable and sustainable source of energy used to create electricity or other forms of power.

Some examples of materials that make up biomass fuels are:
scrap lumber
forest debris;
certain crops;
manure; and
some types of waste residues.

With a constant supply of waste – from construction and demolition activities, to wood not used in papermaking, to municipal solid waste – green energy production can continue indefinitely.

Biomass is a renewable source of fuel to produce energy because:

waste residues will always exist – in terms of scrap wood, mill residuals and forest resources; and properly managed forests will always have more trees, and we will always have crops and the residual biological matter from those crops.

What is biomass power?

Biomass power is carbon neutral electricity generated from renewable organic waste that would otherwise be dumped in landfills, openly burned, or left as fodder for forest fires.

When burned, the energy in biomass is released as heat. If you have a fireplace, you already are participating in the use of biomass as the wood you burn in it is a biomass fuel.

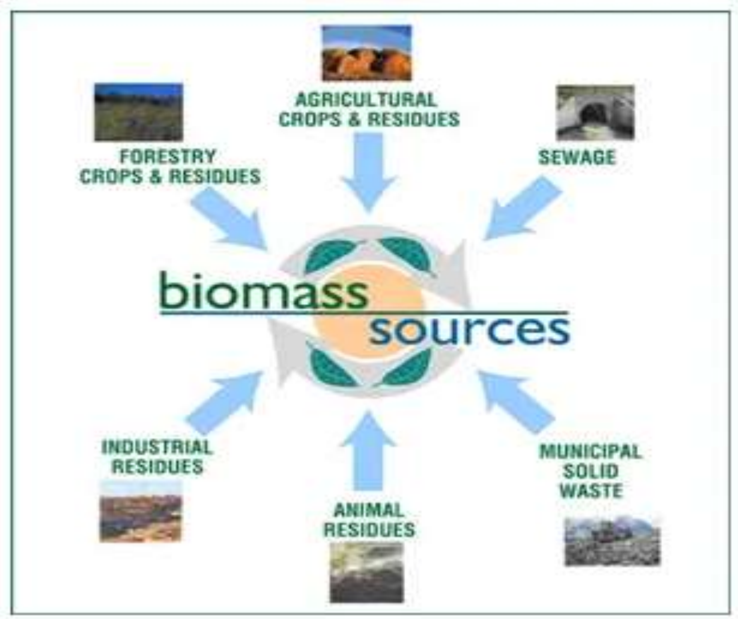
In biomass power plants, wood waste or other waste is burned to produce steam that runs a turbine to make electricity, or that provides heat to industries and homes.

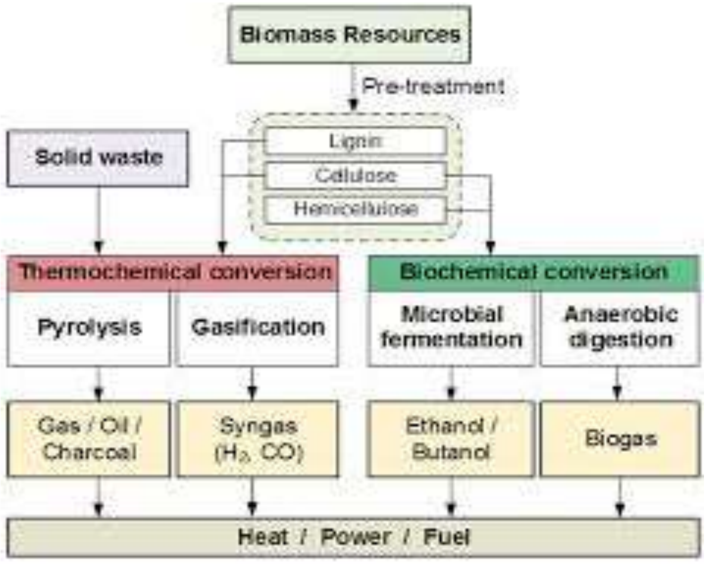
Fortunately, new technologies — including pollution controls and combustion engineering — have advanced to the point that any emissions from burning biomass in industrial facilities are generally less than emissions produced when using fossil fuels (coal, natural gas, oil).

Renewable energy has included these technologies in our facilities.

Biomass resources

Biomass conversion process





Advantages of Biomass Energy

Bioenergy systems offer significant possibilities for reducing greenhouse gas emissions due to their immense potential to replace fossil fuels in energy production.

Biomass reduces emissions and enhances carbon sequestration since short-rotation crops or forests established on abandoned agricultural land accumulate carbon in the soil.

Bioenergy usually provides an irreversible mitigation effect by reducing carbon dioxide at source, but it may emit more carbon per unit of energy than fossil fuels unless biomass fuels are produced unsustainably.

Biomass can play a major role in reducing the reliance on fossil fuels by making use of thermochemical conversion technologies.

In addition, the increased utilization of biomass-based fuels will be instrumental in safeguarding the environment, generation of new job opportunities, sustainable development and health improvements in rural areas.

The development of efficient biomass handling technology, improvement of agro-forestry systems and establishment of small and large-scale biomass-based power plants can play a major role in rural development.

Biomass energy could also aid in modernizing the agricultural economy.

Fixed-dome plant

A fixed-dome plant consists of a digester with a fixed, non-movable gas holder, which sits on top of the digester.

When gas production starts, the slurry is displaced into the compensation tank.

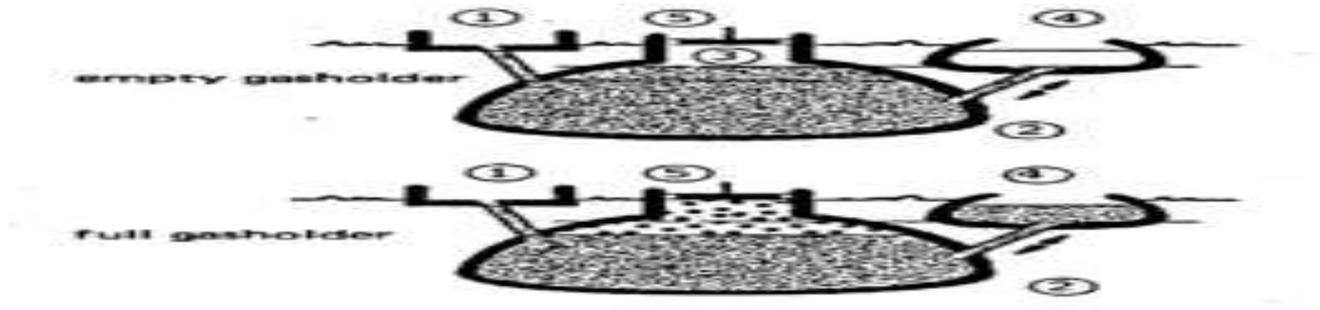
Gas pressure increases with the volume of gas stored and the height difference between the slurry level in the digester and the slurry level in the compensation tank.

The costs of a fixed-dome biogas plant are relatively low. It is simple as no moving parts exist.

There are also no rusting steel parts and hence a long life of the plant (20 years or more) can be expected. The plant is constructed underground, protecting it from physical damage and saving space.

While the underground digester is protected from low temperatures at night and during cold seasons, sunshine and warm seasons take longer to heat up the digester.

No day/night fluctuations of temperature in the digester positively influence the bacteriological processes.

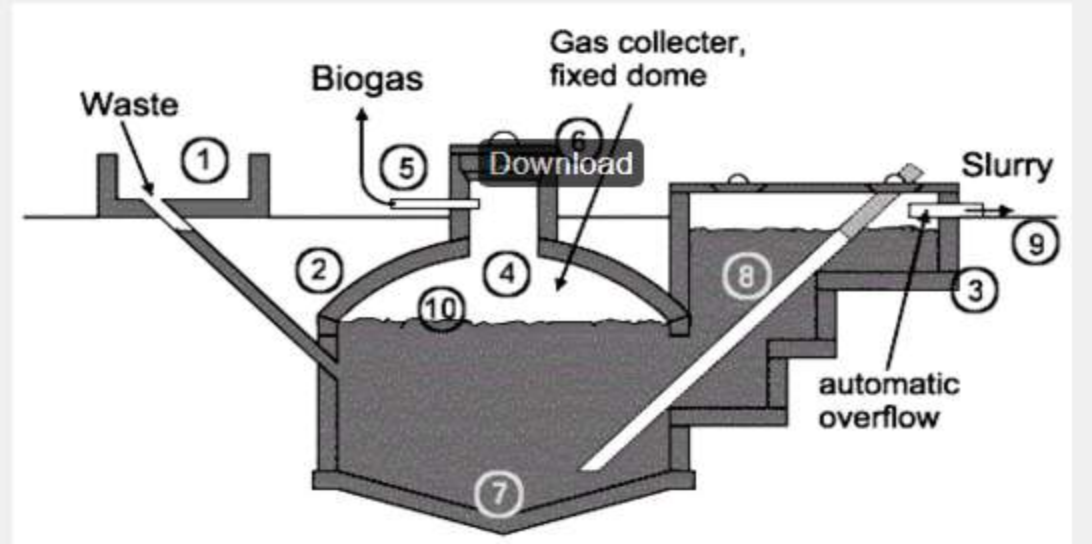


A fixed-dome plant comprises of a closed, dome-shaped digester with an immovable, rigid gas-holder and a displacement pit, also named 'compensation tank'.

The gas is stored in the upper part of the digester. When gas production commences, the slurry is displaced into the compensating tank.

Gas pressure increases with the volume of gas stored, i.e. with the height difference between the two slurry levels.

If there is little gas in the gas-holder, the gas pressure is low.



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Floating Drum Biogas Plants

Floating-drum plants consist of an underground digester (cylindrical or dome-shaped) and a moving gas-holder.

The gas-holder floats either directly on the fermentation slurry or in a water jacket of its own.

The gas is collected in the gas drum, which rises or moves down, according to the amount of gas stored.

The gas drum is prevented from tilting by a guiding frame.

When biogas is produced, the drum moves up and when it is consumed, the drum goes down.

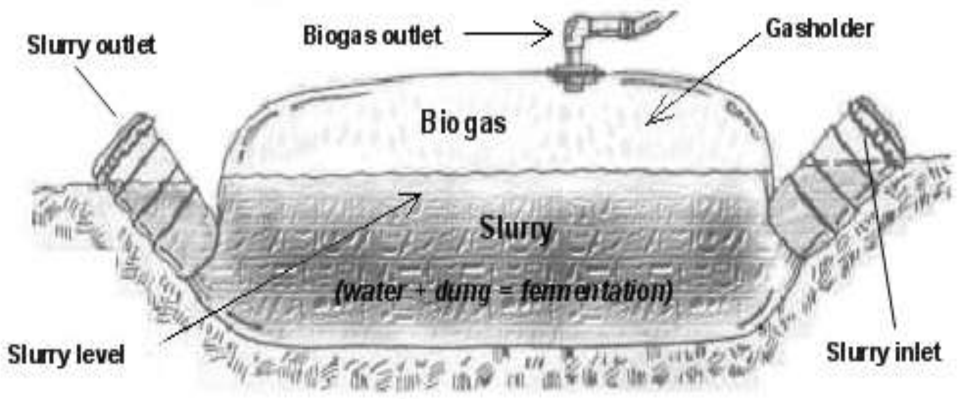
Disadvantages:

The steel drum is relatively expensive and maintenance-intensive. Removing rust and painting has to be carried out regularly.

The life-time of the drum is short (up to 15 years; in tropical coastal regions about five years). If fibrous substrates are used, the gas-holder shows a tendency to get "stuck" in the resultant floating scum.

Low-Cost Polyethylene Tube Digester

In the case of the Low-Cost Polyethylene Tube Digester model which is applied in Bolivia (Peru, Ecuador, Colombia, Centro America and Mexico), the tubular polyethylene film (two coats of 300 microns) is bended at each end around a 6 inch PVC drainpipe and is wound with rubber strap of recycled tire-tubes.



Balloon Plants

A balloon plant consists of a heat-sealed plastic or rubber bag (balloon), combining digester and gas-holder. The gas is stored in the upper part of the balloon.

The inlet and outlet are attached directly to the skin of the balloon.

Gas pressure can be increased by placing weights on the balloon. If the gas pressure exceeds a limit that the balloon can withstand, it may damage the skin.

Therefore, safety valves are required. If higher gas pressures are needed, a gas pump is required. Since the material has to be weather- and UV resistant, specially stabilized, reinforced plastic is preferred.

Other materials which have been used successfully include RMP (red mud plastic)

The useful life-span does usually not exceed 2-5 years.

Advantages:
Standardized prefabrication at low cost,
low construction sophistication,
ease of transportation,
shallow installation suitable for use in areas with a high groundwater table;
high temperature digesters in warm climates;
uncomplicated cleaning,
emptying and maintenance;
difficult substrates like water hyacinths can be used

Disadvantages:
Low gas pressure may require gas pumps;
scum cannot be removed during operation;
the plastic balloon has a relatively short useful life-span and
is susceptible to mechanical damage and usually not
available locally.

COGENERATION

Cogeneration is a technique for producing heat and electricity in one process that can save considerable amounts of energy.

Cogeneration is often associated with the combustion of fossil fuels but can also be carried out using some renewable energy sources and by burning wastes.

Cogeneration often reduces energy use cost-effectively and improves security of energy supply.

Cogeneration helps overcome the main drawback of conventional electrical and thermal systems: the significant heat losses that detract greatly from efficiency.

Heat losses are reduced and efficiency is increased when cogeneration is used to supply heat to various applications and facilities.

Energy analyses of cogeneration-based district energy systems are described in this chapter. Relative to conventional systems, such integrated systems can be complex in that they often carry out the provision of electrical, heating, and cooling services simultaneously.

Geothermal Energy

If you were to dig a big hole straight down into the Earth, you would notice the temperature getting warmer the deeper you go.

That's because the inside of the Earth is full of heat. This heat is called geothermal energy.
People can capture geothermal energy through:

Geothermal power plants, which use heat from deep inside the Earth to generate steam to make electricity.

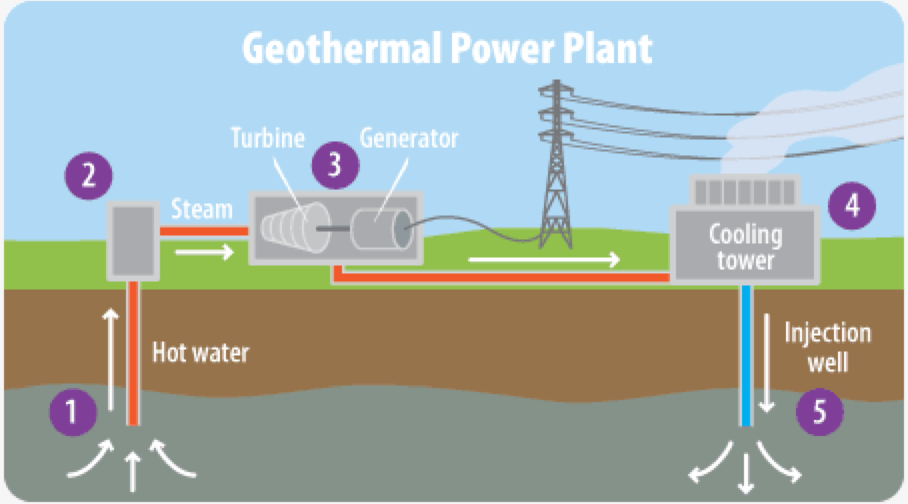
Geothermal heat pumps, which tap into heat close to the Earth's surface to heat water or provide heat for buildings.

Geothermal Power Plants

At a geothermal power plant, wells are drilled 1 or 2 miles deep into the Earth to pump steam or hot water to the surface.

These power plants in an area that has a lot of hot springs, geysers, or volcanic activity, because these are places where the Earth is particularly hot just below the surface.

How It Works



1. Hot water is pumped from deep underground through a well under high pressure.
2. When the water reaches the surface, the pressure is dropped, which causes the water to turn into steam.
3. The steam spins a turbine, which is connected to a generator that produces electricity.
4. The steam cools off in a cooling tower and condenses back to water.
5. The cooled water is pumped back into the Earth to begin the process again.

Geothermal Heat Pumps

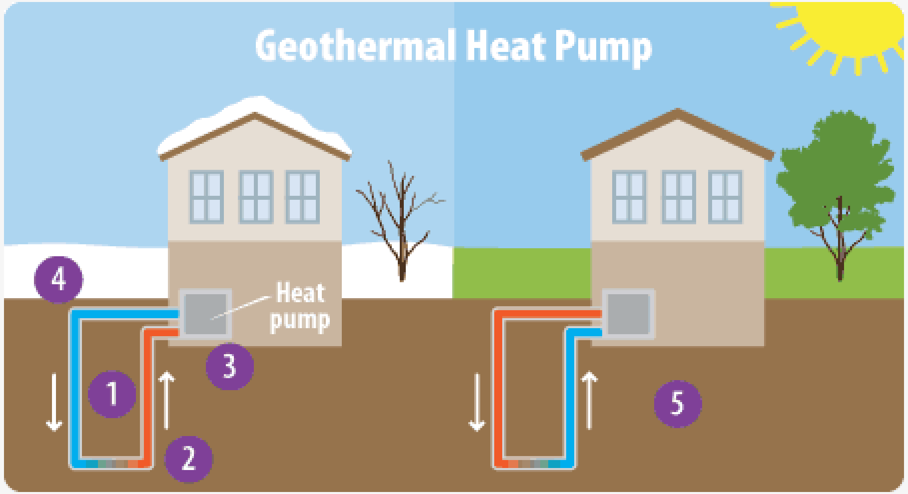
Not all geothermal energy comes from power plants. Geothermal heat pumps can do all sorts of things—from heating and cooling homes to warming swimming pools.

These systems transfer heat by pumping water or a refrigerant (a special type of fluid) through pipes just below the Earth's surface, where the temperature is a constant 50 to 60°F.

During the winter, the water or refrigerant absorbs warmth from the Earth, and the pump brings this heat to the building above.

In the summer, some heat pumps can run in reverse and help cool buildings.

How It Works



1. Water or a refrigerant moves through a loop of pipes.
2. When the weather is cold, the water or refrigerant heats up as it travels through the part of the loop that's buried underground.
3. Once it gets back above ground, the warmed water or refrigerant transfers heat into the building.
4. The water or refrigerant cools down after its heat is transferred. It is pumped back underground where it heats up once more, starting the process again.
5. On a hot day, the system can run in reverse. The water or refrigerant cools the building and then is pumped underground where extra heat is transferred to the ground around the pipes.

Hydro power plant

Hydropower installations can be classified by size of power output, although the power output is only an approximate diversion between different classes. There is no international consensus for setting the size threshold between small and large hydropower.

For the United Nations Industrial Development Organization (UNIDO) and the European Small Hydropower Association (ESHA) and the International Association for Small Hydro (IASH) a capacity of up to **10 MW** total is becoming the generally accepted norm for **small hydropower plants (SHP)**.

In China, it can refer to capacities of up to 25 MW, in India up to 15 MW and in Sweden small means up to 1.5 MW, in Canada 'small' can refer to upper limit capacities of between 20 and 25 MW, and in the United States 'small' can mean 30 MW.

Small hydro can be further subdivided into mini, micro and pico:

• **Mini (MH)**	< 1 MW	grid connected	special know how required
• **Micro**	< 100 kW	partially grid con.	professional know how required
• **Pico (PH)**	< 10 kW	island grids	small series units produced locally; professional equipment available
• **Family (FH)**	< ~1 kW	single households/clusters	often locally handmade solutions; professional equipment available

Classification of Water Turbines

They are basically of two types:
(a) Impulse turbine and
(b) Reaction turbine

(a) Impulse Turbine:

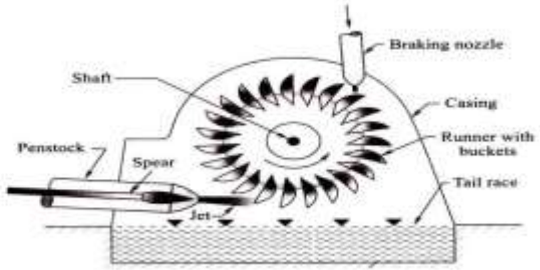
In an impulse turbine, the total potential energy available with water is fully converted into kinetic energy by means of nozzle. The turbine is quite suitable for high head and low discharge available with it.

In this type of turbine, there is a water nozzle which converts the total potential energy available with water into kinetic energy. Water is discharged from the nozzle in the form of water jet and high kinetic energy.

The high kinetic energy jet is made to strike,
On a series of curved buckets or blades mounted on the periphery of a wheel which is placed on the turbine shaft.

This is the type of impulse turbine which requires high head and less water availability.

Pelton wheel is one of the most commonly used impulse turbines.



Reaction Turbine

Reaction turbine is quite suitable for low head and high discharge. The water supplied to the reaction turbine possesses both pressure as well as kinetic energy.

The total pressure energy is not fully converted to kinetic energy initially, as it happens in impulse turbine. The water flows first of all to guide blades which supply water in a proper direction and then it is passed through moving blades which are mounted on the wheel.

A part of the pressure energy of water, when flowing through the moving blades, is converted into kinetic energy which is absorbed by the turbine wheel. The water leaving the moving blades is at low pressure. Thus, there is a difference in pressure between the entrance and exit of the moving blades.

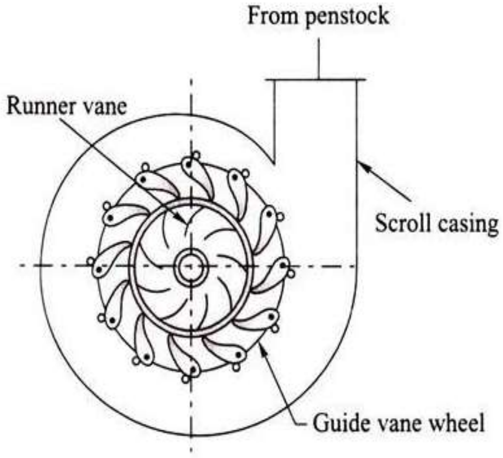
Due to this difference in pressure, there is an increase in kinetic energy and hence a reaction is developed in opposite direction which acts on the moving blades. The rotation of the wheel is set up in opposite direction. In case of reaction turbine, the water is discharged at the tail race through draft tube.

Francis Turbine:

Francis turbine is also called medium head turbine. In this turbine, water flows radically and finally discharges axially. Hence, this turbine is also called mixed flow turbine.

It consists of a spiral casing inside which there are large numbers of stationary guide blades/guide vanes.

They are fixed all around the circumference of an inner ring of moving vanes called runner . The runner is fixed on the turbine shaft.



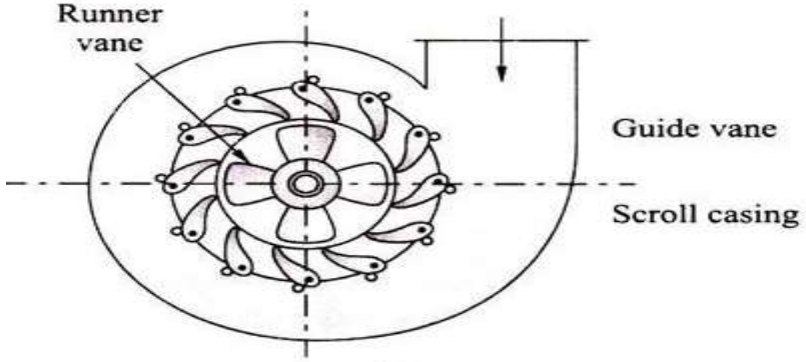
Kaplan Turbine:

Kaplan turbine is also called as low head reaction turbine which is suitable for comparatively low discharge and is known as axial flow reaction turbine.

It is similar to Francis turbine. It consists of a spiral casing in which there are large numbers of stationery guide vanes.

They are fixed all around the circumference of an inner ring of moving vanes called runner. High-pressure water enters the turbine casing and enters into the guide vanes.

The water strikes the runner and flows axially through guide vanes and imparts kinetic energy to the runner which produces rotation. The water is then discharged at the center of the runner in axial direction into the draft tube.



(b)

Essential components of hydroelectric system.

- Fore bay and Intake Structures,
- Head Race or Intake Conduits,
- Surge Tank,
- Turbines and Generators,
- Power House, and
- Trail Race and Draft Tube.