

Introduction to Hydroelectricity

- **Hydropower** is considered as one of the most economic and non polluting sources of energy.
- Power generated from water is known as **hydroelectricity**.
- Hydroelectricity means electricity generated by hydropower or from the use of the gravitational force of falling of flowing water.

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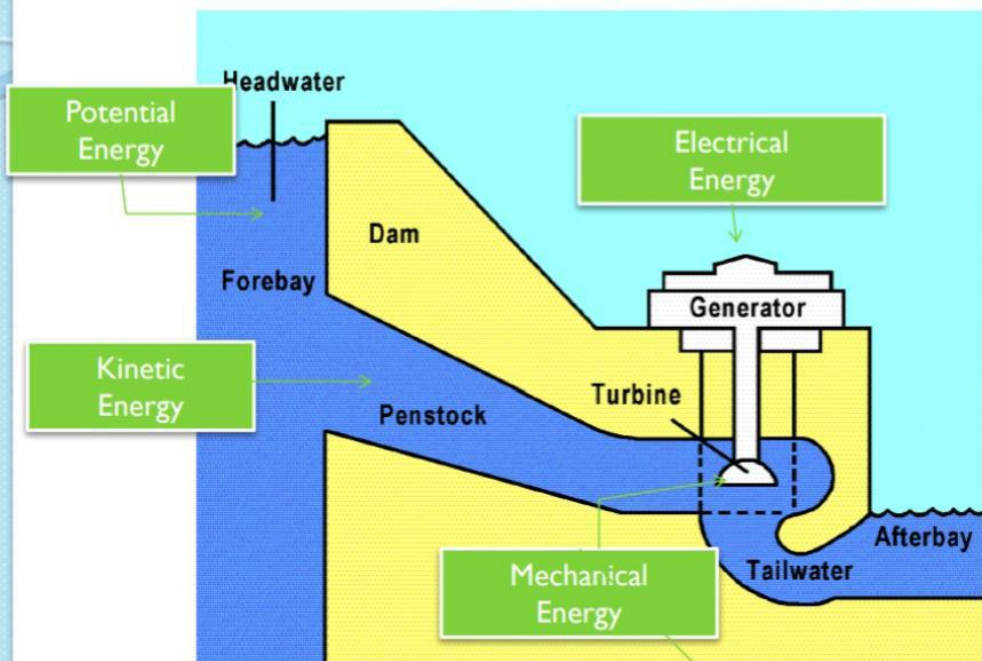
Hydroelectric Power Plants

- **Hydroelectric power plants** are used to convert the hydraulic potential energy from water into electrical energy.
- Hydro-electric power stations are generally located in hilly areas where dams can be built and large water reservoirs can be obtained.

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Hydropower to Electric Power



Classification of Hydroelectric Power Plants by size

Large- hydro

More than 100 MW

Medium-hydro

15 - 100 MW

Small-hydro

1 - 15 MW

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Mini-hydro

Above 100 KW, but below 1 MW

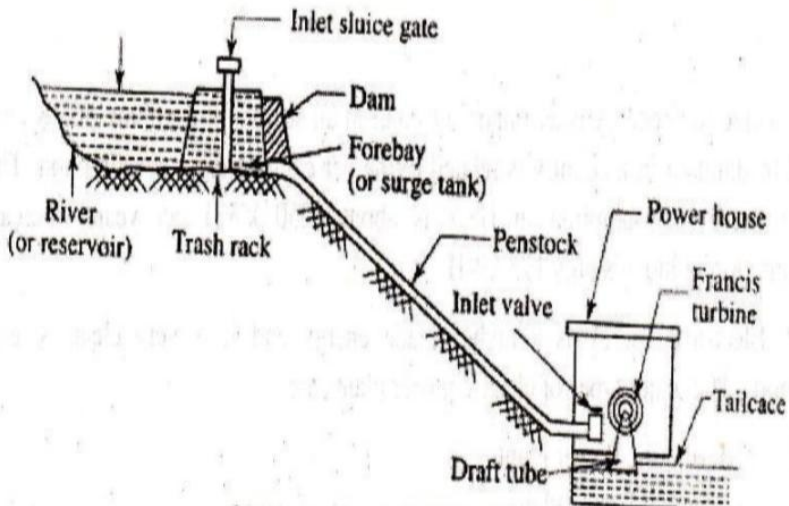
Micro-hydro

From 5KW up to 100 KW

Pico-hydro

From a few hundred watts up to 5KW

Schematic Arrangement of modern Hydroelectric Power Plant



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Working of Hydroelectric Power Plant

- A dam is constructed across a water body.
- Water from the catchment area collects at the back of the dam to form reservoir.
- Water is brought to valve house at the start of penstock.
- The valve house contains main sluice valves and automatic isolating valves.

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- Water is taken to water turbine through a huge steel pipe known as penstock.
- The water turbine converts hydraulic energy into mechanical energy.
- The turbine drives the alternator which converts mechanical energy into electrical energy.

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Constituents of Hydroelectric Power Plant

- Hydraulic structures
- Water turbines
- Electrical equipment

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Hydraulic Structures

- Dams
- Spillways
- Headwork
- Surge Tanks
- Penstock
- Power Stations

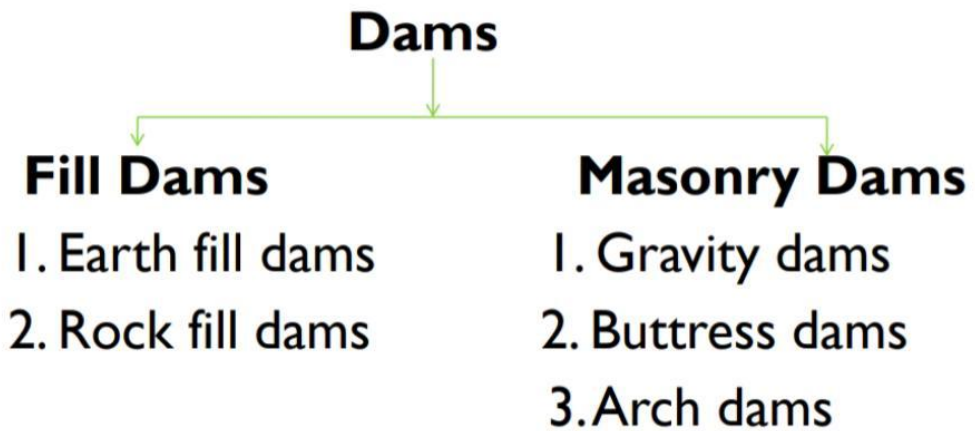
Dams

Dams are structures built over rivers to stop the water flow and form a reservoir.

A dam performs following two basic functions:-

- It develops a reservoir of the desired capacity to store water and;
- It builds up a head for power generation.

Classification of Dams based upon material of construction



Classification of dams based upon the height of the head

- High head – 100m and above
- Medium head - 30 to 100m
- Low head – 25 to 80m

Spillways

- A spillway is a protective device used for spilling of water from dams.
- It is used to provide for the release of flood water from a dam.
- It is used to prevent over topping of the dams which could result in damage or failure of dams.



Classification of spillways

- Uncontrolled type
- Controlled type

Headwork

- The headwork consists of the diversion structures at the head of an intake.
- They generally include booms and racks for diverting floating debris, sluices for by passing debris and sediments and valves for controlling the flow of water to the turbine.

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Surge Tanks

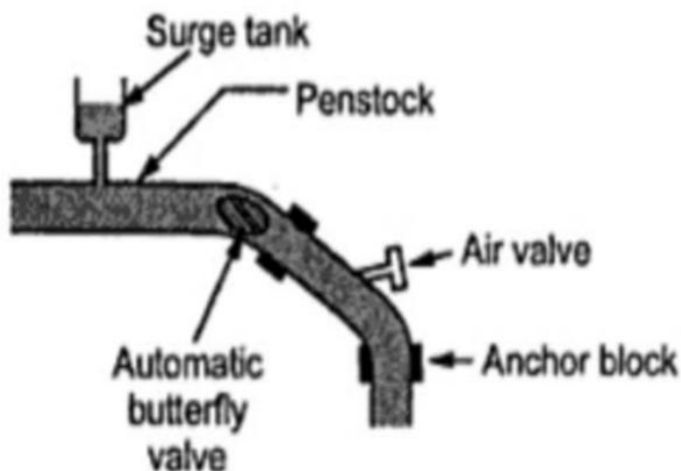
- Surge tanks are tanks connected to the water conductor system.
- It serves the purpose of reducing water hammering in pipes which can cause damage to pipes.

Penstocks

- Penstocks are pipes which carry water from the reservoir to the turbines inside power station.
- They are usually made of steel and are equipped with gate systems.
- Concrete penstocks are suitable for low head ($<30\text{m}$).
- Water under high pressure flows through the penstock.

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Figure showing various devices provided for the protection of the penstock



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Power Station

- Power station contains a turbine coupled to a generator.
- The water brought to the power station rotates the vanes of the turbine producing torque and rotation of turbine shaft.
- This rotational torque is transferred to the generator and is converted into electricity.
- The used water is released through the tail race.

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The equipment provided in the power station

- Hydraulic turbines
- Electric generators
- Governors
- Gate valves
- Relief valves
- Water circulation pumps
- Air duct
- Switch board and instruments
- Storage batteries
- Cranes

Water Turbines

- The water turbines are used to convert the energy of falling water into mechanical energy, which in turn rotates the electric generator coupled to it in producing the electric power.

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The principal types of water turbines are:-

1. Impulse turbine
2. Reaction turbine

Impulse Turbines

- Impulse turbines are one that works under atmospheric pressure. Such turbines are used for high heads.
- In this turbine the entire pressure of water is converted into kinetic energy in a nozzle and the velocity of the jet drives the wheel.

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Ratings of Pelton/ Turgo (impulse) turbines

- Rated head: 80- 1600 m
- Rated flow: 0.1- 20m³/s
- Rated speed: 150- 1500 rpm
- Rated output: 100 KW- 80MW
- Rated efficiency: 89%



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Types of Reaction Turbines

- The important types of reaction turbines are:-
 1. Francis turbine
 2. Kaplan turbine

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Ratings of Francis turbine

- Rated head: 10– 300 m
- Rated flow: 0.3- 100 m³/s
- Rated speed: 68.2- 1500 rpm
- Rated output: 100KW- 100MW
- Rated efficiency: 93%



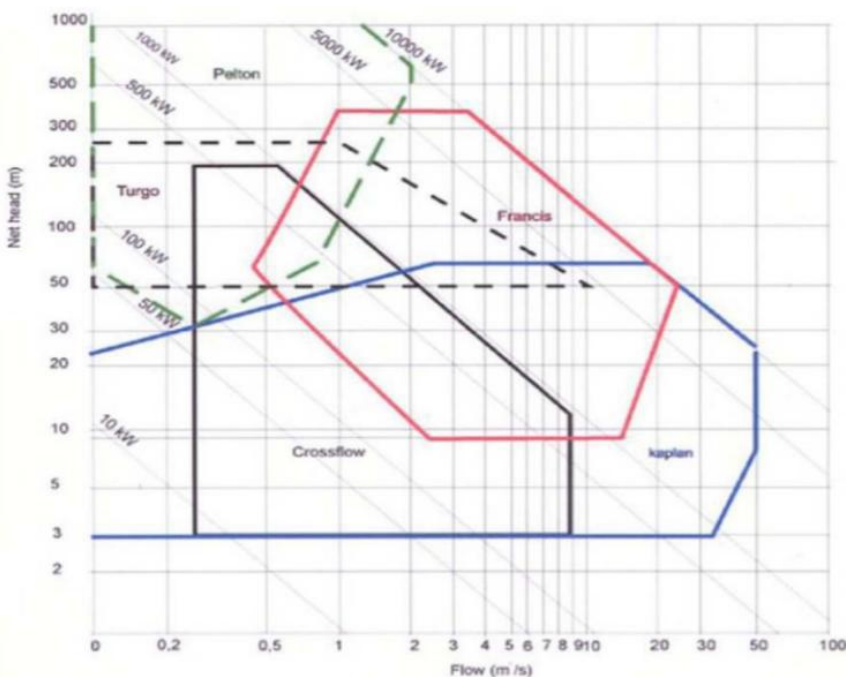
Ratings of the Kaplan turbine

- Rated head: 2- 70 m
- Rated flow: 1- 200 m³/s
- Rated speed: 68.2 – 750 rpm
- Rated output: 100 KW- 100 MW
- Rated efficiency: 93%



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Turbine Selection Graph



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Electrical Equipment

- The electrical equipment of a hydro electric power station includes alternators, transformers, circuit breaker and other switching and protective devices.

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Advantages of Hydroelectric Power Plants

- No fuel is required here as water is used for the generation of electrical energy.
- It is quit safe as no smoke or ash is produced.
- It requires very small running charges than other power plant because water is the source of energy which is available free of cost.
- It is comparatively simple in construction and requires less maintenance.

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- It does not takes more starting time like in steam power station. In fact such plant put into service instantly.
- It is robust and has a longer life.
- The hydropower plant serves many purposes. like generation of electrical energy, they also helps in irrigation and controlling flood.
- Being simple in design and operation.
- Manpower requirement is also low.
- More reliable than others.

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Disadvantages of Hydroelectric Power Plant

- It requires high capital because the construction of dam is required.
- There is uncertainty about the availability of huge amount of water because it is dependent on whether condition.
- Skilled and experienced hands are required to build the plant.
- Since far from the load centre and require long transmission lines is required.

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Conclusion

Hydroelectric power plants should be promoted since they don't pose any threat to the environment and also it requires very small running charges because water is the source of energy which is available free of cost.

THANK YOU