

HYDRO-ELECTRIC POWER PLANT

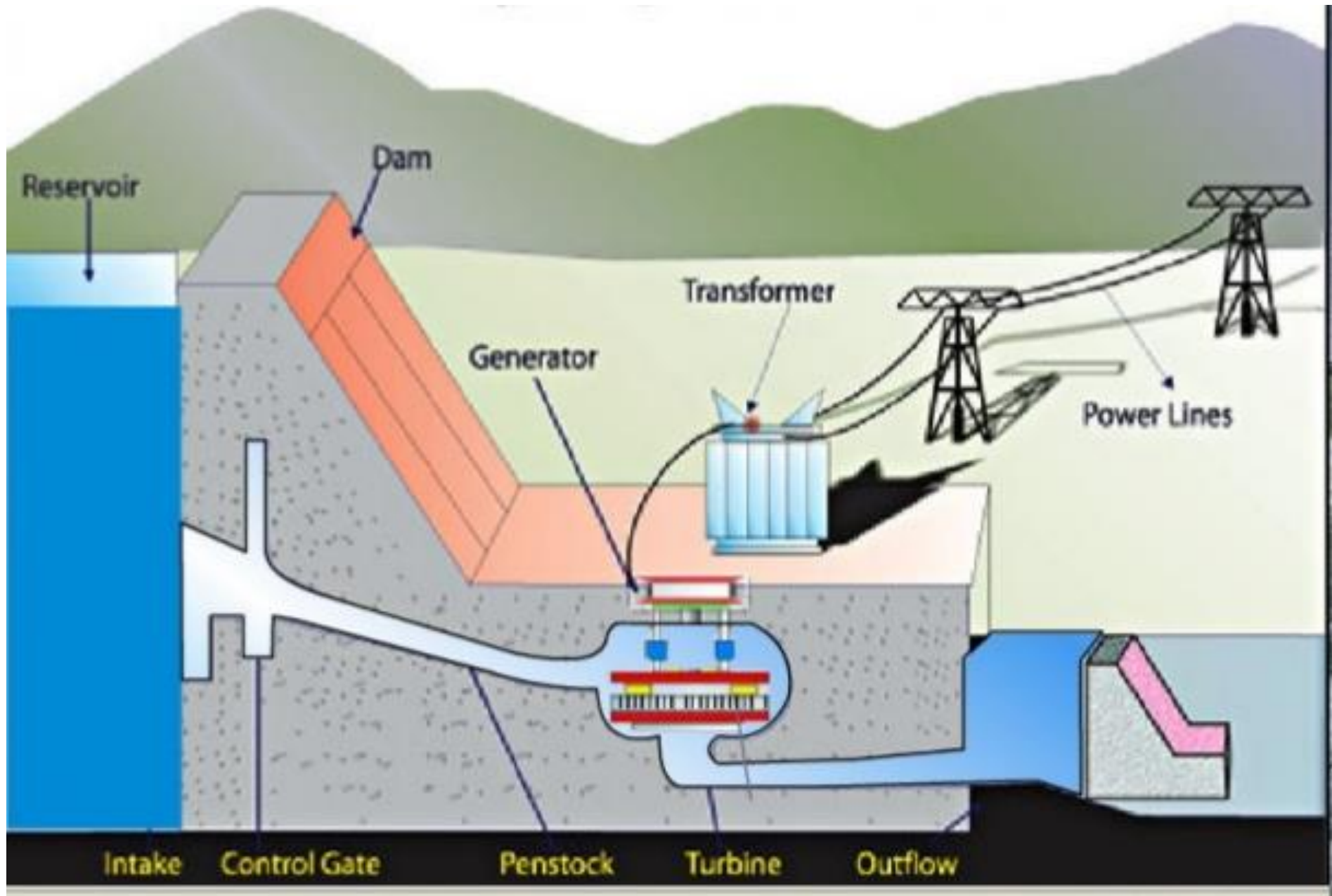
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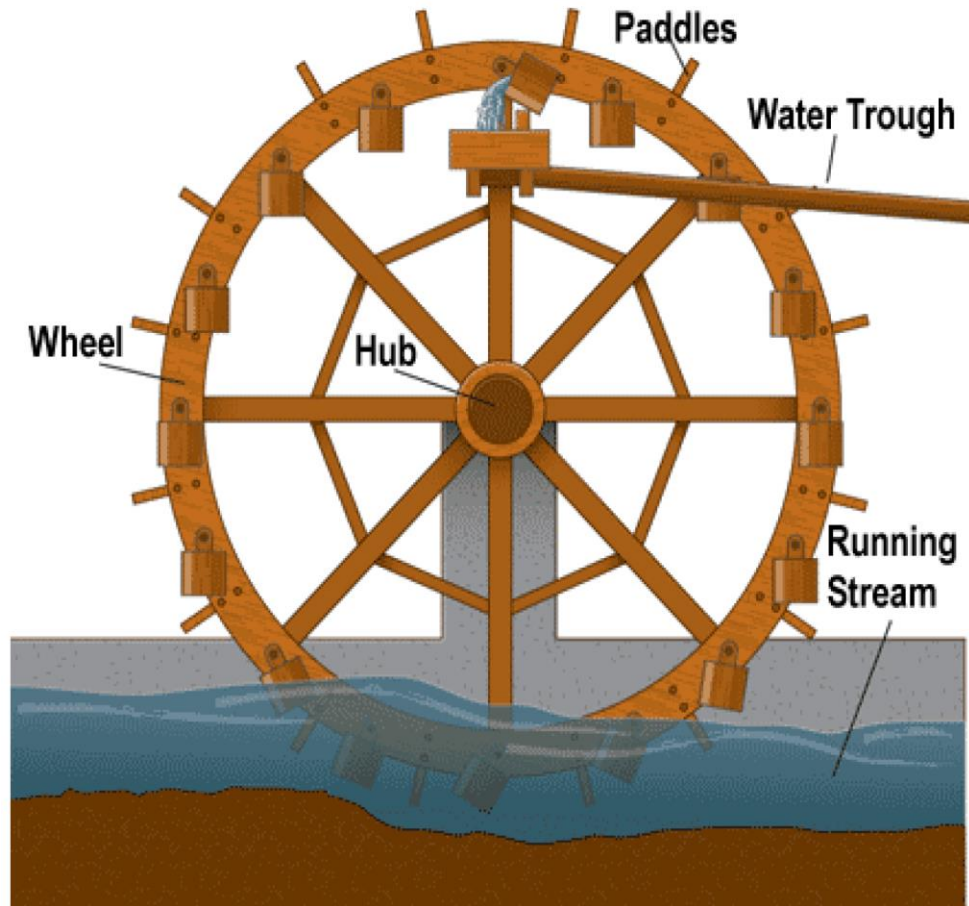


Hydro Electric Power Plant

Content:

- Concept, Classification, types of Hydro-electric Power plant
- Multipurpose Hydro Project
- Advantages and disadvantages
- Basic elements of Hydro-electric Power plant
- Water turbines used in Hydro power plant
- Factors for selecting hydraulic turbines
- Auxiliaries of Hydro-electric Power plant
- Governing of water turbine

Use of Hydro Energy



Hydro Electric Power Plant

Concept

- Human Civilization grew besides river all across the world.
- Water is one of the primary need of humans.
- Energy stored in water in terms of kinetic energy or potential energy can be utilised in hydro power plant.
- Hydro electric power plant provides 25% of the total electricity world's requirement.
- In Norway, 99% is provided by hydro power plant.
- In India, huge capability is there for hydro power plant due to mountains and large rivers.
- In 2008, Three Gorges Dam in China was built. This is the largest power plant at current date, generating 22,500 MW, adding to China's installed hydroelectric capacity of 196.79 GW.

The Three Gorges Dam



Hydro Electric Power Plant

Classification of Hydro Power Plant

- **As per Availability of water**

- 1. Run-off river power plant without pond (Storage)**

Not desirable, but used in remote location

- 2. Run-off river power plant with pond**

with small dam to store water, excess water is stored for week or months only

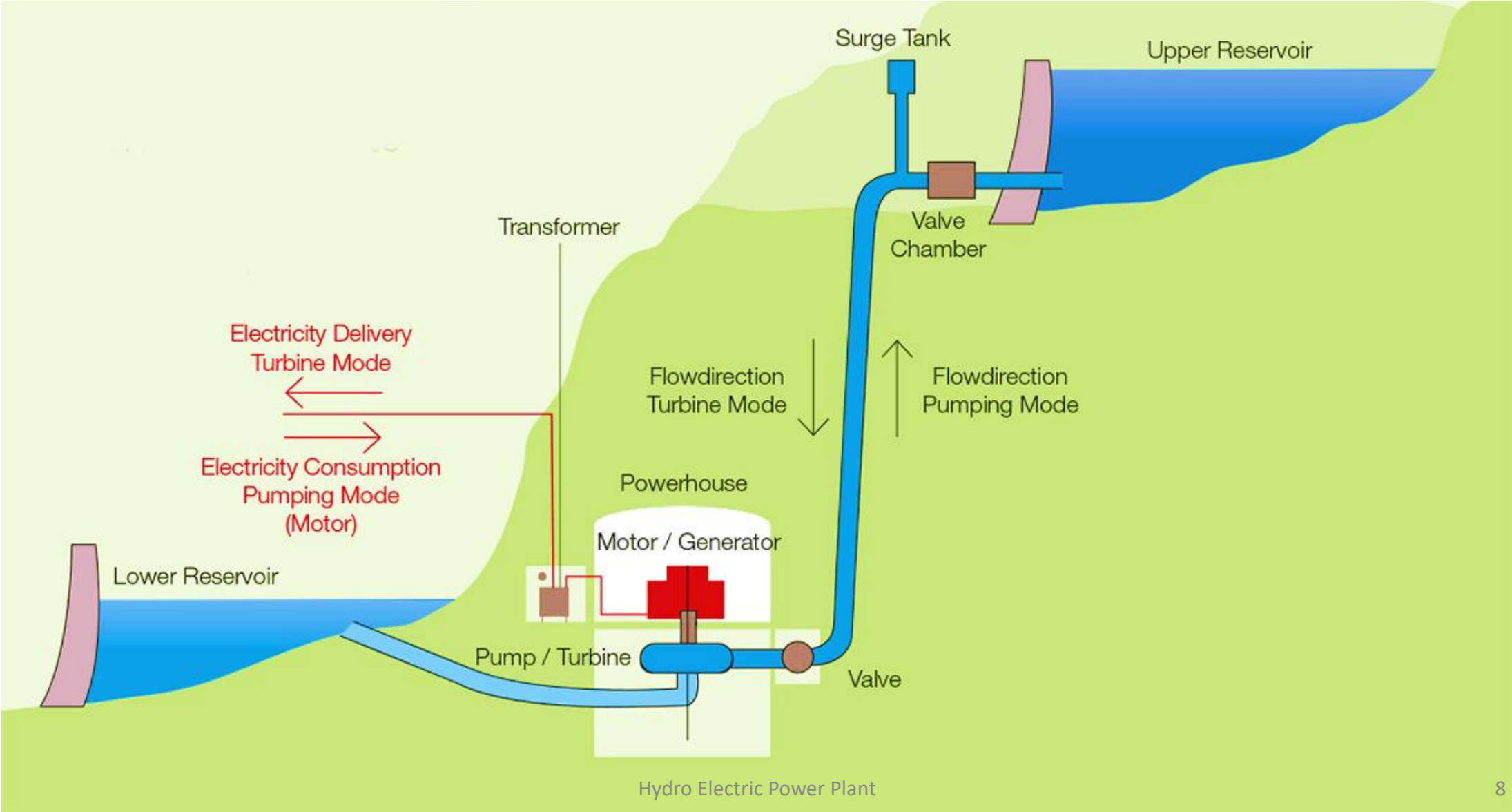
- 3. Storage Reservoir Plant**

Water is stored for electricity production through out a year

- 4. Pump Storage Plant**

excess electricity is utilized for storing fluid to higher level and when needed this water is released to fulfil peak load requirement

Pump Storage Power Plant



Classification of Hydro Power Plant

- **As per Head Available**

1. Low Head Plant (up to 30 meter)
2. Medium Head Plant (30 – 100 meter)
3. High Head Plant (more than 100 meter)

- **As per Electricity Load Connection**

1. Base Load Plant
2. Peak Load Plant

- **As per Location of Plant**

1. Surface Power Plant
2. Underground Power Plant

Classification of Hydro Power Plant

- **As per Plant Capacity**

1. MicroHydel Plant (up to 5 MW)
2. Medium Capacity Plant (5 – 100 MW)
3. High Capacity Plant (more than 100 MW)
4. Super Plant (more than 1000 MW)

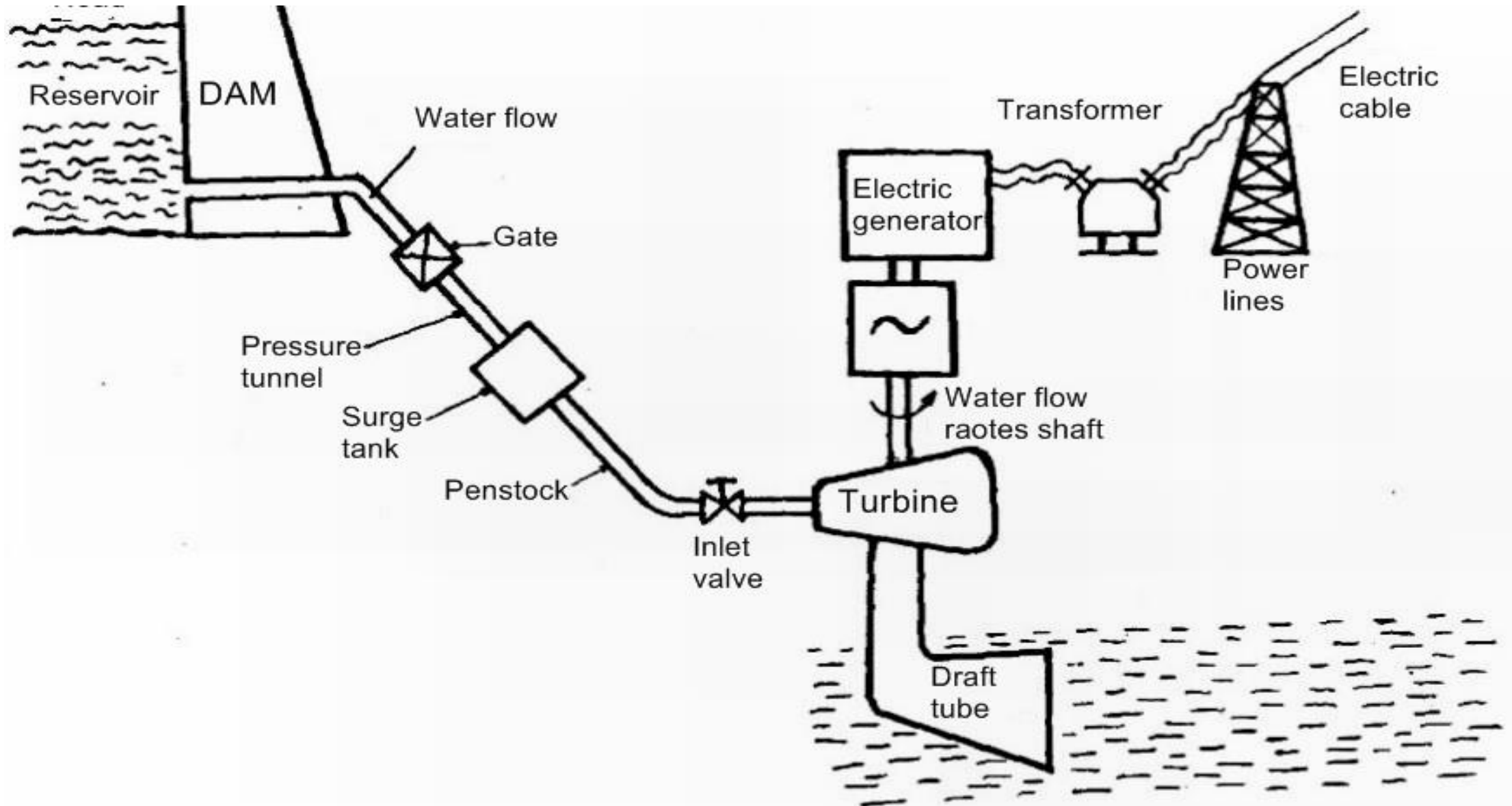
- **As per Turbine Specific Speed**

1. High Specific Speed Plant ($N_s > 340$)
2. Medium Specific Speed Plant ($50 < N_s < 340$)
3. Low Specific Speed Plant ($N_s < 50$)

Multi Purpose Hydro Project

- Contrasted to a single-purpose project that serves only one purpose, a multipurpose project is designed for any combinations of two or more from below mentioned functions.
 1. Irrigation
 2. Hydro Electric power
 3. Flood control
 4. Municipal and Industrial water use
 5. Navigation
 6. Water Quality Control
 7. Recreation
 8. Tourism
 9. Fish and wildlife benefits

Elements of Hydro Electric Power Plant



Elements of Hydro Electric Power Plant

- **Reservoir** – To store water in huge amount for running turbine throughout year.
- **Dam** – To act as resistance to flow of water and to increase head of water available.
- **Trace Rack** – A metal net used to remove garbage, fish or any marine creature from entering the turbine.
- **Fore Bay** – A temporary storage space for water acts as natural surge tank. Controls flow of water during sudden variations.

Elements of Hydro Electric Power Plant

- **Surge Tank** – A tank constructed near turbine to avoid water hammering and cavitation inside penstock is known as surge tank.
- **Penstock** – A pipeline connecting turbine to water body is known as penstock. Gates are provided at the entrance of penstock for maintenance work requirement, if any.
- **Spill way** – A curvature portion provided at the end of exit of water to avoid damage to dam due to high velocity water is known as spill way.

Elements of Hydro Electric Power Plant

- **Power House** – A structure constructed enclosing electricity generating devices like turbine, generator, etc.
- **Prime mover** – A device converting hydraulic energy to mechanical energy is known as prime mover. Turbines like Francis, Kaplan and Pelton wheel are used as prime mover in Hydro electric Power plant
- **Draft Tube** - draft tube at the end of the turbine increases the pressure of the exiting fluid at the expense of its velocity. This means that the turbine can reduce pressure to a higher extent without fear of back flow from the tail race.

Advantages of Hydro Electric Power Plant

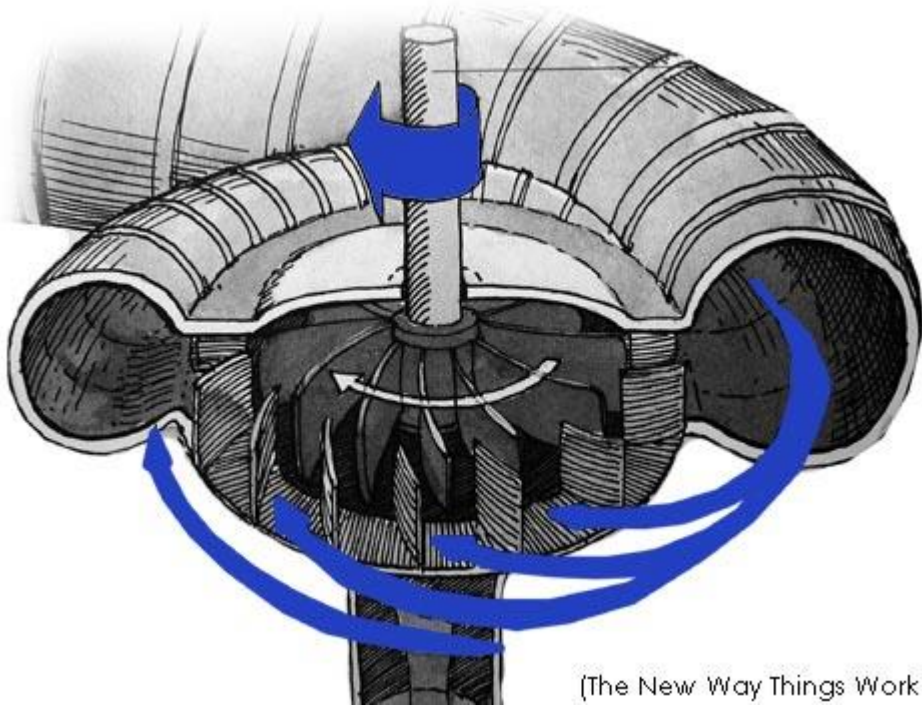
- Working fluid is water so it is known as clean fuel power plant which don't produces any air pollution elements.
- Operating cost is low.
- Can work as per Current electricity demand.
- Start and stop time is less.
- Can last up to 50 years of lifetime.
- Can be used as base load as well as peak load plant.

Disadvantages of Hydro Electric Power Plant

- Highly dependable on availability of water.
- Can cause environmental damage.
- Initial cost is much higher.
- May cause draught.
- Set up time is higher.
- Load center is far from plant so transmission loss is high.
- Needs large amount of space.

Types of Turbines in Hydro Electric Power Plant

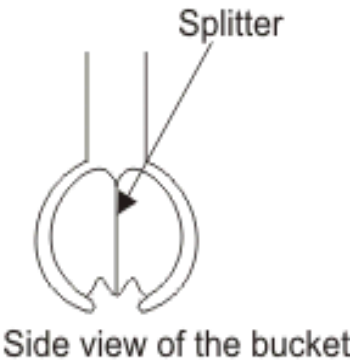
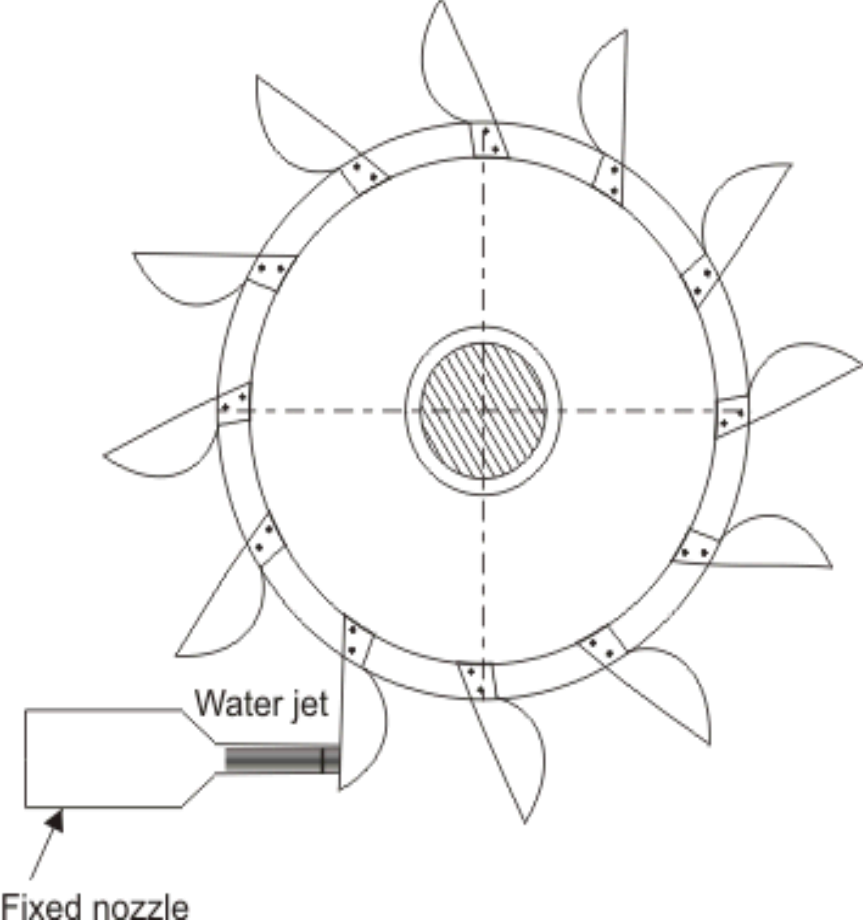
1. Pelton Wheel turbine
2. Francis turbine
3. Kaplan turbine



(The New Way Things Work 33)



Pelton Wheel Turbine



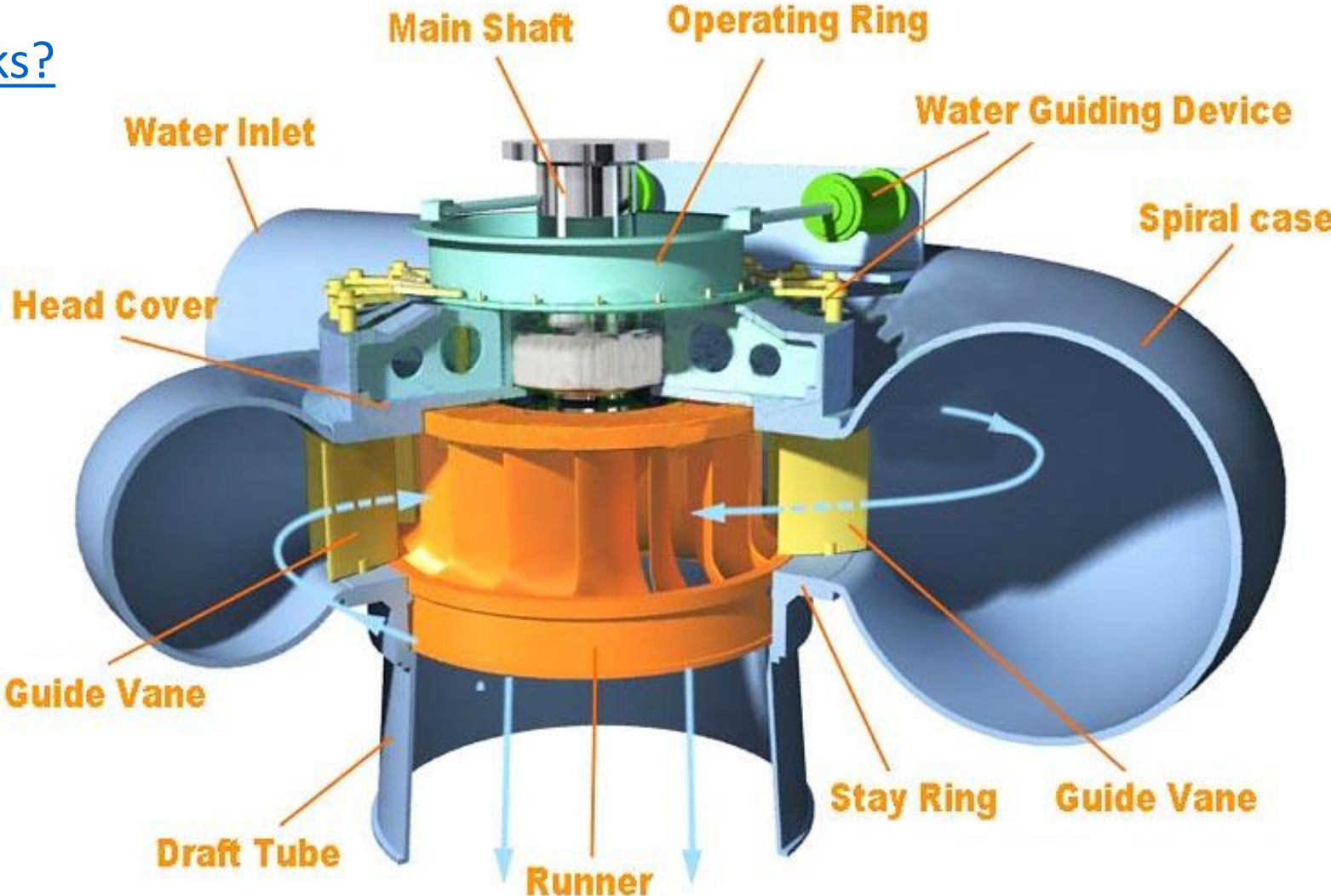
[How It Works???](#)

Pelton Wheel Turbine

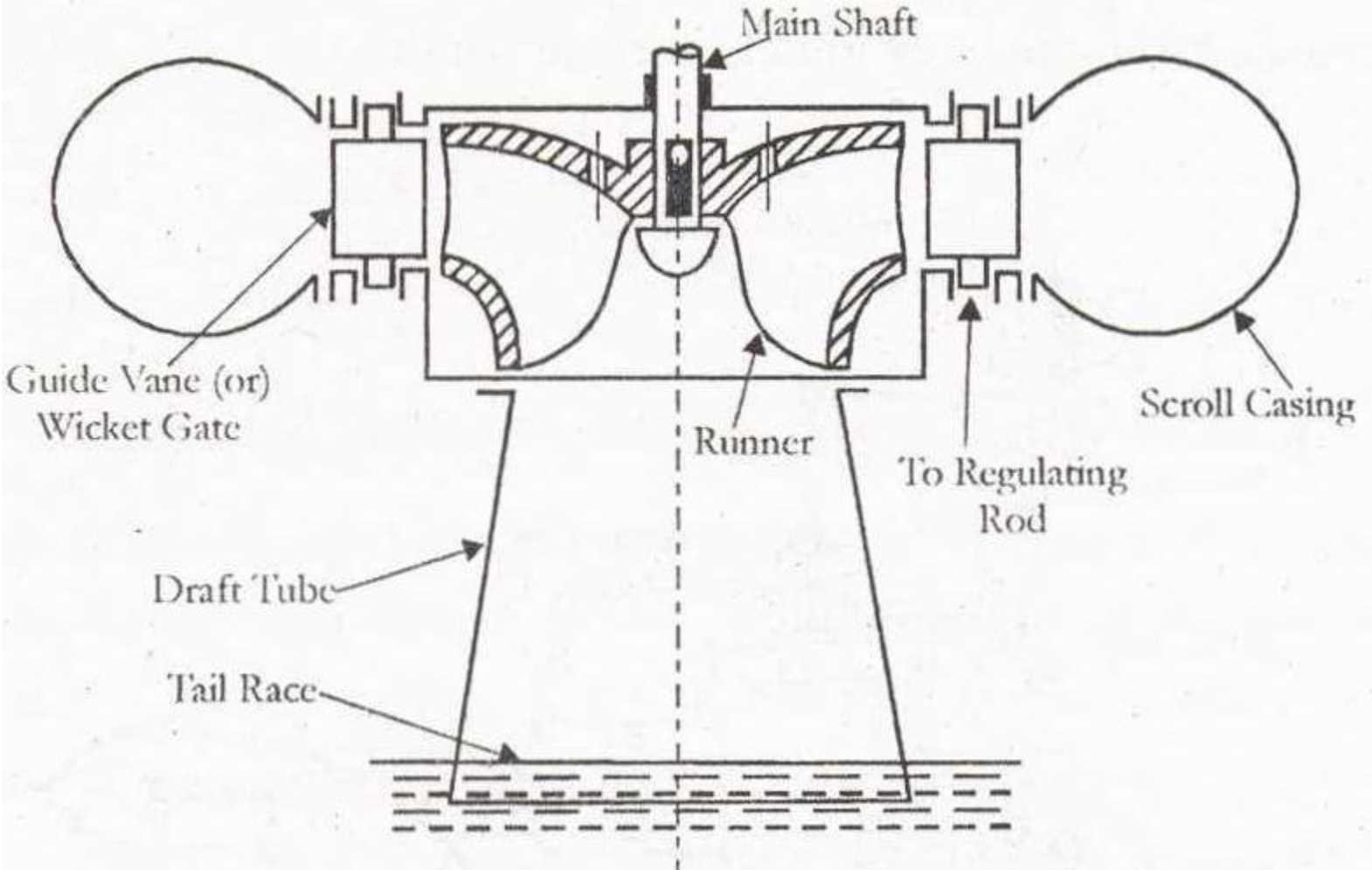
- Impulse turbine
- Set of nozzles and runner with bucket shaped blades
- Nozzles converts fluid energy into kinetic energy by creating fluid jet
- This high velocity fluid strikes with blades (Runner) and creates mechanical energy
- Maximum power and efficiency are achieved when the velocity of the water jet is twice the velocity of the rotating buckets
- Jets are directed in reverse direction by blades so as to get maximum utilization of momentum transfer
- Pelton wheels are the preferred turbine for hydro-power where the available water source has relatively high hydraulic head at low flow rates

Francis Turbine

How it works?



Francis Turbine

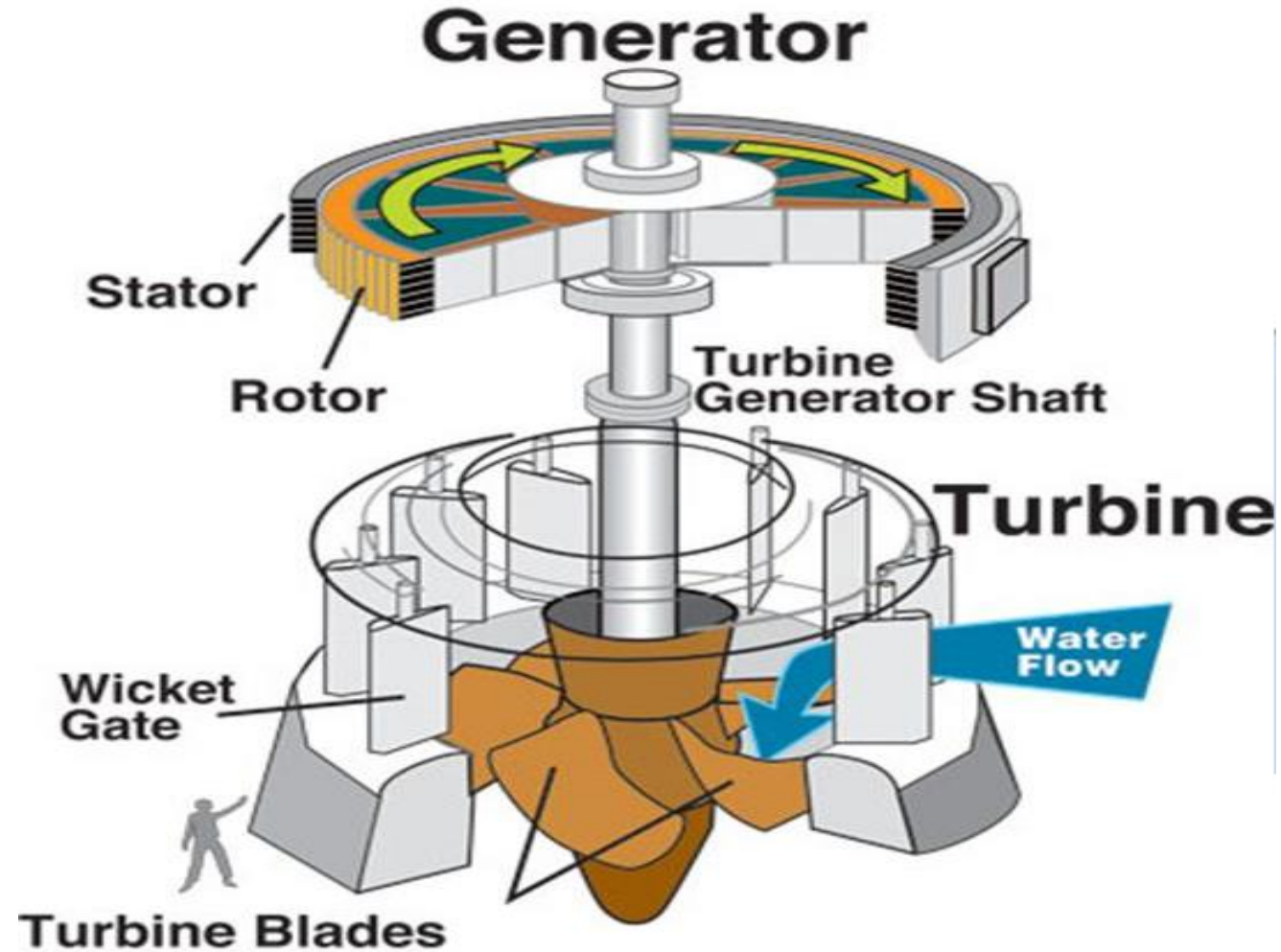


Francis Turbine

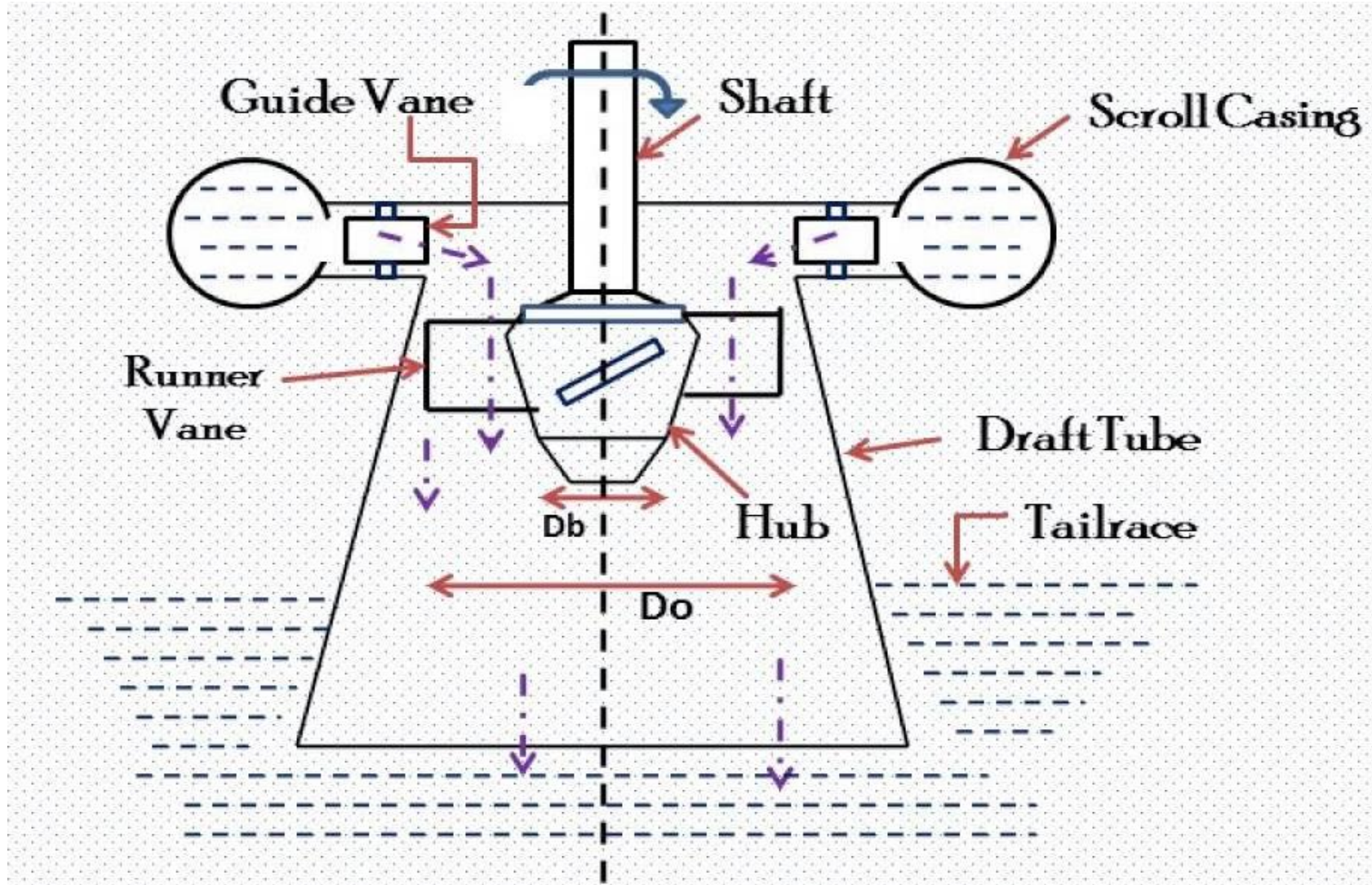
- It is an inward-flow reaction turbine that combines radial and axial flow concepts.
- A part of the energy is given up by the fluid because of pressure changes occurring in the blades of the turbine, quantified by the expression of degree of reaction
- Major components are spiral casing, guide and stay vanes, runner blades and draft tube
- Francis turbines may be designed for a wide range of heads and flows. This, along with their high efficiency, has made them the most widely used turbine in the world. Francis type units cover a head range from 40 to 600 m

Kaplan Turbine

[How it works?](#)



Kaplan Turbine



Kaplan Turbine

- The Kaplan turbine is a propeller-type water turbine which has adjustable blades.
- The Kaplan turbine is an inward flow reaction turbine.
- Water is directed tangentially through the wicket gate and spirals on to a propeller shaped runner, causing it to spin.
- The outlet is a specially shaped draft tube that helps decelerate the water and recover kinetic energy.
- They are used where low head and high flow rate of fluid is available.

Auxiliaries of Hydro electric power plant

- Lubrication system for generator and turbine bearings.
- Drainage pumps for removing leakage water.
- Air compressors for governor, brakes and other system.
- Cooling water system for generator.
- Fire detection and extinguishing system
- Intake gate
- Level monitoring
- Heating, ventilation and AC