Welcome to the presentation on

Hydroelectric Power Plant

By

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Introduction

- Hydro-electric projects may not be used entirely for power generation.
- Some times they are undertaken for flood control and irrigation purpose in which case they are known as multi-purpose projects e.g. Bhakra-Nangal and Damodar Valley Corporation (D.V.C.) projects.
- The former is mainly for mainly power generation and irrigation, whereas the latter is mainly concerned with flood control.

Major Hydro power station in Gujarat state

Type of Power Plant	Name of Place	Total Installed Capacity
Hydro Power Plant	Kadana	60 MW
	Ukai	305 MW
	Narmada Dam	1500 MW

TYPES OF HYDRO ELECTRIC POWER STATION.

PARTS OF HYDRO ELECTRIC POWER STATION.

HIGH HEAD SCHEME.

MEDIUM HEAD SCHEME.

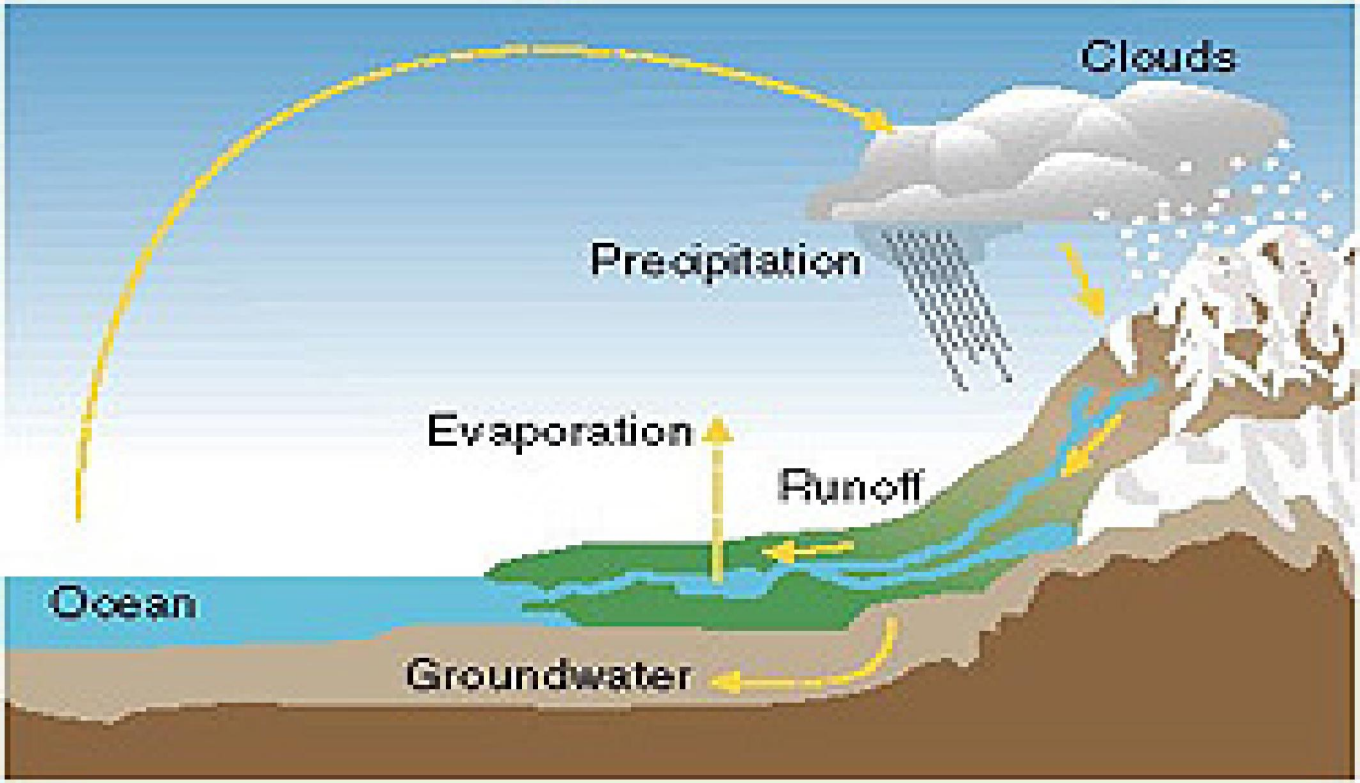
LAW HEAD SCHEME.

ADVANTAGES.

DISADVANTAGES.

SITE SILECTION OF HYDRO POWER STATION.

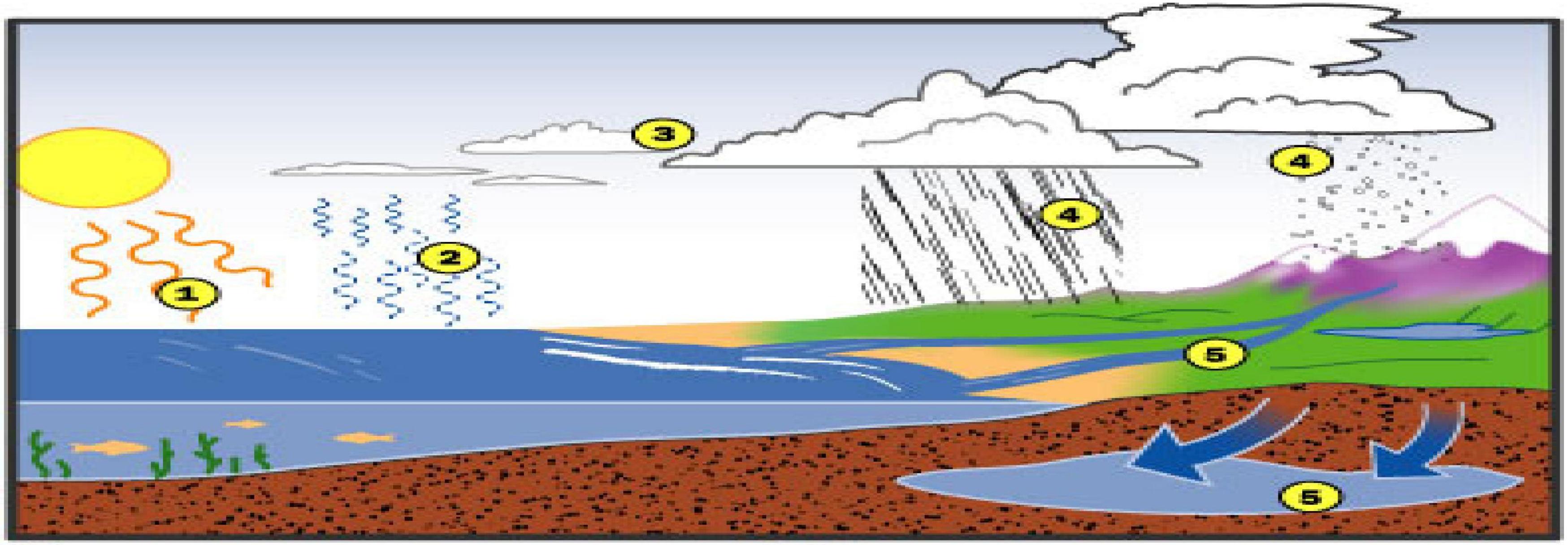
Hydrologic Cycle



Hydrologic Cycle

- The sun heats the air, causing the air to rise in the atmosphere.
- The air is colder higher up, so as the water vapor rises, it cools, condensing into droplets.
- As the sun heats liquid water, the water evaporates into vapor in the air.
- When enough droplets accumulate in one area, the droplets may become heavy enough to fall back to Earth as precipitation.

Hydrologic Cycle



1. The sun heats the ocean.
2. Ocean water evaporates and rises into the air.
3. The water vapor cools and condenses to become droplets, which form clouds.
4. If enough water condenses, the drops become heavy enough to fall to the ground as rain and snow.
5. Some rain collects in groundwells. The rest flows through rivers back into the ocean.

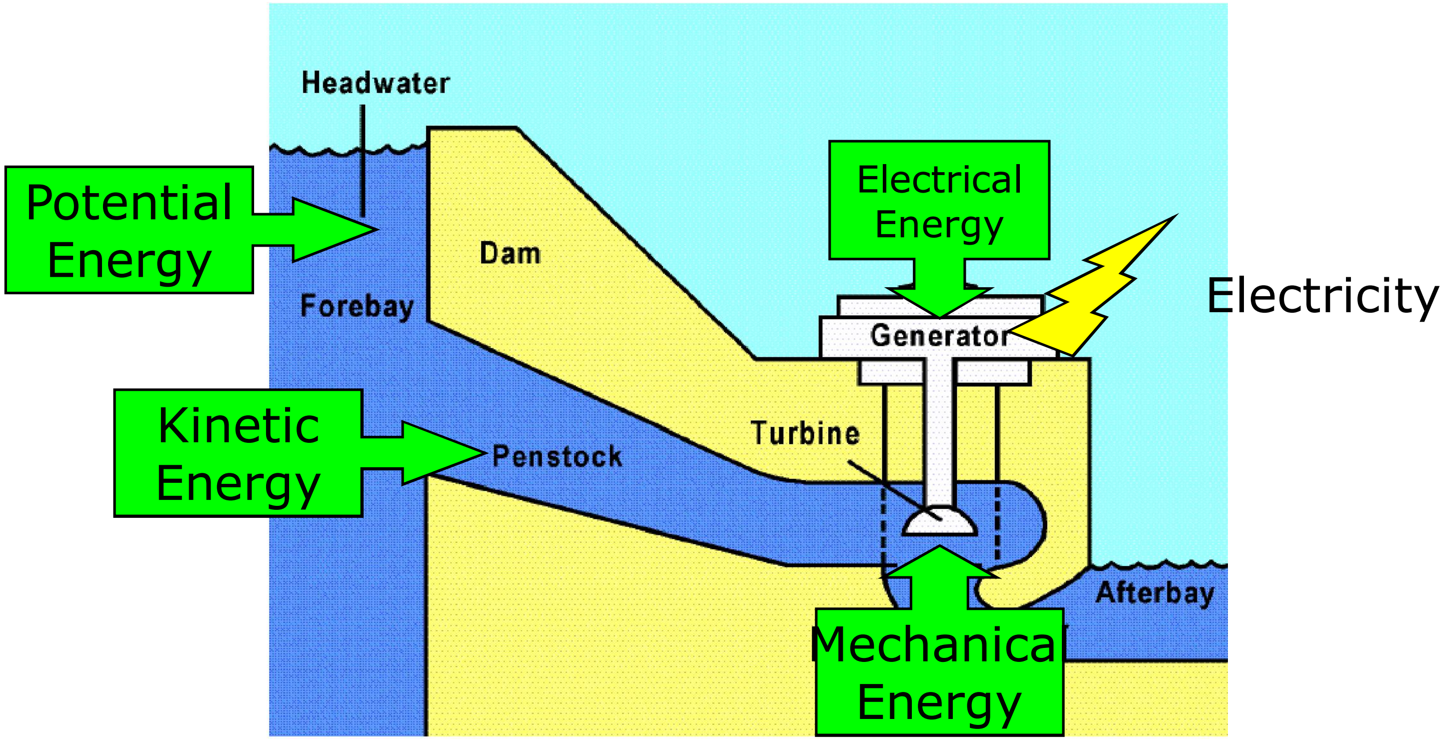
Hydro electric Power Plants

- Moving water, such as a river or a waterfall, has mechanical energy.
- 'Mechanical energy is the energy that is possessed by an object due to its motion or stored energy of position.' This means that an object has mechanical energy if it's in motion or has the potential to do work based on its position. The energy of motion is called kinetic energy and the stored energy of position is called potential energy.
- Water has both the ability and the potential to do work. Therefore, water contains mechanical energy (the ability to do work), kinetic energy (in moving water, the energy based on movement), and potential energy (the potential to do work.)
- The potential and kinetic/mechanical energy in water is harnessed by creating a system to efficiently process the water and create electricity from it.
- A hydroelectric power plant harnesses the energy found in moving or still water and converts it into electricity.

Hydroelectric Power Plant

Water in dam (P.E.) → Nozzle (K.E.) → Turbine (M.E.) → Generator (Electrical)

Hydro Power to Electricity

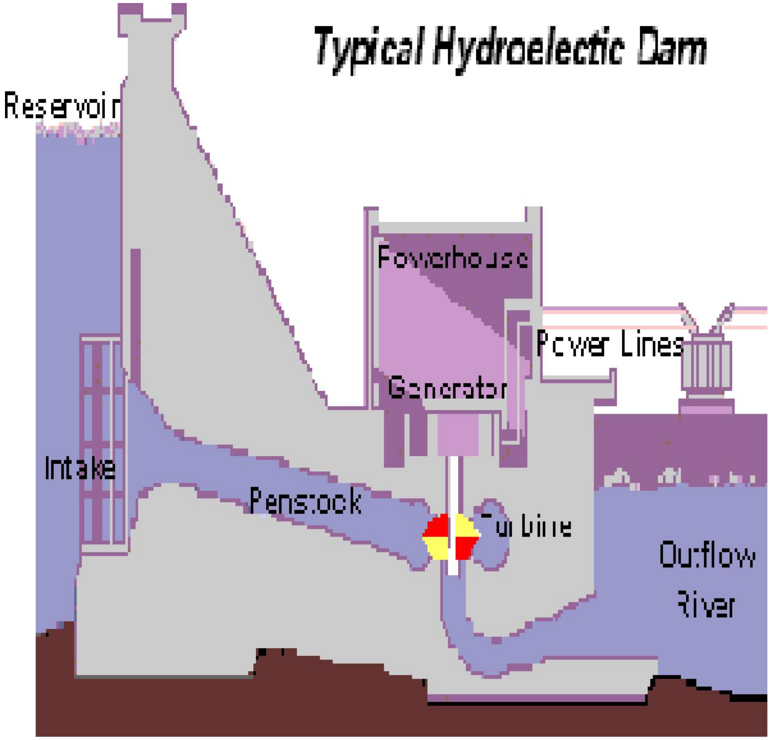


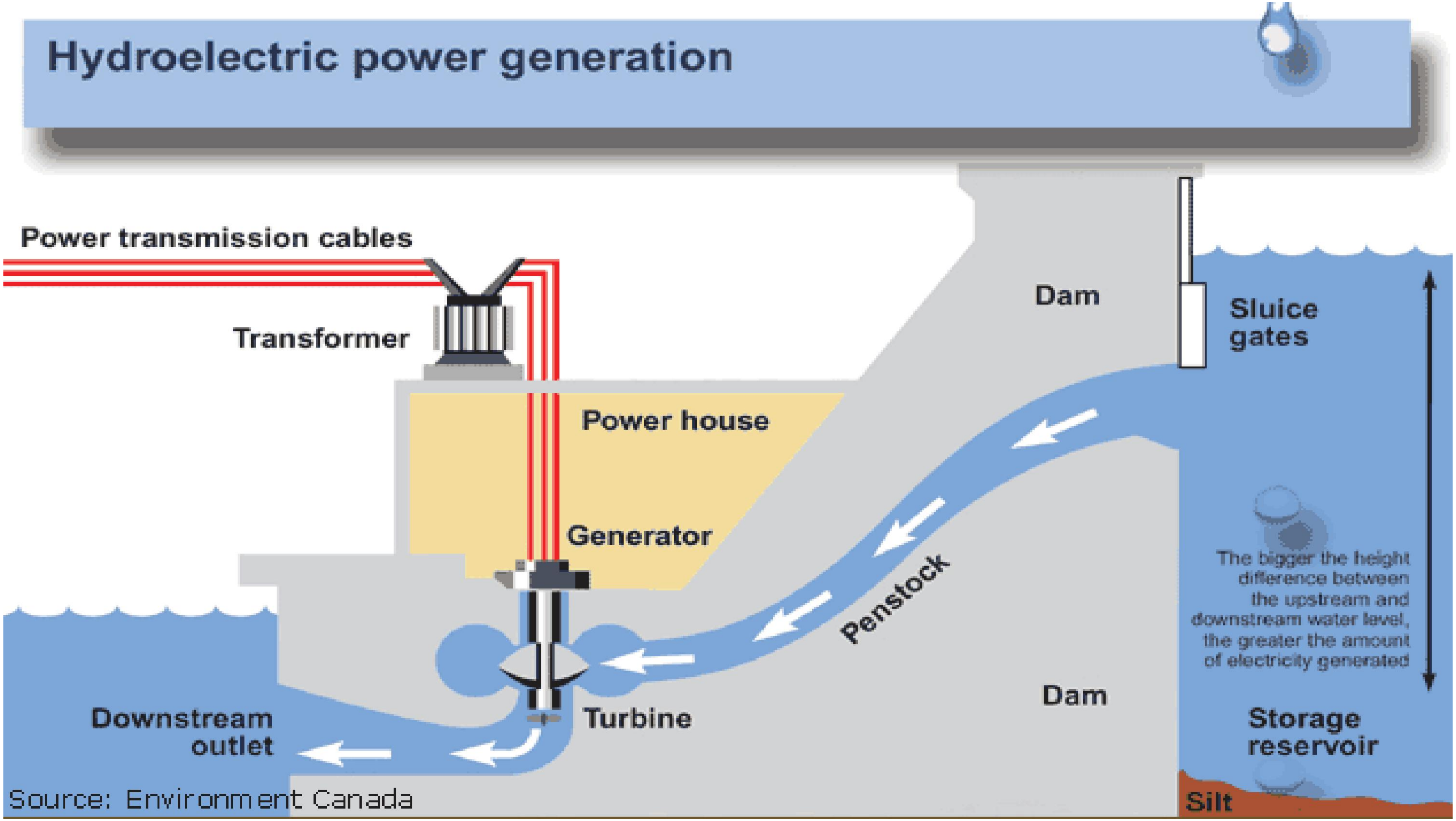
Site selection for a Hydro-station

- The discharge of the river is not constant.
- The variation in discharge of water in the river during the year and over a series of years depends on a number of natural features of the river and specially these:
  - Source of feeding the river – a stream, lake or glacier,
  - Nature of catchment area – plains or hilly,
  - Soil of the river bed – sandy, clayey or rocky,
  - Structure of the bed – steppey or grassy,
  - Number of rainy seasons in a year.

How hydro power works?

- Water from the reservoir flows due to gravity to drive the turbine.
- Turbine is connected to a generator.
- Power generated is transmitted over power lines.

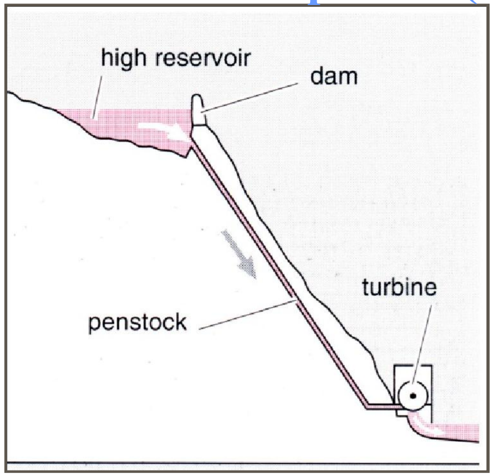


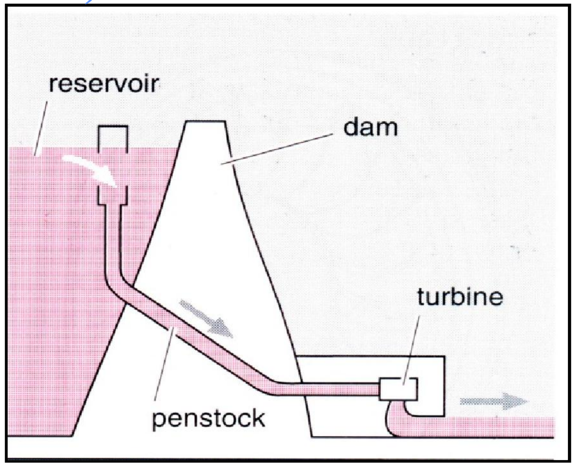


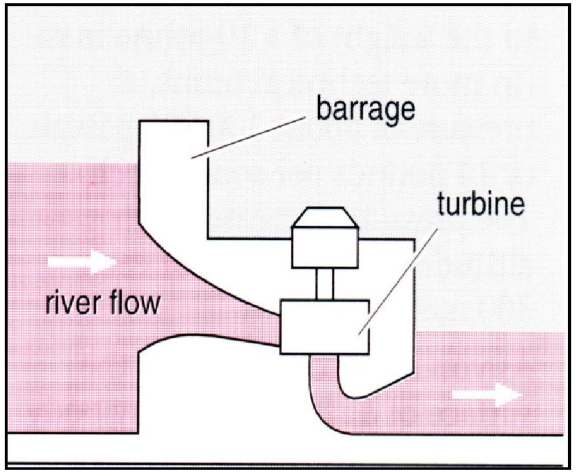
Hydroelectric power generation
Power transmission cables
Transformer
Power house
Generator
Dam
Sluice gates
Penstock
The bigger the height difference between the upstream and downstream water level, the greater the amount of electricity generated
Dam
Turbine
Downstream outlet
Storage reservoir
Silt
Source: Environment Canada

Classification

- ***Classification on head.***
- **High head plant (< 300 m.)**
- **Medium head plant. (60m to 300 m.)**
- **Low head plant. (> 60m.)**







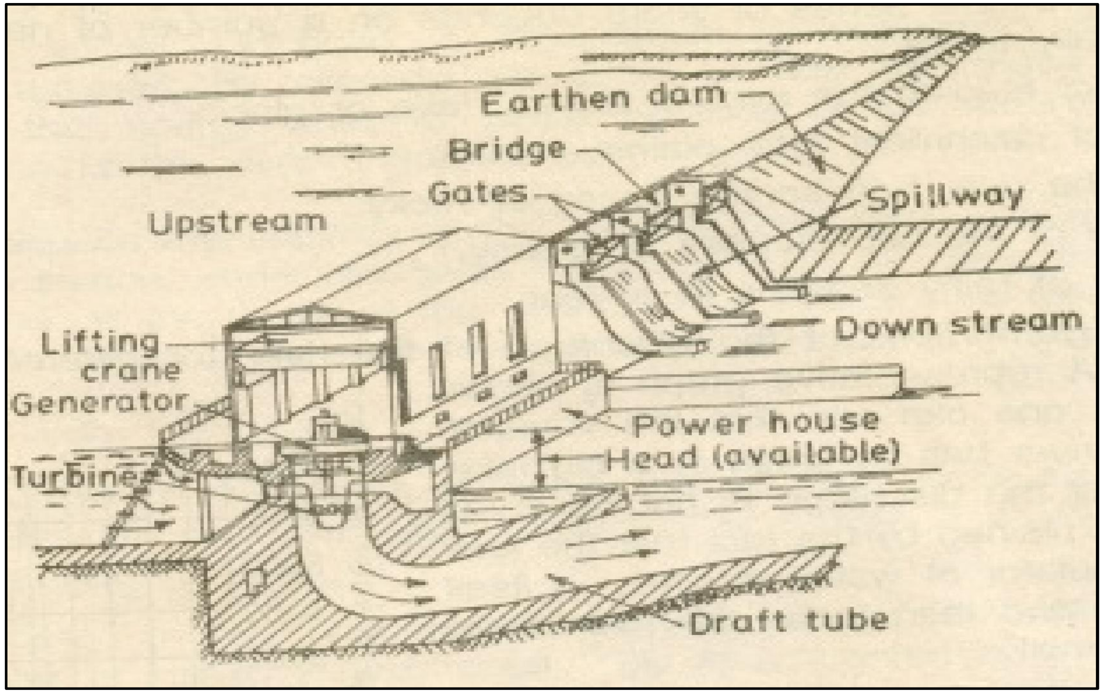
Classification

- ***Classification on operation.***
  - **Manual plant.**
  - **Automatic plant.**
- ***Classification on type of load.***
  - **Base load plant.**
  - **Peak load plant**
- ***Classification on water condition***
  - **Run-of-river plant.**
  - **Storage of water plant.**
  - **Pump storage water plant.**

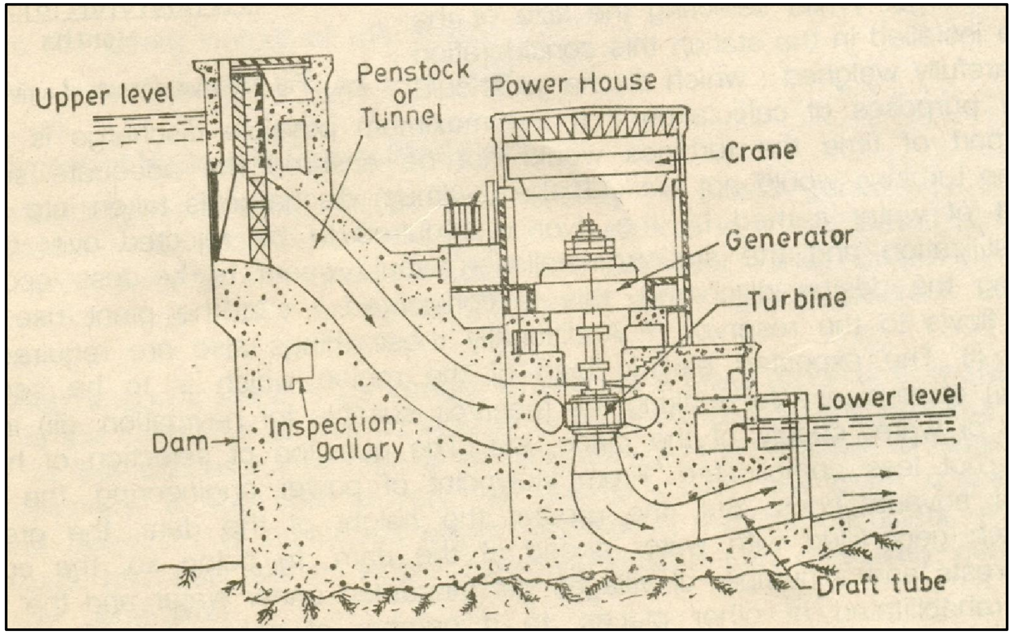
Classification

- ***Classification on power station location.***
  - **Power station located at dam site.**
  - **Canal power station.**

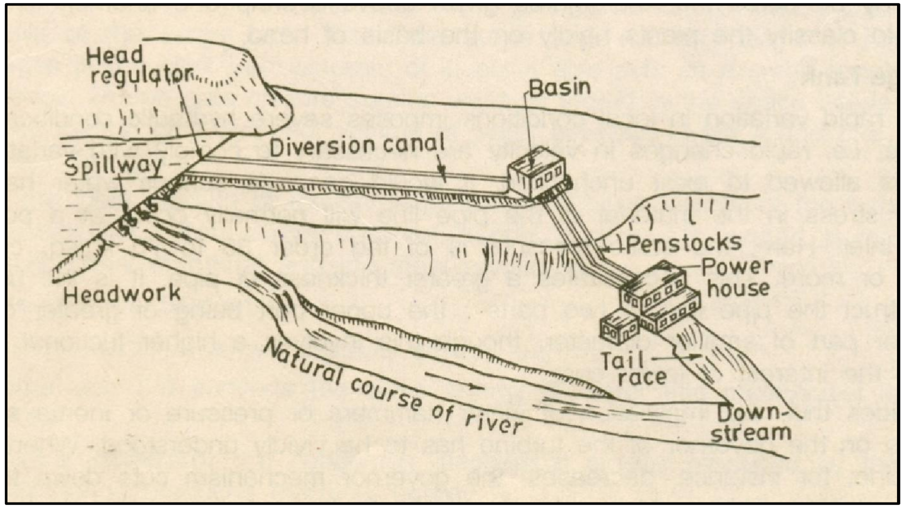
Power Station in the dam



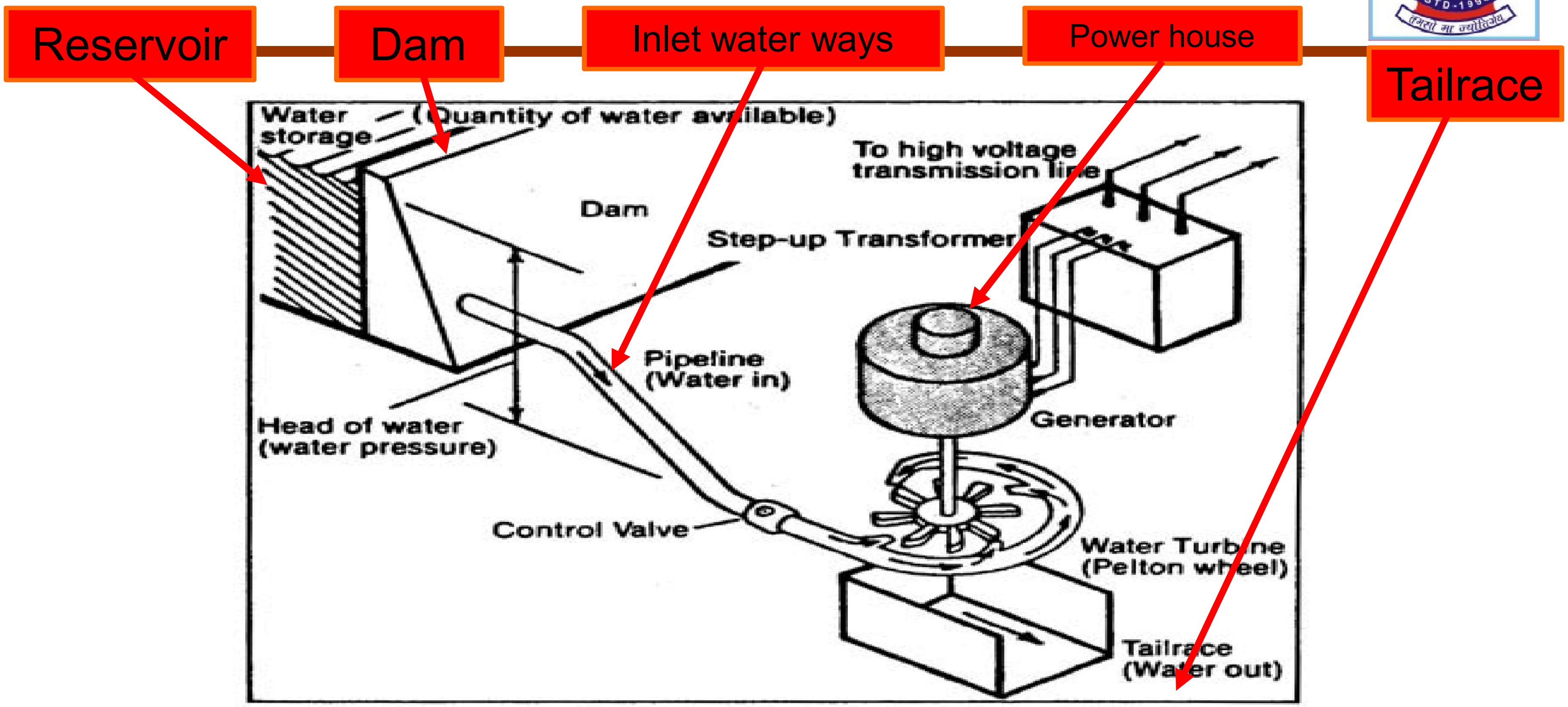
Power station behind the dam



Canal Power Station



Major Components



RESERVOIR

- Includes catchment area and water reservoir
- Purpose: to store water
- Head race => water surface level of the reservoir
- Reservoir can be natural or artificial (i.e. with dam)

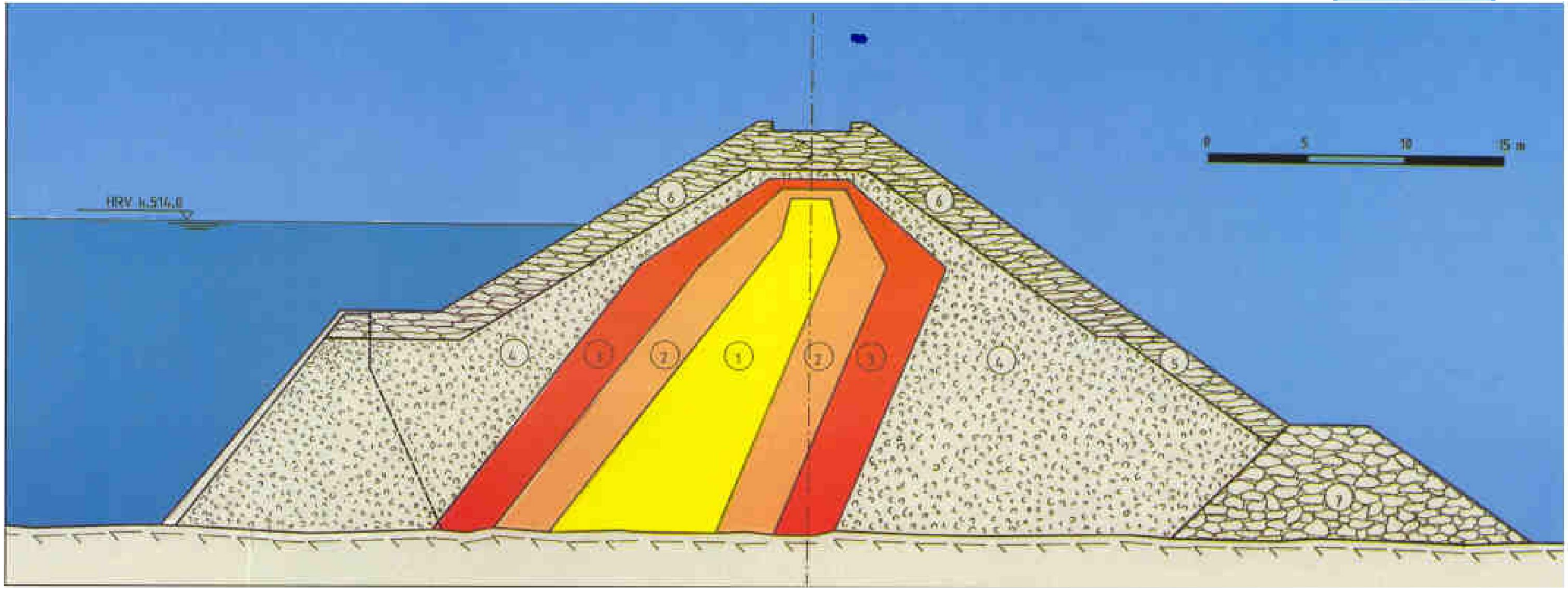
Water Intake

- Dam
- Coarse trash rack
- Intake gate
- Sediment settling basement

DAM

- Dams are structures built over rivers to stop the water flow and form a reservoir.
- The reservoir stores the water flowing down the river. This water is diverted to turbines in power stations.

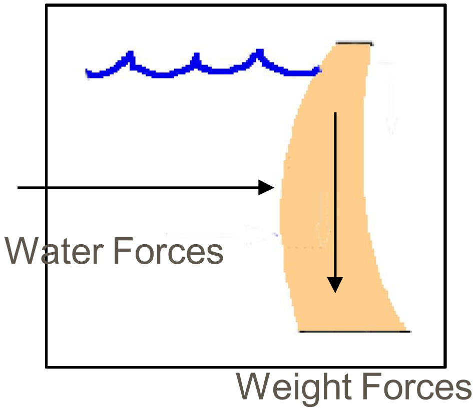
Rock-fill dam



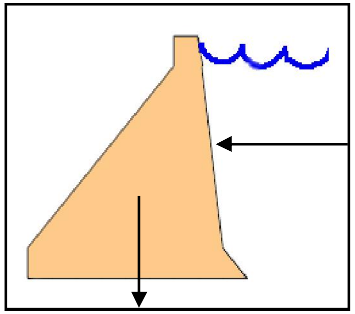
1. Core - Moraine, crushed soft rock, concrete, asphalt
2. Filter zone - Sandy gravel
3. Transition zone - Fine blasted rock
4. Supporting shell - Blasted rock

Slab concrete dam

Arc Dam



Gravity Dam



Water forces

Weight Forces

Arch-Gravity dams

Hoover Dam
(between the U.S. States of Arizona and Nevada)

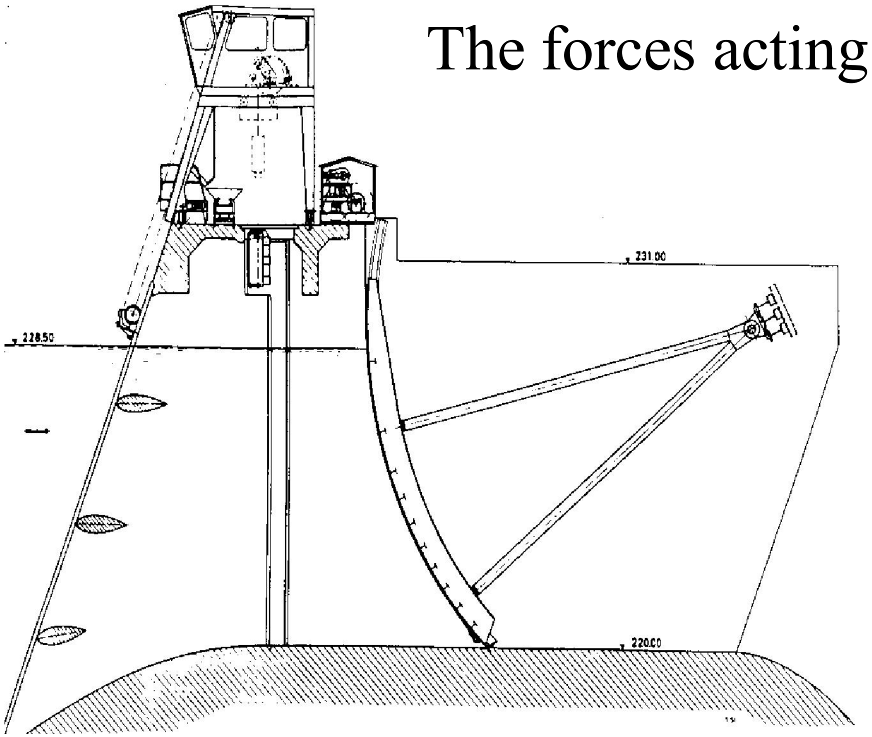
Gates in Hydro Power Plants

Types of Gates

- Radial Gates
- Wheel Gates
- Slide Gates
- Flap Gates
- Rubber Gates

Radial Gates at Älvkarleby, Sweden

Radial Gate

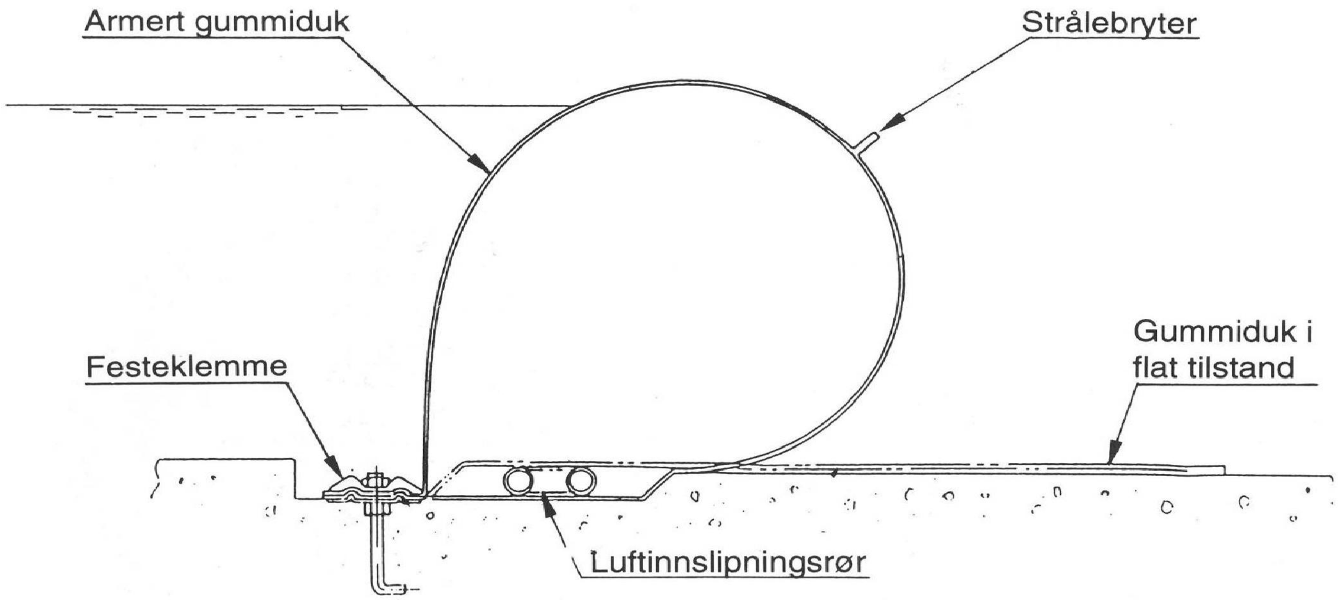


The forces acting on the arc will be transferred to the bearing

Slide Gate at Jhimruk Power Plant, Nepal

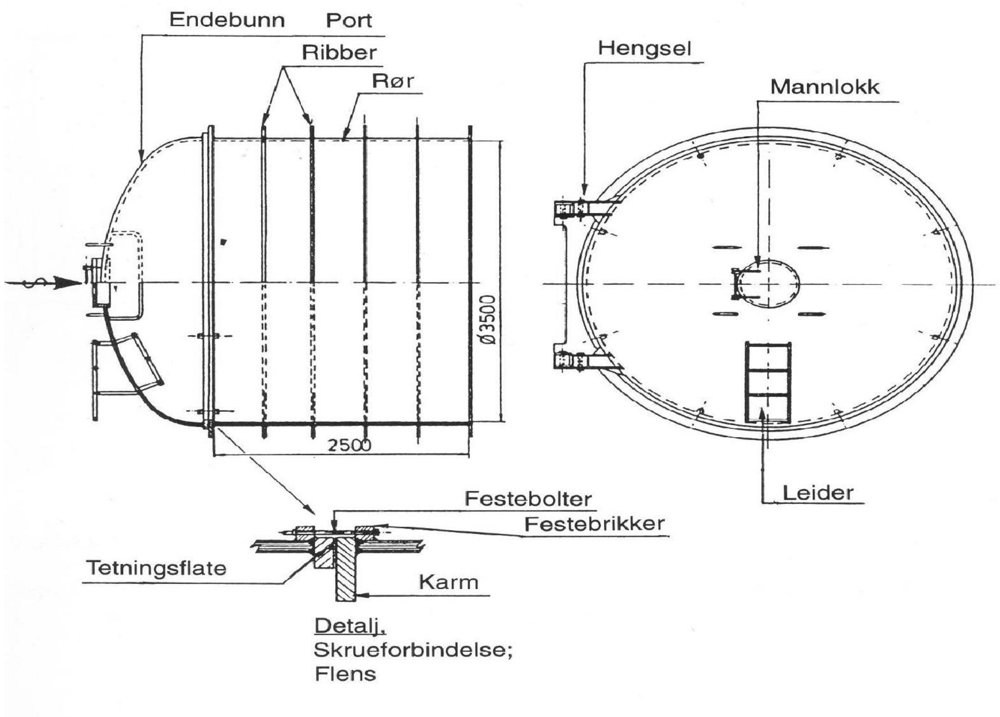
Flap Gate

Rubber Gate



Armert gummiduk
Strålebryter
Gummiduk i
flat tilstand
Festeklemme
Luftinnslipningsrør

Circular Gate



Circular Gate

Trash Rack

Spill Way

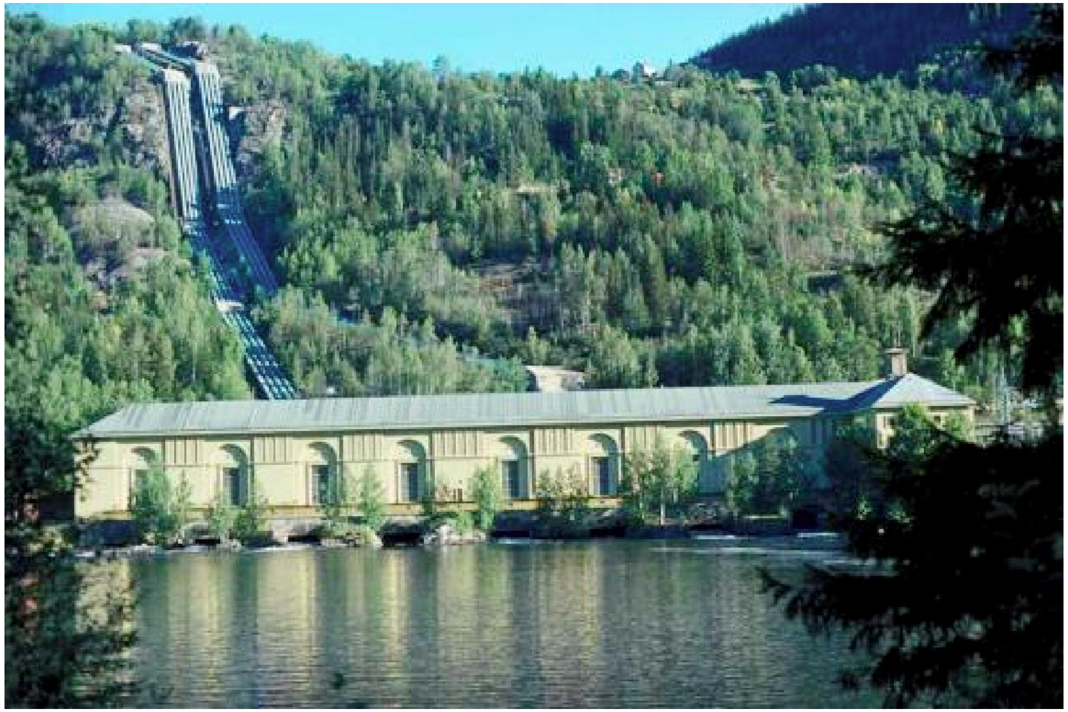
- A spillway as the name suggests could be called as a way for spilling of water from dams. It is used to provide for the release of flood water from a dam.
- It is used to prevent over toping of the dams which could result in damage or failure of dams

PENSTOCK AND TUNNEL

- 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. Water under high pressure flows through the penstock.
- A tunnel serves the same purpose as a penstock. It is used when an obstruction is present between the dam and power station such as a mountain.

Steel pipes in penstock

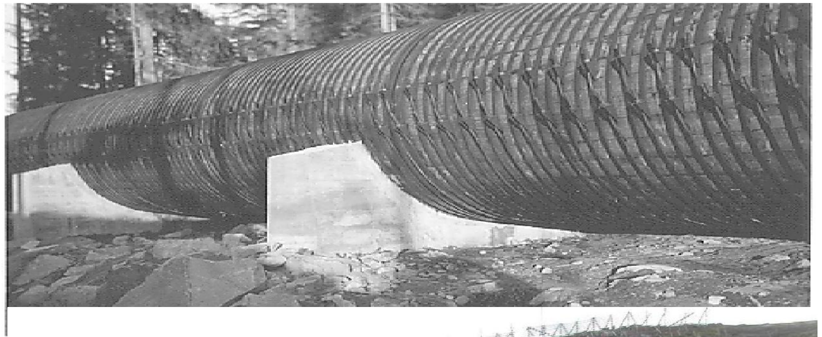
Nore Power Plant, Norway



GUP-Pipe

Raubergfossen Power Plant, Norway

Wooden Pipe



SURGE TANK

- 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.
- The sudden surges of water in penstock is taken by the surge tank, and when the water requirements increase, it supplies the collected water thereby regulating water flow and pressure inside the penstock.

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*. The difference between head race and tail race is called gross head and by subtracting the frictional losses we get the net head

POWER STATION

Typical hydro plant turbines:

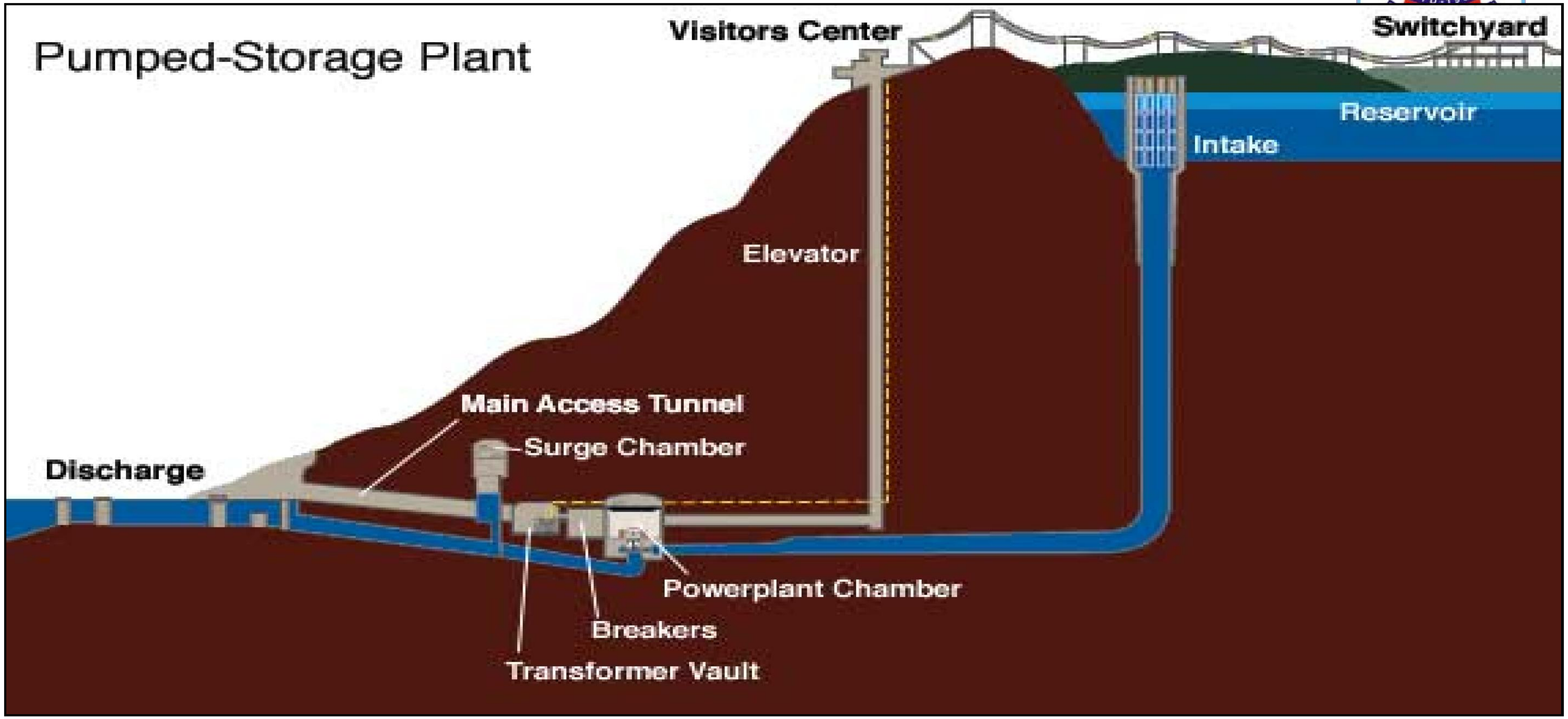
- Pelton turbine => Impulse
- Francis turbine => Mainly reaction
- Kaplan turbine => Reaction

Advantages

- Elimination of the cost of fuel.
- Longer economic lives than fuel-fired generation
- Operating labor cost is also usually low
- No green house gas (CO_2) emission during power generation

Disadvantages

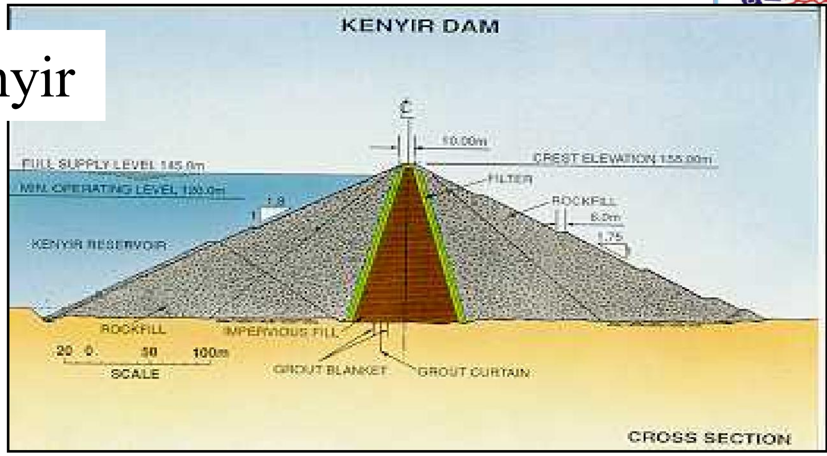
- This projects can be disruptive to surrounding aquatic ecosystems both upstream and downstream of the plant site.
- It needs to relocate the people living where the reservoirs are planned.
- Dams may be subject to enemy bombardment during wartime, sabotage and terrorism.
- Changes in the amount of river flow will correlate with the amount of energy produced by a dam.


Pumped-Storage Plant
Visitors Center
Switchyard
Reservoir
Intake
Elevator
Main Access Tunnel
Surge Chamber
Discharge
Powerplant Chamber
Breakers
Transformer Vault

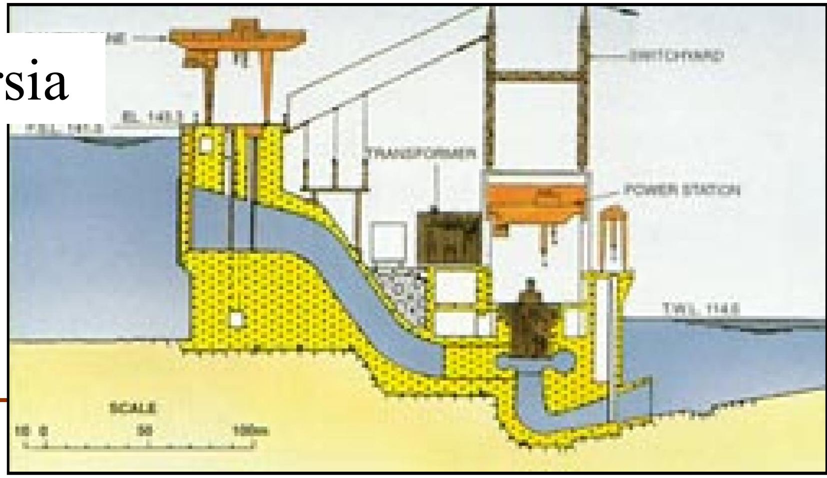
Hydro plant: reservoir

Hydro plant: Dams

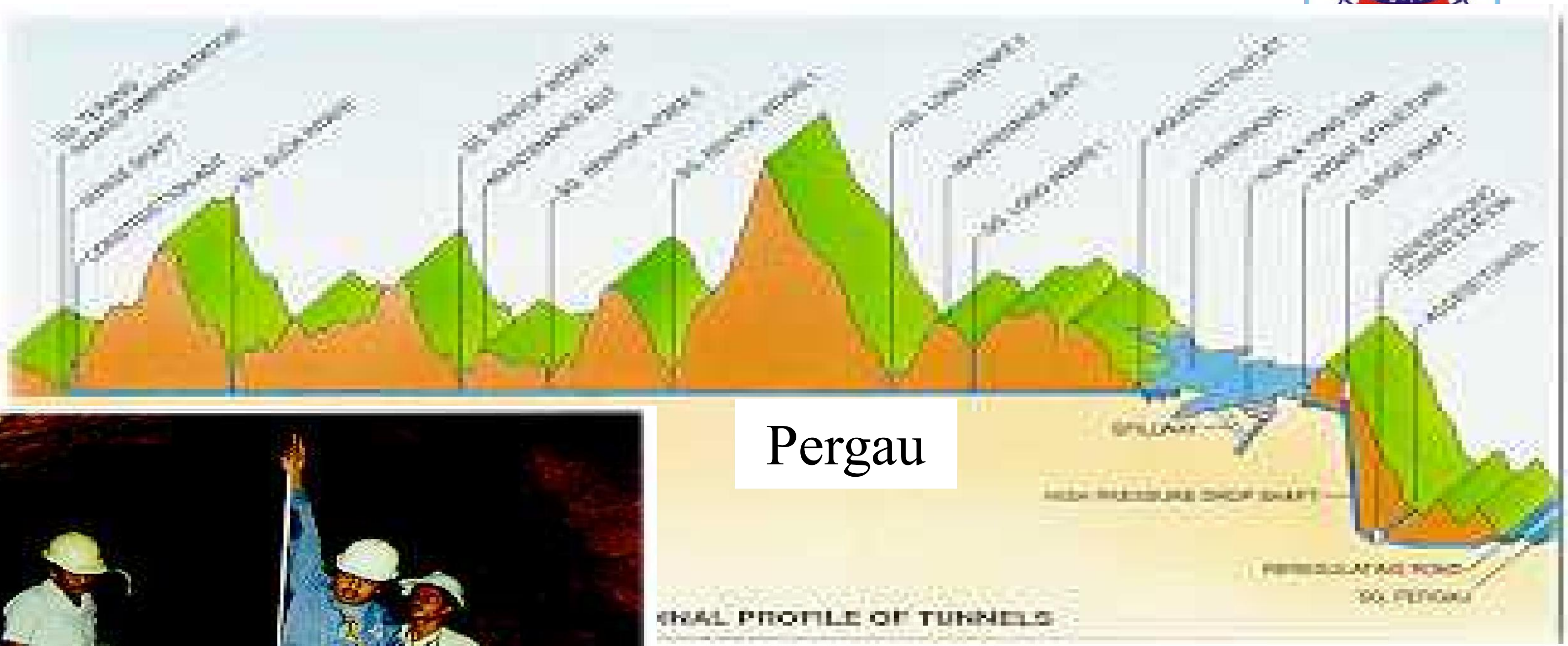
Kenyir



Bersia

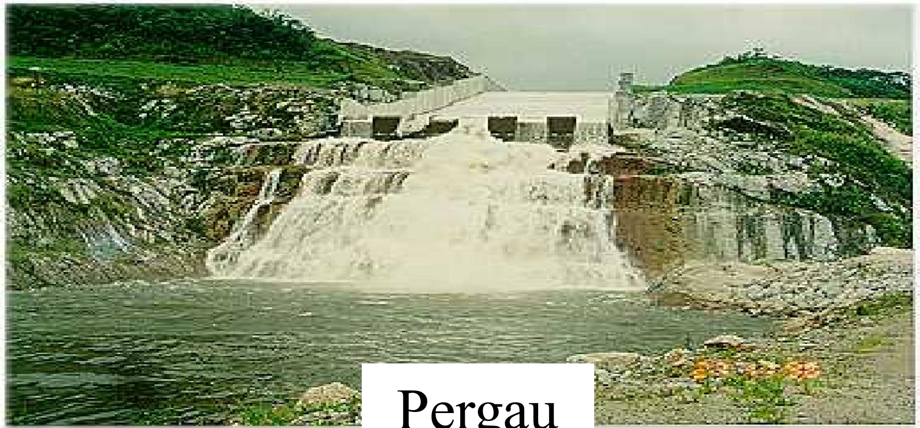


Hydro plant: Tunnel



Pergau

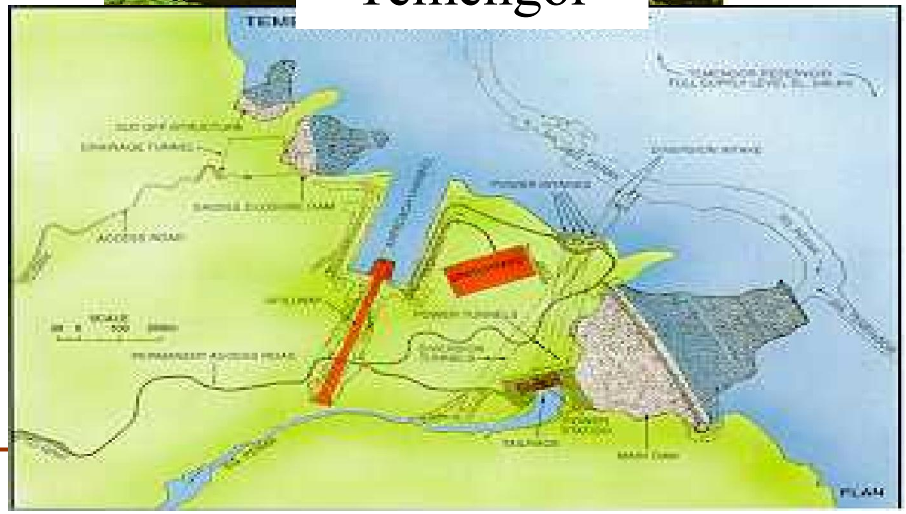
Hydro plant: Spillways



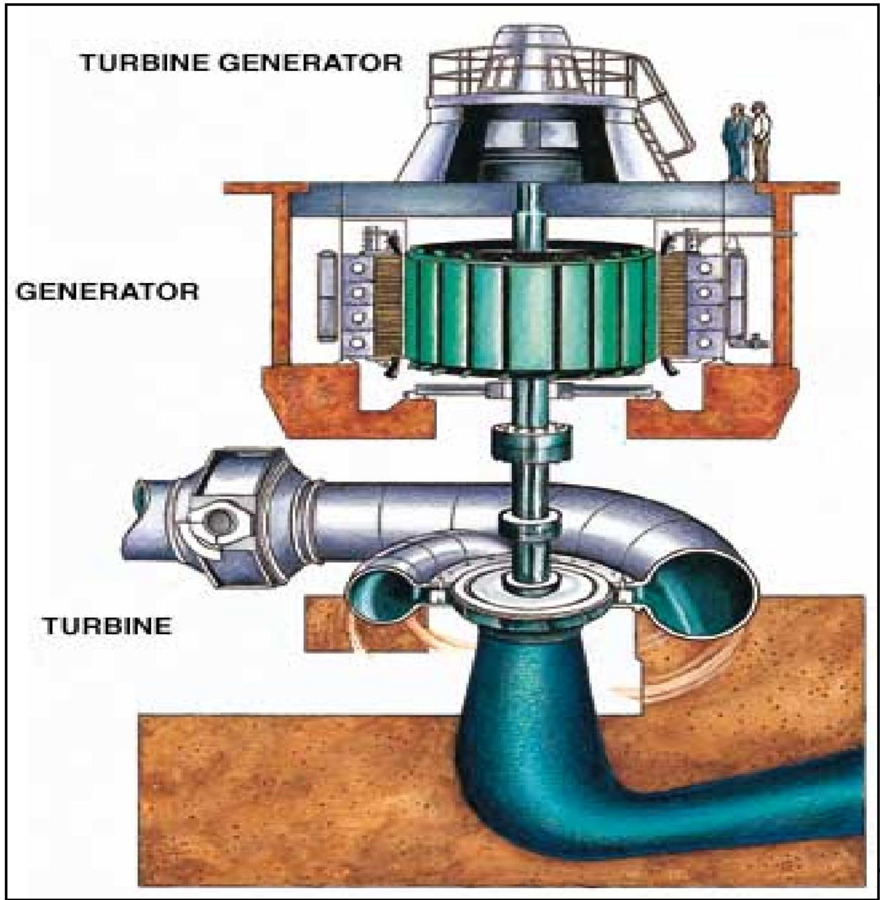
Pergau

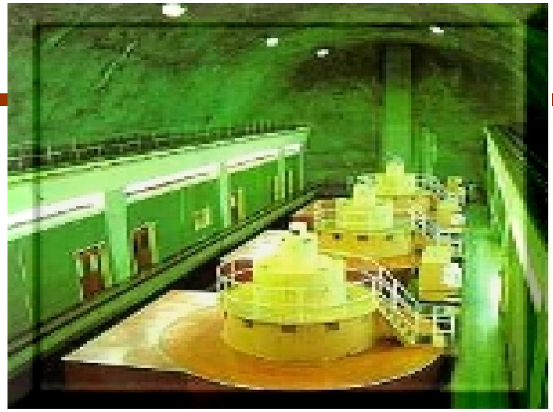
Temengor

Kenyir



Hydro plant: Turbine-generator



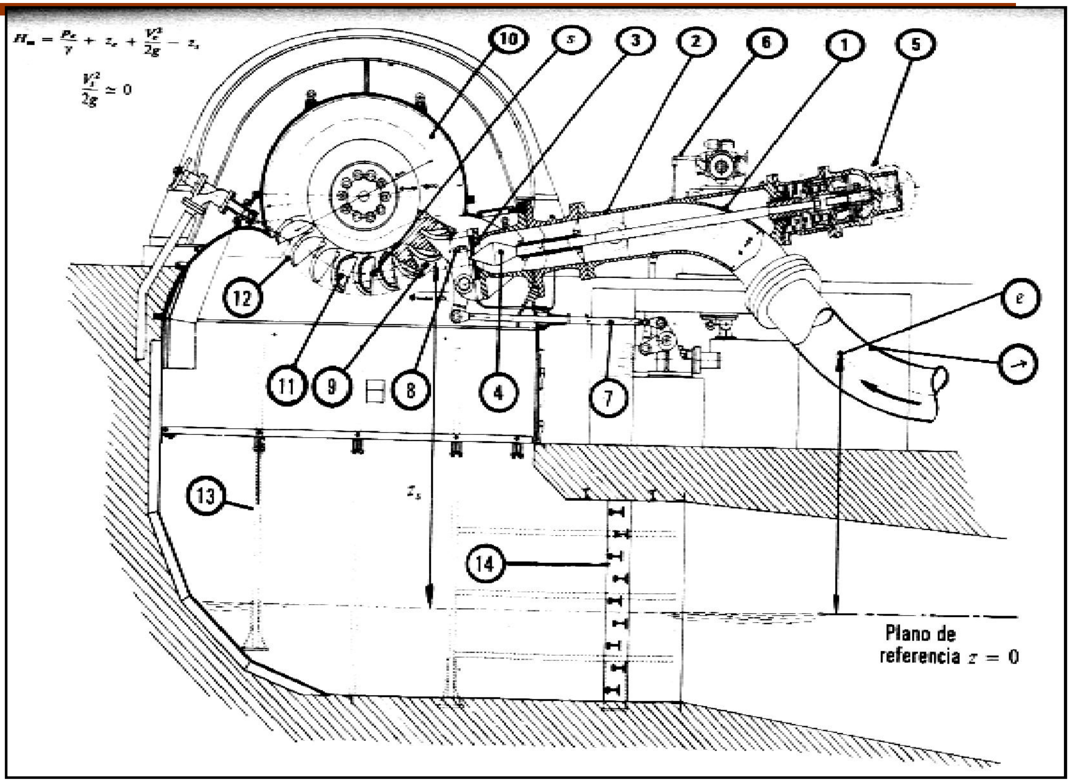


Woh :
Generator

Pergau :
turbine pit

TURBINE - PELTON

- Entrance elbow
- Injector
- Regulator
- Bun
- Blades or spoons.

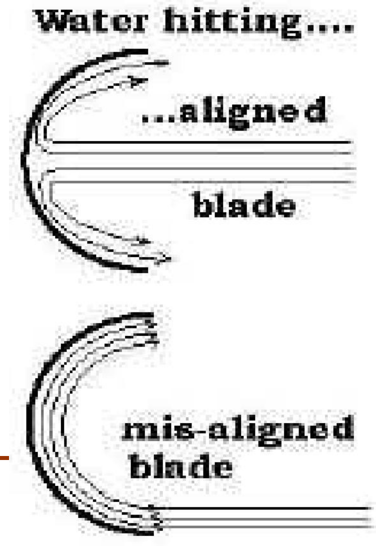


How works the Pelton turbine?

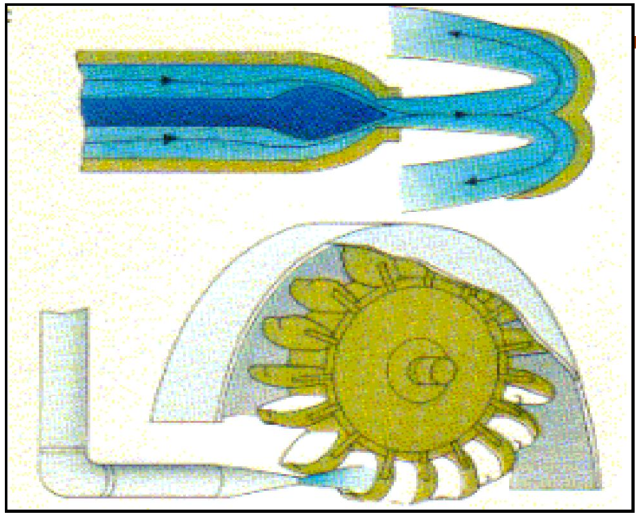
- The Pelton turbines are used with high height jumps.
- The gravitational power energy of the water dammed becomes in kinetic energy.
- The injector throws the high speed water to the blades that are glued to the bun.
- The water spurt transmits its kinetic energy to the bun, where it is transformed instantaneously into mechanical energy.

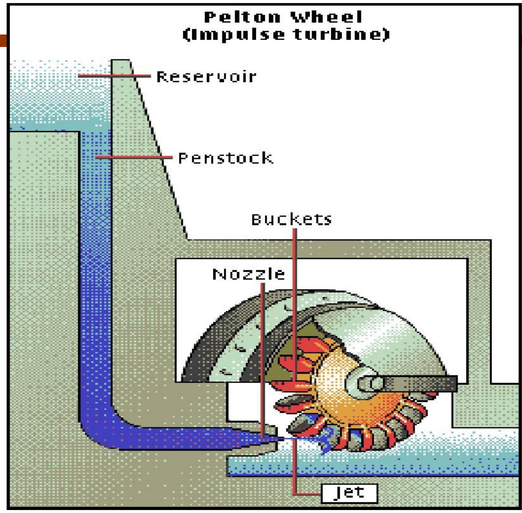
PELTON BLADES

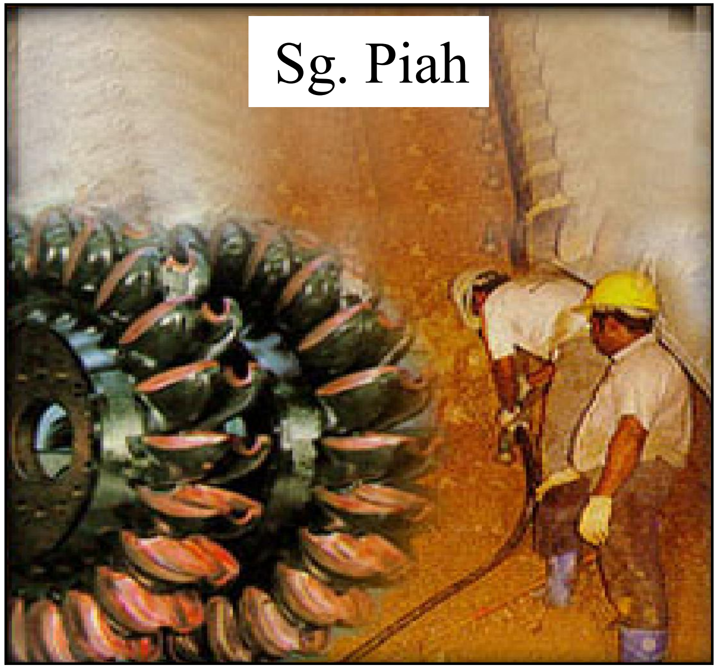
- The edge that divides each bucket in two symmetrical parts cuts the water spurt, sectioning it in two laminae of fluid, theoretically of identical volume. This disposition allows resisting mutually the axial pushes that are originated in the bun.



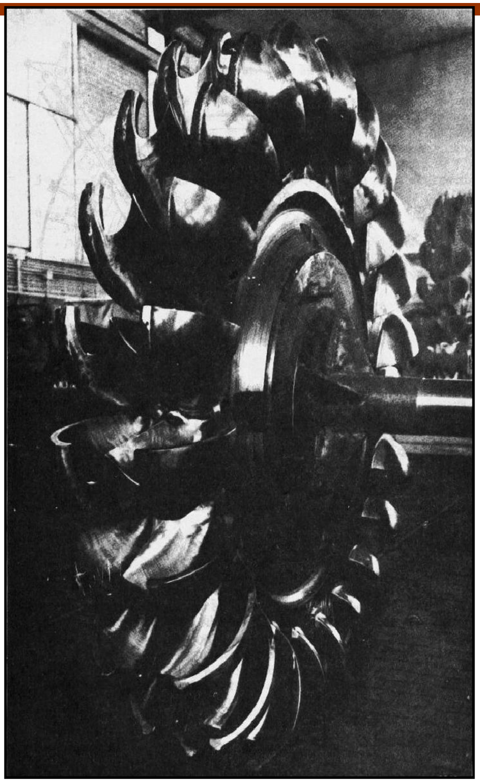
Hydro plant: Pelton turbine







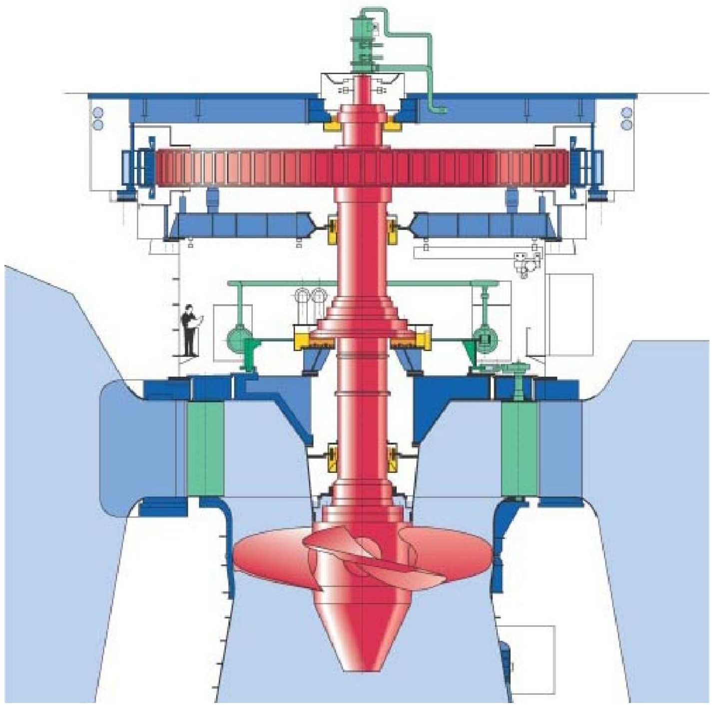
PELTON BUN



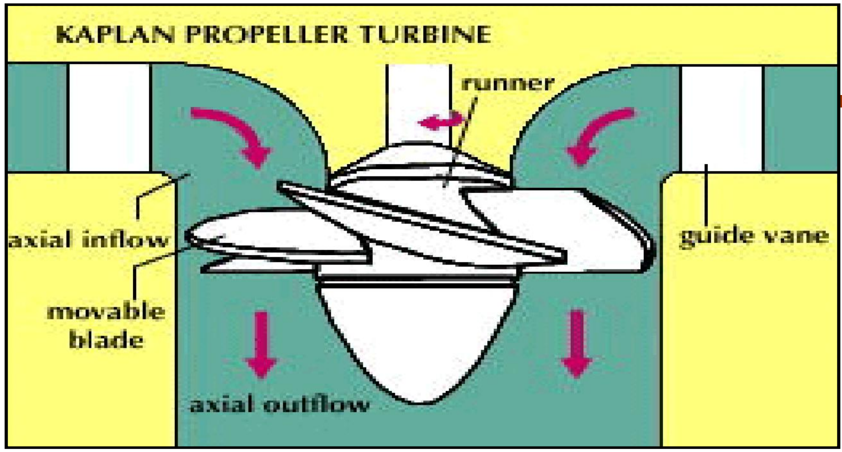
KAPLAN TURBINE

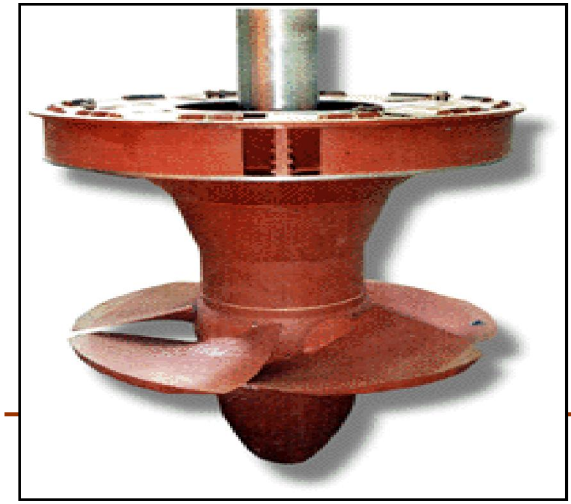
- The turbines that take his name have revolutionized in these years the use of jumps of little height.
- The Kaplan turbines are water reaction turbines of axial flow, with a bun that works in similar way to the helix of a boat.
- The Kaplan turbine is a helix turbine in which the blades of the bun turn itself when it is on, adjusting automatically according the work to the conditions of optimal yield.

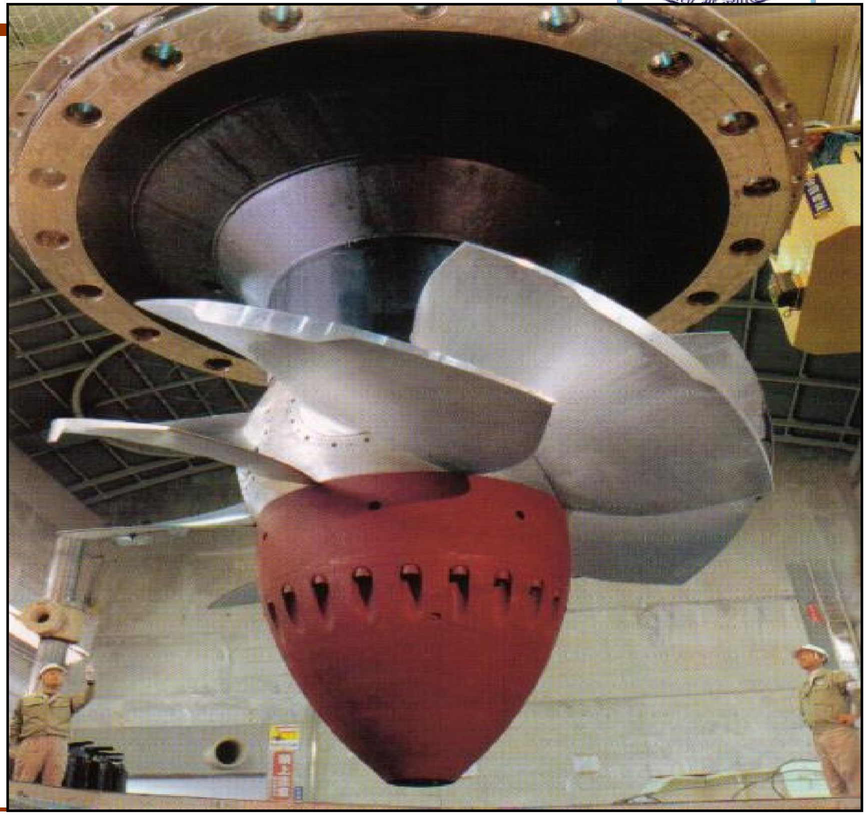
KAPLAN TURBINE



Hydro plant: Kaplan turbine







DERIAZ TURBINE

- Deriaz invented later the turbine that takes his name
- This turbine is reversible
- The price of the machinery is reduced using the same machine like pump and turbine.

DERIAZ TURBINE advantages

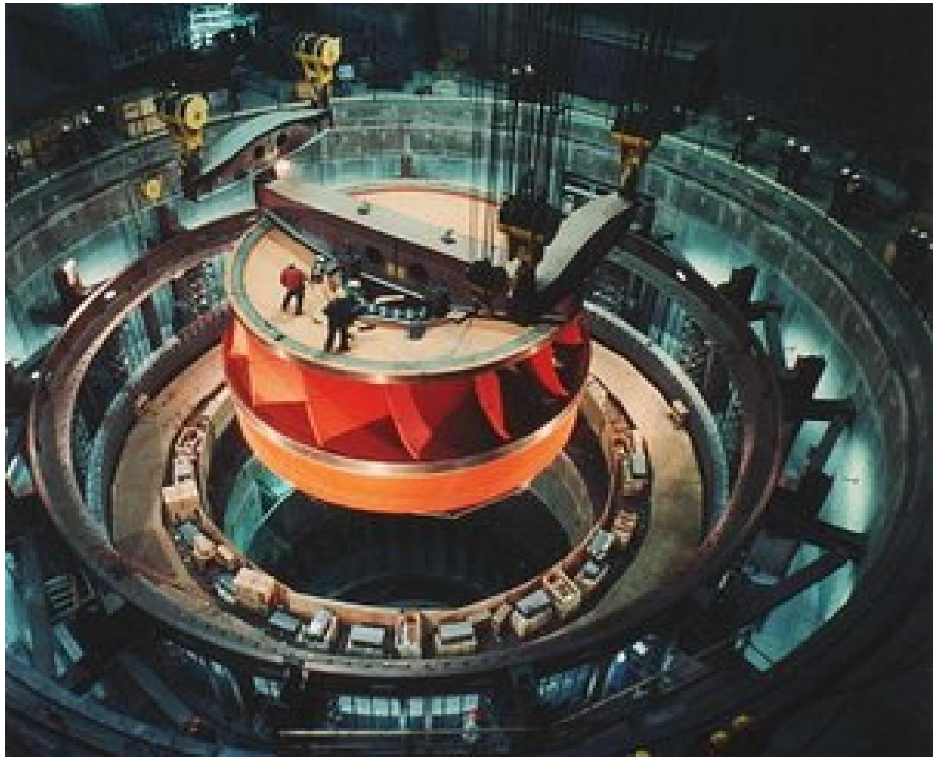
The Deriaz turbine is like Francis turbine but with adjustable blades and has:

- Working like turbine, better yield than a Francis turbine with analogous bun of stator blades
- Working like pump, better yield than a turbine-pump of stator blades

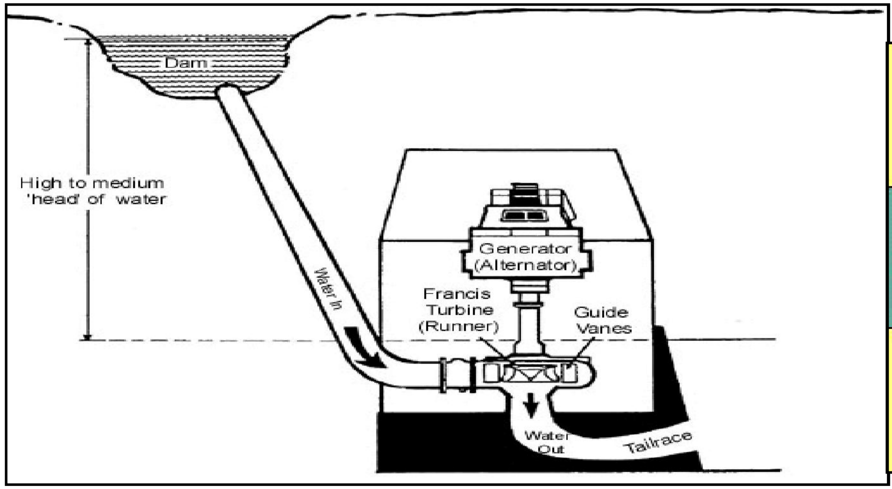
FRANCIS TURBINE

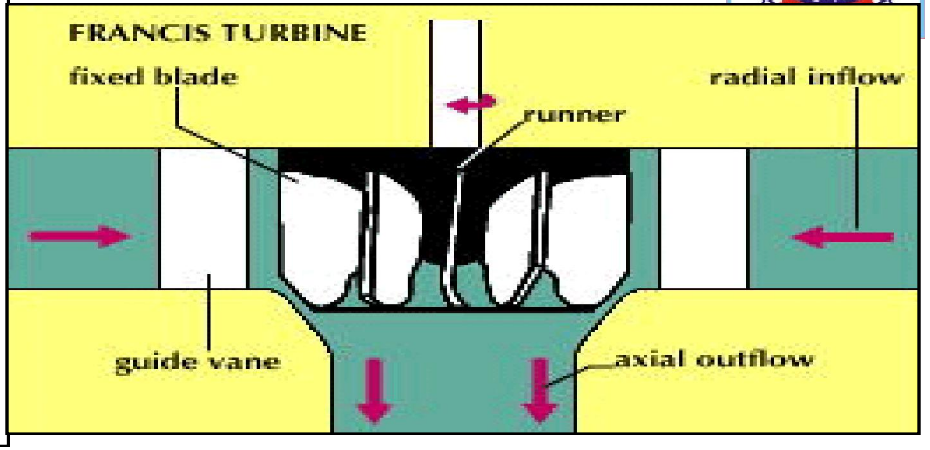
- The Francis turbine is one of the reaction turbines
- The radial flow causes the turn of the runner
- This turbine is reversible
- Francis turbines may be designed for a wide range of heads and flows

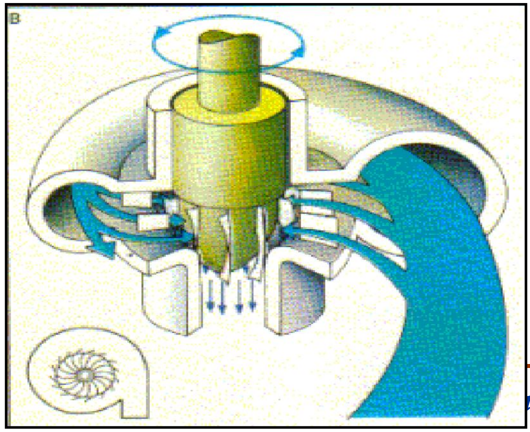
FRANCIS TURBINE

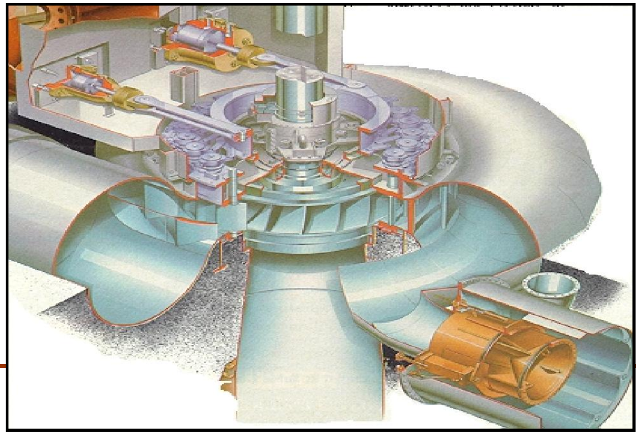


Hydro plant: Francis turbine









TURBINE - selection

Typical range of heads

- Kaplan $2 < H < 40$ (H = head in meters)
- Francis $10 < H < 350$
- Pelton $50 < H < 1300$