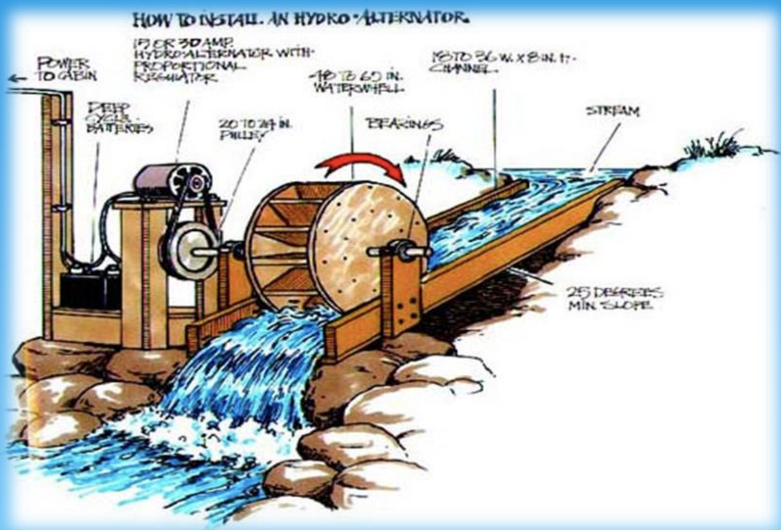

Hydroelectric Power

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Hydroelectric Power

Energy generation is one of the most important problems in the world.

Electricity is commonly generated in hydropower, thermal and nuclear power.

There are several energy sources such as

* Wind Power
* Wave Power
* Solar Energy
* Thermal Power

Hydroelectric Power

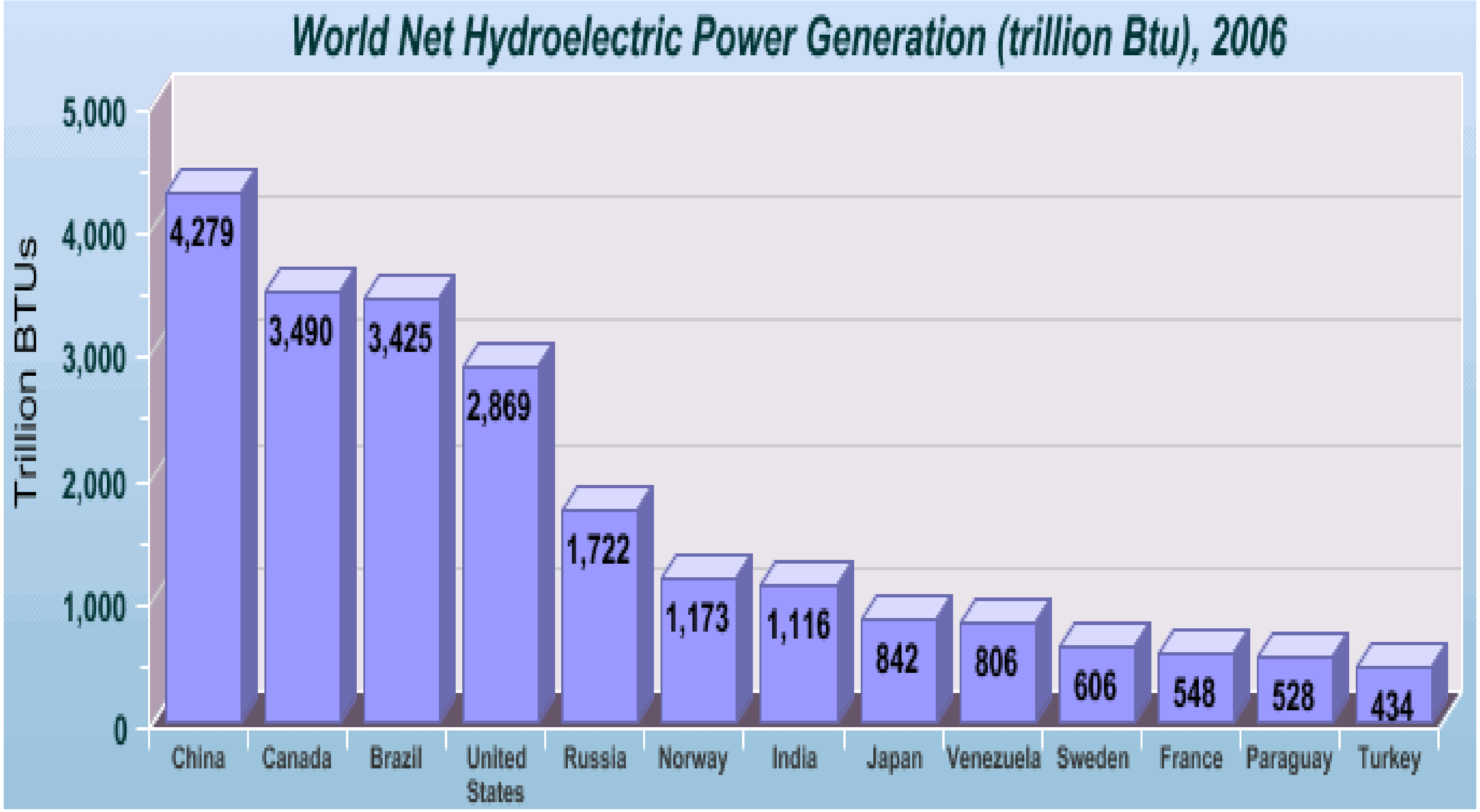
- Hydroelectric power is the oldest method for generating energy.
- Hydropower is the most important energy source
- Hydropower uses widely renewable energy sources

Hydroelectric Power

Comparison of hydropower plants with thermal plants

Parameter	Hydropower Plant	Thermal Plant
Source of energy	Water	Burning fuel
Life time	High	Medium
Initial cost	High	Lower than hydropower plant
Operation and Maintenance impact	Low	High (cost of fuel)
Environmental impact	Non-pollutant	Pollutant
Operational Mode	Easily put in operation (Few minutes)	Put in operation in approximately 30 minutes
Tax rates	Low	High

Hydroelectric Power



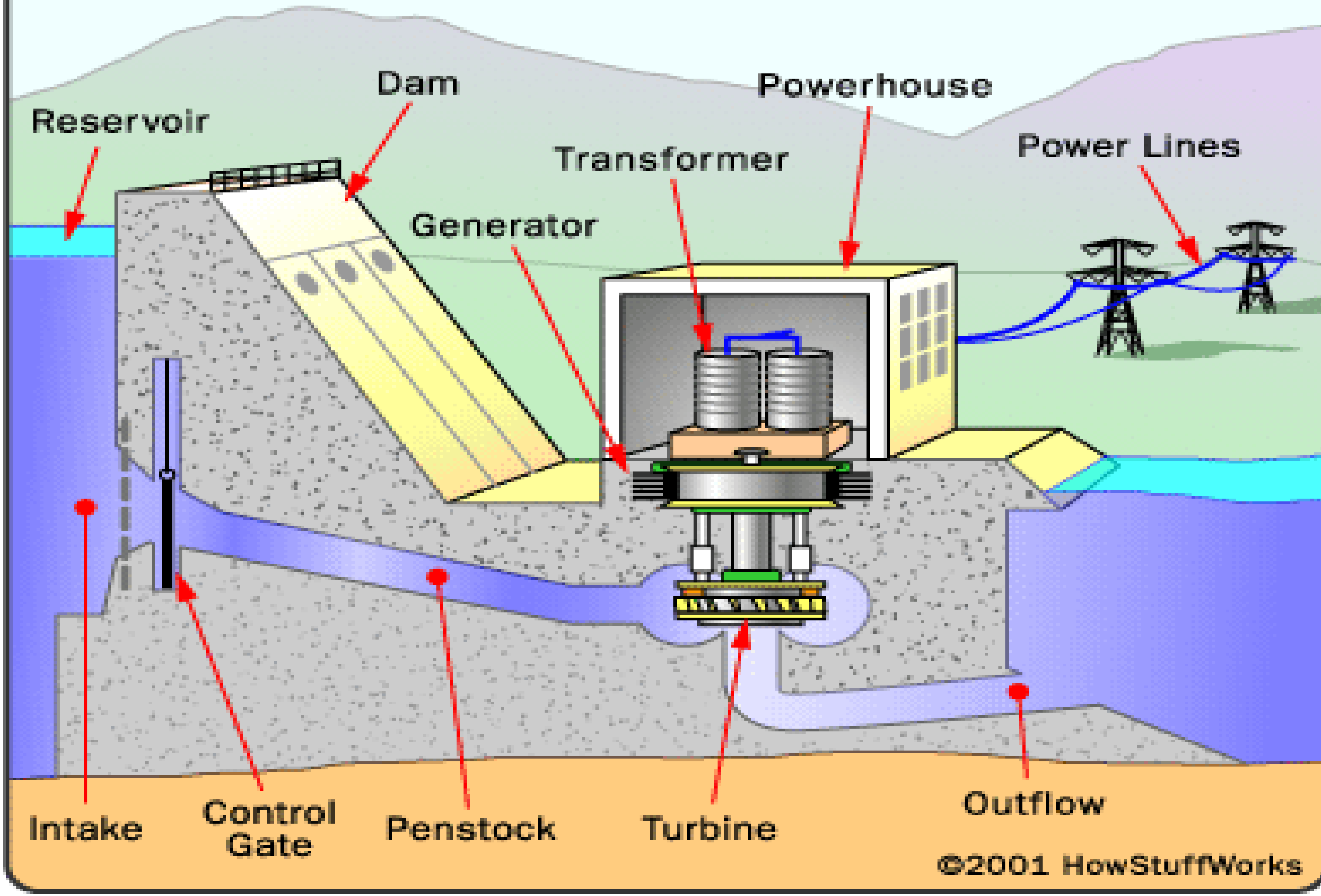
Hydroelectric Power

P_{ins} (Mw)				E (Gwh)			L
Year	Thermal	Hydro	Total	Thermal	Hydro	Total	%
1950	390	18	408	760	30	790	-
1960	861	412	1272	1814	1001	2815	-
1970	1510	725	2235	5590	3033	8623	65
1980	2988	2131	5119	11927	11348	23275	66
1990	9551	6764	16315	34395	23148	57543	73
1992	10335	8389	18724	40774	26568	67342	70
1993	10653	9774	20427	39857	33951	73808	71
1994	10993	9865	20857	47736	30586	78322	70
1995	11272	9865	21137	52548	31973	84521	70

P_{ins}: Installed capacity,
E: Energy
L: Load factor

Development of Electricity Generation in Turkey (DSI, 1996)

Inside a Hydropower Plant



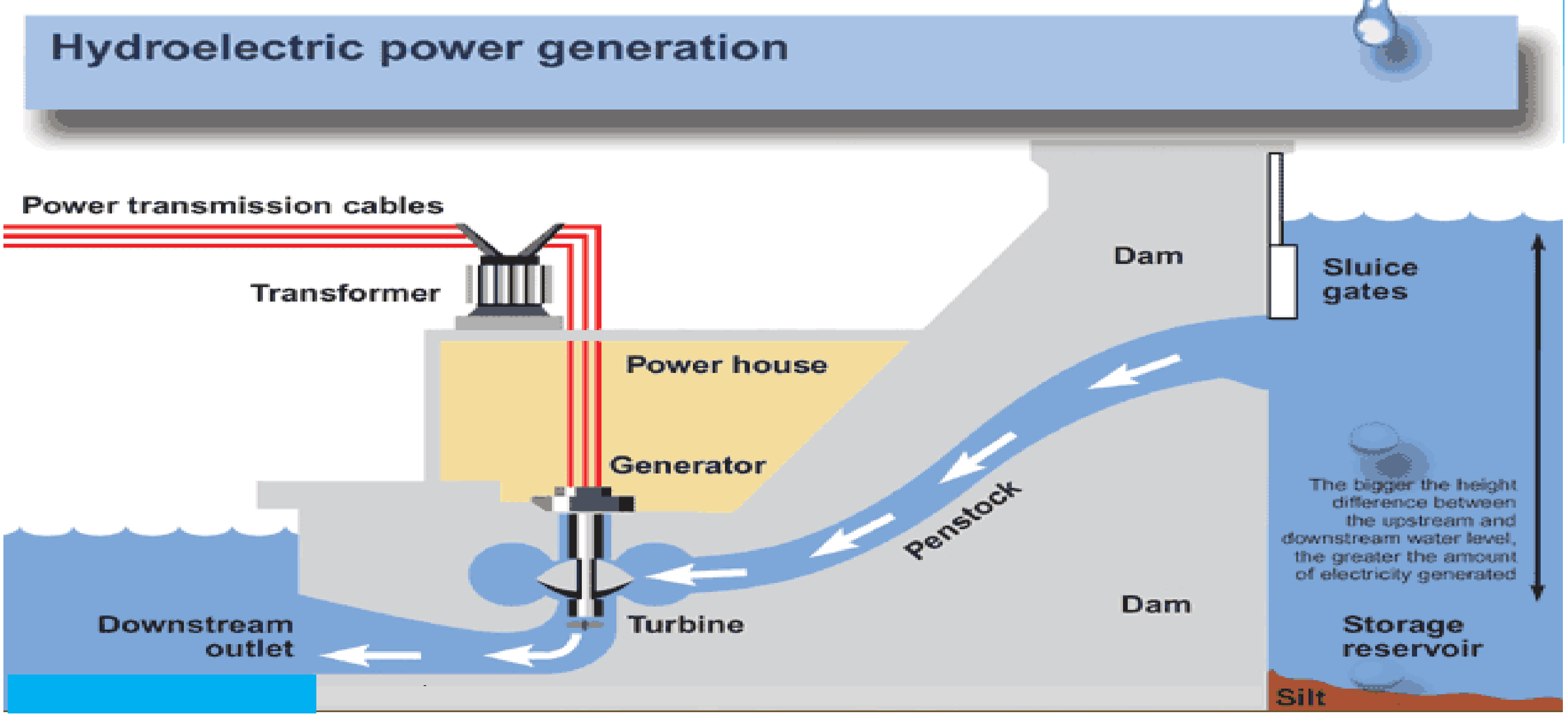
Hydroelectric Power

- The dam collects water behind barriers and forms an artificial lake.
- The storage water is considered as a potential energy.
- The release water flowing through penstock turns into kinetic energy because of water motion.

➢ The amount of electricity is based on several factors:

- Volume of water flow
- Hydraulic head

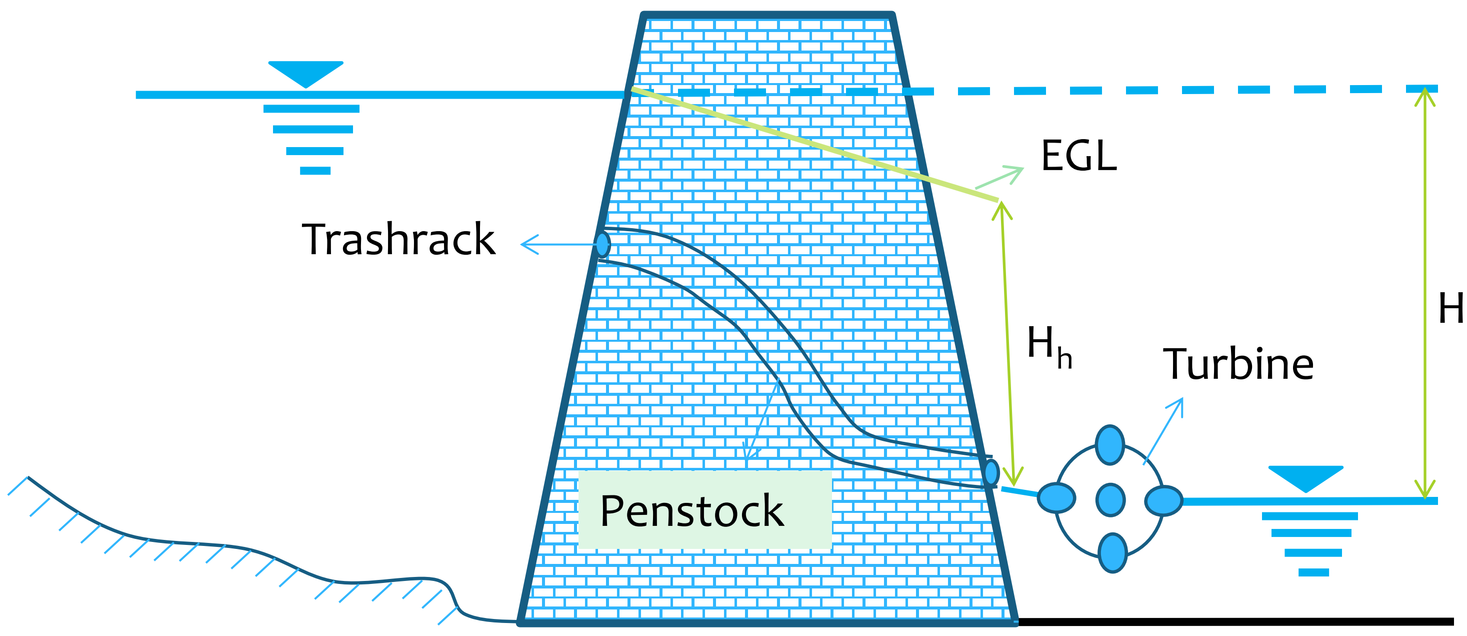
Hydroelectric Power



Hydropower plants use energy of the water and simple mechanics to convert the energy into electricity.

In a hydropower plant, flowing water turns a turbine and this turns a generator.

Hydroelectric Power



Definition of head terms for a hydropower station

Hydroelectric Power

- Hg: Gross head is the vertical difference between the water surface elevations at upstream and downstream
- H_n: Net effective head is the head available for energy production
- e_h: Hydraulic efficiency is the ration of net head to gross head
- e_t: Turbines efficiency
- e_g: Generators efficiency
- e: Overall efficiency ($e = e_h \times e_t \times e_g$)

Hydroelectric Power

- Installed capacity is the maximum power which can be developed by the generators.
- Firm (primary) power is the power which can be produced by a plant with no risk.
- Surplus (secondary) power is all available power in excess of firm power.
- Dump energy is generated energy that can not be stored and is beyond instantaneous needs.

Hydroelectric Power Plants

- Hydroelectric power plants can be classified based on operative mode
  - A run of river plant
  - A storage plant
  - A pumped storage plant

Hydroelectric Power Plants

- A run of river plant: Generally uses the river flow with no storage. Hence, its productivity is mainly based on the river regime.
- A storage plant: It has a reservoir of sufficient size to develop a firm flow substantially more than minimum naturel flow.

Hydroelectric Power Plants

- A pumped storage plant: It generates power during the periods of high demand and water is pumped from the downstream to the upstream reservoir during the periods of low demand for future use.
- Penstock is usually a steel pipe of large diameter for electricity generation.
- Trashrack is composed of closely spaced screens to eliminate the entrainment of floating objects to the system

Availability of Hydroelectric Power and Energy

- Hydroelectric power can be computed following as

$$P = \gamma \; Q \; H_g \; e$$

where

- P is the power in kw
- γ is the specific weight of water in kN/m^3
- Q is the discharge in m^3/s
- H_g is the gross head in m
- e is the overall efficiency (%) [$e = e_h \times e_t \times e_g$]

Availability of Hydroelectric Power and Energy

- Energy generated in a plant can be determined from

$$E = \frac{V_w \quad H_g \, \gamma \; e}{3600}$$

where

- E is the hydroelectric energy in kwh
- V_w is the amount of water falling through penstocks during the period of interest in m^3

Availability of Hydroelectric Power and Energy

- Electrical energy is generally expressed in terms of its annual value
- The mean annual energy productions for large Turkish dams are following as
  - Atatürk Dam= 8.9×10^9 kwh
  - Karakaya Dam= 7.4×10^9 kwh
  - Keban Dam= 6×10^9 kwh

Availability of Hydroelectric Power and Energy

The Installed Capacity

- P_{ins} is the maximum power for which generation develops.

It can be calculated following as

$$P_{ins} = \frac{E}{8760\ L}$$

where

- 8760 is the number of running hours in a year
- L is the load factor which is equal to the ration of average power to maximum power.

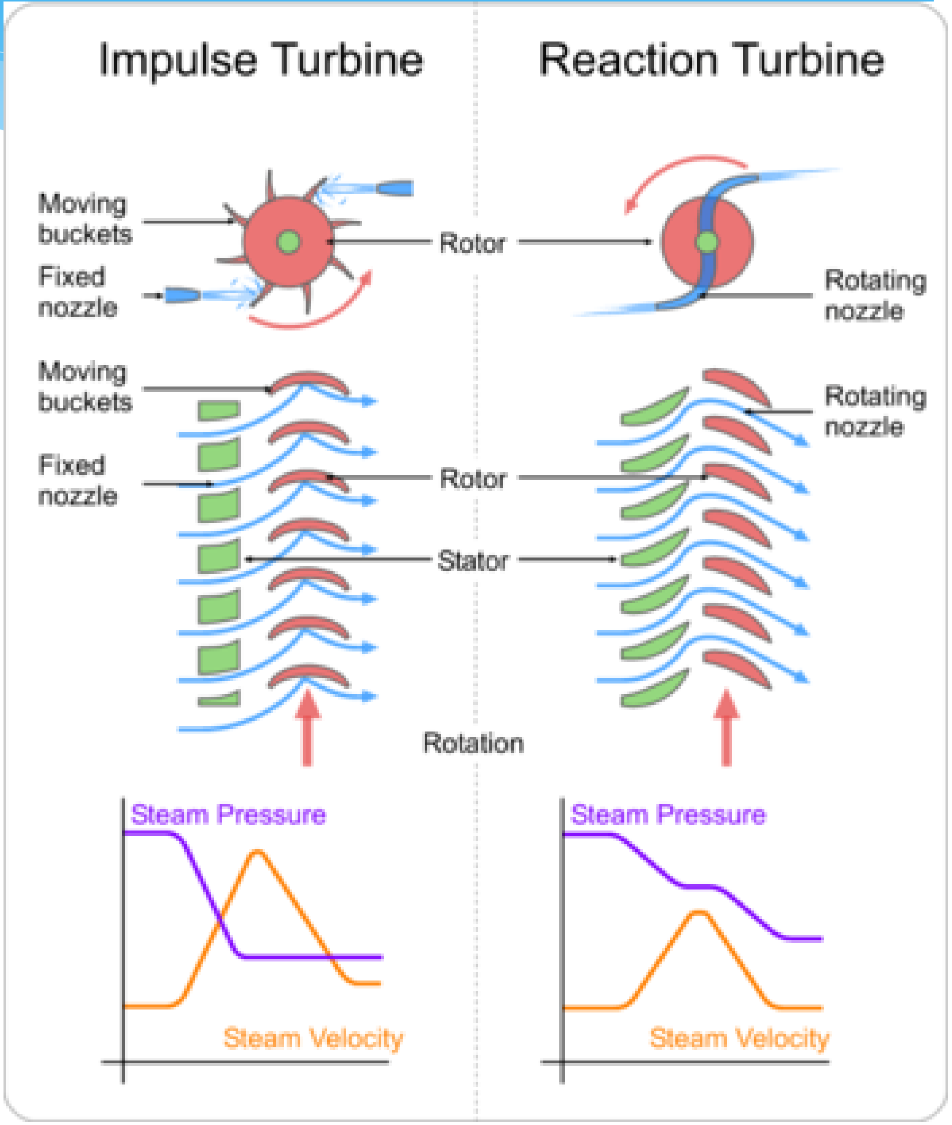
Turbine

* Turbine converts hydraulic energy into mechanical energy and a generator converts this mechanical energy into electrical energy.

Turbine and Generator

Turbine

* There are two types of turbines such as
  * Impulse turbines
  * Reaction turbines



Abrasion of Turbines

* All types of hydraulic machinery can be strongly abraded by sediment-laden water.
* The sediment directly effects performance of turbines, pumps, valve and gate seals.
* Large amount of sediment can break down hydraulic machinery.
* Grain sizes over 0.1 mm should be removed from water for heads exceeding 50 m.
* Even silts should be removed from water if heads exceed over 200 m.

Abrasion of Turbines

* Abrasion is a function of head.
* Namely, abrasion tends to increase with heads exceeding over 400m.
* Pelton wheels can be abraded by 0.05 mm quartz in suspension for high heads.

Abrasion of Concrete Structures

* Spillways, aprons, outlets can be abraded by sediment
* Traditional concrete has threshold abrasion resistance value.
* Concrete structures should be covered with abrasion-resistant materials such as stone, steel, timber fiber-reinforced (at least 2 cm thick).
* Dressed dense granite is strongly resistant to both abrasion and shock, but costly.

TEŞEKKÜRLER

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