HYDRO POWER PLANTS

Subject:
Power Plants ME-403

Mansoor Ali Zaheer
Assistant Professor
Mechanical Engineering Department
University of Sargodha

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- Essential elements of Hydro power plants
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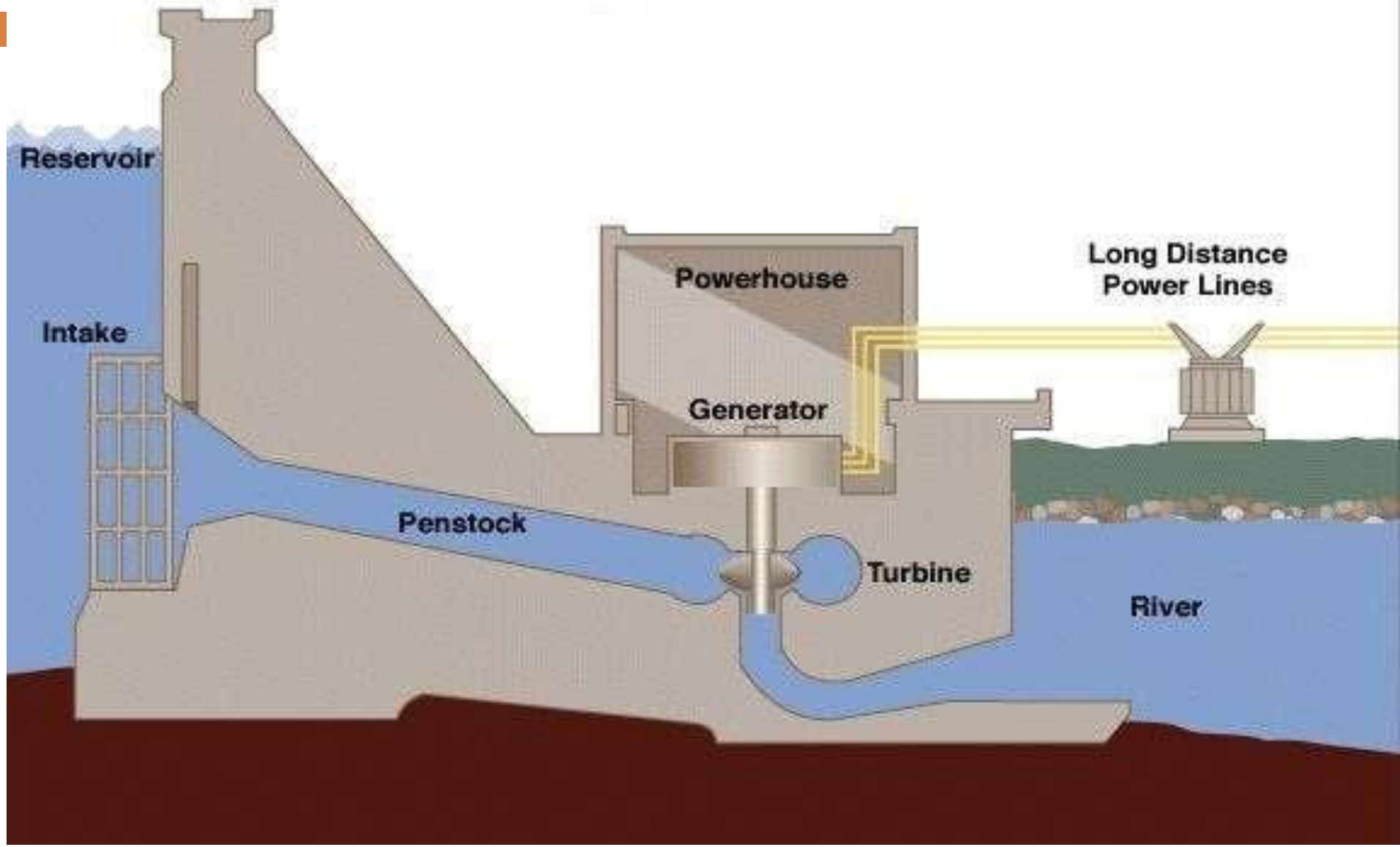
Introduction

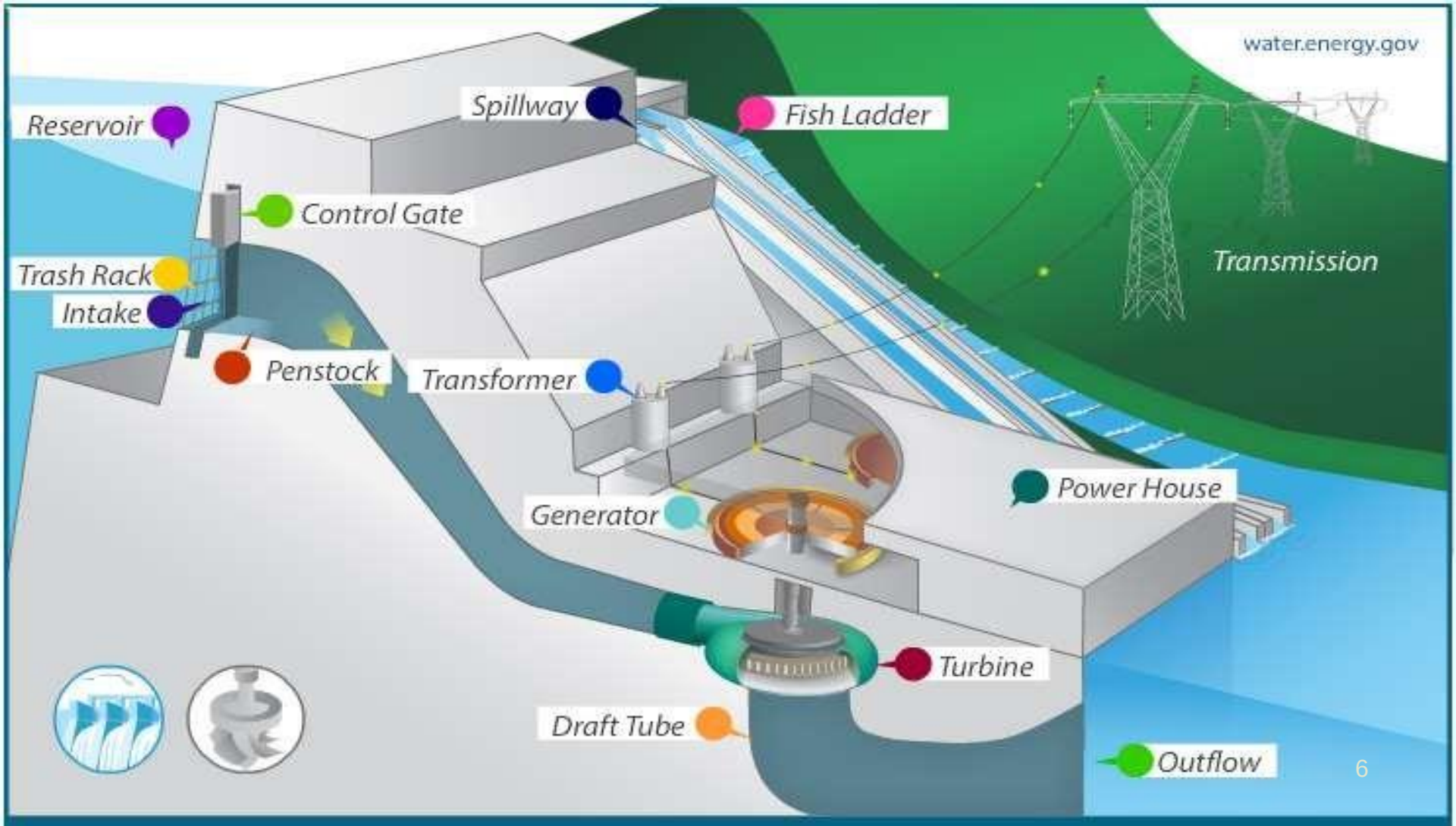
- In Hydro Power Plant the water is utilized to move the turbines which in turn run the electric generators.
- The Potential energy of the water stored in the dam gets converted into the Kinetic Energy of the moving water in the penstock. And this Kinetic Energy gets converted into the Electrical Energy with the help of Turbine & Generator (T-G) combination.
- Hydro Power Plant was invented by H.F. Rogers

Essential parts of a Hydro Power Plant

- Dam
- Water reservoir
- Control gates or intake
- The penstock
- Water turbines
- Generators


Hydroelectric Dam
Reservoir
Intake
Powerhouse
Generator
Long Distance
Power Lines
Penstock
Turbine
River

How Hydropower Works ?



Dam

- The dam is the most important component of hydroelectric power plant.
- The dam is built on a large river that has abundant quantity of water throughout the year.
- It should be built at a location where the height of the river is sufficient to get the maximum possible potential energy from water.

Water reservoir

- The water reservoir is the place behind the dam where water is stored.
- The water in the reservoir is located higher than the rest of the dam structure.
- The height of water in the reservoir decides how much potential energy is in the water.
- The higher the height of water, the more its potential energy.
- The high position of water in the reservoir also enables it to move downwards effortlessly.

- The height of water in the reservoir is higher than the natural height of water flowing in the river, so it is considered to have an altered equilibrium.
- This also helps to increase the overall potential energy of water, which helps ultimately produce more electricity in the power generation unit.

Control gates or intake

- These are the gates built on the inside of the dam.
- The water from reservoir is released and controlled through these gates.
- These are called inlet gates because water enters the power generation unit through these gates.
- When the control gates are opened the water flows due to gravity through the penstock and towards the turbines.

The penstock

- The penstock is the long pipe or the way that carries the water flowing from the reservoir towards the power generation unit, comprised of the turbines and generator.
- The water in the penstock possesses kinetic energy due to its motion and potential energy due to its height.
- The total amount of power generated in the hydroelectric power plant depends on the height of the water reservoir and the amount of water flowing through the penstock.
- The amount of water flowing through the penstock is controlled by the control gates.

Water turbines

- Water flowing from the penstock is allowed to enter the power generation unit, which houses the turbine and the generator.
- When water falls on the blades of the turbine the kinetic and potential energy of water is converted into the rotational motion of the blades of the turbine.
- The rotating blades causes the shaft of the turbine to also rotate.
- The turbine shaft is enclosed inside the generator.

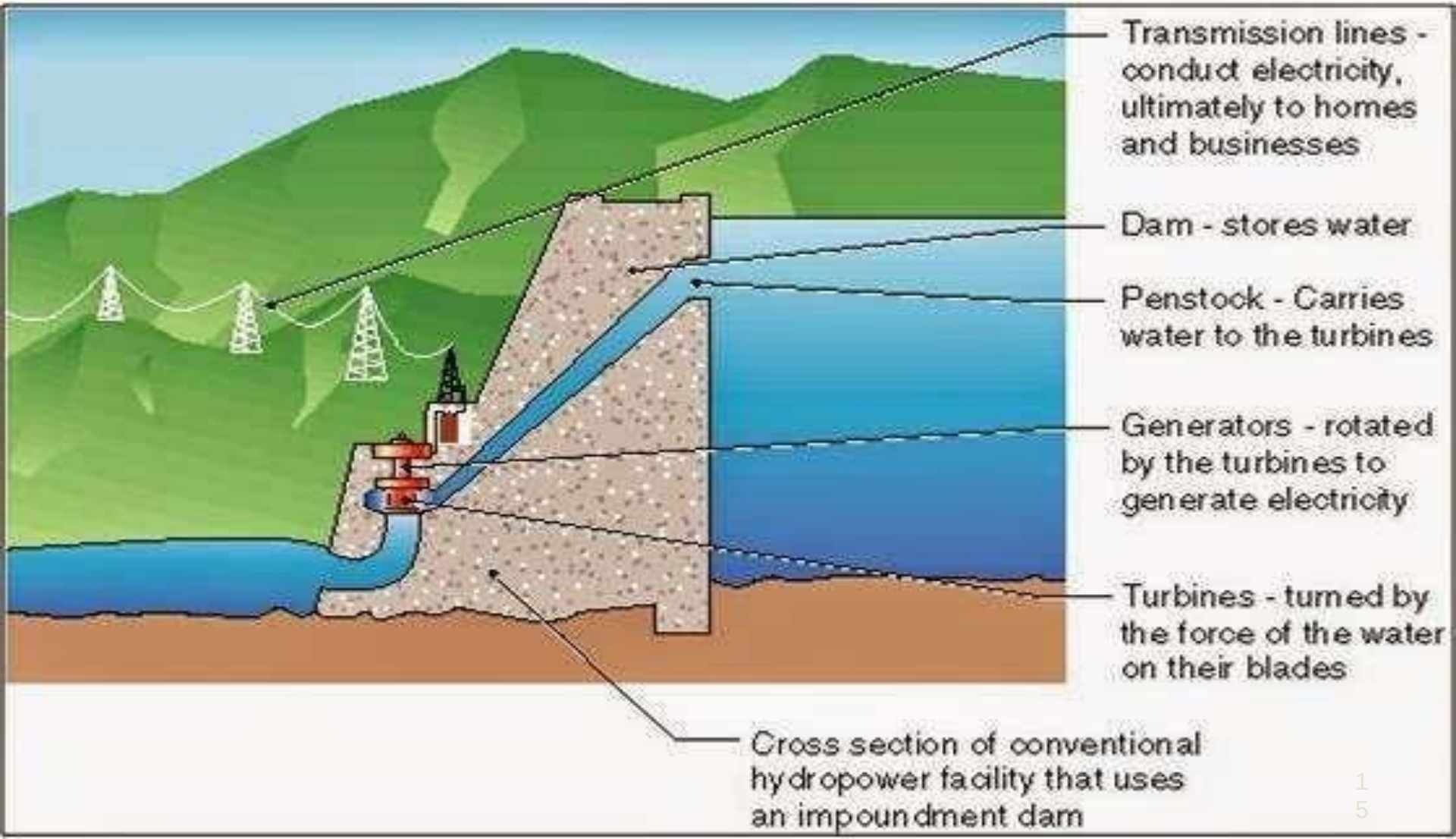
Generators

- It is in the generator where the electricity is produced.
- The shaft of the water turbine rotates in the generator, which produces alternating current in the coils of the generator

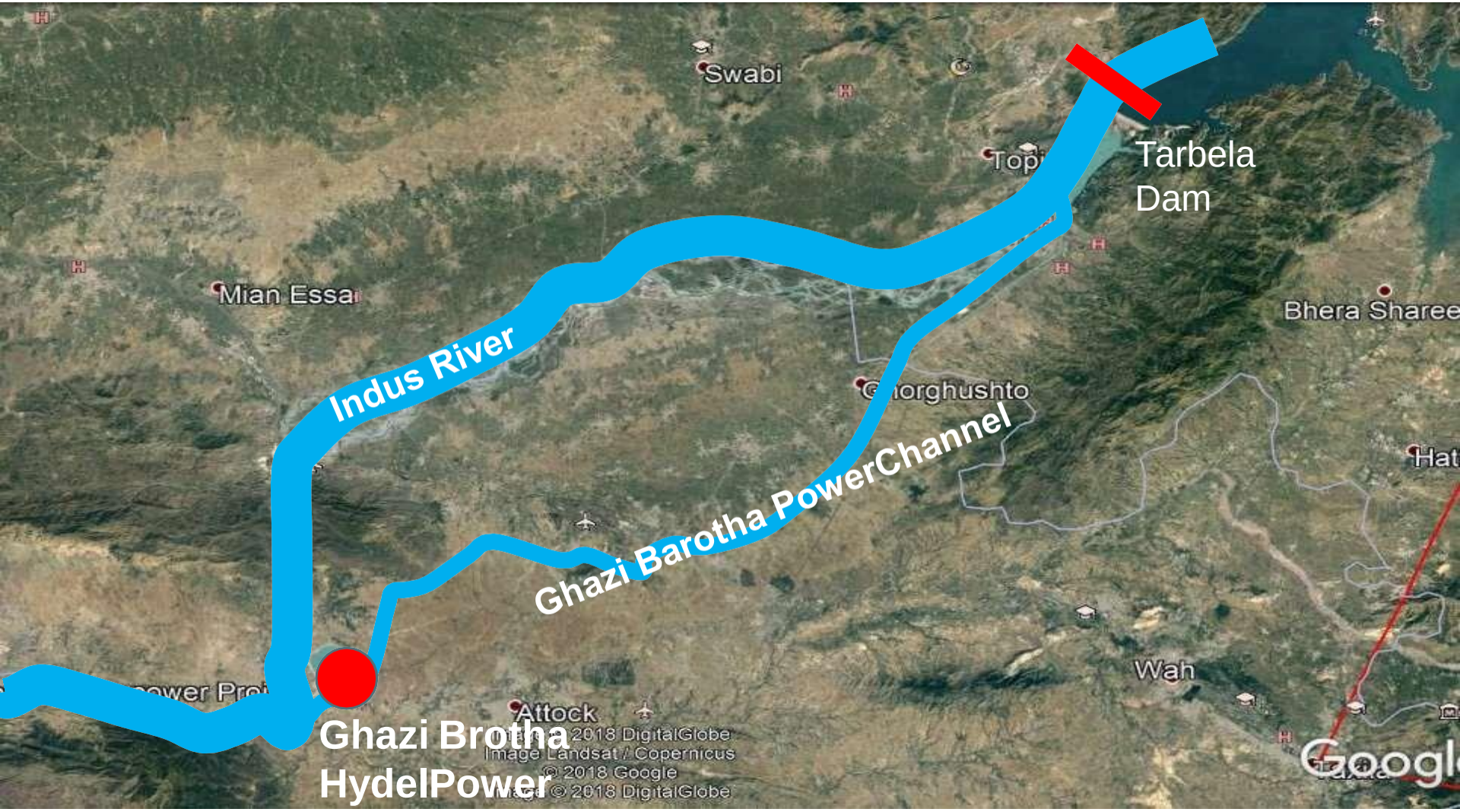
Types of Hydropower Plant

- **According to Topography**
- **According to Production of Electricity**
- **According to Magnitude of Head**

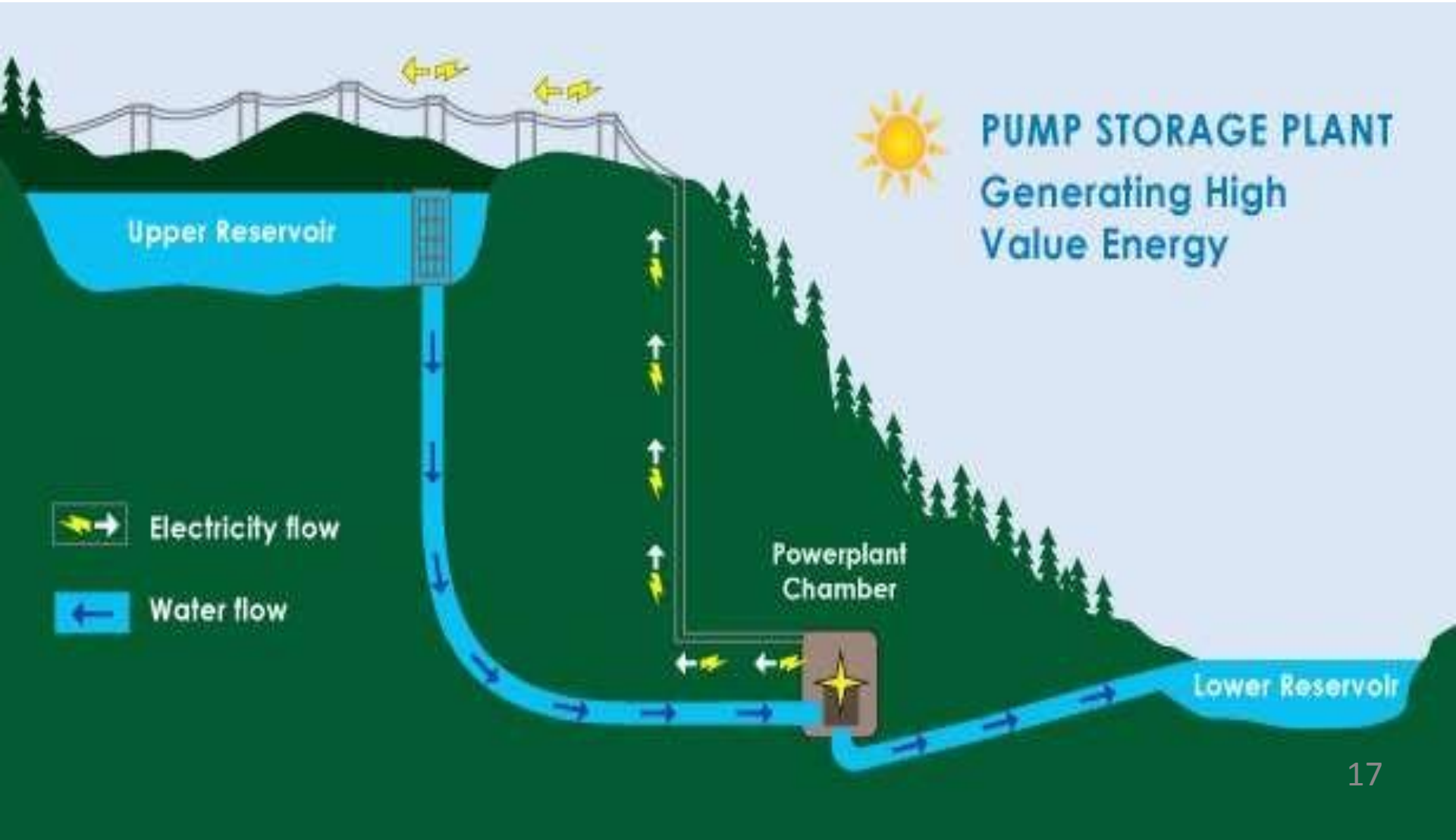
Impoundment Hydropower Plants



Diversion Hydropower Plants



Pumped Storage Hydropower Plants



According to Production of Electricity Hydropower Plants

- **Large Hydropower Plant:**

  Capacity of more than 30 (MW)

- **Small Hydropower Plant:**

  Capacity 10 (MW) or Less than

- **Micro Hydropower Plant:**

  Capacity upto 100 (KW)

According to Magnitude of Head Hydropower Plant

- **Low Head Hydropower Plant:**

  Head is less than 30 meters.

- **Medium Head Hydropower Plant:**

  Head of water is more than 30 meters.

- **High Head Hydropower Plant:**

  Head of water is more than 300 meters.

Low Head Hydropower Plant

- **Chashma Hydropower Plant**
- **Kurram Garhi Hydropower Plant**
- **Shadiwal Hydropower Plant**
- **Nandipur Hydropower Plant**

High Head Hydropower Plant

- **Allai Khwar Hydropower Plant (687 m)**
- **Kayal Khwar**

Produce electricity from Hydropower Plants

- **Total Power Generation Capacity 19,855 MW.**
- **Demand: 14,500 MW.**
- **Total Hydel 6,929 MW**

WAPDA Hydro O&M Projects

- **Tarbela Dam 3478 MW**
- **Mangla Dam 1000 MW**
- **Ghazi Barotha Hydropower project 1450 MW**
- **Warsak Dam 243MW**
- **Chashma HydelPower Project 184MW**
- **Duber Khwar Dam 130MW**
- **Allai Khwar Hydropower Project 121 MW**
- **Khan Khwar Hydropower Project 72 MW**
- **Jagran Hydelpower Project 30MW**

WAPDA Hydro O&M Projects

- **Jabban Hydelpower Project 22MW**
- **Rasul Barrage 22MW**
- **Dargai Hydelpower project 20 MW**
- **Gomal Zam Dam 17 MW**
- **Nandipur 14 MW**
- **Shadiwal Hydelpower Project 13.5 MW**
- **Khurram Garhi Hydelpower Project 4MW**
- **Renala Khurd Hydelpower Project 1 MW**
- **Chitral Hydelpower Project 1 MW**
- **Golan Gol Hydelpower Project 106 MW**

WAPDA Hydro Under Construction Projects

- **Neelam Jhelum**
- **Terbela 4th Extension**
- **Dasu**
- **Terbela 5th Extension**
- **Keyal Khwar**
- **Warsak Power Rehabilitation**
- **Kurram Tangi Dam**
- **Mangla Rehabilitation**

WAPDA Hydro Ready for Construction Projects

- **Lower Palas Valley**
- **Lower Spat Gah**
- **Bunji**
- **Mohmand Dam**
- **Diamer Bhasha Dam**
- **Harpo**

WAPDA Hydro Future Projects

- **Renala Rehabilitation**
- **Chitral Power Enhancement**
- **Thakot**
- **Basho**
- **Patan**
- **Phandar**
- **Shyok Dam**

SUMMARY OF HYDROPOWER RESOURCES IN PAKISTAN

Province/ Territory	Projects in Operation (MW)	Projects Under Implementation			Solicited Sites (Projects with Feasibility Study Completed) (MW)	Projects with Raw Sites (MW)	Total Hydropower Resources (MW)
		Public Sector (MW)	Private Sector (MW)				
			Province Level	Federal Level			
Khyber Pakhtunkhwa	3849	9482	28	2370	77	8930	24736
Gilget-Baltistan	133	11876	40	-	534	8542	21125
Punjab	1699	720	308	720	3606	238	7291
Azad Jammu and Kashmir	1039	1231	92	3172	1	915	6450
Sindh	-	-	-	-	67	126	193
Balochistan	-		-	-			1
TOTAL	6929	23309	468	6262	4286	18751	59796

Advantage

- Flexibility
- Low power costs
- Suitability for industrial applications
- Reduced CO_2 emissions
- Other uses of the reservoir

Disadvantage

- Ecosystem damage and loss of land
- Siltation (the process of blocking something with sand or soil) and flow shortage
- Methane emissions (from reservoirs)
- Relocation
- Failure risks