Wind Power Generation

(Lecture 6)

Renewable Energy
MSc Lecture Notes

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Course Contains:

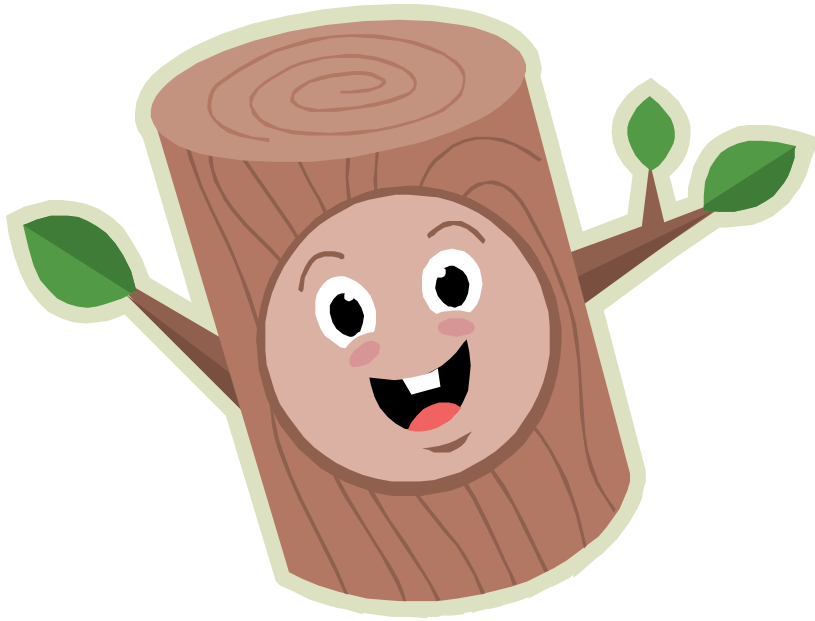
- **Renewable Energy Overview**
- **Basic of Renewable Energy Supply**
- **Solar Thermal Heat Utilization**
- **Photovoltaic Power Generation**
- **Wind Power Generation**
- **Hydroelectric Power Generation**

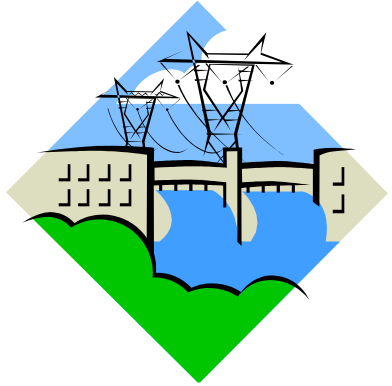
Hydroelectric Power Generation

(Lecture 6)

Benefits of Hydroelectric Power

- Clean, very little pollution
- Renewable resource
- Inexpensive





- Worldwide, hydropower plants produce about 24 percent of the world's electricity and supply more than 1 billion people with power.
- The world's hydropower plants generate a combined total of **675,000 megawatts**, the energy equivalent of 3.6 billion barrels of oil, according to the National Renewable Energy Laboratory.
- There are more than 2,000 hydropower plants operating in the United States, making hydropower the country's largest renewable energy source.

What is Hydroelectric Power?

- Hydropower plants harness water's energy (of motion) and use simple mechanics to convert that energy into electricity.

- Hydropower plants are actually based on a rather simple concept -- water flowing through a dam turns a turbine, which turns a generator.

Principle –Hydroelectric power

Hydropower plants harness the potential energy within falling water and use classical mechanics to convert that energy into electricity. The theoretical water power $P_{Wa,th}$ between two specific points on a river can be calculated according to Equation (8.1)

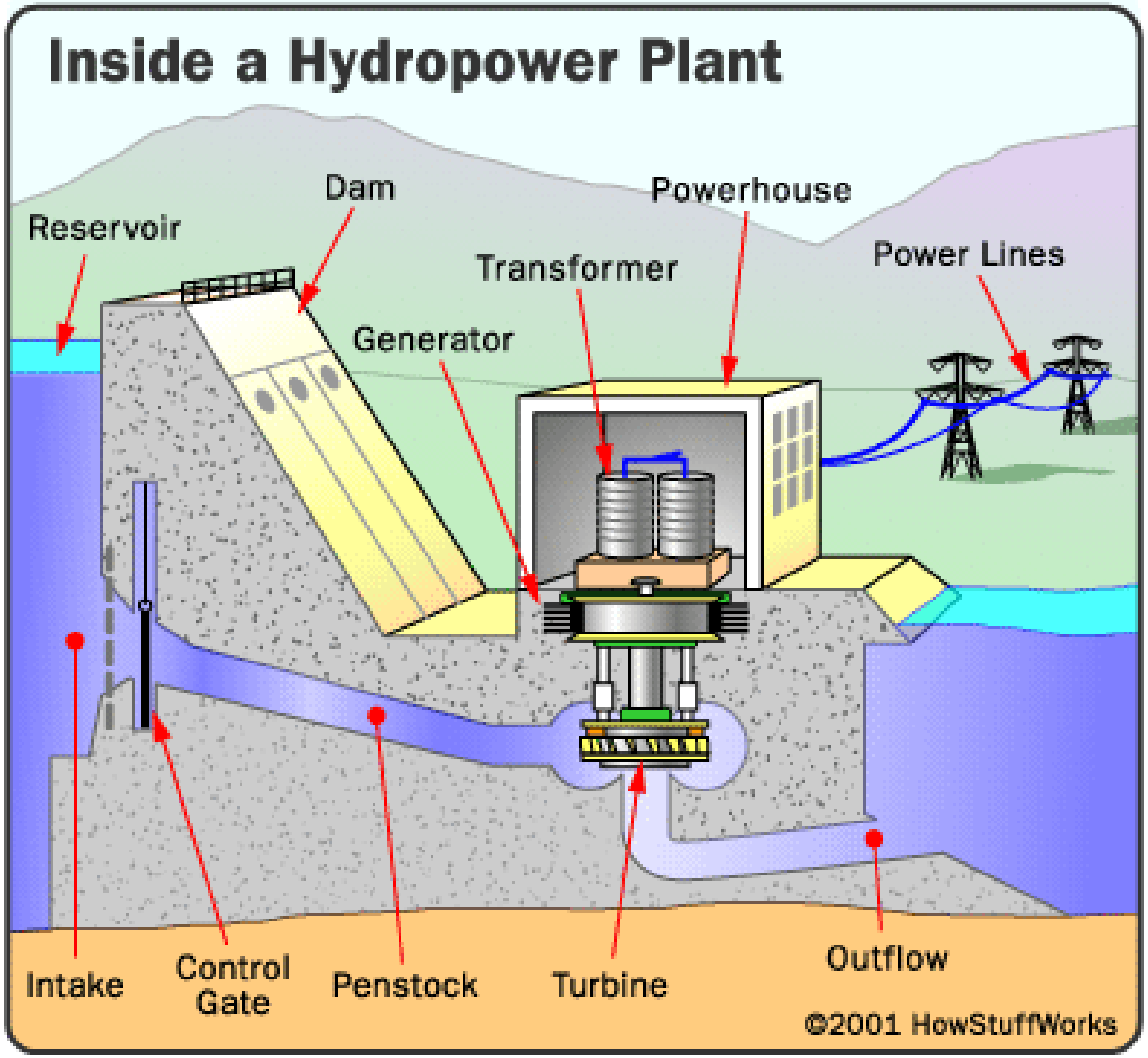
$$P_{Wa,th} = \rho_{Wa}\, g\, \dot{q}_{Wa}\, (h_{HW} - h_{TW})$$

ρ_{Wa} is the water density, g the gravitational constant, and $\dot{q}_{Wa}$ the volumetric flow rate through the hydroelectric power station. h_{HW} und h_{TW} describe the geodetic level of head and tailwater.

Due to the physically unavoidable transfer losses within a hydroelectric power station, only part of the power according to Equation (8.1) can be utilized

What are the parts of a Hydroelectric Power Plant?

1. Intake and Penstock-pull water into the area where turbine is located
2. Turbine-spins as water passes through
3. Generator-generates electricity using mechanical energy of the spinning turbine
4. Transformer-transforms electrical energy for passage through the power lines
5. Reservoir-holds the water


Inside a Hydropower Plant
Reservoir
Dam
Powerhouse
Transformer
Power Lines
Generator
Intake
Control Gate
Penstock
Turbine
Outflow
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- **Intake.** The intake structure is the connection between headwater and penstock or turbine.
- **Penstock.** The penstock bridges the distance between the headwater or intake structure on one side with the turbine on the othe
- **Turbine.** In the turbine, pressure energy is converted into mechanical energy
- **Outlet.** Reaction turbines (e.g. Kaplan turbines, Francis turbines) enable a better utilisation of the head using a draft tube