

Overview of Hydropower

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A concise, easy-to-read guide for students, professionals, and anyone interested in renewable energy.

1. What Is Hydropower?

Aspect	Description
Definition	Conversion of the kinetic and potential energy of moving water into electricity.
Key Principle	Uses turbines to spin generators; water flow provides the mechanical energy.
Main Forms	- Run-of-the-river (no large reservoir) - Storage (reservoir) hydro (water stored behind a dam) - Pumped-storage (energy-storage system)
Global Share	Provides ~16% of worldwide electricity generation and >60% of renewable electricity.

2. How a Hydropower Plant Works

1. **Water Source** – River, dammed reservoir, or pumped water.
2. **Intake & Head** – Water enters through a **penstock** (large pipe) that creates a pressure head (height difference).
3. **Turbine** – Water's kinetic energy turns the turbine blades.
 - o Common turbine types:
 - **Pelton** (high head, low flow)
 - **Francis** (medium head/flow)
 - **Kaplan** (low head, high flow) |
4. **Generator** – Turbine shaft drives a generator, producing alternating current (AC).
5. **Transformer & Grid** – Voltage is stepped up for transmission to the power grid.
6. **Tailrace** – Water exits back to the river downstream.

(Diagram not shown – visualize a dam ? penstock ? turbine ? generator ? transmission.)

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3. Types of Hydropower Facilities

Type	Typical Head (m)	Typical Flow (m³/s)	Main Uses
Dam+storage	30 – 300+	10 – 10,000	Base-load power, flood control, water supply
Run-of-the-river	<30	5 – 500	Peaking or supplemental power, minimal reservoir
Pumped-storage	100 – 800	50 – 1,000	Grid-scale energy storage, load-following
Micro-hydro	<15	<1	Rural electrification, off-grid sites

4. Advantages

Category	Benefits
Renewable	Uses water cycle; virtually inexhaustible while precipitation continues.
Low Emissions	Lifecycle CO ₂ <30g/kWh (vs. >800g/kWh for coal).
High Efficiency	70%–90% conversion efficiency (higher than thermal plants).
Grid Stability	Fast ramp-up/down (seconds to minutes); provides frequency regulation.
Multi-purpose	Can combine power with irrigation, flood control, recreation, and water supply.
Long Lifespan	Facilities often operate 50–100 years with proper maintenance.

5. Environmental & Social Considerations

Issue	Impact	Mitigation Strategies
Habitat Disruption	Alters river ecology, blocks fish migration.	Fish ladders, bypass channels, turbine design (e.g., fish-friendly turbines).
Reservoir Emissions	Decomposition of organic matter releases methane.	Clear-cut