

# HYDROPOWER




## KEY FACTS

Globally, more than 21.8 GW of renewable hydroelectric capacity were put into operation in 2018.<sup>4</sup>

In some countries, hydropower is the largest renewable energy source of electricity. In Norway, 99 percent of electricity comes from hydropower.<sup>1</sup>



The world's largest hydropower plant has a capacity of 22.5 GW. In China, the *Three Gorges Dam* produces **80 TO 100 TWh/YEAR**, enough to supply between **70 AND 80 MILLION HOUSEHOLDS**.<sup>1</sup>

 Hydropower is among the cleanest sources of electricity, with an estimated median greenhouse gas emission intensity of 18.5 gCO<sub>2-eq</sub>/kWh.<sup>8</sup>

Hydropower allows for generation of significant revenue from exports to neighbouring countries.<sup>5</sup>

## WHAT IS HYDROPOWER?

Hydropower is energy derived from the flow of water. Today it is among the most cost-effective means of generating electricity and is often the most preferred method where available.

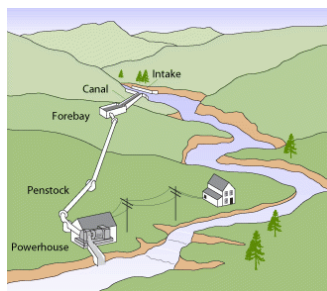
The basic principle of hydropower is using the force in the flow of water to drive turbines that in turn generate electricity.<sup>1</sup>

Hydropower plants can be built with or without dams and reservoirs. They can be categorized into three types: run-off river hydropower, stored hydropower and pumped-storage hydropower.

## RUN-OFF RIVER HYDROPOWER (DIVERSION)

A plant that channels flowing water from a river through a canal or penstock to rotate a turbine. Naturally, a run-of-river project will have a small storage facility (reservoir) or none at all.<sup>2</sup> Run-off hydropower operates without interfering in the flow of the river; therefore many consider small-scale hydro a more environmentally-friendly option.

Figure 1: Run-of-the-river microhydropower systems (<https://www.energy.gov/energysaver/buying-and-making-electricity/microhydropower-systems>)



## STORED HYDROPOWER (IMPOUNDMENT)

This category of hydropower is a larger system that utilizes a dam to store water in a reservoir or in a large catchment area. Electricity is generated by discharging water from the reservoir through a turbine, connected to a generator. It can store water over short or long periods of time to meet base and peak load demands.

It is also able to shut down and start up on short notice according to the requirements of the system (peak load).<sup>2</sup> Figure 2 shows the large hydropower plant with all components.

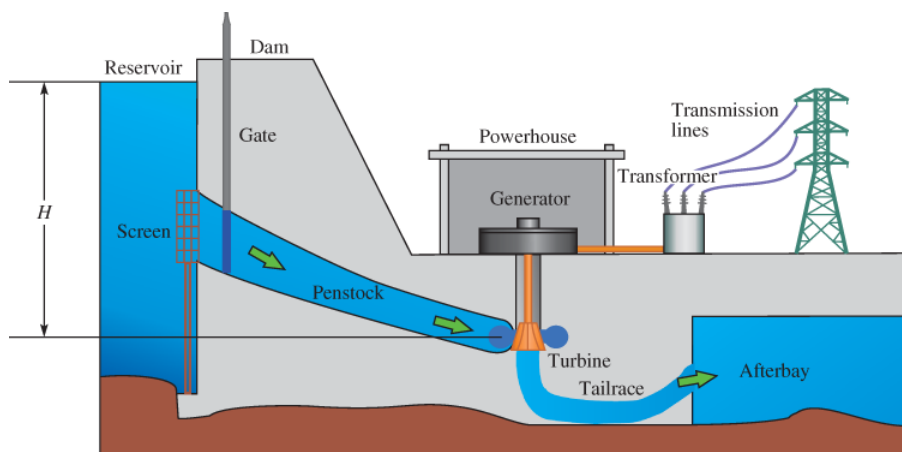


Figure 2: Basic Parts of a Hydroelectric Power Plant (<https://electricalacademia.com/renewable-energy/hydroelectric-power-plant-working-types-hydroelectric-power-plants/attachment/figure-1-17/>)



## PUMPED-STORAGE HYDROPOWER

This system works as an energy storage facility and can be combined well with other renewable energy sources such as solar and wind, for use during peak demand or low resource availability. It stores energy by pumping water to a reservoir situated at a higher level than the water source.

When electricity demand is low, it stores energy by pumping water from the water source at a lower level to the reservoir. When the electricity demand is high, the water is released from the storage reservoir to the turbine, enabling the connected generator to produce electricity.<sup>2</sup> Figure 3 illustrates the typical working principle of a pumped-storage hydropower system.

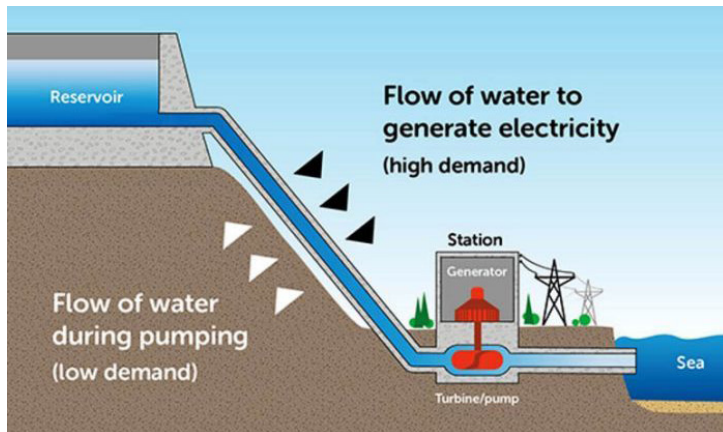


Figure 3: Pumped Hydro (<https://www.sciencealert.com/scientists-spot-530-000-potential-pumped-hydro-sites-to-meet-all-our-renewable-energy-needs>)

## KEY FACTS



Hydropower will play a **vital role in achieving 100 percent renewable energy** due to its flexibility in dispatch

and storage services, answering demand when other renewable energy sources are unavailable.

Despite high upfront costs, **hydropower provides extremely low-cost electricity over its long lifetime.**



In 2018 the global weighted average cost of electricity from hydropower projects was **USD 0.047 per unit.** That makes hydro technology the lowest-cost source of electricity in many markets.<sup>6</sup>

## SUSTAINABILITY OF HYDROPOWER

More than 2 million people are directly employed by the hydropower industry across the globe followed by many more in connected supply chains.<sup>7</sup> In addition to being a clean source of electricity production, hydropower projects of all sizes can result in net-benefits to communities, energy systems, and water security, provided they fit strategically into a river basin and are developed and operated sustainably.<sup>5</sup>

Globally acknowledged "Hydropower Sustainability Tools" exist to assure that hydropower projects can be developed and operated in accordance with good practice.<sup>5</sup>

### HYDROPOWER PLANT SIZES

MICRO

<100 kW

<10 MW

SMALL

>30 MW

LARGE

## REFERENCES

- "Hydropower", Irena.org. Available: <https://www.irena.org/hydropower>
- Types of hydropower, International Hydropower Association, Hydropower.org. Available at: <https://www.hydropower.org/types-of-hydropower>
- Types of Hydropower Plants, Energy.gov. Available at: <https://www.energy.gov/eere/water/types-hydropower-plants>
- 2019 Hydropower Status Report | International Hydropower Association, Hydropower.org (2019). Available at: <https://www.hydropower.org/status2019>
- Fast facts about hydropower | International Hydropower Association, Hydropower.org (2019). Available at: <https://www.hydropower.org/facts>
- Renewable Power Generation Costs in 2018, International Renewable Energy Agency IRENA (2019), Abu Dhabi. Available at: <https://www.irena.org/publications/2019/May/Renewable-power-generation-costs-in-2018>
- Renewable Energy and Jobs Annual Review 2019, International Renewable Energy Agency, IRENA (2019), Abu Dhabi. Available at: [https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jun/IRENA\\_RE\\_Jobs\\_2019-report.pdf](https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Jun/IRENA_RE_Jobs_2019-report.pdf)
- "2018 Hydropower Status Report, International Hydropower Association", Hydropower.org, 2018. Available at: <https://www.hydropower.org/publications/2018-hydropower-status-report>

### Author

Mohamedarif Patel - ICLEI World Secretariat

### Collaborator

Rohit Sen - ICLEI World Secretariat  
Laura Noriega - ICLEI World Secretariat

### Design

Olga Tokareva - ICLEI World Secretariat

### Supported by:



Federal Ministry  
for the Environment, Nature Conservation  
and Nuclear Safety

based on a decision of the German Bundestag

### Copyright

(c) 2020 ICLEI - Local Governments for Sustainability e.V. All rights reserved. The ICLEI World Secretariat holds the copyright of this publication, including text, analyses, logos and layout designs. Requests to reproduce or to quote material in part or in full should be sent to [carbon@iclei.org](mailto:carbon@iclei.org). ICLEI encourages use and dissemination of this report, and permission to reproduce this material without modification will usually be permitted without charge for non-commercial use.