USGS
science for a changing world

Water Science School

Hydroelectric Power: How it Works

So just how do we get electricity from water? Actually, hydroelectric and coal-fired power plants produce electricity in a similar way. In both cases a power source is used to turn a propeller-like piece called a turbine.

Status - Completed

Contacts

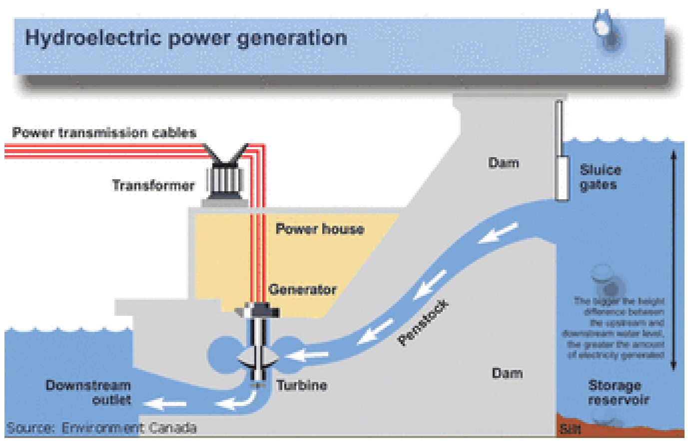
Ask USGS

https://answers.usgs.gov

Explore More Science

hydroelectric
hydroelectricity
hydro power
Water Use
How We Use Water
Water

• Water Science School HOME • Water Use topics •



Falling water produces hydroelectric power. (Credit: Tennessee Valley Authority)

So just how do we get electricity from water? Actually, hydroelectric and coal-fired power plants produce electricity in a similar way. In both cases a power source is used to turn a propeller-like piece called a turbine, which then turns a metal shaft in an electric generator, which is the motor that produces electricity. A coal-fired power plant uses steam to turn the turbine blades; whereas a hydroelectric plant uses falling water to turn the turbine. The results are the same.

Take a look at this diagram (courtesy of the Tennessee Valley Authority) of a hydroelectric power plant to see the details:

The theory is to build a dam on a large river that has a large drop in elevation (there are not many hydroelectric plants in Kansas or Florida). The dam stores lots of water behind it in the reservoir. Near the bottom of the dam wall there is the water intake. Gravity causes it to fall through the penstock inside the dam. At the end of the penstock there is a turbine propellor, which is turned by the moving water. The shaft from the turbine goes up into the generator, which produces the power. Power lines are connected to the generator that carry electricity to your home and mine. The water continues past the propellor through the tailrace into the river past the dam. By the way, it is not a good idea to be playing in the water right below a dam when water is released!

A turbine and generator produce the electricity

As to how this generator works, the Corps of Engineers explains it this way:

"A hydraulic turbine converts the energy of flowing water into mechanical energy. A hydroelectric generator converts this mechanical energy into electricity. The operation of a generator is based on the principles discovered by Faraday. He found that when a magnet is moved past a conductor, it causes electricity to flow. In a large generator, electromagnets are made by circulating direct current through loops of wire wound around stacks of magnetic steel laminations. These are called field poles, and are mounted on the perimeter of the rotor. The rotor is attached to the turbine shaft, and rotates at a fixed speed. When the rotor turns, it causes the field poles (the electromagnets) to move past the conductors mounted in the stator. This, in turn, causes electricity to flow and a voltage to develop at the generator output terminals."

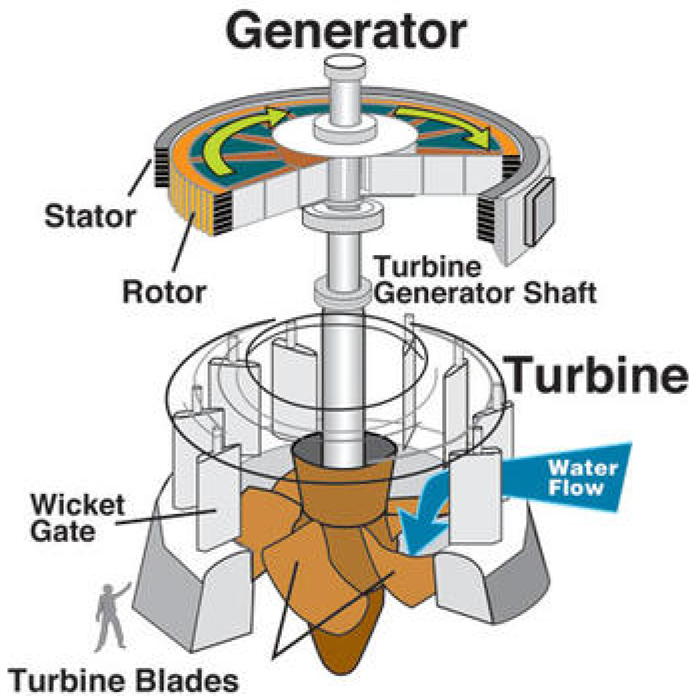
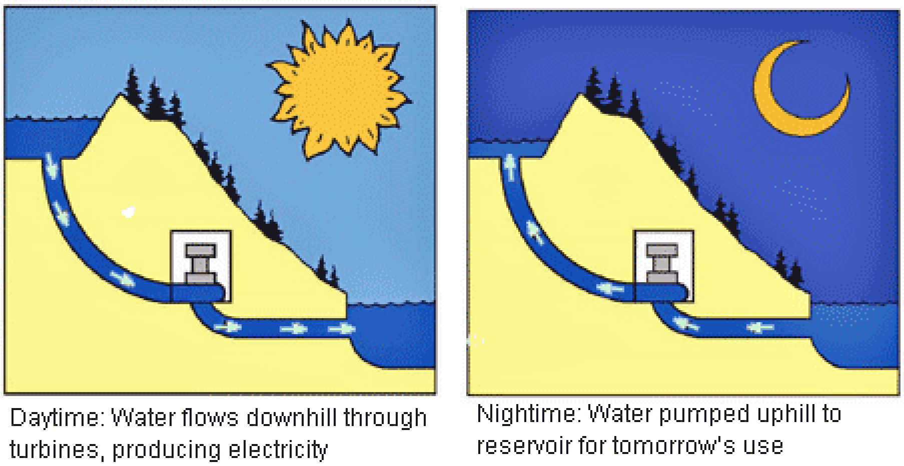


Diagram of a hydroelectric turbine and generator. (Credit: U.S. Army Corps of Engineers)

Pumped storage: Reusing water for peak electricity demand

Demand for electricity is not "flat" and constant. Demand goes up and down during the day, and overnight there is less need for electricity in homes, businesses, and other facilities. For example, here in Atlanta, Georgia at 5:00 PM on a hot August weekend day, you can bet there is a huge demand for electricity to run millions of air conditioners! But, 12 hours later at 5:00 AM .... not so much. Hydroelectric plants are more efficient at providing for peak power demands during short periods than are fossil-fuel and nuclear power plants, and one way of doing that is by using "pumped storage", which reuses the same water more than once.

Pumped storage is a method of keeping water in reserve for peak period power demands by pumping water that has already flowed through the turbines back up a storage pool above the power plant at a time when customer demand for energy is low, such as during the middle of the night. The water is then allowed to flow back through the turbine-generators at times when demand is high and a heavy load is placed on the system.



Pumped storage: Reusing water for peak electricity demand

The reservoir acts much like a battery, storing power in the form of water when demands are low and producing maximum power during daily and seasonal peak periods. An advantage of pumped storage is that hydroelectric generating units are able to start up quickly and make rapid adjustments in output. They operate efficiently when used for one hour or several hours. Because pumped storage reservoirs are relatively small, construction costs are generally low compared with conventional hydropower facilities.

Below are science topics related to hydroelectric power water use.

Date published: AUGUST 30, 2018
Status: Completed

Water Use Information by Topic

Water is everywhere, which is fortunate for all of humanity, as water is essential for life. Even though water is not always available in the needed quantity and quality for all people everywhere, people have learned to get and use water for all of their water needs, from drinking, cleaning, irrigating crops, producing electricity, and for just having fun.

Contacts: Ask USGS

Date published: JUNE 6, 2018
Status: Completed

Hydroelectric Power: How it Works

So just how do we get electricity from water? Actually, hydroelectric and coal-fired power plants produce electricity in a similar way. In both cases a power source is used to turn a propeller-like piece called a turbine.

Contacts: Ask USGS
Attribution: Water Resources

Date published: JUNE 6, 2018
Status: Completed

Hydroelectric Power: Advantages of Production and Usage

Nothing is perfect on Earth, and that includes the production of electricity using flowing water. Hydroelectric-production facilities are indeed not perfect (a dam costs a lot to build and also can have negative effects on the environment and local ecology), but there are a number of advantages of hydroelectric-power production as opposed to fossil-fuel power production.

Contacts: Ask USGS
Attribution: Water Resources

Date published: JUNE 6, 2018
Status: Completed

Three Gorges Dam: The World's Largest Hydroelectric Plant

The Three Gorges Dam on the Yangtze River in China is the world's biggest hydroelectric facility.

Contacts: Ask USGS

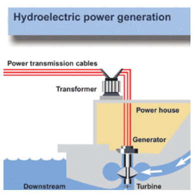
Attribution: Water Resources

Below are multimedia resources related to hydroelectric power water use.

JANUARY 27, 2010

Turbines in Hydroelectric Power Plants

Hydroelectric Power Turbine at Grand Coulee Powerplant, WA



The flow of water produces hydroelectricity.

Falling water produces hydroelectric power.

The theory is to build a dam on a large river that has a large drop in elevation (there are not many hydroelectric plants in Kansas or Florida). The dam stores lots of water behind it in the reservoir. Near the bottom of the dam wall there is the water intake. Gravity causes it to fall through the penstock

...

Three Gorges Dam, China is the world's largest hydro facility.

Three Gorges Dam, China is the world's largest hydroelectric facility.

According to Wikimedia, the Three Gorges Dam is a hydroelectric gravity dam that spans the Yangtze River by the town of Sandouping, in Yiling District, Yichang, Hubei province, China. The Three Gorges Dam is the world's largest power

...

Turbine from Agoyan hydroelectric power plant with severe abrasion ...

Tephra-laden water filtering through the turbines has necessitated the replacement of four turbines in 21 years. The Agoyan Dam and its (orange) floodgates are designed to let highly turbid water bypass the turbines so as to avoid accelerated wear of generation components

Attribution: Natural Hazards, Volcano Hazards Program Office