# The Physics of Hydroelectric Power

The actual process behind hydroelectric power is very simple and relies on some of the basic laws of physics. Two levels of the hydroelectric process exist. First there is the water cycle. Water that evaporates from a river or lake turns into clouds. The water in these clouds that came from a water source will then fall back down to earth. Some of the water that evaporated from a lake or the ocean will fall onto a higher elavation than the lake or ocean that it originally was in. This increase in elevation is directly related to the energy that is created through hydroelectric power. Water evaporates and raises in altitude, while the whole hydroelectric process relies on water falling, and losing elevation.

Gravity is the central force that causes a mass to fall in elevation. Whenever a person jumps, he inevitably falls back to the earth. This is because of gravity. Water that is high in elevation falls to a lower elevation because of gravity. A hydroelectric dam capitalizes on gravity. In order to subtract the gravitational force from the water and cause an energy transfer, a hydroelectric dam blocks the flow of water from a higher elevation to a lower elevation. The physical dam actually lets a small amount of water pass through the dam, but this amount is blocked by a turbine. The turbine is the primary object that utilizes the gravitational force of the water.

As the water accelerates toward the earth because of gravity, the turbine spins and causes the generator to put out energy. This physical process is summed up by several physics equations, first,

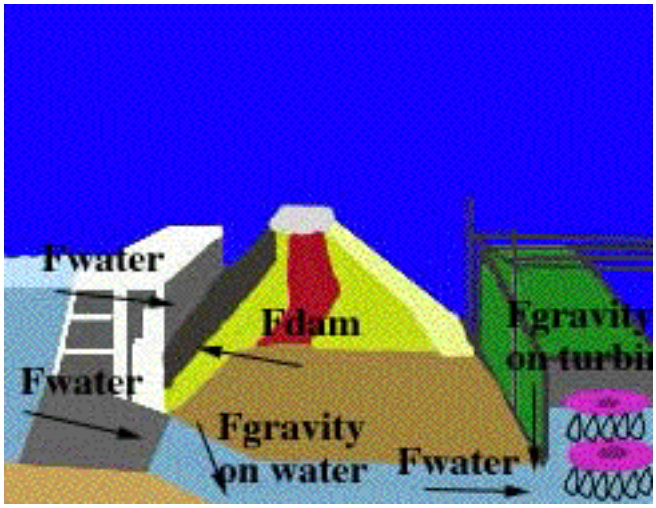
$$F = ma,\ F = m * dv / dt$$

where F is force, m is mass, and a is acceleration. The second part of the previous equation substitutes for the acceleration, where acceleration is equal to the change in velocity divided by the change in time. For the process of hydroelectric power, F is the force of the water that is falling toward the earth. The constant "a" stands for acceleration, and is a value that accounts for the change in velocity divided by the change in time. Cross reference these equations at the Equation page. When a mass is moving toward the earth, the constant "g" can be used, that has a value of -9.8 $m/s^2$ if the direction is negative downward. The mass in this equation is simply the mass of the water.

Considering the kinetic and potential enery that is found in this process, two interesting equations appear. The potential energy of the water before it runs downward to the hydroelectric dam is the mass in the first equation. After being set in motion, the potential energy is converted to kinetic energy, again relying on the velocity of the water. As the previous equation dealt with the force of the water being dependent on the velocity of the water, the velocity of the water is dependent on its kinetic energy (.5 represents a square root):

$$PE = m * g * h,\ V = (2KE / m)^{.5}$$

The turbine is the object that resists the downward acceleration of the water. The force of gravity that accelerates the water downward is transferred to the turbine. The following picture shows the forces acting in the second stage of the hydroelectric process.




The force that was described previously can be expanded in definition. The force is what does the work on the turbine. The power that is generated from the hydroelectric process is equal to the change in work divided by the change in time. Another way to look at this amount of power is by setting the power equal to the force of the water on the turbine multiplied by the velocity of the turbine. Both of these equations are given below:

$$P = dW / dt, P = F*v$$

The electronic definition of power is found at the Electricity help page. This page considered many relationships of the velocity of the water and the energy, force, work done, and power of the water. As discussed ealier, as the velocity of the turbine increases, the more power will be produced. For some problems associated with these equations, go to the Hydro Power Physics Questions page. Also take a quiz on the concepts discussed on this page.