HYDROPOWER FREQUENTLY ASKED QUESTIONS (V10.09)

Are there different types of hydropower plants?

Yes there are three main types:

- Impoundment uses water that is stored ("impounded") in a manmade dam. In the United States, there are nearly 2,500 such hydroelectric power plants. Water is released from the reservoir and flows into a turbine, causing it to spin and activate a generator that produces electricity. The water flow is controlled in these systems, and it may be released to meet changing electricity needs or to stabilize the water level in the reservoir.
- Diversion, or run-of-river plants divert a portion of the current of a river through a canal or penstock. It may not require the use of a dam. There is a large hydroelectric power plant using diversion, at Niagara Falls, Canada.
- Pumped Storage plants store energy by pumping water to a higher reservoir when demand is low. When electricity is needed, the water is released to turn turbines.

What is the difference between small-scale and large-scale hydropower projects?

Hydropower facilities range in size from large power plants that supply many consumers with electricity to small and micro hydro plants that individuals operate for their own energy needs or to sell power to utilities.

- Although definitions vary, DOE defines large hydropower as facilities that have a capacity of more than 30 megawatts.
- Although definitions vary, DOE defines small hydropower as facilities that have a capacity of 100 kilowatts to 30 megawatts. Hydroelectric plants of this size are found in villages around the world and can contribute significantly to local economies.
- A micro hydropower plant has a capacity of up to 100 kilowatts. A small or micro-hydroelectric power system can produce enough electricity for a home, farm, ranch, or village. Of all the forms of renewable energy that consumers can use independently, micro hydro is the most economical. All you need is running water on your property and permission for authorities.

How much more power can be produced by refurbishing older projects?

In some situations, increased rating and efficiency can be obtained by runner replacement. For pre-1960 turbines, it is frequently possible to obtain output increases as high as 30 per cent, and efficiency increases of more than 5 percent, by replacing existing runners with runners of improved design.

How much hydropower could be built at undeveloped sites?

In the United States the Department of Energy has identified 5,677 sites with undeveloped capacity of about 30,000 MW.

How much energy can you gain from a given amount of water falling at a certain height?

The basic elements required for a potential hydropower development are stream flow and an available drop, or "head", through which the stream flow can be used to convert the potential hydraulic energy into electrical energy. The power generated is represented by the equation:

P = eHQgwhere: P = Electric Power Output in kilowatts (kW)
e = Efficiency range 0.75 to 0.88 (75% to 88%)
H = Head, in meters (m)
Q = Design flow, in cubic meters/sec (m3/s)
g = acceleration of gravity, normally 9.81 m/s/s

For small-scale hydroelectric applications, if an Efficiency value of 81% is assumed, the following equation can be used:

P (kW) = 7.95 x H (m) x Q (m3/s)

Where is micro hydro used?

Micro hydro is a hydroelectric power system meant to provide a source of energy for a limited amount of users. While in some cases, micro hydro can be used to power small villages, most of the time it is much more limited in its application, perhaps powering a small manufacturing facility or remote resort, for example. It is a remote area power supply in that it can be used in areas not serviced by other forms of power generation.

Unlike larger forms of hydroelectric power, micro hydro does not have as many lasting effects on the environment. While larger hydroelectric power stations often dam major rivers to create huge reservoirs that forever change the landscape, no such reservoir is needed with micro hydropower generation. If a reservoir is needed, micro hydro often makes use of natural pools found on a stream. However, in most cases, reservoirs are not needed at all.

In fact, micro hydro can be a very efficient form of energy in some cases. While it is mainly found in areas with rushing streams, such as in mountains, micro hydro does not require a large amount of rushing water. It can be used in places where the flow is as little as 2 U.S. gallons (7.6 liters) per minute.

The economics of a micro hydro can also be quite attractive. Systems can be built for $20,000 US Dollars or less in many cases. Some may cost as little at $1,000 USD. Once built, it can provide users with an unlimited supply or renewable energy with hardly any effects on the environment. It is also pollution free.
While the benefits of the energy source can seem quite compelling, there are some shortcomings that should be considered as well. First, the user or users must be located near the energy source. Many micro hydro generators only are built to transmit electricity over distances of 1 mile (1.6 km) or less. Second, stream flows may vary in some months. Often summer months have lower stream flows, especially in mountainous areas after the snow runoff has ended. This could affect output. However, with a good study of the potential micro hydro site, these limitations can be overcome.

<u>I have water running through my property, can I use micro hydro?</u>
Micro-hydro relies on falling water, of course, so the siting is much more specific and limited than it is for any other renewable energy source. The farther any volume of water falls, the more powerful your micro-hydro system will be.

If you have a stream on or near your property, preferably one that runs throughout the year (though this is not absolutely necessary), then you may be able to take advantage of its energy. A fall of water as short as five feet with a volume of a gallon of water per second can be a sensible supplement to any other energy source you use.

If you have water that flows through your property, you may be able to redirect its flow down an incline and through a small hydro system.

<u>What is the world's largest dam?</u>
The world's largest dam is the Three Gorges Dam on the Yangtze River in China. Structural work was completed in 2006. The dam is 2,309 m (1.4 mi) long and 185m 607 ft) tall, six times the size of the Hoover Dam. When its generators are installed and it goes online in early 2009, it will be the world's biggest power plant. The Three Gorges Dam will generate 18.2 GW, or about 2% of China's total power consumption. China's exploding economy needs power, and considerable effort has been placed towards alternative forms of energy that do not pollute the air, as China's primary source of energy is coal.

140,000 people were killed due to catastrophic dam failure; extra precautions were taken in the engineering and fault tolerance of the Three Gorges Dam. It will be guarded by large amounts of soldiers around the clock to deter possible terrorist attacks.

Despite frequent criticisms stating that the costs of the Three Gorges Dam could be as high as $100 billion US Dollars (USD), the actual cost is not likely to exceed $22.5 billion USD. Most of this is being paid for by a national tax on electricity. Officials have stated that the dam will pay for itself with power generation.

Part of the role of the dam is also to engage in flood control. It will decrease the number of major downstream floods from once every 10 years to once every 100 years. Its massive 22 cubic kilometer reservoir will regulate the flow of water, increasing during the big floods and releasing the water at a uniform rate, sparing people downstream from the devastating economic effects of floods. The Three Gorges Dam's reservoir will be 200 m (219 yards) deep when it is fully flooded.

<u>What is a fish ladder?</u>
A fish ladder is a structure that allows fish to move past an obstacle such as a dam. Without fish ladders, fish would be stuck downstream of the obstacle, and this could potentially have a negative impact on the breeding cycles and lifestyle of the fish. Many dams are equipped with fish ladders, often to satisfy requirements from government agencies, and some dams have turned their fish ladders into wildlife viewing areas, allowing visitors to watch the fish as they move up the ladder.

The term "ladder" might seem a bit confusing for people who are trying to figure out how fish could climb up a conventional ladder. Fish ladders are actually made by creating a series of stepped pools. The fish can jump from pool to pool, eventually coming out on the other side of the dam or obstacle. There are a number of different designs and configurations for the pools. For especially large dams, people may use a fish elevator instead. Just like a people elevator, a fish elevator fills with passengers and then rises to the top of the dam before opening to allow the fish out on the other side.

Depending on where one is, fish ladders may be referred to as fishways, fish passes, or fish steps. They are usually designed in such a way that the water becomes noisy, attracting the attention of fish that may be struggling at the foot of a dam. The water is kept calm enough for the fish to be able to swim in the pools, as the designers of fish ladders do not want the fish to get so tired that they cannot navigate the fish ladder successfully.

In some cases, the fish ladder may be mounted in a glass chamber on the side of the dam, allowing observers to watch the fish as they move up the ladder. This can be useful for biologists who want to study the movement of fish populations and look at how dams are impacting fish in a particular region. Visitors to the dam may also enjoy watching the fish as they leap from pool to pool, or hop down the fish ladder, depending on the time of year and the species.

Local wildlife also may become interested in fish ladders, since the ladder confines the fish in a narrow inlet, making it easy to swoop in and grab a snack. Bears, eagles, raccoons, and other fish-eaters tend to congregate around fish ladders, regarding them as a movable feast of fish species.

People have recognized the impact of dams on fish since at least the 1600s, when fish ladders first began to be constructed. Modern versions differ little from the fish ladders of the 18th and 19th century, illustrating the soundness of the basic fish ladder design.

How can we make use of ocean energy?

There are three basic ways to tap the ocean for its energy. We can use the ocean's waves, we can use the ocean's high and low tides, or we can use temperature differences in the water.

Wave Energy

Kinetic energy (movement) exists in the moving waves of the ocean. That energy can be used to power a turbine. In this simple example, (illustrated to the right) the wave rises into a chamber. The rising water forces the air out of the chamber. The moving air spins a turbine that can turn a generator. When the wave goes down, air flows through the turbine and back into the chamber through doors that are normally closed.

This is only one type of wave-energy system. Others actually use the up and down motion of the wave to power a piston that moves up and down inside a cylinder. That piston can also turn a generator.
Most wave-energy systems are very small. But, they can be used to power a warning buoy or a small lighthouse.

Tidal Energy

Another form of ocean energy is called tidal energy. When tides come into the shore, they can be trapped in reservoirs behind dams. Then when the tide drops, the water behind the dam can be let out just like in a regular hydroelectric power plant.

In order for this to work well, you need large increases in tides. An increase of at least 16 feet between low tide to high tide is needed. There are only a few places where this tide change occurs around the earth. Some power plants are already operating using this idea. One plant in France makes enough energy from tides to power 240,000 homes.

Ocean Thermal Energy

The final ocean energy idea uses temperature differences in the ocean. If you ever went swimming in the ocean and dove deep below the surface, you would have noticed that the water gets colder the deeper you go. It's warmer on the surface because sunlight warms the water. But below the surface, the ocean gets very cold. That's why scuba divers wear wet suits when they dive down deep. Their wet suits trapped their body heat to keep them warm.

Power plants can be built that use this difference in temperature to make energy. A difference of at least 38 degrees Fahrenheit is needed between the warmer surface water and the colder deep ocean water.
Using this type of energy source is called Ocean Thermal Energy Conversion or OTEC. It is being used in both Japan and in Hawaii in some demonstration projects.

Can we produce electricity from tides and waves?

Production of electricity from waves and tides is an option today. About twice a day in high as well as low tides, water flows in and out of coasts and estuaries. This water can spin turbines, in order to produce electricity. But analysts have been taking a closer look at this form of energy supply and they believe that tidal power can only make a tiny contribution to the world's energy supply, because of the few suitable sites, the high construction costs and the risk of equipment destruction by saltwater corrosion. However, there are a few areas with the right conditions to produce tidal power. France and Canada own the largest tidal energy facilities right now.

How does tidal power work?

Tidal energy is produced through the use of tidal energy generators. These large underwater turbines are placed in areas with high tidal movements, and are designed to capture the kinetic motion of the ebbing and surging of ocean tides in order to produce electricity. Tidal power has great potential for future power and electricity generation because of the massive size of the oceans. These articles explore the potential energy of tidal power technologies.

Is tidal power currently being used anywhere?

The energy potential of tidal basins is large — the largest facility, the La Rance station in France, generates 240 megawatts of power. Currently, France is the only country that successfully uses this power source.

Tidal energy systems can have environmental impacts on tidal basins because of reduced tidal flow and silt buildup.

French engineers have noted that if the use of tidal power on a global level was brought to high enough levels, the Earth would slow its rotation by 24 hours every 2,000 years.