# Hydropower Program

## Technology Overview

**Hydropower projects use the kinetic energy of flowing water to produce electricity. Most hydropower projects use a dam or diversion structure to retain or channel water from a river or stream. When the stored water is released, it passes through and rotates turbines, which spin generators to produce electricity.**

Water retained in a reservoir can be stored during high flow periods for release during low flow periods. Because reservoir water can be accessed quickly it can also be used as an extra energy source during times when the demand for electricity is high.

Some projects do not require dams. Instead, run of the river projects divert a portion of the river or stream into a small canal, where it passes through a turbine and returns to the river. Because run of the river projects use the natural flow of the river or stream, they produce relatively little change in the stream channel and stream flow.

Hydropower projects range in size from a couple hundred watts up to 10,000 megawatts or more. Small hydro installations can produce enough electricity to power a small piece of machinery, a home, a farm, or a small community. Larger projects are primarily used by power providers to supply electricity to millions of people.

Duane Hippe, NREL/PIX04410

***The King Cove 800-kW microhydro facility in King Cove, Alaska went on line in December 1994 to service the remote 700-resident town. Communities in Alaska find that their electricity is expensive. Before December 1994, King Cove, a remote mountain village, paid 21 cents per kilowatt-hour for its electricity. That is because the village had depended on diesel fuel to generate its electricity. A less expensive source of power for these areas may be small-scale hydropower plants. It is this fact that led King Cove to turn to locally available hydroelectricity.***

## U.S. Department of Energy Program

**The mission of the U.S. Department of Energy's (DOE's) Hydropower Program is to develop, conduct, and coordinate research and development with industry and other federal agencies to improve the technical, societal, and environmental benefits of hydropower.**

The Idaho National Engineering and Environmental Laboratory (INEEL) is the Department of Energy's lead laboratory for engineering R&D for the Hydropower Program, and Oak Ridge National Laboratory (ORNL) is the lead laboratory for engineering R&D for environmental research on hydropower-related issues. Some of the program's projects include:

- ***Developing new turbine designs*** - Conceptual designs for advanced, environmentally-friendly turbines have recently been completed under the DOE-industry program. These new turbines could reduce fish mortality resulting from turbine passage to less than 2% and help maintain downstream dissolved oxygen levels to comply with water quality standards.
- ***Assessing U.S. hydro resources*** – Since 1989, the Hydropower Program has provided leadership in identifying hydro resources that may be available to support the expanding demand for energy in the U.S. As a result of the recent power shortages, many states are using the resource assessment to help them plan for future power needs.
- ***Working with Native Americans*** - The Renewable Indian Energy Resources Program helps Native American tribes learn about and initiate local renewable energy projects, including hydropower. In Alaska, this program is administering funding and providing technical assistance for hydropower projects intended to help Native American communities in Alaska minimize their dependence on expensive diesel fuel.

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## Sensor Fish: Proven Success

They may not swim, but the sensor-packed synthetic salmon that are making their way through the turbines at Bonneville Dam and other hydroelectric projects in the Columbia River are doing something that real fish cannot. The six-inch, rubber-coated sensor fish developed at Pacific Northwest National Laboratory are measuring the conditions that real fish encounter as they pass through turbines of hydroelectric dams on the way to the ocean.

As the fish pass through the turbines, their sensors gather specific information such as changes in pressure and acceleration. Little balloons attached to the fish inflate and bring them to the surface at the end of their trip. Once retrieved, the fish are attached to a computer and the data is downloaded for analysis.

***A school of nine synthetic "sensor fish" went through turbines at Bonneville Dam near Portland, Oregon a total of about 90 times in December 1999 and January 2000. The information provided by these sensor fish is aiding scientists in creating more fish-friendly turbines. Photo courtesy of the Pacific Northwest National Laboratory***

# Market Potential

**Hydropower is the largest and least expensive source of power generated from clean, renewable sources in the United States. In fact, hydropower accounts for about 8 to 10 percent of the electricity used in the United States today, and about 20 percent of the electricity used worldwide.**

While hydropower is still our nation's leading renewable energy source, hydropower generating capacity is now just a fraction of what it was during the middle of the 20th century. In the 1940s, hydropower provided about 33% of the electricity consumed by the United States, and about 75% of the electricity consumed in the West and the Pacific Northwest. With the advent of other forms of electric power generation, the percentage of electricity produced by hydropower has slowly declined.

While many large-scale dam projects have been criticized for altering wildlife habitats, impeding fish migration, and affecting water quality and flow patterns, advances in turbine design are expected to further increase fish survival rates and improve environmental conditions.

If, in the future, the United States is able to achieve a comfortable balance between environmental concerns, regulation, and energy needs, assessments of potential U.S. hydropower resources show that hydropower could play a more significant role in the U.S. energy market. Of the existing dams in the United States, less than three percent are now used to generate power; most are simply small flood-control or water-supply structures. Because these dams are already in place, many could be retrofitted to produce clean, cost-effective electricity with limited environmental effects.

In addition, new technologies can be used to retrofit existing hydropower facilities to produce energy more efficiently without increasing the physical size the project. Small efficiency improvements can have positive benefits for the nation; an improvement of one percent in the efficiency of our nation's existing hydropower system would increase annual generation by roughly three billion kilowatt-hours. This amount of electricity could power an additional 365,000 households and would save the energy equivalent of more than two million tons of coal each year.

## For More Information:

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