

Conventional Hydropower Technologies

The U.S. Department of Energy's (DOE) Water Power Program supports the development of technologies that harness the nation's renewable hydropower resources to generate environmentally sustainable and cost-effective electricity. Most conventional hydropower plants use a diversion structure, such as a dam, to capture water's potential energy via a turbine for electricity generation. The program's conventional hydropower activities focus on increasing generating capacity and efficiency at existing hydroelectric facilities, adding hydroelectric generating capacity to existing non-powered dams, adding new low impact hydropower, increasing advanced pumped-storage hydropower capacity, and reducing potential environmental impacts of conventional hydropower production. The program's research and development efforts fall under two categories: Technology Development and Market Acceleration.

Technology Development

The Water Power Program works with industry, universities, and the DOE's national laboratories to optimize existing facilities and conduct applied research, development, and testing of conventional hydropower technologies that will increase generation of hydroelectricity.

Upgrading Existing Facilities

To increase the contribution of hydropower generation to the nation's renewable energy supply, the Water Power Program assists industry in deploying technologies that maximize generation at existing hydropower facilities. In 2009, the program awarded \$30.6 million in American Recovery and Reinvestment Act funds to modernize the infrastructure at seven facilities; these upgrades will increase generating efficiency and reduce environmental effects of the hydropower facilities. The average cost of hydroelectricity generated by these capacity upgrades is estimated at less than 4 cents per kilowatt-hour, making incremental generation additions at existing hydropower facilities one of the most cost-competitive sources of renewable electricity. The first of these upgrades, the Abiquiu Low-Flow Turbine Hydropower Project in northern New Mexico, was completed in the spring of 2011 and will increase renewable energy generation capacity by 22% at the facility, boosting its output from 13.8 megawatts (MW) to 16.8 MW. The new turbine will produce enough energy to power 1,100 homes annually.

Development & Testing

The Water Power Program's technology development and testing activities provide the data and specifications to prove advanced concepts and to support future full-scale projects. Development and testing projects allow for small-scale and proof-of-concept testing of advanced hydropower components and systems in preparation for testing, demonstration, and deployment at full-scale sites. For example, the program



Grant County Public Utility District successfully demonstrated a fish-friendly Kaplan turbine runner at Wanapum Dam on the Columbia River in Washington; this advanced hydropower turbine was developed as a competitively-selected, cost-shared project with the U.S. Department of Energy. *Photo from Grant County, PUD, Washington*

is funding the Electric Power Research Institute to finalize the design and develop construction specifications and costs for a fish-friendly hydropower turbine. Through Small Business and Innovation Research grants, the program also supports the development of innovative technologies such as a low-head hydropower turbine for manmade waterways and a turbine system that harnesses energy from effluent outflow at municipal wastewater facilities.

Hydropower Optimization Tools

The program undertakes a range of research and testing activities focusing on the development of hardware, software, and analytical methods that provide the scientific basis for improving hydropower technologies. The program designs these products to be used by industry to increase generation and improve the environmental performance of hydropower facilities. For example, the program funds collaboration among four of DOE's national laboratories to develop and demonstrate integrated tools for advanced runoff forecasting, power and environmental planning, and management approaches that will optimize the operational efficiency and environmental performance of hydroelectric power systems.

Market Acceleration

The Water Power Program works with federal agencies, industry, and DOE's national laboratories to reduce the time and costs associated with permitting hydropower projects, to better quantify the potential magnitude, costs, and benefits of hydropower generation, and to identify and address other barriers to hydropower deployment.

Resource Assessments

The Water Power Program is assessing the nation's hydropower resources, including the potential for increased

Incentives for Renewable Energy

Federal and state governments encourage the growth of renewable energy technologies by offering financial incentives for their development and deployment. Federal incentives that may be applied to conventional hydropower projects include:

- **Renewable Electricity Production Tax Credit (PTC)**
- **U.S. Department of Treasury — Renewable Energy Grants (Section 1603)**
- **Clean Renewable Energy Bonds (CREBs)**
- **Qualified Energy Conservation Bonds (QECS)**
- **Tribal Energy Program Grants**
- **U.S. Department of Agriculture - Rural Energy for America Program (REAP) Grants**

For more information on federal and state renewable energy incentives, see www.dsireusa.org.

Funding from the U.S. Department of Energy

The Water Power Program funds research and development projects with industry and in partnership with federal, state, industry, national laboratory, and other stakeholder groups. The program uses competitive solicitations, known as Funding Opportunity Announcements, to award funding for research and development projects. Funding Opportunity Announcements are posted on windandhydro.energy.gov/financial.html.

Additional conventional hydropower funding opportunities for small businesses (located in the United States with up to 500 employees) can be found through the Department of Energy's Small Business Innovation Research/Small Business Technology Transfer (SBIR/STTR) Program that offers grants to small businesses to stimulate technological innovation. Small businesses that are funded under these programs retain the rights to any technology developed and are encouraged to commercialize the technology. For additional information on SBIR/STTR opportunities, see science.doe.gov/sbir.

generation and capacity at existing facilities, new pumped-storage development, new low-impact and small generation, and powering non-powered dams. As part of the efforts to characterize resource potential, the program plans to create a database of environmental, cost, and power system value information for more than 500,000 locations with potential hydropower resources at existing dams, small greenfield projects, and constructed waterways. The database project includes an assessment of the nation's existing hydropower infrastructure, including its age, condition, energy outputs, and opportunities for improvement.

Environmental Performance & Siting

The Water Power Program works to design, develop, and test new ways of reducing the potential environmental impacts of conventional hydropower, which can include impacts on fish populations and migrations, on water quality in reservoirs and downstream from dams, and on river habitats. Particular areas of focus include mitigating fish mortality resulting from passage downstream through turbines, identifying power-efficient and environmentally effective in-stream flow releases, and investigating the contention that hydropower reservoirs may emit greenhouse gases from decomposing vegetation. The program is also developing a toolset and methodology to optimize water use while maintaining the flows required to reduce environmental impacts of hydropower.

Interagency Collaboration

The Department of Energy, the Department of the Interior, and the U.S. Army Corps of Engineers entered into a memorandum of understanding in 2010 to build a long-term working relationship, prioritize shared goals, and align ongoing and future development of sustainable hydropower. Under the memorandum of understanding, the Water Power Program collaborates with relevant federal agencies and stakeholders to develop new approaches for increasing hydropower generation while increasing environmental benefits at the river basin scale.

Grid Services

The Water Power Program works to quantify the benefits of effective and cost-competitive conventional hydropower and advanced pumped-storage technologies to electricity grids, and to communicate those benefits to policymakers, state and federal agencies, industry, and other stakeholders. Because markets do not accurately account for the ancillary services provided by hydropower, the program is developing innovative methods to quantify these benefits. Ancillary benefits for hydropower include electric grid services such as load following, the ability to produce power when electricity demand is highest, and the ability to ramp up and down quickly. The program will use industry-proven analysis and modeling tools at the unit, plant, system, regional, and national levels, over time scales ranging from seconds to years, in order to maximize and quantify the many benefits provided by conventional and pumped-storage hydroelectric projects to transmission grids.

Education and Workforce Development

To boost the development of a high-quality hydropower workforce, the program has established graduate-level fellowships to conduct industry-relevant research in the fields of hydropower engineering and environmental sciences. In addition to contributing to the education of the future hydropower workforce, the research supported by the fellowships will generate new knowledge and technologies that will enhance the competitiveness of the U.S. hydropower industry. Additionally, the program is developing an online tool to communicate the economic benefits of hydropower to local stakeholders. These benefits include job creation, economic activity and tax revenue.

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