

Conventional Hydropower Technologies

The U.S. Department of Energy's (DOE's) Water Power Program supports the development of technologies that can harness the nation's renewable hydropower resources to generate environmentally sustainable and cost-effective electricity. Conventional hydropower refers to the use of dams or impoundments to store water in a reservoir; water released from the reservoir flows through a turbine to generate electricity. The program's conventional hydropower activities focus on increasing generating capacity and efficiency at existing hydroelectric facilities, adding hydroelectric generating capacity to non-powered dams, and reducing environmental effects.

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 conduct applied research, testing, and demonstration of advanced conventional hydropower technologies that will increase generation and improve existing means of generating hydroelectricity.

Upgrading Existing Facilities

In order to increase the contribution of hydropower generation to the nation's renewable energy supply, the Water Power Program assists industry in deploying technologies to 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 impacts at 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.

Development & Testing

Technology development and testing activities provide the data and plans to prove advanced concepts and to support future full-scale projects. Development and testing products are generally prototype designs and concepts that will be ready for demonstration, deployment, and testing at full-scale sites. For example, the program funds the Electric Power Research Institute (EPRI) to finalize the engineering and construction of a radically different fish-friendly turbine with an advanced runner, which will compete commercially with existing designs. The program also uses Small Business and Innovation Research grants to support the development of



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. Credit: Grant County, PUD, Washington.

novel technologies, such as a low-head hydropower turbine to be used in manmade waterways, and a system that harnesses energy from effluent outflow at municipal wastewater facilities.

Hydropower Optimization Tools

The program undertakes a range of research and testing activities, from the development of hardware to software and analytical methods, which provide the scientific basis for improving hydropower technologies. Products are designed to be used by industry in order to increase generation and improve the environmental performance of hydropower facilities. For example, the program funds collaboration between four of DOE's national laboratories to develop and demonstrate integrated tools for advanced forecasting, power and environmental planning, and management approaches that will optimize the operational efficiency and environmental performance at hydroelectric power plants.

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 works to assess the potential size of the nation's hydropower resources, including the potential for generating capacity additions at existing hydropower facilities and non-powered dams as well as the potential for new low-impact and small hydropower generation. For example, the program is creating a database of

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)**
- **Renewable Energy Investment Tax Credit (ITC)**
- **U.S. Department of Treasury — Renewable Energy Grants (Section 1603)**
- **Modified and Accelerated Cost Recovery System (MACRS)**
- **Clean Renewable Energy Bonds (CREBs)**
- **Qualified Energy Conservation Bonds (QECBs)**
- **Qualifying Advanced Energy Manufacturing Investment Tax Credit (Section 48C)**

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 U.S. 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, which 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 www.science.doe.gov/sbir.

environmental, cost, and power system value information for over 500,000 locations with potential hydropower resources at existing dams, small greenfield projects, and constructed waterways. The program also funds DOE's Oak Ridge National Laboratory and industry partners to assess the state of the nation's existing hydropower infrastructure, including its age, condition, energy outputs, and opportunities for improvement. Additionally, the program is preparing an assessment and database of development opportunities for pumped-storage hydropower, which stores energy by pumping water from a lower reservoir to an upper reservoir, eventually releasing the water back to the lower reservoir to generate electricity during periods of high electrical demand.

Environmental Performance & Siting

The Water Power Program works to design, develop, and test new ways of reducing the adverse environmental effects 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 fish mortality resulting from passage downstream through turbines, the selection of power-efficient and environmentally-effective instream flow releases, and the contention that hydropower reservoirs may emit greenhouse gases from decomposing vegetation.

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 (MOU) in 2010 to build a long-term working relationship, prioritize shared goals, and align ongoing and future development of sustainable hydropower. The Water Power Program is also working with relevant federal agencies and stakeholders to develop a new approach for increasing hydropower generation while simultaneously providing increases in 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 technologies 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 for quantifying 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 turn on 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 quantify and maximize the 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-related 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. The program is also developing an economic model to estimate the jobs created by and economic impacts of constructing and operating hydropower facilities.

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