

## **58 Waterpower**

### **Program Overview**

#### **Program Description**

This program assesses the potential, status, generation and environmental performance, and cost of waterpower technologies, including conventional hydropower and emerging technologies that use ocean, tidal, and in-stream energy. It supports research on national and international issues of relevance to the waterpower industry, including technology development and optimization, resource assessment, fish passage and protection, environmental impact assessment and stewardship, and waterpower's relevance in a carbon-constrained world. Primary generation-related research focuses on optimizing the performance and value of hydropower in a carbon-constrained future. Primary environmental-related research focuses on maintaining the Electric Power Research Institute's (EPRI's) fish passage and protection reference manual and developing the next generation of environmentally enhanced (fish-friendly) hydropower turbines. New research focuses on hydropower's contribution to greenhouse gas emissions and its relevance to global climate change. This program helps the waterpower industry develop balanced, science-based strategies to optimize performance, protect ecological resources, and allocate water to ensure continued cost-competitive operation while meeting other stakeholder needs. Supplemental program research on emerging marine energy technologies (ocean and tidal) allows interested parties to stay current with the latest technology and developments while collaborating on innovative concepts for utility marine-energy electric applications and products.

#### **Industry Needs and Issues Addressed**

- Information and technologies for fish passage and protection
- Approaches and information for environmental protection, mitigation, and enhancement to support Federal Energy Regulatory Commission (FERC) relicensing and National Environmental Policy Act assessments
- Fish-friendly turbines
- Hydropower's relevance in a carbon-constrained world
- New opportunities and challenges for hydropower assets with changing operational demands, and hydropower's role in a low-carbon generation mix with the growing value of existing plants
- Information on all marine-energy electric technologies, applications, and market developments

#### **Impact**

- Provides balanced, science-based strategies for protecting ecological resources and allocating water to ensure continued cost-competitive operation
- Supports a public-private-sector partnership to develop the next generation of fish-friendly hydropower turbines
- Provides research and technical results that support recognition of hydropower as a renewable, domestic energy resource
- Provides a forum for participants to share the latest information on waterpower technology opportunities and optimization

#### **Key Accomplishments**

- Performance assessments and information on upstream and downstream fish passage technologies
- Assessment of waterpower's potential and its research, development, deployment, and demonstration needs
- Information resource documents on environmental protection, mitigation, and enhancement approaches

- Sound technical information to support federal and state endangered and threatened species listing assessments
- Advancement of fish-friendly turbine technology, including preparatory work for field deployment and testing
- Workshop and report/conference proceedings on hydropower in a carbon-constrained future and related new opportunities and challenges

**Current Year Objectives**

- Continue redesign of the Alden/Concepts NREC advanced (fish friendly) hydropower turbine in preparation for industry commercialization, field deployment, and testing
- Assess the greenhouse gas contribution of hydropower reservoirs in the United States
- Continue assessment of waterpower growth opportunities and the R&D efforts required to attain them
- Expand interest group activities in the area of hydropower, ocean, and tidal energy
- Examine the role of waterpower relative to renewable portfolio standards and carbon dioxide costs or constraints, with deliverables including periodic intelligence reports, EPRI perspectives and technical updates, presentations, and seminars
- Maintain and update the EPRI Hydropower Fish Passage and Protection Manual
- Continue development of information on endangered and threatened species (e.g., American eel)

**Industry Involvement**

- Estimated 2009 funding: \$0.5M

**Program Technical Lead**

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**Summary of Projects**

<b>Project Number</b>	<b>Project Title</b>	<b>Value</b>
P58.001	Hydropower Technology	This project addresses three areas of opportunity for hydropower in a carbon- constrained future: optimizing the performance and providing modernization best practices for hydro plant assets, positioning existing hydropower to realize full value among other low- and nonemitting generation options, and qualifying new incremental hydropower additions as low-impact renewable generation. The work will be accomplished via a collaborative research forum offering seminars and workshops to address current industry hot topics, plus a summary report on selected topics.
P58.002	Fish Passage and Protection	This project conducts research and development on fish passage and protection technologies, including fish-friendly turbines. Research focuses on identifying cost-effective strategies and technologies for protecting migratory and nonmigratory fish.
P58.003	Advanced (Fish-Friendly) Hydropower Turbine Design Development	Fish-friendly turbine research focuses on developing a design that offers high fish survival and energy efficiency in preparation for field testing and deployment during 2010–2011.
P58.004	Valuation of the Environmental and Social Effects of Hydropower	New research will focus on assessing the extent of greenhouse gas emissions (e.g., carbon dioxide, methane) from hydropower reservoirs in the United States.

## Project Descriptions

### P58.001 Hydropower Technology (063334)

#### Issue

Many conventional hydropower plants face aging assets and workforce, with increasing demands on performance. At the same time, the value of these plants and their part in electric grid operations is increasing in recognition of the renewable and low-carbon-emitting attributes of hydropower. Modernization issues include meeting environmental constraints and optimizing operating efficiency while delivering more precise control of plant output for regulation and ancillary services. Accreditation issues relate to qualifying for production tax and renewable energy credits, low-emitting and green power certificates, and other incentives for capacity expansions and efficiency improvements.

#### Description

This project addresses current hydro industry issues through a collaborative forum offering R&D projects related to hydropower issues and opportunities plus workshops on current industry topics. The project aims to create a forum for members to discuss O&M issues with their peers and maintain an open dialogue with vendors regarding issues that are of mutual interest to the group. Reporting will depend on participation and the nature of the projects. A summary report on at least one selected topic is planned. Participant meetings will be held in conjunction with hydropower industry events such as the HydroVision, National Hydropower Association, and Waterpower conferences. As larger or more complex issues are identified, this project will address research needs in a collaborative structure, allowing reduced individual cost and broadening access to technical expertise.

#### Value

- Facilitating the exchange of information and sharing of best practices to position hydropower for a larger role as a nonemitting and renewable generation option
- Creating opportunities for collaborative R&D activities and sharing of experience with new technology applications for improved maintenance and operation in existing facilities and in optimizing plant operations
- Addressing current hydro industry technical issues through industry surveys, case studies, and an ongoing series of summary reports
- Facilitating interactions among peers to identify key issues in today's hydro industry and pool resources to investigate and develop solutions of mutual benefit

#### How to Apply Results

This project aims to improve O&M performance and help members revalue assets in existing hydropower facilities relative to new electricity market and system operator demands. The work addresses three application areas that present opportunities for hydropower in a carbon-constrained future:

- Optimizing performance and providing modernization best practices for hydro plant assets
- Positioning existing hydropower to realize full value among other low- and nonemitting generation options
- Qualifying new incremental hydropower additions as low-impact renewable generation

The project allows participating organizations to benchmark themselves against their peers and benefit from a broader set of experiences and lessons learned, directly reducing the cost of obtaining that knowledge individually. It also facilitates peer communications and creates a sustaining knowledge base.

**2009 Products**

Product Title & Description	Planned Completion Date	Product Type
<b>Hydropower Workshop:</b> EPRI will hold a one- to two-day workshop covering selected topics of interest to the hydro industry and offering detailed treatment of current issues, similar to the Hydropower Issues and Opportunities in a Carbon-Constrained Future workshop held in 2008. Candidate topics are reliability-centered maintenance for hydropower, incremental expansions with renewable credits, and flow measurement technology and applications.	12/31/2009	Workshop, Training, or Conference
<b>Hydropower Summary Report:</b> EPRI will continue a series of topical reports that address hot issues in the hydropower industry, offering practical treatment of applications, field experience, and information from manufacturers or standards groups.	12/31/2009	Technical Update
<b>Hydropower Interest Group Meetings/Site Tour</b> The assembled package of the 2008 Hydropower Interest Group meeting will include results, presentations, future plans, discussion on selected workshop or summary topics, and summary materials.	8/31/2009	Assembled Package

**Future Year Products**

Product Title & Description	Planned Completion Date	Product Type
<b>Hydropower Workshop</b> A one- to two-day workshop will cover a selected topic of interest to the Hydropower Interest Group. Candidate topics are obtained from advisor and interest group members.	2011	Workshop, Training, or Conference
<b>Hydropower Interest Group:</b> The assembled package of the 2010 Hydropower Interest Group meeting will include results, presentations, future plans, discussion on selected workshop or summary topics, and summary materials.	2010	Assembled Package
<b>Hydropower Summary Report:</b> EPRI will continue a series of topical reports that address hot issues in the hydropower industry, offering practical treatment of applications, field experience, and information from manufacturers or standards groups.	2010	Technical Update

**P58.002 Fish Passage and Protection (101904)**

**Issue**

Protection of migratory and nonmigratory fish populations is an issue for most hydroelectric projects. Protection and passage requirements are expensive, reduce operating capacity, and limit development of the additional U.S. hydropower generation potential. Relevant information on design and operation of fish passage facilities is scattered, and many designs are untested or in need of further development.

**Description**

This project focuses on gathering new fish passage and protection information and maintaining EPRI's web-based fish passage and protection technical reference manual. This reference on technologies and

approaches for upstream and downstream fish passage will be revised as required by developments in research and application of technologies. Monitoring of professional literature and publications by resource agencies and Federal Energy Regulatory Commission (FERC) licensing results will support determination of the need for revised chapters. This project also investigates fish protection issues that are relevant to hydropower operation (e.g., American eel) and conducts research on development, optimization, and evaluation of fish passage technologies.

**Value**

Participation in this project provides the following benefits:

- Assistance and state-of-the-art technical information on all aspects of cost-effective approaches for fish passage and protection
- Contribution to the development of sound life-history technical information on fish and wildlife under consideration for federal and state listing as endangered or threatened species

**How to Apply Results**

Hydroelectric project owners, operators, and stakeholders will use project information and technologies to analyze and plan environmental protection, mitigation, and enhancement alternatives during FERC relicensing of private investor-owned projects and during National Environmental Policy Act assessments conducted for federal projects.

**2009 Products**

Product Title & Description	Planned Completion Date	Product Type
<b>Fish Passage Manual Chapter Updates:</b> This web-based reference on technologies and approaches for upstream and downstream fish passage will be revised as required by developments in research and application of technologies. Monitoring of professional literature, publications by resource agencies, and FERC licensing results will support determination of the need for revised chapters.	12/31/2009	Technical Update
<b>EPRI Technical Research Newsletter (Quarterly):</b> EPRI scientists will monitor professional peer-reviewed technical literature to identify papers of immediate relevance to hydropower environmental issues. On a quarterly basis (March, June, September, and December), EPRI will prepare a technical research newsletter briefly summarizing publications of relevance during the previous quarter.	12/31/2009	Technical Update

**Future Year Products**

Product Title & Description	Planned Completion Date	Product Type
<b>Fish Passage Manual Chapter Updates:</b> Continued maintenance of the web-based fish passage and protection reference resource.	2009	Technical Update
<b>EPRI Technical Research Newsletter (Quarterly):</b> Continued review of technical literature on environmental issues of relevance to the hydropower industry.	2009	Technical Update

## P58.003 Advanced (Fish-Friendly) Hydropower Turbine Design Development (067514)

### Issue

Development of environmentally enhanced (fish-friendly) hydropower turbines that cause minimal injury to passing fish offers an opportunity to maximize energy production while simultaneously providing a safe passage route for fish migrating or moving downstream. Fish-friendly turbines may also lead to development of additional U.S. waterpower energy resources, particularly at existing dams without hydroelectric power.

### Description

This project redesigns the Alden/Concepts NREC advanced (fish friendly) hydropower turbine for installation and testing at a hydropower project. The initial advanced turbine design was developed for laboratory testing. To increase power density and prepare the turbine for commercial deployment and testing, the system's scroll case, runner and turbine blades, and draft tube require additional development. Research in 2009 will focus on completion, in collaboration with a turbine manufacturer, of the engineering design so that it can be deployed at a hydropower project for testing.

### Value

- Fish passage survival and energy efficiency improvements through selection of optimized turbine system designs
- Advancement of hydropower as a component of renewable energy options

### How to Apply Results

The information will be used by hydroelectric project owners and operators in planning new hydropower developments as well as in upgrading existing projects with advanced hydropower turbine systems. Members are encouraged to attend workshops and meetings to obtain the results of the advanced hydropower turbine demonstration and the path for installing the technology.

### 2009 Products

Product Title & Description	Planned Completion Date	Product Type
<p><b>Advanced Engineering Design of the Alden/Concepts NREC Fish-Friendly Turbine:</b> This technical report will review the redesign of the Alden/Concepts NREC advanced turbine for installation at a hydropower project to be determined. The current advanced turbine design was developed for laboratory testing. To increase power density, the system scroll case, runner and blades, and draft tube are being reengineered in preparation for commercial use.</p>	12/31/2009	Technical Update
<p><b>Field Evaluation Plan for Testing Fish Survival Through an Advanced Hydropower Turbine System (Fish-Friendly Turbine):</b> This report will present the detailed plan for testing fish survival following passage through the Alden/Concepts NREC advanced hydropower turbine system, to be installed at a project to be determined. The experimental design will review monitoring procedures, test species, equipment, schedule, and data analysis procedures.</p>	12/31/2009	Technical Report

Product Title & Description	Planned Completion Date	Product Type
<b>Advanced Hydropower Turbine System Workshop:</b> This workshop will be held in mid-2009 with the intent of reviewing and discussing developments in the efforts to install and test the Alden/Concepts NREC advanced turbine. The workshop will be open to EPRI members and nonmembers, including representatives from government (e.g., U.S. Department of Energy, FERC) and nongovernmental organizations.	12/31/2009	Workshop, Training, or Conference

### Future Year Products

Product Title & Description	Planned Completion Date	Product Type
<b>Field Evaluation Plan for Testing Fish Survival Through an Advanced Hydropower Turbine System (Fish-Friendly Turbine): Plan Implementation:</b> In 2010, the site for testing of the advanced turbine is expected to be identified and installation of the turbine to be under way. The field evaluation plan for testing fish protection performance will be refined and implemented in accordance with the site-specific features of the hydropower plant (e.g., species for testing, fish injection and collection locations, operating conditions, and variables for testing).	2010	Technical Update
<b>Evaluation of Fish Survival Through an Advanced Hydropower Turbine System (Fish-Friendly Turbine):</b> This report will summarize the results of fish survival monitoring after passage through the fish-friendly hydropower turbine. Testing will be conducted at a field site where the advanced turbine is deployed (to be determined in 2008–2009).	2011	Technical Update

## P58.004 Valuation of the Environmental and Social Effects of Hydropower (067515)

### Issue

Hydropower operations affect environmental (fish passage and protection, in-stream flows) and social (recreation, land use) values in a number of ways. A recent issue of concern, relative to hydropower's consideration as a renewable, non-carbon-emitting energy resource, is that hydropower reservoirs may be a source of greenhouse gas (GHG) emissions. This issue is of particular importance in tropical and possibly boreal regions, but the extent to which it is an issue in the temperate United States is not well understood. If hydropower is a contributor of GHGs, its value relative to renewable portfolio standards and production tax credits may be at risk.

### Description

In 2009, EPRI will begin a three-year project to comprehensively examine the hydropower GHG emission issue for U.S. operations. In the first year, EPRI will determine what literature is available on GHG emissions from U.S. hydroelectric storage reservoirs and the strengths and biases associated with available GHG measurement and modeling techniques. EPRI will test existing techniques for measuring GHG emissions from reservoirs and develop a model framework for conducting a full GHG accounting of

reservoir development and hydropower operations. Future-year research will involve new data collection via prototype laboratory and field studies.

**Value**

- Clarifying hydropower’s role in a carbon-constrained future
- Providing information on the nature of hydropower as a domestic renewable energy resource

**How to Apply Results**

The information from this project will be used by policymakers, hydroelectric project owners, project operators, and stakeholders to better understand the relationship between hydropower operations and GHG emissions, support new hydropower production planning in a carbon-constrained future, and support generation pricing in accordance with carbon credit values.

**2009 Products**

Product Title & Description	Planned Completion Date	Product Type
<p><b>Greenhouse Gas Emission Research from Hydropower Reservoirs: Year 2 Prototype Assessments:</b> In the second year of this research, EPRI will perform a prototype assessment for several types of reservoirs and hydropower operations based on available data and information; selection of sites will be based on watershed characteristics and geographic region. In year three, EPRI will design a study that includes field investigations to fill gaps in the knowledge and understanding of hydropower operations and GHG emissions. The final report will present the results of this three-year EPRI research project.</p>	12/31/2009	Technical Update

**Future Year Products**

Product Title & Description	Planned Completion Date	Product Type
<p><b>Greenhouse Gas Emission Research from Hydropower Reservoirs: Year 3 Field Investigations:</b> In year three, EPRI will design a study that includes field investigations to fill gaps in the knowledge and understanding of hydropower operations and GHG emissions. The technical report will present the final results of the three-year EPRI research project.</p>	2011	Technical Report