



EPRI Waterpower Program Review

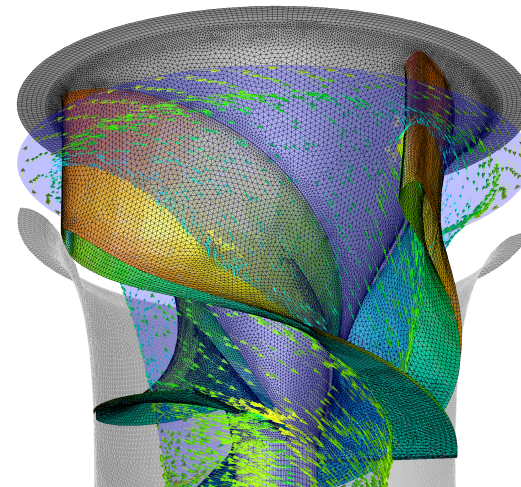
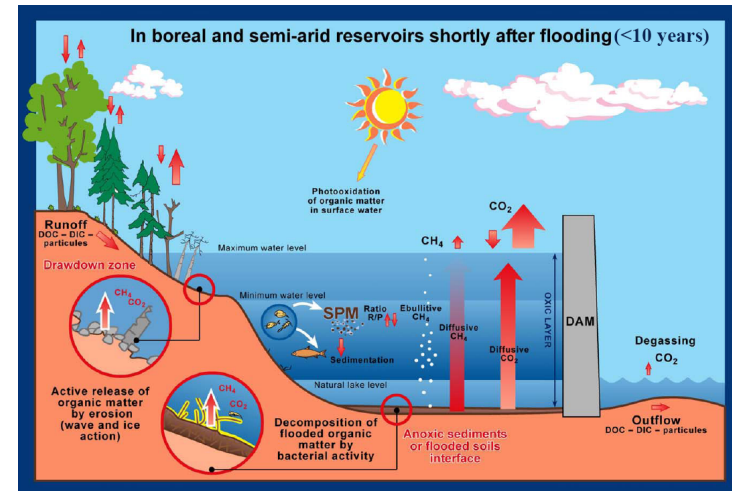
**HPC Fall Meeting
October 5, 2008**

**Doug Dixon
EPRI Waterpower Program Manager**



Key EPRI Initiatives & Research

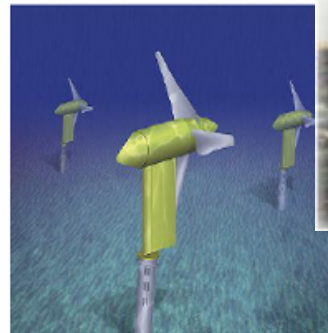
- 2009+ Research Program
- EPRI Workshops:
 - Waterpower R&D Prioritization, October 29-30, 2008
 - Hydropower in a Carbon-Constrained Future, January 29-30, 2009
- Waterpower Potential Report Update
- Green House Gas Research
- EPRI-DOE Advanced Turbine Research



EPRI 2009 Waterpower Program

Conventional hydro, ocean, tidal and instream

- **Waterpower resource assessment**
- **Waterpower social & economic values**
- **Generation Issues**
 - Technology development
 - Optimization & maintenance
 - Dam safety
- **Environmental Issues**
 - Advance turbine development
 - Green house gas research
 - Fish passage & protection



EPRI Report: Assessment of Waterpower Potential and Development Needs

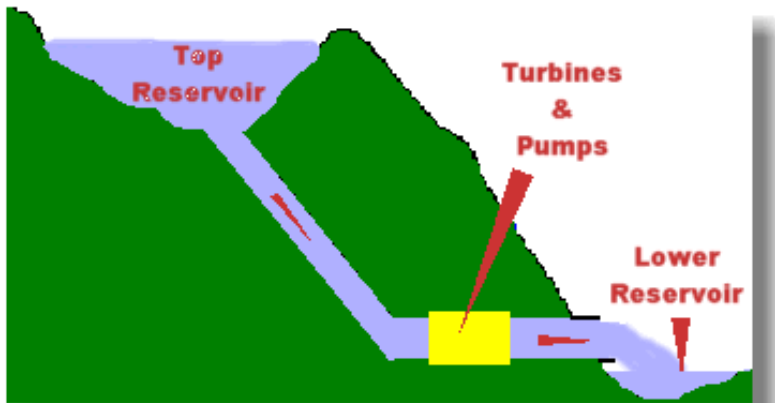
- Report 1014762, March 2007
- Overview of the waterpower industry
- Waterpower potential
- Technology development needs (RDD&D, economic incentives, and regulatory issues)
- Achievable capacity and efficiency gains
- Waterpower's relevance to U.S. energy needs including other renewables

23,000 MW by 2025



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www.epri.com

Plan for Updating Report



- Include pumped storage
- Include new federal estimates of capacity at non-powered dams
- Revise waterpower potential estimates considered overly conservative
- Provide ranges in place of point estimates
- Include new topics (GHG reduction, employment, green power opportunities)
- **Output:**
 - **Briefing papers**
 - **Final Report March 2009**



Hydropower in a Carbon-Constrained: Future Opportunities and Challenges

January 30 and 31, 2008
EPRI Knoxville
942 Corridor Park Blvd.
Knoxville, TN 37932

**See: International Water
Power & Dam
Construction – July
2008 *Examining
Hydro's Future Role***

2009: Hydropower in a Carbon-Constrained Future: Applications and Markets

January 28-29, 2009

**Hosted by Exelon
Generation, MendenHall
Inn, Mendenhall, PA**

- Green power branding and marketing
- Project certifications
- Earning “low carbon” generation credits or payments
- Compliance with RPS
- Earning PTCs
- Obtaining advantageous financing under CREBs

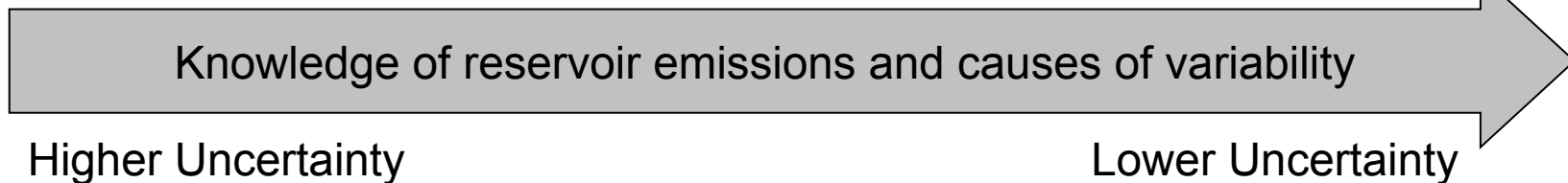
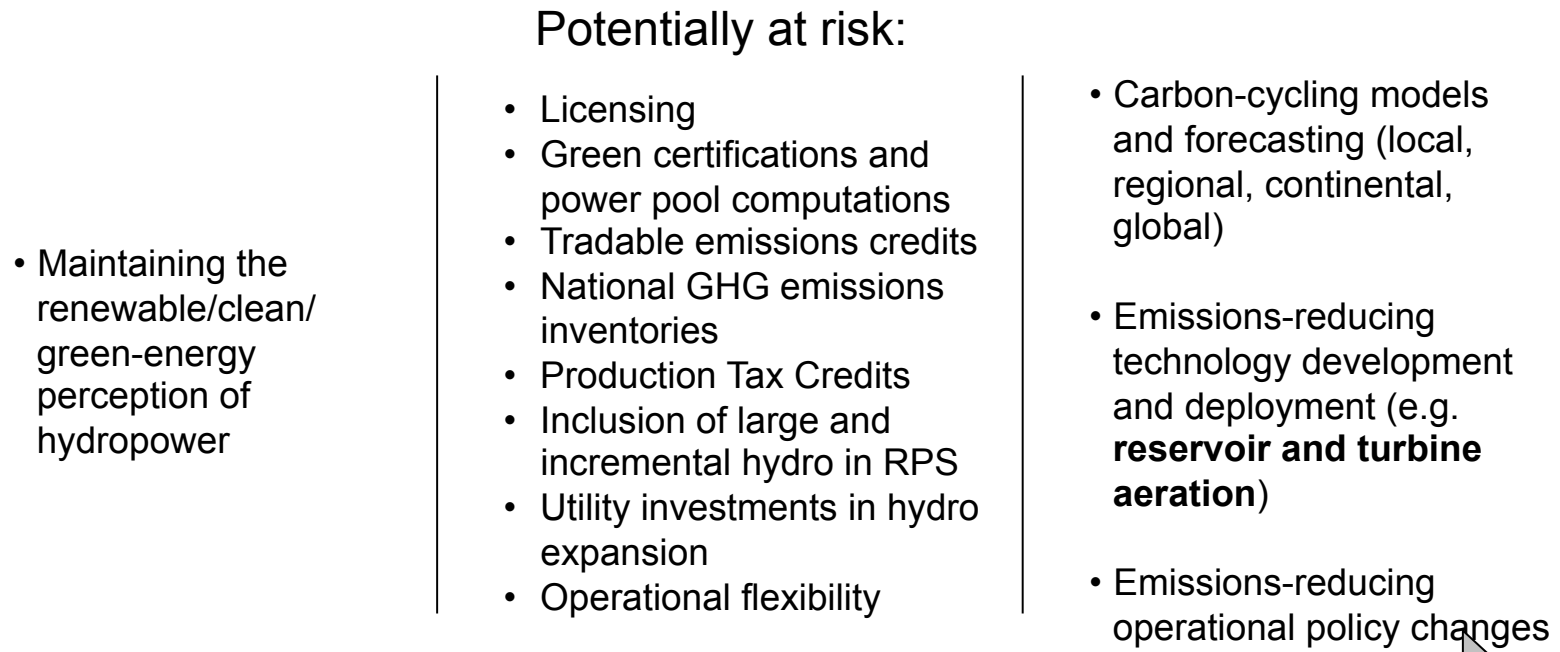




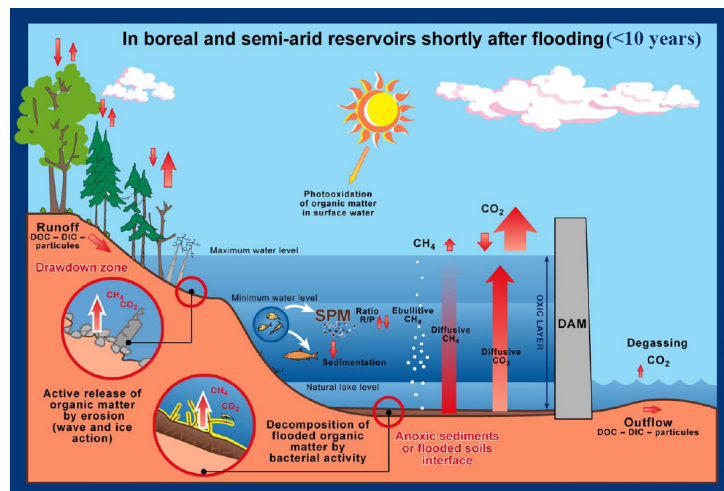
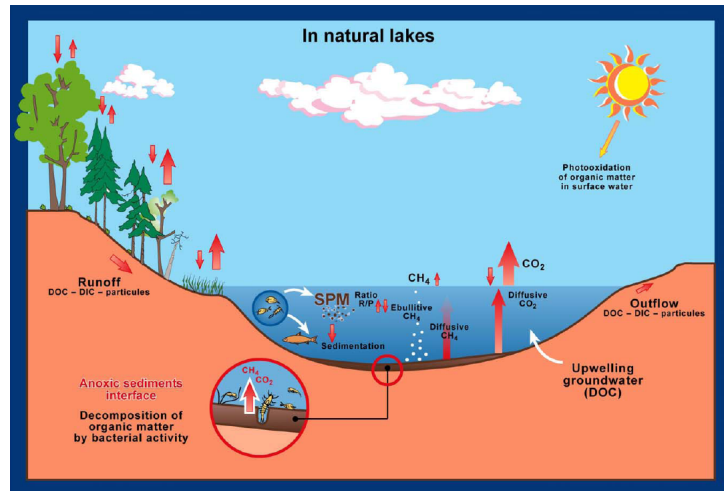
The Role of Hydropower Reservoirs in Carbon Cycling

Why Study Hydro Emissions?

Evolving Uses of Emissions Data and Analyses



2008-09 Phase 1—EPRI/ORNL Literature Synthesis



- Individual summary assessments of peer-reviewed publications 1990-present
- **Product: Synthesis report (2009)**
 - Conceptual model of altered (net) carbon cycling through reservoirs – must explain temporal and spatial variability
 - Science gaps for reservoir carbon cycling assessment
- Phase 2 – International cooperation (IHA)? Sampling?

Upcoming EPRI Waterpower R&D Forum

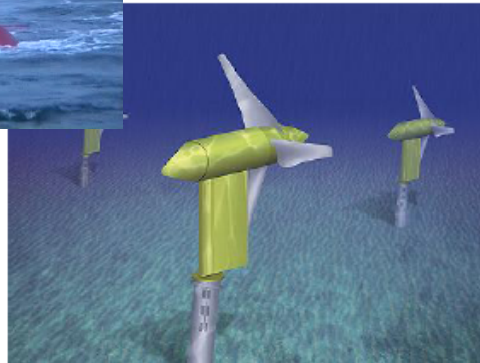
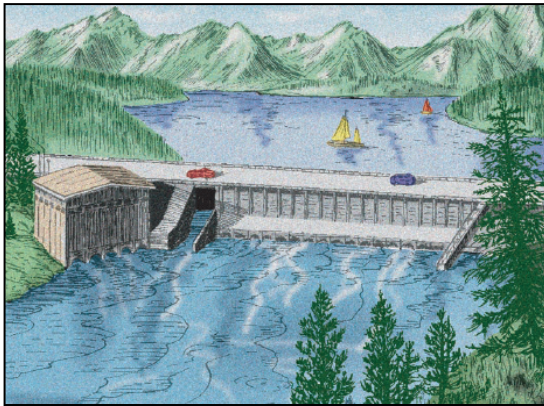
October 29-30, 2008

**FERC Building,
Washington DC**



- Objective - Industry consensus on:
 - Prioritized R&D needs for the marine & hydrokinetic technologies
 - Prioritized R&D needs for conventional hydropower
- Steering Committee formed:
 - Topics & speakers
 - Time & location

How Should DOE's NEW R&D \$s Be Spent?



- Is new conventional hydropower & pumped storage available?
- Can we squeeze additional capacity from existing projects?
- Should money go to emerging water power technologies?
 - Ocean energy
 - Hydrokinetic energy
- How can we get the most bang for the buck?

Example Presentation Topics

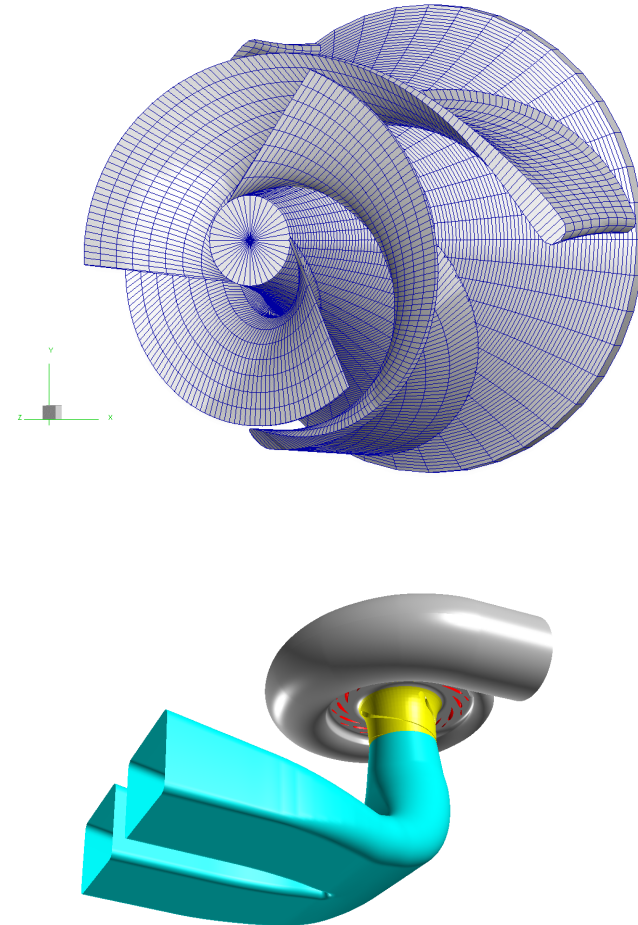
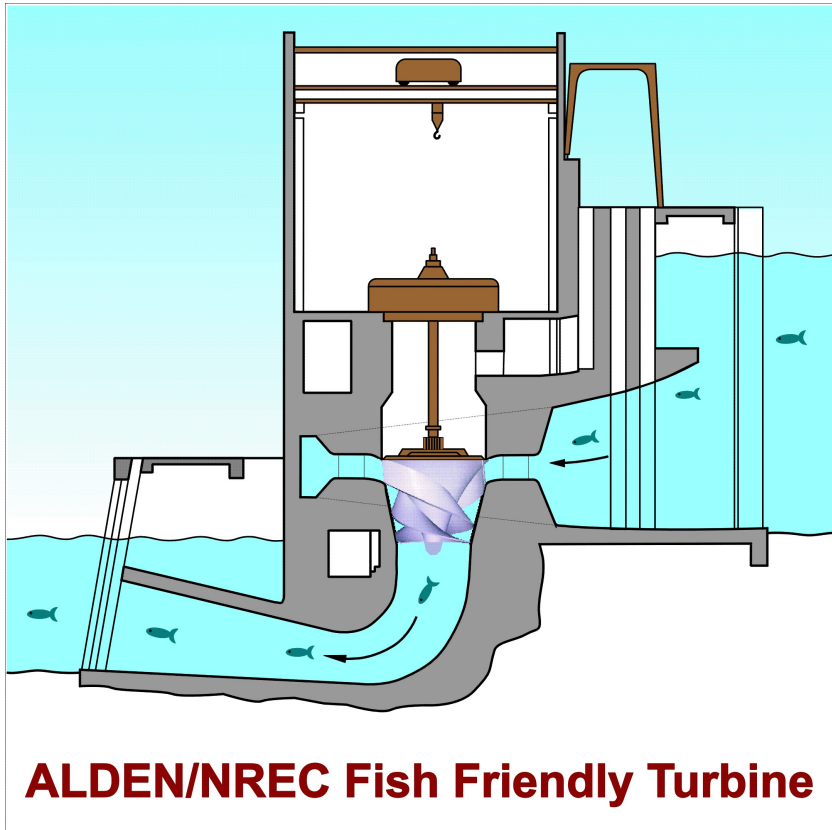
Ocean Energy & Hydrokinetics

- Resource assessments
- Device modeling
- Experimental testing
- Engineering design
- New materials
- Life cycle & manufacturing
- Electrical infrastructure
- Moorings & seabed issues
- Installation & O&M
- Standards
- Environmental impact

Conventional Hydropower & Pumped Storage:

- Advanced turbines
- Efficiency improvements
- Economic modeling
- Weather forecasting
- New materials
- Environmental issues
- System integration (e.g., wind & hydro/pumped storage)
- Regional end-user needs (NE, SE, MW, SW-Mountain W, NW, CA)

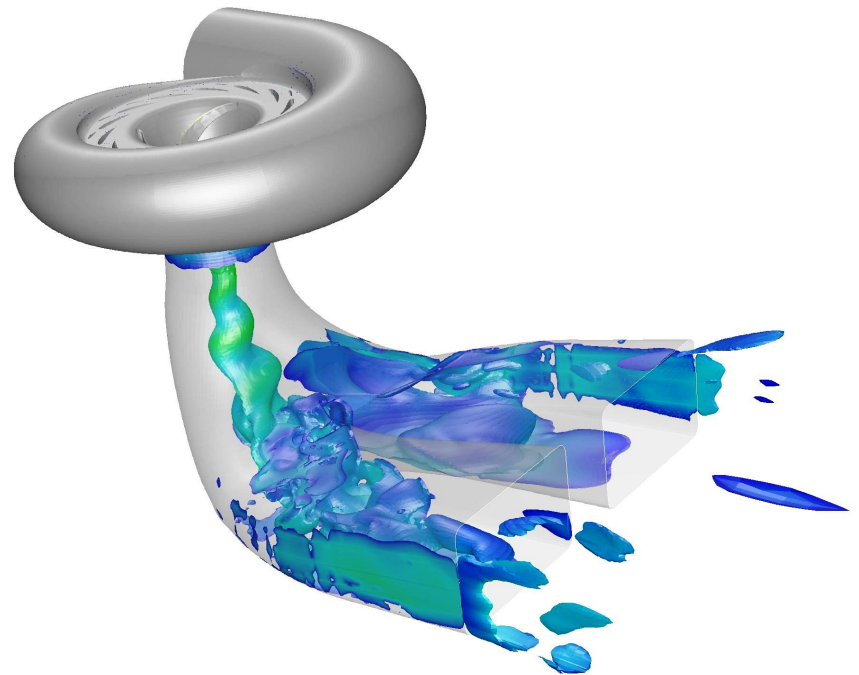
Fish-Friendly Turbine Development



EPRI “Fish-Friendly” Turbine Development Status

Alden/Concept NREC Turbine: Conceptual Design Development

- Scroll case completed
- 4 modified runner designs re-developed and evaluated
 - Includes modified leading edge for additional fish protection
- Draft tube re-design completed
- Currently optimizing scroll +runner+draft tube integration



Future Turbine Applications

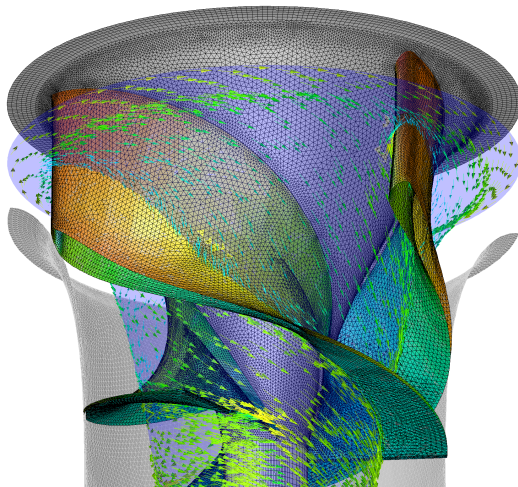
- New development
- Added capacity at existing dams
- Powering non-powered dams
- Fish bypasses
- Minimum flow releases
- Spillways
- Unit replacement/upgrades (1,000-1,600 cfs; 40-100 feet head)



Next Steps: Conceptual to Design Engineering



ALDEN
Solving flow problems since 1894



- Preliminary Engineering

- Turbine spiral, stay vanes, embedment; turbine headcover and gate system; turbine bottom ring, embedded parts integrated with runner; bearings, seals; generator, shafting, thrust bearing; governor, automation, controls concept definition; electrical BOP concept definition; etc., etc.

- Physical Model Testing

- Design and manufacture of model
- Measure efficiency, cavitation, power, pressure pulsation, gate torques, axial thrust, runaway speed, etc.

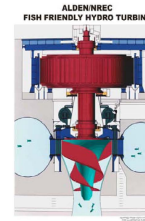
DOE Grant Requires Industry Matching Funds

From conceptual to buildable:

- DOE funding requires minimum 50% industry co-share
- Preliminary Engineering by VSH (\$~1.2 million)
- Physical Model Tests by VSH (\$~1.4 million)
- We need 14 funders at \$50K/year

EPRI | ELECTRIC POWER
RESEARCH INSTITUTE

"Fish-Friendly" Hydropower Turbine Development and Deployment: Phase II



The Alden/Concepts NREC "fish friendly" turbine could reduce fish mortality rates to less than 5%, increase turbine efficiency to 90% or higher and further support hydropower as a renewable, low-carbon energy option.

Hydropower offers opportunities to increase power generation based on renewable, low-carbon technologies if several economic and environmental hurdles are overcome. Addressing these challenges could result in an additional 25,000 MW or more of low-carbon domestic hydropower capacity. This project focuses on further development and testing of a "fish-friendly" turbine that may overcome these challenges.

EPRI is preparing a proposal to the U.S. Department of Energy (DOE) for continued development of the Alden/Concepts NREC fish-friendly turbine. This proposal is in response to a \$10 million DOE solicitation for Advanced Water Power Renewable Energy In-Water Testing and Development Projects. The DOE solicitation requires a minimum 50% industry funding match. This notice describes the project activities and is the focal point for industry support.

Value

Mitigating turbine-induced mortality on downstream migrating fish results in a loss of power output and the issue damages hydropower's claim as renewable energy. Successful demonstration of the advanced turbine will minimize

- Optimize power output of existing carbon-free electric power generation
- Advance renewable energy portfolio options
- Expand domestic fuel choices for electric power generation
- Improve environmental performance of hydro-power operations
- Use turbine as a fish bypass

mitigation needs, maximize power output and lead to additional hydro generation. In addition, companies may realize credit toward state Renewable Portfolio Standards as well as carbon credits in the developing carbon-trade market.

Drivers and Trends

In 1996, DOE, EPRI and industry began a multi-year effort to develop "fish-friendly" turbines for hydroelectric projects that are greater than 90% efficient and reduce fish mortality to 5% or less. By 2001, the research produced two turbine designs. The first, designed for large rivers, is currently being tested in the Columbia River. The second, designed for smaller rivers, is called the Alden/Concepts NREC turbine and features a helical-shaped runner with only three blades. Pilot-scale tests demonstrate mortality levels for many fish species below the 5% goal. DOE funding ended in 2006, but EPRI continued R&D focused on completing a conceptual full-scale design for commercial fabrication and field testing. These efforts are near complete and the next phase of research involves completing an engineering design, fabricating a physical turbine model and model testing.

Why Support This Project?

- You (your company) may need this turbine
- The hydropower industry needs this turbine
- Carbon constrained world presents new opportunities for hydropower growth and this turbine can help (think “renewable” or “green”)
- This turbine could harness wasted spillage & bypass flows
- **Stewardship – it’s the right thing to do!**

Let DOE Know that Hydro Research is Important!



Turbine Development Future: Field Deployment & Testing



- Build power house & install turbine (~2011)
- Evaluate fish survival) (~2011-2012)



NEED INFORMATION?

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