

**EPRI** | ELECTRIC POWER RESEARCH INSTITUTE



**EPRI  
Waterpower  
Update**

*Hydraulic Power  
Committee  
2009 Fall Meeting  
October 14-16, 2009  
Birmingham, AL*

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### Waterpower Program

- **Waterpower resource assessment**
- **Environmental Issues**
  - Advance turbine development
  - Reservoir emissions research
  - Fish passage & protection
- **Generation Issues**
  - Flow measurement technology applications
  - Aerating turbine round up
  - Hydro-wind integration
  - Revenue opportunities
- **Ocean & Hydrokinetic Energy Research**



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### Waterpower Potential Report Update 2009: Estimate of ~40,000 MW by 2025

- Publication December 2009
  - 3 briefing papers to follow (potential, R&D needs, economic incentives)
- Report covers:
  - Technology status
  - Resource potential and what can be achieved by 2025
  - Implementation barriers
  - Importance of incentives
  - R&D needs

Category	Potential	By 2025
Conven. Hydro	58,000	13,750
Pumped Storage	*	10,000
HK River	12,500	500-3,000
HK Tidal	NA	500-3,000
Wave	~20,000	10,000

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## EPRI-DOE Turbine Program: Conceptual to Design Engineering



**VOITH HYDRO** **ALDEN**  
POWER GENERATION Setting the performance since 1884



ALDEN/REC Fish Friendly Turbine

- \$1.2 million DOE matched by \$1.4 million EPRI
- Preliminary Engineering and Model Construction (2009-10)
- Physical Model Testing (Spring 2010)
- Final Design Engineering: (Summer-Fall 2010)
- Late 2010: Final Report
- **TURBINE WILL BE READY FOR DEPLOYMENT & TESTING**

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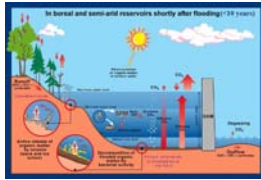
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## EPRI - ORNL GHG Research (2010+)



- **PHASE I:** EPRI sponsored Synthesis Report by ORNL (December 2009):
  - Opportunities at risk and existing science review
- **PHASE II:** EPRI to partner with ORNL for reservoir monitoring
  - EPRI to raise industry contribution via supplemental funding (need minimum 500K maybe more)
  - 10-15 companies at 50K each?

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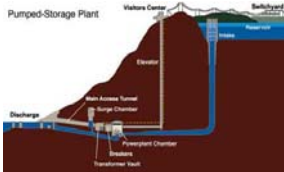
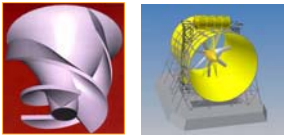
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## New EPRI-DOE Awards



- Laboratory flume studies of hydrokinetic turbine effects on fish injury & behavior (\$600K, 1 year)
- River in-stream hydrokinetic energy resource assessment (\$500K, 1 year)
- Quantify the benefits provided by conventional and pumped storage projects to transmission grids (\$3.2 million, 2 years)

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## “Quantifying the Full Value of Hydropower in the Transmission Grid”

- Objective: Method to value grid services from hydropower
- Participants: EPRI, DTA-HDR, HPPI, LCG Consulting, ORNL, Sandia
- Scope of Work (two year time frame):
  - Conduct Industry Case Studies and Evaluate Hydropower Participation in Ancillary Services Markets (PJM, MISO, SERC, NYISO, CAISO, and WECC-NW)
  - Prepare detailed simulation for WECC Area and Determine Effects of Alternative Policies on Value of Hydropower
  - Analyze Systemic Operating Constraints on Hydropower Resources
  - Develop Data Base of Current and Projected Plant Cost Elements
  - Deliver New Methodology for Planning and Applying Hydropower Assets to Support Integration of Variable Renewables

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## Valuing Hydropower Operations

- Motivated by higher fuel costs, increased value of load following and ancillary services...future cost of CO2.
- Assessment for the value of Hydropower services is analogous to the dispatch or integration cost of wind.
- Key elements are assessment of:
  - Regulation Value
  - Contingency Reserve Value
  - Load Following and Dispatch Value
  - Energy Arbitrage Value
- Opportunity includes analysis for improved energy performance and/or ancillary service value

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## Valuing Hydropower: Value Attributes

- | Energy Production   | Eco-cultural Factors   | Socioeconomic Influences  |
|---|--|---|
| <ul style="list-style-type: none"><li>• Electricity Generation<ul style="list-style-type: none"><li>• Energy Capacity</li></ul></li><li>• Energy Storage</li><li>• Carbon-Free</li><li>• Green Power</li><li>• Future Potential</li></ul> | <ul style="list-style-type: none"><li>• Environmental Stewardship</li><li>• Water Quality &amp; Quantity</li><li>• Aquatic Resources</li><li>• Terrestrial Resources</li><li>• Land Resources</li><li>• Cultural &amp; Historical Resources</li><li>• Air Quality</li><li>• Sustainability</li></ul> | <ul style="list-style-type: none"><li>• Dam &amp; Infrastructure Safety</li><li>• Flood Control, Irrigation &amp; Water Supply</li><li>• Navigation</li><li>• Economy<ul style="list-style-type: none"><li>• Property Values</li><li>• Employment</li><li>• Low-Cost Power</li></ul></li><li>• Recreation</li></ul> |

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## Technology Roundup Report Volume 11: Industry Experience with Aerating Turbines

- Rational: Need for specific industry examples with an emphasis on hydraulic performance (turbine efficiency with and without aeration, turbine capacity increases) and aeration performance (air flows, DO increase, TDG).
- Scope: Provide Technology Roundup report documenting hydraulic performance and aeration performance, and industry experience.
  - Review and Summarize Technical Literature
  - Survey and Summarize Manufacturers' and Utilities' Experience
  - Develop Detailed Case Studies
  - Document Industry Experience
- Available: December 31, 2009

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## EPRI Waterpower R&D 2008 Workshop Report (December 2009)

### Conventional Priorities:

- Advance turbine development
- Technology deployment and testing
- Fish passage and protection (downstream protection)
- Hydro GHG emissions
- Optimization & efficiency improvement research
- Resource assessment updates
- Wind-hydropower integration
- Pumped-storage

### Ocean & Hydrokinetic Priorities:

- Technology development
- Technology deployment and testing
- Environmental impact research
- Development of international standards for design, testing, performance metrics, etc.

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## Niagara Channel Flow Measurement Benchmark

- Objective: Integrate continuous flow measurement data into plant operations
- Technology: **Acoustic Doppler Current Profiler (ADCP)**
- Progress:
  - USGS Niagara channel feasibility analysis in 2007
  - System design, installation or system in channel
  - Flow analysis, tool development and unit calibration
  - Integration into plant operations
- Potential Value:
  - Improved plant control increased revenues, avoid diversion and ISO adjustment costs (**Industry First USE**)



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**Flow calculations and future system calibration will use three methods**

1. RM Formula diversion calculation based on turbine unit operation
2. Theoretical Flow calculation based on channel geometry and section measure
3. Index Velocity method using reference device such as Rio Grande or River Surveyor

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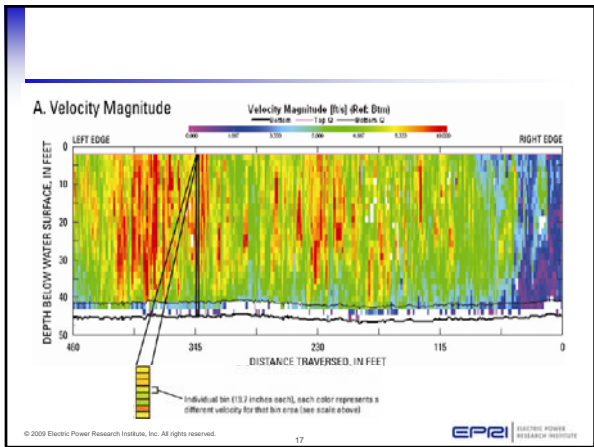
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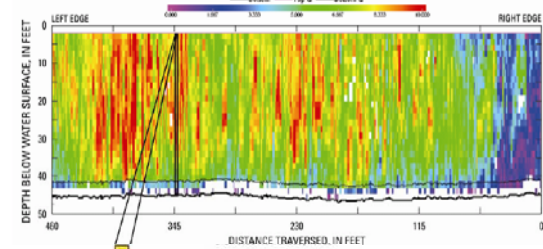
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A. Velocity Magnitude



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### Instrument and Platform

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## Work Site



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## EPRI Hydrokinetic (Wave & Tidal) Energy Research

Project Reports at [www.epri.com](http://www.epri.com)



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*Questions???*

**Thanks for your input and participation in HPC!**

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