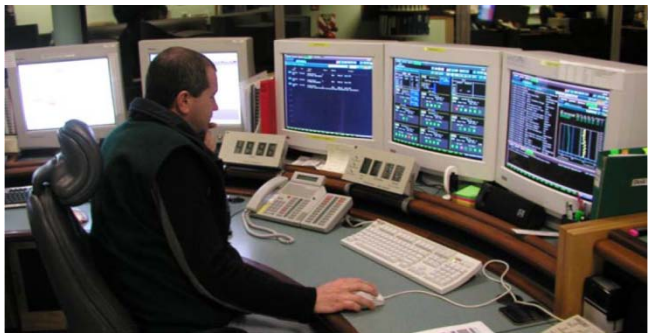
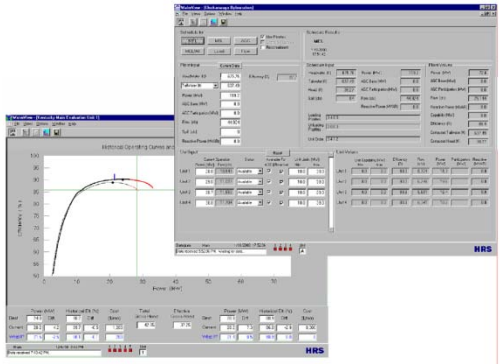
Wind and Hydropower Technologies Program

Conventional Hydropower:

Technology Development & Deployment

NHA Annual Conference, April 27, 2010





Conventional Hydropower (CH)

1.0 CH Tech Development & Deployment

1.1 Technology Deployment

- **1.1.1 Operational Upgrades**
- **1.1.2 Efficiency Equipment Upgrades**
- **1.1.3 Capacity Equipment Upgrades**
- **1.1.4 Powering Non-Powered Dams**
- **1.1.5 Small Hydropower**
- **1.1.6 Constructed Waterways**
- **1.1.7 Audits and Feasibility Studies**

ARRA projects

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1.2 Technology Development

- **1.2.1 Advanced Turbine Design & Testing**
- **1.2.2 Pumped Storage Design & Testing**
- **1.2.3 Generators and Power Systems**
- **1.2.4 Advanced Sensors and Controls**
- **1.2.5 Advanced Materials**
- **1.2.6 Technology Assessments**

1. Small Hydropower
2. Environmental Mitigation
3. Pumped Storage Hydro

1.3 Supporting Research and Testing

- **1.3.1 Water Use Optimization**
- **1.3.2 Audits and Feasibility Studies**

ARRA Projects in 2009

Applicant	Funding				Added Gen (MWh/ yr)	LCOE (¢/kWh)	Technology
	DOE Award	Application					
		DOE Funding Request	Total Project	Non-Fed Cost Share %			
City of Tacoma, Dept of Public Utilities (Large Hydro)	$4.67	$4.67	$23.4	80%	23,500	3	Project will contain two 1.8 MW Francis TGUs. The powerhouse will also incorporate an upstream fish collection pool as part of the tailrace.
Alcoa (Large Hydro)	$12.96	$15.46	$77.30	83.5%	95,000	2.4	Upgrading 4 Francis units that are 90 years old. The capacity of each unit would be increased from 22 to 27.5 MW.
Alabama Power Company (Large Hydro)	$6.0	$6.0	$30.0	80%	36,087	2.5	Rehab of 4 [Francis, Kaplan, and Mixed-Flow] units at three different projects – system upgrades. Project will replace turbine runners, head covers, bottom rings, and wicket gates with stainless steel components.
EnergyNW (Small Hydro)	$0.81	$0.81	$1.62	50%	5,868	0.8	Installation of state-of-the-art Pelton Wheel turbine runner and other associated hydropower upgrades including modification of the existing governor software to allow single-jet operation.
Los Alamos (Small Hydro)	$4.56	$4.56	$9.12	50%	6,468	4.2	Low flow Francis turbine-generator (equipped with dissolved oxygen enhancement). Will utilize low cfs flows from November-February.
North Little Rock (Small Hydro)	$0.45	$0.45	$0.90	50%	-	0.4	Automated industrial equipment including an intake maintenance device and wood grinder.
Boulder (Small Hydro)	$1.18	$2.5	$5.0	77.2%	11,000	1.3	New Pelton turbine would consistently operate in the 70-88% efficiency range through a larger portion of the flow range.

How to increase hydro?

Pathway to stimulate hydro industry involves enabling new development without new dams

Focus on most cost-effective, least controversial types of new development:
Upgrades at existing power plants and retrofitting existing non-powered dams

(1) Create uniform ***auditing standards and procedures***

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(2) Conduct ***feasibility audits*****,** to identify energy upgrade options at existing sites power plants, including advanced technology (cheap screening analyses at as many sites as possible)

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(3) Provide financial assistance for detailed ***engineering design studies*** at most competitive sites, to define construction costs and drive financial decisions by owners

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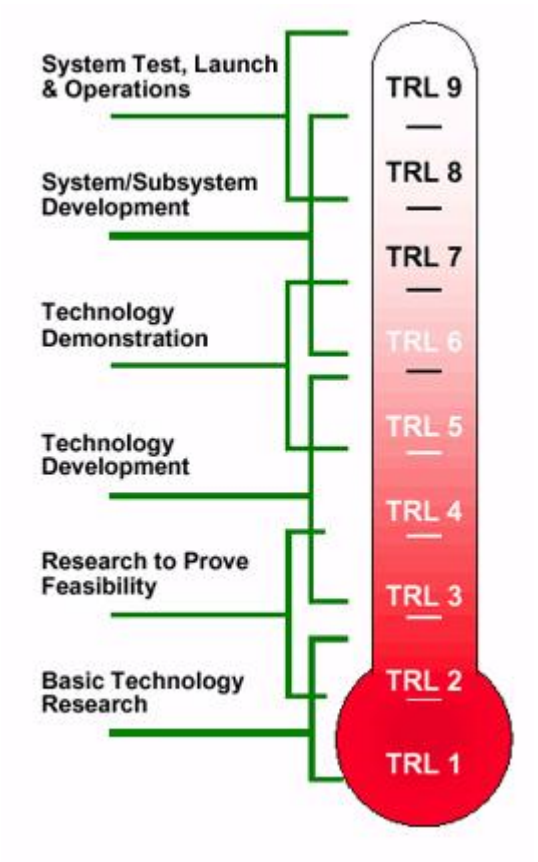
(4) Provide financial assistance for construction, to deploy the most competitive upgrade options; document benefits, costs, and performance to drive duplication elsewhere in the industry

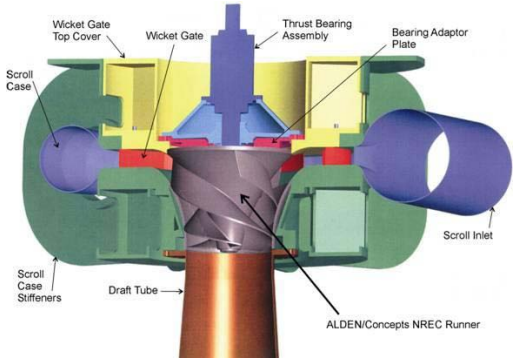
Technology readiness levels (TRLs) measure progress to commercialization



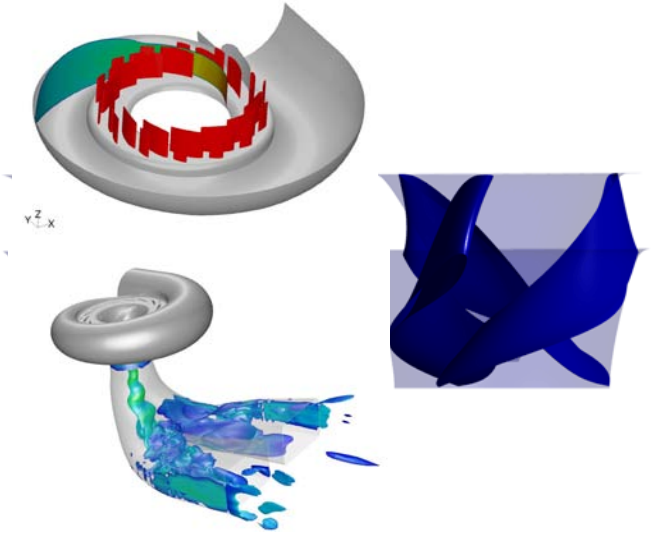
Alden Fish-Friendly Turbine

Successful Innovation in Hydropower Technology

- Totally new turbine runner, designed from beginning to pass fish safely
- DOE-Industry partnership has moved from basic concepts to manufacturing-ready design
- Prototype testing in scale model proved fish survival up to 100%, highest ever in a modern turbine
- First, full-scale deployment expected in 2012 at site in New York state
- Success will enable more generation at sites where water is spilled for downstream fish passage
- For more information, contact:
  - Doug Dixon at EPRI
  - Norman Perkins at Alden Research Laboratory, Inc.



From concepts…



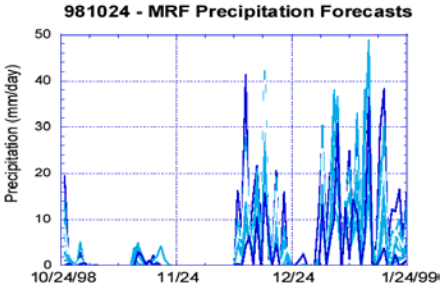
to design and manufacturing

Understanding opportunities to improve hydropower technologies

- ***Approach:*** convene industry experts and other stakeholders in facilitated discussions of about the state of technologies, areas for improvement, and benefits for stimulating new development
- ***Three topic areas:***
  - Small Hydropower (April 7-8, 2010)
  - Environmental Mitigation (June)
  - Pumped Storage Hydropower (July)
- Results will be web-accessible for public review and comment

Water-Use Optimization Toolbox

(ANL, ORNL, PNNL, SNL)



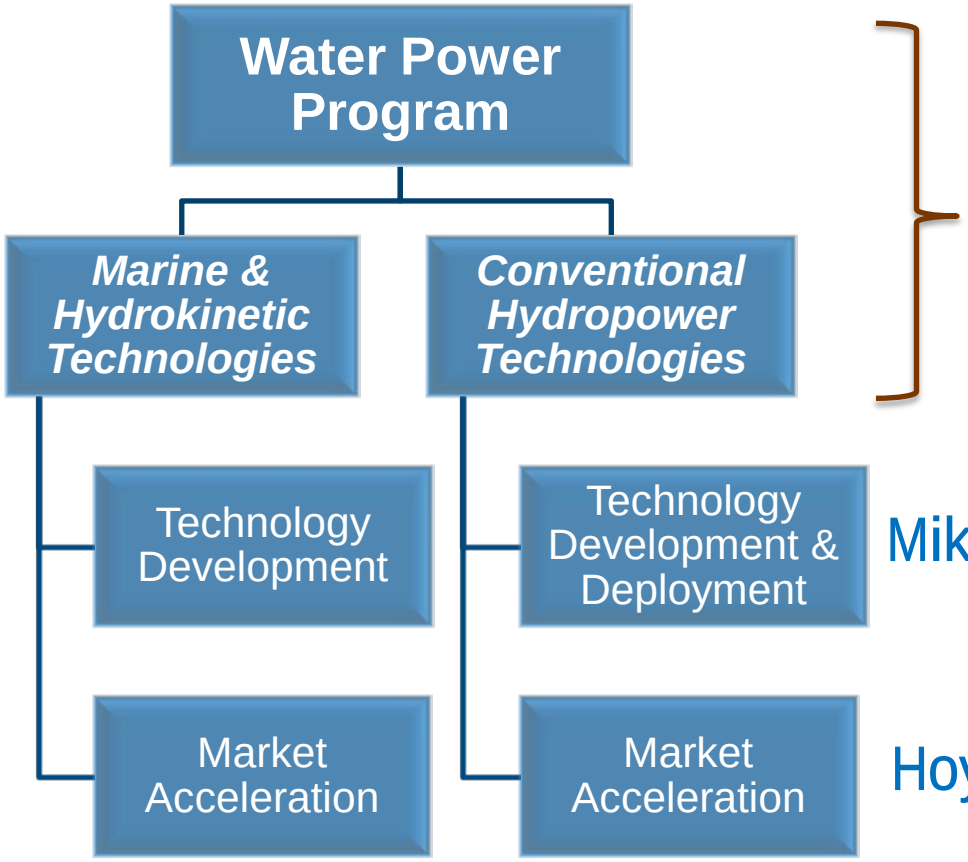
Hydrologic Forecasting: develop a spatially-distributed modeling system that provides sub-daily to seasonal inflow forecasts through the use of remotely-sensed spatial data, high resolution meteorological forecasts, and real time streamflow updating for use in scheduling and dispatch and environmental modeling.

Environmental Performance: environmental performance modeling system for identification and evaluation of the relationships of ecological parameters and hydropower performance objectives in multiple hydroclimatic regions for input to scheduling and dispatch and hydrologic modeling.

Unit and Plant Efficiency: unit and plant optimization gap analysis, baseline protocol development and best practices protocol development and demonstration.

Seasonal Hydrosystems Analysis: balance seasonal and multi-seasonal forecasts of energy, hydrological, and ecological demands against power generation capacities, operational constraints, and environmental performance.


Now let's get to work !



Alejandro Moreno
Technology Leader

Mike Reed; Mike Sale

Hoyt Battey

Conventional Hydropower (CH)

Program Goal: Increase capacity by 100GW by 2050

Technology Development and Deployment

Technology Deployment and Feasibility Studies

- Support immediately available low-cost upgrades and feasibility studies to identify additional opportunities

Advanced Technology Development

- Targeted R&D to reduce key cost drivers to small hydro and PSH technologies

Hydropower Optimization

- Develop operational tools to maximize generation at existing and new facilities

Market Acceleration

Resource Assessments

- Quantify resource availability and integrate with technology data to produce cost curves

Regulatory and Environment

- Engage regulators and environmental stakeholders to reduce license time and cost

Economic Analysis and Education

- Quantify full market value of hydropower services; integrate into energy benefit/deployment model; stimulate private R&D efforts

FY 2011: Pumped Storage and Small Hydro Technology Solicitation

To significantly impact COE, target funding level $4-5M per year

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