WATERPOWER TECHNOLOGY

Waterpower encompasses mature conventional hydropower technologies and nascent marine and hydrokinetic technologies. Research needs differ widely, depending on the class of technology. Conventional and pumped storage hydropower benefits from research addressing reliability, O&M, modernization and life extension, operational optimization, and environmental mitigation. Marine and hydrokinetic technologies benefit from research addressing technology development, environmental impact prediction and assessment, and capital cost reduction. The novel nature of marine and hydrokinetic technologies presents unique challenges for permitting and licensing. This roadmap has three elements encompassing a breadth of research supporting the diverse suite of waterpower technologies: Hydro Asset Management (conventional and pumped storage hydro), Fish Passage and Protection (conventional and pumped storage hydro), and Marine and Hydrokinetic Technologies.

HYDRO ASSET MANAGEMENT

ISSUE STATEMENT
An international focus on renewable and non-carbon-emitting energy sources increases the value of existing hydropower assets, and increases the demand placed on those assets to support integration of other renewable generation. Many conventional hydropower plants are aging and require enhanced maintenance, refurbishment, and in some cases redevelopment in order to continue meeting these demands into the future. Timely information and research are needed to optimize the management of these assets. EPRI is developing and implementing a suite of research activities to support effective management of existing hydropower assets.

DRIVERS
A significant and growing portion of the global hydropower fleet is aging and in need of improved maintenance and refurbishment. Societal constraints on new dam construction severely limit opportunities for de novo development of hydropower projects in the U.S. There is also an accumulation of aging hydropower assets in other parts of the world. Overall demand for renewable energy combined with the intermittency of other renewable energy technologies increases the potential value of existing hydropower assets and the grid services they provide. Plant life extension, improved performance, redevelopment, and operational changes present opportunities to exploit and enhance the potential value of existing hydropower assets.

RESULTS IMPLEMENTATION
EPRI research on hydropower asset management is expected to:

• Identify and communicate best practices for maintenance of conventional and pumped storage hydropower assets
• Evaluate and develop technology options for conventional and pumped storage hydro plant maintenance, refurbishment and redevelopment
• Inform optimization of plant operations with respect to long-term profitability

PLAN
EPRI’s Hydro Asset Management research plan is developed in consultation with EPRI members. The research program will address issues such as degradation of concrete and reinforcements, upgrades to controls and instrumentation systems, automated operations with grid integration, incorporation of fish passage and protection options, aerating turbines, and other available additions and betterments that should be considered in a life extension analysis. Additional research would address the economics of such retrofits against the remaining life of the project and the resulting value of the enhanced generation and
ancillary services. Specific activities include:

1. **Flexible Operation of Hydro Facilities**: Information and tools will be developed to assess and manage costs and wear and tear effects of flexible operation of pumped storage and conventional hydropower facilities.

2. **Enhanced Inspection of Hydro Concrete Structures**: Advanced technologies will be evaluated and demonstrated for enhanced, non-destructive inspection of aging concrete structures at hydro facilities.

3. **Turbine Runner Material Optimization**: The best material for replacement hydro turbine runners will be identified using materials testing and in-plant demonstrations.

4. **Advanced (Fish-Friendly) Hydropower Turbine Design, Development, and Demonstration**: The Alden turbine and other environmentally-enhanced turbines will be deployed and demonstrated to improve fish passage survival and enhance downstream water quality through efficient turbine aeration.

5. **Improved Measurement and Optimization of Hydraulic Flows**: Research will develop technologies for enhanced measurement of levels and flows and optimization tools that utilize enhanced monitoring information.

6. **Hydro Project Economics**: Estimates of capital costs as well as O&M costs for pumped storage hydro and conventional hydro construction, repowering, life extension and modernization, and capacity expansion will be developed to support economic evaluation of existing and proposed hydro projects.

**RISK**

In the absence of information on the state of the art in asset management, hydro assets will likely be managed sub-optimally. If investments in facility refurbishment and upgrade are sub-optimal, the opportunity cost accumulates over the life-span of the investment. Poor decisions on asset management could result in under utilized potential, early retirement, lost capacity, foregone ancillary services, and difficulty in integrating other renewable sources to the grid. EPRI research will inform hydro asset management to enhance their long-term value.