Hydropower Program Overview

Tim Welch, Hydropower Program Manager
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Hydropower: Many Different Opportunities

Upgrades for Existing Hydropower

Non-Powered Dams and Conduits

New Low-Impact Projects

Pumped Storage Hydropower
In 2016, DOE released the *Hydropower Vision report*, which evaluated many different potential future opportunities for the U.S. hydropower and pumped storage industry over the course of coming decades.

- Developed with input from dozens of organizations and hundreds of individuals from outside DOE.
- Based on three equally important foundational principles: (1) opportunities for growth, (2) the need to optimize and maintain existing assets, and (3) the need to improve sustainability and environmental stewardship.
- Contained a *Roadmap*, usable by all industry stakeholders to identify actions that could be taken to support the long-term advancement of the U.S. hydropower industry in-line with the foundational principals of the *Vision*.

WPTO’s Hydropower Program strategy identifies R&D activities that are appropriate for DOE to support over the next decade and aligned with the opportunities identified in the *Vision* and objectives of the *Roadmap*. 
Key Messages: Envisioning Hydropower in 2050

CLEAN ENERGY FUTURE: A clean energy future rests on imperatives that include environmental stewardship, flexible operations, responsible water management, efficient regulatory processes, public safety, new technology advancement, grid and infrastructure resiliency, a ready workforce, and energy storage.

– FLEXIBLE GENERATION: Hydropower is one of the U.S.’s most flexible energy generation and storage resources that has room to grow and is critical to secure a 21st century grid. It is essential to enable the penetration of other renewables with the grid to support climate adaptation and achieve a carbon-free electricity system by 2035.

– SUSTAINABLE APPROACHES: Enabling hydropower through sustainable approaches that optimize project development and operations with ecosystem protection and restoration is integral to successfully achieving a clean energy pathway.

– SAFE DAMS: 21st century hydropower places a high premium on dam safety with responsible management that respects energy, environmental, and societal values while ensuring public welfare.
Reimagining the Hydropower Vision Roadmap

HYDROPOWER’S FUTURE

Flexible Operations

Safe Dams

Sustainable Approaches

GOALS

2050

ACTIVITIES

HYDROPOWER’S FUTURE

GOVERNMENTAL ORGANIZATIONS

RESOURCE AGENCIES

DEPARTMENT OF ENERGY

HYDROPOWER INDUSTRY

Sustainable Approaches

ACTION AREAS

Technology Advancement

Sustainable Development & Operations

Enhanced Revenue & Markets

Optimized Regulatory Processes

Enhanced Collaboration, Education & Outreach


Hydropower Program Vision and Mission

**Vision:** A U.S. hydropower and pumped storage industry that modernizes and safely maintains existing assets; responsibly develops new low-impact hydropower; promotes environmental sustainability; and supports grid reliability, integration of other energy resources, and energy-water systems resilience.

**Mission:** Conduct research, development, demonstration, and commercial activities to advance transformative, cost-effective, reliable, and environmentally sustainable hydropower and pumped storage technologies; better understand and capitalize upon opportunities for these technologies to support the nation’s rapidly evolving grid; and improve energy-water infrastructure and security.
# Hydropower Program Activity Area Breakdown

## Innovations for Low-Impact Hydropower Growth

Develop, test, and validate cost-effective, sustainable technologies for non-conventional hydropower applications in new-stream reaches, NPDs, and conduits.

## Grid Reliability, Resilience, and Integration (Hydrowires)

Understand, enable, and improve hydropower and PSH’s contributions to reliability, resilience, and integration in a rapidly evolving electricity system.

## Fleet Modernization, Maintenance, and Cybersecurity

Develop digitalization, maintenance, and cybersecurity tools and capabilities to enable data-driven decision making, improve system reliability and reduce costs; and enhance infrastructure security.

## Environmental and Hydrologic Systems Science

Research and develop new technologies to better characterize river systems and evaluate potential impacts; avoid, minimize, or mitigate environmental impacts; and improve understanding of various hydrologic risks and uncertainty.

## Data Access, Analytics, and Workforce Development

Improve access to relevant hydropower, river, and water information—including hydropower educational and training materials—and develop analytical tools to explore opportunities and weigh potential trade-offs across multiple objectives at basin-scales.
# Hydropower Program Logic Model

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Approaches</th>
<th>Intermediate Outcomes</th>
<th>Long-Term Outcomes</th>
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<tbody>
<tr>
<td>Limited opportunities for new, affordable hydropower growth</td>
<td>Innovations for low-impact hydropower growth</td>
<td>Cost reductions and commercialization of standard modular hydropower technologies for existing water infrastructure and new stream reach development.</td>
<td>Deployment of new, small, low-impact hydropower projects in the U.S. that integrate multiple social, ecological, and energy needs.</td>
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<td>Untapped potential for hydro and pumped storage to support a rapidly evolving grid</td>
<td>Grid reliability, resilience, and integration HydroWPS3</td>
<td>Industry pursuit of high-impact advanced manufacturing opportunities for hydropower applications to reduce costs.</td>
<td>Increase in U.S. hydropower and PSH plant flexibility and greater value provided to the power systems.</td>
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<td>Maintaining affordability and security of existing hydroelectric fleet age</td>
<td>Fleet modernization, maintenance, and cybersecurity</td>
<td>Reduced design cycle and testing time of new hydropower technologies.</td>
<td>Deployment of new, cost-competitive PSH projects in the U.S.</td>
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<td>Addressing environmental impacts and hydrologic uncertainties</td>
<td>Environmental and hydrologic systems science</td>
<td>Increased developer interest in hydropower projects that utilize new micro hydro proportions beyond generation.</td>
<td>Reduced hydropower operations and maintenance (O&amp;M) costs and/or improved system performance.</td>
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<td>Lack of access to information to support decision-making</td>
<td>Data access, analytics, and workforce development</td>
<td>Commercial availability of new digital tech and approaches to meet hydropower operational needs.</td>
<td>Enhanced cybersecurity for data infrastructure.</td>
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<td>Awareness of the cybersecurity landscape for hydro by operators and policymakers.</td>
<td>Increased resiliency of aquatic ecosystems from improved science on environmental impacts of hydropower.</td>
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**Intermediate Outcomes:**
- Standardization of methods for condition-based monitoring and operational data collection and management.
- Commercial availability of new digital tech and approaches to meet hydropower operational needs.
- Awareness of the cybersecurity landscape for hydro by operators and policymakers.

**Long-Term Outcomes:**
- Deployment of new, small, low-impact hydropower projects in the U.S. that integrate multiple social, ecological, and energy needs.
- Increase in U.S. hydropower and PSH plant flexibility and greater value provided to the power systems.
- Deployment of new, cost-competitive PSH projects in the U.S.
- Reduced hydropower operations and maintenance (O&M) costs and/or improved system performance.
- Enhanced cybersecurity for data infrastructure.
- Increased resiliency of aquatic ecosystems from improved science on environmental impacts of hydropower.
Innovations For Low-Impact Hydropower Growth

Key Results and Performance Goals (2021–2025):

• Develop datasets and interactive geospatial tools to identify development potential and site characteristics of new stream-reaches, NPDs, and conduit resources.

• Publish R&D roadmap that identifies high-impact opportunities to leverage advanced manufacturing and materials in hydropower applications.

• Complete testing and pre-commercial demonstrations of new cost-competitive technologies across hydropower resources, with validated energy and environmental performance characteristics.

• Complete development of a full-scale, federally sponsored hydropower test facility (or network of facilities).

• Establish a framework for assessing costs and benefits of new hydropower projects, particularly those that could utilize new value propositions.
Key Results and Performance Goals (2021-2025):

- Publish regionally focused roadmaps for maximizing hydropower’s value for reliability, resilience, and integration.
- Release the first version of an asset-level cost-benefit toolbox for owners and operators of hydropower plants, which integrates previous model and tool development.
- Release the first version of a system-level cost-benefit toolbox for system-level decision makers, which integrates system values, system costs, externalities of hydropower, and the abilities of other resources.
- Test innovative technology R&D at a small-scale PSH or flexible hydropower demonstration project, potentially including new PSH concepts and/or flexibility enhancement through hybrid controls and advanced operations.
Key Results and Performance Goals (2021-2025):

- Develop and make publicly available hydropower digital twin capabilities (e.g., numerical models, computational codes, and underlying physics/engineering data) appropriately scaled for a diverse range of hydropower plant characteristics and operational profiles.

- Publish valuation assessment guidance to facilitate right-sized investments into hydropower digitalization, maintenance, and cybersecurity.

- Complete initial phases of fatigue and wear mechanism research to reduce forced outages and help design the next generation of hydropower components.

- Develop hydropower plant cyber surrogate capabilities that can be integrated into existing cybersecurity processes and reduce hydropower plant vulnerabilities.
Environmental and Hydrologic Systems Science

Key Results and Performance Goals (2021-2025):

• Complete field validations of novel and improved fish detection and tracking capabilities, including demonstration of environmental DNA and prototypes of acoustic telemetry tags for sensitive species and a self-powered acoustic fish tag.

• Demonstrate innovative tools and technologies that are benchmarked for cost and performance, including innovative fish passage technologies and sensor systems.

• Demonstrate real-time data collection, automation, and visualization to inform choices to operate hydropower resources for enhanced environmental performance in water and species management.

• Release a nationwide analysis and visualization platform that enables utilities and system operators to evaluate long-term water availability and climate change risks to hydropower assets at meaningful local or regional scales.

• Validate new technologies to more accurately characterize and model methane emissions from reservoirs and other water bodies.
Data Access, Analytics, and Workforce Development

Key Results and Performance Goals (2021-2025):

- Launch and improve the new externally oriented HydroSource online data portal with broad use-case capabilities.
- Develop a standard suite of application programming interface (API) capabilities that will provide unprecedented access to power market information for the hydropower community.
- Leverage machine learning and new big-data access approaches, in collaboration with FERC and other stakeholders, to increase access to information available in FERC’s eLibrary.
- Publish a report on the key issues on the time, cost, and uncertainty associated with U.S. hydropower regulatory processes.
- Release a new hydropower-focused STEM/education portal and initiate new partnered efforts to provide data and informational support for high-priority hydropower workforce training needs.
- Launch DOE’s first-ever hydropower collegiate competition and hydropower-focused fellowship program, providing students of diverse backgrounds the opportunity to develop key skills for a career in hydropower.
Addressing Program Level Feedback from 2019 Peer Review

Increase industry expertise and involvement

• Ongoing industry engagement, especially in establishing performance metrics for go/no-go decisions

Improve project management

• More rigorous milestones for go/no-go reviews
• Collaboration with industry on performance metrics
• Project-level logic models for Annual Operating Plans
Thank You Hydropower Reviewers!

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<td><strong>David Sinclair</strong></td>
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<td><strong>Doug Spaulding</strong></td>
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<td><strong>Erik Steimle</strong></td>
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<td><strong>Tom Acker</strong></td>
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<td><strong>Elaine Hart</strong></td>
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<td><strong>Bente Brunes</strong></td>
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