Hydropower Program Overview

Tim Welch, Hydropower Program Manager
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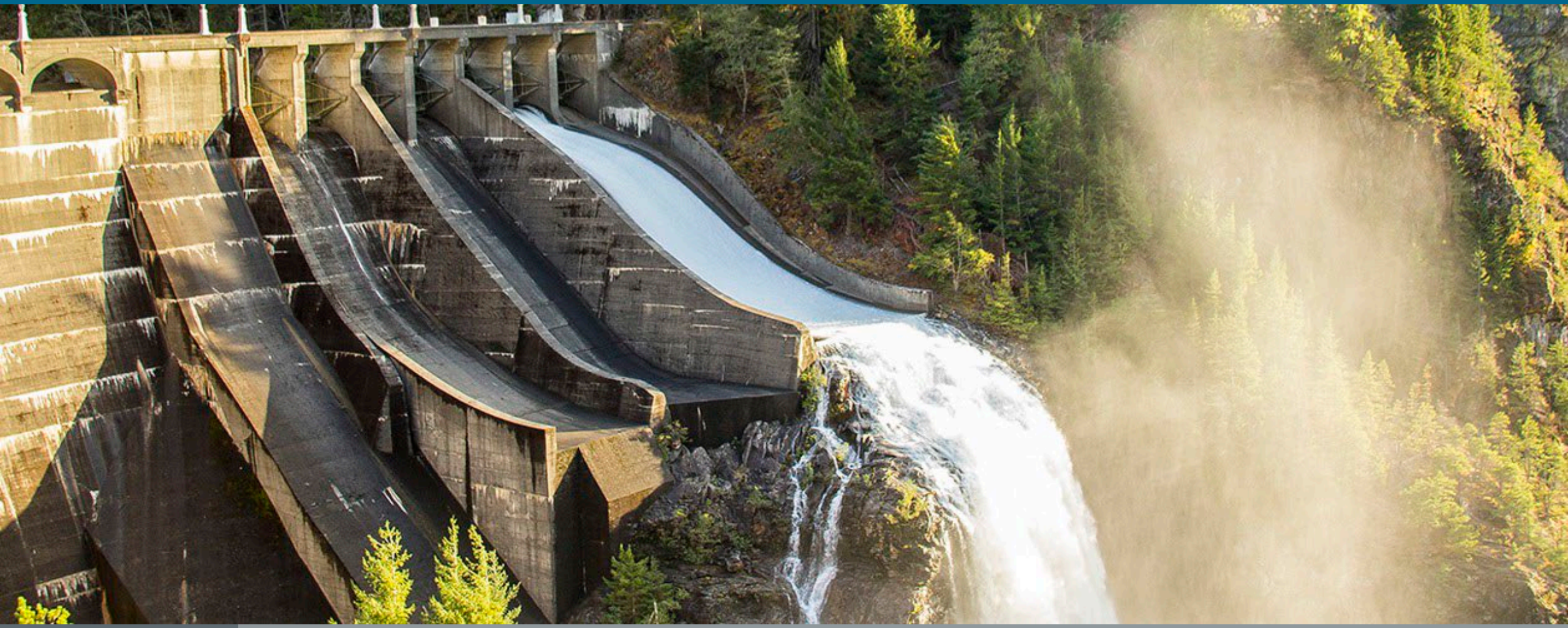
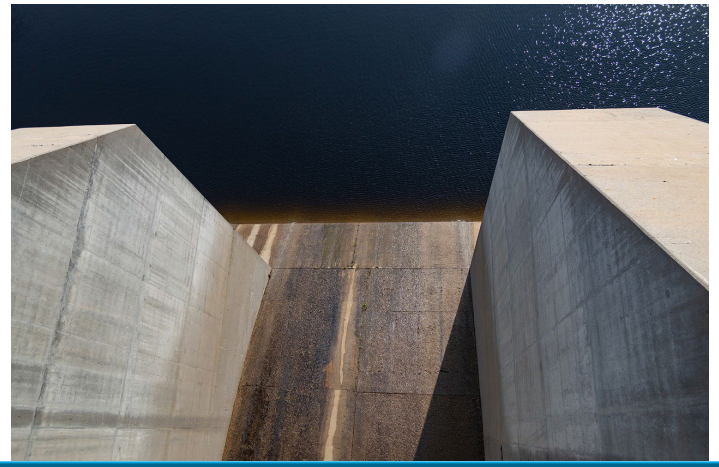
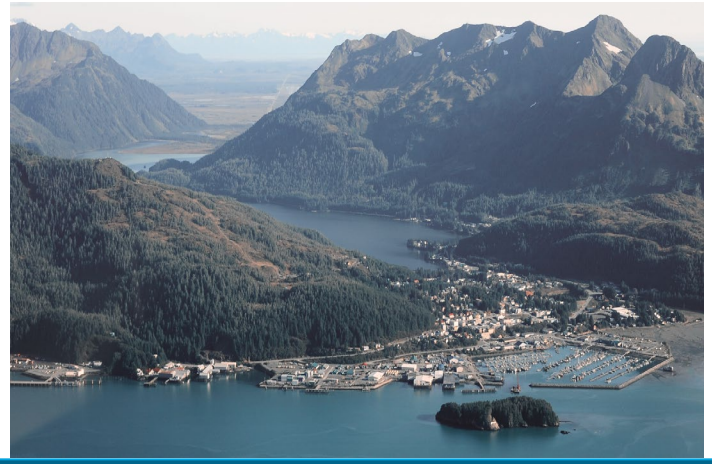


Hydropower: Many Different Opportunities



Upgrades for Existing Hydropower



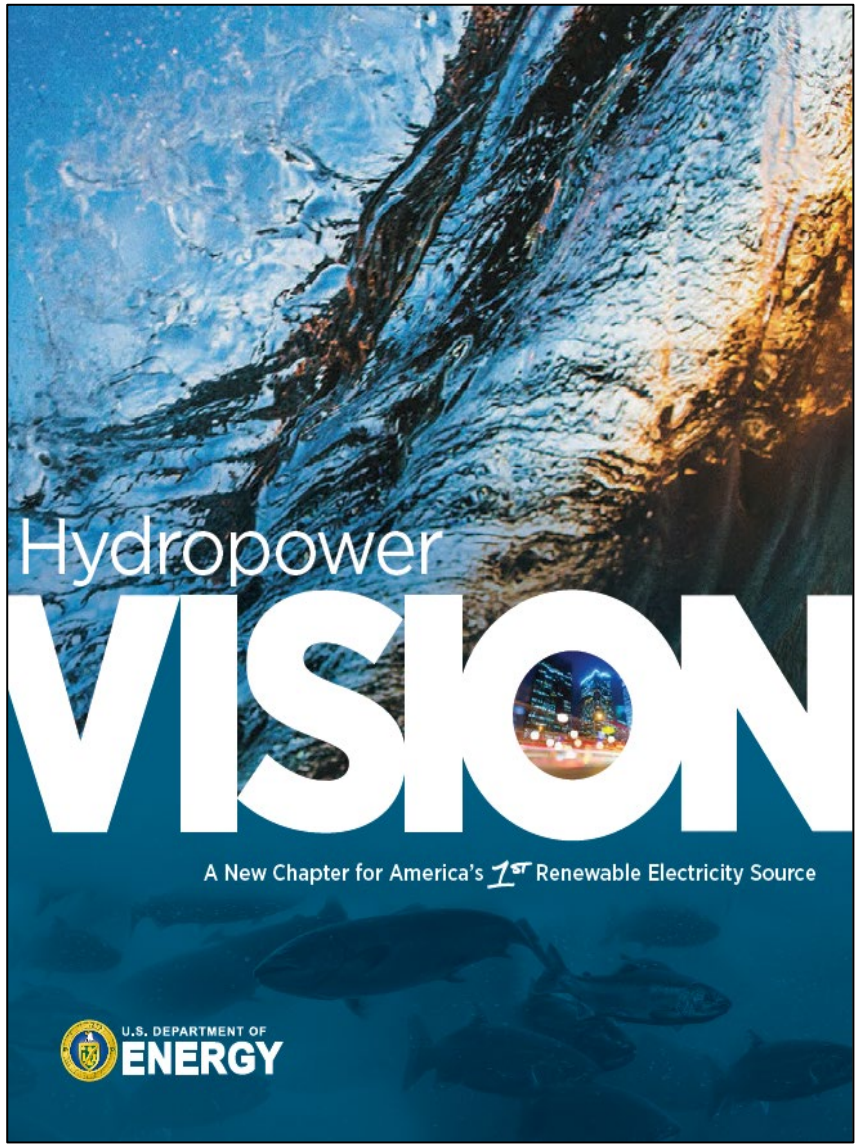
Non-Powered Dams and Conduits

New Low-Impact Projects

Pumped Storage Hydropower

Hydropower Vision Report

- 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

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	GRID RELIABILITY, RESILIENCE, AND INTEGRATION (HYDROWIRES)	FLEET MODERNIZATION, MAINTENANCE, AND CYBERSECURITY
Develop, test, and validate cost-effective, sustainable technologies for non-conventional hydropower applications in new-stream reaches, NPDs, and conduits.	Understand, enable, and improve hydropower and PSH's contributions to reliability, resilience, and integration in a rapidly evolving electricity system	Develop digitalization, maintenance, and cybersecurity tools and capabilities to enable data-driven decision making, improve system reliability and reduce costs; and enhance infrastructure security.

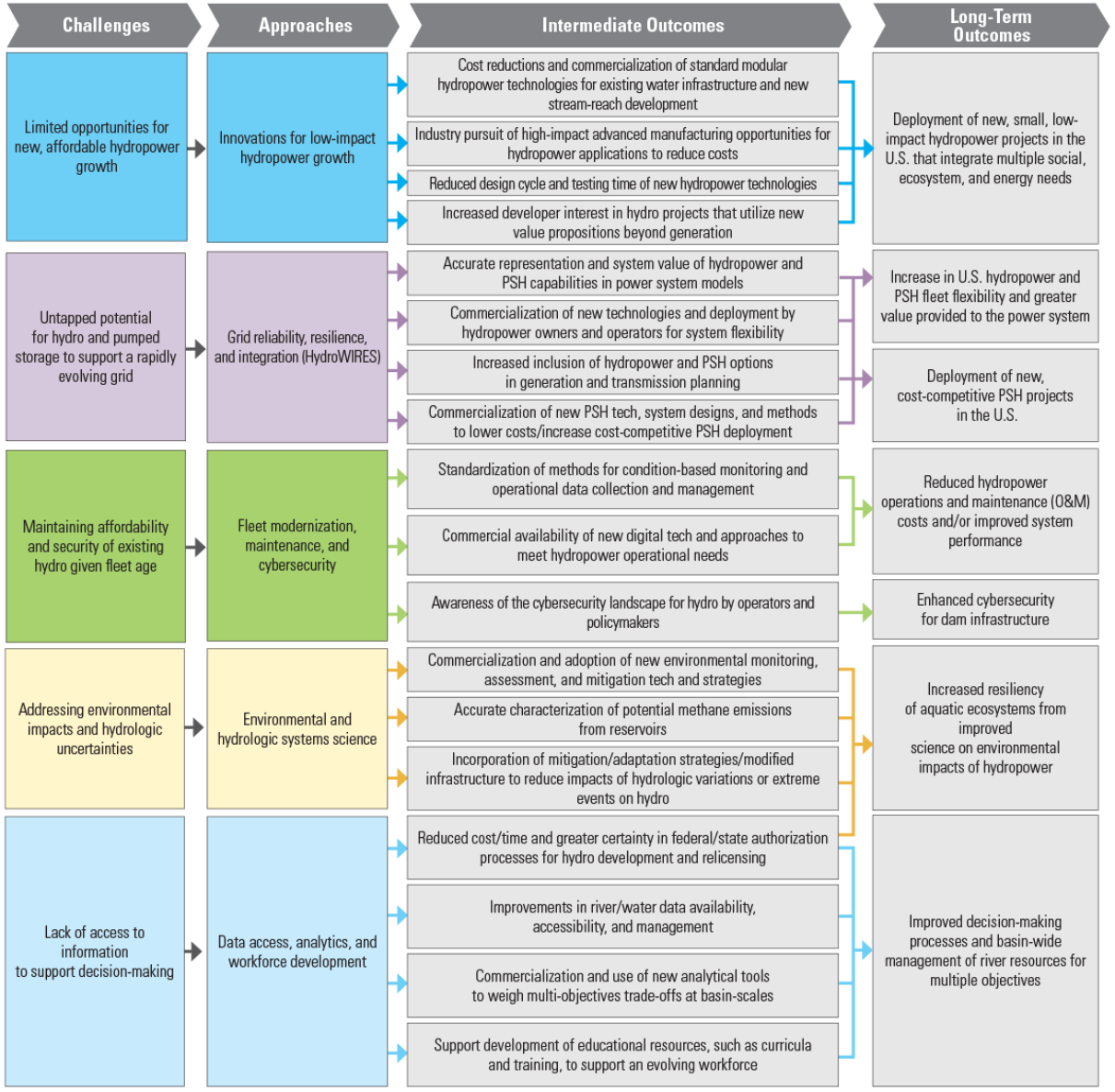
ENVIRONMENTAL AND HYDROLOGIC SYSTEMS SCIENCE

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



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.

Grid Reliability, Resilience, and Integration (HydroWIRES)

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.

Fleet Modernization, Maintenance, and Cybersecurity

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!

Innovations for Low-Impact Hydropower Growth		
David Sinclair	**Advanced Hydro Solutions**	**Panel Lead**
Doug Spaulding*	Nelson Energy	Reviewer
Erik Steimle	Rye Development	Reviewer
Michael Kerr	New England Hydropower Company LLC	Reviewer
HydroWIRES		
Tom Acker	**Northern Arizona University**	**Panel Lead**
Elaine Hart*	Moment Energy Insights LLC	Reviewer
Bente Brunes	Rainpower	Reviewer
Debbie Mursch	GE Renewable Energy	Reviewer
Fleet Modernization, Maintenance, and Cybersecurity		
Cathy Campbell*	**U.S. Army Corps of Engineers**	**Panel Lead**
Craig Bourassa	Avista Utilities	Reviewer
John Bakken	McMillian Jacobs Associates	Reviewer
Ram Veeraraghavan	Tacoma Power	Reviewer
Environmental and Hydrologic Systems Science		
Shannon Ames	**Low Impact Hydropower Institute**	**Program Chair/Panel Lead**
Cheryl Laastch	Wisconsin Department of Natural Resources	Reviewer
Twyla Cheatwood*	NOAA	Reviewer
Wendy Bley	Klienschmidt Associates	Reviewer
Prizes		
Donna Vincent Roa	USAID's Partnerships Incubator, The Kaizen Company	Prize Reviewer
Sally Gutierrez	Environmental Protection Agency	Prize Reviewer
Craig Connelly	NYSERDA	*Hydro Prize Reviewer Only*

Questions?

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