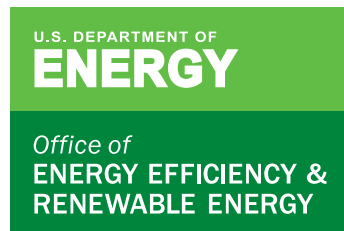




The U.S. electricity system is rapidly evolving, bringing both opportunities and challenges for hydropower and pumped storage hydropower (PSH).

While hydropower and PSH can provide a host of generation and storage resources and capabilities needed for flexible operation of the changing electric grid, the specific design and operational attributes that may prove most useful within the future power system are not well understood. This uncertainty can result in plant and fleet-wide inefficiencies in how existing grid services and ancillary services are evaluated, procured, and compensated. In response to this challenge, the Water Power Technologies Office (WPTO) has launched a new grid research initiative—Hydropower and Water Innovation for a Resilient Electricity System (HydroWIRES)—**to understand, enable, and improve hydropower and PSH’s contributions to reliability, resilience, and integration in a rapidly evolving electricity system.**

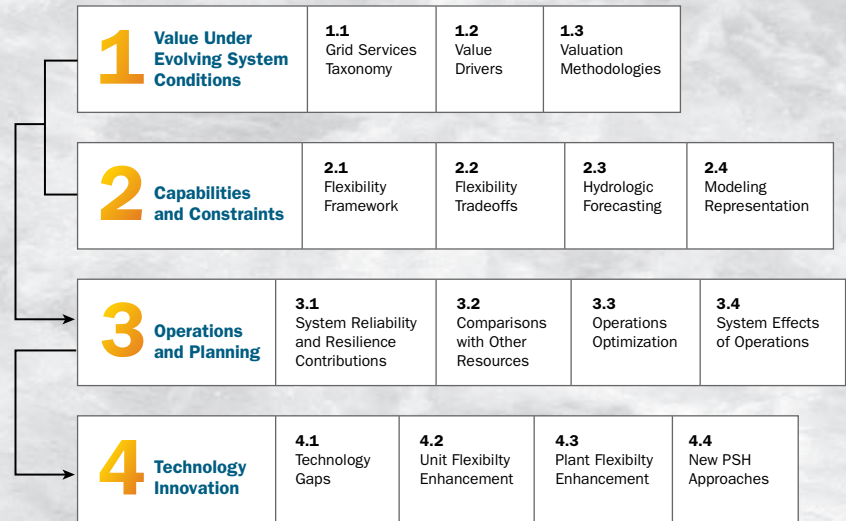


Efforts under this initiative are organized in four interrelated research areas:

- 1 RESEARCH AREA 1 Value Under Evolving System Conditions**
Understand the needs of the rapidly evolving grid and how they create opportunities for hydropower.
What will the grid need?
- 2 RESEARCH AREA 2 Capabilities and Constraints**
Investigate the full range of hydropower’s capabilities to provide grid services, as well as the machine, hydrologic, and institutional constraints to fully utilizing those capabilities.
What can hydropower do?
- 3 RESEARCH AREA 3 Operations and Planning**
Optimize hydropower operations and planning—alongside other resources—to best utilize hydropower’s capabilities to provide grid services. **How can hydropower best align what it can do with what the grid will need?**
- 4 RESEARCH AREA 4 Technology Innovation**
Invest in innovative technologies that improve hydropower capabilities to provide grid services. **What new technology could expand what hydropower can do to meet grid needs?**

Intentionally cumulative, the first and second research areas serve to establish a baseline understanding of what range of services may be most valuable for the future grid together with what services hydropower can (and cannot) contribute. They provide needed insights into the services and attributes the hydropower fleet can and should be prioritizing. The third research area operationalizes this information by developing strategies to take advantage of hydropower’s capabilities to contribute the services required by the evolving grid. The fourth area continuously integrates the findings from these three research spaces to inform technology needs and target innovation that can expand hydropower’s capabilities to provide value to the grid.

RESEARCH AREAS



1 Value Under Evolving System Conditions

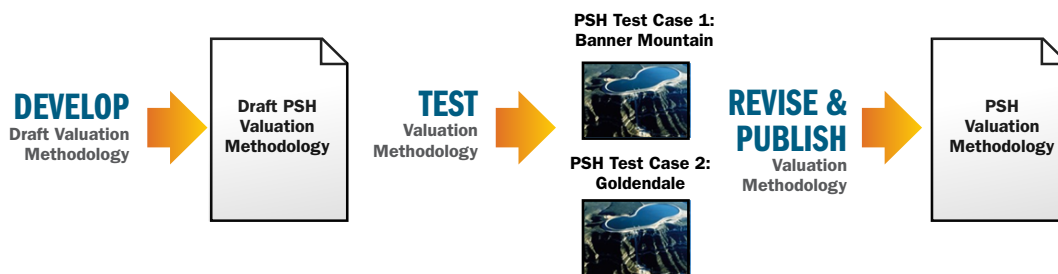
This research area focuses on understanding the variety of grid services that may be most vital for the future grid. These services will depend on the future generation mix, including the share of variable renewables and other system conditions. Central to Research Area 1, as well as for the other research areas, is the development of a complete categorization of benefits and services that hydropower can contribute to the electric system. As the grid evolves, this area of research will analyze how economic drivers and changes in competitive markets affect the benefits and services that are of greatest value to the electric system. New valuation practices within the context of these changes are needed to accurately consider the range of contributions from hydropower and PSH assets.

SAMPLE PROJECT

Valuation Guidance and Techno-Economic Studies for Pumped-Storage Hydropower

WPTO has developed a draft step-by-step valuation guidance that can be used by PSH developers, plant operators, and other stakeholders to assess the potential economic value of existing or planned PSH projects. The methodology is being applied at two competitively selected sites—the Goldendale Energy Storage Project and the Banner Mountain Project—to evaluate and demonstrate the potential for increased economic performance. Through these studies, WPTO will test and refine the valuation guidance, after which the guidance and associated tools will be made publicly available.

Organization of valuation guidance and techno-economic studies



2 Capabilities and Constraints

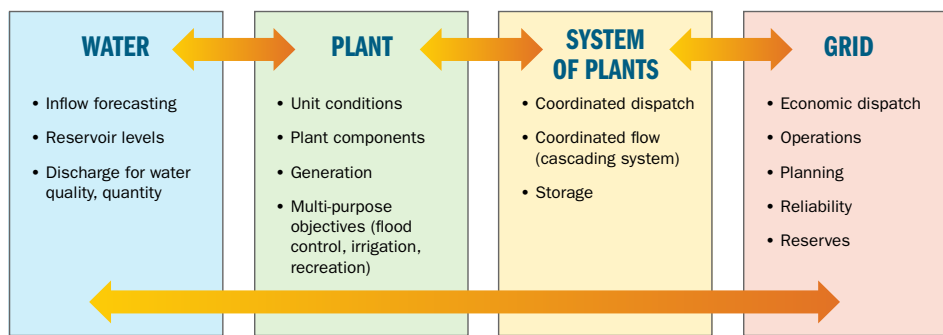
This research area constitutes a comprehensive and quantitative assessment of plant- and fleet-level hydropower capabilities, as well as the barriers, or constraints, to full utilization of those capabilities. These barriers include the precision of hydrologic forecasting over planning horizons and how capabilities and constraints are represented and characterized within electric system operations and planning practices. Research Area 2 also focuses on advancing tools for understanding hydropower capabilities (e.g., evaluating trade-offs, anticipating water availability, utilizing water for the grid) to achieve greater degrees of flexibility.

SAMPLE PROJECT

WPTO Office-Wide 2019 Research Funding Opportunity

As part of a recently announced office-wide \$26 million funding opportunity, the HydroWIREs initiative seeks proposals to understand and improve hydropower operational flexibility. The funding opportunity seeks a rigorous and broadly applicable framework that quantifies hydropower's total potential capability for flexible operation (not just its past operations), as well as specific operational strategies for increasing flexible operation capabilities in significant segments of the fleet. Applications are being reviewed, and selections are expected to be announced in fall 2019.

Hydropower Operational Flexibility



3 Operations and Planning

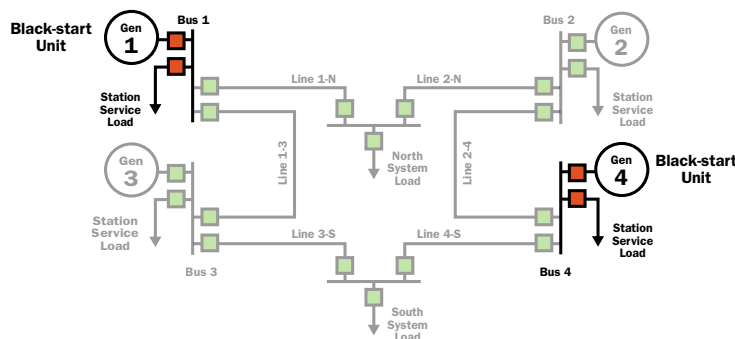
This research area considers the potential needs of the grid in Research Area 1 and hydropower's unique capabilities and constraints in Research Area 2, to develop innovative ways to optimize planning and operations of hydropower from plant to fleet level. The essence of Research Area 3 is investigating the best role for hydropower to play to contribute to a future electricity system that will include many different generation sources, each with their own unique capabilities. Work under Research Area 3 will quantify hydropower plant- and fleet-level contributions to support power system needs while enabling enhancement of these contributions through new operational strategies and planning approaches.

SAMPLE PROJECT

Hydropower Plants as Black Start Resources

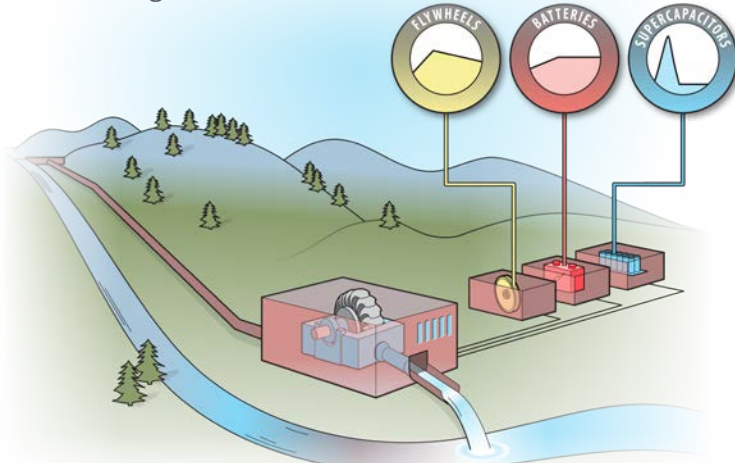
The Hydropower Plants as Black Start Resources report describes hydropower's capabilities for black start relative to other resources. Part of a larger series of technical memos on hydropower capabilities for grid services, the report discusses the sequence of operations to restore the grid after a major blackout. In this context, the report describes how the types, sizes, characteristics, and locations of black start-capable units affect the speed of recovery. In turn, the characteristics of various power generation technologies are compared with the attributes needed to quickly and efficiently re-energize the power system for normal operation. This report can be found at energy.gov/HydroWIREs.

Depiction of Black Start Units Starting Up Following a Blackout



4 Technology Innovation

This research area focuses on the development of innovative technologies and designs needed to maintain or expand hydropower's contributions to the grid, such as by enabling more flexible operation. This research space will be supported by a gaps assessment, which leverages the efforts of the previous three research areas to synthesize technology gaps that limit unit and plant flexibility and identify high-value opportunities for R&D. Performance targets are informed by the previous three research areas to understand future system conditions, current capabilities, and hydropower's role alongside other generation resources.



SAMPLE PROJECT

Integrated Hydropower and Energy Storage Systems

WPTO's Integrated project focuses on evaluating the ability of run-of-river (ROR) hydropower plants to provide grid balancing (services that enable the supply and demand of energy to equal out) through integration with energy storage systems (ESS), such as batteries, flywheels, and supercapacitors. ESS can essentially act as virtual reservoirs, making it possible for ROR facilities, which traditionally have little or no water storage, to adjust the amount of power they deliver, providing similar services as more flexible hydropower plants. The capability for ROR facilities to be used for flexible generation and storage applications will be of increasing importance as the share of wind and solar energy generation continues to grow.

COMING SOON!

- Hydropower Value Study describing the current operational landscape, future grid scenarios, and hydropower capabilities and gap analysis.
- The Furthering Advancements to Shorten Time (FAST) Commissioning for PSH Prize aims to catalyze new solutions, designs, and strategies to accelerate PSH development by reducing the time, cost, and risk to commission PSH. Prize competitors are currently in the incubation state of the competition (receiving up to 50 hours of technical assistance). The grand prize winner will be announced in October 2019.
- Ongoing development of a HydroWIREs Research Roadmap, which provides context, strategic direction, and organization for the initiative at large. Soon to be released for public feedback in 2019.

U.S. DEPARTMENT OF ENERGY NATIONAL LABORATORIES

HydroWIREs includes researchers across five National Laboratories who work collaboratively to identify and develop connections across projects. Laboratory researchers serve as leaders of each research area, providing both technical leadership and strategic insight to inform the WPTO portfolio and broader U.S. Department of Energy efforts.



Questions, comments, or want to get involved?
Samuel.Bockenbauer@ee.doe.gov

energy.gov/HydroWIREs

DOE/GO-XXXXX-XXXX · July 2019