

Innovations for Low-Impact Hydropower Growth

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Innovations for Low Impact Hydropower Growth Overview



New Tech and Advanced Manufacturing

Innovate new technologies for both existing water infrastructure and new stream-reach applications that incorporate ecological and social objectives



Testing Infrastructure

Support testing of new technologies, including development of necessary testing infrastructure



New Value Propositions

Explore opportunities for new development in which hydropower is a critical enabler of a larger suite of benefits

Challenges the Activity Area Addresses

- Limited Opportunities for New, Affordable Hydropower Growth Given Existing Technologies
 - Remaining new hydro resources (including NPDs, new stream-reaches, and conduits) are smaller, lower-energy density and expensive to develop with existing technologies.
 - Uncertain and complex socio-environmental impacts associated with existing hydropower designs that could require difficult or expensive mitigation measures.
 - Lack of infrastructure and capabilities to test and validate new technologies and designs

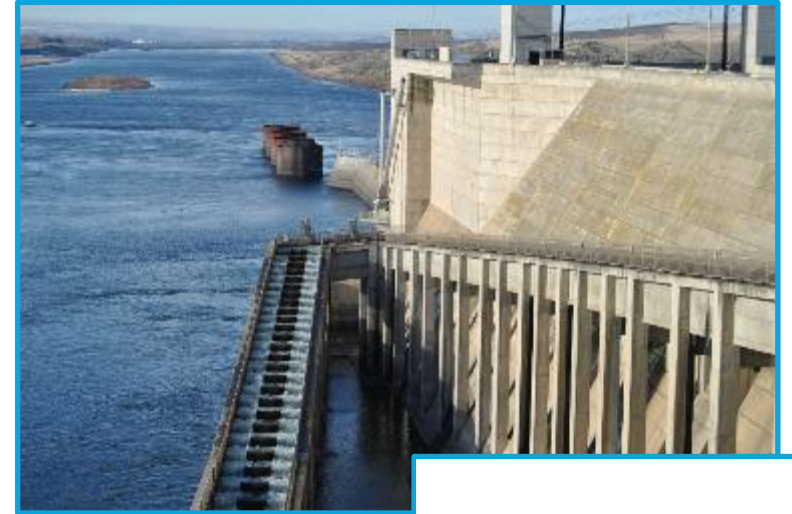
Examples of How Stakeholder Engagement Informed Strategy

- Released a [Request for Information](#) on Testing Capabilities and Facilities to Validate Hydropower Technology Innovation in Aug '21
- Engaged an Innovation Advisory Group across the project lifespan for FOA 1836 awards focused on the development of a full facility design utilizing standard modular hydropower approaches
- Hosted 2 workshops for feedback on a non-powered dam classification and taxonomy tool as well as a NPD Explorer tool (Dec 2020 and July 2021)
- Provided direct technical assistance to FOA awardees through the Standard Modular Hydropower project
- Participated in and presentations at industry groups:
 - NHA Small Hydro Council
 - NHA Water Innovation Council
 - IEA Annex XVI Hidden Hydro
- Engaged with the Federal Hydropower Memorandum of Understanding partners (USACE and USBR) to identify key opportunities
- Disseminated results through conference presentations (e.g., HydroVision, Clean Currents, Water Power Week, CEATI Annual Conference)

Innovations for Low-Impact Hydropower Growth Goals

Key Results and Performance Goals (2021–2025)

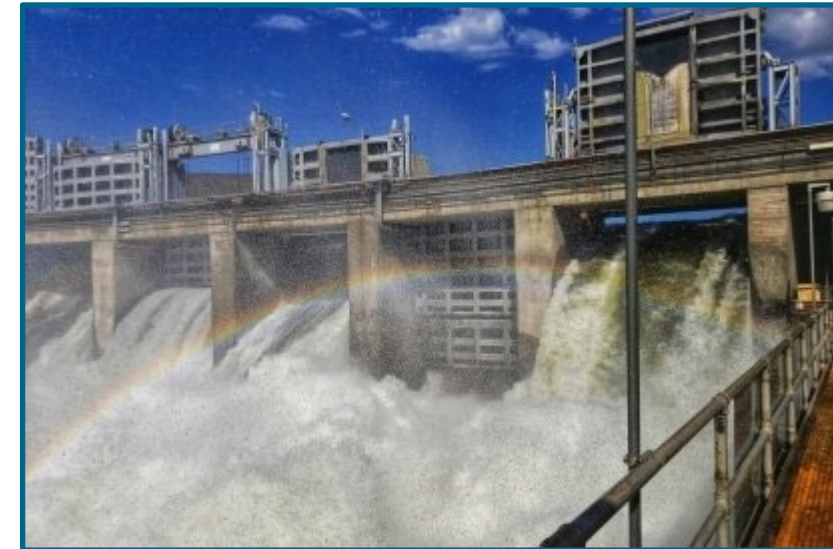
- ✓ Develop datasets and interactive geospatial tools to identify development potential and site characteristics of new stream-reaches, NPDs, and conduit resources.
- Publish R&D roadmap that identifies high-impact opportunities to leverage advanced manufacturing and materials in hydropower applications.
- Complete testing and pre-commercial demonstrations of new cost-competitive technologies across each class of hydropower resource, 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.



Innovations for Low-Impact Hydropower Growth Objectives

Follow-On Objectives (2026–2030)

- Project developers use geospatial tools to site and design new hydropower projects that balance social and ecological considerations, such as recreation, water quality, and biodiversity.
- Technology developers actively pursue and apply high-impact advanced manufacturing opportunities for hydropower applications.
- Deployment of new technology with revolutionary improvements in technology costs and environmental performance due to adoption of standardization and modularity principles, incorporation of advanced manufacturing and materials, and ability to test prototypes at full scales.
- Increased developer interest in exploring hydropower projects that take advantage of new value propositions in addition to energy generation values.

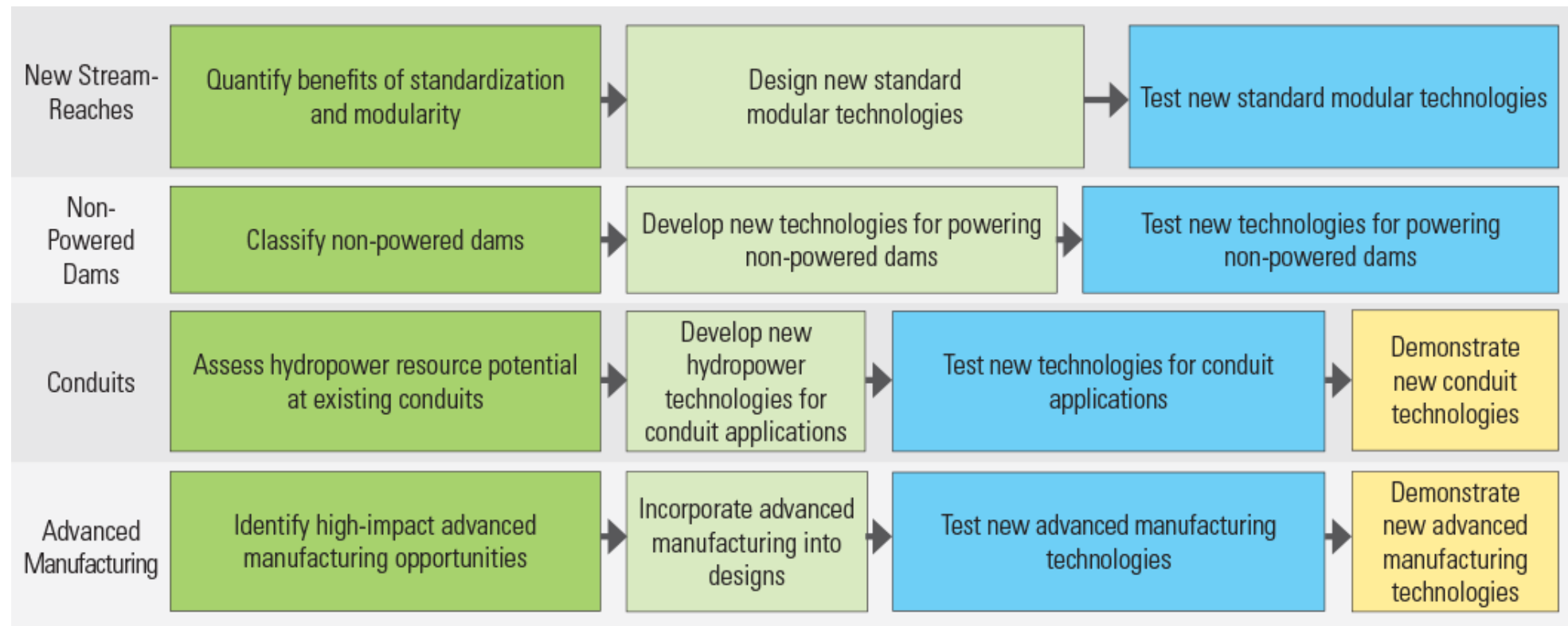


Implementation and Progress – Research Priorities

Current research priorities include:

- New technologies and Advanced Manufacturing
 - New stream reach
 - Non-powered dams
 - Conduits
 - Advanced manufacturing
- Testing and validation
- New value propositions

New Technologies and Advanced Manufacturing



FY2021

FY2025



Foundational Research



Technology R&D

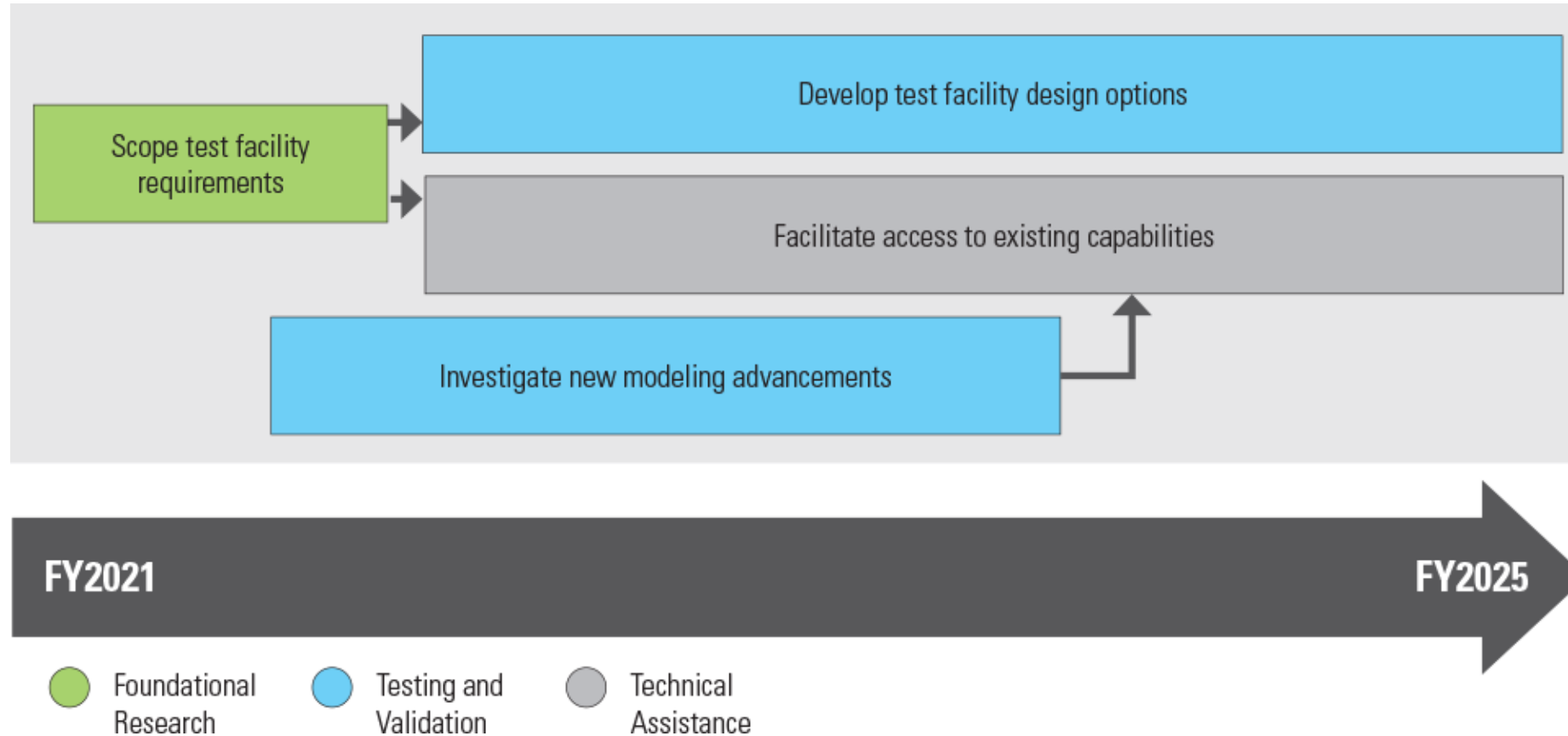


Testing and Validation

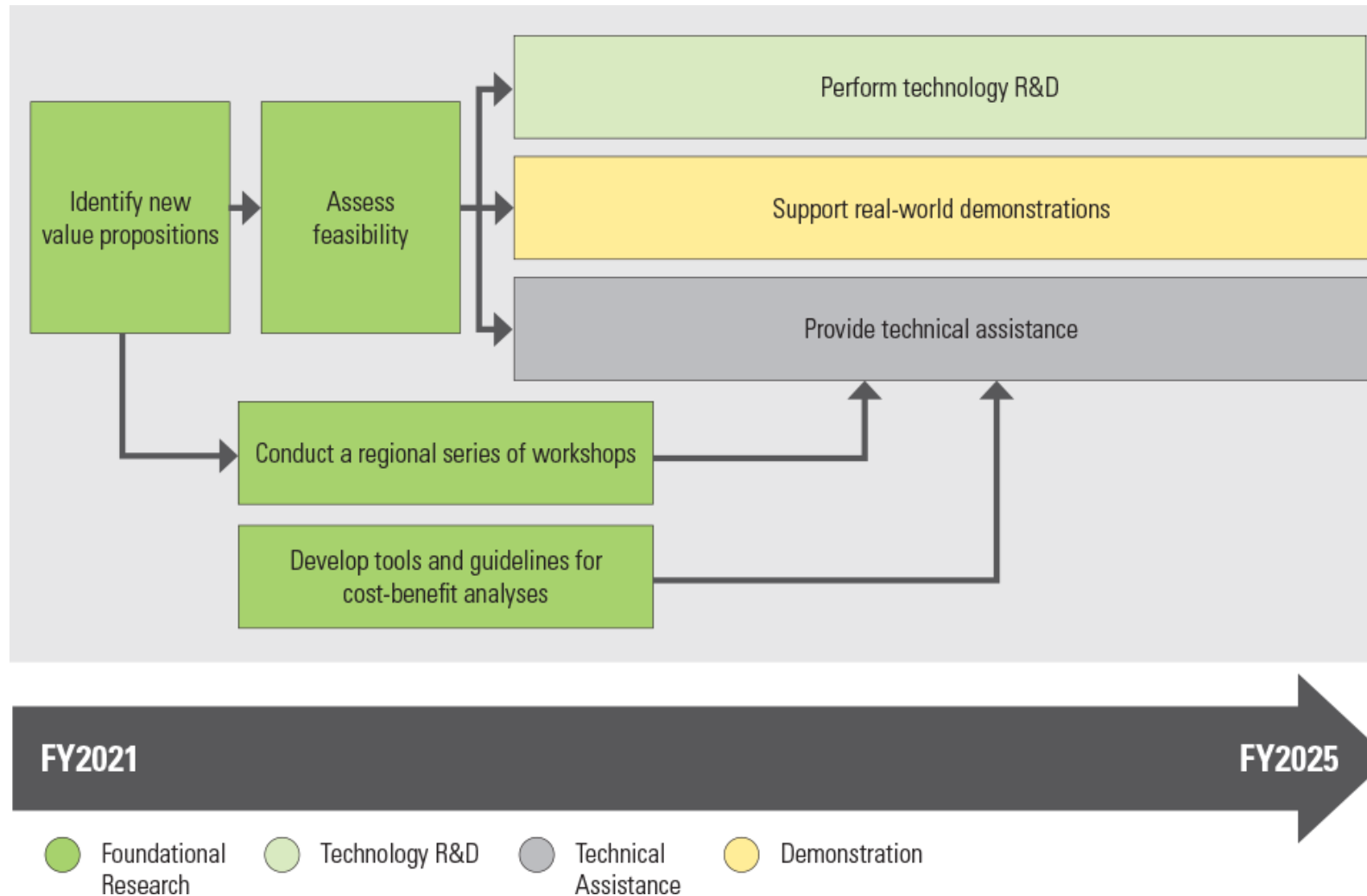


Demonstration

Testing Infrastructure Access and Development



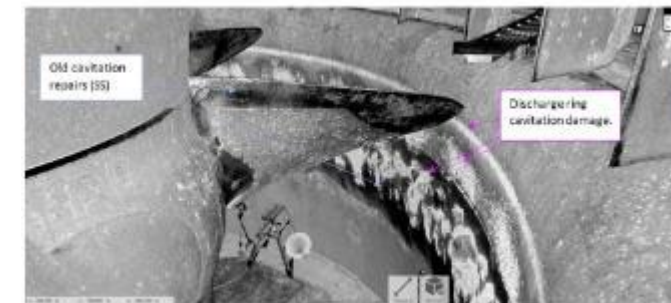
New Value Propositions



Key Accomplishments

- Design and Development of a Composite Hydropower Turbine Runner
 - Successfully fabricated composite runner turbine blades
 - Scaled design, fabricated and deployed a Voith Bulb hydroturbine in PSU water tunnel
 - Tested under simulated hydro turbine operation conditions with similar performance to stainless steel runners

*Report forth coming
- Cold Spray
 - Determined feasibility of cold spray as a repair process for cavitation in hydro turbines
 - Transition process to commercially available portable equipment for in situ repair
 - Characterize performance
 - Finalize field site and begin test plan



Key Accomplishments

Standard Modular Hydropower

- Module R&D – Technical Support to FOA 2080 awardees
 - **Littoral:** computational fluid dynamics modeling, advanced manufacturing (AM) consulting.
 - **Natel:** AM consulting.
 - **Percheron:** target market analysis, AM consulting, cost analysis.
 - **University of Minnesota:** AM consulting, AM prototype fabrication, sediment guide vane research and design, cost analysis.
- SMH Facility R&D
 - Technical support to FOA 1836 awardees Littoral Power Systems and Natel Energy
 - Publication of the [waterSHED](#) tool and user guide (May 2022)
 - 2 Co-Development internal white papers
- SMH for NPDs
 - Development of the NPD Classification tools and NPD dataset including the [NPDamCAT](#) and [NPDExplorer](#) tool
 - 2 journal and 3 lab publications (only [1 within the Peer Review period](#), the rest spring of 2022)

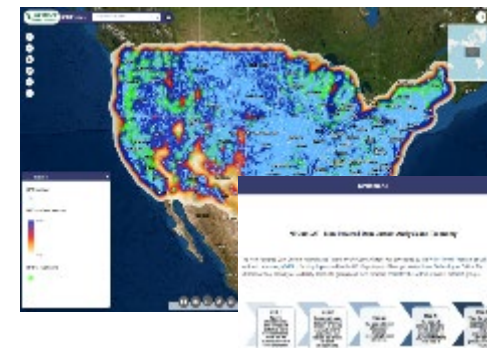
Technical Support to FOA Awardees



waterSHED Tool Development



NPD Classification, Tool, and Design Specification Development



Key Accomplishments

FOA 1836

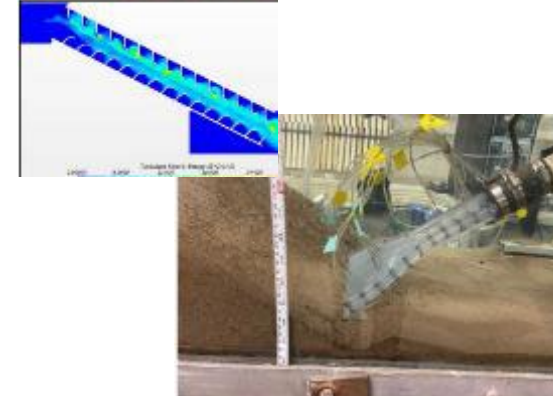
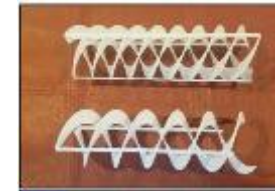
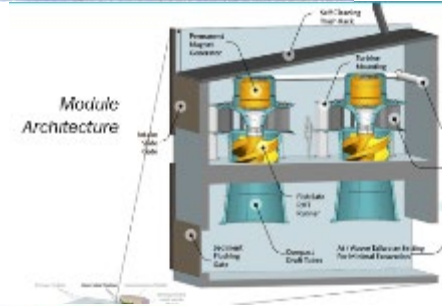
- 2 awardees focused on understanding the potential value of a standard modular hydropower approach for a fully facility design of a new stream-reach hydropower project: Littoral Power Systems and Natel Energy
 - Both successfully:
 - Identified 3 potential sites
 - Initial cost models and designs for modules
 - Successful Go/No Go to continue work into budget period 2
- *Final design reports coming this summer



Key Accomplishments

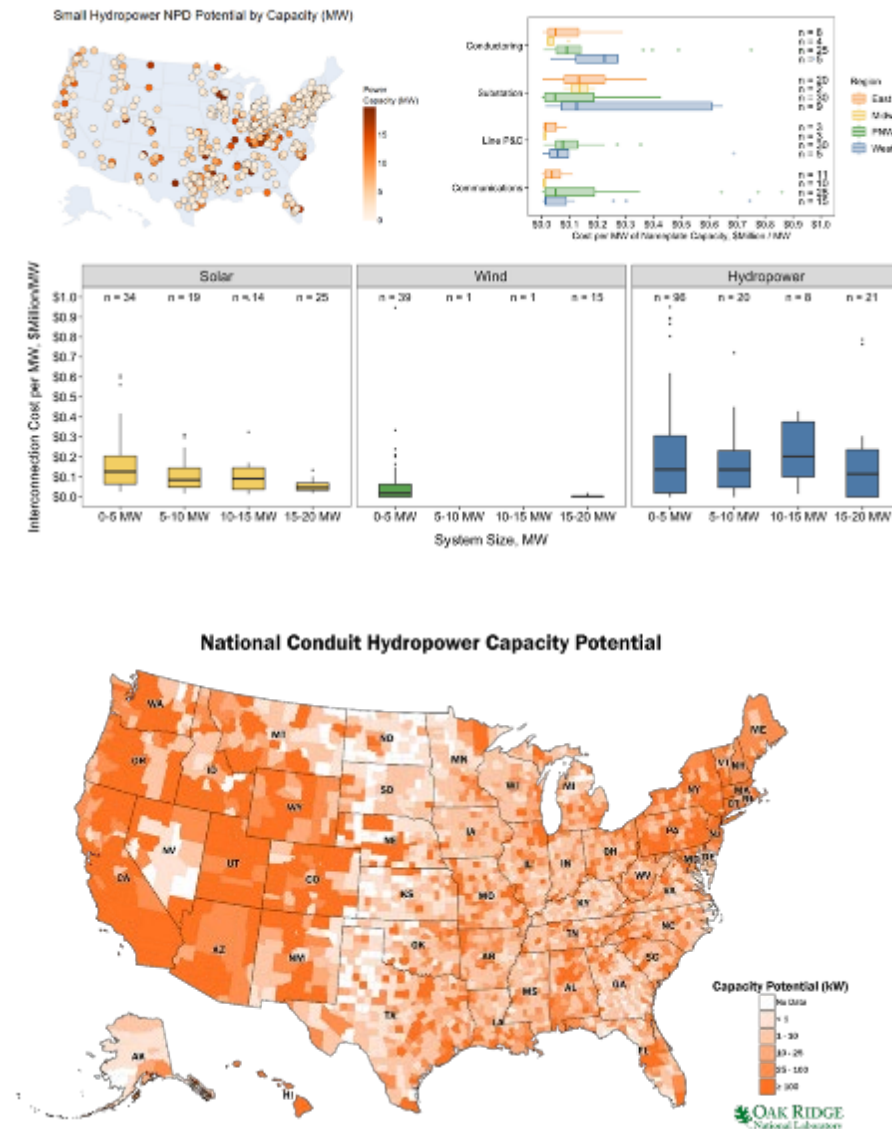
FOA 2080

- 4 awardees focused on improvement of a specific module: LPS, Natel Energy, Percheron Power and the University of Minnesota
 - LPS: Prefabricated zero ascend omnispecies (ZAO) modular fish passage attraction module
 - Natel: Advanced Compact Generation Module with Fish Safe Runner Technology
 - Percheron: Development of a Modular Helical Fish Passage for Low Head Applications
 - University of Minnesota: A Novel Sediment Passage Module Design for Support of Standard Modular Hydropower
- Awards made in late FY20/early FY21
- All 4 awardees have completed budget period 1 and presented to external reviewers for a Go/No Go decision for budget period 2
- All have successfully completed initial module technical designs and initial testing.
- They have also considered advanced manufacturing opportunities for their module manufacturing



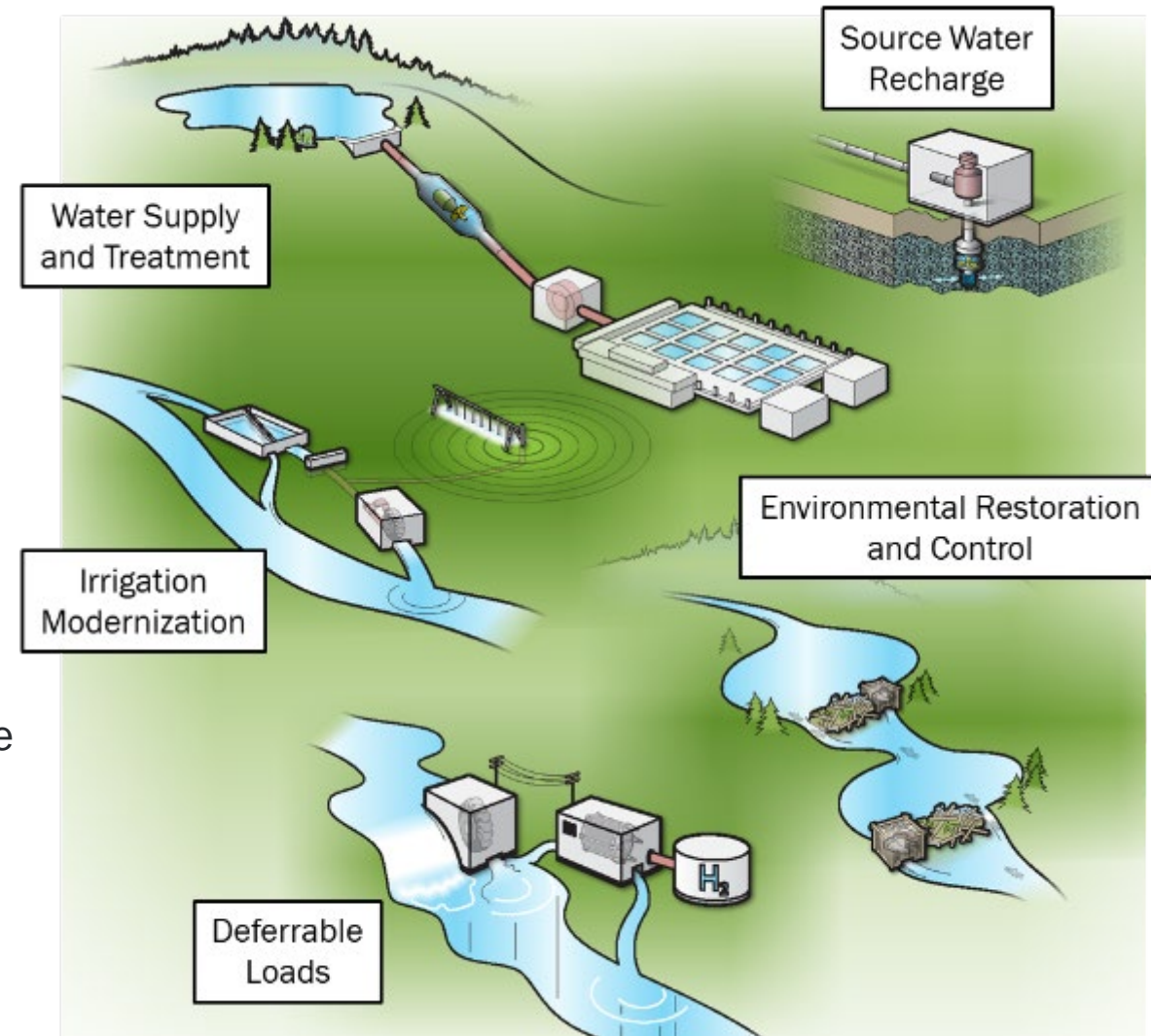
Key Accomplishments

- Small Hydropower Interconnection Benchmarking
 - Produced four distinct products to be made available on a project website:
 1. Taxonomy presenting small hydropower potential across the United States.
 2. State-by-state collation of interconnection processes, policies, or procedures
 3. Database of common grid system upgrades mined from over 200 small hydropower project reports
 4. Best practices comparing small hydropower interconnections to solar PV and distributed wind.
- National Conduit Resource Assessment
 - The main product will be a publicly assessable resource assessment report that aggregates resource findings to both state and county levels without revealing sensitive site information
 - External review of the report in May '22
 - Expected publication Oct '22



Key Accomplishments

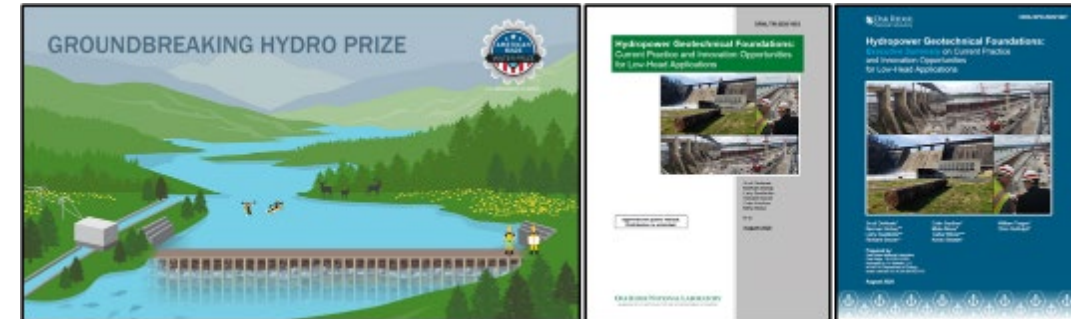
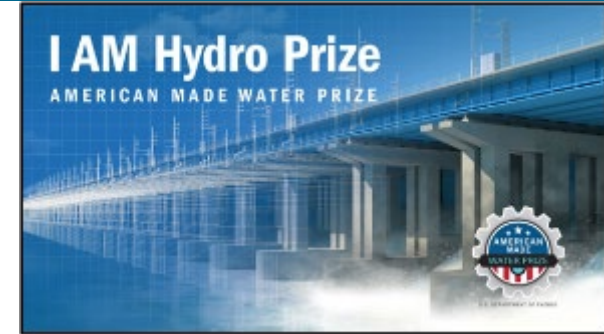
- Alternative Opportunities for Hydropower
 - Identified top 5 alternative opportunities for hydropower
- Irrigation Modernization
 - Conducted two case studies with Oregon irrigation districts to determine the value and drivers of irrigation modernization projects
 - Developed a prototype of IrrigationViz.
 - Scaled up key partnerships with USDA and private stakeholders.
 - Conducted two case studies in Idaho and Washington irrigation districts.
- Integrated Water/Power Resilience
 - Summary memo of research and development opportunities for DOE WPTO (from interviews and landscape assessment)
 - High-impact stakeholder workshop and workshop report
 - White paper on planning for water and climate variability in electric utility Integrated Resource Plans
 - Two journal articles on water-power resilience



Key Accomplishments

Prizes:

- [I AM Hydro Prize](#) offered up to \$250,000 in cash prizes
- [Groundbreaking Hydro Prize](#) and [Geotechnical Foundations report](#) offered up to \$300,000 in cash prizes



NPD Tools:

- [NPDam Custom Analysis and Taxonomy Framework](#)
- [NPD Classification Tools – User Guide NPD Explorer and NPDamCAT Apps](#)
- [NPD Retrofit Exemplary Design Report](#)



Future Work

A select list of upcoming reports and tools:

- Conduit Resource Assessment (Summer 22)
- Interconnection Best Practices Guidelines and Tool (Fall 22)
- Technology Catalog and tool (Fall 22)
- Completion of 1836 FOA awards and reports (Summer 22)
- Completion of 2080 FOA awards and reports (FY23)
- Advanced Manufacturing for Hydropower Workshop (Aug 2-3, 2022)
- Opportunities and Gaps Analysis for Advanced Manufacturing for Hydropower report (Fall 22)
- Advanced Manufacturing Roadmap (Summer 23)
- Test Facility Report to summarize RFI results and next steps (Late Summer 22)
- Alternative Opportunities Workshop report/outputs (Late summer 22)
- IrrigationViz tool (Fall 22)

Innovations for Low-Impact Hydropower Reviewer Introductions



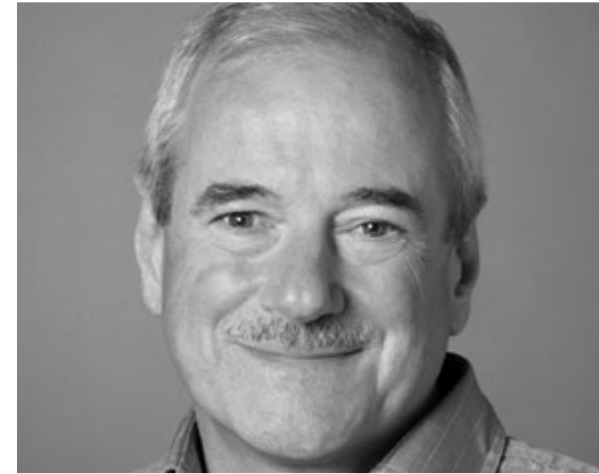
David Sinclair, *Review Panel Lead*
President, Advanced Hydro Solutions



Doug Spaulding
President, Nelson Energy



Erik Steimle
Vice President of Project Development, Rye Development



Michael Kerr
Co-Founder and Managing Principal, New England Hydropower Company

Prize Reviewers



Donna Vincent Roa, *Prize Reviewer*
Partnership Director, USAID's
Partnerships Incubator, The Kaizen
Company



Sally Gutierrez, *Prize Reviewer*
Senior Advisor, Center for Environmental
Solutions & Emergency Response Office of
Research & Development, U.S.
Environmental Protection Agency



Craig Connelly, *Prize Reviewer*
Director of Research and
Development, New York State Energy
Research and Development Authority
(NYSERDA)

Schedule Overview – July 26

START (ET)	END (ET)	PRESENTATION TOPIC	ORGANIZATION	SPEAKER
10:00 AM	10:30 AM	Innovations for Low-Impact Hydropower Growth Activity Area Overview	WPTO	Katie Jackson
10:30 AM	11:00 AM	Groundbreaking Hydro and I AM Hydro Prizes	NREL, ORNL, WPTO	Tessa Greco, Scott DeNeale, Katie Jackson
11:00 AM	11:25 AM	The Design and Development of a Composite Hydropower Turbine Runner	Composite Technology Development, Inc.	Paul Fabian
11:25 AM	11:35 AM	BREAK		
11:35 AM	11:50 AM	Cold Spray Process Development for In Situ Repair and Mitigation of Cavitation Erosion	PNNL	Chris Smith

Schedule Overview – July 26 continued

11:50 AM	12:15 PM	Standard Modular Hydropower Technology Acceleration	ORNL	Scott DeNeale
12:15 PM	1:00 PM	LUNCH BREAK		
1:00 PM	1:25 PM	Restoration Hydro: A Watershed Approach to Standard Modular New Hydropower	Natel Energy Inc.	Abe Schneider
1:25 PM	1:50 PM	Prefabricated Standard Modular Hydropower Installations for Low-Cost Small Hydropower	Littoral Power Systems Inc	David Duquette
1:50 PM	2:15 PM	Small Hydro Interconnection Study	PNNL, ORNL	Alison Colotelo, Todd Wall, Chris O'Reilly, Hope Corsair
2:15 PM	2:40 PM	Reviewer Debrief	Reviewers	

Schedule Overview – July 27

START (ET)	END (ET)	PRESENTATION TOPIC	ORGANIZATION	SPEAKER
10:00 AM	10:25 AM	Development of a Modular Helical Fish Passage for Low Head Applications	Percheron Power, LLC	Jerry Straalsund
10:25 AM	10:50 AM	Advanced Compact Generation Module with Fish Safe Runner Technology	Natel Energy, Inc.	Gregor Cadman, Sterling Watson
10:50 AM	11:15 AM	Prefabricated Zero Ascend Omnispecies (ZAO) Modular Fish Passage Modules Using Advanced Manufacturing Techniques	Littoral Power Systems Inc.	David Duquette
11:15 AM	11:25 AM	BREAK		
11:25 AM	11:50 AM	A Novel Sediment Passage Module Design for Support of Standard Modular Hydropower	Regents of The University of Minnesota	Jeffrey Marr

Schedule Overview – July 27 continued

11:50 AM	12:15 PM	National Conduit Resource Assessment	ORNL	Shih-Chieh Kao
12:15 PM	1:00 PM	LUNCH BREAK		
1:00 PM	1:25 PM	Integrated Water Power Resilience	PNNL, INL	Juliet Homer, Shiloh Elliott
1:25 PM	1:50 PM	Irrigation Modernization	INL, PNNL	Thomas Mosier
1:50 PM	2:15 PM	Alternative Opportunities for Hydropower	PNNL, INL	Rajiv, Prasad, Thomas Mosier
2:15 PM	2:40 PM	Cost Data Collection & Modeling for Hydropower	ORNL	Gbadebo Oladosu
2:40 PM	3:05 PM	Reviewer Debrief	Reviewers	

Q&A