

# Standard Modular Hydropower: Innovator Engagement

## SMH Engagement Vision

Since 2015, standard modular hydropower (SMH) stakeholder engagement has strategically targeted two-way dialogue with a diverse group of technology innovators. This effort has laid the groundwork for a new technology concept and implementation beyond conventional hydropower projects. Partnerships with the small hydropower industry have been crucial for developing stakeholder-validated design concepts that integrate lower-cost civil works, a new approach for classifying potential sites based on their stream function, and a more standardized and environmentally compatible design methodology.

Outreach activities have facilitated information sharing among the SMH team and key industry partners and initiated collaboration across members with expertise in various components of technology design, operation, and management.

## SMH Partners

Engagement efforts to date have been aimed at technology innovators specializing in water resources, hydraulics/hydrodynamics, electro-mechanical machine design, and project development.

These SMH industry partners are pioneers in the small hydropower community with technologies and project development practices that emphasize collaborative stakeholder engagement, enhanced performance, low cost, and minimal environmental disturbance.

## Collaboration Pathways

SMH collaboration is taking place along multiple pathways to holistically (1) develop modular designs that can be scaled to a site while maintaining existing stream functions, (2) standardize design features to achieve site independence, (3) obtain feasible cost reductions, and (4) enable greater stakeholder acceptance.

Participation with the SMH project will include various pathways that leverage expertise from the small hydropower community and at ORNL. The collaboration pathways include, but are not limited to, the following.

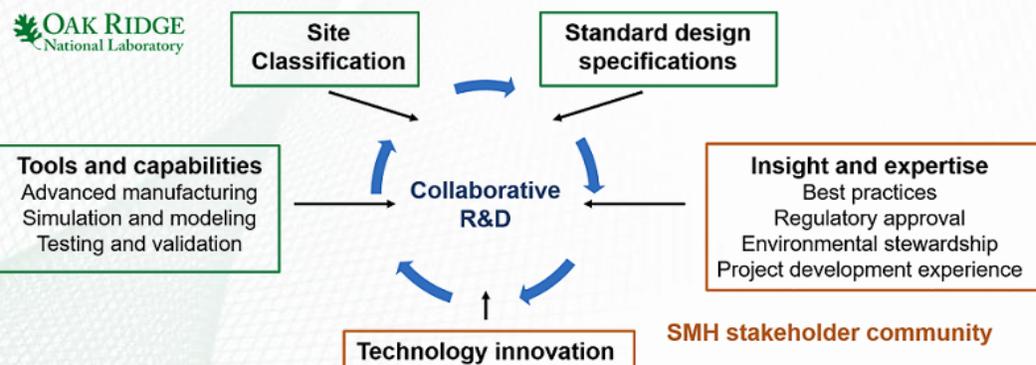
- Funding Opportunity Announcements (FOAs): competitively awarded industry-led projects funded by federal grants
- Nondisclosure Agreements (NDAs) to engage in detailed dialogue about technology challenges and opportunities
- Cooperative Research and Development Agreements (CRADAs): agreements between ORNL and private companies or universities to work together on research and development
- Memoranda of Understanding (MOUs) and Interagency Agreements (IAAs)
- Individual discussion meetings with stakeholders
- Assessment of innovative technologies with advanced modeling and simulation tools
- Joint identification of environmental design criteria

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Process and roles in SMH collaborative research and development

## Connecting with Industry Partners

### Discussions

The ORNL research team conducted individual phone calls with a group of industry partners to discuss the SMH concept, potential challenges, and goals. These interview-style conversations allowed the SMH team to learn about the partners' relevant expertise, perspective, and concerns to further clarify and assess the feasibility of the SMH project goals and research activities.

Prevalent focus areas discussed with partners include the following:

- Validation as a means to achieve broad stakeholder understanding and acceptance
- Streamlining of permitting and regulatory compliance process
- Mitigation of commonly encountered environmental concerns
- Economic feasibility of small hydro projects
- Current use of standardization and modularity
- Benefit of acting as both technology and project developer
- Small hydropower development is not necessarily scalable or transferable
- Need for pre-approved, standardized modules

### Conferences

The SMH research team has participated in multiple industry-related conferences to present SMH concepts and elicit feedback from various subject matter experts. These conferences provide an opportunity to meet one-on-one with industry partners, academics, federal regulatory bodies, and nongovernmental entities that play pivotal roles in small hydropower technology R&D. These conferences include

- HydroVision International
- Upper Mississippi River Conference
- Environmental & Water Resource Institute Congress
- EPRI Generation Program Advisory and Council Meeting
- International Energy Agency Small Hydro Annex

### Website and Email Subscriptions

The SMH website contains relevant information concerning the project approach, research activities, engagement strategy, and publications. The team plans to actively maintain and update the website, using it as a platform for social media and progress updates and as a repository of SMH technology literature.

#### Connect with us

<http://hydropower.ornl.gov/smh>

[hydropower@ornl.gov](mailto:hydropower@ornl.gov)

### Publications/Reports (<http://hydropower.ornl.gov/smh/publications/>)

In addition to conference outreach, the ORNL research team has published reports, peer-reviewed articles, and conference papers. A 2017 HydroVision technical paper and September 2017 Hydro Review article have received notable public recognition concerning how the SMH project is addressing the need for affordable, scalable, and standardized small hydropower technology that minimizes environmental impact. Technical reports that discuss the SMH concept and roadmap for research, development, and demonstration efforts are available on the SMH website. They include

- SMH Multi-Year Research Plan
- SMH Exemplary Design Envelope Specification
- SMH Simulation and Modeling Capability

## Workshop with Stakeholders

### Workshop

In June 2017, ORNL hosted a 2-day workshop that brought together ORNL researchers and five small hydropower technology innovators to candidly discuss SMH concepts and share technology design ideas, needs, and goals related to the SMH project.

The workshop improved understanding of the current small hydropower development landscape; alignment of SMH research activities with small hydropower community needs; and identification of challenges, risks, and opportunities for improvement in the design, assessment, optimization, and deployment of small hydropower. Mutually beneficial collaboration options were identified as next steps for advancing the SMH concept and SMH technologies. The official workshop report can be found at <http://hydropower.ornl.gov/smh/docs/ORNL-2017-SMH-Workshop-Summary-Report.pdf>.

Representatives from Amjet Turbine Systems, Cadens LLC, Littoral Power Systems, Natel Energy, and Rickly Hydrological Company attended the workshop at ORNL.



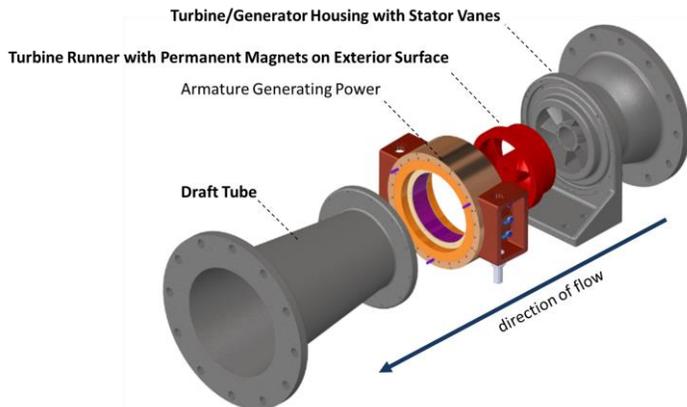
2017 SMH workshop participants

## R&D Advancements

SMH R&D is focused on understanding and overcoming the technical, economic, and environmental challenges to new small hydropower development.

### Additive Manufacturing of Small Turbine-Generators

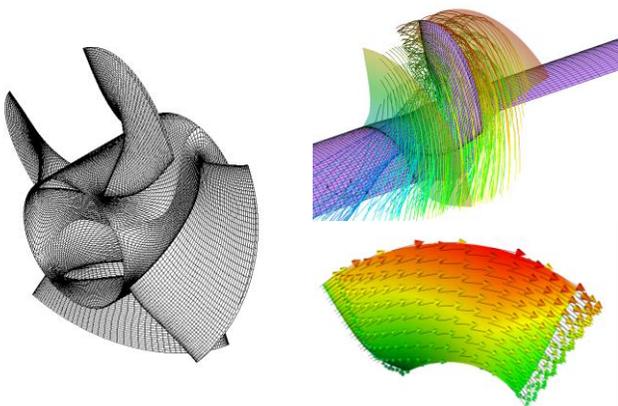
ORNL is partnering with Amjet Turbine Systems LLC to 3D print and test lightweight composite generation modules. This partnership provides access to facilities and expertise that can rapidly advance emerging technologies at cost-competitive rates.



Expanded view of the Amjet Turbine Systems 8-inch-diameter turbine. Additively manufactured (i.e., 3D-printed) components are labeled in bold. For more information, visit <http://www.amjethydro.com/>

### Simulating a Standardized, Modular Design Prototype

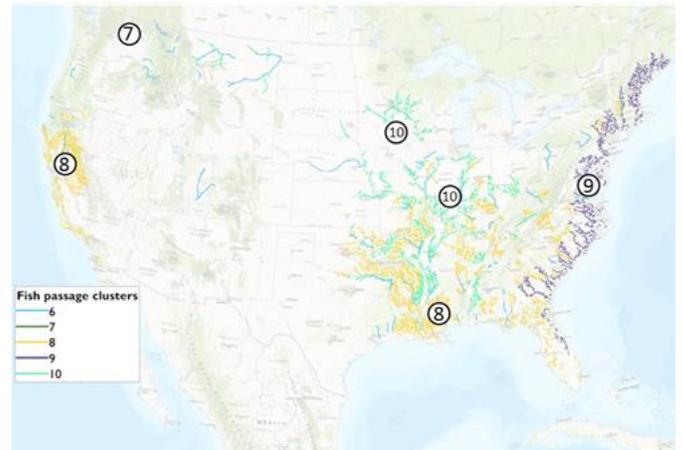
In collaboration with the University of Tennessee–Knoxville, ORNL is using high fidelity hydro-elastic simulations to optimize composite turbine blade design and assess the viability of new materials and coatings. Coupled fluid–structure interaction models will be used to assess trade-offs in strength, efficiency, and cost.



Preliminary model results from a reference turbine (left); streamlines (top right) and flow velocity (bottom right) around the blade are assessed to ensure the blade design is optimized for high efficiency.

## Classifying Our Nation's Stream-reaches

Statistical clustering techniques used to analyze big data reveal similarities in stream-reach characteristics across the country. These similarities are being used to develop standard module design specifications that could be applied at many sites within the same cluster. An example of fish passage site classification is shown below.



Cluster no.	No. of reaches	Defining characteristics	Locale
8	34,836	Low existing passage mitigation, low or absent salmonid presence, eels, high downstream dam count	California and Southeast
9	11,812	Anadromous clupeids, ocean-run sturgeons, eels, high upstream and downstream dam counts	Atlantic coast
10	16,412	Inland sturgeons, low downstream dam count, low existing passage mitigation, low salmonid presence, low anadromous species	Mississippi River valley

### Standardized Assessment of Ecosystem Needs and Infrastructure Tradeoffs

ORNL is working with technical, economic, and environmental subject matter experts to develop a new collaborative framework for innovation in small hydropower environmental design that integrates ecosystem needs into infrastructure design tools.



## Ongoing Outreach and Collaboration

The SMH concept will be successful only through collaborative stakeholder engagement. To learn more and get involved, visit <http://hydropower.ornl.gov/smh> or email [hydropower@ornl.gov](mailto:hydropower@ornl.gov).

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