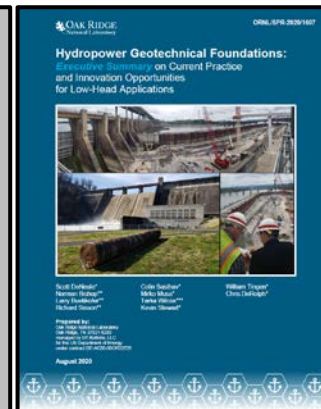
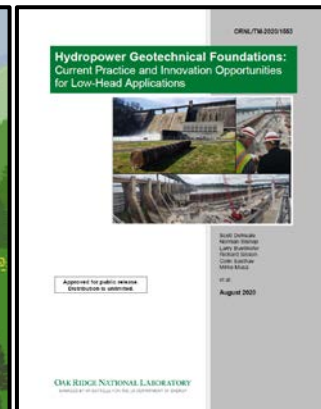
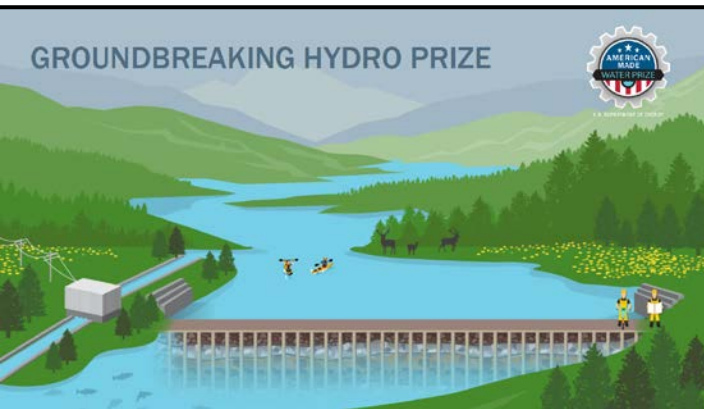
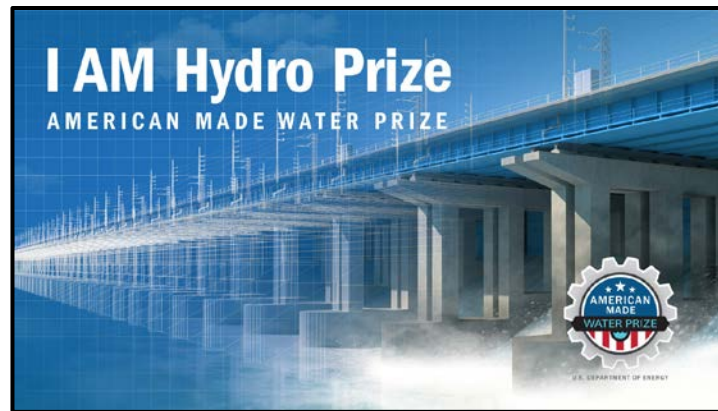


# 1.1.1.401 – Groundbreaking Hydro and I AM Hydro Prizes



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# Project Overview

## Project Summary

- The Hydropower Geotechnical Foundations Prize (Groundbreaking Hydro Prize) offered a total of \$300,000 in cash prizes to elicit and advance innovative concepts for low-head (up to 30 ft of hydraulic head) hydropower geotechnical foundation technologies.
- The Innovations in Advanced Manufacturing for Hydropower (I AM Hydro) Prize sought to identify new ideas with the potential to have a disruptive impact in the hydropower industry and offered up to \$250,000 in cash prizes.

## Intended Outcomes

- The Groundbreaking Hydro Prize intended to receive innovative solutions to reduce cost, time, and risk associated with hydropower foundation development. These results were to be analyzed and further explored by the ORNL hydropower technical team, if sufficient quality applications were received.
- The I AM Hydro Prize intended to receive innovative solutions for employing advanced manufacturing materials, coatings, or processes to reduce the cost for hydropower development. Results from the prize were to be analyzed by ORNL and incorporated into an Advanced Manufacturing Roadmap to inform WPTO activities and investments.

## Project Information

### Principal Investigators

- Katie Jackson, WPTO
- Tessa Greco, NREL
- Scott DeNeale, ORNL

### Project Partners/Subs

- Knight Piesold Consulting (subcontractor)

### Project Status

Sunsetting

### Project Duration

- 2/1/2020
- 9/30/2021

### Total Costed (FY 2019–FY 2021)

\$613,375 (NREL) | \$374,104 (ORNL)

# Project Objectives: Relevance and Approach

## Relevance to Program Goals:

- **Limited opportunities for new, affordable hydropower growth:** *Innovate new technologies for both existing water infrastructure and new stream-reach applications that incorporate ecological and social objectives.*
  - By explicitly seeking concept solutions for cost, time, and risk reduction for low-head, new-stream-reach hydropower foundation development, the Groundbreaking Hydro Prize directly addressed stated intermediate and long-term outcomes noted in the “limited opportunities for new, affordable hydropower growth” challenge.
- **Limited opportunities for new, affordable hydropower growth:** *Leverage new manufacturing and materials to dramatically lower costs of components and systems.*
  - The I AM Hydro prize sought to drive down costs for hydropower, as well as leverage advances in related industries, by crowdsourcing innovative concepts for utilization of advanced manufacturing materials, processes, and coatings.

## Approach:

- A single-stage concept prize was initiated for both the Groundbreaking Hydro and I AM Hydro prizes to encourage broad participation from a range of stakeholders and contributors not already engaged in hydropower. Prizes are an excellent way to leverage funding and historical expertise to procure innovative and entrepreneurial solutions to energy issues.

# Project Outputs and Outcomes

## Outputs:

### Groundbreaking Hydro Prize

- *Geotechnical Foundations for Hydropower* technical report (ORNL)
- *Geotechnical Foundations for Hydropower* executive summary (ORNL)
- Hydropower Foundations Prize rules and requirements document (NREL, ORNL)
- Hydropower Foundations Prize branding and marketing material (NREL)
- Hydropower Foundations Prize website (NREL)
- Winner announcement and cash prize disbursement (NREL).

### I AM Hydro Prize

- I AM Hydro Prize rules and requirements document (NREL, ORNL)
- I AM Hydro Prize branding and marketing material (NREL)
- I AM Hydro Prize website (NREL)
- Winner announcement and cash prize disbursement (NREL).

## Outcomes:

- Both the Groundbreaking Hydro and I AM Hydro prizes received fewer applicants and fewer meritorious solutions than originally hoped for.
- Helpful participation from the hydropower industry was provided when solicited for feedback.
- Innovation in both topic areas is still needed but requires a review of the incentive mechanisms used by WPTO to attract innovation from relevant communities.

### Groundbreaking Hydro:

- 2 winning teams

### I AM Hydro:

- 11 winning teams

# Project Timeline

## FY 2020

*Report on Geotechnical Foundations for Hydropower* (ORNL)  
Groundbreaking Hydro and I AM Hydro Prize rules documents (NREL, ORNL)  
Executive summary for *Geotechnical Foundations for Hydropower* (ORNL)

## FY 2021

Groundbreaking Hydro Prize website – AMC and HeroX (NREL)  
*Advanced Manufacturing Opportunities and Gaps Analysis* report (ORNL)  
Groundbreaking Hydro Workshop (ORNL)  
Hydro Prizes RFI (NREL)

- A Go/No-Go for the Groundbreaking Hydro Prize was originally conceived to perform a post-prize assessment of all submissions to inform a memo documenting the perceived impacts of the prize concepts and recommendations for next steps. This Go/No-Go required at least 20 applications to move forward. Although there were 26 eligible applications, only 7 were considered feasible and interesting. As such, this milestone was not advanced.

# Project Budget

Activity	Original Budget
Prize administration	\$150,000 (Groundbreaking Hydro) \$150,000 (I AM Hydro)
Geotechnical foundations analysis	\$350,000
Advanced manufacturing roadmap	\$350,000
Prize awards	\$500,000 (Groundbreaking Hydro) \$250,000 (I AM Hydro)
<b>Total Budget</b>	<b>\$1,000,000 (Groundbreaking Hydro)</b> <b>\$750,000 (I AM Hydro)</b>

FY 2020	FY 2021	Total Actual Costs FY 2020–FY 2021
Costed	Costed	Total Costed
\$88,105 (NREL) \$258,381 (ORNL)	\$525,270 (NREL) \$115,722 (ORNL)	\$613,375 (NREL) \$374,104 (ORNL)

# Budget Considerations

- Program elements included in costing are:
  - Prize administration
  - Technical contribution and review
  - Subcontract administration and management
  - Cash prize awards
  - Workshop execution
  - RFI development, release, and analysis.
- Both I AM Hydro and Groundbreaking Hydro prizes released less cash awards than originally expected due to a lower-than-expected number of feasible and interesting concepts received. Remaining funds were reorganized to be used for subcontracts for outreach and engagement, as well as RFI and workshop development to better understand the low number of quality applications received.
- Groundbreaking Hydro Prize: \$75,000 from the \$300,000 cash pool was awarded to two winning teams.
- I AM Hydro Prize: \$175,000 of the \$250,000 cash pool was awarded to 11 winning teams.
- An RFI on hydropower prizes, as well as a Groundbreaking Hydro workshop to elicit feedback on the prize and future topics of interest for hydropower geotechnical topics, were held in fall 2021.

# End-User Engagement and Dissemination

The external engagement strategy for Groundbreaking Hydro and I AM Hydro was multipronged, as follows:

- **Strategic Outreach and Promotion Network:** The project team assembled a list of potential targets to inform a strategic outreach and promotion network consisting of experts in hydropower, dam safety, and advanced manufacturing from industry, academia, government, and research institutions. This database was solicited to ensure both prizes reached the maximum potential applicant pool possible.
- **Prize Advertisement:** The hydropower prizes project team engaged with hydropower, advanced manufacturing, and other industry networks, as well as online communities, to maximize the potential applicant pool reach. Outreach organizations were identified and hired to execute outreach to their membership, including direct solicitation, as well as online marketing and advertising.



# End-User Engagement and Dissemination

- Intended beneficiaries of the hydro prizes efforts were:
  - WPTO: Awarded concepts were analyzed and incorporated into summary reports, including:
    - *Advanced Manufacturing Roadmap for Hydropower*
  - Hydropower industry: Results from the hydro prizes were meant to introduce some creativity and new ideas into a well-established industry.
    - In addition, the prizes attracted innovators not already embedded within the hydropower industry.
- The hydro prizes engagement strategy included the identification of relevant industries and audiences that may better inform geotechnical foundation development and the use of advanced manufacturing to improve performance and reduce costs for hydropower facilities.
- Specific associations and membership groups were contacted and solicited during the hydro prizes outreach efforts to ensure the administration team was reaching as diverse an applicant pool as possible. For example, Women in Manufacturing was brought on as a partner for marketing and advertising in the I AM Hydro Prize.
- The Groundbreaking Hydro Prize published a full report and an executive summary on geotechnical foundations for low-head and new-stream-reach hydropower development.
- The I AM Hydro Prize informed an *Advanced Manufacturing for Hydropower Opportunities and Gaps* report being prepared for WPTO. This will inform a roadmap for the opportunity space.

# Performance: Accomplishments and Progress

## Groundbreaking Hydro Prize

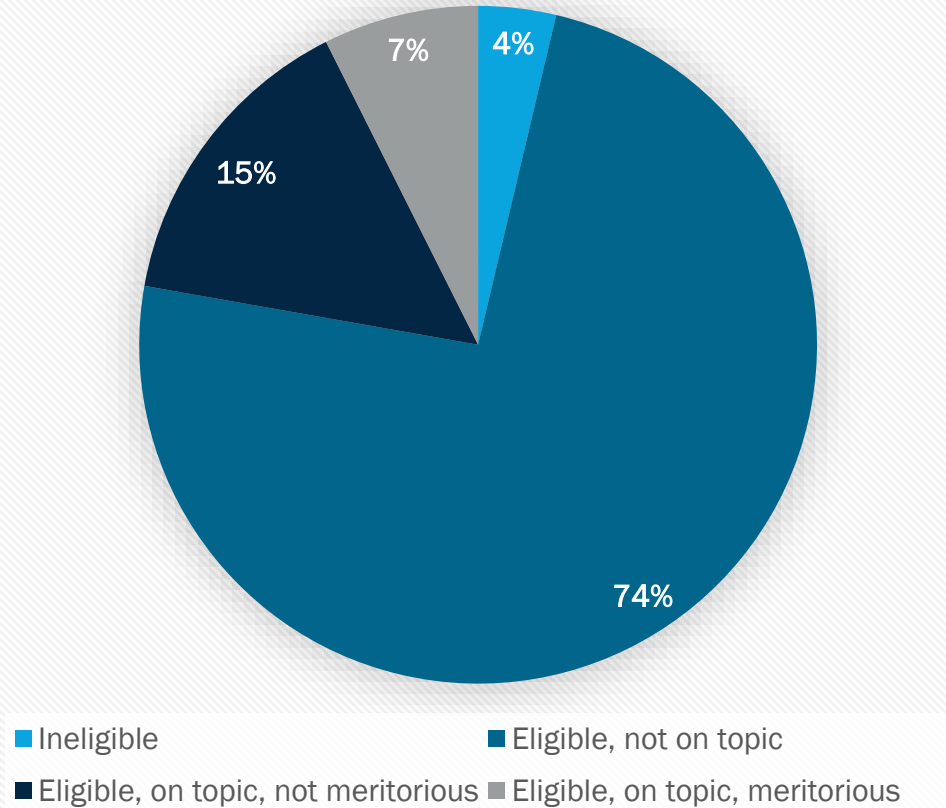
- [Geotechnical Foundations for Hydropower technical report \(ORNL\)](#)
- [Geotechnical Foundations for Hydropower executive summary \(ORNL\)](#)
- [Groundbreaking Hydro Prize rules](#)
- Two winners were selected in April 2021, each receiving a share of the \$75,000 cash prize pool
  - Groundbreaking Prize:
    - Team: GZA GeoEnvironmental Inc and Littoral Power Systems, Terra-Modular Project
    - Concept: Prefabrication of a modular hydropower foundation for a wide range of soils and substructures.
  - Innovator Prize:
    - Team: Team Chemventive, WaterJet Drill with a Deep Array of Anchor Cables Concept
    - Concept: Deep array of high-tension cables drilled through solid rock, using a water-jet drilling robot, to secure a steel dam in tension.

## I AM Hydro Prize

- [I AM Hydro Prize Rules](#)
- Advanced Manufacturing Roadmap (*in progress*)
- Eleven winners were selected in December 2020, each receiving a share of the \$175,000 cash prize pool
  - One Grand Prize winner: Cadens, LLC, *Utility of Large Area AM for Small Hydro*
  - 10 Innovator Prizes
    - Skuld LLC, *Additive Manufacturing Evaporative Casing*
    - AI-Driven Design Optimization of Turbines
    - Interphase Materials, *Anti-Fouling Coating for Hydropower Cost Reduction*
    - Fusion-Free Fabrication, *Augmented Repair via Additive Manufacturing*
    - Composite Magnet for Hydropower Generators
    - Ceramic Rust Universal Sealant Technology
    - Multiscale Systems, *Lowering Costs with Mechanical Metamaterials*
    - RCAM Technologies, *Retrofitting of Non-Powered Dams Using 3-D Concrete Printing*
    - Mazdak International Inc, *Semi-Solid Casting for Hydro-Turbines*
    - *Super-frictionless Surfaces Quasi-R®.*

# Groundbreaking Hydro Concept Breakdown

## Concepts Received



Status	Number of Concepts
Ineligible	1
Eligible, not on topic	20
Eligible, on topic, not meritorious	4
Eligible, on topic, meritorious	2
<b>Total</b>	<b>27</b>

# Groundbreaking Hydro Winners

Team	Entry Title
<b>GZA/LPS (Littoral Power Systems)</b>	Terra-Modular: A prefabricated, modular hydropower foundation for a wide range of soils and subsurfaces
<b>Chemventive</b>	WaterJet Drill with a Deep Array of Anchor Cables

# Groundbreaking Hydro Lessons Learned

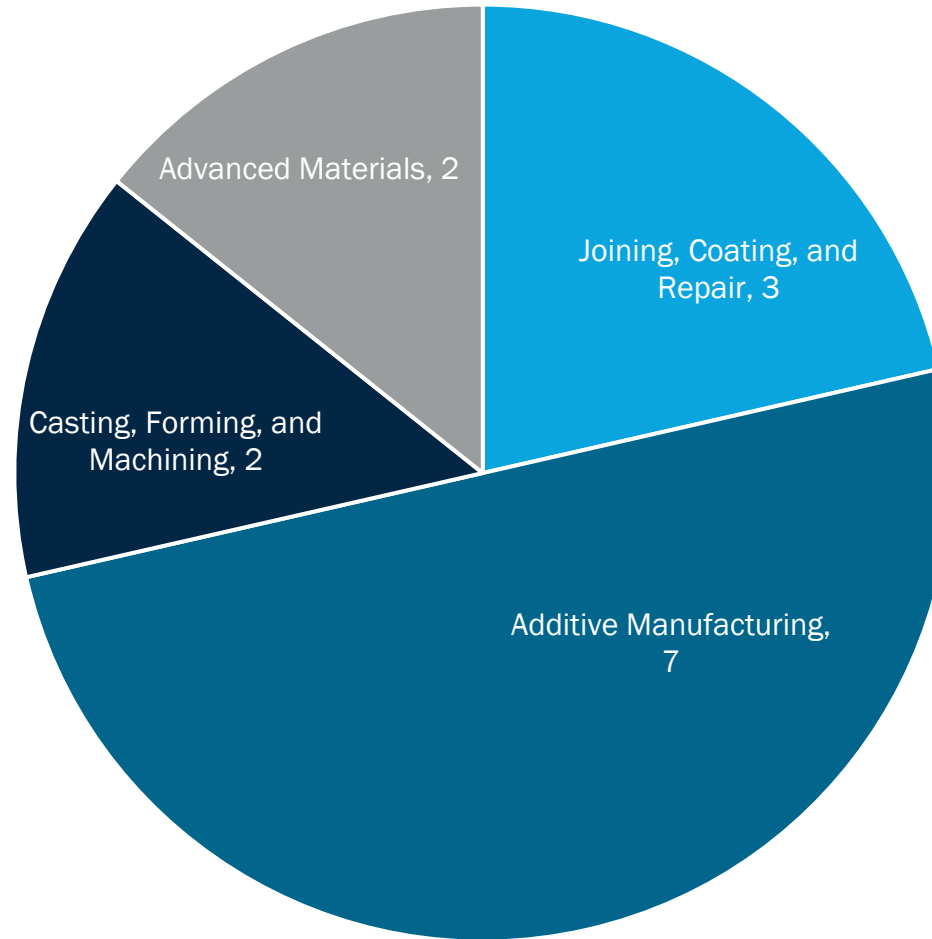
Significant outreach within the hydro community

- Presented at a Northwest Hydropower Association Small Hydro meeting
- Presented at a National Hydropower Association (NHA) Water Innovation Council (WIC) meeting
- Marketed with Hydro Foundation, Hydro Review, Clean Energy Business Network (CEBN), the Centre for Energy Advancement through Technological Innovation (CEATI), NHA, and others.

This prize was very targeted and did not receive quantity or quality of desired solutions, *but the need for innovation is still vital.*

- Feedback from a second WIC call indicated a need for more time/warning to prepare submissions (Note: application period was open for 4 months—typically longer or on par with a Funding Opportunity Announcement).
  - *Unclear whether more time would have improved the results.*
- Larger prize amounts and/or different funding mechanisms may be appropriate when tackling very large design and construction solutions for hydropower.

# I AM Hydro Solution Breakdown



Some solutions applied to multiple opportunity areas

# I AM Hydro Winners

Team	Entry Title
Cadens	Utility of Large Area AM for Small Hydro
Virginia Tech	Augmented Repair via Additive Manufacturing
Interphase Materials	Anti-fouling Coating for Hydropower Cost Reduction
Multiscale Systems	Lowering Costs with Mechanical Metamaterials
MIT Alumni	CRUST - Ceramic Rust Universal Sealant Technology
Skuld LLC	Additive Manufacturing Evaporative Casting (AMEC)
International Business and Technology Service Corporation	Composite Magnet for Hydropower Generators
Chemventive	AI Driven Optimization of Turbine Blades
Mr. Baha Abulnaga	Semi-solid metal casting for Hydro-Turbines
RCAM Technologies	Retrofitting of NPDs Using 3D Concrete Printing
MHI, Inc.	Super-frictionless Surfaces, Quasi-R®

# I AM Hydro Opportunities for Improvement

- **Incentive Structure:** Assess which cash/in-kind award amount is attractive to the hydro community; fewer awards, larger cash value.
- **Outreach:** Outreach should have also included the hydropower base.
- **Messaging:** Create link between advanced manufacturing and hydro; explain how this is one step along the WPTO strategic path for advanced manufacturing and hydro.
- **Applicant Education and Understanding:** We assumed a baseline understanding of hydropower. Informational webinars linking advanced manufacturing and hydro; office hours with hydro experts.
- **Reviewer Score Reconciliation:** Interdisciplinary prizes may see large discrepancies between varying industry experts.



# Hydropower R&D Incentivization Request for Information

A request for information (RFI) from the broader hydropower industry was issued in fall 2021 with the goal of collecting feedback from a variety of stakeholders to ensure that suitable prizes are developed going forward.

The purpose of this RFI was to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on R&D needs that could inform future hydropower prize development.



Water Research • Request for Information: Hydropower Industry Research and Development Incentivization

## Request for Information: Hydropower Industry Research and Development Incentivization

NREL has issued a request for information (RFI) from the broader hydropower industry to work with a variety of stakeholders to ensure that suitable prizes are developed going forward.



Stakeholders will help shape future hydropower prize strategy by providing feedback through the Hydropower Industry Research and Development Incentivization RFI. Photo by Karl Swartz, U.S. Department of Energy

### Purpose

The purpose of this RFI is to solicit feedback from industry, academia, research laboratories, government agencies, and other stakeholders on R&D needs, which could inform future hydropower prize development.

### How To Respond

This RFI is now closed for submissions. All responses were submitted on or before 5 p.m. MT on Dec. 17, 2021.

Read the [Full RFI](#) for details.

### About Hydropower Prizes

The U.S. Department of Energy's Water Power Technologies Office has launched a number of hydropower-focused prizes, including the [FAST Commissioning for Pumped-Storage Hydropower Prize](#), the [Fish Protection Prize](#), the [JAM Hydro Prize](#), and the [Groundbreaking Hydro Prize](#) to encourage the development of new ideas for hydropower and pumped storage hydropower development as well as mitigate the surrounding environmental challenges.

### Questions

# Hydropower R&D Incentivization Request for Information Results

## What do prizes do well?

- Low barrier to entry with easy application
- Communicate to industry and innovators
- Provide access to national lab expertise and facilities
- Operate in a lean, efficient way (compare with FOAs, CRADAs, etc.)
- Signal to innovators the research priorities of DOE.

## Why are responses low?

- Mismatch between prize objective and organization purpose
- Even with a low barrier to entry, a \$25,000 or even \$100,000 prize incentive may not be enough to incentivize participation, especially considering high capital costs needed for engaging in the hydropower industry.
- Some topics are seen as removed from major industry objectives—i.e., supporting innovation in New stream reach (NSD)/Non-powered dams (NPD) related to forthcoming mechanisms such as the Hydropower bipartisan infrastructure law (BIL) provisions: 242/243/247.