

1.4.2.403 – Water Power STEM Workforce Development (Hydro)



THIS PEER REVIEW PRESENTATION WILL FOCUS ON HYDROPOWER ASPECTS OF THIS PROJECT AND COMPLEMENTS A MARINE ENERGY PRESENTATION PRESENTED DURING THE MARINE ENERGY PEER REVIEW

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Project Overview

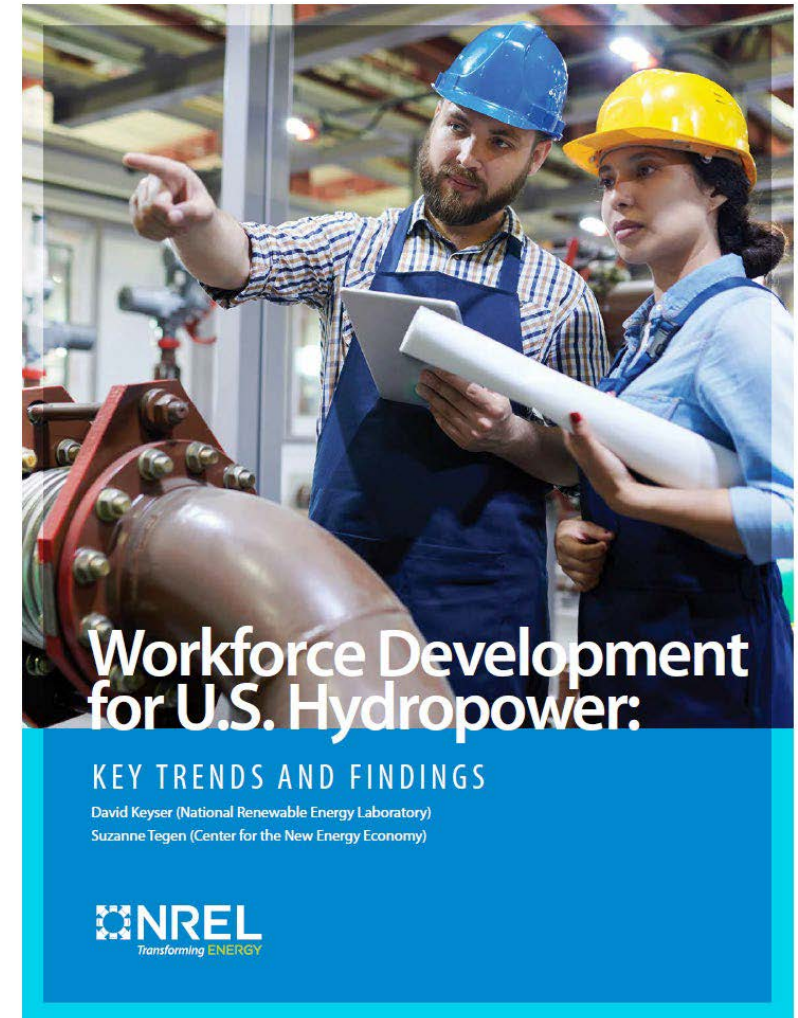
| Project Summary | Project Information |
|--|---|
| <ul style="list-style-type: none">As interest in renewable energy grows, hydropower technologies will continue to play a robust and growing role in reaching our nation’s clean energy objectives. With one-quarter of the domestic hydropower workforce retiring in the coming decade, the need to fill the workforce pipeline has never been more critical. The industry needs new talent to spur innovation and to support industry needs.WPTO efforts to address these needs include more programs, improved program accessibility, and an increased awareness of hydropower as a renewable energy career (secondary school, vocational and apprenticeship programs, and undergraduate curricula). <u>There is much more work to be done.</u> | Principal Investigator(s) |
| | <ul style="list-style-type: none">Elise DeGeorge (hydropower focus) and Arielle Cardinal (marine energy focus) |
| | Project Partners/Subs |
| | <ul style="list-style-type: none">See Next Slide |
| Intended Outcomes | Project Status |
| | <ul style="list-style-type: none">Ongoing |
| <ul style="list-style-type: none">An increased water power workforce pool that is competitive in the global marketplace and that incorporates multiple disciplines into strong diverse teams.Although not expected immediately, an increased number of new students and new hires (potentially moving from other sectors) employed in the hydropower industry.This project covers the breadth of the water power educational infrastructure, including hands-on activities, curricula development, engagement of industry and academia, networking, matchmaking, and more. | Project Duration |
| | <ul style="list-style-type: none">October 2018Project End Date tbd <p>Total Costed (FY19–FY21)</p> <p>\$2.8M (both marine energy and hydropower) \$698K for hydropower</p> |

Water Power STEM Team

| Name | Organization | Expertise |
|---|-------------------------------------|--|
| Core Team and Subject Matter Experts | NREL | A strong core team leads distinct project aspects and a team of technical staff supports Water STEM by providing hydropower and marine energy specialized expertise where needed for content development and review. |
| Bree Mendlin/Linda Ciocci | Hydropower Foundation | Supports assessment of available content and information needs, helps facilitate Dialogue Series, and supports development of materials and/or curricula. |
| Rebecca Lamb/Mary Spruil | The NEED Project | National Energy Education Development (NEED) helps with materials development focused on secondary students and the general public and bringing the materials to classrooms. |
| Mike Arquin | KidWind | KidWind supports material dissemination and teach-the-teacher efforts. |
| Jules Smoke and Team | IKM Testing | IKM develops interactive digital renewable energy island display. |
| Katie Cubina and Laura Batt | Mystic Aquarium | Mystic Aquarium enhances museum displays and conduct community immersion activities through its Energy Engineers Program. |
| Parker Mullins, Chaun McQueen | Bonneville Environmental Foundation | Bonneville Environmental Foundation (BEF) augments STEM content dissemination and localizes messaging in both directions as the program's first Clean Energy Talent Hub. |

Project Objectives: Relevance

- To meet the workforce development challenge identified in WPTO's MYPP's Activity 5 – Data Access, Analytics and Workforce Development and the subsequent action to “support development of new educational resources where gaps currently exist, including curricula and training, to support an evolving hydropower workforce and increase awareness of hydropower opportunities,” this project uses a multifaceted approach to knowledge transfer to address challenges described here and on the following page.
- Hydropower jobs—especially jobs operating and maintaining hydropower facilities—are typically in rural areas that lack economic development or private investment.
- The jobs provided by hydropower are critical to these communities. A trend in hydropower, as in other rural power plant jobs, is for multiple generations within families to work in the industry.



This report can be found at
<https://www.nrel.gov/docs/fy19osti/74313.pdf>.

Project Objectives: Relevance

- Hydropower has an aging workforce - about one-quarter of the current workforce is already eligible for retirement or will be within the next decade.
 - Even without a growth in the overall number of hydropower jobs, a retiring workforce will drive hiring needs. We're already seeing these workforce challenges manifest in industry.
- Recruiting is challenged by the lack of hydropower-focused degree programs or training programs (see excerpt on curricula assessment, top right).
- While the need to replace at least a quarter of the workforce poses a huge challenge, it also presents a great opportunity to attract new and diverse talent—and help ensure the hydropower industry looks more like America as a whole.
- Rebranding hydropower will showcase the innovation and impact that working in this sector can provide.

HYDROPOWER

CURRICULA ASSESSMENT



PURPOSE

Develop an understanding of existing educational programs and curricula available for hydropower at U.S. postsecondary schools to support workforce growth, attract students to work in this sector, support industry needs, and spur innovation.

Hydropower includes in-conduit, run-of-river dams, run-of-river bypass, non-powered dams, storage and release, and pumped storage.

APPROACH

Contacted 105 individuals representing 66 U.S. schools engaged in hydropower – including universities and community colleges.

Schools were asked to discuss current course programming, research, and partnerships.

Received 28 responses from 26 schools

FINDINGS

- 18 schools do not offer degree programs focused on hydropower, 5 offer it as a specialization.
- Only 2 schools have dedicated hydropower courses. 6 schools have no courses relevant to hydropower.
- 19 schools cover hydropower as a topic within other energy courses.
- 13 schools include practical applications of hydropower in their courses. 9 schools partner with power utilities.
- 9 schools want to grow their hydropower programs. 6 schools lack the funding.
- Schools see growing demand from employers for students with hydropower education.
- Students are interested in renewable energy, generating student awareness and interest in hydropower is a challenge.

RECOMMENDATIONS

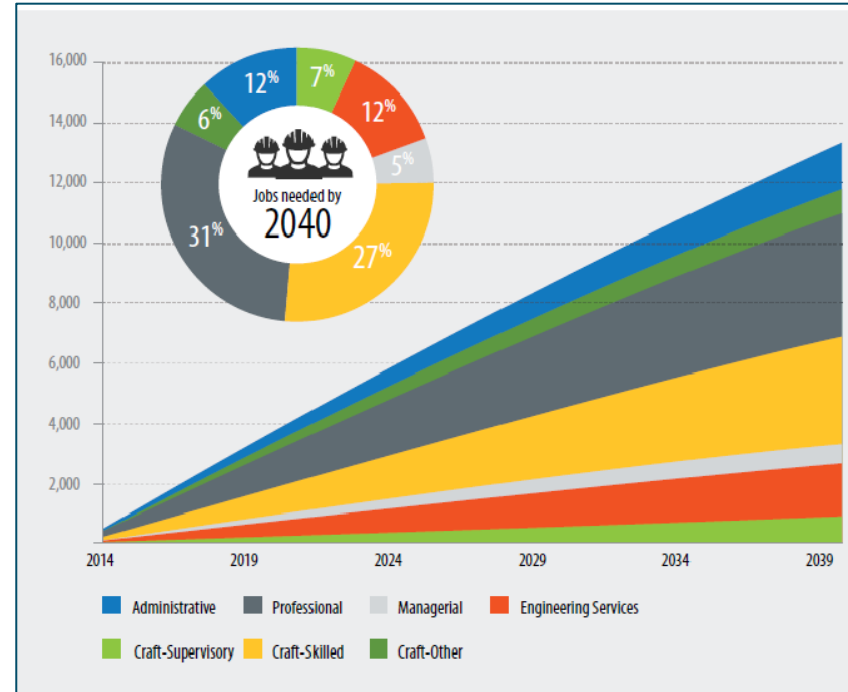


Survey students to understand perceptions of the hydropower industry and information needs to improve awareness and interest as a career.

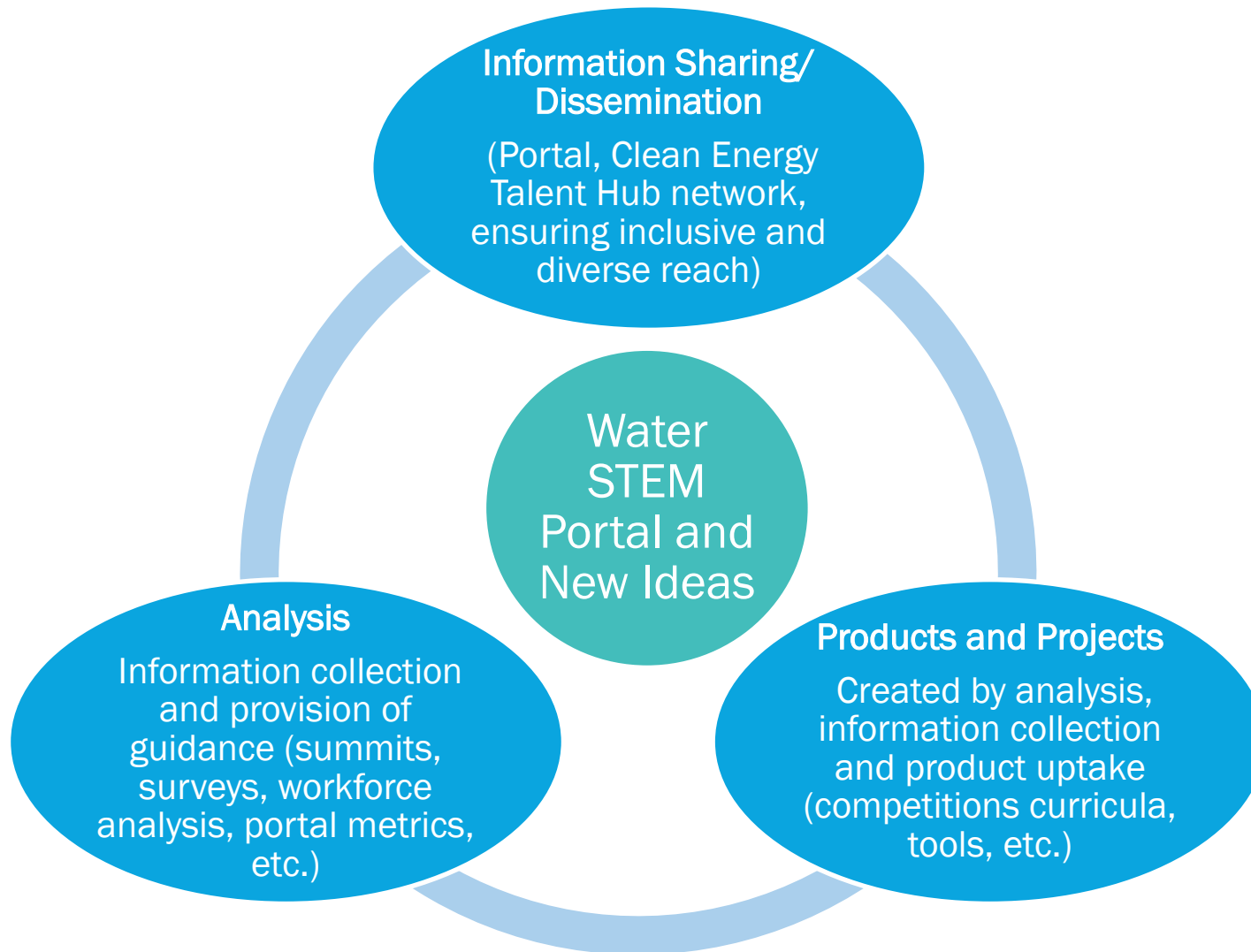
Develop a resource hub to raise awareness of students and educators on hydropower through educational materials, access to hydropower professionals, current events, news, research and jobs.

Assess hydropower industry job readiness, additional training needs, program improvements at educational institutions, and hiring challenges.

Establish online certificate program for hydropower to meet growing industry needs while making curricula available to all interested students and educators.



Project Objectives: Three-Pronged Approach



Fundamentally, NREL's water power team uses the power of leveraging across multiple organizations (NEED curricula, KidWind, Energy Engineers, BEF, etc.) and other funded initiatives to ensure the broadest possible impact within the available WPTO budget.

Project Objectives: Expected Outputs and Intended Outcomes

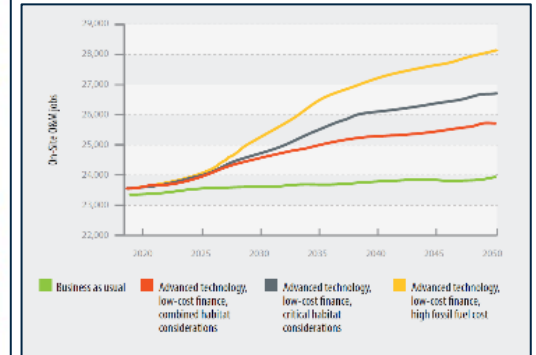
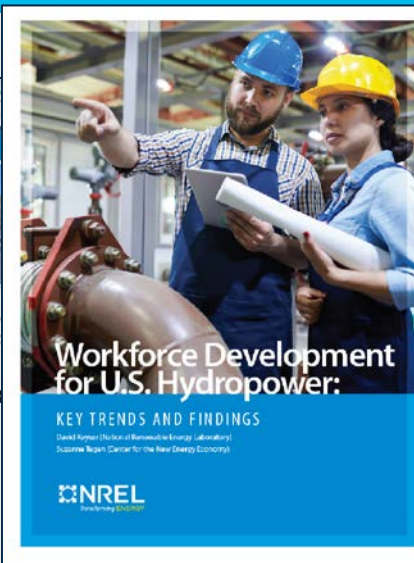
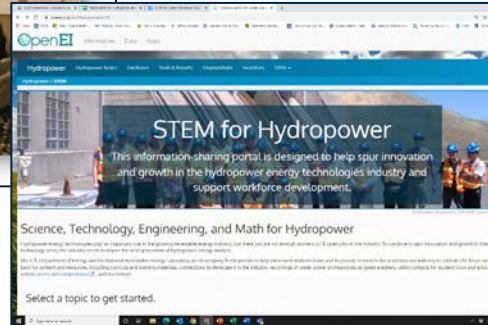
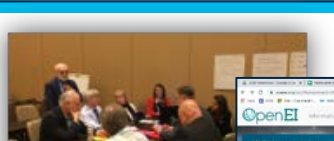
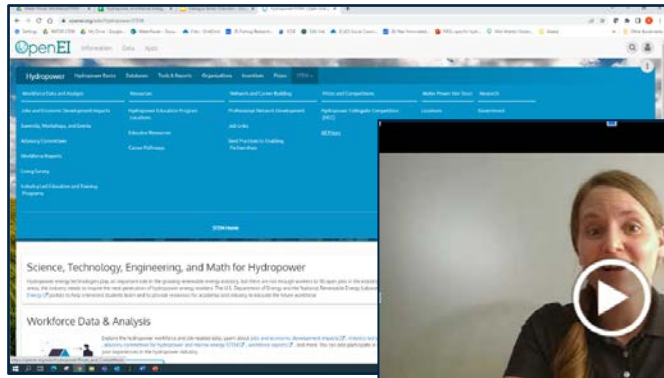
Outputs:

- Updates to hydropower Jobs and Economic Development Impact (JEDI) model and workforce analysis reports and dissemination of information collection mechanisms.
- Development, updates, and dissemination of STEM materials on the [STEM for Hydropower Portal](#).
- Development of initial career competency maps.
- Development of materials that provide expanded details on hydropower workforce opportunities.
- Development of [Hydropower Collegiate Competition](#) (HCC) in partnership with industry.
- Continuation of dialogue “events” to occur quarterly either in person at industry conferences or virtual.
- Development of a Clean Energy Technology hub-and-spoke concept.
- Launch of Energy Equity program for water power education in after-school programs in disadvantaged communities across the nation.
- Development of interactive 3D island animation, Day-in-the-Life videos, curricula, teach-the-teacher programs and more sharing information and workforce opportunities.

Outcomes:

- A growing hydropower workforce that is competitive in the global marketplace and that incorporates multiple disciplines and has a diverse makeup.
- Increased number of new students and new hires employed in the hydropower industry.
- Utilization of hands-on activities, curricula, industry and academia engagement in STEM activities, and inclusion of hydropower in renewable energy STEM activities where it is currently not represented.
- Hydropower perceived as a game-changer in getting the nation to 100% clean energy.

Sampling of Products and Reach



Exploring Hydroelectricity Teacher Guide

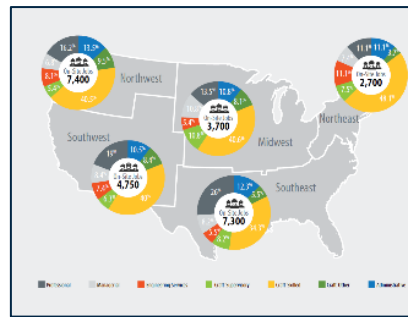
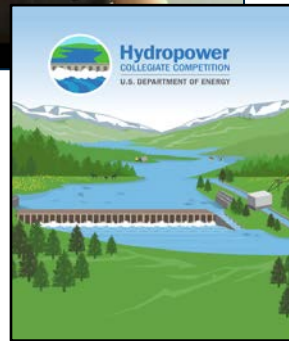
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Exploring Hydroelectricity Kit

- 30 Student Guides
- 34 4 oz Rectangular Bags
- 6 12" x 14" Wooden Boards
- 24 Rubber stoppers with 1/4" holes
- 24 1" Disc magnets
- 4 Cardboard tubes
- 1 Foam tube
- 3 Bundles of wooden spools
- 1 Roll of double-sided tape
- 3.5 Gallon reservoir canister
- 3 Dispensers with screw caps
- 3 3 ft Lengths of tubing
- 3 Funnels
- 3 Sets of alligator clips
- 2 Multimeters
- 2 Large spools of magnet wire
- 9 Melton CD Discs/blank 4 assembly
- 6 6-volt Battery
- 3 Compresses
- 3 Sets of alligator clips
- 3 Large nails
- 1 Pack mini LED bulbs
- 3 6-volt battery clips

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HYDROPOWER CURRICULA ASSESSMENT

PURPOSE: Determine effectiveness of existing educational programs and curricula available for hydropower at U.S. secondary schools to support workforce needs, which include: increased energy literacy, workforce development, and workforce pipeline.

APPROACH:

- Involved 200 individuals representing 28 U.S. states engaged in 12-hour webinars, interviews, and site visits.
- Conducted 100+ interviews with subject matter experts.
- Conducted 100+ interviews with subject matter experts.
- Conducted 100+ interviews with subject matter experts.

FINDINGS:

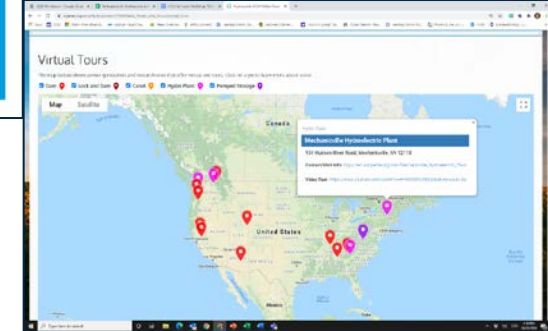
- Hydropower is not often taught in secondary schools.
- Hydropower is often taught in secondary schools.
- Hydropower is often taught in secondary schools.

Hydropower Education Program Locations

The map below shows locations of education programs related to hydropower. Click on a pin to learn more about a program location. Narrow your search by selecting an education program category.

High School
 College
 Graduate School
 Industry-Lead Program
 Vocational School
 Research Program
 Show Only Virtual Learning

M.S. | Environmental Engineering (online and on-campus program)
 Worcester Polytechnic Institute
 100 Institute Road, Worcester, MA 01009 USA



Hydropower STEM/Workforce Timeline

FY 2019

- Received initial project funding and began scoping with WPTO
- Launched water power workforce assessment, in partnership with the Hydro Foundation, through research, interviews, and surveys
- Completed initial assessment of curricula and provided recommendations to HQ
- Held stakeholder workforce/STEM information-gathering workshop at Water Power Week
- Published the [Hydropower Workforce Analysis Report](#)

FY 2020

- Received approval on 5-year roadmap and formalized partnerships with NOSB, KidWind, Oceans First Institute, and NEED to achieve project goals
- Launched the OpenEI STEM portals
- Shared student survey results with DOE and stakeholders
- Launched [Best Practices to Enabling Partnerships](#).

FY 2021

- Launched bimonthly Hydro and ME Dialogue Series w/ 30+ attendees
- Launched JEDI and workforce reports pages on STEM portal, populated maps
- Finalized storyboard with IKM on island animation
- Added hydro education program locations and educator resources on portal
- Established HCC Steering Committee (Hydro Foundation, National Hydropower Association [NHA], industry partners)
- Completed industry survey analysis and disseminated results
- Finalized memorandum of understanding with BEF to serve as the first Clean Energy Talent Development Hub
- Hired intern to focus on expanding DEIB into the water STEM project
- Collaborated with the [NEED Project](#) to create a [hydropower curriculum](#) for primary, elementary, intermediate, and secondary students
- Published NHA Powerhouse articles: [Attracting the Next Workforce Generation](#) and [Expanding the Hydro Workforce One Click at a Time](#)
- [Completed 2 hydropower Day-in-the-Life videos and posted to web portal](#)
- Evaluated HCC survey and dialogue series feedback and submitted Go/No Go to DOE. Received approval to proceed with inaugural HCC.

Project Budget

| FY19 | FY20 | FY21 | Total Actual Costs FY19–FY21 |
|--------------------|--------------------|--------------------|---------------------------------|
| Costed | Costed | Costed | Total Costed |
| \$574K | \$953K | \$1,266K | \$2,793K |
| Hydro only: \$143K | Hydro only: \$238K | Hydro only: \$317K | Hydro only: \$698K |

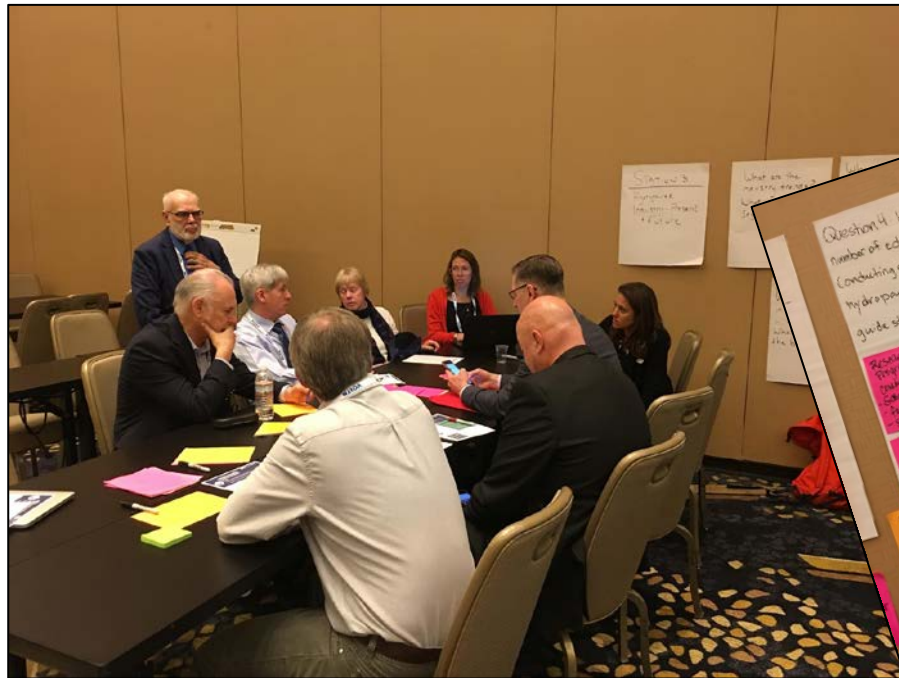
- There have been no variances against planned budget.
- Important to note that this budget covers both marine energy and hydropower activities – this presentation only covers hydropower activities.

End-User Engagement and Dissemination

- Engagement began with advisory committees and morphed into monthly dialogues toggling between marine energy and hydropower.
- Products and approaches, such as REDi Island and our new Hydropower Collegiate Competition are continually grounded in dialogues such as these, survey results, and portal activity.

Overview:

- “Workforce Development for U.S. Hydropower: Key Trends & Findings” report understanding the knowledge, skills, and abilities required to perform essential job functions, JEDI (Jobs and Economic Development Impact Model)
- Competency mapping of STEM skills, Day in the Life Professional Profiles, opportunity for collaboration with universities and technical schools to encourage a more diverse workforce



Question 4: How do we increase the number of educators who are teaching, conducting research, and promoting hydropower as a career path and ultimately guide students to work in the field?

1 Day Seminar
Find out about opportunity

Recruit more faculty
Develop more faculty
Scholarship
Guest professor
Sabbaticals

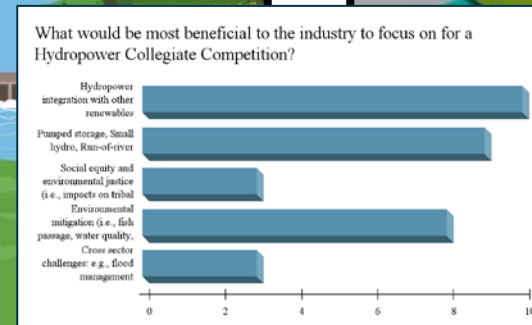
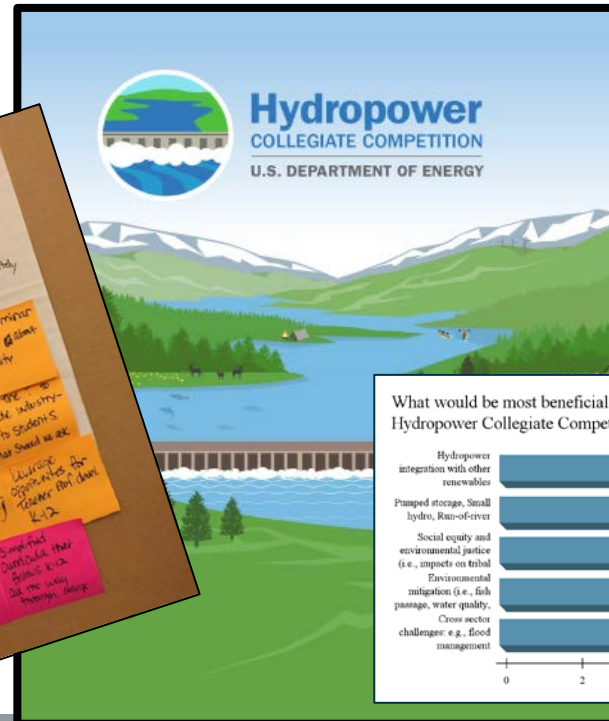
LIST SERVS
Create role exposure or internships

Reach out to trade schools etc

Funding
Leverage opportunities for greater participation

Innovate hands on competition

Support students that pursue this as the only pathway, degree



Sampling of Water STEM Products Tailored to Different Audiences

| Mechanism | Target Audiences | Partners | Reach/ Impact |
|---|---|--|---|
| Online STEM Portals for Hydropower and Marine Energy | <ul style="list-style-type: none"> • K-12 students and educators • Post-secondary students/educators | <ul style="list-style-type: none"> • All Water STEM project partners, primarily Hydro Foundation, and interviewees for Day-in-the-Life videos | Many |
| REDi Island – a 3D Experience | <ul style="list-style-type: none"> • All ages – Middle/High School, College, Trades, General Public, more | <ul style="list-style-type: none"> • IKM and pull from national laboratory subject experts | Will be broad and deep |
| Clean Energy Talent Hub (CETH) Model including the Clean Energy Fellows Program | <ul style="list-style-type: none"> • Recent graduates (Bachelor’s, Master’s, and Doctoral graduates) • Early-career energy professionals • Tribal members | <ul style="list-style-type: none"> • Bonneville Environmental Foundation | CETH – broad and deep |
| Curricula, Teach-the-Teacher Training and Student Competitions | <ul style="list-style-type: none"> • Middle school/high school students • Student families • Industry judges and volunteers | <ul style="list-style-type: none"> • NEED • KidWind | Very broad and deep |
| Hydropower and Marine Energy Collegiate Competitions | <ul style="list-style-type: none"> • Undergrad and graduate students • Community college/trade school students • Professors and faculty • Industry employers and supporters | <ul style="list-style-type: none"> • Hydro Foundation • NHA • Industry | Hundreds of students/professors across many disciplines/employers |
| Energy Engineers After-School Program | <ul style="list-style-type: none"> • Middle school/high school students in disadvantaged communities | <ul style="list-style-type: none"> • Mystic Aquarium | Thousands of disadvantaged students/families |

FY22 Events to Support End-User Engagement and Dissemination

| Dialogue Workshop Session | FY funded | Date | Venue | Location | Description/Objective |
|--|-----------|------------------|---|---------------|---|
| Think Tank and associated workshop | FY22 | Oct. 20, 2021 | Clean Currents | Atlanta, GA | Hosted workshop alongside the Hydro Foundation's Think Tank Competition |
| Teach-the-teacher training | FY22 | Oct. 20, 2021 | Clean Currents | Atlanta, GA | NEED held teacher workshop and tour |
| Clean Energy Education & Workforce Alliance Workshop | FY22 | Feb. 10, 2022 | CEEWA | Virtual | Increase visibility and inclusion of water power in the renewable energy STEM and Career Technical Education (CTE) national network and discussions among partners nationwide |
| No workshop - see notes | FY22 | Feb. 23–25, 2022 | Northwest Hydroelectric Association (NWhA) Annual Meeting | Portland, OR | Amplified activities at a BEF-hosted booth |
| No workshop - see notes | FY22 | April 5–7, 2022 | Water Power Week | Washington DC | Sharing Water STEM collateral and promoting HCC and MECC |
| HCC Informational Webinar | FY22 | April 13, 2022 | Virtual | Virtual | Promote HCC and provide application and competition information to prospective teams |

Performance: Accomplishments and Progress

- The most important technical accomplishment achieved over the life of the project has been the portal - the main repository of the DOE WPTO investment in hydropower workforce and STEM. This portal is designed to help spur innovation and growth in the hydropower energy technologies industry and support workforce development.

Metrics:

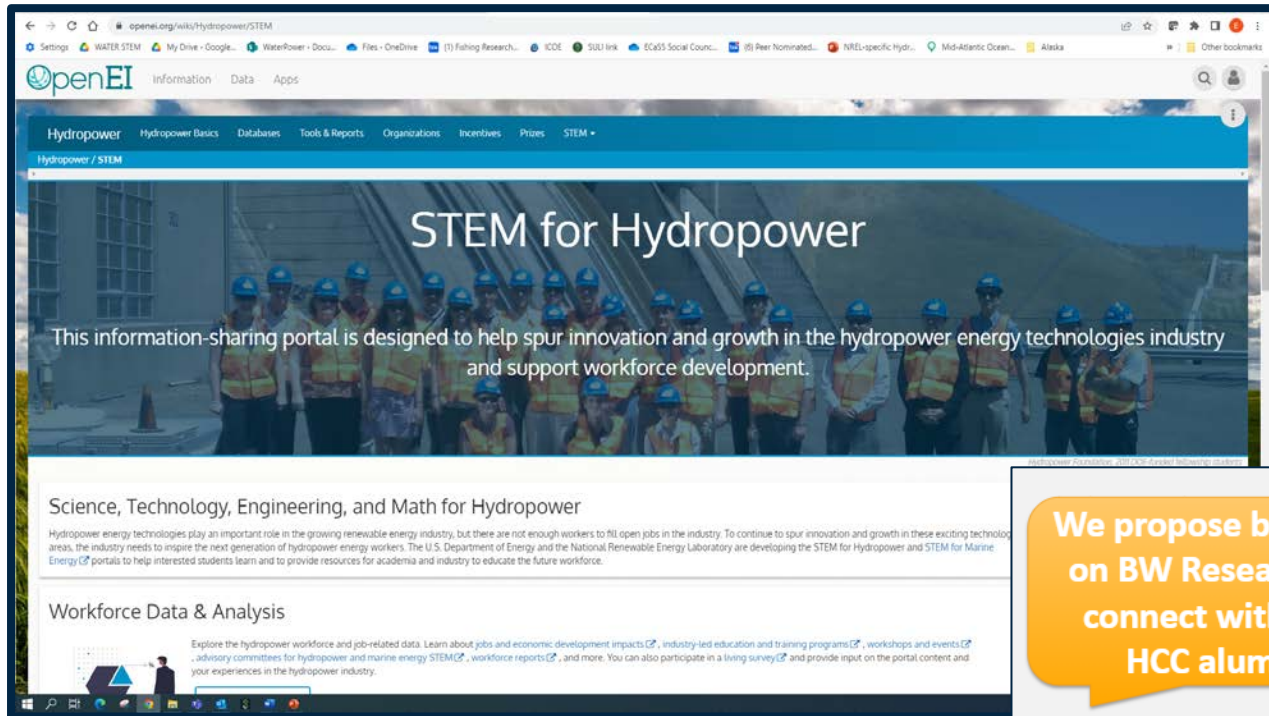
- OpenEI metrics for portal use being tracked.
- HCC metrics just beginning! 11 teams first year out! Developed with a 9-member industry advisory group
- Launching partnership with BW Research to support overarching project impact metric collection in FY22

Lifetime Stats
Since 01/01/2019

Pageviews
56,951

Users
18,620

New Users
16,916



We propose bringing on BW Research to connect with our HCC alumni

BW Research will send an online survey to students and recent graduates who participated in HCC:

- BW will handle student data and contact students
- NREL has partnered with this applied research firm for prior workforce analysis
- Students will receive an incentive for participation
- Online survey around 10-15 minutes

Future Work

- Complete career maps for both hydropower and marine energy including craft and trades with stakeholder input.
- Continue the quarterly engagements with stakeholders.
- **Continual focus on the portal as the core of the water power STEM program.**
- Enhance engagement with underrepresented communities (including rural communities, minorities, and veterans) and other stakeholders who may not traditionally see or be aware of water power as a viable career opportunity. This could be through expansion of CETH and/or development/expansion of a hydropower certification program or similar.
- Will expand upon DEI efforts with the help of summer internships.
- Complete second iteration of hydropower workforce plan along with updated Jobs and Economic Impact (JEDI) assessment.
- Complete a proposed plan for the continuance of Water Power STEM activities for FY24 through FY26 including assessment of certification program and growth of the CETH network including development of preplanning decision documents to determine applicability of certification program and CETH expansion concepts.
- Host inaugural Hydropower Collegiate Competition in May 2023. Lessons learned will be evaluated.
- Will formalize metrics tracking program in FY22 with BW Research and align with metrics tracking from project partners.