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2017 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
WATER POWER TECHNOLOGIES OFFICE

Summary Report
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VOLUME II

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Volume II: Complete Evaluation Results and Appendices

This report details the results of the 2017 Peer Review for the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy's Water Power Technologies Office (WPTO). The purpose of the review was to evaluate projects funded by DOE from fiscal year 2014 through fiscal year 2016 for their contribution to the mission and goals of the office, assess progress against stated objectives, and appraise WPTO's overall management and performance.

This volume (Volume II) includes Sections 6 and 7—the complete program-level and project-level evaluation results—as well as the report appendices. Volume I includes Sections 1–5 of the report: the executive summary, synopses of the program- and project-level evaluation results, and WPTO's response to the 2017 Peer Review findings.

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6 Complete Program Evaluation Results

6.1 Overview

As discussed in Volume I, Section 3, the 2017 WPTO Peer Review included a quantitative and qualitative analysis of the program. Reviewers scored the operations of each WPTO program based on four metrics:

1. Program Objectives: How well do Program objectives align with industry needs and (Presidential) Administration Goals?
2. Research and Development (R&D) Portfolio: Is the Water Program investment portfolio appropriately balanced across research areas and recipient organizations to achieve the program's mission and goals?
3. Management and Operations: What is the quality of the WPTO's team, management practices, and operations?
4. Communications and Outreach: How effective is the Program at engaging with industry, universities, other agencies, international actors, and other stakeholders?

Reviewers were also asked to comment on the strengths and weakness of each track, and to provide written recommendations for maintaining and improving WPTO activities.

Each criterion was scored as a stand-alone metric. Numerical scores were based on a five-point scale, with qualitative descriptors given for the numerical scoring index (i.e. a score of 1 corresponds to a "Poor" rating, 2 to a "Fair" rating, 3 to an "Average" rating, 4 to a "Good" rating, and 5 to an "Outstanding" rating).

Table 6-1 highlights average quantitative scores from the reviewers' evaluations of each WPTO track. Sections 6.2 and 6.3 provide the full body of qualitative comments from reviewers for each track.

Table 6-1. Average reviewer scores for program-level evaluation metrics

Hydropower					
	Program Objectives	R&D Portfolio	Management & Operations	Communications & Outreach	Avg. for All Metrics
Reviewer 1	5.0	5.0	4.0	3.0	4.3
Reviewer 2	4.5	4.0	4.5	3.5	4.1
Reviewer 3	4.5	3.0	5.0	4.0	4.1
Reviewer 4	4.0	4.0	3.0	5.0	4.0
Reviewer 5	4.0	3.0	5.0	4.0	4.0
Reviewer 6	4.0	3.5	4.8	3.5	4.0
Reviewer 7	4.0	3.5	3.8	4.0	3.8
Reviewer 8	3.0	4.0	3.0	4.0	3.5
Averages	**4.1**	**3.8**	**4.1**	**3.9**	**4.0**

Marine and Hydrokinetics					
	Program Objectives	R&D Portfolio	Management & Operations	Communications & Outreach	Avg. for All Metrics
Reviewer 9	4.5	4.5	5.0	4.5	4.6
Reviewer 10	4.0	4.0	5.0	4.0	4.3
Reviewer 11	4.0	4.0	5.0	4.0	4.3
Reviewer 12	4.5	3.5	4.5	4.0	4.1
Reviewer 13	4.0	3.5	5.0	4.0	4.1
Reviewer 14	4.0	2.0	5.0	5.0	4.0
Reviewer 15	3.8	3.7	3.7	3.8	3.8
Reviewer 16	5.0	2.0	4.0	3.0	3.5
Averages	**4.2**	**3.4**	**4.7**	**4.0**	**4.1**

6.2 Hydropower Track Comments

Table 6-2 provides the full body of verbatim comments as provided by the Hydropower reviewers at the 2017 WPTO Peer Review. Comments have been edited to clarify spelling, typographical errors, and acronym usage *only*; no content has been altered from the original submissions.

Table 6-2. All reviewer comments by metric for the Hydropower track

Program Objectives
• Based upon presentations provided in the waterpower segment over the past week, I believe that the DOE program is more than adequately addressing the issues related to hydropower as addressed in the Hydrovision report. I am particularly encouraged at the focus of projects related to the development of the hydropower potential at existing dams. In particular there appears to be a focus on projects that can be employed at small low head facilities which minimize civil costs. I believe that this is a worthwhile avenue of research and development and should be continued. • I feel the program objectives are well aligned with the industry need and goals

- We could use more focus on optimization of the regulatory processes
- Many of the presentations are directed towards improvement of technology costs and performance, although I do think that technology costs can be addressed more efficiently and that some of the programs should not be receiving DOE support
- The hydropower industry can be sustainable, but some of this relates to regulations and economics, which is outside of DOE's responsibility
- An objective of the hydro group is to optimize the regulatory process although DOE is not a regulatory body. The support of the FERC (Federal Energy Regulatory Commission) / USCOE (Army Corps of Engineers) cooperation and MOU (Memorandum of Understanding) is good, but not sure this should be led by DOE.
- The enhancement of review and market strategies is very good but also goes well beyond DOE
- I was pleased to see the number of projects and fiscal resources invested in novel hydropower machines and ancillary equipment. Several of these proposed concepts have a high potential of positively impacting the largely undeveloped small to medium run-of-river sites.
- Overall, I was very impressed by the depth, breadth, and overall quality of the projects. Quite honestly, I thought there would be more projects that fell short of their intended goals. The projects seem to be on track and making a positive impact to DOE's Hydropower program as follows:
  - Improve Technology Costs and Performance (5/5): I was pleased to see the number of projects and fiscal resources invested in novel hydropower machines and ancillary equipment. Several of these proposed concepts have a high potential of positively impacting the largely undeveloped small to medium run-of-river sites.
  - Develop Environmentally Sustainable Hydropower (5/5): I was impressed with the projects underway related to fish friendly turbine, laboratory/field testing and instrument development. In particular, the work at PNNL is quite impressive.
  - Optimize Regulatory Processes (4/5): Although the projects in this area appeared to benefit the industry, I was left with a sense that more, perhaps much more, could be done to optimize the regulatory process. There are still too many projects that do not proceed because of the excessive time/cost required to complete the licensing process.
  - Enhance Revenue and Market Structures (3/5): Generally good interaction with industry but should be much more. Not enough emphasis on taking developments through to market-competitive manufactured cost. I think that there is inconsistent use of LCOE (levelized cost of energy), with new products not really having a good feel for O&M (operations and maintenance) costs. Too many companies just say 7-cent LCOE without proof.
- Lack of project management measures led to insufficient handle on performance of national laboratory projects.
- Too often, the research labs appeared to be pursuing their own ideas rather than ensuring that the projects were market- or end-user driven.
- Good emphasis on fish-friendly devices but almost total lack of projects acknowledging the role that FERC and resource agencies, including states, in allowing solutions to be implemented. The sustainability side of the program needs to continue to strengthen.
- Weak focus on FERC and resources agencies. I question whether there is sufficient coordination between FERC process improvement measures and EERE's own efforts. Not apparent in presentations.
- Very little focus on project returns (ROI/IRR [return on investment/internal rate of return]) all research projects must at some point early in their lifecycles run these tests. Who is going to invest in solutions that cannot show an investible return?
- Little focus on job creation and attracting young people into a graying industry (outside of research labs)

R&D Portfolio

- Future focus needs to shift towards optimization and sustainability
- The R&D portfolio for the waterpower segment appeared to encompass a variety of projects some of which hopefully will move forward into future stages of feasibility and development. There were, however, several projects that were site-specific and did not have applicable to the overall industry. I noted these in the commentary.
- It seems to be balanced well across the national labs and Oak Ridge
- There could be more private industry partners other than federal COE (Army Corps of Engineers), Bureau (of Reclamation), and TVA (Tennessee Valley Authority)

- Having DOE support the hydro industry is a big change and very much appreciated. New hydro is truly renewable and needs DOE support.
- The areas of R&D seem focused, but some of the studies were conducted because DOE had money available
- I was impressed with the projects underway related to fish-friendly turbine, laboratory/field testing and instrument development. In particular, the work at PNNL is quite impressive.
- Good balance and use of research labs but more industry-matching money should be invested. Also, it is questionable that big corporations should receive R&D funding; this is part of their makeup (business model) if they are forward looking and growing
- Insufficient examples of product research being aimed at manufacturability

Management and Operations

- The staff and leadership are clearly committed and dedicated personnel who believe in their work
- The overall management of the program appeared good and there appeared to be a significant amount of progress across most of the research tasks
- This was a very well-managed event. The agenda was controlled well throughout the program.
- DOE support went above and beyond expectations for preparing and supporting the peer review teams
- The quality and diversity of the Peer Review team was exceptional. The process the DOE uses to build this team should be commended.
- Not completely sure what DOE's role is here
- Although the projects in this area appeared to benefit the industry, I was left with a sense that more, perhaps much more, could be done to optimize the regulatory process. There are still too many projects that do not proceed because of the excessive time/cost required to complete the licensing process.
- Very difficult to determine this, as no PM (project management) metrics are provided. Suggest that all programs be measured against some or all key PM metrics. #1: Schedule and Effort/Cost Variance; #2 – Productivity: Resource Utilization; #3: Change requests to Scope of work; #4: Quality and Customer Satisfaction; #5: Gross Margin

Communication and Outreach

- Regarding hydropower stakeholders and engagement of state resource agencies, I feel this area is quite weak. In general with acceptance of hydropower there is a dissonance with the input of state resource agencies and the ability (resources/budget) that those agencies have to make contributions. I realize this is a dilemma outside of the federal government’s purview; however, can DOE provide funding targeted at sustainability that gives state resource agencies a collective voice?
- I believe that there could be further outreach on a number of topics. This is particularly true in the areas dealing with variable speed generation and different types of new turbine applications.
- There could be more early communication with regulatory agencies such as FERC (the Federal Energy Regulatory Commissions) on some of the projects
- Many use the events at HydroVision (international conference) and NHA (National Hydropower Association) Water Power week to educate and advertise. This is a best practice.
- DOE has been very helpful in supporting hydro research and communicating this through your Hydropower Vision statement
- Very few projects were presented in this area, so I don’t feel I can comment on it
- Generally good but too many of the reviewers were asking where they could find the information. DOE EERE needs to be unrelenting in advising interested parties in breaking news, initiatives and reasons for folks to keep coming back to you website. Never give up on this as this is your best way of displaying success.
- Hydropower Vision report is a great medium and shows the strength of the EERE Water program. To get this completed was a triumph. Don't let it be just the report of the year. This needs to be re-visited via a checkpoint review annually. Use a peer group to review and make sure you cover, small and large hydro and pumped storage.

Strengths

- The Water Power office is always a presence at any hydropower-related event I attend. Their staff are friendly and always interested in engaging with stakeholders.
- Funding priorities appear to be coming more in alignment with the more recently established Vision

priorities • Strength of the program appeared to reside in the diversity of research in areas stealing from new turbine and generator development to the implementation of a new procedure for the section 408/FERC (Federal Energy Regulatory Commission) licensing review • Well-managed agenda and great divers peer panel • Audience engagement is critical • Objectives and overall support for the benefits of hydro is appreciated • I do believe we need to have more hydro at existing facilities although I am not yet convinced about hydrokinetics • Diversity in breadth and depth of the projects. Well aligned with the goals and objectives of the program. • Consistency year to year • Great database development…keep regionalizing it • Good results for relatively scarce dollars compared to wind, MHK, and solar • Fight for more dollars. If hydro is to grow it needs to invest in research $$$ as much as new technologies. Investing in R&D in a mature market and securing GWh (gigawatt-hour) gains in power produced can have bigger impact than five gains in an immature market.
Weaknesses • It is difficult to grade project management with the amount of information provided in the presentations • One weakness of the program was the diversity and the ability of the various peer reviewers to address all of the topics covered in a knowledgeable manner. As an engineer, I was able to address the technology issues with a greater knowledge than the environmental issues. I also had problems evaluating the transient electrical research. • More formal time on the front end of the meeting for co-mingling • Do not weaken conventional hydro by tying it with hydrokinetics • Still much remaining work / progress is needed to reduce the time of permitting, which is a complex multijurisdictional issue • Not yet enough emphasis on small-scale hydro • Weak display of FERC's (Federal Energy Regulatory Commission's) role • Weak investment appraisal • Little or nothing about job growth or how we attract young people into the industry
Recommendations • Look at real-world obstacles - local acceptance, particularly the distributed resources and outreach to municipalities and counties with resources looking to advance solutions and in the driver's seat when it comes to local infrastructure • I would recommend that the DOE coordinate with NHA (the National Hydropower Association) to provide research update programs at both the NHA conference, Hydrovision (conference), and at the various NHA annual outreach programs • Develop industry and research lab focus groups to frame the FOAs (Funding Opportunity Announcements). Are we sure that they (the FOAs) are really driving the objectives? • Keep looking outside DOE EERE for best practices • Be unrelenting in searching for real value-added industry partners in the programs • Need to develop a real job growth bias as well as products that can drive exports through competitive manufacturing

6.3 Marine and Hydrokinetics Track Comments

Table 6-3 provides the full body of verbatim comments as provided by the Marine and Hydrokinetics (MHK) reviewers at the 2017 WPTO Peer Review. Comments have been edited to clarify spelling, typographical errors, and acronym usage *only*; no content has been altered from the original submissions.

Table 6-3. All reviewer comments by metric for the Marine and Hydrokinetics track

Program Objectives • Overall, the program is aligning with the industry well. However, there needs to be a more concerted effort to assess the industry across a broad spectrum. More recently the program has focused on one technology (wave) over another (tidal/flow). • Much of the focus of the program appears to have been on integration of MHK into the national grid. This technology may be more effective at this early stage in smaller, more remote locations. • Cross Cutting Approaches - enable access that help facilities accelerate. This needs more thought as some test facilities are limited in what they can provide. There is a need to balance out the "be all for all" mentality. A developer will learn more from going to different sites for testing as each site will have aspects that provide learning. • Overall, MHK Program Phase 1 and Phase 2 program strategies are well aligned with industry needs, but WPO must further evolve its Phase 2 strategies to broaden collaborative partnerships and to attract private funding for MHK development that are critical to successful MHK technology commercialization • DOE Vision and Mission. Development of MHK technology as an indigenous, emissions-free energy resource remains critical to DOE mission to enhance U.S. security and economic growth by meeting energy needs through transformative science, technology innovation and market solutions. EERE vision and mission are well-aligned with ultimate DOE mission • Strategic Objectives: EERE Program objectives of Cost Reduction/Performance Improvement, Technology Validation/Risk Reduction, and Reducing Market Barriers with Phases 1 and 2 remain sound, but Phase 2 focus must evolve in all 3 objective funding strategies to closing the gap to full deployment. Phase 1 funding overall results are strong development of environmental monitoring, resource characterization, and test site development needed for support to MHK technology commercialization, but the more capital intensive and longer-term MHK technology development has lagged significantly and underperformed against potential outcomes. • Strategic Objective Phase 2: The planned aggressive technology innovation and demonstration is outstanding, but must be informed by lessons learned in Phase 1. DOE cannot fund/drive R&D for MHK alone and must innovate to create new partnerships with the private sector industries and with allied public sector/NGO institutions to close the gap to full deployment • A well selected of program objectives to not only reduce the cost of energy but to underpin this with performance and reliability improvements • The DOE has made great progress in supporting the development of safe, reliable and cost-effective MHK technologies and reduce deployment barriers. This is a complex task and the DOW MHK program should be commended on their progress to date. • The program objectives support industry needs overall and are comprehensive to address all aspects from resource characterization to environmental permitting issues. • One expects that a primary objective of the Wave Energy Conversion program would be to find a way to identify a theoretical direct conversion approach based on conversion of sinusoidal oscillating ocean wave motion to sinusoidal voltage and current and do this in the fewest energy conversion steps. • The objectives align very well with industry needs. The program is sponsoring (1) PTO efficiency improvements, (2) controls development, (3) environmental studies, and (4) field tests. These are all necessary to aid the MHK industry.
R&D Portfolio • It should be recognized that the Wave Energy Prize was a great success. Identifying the next generation of technology is vital for this industry to evolve. Congratulations! • There still appears to be a general lack of understanding of the industry's needs with regards to the national labs research • The program has made great strides with funding in-water projects and I would encourage this to continue • Need to understand the presentations in context to the call requirements. SPA1 SPA II calls aims/goals overview would have helped in understanding the control presentations in terms of their outputs/results.

- Key general comments from the MHK Peer reviewers on final day: there was some concern that the number of environmental projects reviewed +25 equaling the technology development +25 was seen as 'unbalanced' in terms of impact to R&D portfolio. On review of the number of environmental projects at 18 compared to site and resource projects at 6 is of concern in terms of portfolio mix and diversity. Baseline environmental projects/surveys should be well established in areas of commercial or demonstration interest. It is important that regulatory agencies provide context to the previous statement in collaboration with MHK activities. A gradual reallocation of the portfolio funds should be reassigned to site and resource focused projects, including encouragement of market, industrial, and regulatory partnered projects; NMFS for example.
- R&D Portfolio overall has produced remarkable results in Phase 1 under all objectives, but the DOE investments in near-term test site development, environmental monitoring instrumentation and resource characterization has produced results more quickly than the longer-term MHK device development. The planned Phase 2 focus on aggressive MHK technology development and deployment is essential to shift with the needs of the MHK sector, but DOE needs to evolve in funding strategies to provide consistent, timely financing support to developers.
- Part of the portfolio investment strategy is timing of DOE investment. The current long lag time between DOE RFPs, combined with thin private sector financing, creates significant funding gaps and drag on MHK innovation. Phase 2 must focus on how to eliminate this drag and delay.
- DOE should consult with interested private sector manufacturing, marine servicing, and state/regional innovation and economic development partners to evaluate a partnered approach to investing in more mature technologies to accelerate timeframe for MHK technology development. (e.g. funding package, with DOE providing/partnering on costs of technology development on gated go/no go milestone evaluation basis).
- Consider a program to challenge the states to partner in MHK early and mature stage technology development funding
- Work with private sector and NGOs (non-governmental organizations) to evaluate how to attract private sector investment and investment in MHK technology
- Can DOE measure the yield from DOE investments in terms of MHK technology maturation? How many technologies funded are still in development; how many companies funded remain viable MHK developers? Is the MHK sector attracting new development and investment? Working to reduce development time is essential to maintaining viable MHK developer pool.
- A well balance portfolio of projects, with a good mixture of device, subsystems, and components to underpin the sector goals and needs
- The DOE MHK program has done really well at identifying and funding projects across research areas, however, it should consider rebalancing the investment portfolio. Resource characterization is needed, but has advanced to a stage that little more work is likely needed (at least for WEC [wave energy conversion] devices) for a number of years as the industry is likely to test at WETS (Wave Energy Test Site) and PMEC (Pacific Marine Energy Center), which are well characterized. Likewise, the development of technology to monitor environmental effects has made tremendous progress due to DOE funding, but really needs active MHK projects to move forward. As a result, I would suggest that a rebalance in the investment portfolio might be needed towards MHK projects that are testing/deploying devices.
- It seems like a lot of the recent funding has gone towards WEC-related projects. Given that CEC (current energy converters) are closer to commercial scale, that seems a bit odd. A rebalance between these two broad technologies might be appropriate
- There are many topics to cover and the breadth of topics lends itself to the dilution of available resources. At this point, it is clear that the portfolio should focus on development of viable technologies that can be brought to commercialization.
- The MHK WEC program includes several approaches to the energy conversion objectives.
- Project #177 was most interesting. Is there a reason that there are not more projects like #177? Why aren't there more projects that try to convert oscillating vertical motion via buoy motion to sinusoidal voltage and current in one mechanical/electric conversion step?
- I would like to see more field tests, but I realize how expensive they are.
- I would also like to see more studies of the environmental effects of MHK devices.

Management and Operations

- DOE may look at adding specific project requirements to national laboratory research to ensure that what the labs are researching is applicable to the industry needs, especially when a project is focused on beta testing (i.e. models or software)
- Both the previous and current leadership groups are impressive groups of individuals - both have been a privilege to work alongside of.
- Alison LaBonte specifically has outstanding support in industry due to her professionalism and ability to work the program. She will be sorely missed.
- DOE WPTO MHK team is outstanding, with excellent leadership and a band of bright, able, motivated staffers who listen carefully, work collaboratively, and produce impressive results
- Hopefully DOE WPTO will continue its outreach to federal agency partners, both resource agencies and permitting agencies, to strengthen DOE leadership in innovation collaboration and economic development
- The program appears to have excellent leadership and management, ensuring that program meets overall strategic sector innovation requirements rather than individual company short-term needs
- My interactions with the MHK team have always been of a highly professional level
- Most of the projects were well managed and were worthwhile projects to pursue
- I was impressed with the organization and efficiency with which the Peer Review program was executed
- During the preliminaries to the actual Feb 13–17 review session, the staff provided timely and informative replies to my questions
- The DOE team is extremely knowledgeable and dedicated to the development of MHK

Communication and Outreach

- Since the last Peer Review, there has been sporadic communication and acknowledgement from the program when addressing some of the industry needs. However, the program continues to build its collaboration both between sister federal agencies as well as private partnerships—well done!
- Outstanding use of multimedia and social media is now more than ever important for communication and outreach in real time
- Improvements in the international links through individuals were good. More organizational alignment with international bodies. OEE (Ocean Energy Europe), IEA (International Energy Agency), etc.
- WPTO staff have excellent communications with MHK community and developers, and have greatly improved collaboration and communication with federal and state partners in past 3 years
- WPTO staff must continue and broaden efforts to inform and engage federal and state regulatory agencies to address/eliminate permitting issues, using grant-funded project results
- WPTO must continue and strengthen international communication to share environmental and development information to accelerate U.S. development
- The program has good communication within its participants - it is not fully clear how this communicated to those outside the program - this may be being done at a project level , but it was not clear how this was achieved at a program level
- DOE outreach has been very effective and take many forms from direct communication from the DOE to providing funding for such things as Tethys, which also provide for outreach and engagement across stakeholder communities
- The program does a reasonable job of communicating and Tethys is a particularly good tool
- My personal experience is that I find out about reports through word of mouth or happenstance, and cannot easily find products on DOE webpages.
- The 41 project presentations were well documented using a standard format. This allowed Peer Reviewers to make "apples-to-apples" comparisons of projects within each of the seven MHK program categories.
- During the preliminaries to the actual Feb 13–17 review session, the staff provided timely and informative replies to my questions.
- The two IEEE papers produced as part of the effort expended in project #158 are excellent examples of an analytical approach
- The wide variety of projects and project investigators demonstrates that the Water Power program is communicating very well with industry, academia, and other government agencies

Strengths
- The water program is vital for the MHK industry to progress in the United States—without its support and guidance, we as an "Industry" would not be anywhere near where we are today. It is having a significant impact.   - The strategy aims and objectives   - There were clear expectations on project deliverables and how they impacted the industry as a whole   - Excellent staff, thoughtful strategic program funding, and strong program and project oversight and implementation   - Tremendous potential to help meet need for environmentally and economically sustainable emissions-free energy source indigenous to the United States, and to address critical water and energy shortages on global scale that threaten U.S. national security   - WPTO was very responsive to input of last Peer Review, and achieved significant upgrades in DOE program and funding and outreach strategies   - Great success stories in last three years re: outreach to DOD (U.S. Department of Defense), and to federal regulatory agencies to understand permitting barriers and get input on environmental monitoring technology development and resource characterization, and to MHK developers on technology development and use of go/no go funding strategies   - Emphasis on sharing lessons learned on a project through publications and other workshop or educational events is excellent strategy to maximize investment value   - A well-balanced portfolio of projects   - Novel approach to wave energy, i.e. the Wave Energy Prize   - Strong leadership   - The go - no go process   - Subsystem projects aligning with and supporting device projects   - Collaboration with lab projects   - Well thought out in terms of the strategies and areas that need to be addressed for MHK   - I found project #177 to be most promising   - The Cross Flow turbines proposed for installation on fast-flowing rivers near remote village load centers without connections to a bulk power grid appear to have a strong possibility of commercialization   - The WEC program strength that I found most impressive is from the point of view that WEC has the potential to provide low-cost electric energy to users (utility customers) in areas/regions adjacent to coastal areas and near fast-flowing rivers   - DOE Water Power Personnel   - Variety of projects and project investigators
Weaknesses
- The program needs to work with the national labs more closely to ensure their research is in line with the current industry needs, particularly the modeling work. The value of this work to the industry questionable.   - Changing targets or metrics across the projects   - Small group of the same companies/researchers/industry participating and accessing funds - risk of group think   - DOE seems to view its technology funding in a silo. Need to evolve to strengthen DOE's special, catalyst leadership role in the U.S. innovation ecosystem to accelerate MHK commercialization.   - No clear cohesive federal policy on innovative energy technology development with forum where federal agencies can coordinate and collaborate across agency lines. Can USDOE lead effort?   - Program does not require a clear commercialization plan for proposed R&D on technology, whether MHK device or environmental instrumentation. More emphasis is needed to assure technology developed with USDOE funds will be transferred to commercial application that benefits the U.S. taxpayers.   - Not all lab projects appear to collaborating with industry projects where there appears be an opportunity for that to happen – materials research is an example of where this could happen   - Appears to an imbalance between environmental and technology projects – i.e. too large a proportion of the program addressing environmental research

- It is not clear the new PMEC center will be fully utilized for some period of time
- The program would benefit from focusing limited resources on moving the MHK industry towards viable technologies
- The program started in 2013/14 and has progressed to its present state. As I read the summaries, in preparation for the Feb 14–17 review, I found myself asking the following question: Was there an initial pre project evaluation of the theoretical physics of wave energy motion that was focused on direct conversion of oscillation wave motion energy to sinusoidal voltage and current? In this regard see "Electromagnetic Fields, Energy and Forces" by Fano R. M, Chu L J & Adler R B,; MIT Press, John Wiley & Sons. Inc.; 1960; Appendix One; Sections A1.2, and Ai.3 for a discussion of the physics of "kinematics".
- If a pre-2013 physics-based evaluation of basic principles was prepared, then can it be provided?
- Will the future evaluation of WEC include a financial value for the fact that electric power from a WEC unit does not contribute to air pollution or global warming?
- I have a concern about the errors in the WECSym program that project 172 found. How many other projects were affected?

Recommendations

- Moving forward from this Peer Review, it would be beneficial to both the program and Industry to focus on near-term goals of development
- Identifying and supporting the next generation of technology (both wave and tidal/flow)
- Develop check points (or Go/No Go milestones) in project funding to reassess if a project is still on target to achieve its end goal
- Continue the challenge/competition FOAs (Funding Opportunity Announcements)!
- Widen participation through attracting other industry, university and research organizations including international participation
- Continue peer review process and align same company/technologies results so it's easy to see the development trajectory
- Phase 2 funding strategies should create a Fast Track with disciplined focus on use of DOE grants as catalyst to accelerate the demonstration/deployment of promising MHK technologies. Phase 2 should also support new technology R&D, but like the NIH (National Institutes of Health) Bench-to-Bedside funding strategy, should focus on near-term applied technology development.
- WPTO must leverage partners and resources from public and private sector to share the heavy burden of full commercialization of MHK. Siloed funding will not work.
- Invest in proven successful collaboration with DOD [Department of Defense] (USN [U.S. Navy], Marines, USCG [U.S. Coast Guard]) to accelerate MHK to meet mission critical base and expeditionary force energy needs. Expand to other federal and international partners to address humanitarian and disaster relief needs (desalinization) to meet emergent critical global threats to U.S. national security due to water and power shortages.
- Work with federal and state partners to convene a forum to highlight MHK as a promising technology and to cultivate partnerships needed to accelerate commercialization (Sidecar event to leading national innovation forum?)
- WPTO must reach out to the commercial development end of the MHK commercialization spectrum, to attract the expertise and financing needed from private sector (MHK supply chain of manufacturing, marine services and financing) and state and regional economic development centers to close the gap to final commercialization)
- Give priority to deployment of MHK in cost-competitive off-grid applications such as desalinization and to grid power for islanded communities with high energy costs
- My recommendations are as follows:
  - Prepare an idealized model of direct conversion of oscillating ocean wave buoy motion to sinusoidal voltage and current. See schematic diagram, for an example, included with notes being sent as a separate file.
  - Long Range: Assuming that WEC energy supplies into regional power grids reaches a significant level, then will there be a need to address the situation that WEC energy will be available throughout the day and night. In the event that the demand for energy is less than WEC supply, then will the surpluses be stored or will the WEC units be required to disconnect or shut down until demand increases?
- I would like to see more field tests, but I realize how expensive they are

7 Complete Project Evaluation Results

7.1 Overview

This section includes project scores and reviewer comments for the full body of projects evaluated at the 2017 WPTO Peer Review. As discussed in section 5 of volume 1 of this report, reviewers scored individual projects on six evaluation metrics, using a numeric 5-point scale (1 = Poor, 5= Outstanding). Qualitative descriptors apply to the numerical scores. These descriptors vary for each of the metrics and are included in the project-level scoring sheet used by reviewers (Appendix B). Score tabulations in this report include averages and standard deviations, providing relative as well as absolute assessments of WPTO and its projects.

The peer review evaluations focused on the following six evaluation metrics. Where applicable, the shortened name used in the project-level Scoring Tables in this report is shown in parentheses:

(1) *Relevance to water power industry needs and overall DOE objectives* (Relevance)—The degree to which the project aligns with objectives and goals of WPTO and meets the needs of the water power industry at large. This is a stand-alone metric reported separately in the scoring tables.
(2) *Methods / Approach*—The degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers.
(3) *Technical Accomplishments and Progress* (Accomplishments/Progress)—The degree to which the project has delivered results and/or progressed technically compared to the stated project schedule and goals.
(4) *Project Management*—The effectiveness of the project's management, including project planning, project execution, and allocation of resources to complete the project within scope, on-time, and within budget.
(5) *Research Integration, Collaboration, and Technology Transfer* (Collaboration/Tech Transfer)—The degree to which the project successfully interacts, interfaces, or coordinates with other institutions (e.g. industry, universities, other laboratories) and projects, and the degree to which projects are disseminating the results of the R&D.
(6) *Proposed Future Research (if applicable)* (Future Research)—The degree to which the future research proposed is relevant, well-planned, and worthwhile of continued funding.

Scoring Tables include a **Weighted Average Performance** score. This weighted score represents the overall performance of each project along evaluation metrics, exclusive of the **relevance** score. It is calculated using the weights listed in Table 7-1.

Table 7-1. Metrics and scores for project-level evaluations

Relevance	Stand-alone metric	Relevance to water power industry needs and overall DOE objectives
Weighted Average Performance	30%	Methods / Approach
	30%	Technical Accomplishments and Progress
	20%	Project Management
	10%	Research Integration, Collaboration, and Technology Transfer
	10%	Proposed Future Research (if applicable)

7.2 Project Scoring Chart Description

Project scores are reported using a detailed chart that provides project information, reviewer scores, and comparative graphs. For the purposes of the 2017 Peer Review, WPTO's portfolio was organized into two tracks: (1) Hydropower, and (2) Marine and Hydrokinetics. These tracks were then organized into subprograms.

The three Hydropower subprograms were:

- Growth
- Sustainability
- Optimization.

The three MHK subprograms were:

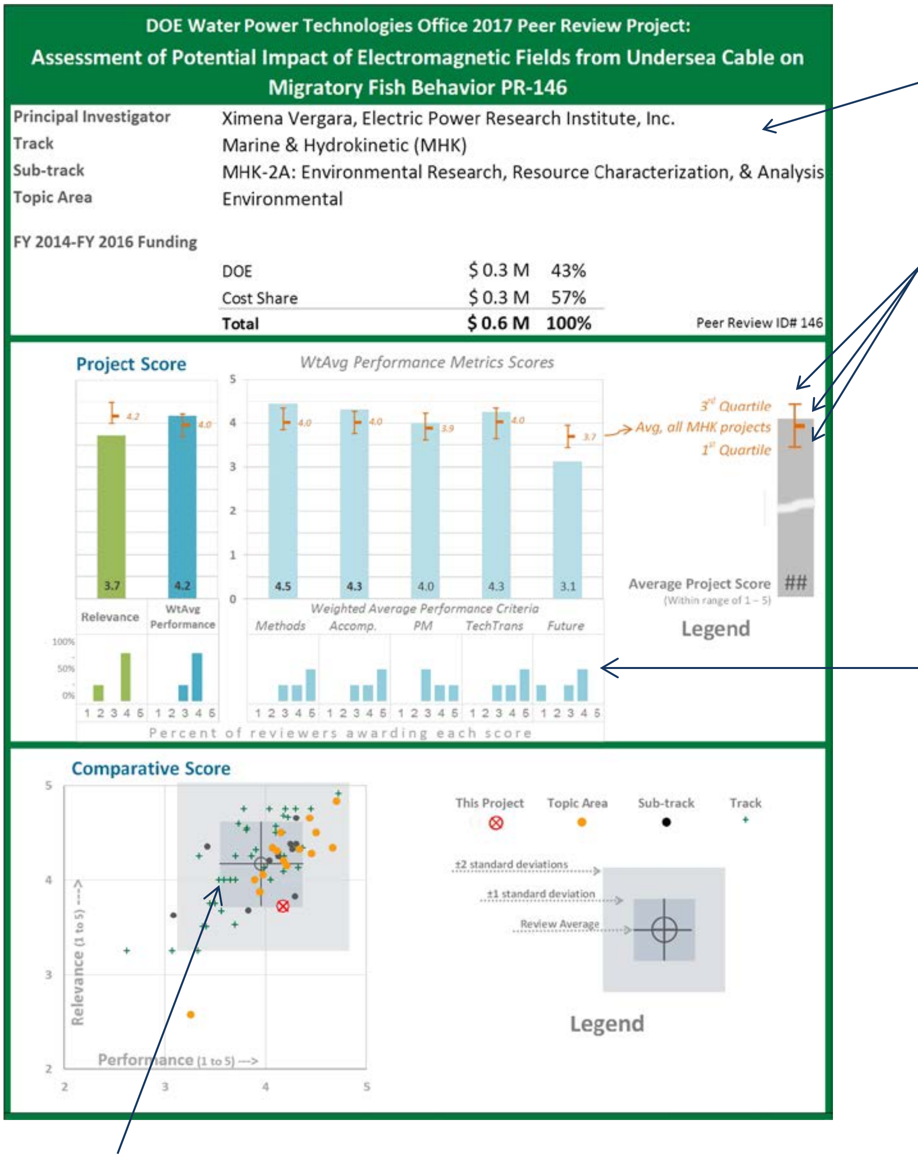
- MHK 2A – Environmental Research, Resource Characterization and Analysis
- MHK 2B – Technology Research and Development
- MHK 2C – Demonstration and Infrastructure.

The MHK agenda sessions (by sub-track) were further divided into three topic areas each (Table 7-2).

Table 7-2. MHK peer review subtracks and topic areas

MHK-2A	MHK-2B	MHK-2C
Environmental	Components	Demonstration
Market and Industry Development, Analysis, and Data Dissemination	Survivability	Infrastructure

Projects within each subtrack/topic area are listed in numerical order based on their PRID (Peer Review ID number). Figure 7-1 provides an overview and explanation of the project scoring charts.



Project demographics include project name, WPTO program, and funding information.

Error bars show the 1st and 3rd quartiles based on the statistics from all projects. The average is also included as the center dash with numeric labels. As an example, the "Methods" metric shown here is scoring is above the 3rd quartile, which indicates this project is performing in the top 25% for that metric.

Reviewer scoring histogram illustrates scoring distributions of the reviewers for each metric. Taller bars indicate more reviewers gave a specific score, e.g. this project's Relevance was scored a "5" by 75% of the reviewers and a "3" by 25% of the reviewers. Wide distributions may indicate disparate reviewer opinions.

Performance vs. Relevance graph illustrates how this project performed on Relevance (y-axis) and Weighted Average Performance (x-axis), compared to the review averages and other projects. The middle of the inner blue shaded area is the review average for each score, and each box is one standard deviation from the average. This example shows this project scored slightly above average for Relevance and greater than >1 standard deviation above the average for the "Performance" (weighted average performance).

This graph also displays how this project performed relative to its subprogram (orange dots) and the entire program (blue dots).

Figure 7-1. Explanation of project scoring charts for individual project evaluations

7.3 Hydropower Track: Project Scores and Comments

This section details project scores and comments for all 39 projects in the Hydropower track. Table 7-3 provides a master list of projects along with respective average scores. Sections 7.3.1–7.3.4 include the individual project score charts and reviewer comments for every project in each respective track.

Table 7-3. Hydropower master project list

Hydropower	Average of Relevance and WAP	Relevance	Weighted Average Performance (WAP)	Methods/Approach	Results	Project Management	Technology Transfer	Future Research
Average scores across all WPTO peer-reviewed projects	**4.0**	**4.1**	**3.8**	3.9	3.9	3.8	3.9	3.6
Growth								
Average scores for Hydropower—Growth	**3.7**	**3.9**	**3.5**	3.6	3.5	3.7	3.4	3.3
Magnetic Gears for Hydropower Drivetrains (184)[1] Emily Morris, Emrgy Hydro, LLC	4.6	4.8	4.5	4.4	4.3	4.6	4.6	4.7
Hydro Research Foundation University Research Awards Program (132) Brenna Vaughn, Hydro Research Foundation	4.2	4.3	4.0	3.8	4.1	4.3	4.2	3.9
SLH100 Demonstration Project at Monroe Hydro (139) Abe Schneider, Natel Energy, Inc.	4.2	4.4	4.0	4.0	3.9	4.0	3.9	4.1
Rapidly Deployable Advanced Integrated Low Head Hydropower Turbine Prototype (175) Arnie Fontaine, Pennsylvania State University	4.1	4.4	3.8	4.0	3.8	3.7	3.4	3.8
Cost-Optimization Modular Helical Rotor Turbine-Generator System for Small Hydro Power Plants (174) David Yee, Eaton Corporation	4.1	4.4	3.8	3.9	3.7	3.8	3.4	3.7
Standard Modular Hydropower (SMH) (97) Brennan Smith, ORNL	4.0	4.3	3.7	3.8	3.5	4.0	3.7	3.9
Demonstration of Variable Speed Permanent Magnet Generator at Small, Low-Head Hydro Site (141) David Brown Kinloch, Weisenberger Mills, Inc	4.0	4.1	3.8	3.9	3.9	3.8	3.6	3.7
Modular Pumped Storage Hydropower Feasibility and Economic Analysis (76) Boualem Hadjerioua, ORNL	4.0	4.2	3.7	3.9	3.6	3.9	3.6	3.4
The Design and Development of a Composite Hydropower Turbine Runner (194) Pat Hipp, Composite Technology Development, Inc.	3.9	4.1	3.8	4.1	3.3	3.9	3.6	3.8
Workforce, Education, and Training Needs Assessment for U.S. Hydropower (159) Jay Paidipati, Navigant Consulting, Inc.	3.9	4.1	3.6	3.8	3.4	4.0	3.4	3.3

[1] Numbers in parentheses after the project names are peer review identification numbers (PRIDs). These were used to organize projects for the peer review. The PRIDs are not in any specific order.

Hydropower	Average of Relevance and WAP	Relevance	Weighted Average Performance (WAP)	Methods/Approach	Results	Project Management	Technology Transfer	Future Research
Optimized Composite Prototype for Archimedes Turbine Manufacture (193) Jerry Straalsund, Percheron Power, LLC	3.9	4.2	3.6	3.8	3.6	3.4	3.1	3.4
French Modular Impoundment (181) Bill French, French Development Enterprises, LLC	3.7	3.7	3.6	3.4	3.8	3.9	3.3	3.5
Demonstration of a New Low-Head Hydropower Unit (143) Wayne Krouse, Hydro Green Energy, LLC	3.3	3.7	2.9	3.2	2.9	2.9	2.4	2.5
Cellular Cofferdam for Hydropower Use (182) Marte Gutierrez, Trustees of the Colorado School of Mines	3.3	3.4	3.2	3.2	3.3	3.3	3.0	2.8
The 45 Mile Hydroelectric Project (142) Jim Gordon, Earth by Design Inc.	3.2	3.4	3.1	3.3	3.2	3.0	3.1	2.6
Modular Low-Head Hydropower System (180) David Duquette, Littoral Power Systems, Inc.	3.2	3.3	3.0	2.9	3.1	3.1	3.1	2.9
Harnessing the Hydroelectric Potential of Engineered Drops (140) Jerry Straalsund, Percheron Power, LLC	3.1	3.4	2.9	2.7	2.7	3.3	3.1	2.6
Cement Changes and Solutions to the Industry (183) Todd Sirotiak, North Dakota State University	3.1	2.9	3.2	3.1	3.3	3.7	3.1	2.6
South Fork Powerhouse Project (137) David Hanson, Sacramento Municipal Utility District	2.8	2.7	2.9	2.9	3.0	3.6	2.6	2.0
Optimization								
Average scores for Hydropower—Optimization	**4.0**	**4.2**	**3.7**	3.8	3.6	3.7	3.8	3.6
Integrated Hydropower and Storage Systems Operation for Enhanced Grid Services (58)[2] Rob Hovsapian, INL	4.4	4.8	4.1	3.9	4.0	4.1	4.1	4.4
Facilitating Regulatory Process Improvements (Federal Interagency Collaborative) (90) Shelaine Curd, ORNL	4.3	4.7	4.0	4.0	3.7	4.1	4.1	4.0
National Hydropower Asset Assessment Program (NHAAP) (77) Shih-Chieh Kao, ORNL	4.2	4.4	3.9	4.0	4.0	3.9	3.9	3.7
Hydropower Regulatory and Permitting Information Desktop (RAPID) Toolkit (116) Aaron Levine, NREL	4.2	4.4	3.9	4.0	3.8	4.0	3.9	3.8
U.S. Hydropower Market and Trends Report (112) Rocio Uria Martinez, ORNL	4.0	4.2	3.9	3.9	3.8	3.8	4.1	4.1
Basin Scale Opportunity Assessment Initiative (111) Kyle Larson, PNNL	4.0	4.3	3.7	3.8	3.6	3.9	3.6	3.7
Cost Data Collection and Modeling for Hydropower (64) Patrick O'Connor, ORNL	3.9	4.0	3.9	3.9	3.8	3.8	4.3	3.9

[2] Numbers in parentheses after the project names are peer review identification numbers (PRIDs). These were used to organize projects for the peer review. The PRIDs are not in any specific order.

Hydropower	Average of Relevance and WAP	Relevance	Weighted Average Performance (WAP)	Methods/Approach	Results	Project Management	Technology Transfer	Future Research
PSH Transient Simulation Modeling (49) Edward Muljadi, NREL	3.9	4.1	3.6	3.7	3.7	3.6	3.3	3.6
Hydropower Asset Management Research (61) Brennan Smith, ORNL	3.9	4.1	3.6	3.8	3.7	3.5	3.7	3.1
Low-Head, Short-Intake Flow Measurement Research (62) Marshall Richmond, PNNL	3.7	3.9	3.6	3.8	3.6	3.4	3.6	3.5
Hydropower Manufacturing and Supply Chain Analysis (43) Jason Cotrell, NREL	3.4	3.6	3.2	3.2	3.3	3.4	3.1	2.7
Iowa Hill Pumped-storage Project Investigations (138) David Hanson, Sacramento Municipal Utility District	3.4	3.6	3.2	3.6	2.7	3.5	3.4	2.4
Sustainability								
Average scores for Hydropower-Sustainability subprogram	**3.9**	**4.1**	**3.7**	3.8	3.7	3.7	3.8	3.6
Monitoring Technology Development for Sensitive Species (Juvenile Eel / Lamprey Tag Development) (54)[3] Daniel Deng, PNNL	4.5	4.7	4.3	4.4	4.5	4.0	4.2	4.1
Biologically-Based Design and Evaluation of Hydro-Turbines (BioDE) (125) Gary Johnson, PNNL	4.3	4.5	4.0	4.1	4.1	3.9	4.3	3.9
Report to Congress-Potential Climate Change Impacts on Federal Hydropower (115) Shih-Chieh Kao, ORNL	4.1	4.4	3.9	4.0	3.8	3.9	3.9	3.6
Environmental Performance Analysis and Testing Campaign for New Technologies (92) Alison Colotelo, PNNL	4.0	4.1	4.0	4.0	3.9	4.1	3.9	3.8
Water Quality Modeling Improvements at Columbia and Cumberland River Basins (32) Boualem Hadjerioua, ORNL	3.9	3.9	3.9	4.0	3.6	3.9	4.0	4.0
CERC-WET Topic 3: Improving Sustainable Hydropower Design and Operations (195) Ashok Gadgil, University of California, Berkeley (Consortium Lead)	3.8	4.0	3.5	3.6	3.4	3.6	3.7	3.3
Informing Hydropower Investment and Operational Decisions Under Changing Hydrologic Conditions (93) Mark Wigmosta, PNNL	3.7	3.9	3.5	3.5	3.4	3.5	3.6	3.4
Environmental Metrics for Hydropower (95) Shelaine Curd, ORNL	3.1	3.4	2.9	3.0	2.7	3.0	2.8	2.8

[3] Numbers in parentheses after the project names are peer review identification numbers (PRIDs). These were used to organize projects for the peer review. The PRIDs are not in any specific order.

7.3.1 Growth

DOE Water Power Technologies Office 2017 Peer Review Project:

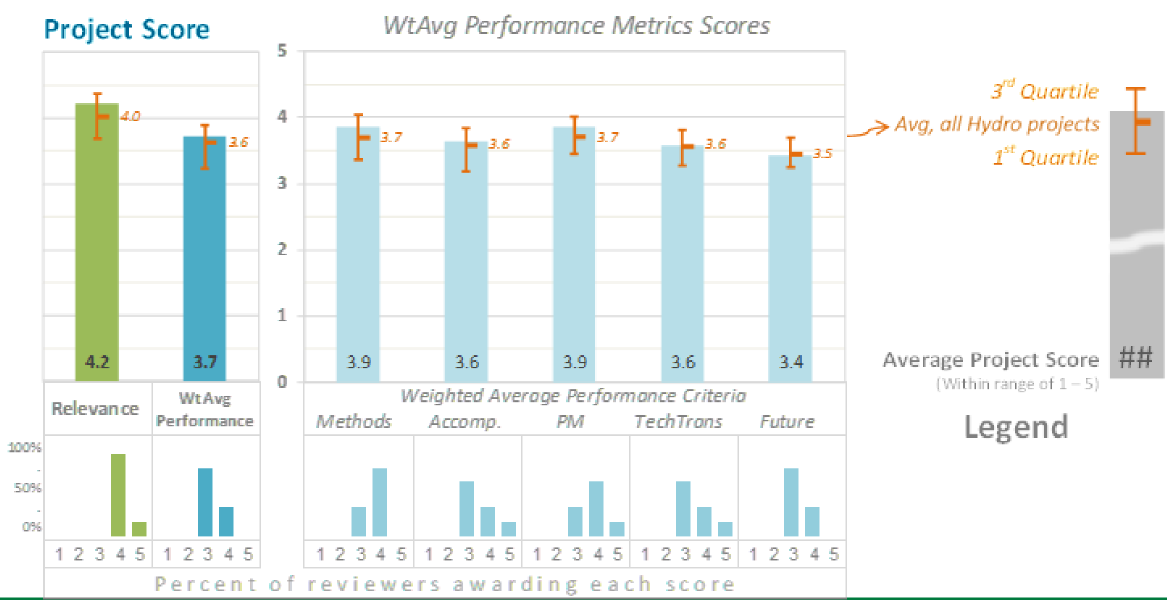
Modular Pumped Storage Hydropower Feasibility and Economic Analysis

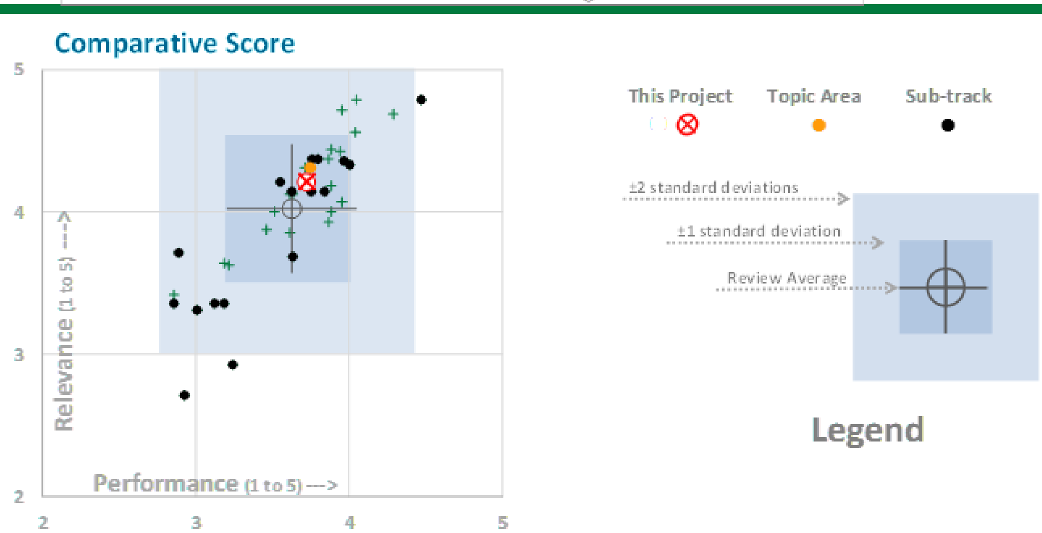
Principal Investigator	Boualem Hadjerioua, Oak Ridge National Laboratory
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Modular Technology and Low Environmental Impact

FY 2014-FY 2016 Funding

DOE	$ 1.4 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 1.4 M**	**100%**

Peer Review ID# 76





Comments made by reviewers during the evaluation of this project (PRID 76)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- The successful development of scalable modular PSH (pumped storage hydropower) is 100% relevant to the Growth category of HydroNEXT - reducing costs and deployment timelines of PSH
- A major element in the cost of a pumped storage facility is the cost of the storage reservoir. The 10 hours of storage appears to be reasonable, but also relatively arbitrary.
- I believe that closed system modular pumped storage could be a viable alternative. I would suggest that the minimum size for these types of facilities is 75 to 100 MW. There is currently technology available to efficiently excavate underground pumped storage systems using circular braised excavation systems. This may be a valuable alternative to investigate.
- In order to be economically viable, I believe that the size of the modular facility needs to be increased to 20 to 25 MW minimum
- The only project which appeared to be economically viable was the use of an abandoned coal mine. This provided an overall head of 500 feet. During the 1990s, I investigated the availability of abandoned mines for use as pump storage reservoirs. I found that there were numerous old mines available, but many of them were likely unstable. I believe that there is potential for the use of abandoned mines for modular pumped storage, but the number is relatively small and would have to be researched.
- This is a relevant research product to DOE objectives
- Good presentation
- Looked at different alternatives
- Needs to accommodate differences that occur regionally like western vs eastern issues
- Seemed to be restricted to existing conventional methods and facilities
- Fits nicely within the growth category
- The relevance of pumped storage to the industry is conditioned by the acceptability of m-PSH in the different regions of the country. For example, in New England the probability of getting PSH implemented is close to zero due to environmental factors.

Question 2: Methods and Approach

- A diverse group of settings makes a strong approach for testing and provides a more comprehensive perspective
- The settings were useful not only to test the technology, but also to examine other critical factors necessary to bring modular PSH to market
- I believe that future pumped storage alternatives should focus on facilities with a capacity of approximately 100 MW. This size is sufficient to provide significant benefits, but not so large that it cannot be easily licensed.
- The approach was good and covered diversity of application
- Did use 5 cost aspects in their model, this is good Civil, Equipment, Electrical, Environmental, etc.
- Included most important aspects
- Restricted to 500 ft of head, should not restrict this way
- Good list of case studies, solid cost model
- Apart from the opening slide it was not clear where the modular approach really came into play
- The range of PSH options reviewed was excellent and should be used as an example of how a stable of technical solutions to a challenge should be developed up front before a project commences
- The use of Biosphere 2 seems a bit weak. Solar in a desert OK but using pumped storage where there is very limited water should have been screened except for the benefit that the UofA (University of Arizona) students might have gained or unless they were able to use gray water

Question 3: Technical Accomplishments and Progress

- Coal mine site was least expensive but the price of electricity in KY was not ideal. Building in NYC was too complicated. Glides - compressed air. Water is compressed to recreate the pressure of high head. But it was discovered that it is cost prohibitive to scale up to hundreds of MW. Biosphere 2 - the cost of the storage tanks was prohibitive.
- Each application had problems, but the success or lack of success for each application does not necessarily reflect on the overall accomplishments of the research. If the goal was to try modular PSH in various settings to gain useful information on the appropriateness of those settings and the obstacles that need to be overcome for success, then the project accomplished what it set out to do.

Comments made by reviewers during the evaluation of this project (PRID 76)

- The project was successful in demonstrating that small sized modular pumped storage is likely unfeasible in many circumstances. As indicated in previous comments, I believe that a larger size pumped storage using a closed system approach with innovative excavation techniques could be more economical.
- It is still a very high level design product. Civil infrastructure could be more intensive than reflected.
- Identified risk such as large amounts of water on top of hotels
- Looked at 5 different types of development
- Some of the research seems out of date since did not consider bringing renewables to market
- Excellent list of publications
- It was not clear that the revenue side of the equation had been adequately addressed

Question 4: Project Management

- Within budget, on time
- Overall it appears that the project was well-managed, within the scope of the study
- The project should start focusing on a market to apply the technology that values ancillary services
- Good cost analysis
- Participants from various sectors which is good
- Suggest they be allowed to be flexible in their analysis
- Good project partners, although it is not clear how they contributed to the project
- Well organized and executed

Question 5: Research Integration, Collaboration, and Technology Transfer

- Conference proceedings papers and website publication - but no notable transfer outside of the relatively internal and narrow audience
- This was an average product within these aspects
- Good team effort and looked at various aspects of modular pumped storage
- Presentations and papers seem to be widely distributed to industry
- Leverage what has occurred in the wind industry regarding compressed air technology. Seems a natural synergy that should be developed to reduce research time and cost while also benefiting the Water and Wind Offices.

Question 6: Proposed Future Research, if applicable

- The project reveals that modular development for PSH under 100 MW remains cost prohibitive. This indicates a need for continued research to identify new innovations to reduce costs, such as bringing down the cost of GLIDES (Ground-Level Integrated Diverse Energy Storage).
- Continue to focus on the coal mine pumped storage project
- New ways of storage to look at
- Would look at different lengths of storage
- Proposed future research not very well defined, needs more specificity
- Need to understand targeted IRR (internal rate of return) for these projects
- Project should move to a fuller business model, one that takes it from site acquisition through licensing, development and operations

Question 7: Project Strengths

- Diverse and real world settings to experiment with modular PSH
- The project looked at a variety of very small PSH projects and determined that a number of concepts were not feasible. This was a valuable conclusion and provides direction for future work.
- Great diversity of products reviewed. This brings credibility.
- Strong project team, good case studies, solid cost model
- Good cross section of alternatives

Question 8: Project Weaknesses

- The size of the projects was very small .The results showed that the economy of scale is needed to make projects feasible and that higher heads are also required.
- We ultimately need a product demonstration in a market that values it
- Stronger conclusions with respect to the case study categories would be helpful
- Insufficient focus on total project IRR potential

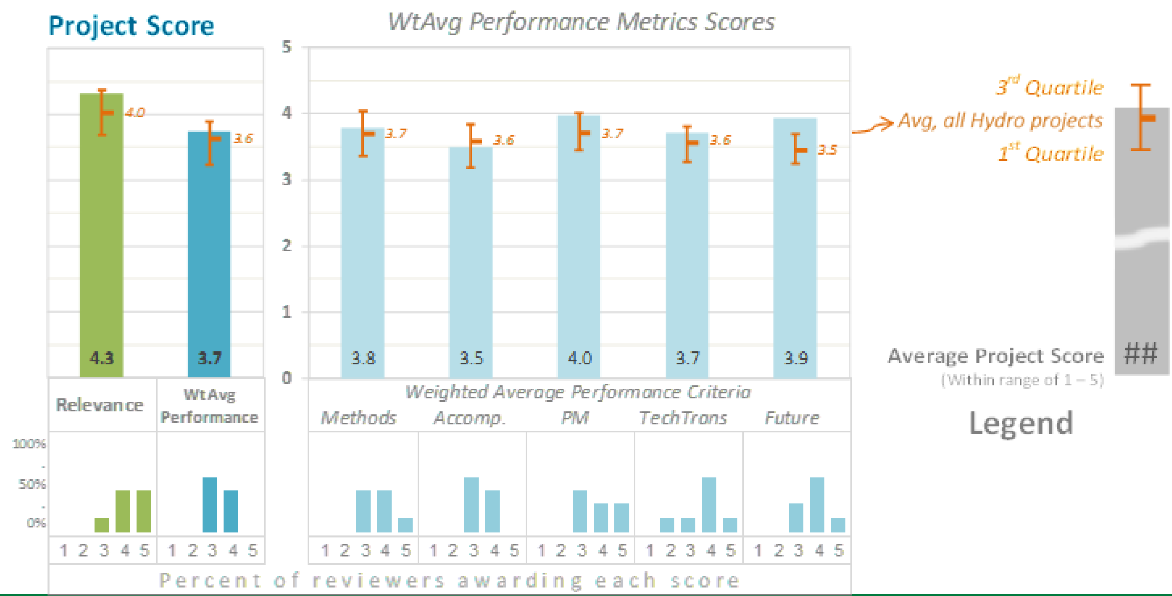
Comments made by reviewers during the evaluation of this project (PRID 76)
Question 9: Recommendations • Future research should be done at larger pumped storage projects utilizing closed systems. I believe that the size should be at least 100 MW using existing topography with heads of 500 feet or greater. Innovative excavation technology is available to construct powerhouses underground for these types of projects. • Companies are bandying about LCOE (levelized cost of energy) but I think that this is inconsistently calculated. DOE needs to jump in here as failure to control this metric will lead to big cost advantage claims that could be disproved. • Example of where Wind and Water should be closely collaborating (on the storage compression) • Good for large PSH but some focus should be placed on smaller PSH or technologies that can be used. For example the Archimedes screw used in a bi-directional manner on low head impoundments. Pump up at night and flow down by day (based on demand).

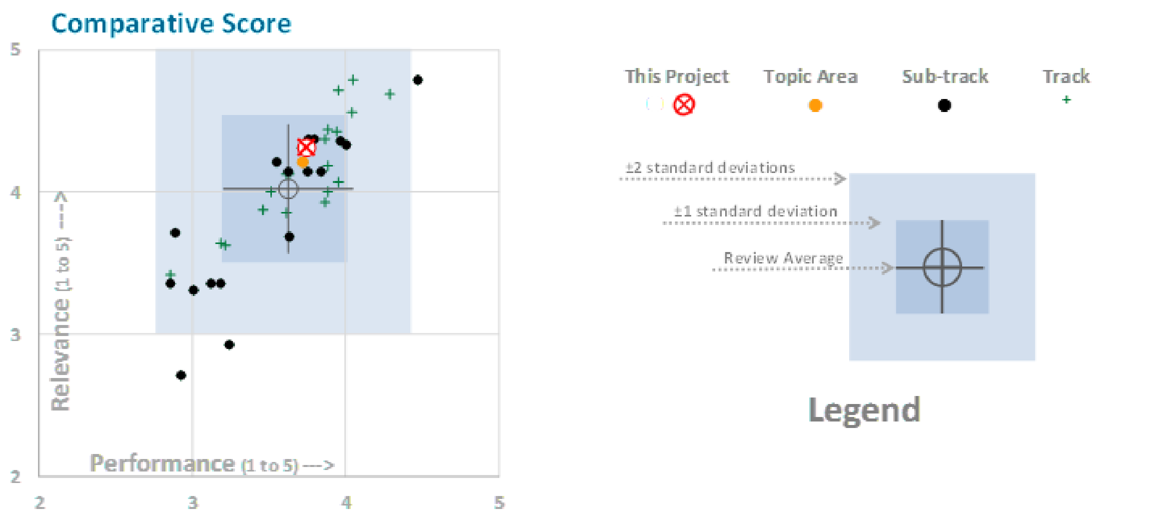
DOE Water Power Technologies Office 2017 Peer Review Project:

Standard Modular Hydropower (SMH)

Principal Investigator	Brennan Smith, Oak Ridge National Laboratory		
Track	Hydropower (Hydro)		
Sub-track	Growth		
Topic Area	Modular Technology and Low Environmental Impact		
FY 2014-FY 2016 Funding			
	DOE	$ 1.1 M	100%
	Cost Share	$ 0.0 M	0%
	Total	**$ 1.1 M**	**100%**

Peer Review ID# 97





Comments made by reviewers during the evaluation of this project (PRID 97)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- This project addresses lowering costs and facilitation of testing in the Growth priority and developing new systems to avoid environmental impacts in the Sustainability priority. The focus of this project is on new stream reach development, which is a very small proportion of the potential future identified in the Vision report. For this reason it is only moderately relevant to the objectives and goals of the WPTO and industry needs.
- I believe that the best potential for the development of new stream hydropower would be at higher head projects which involve a low height diversion dam, a flowline, append stock and a powerhouse utilizing an impulse turbine. The modular dam concept could be utilized for this type of development. I would suggest that the current research effort incorporate this type of a hydropower concept.
- Modular hydropower development is a worthwhile goal. However, based on my involvement with regulatory agencies at the state level, I have my doubts whether any new stream development would be acceptable to many state agencies. I believe that the more likely and worthwhile Avenue of investigation would be the development of a modular power generation at existing dams. This could involve standardized straight-line powerhouses with propeller turbines such as the Voith stream diver or the Andritz Hydro matrix turbine housed in a simply constructed straight walled concrete or steel structure.
- This project is relevant to Water Power industry needs and overall DOE objectives
- Discussed 4 main components which is good. These included site classification, exemplary design, simulation and testing of variables.
- Standard Modular Hydro is something being looked at by FERC (Federal Energy Regulatory Commission) and other entities within the industry
- Very important project with respect to the potential of new site development and growth of traditional hydropower
- Applaud the objective and right on target for unpowered stream flows

Question 2: Methods and Approach

- The approach appears to be well considered and designed. It is difficult to say it is likely to be successful in "fundamentally rethinking hydropower development in the United States" because of significant stakeholder opposition to NSD (New Stream-reach Development).
- I am concerned that any modular system would have significant dam safety issues with the FERC. Depending on the site, these issues could involve seepage, stability or the ability to pass the probable Maximum flood. I would suggest that the team consult with the FERC regarding dam safety issues to obtain input.
- It's a solid approach with a heavy focus on site classification and biology
- Good presentation and pleased that site classification was added
- See above
- 4 research pillars are comprehensive and well-articulated
- Modules within the research pillars are also comprehensive and well-articulated
- Site classification is excellent and all encompassing
- Why nothing on impact of design impeding river flow in flood and also stability of equipment in extreme flood? This could be a killer.
- Why no focus on the licensing process? Technology without the enabling licensing is just mechanics.

Question 3: Technical Accomplishments and Progress

- So far the project has been in the analysis phase. The engagement phase will happen in 2017.
- This project is very young and has not yet delivered heavy on technical accomplishments
- Added site classification pillar which is good
- Project is still early, although the first work-product reports are available
- Looks like a technology looking for a home

Question 4: Project Management

- Site classification was not originally a pillar. As they began the work they realized that they needed to classify the population of sites. They have not yet done stakeholder input, particularly for NGOs (non-governmental organizations), for site classification.

Comments made by reviewers during the evaluation of this project (PRID 97)

- Appears to be managed relatively well
- This appears to be interacting well with the industry and looking for venues to communicate R&D findings
- A lot of variability nationwide and maybe study should be broken up regionally. For example west coast modular opportunities vs east coast. Larger streams vs smaller streams.
- Brennan discussed interaction by others but could expand upon
- Needs to be as practical as possible
- This presenter seems to dominate (somewhat arrogant?) and I wonder if there are really good project management skills operating here

Question 5: Research Integration, Collaboration, and Technology Transfer

- To achieve the objective of wide stakeholder acceptance will be difficult without meaningful input and collaboration from environmental NGOs. The buy in from NGOs for new stream reach development to be successful cannot be overlooked. During the presentation the PI (Principal Investigator) stated that this project does not contemplate new dams, it is passage modules - or structures that do not disrupt geomorphology... That may be, but new development in undeveloped streams is likely to reach opposition, perhaps for non-science based reasons. More strategic thinking is needed in this area.
- Appears to be good to date
- Appears to be going well in this area
- Referred to passage structures vs new dams
- Seems too political at times and both sides need to be discussed
- Project appears to be well connected between lab and industry, especially the vision of a national testing laboratory facility

Question 6: Proposed Future Research, if applicable

- It is relevant; we need new stream development pushed forward
- There are potential learnings from these biological studies that can apply to the industry and existing fleet
- Federal lab should be beneficial but needs to be well thought out
- I strongly support the idea of a national testing laboratory, this should be pushed forward
- Could the existing white water parks (man-made such as used in the Olympics) be converted to become a hydro testing facility? Potentially this would be outside of FERC jurisdiction.
- Look at LIHI (Low Impact Hydropower Institute) to see if their standards can apply and benefit from lessons learned
- Major opportunity to contribute to business case for hydro testing capability
- Modular approach is good but needs to be traded off against potentially lower capacity utilization
- Why not blend this with the R&D done on materials and methods to drive down total lower costs?

Question 7: Project Strengths

- Aligns well with a stretch vision of new stream reach development
- Concept of the new national test facility
- Research pillars well-articulated
- Modular design
- Site identification

Question 8: Project Weaknesses

- This project is framed around the assumption that "the overwhelming majority of the nation's resource potential comes from new stream reach development" and that various constraints (including environmental constraints) have made conventional new hydropower unfeasible. It includes the objective of achieving wide stakeholder acceptance and approval. It is unclear to me how that will be accomplished.
- I have concerns that any type of new instream development would be very difficult to permit and implement in today's environment. As indicated below I would suggest that the most feasible type of instream development would be high head projects which used a small diversion dam, a flowline, a pen stock and an impulse turbine. There are a number of these projects which could be accomplished in the Western United States.

Comments made by reviewers during the evaluation of this project (PRID 97)
• Need solid plans for water to wire approach for these technologies as they develop • Components should be prioritized so that some can be implemented before others so that the industry can benefit from the results ASAP • Insufficient discussion of other stakeholders that will be involved. For example the civic aspects/viewpoints of stakeholders...not in my back yard (NIMBY syndrome) could completely pole axe these projects. • Define "passage modules" • Not clear on the interconnection aspects **Question 9: Recommendations** • As indicated in the previous comment, I would suggest that a major portion of potential instream projects would involve high head projects on Steve flowing rivers in the Western United States. I would suggest that a compendium of these type projects be developed to identify potentially environmentally acceptable sites for high head project development. • Keep pursuing and sharing lessons learned • Include a needs/gaps analysis with respect for needed future research, e.g. do we currently have adequate numerical models to understand fish passage through turbine, or fish preferences for reservoir collection facilities • Bring some real focus in on interconnection challenges. Yet one more intermittent energy resource in potentially remote sites could be a project killer. • These stakeholders (the NIMBYs) should be brought into the conversation right up front

DOE Water Power Technologies Office 2017 Peer Review Project:

Hydro Research Foundation University Research Awards Program

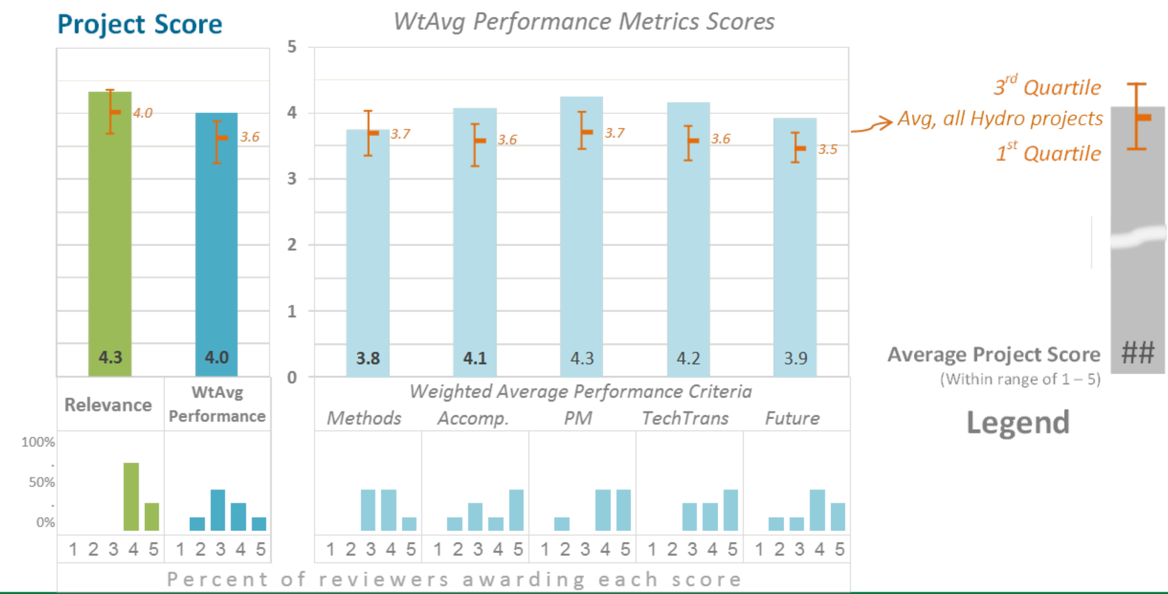
Principal Investigator	Brenna Vaughn, Hydro Research Foundation
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Workforce

FY 2014-FY 2016 Funding

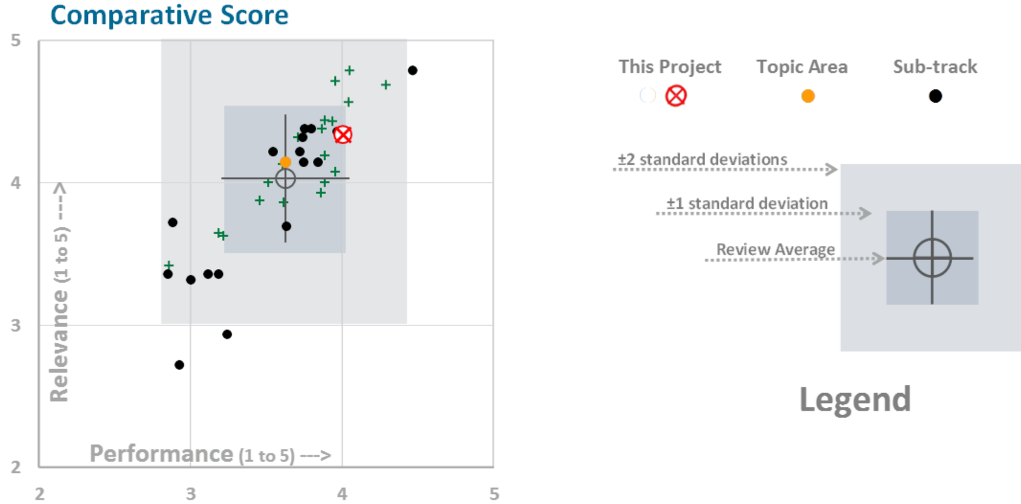
DOE	$ 1.3 M	69%
Cost Share	$ 0.6 M	31%
Total	**$ 1.9 M**	**100%**

Peer Review ID# 132

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 132)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Highly successful effort that has exceeded goals - relevant and impactful to the growth of the hydropower workforce
- The hydropower research foundation program does not provide any benefits for the blue-collar operators required to support the operation of hydropower facilities. A community college effort in La Crosse, Wisconsin focuses on training skilled nonprofessional operational and maintenance personnel. I would suggest that the DOE look at programs in this area in addition to college scholarships to support future industry needs.
- I believe that the Hydro Research Foundation program has provided a valuable tool to promote professional technical employees in the hydropower industry. In the long term these fellowships will result in a number of qualified and skilled technical professionals in the industry.
- This is a great program and is relevant to DOE objectives in Water Power
- Good student participation
- Restricted to DOE funding which should be expanded
- Very good to be looking at trade centers not just Universities and research
- Good project, would be nice if this project could be funded at a higher level!
- Vital to the industry

Question 2: Methods and Approach

- The scale is small, with less than 30 fellows. It would be more impactful if the program was much larger.
- This is proven to be a highly successful design, by engaging experienced industry leaders and building mentoring relationships with bright graduate students
- Good approach and has a repeatable template
- See above
- Trades and crafts are just as important as research or maybe even more important. O&M (Operations and maintenance) becoming very important aspect of NHA (National Hydropower Association)
- Well-conceived method, with a broad steering committee and nice distribution of academic institutions
- Seems under ambitious, goals should be set higher
- This should have industry support from the outset

Question 3: Technical Accomplishments and Progress

- Very high placement rates, with 93% of fellows taking jobs in the hydropower industry. This is extremely impressive.
- The program has a successful track record and appears to effectively bring trained professionals to the industry
- HRF (Hydro Research Foundation) presents the results well throughout the Hydro Industry
- The efforts of the HRF have good measurable results
- Seems to have put through more students than anticipated due to good management
- The population that entered and graduated into the hydro industry (27 or was it 33?) was not clear but by any measure the population is too small

Question 4: Project Management

- Project has been successful in execution, recruiting talented students and mentors, and developing a rich body of technical research
- They have a well-rehearsed template and it's repeatable
- Good management led to good student participation
- Excellent, well thought out management for this project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Excellent coordination with several universities and with industry to identify research topics
- Published research is immensely valuable to the industry, as is the recruitment of talented young potential industry leaders
- They interact well with the industry and DOE
- Good but low ambition. This will not move the needle, yet it should.

Comments made by reviewers during the evaluation of this project (PRID 132)

Question 6: Proposed Future Research, if applicable

- Undergraduate level as well as trades/craft level
- This program has consistently moved individuals from universities into the job market
- Would be nice to include undergraduate projects, curricular development, certificate development
- Leverage the experience gained and take it out to industry (hydro, equipment, interconnection)
- This needs to scale

Question 7: Project Strengths

- This project does an excellent job of coordinating across a diverse group of participants, and collaborating between academia, industry and government. This project has the potential to scale up significantly to help realize some of the workforce shortfalls expected in the next decade or two.
- I believe that this program has been a very valuable tool to bring new professionals into the industry. I would recommend that this be continued.
- Well integrated into the Industry
- Increased number of students
- Looking at ways to increase cost sharing
- Great program, well-conceived, great partners both on the steering committee as well as academia
- DOE has primed the pump

Question 8: Project Weaknesses

- The scope of this program does not include blue collar skilled and unskilled labor
- Continue looking for Industry matched funding and not all dependent on DOE
- Now looking more at trades along with O&M. This is needed.
- Would be nice to have more funding to have this program have a greater impact
- Under funded, should be more industry money in here

Question 9: Recommendations

- This project has the potential to scale up and needs significantly more funding. Perhaps around identifying some of the industry knowledge loss expected as senior industry people retire.
- I recommend that this program be continued since it provides a valuable source of new technical expertise to the industry. I also believe that a program or programs be considered to train blue collar skilled labor at the vocational-technical level.
- Continue funding
- If you have XXX applicants, gear your fund raising to finding these (qualified) folks career opportunities
- In the same way that states collect cents on utility bills to contribute towards clean energy, so this fee should be increased to fund renewable tech job creation

DOE Water Power Technologies Office 2017 Peer Review Project:

South Fork Powerhouse Project

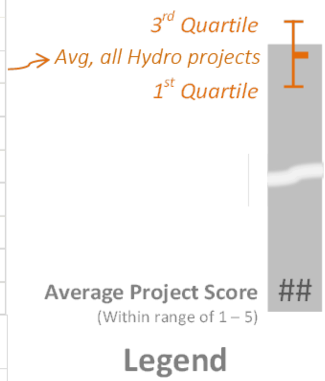
Principal Investigator	David Hanson, Sacramento Municipal Utility District
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Demo Projects

FY 2014-FY 2016 Funding

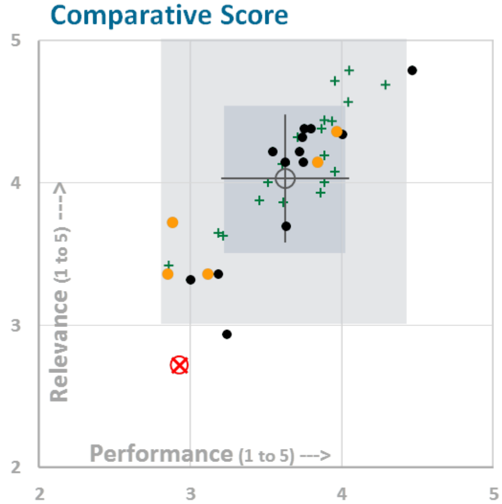
DOE	$ 1.5 M	50%
Cost Share	$ 1.5 M	50%
Total	**$ 3.0 M**	**100%**

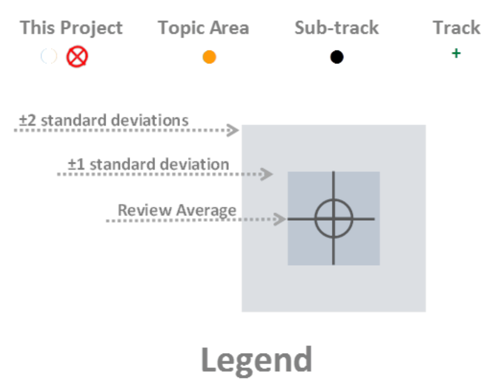
Peer Review ID# 137

Project Score



Comparative Score





Comments made by reviewers during the evaluation of this project (PRID 137)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Addressing the challenges of siting difficulties and cost limitations is very important to effectuate the growth hoped for with new power in non-powered dams. It can be very expensive to newly penetrate existing dams. They decided to use an existing adit as the point of minimum release - but it was 1/4 mile from the dam. So they had to negotiate a new minimum flow for that 1/4 mile segment.
- This project does not seem to involve any specific new technology, but rather a combination of existing technology to capture an increased amount of instream flows. The plan is very site-specific and is likely made feasible by the presence of an adit.
- The feasibility of the project appears to be largely dependent on the existence of an Adit which was part of the original project construction. This is a unique feature which likely does not exist at other projects and does not have widespread applicability to hydropower additions.
- I don't connect with the relevant Water Power and DOE objectives
- SMUD (Sacramento Municipal Utility District) seems to be the utility that can leverage this cost internally
- $70/mW hr
- Demo Project
- Higher Flows with relicensing so let's make power from minimum flows
- Renewable
- Not clear why DoE is investing in this project
- Project focuses on adding a new powerhouse and machines at an existing hydro facility
- If solution works then good, but it looks a long way off
- Looks good on paper in terms of meeting objectives but reality is different

Question 2: Methods and Approach

- Substantial range in minimum flows. The lower range was for summer in a dry year, and the higher range was for spring in a wet year. How can you make power off this range of flows?
- The project appeared to be well designed and well thought out
- They should expand upon their methods and approach from a market standpoint
- Did not want to compromise existing dam
- Will transmission handle this
- Traditional hydro project methods and approaches
- Regulatory issues, while identified, do not seem to have been resolved, hence project looks likely to be stranded
- Not clear that there was any method. Project seems to be a hunt for a re-build with a bolt-on solution.

Question 3: Technical Accomplishments and Progress

- Environmental studies were successfully completed
- Regulatory delays affected project progress. Relicensing began in 2001. It was concluded in 2014. The 401 cert took 6 years. SMUD covered these costs on their own.
- Very difficult FERC (Federal Energy Regulatory Commission) and 401 process but typical expected cost and delays
- 90 % design due tomorrow
- Butterfly valve has been ordered
- Got 401 and special needs project
- Have designed but not constructed
- Have designed new powerhouse
- Starting non-FERC aspects
- Remaining design work underway
- Traditional engineering 50% design
- The Adit seems about the only solution here

Comments made by reviewers during the evaluation of this project (PRID 137)

Question 4: Project Management

- Project appears to be well-managed
- Project Management is anticipating FERC and 401 challenges and is proactive in their management and adapting to schedules
- D. Hanson did good job for complex project in California
- Good team, and seems to be slogging thru the permitting process
- 14 year process.. Project management existed here? Really?

Question 5: Research Integration, Collaboration, and Technology Transfer

- Very closed group with SMUD and MWH
- DOE contribution kept them under 7 cents
- There should have been some. It looks like a Public Works municipally badly run project.

Question 6: Proposed Future Research, if applicable

- This appears to be a "one off" project with only limited relevance to the majority of future developments
- I don't see the value of funding future research on this project
- This is not really a research project
- No idea that this will ever have an IRR (internal rate of return) worth investing in
- If completion of this is a compliance requirement, then let SMUD carry on from here
- This should never have been allowed to get to this point

Question 7: Project Strengths

- Consideration of post licensing flow requirements as an opportunity for optimization is an effective approach that focuses research effort on the practical potential in the real world
- Will generate some great lessons learned on managing new types of FERC and 401 challenges
- Negotiated license with agencies
- Opportunistic implementation of hydro in response to new minimum instream flow discharges
- None evident

Question 8: Project Weaknesses

- The project summary does not provide specific examples of technology transfer to successfully share the outcomes of the research
- Doesn't tie into DOE objectives well
- 13 years to get 401
- Regulatory delays have impacted the project
- Looks like insufficient planning. DOE should not have sponsored this.
- Uncertainty. License amendment in 2014 then 401 license and then the license amendment.

Question 9: Recommendations

- Good example for considering uncontrolled spills and hydropower operation/design
- I would recommend not supporting further funding of this project
- Pull funding

DOE Water Power Technologies Office 2017 Peer Review Project:

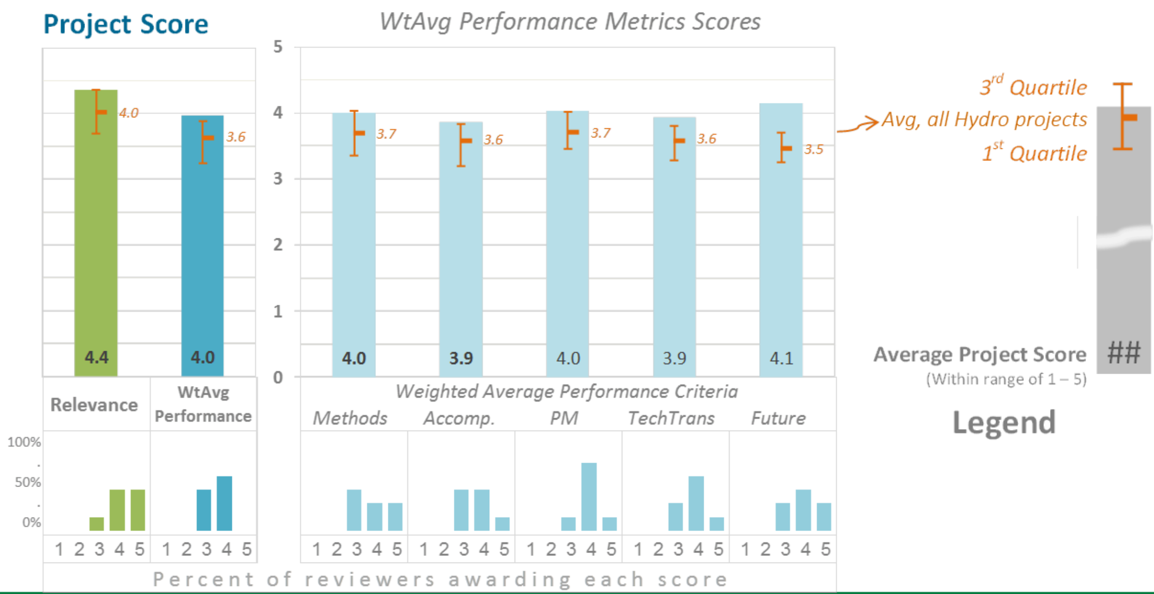
SLH100 Demonstration Project at Monroe Hydro

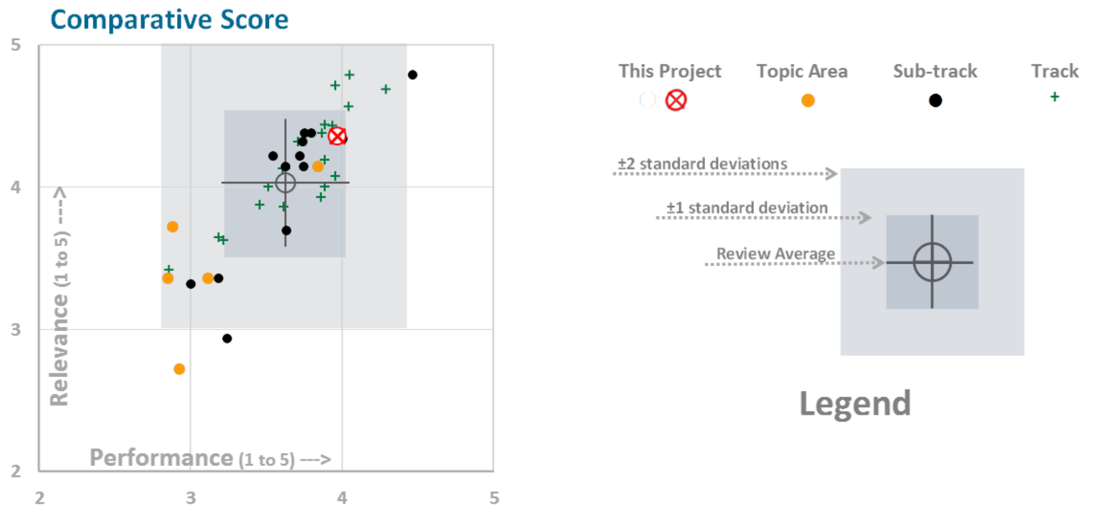
Principal Investigator	Abe Schneider, Natel Energy, Inc.
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Demo Projects

FY 2014-FY 2016 Funding

DOE	$ 0.4 M	42%
Cost Share	$ 0.6 M	58%
Total	**$ 1.0 M**	**100%**

Peer Review ID# 139





Comments made by reviewers during the evaluation of this project (PRID 139)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- The innovation of the powerhouse - potential reduction of cost for applications in existing dams by 80% is a new concept that will impact WPTO goals and help the industry bring more canal projects on line
- This project does a good job of revealing lessons to learn and hurdles and problems that can occur during development (conduit exemption permitting and delays). It is similar to #142 - however this project also involved the first exempt project under new regulatory procedures.
- It does not appear that the economics of this project are comparable to other development scenarios at hydroelectric drop structures. Unless significant cost reductions can be accomplished, this does not appear to be a worthwhile concept to pursue further.
- The efficiency of the system was lower than a reasonable amount for a Hydro facility. This could be offset by a lower project cost, but it was not apparent that this could be accomplished. The resulting cost of $140/MWH is not viable in today's marketplace. Even a cost of $70/MWH is high compared to the current cost of other renewables.
- The project demonstrated an innovative approach to capturing the energy at irrigation systems drops
- Great relevance to Water Power industry needs and DOE objectives
- Very engaging presentation and communicator
- Demonstration project
- New way of thinking about turbine design
- Run of river scheme
- Veins size change provides for more or less power generation
- Novel technology, important for hydro growth
- Very relevant and real practical invention. Few examples of changing the game such that the United States has the chance of developing technology alternatives to the majority of EU based hydro design and manufacturing hydro solutions.

Question 2: Methods and Approach

- The project appeared to be implemented in an effective way. The cost of the project however was too high to be competitive in the current renewable marketplace.
- Very well designed and thought out project
- Was held accountable by partners and delivered results
- Major testing and research concern focused on wear and efficiency of moving parts
- Needs to look closer at manufacturing and supply
- Numerous tests are good
- Too many ideas make it hard to focus
- Unique application of new technology
- This product the SLH100 should now be productized. It's still a deeply engineered product that can only be built by specialist engineers.

Question 3: Technical Accomplishments and Progress

- Turbine innovation - operational benefits from the ability to stop flow without any change in pressure
- Demonstrated innovation in the turbine market
- Demonstrated the success of FERC (Federal Energy Regulatory Commission) small conduit rule with a short licensing/FERC approval. This is transferable lessons learned to the private industry.
- First implementation of the SHL100. Congrats!
- Concern that long term maintenance could be a challenge as would the cost of repairs as there are many moving parts, even though individually many of the parts have been run through long term duration tests

Question 4: Project Management

- Effective project management, PI (Principal Investigator) is highly professional
- Project appeared to be managed in an effective manner
- There appears to be committed PM (project management) to the process with NATEL willing to cover over budgeted cost for travel and startup
- Looking at research options which is good

Comments made by reviewers during the evaluation of this project (PRID 139)

- Now looking at a single stage Pelton turbine being modified into a linear turbine
- Uses standard Francis type unit that is modified to be linear turbine
- Communication to the DOE and via their website has been good, demonstrating confidence in project progress and it would appear in project management

Question 5: Research Integration, Collaboration, and Technology Transfer

- Strong collaboration, particularly with Apple as a partner and with publications in Harpers and Popular Mechanics
- This represents good integration and collaboration. The lessons learned can be applied to new innovation in the linear Pelton machine innovation.
- Abe knew his stuff
- Conduit hydro project on Federal lands
- Numerous tests
- NATEL is doing a good job of getting the word out about this project
- Freedom Mill, ME linear crossflow turbine looks very interesting but not suitable for outdoor operation. Requires powerhouse enclosure....potentially expensive.
- Great invention. Linear Pelton turbine is being developed.
- Natel sees value of direct integration with solar
- Powerhouse design looks good but at what cost?
- True R&D

Question 6: Proposed Future Research, if applicable

- Distributed networks of small hydro, direct integration with utility scale solar. Civil works innovation.
- Yes, the suggested seeded new innovation turbines should be followed and funded
- Looking at a change in powerhouse design where unit is above the tail water
- Looking at various forms of linear turbines
- Continued testing of this technology should be encouraged
- Get to work on lowering cost of manufacture and long term maintenance (I presume that they are developing excellent maintenance records)
- Novel solutions..linear Pelton looks very interesting and extends the product range and options for industry

Question 7: Project Strengths

- Project incorporates an innovative generation scheme that presumably will be less costly than other forms of generation for low head projects. The project team has demonstrated a unique approach and skill set to address the issues of feasibility for low head Hydro projects.
- Project demonstrated real world technology and a true FERC approval process
- Constructed
- FERC exempt and therefore only 7 months
- No change in flow patterns which is great
- Novel application of a new technology, continued innovative turbine development beyond the SLH100
- Civil works flexibility
- Invention
- Technology solutions being adapted for differing products

Question 8: Project Weaknesses

- The relative high cost of generated power is discouraging. Future efforts should be directed at identifying specific features and procedures that could be incorporated to lower costs.
- I have become used to 25-20yr expected life on units prior to major O&M (operations and maintenance) expenses. This unit is tracking at a 10-year expected life prior to major O&M expenses.
- Cost is high and difficult to finance
- Costly
- Every unit is new and difficult to market
- System reliability and need for additional testing
- Agency acceptance (U.S. Fish and Wildlife Service)

Comments made by reviewers during the evaluation of this project (PRID 139)
• Always a challenge to sell this to the bankers? What's the IRR (internal rate of return)? How do I know that if I lend you money that the product will work for 20 years and debt or equity payback can be achieved? • Not evident that this is a financeable product. Still needs "angel" buyers. This must be worked on. • Risk of loss of focus. Company must perfect one solution and make it repeatable. Otherwise this becomes novel yet un-implementable. • Still high cost of LCOE (levelized cost of energy) • Which markets (canals? run of river? steam flow?) is this best suited for **Question 9: Recommendations** • DOE should continue to support NATEL's innovation projects • Should continue sharing lessons learned into the 2017/2018 Hydro industry • Very innovative company, should be encouraged to continue product development • Example of where Wind and Water should be closely collaborating (on composite manufacture) • Companies are bandying about LCOE but I think that this is inconsistently calculated. DOE needs to jump in here as failure to control this metric will lead to big cost advantage claims that could be disproved. • Focus of productionization of SLH100 and drive component and system cost out • Must work on the sale of this product as a commercial solution as opposed to an engineer’s dream • This product could go into the Hydro research center if DOE EERE can fund and establish one

DOE Water Power Technologies Office 2017 Peer Review Project:

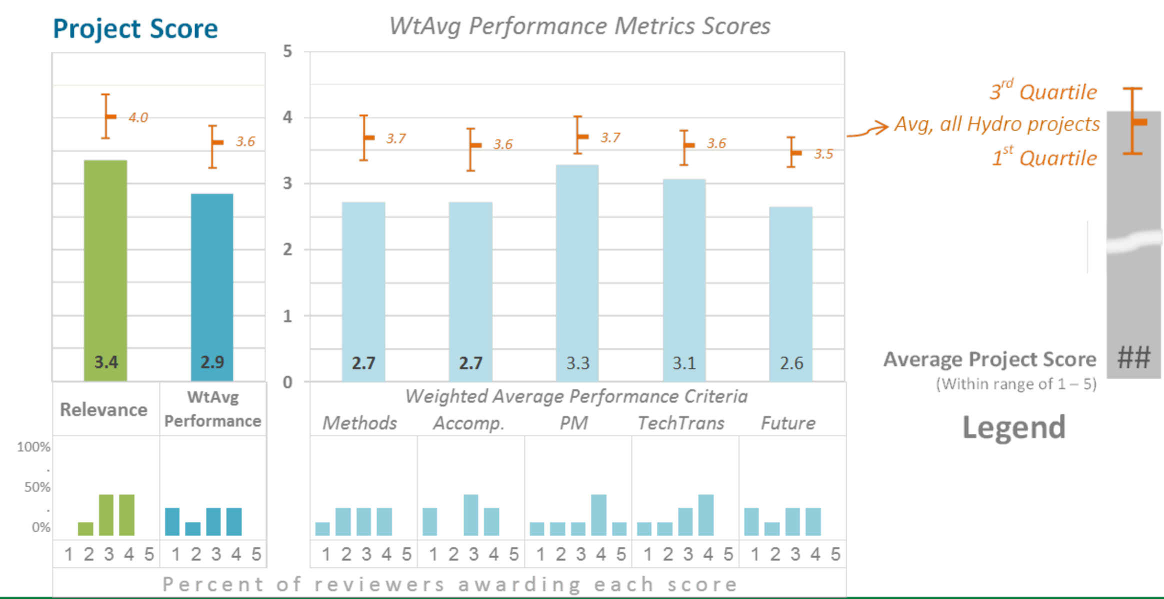
Harnessing the Hydroelectric Potential of Engineered Drops

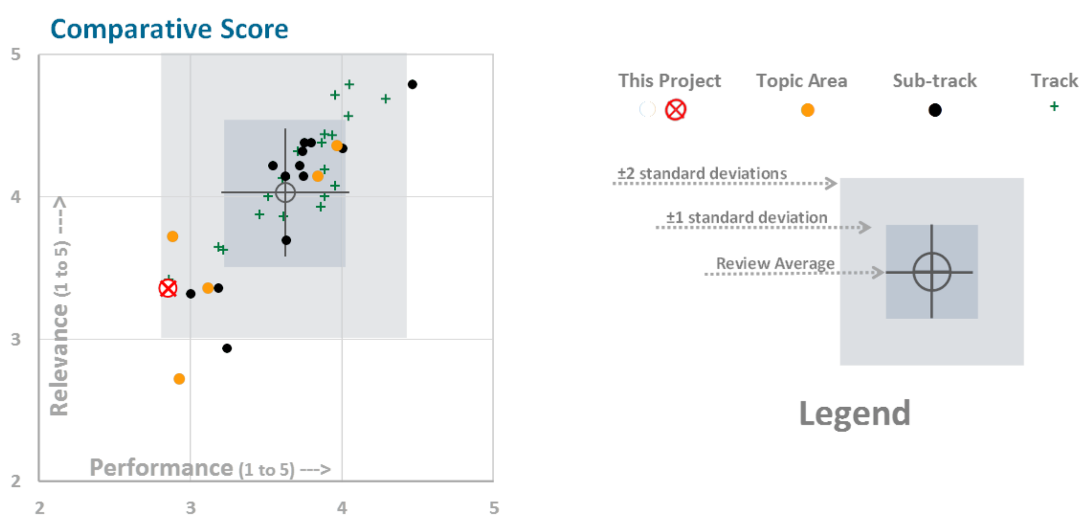
Principal Investigator	Jerry Straalsund, Percheron Power, LLC
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Demo Projects

FY 2014-FY 2016 Funding

DOE	$ 0.8 M	75%
Cost Share	$ 0.3 M	25%
Total	**$ 1.1 M**	**100%**

Peer Review ID# 140





Comments made by reviewers during the evaluation of this project (PRID 140)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Growth - facilitate mechanisms for testing… Sustainability - design new hydro systems that minimize or avoid env impacts. Final deliverable is to construct a large screw plant. Ultra-low environmental impact using man-made drops and infrastructure.
- The use of new technology involving the AHS (Archimedes Hydrodynamic Screw) system has promise for use in a variety of situations. These include canal drops and low head hydroelectric projects. This technology has been used in Europe and appears to have a number of potential applications in the U.S. market.
- This type of turbine is not new, however, the use does tie into the DOE objectives using irrigation canals
- Archimedes Hydrodynamic Screw (AHS) at low head project in large irrigation canal
- Could not obtain suitable PPA (power purchase agreement)
- NOT A RESEARCH PROJECT
- Addresses multiple HydroNEXT areas
- Novel machine technology, used in Europe, but no current applications in the United States
- Implementation of a proven technology, new to the United States and suitable for both conduit and run of river

Question 2: Methods and Approach

- Project is on hold until they can find a suitable power purchaser. Percheron partnered with local coop utility to interconnect as PURPA (Public Utility Regulatory Policies Act) QF (qualifying facility). Supplier petitioned FERC (Federal Energy Regulatory Commission) to charge a penalty fee to recover their power cost if coop buys the QF power. Now they are looking for other off-takers. They are in Colorado.
- Good methods and approach to the project and deliverables
- Not sure DOE should be investing in these sorts of projects
- Seems like too big an investment for DOE and presently not a viable project
- Would be on Bureau canal
- Standard site development approach for the civil structure, unique turbine
- Three (3) turbines producing 4mkw. Sounds expensive, should have run the numbers earlier.
- Poor early identification of site
- Seems to have stumbled from one site to another, looking for a home

Question 3: Technical Accomplishments and Progress

- Obtaining a power purchase contract with sufficient revenue to support new construction is a major challenge in the development of new hydropower projects. Although the project has not progressed as quickly as originally proposed, this is due to a market situation rather than poor management.
- Great technical accomplishment and progress up to the FERC challenge with bringing the energy to market at a recoverable rate
- Not a research project
- After 6 years, little to show
- Poor implementation of what is a great idea damages the industry and others trying to implement the same technology in other locales

Question 4: Project Management

- The project generally seems to be well-managed. The issue related to obtaining a favorable power purchase arrangement is a challenge for any project.
- Good project management through the process. Very cost conservative.
- Seems well managed by Jerry Straalsund but no PPA has been received
- Project seems to be effectively managed and on track, however still awaiting PPA
- Program management here seems to be a misnomer

Question 5: Research Integration, Collaboration, and Technology Transfer

- Involving canal operators, the BURec (Bureau of Reclamation), and local utilities throughout the process was a good idea for collaboration
- This is moderate in that it is using a very old proven turbine technology. The uniqueness is applying this technology to canals which represent an untapped resource.

Comments made by reviewers during the evaluation of this project (PRID 140)

- 15.9 ft head, 1,000 cfs 1 MW, 4,000 MWh / year
- Technical challenges but added to extended viability of the existing site
- To demo that AHS is cost effective and works
- Would be a good example of AHS if they can get the project completed
- No evident outreach to others who could have helped

Question 6: Proposed Future Research, if applicable

- Wants to develop more AHS sites in Montrose valley. Does this make sense if they can't find an off-taker for this project?
- I believe that this technology has the potential to be utilized for smaller low head projects. The ability to install generation at these type projects without extensive excavation or civil work is critical. Additional work is needed to provide more information on utilization of this technology.
- I support continued support of funding to complete this and spring boarding into composites and more efficient drives/coupling for canal screw turbines
- Cost of moving turbine around the United States
- Fish friendly
- Overseas the AHS is environmental turbine of choice?
- Value of ancillary benefits
- Demonstrate the functionality of an AHS
- Would love to see this work but a lot of money has gone into a badly run project

Question 7: Project Strengths

- The limited civil work required for installation of the generation is a major advantage of this technology. The project costs were increased by the need to reconstruct the adjacent drop structure. This would not be an issue on many or most projects.
- Demonstrating a technology that economically taps canal power with a proven industry product
- Novel technology for small irrigation canals
- Great technology

Question 8: Project Weaknesses

- Why use such fish friendly technology in canal systems where fish are typically not present?
- The overall power market is a major concern. The need to increase civil costs to reconstruct the adjacent drop structure also increASED PROJECT COSTS.
- Market trends and cost are a hurdle for sustainability
- DOE $700K
- Even with 72% efficiency
- No PPA
- Power Market has decreased
- Tristate is now $38/MWh and development rate is $70/MWh
- U.S. transportation costs
- Waiting for a PPA
- Has taken project funding away from other similar projects which could have got to market even faster
- Poorly executed. Delays, lack of planning.
- Established a poor reputation for a new technology. This started in 2011.
- Issue for canals is the low flow/dry run for irrigation sites
- Transportation costs are a killer
- Will never hit an IRR (internal rate of return), crazy not to have secured a PPA earlier. Project should have been suspended pending finding a PPA.

Comments made by reviewers during the evaluation of this project (PRID 140)

Question 9: Recommendations

- It sounds like the price of power in Colorado that the wholesale purchaser is willing to pay is not an accurate number, doesn't reflect some externalized costs
- Cautiously support and narrow the focus to proving new composites, drives, and gearing from the screw turbines
- Companies are bandying about LCOE (levelized cost of energy) but I think that this is inconsistently calculated. DOE needs to jump in here as failure to control this metric will lead to big cost advantage claims that could be disproved.
- Good product for a DOE EERE Hydro demo site
- Having said all that, the Archimedes Screw Turbine is a great solution for canals
- Transportation studies and cost. Have to locate close to point of entry to the United States. Long distance transport costs are a killer.

DOE Water Power Technologies Office 2017 Peer Review Project:

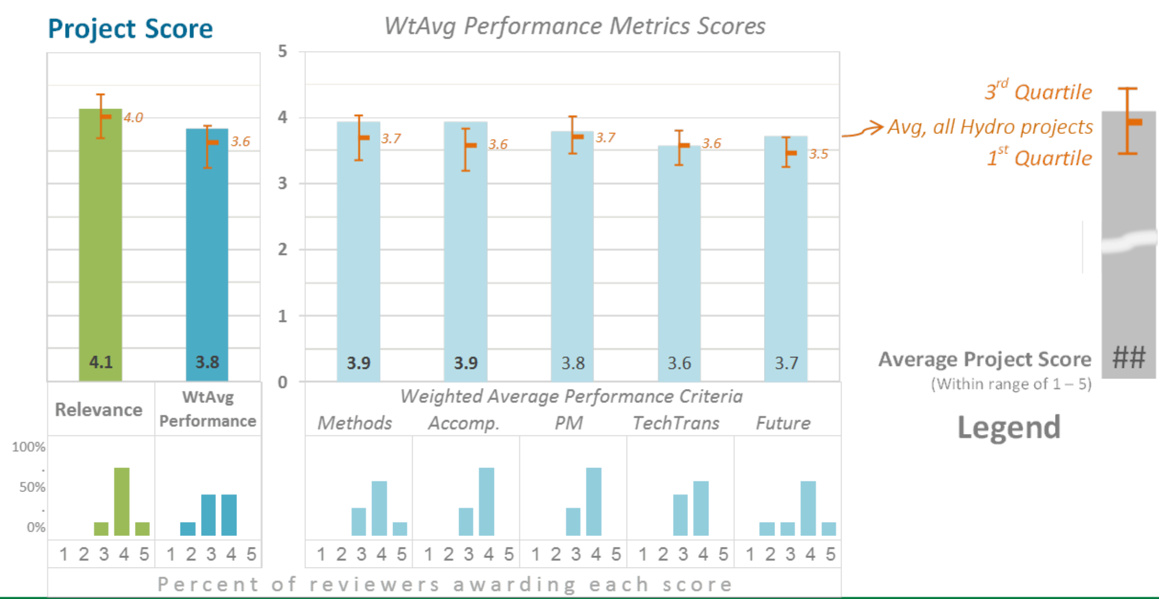
Demonstration of Variable Speed Permanent Magnet Generator at Small, Low-Head Hydro Site

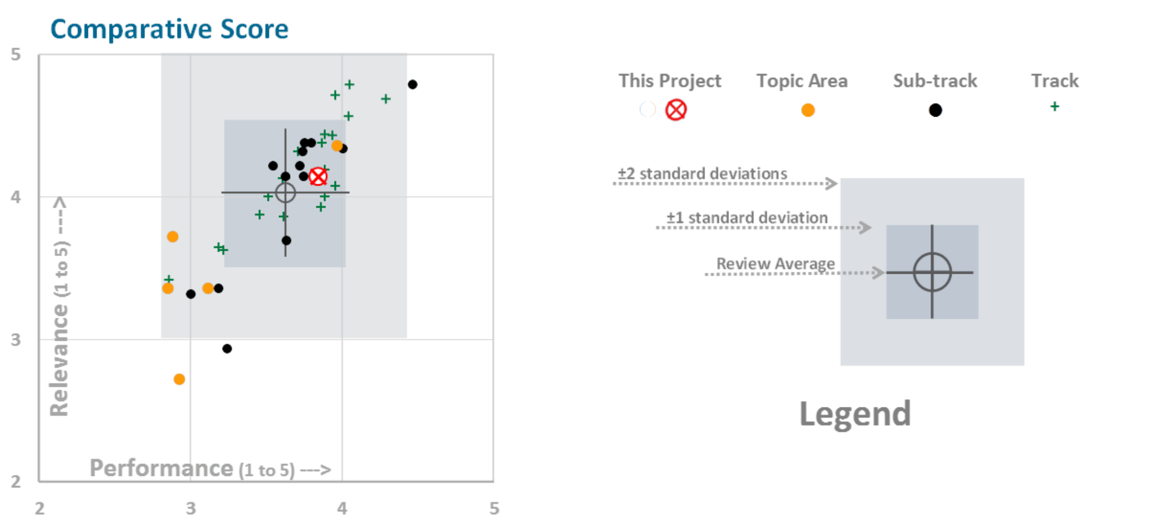
Principal Investigator	David Brown Kinloch, Weisenberger Mills, Inc
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Demo Projects

FY 2014-FY 2016 Funding

DOE	$ 0.1 M	40%
Cost Share	$ 0.1 M	60%
Total	**$ 0.1 M**	**100%**

Peer Review ID# 141





Comments made by reviewers during the evaluation of this project (PRID 141)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Fixed speed generators are not well suited for small hydro, causing low efficiencies. The wind industry is using all variable speed. This work is very important for identifying technology on display in other industries and leveraging it to improve hydropower efficiencies.
- This project is also relevant to optimization - water use efficiency of existing fleet. It appears that the technology could be installed in existing projects, having a very significant effect in optimizing existing resources.
- Additional work on larger projects would provide more information on whether variable speed technology could improve the overall power production and provide an economically justified approach to projects both with relatively constant heads and with variable heads
- I question whether this technology would be useful for projects with relatively constant heads like navigation projects or whether the major benefit would be from lower head projects with variable heads
- This technology seems to have a considerable amount of potential
- Good presenter and passionate about his work
- Good testing of off the shelf products to improve an existing fleet
- Looked at wind industry to assess magnetic generators which is very good
- Needed research to increase efficiency at low head projects
- Optimization leading to growth potentially
- Very relevant for low head variable flows

Question 2: Methods and Approach

- Using placebo data collection is a common sense approach. Permanent magnet generator with an off the shelf variable frequency drive. Useful with net metering.
- The approach seemed to be good and to provide good results
- Showed good flexibility
- They adapted with the project as it evolved
- Applied wind research to hydro industry is great
- Good to compare existing system with new system. Collected data from both.
- Independent data collection is important so numbers are believed
- Most of power is used in mill but a net metering state so they can put power into grid
- Existing technology with a new application
- Like the optimal speed algorithm and approach
- Still looks like a research project with some elements ready for market but others not

Question 3: Technical Accomplishments and Progress

- Also, plant operators do not have to know the optimal speed - the system figures it out automatically. This is important for acceptance and successful transfer.
- Significant 96.4% higher annual energy production. The ability to slow the turbine down when head lowers, to keep the generator operating at optimal efficiency all the time. Hydro is more suitable for this application than wind, because the change in wind flow volume happens suddenly, while water flows alter more slowly.
- The demonstrated results were impressive. The question is can similar results be effectively obtained on large projects?
- It delivered proven results using off the shelf projects and minimizing Civil and Mechanical design components
- 96 % increase in annual energy production but not at every site. Hourly optimized speed is found. Sounds like this is good.
- Graphs showed power generation stopped at 5 feet head
- Put in variable speed generator
- Replace induction generator with a magnet generator
- Good performance results showing increased efficiency and greater operating range
- Claims that the big breakthrough is the use of a Variable Frequency (Speed) drive (VFD), however VFD's have been used in low head hydro (e.g. the Archimedes Screw Turbine) for the past 10 years
- Could the combination of VFD and PMG (permanent magnet generator) be the real breakthrough?

Comments made by reviewers during the evaluation of this project (PRID 141)

- Did not explain the relevance of the Permanent Magnet Generator (PMG). Are this and the use of the VFD more significant?
- Not sure that this project is real invention

Question 4: Project Management

- Three delays - first the placebo data collection happened in a year when there was a drought so they had to wait another year. Second - figuring out how to use the off the shelf drive. Third, the 100 year old mill with oak beams was starting to collapse; they had to build a suspension system to hold it. None of these delays indicated poor management.
- The project seemed to be effectively managed
- The Project Management was adaptable to the changing conditions and control points beyond their control
- Hard to tell
- Appropriate team and good management
- Nothing impressive here. VSDs (variable speed drives) have been used in hydro, wind and manufacturing industries for years.

Question 5: Research Integration, Collaboration, and Technology Transfer

- Great job encouraging the Center for Applied Energy Research to expand beyond coal research. This is significant because it is a breakthrough accomplishment, convincing an organization previously uninvolved in hydropower to expand their work and focus on hydropower.
- Worked well with manufacturers and have proactively shared their input in the Hydro Industry
- Used wind magnetic variable speed turbines
- 2 Conference papers have been presented, would be nice to have a paper in the peer reviewed literature as well
- Leveraged variable speed generator technologies from the wind industry

Question 6: Proposed Future Research, if applicable

- Wants to research retrofitting these variable speed drives onto existing generators at existing plants
- This is a great project to continue funding to help small hydro improve efficiency using off the shelf components
- Can retrofit variable drive at existing facilities? Variable drive can add 10–15 %.
- Flight turbines with variable drives will be used in new projects. Does the powerhouse size need to be increased?
- Should also benefit small modular pumped storage
- Planning to implement at other, larger projects
- Not sure this has many legs on it unless the VFD and PMG combination is a breakthrough

Question 7: Project Strengths

- This project highlights the capacity for better operational efficiencies by small hydro operators in a manner that is automated
- The results for one project are impressive. The demonstration project however is a relatively isolated example and the ability to transfer this technology effectively to other sites is a key question.
- Good real world application and can help relieve the cost burden from small hydro by R&D on this off the shelf product
- Can use off the shelf variable drive
- DOE bought equipment and developer designed and installed
- Payback in five years
- Used clear power
- Good project, looking to gain efficiency on the generator side
- Permanent Magnet Generator
- VFD

Question 8: Project Weaknesses

- Partner with ORNL on applicability to small scale modular PSH (pumped storage hydropower)
- Need to oversize wire and drive
- Does not look like a rigorously run project
- No idea of the IRR (internal rate of return) for this project

Comments made by reviewers during the evaluation of this project (PRID 141)
Question 9: Recommendations • This work seems to be something that would be very useful to small owners faced with relicensing under new procedures - the increase in generation could assist their bottom line • Continue to support • Companies are bandying about LCOE (levelized cost of energy) but I think that this is inconsistently calculated. DOE needs to jump in here as failure to control this metric will lead to big cost advantage claims that could be disproved. • Example of where Wind and Water should be closely collaborating (on the VFD) • Could this be used with the Archimedes Screw Turbine. Replace the gearbox and generator with the Permanent Magnet Generator 4-quadrant ABB drive off the shelf. Mc Cleer Power Technology Implementation.

DOE Water Power Technologies Office 2017 Peer Review Project:

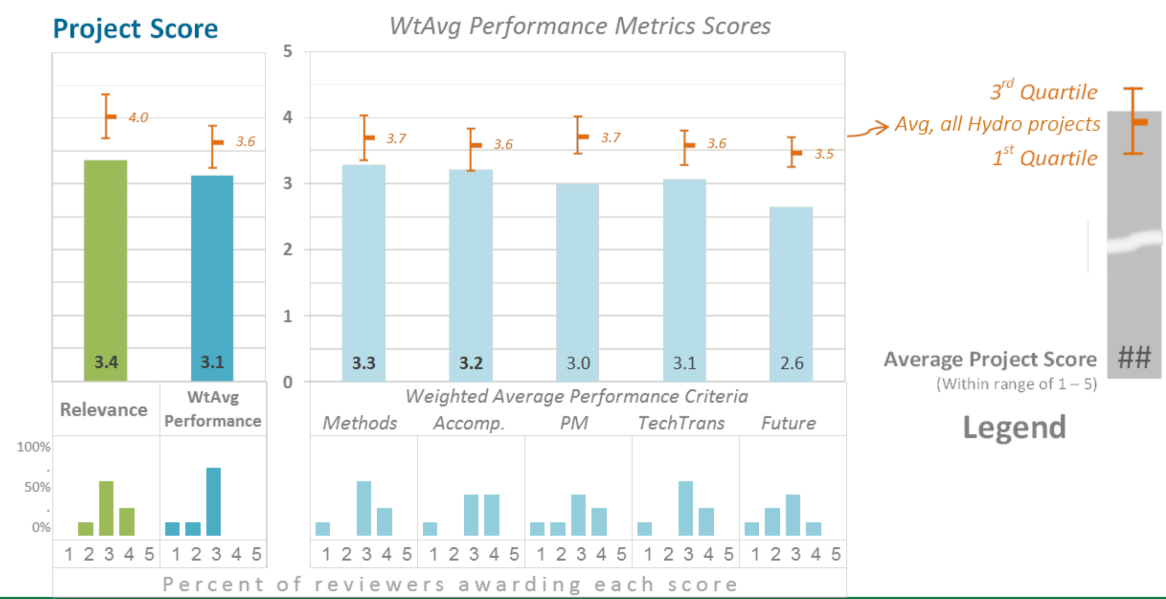
The 45 Mile Hydroelectric Project

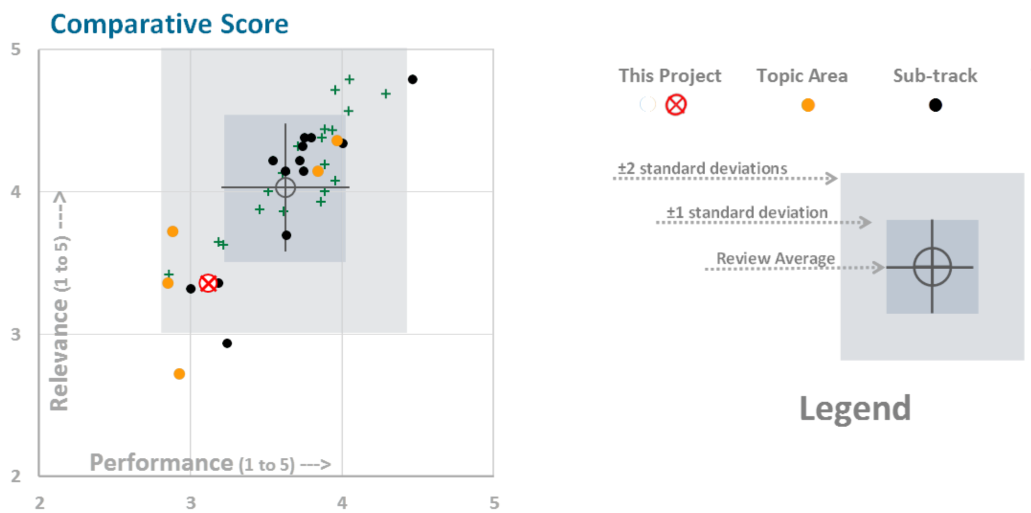
Principal Investigator	Jim Gordon, Earth by Design Inc.
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Demo Projects

FY 2014-FY 2016 Funding

DOE	$ 1.2 M	18%
Cost Share	$ 5.5 M	82%
Total	**$ 6.7 M**	**100%**

Peer Review ID# 142





Comments made by reviewers during the evaluation of this project (PRID 142)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- This project is intended to address the challenges currently inhibiting hydropower growth, assuming that delays, costs and permitting issues are the main culprits responsible for limited hydropower growth. However it is not clear that the research involved in this project was unique or identified a specific problem that is not inherent generally in hydropower development.
- An installed cost of $3200/kw is impressive. The project however did not demonstrate any significantly new approaches to hydropower on existing canal structures. Although the off the shelf Canadian Hydro turbines were referenced, there was no description of how these were unique or innovative. Overall the project appeared to be relatively routine and did not contain any new approaches.
- The $3200/kw as mentioned previously, is good, but with a head of 104 feet does not appear to be an unusually low cost
- Didn’t demonstrate that new of a technology
- Shows the relevant impact to installation of small hydro in an economic environment
- A PPA (power purchase agreement) with Apple is good but not sure of the details
- Did DOE only provide demonstration dollars? They should have supplied their expertise.
- Good demonstration project but Rick Brown did not seem knowledgeable enough about the project
- Should have addressed tax credit more
- Total cost of $5.7 M with a 35% capacity factor. 100 ft of head?
- Unique application of hydro on an irrigation channel, this is an important potential growth area
- Good extension of research for small scale hydropower

Question 2: Methods and Approach

- Well designed and managed
- Willing to move sites and be flexible
- Demonstration Project
- Standard methods were used
- Seems to have achieved the objectives

Question 3: Technical Accomplishments and Progress

- Civil footprint minimal because the canal already existed
- The civil work concepts used in this project were generally available in the 1980s. The only distinctive feature appeared to be the CHC (Canadian Hydro Components) off the shelf turbines which were not described in any great detail.
- Plug and play/ not challenging. Good staying within a canned product from CHC.
- Difficult since Rick put into a difficult position
- Project was built and completed, up and running. Limited data was presented.
- What explains the growth?
- What was the timeline 5 year project???

Question 4: Project Management

- Advanced project management
- It appeared to be a generally well-managed project
- Solid project management was demonstrated
- Maybe Jeff Gordon managed project OK but difficult to tell
- The term 'advanced' project management was stated, but nothing seemed advanced
- Questionable project management

Question 5: Research Integration, Collaboration, and Technology Transfer

- Conference presentations and one magazine article
- Good collaboration between labs, industry and the private sector (Apple)
- Needs to share the CHC quality results and technology to the Industry during 2017/2018 events
- Several publications were listed in the summary

Comments made by reviewers during the evaluation of this project (PRID 142)

Question 6: Proposed Future Research, if applicable

- Broader publication of lessons learned / technical roadmap is a good idea. However repeating the exercise at additional sites is not the best use of DOE funds.
- I don't recommend more of these type unit demonstrations. It has been proven successfully.
- Nothing other than lessons learned or additional sites was mentioned
- Objectives are good but what will incent people to continue to invest?

Question 7: Project Strengths

- Solid technology
- Novel area of application
- Got bought by Apple, potentially proving the ROI (return on investment) and the ability of such projects to attract money to scale

Question 8: Project Weaknesses

- I do not believe that the project provided any significant new information related to the use of canal drops
- Can these results transfer to the private sector is yet to be proved
- Poorly presented with limited information provided
- Shame that the project owner could not present. The poor sod who had to do the job failed to sell this well. Unless there is a family emergency then it should be an obligation for the project owner to present his case.

Question 9: Recommendations

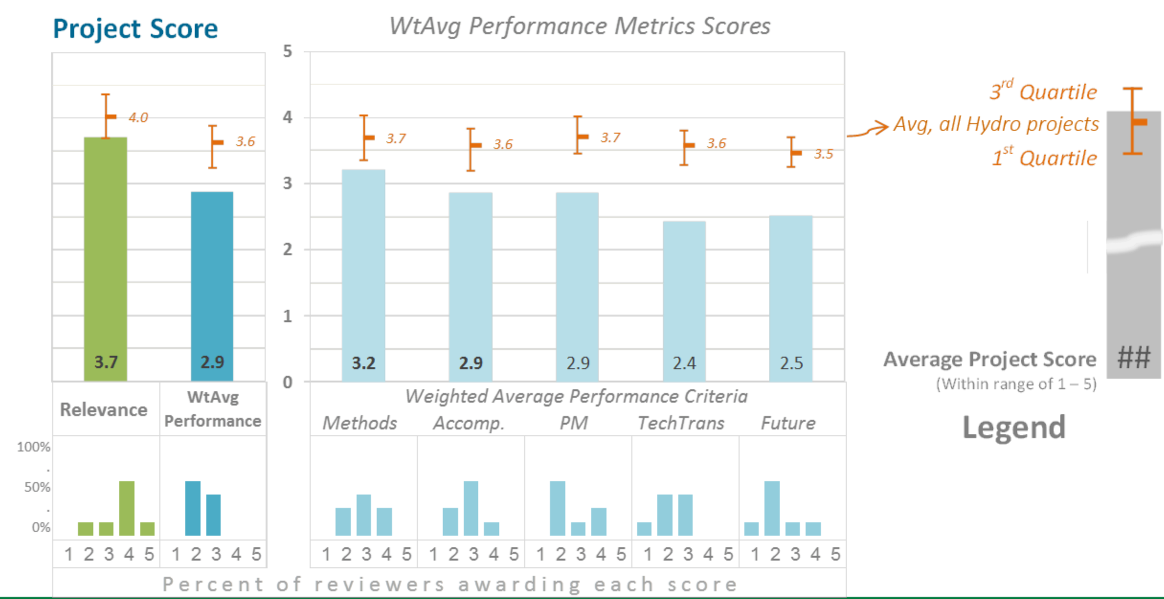
- Promote and educate Industry on the project and lessons learned
- Companies are bandying about LCOE (levelized cost of energy) but I think that this is inconsistently calculated. DOE needs to jump in here as failure to control this metric will lead to big cost advantage claims that could be disproved or never realized.
- Leverage the Apple relationship into other projects. What multiple of future revenues or actual cost was achieved in the sale?
- Very poor presentation

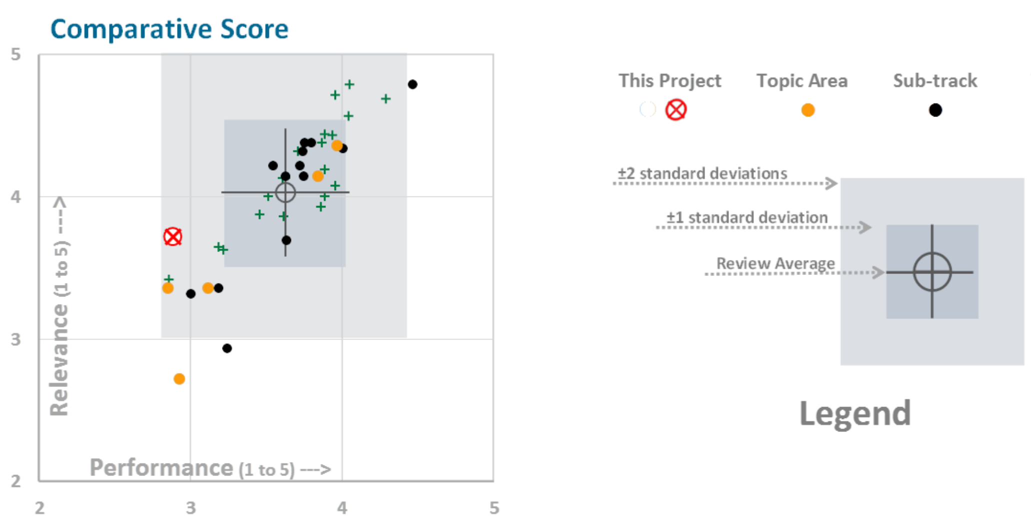
DOE Water Power Technologies Office 2017 Peer Review Project:

Demonstration of a New Low-Head Hydropower Unit

Principal Investigator	Wayne Krouse, Hydro Green Energy, LLC		
Track	Hydropower (Hydro)		
Sub-track	Growth		
Topic Area	Demo Projects		
FY 2014-FY 2016 Funding			
	DOE	$ 1.5 M	100%
	Cost Share	$ 0.0 M	0%
	Total	**$ 1.5 M**	**100%**

Peer Review ID# 143





Comments made by reviewers during the evaluation of this project (PRID 143)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Hydro Green Energy is a IPP (independent power producer) attempting to develop a low cost U.S.-made low-head turbine for use in federally owned lock and dams. Utility scale - about to start the 408 process with Corps. Goal is to reduce the LCOE (levelized cost of energy) for low head turbines.
- Although the projected costs appear very attractive, I have doubts that the final project costs including the civil construction costs will meet the current estimates. My experience with the Corps of Engineers indicates that there will likely be a number of project requirements that will add to the civil work costs.
- I am unclear as to how the turbine technology developed for this project could be transferred to other projects
- I'm not sure how this project fits in to the overall goals of advancing hydropower. The project appears to be focused on developing an alternative turbine manufacturing capability that results in a product that is similar to that available on the market.
- The implementation of this project is based upon the fact that the Braddock Dam has concrete filled sheet pile cells. This structure is relatively unique and the proposed project configuration would not be transferable to many other project sites.
- Modular build turbines are not new but the production of an affordable modular bulb turbine that the small hydro industry can afford is an objective
- 800 kw design
- Demo on Monongahela River
- Full scale not unto 2016
- Hydro Green Energy Modular Bulb Turbine
- Tested at Alden
- Novel technology, with nice integration potential at navigation dams
- Growth and optimization Braddock lock and dam is the site $17-18 Million project 5.75MW
- Invention
- U.S. manufacture

Question 2: Methods and Approach

- Hoping to deploy at 20 sites. Fish studies, no coffer dam involved. Feasible and thorough.
- I have significant doubts that the final design and as constructed project will come in within the estimated costs
- This project is showing the known road blocks of working through 408 hurdles and FERC (Federal Energy Regulatory Commission) process with these types of sites
- Modular Bulb Turbine
- Wanted robust system that was efficient
- Modular approach appears to offer advantages, but FERC licensing process appears to be negatively impacting adoption
- Not sure how much up front planning and feasibility testing went into this
- Ten years and insufficient progress

Question 3: Technical Accomplishments and Progress

- There was little information regarding the proposed civil construction, although the project description indicated that this would be a major focus of the project
- The development of the alternative turbine appears to have been based upon reasonable testing and design. The result however does not represent any new technology, but rather a presumably less costly alternative for a bulb turbine.
- The achievement of progress on licensing and permitting is lacking
- The technical accomplishment in bringing new competition to small modular bulb turbines built in the United States is a good accomplishment
- 408 from USACE (U.S. Army Corps of Engineers) and Corp will do their own EA (environmental assessment)
- Alden modeling
- Model test around 80% but return is higher since not a lot testing
- Regulatory permits from FERC

Comments made by reviewers during the evaluation of this project (PRID 143)

- Still waiting on FERC license so unknown when or if the project will be completed
- None evident yet as far as I can see

Question 4: Project Management

- Expensive and lengthy timeframe
- Investors wanted EPC which is more expensive and takes longer (engineering, procurement, construction)
- The overall impression was that the project management was not aggressive from a time/performance standpoint
- I'm concerned that the project makes it to market
- Project Management appears to be slowed and disrupted by the 408 and COE (Corps of Engineers) interactions
- Not sure if project should be continued. Even needs 408 at this stage.
- Seems like it is in flux with a number of COE issues
- Team appears to be effectively working with the Corps
- This looks like a badly planned project, whose cost alone should have killed it

Question 5: Research Integration, Collaboration, and Technology Transfer

- The project did not describe any technology transfer. Is this because it is a project within the Corps?
- There does not appear to have been a lot of technology transfer to date. Hopefully this will improve as the project nears completion.
- Seems to be somewhat closed with integration and collaboration outside of their scope and dealings.
- EPC or not?
- Nothing really to report, until project gets built
- It appears that little has been sought yet this should have been a necessary element of the project

Question 6: Proposed Future Research, if applicable

- Future research appears to be milestones related to completing this project - and not separate or additional research topics
- This project appears to be site specific and I am doubtful if further research would be valuable to the overall industry
- I would put this on the lower priority for support
- Alden was not optimization but more just installation studies
- Braddock L&D (Locks and Dam) 5.25 MW 7 units rated at 750 kW
- Field testing of full scale machine
- Project seems to have lost its way

Question 7: Project Strengths

- Developing better U.S.-based competition of turbine vendors similar to MAVEL and CHC (Canadian Hydro Components)
- Robust more off the shelf machine and therefore not the high efficiency costs
- Novel, modular approach, should be encouraged to continue development
- Invention

Question 8: Project Weaknesses

- 408 challenges could block bringing the project to market
- Seems closed to their team and interactions
- Around $3,000/kW
- Not yet fabricating and no installation
- Separate powerhouse for each unit?
- Impediments of the permitting process
- Late in coming to decision on the EPC
- Schedule challenges
- Seems like too much discovery on the way and therefore surprises

Question 9: Recommendations

- Maybe consider cutting losses and walking away from this project
- Pity to see this stumble as it should have been good and relevant to DOE EERE objectives

DOE Water Power Technologies Office 2017 Peer Review Project:

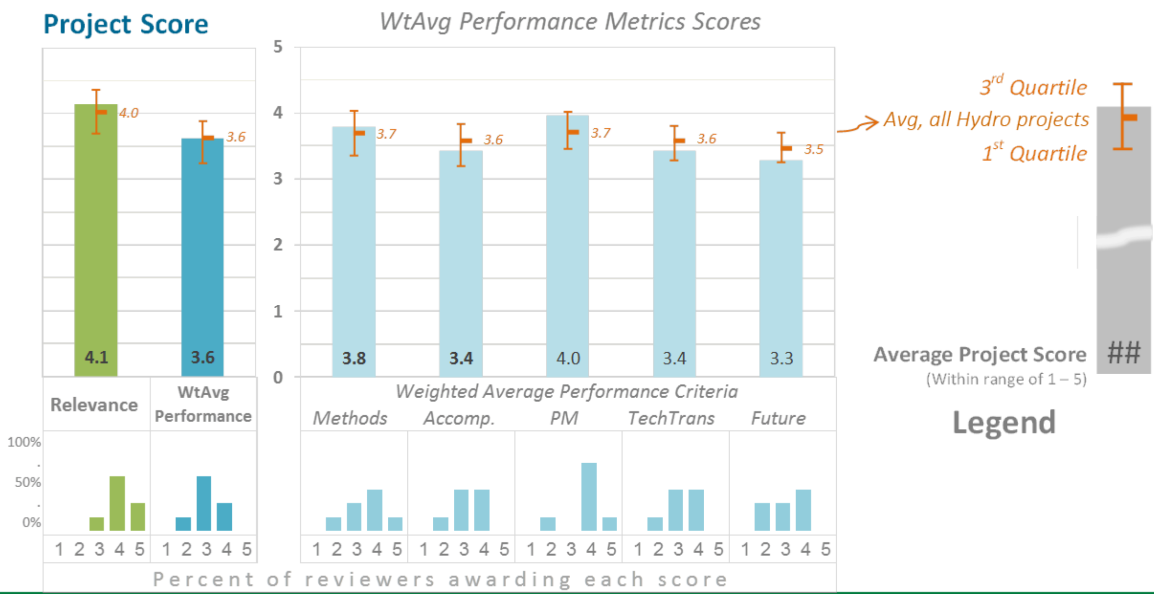
Workforce, Education, and Training Needs Assessment for U.S. Hydropower

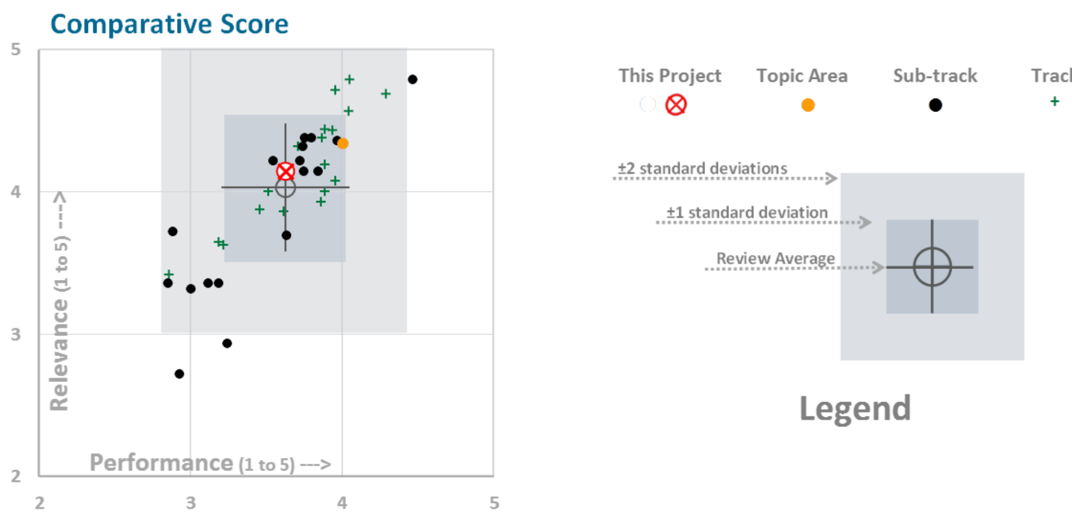
Principal Investigator	Jay Paidipati, Navigant Consulting, Inc.
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Workforce

FY 2014-FY 2016 Funding

DOE	$ 2.0 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 2.0 M**	**100%**

Peer Review ID# 159





Comments made by reviewers during the evaluation of this project (PRID 159)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- A comprehensive assessment of workforce needs for the hydropower industry is valuable to both the WPTO goals and industry needs
- The development of trained and skilled personnel in all areas of hydropower is critical to the future of this generating resource. I believe that the research to date has done a good job at providing a framework to estimate future needs.
- I would have liked to see a more definitive product on the recruitment ideas
- This is a relevant topic
- Good overall but they were directed to use the DOE forecasts
- Was this funded by NHA (National Hydropower Association) also?
- Nice project, fits nicely with the growth program
- Fundamental to change the industry from an O&M (operations and maintenance) mentality to an innovative disruptive industry
- I think this topic is incredibly important I am just not convinced that this is the right approach. We need training and an educated workforce for our existing facilities so there are already some gaps. It isn't just about growth although that will exacerbate things.

Question 2: Methods and Approach

- Focus on direct jobs with markers for 2020 and 2030 to allow for more immediate initiatives. One stated objective is to identify skillset gaps and determine if additional training programs will be needed.
- Simply stated, the first step is to assess the current state, then forecast growth, and finally identify gaps and make recommendations
- The approach appeared to be systematic and effective
- It was well designed and had an efficient approach
- Sound approach but did use DOE forecasts
- Well defined approach, models and methods
- Good focus on risk of loss of institutional knowledge
- Programs should start before college, bring in hydropower education (technical, history, renewables) at high school so that kids have an idea of where they might want to focus at college
- Should tie this into corporate America. Who are the industry Green Leaders (eg. MS, Apple, Google etc.) ? This would add some sparkle.

Question 3: Technical Accomplishments and Progress

- The final report is in departmental review. How will it be disseminated?
- There appears to be good progress
- Decent technical accomplishment
- I would like to have seen the results to better gage these responses
- Good analysis based on information provided
- Ripple effect leads to added jobs development which should have been considered
- Results nicely organized based on potential future scenarios of hydro development
- The presumption is that traditional hydro is the job creator. I would argue that small scale distributed hydropower has a larger potential to develop more jobs, more variety and more interest
- Work with the clean energy centers in the States, they have intern programs that are subsidized and hydropower is not on their radar

Question 4: Project Management

- Seems to be efficient and worked well throughout the Industry
- Suggested that we look at all renewables including hydro, wind, solar
- Standard project management, nice that the project was aligned with the HydroVision Project
- Well organized across institutions

Comments made by reviewers during the evaluation of this project (PRID 159)

Question 5: Research Integration, Collaboration, and Technology Transfer

- The PI (Principal Investigator) did not present the report itself or the findings. How the report and findings will be disseminated is not clear.
- Should consider stronger publication of results at 2017 Hydro Power Industry events
- Some sharing occurred in 2015 & 2016
- Objectives were well defined
- Glad to hear that you have explored retraining work force from retiring energy technologies
- What can we learn from other renewables and their approach to education/training?

Question 6: Proposed Future Research, if applicable

- Potential funding to develop generic Industry templates for marketing and recruitment of staff and knowledge transfer
- Degree to which FTI go down as the expanded hydro industry matures
- Would be nice in future to explore needed skills for future work force and how that will be communicated to academic programs with respect to new courses, programs, skills, etc.
- This cannot be a one-time event. This needs to have a Phase 2 to go from prototype to production.

Question 7: Project Strengths

- This appears to be a valuable study to provide the basis for development of a future workforce
- Well organized
- Did look at size, skills, training
- Did talk with a lot of folks
- Analysis of force needed for various future scenarios of hydro development
- Nice that the project was aligned with the HydroVision report
- Vital to have started this process. Momentum needs to be continued.

Question 8: Project Weaknesses

- Could have presented more draft results for results demonstration
- Only looked at main supply chain staff and could go further down
- Should include or at least document secondary workforce benefits as was done for NHA
- Would be good to perform more of a risk analysis rather than just 2020 or 2030 forecasts
- Not clear how well this project is connected to the academic community

Question 9: Recommendations

- Give research to NHA so they can leverage the findings
- Leverage other agencies at the state level who work on workforce development to attract resources to the hydropower industry
- Develop templates on topic areas
- Bring this down to the state level, this is part of the solution to achieving their RPS (Renewable Portfolio Standard) goals.. more bright young inventive people thinking through the challenge
- Develop modules for each level Elem, Middle, High School level. Leads to awareness as students enter college or trade schools.

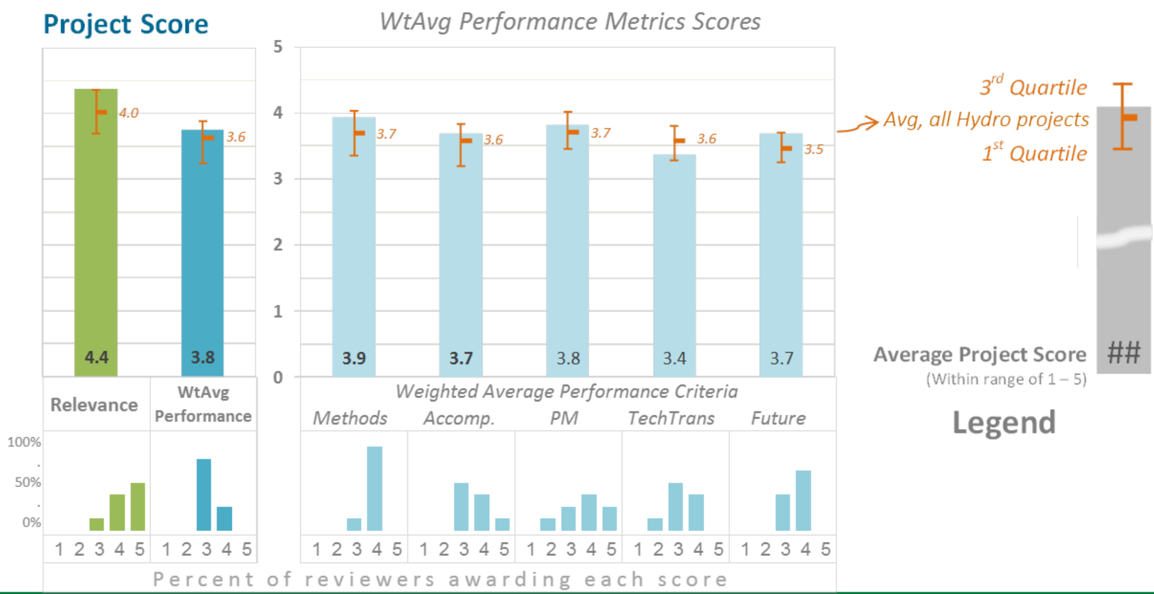
DOE Water Power Technologies Office 2017 Peer Review Project:
Cost-Optimization Modular Helical Rotor Turbine-Generator System for Small Hydro Power Plants

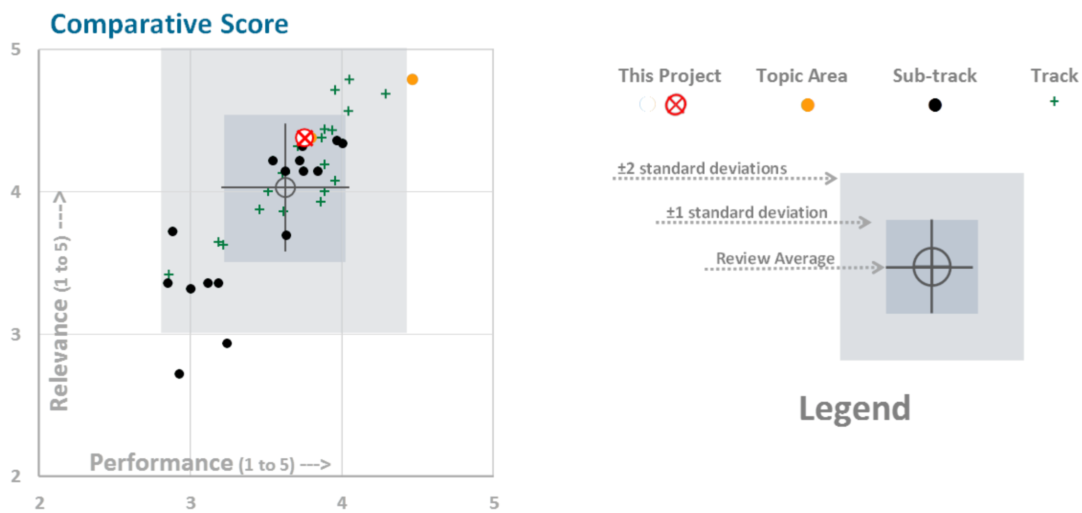
Principal Investigator	David Yee, Eaton Corporation
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Power Train Component Innovation

FY 2014-FY 2016 Funding

DOE	$ 2.0 M	92%
Cost Share	$ 0.2 M	8%
Total	**$ 2.2 M**	**100%**

Peer Review ID# 174





Comments made by reviewers during the evaluation of this project (PRID 174)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Targeting cost reduction through both initial capital costs and LCOE (levelized cost of energy) is a priority and could be a model for other projects
- This type of research is very important for the strategic priorities, including sustainability. The Vision goal for NPD (non-powered dams) development is significantly higher than NSD (new stream-reach development), yet this is the first project we've seen that targets innovations at NPD.
- The project appears to have the promise of a potential new type of turbine that could reduce civil costs. The fact that it can be sited above tail water is a major factor in the cost picture.
- I like bringing in a different industry view and paradigm shift to hydro turbine designs
- This is very good application to overall DOE objectives
- Clever / interesting new approach to turbine design borrowing design concepts and materials from outside the hydropower industry, aiming at reducing costs of turbine manufacturing
- Lower costs by placing turbine generator above the tailrace level
- Seems like a long road to bring on line?
- Utilizes Eaton supercharger to create value for small hydro. I like the concept of modifying existing technology to hydro and DOE supporting this type of research.
- Interesting technology with wide operating range for small dam applications
- Leveraging industry and other industrial sector knowhow
- Cost optimization
- Disruptive technology
- U.S. manufacture
- Not fish friendly at all - screens must keep them out
- Scalability through multiple turbines - right now it's small per turbine - 70 kw at 12 meters
- Trying to monitor cavitation - potential risk with design

Question 2: Methods and Approach

- Higher efficiency of the turbine allows for maximization of power generation
- Small scale modeling and the use of compressible liquids for testing may not accurately portray how the unit will perform when built to scale
- Will try to measure for indications of cavitation in the next phase
- The technical approach and feasibility is sound and has good commercial development support
- Interesting approach to exploring potential new turbine design by a company that doesn't typically do hydropower but clearly knows how to investigate new design concepts and do manufacturing. I'm not qualified to evaluate whether it's technically sound.
- Applied research is good
- Siphon intake not included
- Solid approach, still early in the project
- Ability to scale the model
- Excellent modelling

Question 3: Technical Accomplishments and Progress

- This is not intended to be a fish friendly design. Instead they need to prevent fish from entering the intake.
- Good technical accomplishments leveraging proven auto industry designs and applying to hydro
- Modeling only so far. Not quite there with achieving targets, so more is necessary.
- Good methodology
- Need to upscale big time but they know this
- CFD (computational fluid dynamics) Model is up and running
- Working on systems integration and turbine design
- Designs now ready to scale
- Potential for composite design

Comments made by reviewers during the evaluation of this project (PRID 174)

Question 4: Project Management

- Slightly under budget despite the extra work required to reach the 80% efficiency. They saved in materials for the 3D model printing
- There have been schedule delays with on boarding key partners, however, the budget and products have been managed well
- On budget and on-time; some hiccups with subcontractors?
- David Yee presented well
- Well organized within Eaton
- Project started slowly due to issues with getting subcontractors on board
- Standard project methods have been applied
- Good, as part of a big corporation
- Will this get enough attention within Eaton. Is it core. Can they make a business out of it?

Question 5: Research Integration, Collaboration, and Technology Transfer

- Great collaboration both in the auto industry and the hydro industry
- None (although project fairly new so maybe this is appropriate)
- Leveraging technology from auto industry
- But failed to consider regulatory requirements ...USF&W (U.S. Fish and Wildlife Service)

Question 6: Proposed Future Research, if applicable

- Still needs a full-scale test. They are hoping to use the new testing facility being considered by DOE. They are concerned about the licensing requirements to test a full scale model.
- I believe that the proposed turbine has sufficient potential to warrant continued work to determine the potential for cavitation. This is particularly important since the advantage of this machine is its setting above tail water, thereby reducing civil costs significantly.
- I support funding a full-scale test of this technology
- Standard proof-of-concept stuff
- Cavitation is an issue
- Needs to ensure fish non-entrainment is achieved
- Additional work anticipated to increase the design size and modularity
- Break dominance of non-U.S. supply, look at scaling, economics and regulatory impact
- Get this to market

Question 7: Project Strengths

- One major project strength is the experience and manufacturing expertise of Eaton Corporation. It is apparent that if the research develops a cost-efficient new type of turbine that can be installed economically, that the Eaton Corporation has the capability to bring this effectively to the marketplace.
- Good collaboration, solid engineering support, proven auto industry technology
- Creative / different approach to hydropower with design concepts that are clearly from the ""outside."" That's good for the industry.
- Did original design and it seems to work
- Novel technology, high efficiency, wide operating range
- Qualified team
- Leveraging auto industry expertize
- Now at TRL4 (Technology Readiness Level 4)
- Polymer based rotor

Question 8: Project Weaknesses

- A mechanical efficiency of 80% is on the low side and would need to be offset by a decrease in overall project costs
- The estimated costs of $2000/KW may be on the high side for small Hydro development. The presentation indicates that the water delivery system would utilize a siphon system. This may or may not be practical.
- Cavitation concerns exist and can the partnership stand up to the licensing process for a full scale test

Comments made by reviewers during the evaluation of this project (PRID 174)
• High performance screens for intakes are critical to this technology • This turbine is 100% fish-unfriendly. Screening will be absolutely necessary in systems with presence of fish. Unclear if PI (Principal Investigator) is considering costs associated with screening in capital cost estimates. If they don't, then that's potentially a huge flaw. • Not really a fish friendly design so will prevent fish entrainment through screening • Need for prototype testing • 75 kW at 12 meter head with a rotor diameter of 750mm • Can this be scaled? • Can this scale minimum level is 150 kw but likely they will put these in series • Consider FERC (Federal Energy Regulatory Commission) • Will this get enough attention within Eaton. Is it core. Can they make a business out of it? **Question 9: Recommendations** • The proposed turbine generator configuration is intriguing and deserves further work. I wonder if the use of a variable speed generator in combination with this technology would be a viable option? • I support further funding of this project • Develop the business case / model

DOE Water Power Technologies Office 2017 Peer Review Project:

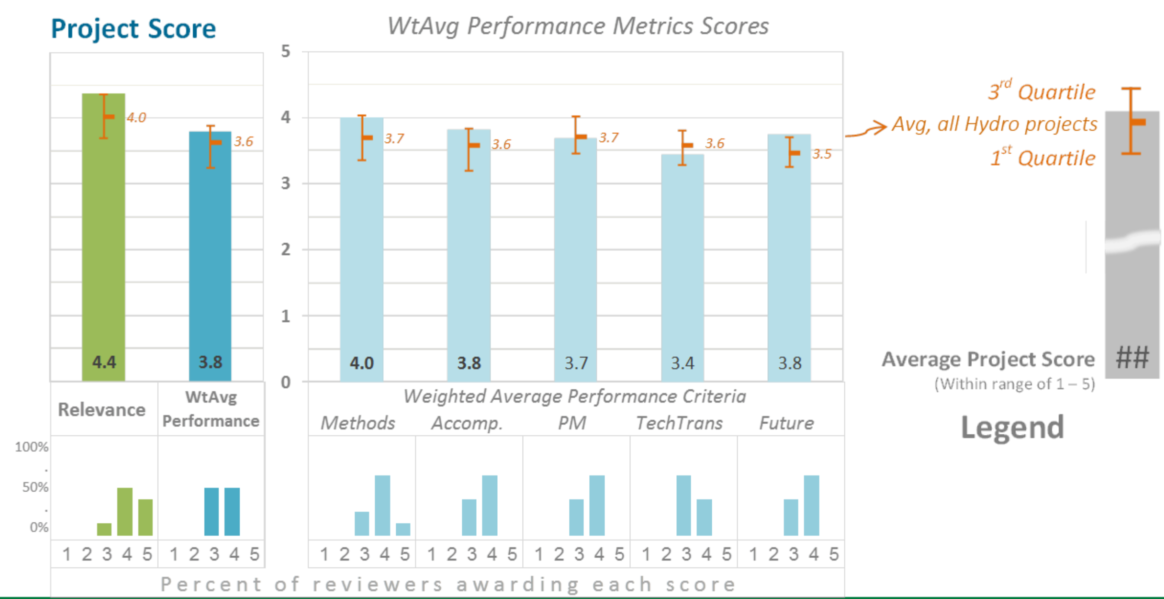
Rapidly Deployable Advanced Integrated Low Head Hydropower Turbine Prototype

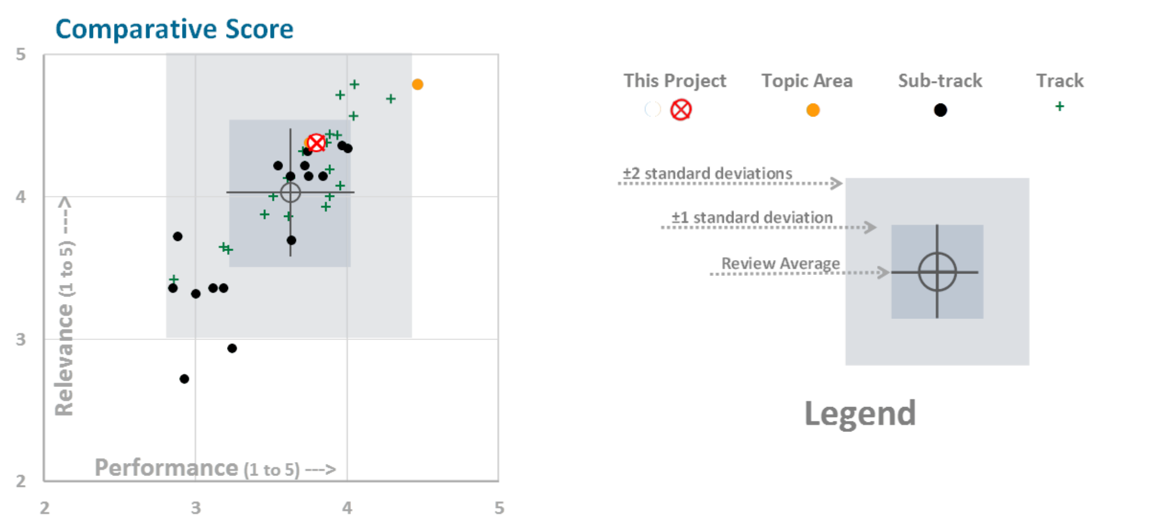
Principal Investigator	Arnie Fontaine, Pennsylvania State University
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Power Train Component Innovation

FY 2014-FY 2016 Funding

DOE	$ 2.2 M	88%
Cost Share	$ 0.3 M	12%
Total	**$ 2.5 M**	**100%**

Peer Review ID# 175





Comments made by reviewers during the evaluation of this project (PRID 175)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Hubless design is very effective and successfully passes fish
- Looking at low cost health monitoring to optimize O&M (operations and maintenance) costs
- Low head turbine prototype intended for existing dams and infrastructure
- On strategic priorities - this project hits all 3
- Based upon the information provided in the presentation and the summary, I believe that this application has a very large potential to enable the development of smaller flow head hydroelectric sites
- The integrated configuration could allow a rapid deployment as indicated by the title of the project. This could be employed at any number of smaller dams throughout the United States.
- This does have good application to DOE objectives. Unique design that if proven could provide real world applications to low head hydro.
- More efficient, less expensive turbine with improved fish passage outcomes that can be retrofitted to existing dams: this has the potential to hit all of the DOE program objectives
- 6 % through central hub therefore how can efficiency be obtained?
- 90 - 95% turbine efficiency
- External rotator design needs to be further assessed
- Hubless but used proven naval design
- Turbine generator design complete
- Potential to have a very positive impact for low head hydro development, benefitting all three pillars of HydroNEXT
- Allows for custom manufacture
- Innovation leading to cost optimization
- Should be scaled to size for market
- U.S. manufacture
- How will these survive over time - bearings will likely fail due to high rpms and being submerged
- Interesting device - fish passage is a question - 95% efficiency seems really high - say worked with Navy and are within 1-2% of that 95% - not water to wire just hydro efficiency

Question 2: Methods and Approach

- The approach to date appears to be systematic and reasonable
- Similar to the oceanic open hydro design. There may be gaps in the bearing design related to the 180 rpms on this device.
- They do have a proven application in the marine field. However, there are many questions remaining and a lot of preliminary design phases.
- Lots going on here: new design, new materials, new types of assessment and modeling based on work for the Navy. I'm not really qualified to determine whether or not the approach is technically sound.
- Bearing issue stopped open hydro concept. Needs to be assessed.
- Inclusion of systems health monitoring is strong element of this project
- Highly qualified team
- Great desktop and prototype modelling
- Speed of rotation 180 rpm and space between blades

Question 3: Technical Accomplishments and Progress

- The progress to date has been good. Additional questions involve the project cost and the setting of the unit relative to tail water elevation. The question is what elevation does the unit need to be set at relative to tail water? A deeper setting for the turbine would require more civil work and significantly higher costs as the potential excavation decreases.
- They have delivered good preliminary design ideas and prototypes backed by some proven marine applications
- Not clear from materials provided whether or not milestones were actually met
- Turbine design is done, beginning to develop test plan for tunnel tests this summer

Comments made by reviewers during the evaluation of this project (PRID 175)

- Get this into a lab, NREL or Alden
- Modelling
- Need to see it in real life prototype

Question 4: Project Management

- The no cost extension has already been approved
- Project management appears to be effective and has progressed in a systematic effective manner
- Project Management has been average on this with delays at the start. Budget management has been effective.
- Seem to have been significant delays. Availability of water tunnel not the fault of PI (principal investigator), although contract initiation delays could be indication of poor project management.
- Standard project management methods are used
- Disciplined approach

Question 5: Research Integration, Collaboration, and Technology Transfer

- Several graduate students are involved - good for workforce development
- It appears that this technology to date has not been shared widely
- They are leveraging well from a proven marine design and collaborating well within the University's strengths. They do need to reach out to the oceanic industry and leverage lessons learned on the open hydro design.
- Conference presentation, training grad students
- Project team seems to be working well together
- Leveraging U.S. Navy research

Question 6: Proposed Future Research, if applicable

- Testing should be at an existing facility rather than at a new site, will be easier to get fish agency review
- Future research will be directed at prototype installations which will provide useful information regarding the new technology. In addition to the prototype installation, guidance should be developed relative to how the turbine can be installed in existing embankments or concrete structures. In other words for various size installations, what are the setting requirements relative to minimum tail water. This information is critical to determining whether this alternative is cost effective enough to enable the economic Development of many potential sites.
- Research should also be focused on determining what type of intake and draft two configurations that can be employed to maximize the effectiveness of this type of turbine
- I support a phase two funding for this project and advancing this design
- Standard proof-of-concept stuff
- Size needs to be assessed
- Environmental testing, including fish passage
- Impact on fish...need to work with NREL or Oak Ridge or Alden
- Manufacture scale for market readiness
- Need to see some cost models and understand ROI (return on investment)

Question 7: Project Strengths

- The proposed configuration which is readily deployable is a huge advantage for the use of this technology
- Great engineering support from University system
- Proven marine based technology
- Structural health monitoring system
- Systems integration from turbine to generator design
- Very strong team
- Use of proven design techniques
- Focus on lower O&M low cost health monitoring
- Great designs

Comments made by reviewers during the evaluation of this project (PRID 175)
Question 8: Project Weaknesses • As indicated previously, the required setting of the equipment relative to tail water will have a major effect on the overall project cost. If deep excavations are required this would be a major concern. • Need to leverage lessons learned from the oceanic open flow designs • This is very preliminary • Potential issues with bearing life and reliability • Serious omission - fish passage claims need to be reviewed • FERC (Federal Energy Regulatory Commission) challenge **Question 9: Recommendations** • I recommended continued support of this project • They need to engage and communicate more in the industry such as Hydrovision • 6% of flow going through central hub is this enough? • Candidate for DOE hydro demo site – facility • Fish studies - vital

DOE Water Power Technologies Office 2017 Peer Review Project:

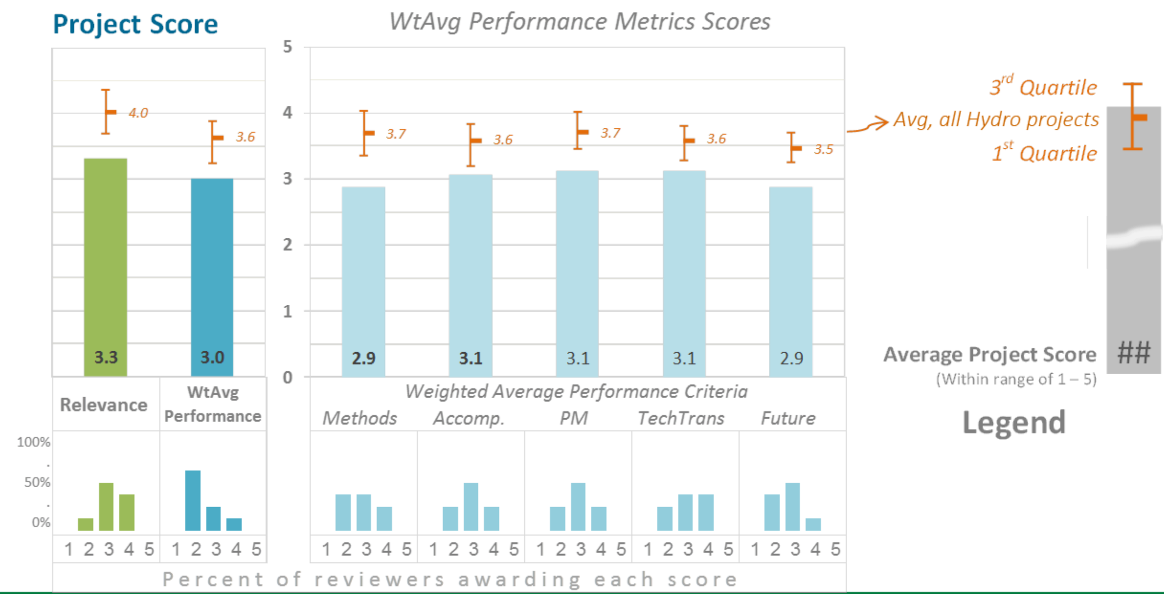
Modular Low-Head Hydropower System

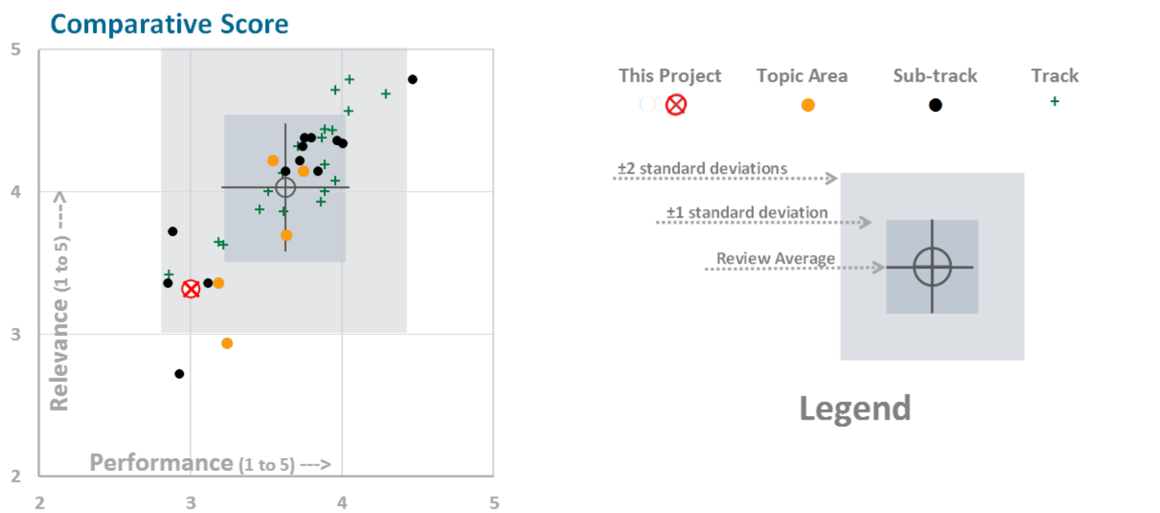
Principal Investigator	David Duquette, Littoral Power Systems, Inc.
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Lower Civil Works Costs

FY 2014-FY 2016 Funding

DOE	$ 1.3 M	95%
Cost Share	$ 0.1 M	5%
Total	**$ 1.4 M**	**100%**

Peer Review ID# 180





Comments made by reviewers during the evaluation of this project (PRID 180)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- In response to the 2014 ORNL new stream reach report - identifying the need for environmentally sensitive and low cost civil works technology. Growth and Sustainability. Their system involves a 50% reduction in civil works costs vs traditional concrete.
- I have major concerns that the proposed modular system will satisfy either environmental concerns or dam safety issues. Also, the proposed design looked at a conceptual foundation design involving sheet pile cut offs. The adequacy of this foundation system is dependent largely on the character of the foundation below the river bottom. A rock bottom or a significant amount of boulders and cobbles would make the use of sheet pile very difficult or impossible. A major concern also is the capability of the modular dam to safely pass large extreme flood events. The PI (Principal investigator) was questioned about this concern during the question session of the presentation. The response was that large floods would over top the modular dam and thereby pass downstream. As currently shown in the presentation, the modular dam is conceived to be on the order of 20 feet high. An overtopping flow would likely quickly scour out the foundation on the downstream side of the modular dam and lead to a rapid failure condition. As indicated below, there are a number of other concerns related to this system. I believe that the FERC (Federal Energy Regulatory Commission) Dam safety folks would have significant concerns with this type of system if there were any hazard prone areas in the downstream areas.
- FERC discussion and applicability in permanent situations is questionable
- This does have some relevance to DOE objectives. Using an available resource for an application like this is unique.
- Finding a way to significantly lower the costs associated with new dam construction could help to bring down the cost of hydropower development. That's clearly in line with DOE's objectives.
- Goal was to drop ICC (initial construction cost) by 50 %
- Issues included things like uplift, seepage
- Needed readily available equipment
- Uses shipping container
- Very good that LCOE (levelized cost of energy) was key to the project
- Project has potential benefits for several areas of HydroNEXT
- Invention growth and optimization
- Seems to be a solution looking for a market
- Basically building a modular dam
- Haven't worked with dam safety folks at this time
- Is there opportunity to use this for emergency situations at existing facilities
- Shipping container method

Question 2: Methods and Approach

- ISO (International Organization for Standardization) shipping containers ISO 1496 regulations allow certification of a box for shipment on a container vessel. They have to be able to bear the load of stacking under as many as 8 other containers.
- The use of these containers obviates the need for coffer dams
- I do not believe that the proposed system can be effectively implemented in most streams in the United States. One additional concern relates to the use of the modular elements to support generating facilities. My experience indicates that rotating turbine equipment of most kinds is very sensitive to shifts in alignment. I suspect that the proposed modular system would be relatively flexible and could move significantly based upon changing load and foundation support conditions. This would make it very difficult to use to support rotating generating equipment.
- The method and approach are sound technical solutions
- We question the FERC approval for permanent type situations

Comments made by reviewers during the evaluation of this project (PRID 180)

- !CD In addition, the PI's argument that this project somehow produces significant sustainability benefits is unconvincing. Environmental performance was clearly not a real consideration of this project. The PI made the point that these facilities have the potential to be easier and less expensive to decommission than a traditional concrete dam at the end of its service life (20-50 years). That's likely the case, but there is nothing about this design that is aimed at improving on the ecological impacts associated with new dam construction while the dam is in the water. It's still a dam. It still impounds water. The PI admitted that they did not consider whether fish passage could even be retrofitted to dams constructed using this method.
- !CD Presentation describes how this technology "enables ecological small, low head and run-of-river installations that take advantage of new streamlined FERC regulations." This is confusing, as ecological considerations do not appear to have been taken into account in the design of this project or its technology. It also begs the question of whether or not the PI has any familiarity with the state of hydropower regulation in the United States. There are no FERC regulations, new or old, that provide streamlined or expedited permitting for hydropower projects involving the construction of new dams.
- !CD Using shipping containers in lieu of concrete is a fairly novel approach to dam construction. But it's not clear how safe these would be over time, and it seems like the time/expense required to get stakeholder and regulator buy-in for the construction method at any given project (particularly whichever deployment of this technology comes first) could pretty quickly offset any savings in civil works costs, and the sites where this technology could be deployed would be limited to those sites where a vertically-oriented shipping container was the right size for a dam.
- Each module is a stand-alone structure
- Need to assess position on stream and spillway design and overtopping is critical
- Seepage analysis within COE (Corps of Engineers) guidelines?
- Use connectors and bolted on site, no welding
- Good strategy to consider base design on ISO 1496
- Project seems to be focused on elements of flow blockage, but has serious deficiencies in design details for the turbine and spillway
- Form factor using containers - low cost
- Ignores FERC and FERC Dam Safety and resource agencies who could kill this in its tracks
- Not clear that containers are still in use
- Sheet piles into river bed - not very practical
- Steel deterioration

Question 3: Technical Accomplishments and Progress

- It appears that the development is progressing on schedule
- The engineering studies are complete but lack real world application
- Modeling appears to show that the technology could perform as advertised (i.e. the dam would not fail), but project might have benefited from reaching out to regulators with responsibility for dam safety to determine if there is any future in this technology
- LCOE model
- Partners GZA GeoEnvironmental, Alden, UMASS (University of Massachusetts), NREL
- Not clear how the spillway functions, or if that has been considered with respect to downstream erosion and flow conditions
- Design to reduce environmental impacts -removable and low environmental impact

Question 4: Project Management

- On time, on budget
- Although the project management effort seems to be accomplishing the propose scope, it does not appear that the management has a realistic understanding of the requirements for construction of dams that meet current dam safety criteria
- At this stage the Project Management seems to be effective and on budget
- Project appears to have met major milestones (not clear from the materials provided if they were on time and/or on budget)
- Management seems a little loose
- Standard project management approaches have been used
- Seems to be well managed

Comments made by reviewers during the evaluation of this project (PRID 180)

Question 5: Research Integration, Collaboration, and Technology Transfer

- They need to be more inclusive with other agencies, organizations with their review and input. Consider FERC, CEATI (Centre for Energy Advancement through Technological Innovation), and HPC (National Hydropower Association Hydraulic Power Committee) organizations.
- Communications primarily aimed at marketing the technology to potential customers and investors. Cooperation with universities and labs is a plus, although not certain from materials provided what role others played in this project.
- Need to collaborate with emergency repair folks
- Good local advisors
- Strong work with NREL

Question 6: Proposed Future Research, if applicable

- Continued research in this area should involve import from the FERC dam safety section. Any new hydroelectric development will ultimately need to satisfy their criteria. Input on proposed modular dam systems is critical if the proposed systems are to be actually placed in service.
- Yes, they should continue. I suggest a focus on emergency repairs.
- !CD Despite PI's promoting the ecological benefits of this technology, there is no past, current, or future research aimed at building ecological needs into the design or measuring some (any!) aspect of environmental performance
- Next steps all appear to be reasonable exploration in determining whether or not this method can actually work for new dam construction
- Assessment of non-power dams
- Budget seems very high for assessment being done
- Infrastructure repair
- Site flexibility
- Seems like there is a lot of work left to be done. I have doubts that this project will result in a viable technology.

Question 7: Project Strengths

- Good preliminary engineering
- Uses a readily available product
- Interesting / creative approach to civil works construction that has real potential to lower costs of new hydropower development
- Met USACE (U.S. Army Corps of Engineers) guidelines for erosion, used USACE long term standards?
- Using Alden facilities to model
- Good project partners
- Novel design
- If a licensed technology then can cost reduction be 50%?
- Speed of implementation

Question 8: Project Weaknesses

- As discussed above, the project concept has not adequately addressed dam safety concerns. Specifically spillway capacity and failure due to overtopping are a major concern that would need to be addressed on a site-specific basis.
- Lacks FERC input and opinion
- No real world application. Gaps on permanent potential.
- No more than lip service paid to ""Ecological"" / ""Sustainability"" considerations, marketing of the project to the contrary. New dam construction still involves considerable economic impacts.
- Need to get agencies involved earlier
- Needs to have spillway design assessed
- No steel in water yet
- Need to focus on most critical design elements
- Flood controls and river passage
- LCOE is still high at 13.4cents
- Too simple an approach

Comments made by reviewers during the evaluation of this project (PRID 180)
Question 9: Recommendations • He referenced LIHI (Low Impact Hydropower Institute) and the requirement to get certification for RPS (Renewable Portfolio Standard) qualification in New England. But this project seems to involve new impoundment construction, which is not eligible for LIHI certification. • Continue studying but focus more on emergency and temporary applications • Dam safety issues (and regulator buy-in) need to be addressed sooner rather than later. If purported sustainability gives this project an edge over others in DOE funding priorities, it should be re-evaluated – there are few if any sustainability benefits here – and either be encouraged to build ecological considerations into its design or should be dropped altogether. If the project is being pursued/funded solely on the basis of its potential to significantly lower construction costs, then it may be worth additional exploration. • Companies are bandying about LCOE but I think that this is inconsistently calculated. DOE needs to jump in here as failure to control this metric will lead to big cost advantage claims that could be disproved. • Need to get some real focus on FERC, FERC Dam Safety and State research agencies • This company may have the correct methodology for LCOE -explore this. Can the model be made available? • Use the quickinstall prefab dam from yesterday's presentation • Why not build in fish passage into the design

DOE Water Power Technologies Office 2017 Peer Review Project:

French Modular Impoundment

Principal Investigator	Bill French, French Development Enterprises, LLC
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Lower Civil Works Costs

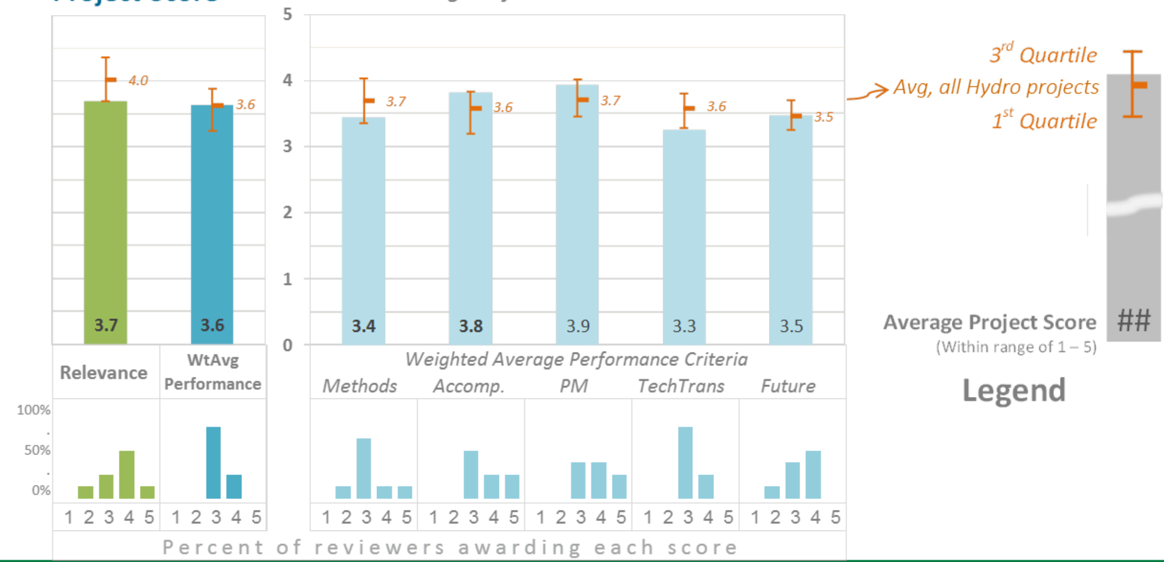
FY 2014-FY 2016 Funding

DOE	$ 1.3 M	85%
Cost Share	$ 0.2 M	15%
Total	**$ 1.6 M**	**100%**

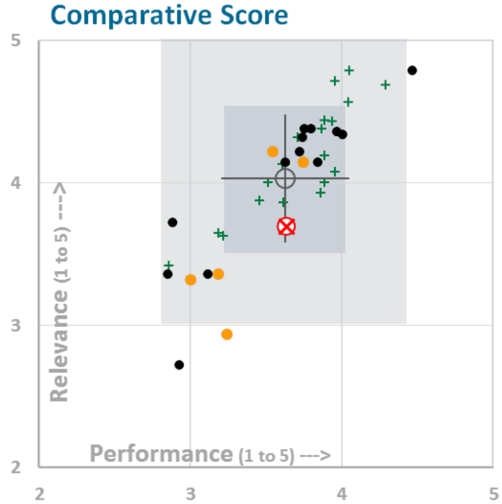
Peer Review ID# 181

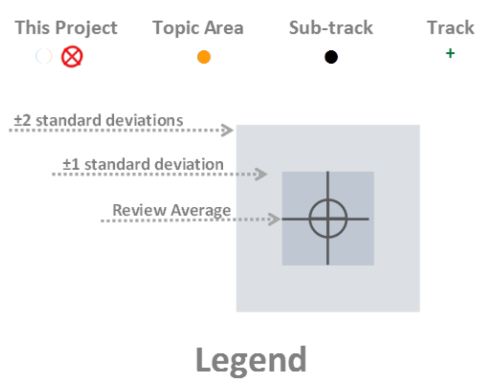
Project Score

WtAvg Performance Metrics Scores



Comparative Score





Comments made by reviewers during the evaluation of this project (PRID 181)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- The high civil cost of new hydropower development is prohibitive. This project is attempting to address that challenge. Eliminate risk from having to cast concrete on site by using precast concrete. This appears to be directly relevant to the Growth - lower cost of civil works.
- Work to date has indicated that the modular system can be constructed to provide a relatively small dam. The information provided in the presentation did not adequately address how the foundation of the dam system would be constructed. The PI (Principal Investigator) indicated that a slab would be poured directly on the sleet streambed and would form the basis for the precast structure. This did not provide any information regarding how varying foundation conditions would be handled. The absence of any cutoffs or seepage control devices likely would create potential seepage conditions. This type of a system might be useful if there were a bedrock foundation. The presence of a soil foundation beneath the riverbed would create significant questions regarding seepage, stability and settlement. As indicated in other comments, rotating generating equipment can be extremely sensitive to misalignment. A foundation system consisting of just one slab poured directly on the streambed could create the potential for significant settlements, depending upon the character of the underlying foundation. This system also does not presently address concerns related to overtopping under extreme flow events which could erode the downstream river bed and fail the dam.
- Takes an existing technology and applies it to a unique solution to low head hydro
- This is relevant to Water Power Industry and DOE objectives
- Finding a way to significantly lower the costs associated with new dam construction could help to bring down the cost of hydropower development. That's clearly in line with DOE's objectives.
- DOE should look at using precast concrete that has been studied extensively in other industries. Should not be a research project but more of an application exercise.
- Need to continue to focus on precast companies that are approved by the American Society of Concrete
- Reduced costs - 60%
- Risk reduced - 2 times
- Time saving - 43%
- Project has the potential to impact several areas of HydroNEXT
- Cost optimization
- Speed to market
- U.S. construction and opportunity to go national
- Also working on patent for fish passage…not part of this project
- How is this new? It’s not. Bringing it to hydro world.
- Precast modular dam
- Thinks costs are the biggest impediment to new dam construction
- Worked with state of NY on dam safety…will be working with FERC (Federal Energy Regulatory Commission)

Question 2: Methods and Approach

- Smart concrete with metal fibers and sensors on each side can notify operators when there is extreme pressure on the dam
- Modular precast system is meant to be universally applicable
- The proposed system while apparently very constructible, has major issues related to dam safety concerns which would make it difficult to gain approval from the FERC without significantly more information and site-specific data
- Good engineering and real world test product. This brings confidence to the next phase’s potential.
- !BP It's kind of surprising that modular pre-fabricated concrete (which is widely used in other types of major civil-works construction) hasn't been applied to hydropower yet. So kudos to PI for attempting to bring some best practices from other industries into this one.

Comments made by reviewers during the evaluation of this project (PRID 181)

- !CD Not clear that "does it meet dam safety regulations" question was actually answered. PI says "yes," but no evidence provided that regulators were consulted and that technology was approved. While there was an objective involving dam safety, it does not appear to be reflected in any of the tasks or achievements.
- Project focuses on building of the dam, little detail with respect to turbine and spillway
- Applied R&D
- Manufacturer bringing to bear his expertize

Question 3: Technical Accomplishments and Progress

- New York State has approved the design - and they believe that the process will comply with dam safety regulations in every state
- Testing has shown zero leaks in 5 months - through severe weather conditions
- The project has moved forward and demonstrated that precast can be used to efficiently construct new structures. The ability of these structures to satisfy long-term dam safety criteria is in doubt.
- The project has brought solid technical accomplishments
- Appear to have proven the initial concepts, although perhaps there's quite a bit more work to be done before this design is ready for prime time in a real-world setting
- Project has demonstrated a modular precast concrete element
- Rock bolts hold working platform and then linkage to pre-cast modules -all very practical

Question 4: Project Management

- Project management effort to date has resulted in the successful completion of the initial tasks in the scope of work. As indicated in the presentation, the project management does not appear to provide an objective evaluation of the cast in place alternative versus the precast alternative. The PI appeared to be more of salesmen than a researcher. Statements during the presentation that indicated the life span of cast in place concrete as 50 years or less are totally incorrect. There are many cast in place concrete structures well over 100 years old in the United States.
- Solid Project Management and all aspects of schedule and budget have been met
- Largely completed tasks described in the summary, although it's not clear if all of the objectives (see previous point on dam safety) were met
- Approved by state of NY if regulations are followed
- Seems to be well managed
- Standard project management methods have been used
- Commercially driven project, as a business meeting schedule and budget is fundamental

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good job of working with a diverse team on successfully staying on schedule
- It does not appear that the project has obtained outside reviews in regard to dam safety issues from either engineering firms or regulatory agencies. Although the project team has several reputable engineering firms involved in the project, it does not appear that their scope of work has involved any type of commentary in regard to meeting current dam safety standards. Meeting dam safety standards in gaining the approval of the FERC and state dam safety agencies will be a key requirement if this modular system is to move forward.
- They appear to be working well with State Dam Safety inspectors. However, they have no official certification and they have not engaged FERC for opinion and comment.
- They are sharing very well their lessons learned into the industry
- Marketing and demonstration day
- Compared to cast in place
- News releases and a presentation at HydroVision
- PI should be encouraged to write this project up and present at conference and/or journals
- Working closely with Oak Ridge: great combination of research and industry

Question 6: Proposed Future Research, if applicable

- I support funding for future full scale demonstration with FERC review and approval
- Proposed future research has PI moving straight to full deployment. Not clear if safety issues have been adequately addressed.
- Still believe there is much work to be done to get through final design/implementation with respect to the powerhouse and spillway
- Need to get this to market at competitive pricing

Comments made by reviewers during the evaluation of this project (PRID 181)

Question 7: Project Strengths

- Communicating well into the industry
- Great approach to using existing technology for new low head hydro application
- Sharing a cost model that can help all developers
- Creative, innovative approach to lowering costs of civil works construction (and potentially improving the quality of that construction)
- Whole structure has same strength
- Novel approach to dam construction
- PI has strong background in contracting and construction
- Build in the factory rather on site
- Cost modeling and allowing for cost reductions
- Life expectancy of pre-cast 100 years approach to cast in place 50 years
- Quick to modify
- Understanding insurability

Question 8: Project Weaknesses

- Compliance with site-specific dam safety criteria has not been demonstrated
- Need FERC support review/opinion
- Need full scale installation and long term testing
- Appears to have been somewhat designed and implemented in a vacuum. Test facility seems to have been a success, but a concrete box is a very different beast than an actual river. Not clear whether this will work in practice and/or whether PI has thought through what would be necessary to bring this technology to commercial, in-river deployment.
- Must address issues related to spillway design and passage of standard project flood and/or PMF (Probable Maximum Flood)
- A little too much of a marketing pitch
- Securing the concrete dock to the riverbed
- Subcontracting the work outside of New England will increase cost

Question 9: Recommendations

- The project should be reviewed by the FERC and other dam safety agencies to determine how the system can be employed at various sites and satisfy dam safety criteria in regards to stability, settlement, seepage and the ability to pass extreme flood events. This is the only way that this type of system can move from the research phase into potential practical application.
- Continue to support the next level of full scale application
- Before moving on to deployment, more questions need to be answered about how these will perform in the field
- Build in smart concrete
- Demonstrate national repeatability
- Fish passage including counting system. Should be exploited.
- Intake and tailrace designs
- Need to come up with standard designs for different types of equipment

DOE Water Power Technologies Office 2017 Peer Review Project:

Cellular Cofferdam for Hydropower Use

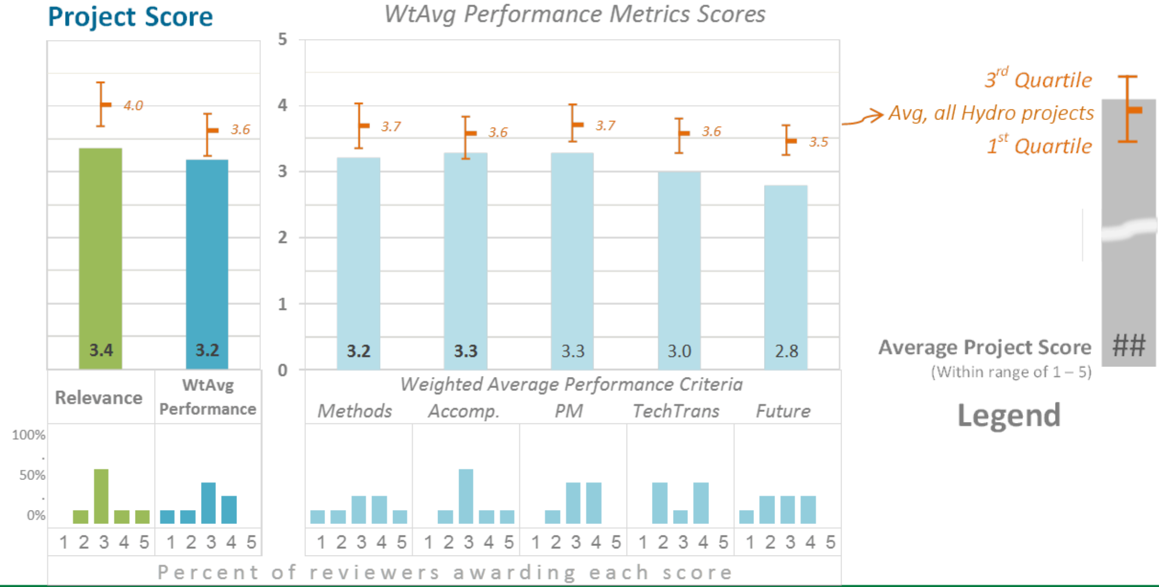
Principal Investigator	Marte Gutierrez, Trustees of the Colorado School of Mines
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Lower Civil Works Costs

FY 2014-FY 2016 Funding

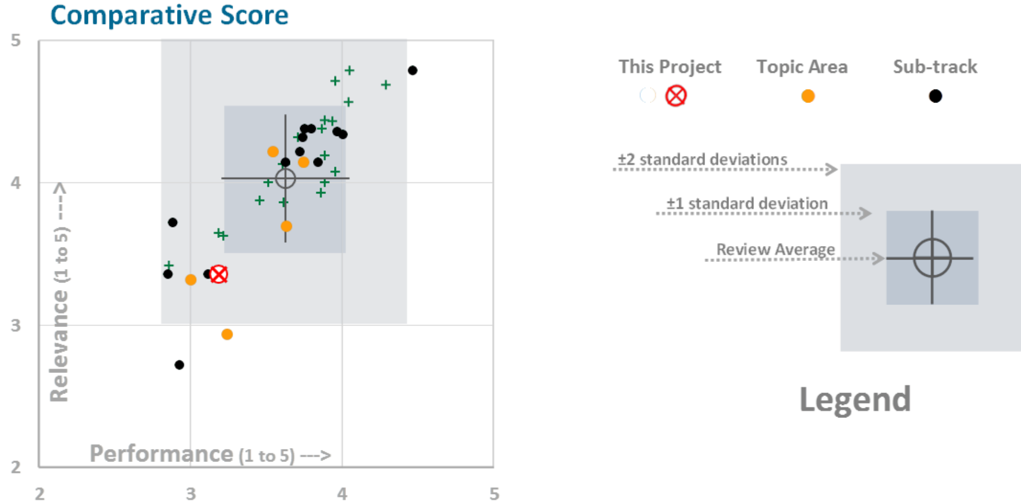
DOE	$ 0.2 M	89%
Cost Share	$ 0.0 M	11%
Total	**$ 0.2 M**	**100%**

Peer Review ID# 182

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 182)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Cofferdams have been mainly used as temporary structures. It is very low cost, so relates to growth. But it is also low impact because you can build it in water, no excavation or foundation construction needed. Decommissioning is also expected to be low cost and low impact also.
- I believe that the use of cellular sheet pile structures can be a valuable tool for new hydroelectric projects. The current research however does not provide any significant new or useful information.
- One of the major findings of the research is the use of an asphaltic liner to increase the stability of the cellular structures. The researcher did not respond adequately to the question of how this type of aligner would be installed underwater. The researcher did not appear to understand how cellular structures were actually constructed.
- I am aware that concrete filled cells have been proposed for the installation of hydroelectric power at lock and dam on the Kentucky River. The use of cellular coffer dams should also consider employing concrete fill rather than sand. Although this would be more costly, it would decrease the design concerns and increase the longevity.
- I recently became aware of a failure of a cellular sheet pile wall that was part of the Racine hydroelectric project on the Ohio River. American Electric Power should be contacted to evaluate the cause of this failure and it's applicability to the current research.
- The Jim Falls hydroelectric plant in Wisconsin utilizes sheet pile cellular sections with an overall height of approximately 40 feet. Plant has performed well for over 30+ years.
- There is a relevance to Water Power industry by targeting how to better control civil cost for a potential New Stream Reach application
- Faster
- Review of cellular cofferdam designs
- Reviewed as whether or not they can have permanent hydropower applications
- Good research project, helpful information for the hydropower industry
- Lower cost non river diversion solution
- Optimization but not so sure about sustainability
- Real advantage for dam replacement

Question 2: Methods and Approach

- Why isn't cellular coffer dam used for permanent use? Because of leakage. They wanted to consider a design concept that mimicked dry construction with a waterproof liner.
- The premise that the stability of a cellular structure could be increased by use of a liner to waterproof the interior of the cell is not realistic. FERC (Federal Energy Regulatory Commission) dam safety requirements would likely discount the ability of an asphaltic liner to prevent saturation of the fill inside the cell. The use of an asphaltic liner is an unrealistic assumption. The stability of a cellular structure could be increased simply by increasing the diameter of the cell. Although this would involve more sheet pile costs, it would still likely be a much more economical alternative to use cells as compared to concrete structures.
- Good engineering but needs input from FERC on applicability
- Corrosion of steel is an issue but not mentioned in the presentation
- Could be other flexible membrane materials
- Why is temporary cellular cofferdam not suitable? Sometimes they allow leakage.
- Detailed analysis, solid technical approach
- Excellent modeling and a classic example where good thorough desktop analysis and computation can shorten the development life cycle

Question 3: Technical Accomplishments and Progress

- In addition to the dry construction design concept, they also validated computational modeling techniques and are on track
- The results to date do not provide any significant new information for the use of cellular structures
- All technical and no real world application yet
- Not a research project
- Project is on track and using appropriate technologies

Comments made by reviewers during the evaluation of this project (PRID 182)

- Low cost rapid deployment solution
- Should be in the armory of any existing large dam owner where it could be used as an emergency response solution

Question 4: Project Management

- The management of the project did not have a good grasp of the requirements related to dam safety for this type of structure
- Not yet proven across field installation and agency approvals
- Dry construction OK
- Standard approach to project management
- On time and on budget, therefore presume well managed

Question 5: Research Integration, Collaboration, and Technology Transfer

- Needs better integration and collaboration with HPC (National Hydropower Association Hydraulic Power Committee), CEATI (Centre for Energy Advancement through Technological Innovation), and FERC
- Wet construction results in extensive failure zones
- Early in the project, but solid plan for communication and tech transfer, including the potential to develop a patent
- Not too many cooks in the kitchen and so good focused solution
- Practical hands on project using known solutions (sheet piling and fill)

Question 6: Proposed Future Research, if applicable

- ! The research to date appears to be a regeneration of currently available methods to analyze the stability of sheet pile structures. There were no significant new results that came from the work to date. The concept of using an asphaltic liner does not appear to be constructible or adequate for dam safety purposes. An alternative to the use of a liner would be to increase the diameter of the sheet pile cells. Although this would increase costs, it would not that the use of cells for dam safety structures.
- If they work on outreach and collaboration so that the product is supported by FERC, then yes
- Need to drive to a cost per square foot to determine cost advantage
- Suggest work with FERC Dam safety and Army Corps

Question 7: Project Strengths

- The use of sheet pile cells could be a valuable tool in the installation of new generation at existing dams. The research however does not provide any new or relevant information regarding this topic. I was hopeful prior to the presentation that there would be some new or innovative information provided. This however was not the case.
- Using proven technology for a cost effective new approach
- Good research project, results should be directly applicable to industry
- Demonstrable
- Low cost
- Rapidly deployable

Question 8: Project Weaknesses

- Has there been any coordination with other DOE efforts for appropriate site classification?
- They have not yet considered dam safety
- What about corrosion of steel and potential impacts on water quality?
- There does not appear to be any significant new contribution to the knowledge base resulting from this project
- Lack of FERC and Industry Dam Safety review and pre-opinion
- Not clear what type of additional geometries / layouts will be explored in the final year of the project
- Should have involved FERC Dam Safety

Question 9: Recommendations

- Consider funding with the requirement of FERC, CEATI, and HPC consultation
- Bring this to market

DOE Water Power Technologies Office 2017 Peer Review Project:

Cement Changes and Solutions to the Industry

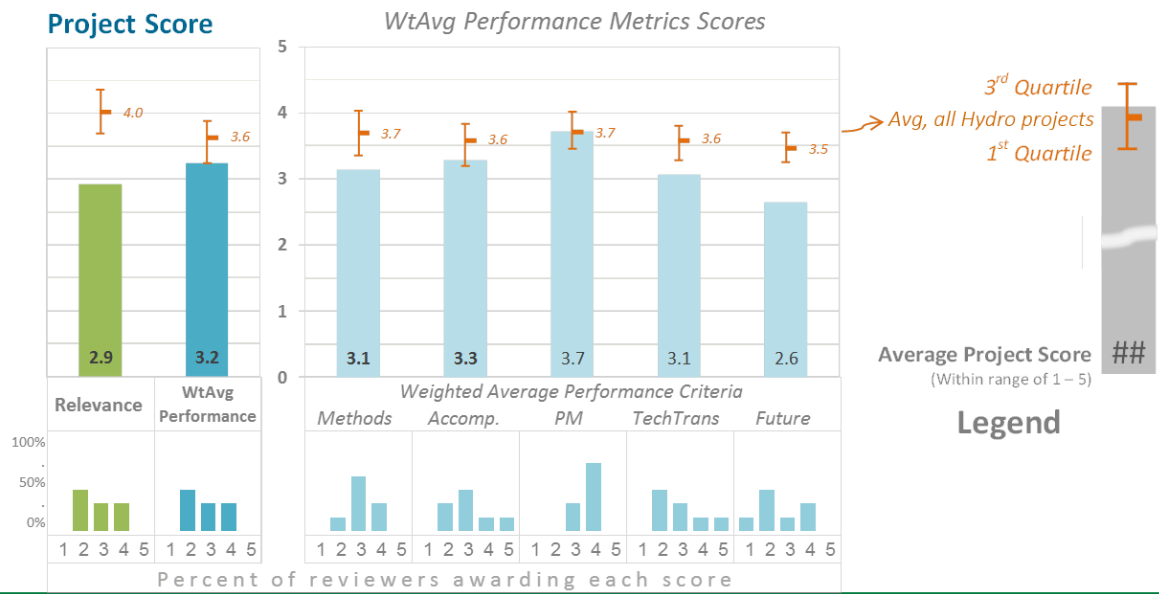
Principal Investigator	Todd Sirotiak, North Dakota State University
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Lower Civil Works Costs

FY 2014-FY 2016 Funding

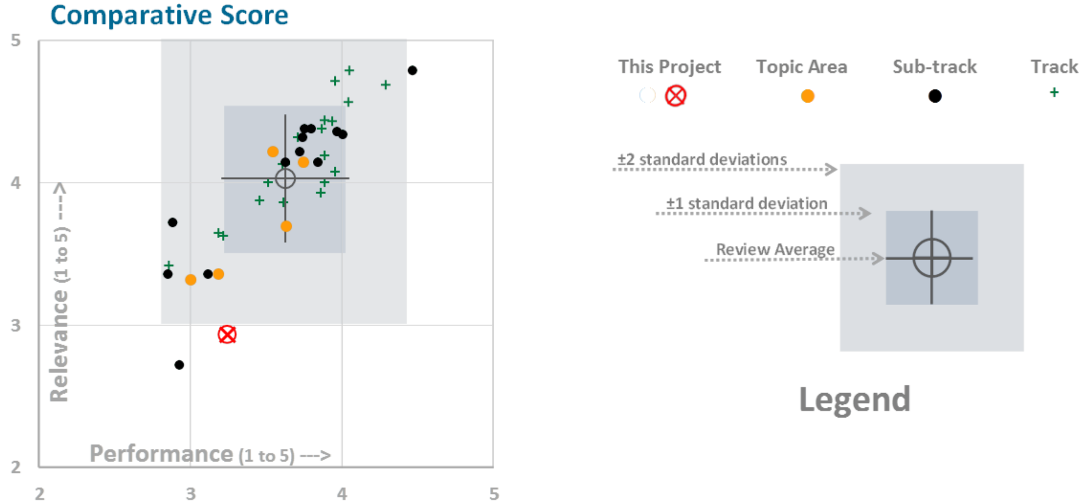
DOE	$ 0.2 M	86%
Cost Share	$ 0.0 M	14%
Total	**$ 0.2 M**	**100%**

Peer Review ID# 183

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 183)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Growth - lower cost. Environmental benefits. Manufacturing concrete is highly carbon intensive. They were looking to lower that also.
- The challenges with concrete warrant research. Cement has changed. In the 1940s cement was different - better. This research is about enhancing the equality to today's concrete - particularly to minimizing cracking. Rust of rebar can become visible in the cracks, increasing maintenance costs.
- Although the research provided valuable information in the area of dam construction and rehabilitation, the results will not have a major impact on the viability of new construction or new generation.
- This would be applicable to more than just hydro, does it only apply to new dams, does it also span to preservation applications.
- Cement changes in hydro
- Did not mention concrete aggregate reactivity even though this seems to be one of the biggest issues in the hydro industry
- DOE $129 K in 2016 and another $70-$80 K for 2017
- Does help with putting some of our waste fly ash to work
- Managed well but really a university concrete activity not a hydro research issue
- Seems to have approached DOE because they offer some money not because concrete is a specific issue for the hydro industry
- Impacts to hydro and the broader construction industry are positive
- Looked outside the United States for best practice (use of portland limestone)
- Interesting rarely examined component solution
- Lower cost component and lower maintenance

Question 2: Methods and Approach

- The research on cement is useful, but will not have a major impact on the development and expansion of the hydropower potential in the United States
- Strong methods and approach and sound engineering support
- Solid, research approach by credible team
- Good lab work

Question 3: Technical Accomplishments and Progress

- The research to date appears to have satisfied the initial goals of the project
- This project is in its initial stage and lacks a lot of true applicable accomplishments at this point
- PI (Principal Investigator) reports that project is on or ahead of schedule
- Good comparative analysis against known alternatives

Question 4: Project Management

- The project appears to have been relatively well-managed
- Project Management appears to be strong and is managing cost well
- Standard project management techniques have been used
- Seems to have been on time and on budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- I feel this needs to be stronger and they need to start early interaction with FERC (Federal Energy Regulatory Commission), CEATI (Centre for Energy Advancement through Technological Innovation), and HPC (National Hydropower Association Hydraulic Power Committee) to ensure real Hydro challenges are being addressed with a true market solution
- Appears that there is very close collaboration between NDSU (North Dakota State University) and ISU (Iowa State University)
- Focused two university research work
- Tech transfer should be easy

Question 6: Proposed Future Research, if applicable

- Freeze - thaw durability
- Yes as long as they integrate FERC, CEATI, and HPC real world solution driven feedback
- Explore Freeze Thaw conditions

Comments made by reviewers during the evaluation of this project (PRID 183)

Question 7: Project Strengths

- The improvement of durability and strength of concrete is an important innovation for the hydropower industry. The findings here have useful implications for all civil works projects beyond hydropower.
- The research regarding cement is a valuable tool for the long-term longevity of water retaining structures. It does not however have any significant impact upon new generation. This research is valuable for the ongoing rehabilitation and maintenance of Hydro generation and from this perspective may be a valuable contribution.
- Very applicable to new concrete pours
- Solid PI and team, application of the research should be directly applicable to industry
- Good example of low cost funding producing an industry wide cost advantaged solution
- Lower long term O&M (operations and maintenance) advantages

Question 8: Project Weaknesses

- The research does not appear to include an examination of environmental impacts, or of the cost differential of the different types of cement
- The results of this research should be distributed through trade associations and organizations including hydroelectric operators
- Not applicable to maintenance of 100 year assets. Sustaining the existing fleet.
- Benefits of different concrete mixes were discussed in general, but specific details would have been nice as well

Question 9: Recommendations

- Continuing funding but low priority and require FERC, CEATI, and HPC early interaction and feedback
- Need to get this research backed by the industry. Time to commercialize.

DOE Water Power Technologies Office 2017 Peer Review Project:

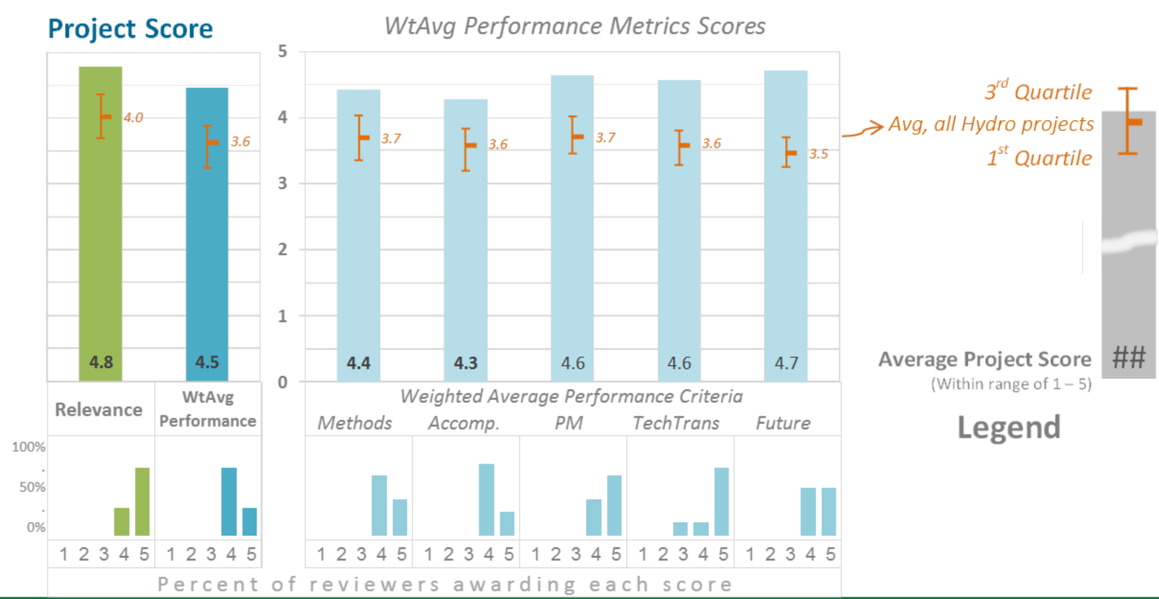
Magnetic Gears for Hydropower Drivetrains

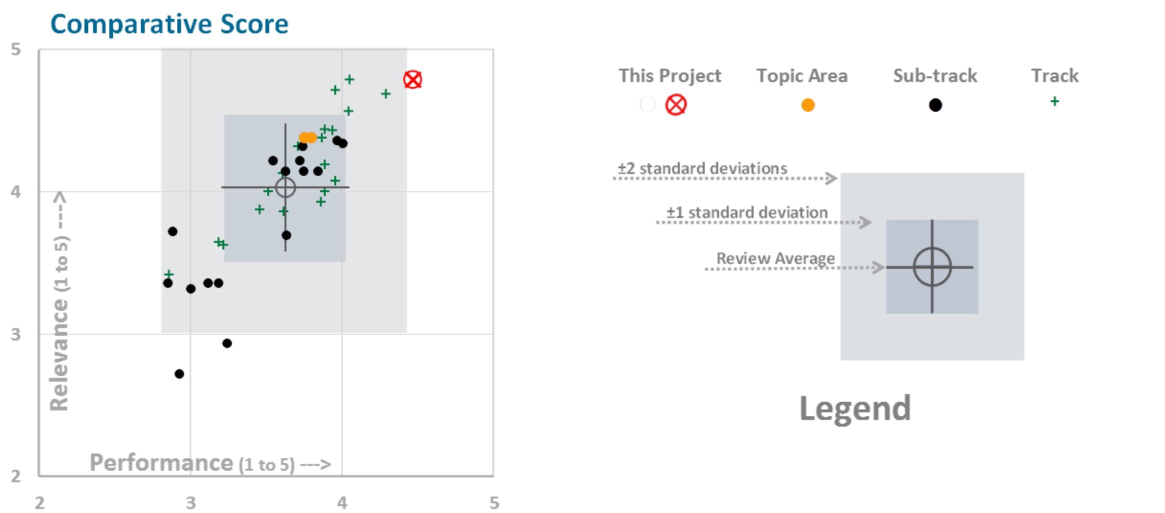
Principal Investigator	Emily Morris, Emrgy Hydro, LLC.
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Power Train Component Innovation

FY 2014-FY 2016 Funding

DOE	$ 0.9 M	89%
Cost Share	$ 0.1 M	11%
Total	**$ 1.0 M**	**100%**

Peer Review ID# 184





Comments made by reviewers during the evaluation of this project (PRID 184)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- The project is focused on improving performance, reliability and lifespan of gearboxes
- It should be noted that this is not my area of expertise
- This research appears to have a valuable long-term potential. Mechanical gearboxes have been long used particularly in pit turbine applications. Although the gearboxes have been relatively reliable at power loads on the order of 2 to 5 MW, installations involving generating capacities greater than that have suffered from significant issues and downtime. The potential use of magnetic gearboxes could in the future provide a valuable tool for the use of more economical high-speed generators.
- The speed increaser is the key innovation that can add value to small hydro development
- This product is well advanced and does apply to overall DOE objectives
- !BP borrows off-the-shelf technology from other industries to try and reduce costs of hydropower drivetrain
- Can be applied to others industries such as wind and cranes
- Good presentation; well organized, Emily knows the topic well, well organized management and team
- Upscale gear box
- Novel technology that has the potential to benefit Hydro
- 10 year life time
- Growth
- Sustainability—eliminates gearbox oil
- U.S. manufacture of gearbox- critical long lead time item
- Combining this with a generator so there is one package
- Could improve reliability 10 year interval for maintenance - very customizable in rpm ratio
- I like it. Good potential in small hydro and potentially other industries.
- In theory very quite
- Need to get costs down - working on it through a CRADA (cooperative research and development agreement) with ORNL

Question 2: Methods and Approach

- Good work with feasibility and market studies - other project could learn from this approach
- Highly well designed and technically feasible approach with a Navy supported real world application
- !BP Clearly-defined performance targets up front help determine if the project was successful. Better to work on a component that is trying to achieve a specific level of performance – and set that target up front – than to try and build something new just to show that it can be done. Admirable focus here.
- !BP Using technology that's already been proven in another industry to improve this industry
- Project involves design, prototyping, and manufacturing considerations
- Criteria well established
- Focused on upscaling
- Should show hydro applications to the various aspects of the industry
- The PI (Principal Investigator) and company seem to be on a fast start, and destined for success
- Agile, light focused approach to a challenging topic

Question 3: Technical Accomplishments and Progress

- 10 year continuous operation service life - to reduce maintenance cycles, very beneficial
- Increasing the power rating tenfold and torque almost double
- Still working on the reduction of LCOE (levelized cost of energy) but expect to achieve it with future work in continuing phase
- Solid technical accomplishments and demonstrated progress based upon planned schedules
- I'm not really qualified to evaluate technical accomplishments here. That said, the description of the performance as modeled seems impressive.
- Criteria well established
- Focus on torque rather than speed was a good approach
- Project is on track and should be completed on time and within budget

Comments made by reviewers during the evaluation of this project (PRID 184)

- 10X using gearbox
- 40 rpm input to `1200 rpm output
- Power dense gearbox, small footprint
- Scale devices as a function of torque
- Torque 1600nmn to 30,000Nm

Question 4: Project Management

- Good shared cost interest in this design and project
- Solid project management so far, is communicating well the potential budget gaps in phase 2 proposal
- Impressive. Each step was clearly defined and executed, and each step maintained momentum towards the final product. All steps completed within schedule and budget.
- Emily well organized and good management of project
- Standard project management methods are being used
- Small agile company led by a strong visionary leader

Question 5: Research Integration, Collaboration, and Technology Transfer

- No technology transfer planned yet, but may be too early. Only two partners.
- Great collaboration and well communicated throughout the industry for feedback and input
- N/a (Not applicable)
- Future research opportunities well defined
- Need integration to wind and crane industries
- Should place more emphasis on existing gears and studies being done within other industries. Could be other similar studies being done that could benefit design
- This is a platform technology that could impact many other industries
- Applicability to many different turbines
- Leveraging auto industry
- Very detailed integration

Question 6: Proposed Future Research, if applicable

- Need to examine how FERC (Federal Energy Regulatory Commission) will interpret this technology as affecting the installed capacity of the project. Will they consider what was a 10 kW project to be a 100kW project after this technology is installed? Also state RPS (Renewable Portfolio Standard) offices - which often use installed capacity as a threshold to eligibility.
- This is very promising work and should be prioritized. Very significant in reducing footprint by amplifying output. Also the reduction in maintenance is very important for small low impact operators.
- This project deserves continued support, the technology and developments can have positive impacts across new and existing Hydro fleet
- Better than most: goes beyond proof-of-concept to setting additional numeric performance targets
- Should continue to look for other opportunities
- Integrating the generator directly into the gearbox should be explored
- This innovative project should continue to be supported
- Extensive testing required
- Marry this up with a corporate partner
- Scale and bring to market
- This could be a breakthrough technology

Question 7: Project Strengths

- The proposed system could provide a lower maintenance speed increaser which will allow the use of lower-cost high-speed generators for low head applications
- Backed by proven Navy sponsored success projects
- Real world demonstrated product
- Strong designs and very good collaboration
- !BP presenter was impressive. She knew her material cold and gave one of the best presentations of the week.
- Novel Technology

Comments made by reviewers during the evaluation of this project (PRID 184)
• Potential high impact technology • Strong team • Can it scale up from 100kW • Platform technology scoped for wider industry • Reduction in overload risk • Size, cost • Very quiet **Question 8: Project Weaknesses** • The project description states it has low impact applications, but I am not sure that I see how specifically? Does the traditional gearbox design have a detrimental impact that this new technology cures or minimizes? If not, then the use of "low impact" feels like a buzz word. • The proposed cost limit of $.80/watt is very high and would not be economical for most small Hydro installations. Cost of this technology needs to be driven down to be usable. • Overcoming the burdens of scalability • MTBF (Mean time between failures) **Question 9: Recommendations** • I recommend supporting this project • Water power program would do well to fund more projects like this one: targeted, discrete, and • Integrating the generator directly into the gearbox should be explored • Explore integration of generator • Great research • Leverage across DOE wind • Total lower cost target -how low can we go

DOE Water Power Technologies Office 2017 Peer Review Project:

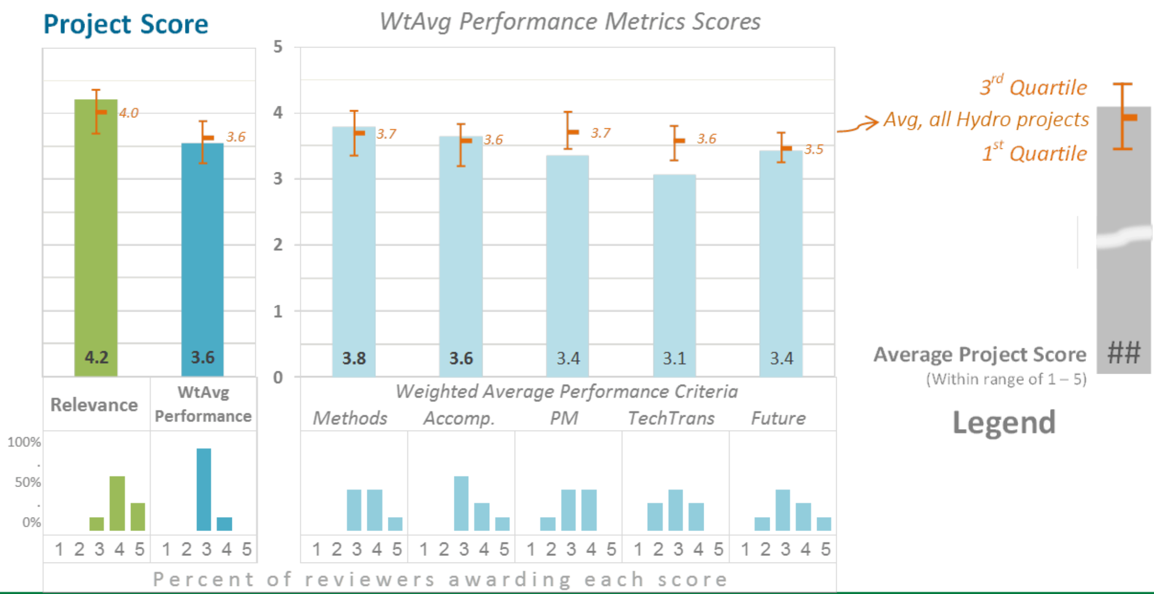
Optimized Composite Prototype for Archimedes Turbine Manufacture

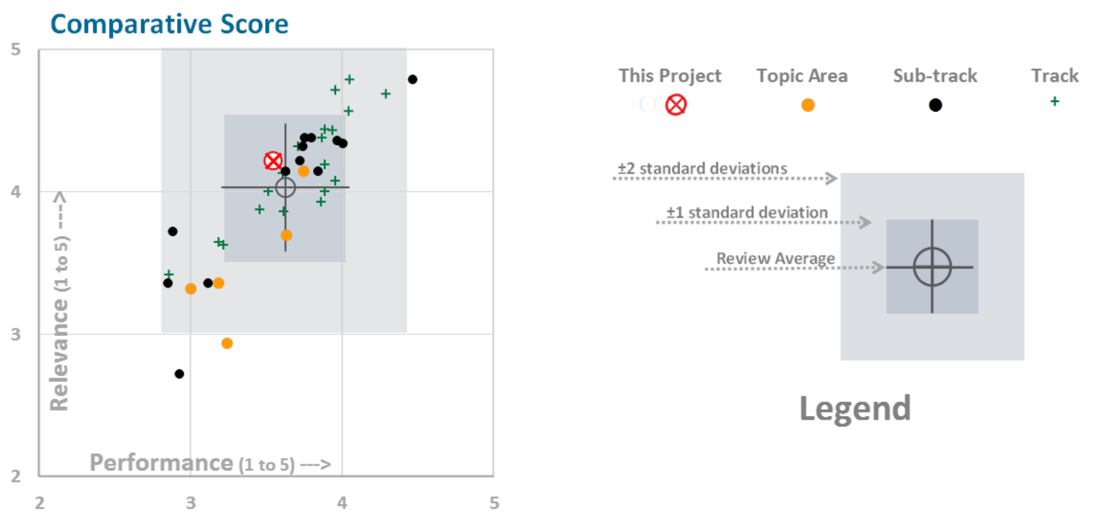
Principal Investigator	Jerry Straalsund, Percheron Power, LLC
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Lower Civil Works Costs

FY 2014-FY 2016 Funding

DOE	$ 1.1 M	91%
Cost Share	$ 0.1 M	9%
Total	**$ 1.2 M**	**100%**

Peer Review ID# 193





Comments made by reviewers during the evaluation of this project (PRID 193)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Trying to bring down the cost of fabricating Archimedes screw turbines. Growth and Sustainability.
- There are a large number of potential low head Hydro sites in the United States that could benefit from economical new technology such as AHS (Archimedes Hydrodynamic Screw). I believe that this type of generation has been successfully used in Europe and that the development of American sourced turbines may stimulate the development of a number of valuable projects both at canal drops and at low head dams.
- If this develops into a low cost U.S.-manufactured 3D printed turbine for low head impact dams, the value will be great
- This has more application to DOE strategy over the former study on the Engr Drop
- Composites could give cheaper construction costs and modeling could give a better design
- Novel technology, unclear whether the cost targets can be achieved to make this viable
- 3d printing of models is an excellent fast turnaround of design changes
- Lower cost and more opportunity to build more in factory
- Very relevant for wider application of the AST (Archimedes screw turbine)

Question 2: Methods and Approach

- The project appears to be well organized and progressing in a reasonable manner. The research to date has been systematic and appears relatively comprehensive.
- Good approach and methods with strong lab support and validation of CFD (computational fluid dynamics) models
- Good approach, solid team with PNNL and USU (Utah State University) lab as well as other contractors
- Should have involved manufacturers
- Still seems a little too kitchen sink research

Question 3: Technical Accomplishments and Progress

- The key element in this project will be the implementation of a prototype and the resulting costs and measurements
- Good technical accomplishments and progress to date
- Looking at entrance and exit aspects. Looking at mainly energy now but maybe fish later.
- No CFD modeling as part of funding
- Project appears to be on track, the next year through scenario development will be interesting
- OK but why were solutions from Wind (composites and 3D printing) not brought in as collaborators

Question 4: Project Management

- The project appears to be well-managed
- Seems to be effective up to this point
- Standard project management methods have been applied
- No real track record of good project management by this entrepreneur

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good effort securing matching funds and coordination with partners
- The technical results to date have been shared with the industry and academia. A continued sharing of information including specific information on project costs and generation efficiencies will be critical to establishing the AHS as a viable generating alternative for low head sites.
- They could communicate and share findings on a larger platform in the Industry such as HydroVision 2017 panel. They need to communicate results faster and more often.
- Appear to have the typical communications and technology transfer approach
- Kitchen sink approach as opposed to focused industry approach

Question 6: Proposed Future Research, if applicable

- It is difficult to envision future research until the project prototype is in place. It is likely that future research will be warranted to address concerns identified during the installation and operation of the prototype.
- Future research is a good investment for our industry
- Solid research plan, with high potential for additional research
- Good idea that will get lost unless industry is involved

Comments made by reviewers during the evaluation of this project (PRID 193)

Question 7: Project Strengths

- The AHS technology appears to be a fish friendly and relatively low cost methodology to capture the hydro-potential at existing low head sites. Since there are a large number of these sites throughout the United States, this technology could be a valuable part of future hydro-generation. The environmentally friendly nature of the site combined with the relatively small project size and lower cost would allow this type of technology to be developed by smaller investors rather than large institutional financing required for many conventional hydro-projects.
- Good lab and engineering support and progress on design with CFD model validation
- Strong team, very comprehensive research approach
- Good research
- Modelling capability

Question 8: Project Weaknesses

- Needs to share results and lessons learned in the industry faster and more often. Seems closed group of communications.
- Too much of an engineering sandbox solution, should have been scoped more aggressively

Question 9: Recommendations

- PI (Principal Investigator) explained that Europe is ahead of the United States on this because of their policy, i.e. FIT (feed-in tariff) where the power is valued at $0.30/kWh. In the United States, he is dealing with $0.038/kWh which makes it unfeasible to develop here. Can this dilemma be overcome without a shift in policy? Can DOE help policy makers understand this?
- As indicated in the response to Q7 above, this technology appears to have a potentially important role in the development of new Hydro generation projects throughout the United States
- I recommend continued support of this item and dropping project 142
- Blend work on this with the VFD (variable frequency drive)
- Companies are bandying about LCOE (levelized cost of energy) but I think that this is inconsistently calculated. DOE needs to jump in here as failure to control this metric will lead to big cost advantage claims that could be disproved.

DOE Water Power Technologies Office 2017 Peer Review Project:

The Design and Development of a Composite Hydropower Turbine Runner

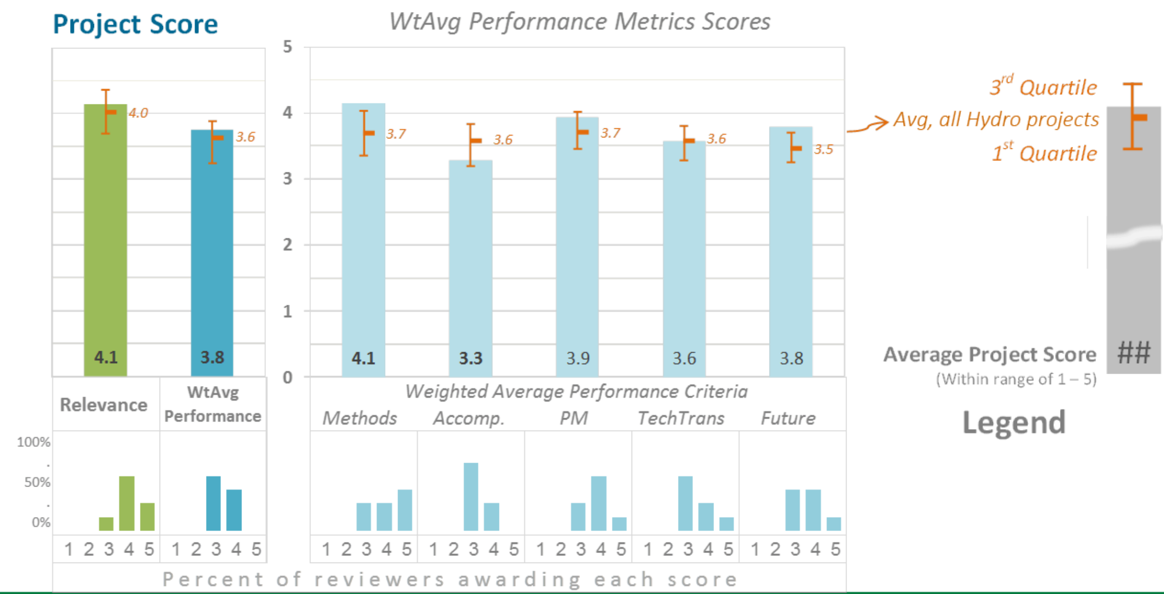
Principal Investigator	Pat Hipp, Composite Technology Development, Inc.
Track	Hydropower (Hydro)
Sub-track	Growth
Topic Area	Lower Civil Works Costs

FY 2014-FY 2016 Funding

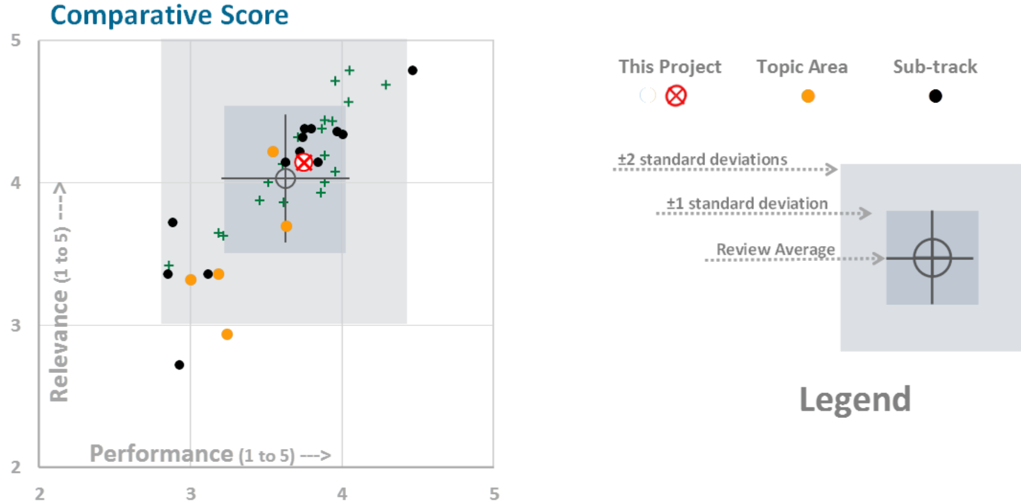
DOE	$ 1.0 M	97%
Cost Share	$ 0.0 M	3%
Total	**$ 1.0 M**	**100%**

Peer Review ID# 194

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 194)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Growth- improving fatigue resistance. Composites are advantageous for smaller variable flow systems.
- The use of composite materials to develop Hydro turbine runners has the potential to decrease the cost of hydropower facilities and to increase the longevity of the facilities. Given the current state of technology, the exploration of the use of these composite materials is appropriate and potentially very valuable.
- This does have relevance to the industry and overall DOE objectives
- Includes Voith and Sandia Labs, also Penn State
- Very good project, highly qualified team
- A rare example of industry being attracted

Question 2: Methods and Approach

- Building block approach. Testing at the component level and the system level. Key issue is to use material that can survive the marine and erosion environment.
- The approach appears to be very systematic and to incorporate industry input
- It is early in the project but their method and approach is sound
- They need to leverage learnings in aerospace and wind turbine blades throughout the project
- Looking at coating, materials and design aspects
- Marine is mentioned which goes beyond hydro and is wind and or tidal
- Mention MHK
- Needs to be as strong as steel, resist erosion and not have cavitation. Needs to be researched and studied.
- Period 2 is fabrication
- Strong technical approach
- Leveraging the scale of industrial partner
- Lower long term O&M (operations and maintenance) and cost
- Should involve USFW (U.S. Fish and Wildlife Service) and other affected resource agencies

Question 3: Technical Accomplishments and Progress

- Progress to date appears very good
- It is early in the stage with initial technical results being more literature research and setting second phase technical objectives
- Project has a good start, will be an interesting year of testing and design
- Could they have moved faster by leveraging an outside composite manufacturer?

Question 4: Project Management

- Project appears to be very well-managed
- There appears to be strong Project Management across the project with inclusion of the key contributors
- Seems to be a well-managed program, David knows his stuff and has brought together a good team although needs wind and marine funding as well
- Standard project management methods appear to be being used
- Looks on time and on budget so presume good PM (project management)

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good diverse and balanced team
- Too early for publications, but the presentation was weak on describing what they plan to do when they are ready
- This project could provide very valuable technology for improving and preservation of our existing fleet. Past Voith involved projects have shown that they communicate very well results and potential freely throughout the industry.
- Needs to assess life cycle fatigue testing
- Should be integrated with other industries
- Each partner appears to serve an important role, with each being highly qualified
- Blend industry, universities and labs to get strong results

Comments made by reviewers during the evaluation of this project (PRID 194)

Question 6: Proposed Future Research, if applicable

- I support continued funding of this research
- Runner blade design has lots of research data
- Should be industry wide in fact apply to other industries such as wind
- Study focusing on matching existing design not improving on the design
- Strong possibility of future research
- Develop cost models
- Long term endurance test to determine MTBF (mean time between failures)

Question 7: Project Strengths

- The project appears to be well conceived and to be a steppingstone into the potential use of more economical and more easily fabricated turbine runners utilizing state-of-the-art materials. This has the potential to be a significant contribution to the generation at both new sites and the rehabilitation of existing hydroelectric facilities.
- Could provide good transferable technology to our fleet. Voith is a strong partner for this effort.
- Highly qualified team
- Important research for hydro
- Targeted known problem area (cost)

Question 8: Project Weaknesses

- Early in the project
- Does not seem to be looking at underwater fatigue although this could be an issue, especially with hydro

Question 9: Recommendations

- I would recommend that continued research in this area be funded and that other turbine manufacturers be included in future research projects
- I support continued funding for this project
- Need to assess if different intake criteria are established
- Lessons learned and best practices should be exchanged
- Should marry composite research on this with project 193 (composite Archimedes screw) or any other composite solutions

7.3.2 Optimization

DOE Water Power Technologies Office 2017 Peer Review Project:

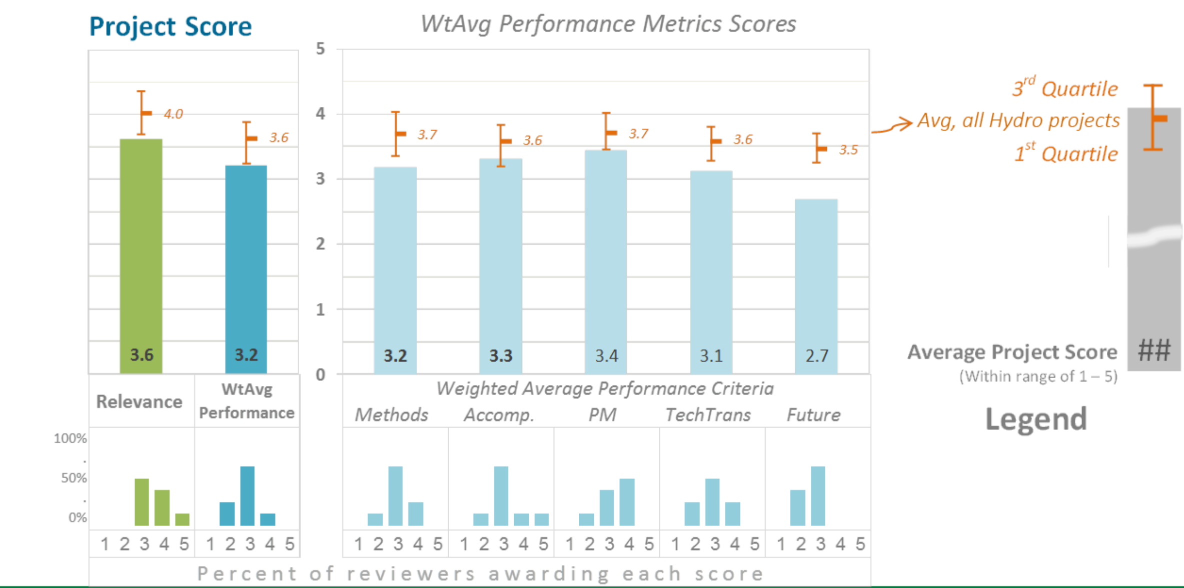
Hydropower Manufacturing and Supply Chain Analysis

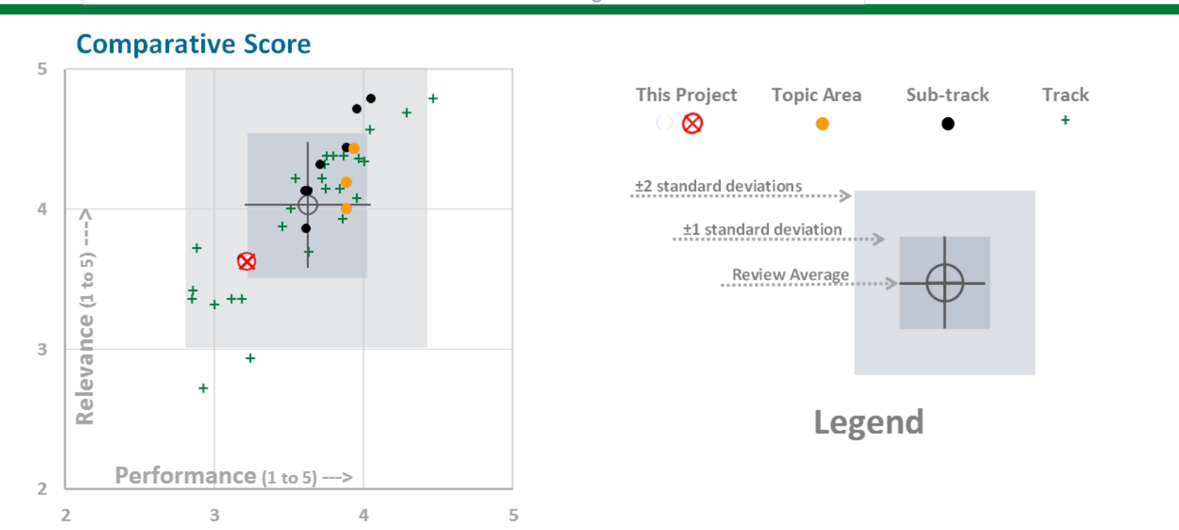
Principal Investigator	Jason Cotrell, National Renewable Energy Laboratory
Track	Hydropower (Hydro)
Sub-track	Optimization
Topic Area	TechEcon and DB

FY 2014-FY 2016 Funding

DOE	$ 0.3 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.3 M**	**100%**

Peer Review ID# 43





Comments made by reviewers during the evaluation of this project (PRID 43)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Primary objective here is to lower costs through study of supply chain - look for inefficiencies and constraints. But is the cost of manufacturing the leading driver to the lack of U.S. hydropower development? Or is it more related to (1) the cost of electricity from fossil fuel which is indirectly subsidized because the United States does not have a price on carbon and (2) regulatory burden related to 6 year licensing process.
- Strategic priority is Growth (to inform investment strategy)
- This is not my area of expertise, however I believe that the study efforts are focused more on increasing American competitiveness in the overall manufacturing area than on developing solutions that will enable the implementation of low-cost hydroelectric power. Is my impression that the manufacture of many components for low head Hydro is more efficiently performed outside of the United States due to lower labor costs and other factors. For this reason I'm not sure that increased production of American goods will necessarily reduce the cost of hydroelectric implementation and promote more Hydro development in the United States.
- This is good information for our Industry to know and ties to the overall DOE objectives
- I have to confess that I really do not understand what this project set out to do and what it accomplished or did not accomplish. Perhaps intended to provide DOE and others with a sense of what avenues for future research might be most fruitful in order to lower manufacturing costs of hydropower components. Not obvious how this will help accomplish that goal. Feels a little theoretical, but again that could be a function of me not really understanding it.
- Supply chain is so important but maybe this belongs in Dept of Commerce rather than DOE
- Clean Energy Manufacturing Analysis Center (CEMAC) the AST (Archimedes Screw Turbine) needs to be part of this
- Growth
- Optimization
- No specific plan going forward…will reveal itself in ongoing interviews
- Not sure what to make of this

Question 2: Methods and Approach

- The methods and approach are feasible and will deliver a measurable product
- Not sure I understand what this project was meant to accomplish, so don't feel qualified to pass judgment on the approach
- Jobs, cost reduction and technical innovation are important
- Not sure that we need to break down the turbine parts supply
- Good adaptation of existing methods to hydropower
- Structured DFM (Design for Manufacturing) analysis looks solid

Question 3: Technical Accomplishments and Progress

- They are delivering results as planned successful at delivering
- Appears to have met all milestones
- Good to assess what factors in production are most important
- Project is moving along on track
- Selected a high volume technology Kaplan… should consider other turbines
- Too early to form a strong opinion

Question 4: Project Management

- Project Management has done a good job at meeting schedule and budget
- Milestones met on time and on budget
- Should be tightened up at the most senior level
- Standard project management methods are being used

Question 5: Research Integration, Collaboration, and Technology Transfer

- They could work better with the Industry Associations early in the project (NHA (National Hydropower Association)) to better target the value add of this data to the industry
- Conference presentation and final report; cooperation with ORNL
- Project needs to be communicated more at future conferences and meetings
- Clearly strong but where is industry input to the study?

Comments made by reviewers during the evaluation of this project (PRID 43)

Question 6: Proposed Future Research, if applicable

- No, I feel that this project should be finalized and let the current data stand on its own
- This might have been better described as N/A (not applicable)

Question 7: Project Strengths

- Strong data and access to manufactures
- Good team, established methods
- Leveraging wind and MHK experience

Question 8: Project Weaknesses

- This effort has the potential to be helpful with several of the innovations that DOE research is funding, yet I am not certain that it will be effective in lowering supply chain costs
- Needs better communication with NHA on how this data focus can affect policy and the industry
- Manufacturers or supply side not evident in program
- Still early stage

Question 9: Recommendations

- This is not my area of expertise and therefore my comments may be shortsighted. As indicated in my response above, I am having difficulty in concluding that this study will result in significant policy changes that will promote the cost-effective development of hydroelectric projects in the United States.
- Finalize and finish the project and don't pursue new results
- Follow through with industry interviews
- Run Emergy and Percheron composite Archimedes Screw Turbine through this

DOE Water Power Technologies Office 2017 Peer Review Project:

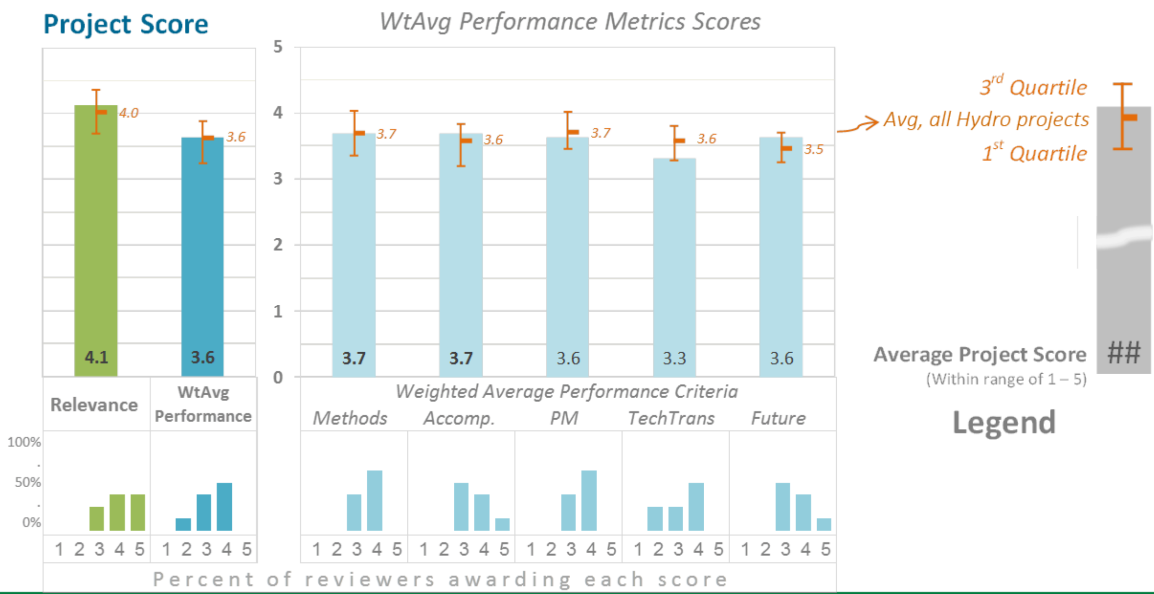
PSH Transient Simulation Modeling

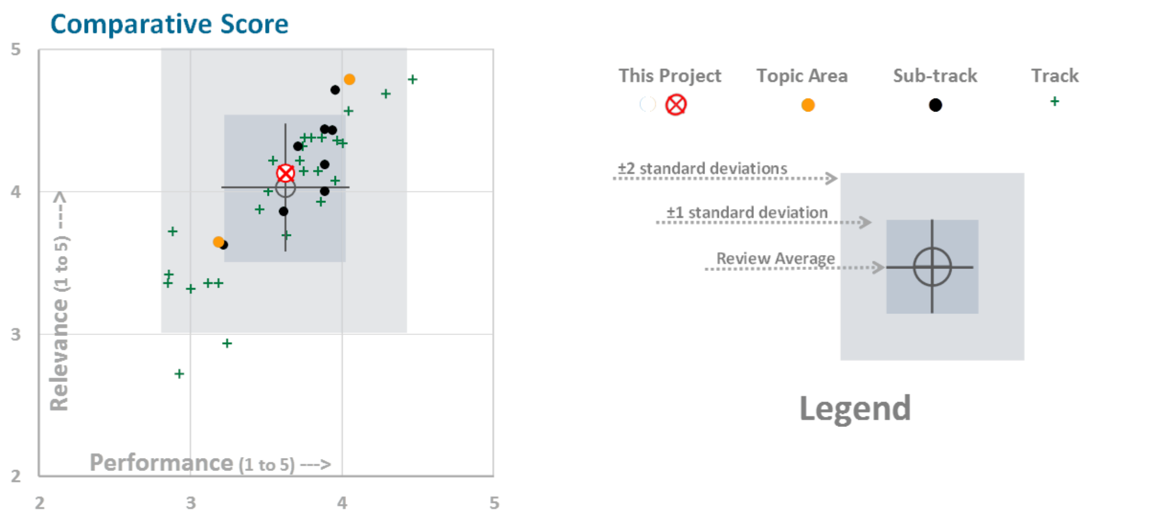
Principal Investigator	Edward Muljadi, National Renewable Energy Laboratory
Track	Hydropower (Hydro)
Sub-track	Optimization
Topic Area	Grid Support

FY 2014-FY 2016 Funding

DOE	$ 0.1 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.1 M**	**100%**

Peer Review ID# 49





Comments made by reviewers during the evaluation of this project (PRID 49)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- The Vision has a very aggressive goal for developing new PSH, and this research directly addresses a significant gap in currently available technology which, if effective will be demonstrably helpful in new PSH development
- Although I am an engineer, I do not feel extremely qualified to evaluate this project. I understand that the evaluation of transients and ancillary benefits are critical to integration of renewable intermittent resources. It appears that this project will provide valuable information in this regard. I do not however feel qualified to evaluate this project to any great depth. I therefore have put down "good" scores for all of the items.
- This is not my area of expertise
- This project does have relevance to water industry and DOE objectives
- I really do not feel qualified to evaluate this project. In all honesty, I barely understood it.
- Assists in bringing renewables to market
- Can see effects of changes in the electrical components in the system
- Variable speed is valuable
- Project benefits pumped storage development
- No question that the United States is behind Europe in pumped storage, not just usage but also technology
- Optimize and growth. Very important to the program. I get the impression that technology is ahead of market. In other words we have solutions looking for locations. Are investors and bankers ready for this? Do they understand the superior investment returns?
- Hard for me to see the driving need for this. We already know new pumped storage technologies can provide a variety of ancillary services. Not sure how this helps us get any new pumped storage actually built. Seems like this kind of analysis (or at least real world results) could be available from European and Japanese experiences.

Question 2: Methods and Approach

- Good methods and approach to meeting technical hurdles for this complex project
- I have seen presentations before
- Variable speed for PSH is so important
- Appropriate methods have been used
- Concepts are easy to understand and the modelling is powerful

Question 3: Technical Accomplishments and Progress

- The development of more variable response for efficiency to balance integration of transient renewables is necessary and relevant
- They have proceeded according to scope and stated goals
- Assessed ancillary benefits which is excellent
- Objectives of this research relative to what is already being used, was not clear
- Development of tools to advance the process are excellent and fundamental

Question 4: Project Management

- Project Management has been effective to date
- Seems to be a well-managed research program
- Standard approaches have been used
- Clearly professionally run

Question 5: Research Integration, Collaboration, and Technology Transfer

- Open source data is an extremely effective way to transfer technology as our society moves more towards shared resources
- Research and interaction are good, collaboration with end users and vendors that have existing technology should be stronger
- Needs to take next step so that variables can be proposed in the United States
- It just staggers me that we in the United States have just woken up to the benefit of Variable speed drives in small hydro and pumped storage when they have been around for years in the water industry in Europe (I may be off base here)

Comments made by reviewers during the evaluation of this project (PRID 49)

Question 6: Proposed Future Research, if applicable

- I support continued funding of the study
- Need implementation plan
- Bring this to market and insure that ROI (return on investment) is developed for these projects as the $$$ needed are huge and the investment market/banks may balk

Question 7: Project Strengths

- Very applicable study with the impacts of solar and wind variability on our grid
- Complex systems integration
- Balance out variability of renewables
- Least cost solution for storage
- Leveraged wind knowledge
- Solving the electrodynamics from the hydrodynamics challenges

Question 8: Project Weaknesses

- Needs better collaboration in the industry and communication to the Hydro Industry
- It was hard to understand what exactly was being done, the Q/A (Question/Answer) session was very helpful to understanding this project
- No ROI
- Not clear on scale that the system can handle. Clearly at the top end but we have to come up with solutions for low head run of river, as the alternatives are batteries and it is difficult to justify their investment returns.

Question 9: Recommendations

- Good timing for this study. It should continue to be funded.
- Very good modelling solution
- Where in NE can pumped storage be implemented?

DOE Water Power Technologies Office 2017 Peer Review Project:

Integrated Hydropower and Storage Systems Operation for Enhanced Grid Services

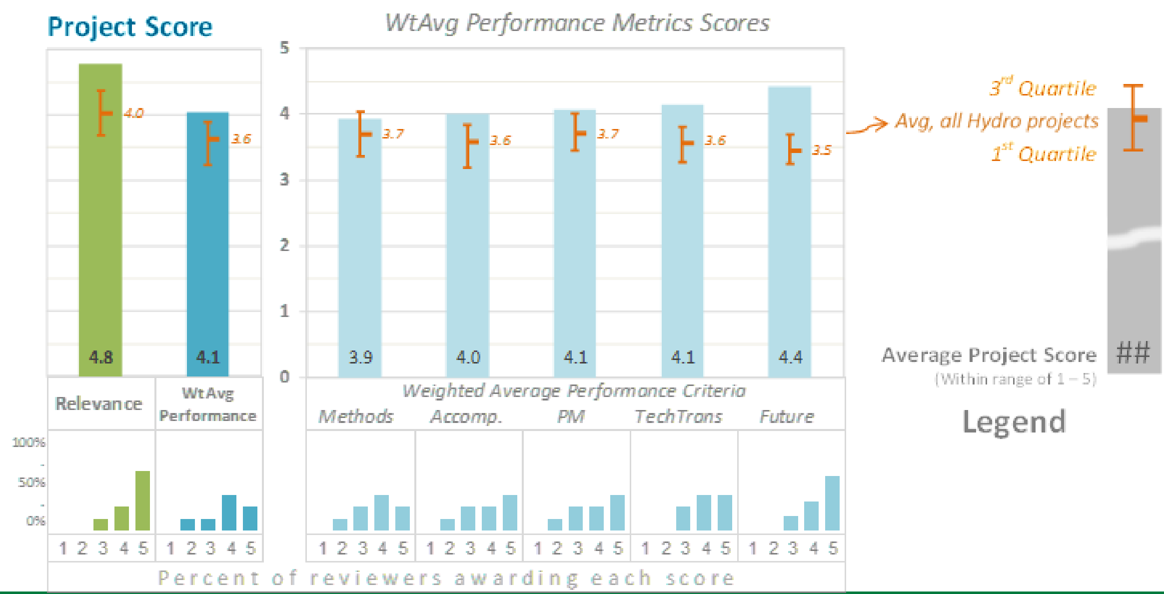
Principal Investigator	Rob Hovsapian, Idaho National Laboratory
Track	Hydropower (Hydro)
Sub-track	Optimization
Topic Area	Grid Support

FY 2014-FY 2016 Funding

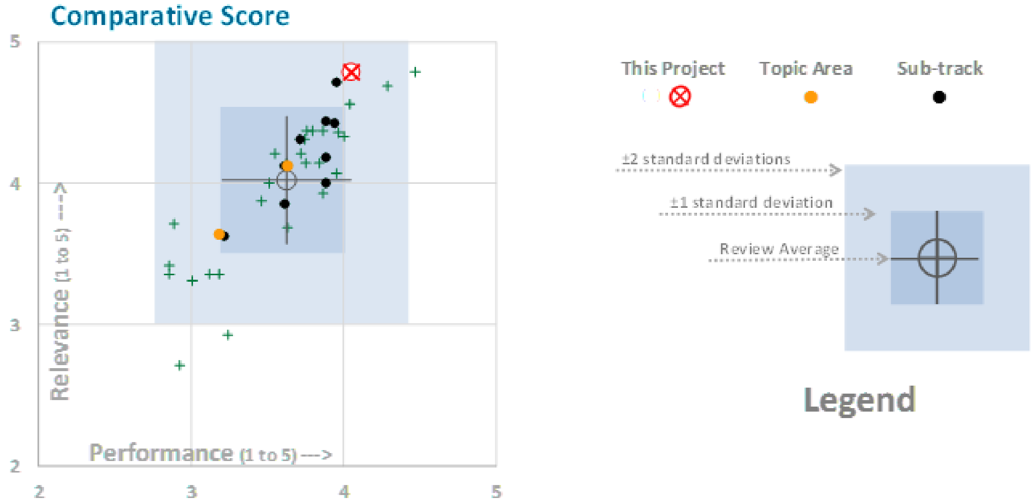
DOE	$ 1.0 M	95%
Cost Share	$ 0.1 M	5%
Total	**$ 1.1 M**	**100%**

Peer Review ID# 58

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 58)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Involves both ROR (run-of-river) and some storage. Supercapacitors and batteries. Challenge - how do you control it? They are not interconnected by wires. They created a smart communications system for coordination.
- Quantification of ancillary services is a key component of Optimization - identify revenue streams for ancillary services
- The increase of new ROR - the challenge, can they be coordinated as a single system to add stability back into the grid
- Although this is not my area of expertise, I believe that the research is well-founded and could identify valuable methods to utilize run of river hydroelectric projects to provide ancillary services. Hopefully this will also provide an additional revenue source for these types of projects.
- The aspects of inertia to the grid and valuing AS (ancillary services) are a critical delivery aspect of this study. That's why I give it a 5.
- This is a good study that directly meets Industry and DOE objectives
- Very interesting project. A little over my head technically. Very interesting and innovative thoughts about how to use energy storage to add stability to the grid. But in all honesty, the hydropower portion of this project feels like an add-on afterthought. Much of this research into grid stability technologies would have been every bit as relevant had it not involved RoR hydropower, and it's not clear that hydropower added much.
- How a series of small RoR projects can be operated as a storage project
- This is really a study as to how energy storage aspects such as the smart energy box, super conductor, flywheel and potentially a battery can be added to RoR hydro to make them into a storage project
- Project explores integrated ROR projects with a control system to enhance grid stability
- Creating instability in the supply as we replace stable supplies with renewables
- Front end controller tying ROR plants together to complete a managed storage solution

Question 2: Methods and Approach

- Using proven technology open source smart energy box from Siemens is a model to replicate in other applications
- Supercapacitor comes from the automotive industry
- This is about inertia of the system - how quickly will the storage respond and provide stability?
- It appears that the process and research are progressing in an organized systematic way utilizing all participants
- The methods and approach to date are light on direct Hydro integration and seem to be heavy on batteries and flywheels
- Don't feel qualified to judge technical merits
- This project led an interesting discussion about what ""Run of River"" hydropower means
- Included Siemens and used their "smart Energy Box" developed under a separate DOE grant which was a good idea. Allows research to continue and applies research from other projects.
- Complex systems modeling, with both hardware development and model simulations
- Seems to be an outstanding example of inter research lab work

Question 3: Technical Accomplishments and Progress

- Modeling and analysis of generation topology and flow data by ANL and NREL
- The front end controller allows multiple ROR plants to talk to each other and to the utility and storage devices
- Use of supercapacitors can help provide stability and reduce the need to use the battery, and reduce the necessary size of the battery
- Using batteries for regulation rather than providing energy needs more testing - has not been studied to any length. What are the impacts i.e. fatigue to the battery?
- The progress appears good to date
- Very early in the project and a lot of proposed aspects communicated at this stage. There were initial delays in the schedule.

Comments made by reviewers during the evaluation of this project (PRID 58)

- Don't feel qualified to judge technical merits
- Also integrates various research aspects even though RoR hydro has restrictions
- Developed system approach to give real time application which is good
- Project appears to be well on its way, with good accomplishments to date
- Adding power and controllers, generator, governors super capacitors and fly wheels
- Analog to wind and solar
- Open source for automation using Siemens smart energy bus. Tying gird signal. Siemens has an open source energy box Siemens Smart Energy Box (inverter controller) developed for building automation.
- Respond to ancillary services
- Talk about the power of energy storage how quickly can we respond to grid instability and create inertia in system in which to stabilize this

Question 4: Project Management

- Project management appears good
- Project Management will be challenged on this study containing focus due to the many emerging technologies integrated into one study
- Unclear from materials provided whether milestones were met on time and on budget
- Very well managed that brings in all 3 labs and the private sector
- Complex project with multiple labs contributing
- Standard methods have been applied
- Seems superb but no real insight. It would be good to look at this research project for Best Practice in Project Management.

Question 5: Research Integration, Collaboration, and Technology Transfer

- Coordinated with ORNL on their prior supercapacitor work
- This work should be disseminated to system operators and utilities. Individual ROR owner/operators would benefit from the prospect of receiving value for their ancillary services, but it is the system operator that would really benefit.
- It’s early but this team will need to work very hard communicating results to the many venues in the industry
- Primarily among the labs (not the best integration with the real world), but bringing in Idaho Falls Power Distribution Network is an interesting real-world collaboration
- Can be applied to wind and solar variable sources as well
- Seemed to push some of the aspects like flywheels and super capacitor to push the research aspects
- Automotive, Siemens smart box
- Front end controller that talks to low level controllers that talks to storage and utilities
- Integration of SEB (Siemens Smart energy Box) and

Question 6: Proposed Future Research, if applicable

- I propose continued support of this project. It really captures how the future of our industry is transitioning and can be valued.
- N/a (Not applicable)
- Seems like there is unlimited future research potential in this area
- Want to see this drive to small distributed hydropower projects

Question 7: Project Strengths

- Very impressive that this has not been done anywhere else in the world
- It is supported well with good technical organizations
- Incorporates superconductor at front to take stress off the batteries
- Complex project with multiple partners
- Highly valuable project that will enhance grid stability
- 3 year project completion date 3 years
- Leverage existing technologies. Automotive super capacitors. NREL run of river model. Idaho focuses on storage devices. Wind. Grid modernization project 3 Run of river plant. Collaboration.
- Using rotational fly wheels from de-commissioned coal power plants

Comments made by reviewers during the evaluation of this project (PRID 58)

Question 8: Project Weaknesses

- Very broad scope and new emerging technologies are covered and can lead to scope and schedule creep
- They have identified a critical factor that the battery companies never tell end users ..fatigue on batteries from dynamic use of batteries
- Use the supercapacitors at front of batteries to absorb intrantantenoeus to reduce size of battery and battery fatigue

Question 9: Recommendations

- Research from Uganda: https://www.researchgate.net/profile/Patrick_Mugisha/publication/268257884_INTEGRATION_OF_MINI-HYDROPOWER_PLANTS_IN_ELECTRICITY_TRANSMISSION_AND_DISTRIBUTION_NETWORK/links/55e747ef08ae3e12184208f1.pdf
- This is still conceptual. New paradigm for hydro - this is also about sustainability. This allows the system to achieve the benefit of a large reservoir from aggregation of distributed small resources.
- If this project results in methodology that can use ROR facilities to provide grid support and ancillary services a follow-up study could involve how these facilities could be compensated for providing this service to the grid
- Continued support of this project should be supported
- Argonne is doing the energy and economic tools -the capability must be highlighted frequently. V impressed By Vladimar.
- Battery fatigue
- Bring this to small scale hydro
- Provide them with a real life model
- Use real-time simulation

DOE Water Power Technologies Office 2017 Peer Review Project:

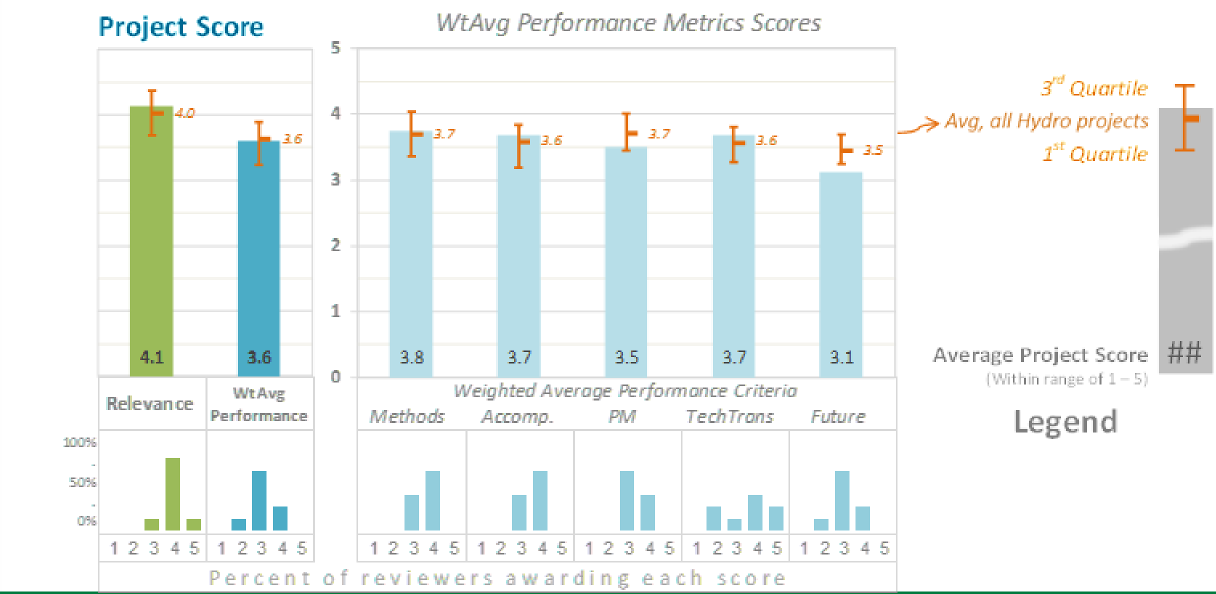
Hydropower Asset Management Research

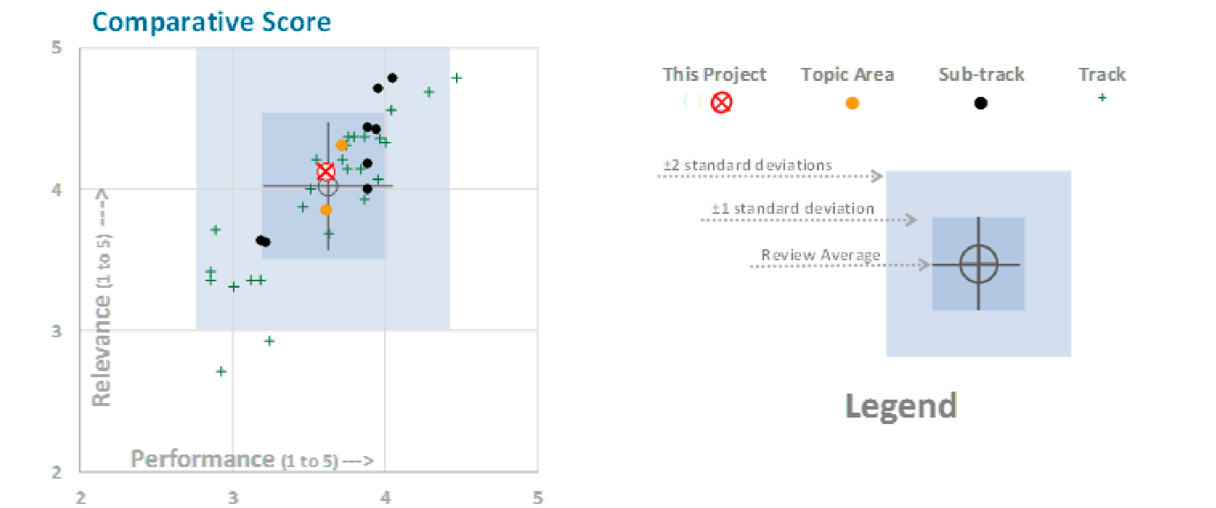
Principal Investigator	Brennan Smith, Oak Ridge National Laboratory
Track	Hydropower (Hydro)
Sub-track	Optimization
Topic Area	Water Use

FY 2014-FY 2016 Funding

DOE	$ 0.8 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.8 M**	**100%**

Peer Review ID# 61





Comments made by reviewers during the evaluation of this project (PRID 61)
Question 1: Relevance to Water Power industry needs and overall DOE objectives • This project is geared towards optimization, using data enhancement for optimization of the existing fleet • The efficient use of existing resources is an important complement in maximizing the value of hydropower production. New technology allows more real-time decisions regarding dispatching and the efficiency of various units. This is an important aspect of the ongoing need to increase hydroelectric production. As discussed below it is not apparent that the results of this study have been shared with private owners of hydroelectric facilities. • This project does meet with DOE objectives and the needs of the Water Power Industry • Better data analysis can result in more efficient operations of the existing hydropower fleet. This is an important part of identifying best practices. • Finalizing and summing up study. Good information but again need to cut back or close once objectives have been met. • O&M (operations and maintenance) costs • Important analysis and tool development that will benefit the hydro industry • I can imagine that this has great relevance • Optimization • This one stumped me…way too technical for a diverse Peer Review group. Too much theory too late in the day. **Question 2: Methods and Approach** • Studies operational data as well as maintenance and reliability data • The study should've included nonfederal hydroelectric facilities • Good approach and method of overcoming technical barriers to provide beneficial data • Don't feel qualified to judge • Methods and approach are technically sound • Impossible to comment -too technically dense **Question 3: Technical Accomplishments and Progress** • Private and Bureau projects included in the results is a positive • The project has accomplished good progress to date • Don't feel qualified to judge • Project is near completion and should finish positively • Impossible to comment -too technically dense **Question 4: Project Management** • The project management is executing well to date on this project • Difficult to say if this project was well-managed or not. Significant delays attributed to data quality and partner's ability to extract the data. Only one milestone identified for FY16 (Go/No-go), which was not completed. • Well managed • Standard project management methods were used • No clear explanation of methods **Question 5: Research Integration, Collaboration, and Technology Transfer** • Coordination with NERC (North American Electric Reliability Corporation) on GADS (Generator Availability Data System) • Excellent job working with collaborators on extracting difficult data • Prize winning paper and more papers to be published • The results of this study should have been shared with nonfederal groups such as CEATI (Centre for Energy Advancement through Technological Innovation) and the Hydro production committee of NHA (National Hydropower Association) • Good collaboration working in the private sector and the Bureau

Comments made by reviewers during the evaluation of this project (PRID 61)

- Cooperation with both federal and non-federal operators is good
- Strong, well-integrated team
- Impossible to comment -too technically dense

Question 6: Proposed Future Research, if applicable

- Would it be possible to use this kind of research for coordination of flows amongst and between operators to enhance sustainability objectives?
- I support future research of this study
- This proposed research might be worthwhile, but it's not explained well in presentation so I'm not sure what they're proposing
- Will be interesting to see how widely adopted the use of the tool will be by plants

Question 7: Project Strengths

- Focus on improving flow measurements which are critical
- Good collaboration
- Good tool
- Strong, integrated team
- I can only imagine very valuable to plant owners

Question 8: Project Weaknesses

- This project has continued for quite some time. Has it not achieved its original objective? Is it working?
- Needs more focus on phase 2 of the study
- PI (Principal investigator) admitted that the project is quite ambitious (by way of explaining why go-no-go milestone not met). Perhaps they bit off more than they could chew?
- Impossible to comment -too technically dense. However the presenter gives the impression that his view is the one that counts. Not the most open minded presenter but clearly brilliant in other ways.

Question 9: Recommendations

- This study should be pursued more
- Get this down to a mere mortal's level and present it with real tangible solutions

DOE Water Power Technologies Office 2017 Peer Review Project:

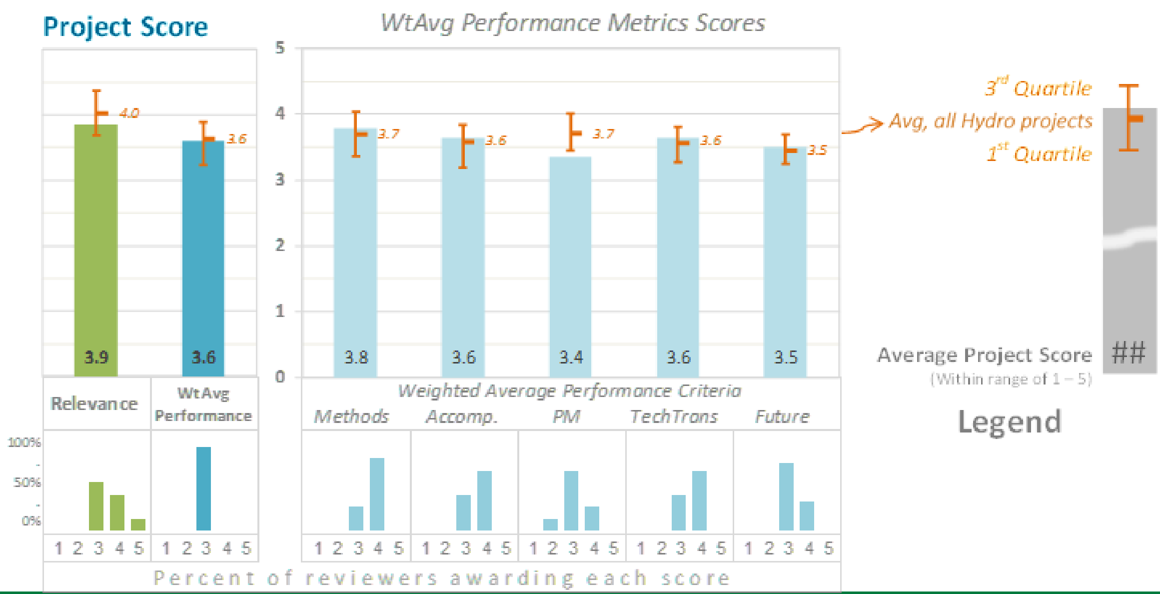
Low-Head, Short-Intake Flow Measurement Research

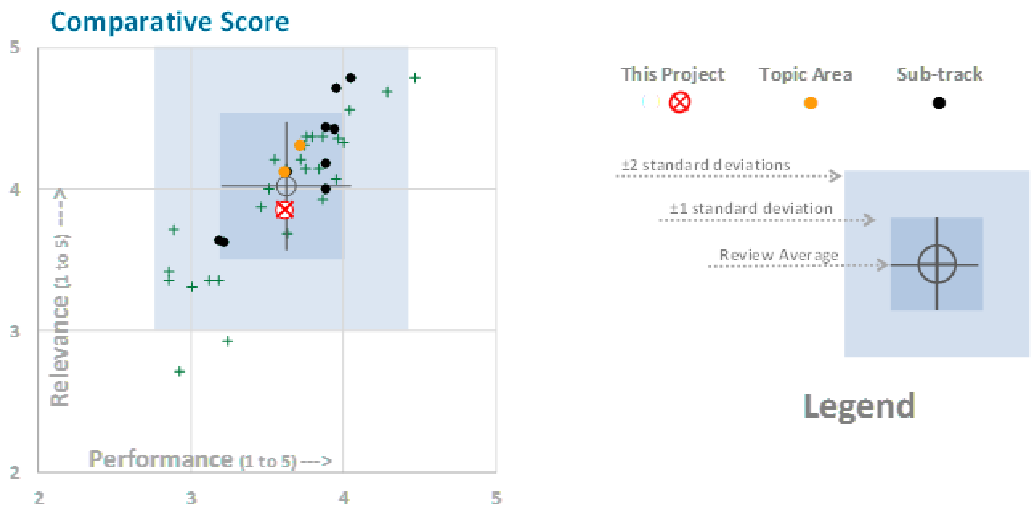
Principal Investigator	Marshall Richmond, Pacific Northwest National Laboratory
Track	Hydropower (Hydro)
Sub-track	Optimization
Topic Area	Water Use

FY 2014-FY 2016 Funding

DOE	$ 0.4 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.4 M**	**100%**

Peer Review ID# 62





Comments made by reviewers during the evaluation of this project (PRID 62)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- How accurate are flow rate measurements? Absolute accuracy is needed for effective optimization.
- It should be noted that this is not my area of expertise
- This study has relevance to larger hydroelectric projects and presumably will allow optimization of power production. I believe that the use of this information may be relatively limited and the impact on overall national power production may also be limited.
- Having a new approach to better measure flow gives us the ability to more efficiently operate our fleets
- This study is relevant to the overall DOE objectives
- Interesting (albeit over my head technically). What I can't tell from this presentation or the materials provided is the extent to which overcoming the technical challenge of better measuring flow in short converging turbine intakes will result in substantially improved performance of the hydropower fleet. In other words, this seems like good research, but it's more difficult to evaluate the real-world relevance of this research.
- Research project that I assume was based on suggested work?
- Project will benefit the hydro industry
- Optimization
- Sustainability
- This one also stumped me...way too technical for a diverse Peer Review group. Too much theory too late in the day.
- Can also be used for index calibration for other types of unit flow measurement
- To lower cost of flow measurement techniques that are currently being used

Question 2: Methods and Approach

- Virtual instrument
- Good methods and approach have been taken with the study and they are meeting some very technical hurdles successfully
- I am not qualified to assess this
- Well-designed project
- Not really able to comment but seems to be achieving objectives

Question 3: Technical Accomplishments and Progress

- The approach to the research is systematic and appears to have provided reasonable results
- They are delivering good technical accomplishments and results on this project in line with stated goals
- I am not qualified to assess this
- Not really competent to comment

Question 4: Project Management

- Project Management was impacted beyond items of their control with no funding released by DOE FY2015. They managed the best that can be expected. They are now funded and have reestablished a schedule of deliverables.
- Clearly someone erred in failing to allocate funds that were needed for this research in the last fiscal year. Unclear whether DOE or PI (Principal Investigator) was responsible for the error, which appears to have led to significant delays.
- Standard project management methods have been used

Question 5: Research Integration, Collaboration, and Technology Transfer

- They have shown great collaboration across the public and federal sectors. They have communicated with ASME (American Society of Mechanical Engineers) early and often.
- Published journal articles and presentation
- Peer reviewed papers are in review and in press

Question 6: Proposed Future Research, if applicable

- I proposed supporting future funding of this study
- Field demo will be vital

Comments made by reviewers during the evaluation of this project (PRID 62)

Question 7: Project Strengths

- Our industry needs a solution of this type. Flow studies are often objectified and need confirmation via approved alternative methods.
- Good team, qualified individuals

Question 8: Project Weaknesses

- Need more field and situational validation tests
- Output seems merely to be in papers written…any empirical studies in real life?

Question 9: Recommendations

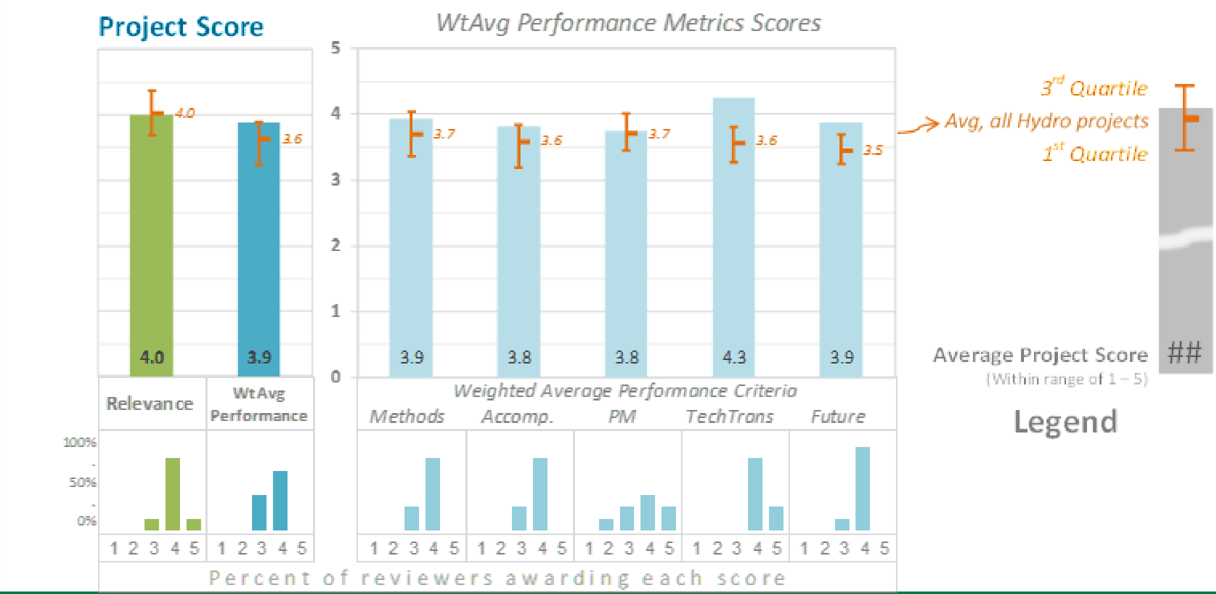
- This project should be supported through the next phase
- Would be interesting to see the range of unit discharge variability as a result of plant loading

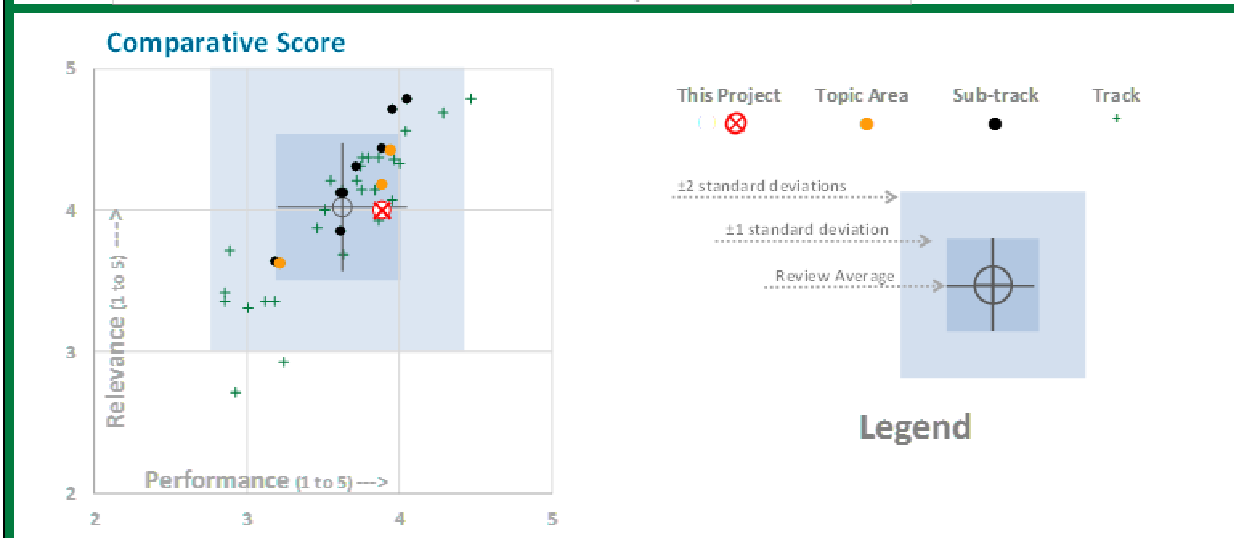
DOE Water Power Technologies Office 2017 Peer Review Project:

Cost Data Collection and Modeling for Hydropower

Principal Investigator	Patrick O'Connor, Oak Ridge National Laboratory		
Track	Hydropower (Hydro)		
Sub-track	Optimization		
Topic Area	TechEcon and DB		
FY 2014-FY 2016 Funding			
	DOE	$ 0.9 M	100%
	Cost Share	$ 0.0 M	0%
	Total	**$ 0.9 M**	**100%**

Peer Review ID# 64





Comments made by reviewers during the evaluation of this project (PRID 64)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Growth - to facilitate data-driven decision making
- It should be noted that this is not my area of expertise
- The current study provides valuable information for policymaking in the area of hydroelectric development
- This project does align with DOE overall objectives
- Better understanding of costs and what is driving costs can help DOE determine how best to invest research dollars to move the industry forward
- Objectives well laid out and industry review has been very good
- Project has value to the hydro industry
- Definition challenge: what's small hydropower?
- Optimization
- Would like to see more focus on existing fleet costs and not just on new hydro costs

Question 2: Methods and Approach

- Quality control focus on data collection
- The approach and methods are well designed. The use of EUCG (Electric Utility Cost Group) as a base is a great call for this study.
- Again well done and industry review has been good
- Delays are understandable
- Methods clearly outlined and targets clarified
- Small Hydro IDEA (Integrated Design and Economic Assessment) model appears that it will make a significant contribution
- Big budget with course change and so unclear if objectives were achieved

Question 3: Technical Accomplishments and Progress

- EUGC HPC (hydroelectric productivity committee) participation thanks to this research
- The project has generally delivered upon the technical objectives
- See above
- Project is well underway and on track
- Would love to see the IDEA model, maybe not released yet?

Question 4: Project Management

- Delay impacted the timing but not the content
- The project did suffer schedule impacts and is behind. Current PMs (project managers) have communicated the impacts and adapted.
- PI (Principal Investigator) appears to have done a great job of picking up a project and keeping it moving after it lost its original PI and was subsequently deprioritized by DOE during the preparation of the Hydropower Vision
- Standard project management methods have been used
- Probably not too strong given the change in direction

Question 5: Research Integration, Collaboration, and Technology Transfer

- Data available to external groups trying to understand hydropower
- Good balance of collaborators
- How will IDEA be used? Is it meant to be for small developers who are trying to make decisions about development?
- There appear to be many papers and reports which have been disseminated to document the results of the project
- Holding the 2015 Cost Reduction Workshop is a best practice on getting the value of these studies back to the industry
- The project is showing an excellent example of collaboration
- Very good communications at conferences / meetings
- Nice to see both conference publications, as well as, a peer reviewed paper in HydroReview
- But if it contributed significantly to Hydrovision report then good
- Needed better definition of segments being studied
- Not sure if the scope of data collection was as wide as possible

Comments made by reviewers during the evaluation of this project (PRID 64)

Question 6: Proposed Future Research, if applicable

- I support future funding, consider not going down the path of modularity in this scope
- Poses interesting question: "what wasn't built and why? Moving beyond what drives cost to what's killing projects." Most discussion of this topic tends to be rather qualitative, with answers to that question often driven by one's preferred policy outcome. Bringing some analytical rigor to that question would help to move the discussion forward, so pursuing that line of inquiry in a neutral fashion would be worthwhile. Ditto for an attempt to really quantify project development risks.

Question 7: Project Strengths

- Use of EUCG data as a base is very creditable
- Strong / qualified PI
- Strong data base
- Very good model under development
- Engaging with Electricity industry
- Stakeholder involvement

Question 8: Project Weaknesses

- I'm doubtful that the study includes an assessment of interconnection and transmission issues. Hydropower competes against other renewable sources of energy which often require major system upgrades and many miles of new transmission between the generation location and the market. These types of improvements and the cost associated with them are not compared in the renewable arena. The cost of hydropower interconnection can be significant but also in many cases is less than a realistic comparison with all renewables.
- Phase two scope should be less broad and more linked to phase one theme. Don't make it about modularity.

Question 9: Recommendations

- Continue to pursue this data study and collection with sharing in the industry on a routine plan
- Any future research into hydropower markets should focus on areas where the answer to a question will demonstrably move the industry forward. I'd like to see research aimed at quantifying hydropower's
- Drop this down a level to other small scale hydropower projects, run of river and conduit based systems

DOE Water Power Technologies Office 2017 Peer Review Project:

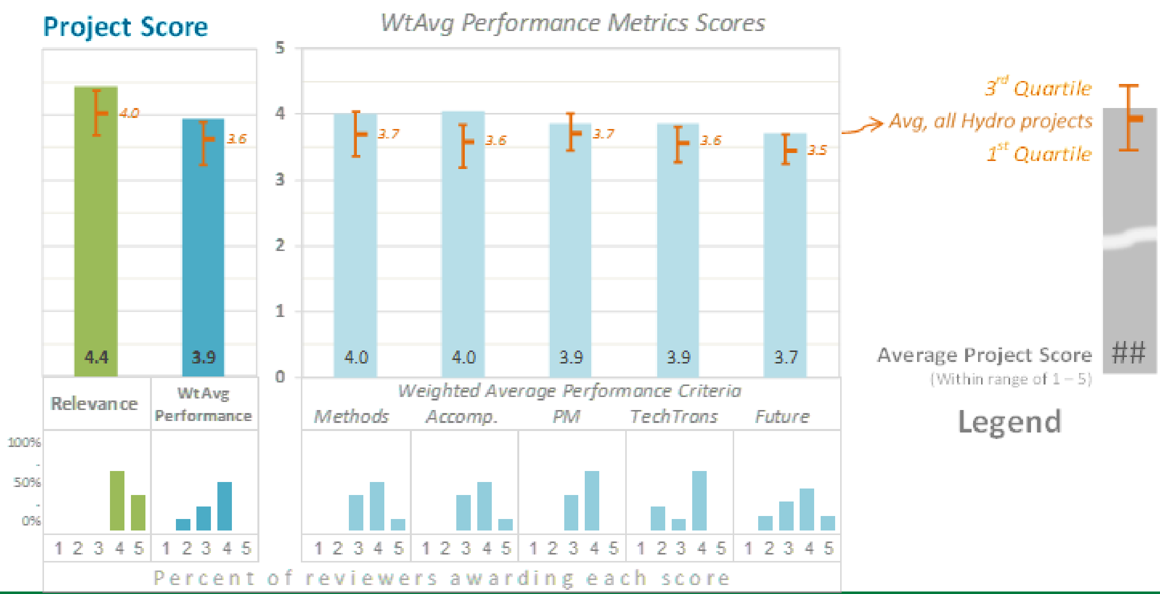
National Hydropower Asset Assessment Program (NHAAP)

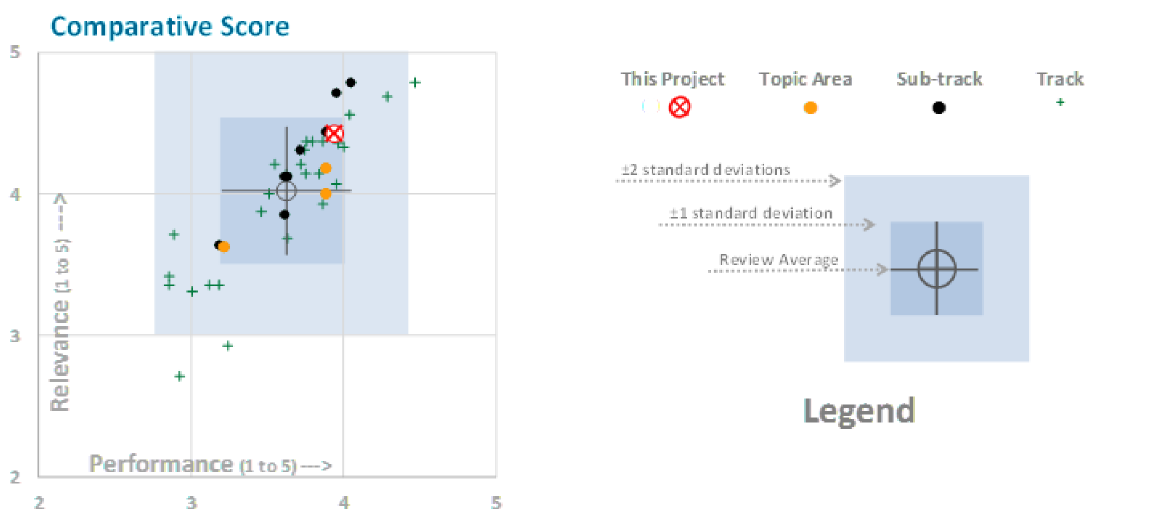
Principal Investigator	Shih-Chieh Kao, Oak Ridge National Laboratory
Track	Hydropower (Hydro)
Sub-track	Optimization
Topic Area	TechEcon and DB

FY 2014-FY 2016 Funding

DOE	$ 1.8 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 1.8 M**	**100%**

Peer Review ID# 77





Comments made by reviewers during the evaluation of this project (PRID 77)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Environmental mitigation tool extracted information from 380 FERC (Federal Energy Regulatory Commission) licenses and put it in a database. This is a very useful exercise for understanding the existing environmental concerns in the current fleet, which is necessary for the priority of sustainability.
- The source of information is extremely valuable to the industry both in documenting the existing contribution of hydropower and more importantly to the identification of potential locations for new hydropower development
- This does provide good data for overall DOE objectives
- You can't improve that which cannot be measured, so there's a need for this information to live on. Seems like a potentially huge, long-term / never-ending project, though.
- Changing name to HydroWise but same program
- Goal of having this data base as a one-stop-hydro-shop is excellent
- Good that information is updated on a regulation basis including location and energy availability
- Oak Ridge does not create data but organizes and maintains it
- This project provides a valuable data resource for Hydro
- Knowledge base Optimization
- Need one central database

Question 2: Methods and Approach

- Good approach and method of bringing data sets in and producing a useable project
- Lots of interesting data sets. Environmental mitigation / stream classification data sets appear to be largely speculative at this point, so good to see that they're building those out.
- Stream classification tool is incredibly ambitious. Remains to be seen whether it can done in a way that provides useful information.
- Can use this information when developing FERC PADs (Pre-Application Documents)? T&E (Threatened and endangered species) or fish passage data
- Good tools being developed
- How much is DOE actually contacting other Federal and State agencies for data; specifically T & E and cultural resources information
- Need to rely on information available from Utilities and resource agencies
- Strong methods for data collection, data archival and web-based information system
- Considered stakeholders in developing the project structure

Question 3: Technical Accomplishments and Progress

- It has provided results and progressed according to schedule and goals
- Hard to measure progress. Can't tell from materials provided what the goals were for this budget period, so can't tell how much progress was made towards that goal.
- The summary of Environmental Mitigation is very valuable

Question 4: Project Management

- Schedule and budgets have been met demonstrating good Project Management
- Hard to compare original budget and timelines to actuals from the materials provided
- Standard PM (project management) methods were used
- Strong inter lab coordination

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good interactions and engagement so far. The future steps needed to see true Industry Stakeholder discussions and input.
- Developing environmental mitigation and stream classification database, but no collaboration with USGS (U.S. Geological Survey) or natural resource agencies
- Very good outreach and communications of this project
- Good weaving of databases

Question 6: Proposed Future Research, if applicable

- Maintaining these data sets and refining them further is essential for several of the DOE vision goals
- I support future research on this item but place it on a lower priority
- N/a (Not applicable)

Comments made by reviewers during the evaluation of this project (PRID 77)

Question 7: Project Strengths

- Good results bringing complicated data together and purposing in a useable format
- Oak Ridge resource assessments tend to be reasonably high-quality. Placing information about sites, impacts, and mitigation together in the same database as information about existing hydropower assets and potential new hydropower sites could provide the basis of some very interesting future analysis about hydropower sites, feasibility, and sustainability.
- Outstanding data resource
- Very strong project, with proven methods
- Excellent interagency collaboration
- Environmental Mitigation Tool - use this to predict
- Layers of info are important
- Uses Stream Flow db and Natl Hydropower map

Question 8: Project Weaknesses

- Needs Industry Stakeholder dialogue and input
- Who will continue to maintain the database?
- Project does not reflect full cost of effort: eg use of high computational resources at no charge was worth $500,000. If so then there was an opportunity cost of doing this? What else could it have been spent on? Where is the cost comparison.
- Is this CEII (Critical Energy Infrastructure Info (DHS (Department of Homeland Security)) classified?

Question 9: Recommendations

- This project can also get data from large regulated utilities
- Support next level of study
- Also a concern that mitigation database could be used to attempt to substitute for actual site-specific needs
- Are mitigation measures based on actual performance, or just regulatory requirements? Consider Cross-referencing with data sets that look at the types of design configurations of different projects. That information plus GIS (geographic information system) layer of environmental attributes might be more accurate in predicting likely outcomes.
- Skeptical that environmental mitigation database can work in real world. Rather than just looking at requirements, they might also want look at studies that have been requested / required since 2005 in licensing proceedings using the ILP (Integrated Licensing Process). A more thorough understanding of those issues and questions could help better predict potential mitigation measures.
- Create a public database
- Get this out to end users and the industry

DOE Water Power Technologies Office 2017 Peer Review Project:

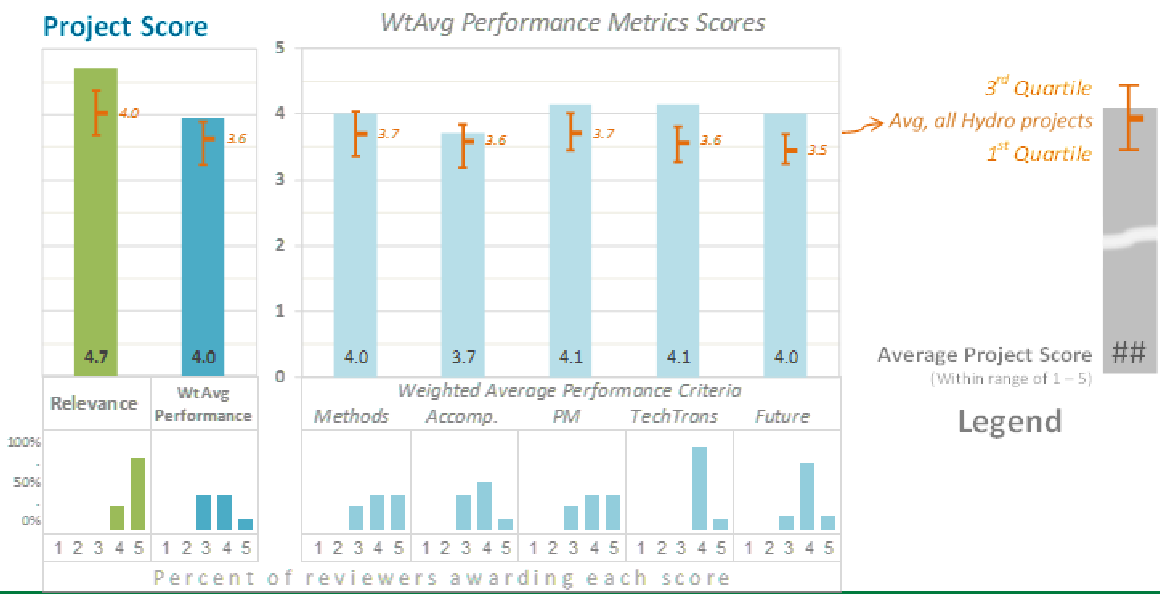
Facilitating Regulatory Process Improvements (Federal Interagency Collaborative)

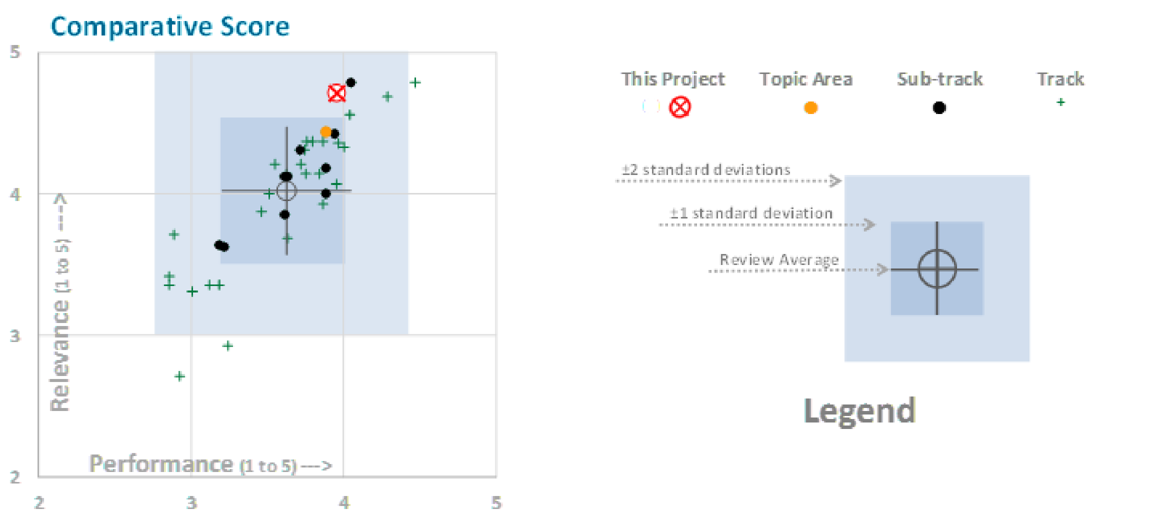
Principal Investigator	Shelaine Curd, Oak Ridge National Laboratory
Track	Hydropower (Hydro)
Sub-track	Optimization
Topic Area	Regulatory

FY 2014-FY 2016 Funding

DOE	$ 0.1 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.1 M**	**100%**

Peer Review ID# 90





Comments made by reviewers during the evaluation of this project (PRID 90)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Communication earlier in the process. Schedule environmental review to be simultaneous in a single coordinated review.
- Directly relevant to the optimization priority of interagency collaboration. Extremely important and effective - a very large amount of developable potential could be affected.
- This effort was extremely important in the development of hydropower potential at existing Corps of Engineers dams. I participated in this process and was encouraged by the fact that the Department of Energy's participation was a key element in forcing the Corps of Engineers to revise their procedures to make the section 404 approval concurrent with the licensing process.
- I rated this as a high priority item, however, I need to see real world use and see that the COE (Corps of Engineers) follows the process efficiently
- This is a good concept that does apply to the Water Power Industry and DOE objectives
- The overlap and duplication of effort between the FERC (Federal Energy Regulatory Commission) licensing process and the Corps 408 process is probably the single most important regulatory problem to be solved for hydropower. It is a consistent and recurring problem that affects those projects – hydropower retrofits at USACE (U.S. Army Corps of Engineers) dams – that a) are the least controversial and most straightforward (no new dam construction) method of new hydropower development, and b) probably hold, as a class, the largest slice of readily-available new hydropower capacity.
- Congratulations if you cracked the nut on this
- Excellent need for this type of discussion and agreement
- USACE is putting out guidelines when
- Any project that simplifies or expedites permitting, has value to the hydro industry
- 404 environmental assessment NEPA (National Environmental Policy Act)
- 408 improvements to USACE sites
- Optimization
- Single biggest win in process improvements if the duplication and overlap can be eliminated

Question 2: Methods and Approach

- Invited public input - there was support to continue
- New MOU (Memorandum of Understanding) was signed in 2016
- The process works very well and the use of a conference with developers and other users was very effective in providing USACE with the development perspective and hurdles. The process also included the NHA (National Hydropower Association) and I was fortunate to be able to draft a large part of the NHA position regarding the section 408, FERC licensing and section 404 approvals.
- Good textbook approach on how the process should perform
- Well done. Project brought the two agencies together and created the right conditions for those agencies to solve the problem.
- Bringing staff from Corps districts to DC and putting them in a room together was a stroke of genius
- Should probably have had more USACE districts involved
- Worked with COE and FERC
- Standard methods and approach to coordinating the completion of the MOU
- Not much detail here to get a fuller understanding

Question 3: Technical Accomplishments and Progress

- A template has been developed for the process and is aligned with the goals
- Completed revised MOU with FERC and the Corps. That's a real accomplishment, albeit one not yet proven by actual experience with the project. Looking forward to seeing how it goes in an actual licensing process.
- Project is completed, impact will continue to be evaluated
- This looks to be underfunded and on too slow a track given its importance to the industry

Comments made by reviewers during the evaluation of this project (PRID 90)

Question 4: Project Management

- Project Management has been effective on this study
- Appears to have met all major milestones (project is complete) and within budget
- Good coordination
- Standard project management techniques have been implemented
- Not clear but seems to be on a slow track

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good outreach and collaboration has occurred. We need to see real-world application to build Industry trust in the process.
- Good stakeholder outreach. Good bringing in industry along with FERC and USACE for buy-in.
- Stakeholders have been appropriately engaged throughout the process
- Conflicts between the military approach and methodology (USACE) and the commercial (FERC). We have one objective…compliant timely licensing.
- FERC and USACE vital collaboration

Question 6: Proposed Future Research, if applicable

- The proposed future steps involve monitoring of the process to determine the overall efficiency of the licensing in section 408 process. I would recommend that consideration be given to studying the technical review section of the 408 process to verify that this is being performed in an efficient manner that minimizes the development time for new hydroelectric projects. Historically there has been a large variation in the attitudes and performance of the USACE from District to District. A uniformity of approach including a more direct less involved review process would be helpful. It should be noted that prior to the Corps " rediscovering" the 1896 approval authority, over 60 nonfederal hydropower facilities were installed at USACE dams without a dam safety incident. The implementation of section 408 and the long-term review requirements are not needed to ensure the integrity of the USACE structures.
- I support continued future support of the project delivering a real world use example
- N/a (Not applicable)
- Would be nice to get commonality in environmental review to have a single process

Question 7: Project Strengths

- Great logical process
- Focused on a discrete regulatory problem that was known to be holding back development at a number of sites and set out to solve it. Without legislation or rule change. Good focus.
- Regulatory process is very complex, and regulatory reform even more so. This worked because it brought everyone together to solve a discrete problem and did not try to do everything at once.
- Project is complete, and MOU has been executed
- Well-coordinated effort

Question 8: Project Weaknesses

- No real world application to date building trust in the process
- No Weaknesses
- Presenter was weak. Suspect that there is more benefit here than is evident from the presentation.

Question 9: Recommendations

- Continued support and promotion in the Hydro Industry is recommended
- More like this, please
- Kearns and West strikes again. Are they being used as the default firm for work that should be done within the various research labs?
- Need to work with the developers, how has this encouraged/de-risked the process

DOE Water Power Technologies Office 2017 Peer Review Project:

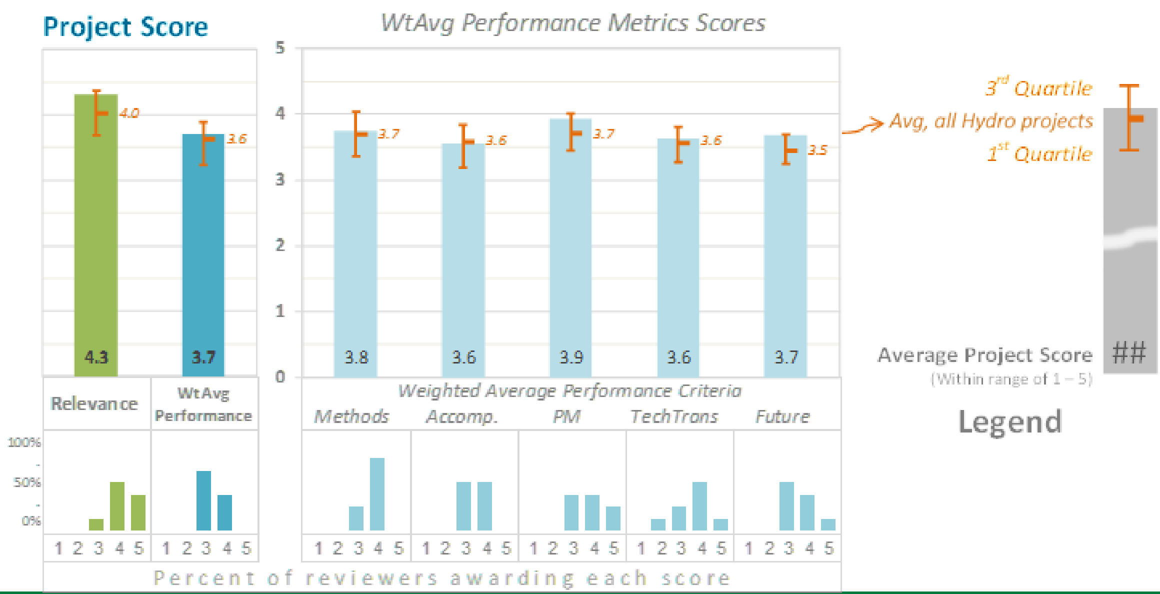
Basin Scale Opportunity Assessment Initiative

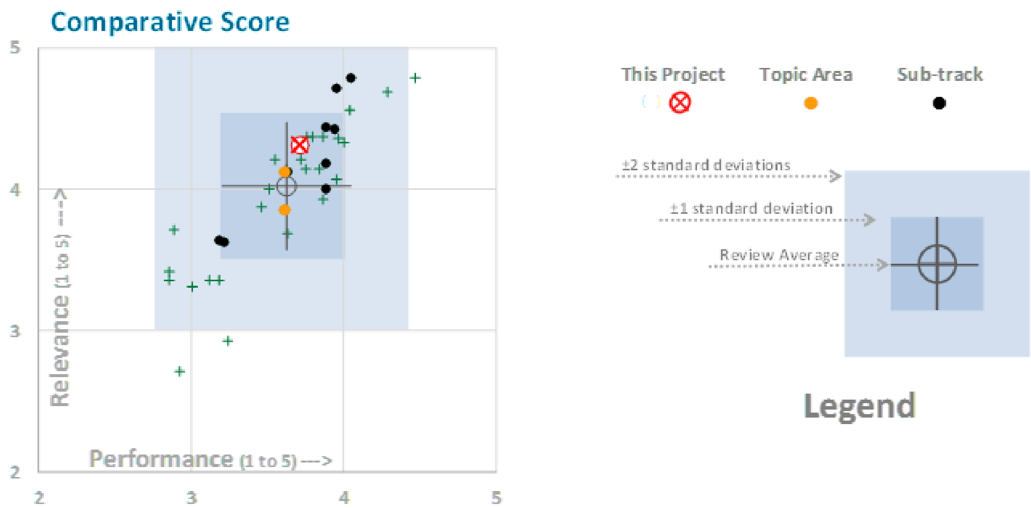
Principal Investigator	Kyle Larson, Pacific Northwest National Laboratory
Track	Hydropower (Hydro)
Sub-track	Optimization
Topic Area	Water Use

FY 2014-FY 2016 Funding

DOE	$ 1.1 M	95%
Cost Share	$ 0.1 M	5%
Total	**$ 1.1 M**	**100%**

Peer Review ID# 111





Comments made by reviewers during the evaluation of this project (PRID 111)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Protecting and potentially improving environmental conditions through basin scale solutions is an excellent initiative
- Optimization - better coordination of environmental data within a river basin allows for streamlining and improved outcomes for both increased generation and environmental protection
- Sustainability - facilitation of basin planning is a relatively new concept, has also occurred in the Penobscot River basin in Maine. More of this work is vital.
- This tool could have a significant contribution to the development of hydropower at new sites. As a developer, I question the amount of interest in these types of sites, given the potentially large development and study costs.
- This project does tie into the overall DOE objectives
- In concept, this is highly relevant: new hydropower development on unimpaired stream reaches is going to have a hard time getting the support of stakeholder groups that will be necessary to overcome opposition to new dam construction on environmental grounds. If, however, developers can find a way to approach new development with substantial improvements in environmental performance at a basin or watershed scale (e.g. coupling new dam construction with operational improvements – or even decommissioning – that results in a net environmental gain for the watershed). This project is intended to help identify those opportunities.
- When using CT River basin it should have assisted in making the relicensing of these projects better
- Project has value to the hydro site development process
- Optimization and sustainability
- Seems like a great project but is there an encore? Is all the work complete?

Question 2: Methods and Approach

- Geospatial data model is an effective way to allow disparate information to be viewed holistically, providing an opportunity to identify fish passage improvements and other beneficial outcomes
- The study appears to be well conceived and well executed
- Very good degree of designing the methods to make this technically feasible
- Project approach changed significantly over the years, but current approach seems to be solid, with more focus on creating scenarios to inform discussion
- Worked with the resource groups closely which is good
- Good methods and approaches
- Modelling three watersheds…excellent
- Can the methodology be generalized to many other watersheds?

Question 3: Technical Accomplishments and Progress

- BSOA (Basin Scale Opportunity Assessment) web demonstration tool is poised to be a very effective way to enhance environmental stewardship of river ecosystems
- Very diverse group of collaborators and participants, including resource agencies, labs, NGOs (nongovernmental organizations), associations and utilities
- The study appeared to satisfy the initial goals and scope
- To date the project has delivered upon stated schedule and goals and is considered complete in its current phase
- Web-based scenario identification and discussion tool appears to be useful (hard to tell from a slide), but if it's not publicly available, it's of limited utility
- Again concerned that use of the CT river did not seem to help
- Project has ended and tool does not seem to be fully complete, or having been used by external users yet

Question 4: Project Management

- The project appeared to be well managed
- Good Project Management does exist for this project
- Seems to have been managed well. Deadlines and budget for most recent three-year period not explained in information provided.
- Kyle did a good job
- Standard methods have been applied
- On schedule and budget

Comments made by reviewers during the evaluation of this project (PRID 111)

Question 5: Research Integration, Collaboration, and Technology Transfer

- Interaction with stakeholders worked well. Revealed the need to integrate locally relevant environmental data.
- Although there appeared to be significant coordination with fisheries groups, the results of the study were not shared with any potential development groups to date. This is a key failure. If this study is to be useful utility groups and developers need to be aware of the study and need to learn its use.
- Their last industry presentation on this was in 2014. They should look at a 2017 Industry element to present results.
- They have done a great job of collaboration and integration
- Seems to have been managed well. Deadlines and budget for most recent three-year period not explained in information provided.
- Good engagement with stakeholders, broad input
- Seems to have been well coordinated project with diverse interest groups/users
- Collaboration was good in the basins, but the tech transfer of the tools has been lacking

Question 6: Proposed Future Research, if applicable

- The tool is in a demonstration phase - they are trying to secure funds to support broad public integration
- They need use agreements
- My understanding is that the website and user manual are being developed. These are key elements in the successful use of this research.
- Yes, seeing through phase 2 to generate a tool that is self-sustaining and available to the industry is key to making this effective
- Right now this is only useful as an academic exercise. Future research would a) make the tools available to others, and b) potentially test the concept in the real world.
- There is a need to allow users to upload data into the system
- Demonstration web GIS (geographic information system) tool that showcases Basin Scale Opportunity Assessment approach and provides a launch point for identifying case study applications and tech transfer opportunities. How do we find this...access it? Example of where information may not be evident to many users.

Question 7: Project Strengths

- This tool as good application in valuing and planning hydro project in the industry
- Did a good job engaging diversity of stakeholders and providing them with a framework that they described as having the potential to be useful
- Valuable site development tool
- Integration with many datasets ...excellent

Question 8: Project Weaknesses

- The industry accessible tool is not yet developed and accessible
- Timing was not ideal for tool to be useful / demonstrated in real-world situation. Testing concept in basins where licensing is already underway doesn't really allow tool to identify potential opportunities; by the time you start talking in that situation it's too late.
- Tool needs further development, ability to upload data into the system and built in model flexibility

Question 9: Recommendations

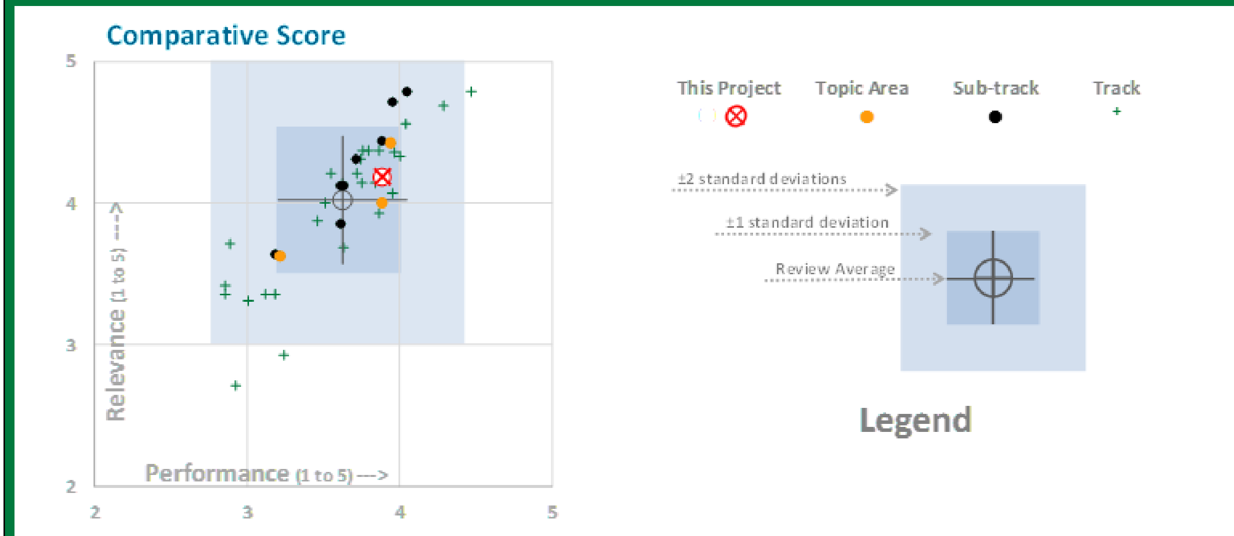
- This research is reminiscent of comprehensive regional planning in land use management
- Continue to fund with the main objective of having the public accessible tool stood up
- Demonstration web GIS tool that showcases Basin Scale Opportunity Assessment approach and provides a launch point for identifying case study applications and tech transfer opportunities. How do we find this...access it? Example of where information may not be evident to many users.
- Release the CT (River) Basin data
- What's the output look like?

DOE Water Power Technologies Office 2017 Peer Review Project:

U.S. Hydropower Market and Trends Report

Principal Investigator	Rocio Uria Martinez, Oak Ridge National Laboratory		
Track	Hydropower (Hydro)		
Sub-track	Optimization		
Topic Area	TechEcon and DB		
FY 2014-FY 2016 Funding			
	DOE	\$ 0.3 M	100%
	Cost Share	\$ 0.0 M	0%
	Total	**\$ 0.3 M**	**100%**

Peer Review ID# 112



Comments made by reviewers during the evaluation of this project (PRID 112)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Collecting, standardizing and cleaning disparate sources of data
- This is valuable information that is very worthwhile to the implementation of new hydro development throughout the United States
- This study does align with overall DOE objectives
- To my knowledge, there is no report like this one. Provides useful information about the existing hydropower fleet.
- If database is to include benefits of hydro such as recreation and taxes it is important that regulated vs unregulated states be documented separately
- Country broken into 5 regions
- Fleet ownership by category
- Need to bring together fragmented data
- Should be restricted to database update at this stage. Do not need to justify level of effort and budget from the first year does not need to be spent each year.
- Timelines in the report
- Project is a valuable contribution to hydro development in the United States
- Good macro level view undertaken with a view to identifying barriers
- Optimization

Question 2: Methods and Approach

- Consideration of FERC (Federal Energy Regulatory Commission) docket to examine licensing attrition
- Good method and approach to bringing data together
- Began with a set of questions to be answered / addressed, and then set out to gather the data to answer/address them
- Good program but should be in an updating mode so budget and level of effort can be reduced
- Appropriate methods and approach
- Complementary to Session 77 NHAAP (National Hydropower Asset Assessment Program)

Question 3: Technical Accomplishments and Progress

- Project development pipeline approach is extremely useful. Detail on owners, other purposes of dams, information about investment in upgrades and refurbishment, etc.. These are all very useful and important data sets.
- To date the project has delivered desired results and compared to stated goals
- Report complete, published, and providing value
- Good data to date
- Project is well underway with the report available

Question 4: Project Management

- Appears to be very good and effective in achieving the project goals
- The Project Management has been good through this stage of the project meeting budgets and schedules
- Project has met goals on time. Budget is not entirely clear. More than $1 million for what is essentially a research paper study seems quite expensive, but perhaps not in the world of the national labs?
- Rocio manages the program well
- Standard project management methods have been used

Question 5: Research Integration, Collaboration, and Technology Transfer

- There apparently has been a very robust effort to distribute the information developed by the study
- There has been good collaboration through this stage of the project. They are due another formal presentation discussion at an Industry event such as HydroVision.
- Communication’s better than most. Good job communicating this product and making sure that end users would be aware of it.
- Very nice approach to communicate results and engage partners

Comments made by reviewers during the evaluation of this project (PRID 112)

Question 6: Proposed Future Research, if applicable

- I believe that this effort should be continued on a regular basis and the information should be updated in a similar manner. This will provide information to the industry and legislators regarding the development of the hydropower resources in the United States.
- Yes, I feel this project should continue to be funded
- Some proposed FY17 questions seem less useful than others (comparing U.S. hydropower development trends to those in other world regions doesn't seem like it will necessarily move the industry forward)
- Should we have section that is just update
- International assessment will be helpful for technology providers and manufacturers for export potential
- Research why the various attrition rates exist. Can this inform areas for process improvements or screening of license applications. High attrition rates could mean wasted cost and effort.

Question 7: Project Strengths

- Good collection of data presented in an Industry beneficial format
- Fairly straightforward set of goals: research and analysis to answer discrete questions that can inform policy
- Comprehensive data set, valuable information
- Credible work

Question 8: Project Weaknesses

- Need more value specifics in the area of mitigation, recreation, and tax base
- Project does not have clear end state and is very open-ended. When will it be complete? It's not clear.

Question 9: Recommendations

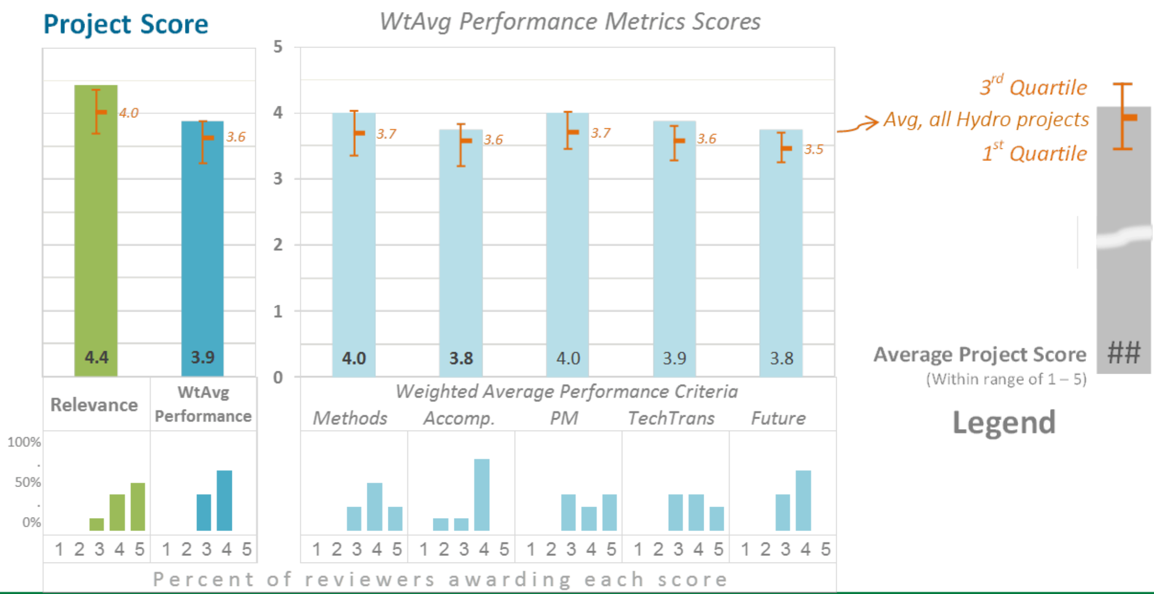
- I recommend continued support. They need to present latest findings at an upcoming Industry Event.
- A series of smaller reports intended to ask and answer discrete questions might be more cost-effective than an open ended task order like this one appears to be. Budget is pretty high for a report.
- Data is vital
- Research why the various attrition rates exist. Can this inform areas for process improvements or screening of license applications. High attrition rates could mean wasted cost and effort.

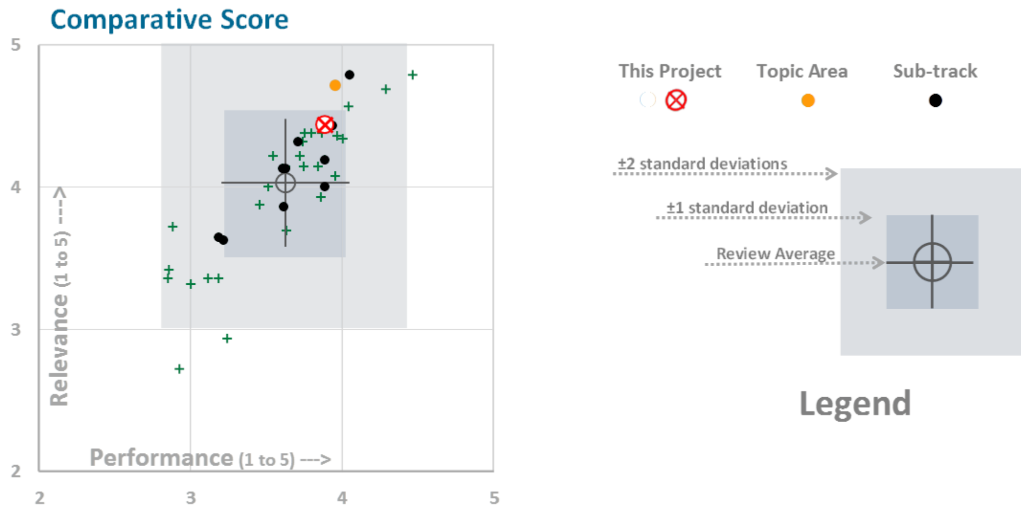
DOE Water Power Technologies Office 2017 Peer Review Project:

Hydropower Regulatory and Permitting Information Desktop (RAPID) Toolkit

Principal Investigator	Aaron Levine, National Renewable Energy Laboratory	
Track	Hydropower (Hydro)	
Sub-track	Optimization	
Topic Area	Regulatory	
FY 2014-FY 2016 Funding		
	DOE	$ 0.0 M
	Cost Share	$ 0.0 M
	Total	**$ 0.0 M**

Peer Review ID# 116





Comments made by reviewers during the evaluation of this project (PRID 116)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- A useful tool for navigating regulatory procedures is extremely valuable for both optimization and growth. Soft cost barriers are very intimidating, especially for small owners.
- This is an extremely important tool in the development of hydroelectric potential in both existing dams and new sites. In addition this could have widespread use for the relicensing of existing hydroelectric projects.
- This is a good product that aligns with overall DOE objective
- There has long been a need for a single source for information about multiple hydropower regulatory processes. Having all of that information in one place is an enormous improvement over the status quo, where regulatory requirements are buried in multiple sets of regulations across multiple jurisdictions. This project can help reduce transaction costs associated with responsible hydropower development.
- Great tool for industry
- Should reduce soft cost of hydro regulation and development
- Any project that can improve the permitting process will have a very positive benefit to the hydro industry
- Fundamental to allowing hydropower to grow
- Optimized interagency collaboration

Question 2: Methods and Approach

- Case studies are an effective tool to assist industry with understanding how to navigate the regulatory process
- Good idea to engage legal subcontractor to ensure accuracy
- User interface work appears to be well executed
- The approach seems to have been systematic and to have included all stakeholder federal regulatory agencies
- This project has good methods and approach meeting technical needs
- !BP Choice of California as one of the first states was good one given the complexity of its permitting requirements. Choice of next two locations is also correct given that Mississippi and Ohio River Valley Corps districts probably contain most of the untapped hydropower potential, particularly hydropower at existing dams.
- !CD My biggest concern with this project is with longevity. Will this database be updated as regulations are updated? If not, it could cause problems for developers that rely on it.
- Case studies are presented which is good
- Solid approaches and methods
- Interesting start but very limited at the State level so far

Question 3: Technical Accomplishments and Progress

- Good collaboration with all federal agencies
- Still a lot of work to do to get to all states
- The process seems to be moving forward and the tool kit is evolving
- Good technical accomplishments meeting expected goals
- Website is well-designed, useful, and relatively easy to navigate. Information is a little dry (website returns straight copies of the regs, which might be less than user-friendly for individuals who aren't already familiar with the process. Some explanatory material might be helpful.)
- Received review from others which is good
- Project is delivering as promised, and communicating appropriately with partners
- Not sure how this marries with the work that FERC (Federal Energy Regulatory Commission) is doing in this exact same area

Question 4: Project Management

- They have done a great job at managing this project within scope and budget
- Materials did not include timelines, budget, and milestones, so it's difficult to assess this based on the information received
- Strong project management throughout the project
- Coordinated with FERC??

Comments made by reviewers during the evaluation of this project (PRID 116)

Question 5: Research Integration, Collaboration, and Technology Transfer

- Quarterly newsletter is a smart idea
- Given the potential importance of this toolkit in the development of new hydroelectric potential and the relicensing of existing hydro facilities, the outreach has not been as widespread as it could be. As a developer, I was not aware of this tool.
- Good job soliciting feedback on the beta version of the web and then responding to the feedback and improving the site
- They have collaborated and integrated this project well. They have actively communicated and demonstrated in the industry and are tracking usage statistics showing value recognition in the industry.
- They've done a good job at demonstration and outreach, which is what this project needs. It's only useful if people can find it.
- Can apply to NHA (National Hydropower Association) at their regional meetings
- The project has really done a fantastic job of communicating their project and its outcomes
- Kearns and West again! It seems like the various agencies can't work without a facilitator
- Collaboration has been very good, but the tech transfer piece could be improved. Not everyone knows about this work that should.

Question 6: Proposed Future Research, if applicable

- Will more states be included?
- The inclusion of more state regulations would be useful
- Yes, this should continue to be strengthened and data from actual projects acquired
- NEPA (National Environmental Policy Act) database is an interesting concept. Could be improved by adding other documents that are part of the regulatory process: Pre-Application Documents (PADs), study plans, license applications, license orders may be as useful if not more useful than NEPA documents. Should also look at settlement agreements, how those are structured, and how settlement discussions happen in practice.
- Get this into more states, esp New England and New York

Question 7: Project Strengths

- Good knowledge retention and transfer tool that can help improve licensing efficiency across our industry
- Have been proactive promoting the tool in the industry
- Really does a great job at pulling all of the disparate regulatory requirements together into a single workflow. That's no small feat.
- Basic tool development is very good
- Excellent communications strategy
- Strong project team
- Vital if we are to have the throughput required over the next few years with so many sites coming up for re-licensing

Question 8: Project Weaknesses

- Needs more data and inputs for Public owners
- Lots of the heavy lifting in a FERC licensing takes place in settlement talks that occur outside of FERC regulatory process. By focusing on the regulatory steps that are strictly associated with permitting, this project risks missing some of the most important – albeit informal – steps.
- There is a risk that this could become obsolete before it is completed. Regulatory requirements – and agencies' interpretations of those regs – are constantly changing. Without some commitment to regular maintenance, this project runs the risk of not having the best shelf life. That's going to be difficult given that only a few states have been captured here to date.
- Not clear that there has been huge state involvement- potential issue
- Missed small hydropower on existing run of river conditions in their scope? Whatever happened to unpowered dams????
- Oh dear, Kearns and West again. They should be subject to a Peer Review…do they provide best practices? How do we measure them? Value for money?
- Seems to be duplicating work that FERC is doing in their 2 year licensing process thrust

Comments made by reviewers during the evaluation of this project (PRID 116)

Question 9: Recommendations

- RAPID Toolkit could be a very interesting educational tool for law students and future workers to learn about the hydropower regulatory process
- The PIs (Principal Investigators) should coordinate with the National Hydropower Association to provide outreach presentations at the NHA's regional meetings throughout the United States. This would serve to reach a much larger audience than just a presentation at Hydro Vision or elsewhere.
- This is a solid project and should be maintained for the long-term
- Rectify this: Missed small hydropower on existing run of river conditions in their scope? Whatever happened to unpowered dams????

DOE Water Power Technologies Office 2017 Peer Review Project:

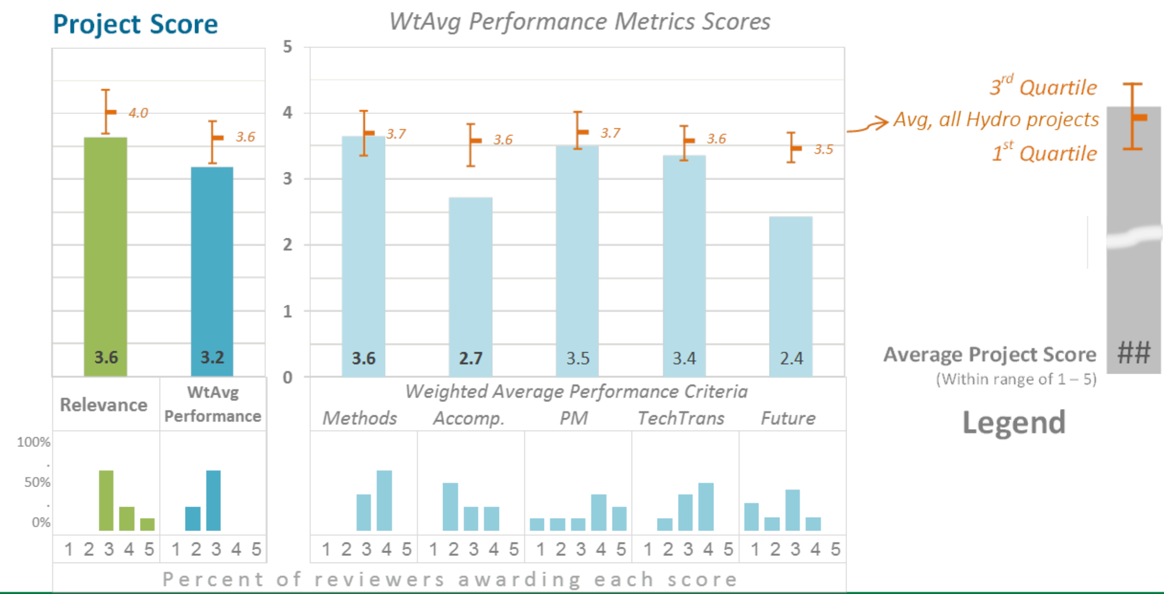
Iowa Hill Pumped-storage Project Investigations

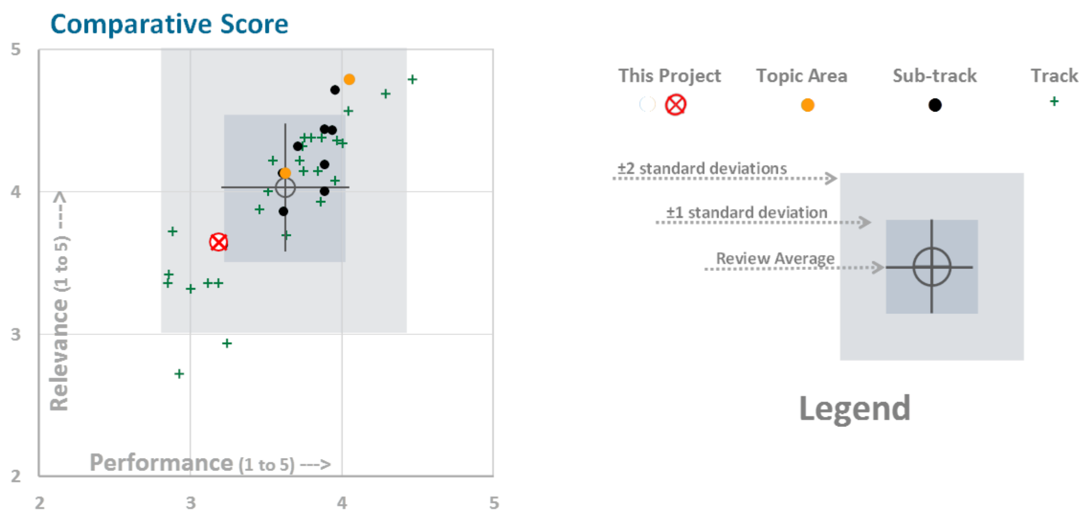
Principal Investigator	David Hanson, Sacramento Municipal Utility District
Track	Hydropower (Hydro)
Sub-track	Optimization
Topic Area	Grid Support

FY 2014-FY 2016 Funding

DOE	$ 2.1 M	32%
Cost Share	$ 4.4 M	68%
Total	**$ 6.4 M**	**100%**

Peer Review ID# 138





Comments made by reviewers during the evaluation of this project (PRID 138)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Cancelled in Feb 2016. Goal was to reduce the time of licensing.
- Optimization - revenue streams for ancillary services. Variable speed turbine, operational flexibility.
- Want to reduce the need to curtail wind and solar
- Understanding the reason that the Iowa Hill project was terminated is useful information for other potential pumped storage projects. Justification of the economic feasibility of pumped storage based solely looking at "on peak" versus "off-peak" power values is impossible in today's power market. The fact that a large municipal utility with tax-exempt financing could not justify this project is important to understand in today's marketplace. A large number of the benefits of pumped storage do not accrue to the developer but rather to the transmission operator. For this reason the development of pumped storage should probably be viewed as a function of transmission and grid reliability rather than a generation source.
- This project did have relevance to DOE overall objectives
- !BP Use of DOE research funds to identify and quantify potential value/revenue streams (e.g. ancillary benefits) from PSH (pumped storage hydropower) is a good use of DOE research funds. If scored on this purpose alone, would score project a 4-5.
- !CD Use of DOE research funds to evaluate geotechnical conditions at the proposed site doesn't seem particularly relevant to industry needs or DOE objectives. It's simply offsetting the cost of a study necessary for development. If scored on this purpose alone, would score project a 1-2.
- This project would have happened without DOE funding. Underwriting a fairly large utility's attempt to explore and develop a new hydropower project is probably not the best use of scarce DOE funds.
- Would have been the first variable-speed PSH project in the United States. Precedential nature adds some additional relevance to the project.
- Not sure why DOE spent $2M on this project and why costs were not just absorbed by SMUD (Sacramento Municipal Utility District)
- Review of the Iowa Hills pumped storage hydro project
- Good project, unfortunate that it did not continue
- Growth and Optimization
- Would have been first in the United States
- Struggle with this one because pumped storage is certainly of interest in the industry and DOE and can provide valuable long term benefits. Would like to see a pumped storage plant be completed, but could industry have provided this service? What new did we learn? Was this just a grant to help them build a new plant? Where is the innovation?

Question 2: Methods and Approach

- Geotechnical - assessing the nature of the rock
- The project development appeared to progress in a reasonable and technically responsible manner
- Good engineering and applied strategy to closed loop pumped storage project
- Use of modeling approaches from other industry to analyze value streams seems valid. Interesting to see study assuming project would be used alongside intermittent renewables with varying levels of market penetration.
- Reviewed technical and ancillary benefit issues
- Well outlined in presentation
- Comprehensive study, integrating pump storage with other renewables
- Focused work on rock intrusions -well structured
- Geotech investigation
- Integrated with wind and solar inputs
- Modelling of value stream

Question 3: Technical Accomplishments and Progress

- Technical report was submitted to DOE
- They were looking for a lower contingency value of construction cost 21.5%
- Value modeling - considering different levels of penetration of solar and wind. Sensitivity analysis - looking at balancing.

Comments made by reviewers during the evaluation of this project (PRID 138)

- This project did not achieve its end objective. However, they did meet technical progress steps in the progress.
- Met all milestones and completed final report despite project cancellation, and came in well under budget since some work not completed after project cancelled. Good value stream modeling can't overcome risk associated with extremely high capital costs.
- Cancelled due to good reason
- Load requirements and renewables to market changed during the course of the study
- Detailed cost and exploratory analysis was completed
- Projects should always be looked at from the opportunity cost POV (point of view) of other projects
- Load growth had stagnated
- Project curtailed due to cost $1.4Bn . Wise decision by the SMUD owners. Project risked being a white elephant. Unfortunate.
- There was progress in valuation and geotec efforts but the project was not viable even with DOE assistance

Question 4: Project Management

- Project was cancelled for cost. Total project cost (including financing, indirect costs) $1.4 billion.
- The project appeared to be well managed
- The fact that they did not waste money/funding once they recognized this project would not move forward is why I rated it a 5
- The project management was effective in this study. It is good to see that they recognized the stall of the project and made a prudent decision in stopping the funding.
- Well-run project
- Good presentation by Dave Hanson. Honest and open.
- Standard methods were used
- Seemed good - at least they knew when to pull the plug

Question 5: Research Integration, Collaboration, and Technology Transfer

- Technical reports on value modeling and geotechnical data on the project - are there lessons learned?
- They did a good job with collaboration and effectively shared their lessons learned and technology throughout the industry and in a timely manner
- Very pleased to see that final technical report is published and available to the public rather than kept hidden away in a utility's files as a proprietary trade secret
- It is good that the information acquired was made available and used by others such as Southern Company
- Openly shared data and final technical report
- Project team appeared to function well

Question 6: Proposed Future Research, if applicable

- The project should not be funded further
- N/a (Not applicable)
- Future pumped storage projects may still make sense in the long term but our thought and planning process needs to change
- Length of study period needs to be shortened
- Would really like to see a first in the United States. Shame that this failed.

Question 7: Project Strengths

- Stayed with good traditional PSH (pumped storage hydropower) science
- This project gave the Industry a fresh real world perspective on a PSH business case
- Value stream analysis interesting and relevant to waterpower industry needs, particularly given that it is not just theoretical but rather involves a specific, real-world project (albeit one that was not developed in the end)
- Pumped storage hydro
- Comprehensive economic and engineering analysis
- Correct investment approach failure to meet SMUD financial yardsticks
- Great value for future projects. Lessons learned should be extracted.

Comments made by reviewers during the evaluation of this project (PRID 138)

Question 8: Project Weaknesses

- Failed to actually follow through on product construction
- DOE research funding really has no business being used to underwrite the costs of geotechnical surveys for a major utility
- With timeline things changed
- Project was cancelled
- Distributed resource solutions won over long-term, stable solution. Short termism won over long-term benefit.
- Pumped storage fails to stand up against other more contemporary storage techniques

Question 9: Recommendations

- SMUD is investing more in DER (distributed energy resources), and is choosing to go the battery route. This is unfortunate for the longer view and more sustainable approach of PSH.
- Keep promoting the data gathered on the business case in the industry. Stop future funding as recommended.
- Question whether/how paying a utility to do site-specific work that they were going to do anyway on a specific project is the best use of research funds unless they're trying to address specific, broadly-applicable questions or solve problems that are yet unsolved. Seen from that vantage point, geotechnical analysis doesn't seem like the best investment.
- Don't lose track of this

7.3.3 Sustainability

DOE Water Power Technologies Office 2017 Peer Review Project:

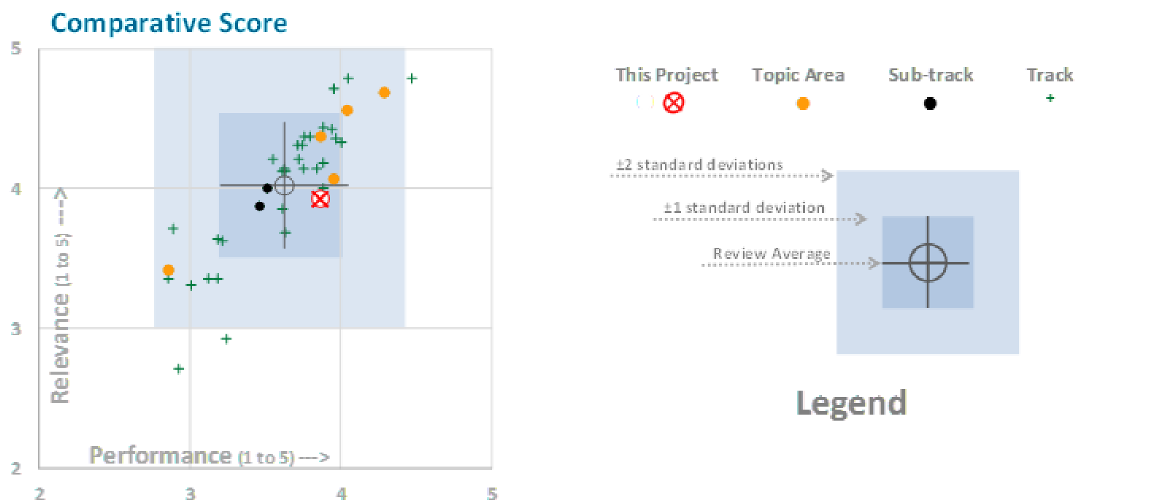
Water Quality Modeling Improvements at Columbia and Cumberland River Basins

Principal Investigator	Boualem Hadjerioua, Oak Ridge National Laboratory
Track	Hydropower (Hydro)
Sub-track	Sustainability
Topic Area	Lower Impacts

FY 2014-FY 2016 Funding

DOE	$ 0.5 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.5 M**	**100%**

Peer Review ID# 32



Comments made by reviewers during the evaluation of this project (PRID 32)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- The study appears to have benefits for large hydropower systems which have the ability to dispatch storage in response to both generation needs and water quality concerns. While these factors are of concern for large-scale hydropower systems, they do not have major importance to the majority of small run of river Hydro facilities located throughout the United States. For this reason I believe that the project is worthwhile, but not critically important to the future development of hydropower potential in the United States.
- This has relevance to Water Power Industry and overall DOE objectives
- Ability to predict water quality impacts associated with real-time scheduling would be fantastic
- Seems to fit with overall DOE program
- Sustainability

Question 2: Methods and Approach

- They are using very strong methods and technical tools to address this complex task
- This is a really interesting project
- I like the approach to the modeling: optimize and check approach allows operators to safely meet water quality requirements at lower cost while still squeezing additional generation out of the system
- Methods and Approach outlined well
- Research methodology was way above my head

Question 3: Technical Accomplishments and Progress

- Real time feedback for this effort checking/validating the equations would help build early trust in the project
- They have delivered good technical accomplishments at this stage
- I don't really feel qualified to evaluate technical accomplishments. Progress appears to have been good: the model appears to have performed well.
- Technical accomplishments were outlined well
- Research methodology was way above my head

Question 4: Project Management

- The project has been managed well to date
- Appears to have been well-run, although information provided does not address timeliness of milestone completion or adherence to budget
- Managed well and presented well
- Presumed to be run effectively but no metrics to demonstrate

Question 5: Research Integration, Collaboration, and Technology Transfer

- Strong diversity in participants
- There has been good collaboration and technology transfer to date
- Already working with BurRec (Bureau of Reclamation) and the Corps to build this into their operations models (TVA (Tennessee Valley Authority), Corps, Bureau of Reclamation each have their own way of doing things)
- Utilities, academia, labs, federal operators. Multiple technical papers published.
- Pleased that modelling was done on the Columbia in the Northwest and Cumberland in the Southeast, we need both because they are different
- Pretty broad reach and good consultative approach

Question 6: Proposed Future Research, if applicable

- As indicated in the presentation, to have value, the research needs to be implemented on major dispatchable hydropower facilities throughout the United States
- This project should continue to be funded and supported
- Focusing on incremental improvements, testing, fine-tuning, and application at a larger scale. These seem like logical next steps for a model that performed well.
- Needs to focus on results not modelling
- Take this to other stream reaches/watersheds particularly in the NE

Comments made by reviewers during the evaluation of this project (PRID 32)
Question 7: Project Strengths • Good collaboration and strong technical bench strength of support • Provides two views of reservoir operations across different regions of the United States • Coordination and cooperation with BurRec and the Corps so that this project has real-world implications • Included northwest and southeast • Inter research dept collaboration **Question 8: Project Weaknesses** • Needs real time data verification of model runs to build trust • Did not consult with USBR (U.S. Bureau of Reclamation) • Not sure if this is relevant for small hydro **Question 9: Recommendations** • This project should continue to be supported • Develop a model that can be used for low head dams and river systems

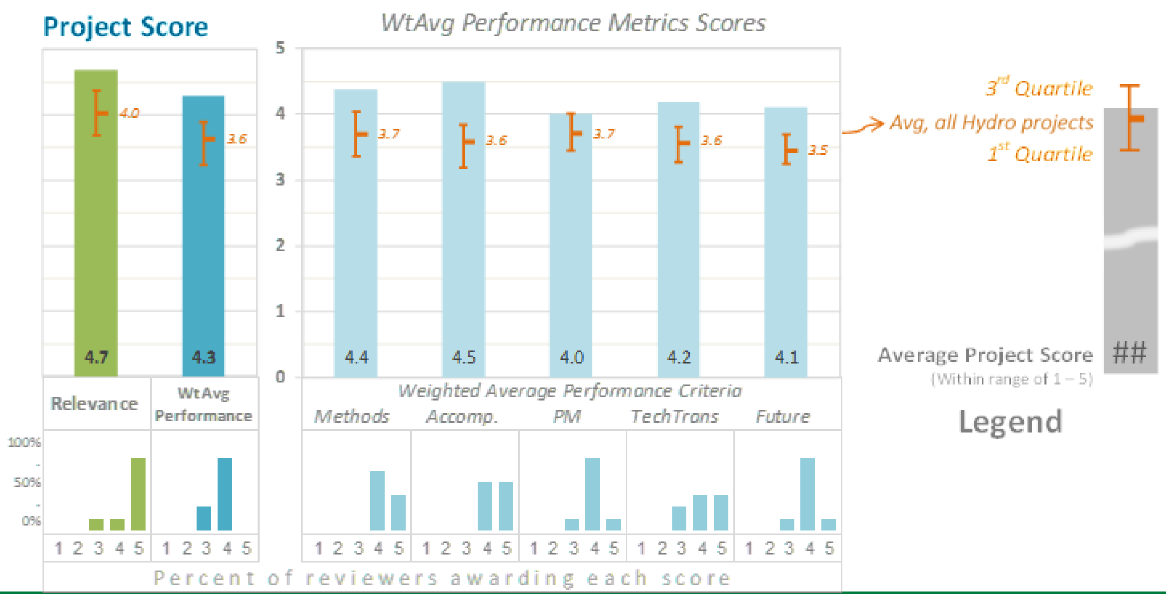
DOE Water Power Technologies Office 2017 Peer Review Project:
Monitoring Technology Development for Sensitive Species (Juvenile Eel / Lamprey Tag Development)

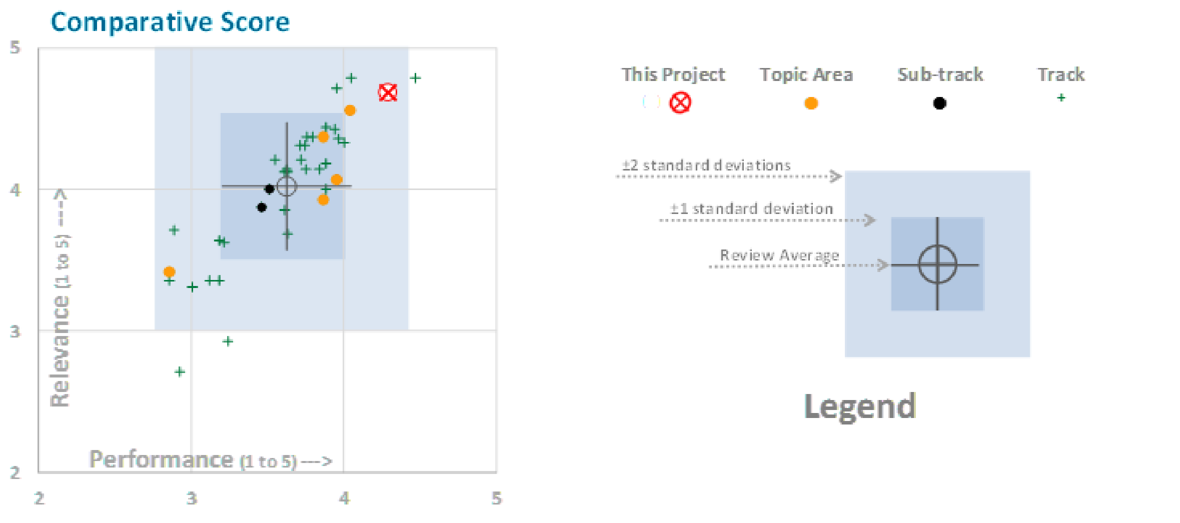
Principal Investigator	Daniel Deng, Pacific Northwest National Laboratory
Track	Hydropower (Hydro)
Sub-track	Sustainability
Topic Area	Lower Impacts

FY 2014-FY 2016 Funding

DOE	$ 1.2 M	45%
Cost Share	$ 1.4 M	55%
Total	**$ 2.6 M**	**100%**

Peer Review ID# 54





Comments made by reviewers during the evaluation of this project (PRID 54)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- If American Eel becomes listed on ESA (Endangered Species Act) it will have an impact on the operation of 30 GW of hydropower capacity. Acoustic telemetry is the preferred method for tracking fish.
- Interesting to recognize that the older technology used to track fish may have been faulty and the data collected may have been flawed
- Sustainability priority -this research will directly support the development of new fish passage technologies
- This is not my area of expertise
- This research has developed a potentially valuable tool to evaluate issues related to fish passage and turbine mortality. At the present time these concerns are not applicable to many projects so that the proposed tool will have somewhat limited value for the overall development of new generation. Having said that, it is an innovative tool that can provide valuable information on the site specific basis.
- This is very relevant study to overall DOE objectives
- Listing American Eel would put 33 GW of hydropower at risk. ESA is a blunt instrument. Better to figure it out now before we get to that point and stress our hydropower system. Also better to do this now (while eel are not listed) so as to avoid ESA compliance issues associated with development, testing, and use of this transducer.
- Very useful: can improve knowledge of sensitive species behavior at hydropower interface, and lead to better protections
- Acoustic methods allow eels to be tracked from a further distance
- Cost recovery will be applied to industry but mainly on production costs
- If eels get placed on the endangered species list could be 33 MS of hydro on the east affected
- Original $20K, lately $3K, ultimately $200
- Project supports several areas of the sustainability pillar of HydroNEXT
- Stunning micro technology
- Sustainability

Question 2: Methods and Approach

- Great job engaging stakeholders early in the scoping of the research
- Ensuring the tags can be manufactured at a reasonable price
- Multidisciplinary and multiphase approach
- Only certified and accredited lab in the United States for underwater acoustics
- They are leveraging industry experts in the area of batteries that helps this project meet the technical challenges
- This project has very good methods and approach and is delivering a good technical product to date
- Good focus to this project. Team took a specific ecological problem (existing transducers don't work for juvenile eel and lamprey) and set out to design a solution to solve that problem.
- Impressive. Particularly appreciated the multidisciplinary nature of the project use of other PNNL labs resources (e.g. battery technology) to make this project happen.
- Can be injected quickly instead of ingested
- Goal was to develop a smaller and lighter tag
- Took multi-disciplinary and multi-phase approach
- Multidisciplinary, multi-phased approach
- Leveraging other projects, learnings and technologies

Question 3: Technical Accomplishments and Progress

- Fascinating innovation, very exciting and has the potential to be successfully promoted to the general public as an indication of the commitment to fish protection by the hydropower industry
- Strong recognition of published work in Journal of Power Sources
- This project has delivered solid technical results at approved budget and within schedule
- Project seems to have met all of its goals from a design and initial testing perspective. Looking forward to seeing results of real-world testing at Roanoke Rapids site

Comments made by reviewers during the evaluation of this project (PRID 54)

- Can be applied to other sensors, especially the battery component
- Can inject
- Tag .o8 gm, 1 cm long, can detect 100-125 M away
- Final prototype field testing is still to be completed this year
- Project is nearing completion, with a final prototype available
- But still not deployable because of cost. Bring industry in.
- Huge step forward for fisheries

Question 4: Project Management

- The project management has been effective on this study
- All steps completed on or ahead of schedule with no budget variances. As a reviewer, I particularly appreciated the clear project plan and schedule provided in the presentation.
- Well managed and well presented
- Standard methods have been used
- No metrics so presume good

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good use of diversity and strong collaboration with federal agencies, tribal governments, utilities and regulatory agencies
- They seem to have a plan for aggressively transferring this technology in the industry
- Very good collaboration in reaching out to the industry and leveraging emerging and proven technology that could be used in this study
- Partnering with federal and state agencies and hydropower operators, academia, Tribes, and private industry
- Published journal articles and one patent under review
- Staff used personal time or non-DOE on journal articles (personal career development given that they innovated in a number of areas). Shows real dedication to the work and excitement about it.
- Can be applied to other research areas
- Has received positive reviews
- PI (Principal investigator) and team have done a nice job of publicizing the project
- Leveraged publications
- Commercialization is vital
- Excellent scope

Question 6: Proposed Future Research, if applicable

- Continuing research in survival sensitive fish populations is critical for the sustainability objective of the Vision, and should be prioritized
- Funding should be made to further this study through commercialization
- Would very much like to see this technology optimized for cost and applied to other sensitive species that have a difficult time with passage
- Future research can be focused on cost
- Continued miniaturization of tags will be ongoing
- Identify new sites to use where existing fish studies are being performed. Hanover Pond Dam in Meriden, CT.
- Use on small hydro

Question 7: Project Strengths

- The results of the research provide a valuable tool to utilize for site-specific environmental concerns
- Good beta product and good Industry collaboration
- Excellent focus and multidisciplinary approach
- Design is available to industry
- Prototype has been completed
- Qualified team
- Multiple applications beyond fisheries

Comments made by reviewers during the evaluation of this project (PRID 54)
Question 8: Project Weaknesses • Needs to develop a larger option for 6-month battery life along with the 30-day small version • None • Still prototype cost and prohibitive **Question 9: Recommendations** • Good product and study for our Industry that can benefit relicensing studies • More like this, please • Keep momentum up on this program

DOE Water Power Technologies Office 2017 Peer Review Project:

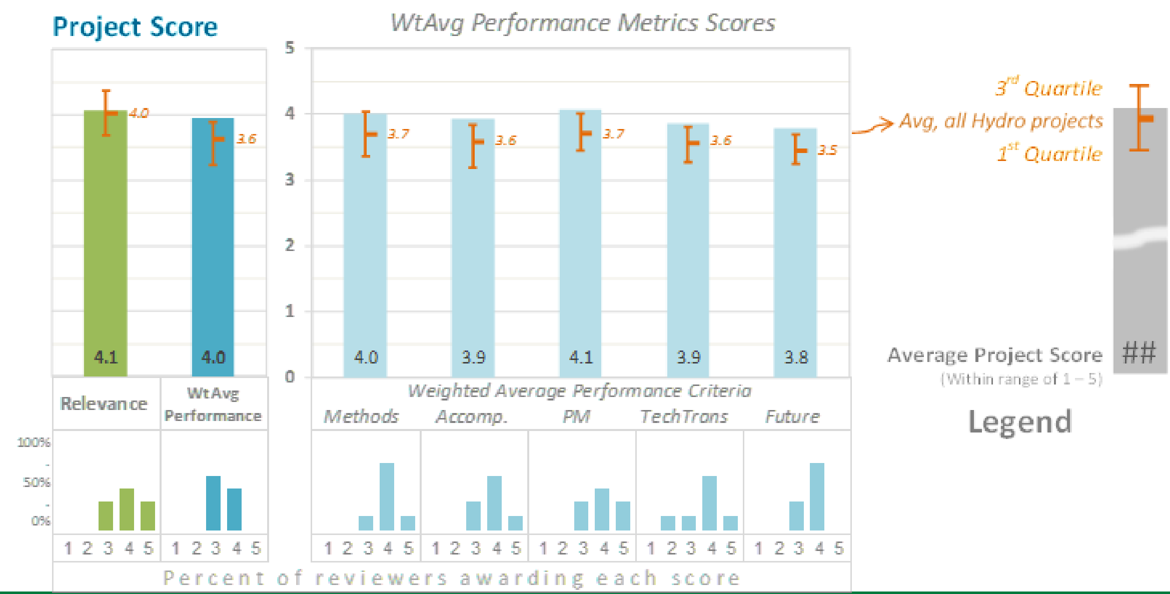
Environmental Performance Analysis and Testing Campaign for New Technologies

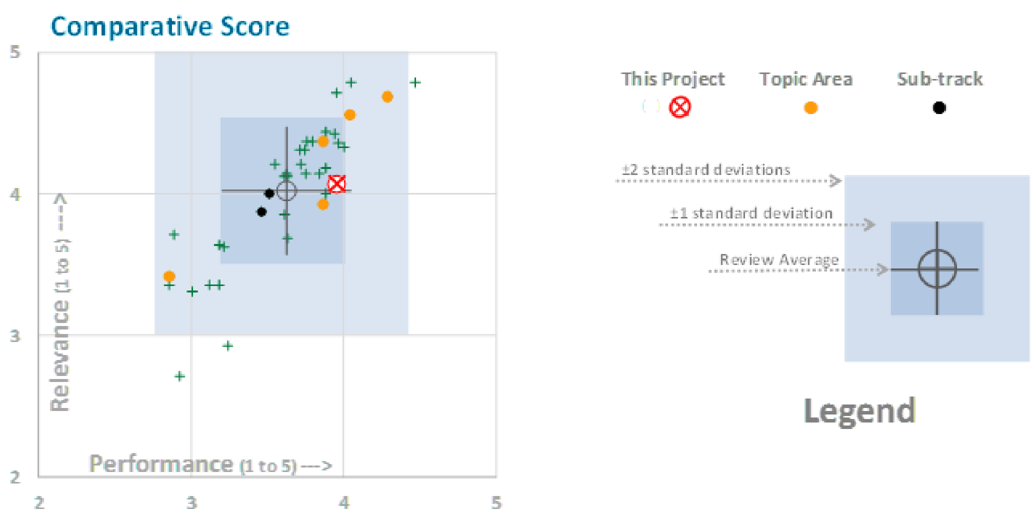
Principal Investigator	Alison Colotelo, Pacific Northwest National Laboratory
Track	Hydropower (Hydro)
Sub-track	Sustainability
Topic Area	Lower Impacts

FY 2014-FY 2016 Funding

DOE	$ 0.3 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.3 M**	**100%**

Peer Review ID# 92





Comments made by reviewers during the evaluation of this project (PRID 92)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Purpose was to help commercialize the Woosh technology - challenge is to overcome the expensive regulatory burden of testing new technology - defendable data provided by independent scientific sources
- This is not my area of expertise
- This project may have future viability if a suitable and effective attraction scheme can be developed to eliminate the need to handle the fish directly. If this cannot be accomplished, I'm not sure that the current truck and whole system is not more effective.
- This does have overall relevance to DOE objectives
- Great use of labs to access available technologies
- Compare to existing technologies
- Evaluates technology close to production
- Good application of other industries where Woosh started moving soft fruit
- Rely on expertise of biologist etc. regarding aspects to monitor
- Project focuses on the biological impact of a novel fish passage device
- Sustainability

Question 2: Methods and Approach

- The testing program seems to be effective relative to injury and mortality of the fish
- They are applying solid methods and approach to overcoming barriers
- Woosh does have different size molds
- Standard biological testing protocols have been used
- No real riverine testing
- Great in captive environment

Question 3: Technical Accomplishments and Progress

- No injury or alteration of physiology of mature adult Chinook salmon. But more questions on migration - survival after reintroduction.
- The research demonstrated that the project could move fish without injury that were hand loaded into the device
- The project has delivered progress technically as stated in the schedule and goals
- Parts of program complete but still remaining issues
- Project is complete and communicated
- Making strides in right direction

Question 4: Project Management

- Experienced biologists with long history in studying fish passage had to think outside the box to evaluate this technology. These types of innovations and challenges result in new creative thinking in the field.
- Project management appeared to be good
- Good project management has been demonstrated. Most notable was their call on narrowing the scope of fish physical test.
- Seems to be well managed
- Standard methods were used
- Appears good but no metrics

Question 5: Research Integration, Collaboration, and Technology Transfer

- Collaboration with fish agencies and acceptance of the technology
- Publication in journal of fish and wildlife management
- It does not appear that the technology has been widely shared within the hydropower community. This is not my area of expertise so I may not have been aware of all of the attempts to share this data.
- Very good collaboration has occurred with Industry involvement and promotion of the technology in our Industry
- Discussion on what remaining issues are
- Field studies planned in 2017

Comments made by reviewers during the evaluation of this project (PRID 92)

- Woosh will need to address various species
- Good collaboration with lab, the vendor, and utility owner
- Appears good

Question 6: Proposed Future Research, if applicable

- Reduce fish handling
- Test with other species
- The key element in this technology is to develop an attraction system such that the individual fish do not have to be handled. If this can be accomplished this type of fish passage could be very effective.
- Support for this study should continue
- Get it out into rivers
- Test regionally
- Good progress. Still gaps that need to be addressed. Good likelihood of progress based on accomplishments to date.

Question 7: Project Strengths

- This is an excellent example of an innovative technology successfully achieving goals (acceptance of resource agencies) using DOE funds - rather than imposing the high cost of achieving that acceptance to hydro operators who need to install fish passage
- Very good solution that applies to our Industry with the potential to extend to other species
- Qualified team
- Standardized biological test methods
- Anything to try and cut the cost of delivering fish safely up or down stream

Question 8: Project Weaknesses

- Agency's ultimate acceptance and approval of when and where it could be used is still in question
- Concept with a very limited application
- Always subject to Peer Review Acceptance
- Cost...not commercial for fish
- Manual process big O&M (operations and maintenance)
- Size, speed
- Voluntary entry challenges for fish

Question 9: Recommendations

- Seeing this project through completion will be valued by our Industry
- Can this be used on trout?
- Expand research to cover sensitive species
- Great example of use of Govt funding to assist in the development of a technology that is used in one area and then carried over to another

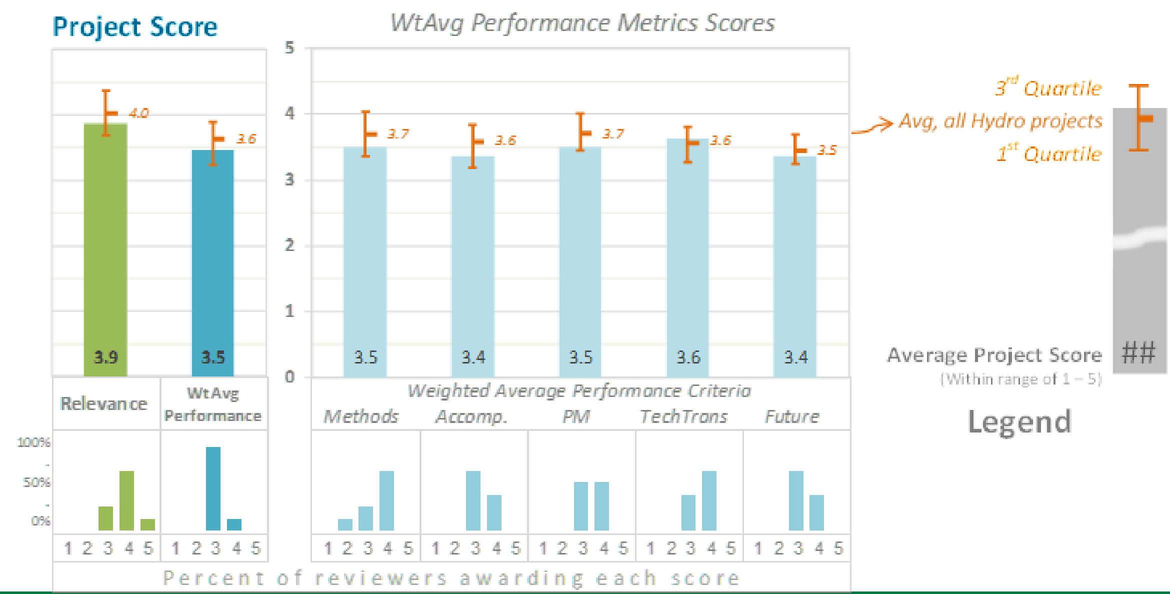
DOE Water Power Technologies Office 2017 Peer Review Project:
Informing Hydropower Investment and Operational Decisions Under Changing Hydrologic Conditions

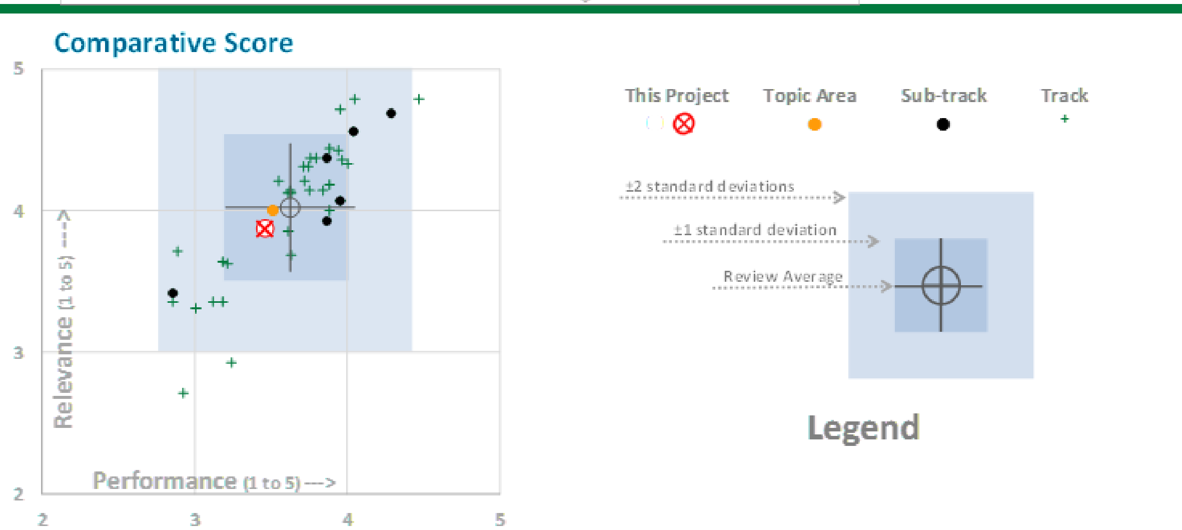
Principal Investigator	Mark Wigmosta, Pacific Northwest National Laboratory
Track	Hydropower (Hydro)
Sub-track	Sustainability
Topic Area	Energy-Water Analyses

FY 2014-FY 2016 Funding

DOE	$ 0.0 M
Cost Share	$ 0.0 M
Total	**$ 0.0 M**

Peer Review ID# 93





Comments made by reviewers during the evaluation of this project (PRID 93)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Sustainability - model the likelihood, location and severity of water-temperature events under current conditions and a range of future scenarios
- This project is just beginning and appears to have relevance to issues related to the Columbia River project. Although this is an important step in addressing potential environmental issues, study does not have relevance to the overall hydropower industry in the United States. It is therefore difficult to provide commentary on this study. It is particularly true since the study is just beginning.
- This does tie into the DOE objectives
- Of the climate-related hydropower studies that are labeled in this peer review as "sustainability" projects, this project has the most to do with actually improving the ecological sustainability of hydropower by linking climate modeling with local ecological needs (water temperature for habitat)
- This project provides optimization AND sustainability benefits
- Did a merit review and passed, looks like a good program
- Important project that is just getting started
- Could findings be merged or leveraged by other studies within the climate change suite of studies?
- Helping to unravel the issues behind fish mortality as a result of extremely warm summer should be a valuable guide
- Project too early stage to fully evaluate but objective is solid

Question 2: Methods and Approach

- Columbia River Basin - recent federal court ruling found the current salmon plan fails to adequately consider climate change and address the federal hydropower dams effect on fish (not related to the case or NEPA (National Environmental Policy Act) process)
- Models - a regional climate modeling, watershed model for tributary streamflow and temp, and river models, including USACE (U.S. Army Corps of Engineers) reservoir operations models
- Stakeholder engagement, User Need Assessment to scope and focus the framework. National steering committee and basin stakeholder groups.
- The methods and approach are well designed and technically feasible
- Choice of Columbia River basin is convenient for PI (Principal Investigator) (PNNL), but it's also the right choice for this study. In the Columbia, natural snowpack storage is rapidly being lost due to climate change and temperate issues are critical for aquatic species health. Putting this study here risks it being politicized, but it also offers an opportunity to solve some difficult problems.
- Lots of initial scoping with stakeholders slows progress, but does increase likelihood that end result is useful to many
- Are looking in se as well which is good
- Methods have been thought through
- Not sure how environmental impacts will really be assessed
- Strong team, with a well-designed approach
- Contrast between basins will be valuable
- Findings likely to be most relevant to western high head dams

Question 3: Technical Accomplishments and Progress

- Fairly new project
- It is early but they have met stated schedule and goals
- No real progress yet outside of stakeholder engagement, but project began in Q4 2016
- Just started but thought out
- Looking at RESSIM (Army Corps of Engineers' Reservoir System Simulation) which is good because model development should not be an objective of the study
- Should look at environmental regulations maybe even more actual environmental factors
- Project is just starting, so not much progress yet, beyond program design, which seems good
- Plan and model outlines are strong

Comments made by reviewers during the evaluation of this project (PRID 93)

Question 4: Project Management

- Project Management has been effective on this project
- Project only began in Q4 2016; there's no information about timeliness of milestones or adherence to budget
- Seems to be well thought through
- Standard methods are being used
- Presume it will be good but too early to say

Question 5: Research Integration, Collaboration, and Technology Transfer

- They are collaborating well at the early stage of this project
- So far only listening mode. It's the right way to start the project on a collaborative note, but a little too early to really evaluate.
- Maybe some of the environmental issues discussed can be handled by others and hydraulics be stressed in this study
- Seems like a strong stakeholder engagement
- Clearly strong inter relationship between entities
- Still early but are talking to the right people

Question 6: Proposed Future Research, if applicable

- I support future research of this project
- Project looks well-designed and useful. Nearly all of it is future research.
- Too early to say

Question 7: Project Strengths

- Good proven model bases as a start
- Good choice of location for this work
- Strong methods and approaches
- Strong team
- Could provide a basis or model for extension of studies to other river basins
- Deep focus on one study area

Question 8: Project Weaknesses

- None noted
- Some of the most important temperature issues require fully 3D models to fully understand

Question 9: Recommendations

- None noted
- Could findings be merged or leveraged by other studies within the climate change suite of studies?

DOE Water Power Technologies Office 2017 Peer Review Project:

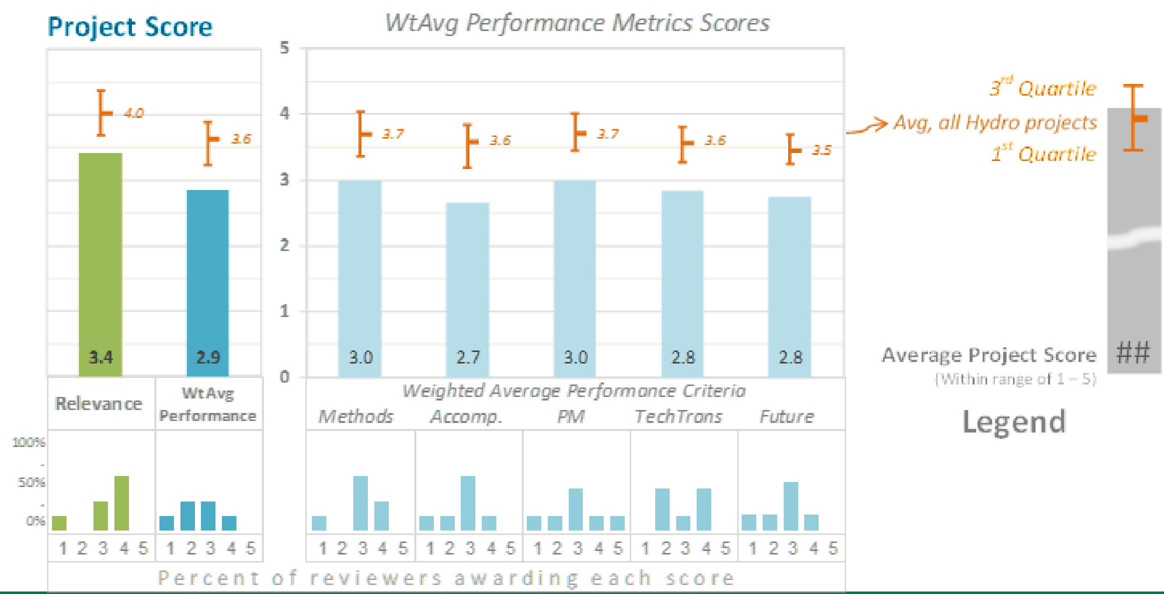
Environmental Metrics for Hydropower

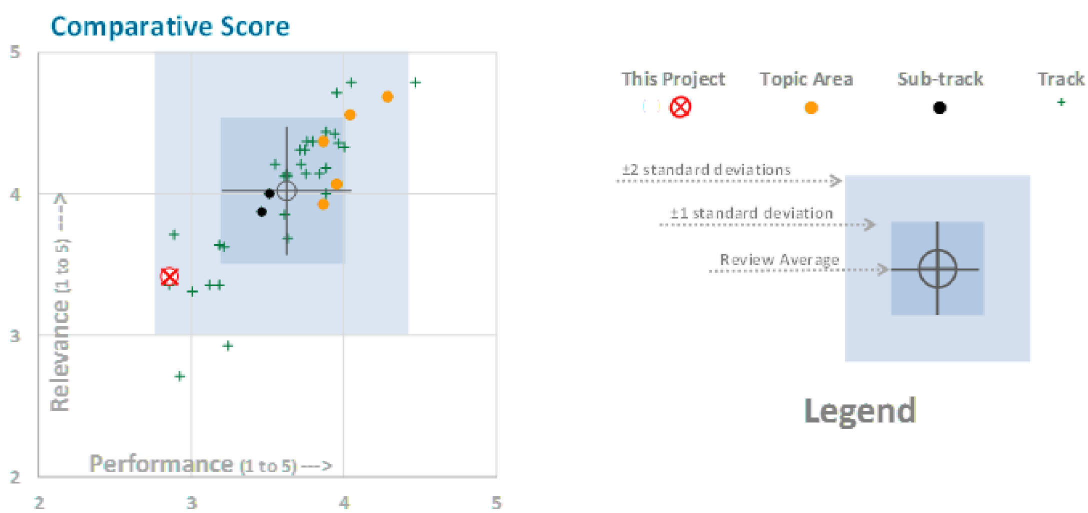
Principal Investigator	Shelaine Curd, Oak Ridge National Laboratory
Track	Hydropower (Hydro)
Sub-track	Sustainability
Topic Area	Lower Impacts

FY 2014-FY 2016 Funding

DOE	$ 0.6 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.6 M**	**100%**

Peer Review ID# 95





Comments made by reviewers during the evaluation of this project (PRID 95)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- LIHI (Low Impact Hydropower Institute) was "intentionally excluded" because as an author of a metric system it would not be appropriate to include LIHI. Yet FERC (Federal Energy Regulatory Commission) has representatives on both advisory panels and FERC is the other existing metric system referenced.
- Mission advisory board - utilities, asset owners, developers, resource managers and technology developers make up 5 of 9 areas. Envriron NGO (non-governmental organization) is only one. NGO representation should be balanced with industry for credibility, i.e. include several NGO voices for different characteristics as with industry (flows, fish protection, recreation, cultural resource protection, etc...)
- State energy official is not a good representative of the interests of state resource agencies. Energy offices have very little knowledge or input of environmental effects of hydropower. Instead, choose a few state agency representatives from key states.
- I currently serve on the panel that is developing the environmental metrics. I therefore have somewhat of a conflict of interest. I believe that the whole process is worthwhile and will result in some useful quantification of environmental concerns both for new hydropower facilities and for installation of hydropower at existing dams.
- I'm having trouble with the vagueness of this study to make a concrete decision on if this ties to overall DOE objectives
- Premise ("New hydropower development will not be widely accepted as a sustainable renewable energy option without an unbiased understanding of environmental effects") is flawed. First, it implies that the existing understanding of environmental effects (more commonly referred to as "impacts") is somehow biased, despite those impacts being well-documented and studied. Second, it assumes that a better (or less "biased") understanding of environmental effects will result in hydropower being better accepted as a sustainable form of energy. This is not necessarily the case; it's also quite possible that an unbiased examination of environmental effects would lead some to conclude that hydropower is not in fact sustainable.
- Common language for and understanding of environmental effects would benefit the industry
- Concerned that this project could be a little too ambitious. There's a risk of developing a technically perfect explanation of environmental effects that is not applicable to the real world.
- Concerned that this project's end goal will be to create a need for additional research, not an actionable / usable project. Getting this into a place where it will be useful for industry and other stakeholders could take many years and many millions of dollars of investment.
- Evaluation factors are still under consideration and should include operational aspects such as R of R (run of river) vs peaking, closed vs open, existing dam, etc.
- Sustainability
- I don't fully understand what this is designed to accomplish since it seems so very broad in scope. How will this move the industry forward?

Question 2: Methods and Approach

- More inclusion of NGO representatives is necessary for credibility
- The environmental metrics are being developed utilizing a broad constituency of owners, developers, regulatory agencies and NGOs
- The large representation of the Board may limit their ability to actually narrow scope and accomplish deliverable results
- "Unbiased understanding of environmental effects" is helpful, but what happens when stakeholders are resistant to unbiased understanding? This may not solve the problem you're trying to solve.
- Have concerns about the creation of two separate advisory boards (scientific and mission). First, serving multiple masters complicates organizational governance. It also creates risk of situation where metrics are technically perfect but not practically applicable, and work has to be repeated. This will only increase costs in the long-run.
- Measurement / Statistic / Indicator nomenclature to define metrics is very complicated, and it's hard to imagine how a list of 3000 metrics could be refined into something that is usable in the real world
- Have included Mission Advisory Board and Scientific Advisory Board to provide input which provides good diversity

Comments made by reviewers during the evaluation of this project (PRID 95)

- Methods were outlined but need to be expanded and need to address operations
- See above
- Issue of Federal v State. States have a huge say in this.
- This needs some re-work

Question 3: Technical Accomplishments and Progress

- Too early to tell
- To date there has not been a large amount of progress since the project just was initiated
- Nothing to date, just preliminary planning
- Note that this list of metrics is not particularly new or revolutionary. See, for instance, this similar document created by the Hydropower Reform Coalition in 2006 for the fraction of the cost of this project: http://www.hydroreform.org/hydroguide/scientific-approaches-evaluating-hydroelectric-project-effects.
- So far, no real progress other than convening of stakeholder group, some interviews, and a laundry list of categorized metrics
- Diverse group to provide input
- Needs to include operations not just location and size
- Advisory panels needs some re-work

Question 4: Project Management

- Project management to date appears to be good
- Project was delayed and definition of deliverables to schedule and goals are weak
- Concerns about transparency (NOTE potential conflict inherent in this comment). I recommended that LIHI be consulted since the project was evaluating their certification protocol. I know LIHI staff made a similar request. Despite these requests, they were not consulted. Such consultation would have substantially improved the review of LIHI's program (e.g. use of newly-revised criteria instead of old criteria; choice of certified projects that might be more applicable to the project at hand; etc.). Rationale provided was that it would be inappropriate to involve LIHI given that their program was being evaluated. Yet FERC's program is also being evaluated, and FERC is represented on both science and mission boards. This does not make sense.
- Multiple delays appear problematic. Some appear to be at the request of DOE, other appear to be related to the management of the project itself (e.g. delaying initial advisory board establishment). It's hard to gage from the information provided why this happened.
- Well presented

Question 5: Research Integration, Collaboration, and Technology Transfer

- There does not appear to have been any opportunity for technology transfer to date
- They have assembled a broad assembly of advisers that can add value to mission
- Good job of outreach / collaboration in putting together the boards (with exception noted in comment above). A little premature for integration and technology transfer at this point
- Not sure that they have done their job...if it is to coordinate and drive results
- Why do you need to spend money on expensive outside help such as Kearns and West?

Question 6: Proposed Future Research, if applicable

- I would place this on a low priority for funding
- Proposed future research based on milestone nearly two years away. At this point, too speculative to judge.
- Suggest major checkpoint review

Question 7: Project Strengths

- The project process has brought together a diverse group of owners, developers, regulators and NGOs. Hopefully this group will be able to identify and quantify environmental metrics in a manner that will facilitate the future development of projects both new Stream Hydro and installations at existing dams.
- Capturing Industry valued Environmental Metrics and linking to a common database would be helpful
- Thoughtful and rigorous approach to categorizing effects
- Nothing compelling so far

Comments made by reviewers during the evaluation of this project (PRID 95)

Question 8: Project Weaknesses

- Very vague scope
- Rigorous categorization of effects does not necessarily translate to practical utility
- Excludes groups like LIHI but includes regulatory agencies like FERC; could be inconsistent
- Not a great presenter

Question 9: Recommendations

- For LIHI, they looked at 5 certified projects. These were all certified under old criteria. Recommend that new criteria also be considered.
- The reliance on state energy offices for state opinions on environmental impact is problematic. Energy officials do not have expertise or knowledge about environmental impacts of hydropower. Perhaps this identifies a need for a new effort to coordinate state resource agency offices - maybe DOE could help them create a state consortium to catalog their issues and concerns related to environmental impacts of hydropower, as well as share resources and learn from each other?
- I recommend not funding this. If it is funded, they should set their reference on deliverables according to task identified in the appropriate section of the DOE Vision for Hydro.
- Project would be much better if it was narrower / focused in scope. Simple is best: pick a particular problem (some environmental metric that is difficult to quantify well) and focus on better quantifying it instead of trying to create an exhaustive list of everything that could possibly be measured.
- Kearns and West strike again…seems to be little competition for the work they do
- Metrics how do we use them
- Suggest that there should be a hold and review

DOE Water Power Technologies Office 2017 Peer Review Project:

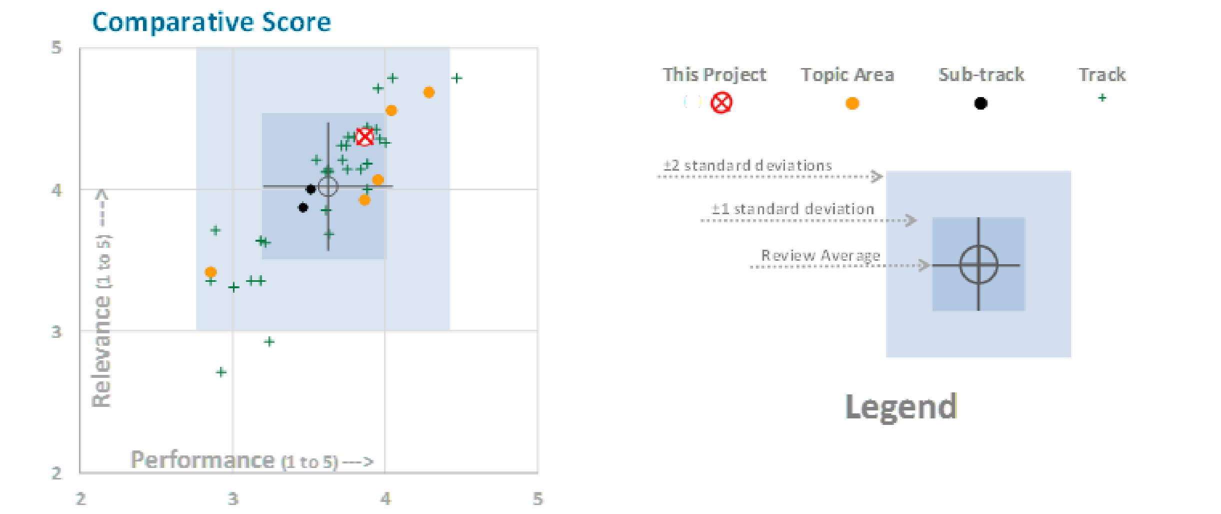
Report to Congress-Potential Climate Change Impacts on Federal Hydropower

Principal Investigator	Shih-Chieh Kao, Oak Ridge National Laboratory
Track	Hydropower (Hydro)
Sub-track	Sustainability
Topic Area	Lower Impacts

FY 2014-FY 2016 Funding

DOE	$ 0.4 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.4 M**	**100%**

Peer Review ID# 115



Comments made by reviewers during the evaluation of this project (PRID 115)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Assess the risk of climate change to federal hydropower fleet. Sustainability: increase resilience to climate change.
- The study has served to develop information that is very important to future energy planning in the face of ongoing climate change. It appears to be a very worthwhile and necessary undertaking.
- This is not my area of expertise
- This does provide Water Power Industry relevance and overall DOE objectives
- Not sure why we're peer reviewing a non-discretionary study. Congress required DOE to conduct the research; therefore it is highly relevant to DOE objectives (you have to do what Congress tells you to do).
- Understanding risks that climate change presents to hydropower fleet in the future can help us better manage existing fleet and guide where/how we develop hydropower in the future
- Good that they looked at Federal Projects from a watershed perspective since there are significant differences
- Shih also avoided the whole do I believe in Global Warming question or its degree issue
- Important project, climate will have a major impact on hydro
- Sustainability and important

Question 2: Methods and Approach

- High resolution multi-model simulation
- They do seem to have good research methods and engineering approaches to achieve a complete tool
- Risk assessment approach is a good approach
- Well thought out
- Data developed by region, brought down to local region

Question 3: Technical Accomplishments and Progress

- New regional model to simulate seasonal generation for each power market study area
- Provided future water availability scenarios for HydroVision
- Two journal papers
- Two main products. Technical report, over 200 pages involving more than 40 external reviewers. Also draft DOE report to Congress in concurrence with power marketing administrators.
- They have progressed well and advanced on schedule and goals
- Report is complete. I'm not qualified to judge merits of technical accomplishment.
- Accomplishments seem to be drawn out
- Project is complete

Question 4: Project Management

- Project Management has been effective at meeting budget and schedule milestones
- Report is complete. No information in materials to help assess this category.
- Well managed but nothing exceptional
- Standard methods have been used
- Presumed to be well coordinated

Question 5: Research Integration, Collaboration, and Technology Transfer

- They appear to be working well with experts in this area
- Most of federal hydropower family (PMAs (Power Marketing Administrations) were co-authors, Reclamation, USACE (U.S. Army Corps of Engineers)) participating
- Not just a scientific exercise: it's provided an opportunity for coordination among the federal family (ORNL coordinating with Bureau of Reclamation, Corps, as part of federal Climate Change and Water Working Group)
- Reclamation also did a water supply in western U.S. study, so they had to coordinate fairly closely, even if they didn't use the same methods
- Needs to stay focused on this
- All relevant research agencies involved

Comments made by reviewers during the evaluation of this project (PRID 115)

Question 6: Proposed Future Research, if applicable

- I support funding for this project's continued study and advancement
- Congress has requested that you do it, so you have to do it. An additional 5-years (through 2023; next report available/reviewed in 2020).
- Could affect dam safety analysis (another 10% of flow could kill a project from a dam safety perspective)
- Again needs to stay focused
- This program should be continued
- Monitor progress and note impact of any major global changes that will have impact on the United States

Question 7: Project Strengths

- Very timely and relevant to Hydro Vision
- Good and extensive database
- Regional information very helpful
- Strong Approach
- Comprehensive and objective

Question 8: Project Weaknesses

- Ensure the National Weather Service (NWS/NOAA (National Oceanic and Atmospheric Administration)) has a touch point and FERC (Federal Energy Regulatory Commission) dam safety is considered

Question 9: Recommendations

- We should continue supporting this study. Industry review and comment is critical to validating the final product.
- It's not really DOE's call since this study was required by Congress. But FERC really should have been required to perform a similar study of the assets it regulates, since it accounts for roughly half of hydropower capacity. That's a big missing piece.
- This study really should fall under the "optimization" heading rather than the "sustainability" section. This project is about preserving and optimizing the existing hydropower fleet in the face of a changing climate. It does not address the ecological sustainability of the existing fleet or of potential new hydropower development.
- Can model be used for other regions and also other purposes, dam stability
- Flashiness of rivers needs to be considered as an overlay

DOE Water Power Technologies Office 2017 Peer Review Project:

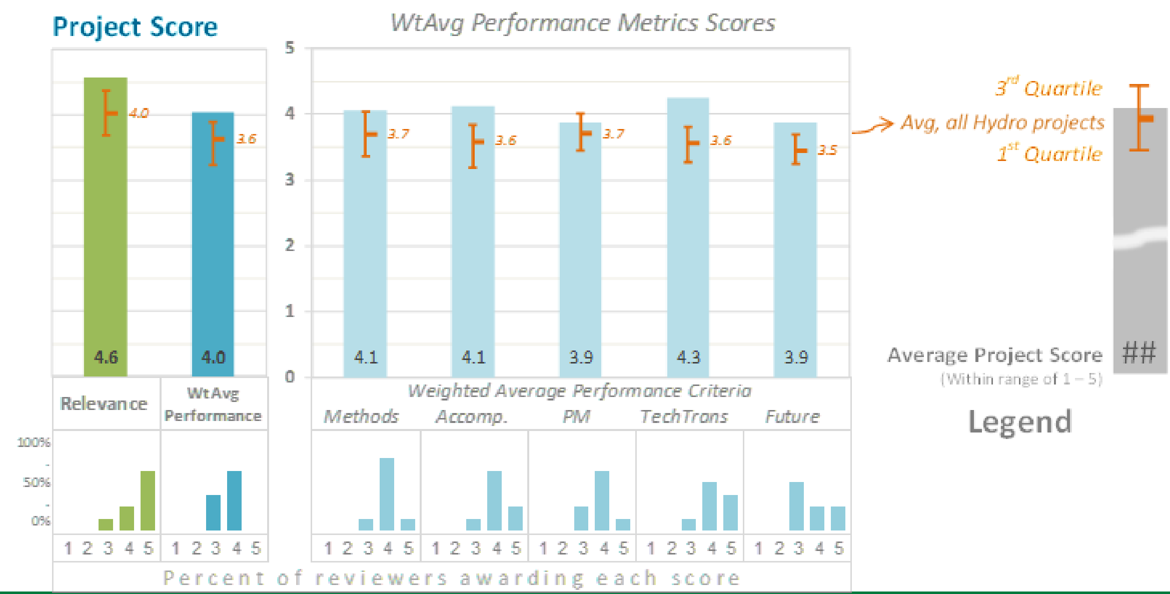
Biologically-Based Design and Evaluation of Hydro-Turbines (BioDE)

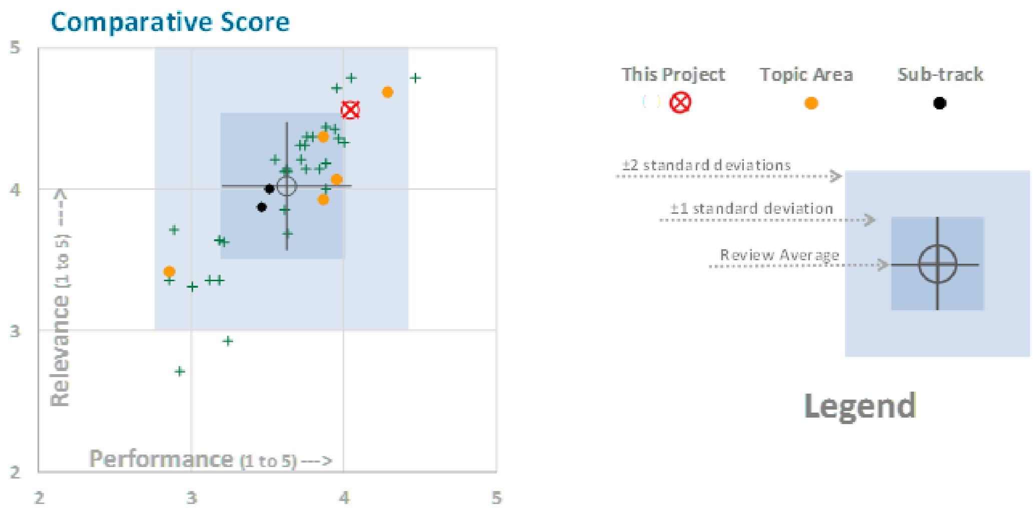
Principal Investigator	Gary Johnson, Pacific Northwest National Laboratory
Track	Hydropower (Hydro)
Sub-track	Sustainability
Topic Area	Lower Impacts

FY 2014-FY 2016 Funding

DOE	$ 3.6 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 3.6 M**	**100%**

Peer Review ID# 125





Comments made by reviewers during the evaluation of this project (PRID 125)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Sustainability - several sub areas PNNL and ORNL
- The design of turbines that are more fish friendly, using both engineering and biology expertise
- This is not my area of expertise
- While the issue of entrainment mortality may be critical for some projects, the FERC (Federal Energy Regulatory Commission) has identified that in many cases the only fish that become entrained are young of the year. The relatively small loss of these type of fish does not harm the fishery. It appears that larger fish generally can feel the entrainment flows and avoid the turbines. From this perspective fish mortality does not appear to be a major stumbling block in the development of new hydropower potential. My expertise however is not in this area. I therefore acknowledge that turbine mortality may in certain circumstances be a critical factor. The current research provides a very good tool to assess potential for mortality and therefore is a worthwhile endeavor.
- This does have relevance to the overall DOE objectives
- Providing tools that allow industry to design better turbines rather than just designing turbines (teach a man to fish…)
- This literally benefits all stakeholders, improving outcomes and hopefully lowering costs and externalities. Also, it's good for fish.
- Extension of the earlier fish friendly design and evaluation work
- Very important project, covering multiple facets of fish - turbine injury / mortality
- American eel, Am shad, shad and striped bass
- Design, evaluation tools (sensor measures) and dose response tools for technology developments
- Sustainability

Question 2: Methods and Approach

- Compression, simulated blade strike, simulated shear stressor - all experiments to assess fish mortality and injury rates
- This project is using methods and approach that are delivering success
- Direct measurements of biological performance with sensor fish and new Hydropower Biological Evaluation Toolset (HBET)
- Lab experiments with actual stunt fish
- New CFD (computational fluid dynamics) software (BioPA (Biological Performance Assessment)) for modeling biological performance in turbine design
- Need to work on solutions with manufacturers etc., not just identify problems
- Needs to interface with other private labs like Alden to ensure research is coordinated
- Outstanding sensor and tool development
- Very multidisciplinary project
- Evaluation sensor exists to pass down a turbine and monitor records pressures, hits, flows etc. Hydropower Biological Evaluation toolset
- Sensor should be available to test other turbine types

Question 3: Technical Accomplishments and Progress

- Synthesis of sensor fish data on Francis turbines. Hydropower evaluation toolset. Completion of several experiments.
- They have progressed well and delivered solid technical accomplishments that are within schedule and goals
- This is good: it's focused on a specific problem (fish/turbine interface) and iterating on existing turbine designs with a single goal: provide new tools that can help improve fish mortality outcomes
- Clearly outlined in the program which is good

Question 4: Project Management

- Project Management is effective on this project meeting schedule and budget deliverables
- Appears that all milestones were met, but materials did not provide schedule or detailed budget information so difficult to assess
- Well managed but need to make sure study and research are not an overlap
- Standard project management methods have been used
- Would like to have seen bigger $$$ contribution from equipment suppliers and industry

Comments made by reviewers during the evaluation of this project (PRID 125)

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good interaction with resource agencies, e.g. identifying priority species...
- Industry involvement group meetings - targeted to the utilities and turbine manufacturers. They also reach out to the American fishery society.
- One on one webinars
- Scientific peer review group - Glenn Cada (retired ORNL) but worked on previous advanced hydro turbine systems program. Institutional knowledge carryover.
- Strong priority to disseminate findings to hydro operators, turbine manufacturers and resource managers, regulators
- It appears that the research has been widely distributed
- The team is collaborating well with Industry and leveraging lessons learned from past EPRI (Electric Power Research Institute)/DOE sponsored projects
- !BP Excellent use in real-world situation: Grant County PUD (Public Utility District) used the BioPA model as a filter for part of Priest Rapids procurement process: all manufacturers had to have their turbine scored and do better than the old unit
- Journal articles
- Labs, industry, regulators, resource agencies
- Working closely with turbine manufacturers, licensing technology so that they can improve their own designs
- See above
- Strong outreach and collaboration program elements
- Seems like results are being shared

Question 6: Proposed Future Research, if applicable

- Population level interpretation. How much difference does it make to the population? Field studies, release sensor fish and work with industry.
- Several specific suggestions on the future, more species, refinement of the tools, population level impacts
- I propose supporting future funding of this project
- Focus on additional species is good. Validating with field data also good. Future research appears to be mostly iterative.
- Will be ongoing research in this area for many years to come
- This could be an open ended research stream. Perform a rigorous check point review.

Question 7: Project Strengths

- This lab is well positioned and equipped with the latest technology to perform the biological testing
- Outreach components
- Strong, qualified team
- Tool and sensor development
- Ability of labs to conduct and be funded for research/experiments that nonfederal entities cannot perform
- Combination of techniques results in solid approach

Question 8: Project Weaknesses

- Need more presentations at Industry Events and a more broad U.S.-based species studies
- No consideration of FERC
- Limited to traditional hydro turbines

Question 9: Recommendations

- I recommended supporting this project because of its continued importance in our Industry
- Other resource agencies should be consulted
- Will these studies be accepted by USFWS (U.S. Fish and Wildlife Service)?

DOE Water Power Technologies Office 2017 Peer Review Project:

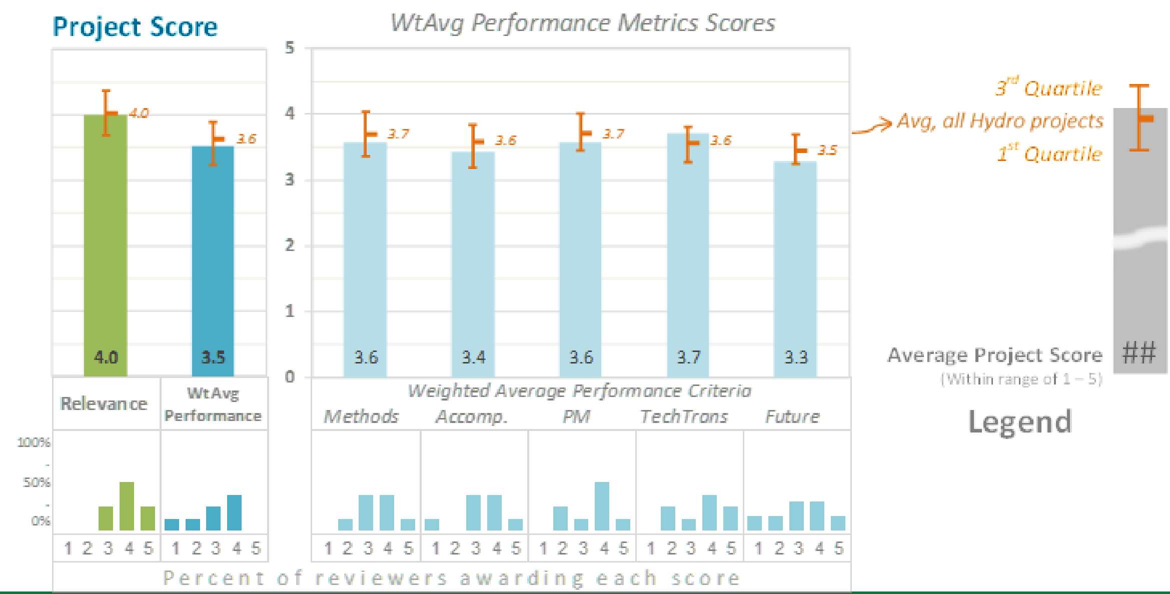
CERC-WET Topic 3: Improving Sustainable Hydropower Design and Operations

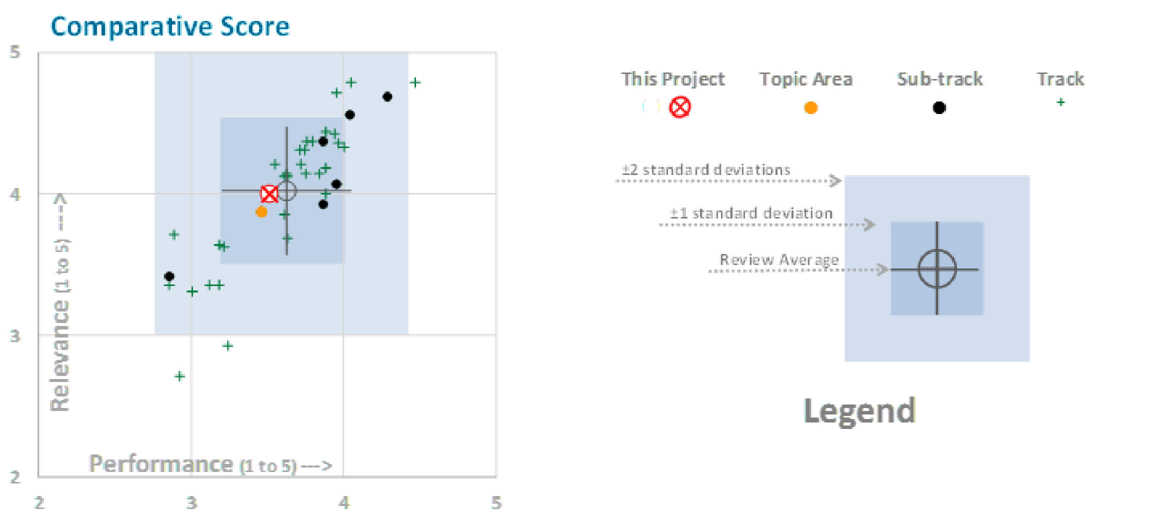
Principal Investigator	Ashok Gadgil, University of California, Berkeley (Consortium Lead)
Track	Hydropower (Hydro)
Sub-track	Sustainability
Topic Area	Energy-Water Analyses

FY 2014-FY 2016 Funding

DOE	$ 0.4 M	19%
Cost Share	$ 1.6 M	81%
Total	**$ 2.0 M**	**100%**

Peer Review ID# 195





Comments made by reviewers during the evaluation of this project (PRID 195)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- The overall focus of the project will provide tools to optimize the production of major hydropower facilities in the face of ongoing changes in the climate. Although there has not been a great deal of progress to date, the overall goals of the project are very worthwhile.
- This is not my area of expertise
- This does have relevance to the DOE and overall objectives
- Not sure why we're being asked to provide peer review for a non-discretionary study
- The White House required the study, at which point it became immediately relevant to DOE objectives
- Difficult to assess
- Very academic and needs to be focused on making hydro resilient to climate change
- Very important project
- Optimize and sustain resilience to climate change

Question 2: Methods and Approach

- The initial group and sponsors have a method and approach that is well designed and structured
- This is an arbitrary rating; I really did not follow / fully understand this study
- Well laid out
- Very strong project team, with a great project design and approaches
- Impossible project to develop a consistent approach

Question 3: Technical Accomplishments and Progress

- They have delivered solid technical results as per stated project schedule and goals
- Project is at its beginning
- United States seems to be doing OK but still need Chinese commitment
- Global multi-objective approach and optimization is very strong
- None Evident

Question 4: Project Management

- Project Management has been effective at maintaining schedule and the co-funding is exceptional and influenced my rating this at a 5
- Soroosh seems to have a good understanding of the program and U.S. responsibilities
- Not entirely clear how well the U.S. program is integrated with the Chinese program
- Standard project management methods
- Looks like a bureaucratic bun fest

Question 5: Research Integration, Collaboration, and Technology Transfer

- Great industry group spanning two great countries and even Disney as a partner leads my rating this at a 5
- Yet to be done
- Strong program elements with respect to the communications and tech transfer
- Almost impossible to succeed

Question 6: Proposed Future Research, if applicable

- I support future funding of this project
- N/A (Not applicable)
- This project has the potential to identify many future research topics

Question 7: Project Strengths

- Great team and sponsorship with a very technically in-depth team
- Very good progress to date on the U.S. program
- Very strong methods/approaches
- Very strong project team

Comments made by reviewers during the evaluation of this project (PRID 195)
Question 8: Project Weaknesses • Potential China/U.S. tensions could impact the partnership and deliverables • Needs China's commitment to the program • Not sure how well integrated with the Chinese program • No way to control expense • Way too much money dedicated to this • Is this duplicating effort with prior presentation…impact of climate change • Likely to get cut by Administration • Need to clarify the difference between models **Question 9: Recommendations** • Continued pursuit of this project is recommended • This study really should fall under the ""optimization"" heading rather than the ""sustainability"" section. This project is about preserving and optimizing the existing hydropower fleet in the face of a changing climate. It does not address the ecological sustainability of the existing fleet or of potential new hydropower development. • Way too much money from a scarce budget allocated to this. Unfair push down by the Administration. • Cut [the project]

7.4 Marine and Hydrokinetics Track: Project Scores and Comments

This section details project scores and comments for all 68 projects in the Marine and Hydrokinetics (MHK) track. Table 7-4 provides a master list of projects along with respective average scores. Sections 7.4.1–7.4.9 include the individual project score charts and reviewer comments for every project in each respective track.

Table 7-4. Marine and Hydrokinetics master project list

Marine and Hydrokinetics	Average of Relevance and WAP	Relevance	Weighted Average Performance (WAP)	Methods/Approach	Results	Project Management	Technology Transfer	Future Research
Average scores across all WPTO peer-reviewed projects	**4.0**	**4.1**	**3.8**	3.9	3.9	3.8	3.9	3.6
MHK-2A—Environmental								
Average scores for MHK-2A—Environmental	**4.2**	**4.1**	**4.2**	4.3	4.3	4.2	4.1	3.9
Annex IV and Tethys: International Environmental Data Sharing Initiative (PRID: 118)[4] Andrea Copping, PNNL	4.8	4.8	4.7	4.7	4.7	4.7	4.9	4.7
MHK Regulator Trainings (PRID: 60) Ian Baring Gould, NREL	4.5	4.7	4.4	4.4	4.3	4.4	4.7	4.7
An Intelligent Adaptable Monitoring Package for Marine Renewable Energy (PRID: 169) Brian Polagye, University of Washington	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Triton Initiative (PRID: 63) Genevra Harker-Klimes, PNNL	4.5	4.3	4.7	4.7	5.0	4.7	4.0	4.3
Unobtrusive Multi-static Serial LiDAR Imager (UMSLI) for Wide-area Surveillance and Identification of Marine Life at MHK Installations (PRID: 168) Gabriel Alsenas, Florida Atlantic University Board of Trustees	4.4	4.3	4.5	4.7	4.6	4.3	3.8	4.5
Automatic Optical Detection and Classification of Marine Animals around MHK Converters using Machine Vision (PRID: 166) Steven Brunton, University of Washington	4.3	4.3	4.3	4.6	4.3	4.0	4.6	4.3
FY16 FOA [Funding Opportunity Announcement] Awards: Innovation, Testing and Validation of MHK Environmental Monitoring Instrumentation (PRID: 198) Samantha Eaves, DOE	4.3	4.5	4.2	4.4	4.0	3.5	4.3	5.0
Interactions of Aquatic Animals with the ORPC [Ocean Renewable Power Company] OCGen® in Cobscook Bay, Maine (PRID: 147) Gayle Zydlewski, University of Maine	4.2	4.3	4.1	4.2	4.2	4.1	4.2	3.6
Evaluating Potential for Impacts from Seal Collisions with Tidal Turbines (PRID: 98) Andrea Copping, PNNL	4.2	4.3	4.1	3.7	4.3	4.2	4.3	4.0

[4] Numbers in parentheses after the project names are peer review identification numbers (PRIDs). These were used to organize projects for the peer review. The PRIDs are not in any specific order.

Marine and Hydrokinetics	Average of Relevance and WAP	Relevance	Weighted Average Performance (WAP)	Methods/Approach	Results	Project Management	Technology Transfer	Future Research
Nekton Interaction Monitoring System (PRID: 44) Kenneth Ham, PNNL	4.2	4.2	4.2	4.3	4.2	4.0	4.4	4.0
Informing a Tidal Turbine Strike Probability Model through Characterization of Fish Behavioral Response using Multibeam Sonar Output (PRID: 65) Mark Bevelhimer, ORNL	4.2	4.2	4.2	4.5	4.5	4.3	4.3	2.3
Evaluating the Potential for Marine and Hydrokinetic Devices to Act as Artificial Reefs or Fish Aggregating Devices (PRID: 150) Dr. Sharon Kramer, H.T. Harvey and Associates	4.0	4.1	4.0	3.8	4.0	4.4	4.1	3.8
Effects of EMF Emissions from Cables and Junction Boxes on Marine Species (PRID: 149) Manhar Dhanak, Florida Atlantic University	4.0	3.7	4.2	4.4	4.1	4.4	4.3	3.4
Acoustics Exposure Experimentation for Sensitive Fish Species (PRID: 114) Mark Bevelhimer, ORNL	3.9	4.0	3.9	4.2	4.1	4.0	2.4	3.9
Assessment of Potential Impact of Electromagnetic Fields from Undersea Cable on Migratory Fish Behavior PR-146 (PRID: 146) Ximena Vergara, Electric Power Research Institute, Inc.	3.9	3.7	4.2	4.5	4.3	4.0	4.3	3.1
Improvements to Hydrodynamic and Acoustic Models for Environmental Prediction (PRID: 73) Jesse Roberts, SNL	3.9	3.9	3.9	3.9	4.0	3.8	4.6	3.7
Current Ability to Assess Impacts of Electro Magnetic Fields Associated with MHK Technologies on Marine Fishes in Hawaii (PRID: 151) Jeremy Claisse, Vantuna Research Group	2.9	2.6	3.3	3.1	3.5	3.9	2.6	2.5
MHK-2A— Market and Industry Development, Analysis, and Data Dissemination								
Average scores for MHK-2A—Market and Industry	**4.2**	**4.4**	**4.0**	4.0	4.2	4.1	4.0	3.4
MHK Data Repository and Instrumentation Database (PRID: 71)[5] Rick Driscoll, NREL	4.5	4.7	4.3	4.2	4.4	4.4	4.0	4.5
MHK Risk Management Framework (PRID: 104) Jochem Weber, NREL	4.3	4.4	4.3	4.3	4.6	4.5	4.1	3.0
MHK Levelized Cost of Energy (LCOE) Analysis (PRID: 11) Rick Driscoll, NREL	4.2	4.3	4.1	4.0	4.0	4.3	4.6	4.3
MHK Manufacturing and Supply Chain Needs Assessment (PRID: 70) Jason Cotrell, NREL	3.9	4.4	3.4	3.5	3.9	3.4	3.4	2.0

[5] Numbers in parentheses after the project names are peer review identification numbers (PRIDs). These were used to organize projects for the peer review. The PRIDs are not in any specific order.

Marine and Hydrokinetics	Average of Relevance and WAP	Relevance	Weighted Average Performance (WAP)	Methods/Approach	Results	Project Management	Technology Transfer	Future Research
MHK-2A— Site and Resource								
Average scores for MHK-2A— Site and Resource	**4.0**	**4.0**	**4.0**	4.2	4.1	3.8	3.9	3.3
DoD MHK Deployment Opportunity Identification (PRID: 121)[6] Robi Robichaud, NREL	4.3	4.4	4.3	4.5	4.2	4.1	4.4	4.2
Wave Environmental Characterization at Wave Test Sites (PRID: 31) Vincent Neary, SNL	4.3	4.3	4.3	4.3	4.7	4.4	4.7	2.3
Model Validation and Site Characterization for Early Deployment MHK Sites and Establishment of Wave Classification Scheme (PRID: 55) Levi Kilcher, NREL	4.1	4.2	4.0	4.4	3.9	3.8	4.0	4.0
Wave Resource Model Integration (PRID: 14) Zhaoqing Yang, PNNL	4.1	3.8	4.3	4.2	4.5	4.4	4.4	3.8
National Wave Energy Resource Refinement Using 30-year Hindcast (PRID: 45) George Scott, NREL	3.8	3.7	3.8	4.3	4.0	3.3	4.2	2.8
Marine and Hydrokinetic Energy Metocean Data-use, Sources, and Instrumentation (PRID: 96) Senu Sirnivas, NREL	3.4	3.6	3.1	3.2	3.4	3.1	2.0	3.0
MHK-2B— Components								
Average scores for MHK-2B—Components	3.9	4.1	3.7	3.8	3.7	3.6	3.8	3.7
HydroAir Power Take Off System (PRID: 162) Gary Pearson, George Laird, Dresser-Rand Group, Inc.	4.4	4.8	4.0	4.3	3.9	4.1	3.6	4.1
Advanced WEC Controls (PRID: 78) Ryan Coe, SNL	4.3	4.5	4.1	4.0	4.3	3.6	4.5	4.5
Advanced Technology Integration and Demonstration (FY16 FOA[7] 1418 Topic Area 1 Awards Overview) (PRID: 86) Alison LaBonte, DOE Program Manager	4.3	4.8	3.8	4.4	3.3	3.8	3.0	4.5
Net Shape Fabricated Low Cost MHK Pass-Through-The-Hub Turbine Blades with Integrated Health Management Technology (PRID: 179) Kevin Koudela, The Applied Research Laboratory (ARL) - The Pennsylvania State University	4.2	4.1	4.3	4.4	4.6	4.1	4.0	4.0
Advanced Direct-Drive Generator for Improved Availability of Oscillating Wave Surge Converter Power Generation Systems (PRID: 155) Dr. V.R. Ramanan, ABB, Inc.	4.2	4.3	4.2	4.1	4.5	4.1	4.1	3.6
Advanced Energy Harvesting Control Schemes for Marine Renewable Energy Devices (PRID: 152) Jarlath McEntee, Ocean Renewable Power Company, LLC	4.2	4.3	4.2	4.0	4.3	4.0	4.8	4.0

[6] Numbers in parentheses after the project names are peer review identification numbers (PRIDs). These were used to organize projects for the peer review. The PRIDs are not in any specific order.
[7] FOA = Funding Opportunity Announcement

Marine and Hydrokinetics

	Average of Relevance and WAP	Relevance	Weighted Average Performance (WAP)	Methods/Approach	Results	Project Management	Technology Transfer	Future Research
Assimilation of Wave Imaging Radar Observations for Real-Time Wave-by-Wave Forecasting (PRID: 170) Merrick Haller, Oregon State University	4.1	4.3	3.9	4.0	3.8	3.8	4.0	3.9
Direct Drive Wave Energy Buoy (PRID: 144) Ken Rhinefrank, Columbia Power Technologies, Inc.	4.1	4.1	4.0	4.1	4.3	3.9	3.5	3.5
Advanced Controls for the Multi-Pod Centipod WEC[8] Device (PRID: 158) - Alex Fleming, Dehlsen Associates, LLC	4.0	4.0	4.1	3.8	4.0	3.8	4.8	5.0
Efficient and Reliable Power Take-Off for Ocean Wave Energy Harvesting (PRID: 177) Lei Zuo, Virginia Polytechnic Institute and State University	4.0	4.0	4.1	4.1	4.0	4.0	4.1	4.0
Power Take-off System for Marine Renewable Devices (PRID: 153) Jarlath McEntee, Ocean Renewable Power Company, LLC	3.8	4.0	3.7	3.8	3.4	3.5	4.5	3.6
Wave Energy Converter Structural Optimization Through Engineering and Experimental Analysis (PRID: 163) Ken Rhinefrank, Columbia Power Technologies	3.8	4.3	3.3	3.3	3.1	3.4	3.8	3.8
Build and Test of a Novel, Commercial-Scale Wave Energy Direct-Drive Rotary Power Take-off Under Realistic Open-Ocean Conditions (PRID: 154) Ken Rhinefrank, Columbia Power Technologies, Inc.	3.8	4.0	3.6	3.8	4.0	2.8	4.0	3.1
Passive Control for WECs (NASA CDOF)[9] (PRID: 79) Vincent Neary, SNL	3.8	4.0	3.5	3.8	3.3	3.8	3.5	3.3
Controls Optimization of Three Different WEC Devices (PRID: 176) - Mirko Previsic, ReVision Consulting, LLC	3.6	3.8	3.5	4.0	3.3	3.5	3.0	3.3
Optimization of Hull Shape and Structural Design for OE [Ocean Energy] Buoy (PRID: 157) Mirko Previsic, Ocean Energy USA LLC	3.4	3.5	3.4	3.3	3.3	4.0	3.3	3.0
System Agnostic Switched Reluctance Linear Generator for WECs (PRID: 178) Alan McCall, Dehlsen Associates, LLC	3.2	3.3	3.1	3.1	3.1	2.9	3.4	2.9
Optimal Control of a Surge-Mode WEC in Random Waves (PRID: 156) Allan Chertok, Resolute Marine Energy, Inc.	2.9	3.3	2.6	3.3	2.5	2.0	3.0	2.0
MHK-2B— Survivability								
Average scores for MHK-2B—Survivability	**3.6**	**3.7**	**3.5**	3.6	3.5	3.4	3.6	3.0
Survivability Enhancement of a Multi-Mode Point Absorber (PRID: 187) Tim Mundon, Oscilla Power, Inc.	3.9	4.0	3.7	3.7	4.0	3.3	4.0	3.3

[8] WEC = wave energy converter
[9] NASA = National Aeronautics and Space Administration; CDOF = compressible degrees of freedom

Marine and Hydrokinetics	Average of Relevance and WAP	Relevance	Weighted Average Performance (WAP)	Methods/Approach	Results	Project Management	Technology Transfer	Future Research
Improved Survivability and Lower Cost in Submerged Wave Energy Device (PRID: 186) Mike Morrow, M3 Wave LLC	3.6	3.8	3.5	3.6	3.4	3.5	3.8	2.8
Numerical Modeling and Experimental Validation of Extreme Conditions Response for the Centipod WEC [wave energy converter] (PRID: 185) Alan McCall, Dehlsen Associates, LLC	3.3	3.3	3.3	3.5	3.3	3.5	3.0	3.0
MHK-2B— Systems								
Average scores for MHK-2B—Systems	**4.3**	**4.5**	**4.1**	4.0	4.3	4.0	4.3	4.0
Wave Energy Prize: Testing and Data Analysis (PRID: 80) Rick Driscoll, NREL	4.6	4.8	4.5	4.5	4.5	4.5	4.5	4.0
Administration of the Wave Energy Converter (WEC) Prize (PRID: 164) Wesley Scharmen, Ricardo, Inc.	4.5	4.8	4.3	4.0	4.5	4.5	4.5	4.0
Wave Energy Converter Modeling (PRID: 67) Yi-Hsiang Yu, NREL	4.5	4.8	4.2	4.5	4.5	3.3	4.5	4.0
DTOcean (Optimal Design Tools for Ocean Energy) (PRID: 75) Jesse Roberts, SNL	4.4	4.3	4.4	4.0	4.7	4.0	4.7	5.0
Marine and Hydrokinetics Advanced Materials Program (PRID: 69) Bernadette Hernandez-Sanchez, SNL	4.3	4.5	4.2	4.0	4.5	4.0	4.3	4.0
MHK Industry Support (PRID: 4) Al Livecchi, NREL	4.0	4.3	3.7	3.5	4.0	3.8	3.5	3.5
Structured Innovation (PRID: 18) Jochem Weber, NREL	3.8	4.0	3.6	3.5	3.5	3.8	4.0	3.3
MHK-2C— Demonstrations								
Average scores for MHK-2C—Demonstrations	**4.1**	**4.4**	**3.9**	4.0	3.8	3.9	4.1	3.8
Demonstration of the Ocean Energy (OE) Buoy at US Navy's Wave Energy Test Site (173) Tony Lewis, Ocean Energy USA LLC	4.4	4.7	4.2	4.3	4.1	4.1	4.3	4.0
Wave Energy Test - New Zealand Multi-Mode Technology Demonstration at the US Navy's Wave Energy Test Site (145) Steven Kopf, Northwest Energy Innovations	4.3	4.6	4.1	3.8	4.3	4.0	4.6	4.2
Next Generation MHK River Power System, Optimized for Performance, Durability and Survivability (189) AlexAnna Salmon, Igiugig Village Council	4.2	4.5	3.8	4.1	3.6	3.9	3.6	3.7
Integrated Development and Comprehensive IO&M Testing at RITE of a KHPS TriFrame Mount[10] (190) Dean Corren, Verdant Power Inc.	4.2	4.5	3.8	3.7	3.9	4.0	3.8	3.6

[10] IO&M = installation, operations and maintenance; RITE = Roosevelt Island Tidal Energy

Marine and Hydrokinetics	Average of Relevance and WAP	Relevance	Weighted Average Performance (WAP)	Methods/Approach	Results	Project Management	Technology Transfer	Future Research
Reduction of System Cost Characteristics Through Innovative Solutions to Installation, Operations, and Maintenance (188) Ken Rhinefrank, Columbia Power Technologies	4.2	4.6	3.7	4.0	3.4	3.6	3.9	3.9
Azura™ Demonstration at the Navy's Wave Energy Test Site (172) Steven Kopf, Norhwest Energy Innovations	4.1	4.3	3.9	3.9	4.0	3.7	4.1	3.8
Current Energy Harnessing Using Synergistic Kinematics of Schools of Fish-Shaped Bodies (165) Michael Bernitsas, Vortex Hydro Energy, LLC	3.6	3.5	3.7	3.9	3.5	3.8	4.0	3.3
MHK-2C— Infrastructure								
Average scores for MHK-2C—Infrastructure	**4.0**	**4.1**	**3.9**	3.8	4.0	3.9	4.3	3.5
Pacific-Marine Energy Center South Energy Test Site (PMEC-SETS) (161) Belinda Batten, Oregon State University	4.4	4.7	4.2	4.1	4.3	4.1	4.6	4.3
Advanced Laboratory and Field Arrays (ALFA) (171) Belinda Batten, Oregon State University	4.2	4.3	4.1	4.0	4.3	3.9	4.6	4.1
California Wave Energy Test Center (CalWave) (160) Dr. Sam Blakeslee, Cal Poly Corporation	3.5	3.5	3.4	3.3	3.5	3.8	3.7	2.2
MHK-2C—Sensors and Measurement								
Average scores for MHK-2C—Sensors and Measurement	**4.2**	**4.2**	**4.2**	4.2	4.3	4.0	4.3	3.7
Standards Development, IEC TC 114, IEA-OES Annual Contribution (33)[11] Walt Musial, NREL	4.8	4.9	4.7	4.7	4.8	4.6	4.9	4.7
Modular Ocean Instrumentation System (MOIS) (88) Eric Nelson, NREL	4.1	4.1	4.2	4.2	4.3	4.1	4.3	3.7
Tidal Device Field Measurement Campaign (FMC) (16) Vincent Neary, SNL	3.6	3.7	3.6	3.7	3.7	3.3	3.9	2.9

[11] IEC = International Electrotechnical Commission; IEA-OES = International Energy Agency-Ocean Energy Systems

7.4.1 MHK-2A : Environmental

DOE Water Power Technologies Office 2017 Peer Review Project:

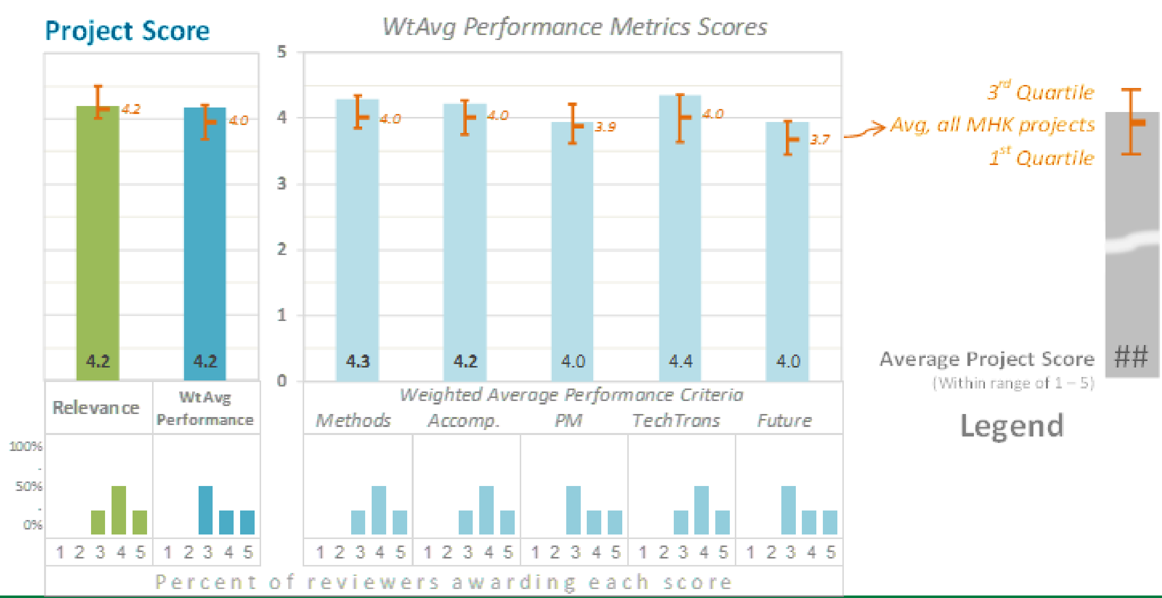
Nekton Interaction Monitoring System

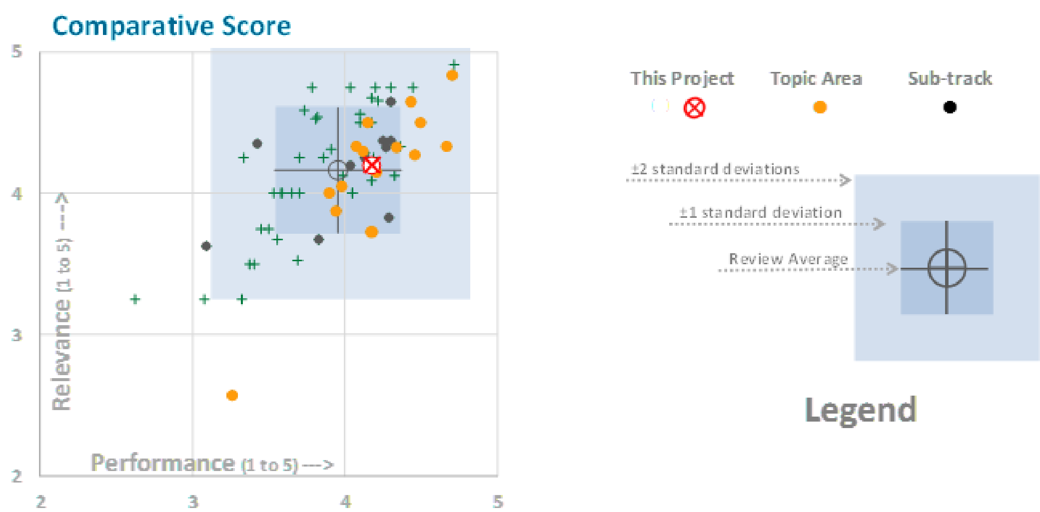
Principal Investigator	Kenneth Ham, Pacific Northwest National Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 0.5 M	90%
Cost Share	$ 0.1 M	10%
Total	**$ 0.6 M**	**100%**

Peer Review ID# 44





Comments made by reviewers during the evaluation of this project (PRID 44)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Push down future costs of processing real-time data
- Underwater monitoring of biological species is a necessary part of deploying MHK devices, particularly in the early stages of this industry. Projects such as this support the retirement of potential risk and assist the regulatory process.
- Good first step on the acoustic data, but no rigorous evaluation of the accuracy of the data outputs because no concrete project data
- Open source software will be project deliverable
- Outstanding project to develop automated marine domain monitoring to enable detailed study of device-animal interaction at reduced costs
- Data reduction is important to making these monitoring instruments viable in the marine environment
- Not sure this should be a high priority for the program

Question 2: Methods and Approach

- Appreciate the implementation of standard monitoring indices
- Excellent effort to collaborate with regulators to get input on the system; worth the 5.5 month delay
- Project approach included tests for both river MHK device and open water test in Puget Sound
- Use of ethernet based data flow seems key to allow for a variety of hardware to be used as well as integration with data flow from other instrumentation
- May need more rigorous evaluation of the quality of the output
- The technical approach is sound

Question 3: Technical Accomplishments and Progress

- Development of a new tracking algorithm that can be applicable to multiple species (fish, marine mammals, etc.)
- Successfully developed a reduction of big data enabling researchers to use an "off the shelf" approach (e.g., use a basic internet connection)
- Excellent accomplishments and progress
- BP! Use of 'wrappers' so that the software is not hardware specific is key to adoption by others in the industry
- Good data reduction results
- Success with using at a site with an active device

Question 4: Project Management

- Initial project delays were related to either technology or personnel acquisition; however, the team caught up with the project milestones by the 4th Q of the first year
- Project budget $500K including U. of Washington component produced high value package for data reduction, analysis and monitoring package that can be used with a variety of acoustic instruments in cabled or autonomous deployments with near real-time processing
- Some delays, but managed
- Project is currently on schedule and within budget
- Some delays in project execution. Nothing that affected project outcome.

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good partnership between a national lab, academic group, and private industry
- Results were presented at several conferences and in a peer reviewed journal
- Collaboration with developers enabled both dockside and open water demonstration of product and data results
- Strong collaboration in project design and implementation with the University of Washington, sonar hardware and expertise, Alaska Hydropower Energy Research Center enabled technology
- Strong follow through to share results both nationally and internationally
- Great collaboration between a lab, academia and industry (sonar)
- Please add the software to Github
- Good list of collaborators
- Several conference presentations
- Will be available on Github

Comments made by reviewers during the evaluation of this project (PRID 44)

Question 6: Proposed Future Research, if applicable

- Expanding this technology into the conventional hydro industry, focusing on entrainment
- Follow on research proposed should be pursued IF regulatory wildlife agencies, after full briefing on beta project, indicate they will accept technology and data results as trustworthy and reliable for permitting decisions
- Integration of systems like this into monitoring projects will be needed
- May have some additional tools, but evaluation of the need should be made before funding
- Needs to be deployed more widely

Question 7: Project Strengths

- Integrates well with other sensors
- Strong collaboration and project implementation
- Use of ethernet based data flow and 'wrapper' approach to allow it to be hardware agnostic

Question 8: Project Weaknesses

- Ability to use the data will rest upon regulatory wildlife agency receptivity, and follow up is required to educate agencies on the results
- The Echogram/detection software needs validation

Question 9: Recommendations

- Implement this approach on an active system (i.e., operating device)
- Need focused, DOE-supported effort for developer to present the beta project results to the wildlife regulatory agencies to confirm that data will be acceptable to the agencies in permitting decisions before further funding

DOE Water Power Technologies Office 2017 Peer Review Project:

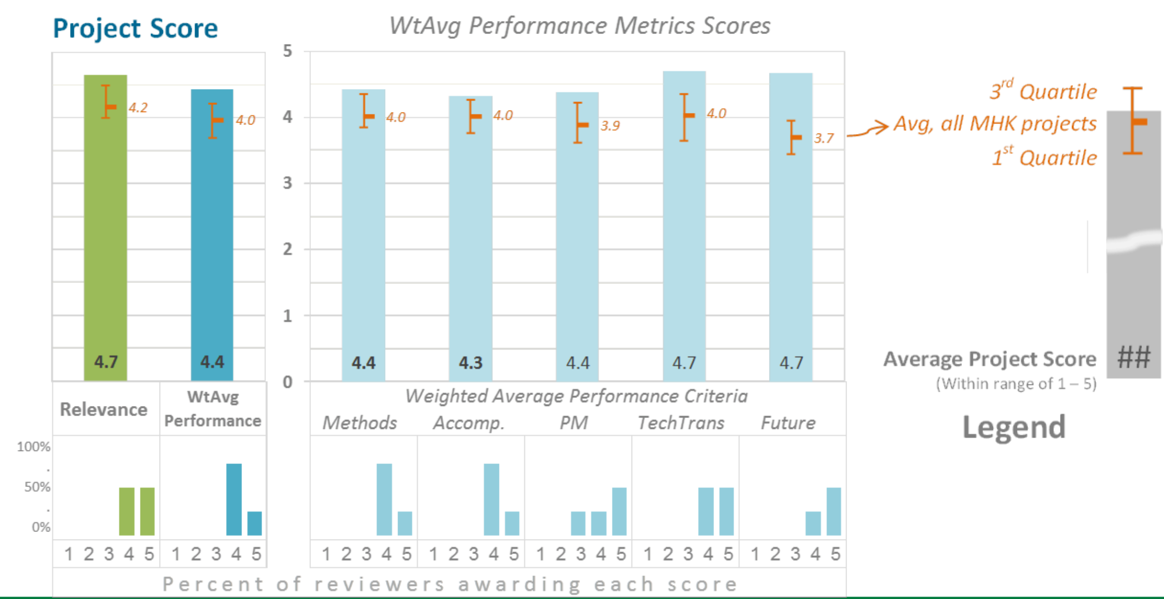
MHK Regulator Trainings

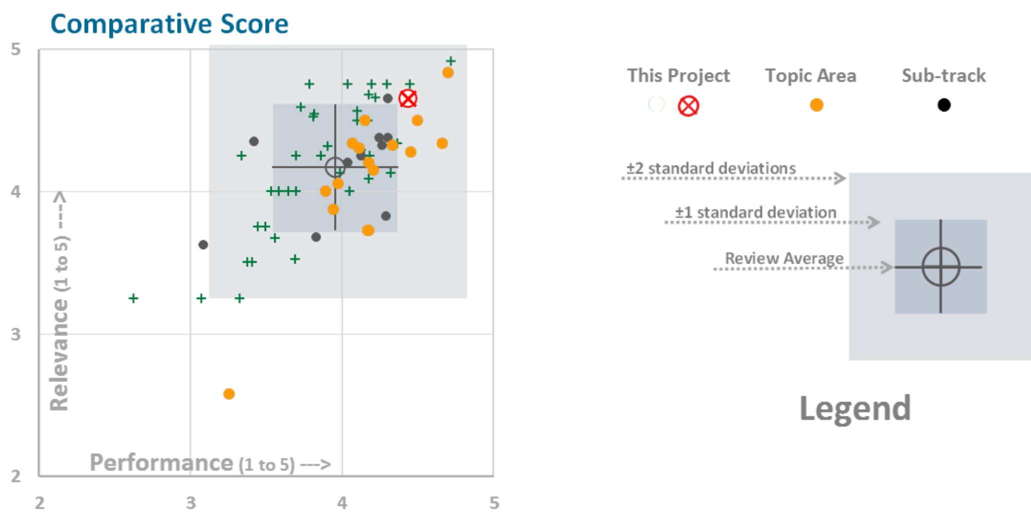
Principal Investigator	Ian Baring Gould, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 0.0 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.0 M**	**100%**

Peer Review ID# 60





Comments made by reviewers during the evaluation of this project (PRID 60)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- This was a positive project that addressed small scale projects (i.e., projects that are currently occurring)
- BP! Most valuable product DOE could develop as a follow-on piece to the regulator training might be a written piece with concrete example of decision-making process on typical wave or current/tidal project with sample permit conditions and detailed analysis on why the conditions are adequate
- BP! This project ranks equally with technology development as dual priorities for DOE funding; Working with federal and state wildlife regulatory agencies to provide detailed data on technology impacts on marine/riverine environments and build scientific consensus that projects do not cause adverse impacts
- This kind of dialog and facilitation is crucial to moving this industry forward. I hope that this kind of work continues.
- Convening the Federal and State players may not be the DOE's best role and expenditure of time and resources
- Disseminating information to the key government representatives is critical to addressing perceptions and focusing on the important issues

Question 2: Methods and Approach

- Positive Result - Including participants of the workshop (i.e., regulators) as part of the review of the workshop findings
- Positive Result - Workshops included numerous federal and state agencies, soliciting their input
- Consider potential upgrade - Consider this a Learning Forum that builds a sample permit with talking draft to serve as decision-making document to serve as permanent resource for this and next generation of decision makers
- Expand outreach to state regulatory decision makers as most MHK deployment will be in near shore environment in early stages
- Great strength - significant participation by FERC (Federal Energy Regulatory Commission), BOEM (Bureau of Ocean Energy Management), NOAA (National Oceanic and Atmospheric Administration), DOD (U.S. Department of Defense) service branches, two ME state agencies in NE and OR, Wash and AL in West workshop
- In future workshops, more upfront planning work with regulatory agencies to enable DOE to focus on their regulatory concerns and permitting case studies
- BP! The first workshop often does not go well. Taking lessons learned and applying those to future workshops is a great strength of this project.
- Good to see the learning from the first workshop to improve the second workshop
- The workshop process is important if executed in an effective manner

Question 3: Technical Accomplishments and Progress

- Attendees from both workshops were successful and included numerous federal and state regulatory communities
- It helped educate regulators on the spatial impacts likely from small scale deployments
- Completion of two workshops as test bed is excellent learning opportunity for DOE on how best to support federal/state regulators
- The project conducted the two workshops as planned and delivered the results

Question 4: Project Management

- Well designed and implemented; should be repeated with at least annual forum that enables federal and state regulators to participate via webinar
- The project is complete and was accomplished on budget and within the planned timeframe

Question 5: Research Integration, Collaboration, and Technology Transfer

- This project incorporated numerous private and public groups in discussing the potential impacts of small scale MHK devices
- BP! Excellent consensus builder among key decision makers in regulatory agencies on key issues
- BP! Collaboration with federal partners, equipment manufacturers and expert facilitators to provide learning forum for federal regulators on MHK technology through dialogue on small scale MHK projects

Comments made by reviewers during the evaluation of this project (PRID 60)

- BP! Much to be gained by collecting data from small scale projects to study impacts without burdening projects with overwhelming costs of developing new scientific data
- Going forward, will be important to enable examination of impacts of large-scale projects
- Seems like good outreach to regulatory community and involved academia. Would it be a hindrance to have industry there as well?
- Good partnering with relevant experts
- Products are appropriately disseminated in Tethys and other locations

Question 6: Proposed Future Research, if applicable

- Not Applicable
- Consider at least an annual event, combined with other federal regulator training or State Fish and Wildlife Agency Commissioner meetings to give updates
- Consider expanding to state wildlife permitting agencies, given near-shore deployment of projects and collegial dynamic among state-federal regulators
- Ongoing dialog on this subject with regulators is crucial. Doing this around an actual project would be the most valuable. Having DOE and/or a national Lab as a facilitator of the dialog between the regulatory agencies seems like a key and crucial role.
- Workshops should continue to focus on regional issues as state and federal agencies operate on a regional focus

Question 7: Project Strengths

- Provided a significant education for regulators to understand the potential impacts related to deployment of small scale devices
- Well designed and implemented at federal level
- Adaptations of workshop after the first workshop is a key strength. One never gets it right the first time.

Question 8: Project Weaknesses

- Need to consider how to maintain this education with each agency as generations of regulators move through a particular role
- Great initial effort, but Important to move to 2nd phase to build strong pipeline for technology/data transfer to both federal and state wildlife permitting agencies

Question 9: Recommendations

- Encourage dialogue to continue at a regional level
- Incorporate ongoing regulatory updates in the final report, posting it on Tethys
- Develop follow on piece that provides Workbook for permitting decisions with draft permit conditions, summarizing data and conclusions
- Work with federal wildlife permitting agencies to discuss how best to inform DC and regional office permitting staff of new technology/data
- Work with state wildlife permitting agencies through national events and webinars to inform them of technology, data, and provide workbook on issues
- Keep the dialog going so that staff turnover doesn't defeat your initial efforts, and focus dialog on specific projects that are going through the permit process
- DOE should participate in workshops as a provider of technical expertise and for sharing of information. Not sure if DOE should be the lead in doing so. BOEM has hosted many public opportunities and included DOE as presenters. This may be a better use of resources, particularly if budgets are tight.

DOE Water Power Technologies Office 2017 Peer Review Project:

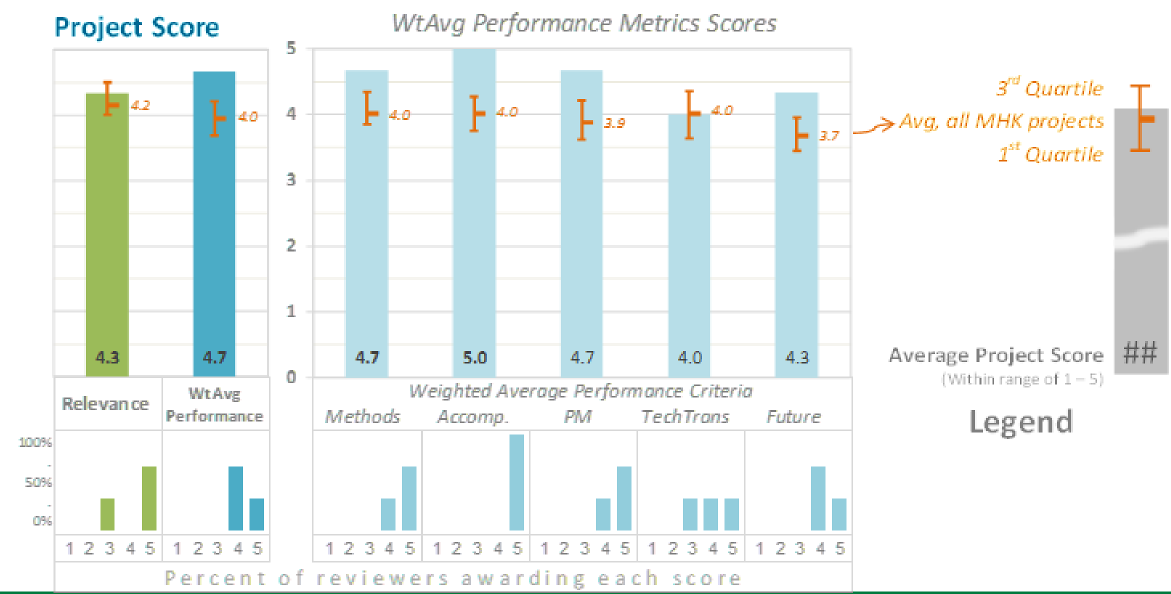
Triton Initiative

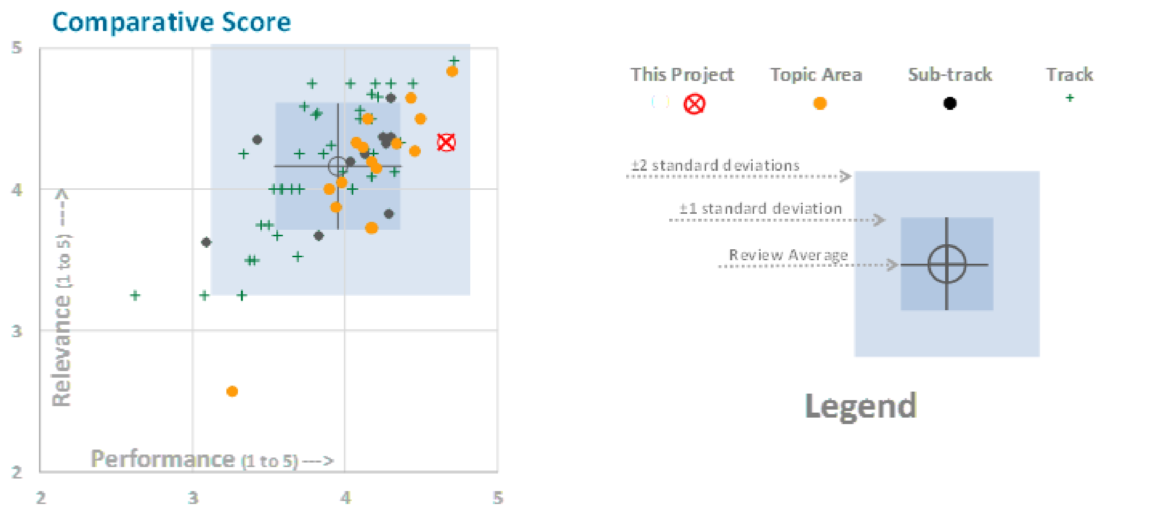
Principal Investigator	Genevra Harker-Klimes, Pacific Northwest National Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 2.0 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 2.0 M**	**100%**

Peer Review ID# 63





Comments made by reviewers during the evaluation of this project (PRID 63)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Good effort to develop collaborations among university test centers, developers and private sector firms to develop new measurement technology
- Triton focuses on acoustic measurement and analysis, EMF (electromagnetic field) measurement, animal-device interaction, sensor integration to provide environmental data to lower permitting barriers to MHK deployment
- It is not clear that providing access to a DOE Lab's marine lab is helping move the industry forward. There are other marine labs that are available to folks wishing to test instrumentation. Is there the chance that forcing DOE recipients to use the SML will result in higher budgetary expenditures?
- Providing support to allow for testing and reducing the costs for testing is a critical objective for the program
- Seven projects to date

Question 2: Methods and Approach

- Good collaborative approach using existing development projects to gather data
- Good outreach to regulators to understand issues of concern
- Blanket permit is an important aspect of getting projects to use this facility
- Baseline data is provided to expedite testing
- Having a blanket permit makes it easier for testing
- Streamlining for the projects to ensure success is important

Question 3: Technical Accomplishments and Progress

- Looking forward to using multiple technologies to compare effectiveness in measuring the same project
- ORPC (Ocean Renewable Power Company) 2015 Iguiigig project data collected and being analyzed 15 hrs f data abakysis on human study for 1 hour of nighttime video; development of algorithm
- Reported results demonstrate strong progress in instrument and measurement methods development
- Capabilities of SML seem outstanding
- Provided important support for other key projects plus assisting with data processing

Question 4: Project Management

- Excellent project management enabled 7 project pipelines to meet steep curve on site permitting, project implementation and data management systems
- Good progress at setting up the necessary support logistics to enable project testing

Question 5: Research Integration, Collaboration, and Technology Transfer

- Aim of most of Triton-supported projects is to develop the technologies to commercially ready state, and this is not subject of public outreach; next sae is to focus on fish identification systems, which will significantly reduce costs of environmental site monitoring
- Strong collaboration team
- Collaboration with academia and industry is good
- Need to advertise their capabilities
- No formal partners, but working with others as required. Collaborating with project leads doing the testing.

Question 6: Proposed Future Research, if applicable

- Future research will allow efficacy of the different fish identification systems to be evaluated under different conditions
- Future efforts should include more FOA (Funding Opportunity Announcement) that use the area

Question 7: Project Strengths

- Provides physical location and team of knowledgeable scientists on testing of data and small systems
- Good to have an area for industry to conduct testing where they can focus on the technology and not permitting

Question 8: Project Weaknesses

- DOE should make some effort to assure project developers have a commercialization plan through University Tech Transfer Office or project partners to assure technology will not be stranded by failure to commercialize

Comments made by reviewers during the evaluation of this project (PRID 63)
Question 9: Recommendations • Critical to take preliminary test results to regulators and get clear feedback on whether the data will be accepted as demonstrating preliminary conclusions of researchers • In evaluating this instrumentation class of projects, DOE WPTO needs to evaluate whether testing instrumentation and technology ultimately will be commercialized • It appears that the DOE allocation of funds may have over-weighted environmental measurement and instrumentation category and test site development, and under-weighted technology development given thin pool of surviving U.S. MHK developers and significant number of empty test berth sites in test centers

DOE Water Power Technologies Office 2017 Peer Review Project:

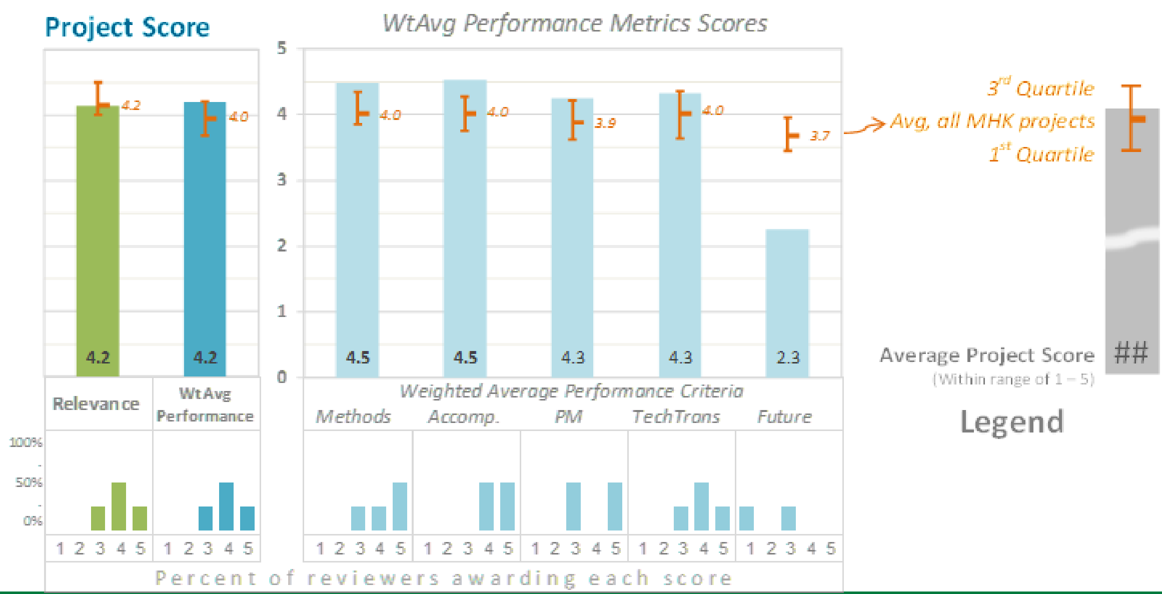
Informing a Tidal Turbine Strike Probability Model through Characterization of Fish Behavioral Response using Multibeam Sonar Output

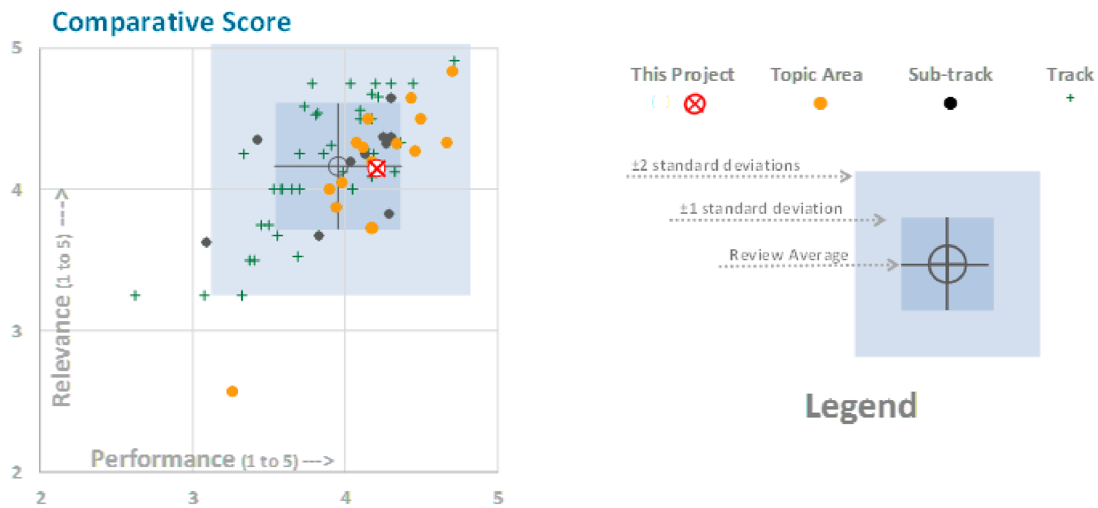
Principal Investigator	Mark Bevelhimer, Oak Ridge National Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 0.2 M	80%
Cost Share	$ 0.0 M	20%
Total	**$ 0.2 M**	**100%**

Peer Review ID# 65





Comments made by reviewers during the evaluation of this project (PRID 65)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Fish strike has been a concern suggested by multiple state and federal resource agencies
- Interactions of a device or multiple devices is needed to understand how HK devices impact the natural environment
- Part of Market Deployment Barriers strategy; minimize regulatory burden on developers in seeking a site
- Project provides concrete, site-specific, array-specific information on core permitting issues
- Highly relevant. Funding work on monitoring deployments is high priority.
- Understanding fish interactions with devices is a concern of resource agencies, both state and federal

Question 2: Methods and Approach

- A good use of various technology (e.g., split-beam, multi-beam, etc.)
- Approach enabled researchers to assess fish direction both on the ebb and flood tides
- BP! Study confirms important fish behavior pattern that should be shared in other studies: fish tend to conserve energy during high current portions of tidal cycle explaining in part why there are fewer fish observed near turbine when operating
- Project captured baseline data w/o deployment, non operating deployed, unit, etc; and across the flow velocity spectrum in this tidal site on river; also analyzed 2009 data to understand fish interaction model
- Sandia modeled the software to interpret data as fish (used video to confirm accurate)
- Really nice approach to automating and extracting fish movement from the Didson sonar
- Using a DIDSON to monitor the fish is probably the best approach available at this time
- Well-designed project that includes no turbine, turbine not moving, and turbine moving

Question 3: Technical Accomplishments and Progress

- A comprehensive data set assessed with results suggesting avoidance is more likely than strike
- Excellent product deliverable on key issue for limited DOE investment of $150K to Oak Ridge w Verdant match of prior collected data worth $100's of thousands
- This study provides excellent data about fish responses to the turbine that is clear and easy to understand

Question 4: Project Management

- Project was on time/on budget
- Well planned and executed with top team
- Slight slippage in schedule at beginning of project
- Completed on time and in budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good team combination of national lab, device developer and private industry
- Important that study results be presented to permitting agencies in proactive way to engage on key issues and build consensus
- Outstanding use of top National Lab talent to provide highly credible study
- Really nice collaboration with industry and lab and nice job leveraging data that had already been collected
- Published the work so it can be shared
- Worked closely with Verdant and their contractor

Question 6: Proposed Future Research, if applicable

- Depending on the acceptance of the current data by regulatory agencies, there is limited scope for ongoing research
- NA (Not applicable)
- NA
- None was proposed.

Comments made by reviewers during the evaluation of this project (PRID 65)

Question 7: Project Strengths

- Demonstrated real-time interactions between fish and turbine technology
- Very well designed and executed
- Applying lab expertise to an industry collected dataset
- Well-designed project that provided good results demonstrating that fish probably avoid devices

Question 8: Project Weaknesses

- Unfortunate migratory fish movements were not captured during this study
- Not clear that project value will be fully leveraged beyond this single project unless DOE facilitates presentation to permitting agencies

Question 9: Recommendations

- Results from this project needs to be combined with the ORPC (Ocean Renewable Power Company) results to provide a succinct picture of potential impacts of tidal turbines on both resident and migratory fish
- Ongoing regulator workshops by DOE should include focus on these findings and implications for tidal MHK generally
- DOE needs to assure project findings are effectively presented to federal and state permitting regulators w conclusions for tidal/current MHK

DOE Water Power Technologies Office 2017 Peer Review Project:

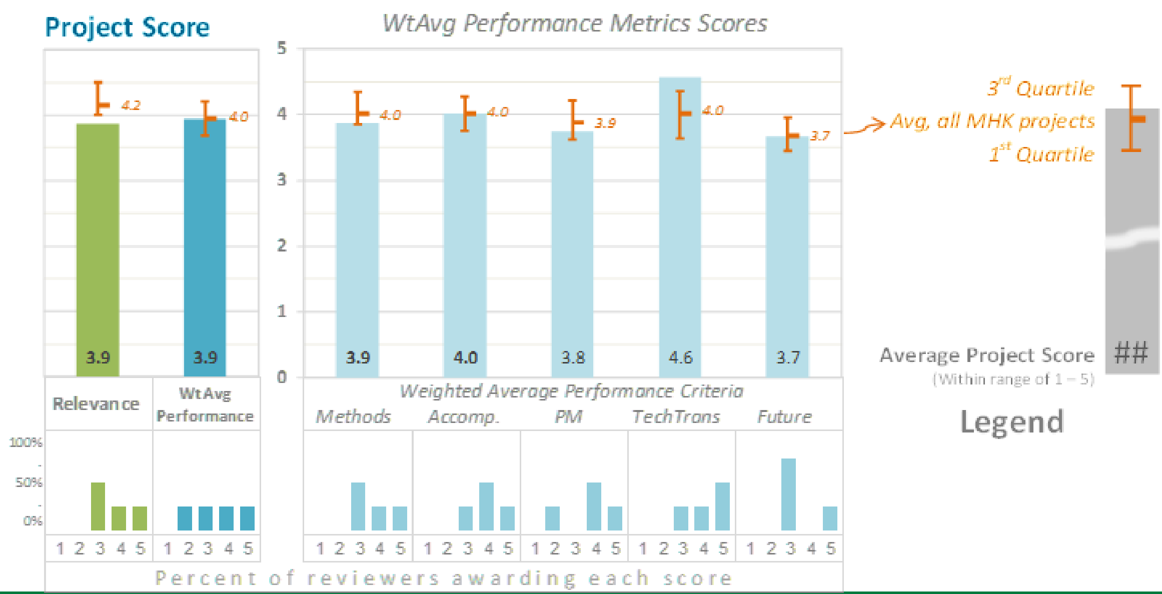
Improvements to Hydrodynamic and Acoustic Models for Environmental Prediction

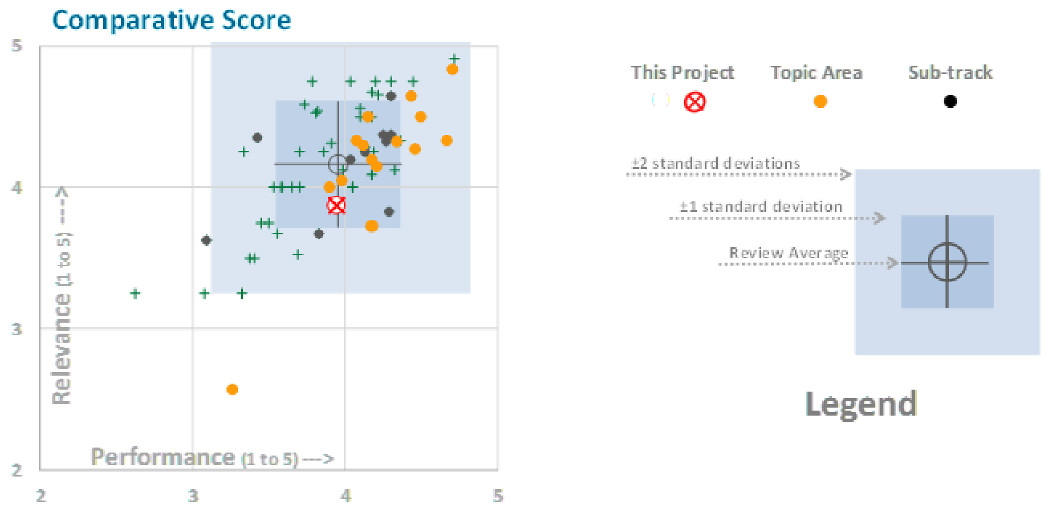
Principal Investigator	Jesse Roberts, Sandia National Laboratories
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 1.6 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 1.6 M**	**100%**

Peer Review ID# 73





Comments made by reviewers during the evaluation of this project (PRID 73)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Changes to waves or tidal flow modeling can be applicable to streamlining the permitting process and address the environmental impacts to the surrounding environment. However, the impacts of acoustic characteristics from a small array (less than 10 units) in the open ocean are hard to calculate. Increased sea state = increased background noise.
- Project is well aligned with goals for reducing permitting barriers and providing modeling tools to MHK and regulator communities for project design
- Seems to cover DOE priorities
- However, this may be a project that is before its time. Need to have working technologies to fully understand the environmental effects and have regulators buy in to results.
- Streamlining regulatory processes and retiring risk is critical to the advancement of a nascent industry

Question 2: Methods and Approach

- Methodology appears adequate
- Not clear that models fully capture the overwhelming background noise and turbulence in high energy zones to enable regulators to understand full context
- Well designed to build on existing models and provide tools to understand impacts and perform mitigation in project design
- Well designed to clear initial permitting bars, demonstrating that small arrays (<10) have negligible physical impacts on environment
- How do you validate the model outputs (e.g. model says no significant changes in physical properties from small array). What kind of confidence is associated with these results? Will be good to see results from real world environments.
- Good technical approach using already validated models
- Not clear that they took the model assumptions into account to ensure their modifications did not produce artifacts

Question 3: Technical Accomplishments and Progress

- Excellent project results, progress to date; demonstrates that small projects have negligible hydrodynamic/acoustic adverse impacts
- Produced modeling tools for regulators and MHK community to mitigate any impacts of larger projects
- Applied to sound, but at levels that are very low around 120 db which is background
- Can look at potential effects but not clear that they would be valid in real world
- Validated models with controlled laboratory experiments

Question 4: Project Management

- It is hard to understand how the $2 million+ budget over the 3-year project term was developed for this modeling project
- Excellent collaborative project team drawing from many expert partners and building on prior knowledge
- On time and on budget thus far

Question 5: Research Integration, Collaboration, and Technology Transfer

- It is good to see a project team combining private, public, and academic partnerships
- Would have been good to hear more of the results from the stakeholder workshops and what the agency responses were
- Excellent efforts to publish in Tethys, present at European Forums and publish results
- Excellent research team collaboration and excellent efforts to create user friendly software with manual for software, self-guided tutorials; workshops planned
- Good collaboration/outreach with academia, labs, industry
- Make their products publicly available through common places people go Github
- Provide training and outreach to a wide audience
- Working with a variety of partners

Comments made by reviewers during the evaluation of this project (PRID 73)

Question 6: Proposed Future Research, if applicable

- Future stakeholder outreach should include both regional NMFS (National Marine Fisheries Service) offices and State agencies
- Continue to completion, being sure to obtain feedback from user community on whether software models delivered are helpful or need revision
- Didn't have time to cover
- Continuing model development

Question 7: Project Strengths

- Important to provide planned training workshops to federal regulators FERC (Federal Energy Regulatory Commission) BOEM (Bureau of Ocean Energy Management) and NOAA (National Oceanic and Atmospheric Administration) (ESA (Endangered Species Act), MMPA (Marine Mammal Protection Act))
- Project deliverables should provide data and mitigation tools for regulators to enable MHK projects to advance
- Great that you are reaching out to the regulators with training, etc. Make sure you include regional regulator offices where appropriate.
- Outreach, teaching, collaboration definite strengths of project

Question 8: Project Weaknesses

- Early stage results, will need field verification to verify models are reliable
- What are the risks of end users mis-using the software? How do you decrease that likelihood?

Question 9: Recommendations

- Be sure to get MHK community feedback on models and whether revisions needed as planned in workshops
- Modeling is great, but how have you worked to convince regulators and or user groups that this is a good approximation of reality?
- Jasco, Maine Acoustics, and Cornell all have a lot of baseline acoustic information
- Should reach out to Bruce Mate at OSU (Oregon State University) who collected sound information in the NNMREC (Northwest National Marine Renewable Energy Center)

DOE Water Power Technologies Office 2017 Peer Review Project:

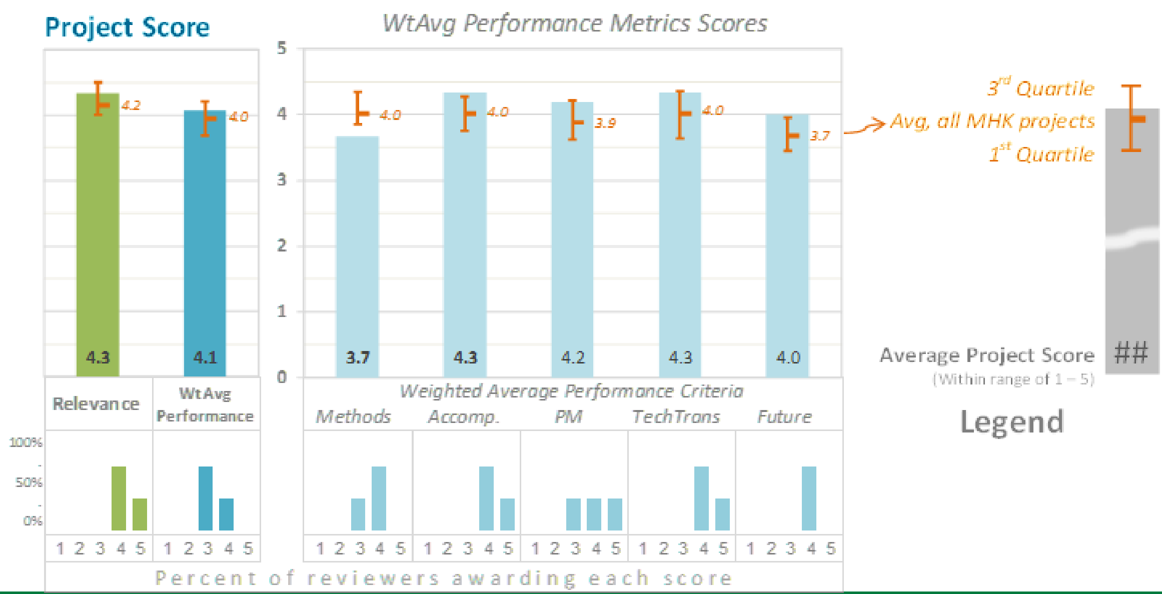
Evaluating Potential for Impacts from Seal Collisions with Tidal Turbines

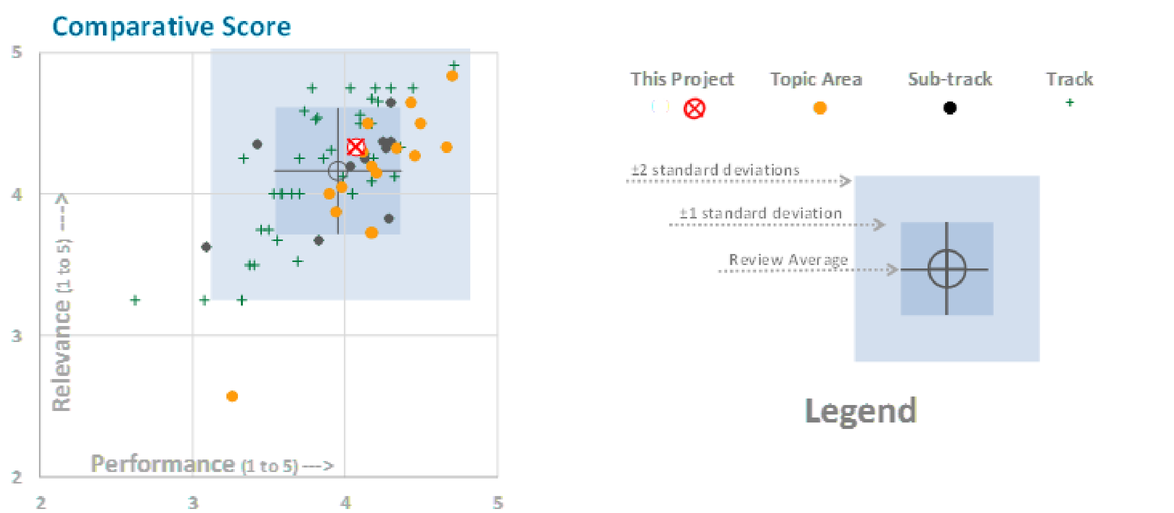
Principal Investigator	Andrea Copping, Pacific Northwest National Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 0.1 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.1 M**	**100%**

Peer Review ID# 98





Comments made by reviewers during the evaluation of this project (PRID 98)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Addresses a key ongoing concern; the potential conflict between a tidal device and marine mammals
- Project is well aligned with goal of reducing permitting barriers for MHK devices
- A definite concern of the public that needs to be addressed

Question 2: Methods and Approach

- Utilizing methodology developed during their Orca collision study, PNNL were able to refine their study approach - this also enabled researchers to assess risk of both strike and injury
- Project does not take into account seal cognitive capacities/likely response to tidal device presence, (avoidance of threat, danger of injury)
- Project very well executed on its scope to evaluate the probability and consequences aspect of risk to a marine mammal from a tidal turbine collision
- Reasonable approach to make the estimate but basic

Question 3: Technical Accomplishments and Progress

- Behavioral study of long term placement of a turbine to seals may help with future assessment of potential impacts
- Demonstrated that previous concerns were limited and that seals are more likely to 1) avoid the turbine and 2) predominantly position themselves away from the turbine (at the sea surface)
- Study makes valuable contribution by demonstrating low risks of interaction/adverse consequences if strike occurs, addressing regulator concern on test sites
- Learned something about the tissue testing

Question 4: Project Management

- Well designed to build on prior DOE WPTO funded ORCA study and well implemented
- The project was on schedule despite issues with getting seals

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good distribution of the information developed from this research
- A strong public and private partnership of experts, including tidal turbine developer input
- Close coordination with prior work and tremendous team collaboration with multiple experts in the field highly credible to regulators
- Several papers though not published yet
- Worked with a number of partners including marine mammal experts

Question 6: Proposed Future Research, if applicable

- Different turbine design collision needs to be assessed
- Would be helpful if there was a way to combine the orca strike data developed from the Snohomish County PUD (Public Utility District) project with the seal collision data
- NA (not applicable)
- Project complete and no follow on funding proposed; no further modeling studies are needed
- Extending the project to other marine mammals
- The risk using real data would be an enhancement

Question 7: Project Strengths

- Sufficient data to enable regulators to permit initial small scale test sites, where baseline and deployment environmental data can id interaction risk/impact
- Excellent attempt to address a very difficult question

Question 8: Project Weaknesses

- Unfortunately, there is a limited amount of behavioral results (outside of the researchers capacity) to incorporate into the study
- Project does not address role of seal cognitive response to potential danger or injury, or potential attraction to device; best opportunity will be at test sites
- Did not include avoidance or other behavior by the mammal

Question 9: Recommendations

- Future research may include habituation of a turbine in the region and/or cumulative impacts to seals from a turbine in an area
- In situ testing during MHK test site deployments should now be the focus
- One concern is whether biofouling by mussels or a food source might cause them to come near the turbine

DOE Water Power Technologies Office 2017 Peer Review Project:

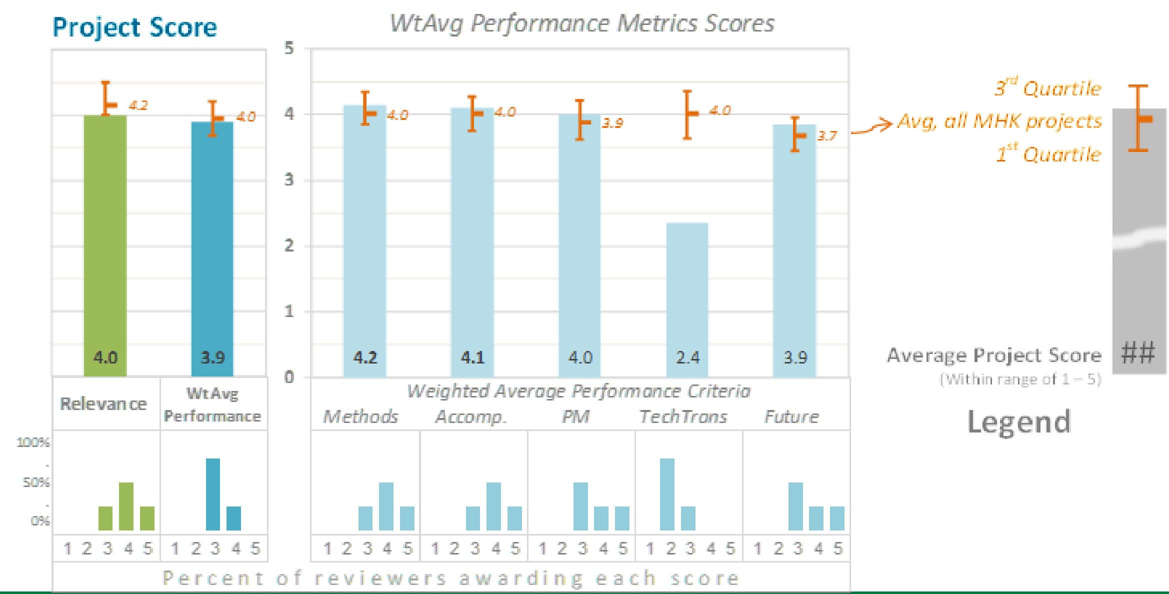
Acoustics Exposure Experimentation for Sensitive Fish Species

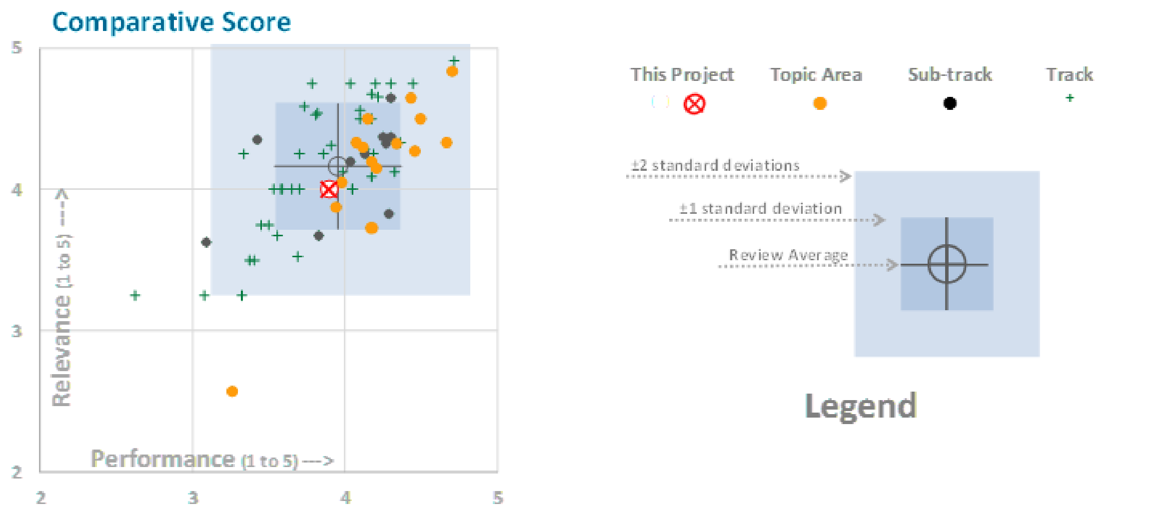
Principal Investigator	Mark Bevelhimer, Oak Ridge National Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	\$ 0.3 M	100%
Cost Share	\$ 0.0 M	0%
Total	**\$ 0.3 M**	**100%**

Peer Review ID# 114





Comments made by reviewers during the evaluation of this project (PRID 114)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- It is good to see an approach of testing in an "open water" situation, not within a lab tank
- The project addresses issue of high priority concern to regulators essential to successful site permitting as a first phase assessment of likely impacts
- Very relevant to DOE objectives
- Understanding sound exposure to fish is of importance to resource agencies (NOAA (National Oceanic and Atmospheric Administration), FWS (Fish and Wildlife Service))

Question 2: Methods and Approach

- Testing included a wide range of fish species that may be observed throughout the United States and that have a variety of hearing systems
- Well planned and executed as first phase study to enable small scale projects to proceed
- Fish may be more sensitive to particle motion from sound, not pressure. The particle motion of the MHK device may not have been accurately reproduced. Was particle motion of the playbacks recorded?
- Good controlled experimental design. Not clear what statistical controls were used, but that was due to lack of time. Not clear what the hour on/hour off vs longer exposure was trying to achieve and how that was representative of fish exposure to MHK
- The sudden onset of the playback signal may have caused a startle response that may have affected the fish longer term behavior. Since a sudden onset signal is not likely from an MHK device, I'm not sure this was the best approach.
- Good selection of fish species that represent a spectrum of species response
- Well-designed experiment

Question 3: Technical Accomplishments and Progress

- May see statistical differences, but overall no behavioral differences
- Next steps - Further investigation to assess potential impacts from other turbine designs and commercial operating turbines
- Excellent design, implementation and publications to push information to regulators and MHK community
- Project collected some interesting data but also left some questions about fish behaviour
- The exposure levels seemed quite low compared to potential ambient sound

Question 4: Project Management

- Completed on budget/on time
- Well run, successful project
- Some slippage in timeline due to quarry permissions needed
- Project is completed. There was about a 3 month delay but was within budget.

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good distribution of the science within the fisheries community, but limited distribution outside the fisheries community
- Limited collaboration outside of the lab
- No collaboration apparent, and not clear whether other pre-existing data from hydropower sector or other MHK projects or similar marine noise studies could have provided same information more efficiently
- No work on marine mammal impacts which will be a high priority concern for regulators
- Were there fish biologists involved? The reactions seen on one species that varied with exposure may be related to anti-predator response and they might have some insight into that.
- No partners, should consider reaching out to State agencies or Fish and Wildlife Service to get participation and buy in

Question 6: Proposed Future Research, if applicable

- There is potential for additional field testing with a wider variety of turbine designs
- Agree that in situ studies on project specific sites, taking into account cumulative sound impacts at high energy sites, will be important for permitting decisions
- Cumulative is a good question for the future
- Other sounds or species

Comments made by reviewers during the evaluation of this project (PRID 114)

Question 7: Project Strengths

- Utilizing a wide variety of fish species that represent numerous fisheries found throughout the country
- Should be sufficient to give regulators comfort to allow small scale single device testing projects to proceed
- Great that moved to a larger environment that could still be controlled for experimental purposes
- Good design with pens, telemetry, and different species

Question 8: Project Weaknesses

- Study design for open water systems will be difficult to set up
- Using the same fish throughout the project and not rotating species
- Project premise is that only this type of representative fish study in simulated environment would be acceptable to regulators to justify test MHK projects; in hindsight, was this really necessary to clear that initial test project bar, or could pre-existing sound studies on marine noise have sufficed?
- Concern about sound levels relative to ambient

Question 9: Recommendations

- Collaborative effort with USN (U.S. Navy) on sound studies to date on marine mammals will be essential to develop sound case for regulators
- In situ studies on specific project sites will be most helpful approach going forward
- Consider measuring the sound level of rain

DOE Water Power Technologies Office 2017 Peer Review Project:

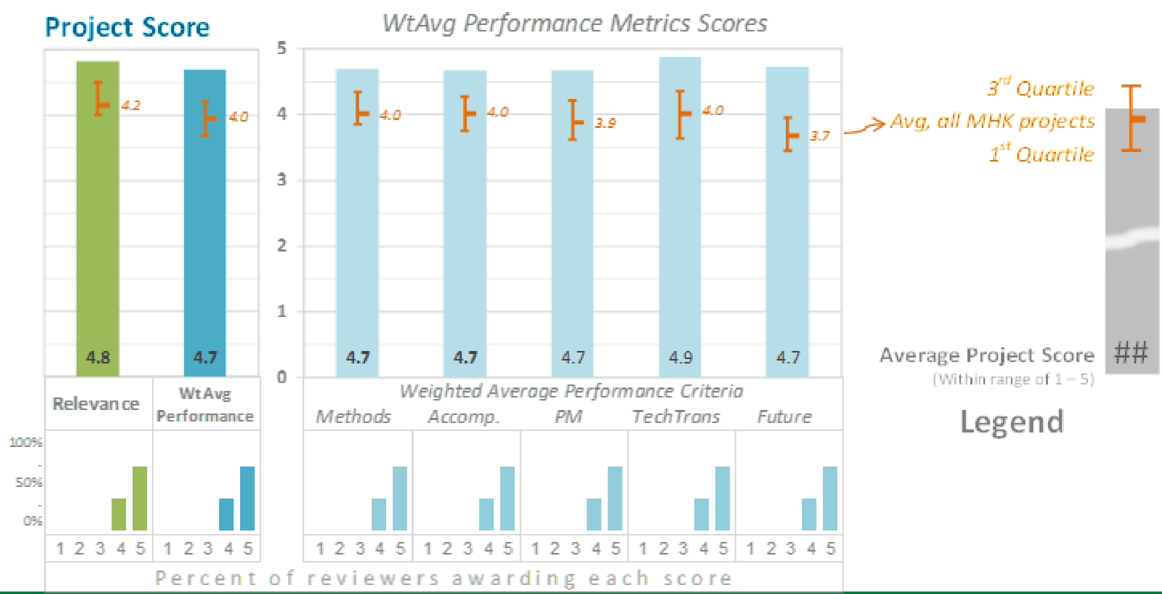
Annex IV and Tethys: International Environmental Data Sharing Initiative

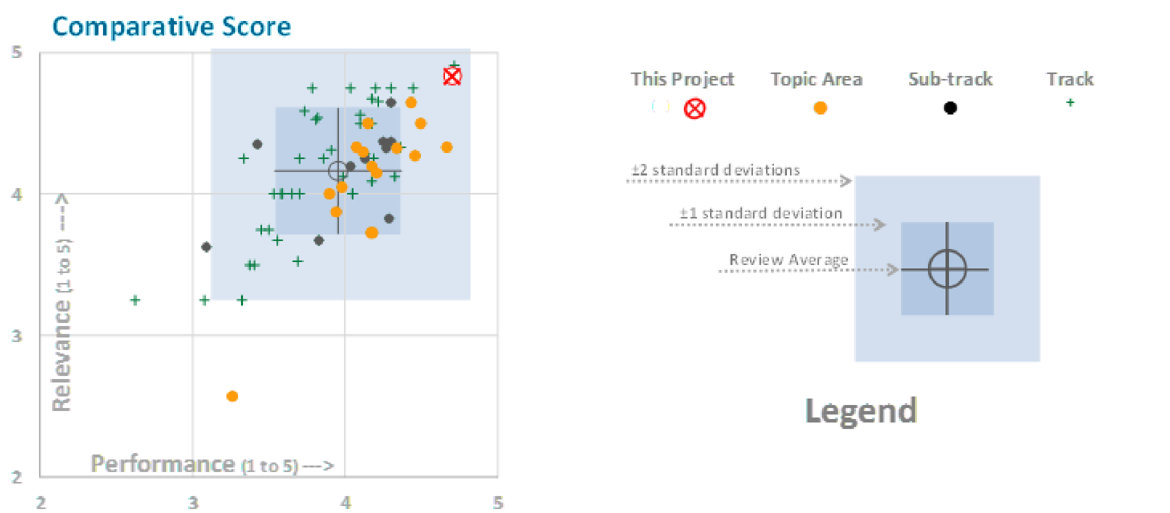
Principal Investigator	Andrea Copping, Pacific Northwest National Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 1.8 M	84%
Cost Share	$ 0.3 M	16%
Total	**$ 2.1 M**	**100%**

Peer Review ID# 118





Comments made by reviewers during the evaluation of this project (PRID 118)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Tethys is an effective online tool distributing information related to both the MHK industry as well as general offshore marine infrastructure that can act as a surrogate to the MHK industry
- BP! Tethys project is high priority for DOE to lower permitting barriers
- BP! Provides essential repository of international/U.S. MHK research and MHK device deployment data for regulators, developers, etc.
- Important to provide a location to aggregate this information and this is something the Federal government should be doing

Question 2: Methods and Approach

- Tethys provides a variety of functions, both connecting researchers with published material as well as other researchers/experts in the industry
- BP! Excellent 13-nation international collaborative effort to coordinate long-term inputs and to publish 2016 State of the Science report translated in seven languages
- BP! Excellent rollout and public outreach to push information to interested parties through impressive internet site
- Tethys is a great resource and needs both the web presence as well as the interaction with the community to ensure that the important results are being included. This cannot be done by simply relying on the community to provide information.

Question 3: Technical Accomplishments and Progress

- Enables those regulators/non-science based staff that do not have continual access to published material, to keep up with the industry and its evolution
- State of the Science report enables the greater community to target likely stressors as published material is developed
- Excellent strategy to introduce and build content of environmental study presentations at European Utech to encourage more international contributions
- Running quarterly webinars important to continue over time to build community of users familiar with the data; Expert Forums available for download are important additional value
- State of the Science lays important platform for future research collaboration
- State of the Science Report is an excellent summary of the global knowledge base up to 2016
- Webinar and outreach is excellent

Question 4: Project Management

- In addition to funding from DOE, there is also support from the international partners
- This project is on budget/on target
- Excellent, steady project management to collect and curate information and then make easily accessible to community of users
- Project is ongoing and continues to meet goals

Question 5: Research Integration, Collaboration, and Technology Transfer

- A strong partnership between multiple federal agencies and a national lab
- This is a truly international project incorporating numerous countries
- !BP - Puts the nUnited States at center of data collection and dissemination of data
- !BP- Tethys capture of metadata from actual project deployments is very important and will be helpful for future analysis
- Good proposed use to use the platform to coordinate study on priority topic of animal strikes and to develop consensus around transferability of scientific data
- Collaboration is international and includes the majority of the interested community

Question 6: Proposed Future Research, if applicable

- Collaborate/incorporate not just the science community, but those overseeing the permitting of the deployment of MHK devices - both at federal and state levels
- Critical to maintain the Tethys collection going forward to capture new MHK monitoring data as MHK projects are developed and deployed

Comments made by reviewers during the evaluation of this project (PRID 118)

- Going forward, break out budget on DOE/cost-share table to demonstrate that >1/2 budget supports curation of Tethys and much of remaining outreach on international level is to collect environmental data helpful to support both Tethys and advancement of U.S. MHK community during permitting process
- Continuation of Tethys as a resource

Question 7: Project Strengths

- Continuing dialogue with regulators and educating this community on the limitations of the environmental information
- Identifying potential risks with deploying MHK devices and mitigating/retiring those risks
- Excellent project management; user-friendly website, great collaboration with MHK nations, and great outreach to push information to user community

Question 8: Project Weaknesses

- This project is significantly funded by DOE with limited funding from other international partners
- International community, especially Europe, Australia, and New Zealand, gain significant benefit from Annex 4 and would be helpful for them to contribute more $

Question 9: Recommendations

- A more detailed break out of the budget details (domestic vs international funding sources) would help understand this subject better
- Continue and extend outreach efforts by presenting Tethys updates and by developing regional filters on data and push to U.S. federal and state regulators
- Important to cultivate the state and federal regulatory agencies as users of the Tethys collection; consider regional regulator conference presentation (e.g. to existing annual forum for National State Fish and Wildlife Commissioner meeting and federal equivalent, as well as to regional NMFS (National Marine Fisheries Service) staff meetings
- Tethys is a great resource and we at BOEM (Bureau of Ocean Energy Management) use it frequently. We especially like the Tethys Blast which brings research publications to us without onerous searches. With budgets uncertain, Tethys should be a high priority to continue funding. The private sector cannot do it.

DOE Water Power Technologies Office 2017 Peer Review Project:

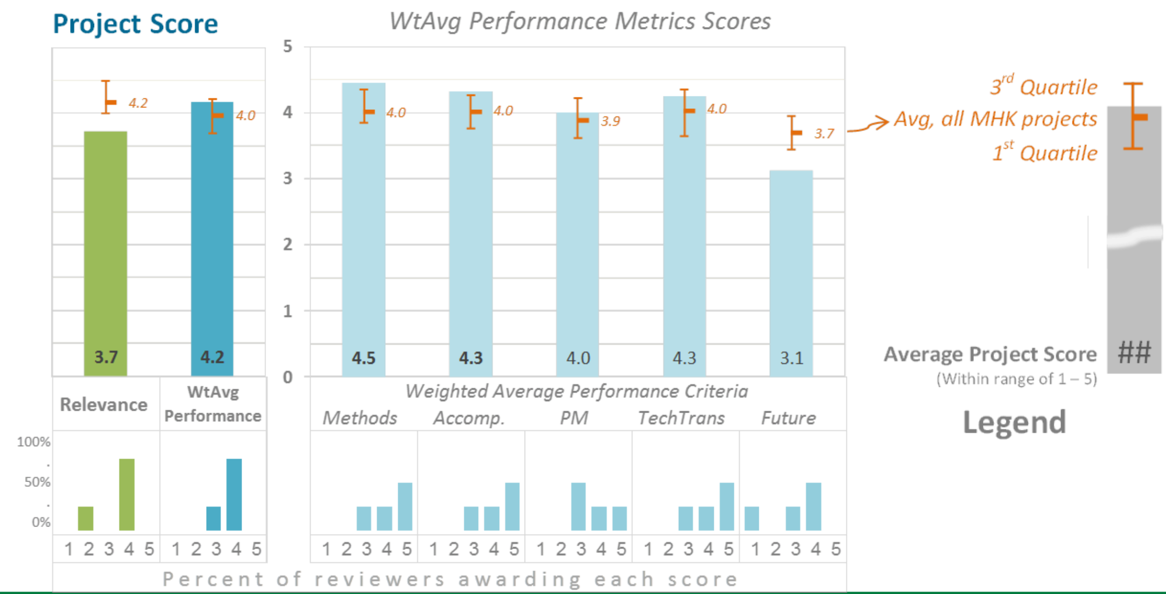
Assessment of Potential Impact of Electromagnetic Fields from Undersea Cable on Migratory Fish Behavior PR-146

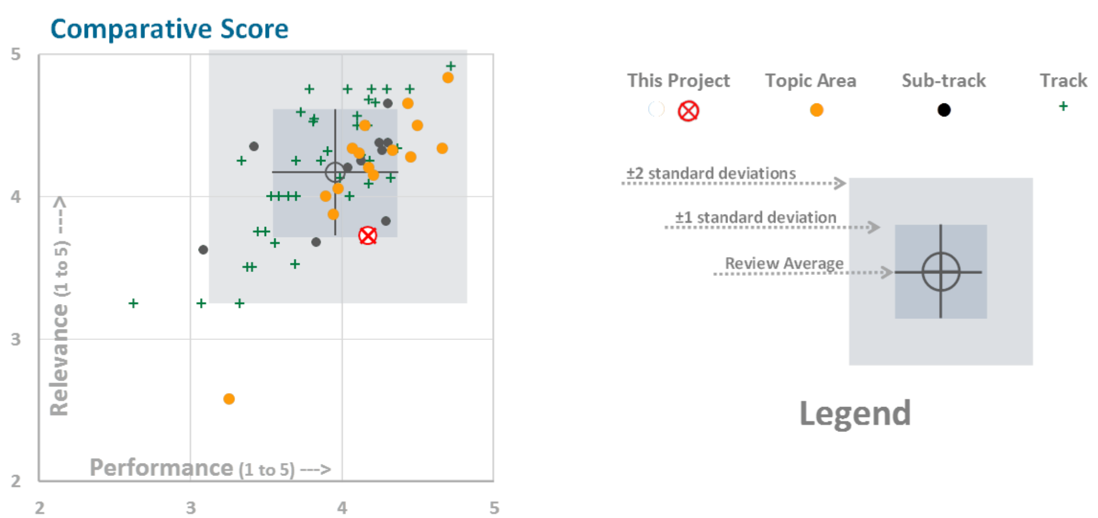
Principal Investigator	Ximena Vergara, Electric Power Research Institute, Inc.
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 0.3 M	43%
Cost Share	$ 0.3 M	57%
Total	**$ 0.6 M**	**100%**

Peer Review ID# 146





Comments made by reviewers during the evaluation of this project (PRID 146)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- EMF (electromagnetic field) impacts have been studied sufficiently for developers to mitigate their risk during the permitting process
- This project is a good example of using existing infrastructure to assess potential impacts on both benthic and pelagic migratory fish species
- BP! Confirmed that EMF cables have far less impact than bridge on salmon migration patterns and resident sturgeon patterns
- Not clear that this should be WPTO priority and sole burden given large number of pre-existing subsea cables in the United States and world
- Successful deployment of large scale MHK projects must demonstrate that MHK projects will not adversely impact marine species; project well-aligned w WPTO goals
- Field trials of emf effects meets DOE objectives
- Another piece addressing the concerns about EMF

Question 2: Methods and Approach

- Researchers developed a well-developed study under unique conditions (e.g., increased electro-fields from bridges)
- BP! Excellent collaboration in tapping centers of expertise on fish behavior and tracking analysis to produce detailed information
- Great that they could collaborate with others who have been tagging fish in the Bay Area. This provides a much richer data set.
- Valuable that they validated magnetic field model with empirical data
- Determination that the bridges has a greater effect is important
- Fantastic study that took advantage of existing information and apply to a specific question

Question 3: Technical Accomplishments and Progress

- Validating the methodology, it would be an interesting study to conduct in a less anthropogenic-impacted area
- While no significant impacts to fish from the cable were noted, the background conditions may have had an impact on results
- Demonstrated low EMF impacts on species of concern in this regional area
- Good progress and accomplishments with additional unexpected and relevant results
- The project results are excellent including the modeling as well as the observations about bridges relative to cables

Question 4: Project Management

- Project was completed on budget/on time
- Well designed and implemented
- Some delays, but not large
- Project was completed with one delay and in budget. The delay did not affect the timeliness of the results.

Question 5: Research Integration, Collaboration, and Technology Transfer

- Distribution of results in peer reviewed journals is well-documented; however, it was not possible to determine the audience targeted (e.g., fish biologist, electrical engineering, etc.?)
- Limited team members; however, this did not limit the success of the team's results
- BP! Great collaboration team with academic experts on fish resources of sensitive species and use of leading technology to perform comparative assessment on behavior of sensitive fish species before and after EMF cable installation
- Great collaboration with industry, academia and with ongoing fish tagging studies
- Good collaboration between EPRI (Electric Power Research Institute) and UC Davis (University of California – Davis)
- Three peer-reviewed publications

Comments made by reviewers during the evaluation of this project (PRID 146)

Question 6: Proposed Future Research, if applicable

- NA (not applicable) -The subject matter has been documented sufficiently to enable MHK developers to mitigate this potential impact when processing through the permitting process
- Any new EMF work should focus on data transferability; why many subsea cable studies to date are sufficient for decisions w/o more site-specific studies
- Project complete and none proposed
- Seems worthwhile going beyond passage rate and looking at finer spatial analysis of movements
- The suggested next steps are reasonable although with the bridge effects, it may not be worth pursuing this type of study further

Question 7: Project Strengths

- Researchers able to utilize 1 to 2 years of baseline data prior to cable installation
- Well executed project demonstrates low EMF impacts
- Historic data and collaboration with fish tagging groups

Question 8: Project Weaknesses

- Risk is that permitting agencies will seize on this report and insist on duplication for each deployment site and species of local concern

Question 9: Recommendations

- Can follow on funding be designed to demonstrate transferability of conclusions to other fishes, marine mammals and other animals?
- Careful review with regulatory agencies of study data is needed to build consensus on EMF impacts and assure acceptance of data

DOE Water Power Technologies Office 2017 Peer Review Project:

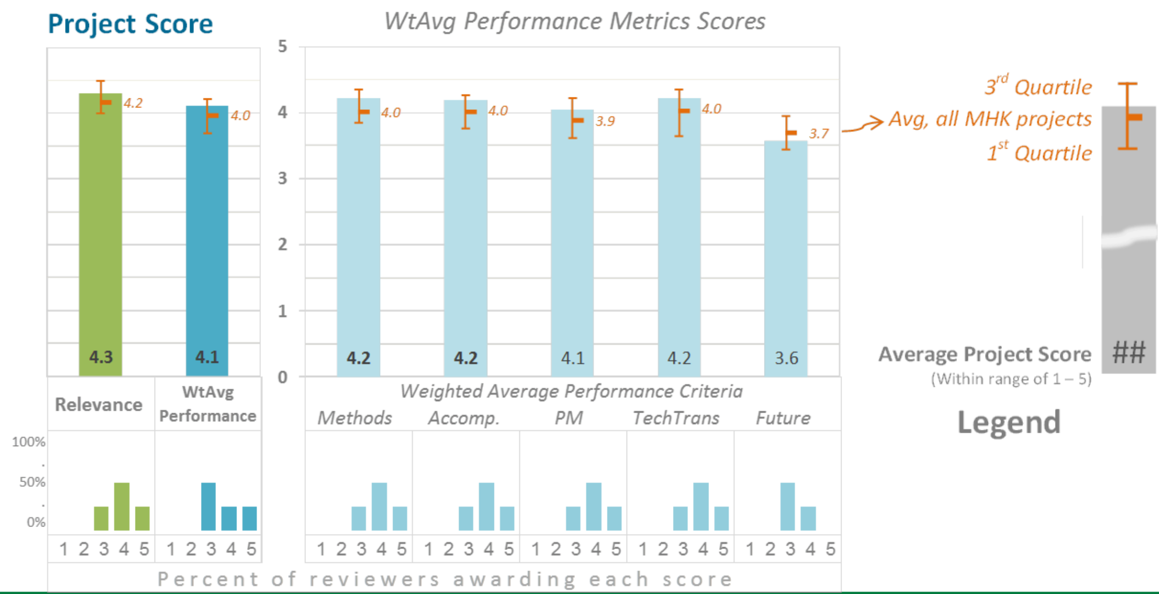
Interactions of Aquatic Animals with the ORPC OCGen in Cobscook Bay, Maine

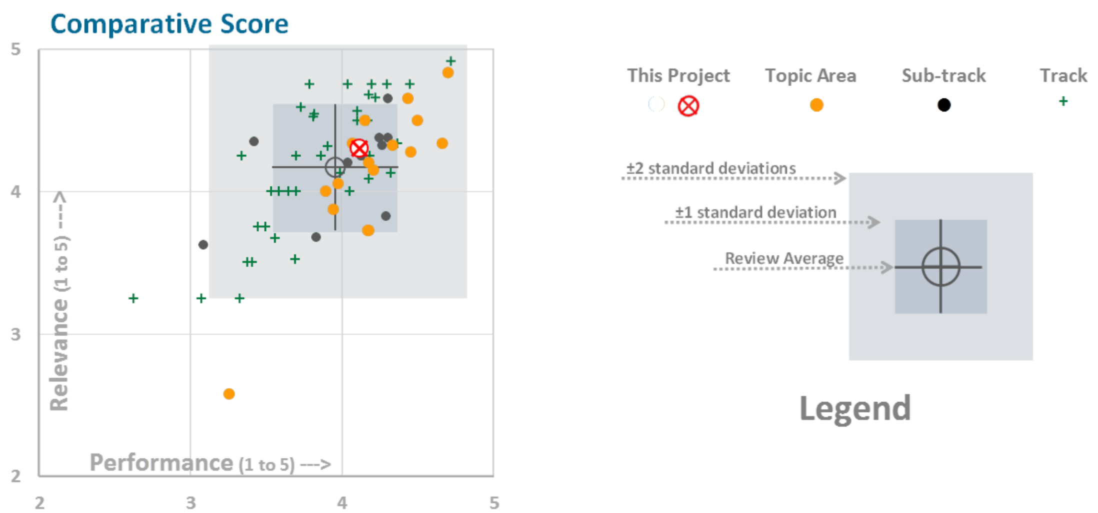
Principal Investigator	Gayle Zydlewski, University of Maine
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 0.4 M	81%
Cost Share	$ 0.1 M	19%
Total	**$ 0.5 M**	**100%**

Peer Review ID# 147





Comments made by reviewers during the evaluation of this project (PRID 147)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- A positive study of fish interactions with a real-time, in field tidal turbine - many of the previous studies have been done within confined lab scenarios
- Project well designed/ executed to lower permitting barrier for tidal/current MHK devices in test projects and larger arrays by confirming low fish strike risk
- Highly relevant. Using funding to help monitor effects at actual deployments are money well spent!
- Interactions of fish with devices are a concern of resource agencies that should be addressed
- Retiring the need for industry to monitor fish interactions would save the industry money

Question 2: Methods and Approach

- Unfortunate researchers could not segregate fish with and without swim bladders
- Well-designed approach incorporating vertical distribution, diel and tidal cycles into the design
- Excellent project design building on long term data sets and specific project deployment to build an encounter probability model applicable to all tidal/current devices archers with expertise in local area species
- Focus on how to address specific project but also how to develop transferable findings and models to other tidal/current MHK projects
- Project team comprised of academic researchers expert in local area species and conditions
- Good approach to methods and dealing with field challenges
- Great approach to sub sample to help inform future sampling regimes
- A reasonable approach for looking at fish interactions with devices
- Able to identify zooplankton from fish
- Used nested probability models

Question 3: Technical Accomplishments and Progress

- Long-term field study improves the confidence of the data use
- Adds to body of work that shows low likelihood that fish will encounter the swept area
- Produced some good information about methodology for looking at fish interactions

Question 4: Project Management

- The project appeared to require close coordination with the management of sampling of similar data by ORPC at the same site, but under a different funding mechanism
- 1 publication published and others are pending
- Product produced on time and on budget wrapped up by 2014/2015; 470 K with 370K from DOE and rest [from] U ME (University of Maine)
- Project developed an optimal sampling regime for specific project site and a model for larger scale tidal/current projects
- This award to U ME to do this project and ORPC did not do any of the work - just shared data
- Project was completed on time and within budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good distribution of this data both through conference presentations and peer reviewed papers
- Limited collaboration, although this did not limit the results. Researchers may want to consider working with other device developers to assess potential fish impacts with other turbine designs
- Well-designed project to use neutral research team with expertise in local conditions and to enable transferable findings to other projects
- Seems like good collaboration between academia and industry as well as training the next generation of researchers
- Publications were produced from this project
- Worked with ORPC

Question 6: Proposed Future Research, if applicable

- Distribution of information targeting multiple audiences in various disciplines
- NA (not applicable)
- Adds to the body of knowledge about fish impacts with structures. But there are some outstanding questions to be addressed through some future effort.
- Note - It will not let me enter NA since no future work was proposed by the researcher

Comments made by reviewers during the evaluation of this project (PRID 147)

Question 7: Project Strengths

- Well designed and executed to address specific project site and to provide model and findings for larger projects and other tidal/current devices
- Adds to the body of knowledge about fish interactions

Question 8: Project Weaknesses

- None

Question 9: Recommendations

- Like Verdant Project by Oak Ridge, these project findings should be formally presented by DOE WPTO to federal and state permitting agencies

DOE Water Power Technologies Office 2017 Peer Review Project:

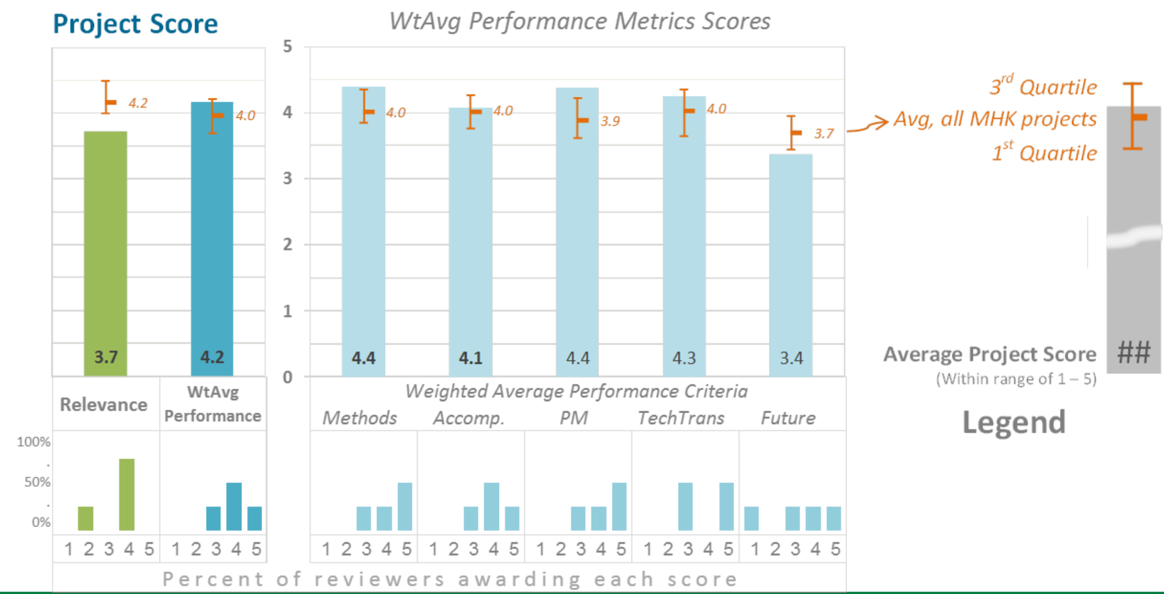
Effects of EMF Emissions from Cables and Junction Boxes on Marine Species

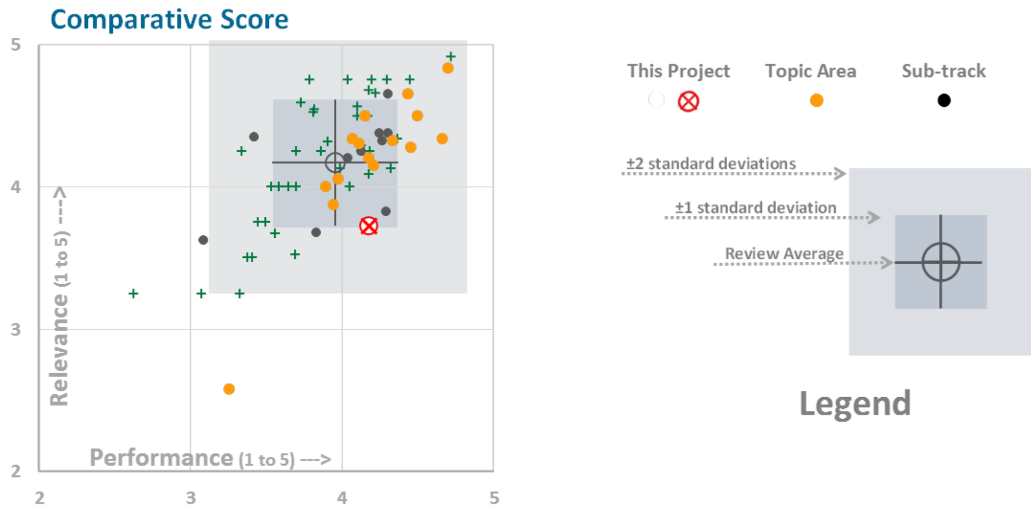
Principal Investigator	Manhar Dhanak, Florida Atlantic University
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 0.4 M	80%
Cost Share	$ 0.1 M	20%
Total	**$ 0.5 M**	**100%**

Peer Review ID# 149





Comments made by reviewers during the evaluation of this project (PRID 149)
Question 1: Relevance to Water Power industry needs and overall DOE objectives • EMF impacts have been studied sufficiently for developers to mitigate their risk during the permitting process • It is a very useful project assessing real-time/in field EMF impacts on marine species • Unclear that this should be DOE WPTO priority and sole funding burden given extensive subsea cables for electricity grid in the United States and world • Well aligned with SPO goals and industry needs to obtain permits on subsea cable installation • Glad to see an experimental approach to EMF issues • The project adds to the body of knowledge on EMF and environmental effects and addresses the concern from cables not buried • The use of an AUV (autonomous underwater vehicle) is an advancement **Question 2: Methods and Approach** • Location selected for the research is occupied by numerous EMF-sensitive species • Positive - use of 3 cables transmitting AC (alternating current), DC (direct current), and nocurrent. Very few other studies have assessed these differences. • Excellent project design and execution, with excellent collaboration with existing DOD (Department of Defense) cable and use of AUV and South Florida Ocean Measurement Facility • BP! Great that they could get the Navy to alter the power in the cable. This provides experimental control in a natural setting. • Max depth of 45 feet is limited by diver needs. Does this affect the species available (i.e. miss deeper water species)? • No discussion of sample size. Were there enough data collected to support results suggesting little effect from EMF? • Good methodology for measuring EMF and making observations **Question 3: Technical Accomplishments and Progress** • After demonstrating the distance of an electro-field, there was not a significant response exhibited by many species swimming in the area • Project developed good quality measurements of EMF emissions, confirming models of EMF decay away from cables and related marine animal behavior • Some delays, but due to trying to collect more shark data, so seems reasonable • Adds to the body of knowledge about actual filed observations of interactions of species with cables • Proved that the AUV can be used to measure the field at MHK devices **Question 4: Project Management** • Project was completed on budget/on time • Well implemented project, using existing resources and avoiding duplication of effort on test site, AUV and DOD existing cable site • The project was completed on time and within budget **Question 5: Research Integration, Collaboration, and Technology Transfer** • A good distribution of information through peer review papers and conference presentations • Excellent collaboration • Great that collaborated with the Navy to use their cable and control voltage • Other than divers from NOVA, not clear who was collaborator or how the AUV technology might be shared • Good partnering with Navy • One peer reviewed publication • Sensor developed being used for another project

Comments made by reviewers during the evaluation of this project (PRID 149)

Question 6: Proposed Future Research, if applicable

- NA (not applicable) -The subject matter has been documented sufficiently to enable MHK developers to mitigate this potential impact when processing through the permitting process
- No
- Suggest co-location of sensors for improved geo-location capabilities. Not clear that this was a large hurdle/challenge in the current study?
- The AUV is a great tool to further enhance

Question 7: Project Strengths

- Well executed project with helpful data on EMF effects on most sensitive marine animals
- Control of cable voltage was definite strength!
- The development and use of the AUV to measure the magnetic field. Monitoring may be required of developers and this tool could work.

Question 8: Project Weaknesses

- Not clear the regulatory agencies will agree that species studied are satisfactory surrogates for all marine species
- Risk is that regulatory agencies will demand similar in situ study in region of each project to assess local species of concern

Question 9: Recommendations

- This subject matter has been documented sufficiently to enable MHK developers to mitigate this potential impact when processing through the permitting process. However, a future study looking at vertical cables of similar types that extend into the water column, from the seafloor to a MHK device may contribute to this science base.

DOE Water Power Technologies Office 2017 Peer Review Project:
Evaluating the Potential for Marine and Hydrokinetic Devices to Act as Artificial Reefs or Fish Aggregating Devices

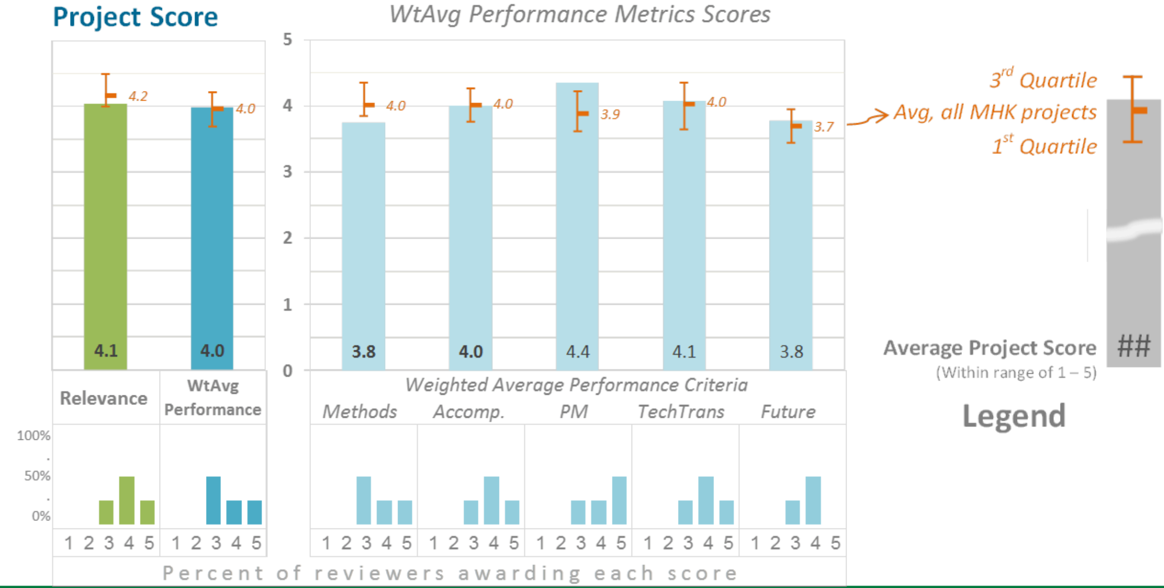
Principal Investigator	Dr. Sharon Kramer, H.T. Harvey and Associates
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

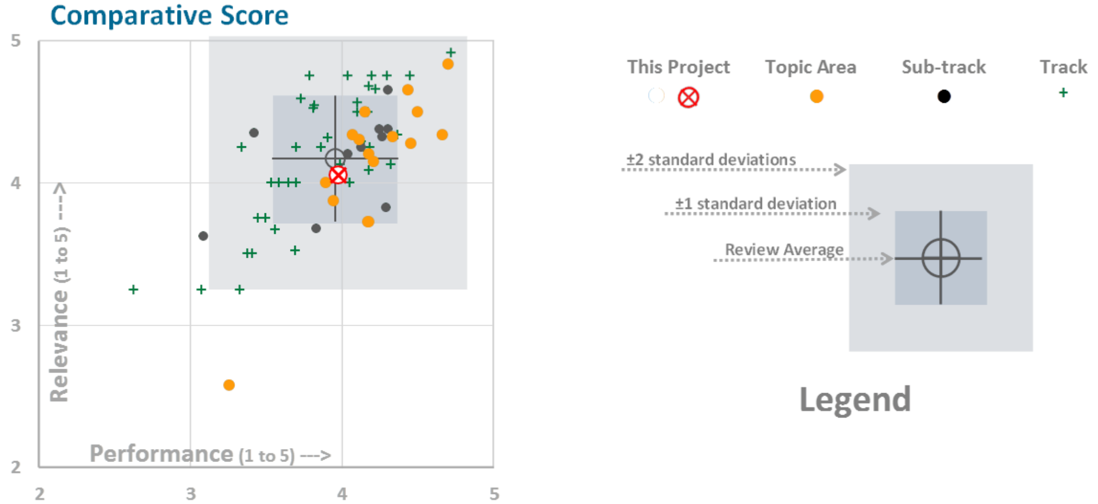
DOE	$ 0.0 M	0%
Cost Share	$ 0.0 M	100%
Total	**$ 0.0 M**	**100%**

Peer Review ID# 150

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 150)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- It is a likely assumption that devices would act as FADs (fish aggregating devices), similar to other natural and artificial structures
- Helpful to capture learning from existing literature on surrogate structures to find transferable conclusions for MHK devices
- Well aligned with objective of lowering permitting barriers
- Using surrogate structures may give answers that address concerns about MHK devices and reduce need for future study

Question 2: Methods and Approach

- Going beyond a lit review and holding guided discussions with subject matter specialists is a good approach
- Literature synthesis and targeted conversations were used

Question 3: Technical Accomplishments and Progress

- Well executed and presentations to leading experts at conferences and associations
- They examined negative effects of artificial reef structures
- Useful to address concerns prior to structure placement in the water

Question 4: Project Management

- Project was completed on time/on budget
- On spec and on time; Final report on Tethys and on OSTI (DOE Office of Scientific and Technical Information)
- Product is completed on time and within budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good distribution of these findings through peer review papers and conferences
- Fisheries Society meeting and federal working group via webinar
- Very good outreach to experts
- Included collaborators and subject matter experts
- Results were disseminated through presentations

Question 6: Proposed Future Research, if applicable

- Complete observations on existing devices/buoys in temperate waters
- No further research described. Before any additional detailed study, important to consult with wildlife permitting agencies to determine if agencies will accept the protocols and results as trustworthy for permitting decisions.
- NA (not applicable)
- Extend to studies in temperate waters by looking at existing navigational buoys or weather buoys

Question 7: Project Strengths

- Helpful to have information on surrogate structures organized and how transferable
- Well executed project with excellent collaboration and partners
- Outreach to topic area experts

Question 8: Project Weaknesses

- *None*

Question 9: Recommendations

- Assess what interactions/predation will likely occur around MHK devices over the long-term
- Recommend combining this project with an EMF (electromagnetic field)-focused project, assessing impacts of the FAD (the device) and EMF (from electrical cable extending from a device to the seafloor junction box)
- Important to present findings to the regulatory agencies to determine their receptivity to findings and what protocols are acceptable for monitoring at actual deployment site

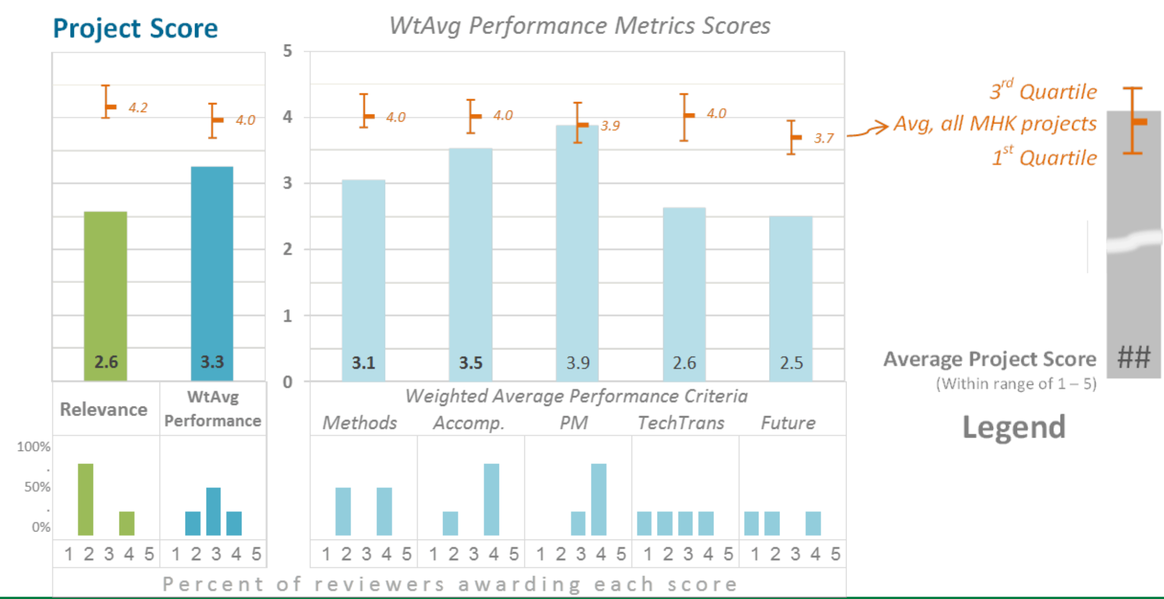
DOE Water Power Technologies Office 2017 Peer Review Project:
Current Ability to Assess Impacts of Electro Magnetic Fields Associated with MHK Technologies on Marine Fishes in Hawaii

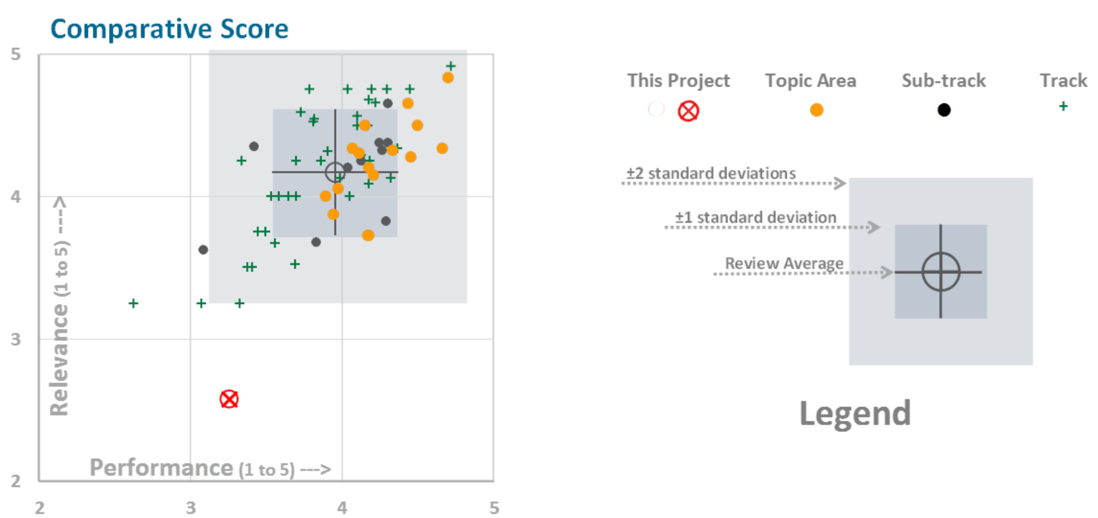
Principal Investigator	Jeremy Claisse, Vantuna Research Group
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 0.0 M
Cost Share	$ 0.0 M
Total	**$ 0.0 M**

Peer Review ID# 151





Comments made by reviewers during the evaluation of this project (PRID 151)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Sensitivity of EMF (electromagnetic field) from subsea cables have been documented to have limited impact to fish species, particularly when a cable has been buried
- There have been several literature review studies published by federal, state, and non-profit groups already
- DOE should have coordinated the component on lit search of other EMF sensitivity of marine fishes, potential impacts component with other EMF contracts
- While understanding EMF impacts will be important to lowering permitting barriers for large scale MHK arrays in HI, DOE WPTO cannot resolve issue alone
- Was this needed given previous EMF literature reviews?
- Gathering this information helps both industry and regulatory agencies to focus attention on the most sensitive species
- Literature based project to synthesize the current state of knowledge. Important to pull information together to make a good assessment. The identification of focal species is important.

Question 2: Methods and Approach

- There is very little new information developed from this project. Because of the MHK activity in Hawaii, the only true benefit is that this study focused on Hawaiian specific fish.
- The methodology is not feasible; to attempt to identify all potential species impacted and then study each species raises, not lowers, permitting barriers
- This $65K DOE investment seems to have limited value deliverable - a 5-year literature review update and a matrix of all HI species likely impacted by EMF
- Use of Potential Interaction Index seems like a good approach. This should make ranking transparent and systematic.
- A decision tree is one good method to help focus on significant species of concern
- Literature synthesis that included ranking of identified species and determined information gaps
- Used behavior to help elucidate which species are most vulnerable or should be studied further

Question 3: Technical Accomplishments and Progress

- Researchers identified that results will assist regulatory agencies and developers prioritize species that have a higher likelihood of being impacted by EMF - the main concern here is that it's not a high priority expressed by regulatory agencies (unlike acoustic impacts etc.)
- Study ID'd 99 HI region species likely to come into EMF zone contact; 11 with known EM (electromagnetic) sensitivity, assuming all shark, ray species are EM sensitive
- Identified the types of research that may be required for specific projects
- Reduced the list of potentially vulnerable species

Question 4: Project Management

- Project on time/on budget
- Product delivered on time and to specifications, but no visibility into quality of work
- On time, on budget
- Project is completed. Was on time and within budget.

Question 5: Research Integration, Collaboration, and Technology Transfer

- Future studies may want to assess EMF from field deployed devices instead of conducting yet another literature review
- CD! DOE needs to reframe approach; view EMF issues in context of int'l electricity grid w many subsea cables; mine info from Europe, NZ, Japan, etc.
- CD! DOE needs to work w other regulatory agencies to pull subsea cable project env monitoring data to understand EMF data not published
- Duplication among DOE projects on "synthesis literature review" on EMF impacts (see Florida projects)
- No collaboration outside group
- Report is published and available in several locations

Comments made by reviewers during the evaluation of this project (PRID 151)

Question 6: Proposed Future Research, if applicable

- Work with regulatory agencies to understand what specific concerns might be and build site-specific projects to test large array impacts
- Ranking of recommended future research is key given large data gaps in this area
- No further research

Question 7: Project Strengths

- Project built on prior 2011 Normandeau EMF literature review co-funded by BOEM (Bureau of Ocean Energy Management)
- Project results published and available to MHK community and potential HI MHK project developers
- Good synthesis of information and recommendations for future studies

Question 8: Project Weaknesses

- There have been multiple EMF lit reviews. It doesn't appear that this review provides any new/additional data to the discussion.
- CD! Underlying research plan on EMFs is cost prohibitive; calls for identification of all potentially impacted species in region, and research on each

Question 9: Recommendations

- !CD - Need more coordinated, pragmatic EMF permitting strategy that focuses on true scale of problem and realistic project conditions actual likely EMF; (1) what is Best Available Technology for EMF shielding in subsea cables likely to be used on projects + costs of incremental shielding?; (2) given the remaining EMF emissions, conduct specific species study on likely large array MHK site
- Adopt a 2 prong approach: (1) what is Best Available Technology for EMF shielding in subsea cables likely to be used on projects + costs of incremental shielding?; (2) given the likely EMF emissions of small, medium, and large array, what are impacts on species found at likely MHK project site?
- Reframe the EMF issue to collaborate w stakeholders in Electricity Grid subsea cable community

DOE Water Power Technologies Office 2017 Peer Review Project:
Automatic Optical Detection and Classification of Marine Animals around MHK Converters using Machine Vision

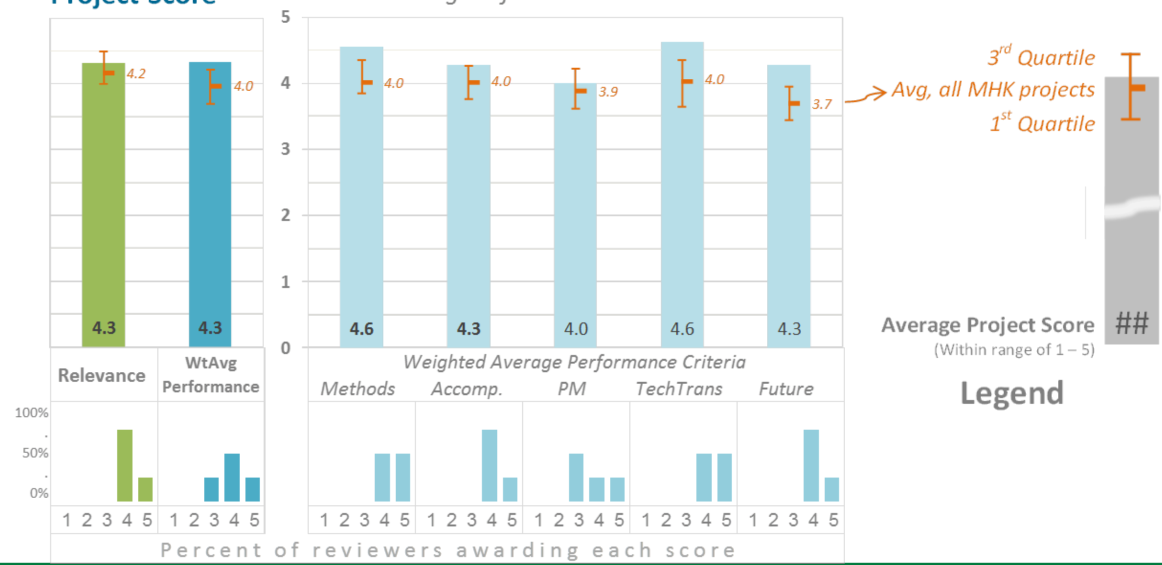
Principal Investigator	Steven Brunton, University of Washington
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

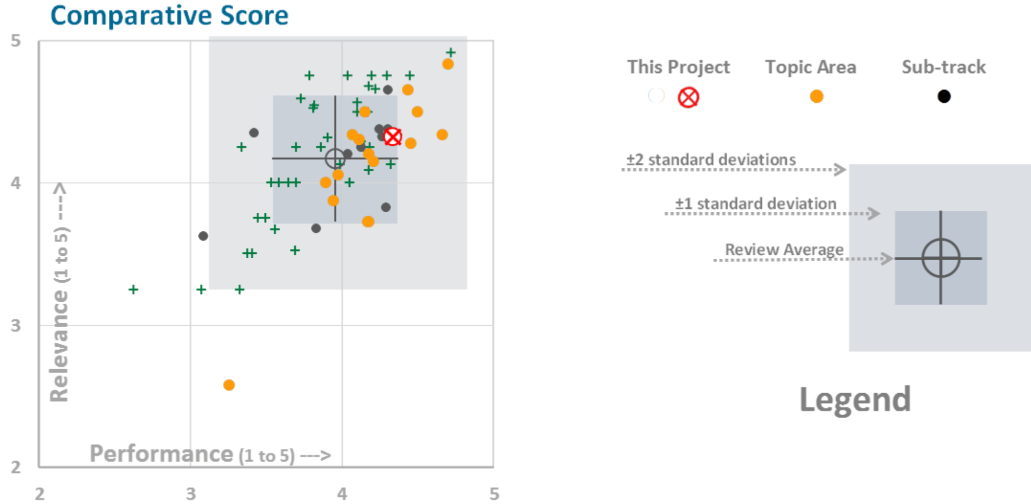
DOE	$ 0.2 M	91%
Cost Share	$ 0.0 M	9%
Total	**$ 0.3 M**	**100%**

Peer Review ID# 166

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 166)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- To maximize each stage of data collection, researchers will be able to dedicate more resources on post-data processing
- While a fish-related project, big data collection is an issue across multiple resource areas related to MHK environmental monitoring
- BP! Excellent project concept to utilize centers of excellence in different fields to advance technology available for key environmental monitoring
- BP! Excellent project critical to objective of collecting and analyzing metadata data from environmental impact studies at lower cost
- Data processing is a big challenge to reduce costs of monitoring
- This is a great area to address as it has a lot of other applications for any video environmental data

Question 2: Methods and Approach

- An exciting approach incorporating "other" computer technology to develop this machine learning and data scrubbing
- Excellent plan to develop open source software that will enable improvements in future and collaborator App development
- Excellent project design to include computer science/machine learning and data scrubbing experts to design and develop new "FishBook" Tool
- Use of available machine learning algorithms and applying them to fish is a great approach as it builds on readily available techniques
- Great approach to processing the data with a focus on the important factors

Question 3: Technical Accomplishments and Progress

- As the industry advances and studies focused on assessing environmental impacts on resources (such as fisheries) become accepted, transitioning this software for other big data collection efforts will be essential
- Development of an open source software for future investigators to utilize
- The integration of the technology in monitoring marine mammal behavior around devices will significantly support the permitting process in this area
- Outstanding productivity with DOE WPTO investment of app $250K to produce important software platform and recognition filters
- Product, if successfully deployed, will enable considerable permitting cost reduction through automation of marine animal interaction monitoring and ID
- Good results thus far

Question 4: Project Management

- Project milestones have been met on time/on budget
- Impressive collaborative team with strong project management and implementation
- Some delay at end to finish write up
- Milestones met on time though the project is still ongoing
- On budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good team of academia and private consulting
- Information is being distributed through multiple peer review papers
- Software is available via open source
- Excellent use of senior experts while involving gifted students; helps to attract top talent to MHK sector
- Great mix of disciplines (environmental, computer science, and MHK development center data)
- Good spread and collaboration between lab, academia and env consulting company
- Good that biologists were included
- Good that it is open source and shareable
- Publication products are excellent

Comments made by reviewers during the evaluation of this project (PRID 166)

Question 6: Proposed Future Research, if applicable

- While the potential impacts to fish species are being addressed with optical technology included in this study, more importantly, this technology can also be applied to underwater monitoring of marine mammals and their interaction with a MHK device
- BP! Develop technology tools to address the "Data Mortgage" problem
- Suggest DOE WPTO arrange presentation of project results to wildlife regulatory agencies to assure agencies will accept project product data as trustworthy in permitting decisions
- Moving this towards real time seems key to some MHK deployments
- Concern that this is the best use of limited resources when technologies are still under development
- Extend to real-time is important

Question 7: Project Strengths

- Excellent project design and implementation producing very impressive results
- BP! Providing the software as open source AND providing the dataset that has been validated is crucial to moving this field forward. Well done.

Question 8: Project Weaknesses

- *none*

Question 9: Recommendations

- Present results to regulatory agencies to assure that they will accept as reliable technology and accept data in permitting decisions
- Don't throw away the negative data or when nothing was observed, this can be valuable

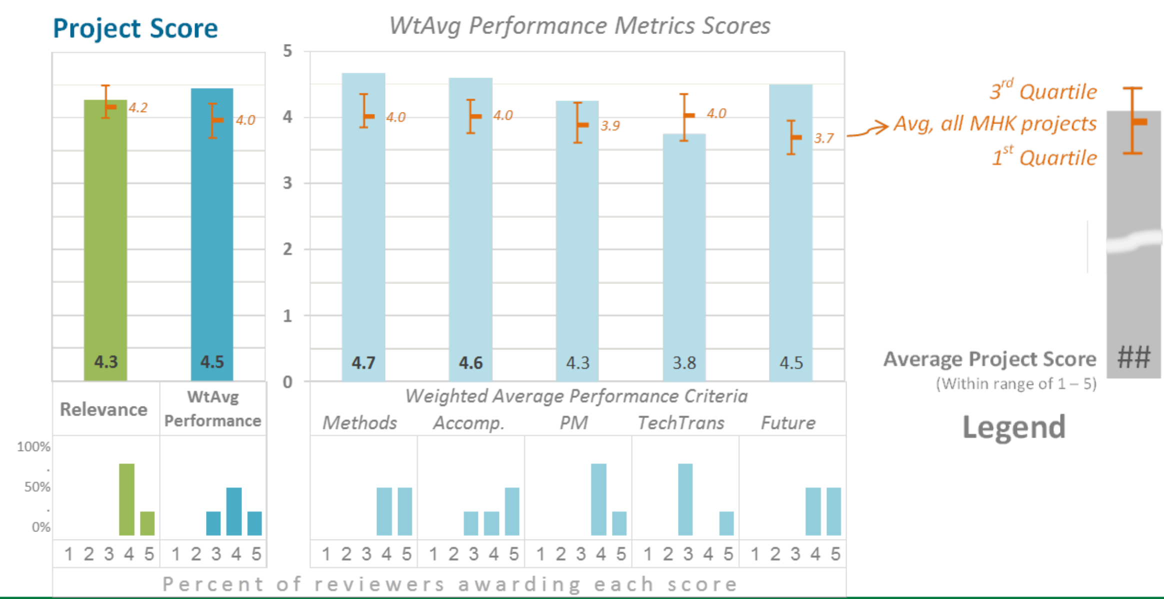
DOE Water Power Technologies Office 2017 Peer Review Project:
Unobtrusive Multi-static Serial LiDAR Imager (UMSLI) for Wide-area Surveillance and Identification of Marine Life at MHK Installations

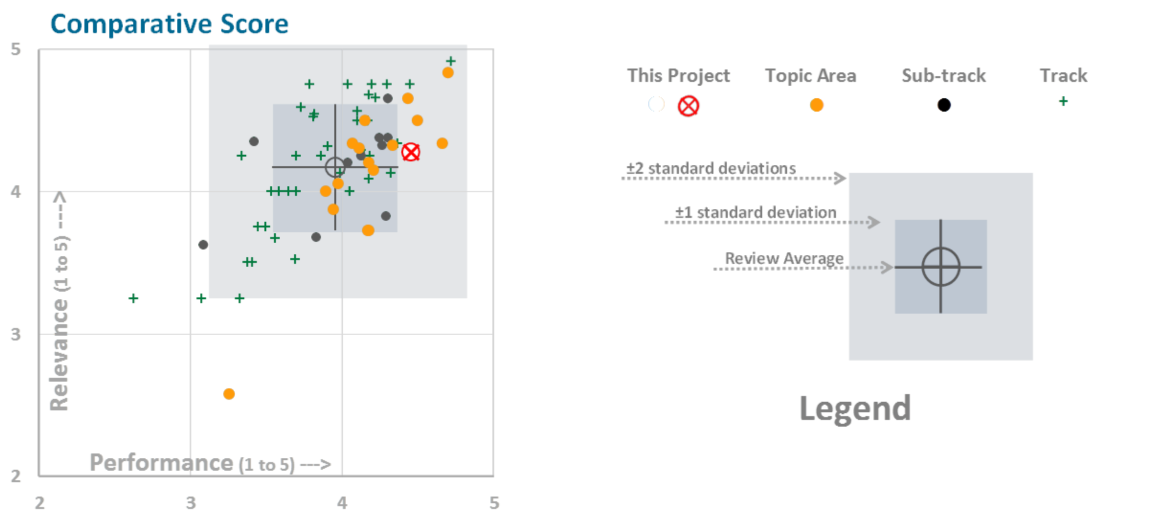
Principal Investigator	Gabriel Alsenas, Florida Atlantic University Board of Trustees
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 0.5 M	93%
Cost Share	$ 0.0 M	7%
Total	**$ 0.5 M**	**100%**

Peer Review ID# 168





Comments made by reviewers during the evaluation of this project (PRID 168)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Building off technology originally developed for the Navy
- Utilizing existing technology as a "new" or novel approach
- Project to develop precommercial hardware/software tool demonstrated in field and lab conditions, which, if successfully commercialized, could reduce environmental monitoring costs for site development, licensing, and monitoring is consistent with WPTO goal of removing permitting barriers
- Finding good ways to monitor animal interactions is important to address the questions raised by regulators

Question 2: Methods and Approach

- Machine learning, software reduces the overall output data volume
- BP! Strong collaborative approach to develop project protocols through consultation with regulatory agencies to secure regulator buy in to project approach
- Project carefully used Human Maximum Permissible Exposure for radar beam used as most protective level (fully protective of marine life)
- Strong inter-disciplinary team included fish and marine mammal experts to help with tagging of data to assure accurate identification
- Strong collaborative approach to use DOD (U.S. Department of Defense) technology as foundation for research
- Seems an innovative approach, although range restricted
- The fact that the lidar does not collect data when nothing is there is a large benefit in data storage
- A novel approach for monitoring the area

Question 3: Technical Accomplishments and Progress

- Regulatory-supported marine life eye-safe monitoring system - this impact/lack of impact should be validated in the field
- Short integration times and adaptive mode enables long-range, high resolution imagery - making it an effective and accurate technology
- LiDar plus shape-based classifier software using 3D Taxidermy models enables faster, more efficient data collection at project site, with capacity to detect animals up to 10–12 meters out from device
- Good progress, especially given the novelty of the instrumentation
- Good progress with a high match rate
- The system has a lot of promise as a better technique than current sonar methods

Question 4: Project Management

- Project managed well
- Well-run, successful project
- Slight delays but seems good
- Milestones and tasks were on time
- Project is on budget
- Project was extended to allow for field tests

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good engineering team, but there is a lack of fisheries biologists identified on the team
- Good collaboration with Battelle Memorial Institute during project development to ensure compatibility with commercial tech transfer at project conclusion) (anticipated open source software; hardware status unclear)
- Good use of prior DOD R&D of mine scanning hardware/software system
- Classifier will be open source, but not clear on the hardware? Is it to be a commercial product?
- Good collaboration with another academic unit and Battelle
- The project has some partners
- Two presentations and one paper

Comments made by reviewers during the evaluation of this project (PRID 168)

Question 6: Proposed Future Research, if applicable

- Looking to refine the technology's efficiency while reducing production costs
- Completion of FY17 research essential to evaluate project deliverable and determine whether regulatory agencies will accept the results
- If regulators indicate that they accept the technology and data produced as trustworthy information upon which they can rely in permitting decisions, makes sense to proceed with proposed future research
- While this project has been well developed, there is a separate, overarching question whether there is a need to develop multiple, parallel Creature Peeper technology with most advanced possible recognition gear; is this entire instrumentation sector receiving an over-weighted WPTO fund allocation?
- Field testing evaluation will be crucial to the final evaluation of the system. How well does it perform in high energy sites?
- Additional work is optimization and validation. The project seems well worth continued funding.

Question 7: Project Strengths

- Cost effective - Applying existing technology, traditionally used above-sea, in an underwater environment
- Very well designed and executed with impressive project team

Question 8: Project Weaknesses

- Does the project rely upon a technology that simply can't win with the regulatory agencies in fish and wildlife impacts? This must be clarified before further investments.
- Experience indicates that even though most protective standards for lasers have been adopted, wildlife permitting agencies will very likely raise concerns on basis that there is no conclusive data on protective levels needed for all marine species
- Detection ranges are likely to be ~10 m so will be a potential alternative to visual photo techniques, but not others

Question 9: Recommendations

- Detailed consultation with regulatory agencies of concern should be undertaken before any further funding to confirm that agencies will allow technology to be deployed in current proposed configuration and will accept data analysis as reliable indicator of marine species on project site

DOE Water Power Technologies Office 2017 Peer Review Project:

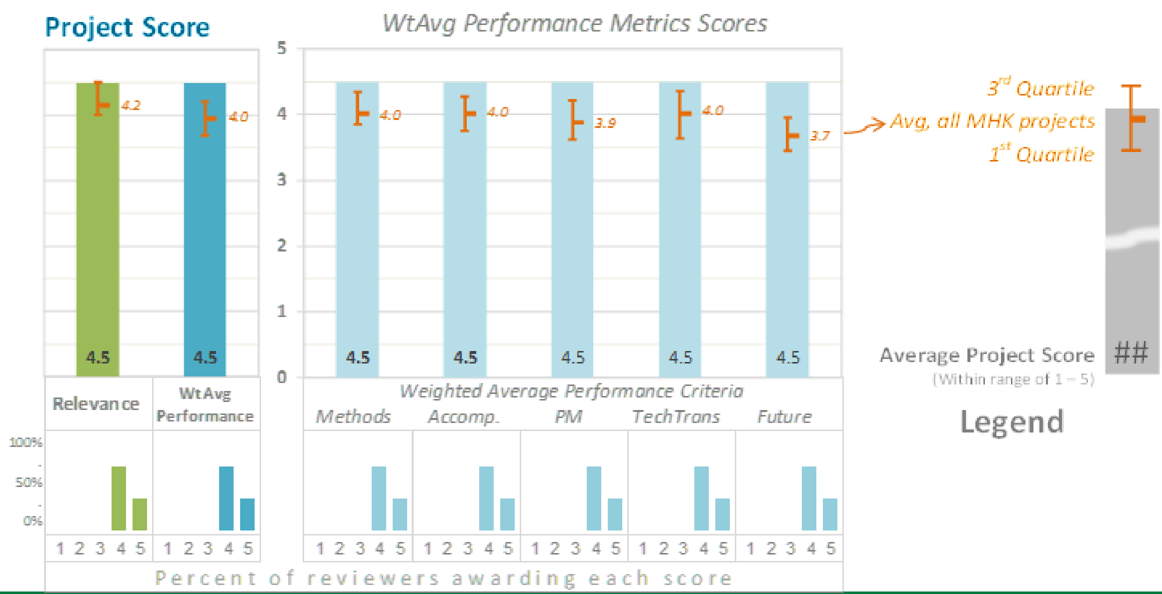
An Intelligent Adaptable Monitoring Package for Marine Renewable Energy

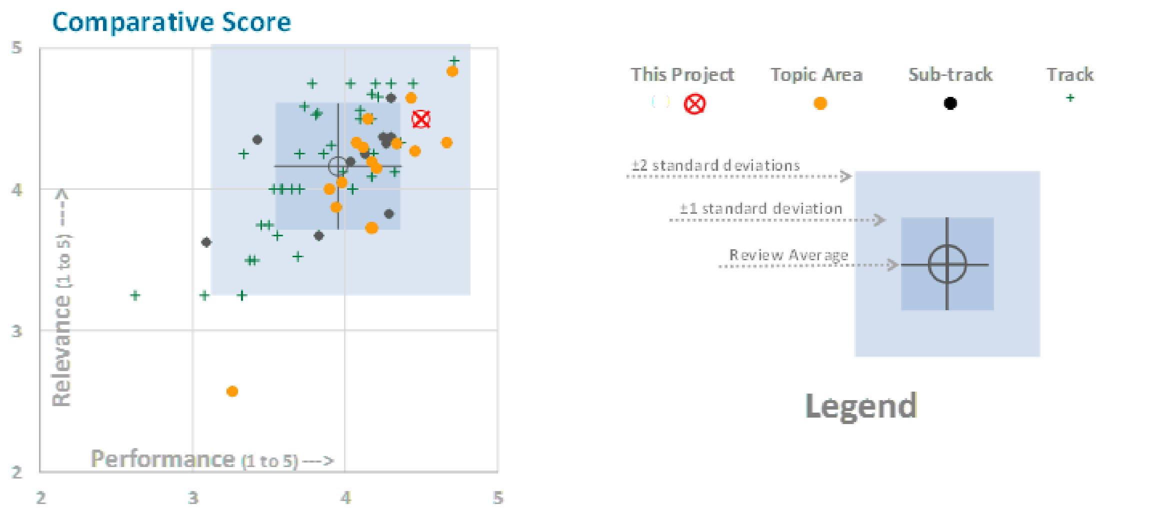
Principal Investigator	Brian Polagye, University of Washington
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

DOE	$ 1.0 M	94%
Cost Share	$ 0.1 M	6%
Total	**$ 1.1 M**	**100%**

Peer Review ID# 169





Comments made by reviewers during the evaluation of this project (PRID 169)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Development of a system with multiple sensors
- Adaptable Monitoring Package needed to lower costs of project development environmental costs
- An integrated monitoring device would be of great value for evaluating projects in early stages
- Not sure this is a high priority focus for the program

Question 2: Methods and Approach

- An excellent approach of recording data when there is something to actually record, thereby limiting the amount of data gathered
- Excellent project design features assembling a team of collaborators from different disciplines to advance the system and field test same
- Excellent project design to work with EMEC (European Marine Energy Center) and trade software with EU on its Monitoring Package
- Excellent work to leverage other funding sources and student support from NSF (National Science Foundation) Graduate Research Fellowship
- Solid approach for collecting the most relevant observations

Question 3: Technical Accomplishments and Progress

- Deployment of the equipment in the field for four months
- Detection of a fish tag out to 100 meters
- Successful integration of project monitoring instrumentation for comprehensive monitoring in both cabled and autonomous deployment modes
- Have gotten some good results

Question 4: Project Management

- A positive combination of funding between Navy and the DOE
- Project on time/on budget
- Excellent project design, collaboration and implementation to achieve a concrete result helpful to lowering barriers to permitting for MHK projects
- On budget and good use of partnering
- Some challenges with technology as would be expected with any new technologies

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good combination of academic, national lab and private industry working together
- Excellent academic collaboration with developers, but next round of funding may want to assure the IP (intellectual property) developed by the funding on instrumentation side will have a future commercialization plan to assure it won't be stranded with end of funding
- Actively sharing results
- Solid group of collaborators

Question 6: Proposed Future Research, if applicable

- Makes sense to further refine technology, but important to encourage plan to commercialize the technology
- Project is being continued
- Working towards data classification in real-time

Question 7: Project Strengths

- Excellent design and implementation with strong research personnel

Question 8: Project Weaknesses

- Not clear if DOD (U.S. Department of Defense) or private sector has already developed similar technology resulting in duplication of effort

Question 9: Recommendations

- Encourage commercialization plan for the technology, whether through private sector partnerships in next phases of research or otherwise
- DOE should facilitate outreach to DOD to determine whether there is duplication of effort on certain aspects of the project, or whether certain project technology could be used for multiple purposes

DOE Water Power Technologies Office 2017 Peer Review Project:
FY16 FOA Awards: Innovation, Testing and Validation of MHK Environmental Monitoring Instrumentation

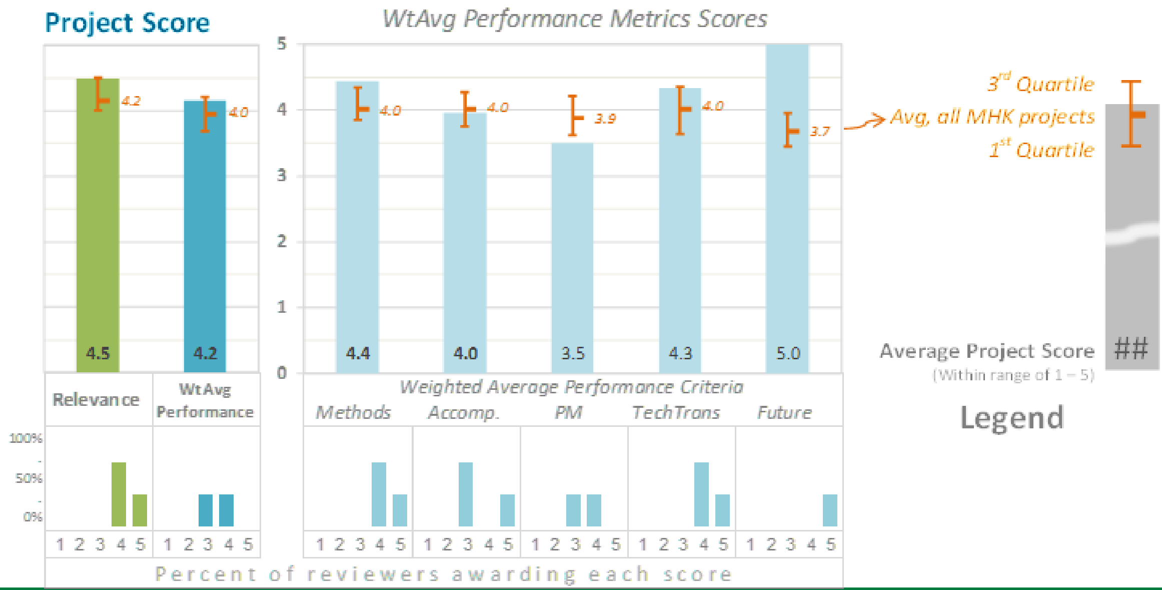
Principal Investigator	Samantha Eaves, DOE
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Environmental

FY 2014-FY 2016 Funding

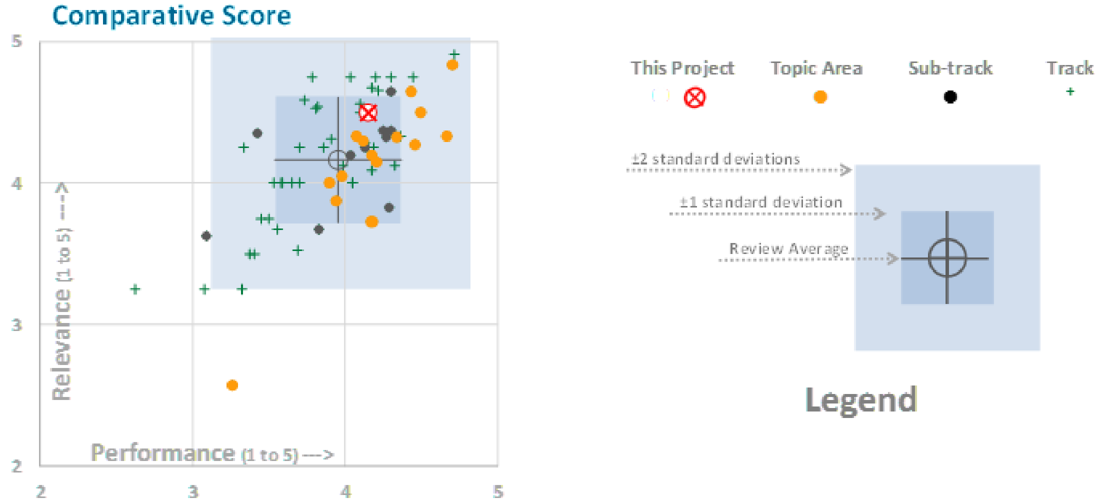
DOE	$ 0.0 M
Cost Share	$ 0.0 M
Total	**$ 0.0 M**

Peer Review ID# 198

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 198)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Development of cost-effective environmental monitoring devices to assess the potential environmental impacts of MHK devices is essential. Collection of this data is currently time-consuming and costly.
- Drawback is that the project framework does not address the entire commercialization plan; Who will build and sell these units?
- Goal is to get sufficient data for the regulators to accept prompt permitting of small scale devices; in turn this justifies DOE funding for multiple iterations of different instrumentation to gather similar marine animal interaction data
- The development of instrumentation and testing methods to gather and validate data requested by regulatory permitting agencies is essential to lower the permit barriers for MHK
- Not sure if this is the best use of limited funds, unless the project is critical for getting MHK closer to viable technologies
- The FOA topics are relevant to collecting information useful to regulatory agencies

Question 2: Methods and Approach

- A well-developed approach with a built in Go/No-Go gate process during each year of funding
- BP! DOE required project managers contribute 20% cost share, creating strong project manager investment in successful outcome of the project
- BP! DOE encouraged projects to hold a specific consultation w regulatory agencies to assure that the project development tracks regulator's requests
- Instrumentation projects overall are well designed and implemented
- The projects chosen are relevant to meeting the questions raised by regulatory agencies

Question 3: Technical Accomplishments and Progress

- It is unclear if these awards are to support science and the greater understanding of environmental impacts of MHK devices, or if they are being developed to provide cost-effective techniques for MHK developers to utilize during the permitting process
- The majority of these projects are well-developed and will potentially assist with supporting the regulatory/permitting process in the future. However, it is uncertain as to what benefit the Benthic Habitat Mapping and EMF (electromagnetic field) studies will provide with regards to supporting the permitting/regulatory needs or how they will benefit the MHK industry, specifically.
- Each instrumentation project, viewed in isolation, is well designed and implemented and has achieved good technical progress
- Excellent technology development to automate data gathering on marine mammal interaction at much lower cost
- Viewed collectively, the entire project funding category raises question of whether duplicative technologies can be justified, and whether DOE needs to bring to each technology to full commercialization status
- The effort just started

Question 4: Project Management

- Viewed collectively, the entire project funding category raises question of whether duplicative technologies can be justified, and whether DOE needs to bring to each technology to full commercialization status
- The projects just started

Question 5: Research Integration, Collaboration, and Technology Transfer

- There is a strong cross section of academic and private industry awarded
- BP! Strong DOE collaboration to develop the innovation focus, based upon DOE workshop 3 years ago with regulatory agencies to identify the information they would need to resolve permitting and to ID where a gap or lack in instrumentation existed
- Projects ideally would have had more participation by private sector companies with expertise and potential to manufacture the instrument developed
- Not sure this is appropriate to evaluate since it is a collection of efforts

Comments made by reviewers during the evaluation of this project (PRID 198)

Question 6: Proposed Future Research, if applicable

- Projects are scheduled to start in Jan 2017
- Careful consultation with regulators to determine whether they accept the instrumentation data and analysis is needed before further investment can be justified in the technology
- Consider requiring a commercialization plan as part of any further funding to assure technology developed is not stranded
- New projects that are not ready for identifying future research needs

Question 7: Project Strengths

- Projects overall well designed and executed with specific goal of developing multiple iterations of technical data solutions and analysis

Question 8: Project Weaknesses

- Can ongoing funding to each successful technology be justified, given duplication of technology purposes
- DOE should require commercialization plans to assure projects will not be stranded

Question 9: Recommendations

- If presenting a FOA that will help support reduce the cost of the permitting process, applicants for the funding should relate how their project relates to the permit process. What is the need and how will their project fulfil this need?
- Before funding further research on any of the instrumentation, DOE WPTO should require the researchers to submit a strong commercialization plan that demonstrates how the technology will be commercialized and made available to the MHK community

7.4.2 MHK-2A : Market and Industry Development, Analysis, and Data Dissemination

DOE Water Power Technologies Office 2017 Peer Review Project:

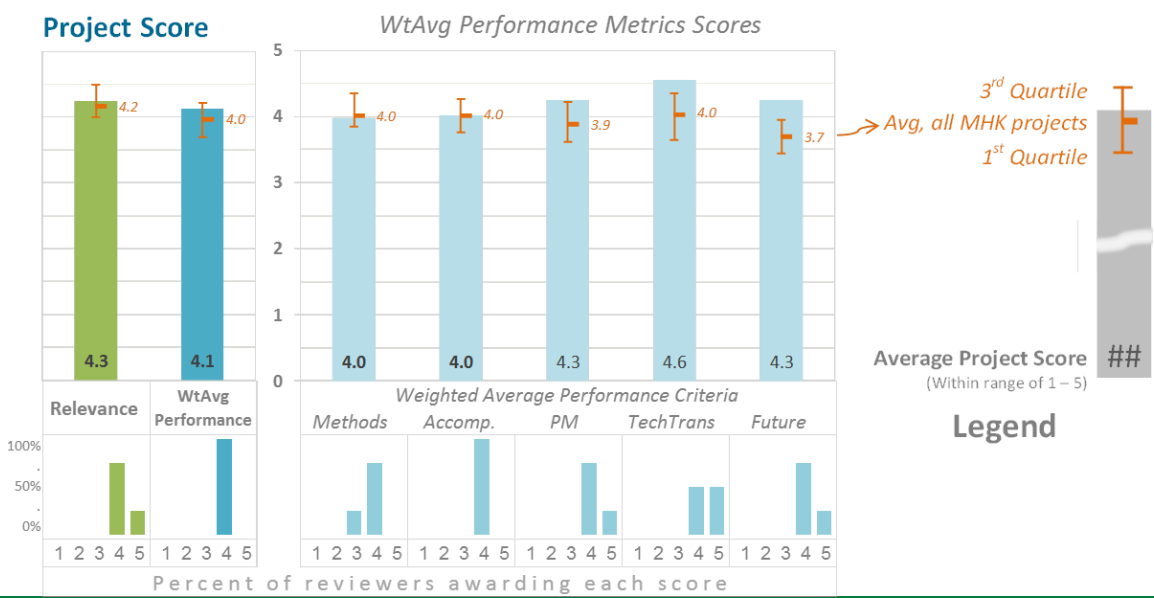
MHK Levelized Cost of Energy (LCOE) Analysis

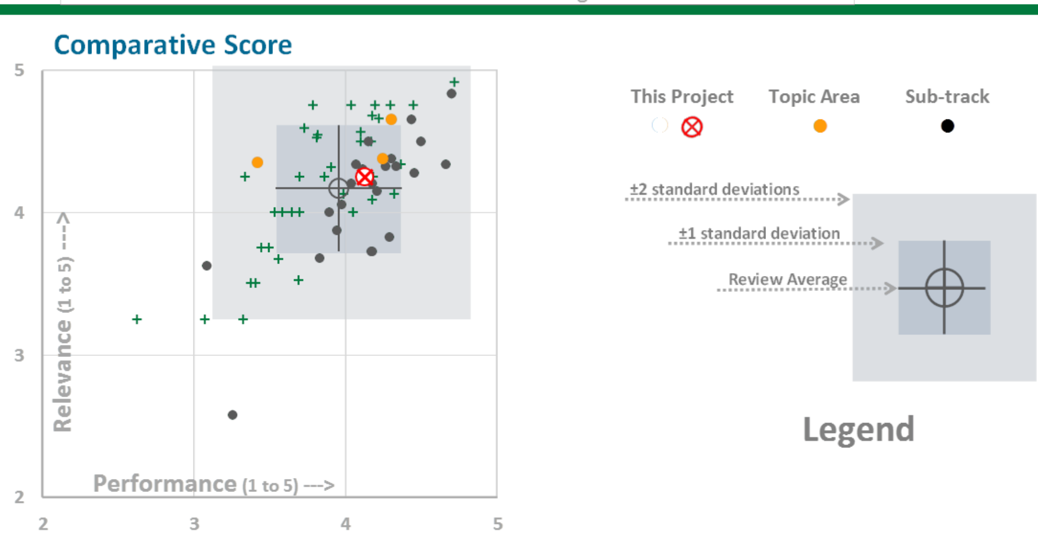
Principal Investigator	Rick Driscoll, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Market, and Industry Development, Analysis, and Data Dissemination

FY 2014-FY 2016 Funding

DOE	$ 1.0 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 1.0 M**	**100%**

Peer Review ID# 11





Comments made by reviewers during the evaluation of this project (PRID 11)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- There is a multi-facet approach to the project that benefits the Program overall and will enable the Program to focus on specifics to reduce the LCOE of MHK
- MHK LCOE analysis is critical to WPTO goals on Market Development, but restriction of detailed analysis to wave only ignores tidal/current as nearest to market technology
- NREL study detailed focus on WEC (wave energy converter) is well executed, but study design was incomplete, failing to address nearest-to-market technology, tidal/current technology
- Without a common and agreed upon economic metric, it's impossible to compare different technologies, so this is crucial to DOE objectives
- Concern that it may be too early in development to have meaning. Technology designs are not well established.
- Important project for advancing MHK

Question 2: Methods and Approach

- BP! Excellent NREL project study design uses established LCOE methodology for geothermal, wind sector LCOE analysis methods, enabling comparisons
- BP! Excellent project approach engaged with international as well as domestic partners to obtain most comprehensive, current technology cost information
- BP! Excellent to focus on non-grid applications (desalinization; mini-grids), given urgent need for clean drinking water technology/military expeditionary power sources and minigrid remote energy sources in both US and global markets
- CD! Method/Approach that prioritized wave over current technology failed to hit the priority near-to-market technology, ready to deploy in distributed generation scenarios on cost competitive basis
- Seems appropriate
- Used experience from other sectors to develop the LCOE framework

Question 3: Technical Accomplishments and Progress

- Provided a road map of LCOE costs over the next 20 years
- Excellent to complete 1st phase WEC LCOE analysis
- Summary and Presentation should have included more cogent presentation of conclusion on scale/timeline for likely WEC technology LCOE cost reductions for grid and non-grid applications
- Good progress with a wide variety of technologies
- Successful collection of information and looking at all aspects including synergy with desalination plants

Question 4: Project Management

- Project on time/on budget
- Excellent use of experienced personnel and prior LCOE models; excellent collaboration to obtain data and best practices in LCOE analysis methodology
- Project is on time and within budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- A strong partnership between multiple labs and private industry
- LCOE is available via an open source website
- !BP Excellent research collaboration to tap both domestic and international centers of LCOE expertise to use best methodology and industry cost data
- Good collaboration between labs and reached out to developers
- Interacting with other National Laboratories
- Positive feedback from industry
- Reached out to appropriate parties to develop the LCOE framework

Comments made by reviewers during the evaluation of this project (PRID 11)

Question 6: Proposed Future Research, if applicable

- Stakeholder outreach to investors as the technology develops
- Highest value future research for both WEC and current technologies is LCOE for off-grid applications as proposed in Presentation, including remote rural communities and military expeditionary applications
- Immediate future research priority should focus on completing equivalent studies for closer -to-market current tidal/current technology
- The Project proposal for additional refinement research should await actual deployment of devices and related energy production data
- Ongoing improvements of metric
- Appropriate next steps are identified

Question 7: Project Strengths

- Built on prior national labs LCOE analysis work on wind, geothermal sectors, and included strong collaboration with international experts and data sources
- Working with other labs and reaching out to developers to get their input/feedback/buy in

Question 8: Project Weaknesses

- Priority for detailed assessment was mis-assigned to WEC technology, over tidal/current technology

Question 9: Recommendations

- Essential to clearly communicate MHK LCOE results in historical context of other RE (renewable energy) technology historical cost reductions, to explain/justify why MHK can be viable mid-term RE technology for grid and alternative electricity sources, and to explain/prioritize R&D needed to lower costs
- Prioritize current work described in Presentation to "Work with DOE to develop graphics representing LCOE trends and R&D impact"
- Proceed ASAP with detailed LCOE analysis on current (tidal, river, mono) technology to develop equivalent data to WEC analysis generated by this study. MHK current technology is closer to full commercialization and should be prioritized for work to lower manufacturing/production costs for all MHK technologies.
- This is for the longer term, but reaching out to investors to make sure they are in agreement with the metric and that it also meets their needs for making investment decisions, would be a good thing to do

DOE Water Power Technologies Office 2017 Peer Review Project:

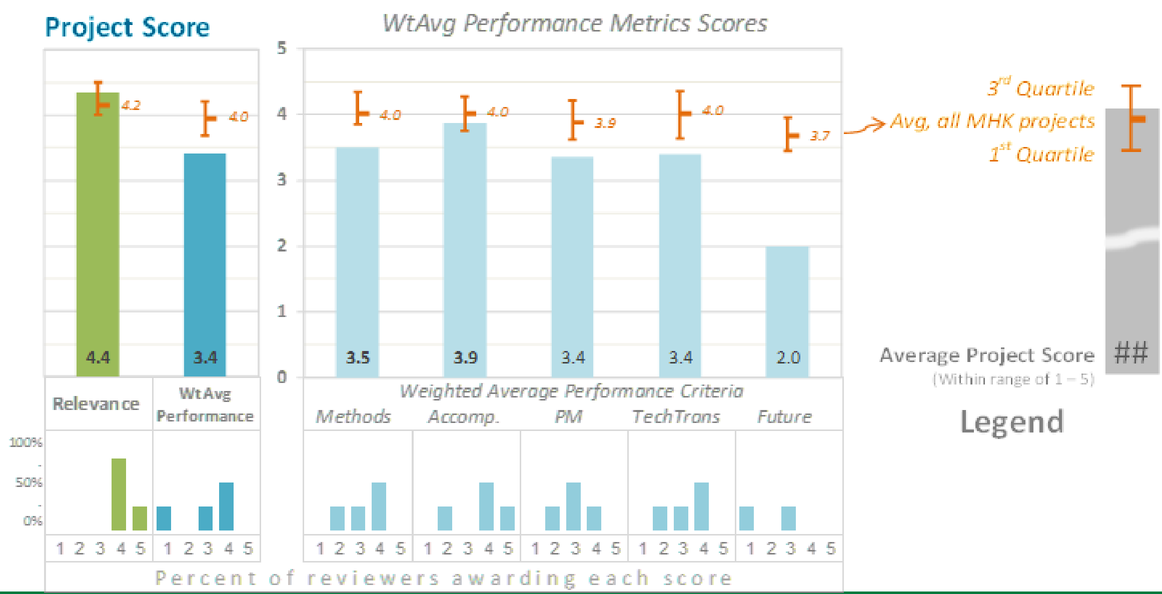
MHK Manufacturing and Supply Chain Needs Assessment

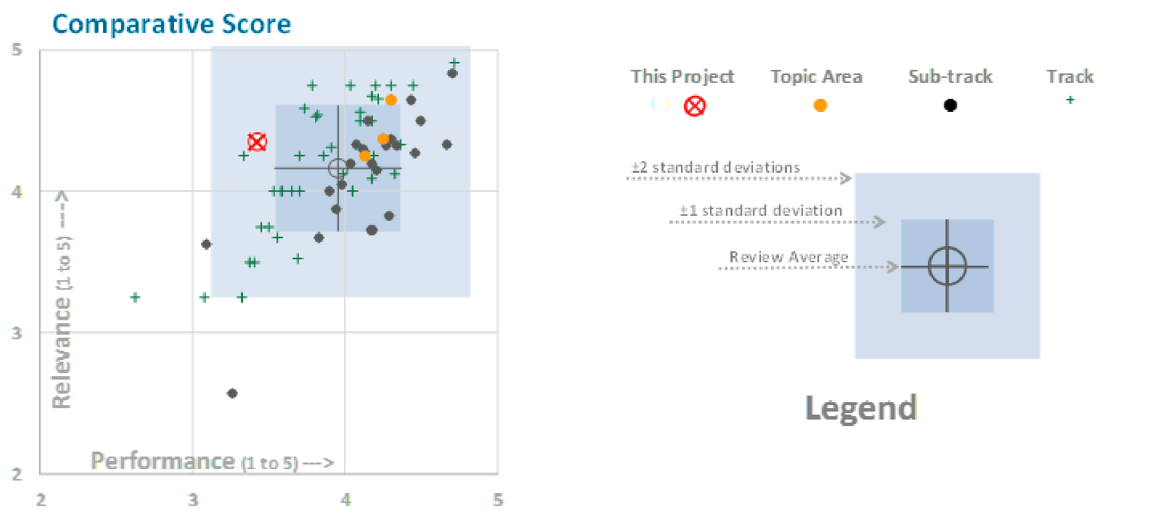
Principal Investigator	Jason Cotrell, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Market, and Industry Development, Analysis, and Data Dissemination

FY 2014-FY 2016 Funding

DOE	$ 0.0 M
Cost Share	$ 0.0 M
Total	**$ 0.0 M**

Peer Review ID# 70





Comments made by reviewers during the evaluation of this project (PRID 70)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- An assessment on how the MHK industry will increase job growth potential. Incorporates all phases of a project deployment from R&D to Decommissioning.
- NREL study is good first step analysis to identify MHK supply chain gaps, needs, weaknesses and to identify market opportunities in MHK development
- Project critical to DOE WPTO objective of responding to strong input of MHK community and 2014 reviewer comments that work to lower LCOE (levelized cost of energy) for MHK would be helpful, so long as not overly burdensome
- Important for the industry to understand the challenges
- May not be the best area to put resources at this point. Wait until viable technology designs are determined.

Question 2: Methods and Approach

- A well-designed background investigation and outreach approach, understanding who would be involved with the entire supply chain
- CD! Consultation with only 5 WEC (wave energy converter) manufacturers/fabricators/assemblers and 4 assembly/installation firms gives low confidence that study has captured accurate portrait of US manufacturing and marine deployment firms capable of servicing supply chain needs of MHK community; Analysis fails to address whether "gap" is lack of US capacity or lack of interest among established and fully capable U.S. firms
- CD! Decision to select Wave Energy Converter to study, as opposed to the more near-term current/tidal sector, ignores more near-term technology that could be used to better assess actual US firm capacities
- CD! Project approach for Wave technology was well executed, but the project price tag should have enabled review of current/tidal technology supply chain issues; this analysis is critical given significantly different market barriers on manufacturing supply chain and riverine/nearshore/deepwater deployment locations
- CD! The project design produced a "get ready", first phase, high level, academic scoping analysis of the market supply chain for wave technology, but more extensive analysis, data and overview conclusions should have been produced given the $270K price tag
- Next phase of work must include other federal and key state and industry innovation hubs who have detailed information on the regional manufacturing and marine deployment supply chain participants as well as those established participants to accelerate commercialization potential for all participants
- This first phase study merely sets the table for the needed collaborative work in the innovation ecosystem to accurately characterize and engage commercialization supply chain participants for both wave and current technologies
- Combination of lit review and stakeholder interview
- Not sure that down-selecting to WEC is the right approach. Even if there are few CEC (current-energy capture) companies, wouldn't it be likely that foreign CEC companies would lead to local manufacturing jobs as well?
- Review of existing material and interviews were good as well as actual site visits

Question 3: Technical Accomplishments and Progress

- Identified weaknesses in the current supply chain and which components could be strengthened to increase job potential
- Overall, an extensive supply chain in the United States identified
- Recognizing the strength of the transportation system (i.e., rail) may in the long-term, open untapped, potential manufacturing in the mid-west United States
- CD! Study conclusion that a supply chain gap exists because MHK manufacturers only interested in domestic demand for product significantly underestimates the global perspective and capacities of many large and even medium size manufacturers who evaluate revenue potential on global market basis
- CD! Study underestimates potential of U.S. large and SME to meet supply chain demands of MHK because it failed to leverage existing centers of expertise on supply chain strengths and regional manufacturing and marine deployment
- Feedback from manufacturers confirms that DOE can play an essential role to connect WEC developers to supply chain expertise

Comments made by reviewers during the evaluation of this project (PRID 70)

- Presentation noted that $1USDOE investment required to match up to $5 USD or more private investment to get product to commercial manufacture emphasizes that this supply chain analysis and focus on final stages of commercialization MUST develop close working partnership with private sectors and states where technologies will be deployed and manufactured
- Project produced a Door Opener study on the opportunities and challenges for supply chain to support MHK technologies
- Best rail/freight system to transport from lower cost to higher cost locations for manufacturing
- Brought together good insights to the supply chain that would be useful to industry and corrects misconceptions
- Many advantages of the U.S. supply chain were identified
- Project is complete

Question 4: Project Management

- Project on time/on budget
- CD! Project management should have produced more extensive project scope of work and more detailed results; supply chain assessments cannot be accurately painted by national labs working in isolation
- Some minor delays
- Project delivered on time and on budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- Outreach to only 5 WEC manufacturers/developers, 4 assembly/installation firms, and 3 advocacy/university research centers for total of 12 external contacts is severely deficient collaboration in a market supply chain study
- Study failed to identify the need to lock into the federal, state, and regional economic development centers developed for the specific purpose of strengthening supply chains and bringing near-to-market technologies to full commercialization
- USDOE WPTO needs to focus on "transfer" in Technology Transfer by developing collaboration partners who can now lean in to support developer commercialization of USDOE's excellent technology development investments
- Outreach to stakeholders is excellent, but no other collaboration which is a downside
- Interviewed the relevant companies

Question 6: Proposed Future Research, if applicable

- NA (not applicable) - Project completed
- Next step is to use this high-level academic study to build a collaborative network to (1) inform federal, state, and regional centers of expertise in manufacturing/marine deployment supply chains about USDOE investments and resulting technology; and (2) provide the "missing link" between MHK developers and manufacturing/marine and riverine deployment supply chain as well as financing sources
- No further desktop research is currently needed
- Ran out of time to discuss next steps
- None proposed

Question 7: Project Strengths

- Study provides an overview of the wave technology supply chain and marine deployment issues enabling WPTO to design future tech transfer collaboration

Question 8: Project Weaknesses

- Not much value for money

Question 9: Recommendations

- BP! Project results emphasize need for USDOE WPTO to shift focus in final commercialization stages from purely siloed technology R&D research to collaborative work within innovation ecosystem to "connect the dots," empowering existing federal, state, private sector and NGO (non-governmental organization) partners to understand and act on potential market opportunities in MHK

DOE Water Power Technologies Office 2017 Peer Review Project:

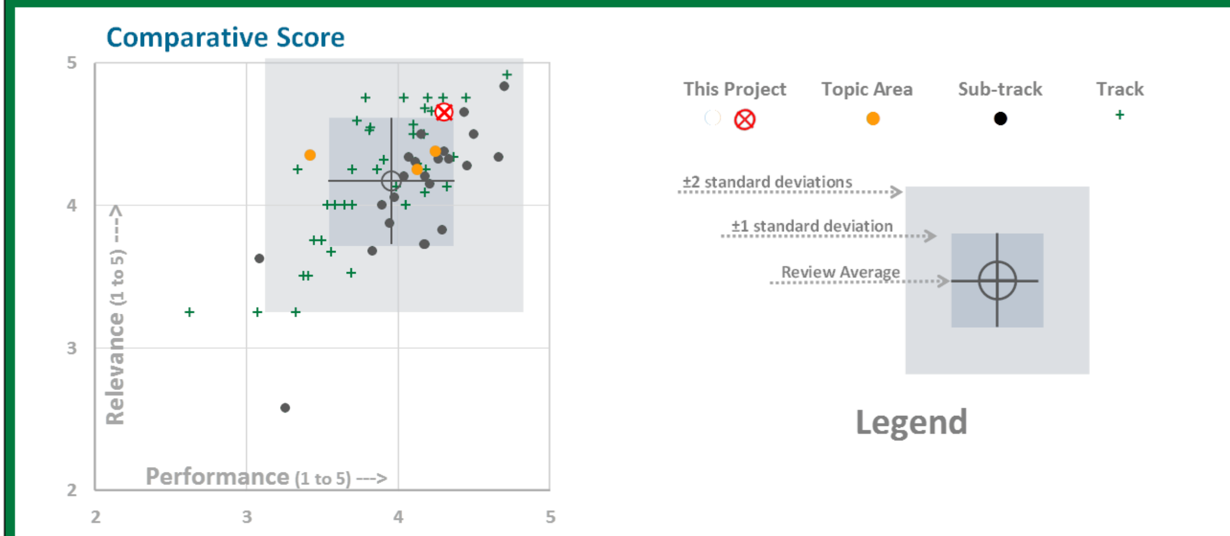
MHK Data Repository and Instrumentation Database

Principal Investigator	Rick Driscoll, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Market, and Industry Development, Analysis, and Data Dissemination

FY 2014-FY 2016 Funding

DOE	$ 1.2 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 1.2 M**	**100%**

Peer Review ID# 71



Comments made by reviewers during the evaluation of this project (PRID 71)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- A valuable, centralized repository that researchers, developers, and industry support can access
- Has a very broad impact on the entire industry
- Important to allow public access to non-confidential data collected under DOE-funded projects
- The sharing of data has the potential to help meet DOE objectives
- Creating a repository for data is critical and a function that only the Federal government can do

Question 2: Methods and Approach

- This is an effective system; however, was not clear during the presentation as to how an individual company's intellectual property was handled as part of the upload process
- Helpful design to build on prior geothermal data collection methodology and curation system, and lessons learned there
- Risk of consolidated data is that it contains DOE grant recipient confidential business data; DOE must assure protocols to ring-fence confidential data during 5 year confidentiality term
- Seems appropriate
- Good use of existing efforts
- Important set of products that should be useful to developers
- Reasonable approach for developing the database

Question 3: Technical Accomplishments and Progress

- Good product, but does need to allow update to permit step-wise entry that stores and allows later completion by submitter
- Good progress
- Establishing methods for data intake is important
- Good outreach activities

Question 4: Project Management

- On schedule and on budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- An open system enabling numerous groups to contribute
- DOE must manage risk of inadvertent disclosure of proprietary data if loaded during 5-year confidential term
- The project design allows the DOE MHK data to be accessible to other projects/researchers
- Upside is that upload of all data directly from users will allow much broader access; downside is no quality assurance step on uploaded data, and there is only a contact name for user to query source
- No partners, but must have reached out to folks likely to submit data?
- Reaching out to the user community and gathering input

Question 6: Proposed Future Research, if applicable

- A positive step forward with this repository will be to connect it with Tethys
- Future priority should be to enable single access port USDOE MHK data to allow access through both Tethys and new platform; links to other DOE data
- Continued development and improvement proposed

Question 7: Project Strengths

- Data system can handle significant amounts of data loads
- Data Products and Community Project goal is important to empower the community to post and share its own data, enabling new applications
- The database and associated products are a critical part of a successful program and it is good to get started early before there are too many projects to collect data from

Question 8: Project Weaknesses

- Limited "advertising" of this database through word of mouth by DOE/National Lab staff only
- Limited QA/QC process of the dataset
- Unclear as to how intellectual property will be protected
- Likely increasing future costs; feasibility of storage of metadata for all projects suggests that DOE should create guidelines for prioritizing and organizing what data should be saved and train project recipients on same

Question 9: Recommendations

- Connect this database with other DOE-funded database (e.g., Tethys)
- DOE not likely to be able to sustain uncapped storage costs for system, so start with structure that encourages upload of only valuable, relevant data sets
- The data curation (i.e. making sure that the data is correct, not corrupt, the associated metadata) so that people using it can trust it will be a big ongoing effort

DOE Water Power Technologies Office 2017 Peer Review Project:

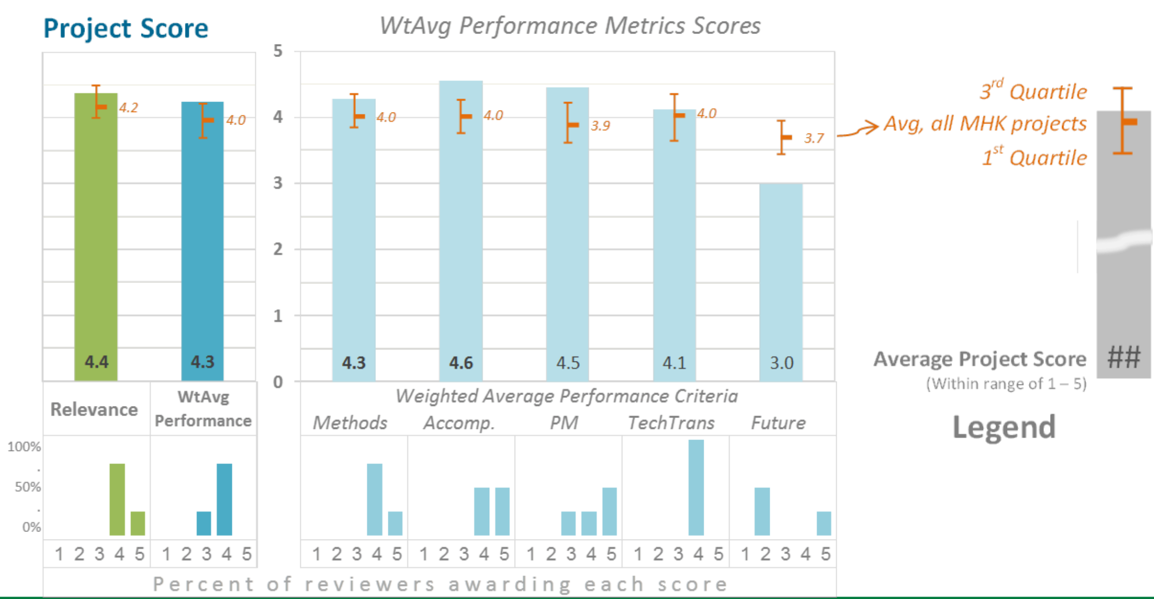
MHK Risk Management Framework

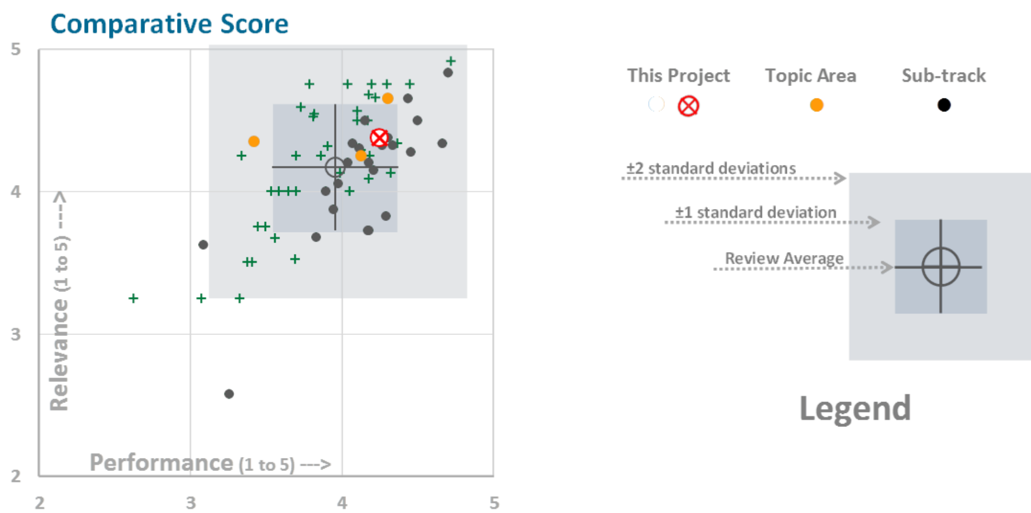
Principal Investigator	Jochem Weber, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Market, and Industry Development, Analysis, and Data Dissemination

FY 2014-FY 2016 Funding

DOE	$ 0.0 M
Cost Share	$ 0.0 M
Total	**$ 0.0 M**

Peer Review ID# 104





Comments made by reviewers during the evaluation of this project (PRID 104)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- There are numerous risks associated with deploying anything in the aquatic environment. Identifying these potential risks is vital if a project is to succeed.
- High value contribution to risk reduction in all DOE WPTO-funded MHK projects, and can improve grant FOA designs and DOE portfolio management
- Given past failures and how they affect the industry, this seems a very pertinent project
- Communicating the risks is important for the success of MHK

Question 2: Methods and Approach

- A detailed risk management design
- Standardizing the risk register approach will enable DOE to review risk of future projects on an equal setting
- BP! Project methodology developed in close consultation with MHK community, incorporating lessons learned from prior project failures, to build QA/QC best practices for MHK commercialization process
- Excellent team drawn from public and private sector, using best practices to develop helpful QA/QC tool for risk reduction in the design process
- Project methodology used proven best risk reduction engineering practices to ensure improved QA/QC in DOE-funded MHK project design
- Tool can be used by DOE WPTO in assessment of FOA responses and in assessing project results
- Seems like appropriate and logical steps were taken
- Reasonable approach to developing the risk management framework

Question 3: Technical Accomplishments and Progress

- Resulted in the development of a risk register that has been used for multiple projects
- Excellent to have published, user-friendly assessment and reporting system to provide uniform, comparable data to USDOE
- Good work in outreach to MHK community in developing and educating developers on the tool through webinars and publications
- Important to get ongoing feedback from industry to assure not overly burdensome to use
- Created the framework
- Project is complete

Question 4: Project Management

- Project on time/on budget
- Good outreach to private developers in design
- Good work in including private sector expertise in project implementation
- On time on budget
- Project was completed on time and in budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- Information was distributed via a webinar and the Risk Register is available on the web - for a "small" project, this framework is being used by the industry to supplement their own risk management strategy
- NREL project that used effective outreach to private MHK developer community and private sector expertise to identify best engineering design/commercialization practices
- Excellent outreach to MHK developers
- Would this tool be of value to potential funders (i.e. if the developer has already completed the excel spreadsheet, could they then use this to help persuade investors of the soundness of their plans)?
- Document is available on the web
- Had a rollout webinar that was well attended
- Used partners and subject matter expert review

Question 6: Proposed Future Research, if applicable

- Not Applicable - only minor adjustments are needed
- Recommended small follow up review to get feedback on tool and improvement
- None really expected
- Only minor improvements are planned

Comments made by reviewers during the evaluation of this project (PRID 104)

Question 7: Project Strengths

- This Risk Register provides a "completeness" compared to some industry examples
- Should help developers to use best practices to improve QA/QC in device design process, reducing risks of device failure or deployment errors
- Should help to maximize investment value for DOE WPTO by reducing project failure risks and better allow NREL staff to evaluate the grant proposals

Question 8: Project Weaknesses

- If USDOE is overly prescriptive in insisting on the use of this risk reduction system, to the exclusion of other equally effective best practices in risk reduction, the result could be duplicative planning costs for developers or inadvertent suppression of even better risk reduction practices; leave room for flexibility in developer choice of equally effective risk reduction methodologies
- May be duplicative of existing, but different engineering QA/QC/risk reduction systems used by companies

Question 9: Recommendations

- Would be helpful to assess the success rate of the companies using the tool, whether at time that data becomes public in 5 years for publication, or in interim for NREL internal review

7.4.3 MHK-2A : Site and Resource

DOE Water Power Technologies Office 2017 Peer Review Project:

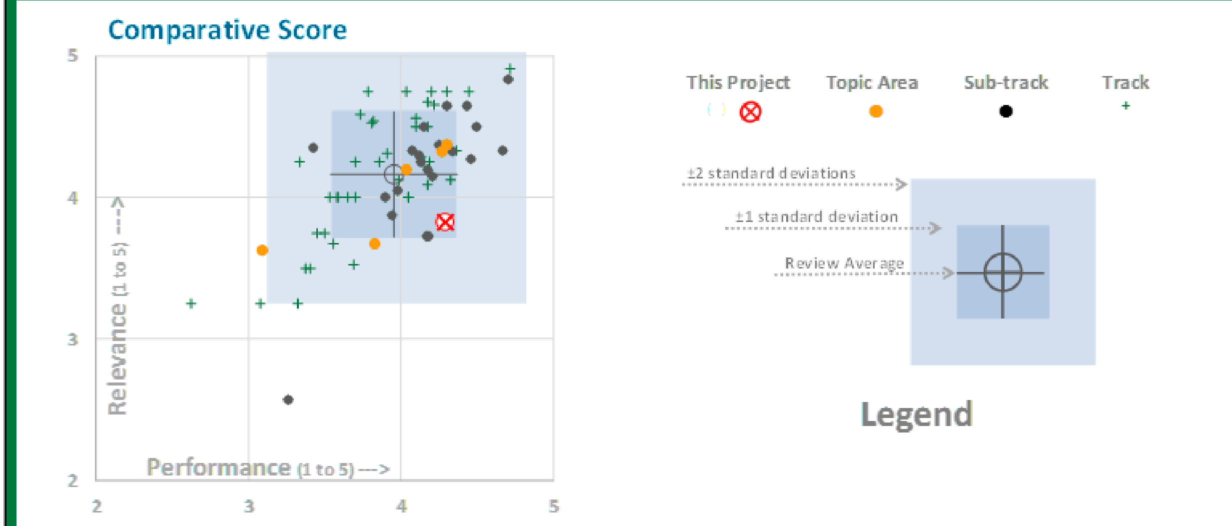
Wave Resource Model Integration

Principal Investigator	Zhaoqing Yang, Pacific Northwest National Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Site and Resource

FY 2014-FY 2016 Funding

DOE	$ 1.1 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 1.1 M**	**100%**

Peer Review ID# 14



Comments made by reviewers during the evaluation of this project (PRID 14)
Question 1: Relevance to Water Power industry needs and overall DOE objectives • This study has direct relevance to wave energy developers, enabling them to target micro locations • Breadth of spatial scales may go beyond the needs of U.S. developers for national projects, but will be needed for export of technology for international projects • Important project to improve local and global modeling efficiency and enable effective comparison of modeling; DOE's best modelers on the project, plus a technical steering committee of experienced modelers to strengthen the project approach, protocols • Encompasses site characterization and therefore financial concerns • This work is absolutely needed for the WEC (wave energy converter) industry moving forward, but given the maturity of the industry at this point (only testing at WEC test sites), it could be argued that this work is not needed just yet and that DOE funds would have been better spent on issues currently slowing down the industry • To be useful for siting, it is important that the model be at the appropriate scale to be useful for a developer **Question 2: Methods and Approach** • Methodology appeared adequate to meet the needs of the research • BP! Great work by USDOE in working with NOAA (National Oceanic and Atmospheric Administration) to shift from its operational mindset to the R&D and partnership approach needed for this joint R&D project; NOAA is critical partner with essential data for future projects • Field measurements are based on NWC (National Water Center) data and based upon high quality NOAA wave buoy data • Get a consensus on higher scale models that can be used for finer scale model for specific projects; regional models should enable MHK developers to use the existing regional hindcast models • Strong credit for steering committee approach, and for attempt to get international modeling input on the panel • Very encouraging that had a technical steering committee • Good approach to use a grid area that incorporates a wave buoy **Question 3: Technical Accomplishments and Progress** • Positive - Assessed multiple models to evaluate their efficiencies • The project achieved its goals of improving the efficiency of the model **Question 4: Project Management** • Project completed within the budget and on time • Strong project management design advantage to have Steering Committee to endorse the comprehensive review of identified models • Well done coordinating all the partners/collaborators to finish this on time and budget • The project accomplished its goals and was completed on time and in budget attaining the goal of improving the model parameters **Question 5: Research Integration, Collaboration, and Technology Transfer** • An excellent example of collaboration, utilizing federal agencies, academic resources, and private MHK device developers • Excellent collaborative approach with the steering committee feature • Good sharing of project data through publications and conferences • Reach out to the coastal communities planning for inundation due to extreme weather/ocean level rise to assure info sharing on storm impacts • Good mix of labs, academia and industry • The model development included good collaboration and used a technical committee for input that broadened the viewpoints and considerations for the model • The model is being used by others, which is a good indication that it is accepted

Comments made by reviewers during the evaluation of this project (PRID 14)
Question 6: Proposed Future Research, if applicable • International collaboration would support the development of streamlining future modeling • None identified, but presenter mentioned greater detail in future models • Future research also including steering committees, international involvement • The intent to look at extreme conditions is critical for the industry to design robust devices that can withstand the 100 year or 1000 year storm. Having good predictions will help ensure that the devices/moorings are not underdesigned. **Question 7: Project Strengths** • Distribution of information through numerous peer review papers, presentations, and conference papers • Excellent collaboration • Modeling approach taken from an international model approach • Incorporation of steering committee with broad representation (labs, academia, industry) **Question 8: Project Weaknesses** • Seems to have focused in one area (Oregon). This is probably due to budgetary constraints, so understandable. It would be nice to see how this would do in other locations. **Question 9: Recommendations** • Investigate the added value of extreme sea states (i.e., coastal flooding) impacts. This would not be part of the DOE Power Program. • Suggest future additional revisions await deployment of tidal devices at test sites to gather concrete data on resource and device interaction • Keep involving external committees in helping to steer work

DOE Water Power Technologies Office 2017 Peer Review Project:

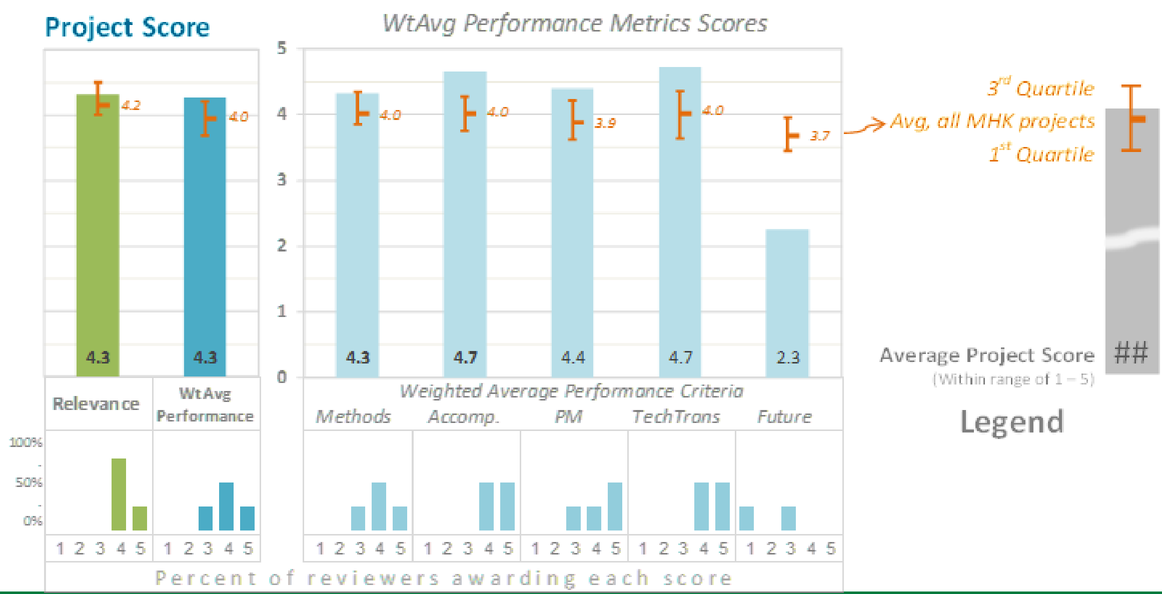
Wave Environmental Characterization at Wave Test Sites

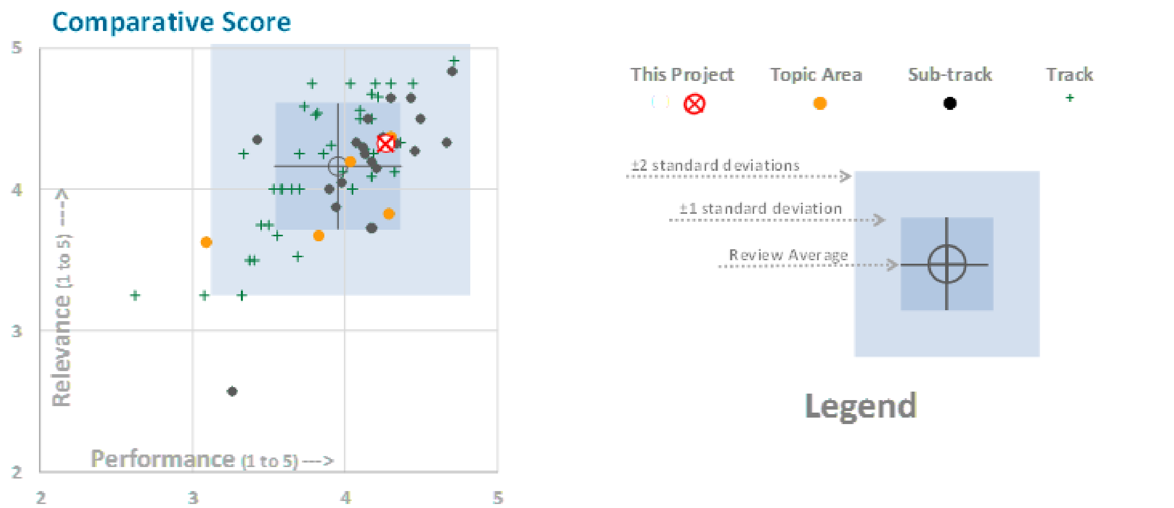
Principal Investigator	Vincent Neary, Sandia National Laboratories
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Site and Resource

FY 2014-FY 2016 Funding

DOE	$ 0.0 M
Cost Share	$ 0.0 M
Total	**$ 0.0 M**

Peer Review ID# 31





Comments made by reviewers during the evaluation of this project (PRID 31)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Focused study on data relevant to wave developers
- Information developed from this model will enable device developers to micro-manage the siting of their devices
- Catalogue with comprehensive and consistent wave climate characterization at eight (8) U.S. WEC (wave energy converter) test sites will assist developer test site selection
- Facilitates technology testing, while reducing deployment risk
- Good clear understanding/explanation of who this will benefit
- Great focus on WEC test sites as that is needed now
- Sounds like a useful tool for industry
- Sounds like this is one piece of the puzzle for a testing site, but also need other support such as infrastructure for testing
- The project was critical to support testing locations for new technologies

Question 2: Methods and Approach

- Solicited industry input to support the design of the methodology
- Not clear whether the final conclusions were reviewed with collaborators prior to publication; what feedback was received from test sites and developers?
- Well-designed and executed, drawing form key collaborator data sources
- Great that using international standards and emphasized consistent characterization
- Good use of standardization to allow comparison and use of latest standards
- Included the risks such as extreme conditions which is important for testing trials
- The level of detail and appropriate parameters were identified
- Weather window identification is excellent and DOE should pursue this for all potential sites, both MHK and wind which is critical for developers to plan construction activities and utilize the correct vessels

Question 3: Technical Accomplishments and Progress

- Excellent distribution of information through peer review papers and conferences papers
- Made a positive effort to connect with wave energy developers to educate them on the availability of the dataset
- Focus with MHK developers on weather windows both for deployment and O&M (operations and maintenance) essential in high energy sites
- Publication of catalogue
- Seems like good progress
- The catalogue is published

Question 4: Project Management

- Project completed on budget and on time
- Well planned and executed
- Project is completed
- The project was completed on time and in budget

Question 5: Research Integration, Collaboration, and Technology Transfer

- A strong collaboration with academic institutions and federal groups that are also developing wave energy test centers
- Solicited input from wave energy developers (e.g., Columbia Power and Oscilla Power)
- Excellent outreach to collaborators for data resources and to MHK developers to get input on the project design; developed concept of weather windows to conduct O&M on wave devices
- How best to better integrate the data into public information platforms?
- Good collaboration with labs and academia. Great that included industry!
- Coordinated with important universities and the Corps of Engineers who managed facilities which were critical for making the project a success
- Published a peer reviewed article for the methodologies
- Reached out to the developers to ensure they were providing a product that would be used

Comments made by reviewers during the evaluation of this project (PRID 31)

Question 6: Proposed Future Research, if applicable

- Not future research, but tracking the use of this catalog by both the wave energy industry as well as other industries
- NA (not applicable)
- Presenter noted that regional hindcast project may produce even more information that can be folded up and reprocessed into the catalogue
- NA
- No future plans
- Suggest creating a weather window tool to aid developers

Question 7: Project Strengths

- Developed a consistent methodology and applied international characterization standards
- Using existing data sources, not "re-inventing the wheel" and obtaining original data
- Great opportunity for NREL to partner with test facilities and with test developers; for Sandia Lab to connect directly with test sites and MHK developers and to provide services to advance solutions for MHK industry
- Peer reviewed articles and conference presentations
- Product assists MHK developers with site selection, device design, and O&M planning and risk reduction
- Strong partnership with private and other stakeholders on design of project
- Two stage project well managed with total $600K budget
- Open catalog that is available to others

Question 8: Project Weaknesses

- Project did build in input on data sources and presenter noted outreach to test sites and developers to get feedback, but not clear that ultimate consumers - the test sites and MHK developers - had opportunity to review draft catalogue and give feedback; projects should build in this step
- Data results are not available

Question 9: Recommendations

- Identify if other industries are using the catalog
- Track the use of this catalog by developers and solicit their feedback on how effective it is
- Would be great to give end users access to the data that are used for the figures/tables in the catalog so that they can query it for the data that is explicitly of interest to them

DOE Water Power Technologies Office 2017 Peer Review Project:

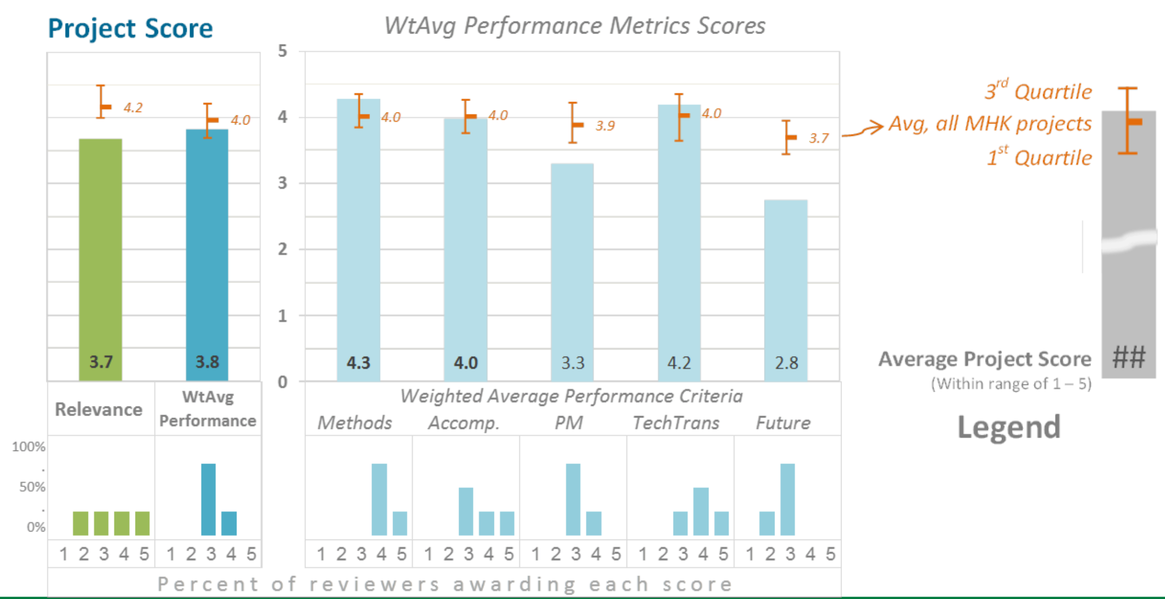
National Wave Energy Resource Refinement Using 30-year Hindcast

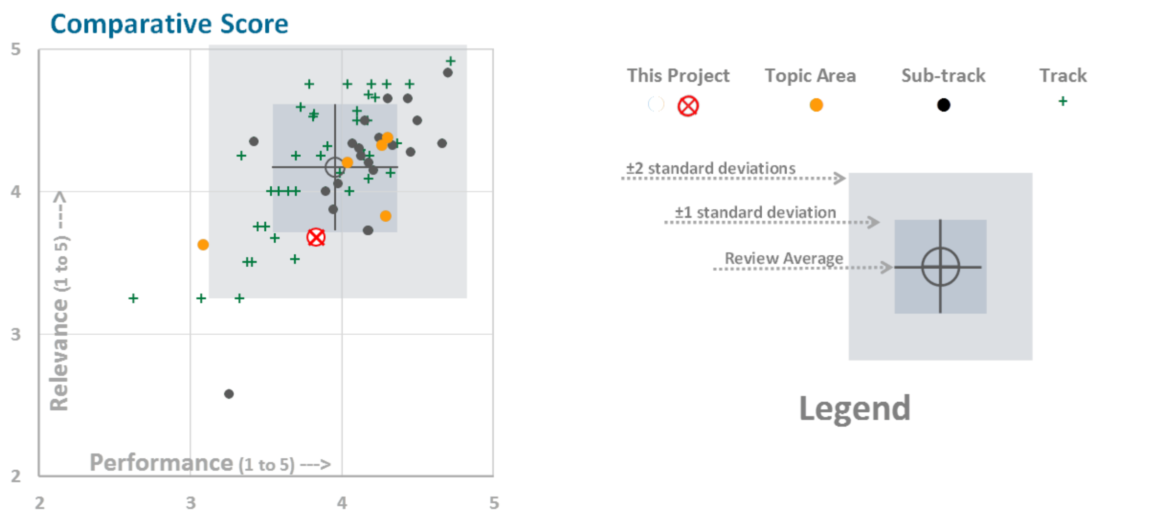
Principal Investigator	George Scott, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Site and Resource

FY 2014-FY 2016 Funding

DOE	$ 0.1 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.1 M**	**100%**

Peer Review ID# 45





Comments made by reviewers during the evaluation of this project (PRID 45)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Assesses the wave characterization over a 30-year period, enabling high fidelity modeling for future wave energy device deployment
- Not clear whether final product actually provides significantly more complete or accurate tidal resource characterization than prior art
- Wave Energy resource characterization is an important WPTO objective; project built on recommendations to complete/expand EPRI (Electric Power Research Institute) 2011 survey
- Direct response to NAS (National Academy of Sciences) comments for better resource characterization (need direction not just mean)
- This work is absolutely needed for the WEC (wave energy converter) industry moving forward, but given the maturity of the industry at this point (only testing at WEC test sites), it could be argued that this work is not needed just yet and that DOE funds would have been better spent on issues currently slowing down the industry
- Good resource information is critical for both industry and the government in determining the best locations for development

Question 2: Methods and Approach

- Positive - used 16 sites around the United States with existing datasets that could then be refocused as part of the modeling effort. These sites provided a country-wide representation.
- DOE should evaluate whether NOAA (National Oceanic and Atmospheric Administration) was under-resourced in the project, leading to the errors in initial data sets. Good work by DOE and project team to work with NOAA/NCEP (National Centers for Environmental Protection) to correct and resubmit the data.
- Not clear that project plan included presentation to MHK developers/community to get their feedback on whether the data is helpful to actual site selection, and whether the project data will actually allow them to plan project array, as suggested in project objective
- Project relied upon assumption that the 30 year vs 51 month hindcast will provide more accurate wave energy profile. Did the mapping data change significantly with the longer term data? Was the variation significant in terms of a project developer site selection? Not clear from presentation.
- Seem like reasonable approach
- The approach of using hindcast data for 30 years is important for making the best estimations. The data used are the best available for this type of modeling.

Question 3: Technical Accomplishments and Progress

- While the data supplied by NCEP delayed the production of data, to their credit, this team has been able to make significant progress with this project
- Did the longer 30 year hindcast analysis justify the $400K investment? Did the project achieve the proposed objective of a significantly more accurate data set, and helpful directional data that will allow wave developers to screen for sites? No summary analysis by project team.
- The project has delivered as indicated although there were challenges with data analysis

Question 4: Project Management

- While stayed within the budget it is uncertain how effectively this project was managed due to how the NCEP data disruption played into the project
- Project represents important collaborative effort to use expertise of both DOE and NOAA
- Project team addressed NOAA data glitch well. Lesson learned going forward is that project design and management must give close analysis to the capacity of the federal agency partner to produce deliverable with given budget and timeframe
- Delays due to delay in data from others outside of their control. Persistence pays off!
- Project was delayed due to issues with production of data as explained in the presentation

Comments made by reviewers during the evaluation of this project (PRID 45)

Question 5: Research Integration, Collaboration, and Technology Transfer

- A positive teaming between a National Lab, academia and a federal government agency
- Excellent collaboration among federal agencies, and academic center of excellence in Virginia Tech. But concerned about the lack of interaction with private sector developers in the design and in review of results to assure most helpful data development and presentation.
- Matlab script provided for querying specific grid cells. This seems important.
- The project is building on the work of Virginia Tech and is working collaboratively with NOAA, which is the source of the data. The inclusion of the products in the Marine Cadastre is important as this is a primary source of information for offshore renewable energy projects.

Question 6: Proposed Future Research, if applicable

- Proposed future research to incorporate additional improvements to dataset package that might increase wave resource estimates is only marginally relevant and is not demonstrated to achieve the results. If the resources are already significant, isn't this data set sufficient for the high level site selection purpose?
- Highlighted limitation of WW3 (Wavewatch III)
- Good recommendation for ensuring data are available before proceeding with modelling and mapping

Question 7: Project Strengths

- Collaboration among agencies and academic centers and helpful high level site selection screening tool for wave industry
- The methodology for calculating the wave energy is useful for identifying areas best suited for siting of wave converters
- The project addresses the critical need for the best resource information for siting wave energy conversion devices. The use of a 30-year hindcast makes the most sense since the data are available and provide a reasonable window for looking at surface variations.

Question 8: Project Weaknesses

- Not sure if this is a good use of funds at this early stage of the industry development
- Not clear whether the $400K investment bet paid off - did we get substantially different data set, or better tool for wave project development site selection?
- Does this scale (spatial and temporal) for what developers need?
- Reliant on data from NOAA which hindered project. Not sure that is a weakness, but highlights the need to bring these groups in as partners of some kind.

Question 9: Recommendations

- Given limited funds, should future priority be placed on characterization of areas most likely to be development sites due to grid and resource profiles?
- Need feedback from wave project developers and other potential dataset users on whether the dataset is more helpful

DOE Water Power Technologies Office 2017 Peer Review Project:

Model Validation and Site Characterization for Early Deployment MHK Sites and Establishment of Wave Classification Scheme

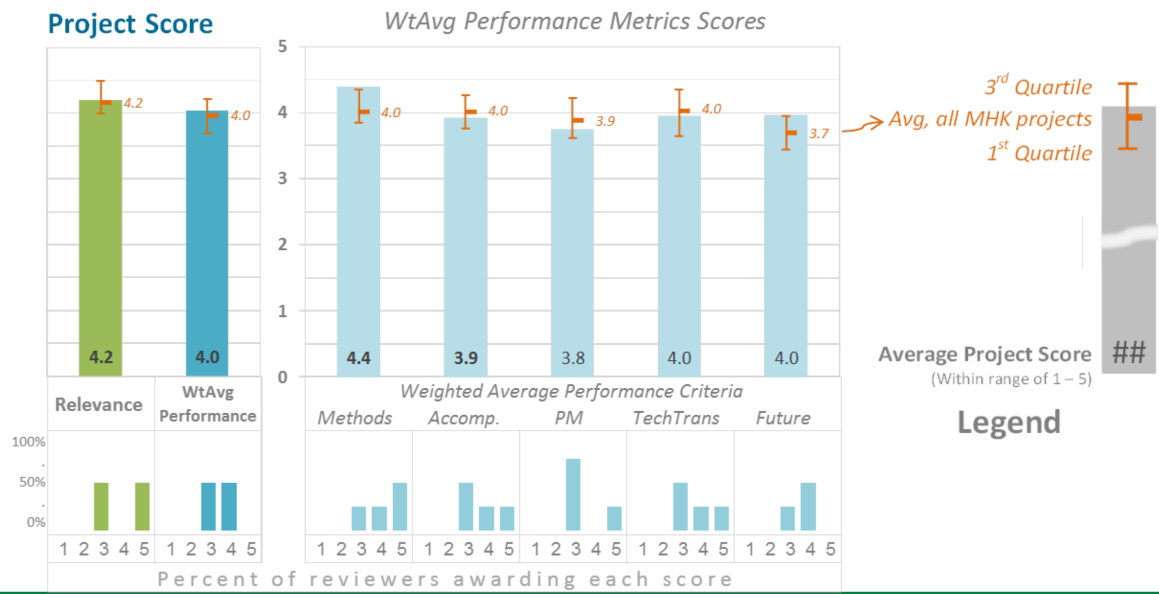
Principal Investigator	Levi Kilcher, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Site and Resource

FY 2014-FY 2016 Funding

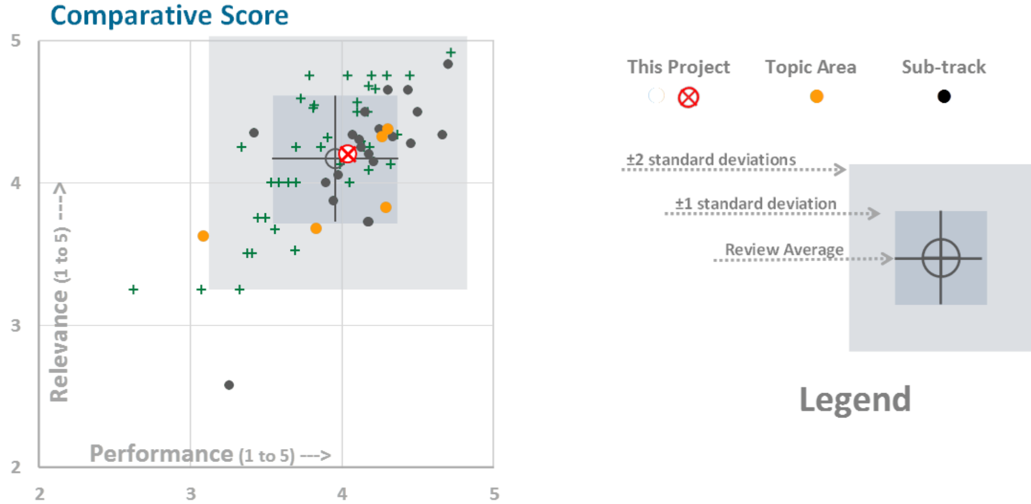
DOE	$ 2.8 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 2.8 M**	**100%**

Peer Review ID# 55

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 55)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Very applicable to enabling wave/tidal developers to narrow their site selection process
- Builds on prior tidal studies to create higher-fidelity validated models to more accurately quantify the resource, and to support detailed array design studies
- Follow on studies to prior EPRI (Electric Power Research Institute) 2011 wave resource study and National Research Council recommendation for more accurate resolutions in shallow waters
- Covers a lot of objectives
- However, at least for WEC (wave energy converter) resource characterization, this information will be needed for the industry, but likely first locations for testing will be at the WEC test sites, meaning this resource characterization is not likely needed just yet and money might have been better spent on other issues currently slowing down the industry
- Making measurements at most likely sites for early development
- A well described wave classification scheme is a useful tool for developers
- Models must always be validated with real world data, so this is a much needed effort to ensure the best sites are identified early

Question 2: Methods and Approach

- Much of the modeling efforts conducted by NREL are focused on a macro-scale of multiple device deployment; however, this is still a long way off. It may help the immediate needs of the industry to focus on the deployment of one/two devices.
- The instruments for measuring the waves are appropriate
- The process for identifying sites is a strength

Question 3: Technical Accomplishments and Progress

- Uncertain where there were permitting issues as this is a simplistic project - this is misleading and should be addressed/refined before future deployments
- Some delays due to permitting for measurements
- The project seems to be progressing well to identify sites for making measurements to validate the models

Question 4: Project Management

- Provide a positive insight with modeling potential nearshore sites
- Strong use of regional partners and strong expert team to develop multiple work products
- Seemed to be coordinating between collaborators fairly well
- Some delays in identifying priorities and addressing permitting issues

Question 5: Research Integration, Collaboration, and Technology Transfer

- A strong collaboration with regional experts, be it device developer (e.g., ORPC (Ocean Renewable Power Company)) and academia (e.g., University of Washington)
- It is positive to see the researchers solicit significant input from the Marine Energy Council to determine "Hot Spots"
- Good collaboration to bring on technical implementation partners on regional basis
- Oregon project slowed by state expression of concern about prior projects
- Not sure what collaboration is beyond labs? This may just have been left out due to time.
- Using a steering committee for site identification is a strength

Question 6: Proposed Future Research, if applicable

- Expand modeling not just with wave/tidal but also offshore wind industry
- Consider synergies with offshore wind to understand impacts of wind-driven offshore seas
- Definitely leverage national labs to assist with test site selection and characterization and data collection during device deployment
- Hold off on further large-scale resource characterization until after test projects deployed and collection of data to measure accuracy of tidal models
- Important to assess any inconsistencies between tidal models and resource measurements
- Working towards field measurements will move this forward

Question 7: Project Strengths

- Utilization of more refined spatial resolution for modeling
- Strong mix of modeling and measurements

Comments made by reviewers during the evaluation of this project (PRID 55)
Question 8: Project Weaknesses • Delay in obtaining data at the selected sites, related to site selection and permitting • Not clear that site selection is based on anything other than the physical qualities. What about human/political willingness, or the biological concerns? Perhaps beyond scope, but could be a show stopper. Question 9: Recommendations • May consider looking at working with DOE's Wind Power Program in support with the offshore wind industry • Evaluate carefully whether highest and best use of national lab resource in next phase is to support MHK developers with more detailed tidal and wave assessments at MHK developer-identified preferred sites, screened for grid interconnection or microgrid applications • It seems like permitting is a problem shared by many. How is the DOE collecting this into 'institutional knowledge' so that every group doesn't have to reinvent the wheel?

DOE Water Power Technologies Office 2017 Peer Review Project:

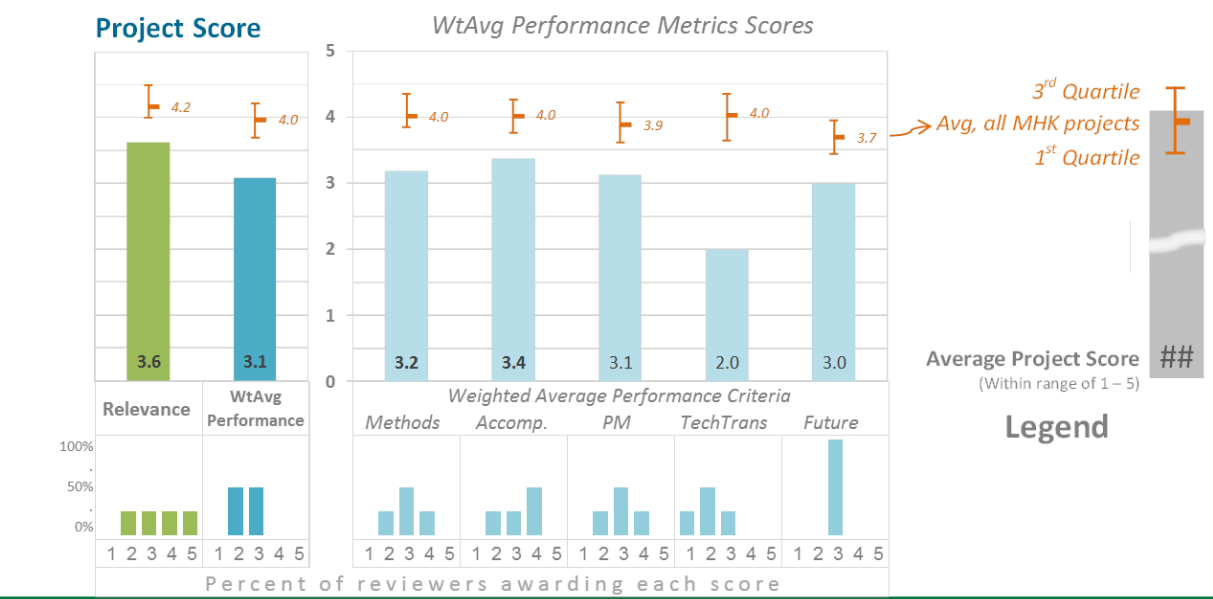
Marine and Hydrokinetic Energy Metocean Data-use, Sources, and Instrumentation

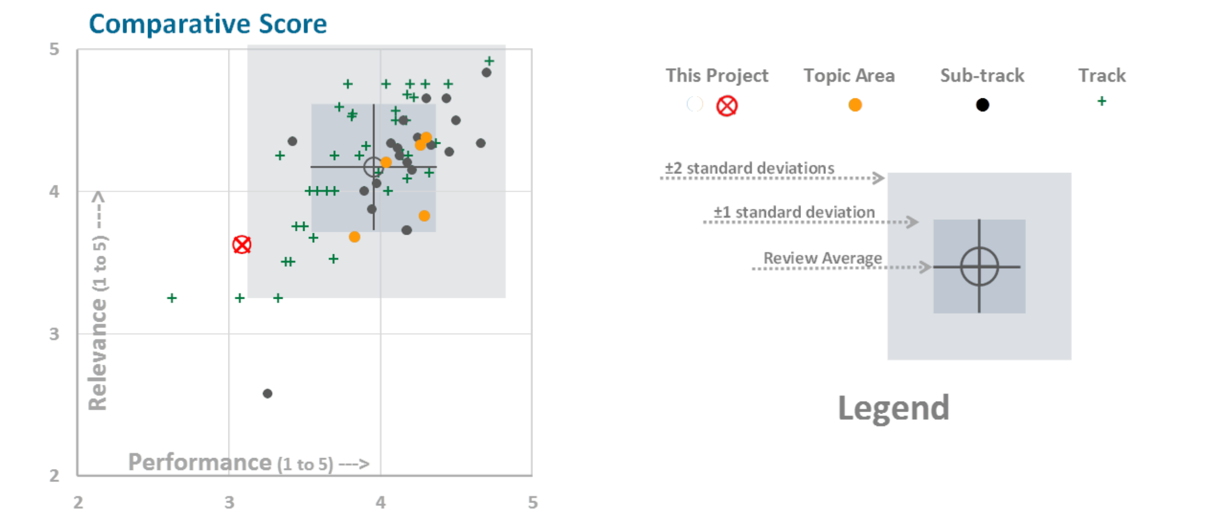
Principal Investigator	Senu Sirnivas, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Site and Resource

FY 2014-FY 2016 Funding

DOE	$ 0.4 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.4 M**	**100%**

Peer Review ID# 96





Comments made by reviewers during the evaluation of this project (PRID 96)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Positive - This development of the data use will continue the building of the MHK atlas, supporting future siting of wave energy devices deployments
- International ocean observing system (IOOS); IOOS common ; regional ocean observing systems only 2 responded to outreach, but the high level coordinating was not demonstrates that even the most knowledgeable cannot tap the pockets of information
- Project demonstrates pressing need for coordination in data collection and sharing in future
- Significantly reduces burden on regulators and MHK developers to access relevant data in designing and permitting sites
- Useful project to assemble inventory of ocean data and standards applicable to MHK industry, but not clear that all potential sources of data captured
- Not clear how this de risks projects. Perhaps I missed the point?
- Collecting this information is something any developer would need to do, so providing the information in a one stop format is useful

Question 2: Methods and Approach

- Appeared to be limited data integrated from the IOOS database
- No formal collaboration with expert ocean state and federal agencies; may have resulted in gaps in data sources
- Did you reach out to data users to verify you understood what their needs were?
- Wasn't it necessary to go beyond just web searches? Reaching out to stakeholders?
- Good documentation
- Reasonable approach for gathering data and information

Question 3: Technical Accomplishments and Progress

- Able to achieve the compilation of numerous data sets; however, there appeared to be "blind spots" within the data gathering. Other sources should be revisited to fill in these "blind spots".
- Project completed but no way for public to access the data
- Aren't the data available always evolving? Won't this report be out of date by the time it is done?
- If only three out of 15 groups replied to your outreach, then how did you follow up?
- Compiled a thorough list of parameters needed
- Good to include a list of instrumentation needed for collecting unavailable data
- Not sure if there are data sources missing

Question 4: Project Management

- Project completed on budget/on time
- Not clear from presentation and summary, but the project presumably required publication of project conclusions; yet recommended future research calls for additional $ to "get report ready for public distribution"; paper publication should have been completed in original project
- Project management seems relatively simple since there are so few people involved

Question 5: Research Integration, Collaboration, and Technology Transfer

- Work was conducted in-house with no collaboration; however, it is uncertain if collaboration was necessary for this project
- Collaborative partnerships might have improved responses by multiple data sources that did not respond to NREL inquiry
- Even though this is a high-level, data review project, a direct partnership with key federal and state agencies responsible for data gathering might have significantly enriched info on available data sources
- Failure to engage the regional Ocean Observing Systems and national coordinating forum effectively (only 2 regional OOSs responded to inquiry) leaves a major potential hole in data; State GIS (geographic information system) systems and other data inventories may have additional data sources
- Seems like little discussion/outreach with others beyond NREL
- No collaboration was included
- Would have benefited from reaching out to the oceanographic community through the IOOS working group, facilities working group, and others to find out about resources

Comments made by reviewers during the evaluation of this project (PRID 96)
Question 6: Proposed Future Research, if applicable • Solicitation from industry (e.g., Marine Energy Council) may help refine future scope of this database development • Careful evaluation of future research to build NREL MHK Atlas for the United States is needed to understand incremental benefits to existing data sets • Not clear additional $ needed for publication of the study results; should have been in original project budget • Fill in gaps with 30 year hindcast? • Interesting application for 30 year hindcast **Question 7: Project Strengths** • Groundwork to enable development of improved access by MHK community and regulators to ocean data • Gathering information and pulling it together is always a useful effort **Question 8: Project Weaknesses** • Original project should have included presentations to regulators and MHK industry with MED Resource Assessment Subcommittee assessment and industry feedback on work prior to public presentations • Project not designed with final objective in mind of enabling access by MHK community to data identified by project • Not much outreach to sources of data and end users. Will this be of value to end users? If so, how will they know about it? • Seems like this will become dated soon, unless it is a 'living document' • Did not reach out to the oceanographic community for validation **Question 9: Recommendations** • Review IOOS database to integrate/update data • Focus on how to make MHK community access to the various data sources as simple and easy as possible, with minimal updating burdens • Does this really save proponents/developers much time in gathering data? • What is the reason to reach out to academia on what instruments they have? Is it to set up a consortium to share instruments?

DOE Water Power Technologies Office 2017 Peer Review Project:

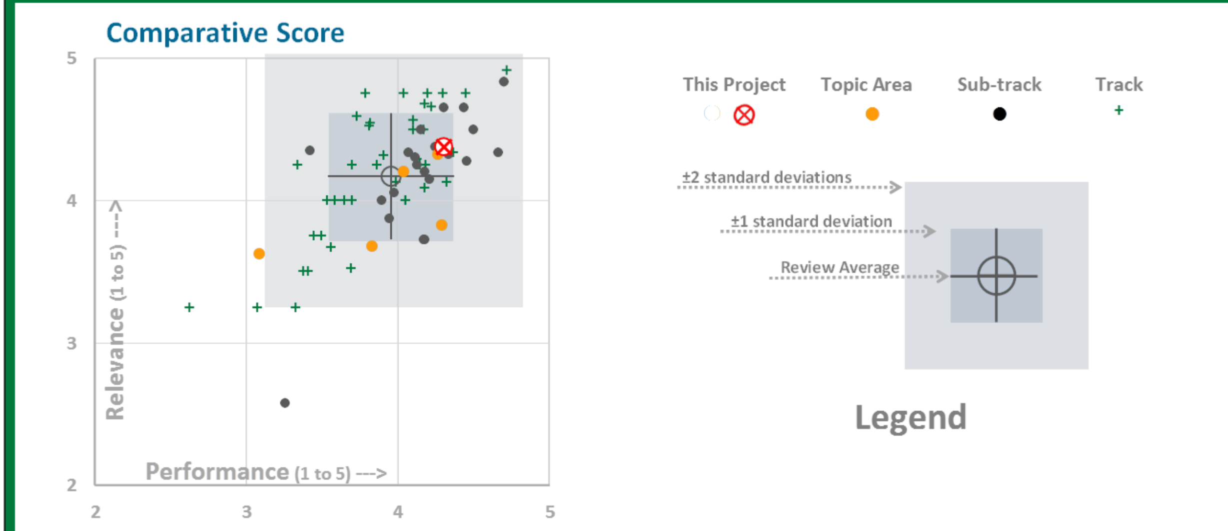
DoD MHK Deployment Opportunity Identification

Principal Investigator	Robi Robichaud, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2A: Environmental Research, Resource Characterization, & Analysis
Topic Area	Site and Resource

FY 2014-FY 2016 Funding

DOE	$ 0.2 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.2 M**	**100%**

Peer Review ID# 121



Comments made by reviewers during the evaluation of this project (PRID 121)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- A practical project help to identify new DOD (Department of Defense) users (e.g., U.S. Coast Guard) and how these departments can utilize MHK to meet the department's renewable targets
- Critical national security ; Use of technology Expeditionary Warfare - how apply the technology in that space; also in international disaster relief
- Great use of partners in USCG (U.S. Coast Guard), U.S. Army, USN (U.S. Navy) , U.S. Marines; USDOE assistance to Early Adopter Military
- Outstanding use of USDOE special skills to assist DOD in understanding and evaluating full potential of MHK in planning for the DOD's 20%
- Project is critical to RPO and MHK community needs as well as DOD objective of building resilient energy supplies to DOD bases and expeditionary forces
- Take playbook and use with other federal and state agencies for their coastal installations
- At first I was dubious since this is aimed at another Federal branch, but seems in retrospect to be a great way of getting other Federal Depts onboard
- Great opportunity to advance MHK with a well-funded potential user

Question 2: Methods and Approach

- A positive step was to utilize similar methodology as other NREL projects, through the identification of nearshore wave energy sites for DOD
- BP! Collaborative work w DOD, primarily USN/Marines, at early planning stages, to enable MHK to be included in portfolio of technologies to meet DOD objective of 20% RE (renewable energy) in multi-year energy plans; recognizes that military has always been early adopter
- BP! Excellent collaboration among project team to help services id potential coastal facilities that could host MHK sites
- Good that they focused on more than just the physical resource
- Looked at a good suite of project factors
- Thorough examination of all potential sources, but maybe should have included Guam and other locales outside 48 states

Question 3: Technical Accomplishments and Progress

- Positive - project team was able to build off previous study knowledge from Naval MHK sighting, to refine a methodology for other specific end user locations
- Excellent progress on enabling DOD to launch important test projects suitable to DOD objectives
- Study nearing completion
- Good progress with identifying locations of prime facilities

Question 4: Project Management

- Project completed on time/on budget
- DOD is analyzing the potential for own test site - evidence of efficacy
- Ended up with detailed assessment of facilities and the fit with MHK; downselect to a few sites and more detailed analysis; final list for sites to do detailed work - final 2 sites Cape May NJ (USCG) and Cape Edwards, MA (Army). Georgia Tech more detailed analysis at the two locations.
- Final dialogue with DOD on process methodology: Did a screening of military installations of USCG, Army, Navy on resources in base and its energy needs, grid capacities and determine if makes sense to use MHKS in near or longer term
- Project Plan FY 14, through FY 16 partnering process slows the process, but final downselect occurs in the next quarter
- Stakeholder outreach to DOD is impactful enabling them to understand the possibilities, USN was up to speed, but USCG was surprised that their protected locations for ships were not great match with MHK
- Good progress and appears on time and within budget

Comments made by reviewers during the evaluation of this project (PRID 121)

Question 5: Research Integration, Collaboration, and Technology Transfer

- Positive - Focusing on and worked closely with the end user (e.g., other agencies within the DOD) to educate them on the technology and potential use of them at select DOD facilities
- Consider tighter ongoing collaboration with DARPA-E (Defense Advanced Research Projects Agency-Energy) and DOD engineering services on technology development and near term commercial applications
- DOD base power often serviced by local civilian grid; risks in future Smart Grid vulnerability; distributed MHK generation could lower risk at some bases
- DOD and academia. What about industry?
- Good that USCG is considering launching a test center
- Including the Navy, Army, Coast Guard and others to identify locations for prime siting
- Working with all potential armed forces branches

Question 6: Proposed Future Research, if applicable

- Work with other bases to identify if they are an ideal candidate for MHK and what would the logistics be to integrate MHK technology into the existing base energy infrastructure
- Consider ongoing collaborative partnership with DOD engineering and DARPA-E on MHK commercialization projects
- More focus needed on expeditionary forces need for power and water in remote, off-grid or no power zones; provides near term application for MHK projects
- Expect dialog between DOE and DOD to continue
- Potential to continue dialog

Question 7: Project Strengths

- In addition to DOD bases, there is potential collaboration with other federal agencies (e.g., NOAA (National Oceanic and Atmospheric Administration)) as well as coastal State agencies
- There is a long-term potential to develop DOD bases to be energy self sufficient
- Strong consistency with Strategic Objectives and cross cutting benefits
- Building key relationships between federal agencies
- Educating DOD about MHK possibilities
- Good opportunity to develop a working model for private sector site evaluation

Question 8: Project Weaknesses

- While methodology for site characteristics can be shared, limited distribution of base-specific data will be available
- How do you now integrate/involve industry?

Question 9: Recommendations

- Engage locations within each DOD group to identify potential MHK capabilities
- More collaboration with DOD for both base and expeditionary force power requirements is essential
- New technology has often found a way to a mature market via early adoption by the DOD. It would be great to see a 'roadmap' or vision for the next steps of how to bring in and involve industry.

7.4.4 MHK-2B: Components

DOE Water Power Technologies Office 2017 Peer Review Project:

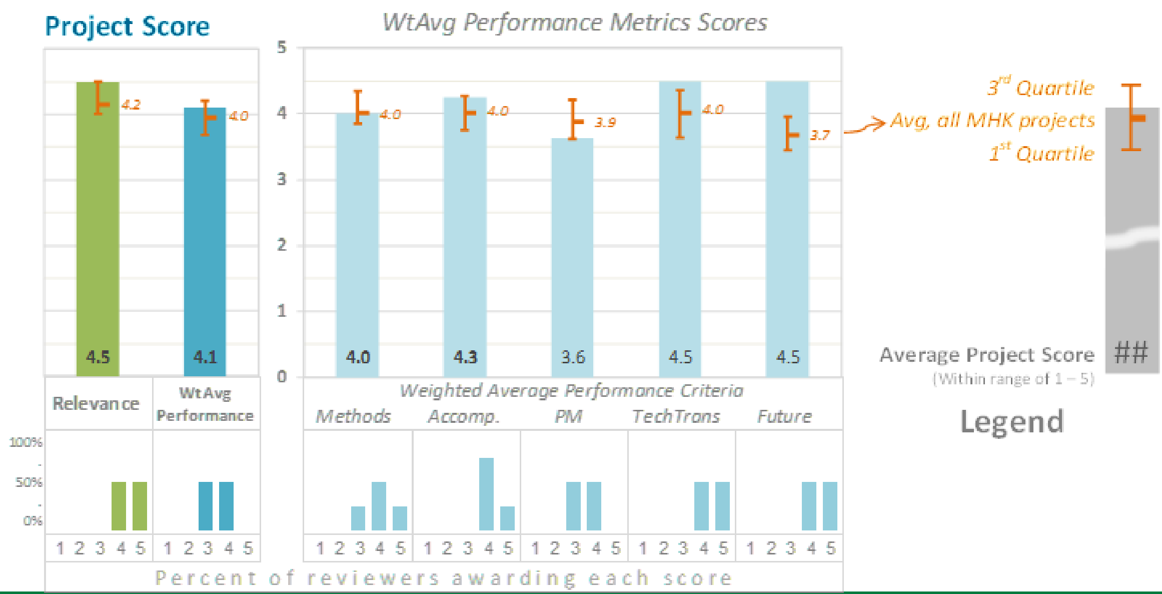
Advanced WEC Controls

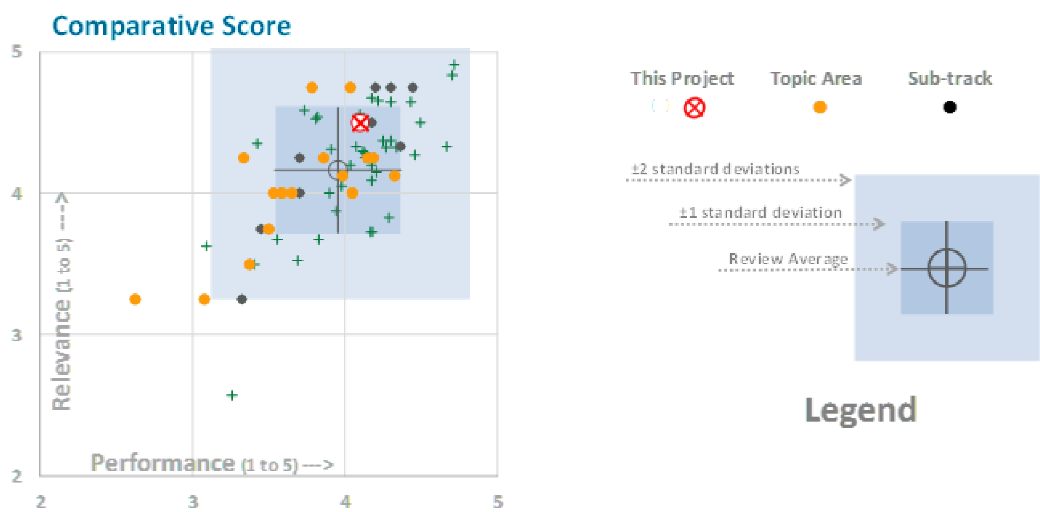
Principal Investigator	Ryan Coe, Sandia National Laboratories
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 3.7 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 3.7 M**	**100%**

Peer Review ID# 78





Comments made by reviewers during the evaluation of this project (PRID 78)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Method and tool development - impact empowering developers with key knowledge and proven methodologies to design and implement advanced control strategies for their devices and improve device design is fundamental impact for control system sector development
- Significant impact of 200% demonstrated thru numerical modelling
- $3m projects
- A very good fit with the sector needs for control
- Can this approach provide a "signal processing" analysis of incoming and passing waves? Can this also be used to prepare a Fourier series analysis of the passing waves such that the frequency of the Fourier sine or cosine signal with the maximum power is identified and used to tune the WEC (wave energy converter) to that frequency?
- CD! Can a block diagram of the basic control system be provided? Is the control a feedback type using state variable modeling? If not, then describe the control theory being used.
- Claims to have developed a control system approach that can be used with other WEC technologies. Mentioned seven different control methodologies. Are the control methodologies available, and if so are they available to the public? Can signal flow block diagrams be provided for each of the seven control methodologies?
- Increasing energy capture efficiency will be a valuable contribution to the MHK community

Question 2: Methods and Approach

- Challenge of current state of the art WEC dynamic models is clearly insufficient
- Very exciting development of the use of pressure-based sensors for wave state estimation. This method of integration of sensors into the WEC structure is innovative and creates opportunities for use in other WEC designs.
- Good, well-structured approach
- What is the nature of the PTO (power take-off) output? Can the voltage characteristics be provided? Is the output voltage alternating current or direct current? If alternating current, then what is the nominal frequency and what is the range of rms (root mean square) voltage?
- Device agnostic tool is a crucial goal
- Well-planned and executed project

Question 3: Technical Accomplishments and Progress

- The public dataset and methods for testing/system ID should provide substantial further research/collaboration opportunities. For example WES (Wave Energy Scotland) has a controls call upcoming in 2017 and a mirror project should be encouraged with the WES developers.
- The use of pressure sensors is outstanding through integrating and adapting existing technology for wave state estimation
- Good understanding of the practicalities of achieving the attractive results shown in theoretical projects
- Very good presentation - good investigation of PTO force and associated cost
- Based on the number of technical papers prepared and accepted for presentation and publication it appears that these researchers made significant progress
- Good results. Combination of numerical and lab work.
- Laboratory tests at NSWC (Naval Surface Warfare Center)

Question 4: Project Management

- Additional funding required to support model design and fabrication. This is significant budget increase and should have been addressed during scoping.
- A well-managed project
- No comment
- Well-managed project

Comments made by reviewers during the evaluation of this project (PRID 78)

Question 5: Research Integration, Collaboration, and Technology Transfer

- Impressive collaboration with space and military R&D; step change / leap ahead in control implications for wave sector
- Outstanding communications and technology transfer with number of publications; use of webinars, conference presentations and most popular dataset on MHK-DR (Marine and Hydrokinetic Data Repository)
- Good tech transfer from defense - good publications
- Looks at also reducing structural loads
- The public database is a worthwhile accomplishment
- The technical accomplishments are listed in the summary
- Strong publication record
- Strong, collaborative team of government, academia, and industry: NSWC Carderock, Michigan Technical University, South Dakota School of Mines and Technology, ATA Engineering

Question 6: Proposed Future Research, if applicable

- Agreed that next steps are to apply to a second device. Evaluation of WES developers or others through WES/EMEC (European Marine Energy Center) networks.
- Good array control future research proposed
- Future effort on the control modeling is in order
- Proposed future research would be worthwhile if funding permits

Question 7: Project Strengths

- Roadmap for WEC controls and supporting methods is vital to WEC energy absorption increases. The advantage of this advanced control should also demonstrate ability of WEC to operate in extreme conditions for improved survivability.
- Is there collaboration between this project and the Re Vision controls project - not currently - but there should be !
- Strong analytical team
- Device agnostic goal
- Numerical models verified by lab tests
- Strong team, good results

Question 8: Project Weaknesses

- None noted
- Quantity of publications and webinars is impressive. However one would expect that there would be more than one publication in an IEEE publication.

Question 9: Recommendations

- Geophysical companies (Schlumberger Q sensors, and CGG for example) have state of the art pressure sensors that should be evaluated and used for providing more accurate data predictions
- Technical publications describing the controls methodologies should be encouraged. It would be helpful to the industry if PTO electric energy conversion devices and associated control models were developed. This would be helpful in the case where a WEC device were to be connected to an operating electric distribution feeder or grid scale high voltage substation.
- Continue with project
- Perform full-scale tests if funding permits.

DOE Water Power Technologies Office 2017 Peer Review Project:

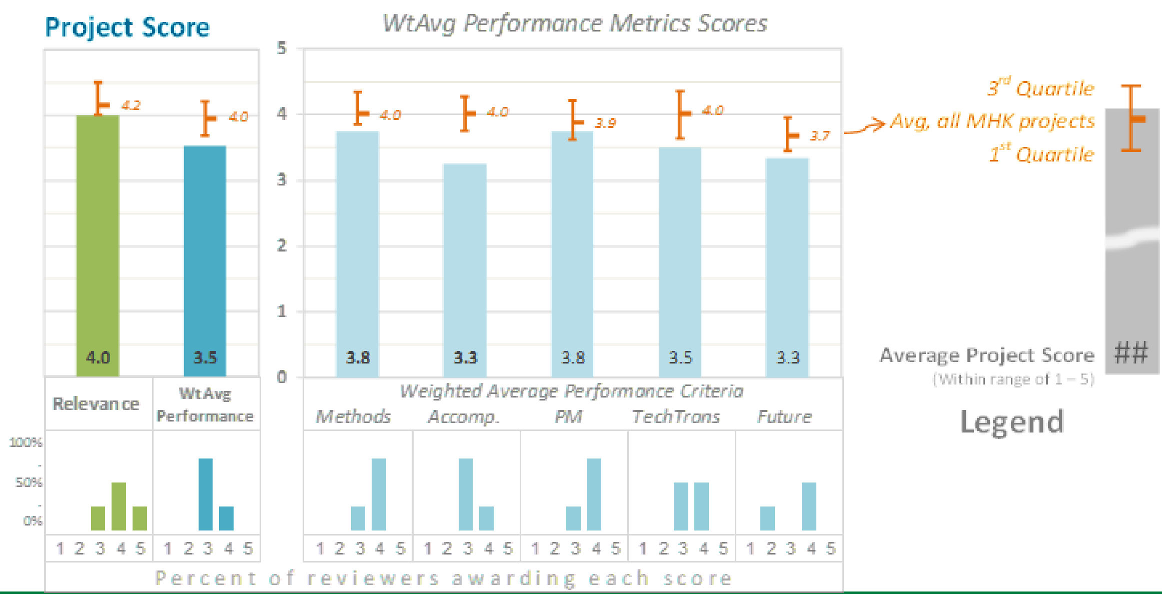
Passive Control for WECs (NASA CDOF)

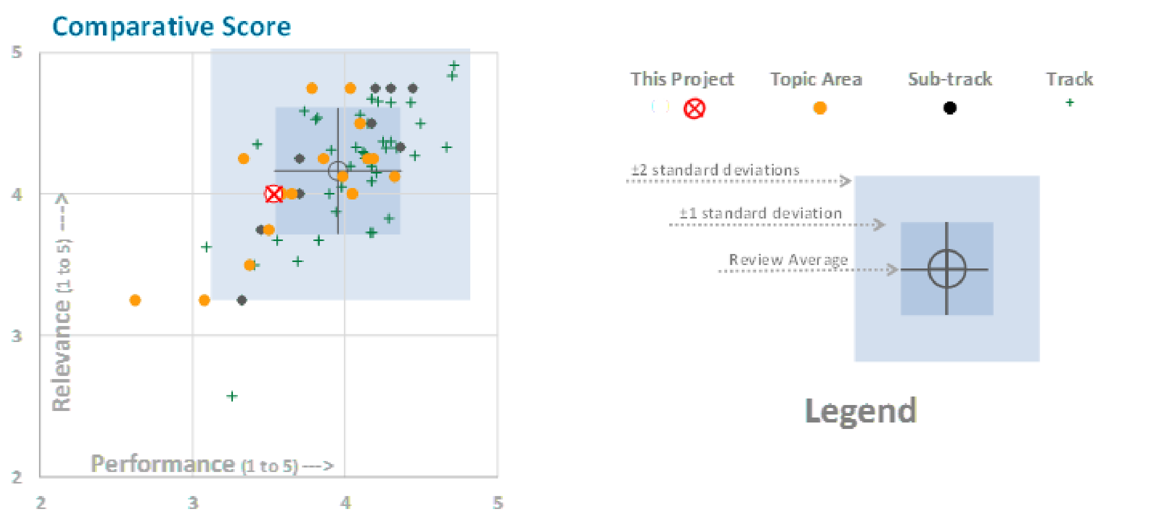
Principal Investigator	Vincent Neary, Sandia National Laboratories
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 0.2 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.2 M**	**100%**

Peer Review ID# 79





Comments made by reviewers during the evaluation of this project (PRID 79)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Impact: project has identified and demonstrated early TRL (Technology Readiness Level) WEC (wave energy converter) technology developers a strategy to reduce design complexity and cost. It is not clear whether the currently funded WEC developers at more advanced TRL stages could take advantage of these findings. See recommendations for additional comparative research.
- Product: demonstrated proof of concept; SAND report with study details, paper submitted to RE (renewable energy) journal
- Target/Perf Metric: maximum theoretical limit of absorbed power over full range of incident wave periods; energy capture increased by broadening the bandwidth response
- Fits well with program
- How was the energy input to the PTO (power take-off) device measured? What is the nature of the mechanical input to the PTO? Need description of the linear converter input to the PTO.
- Increasing energy capture efficiency will be a valuable contribution to the MHK community

Question 2: Methods and Approach

- A well-structured method
- It is not clear how the term "reactive power" is being used in paragraph 2 of the summary. Reactive power is used in electrical terms to quantify the inductive (magnetic field flux) and capacitive (electric charge field) as opposed to real power in the form of heat produced by electrons flowing through an electric resistance.
- Well-designed project

Question 3: Technical Accomplishments and Progress

- The compressible - body providing unidirectional power flow is demonstrated for PTO efficiency and also important in terms of comparison for power conditioning with bi-directional power flow
- Theoretical increases of absorption width are demonstrated and of great interest moving forward
- Control only of the device - not the PTO
- Good forward thinking with regards to future devices
- Interesting but not clear how it’s utilized - may have benefited from industrial partners
- It is not clear what the accomplishment(s) is/are. Is there a result that can be quantified in terms of force (lbs. or nt) and associated motion (ft/sec or m/unit time)?
- Limited theoretical model with calculations

Question 4: Project Management

- Appears to be well managed project
- Inadequate information about project management
- Well-managed

Question 5: Research Integration, Collaboration, and Technology Transfer

- Technology transfer from NASA (National Aeronautics and Space Administration) CDOF (compressible degree of freedom) is outstanding. I rate overall as good because Sandia labs coordination with UK researchers did not happen until after project had begun. It is a missed step that should be avoided in further to ensure robust scope of work on an important topic as WEC control technologies.
- Good example of tech transfer from fuel tank technology
- It is not clear how it will be used by industry and not clear how it will be implemented
- Since this work is based on prior work with NASA it involves collaboration and an attempt at technology transfer
- Limited project team. SNL and NASA only.

Comments made by reviewers during the evaluation of this project (PRID 79)

Question 6: Proposed Future Research, if applicable

- Linking this work with the Advanced WEC Dynamics and Control project will be important to further experimental understanding of a compressible point absorber
- NA (not applicable)
- The base work was done by NASA as an analysis of the physics of fluid motion and some form of associated mechanical power. However the explanation of the application to the conversion of mechanical power and energy to electric power and energy does not resonate with this electrical engineer. Additional research, if approved, should focus on an explanation of Compressible Degree of Freedom physics in terms of electric energy and power terms.
- Need to determine the practicality of building a WEC device with a compressible degree of freedom component before putting additional funds in this project

Question 7: Project Strengths

- The effects on conversion efficiency with the compressible volume acting as storage important in terms of unidirectional power flow to the gird. The grid regulations for reactive power are stringent and normally not addressed until the device is ready to deploy. Key to understand the site requirements in terms of connection restrictions early.
- Fluid motion and associated motion and forces
- Project is addressing an important topic, namely, improving the efficiency of wave energy devices

Question 8: Project Weaknesses

- Re-scoping the project based on findings of other UK researchers demonstrating the benefits of compressible point absorber WEC's. Fundamental to all MHK research is ensuring research efforts are not duplicated.
- Does not explain how the physics of fluid motion result in usable electric energy and power
- Project summary hard to follow. It is not clear from the presentation whether or not the improvement in energy extraction efficiency is significant.

Question 9: Recommendations

- There are a number of passive control designs underway from the EU. It appears there is potential for design or optimization convergence. Comparison studies should be included in the future research opportunities, which opens possibility for increasing technology transfer.
- An interesting project but needs an application
- Provide an explanation of how the forces and motion of fluids result in mechanical power that can be converted to electric power and energy
- Need to determine practicality of a WEC device with a compressible degree of freedom component

DOE Water Power Technologies Office 2017 Peer Review Project:

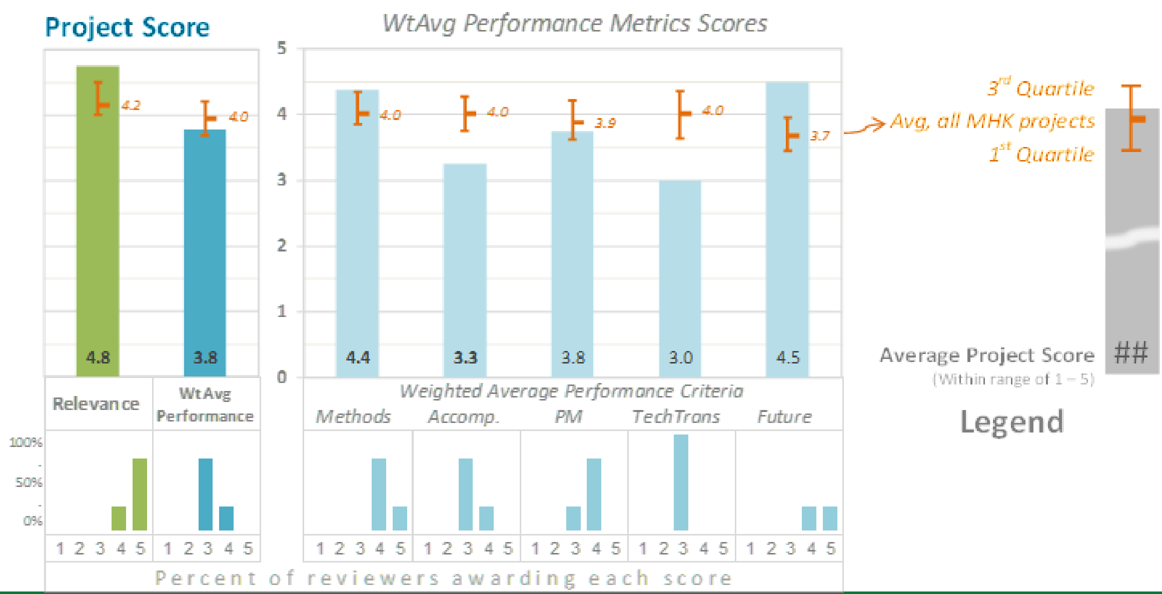
Advanced Technology Integration and Demonstration (FY16 FOA 1418 Topic Area 1 Awards Overview)

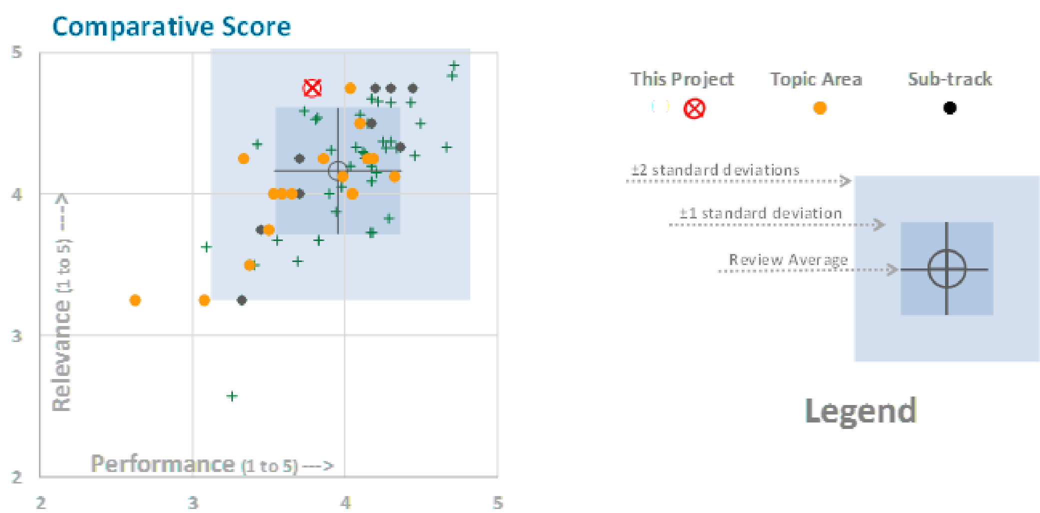
Principal Investigator	Alison LaBonte, DOE Program Manager
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 2.6 M	17%
Cost Share	$ 13.0 M	83%
Total	**$ 15.6 M**	**100%**

Peer Review ID# 86





Comments made by reviewers during the evaluation of this project (PRID 86)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- 3 technologies funded; Oscilla Triton-C 80 kW WEC (wave energy converter) novel design; ORPC (Ocean Renewable Energy Company) cross flow tidal turbine deployed in floating configuration and DresserRand air turbine PTO (power take-off)/OE (Ocean Energy) OWC (Oscillating Water Column) WEC all with in-sea testing for 1 year at WETS (Wave Energy Test Site)/Maine/EMEC (European Marine Energy Center)
- All demonstrations and critical to objectives and goals of program
- An excellent project to integrate solutions into devices
- Not entirely clear how this fits with the wave energy prize
- The TA1 (Topic Area 1) project's objective is to work with three selected WEC project approaches and assist in the achievement of a $0.15/kWh LCOE (levelized cost of energy) target value
- This project is supporting three field demonstrations which will provide valuable knowledge and technology to the MHK community

Question 2: Methods and Approach

- Clear goals for respective technologies evidenced; integrate MHK hardware into optimized system, fabricate full scale, install and demonstrate and demo improvements in AEP (annual energy production) and LCOE
- An excellent approach to derisk and integrate sub system development
- Apparently the three selected projects have met predetermined WEC performance criteria. In that regard they are "operational" and need assistance to refine their systems in terms of improving operational efficiency.
- Award to three separate technologies is an especially good plan
- Well-designed project

Question 3: Technical Accomplishments and Progress

- Awards made
- Not clear from the overview the actual technical progress made
- Project was initiated in Dec 2016 and its only accomplishments are identification of goals
- Project has just begun. No results or progress to evaluate.

Question 4: Project Management

- Efficient schedule and budget periods with Go/No-Go decisions
- Appears a well-structured and managed process
- See project #18
- Project has just begun. No results or progress to evaluate.

Question 5: Research Integration, Collaboration, and Technology Transfer

- Awards process and thus limited on collaboration and technology transfer until the results of the individual company projects produce results
- Not clear from this overview presentation what the collaboration and tech transfer involves
- None reported since project just started
- One would expect that results will be reported at appropriate professional society meetings; including: IEEE Power Energy Society, NHA (National Hydropower Association), CIGRE (International Council on Large Electric Systems), etc.
- Project has just begun. No results or progress to evaluate.

Comments made by reviewers during the evaluation of this project (PRID 86)

Question 6: Proposed Future Research, if applicable

- NA (not applicable)
- NA
- Are PSS/e (Power System Simulator for Engineering) and/or PSLF (GE Positive Sequence Load Flow Software) models of the mechanical and electric components available for use in preparation of short circuit and transient stability studies required by FERC (Federal Energy Regulatory Commission) interconnection SGIA (small generation interconnection agreement) and LGIA (large generation interconnection agreement) system impact studies?
- How will the point of interconnection to the electric power grid for the PMEC (Pacific Marine Energy Center) test facility be determined? Will it be in accordance with FERC SGIA requirements? What is the voltage at the point of interconnection?
- Question from the audience about how the test site was selected. Test is to be "full Scale".
- What equipment cost components are included in the capital costs? Provide reference to the DOE's basis for an LCOE value of $0.15 per kWh. What is the Base Line LCOE in Project #86 Summary description?
- Not applicable

Question 7: Project Strengths

- Significant Funds for fabrication, deployment and testing for 1 year in real sea conditions
- Should provide solid "real time" costs that can be used by receiving electric distribution companies
- Another strength is planned field tests
- The strength of this project is that the planned improvements will be widely applicable in the MHK industry

Question 8: Project Weaknesses

- None evidenced
- It is not clear if the capital costs used in the LCOE calculation include the cost to transmit electric power and energy from the PTO unit in the ocean to an on-shore point of interconnection with meter
- None noted

Question 9: Recommendations

- Design a follow up business exploitation and technology dissemination plan for Oscilla, ORPC, DresserRand. Utilize a business support voucher if needed.
- Confirm if/that FERC rules regarding interconnection to operating distribution companies were followed and indicate which rules apply
- Describe how the point of interconnection to an on-shore electric distribution company was selected
- Continue project

DOE Water Power Technologies Office 2017 Peer Review Project:

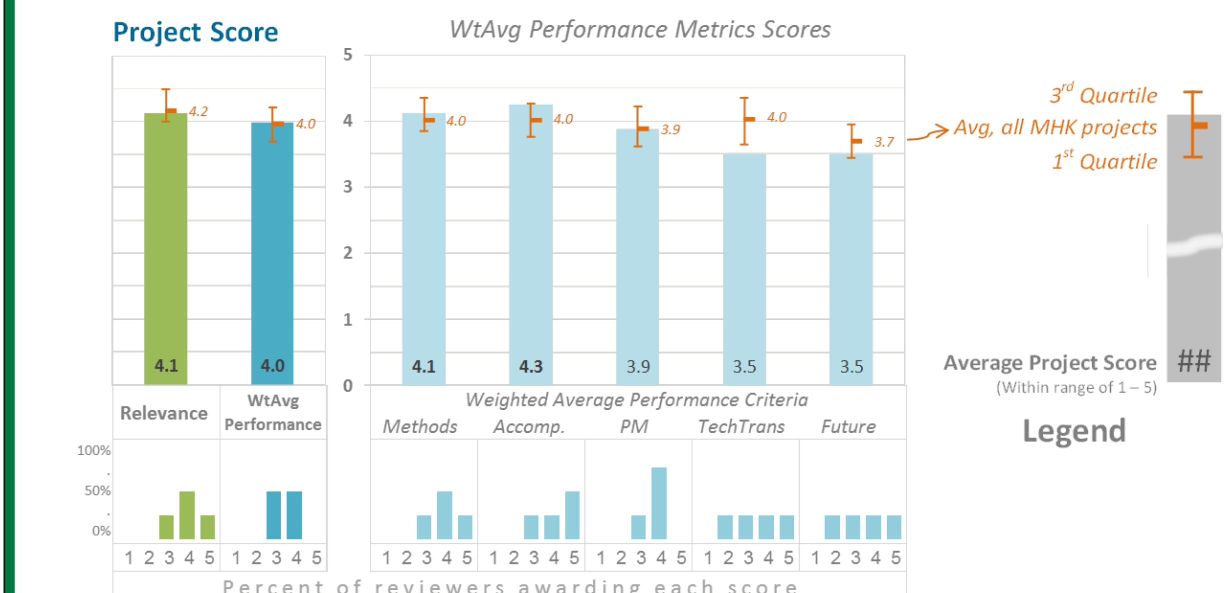
Direct Drive Wave Energy Buoy

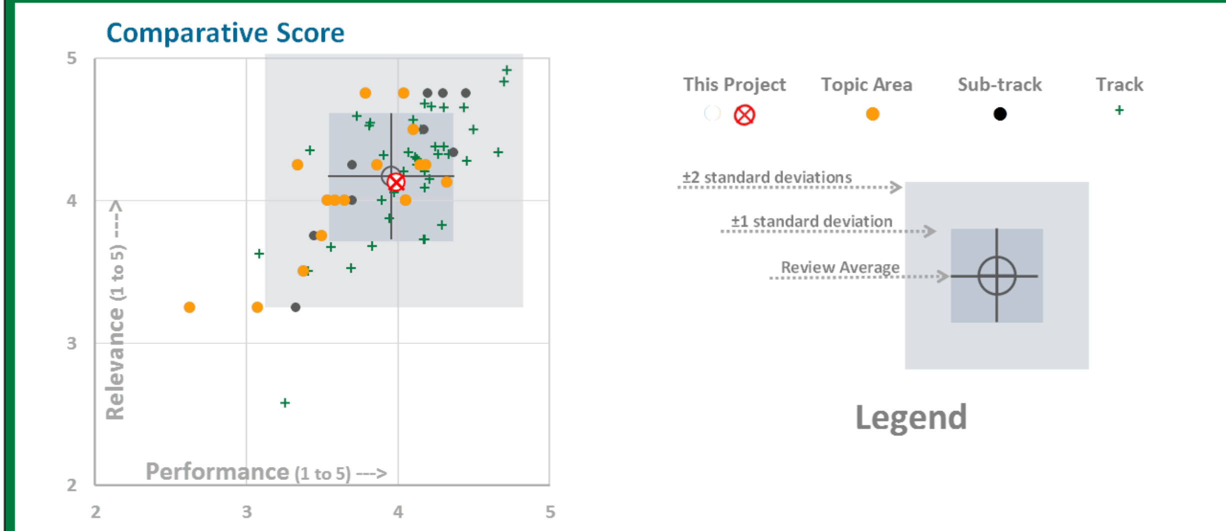
Principal Investigator	Ken Rhinefrank, Columbia Power Technologies, Inc.
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 1.5 M	60%
Cost Share	$ 1.0 M	40%
Total	**$ 2.5 M**	**100%**

Peer Review ID# 144





Comments made by reviewers during the evaluation of this project (PRID 144)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Not sure I see the relevance to industry by helping DNV GL establish process for certification. This process is relevant for DNV GL to develop the certification market.
- Prepare for full scale demo - TRL (Technology Readiness Level) readiness; increase stakeholder confidence, DNV GL certification statement of feasibility
- Technology maturity summary points not aligned in presentation If the aim is technology maturity the key point is development of the WEC (water energy converter) in prep for open water testing
- Although this project is clearly in alignment with the overall goals of the sector it is not clear how this fits with subsystem development
- Good progress towards a commercially viable device. Needs more research regarding how an array of these devices would be configured and connected to an on-shore Point Of Interconnection (ie. Substation).
- How many other projects have received the certificate of Feasibility?
- PTO (power take-off) provides DC (direct current) output that is then converted to AC (alternating current) and stepped up to a high voltage for transmission to an on-shore metered POI (point of interconnection).
- USE OF THE TERM "LOAD" IS IN THE STRUCTURAL MECHANICAL SENSE. However, the term "load" has a different meaning to electric power engineers. Since the objective of the WEC is to generate electric power and energy, then a foot note to clarify that the term "load" is being used in the mechanical or structural sense would be helpful.
- In-water demonstration of WEC device is an important DOE objective. This project completed the preparation towards that end for the Columbia Power Technologies StingRAY device.

Question 2: Methods and Approach

- Additional design optimization during tank testing: change in float design where one float fits within the others…eliminates need for end stops cost as much as PTO. How did that change your OPEX (operating expense) costs in terms of improving maintenance? End stops are a structural impact all components in chain have to be considered.
- Moorings condition monitoring and development of controls additional learning during this project
- PTO tank testing is difficult due to all the losses in the tank
- Trusted approach backed by Statement of Feasibility from DNV GL
- A good approach although it appears to be more of a novel device project more than a sub systems development project
- It is not clear whether this is the whole device or just the PTO or other sub system that is being developed
- PTO provides DC output that is then converted to AC and stepped up to a high voltage for transmission to an on-shore metered POI
- Well-planned project

Question 3: Technical Accomplishments and Progress

- 3 design iterations occurred with final being certified with DNV GL
- Average 100kW range
- Mooring 3 points to single point that was designed theoretical and demonstrated at WETS (Wave Energy Test Site)
- SCADA (supervisory control and data acquisition) designed, built tested and installed - for generator under System Health Monitoring same thing - how to control system and notifying operators will be improved through the SCADA designed. Does the SCADA design system have the ability to be adapted for other WEC's?
- This project outputs impact the inputs/outputs for the other funded projects; The critical path, cost and risk reduction tasks for open water demo did not fully mitigate the issues Cpower has had during projects 154 and 188
- A clear benefit to the overall structural feasibility of the device by the removal of the end stops
- Appears a number of sub systems have been improved but not clear which ones
- Good progress towards a commercially viable device. Needs more research regarding how an array of these devices would be configured and connected to an on-shore Point Of Interconnection (i.e. Substation).

Comments made by reviewers during the evaluation of this project (PRID 144)

- Completed all necessary planning and design for preparation to test device at the Navy WETS facility
- First DNV-GL WEC Certification: Completion of Failure Modes, Effects, and Criticality Analysis, Issuance of the Statement of Feasibility

Question 4: Project Management

- Cost share support necessary from Oregon Wave Energy Trust
- Delays due to certification body merger – out with control of project manager
- Project management appears to be effective
- Receipt of a certificate of Feasibility is an indication of good project management
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good and appropriate collaboration and technology transfer
- Appears to be project specific to the developers needs and has limited tech transfer both in and out of the project
- One would expect more technical papers for a project that has reached this level of development
- Strong collaborative team: Columbia Power, Ershigs Inc., DNV-GL RA, DNV-GL RC, Concept Systems, Oregon State University

Question 6: Proposed Future Research, if applicable

- Development of a programmable mooring controller. Ensure alignment with the successful results of the previous highly scored control presentations.
- Scaled PTO development rigs
- There needs to be more aims listed here for where the future research necessary will support and achieve the deployment at WETS
- Not clear
- As noted in the project summary there is a need for R&D with regard to a PTO that can be connected to an on-shore grid
- Future research proposed is the extended use of the SCADA System in an open-ocean, grid-connected test at WETS; Universal small-scale PTO; and programmable mooring controller. These are useful tasks if funding permits.

Question 7: Project Strengths

- The recommendations for future research are critical to the industry as a whole and it would be good to anonymize data/results of PTO scalability and PMC (programmable mooring controller) so as to stimulate next steps for research priority areas
- PTO provides DC output that is then converted to AC and stepped up to a high voltage for transmission to an on-shore metered POI
- First DNV-GL WEC Certification: Completion of Failure Modes, Effects, and Criticality Analysis, Issuance of the Statement of Feasibility
- Preparation for a field test

Question 8: Project Weaknesses

- Ability to identify and mitigate the critical path tasks and risks that have occurred in project 188
- No clear identification of lessons learnt across all Cpower projects including this one
- USE OF THE TERM “LOAD” IS IN THE STRUCTURAL MECHANICAL SENSE. However, the term ”load” has a different meaning to electric power engineers. Since the objective of the WEC is to generate electric power and energy, then a foot note to clarify that the term “load” is being used in the mechanical or structural sense would be helpful.

Question 9: Recommendations

- Certification process - DoE collaboration with certification bodies to achieve best practice for certification
- PMC programmable mooring controller
- Universal Scaled PTO - PTO development rig…
- Provide a description of the PTO electric output to be connected to an on-shore point of delivery for a single WEC unit or an interconnected array of units
- Project complete

DOE Water Power Technologies Office 2017 Peer Review Project:

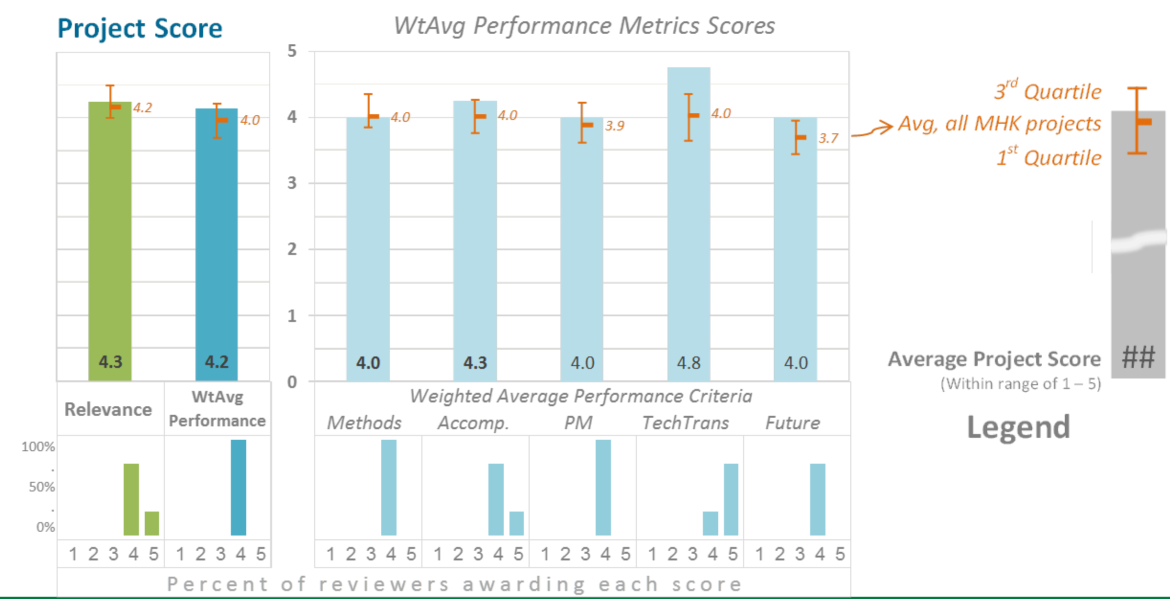
Advanced Energy Harvesting Control Schemes for Marine Renewable Energy Devices

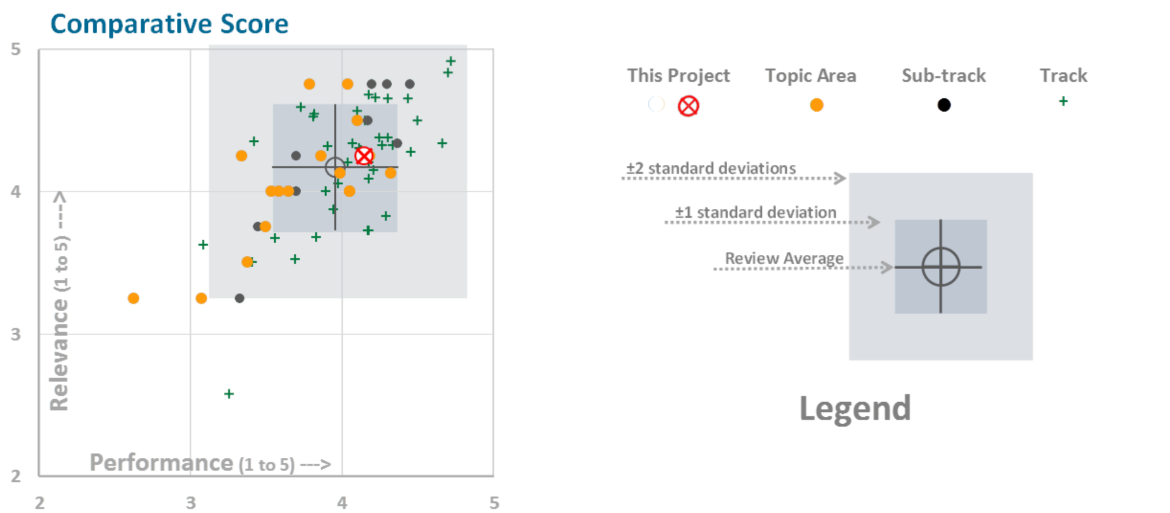
Principal Investigator	Jarlath McEntee, Ocean Renewable Power Company, LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 1.9 M	80%
Cost Share	$ 0.5 M	20%
Total	**$ 2.4 M**	**100%**

Peer Review ID# 152





Comments made by reviewers during the evaluation of this project (PRID 152)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Good achievements in AEP (annual energy production) and PWR (power to weight ratio) from 10% to 25.5%. On target for LCOE (levelized cost of energy) of 20% improvements.
- The benefits to industry in terms of advances in environmental monitoring are secondary and are not directly attributed to impact for innovative MHK components
- Fits well with the program aims
- BP! Example described is for a small isolated electric load separate from an interconnected grid with multiple generators. How would this system work if it were connected to a grid with multiple generators?
- Is the process dispatchable? What happens if the PTO (power take-off) output is greater than the electrical load? Is the system capacity in kW less than the minimum electric load of the village? If so, then what is the other generation source or does the village practice load shedding?
- Optimization of power production for a river turbine will be a valuable contribution to the MHK community

Question 2: Methods and Approach

- There appears to be a gap missing between the implement and validate the feedforward controller in step 3 and step 4 where the control scheme is refined and how it will impact behavior of the turbine
- Very well explained by Brian Polayge compared to write up in the summary. It was clear how the performance of the 3 torque controllers responded. Including the knowledge gained from turbulence studies from the field trails.
- Good structured approach of different methods for comparison
- Good understanding of the effect of turbulence on performance of turbine
- Four control technologies were evaluated. It is not clear what the control methodology was for the controllers. Were they feedback, feed forward? What mathematical models were used and|or developed? Can technical papers be presented that describe the control methodology?
- Well-planned project

Question 3: Technical Accomplishments and Progress

- Clear progress against the intended targets for AEP/ LCOE
- It is clear the adaptive Kw2 feedforward controller has the ability to control the nonlinear system accurately
- Valuable understanding from the adaptive Kw2 (unable to insert symbols into spreadsheet?)
- Solid results with clear correlation between tests
- Stable controller identified
- Installation of a working installation at Igugig Alaska
- Both laboratory and field tests performed
- Positive results with regard to increased energy production

Question 4: Project Management

- It is understood that Data analysis deadline was too tight within the data collection quarter. Does not seem to have made a difference in on time schedule.
- Appears to be a well-run project
- Seems good work with clear outcomes
- No comment
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good number of papers published. Strong technology transfer demonstrated with training of PhD students.
- Very good integration with the partners demonstrated. The results and impact on the Alaska community were also demonstrated. Value will be seen by the public stakeholders when projects such as this demonstrate value including the environmental impact or lack of substantial impact to the fishing industry which it is assumed the Alaska community was reliant on.
- EU H2020 collaboration with partner project
- Well disseminated results used on industry device

Comments made by reviewers during the evaluation of this project (PRID 152)

- Eight publications were prepared and presented
- Numerous papers published
- Strong collaborative team including industry and academia: Ocean Renewable Power Company, Univ of Washington, AeroCraft, and Nortek.

Question 6: Proposed Future Research, if applicable

- It appears the Kw2 feedforward controller is part of ORPC (Ocean Renewable Power Company) IP (intellectual property) and thus limited technology transfer could occur
- NA (not applicable)
- Investigate applications at existing small hydro plants that do not have locations for an on-shore power house
- Proposed future research would be worthwhile if funding permits

Question 7: Project Strengths

- Close collaborations with UW (University of Washington) and for the project to address deployment barriers to further support research focused on retiring or mitigating environmental risks and reducing costs
- NA (not applicable)
- Control system methodology may have other applications
- Combination of numerical, lab and field studies. Strong team.
- Potential application to remote villages

Question 8: Project Weaknesses

- No factors appear to weaken the project
- Possible limited application. Can the system be used on a large river like the Mississippi or its tributaries?

Question 9: Recommendations

- It is recommended to determine IP and see if the adaptive feedforward controller can be utilized in other floating TEC (tidal energy converter) designs
- Since the result of the WEC (wave energy converter) is an output of energy in the form of electricity it would be expected that a publication describing the mechanical/electric conversion device would be in the list of publications. Perhaps a future paper can be submitted to the IEEE Power Energy Society.
- Project complete

DOE Water Power Technologies Office 2017 Peer Review Project:

Power Take-off System for Marine Renewable Devices

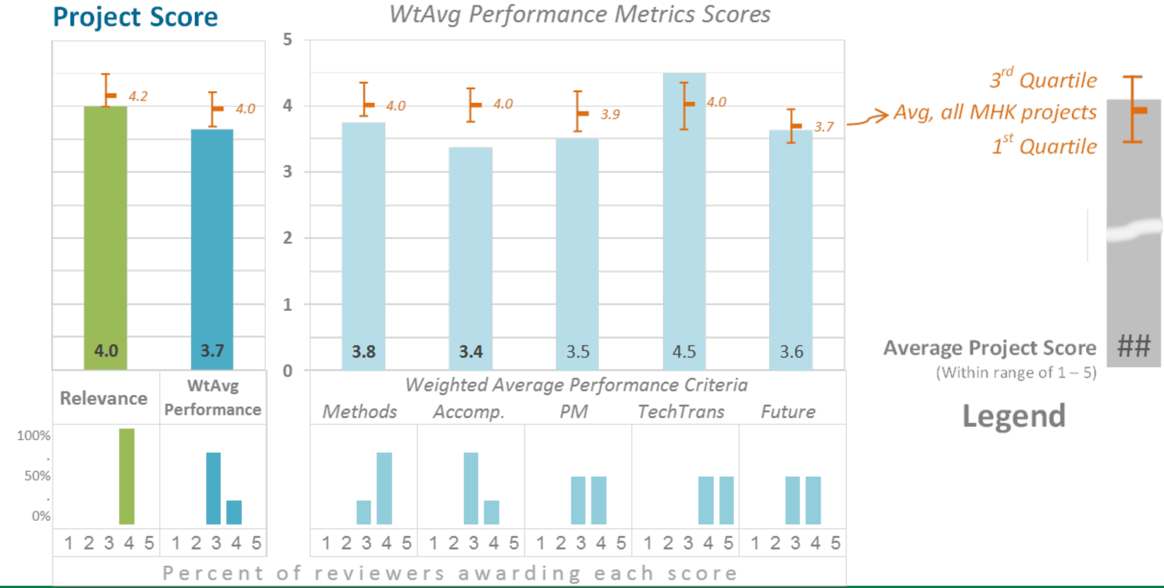
Principal Investigator	Jarlath McEntee, Ocean Renewable Power Company, LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

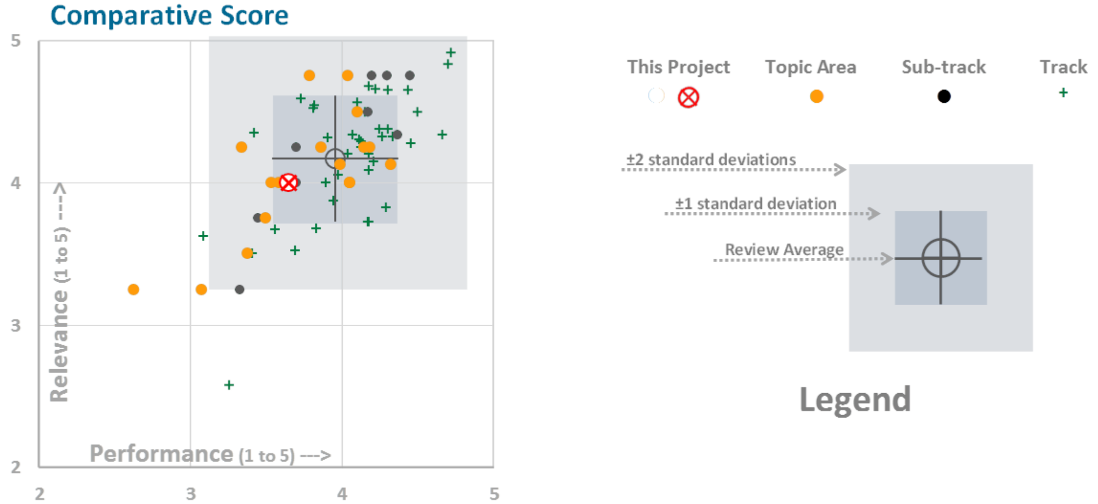
DOE	$ 3.0 M	86%
Cost Share	$ 0.5 M	14%
Total	**$ 3.5 M**	**100%**

Peer Review ID# 153

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 153)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Aims of project: solve bearing issues that lower LCOE (levelized cost of energy) and design an electrical generator (seawater flooding issues - due to seal wear/failure)
- Impact: PWR (power to weight ratio) by 23%, availability target 94%; reduction in LCOE of 25%
- A good project in full alignment with sector needs
- This project is relevant to the water power industry because it provides a way to accomplish the Wave to Wire objectives of the DOE program
- This project is developing improvements to components of an MHK PTO (power take-off). Those components are bearings, couplings and a subsea electrical generator. These improvements will be widely applicable in the MHK industry and therefore will be a valuable contribution to the MHK community.

Question 2: Methods and Approach

- Bearing design is optimized and important for the project; sliding polymer thrust loading onto the bearings resulting in wear; looked at different types of bearing designs roller element and oil lubed but water ingress will cause bearing failure
- Change of machine design from SR (heavier) to PM architecture. Rolls Royce testing their encapsulation technology to seal stator windings - 'wet gap' solution. ORPC (Ocean Renewable Power Company) is developing bearings for wet gap version.
- Generator design has overlap fully flooded moving away from seals; oil filled at the moment incremental results
- Movement of the shaft to end of structure due to the issues on seals and shafts with the permanent magnet generator
- Seal is the greatest failure; lipseal - 3 years - won't give guarantee; 1 year life specific and dependent on operating environment
- An ambitious project but with a well-structured approach
- One would expect that the participation of Rolls - Royce Marine will address the bearing and related materials issues
- The change from a series reluctance to a permanent magnet generator appears to be justified on technical grounds
- The issues addressed in this project appear to be focused on mechanical issues; that is bearings
- "... validate the bearing solutions in test facilities, and incorporate them into the design of a cross-flow turbine."
- "...design a high reliability electrical generator system for application in MHK devices... "
- Well-planned approach, including the two item listed below:

Question 3: Technical Accomplishments and Progress

- Bearing design with low wear rates; and 5 year service life target with reduction on LCOE OPEX (operating expense) costs is the expectation. But will know results during the testing in Feb 2017
- Weight reduction significant to LCOE including reduction of length of final PM design
- The flooded system has significant advantages for the entire sector
- RR (Rolls Royce) completed design package is reported. Tangible results are yet to be reported.
- Some success in bearing tests
- Still needs to develop bearing and generator submerged solutions

Question 4: Project Management

- Delays in windings and other manufacturing components; potential avoidance if manufacturer were directly involved in project and not subcontracted out
- Scope variance but appropriate change from SR to PM generator for project
- Appears a well-managed project
- It is not clear what the IP (intellectual property) arrangements will be with Rolls Royce and this will be essential to investigate if the entire sector is to benefit
- Several setbacks and delays are reported
- Well-managed project

Comments made by reviewers during the evaluation of this project (PRID 153)

Question 5: Research Integration, Collaboration, and Technology Transfer

- Component learnings from development of the no leak seals and bearings would be important for technology transfer
- Strength of industry in project with Rolls Royce, but additional manufacturer on project potentially have avoided manufacturing delays
- Excellent tech transfer by adapting an existing RR product
- Has applications all across the MHK and other marine industries
- Four major publications
- "What is the approximate electric power output in Kilo Watts? Ans. About 150 kW.
- Are the bearing and generator “seals” problems resolved?
- The LCOE calculation by NREL includes the cost or the interconnection from the output of the PTO to a POI (point of interconnection) with the receiving utility."
- Several NREL publications completed
- Strong collaborative team: Ted Lesster, RCT Systems; Levi Kilcher, NREL; Rick Fontana, Fontana Engineering; Hal Youngren, AeroCraft; Eduard Muljadi, NREL; Rolls-Royce Marine, Espen Schuller

Question 6: Proposed Future Research, if applicable

- Generator in-sea testing. Why can't Rolls Royce provide in house testing of this generator first to improve/inform generator targets for ORPC? Appears ORPC having to take significant risks for the generator testing.
- Limited description of future research provided
- Can the bearing and generator “seals” problems be resolved? The LCOE calculation by NREL includes the cost or the interconnection from the output of the PTO to a POI with the receiving utility; will the cost to convert Direct Current (DC) output to alternating current (AC) be included in future?
- Suggested future in-water test of generator and driveline system would be extremely valuable

Question 7: Project Strengths

- Clear and identified problems with well-defined requirements for solutions
- The cross flow turbine approach to the Wave to Wire objective provides a solid base for this project
- Wide applicability of the technology being developed

Question 8: Project Weaknesses

- Lack of manufacturer on project
- Some issues with logistics regarding the "in water" testing

Question 9: Recommendations

- Future testing liability risks shared with Rolls Royce or other companies who have capacity to take on shared liability
- Update the Research Integration & Collaboration with names, authors, dates of the technical papers
- The summary indicates that the output of the electric generator will be direct current. Will there be an added effort to add or include additional electric equipment (ex dc to ac inverter) and provide an alternating current voltage that is compatible with existing electric power grid (i.e. 60 Hz) systems?
- Complete project

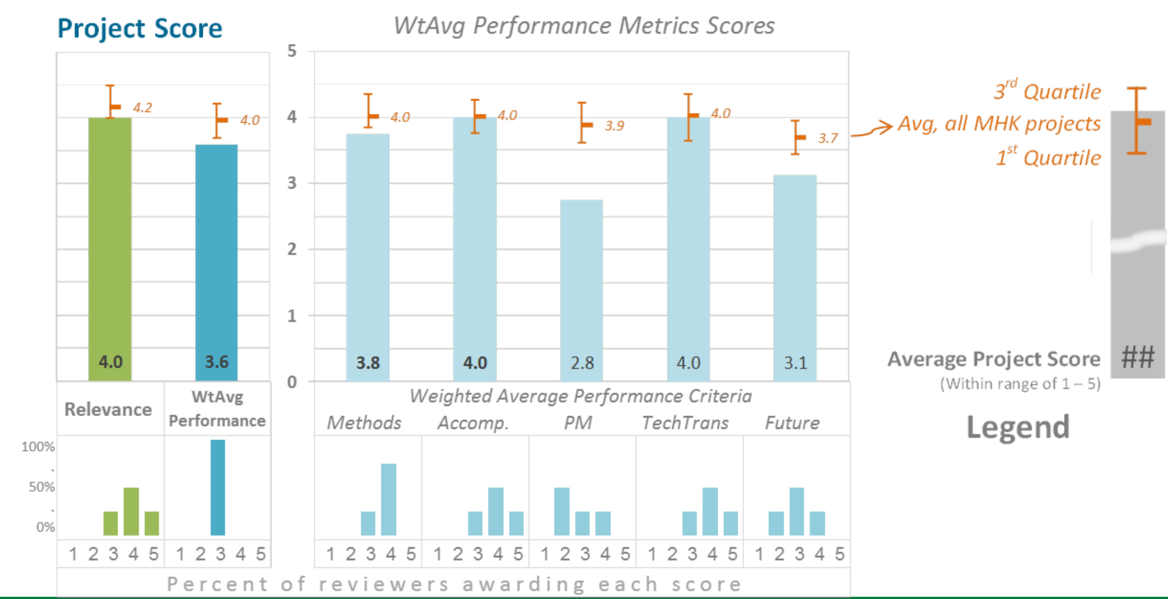
DOE Water Power Technologies Office 2017 Peer Review Project:
Build and Test of a Novel, Commercial-Scale Wave Energy Direct-Drive Rotary Power Take-off Under Realistic Open-Ocean Conditions

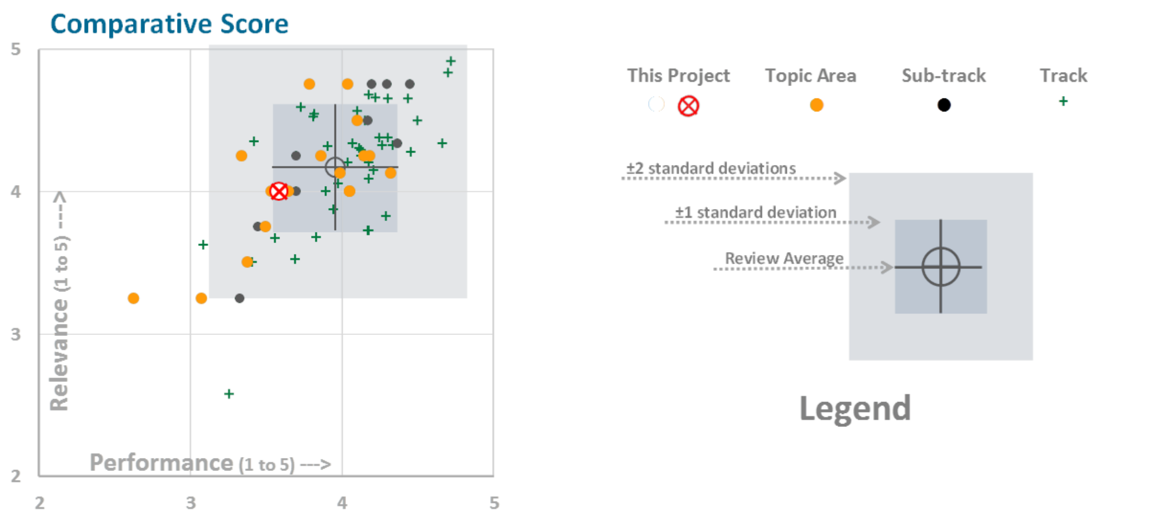
Principal Investigator	Ken Rhinefrank, Columbia Power Technologies, Inc.
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 3.0 M	45%
Cost Share	$ 3.6 M	55%
Total	**$ 6.6 M**	**100%**

Peer Review ID# 154





Comments made by reviewers during the evaluation of this project (PRID 154)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Cross sector impact for Wind
- Next step Generator development permanent magnet - 7 m diameter; torque 1M N. Had to scale down diameter by 10% and generator to save on costs. 100MW roughly
- A good PTO (power take-off) project meeting sector needs
- This project addresses phase II objectives in that it demonstrates how established rotating generator design principles can be applied to convert slow rpm high torque WEC (wave energy converter) energy into electric energy
- Work is being done in preparation for an in-water demonstration at WETS (Wave Energy Test Site). In-water demonstrations of MHK devices are a critical objective of the Water Power Office.

Question 2: Methods and Approach

- Demonstrating knowledge capture through scaling up
- Did a SPIR for low-speed drive. Average RMS (root mean square) speed < 1rpm very challenging and cost is high at those speeds for direct drive generator…gearbox or hydraulics with speed ups and torque down have O&M (operations and maintenance) challenges. Direct Drive path is better and cost effective. No high air gaps ability to demonstrate in 1/10th scale; challenges in building at scale.
- Good use of the NREL facilities' 7 m diameter machine
- It appears from the photos in the summary and presentation that the machine construction has similarities to conventional single speed synchronous hydro generators. However there are obvious major differences too.
- The machine is shown to be mounted in a horizontal position. Given the weight one wonders if the bearings at either end of the shaft will be expensive and require frequent maintenance. Have the designers considered the possibility of a machine on a vertical shaft?
- The summary indicates that the DDR (direct-drive rotary) PMG (permanent magnet generator) machine has low "system inertia". What is the value of the moment of inertia of the rotating part of the machine and how does it compare with the moment of inertia of a conventional synchronous speed salient pole hydro generator of similar weight and diameter?
- Well-planned project

Question 3: Technical Accomplishments and Progress

- 55% PWR (power to weight ratio) over comparable over high speed high torque vs high speed low torque
- Novel air-gap control system for wave and potentially wind market
- Testing small scale storage - 10 kW level for the DC (direct current) energy storage system
- It is really not clear where the LCOE (levelized cost of energy) reductions come from
- Sealing appears to be an issue as is corrosion
- Major accomplishments include design, fabrication and testing of the rotor. Given the large physical size of the machine this is a major manufacturing accomplishment.
- Began important land-based test of an innovative PTO, described as "… most effective PTO for this application is a slow-speed, high-torque, direct-drive-rotational (DDR) permanent magnet generator (PMG)."

Question 4: Project Management

- Issues with the seals are a challenge undergoing repair works; Seals continue to plague industry and thus partnering with Seal OEM (original equipment manufacturer) that may not have had much experience could have been avoided. This statement is not completely justified by evidence it is an assumption at this stage.
- The above is a resourcing challenge
- Sum overrun on the testing schedule
- No comment, see also project #18
- Very concerned about the effect of this work on the planned WETS deployment. Is enough attention being paid to the WETS schedule?

Comments made by reviewers during the evaluation of this project (PRID 154)

Question 5: Research Integration, Collaboration, and Technology Transfer

- The ability to utilize NREL facilities appears added value for the project
- Good collaboration with NREL
- A presentation was made at the IEEE PES (Power and Energy Society) 2016 general meeting in Boston, and one would expect that there will be future presentations and papers at CIGRE (International Council on Large Electric Systems) and other international conferences
- Participation of Siemens implies that their experience as designers and manufacturers of large hydro generators of similar physical size will result in a machine that will be practicable in commercial operation
- Strong collaborative team: Ershigs, Inc. – Generator and Test Stand Structural Design, NREL – NWTC (National Wind Technology Center) Test Facility and Support, Siemens – Generator Active Materials and Power Electronics Supplier, Northern Power Systems – Generator Mechanical Design, Greenberry – Test Stand Supplier, Katon – Bearings Supplier, SpenTech – Drive Shaft, Fixed Shaft, and Drivetrain Flanges Supplier

Question 6: Proposed Future Research, if applicable

- Good proposed future research focused but has capability to demonstrate impact to rest of industry for a next gen air gap control system
- Good future airgap and tech transfer research proposed
- Can there be some discussion about the range of mechanical power capacity (input & output) of this DDR PMG machine? This could be based on a comparison similar to those prepared by manufactures of conventional small and large hydro generators. What is the range of mechanical power capabilities of the DDR PMG machine?
- How does the air-gap of this slower speed machine compare to the air gap on existing hydro turbine generators with speeds greater than hundreds of rpm?
- What is the magnetic flux density in the air gap and how does it compare to that of a similar higher speed hydro generator with a similar diameter?
- Complete project
- Do not fund future research. The device needs to be prepared for deployment at WETS.

Question 7: Project Strengths

- The lessons learnt in scaling up are invaluable for Cpower and industry (lessons learnt) this is a strength but a costly one (weakness) for the project overall
- Availability of testing station
- Significant manufacturing means and methods
- Work is being done in preparation for a field test at WETS

Question 8: Project Weaknesses

- Costly delay due to seal manufacturing issue
- Based on experience with similar size hydro generators one wonders about how a WEC device in active service would be serviced?
- Given the physical size and mass of materials one is lead to contemplate if a reasonable power to weight ratio is achievable
- "This project is satisfying an essential risk-reduction step prior to CPower's next open-ocean deployment. Since such a PTO has never been tested before, it is appropriate to do so first on land ..." What is the effect on the WETS field test?
- The initial stages of testing have commenced. If these tests are not successful, what is the effect on the WETS field test?

Question 9: Recommendations

- As per recommendations in project 163
- Detailed registration of lessons learnt, and continue risk evaluation for each manufacturing stage. Concern cost of transportation to WETs will skew Cpower LCOE.
- If the manufacturers are willing to continue to provide cost sharing that is several orders of magnitude greater than the DOE contribution, then the program should continue. However if the manufacturers are not willing to continue to provide significant cost sharing contribution, then this would be an indication that the manufacturers' have concluded that the machine is not commercially or technically viable.
- Complete project

DOE Water Power Technologies Office 2017 Peer Review Project:

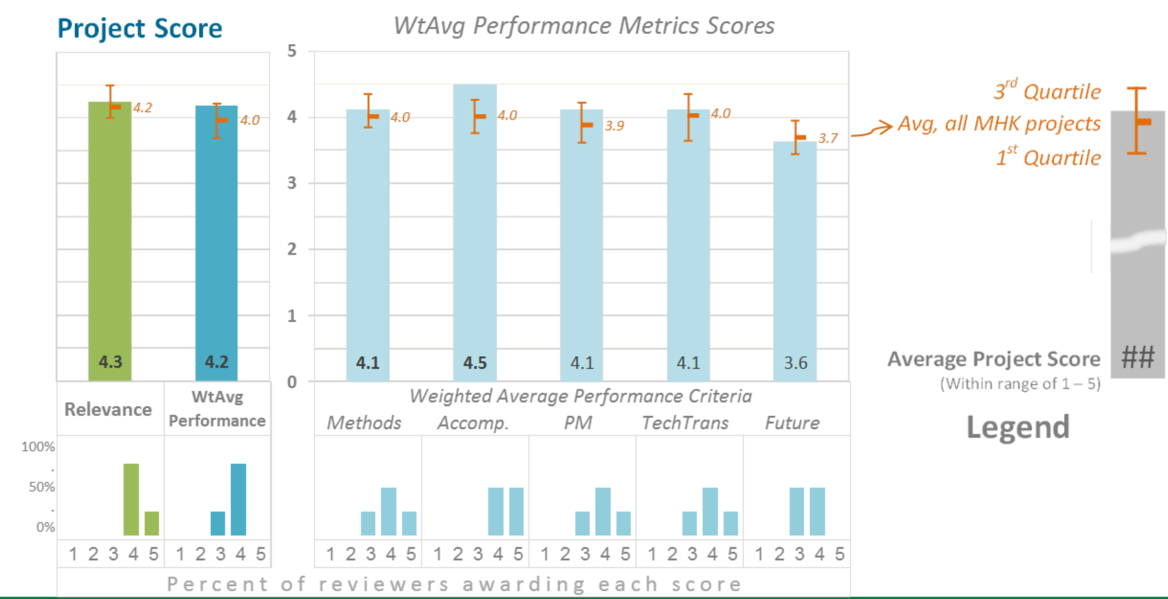
Advanced Direct-Drive Generator for Improved Availability of Oscillating Wave Surge Converter Power Generation Systems

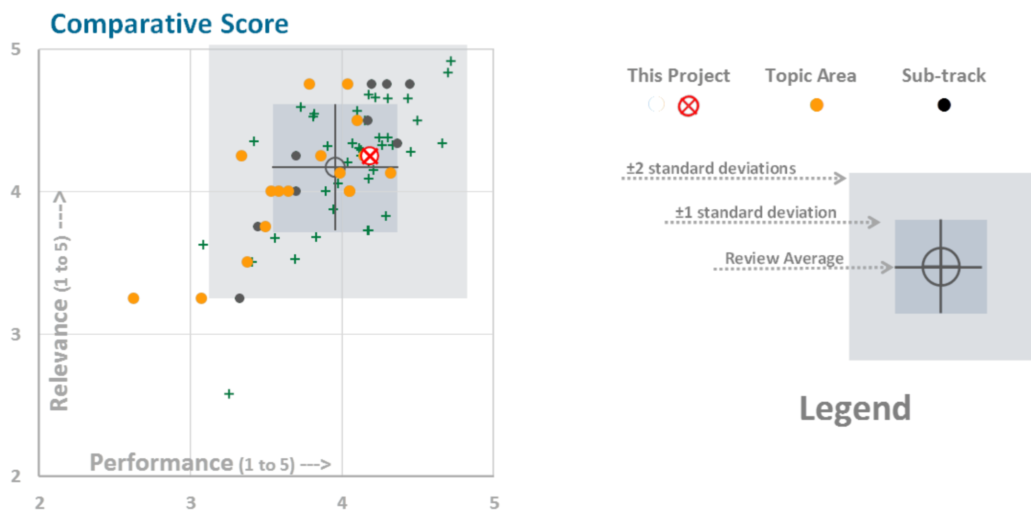
Principal Investigator	Dr. V.R. Ramanan, ABB, Inc.
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 2.0 M	67%
Cost Share	$ 1.0 M	33%
Total	**$ 3.0 M**	**100%**

Peer Review ID# 155





Comments made by reviewers during the evaluation of this project (PRID 155)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Clear understanding of the challenge and identification of solution for low speed high torque direct drive generator.
- Comment on RME (Resolute Marine Energy, Inc.) improvement over existing PTO (power take-off) system is significant but that could be a function of a poorly designed PTO for the RME device. Would be interesting to understand if this generator would achieve improvement in energy generation for other WECs (wave energy converters).
- A good novel project in direct alignment with sector goals and needs
- "Average speed of mechanical output of the WEC is less than 2 rpm. Can a graphic or additional information about the 4 to 1 peak to average speed ratio be provided?
- What is the output to input efficiency of the magnetic gear?"
- This project is relevant because it attempts to address the problem of low speed high torque WEC energy input to overall PTO performance
- Development of a direct-drive electrical PTO will have a valuable impact on Water Power Office objectives

Question 2: Methods and Approach

- Aim to develop a reliable low speed high torque electrical generation
- Different approach to low speeds; low speed and variable speed of ocean waves. 3 air gaps inner stator high speed rotor interior and sandwiched in is the fixed poled modulated 11:1 magnetic gear ratio 30 rpm continuous operation. Inner rotor 300 rpm. Smaller prototype developed.
- A good methodical approach
- Development of a magnetic gear (speed torque converter) to increase electric generator rotational speed to a level that is at a reasonable level that can be used to provide PTO electric output
- Well-planned project

Question 3: Technical Accomplishments and Progress

- Challenges with positioning of the components not new challenges but achievable. Bearing issues have not been addressed.
- Cross sector markets identified and early commercialization opportunities are significant for ABB
- Industry milestone achieved; largest ever built 1/3 power 15x speed impact. LCOE (levelized cost of energy) impacts in terms of increased energy generation and improved maintenance and availability
- Good progress and met project goals
- Has a good novel approach using a magnetic gear
- Design, manufacture and testing of the magnetic gear and electric generator are major accomplishments
- One of the world's largest magnetically geared generators (0.8 m in diameter, 3800 Nm, 10 kW at 30 rpm) was successfully built and tested
- The original targets in LCOE and torque density by mass and volume have been met. 35% reduction in LCOE, an increase in efficiency by 33%, and generated energy increased by 26%.

Question 4: Project Management

- Project management effectiveness; ABB demonstrates strong product development lifecycle
- Appears to be a well-managed project
- No comment, but see project #18
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Commercial launch of low speed/high torque generator appears ready. Comment why did DoE need to fund ABB to deliver this generator when ABB could have seen market demand in other sectors to encourage internal development?
- Good collaboration with Industrial developers
- Has the option to transfer to number of devices
- The magnetic gearing has considerable benefits for the overall sector - both wave and tide

Comments made by reviewers during the evaluation of this project (PRID 155)

- Presentations at IEEE and ASME (American Society of Mechanical Engineers). Fixture presentations at IEEE should be directed to the Power Energy Society electric machines and energy conversion committees.
- There should also be presentations at CIGRE (International Council on Large Electric Systems) and this can be done via ABB
- Numerous papers, conferences and outreach to technical community
- Strong collaborative team: Resolute Marine Energy - expertise and specifications for the wave energy conversion system; Texas A&M - magnetic gear modeling and design of the prototypes; North Carolina State University - power converter and control system; Baldor (ABB) - assembly of the Phase 2 prototype

Question 6: Proposed Future Research, if applicable

- There will be a need to identify challenges/risks when marinized...sealed unit was the answer does not discuss the heat and condensation issues that could create issues with the generator
- Will need to address bearing issues not directly addressed in summary or in presentation
- Good future research to address future challenges
- The use of a complex device with two speeds has potential reliability issues. The need to service (maintain) bearings etc. may be a negative and result in excessive "down time". Needs further investigation. How common is this design in the electric power industry?
- Proposed future research of extension to marine propulsion would be worthwhile if funding permits

Question 7: Project Strengths

- Clear objectives aims for delivering a product to market
- Participation of ABB is a plus
- Improved PTO

Question 8: Project Weaknesses

- None evident
- What are the ultimate characteristics of the PTO's electric output? Will the output be Alternating current or direct current? If AC (alternating current), then what will the nominal frequency (Hz) be? What is the expected operating range of output voltage?

Question 9: Recommendations

- Evaluate whether DoE needs to fund ABB for this work? Or provide synergies with other developers for application and use of the generator.
- If the manufacturers are willing to continue to provide cost sharing that is several orders of magnitude greater than the DOE contribution, then the program should continue. However if the manufacturers are not willing to continue to provide significant cost sharing contribution, then this would be an indication that the manufacturers have concluded that the machine is not commercially or technically viable.
- Project complete

DOE Water Power Technologies Office 2017 Peer Review Project:

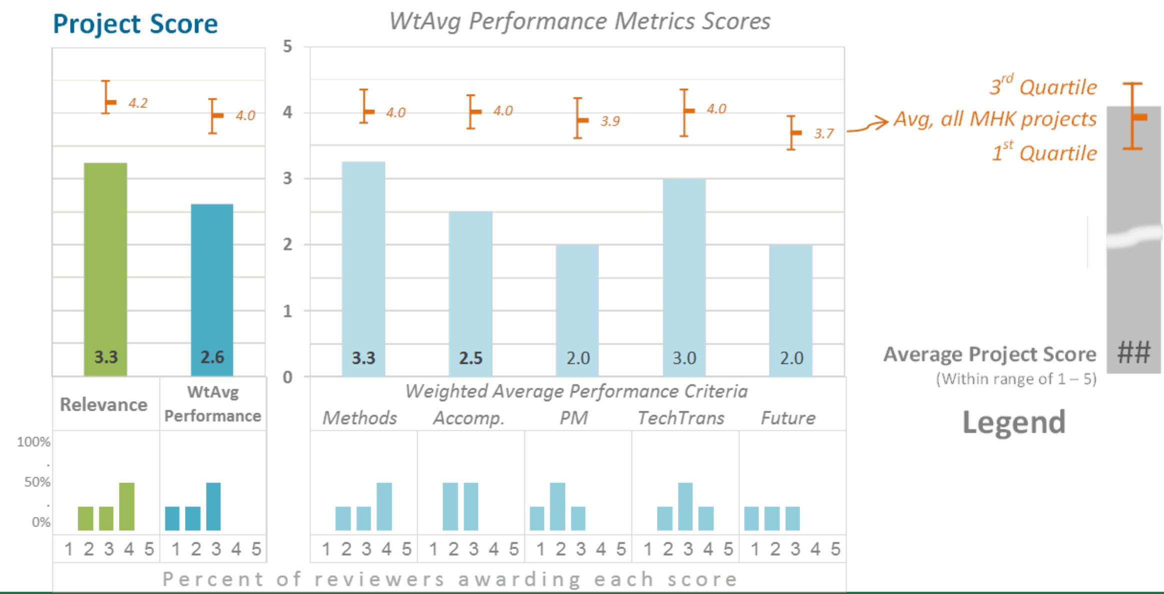
Optimal Control of a Surge-Mode WEC in Random Waves

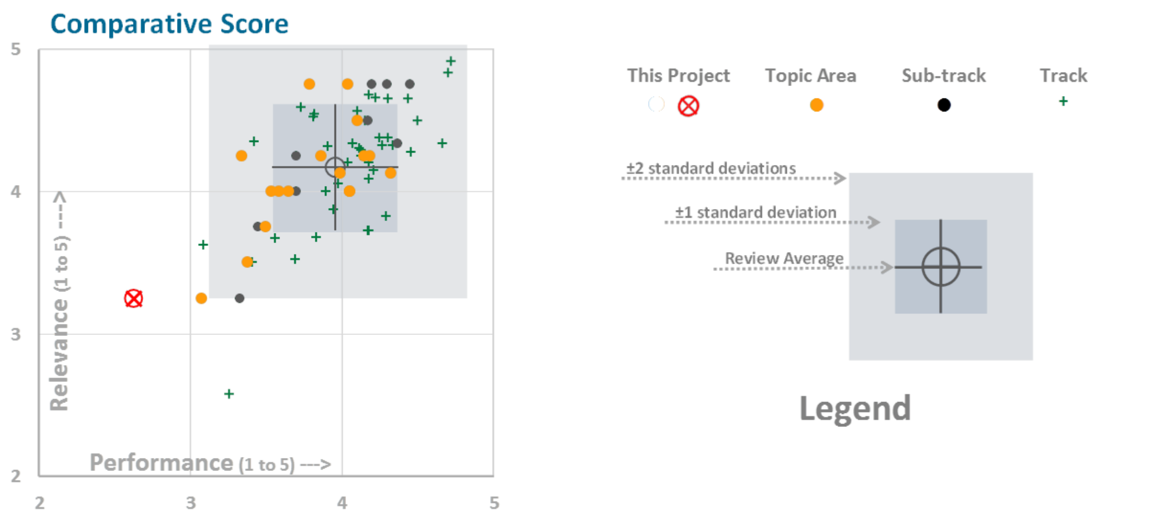
Principal Investigator	Allan Chertok, Resolute Marine Energy, Inc.
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 0.8 M	61%
Cost Share	$ 0.5 M	39%
Total	**$ 1.3 M**	**100%**

Peer Review ID# 156





Comments made by reviewers during the evaluation of this project (PRID 156)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Project had setbacks that negatively impacted results overall
- The comment in the slides that indicated the RME (Resolute Marine Energy, Inc.) LCOE (levelized cost of energy) model identified deficiencies in the NREL model were not well explained. The project aim was not to compare LCOE models but was to demonstrate reduction of LCOE.
- The intent was to demonstrate reduction of LCOE but demonstrating a significant reduction based on implementation of causal and non-causal controls system versus Coulomb damping was not presented effectively
- Fits well with the program aims
- CD! What is the nature of the hydraulic power input to the mechanical to electric converter? Is it a piston or a rotation? Is the output of the PTO (power take-off) mechanical/electrical energy converter alternating or direct current?
- Increasing energy capture efficiency will be a valuable contribution to the MHK community

Question 2: Methods and Approach

- 4 options presented; (evaluate 4 causal and 4 non-causal controller configurations). The results in flap capture efficiency gains are not explained well in terms of the approach on how RME reached the efficiency gains.
- It is not clear how the control strategy will be applied to the hardware
- Method appears adequate
- Table 1 of the summary provides good data for comparison of P1 and P2. Is the Rated Plant Power (kW) for the final SOPO (standard operating procedure) really 73.2 MW and 131.76 MW?
- Well-designed project

Question 3: Technical Accomplishments and Progress

- Comparison of summary and presentation accomplishments not clear. Demonstration of the outcomes and how they directly impacted LCOE reduction of 17% was not clear.
- It is not clear how the PTO will cope with the control strategy recommended
- There is development over time
- Identified potential efficiency gains but not verified by hardware tests

Question 4: Project Management

- Aims of the project changed continuously, and thus clear outcomes were difficult to evidence and impacts demonstrated were weak
- Budgeting of the project not exactly clear; had to get supplementary funds to cover and thus HIL (hardware-in-the-loop) testing was decided not to be funded by DoE
- Overall appears well run but it was not clear why the final section of the project was not completed
- The presentation indicates some lack of coordination
- There were budget issues

Question 5: Research Integration, Collaboration, and Technology Transfer

- This project would have benefited from collaboration with Nat/lab control projects
- Minimal dissemination of results in professional journals
- Good collaboration with industry and academia

Question 6: Proposed Future Research, if applicable

- NA (not applicable)
- None described in summary
- The project was stopped before hardware-in-the-loop test. Cannot recommend future research.

Question 7: Project Strengths

- The evaluation of causal and noncausal controller methodologies could be evaluated as part of the
- Plant power output of 720kW is encouraging
- Project is addressing an important goal of DOE, namely, improved efficiency of a WEC device

Comments made by reviewers during the evaluation of this project (PRID 156)

Question 8: Project Weaknesses

- The phase 1 project delivered theoretical evidence, but was not further funded by DOE. RME testing of the controllers was not complete and thus insight into how the advanced control system would be implemented in RME's PTO was not achieved. Net effect is that the LCOE analysis RME prepared will need data from further experimentation before results can be definitive.
- Does not give the output voltage of the PTO
- The project was stopped before hardware-in-the-loop test. Therefore results of work are of limited usefulness.

Question 9: Recommendations

- Can a description of the electrical output of the PTO be provided? Is the output direct current or alternating current? If alternating current, then what is the frequency?
- Do not commit any more funds

DOE Water Power Technologies Office 2017 Peer Review Project:

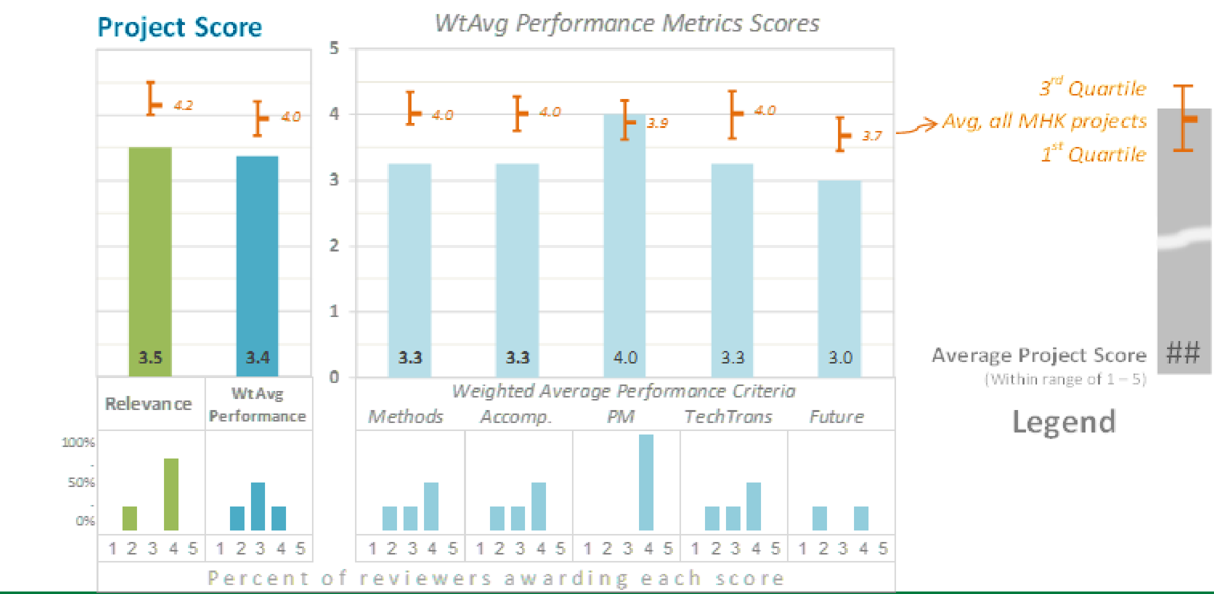
Optimization of Hull Shape and Structural Design for OE Buoy

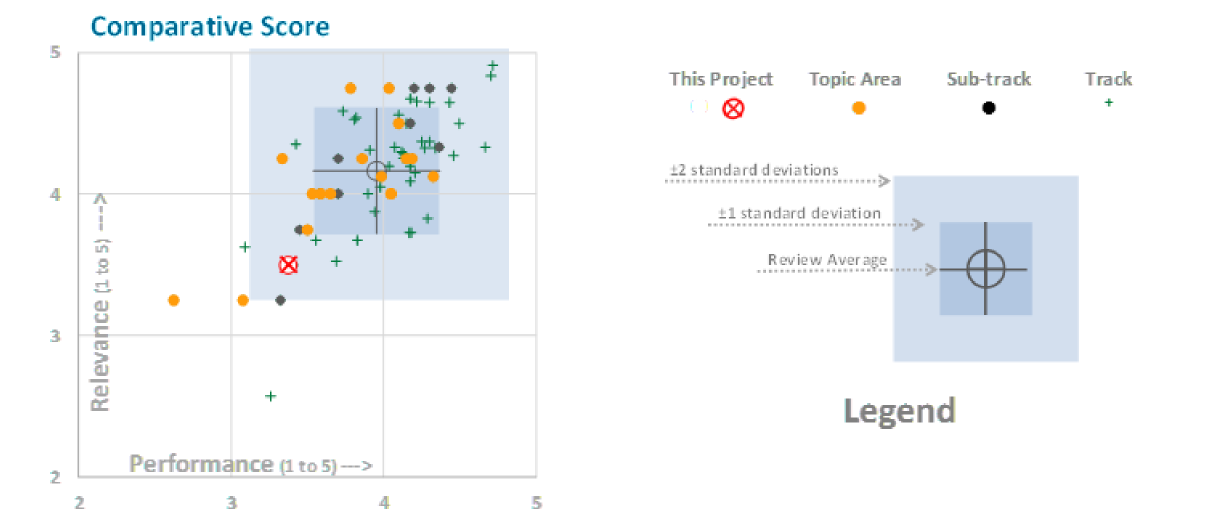
Principal Investigator	Mirko Previsic, Ocean Energy USA LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 1.0 M	85%
Cost Share	$ 0.2 M	15%
Total	**$ 1.2 M**	**100%**

Peer Review ID# 157





Comments made by reviewers during the evaluation of this project (PRID 157)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Reduction of LCOE (levelized cost of energy) through hull optimization ; challenge was the techno-economic optimal dimensions understanding the structural loads and material choices
- Strong results against targets: PWR (power to weight ratio) target of 50% improved by 60% results steel to FRP (fiber-reinforced plastic). LCOE simplified 65% reduction. ACE metric was also used and measures structural efficiency. Not part of the scope requirements but able to present the results holistically and should be evaluated as part of DoE metric study.
- The project is in direct alignment with the sector needs
- Presented an overview of the process as opposed to a report on the technology or energy capture device
- The obvious relevance is to convert wave energy into compressed air that is used to drive a turbine and some sort of electric generator
- Optimization of WEC (wave energy converter) hull design will be a valuable contribution to the MHK community

Question 2: Methods and Approach

- Abandoned the extreme load model using Leidos code…so how did you derive the loads for the model?
- Novel launch and recovery options - explanation given but not fully convinced of launch and recovery practicality at full scale
- Set up computational Model Setup RE-WEC (Resonant Wave Energy Converter) code (proprietary) similar to WEC Sim (Wave Energy Converter SIMulator) - 10 different parameters used for input
- Using a concrete / steel sandwich and new jointing process; concern is structural integrity along joints during extreme loadings. Not clear how the sandwich approach provides structural strength.
- Using different 100 configurations evaluated leading to techno-economic optimal size
- A very well structured approach
- Appears to be using conventional salient pole rotating machine technology adapted to low rpm and high torque
- The summary advises that the approach is to convert wave energy motion into compressed air such that the compressed air is used to drive a turbine that would drive some sort of electric generator
- Well-planned project

Question 3: Technical Accomplishments and Progress

- Biggest concern is the joints in the structure and number of cycles which will significantly impact the design
- Novel launch and recovery again in practice at full scale could have issues depending on site
- A very successful project with excellent potential for a number of devices
- Very thorough modelling approach
- The summary advises that the focus has been on a modeling effort
- Novel launch and recovery process
- Optimization of structure
- Validation at OSU (Oregon State University) test facility

Question 4: Project Management

- Some modifications due to subcontractors but unaffected overall budget. No apparent scope creep.
- A well-managed and structured project
- No comment, but see project #18
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Apparent generic design process related items to be transferrable to WEC industry through presentations at Conference
- Close coordination and support from national lab NREL for CFD (computational fluid dynamics) modeling
- Could have collaborations with the Sandia materials projects
- Makes reference to a future technical paper presentation
- "Strong collaborative team: Re Vision Consulting , Numerical Modeling, COWI Group/Ben Gerwick, NREL, Oregon State University Leidos"

Comments made by reviewers during the evaluation of this project (PRID 157)

Question 6: Proposed Future Research, if applicable

- NA (not applicable)
- Good suggestion of future tests around joints and fatigue
- Can the electrical characteristics of the PTO (power take-off) be provided? Specifically what is the range of output voltage? Is the electric output alternating current or direct current?
- Reduction of power to weight ratio
- Project complete

Question 7: Project Strengths

- Modeling and tank testing results that achieved improved PWR and reductions in LCOE
- Not obvious from information provided
- Ability to vary draft to enable launch and recovery is a significant capability
- Laboratory validation of scale model
- Optimized WEC structure

Question 8: Project Weaknesses

- Structural joints and loadings risks
- The novel launch and recovery process for the OE device if not successful at full scale will negatively impact LCOE
- A schematic diagram similar to the one in figure 2 of project # 79 would be helpful

Question 9: Recommendations

- Marine operations 3rd party review of the novel launch and recovery process for identification of any issues with handling
- More modeling necessary and FMECA (failure mode, effects and criticality analysis) analysis done for structural joints
- The researchers should be asked to provide a description of the expected electrical output of the PTO. This should include a description of basic electrical characteristics including alternating or direct current, range of voltage and if alternating current, then the nominal frequency (ex 60 Hz).
- How will the design be affected by Ocean Energy's decision to use the larger Dresser-Rand turbine for the follow-on test after WETS (Wave Energy Test Site)?
- Project complete
- Will the material be able to hold coating needed to prevent deterioration and marine growth?

DOE Water Power Technologies Office 2017 Peer Review Project:

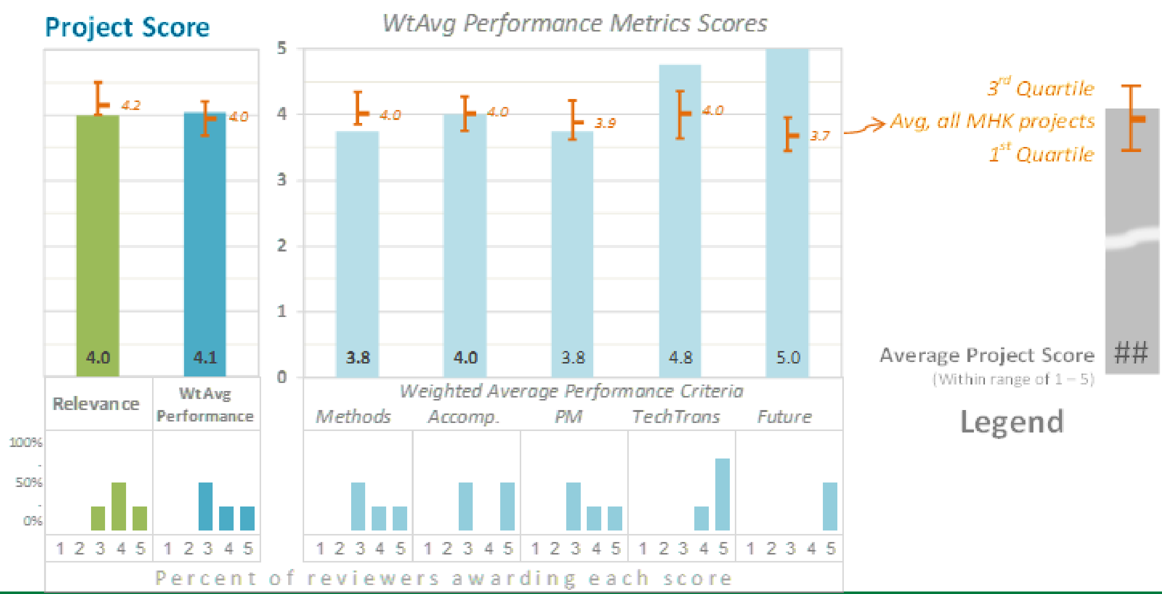
Advanced Controls for the Multi-Pod Centipod WEC device

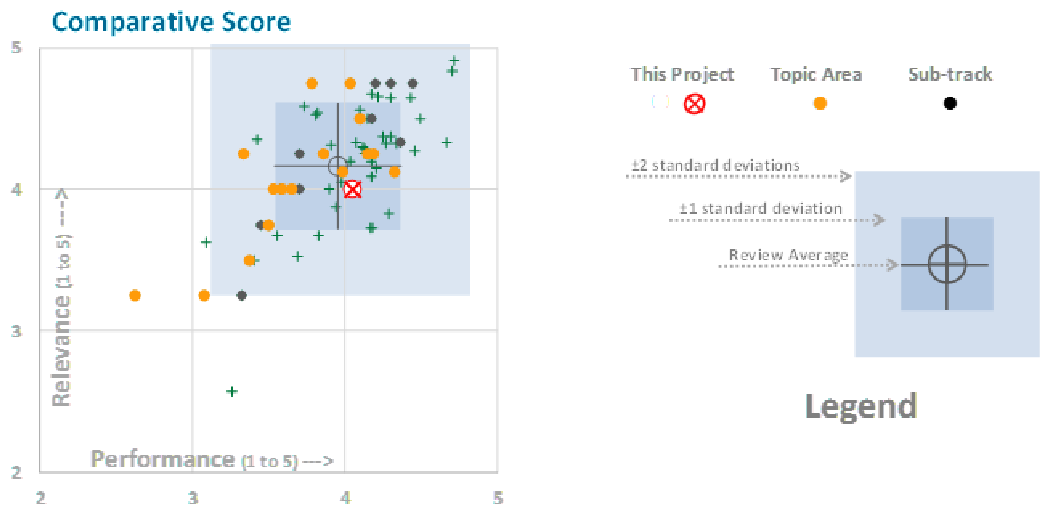
Principal Investigator	Alex Fleming, Dehlsen Associates, LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 0.5 M	80%
Cost Share	$ 0.1 M	20%
Total	**$ 0.6 M**	**100%**

Peer Review ID# 158





Comments made by reviewers during the evaluation of this project (PRID 158)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Centipod WEC structure is not a well-known device however an improvement of 160% in AEP (annual energy production) is significant. The use of MPC (multi-pod centipod) should be further demonstrated on other WEC designs.
- The project demonstrated outstanding results in terms of cutting LCOE (levelized cost of energy) in half compared to fixed damping control methods
- Good for with the program objectives
- CD! What is the nature of the mechanical force that would be input to a device that converts mechanical power into electric power and energy?
- If a linear force, then what is the range of speed in ft per second?
- If a rotating force, then what is the range of rpm?
- Is the mechanical power that is input to the electric generator a linear or a rotating force?
- Optimization of power production, if successful, will be a valuable contribution to the MHK community

Question 2: Methods and Approach

- Approach is straightforward and uncomplicated
- The overall method is adequate but it not clear why they use wavedyn and not wecsim (Wave Energy Converter SIMulator)
- Why doesn't the diagram of controller show the electrical output of the PTO (power take-off)?
- Well-designed approach

Question 3: Technical Accomplishments and Progress

- As noted 160% AEP and 50% reduction in LCOE are significant and out of all the controller related projects this one demonstrated the best overall progress
- It is not clear what the main achievements are - and what the original performance was that they got the 160 % improvement on
- No comment
- Excellent results. Numerical model showed significant improvement in power production.

Question 4: Project Management

- On time and on budget
- Adequate projects management appears to be in place
- No comment
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- The ability of lead PI (principal investigator) to organize inputs and outputs from DNV, OSU (Oregon State University), Helios Engineering, NREL and Sandia demonstrates strong research coordination
- Good publications - and also a public report
- It is not clear how some of these reports are shared with the sector
- The two IEEE papers are very informative and provide useful mathematical models
- Strong collaborative team: DNV GL, Oregon State University, Helios Engineering, National Renewable Energy Laboratory, Sandia National Laboratories

Question 6: Proposed Future Research, if applicable

- I would expand the future research opportunities to evaluate the MPC on other WEC designs
- NA (not applicable)
- This research team should be funded to continue the analysis used in the two IEEE papers
- Already being funded in another DOE MHK project

Question 7: Project Strengths

- The results / outcomes of utilization of the MPC are impressive, however I would like to understand the WEC it was applied to better. In other words are the improvements based on a suboptimal WEC design and thus the resultant increases so large? Would the MPC have as large of an impact on other WEC designs?
- The strength of project #158 is the mathematical analytic models as presented in the two IEEE papers
- Excellent results

Comments made by reviewers during the evaluation of this project (PRID 158)
Question 8: Project Weaknesses • None that can be readily seen • What are the electrical output characteristics of the PTO? Is the voltage alternating current or direct current? If AC (alternating current) then what is the RMS (root mean square) value and what is the nominal frequency in Hz? If DC (direct current) then what is the magnitude of the voltage (VOLTS) and maximum current (AMPS)? • Only used a numerical model. Laboratory and field tests are required to make the results more useful. **Question 9: Recommendations** • As above; further research utilizing MPC will be a significant step change in WEC control systems. It is critical the MPC is also demonstrated on another WEC design for AEP comparison. • See response to Q8. The quantities given in Q8 should be provided as part of the summary and presentation. • Project complete

DOE Water Power Technologies Office 2017 Peer Review Project:

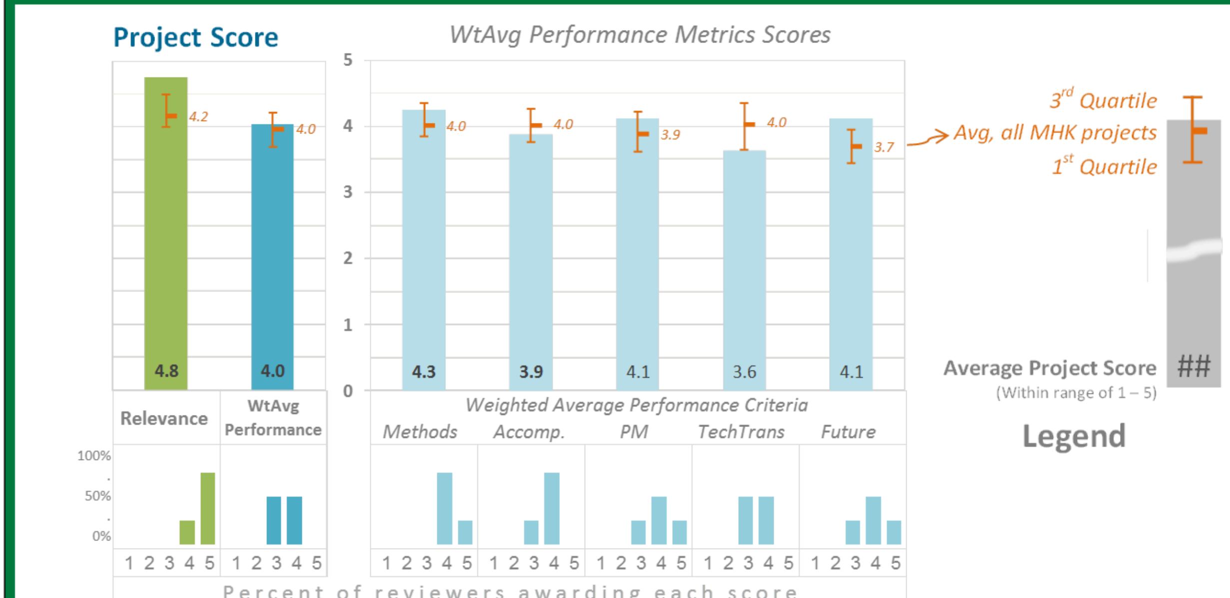
HydroAir Power Take Off System

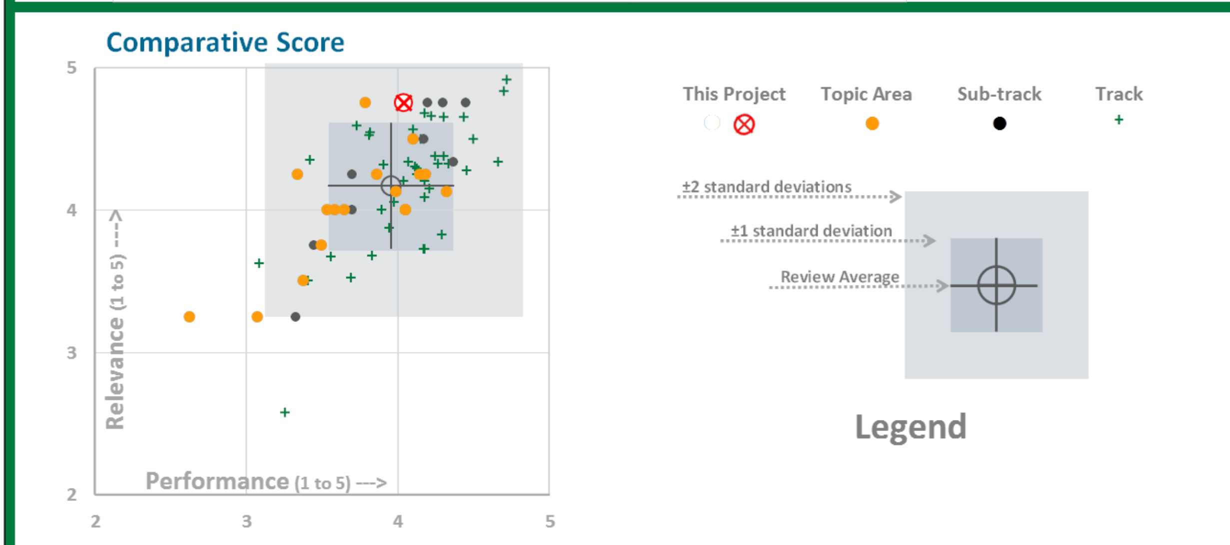
Principal Investigator	Gary Pearson, George Laird, Dresser-Rand Group, Inc.
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 2.5 M	68%
Cost Share	$ 1.2 M	32%
Total	**$ 3.7 M**	**100%**

Peer Review ID# 162





Comments made by reviewers during the evaluation of this project (PRID 162)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Novel HydroAir turbine PTO 500kW attached to OWC (Oscillating Water Column) on the Ocean Energy buoy
- Outstanding alignment with technology maturity and market development priorities first grid connect full scale system tested at WETs (Wave Energy Test Site); a test site milestone
- Reliability comments but as of yet unproven at scale
- Good project in direct alignment with sector needs
- This project's approach addresses the challenge of converting wave action energy to mechanical energy (in the form of compressed air) that is used to drive a synchronous generator and produce electric power and energy output that can be delivered to electrical loads. The project meets the "wave to wire" objective.
- Development of Oscillating Water Column air turbine advances the possibility that this particular WEC (wave energy converter) device type will be successful. This meets one of the critical objectives of the Water Power Office.

Question 2: Methods and Approach

- Build and test at WETs in Hawaii - 6 months testing
- Identification of the problem and addressing the solutions from the problem is evidenced in the approach taken. Especially with design reliability (one moving part) and incorporating a shut off valve increases survivability.
- A well-structured and run project
- Can a block diagram be provided showing the steps that are involved in the conversion of wave energy motion to compressed air to mechanical force at the input to the generator rotor shaft?
- This approach appears to have a two-step mechanical energy conversion process: (1) wave motion energy to compressed air and (2) compressed air driven turbine. From an energy conversion efficiency point of view is the efficiency of the two step mechanical energy conversion on a par with, greater or lesser than other technologies that have a single step conversion of oscillating wave energy to linear or rotational torque?
- Well-planned project

Question 3: Technical Accomplishments and Progress

- Design and manufacturing of PTO; however integration issues into OE's (Ocean Energy's) OWC
- The claimed 63% cost improvement is impressive but details need to be checked
- The figure titled "Electrical Power System" in the Power Point presentation under the heading "Technical Approach" implies that "Wave to Wire" has been built and demonstrated. If so, then this is the only project that is showing 100% Wave to Wire conversion.
- Completion date on slide 9 of presentation is December 2017. However, the device is planned for deployment at WETS (Wave Energy Test Site) in October 2017. Which is correct?
- Made progress on air turbine development

Question 4: Project Management

- Integration issues discussed and adjustments made to modified support structure - how did this impact budget? By $450K?
- PM (project management) risk identified with dependency on OE WEC device completed
- Some overrun - but appears a well-managed project
- No comment, but see project #18
- The participation of two major manufacturers Siemens and Dresser Rand, gives one confidence in the demonstration project
- Well-managed project

Comments made by reviewers during the evaluation of this project (PRID 162)

Question 5: Research Integration, Collaboration, and Technology Transfer

- Close collaborations evidenced; technology transfer through MHKDR (Marine and Hydrokinetic Data Repository)
- A very good set of industry partners
- I wonder if there is a link with the APL (Applied Physics Laboratory) blade manufacture project - this should be explored
- There is no mention in the summary of Pwr Point presentation that any technical papers or conference presentations have been made. If that is so, then the failure to share results with the professional societies is a negative against the project and is a disappointment.
- Strong collaborative team: Dresser-Rand; Siemens Industry, Inc. - Sub-contractors for electrical major buyout components; Ocean Energy - Project partner for testing the OWC-based OE buoy; Paxford Composites - Composite materials manufacturer, Composite Consulting Group
- Uploaded document to MHK data repository

Question 6: Proposed Future Research, if applicable

- Clear aim to commission and test at 1MW scale critical for industry success
- Good future research proposed
- Can the need for an AC (alternating current)-DC (direct current)-AC electrical converter be eliminated by the use of a compressed air storage tank and speed governor controlled air pressure at the input to the air compressor driven electric generator? If this were done, then would the overall Wave to Wire efficiency be improved?
- Complete project before considering any further research

Question 7: Project Strengths

- Novel and simple concept developed within a well-defined technology development lifecycle
- Project supports an in-water test at WETS, which is a high priority for the Water Power Program
- Simple design, one moving part, which increases reliability

Question 8: Project Weaknesses

- The summary, section 2, states: "The overall system is scheduled for deployment at the US Navy's Wave Energy Test Site (WETS) in Q2 of 2017." We are already in Q2 of FY17. However the presentation, slide 12, describes the FY17 work as "Finalizing system integration between HydroAir PTO and OE buoy; Testing and commissioning the PTO ..." Which is correct?

Question 9: Recommendations

- Finish project. Determine if the installation at the WETS will be delayed.
- Will exposure to the marine environment result in deterioration of the turbine?
- Will full scale flow rate testing be done on turbine to verify design flow?

DOE Water Power Technologies Office 2017 Peer Review Project:

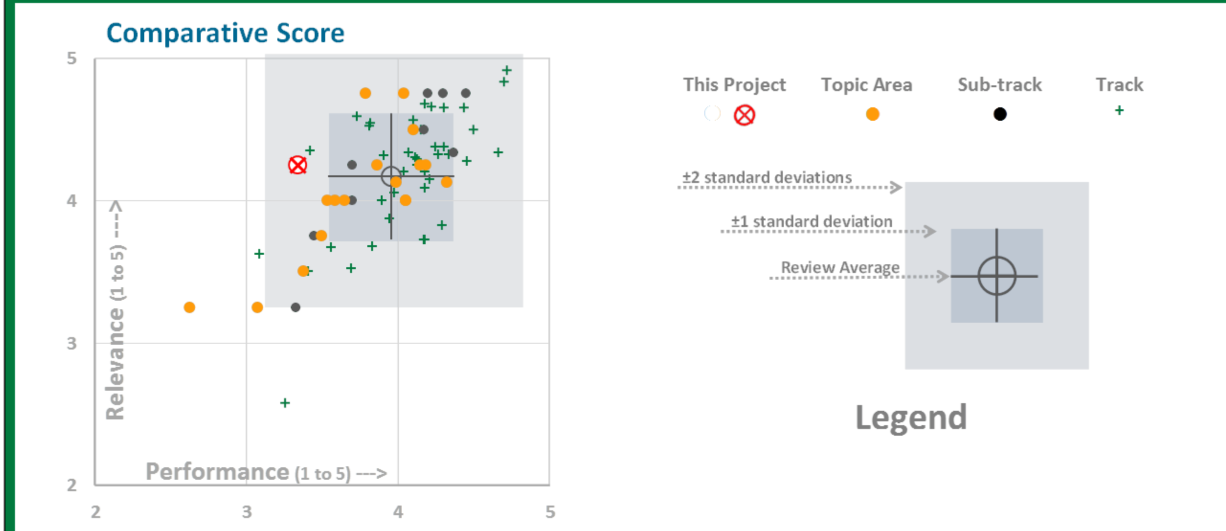
Wave Energy Converter Structural Optimization Through Engineering and Experimental Analysis

Principal Investigator	Ken Rhinefrank, Columbia Power Technologies
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 1.0 M	83%
Cost Share	$ 0.2 M	17%
Total	**$ 1.2 M**	**100%**

Peer Review ID# 163



Comments made by reviewers during the evaluation of this project (PRID 163)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Hull design optimization is valuable for Cpower not sure value of this design configuration to industry looking at the different hull designs for Azura for example; there should be joined up thinking in terms of hull design consensus, there by focusing budgets across two companies with similar hull designs
- Industry advancement of composite hull structures - important for MHKDR (Marine and Hydrokinetic Data Repository) composite database
- PWR (power to weight ratio) performance improvement and decrease LCOE (levelized cost of energy) goal; AW (active weight) PWR (power to weight ratio) and DW (dry weight) PWR 64% and 15% comparatively; ability to discuss the wet and dry weight and how dry weight or active weight is better for PWR. This improves understanding of the metrics to be used.
- Materials project in direct alignment with sector needs
- In the summary description there is a mention of "system inertia". Is this a reference to the StingRay unit or to the inertia of a receiving power grid; it is assumed by this reader that the reference is to the device not the power grid- please clarify.
- This project has reached an advanced state of development and offers good prospects for a grid connected facility
- In-water demonstration of WEC (wave energy converter) device is an important DOE objective. This project completed the preparation towards that end for the Columbia Power Technologies StingRAY device.

Question 2: Methods and Approach

- FEA (Finite element analysis) confirmed physical testing DLC (design load cases) consider appropriate range of environmental conditions, design and operational situations including the limit states. Aqua to get the loads where used to define the loads and then in FEA for understanding the structural limitations. Transferring the data between Aqua to FEA requires in house code development, which not sure Cpower has resourced appropriately.
- By taking the modelling function inside the CPT (Columbia Power Technologies) team - then this has improved the company's expertise but not that of the overall sector
- I wonder if this project would have been more effective if the original modelling partner had been in place - is there lesson about partner changes that are allowed
- Assuming the PWR objective is under way and is successful, then what is the next step? Is it focused on the PTO (power take-off) configuration, if not why not?
- The focus appears to be on the mechanical and structural aspect of the Sting Ray unit and reduction of the Power to Weight ratio
- Major change in team. Cpower took over.

Question 3: Technical Accomplishments and Progress

- Advancement for hull composite structure
- Did elimination of the end stops carry over to the H2? Will you also follow the same certification process? Answered yes for both.
- Some scope creep apparent with additional need to building the load modelling has impacted the schedule as well as highlighted potential gaps in Cpower's technology product development process
- I wonder if this would have been more efficient if the original modelling partner had been in place - is there lesson about partner changes that are allowed
- The use of composites is novel and productive
- Made Power Weight Ratio (PWR) improvements
- Performed optimized hull design for reduced mass and cost, in preparation for the WETS (Wave Energy Test Site) deployment.
- Removed Northern Power Systems (NPS) and gave work to Cpower. Why? This resulted in significant delays. This could have a negative impact on the Navy WETS facility.

Question 4: Project Management

- Scope creep comment above
- The project management is adequate
- This project appears to be well managed; see also project #18
- Behind schedule

Comments made by reviewers during the evaluation of this project (PRID 163)

Question 5: Research Integration, Collaboration, and Technology Transfer

- Two organizations presented that supported project
- Good collaboration with NREL and SNL
- Participated in an IEEE panel session on MHK at the 2016 PES (Power and Energy Society) general meeting. Is a proceedings paper being submitted for the 2017 meeting?
- Team: Columbia Power, Ershigs, NREL

Question 6: Proposed Future Research, if applicable

- Future research is incremental to direct development of Cpower not necessarily for industry needs
- Useful future research proposed
- How would the PTO for the system with a linear mechanical power output be converted to electric energy?
- Rotary as well as linear power output designs
- Need to complete work in this project

Question 7: Project Strengths

- Advancements in composite hull structure
- Steady progression of learning from hull design work and elimination of end stops evidenced in project 144
- Strong technical capabilities among team members
- Sophisticated structural design

Question 8: Project Weaknesses

- Scope creep; resource constraints
- No comment
- Behind schedule. Test at WETS at risk.

Question 9: Recommendations

- All the Cpower projects need to be presented together in order to understand clearly the results and impacts from one project to the other. It appears that project 188 study should have been completed earlier on in Cpower development which could have positively impacted project 154 and this project.
- Needs additional analysis of the need for a linear (rack & pinion) type electric generator to convert mechanical power to electric power
- Stay on top of this project to ensure there are no more delays getting into the WETS

DOE Water Power Technologies Office 2017 Peer Review Project:

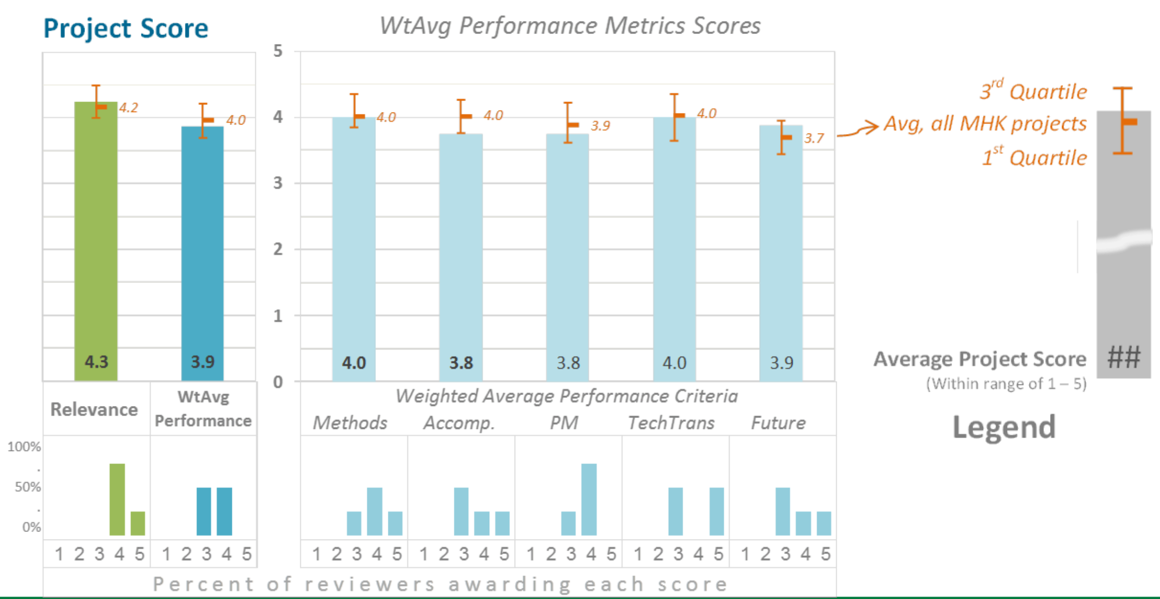
Assimilation of Wave Imaging Radar Observations for Real-Time Wave-by-Wave Forecasting

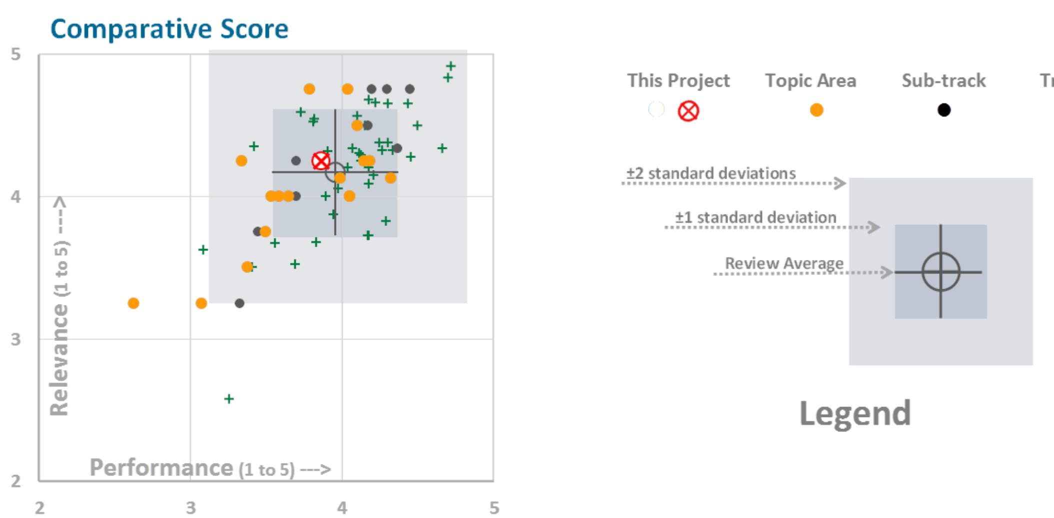
Principal Investigator	Merrick Haller, Oregon State University
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 0.5 M	79%
Cost Share	$ 0.1 M	21%
Total	**$ 0.6 M**	**100%**

Peer Review ID# 170





Comments made by reviewers during the evaluation of this project (PRID 170)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Evident this project delivers a tool that has potential to optimize device performance including the cross cutting approach to improve resource characterization
- Forecasting methods are critical for WEC (wave energy converter) control applications
- It is not clear whether this forecasting tool until integrated into WEC system will provide improvement in energy capture of 100-300%
- A good fit with program needs
- How are the signals from the radar scans analyzed? Can a way be developed so that the radar information can be analyzed using a Fourier series signal processing method and identify a fundamental sinusoidal frequency associated with the maximum power of incoming waves? Can the fundamental sinusoidal frequency of a rising and falling wave be linked to the generation of alternating current power and the PTO (power take-off) inverter/converter output? If this can be done, then will the identification and use of a sinusoidal fundamental frequency to control the solid state devices (IGBT (insulated-gate bipolar transistor) or other) in the inverter/converter result in an optimum maximum real power (kWatts or MWatts) PTO output?
- Wave forecasting will be a valuable contribution to the MHK community

Question 2: Methods and Approach

- The model has clear sound approach
- Unsure of the value of the field data collection in terms of applying this method at array scale and when cost is borne by a developer
- A well designed and structured project
- Use of radar to analyze incoming wave patterns should result in a controls predication methodology that may be used to optimize the PTO electric output
- Well-executed project

Question 3: Technical Accomplishments and Progress

- Modeling results were good and demonstrated however improving the data into the model will improve the error margin of the wave crest location if you do not have good positioning information at the X-band location
- Field verifications seem incomplete
- Good progress but still incomplete results
- It's not clear how these project results fit with the industry projects
- Recognizes the survivability benefits of control
- Accomplishments are described in the project summary
- Field data collection and comparison at the South Energy Test Site
- Validated with several synthetic datasets
- Wave radar system is commercially available. This reduces risk to the eventual adoption of the method the project is developing.

Question 4: Project Management

- Limited budget on marine vessel costs and impact when you apply cost of a dynamically controlled vessel on a day rate of $$$
- When questioned the PI (principal investigator) on the above statement; he said the cost was very inexpensive, but this is due to vessel owned operated by university
- Adequate project management - but limited time planned for the vessel tests
- No comment
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- This project had merit for more collaboration and technology transfer with WEC developer and other test sites who have available marine radar data/wave rider buoy data
- Limited tech transfer and links to industry
- Two publications in IEEE are significant as are the other two presentations
- Numerous publications and presentations
- Strong collaborative team: Oregon State University, SRI International, University of Southern California

Comments made by reviewers during the evaluation of this project (PRID 170)
Question 6: Proposed Future Research, if applicable • The field data collection methodology needs to be rescoped. The issues with data collection on a small vessel were evident and thus not the best way for field data to be collected. It was a cost efficient method only. • The proposed future test improvements made with additional wave model physics are fine but a requirement on the value of the additional benefits should be understood • An outline plan for future work with a suggest collaboration with re vision • Plans and support of continued efforts and presentation of results at professional conferences and in publications should be a top priority • Project is over but further comparison to field data and further improvement to wave prediction methodology, such as inclusion of second-order effects, would be beneficial **Question 7: Project Strengths** • Forecasting model • Development of methods by which incoming wave amplitude and wave length can be predicted • Comparison was made to field data • Complements other projects which are developing control methods • Physics-based wave model **Question 8: Project Weaknesses** • And lack of integrating the forecast model with a WEC developer • Field data collection methodology • What RADAR technology is being used? Provide a description. • Not clear how this would be deployed at an actual WEC site. For example, there are directional and movement restrictions that would have to be resolved for a successful field deployment. **Question 9: Recommendations** • EMEC (European Marine Energy Center) has 1 year marine radar raw data set (100 GB) for potential integration into this model. The ability to determine average sea states versus extreme sea states with radar and wave rider buoy data can be evaluated and used for the forecasting model. • I would recommend evaluating a different field data collection methodology. Land based if possible X-band radar should provide stable data set for model. • It is not clear if there is a goal to link the incoming wave amplitude and frequency as an input to the optimization and the PTO electric energy converter. Is there a way to use the radar generated wave characteristics to optimize the electric output of the PTO? For example can the Radar data be used to regulate the alternating current voltage output of the PTO? • Future work should include an investigation of existing and ongoing work of other investigators in academia and government • Project is over but further comparison to field data and further improvement to wave prediction methodology, such as inclusion of second-order effects, would be beneficial

DOE Water Power Technologies Office 2017 Peer Review Project:

Controls Optimization of Three Different WEC Devices

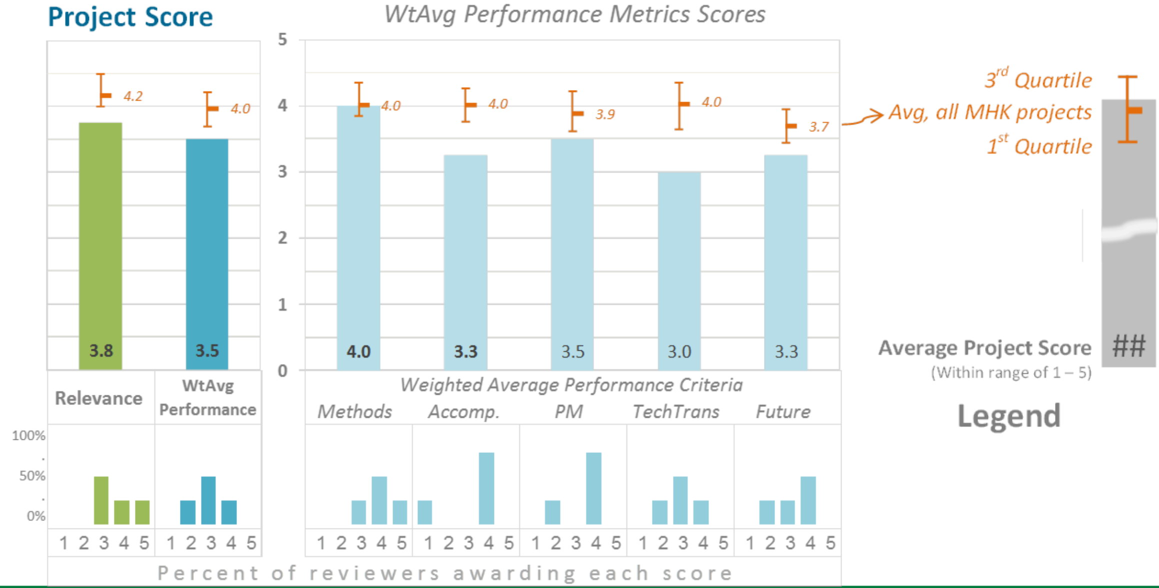
Principal Investigator	Mirko Previsic, ReVision Consulting, LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

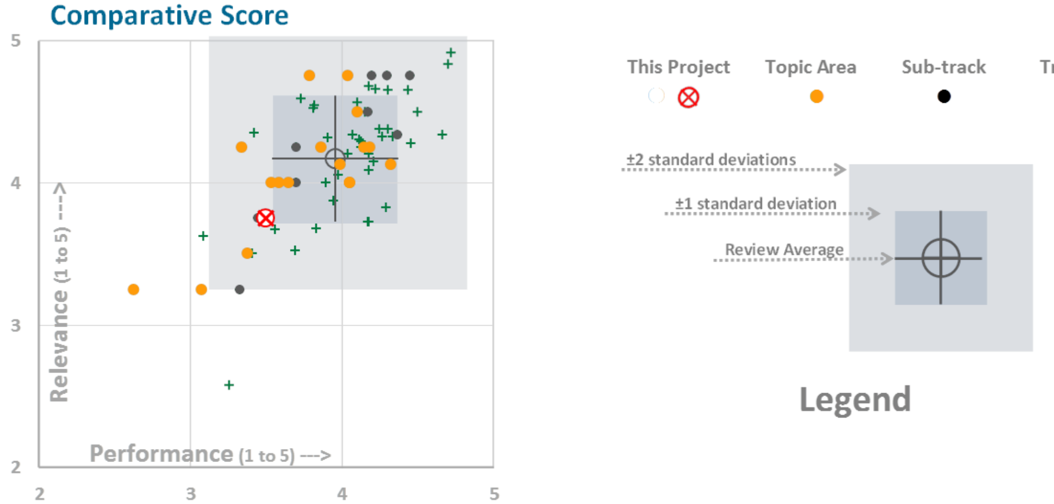
DOE	$ 2.5 M	97%
Cost Share	$ 0.1 M	3%
Total	**$ 2.6 M**	**100%**

Peer Review ID# 176

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 176)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- The impact of optimal WEC control as described in the summary under DoE impact is not disputed here. What is disputed is the optimal control methodology using causal non causal control controller. The results from project 156 do not give strength to the current project and thus the project has moderate relevance.
- Control framework that can be used for any device - so very interesting and an excellent fit with program
- Can a block diagram be provided that shows the control configuration?
- Define how the term "topology" is being used here. Is topology being used as a collection of sets or is it referring to the configuration of an electric circuit?
- Provide a list of technical paper references that describe the methodology used for the optimization of the feedback controls. Explain how non-linear control variables are analyzed as part of the control optimization.
- Achieving "optimal control" in a WEC device will be a valuable contribution to the MHK community

Question 2: Methods and Approach

- Methods / approach utilizing the causal non causal controller for RME (Resolute Marine Energy), OE (Ocean Energy) and CalWave should be questioned more thoroughly. The approach and results were not well demonstrated and how they would impact OE and CalWave design optimization is unclear.
- Not fully clear the hardware it will use - but will have challenges as it moves to the empirical scale , but this was well explained
- Mathematical analytic methodologies are required
- Agree with project investigators on the benefits of testing optimal controls on three separate devices
- Agree with project investigators on the benefits of testing optimal controls using two separate approaches

Question 3: Technical Accomplishments and Progress

- In the offline environment they are optimizing and separating out the controller to handle more nonlinear parameters...how will this then impact the simplest controller that only has the Velocity and Position of the WEC input into the controller?
- Mid way in project but good progress to date
- Uses a model predictive controller approach and a causal controller and a prediction algorithm
- Initiate "Wave to Wire' objectives
- Good so far
- OSU (Oregon State University) tests underway
- Wave prediction tests underway off coast of California

Question 4: Project Management

- Concern due to the overlap with RME project 156 outputs (rescoping) there will not be significant improvement in project management of this current project utilizing the other two WEC configurations
- Appears a well-managed project - uses a go no go - before deployment at sea
- Project is in its first year of funding
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- The lessons learnt from the RME project 156 should better inform how the causal / non causal controllers will be improved for RME, OE and CalWave, however this was not made evident in the presentation
- Unclear what Dresser Rand provided as project partner?
- Good range of research and industrial partners
- Limited dissemination to date
- Mirko uses code similar to wecsim (Wave Energy Converter SIMulator)
- Dissemination of results in professional journals and conferences in the second year of the project is expected
- Strong, collaborative team: Resolute Marine Energy, Ocean Energy USA, CalWave, Dresser Rand, University of Michigan, Integral Consulting

Comments made by reviewers during the evaluation of this project (PRID 176)

Question 6: Proposed Future Research, if applicable

- If as noted above the lessons learnt in the previous RME causal/non causal controller approach are integrated into this project then the outcomes may provide evidence on value of causal/non-causal controller methodology
- Sea trials planned after no go - so a well-structured program
- Analytic models of the controls based on state variable and similar mathematical methods in the next phase is expected
- Complete project before considering future research

Question 7: Project Strengths

- Ability of this project to align with outcomes from project 156
- Demonstrate impact of optimal controls and test fully integrated optimal controller
- Three devices, two optimal control methods, tank tests, planned ocean tests

Question 8: Project Weaknesses

- As presented there is no substantial progress and thus outcomes from now to the go/no go will need to be substantial
- The project is one year old no apparent weaknesses

Question 9: Recommendations

- Review of offline controls optimization methodology should be made clear on benefits for each of the WEC designs include targets for demonstration in tank/in sea demonstrations
- Publish papers with description of the logic and methodology of the optimal controls
- Continue project

DOE Water Power Technologies Office 2017 Peer Review Project:

Efficient and Reliable Power Take-Off for Ocean Wave Energy Harvesting

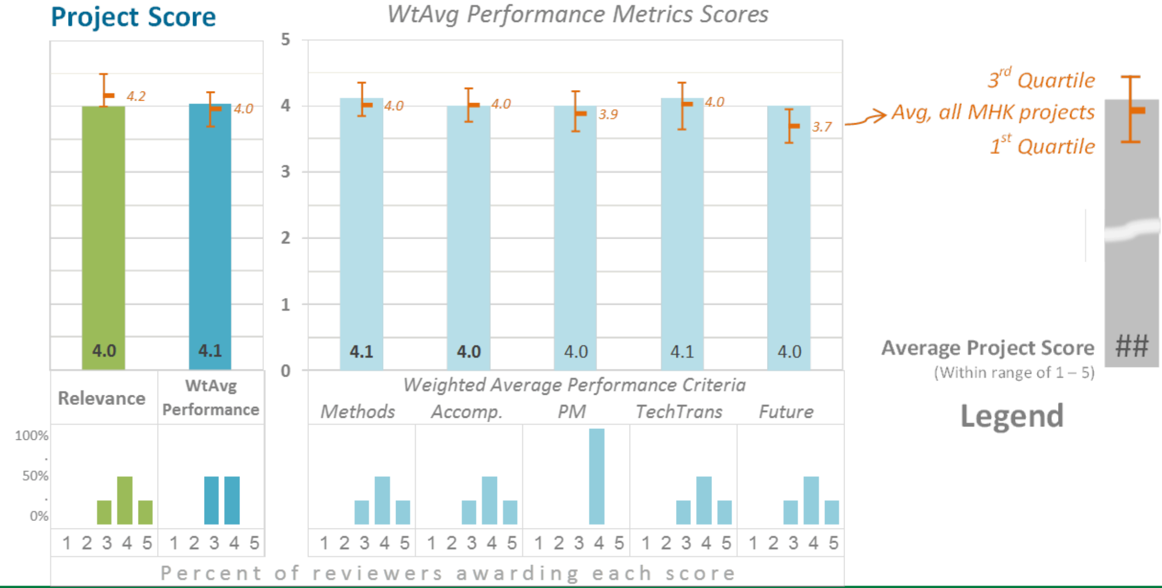
Principal Investigator	Lei Zuo, Virginia Polytechnic Institute and State University
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

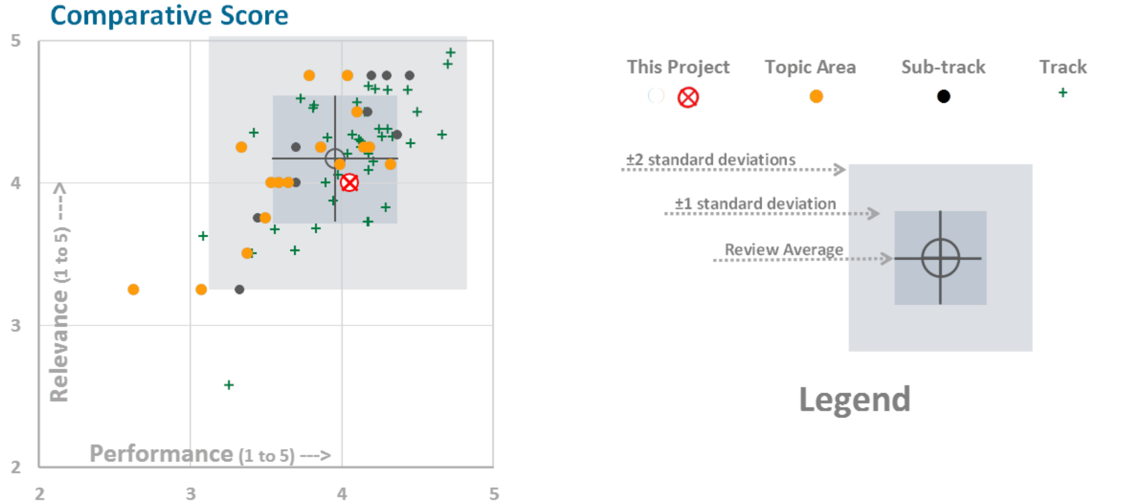
DOE	$ 1.8 M	89%
Cost Share	$ 0.2 M	11%
Total	**$ 2.0 M**	**100%**

Peer Review ID# 177

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 177)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- This is an excellent demonstration however it appears to overlap with other novel designs. This project concept started with the PTO (power take-off) and now the rest of the WEC (wave energy converter) system is being designed around the PTO. This is not wrong but I expect the potential for > 20 design iterations.
- A novel PTO project with good alignment with sector needs
- This approach directly addresses the problem of converting linear (buoy) motion to rotating motion, offers good potential with regard to energy conversion and is totally in line with overall objectives
- This project is developing an innovative PTO with a mechanical Motion Rectifier (MMR) mechanism and unique power electronics. If successful, this mechanism could have a significant impact on wave energy extraction efficiency and be widely applicable in the MHK industry.

Question 2: Methods and Approach

- .2m seas ability to generate 2MW in MMR mechanical motion rectifier. Change the bi-directional to one directional power flow straightforward approach to the power issues.
- A well-structured and detailed project
- Would benefit from international collaboration and WES (Wave Energy Scotland) projects
- This project uses a unique and innovative approach to the problem of converting linear motion to rotating motion. In that regard this approach offers a single step to capture linear wave motion and power and use it to drive an electric generator. The impact on overall efficiency and operational benefits of this approach needs to be fully recognized.
- Use of Eigen function to analyze the refraction and diffraction problem is outstanding
- Well-planned project. Combination of numerical, laboratory, and field tests are planned.

Question 3: Technical Accomplishments and Progress

- Damping of the power output with the second body. Reduction of drag will change the plate to cone. Again my above comment on expected number of design iterations.
- First project that went into detail on PTO component failures. Would expect failed components analysis to feed into the MHKDR (Marine and Hydrokinetic Data Repository).
- Innovative generator for WEC's and TEC's (tidal energy converter's) with the MMR
- Very good progress and achieving the project goals
- Would be better if they partnered the point absorber WEC developer
- The description of the power electronics train from mechanical input to electrical output is the best of all project descriptions
- Significant numerical design and laboratory test results

Question 4: Project Management

- Appears well managed
- A well-managed project
- No comment - see project #18
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- The publications should have names, authors and dates. Not able to research with limited information.
- Missing some potential EU collaboration with similar technology
- Why do they have an NTOU (National Taiwan Ocean University) collaboration
- Continued R&D for this approach should be provided
- Several papers and presentations at conferences are noted. In future the researchers should consider submittal of a paper or papers to the IEEE Power Energy Society.
- Numerous publications and presentations
- Strong collaborative team: Virginia Tech, NREL, THK North America Inc., Resolute Marine Energy Inc., Hawaii Wave Energy Test Site, National Taiwan Ocean University (NTOU) Ocean Energy Center
- Supporting many students

Comments made by reviewers during the evaluation of this project (PRID 177)

Question 6: Proposed Future Research, if applicable

- Not sure I agree with commercialization comment. Needs more evidence of a market study to determine commercial opportunities.
- Very interested in the 'scale down for ocean sensing applications and results of this work. This can be an enabling technology for WEC array plants.
- Good proposed future research on model device
- An open question is "how will the electric cable from the mechanical to electrical converter (aka generator) be routed from the bottom of the assembly to an on-shore metered point of interconnection with an electric distribution entity?"
- Are the models of the mechanical and electric components of the PTO available in PSS/e (Power System Simulator for Engineering) and/or PSLF (GE Positive Sequence Load Flow Software) software for use in preparation of short circuit and system impact studies as required by FERC (Federal Energy Regulatory Commission) interconnection SGIA (Small Generation Interconnection Agreement) and LGIA (Large Generation Interconnection Agreement) rules? If not, then what would be required to develop open source models?
- Complete project before considering future work

Question 7: Project Strengths

- MMR technology appears efficient
- The use of modern mathematical modeling and analytic methods is outstanding
- Multidisciplinary R&D in motion system design, hydrodynamics, power electronics, reliability analysis, lab and ocean tests

Question 8: Project Weaknesses

- Enhanced reliability statement of the PTO that sits underwater; potential not be reliable. I understood PI (Principal Investigator) also made a change to have the PTO to sit above the waterline?
- Multiple design iterations expected with the approach followed
- None noted
- Not enough funds to perform field tests

Question 9: Recommendations

- Pursue scale -down study for ocean sensing applications
- This approach has potential to be the most efficient way to reach the goal of direct conversion of oscillating (sinusoidal) ocean wave motion to sinusoidal voltages and currents
- Complete project

DOE Water Power Technologies Office 2017 Peer Review Project:

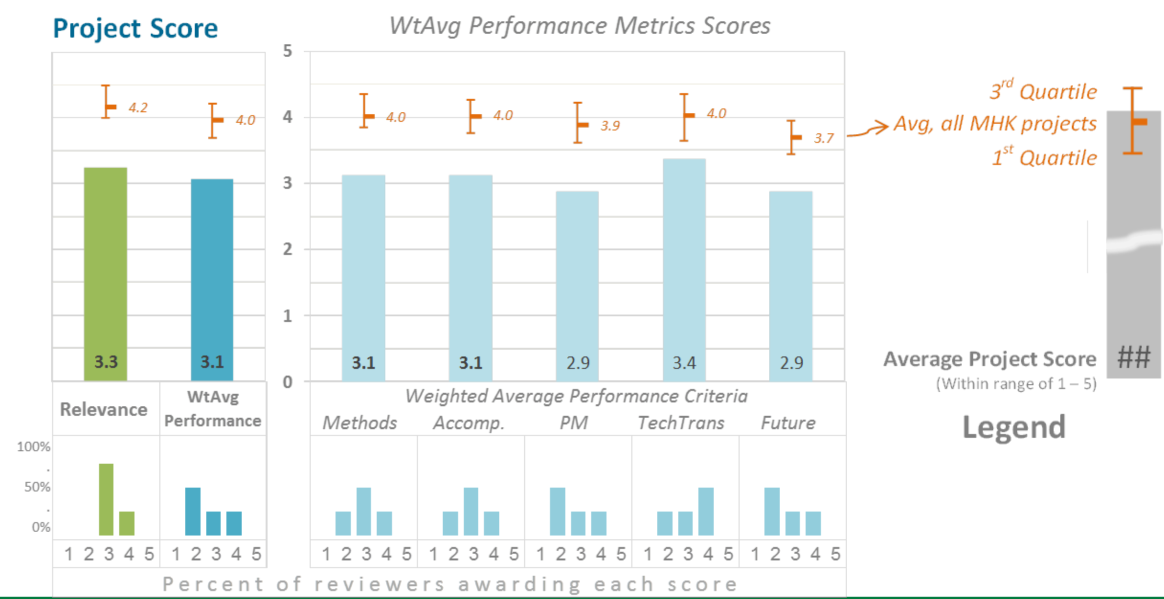
System Agnostic Switched Reluctance Linear Generator for WECs

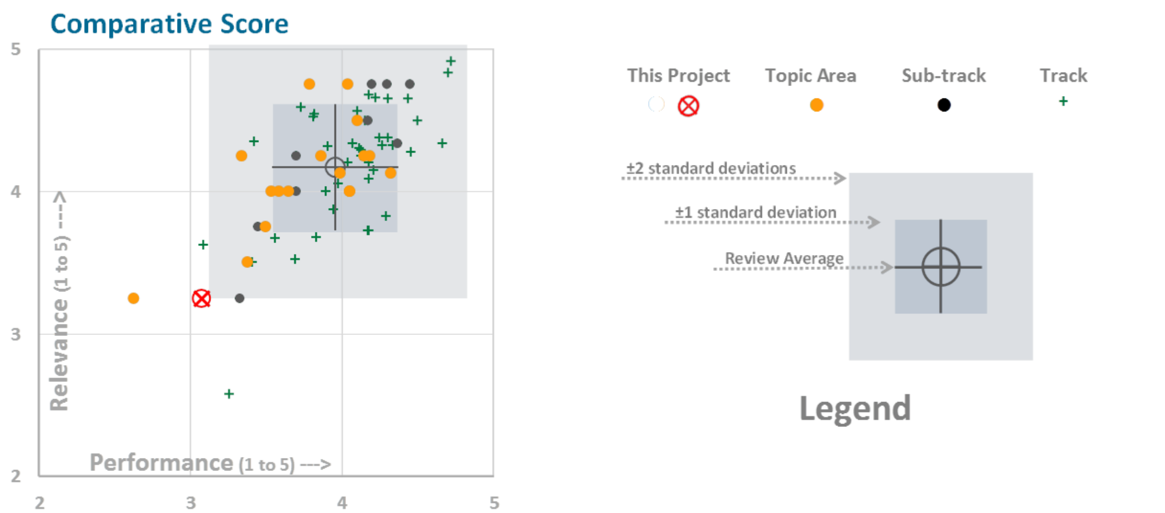
Principal Investigator	Alan McCall, Dehlsen Associates, LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 1.9 M	97%
Cost Share	$ 0.1 M	3%
Total	**$ 1.9 M**	**100%**

Peer Review ID# 178





Comments made by reviewers during the evaluation of this project (PRID 178)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Good but limited information shared to determine impact
- Switched reluctance linear generator - but difficult to tell the actual objectives of the projects
- This project appears to be focused on conversion of a linear mechanical force derived from wave action to electric power. The focus is on the electric generator (switched reluctant linear generator) independent of a wave powered prime mover.
- This project is developing an innovative PTO (power take-off), called the Switched Reluctance Linear Generator. If successful, this mechanism could have a significant impact on wave energy extraction efficiency and be widely applicable in the MHK industry.

Question 2: Methods and Approach

- Links with SPAs I award controller work without specific PTO topology and now the controller works influenced the PTO design
- Methods/approach process straight forward
- Switched Reluctance to provide lower cost option to permanent mag generators to improve costs
- Wedge Global PTO linear generator - air gap issues?
- It is difficult to assess the methodology it is very unclear what the project will be doing over and above the existing WG (Wedge Global) EU projects
- What are the "new PTO module constraints"? The use of a linear drive to deliver mechanical input to the converter (aka generator) offers the prospect of greater overall WEC energy conversion efficiency.
- What is the ratio of total weight of energy converter to kilo Watt capacity?
- Well-planned project

Question 3: Technical Accomplishments and Progress

- 68% component improvements
- Efficiency dependent on operating conditions. Power Factor 60% for Wedge.
- Little evidenced in term of progress details. Do not have a clear understanding of the PTO architecture and how it is novel or game changing against the challenges (loads) modelled.
- What was the advanced control strategy used by the PTO?
- It's really not clear how this adds to the existing WG work
- The project was initiated in October 2016, and the initial design is reported to be complete
- Good progress: PTO system requirements established; completed PTO initial design; PTO final design and fabrication planning underway; Controller development progressing

Question 4: Project Management

- No clear development plan evidenced
- No evidence given why the budget is under allocated
- Again hard to assess as the projects are not clear
- No comment - see project #18
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Ability to be able to integrate this with other WEC's, besides WEDGE
- No publications or technology transfer evidenced
- Work from the MPC (multi-pod centipod) work led them to design for a different WEC design to demonstrate and build upon their capabilities. Worked with OSU (Oregon State University) for controllers.
- Again not clear what this will be
- It is to be expected that the researchers will be presenting technical papers at appropriate professional society meetings and in journals
- "Strong collaborative team: Wedge Global - Design and manufacture of their MTLSRM (Multitranslator Linear Switched Reluctance Machine) machine; Oregon State University - Controls development ; McCleer Power - Electrical machine design consulting; National Renewable Energy Laboratory - Testing support, risk management, and LCOE (levelized cost of energy) review; DNV GL - Hardware in the loop support and test planning; Straight Forward Systems, Inc. - Design consulting on hydraulic machines for baselining"

Comments made by reviewers during the evaluation of this project (PRID 178)
Question 6: Proposed Future Research, if applicable • Future research focused on scaling up and putting it to test in the sea. Is there not a need first to deliver on the current scope before a decision is made Go/No-Go? • Again hard to assess as the projects are not clear • Can this device be operated in a vertical position and powered by vertical buoy motion? • From the presentation and description it is not clear how wave action is used by the device. Is the prime mover for the PTO a buoy or some other device? Is the linear force converted to rotational force to drive a rotating electric generator? • Complete project before considering future work **Question 7: Project Strengths** • None really evidenced • If the unit can be operated in a vertical configuration and driven by a vertical buoy action, then this may be an attractive approach • Innovative PTO is being designed to be system agnostic **Question 8: Project Weaknesses** • Inconsistent approach and lack of plan evidenced • None were noted **Question 9: Recommendations** • Consider No-Go • Can a test be done to determine if the device can be operated by vertical buoy motion? • Proceed only if the weight to electric output ratio is acceptable • Continue with project

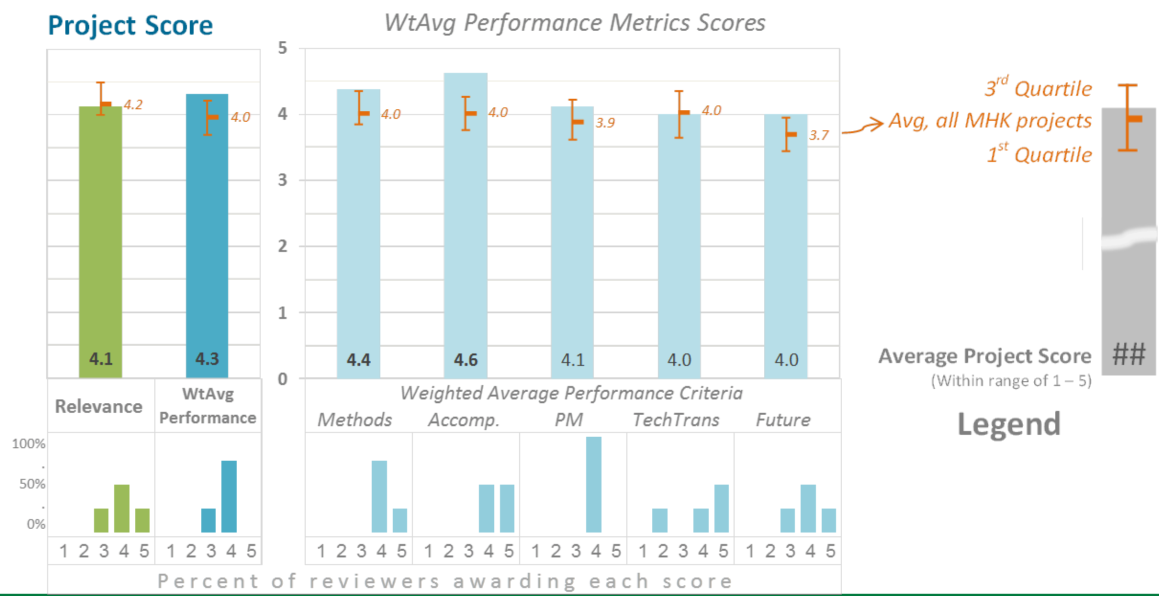
DOE Water Power Technologies Office 2017 Peer Review Project:
Net Shape Fabricated Low Cost MHK Pass-Through-The-Hub Turbine Blades with Integrated Health Management Technology

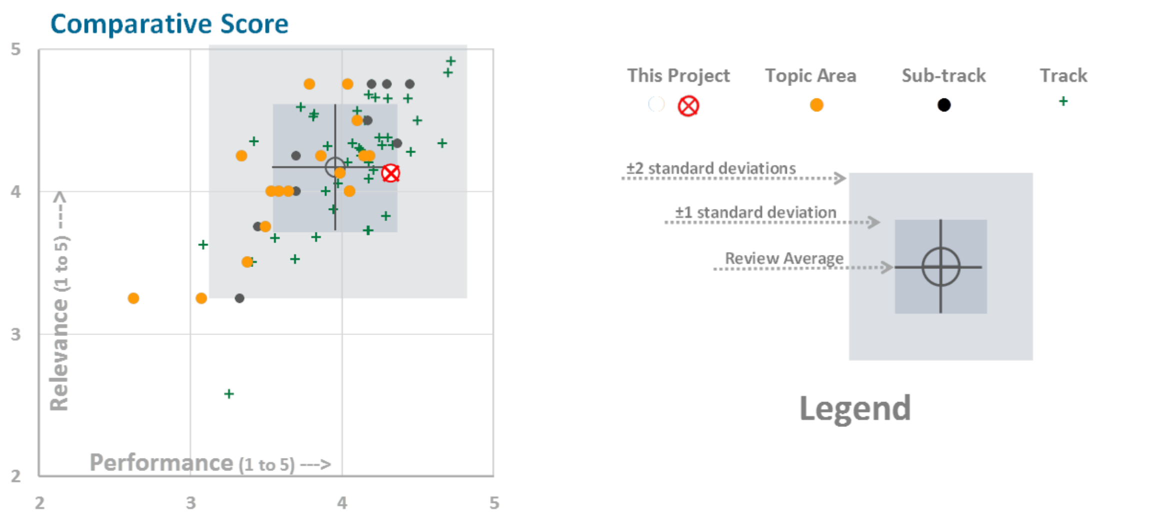
Principal Investigator	Kevin Koudela, The Applied Research Laboratory (ARL) - The Pennsylvania
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Components

FY 2014-FY 2016 Funding

DOE	$ 0.9 M	80%
Cost Share	$ 0.2 M	20%
Total	**$ 1.1 M**	**100%**

Peer Review ID# 179





Comments made by reviewers during the evaluation of this project (PRID 179)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Is this site specific design work? Yes
- This is a unique fabrication process that has merit to the objectives. However once scaled up the cost of manufacturing could increase LCOE (levelized cost of energy) compared to conventional - Economies of Scale are necessary with this net shape fabrication.
- Overall this is an excellent project, in direct alignment with sector needs
- This work is relevant to the WEC (wave energy converter) program because it is investigating ways to manufacture low weight propellers that can be used on three blade hub type WEC devices that can be located in locations with steady tidal or river currents
- Improved design and manufacturing of a turbine blade is of moderate relevance

Question 2: Methods and Approach

- Clear technical approach defined into discrete tasks with risks and mitigations identified
- This is excellent result for this scale but concern is the LCOE results once scaled up
- Excellent approach to a robust technical solution
- Investigating e-glass / epoxy composite blade configuration and manufacturing techniques
- Offers expectation of lower capital cost for material and manufacturing. Use of lighter weight hub blades would also offer the prospect of higher efficiency due to lighter weight as compared to heavier, higher inertia, metallic blades.
- Well-planned project

Question 3: Technical Accomplishments and Progress

- Clearly demonstrated value of composite design method using net shape fabrication process
- Good innovative solution to reduce capex (capital expenditures)
- Designed and fabricated blades. Blades were presented for inspection at the session.
- Good technical accomplishments: "Completed design and analysis of full-scale and ½-scale single blade net shape fabricated rotor, net-shape fabrication of two ½-scale single blades using composite molds, design of ½-scale aluminum three blade rotor clam shell mold, initial 10M cycle tension-tension and compression-compression threshold fatigue strain coupon tests, design of ½-scale rotor test fixture"

Question 4: Project Management

- All appears good and with successful outcomes
- A well-managed and good value project
- Appears to be well managed. See also project #18.
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Limited interaction; however technology transfer of results (net shape fabrication) should be significant
- Excellent tech transfer from the defense sector
- Good approach with potential for application to small conventional hydro generators as replacement for Francis or Kaplan turbines fabricated from cast steel
- Net shape manufacturing technology will be transitioned to Verdant Power Inc.
- Team: Applied Research Laboratory (ARL) at the Pennsylvania State University and Verdant Power Inc.

Question 6: Proposed Future Research, if applicable

- Will be very interested to know the outcomes of scaling up the manufacturing process
- Excellent proposed research of a complete hub and blade assembly at a larger size
- Will test results include water flow (input) and mechanical output (torque and speed) data? What is the range of rotational speed? The analogy with a wind turbine is clear. Can/will there be a follow-on effort that correlates the water propeller driven electric generator with a wind powered propeller driven electric generator? What is the relationship of power output from the propeller and water flow – give results in MW at rpm.
- Complete project before considering future work

Comments made by reviewers during the evaluation of this project (PRID 179)
Question 7: Project Strengths • PI (principal investigator) experience in composite fabrication process • Can the IP (intellectual property) go to VP (Verdant Power)? • Project has resulted in tangible results that have the potential to reduce capital cost of hub type WEC units **Question 8: Project Weaknesses** • None evident • None **Question 9: Recommendations** • Fabrication risk analysis for scaled up process. Understand there will be heating/power issue at larger scale. • This project may have benefits to the hydro industry beyond the present WEC program • Complete project • Will the material be able to hold coating needed to prevent deterioration and marine growth?

7.4.5 MHK-2B: Survivability

DOE Water Power Technologies Office 2017 Peer Review Project:

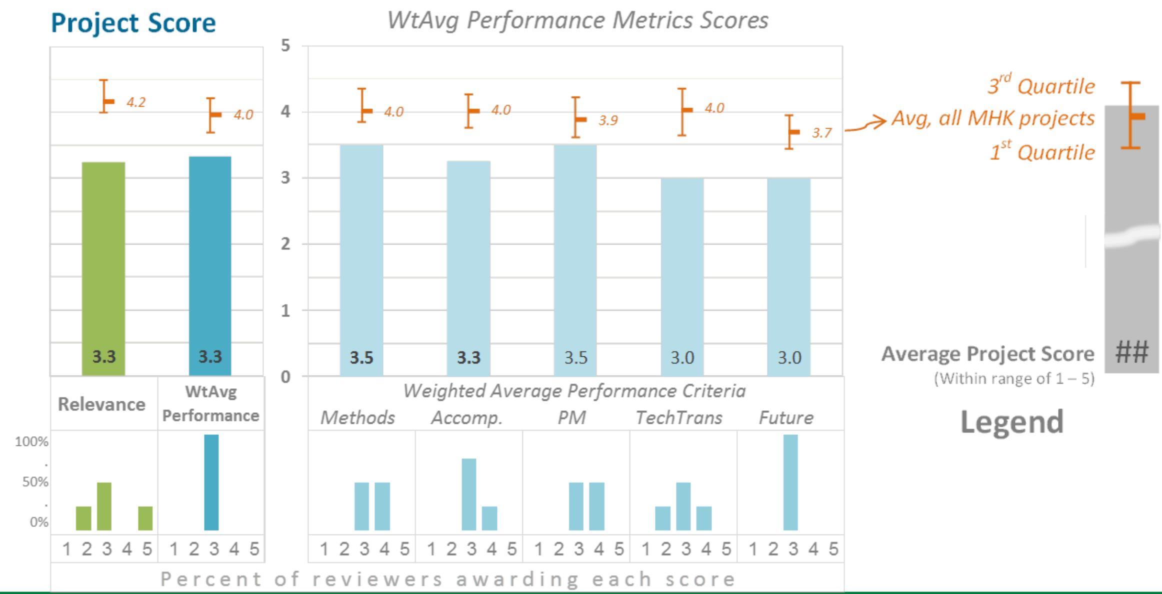
Numerical Modeling and Experimental Validation of Extreme Conditions Response for the Centipod WEC

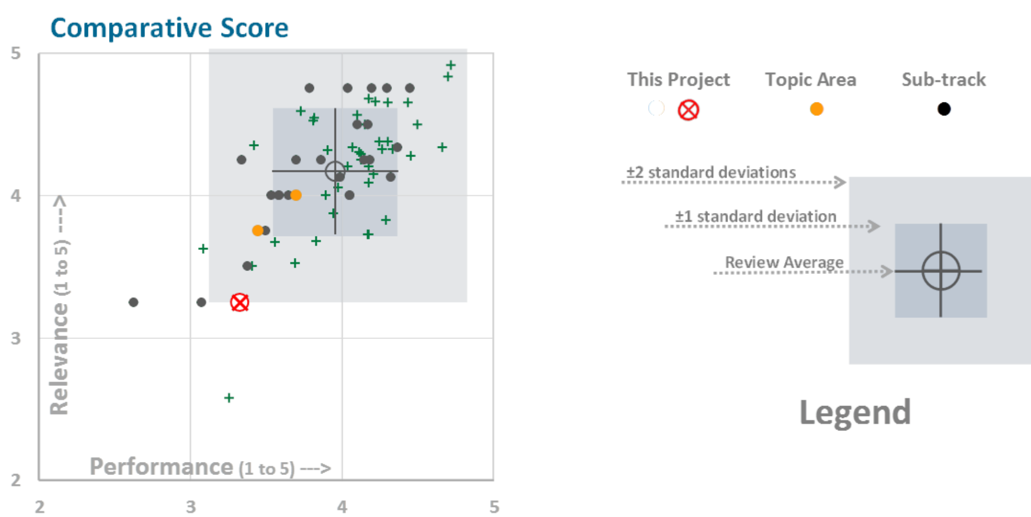
Principal Investigator	Alan McCall, Dehlsen Associates, LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Survivability

FY 2014-FY 2016 Funding

DOE	\$ 0.6 M	100%
Cost Share	\$ 0.0 M	0%
Total	**\$ 0.6 M**	**100%**

Peer Review ID# 185





Comments made by reviewers during the evaluation of this project (PRID 185)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Centipod WEC concept has the potential to be a distraction from the other more mature technologies under development and especially against the WEP (Wave Energy Prize) concept winner
- The value is in the work on the design tool and ECM (extreme conditions modeling)
- Reasonable fit with sector needs
- This project is just starting and there is not much to review. A short term goal is to provide a description of the way that wave energy is converted to usable mechanical power; is the mechanical power linear or rotating? In both cases give an estimate of the range of mechanical power in ft. lbs. or nt meters and the linear velocity or rotating shaft speed of the input to the device (aka generator) that converts mechanical power to electricity.
- This project is investigating the survivability of the Centipod WEC. However, the Centipod is a unique device. Therefore lessons learned will have narrow application to the MHK industry.

Question 2: Methods and Approach

- Standard modeling approach
- Limiting the scope to mechanical survivability seems to also limit the opportunity in this project
- Needs more detail about the mechanical to electric conversion process
- Laboratory tests planned
- Well-planned project

Question 3: Technical Accomplishments and Progress

- No evidence given on how this project aligns with project 158
- No evidence of the baseline load cases and the impact of those results on the concept design
- No evidence yet of the winning load mitigation strategy or discussion of what that would look like how it would be shared etc…
- Project just started so limited progress
- Mid-fidelity model established and baseline loads computed, assessment of load mitigation strategies underway

Question 4: Project Management

- Not well evidenced but accept it is on schedule
- Too early to say
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Collaboration still within a tight MHK family. I challenge the risk of group think here and across the other projects.
- It is missed opportunity that this project does not use control as part of its scope given Delson have a PTO (power take-off) control project also funded by DOE
- Need to present results at professional meetings
- Strong collaborative team: NREL - High-fidelity modeling, test planning, impact analysis; SNL - High-fidelity modeling, test planning, impact analysis; DNV GL - Mid-fidelity modeling, test planning; Navy Surface Warfare Center, Carderock - Wave basin testing

Question 6: Proposed Future Research, if applicable

- Next steps ok but where will they pursue funds for the future research?
- Too early
- Funding should be linked to development of an explanation of how the wave power is used to drive a mechanical to electric (generator) converter
- Complete project before considering future research

Question 7: Project Strengths

- Not clear
- This project is investigating the survivability of a WEC. Since all WECs are impacted by storm events, the results of this work can be widely applicable.

Comments made by reviewers during the evaluation of this project (PRID 185)
Question 8: Project Weaknesses • Not strong presentation evidencing the ECM and response for the Centipod • Not well presented or described • The Centipod is a unique device. Therefore lessons learned will have narrow application to the MHK industry. **Question 9: Recommendations** • Publication of the winning load mitigation strategy mentioned above • None • Complete project

DOE Water Power Technologies Office 2017 Peer Review Project:

Improved Survivability and Lower Cost in Submerged Wave Energy Device

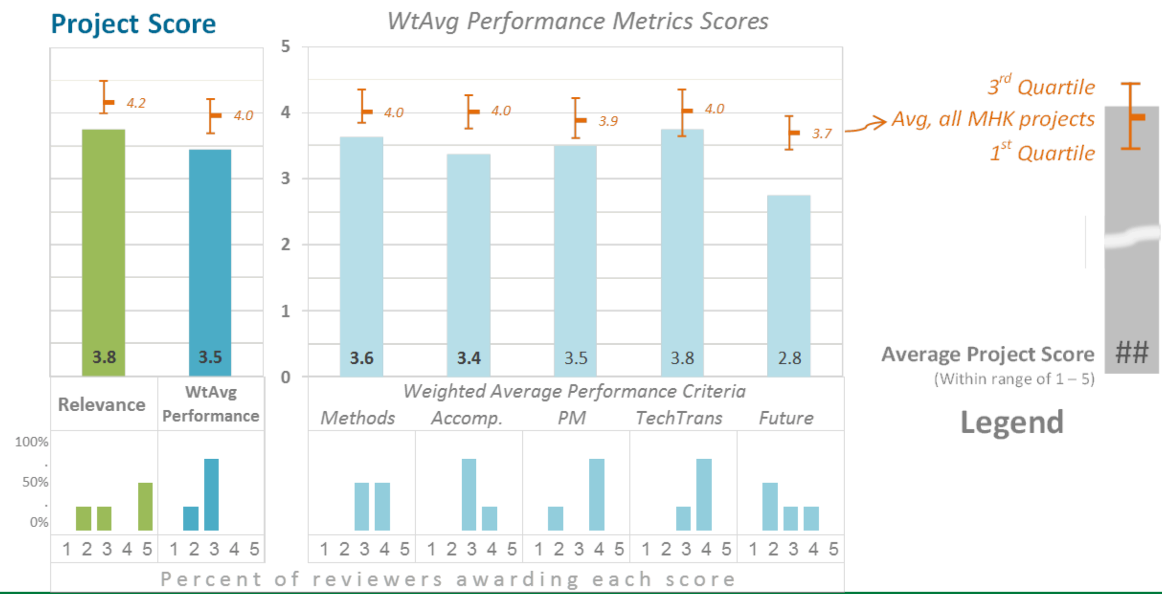
Principal Investigator	Mike Morrow, M3 Wave LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Survivability

FY 2014-FY 2016 Funding

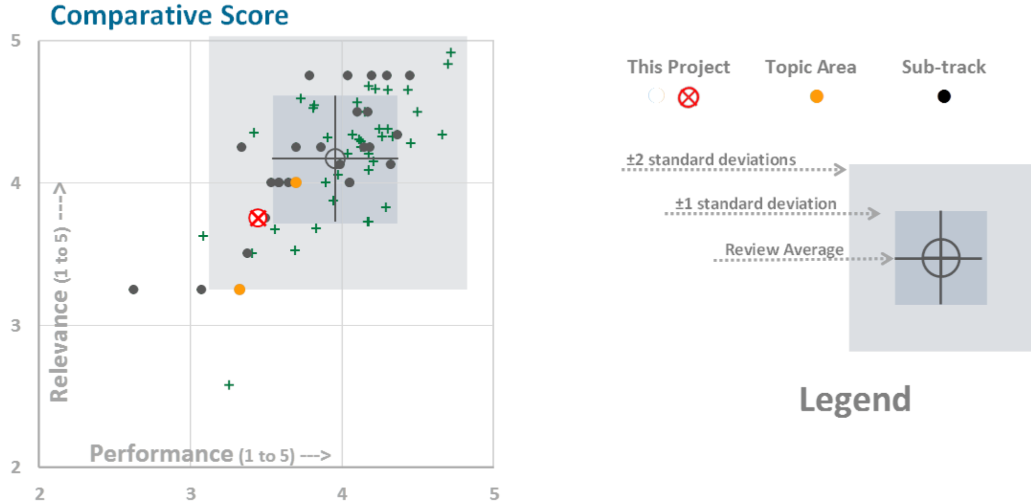
DOE	$ 0.6 M	98%
Cost Share	$ 0.0 M	2%
Total	**$ 0.6 M**	**100%**

Peer Review ID# 186

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 186)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- No clear targets AEP (annual energy production) or LCOE (levelized cost of energy) target
- The number of projects reviewed do not have an apples to apples comparison in terms of survivability with the M3Wave
- The supporting technology development of CFD (computational fluid dynamics) model and validation techniques is of potential value if incorporated into wider modeling tools and validation processes developed through the national labs
- A very interesting device which if successful could make a step change in survivability for the wave sector
- Sea bed conditions are critical to the long term survivability of any WEC (wave energy converter) device that has a connection to or a foundation in/on the sea bed
- A key deliverable of this project is a versatile numerical modeling tool for evaluating sediment transport around WECs as well as other floor-mounted structures. However, bottom-mounted WECs are few.

Question 2: Methods and Approach

- Scouring issues unbalance the device on seabed and thus issues with availability
- Sediment modeling is not really to solve their problem. The issue could be alleviated if they move it up off the seabed…sediment model may be of interest for other users coastal engineers for example.
- The approach is based on 1 challenge is there a simpler deployment option to alleviate the device / scour on sea bottom issue?
- A good approach to sediment transfer component of the project
- However it’s not clear what the actual performance of the device is
- No comment. The qualifications of the experts selected to carry out this task are key to its success.
- Laboratory tests of scale models and sediment transport models to verify numerical models is a good approach
- Well-planned project

Question 3: Technical Accomplishments and Progress

- Challenge was scour and sediment transport due to WEC sitting on ocean bottom utilizing ocean pressure
- If an approach is to determine the height off the bottom to alleviate scour what will happen to orientation with accumulation of biofouling - could be an issue
- The approach to see at which height is best for modelling and tank testing might be considered inappropriate - makes sense to take costs and test the device in the water with the different height levels
- Good progress on the technical aspects of the project
- If focuses on sediment , but not clear the success of the base device
- This project is starting in the 3rd quarter of 2016. Necessary preparations are being made as reported.
- Technical accomplishments so far have been the development and application of the numerical modeling

Question 4: Project Management

- Scope issues; but by bringing moving back to numerical modeling provided reduction in number of design options
- Appears to be well managed project
- Should the U.S. Navy be part of the team?
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Appears that collaborations, partnerships are certainly with a few key companies/labs…support need to widen the sector supply chain, and research labs
- Appears to have good tech transfer from the caisson marine sector
- Results should be reported in appropriate professional journals and at conferences
- Public release of modeling tools is planned
- Strong collaborative team: Sandia National Labs, NREL, DNV-GL, Oregon State University, Ershigs

Comments made by reviewers during the evaluation of this project (PRID 186)

Question 6: Proposed Future Research, if applicable

- Interested in results of seeing how this WEC will perform in sea. Not sure where M3 will get the budget?
- This was not clear
- Assuming that a WEC unit will be connected to an on-shore electric distribution system substation and that an undersea power cable will be required, then should this task also include some investigation of the cable?
- Complete project before considering future research

Question 7: Project Strengths

- Novel concept
- Based on the qualifications of the consultants and researchers
- Laboratory tests verification of numerical model

Question 8: Project Weaknesses

- Device positioning in water column
- None noticed
- A ten-second wave has a wave length of 500 feet. Will this device need to be 250 feet long?
- The Army Corps of Engineers has been studying scour and sediment transport for a while. In particular, the Coastal and Hydraulics Laboratory of the Engineer Research & Development Center are the experts in these areas. Neither the project summary nor the presentation reference the Corps work.
- This type of WEC depends on two points of a wave profile. Therefore it is particularly susceptible to interference from a confused or multi-modal wave field that will negatively affect the efficiency.

Question 9: Recommendations

- M3 to provide more analysis (feasibility study) on device positioning above seabed and the modifications necessary for station keeping
- Some attention should be paid to the undersea cable; especially the identification of a landing location approach to the point of interconnection substation
- Complete project. Look into scour and sediment transport work of the Army Corps of Engineers.

DOE Water Power Technologies Office 2017 Peer Review Project:

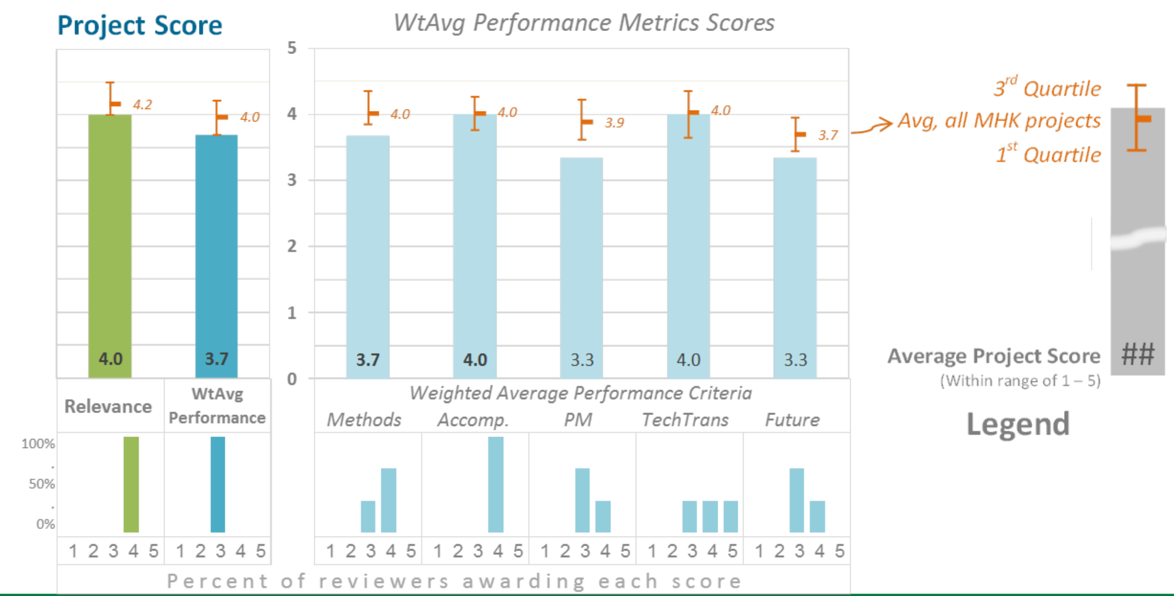
Survivability Enhancement of a Multi-Mode Point Absorber

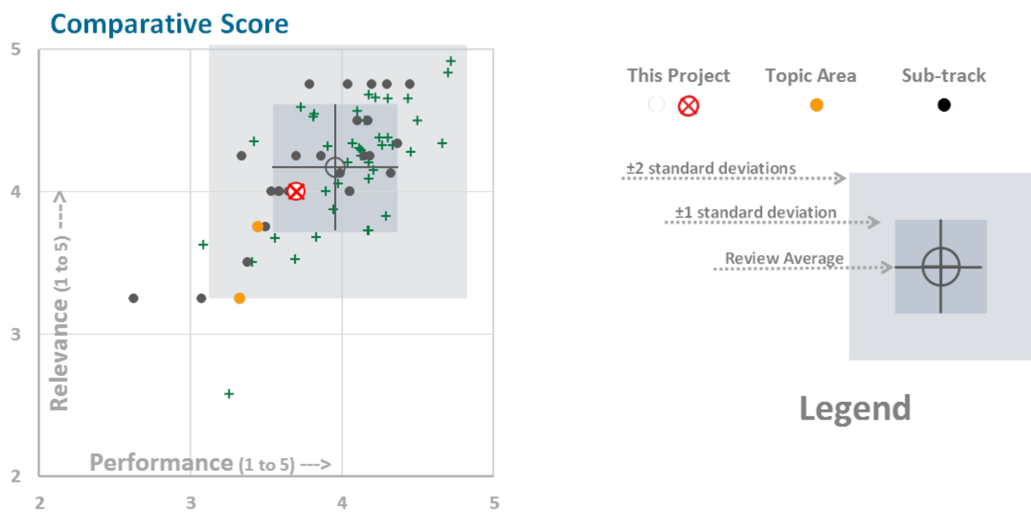
Principal Investigator	Tim Mundon, Oscilla Power, Inc.
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Survivability

FY 2014-FY 2016 Funding

DOE	$ 0.6 M	96%
Cost Share	$ 0.0 M	4%
Total	**$ 0.6 M**	**100%**

Peer Review ID# 187





Comments made by reviewers during the evaluation of this project (PRID 187)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Good alignment with sector needs
- A similar argument can be made from the point of view that on-shore customers depend on reliable electric energy sources - especially during and following storm events
- Any WEC (wave energy converter) device that is located in the open ocean but near shore will be faced with the risk of damage from extreme waves. From that point of view it is necessary to know what steps or design criteria need to be established. The results should be applicable to any WEC device that is to be operated in a commercial setting.
- This project is investigating how best to increase the survivability of the Triton WEC. However, lessons learned for the Triton will have application to some degree to all WECs.

Question 2: Methods and Approach

- It would have been good to have had the survivability strategies in advance of the project - as it's not clear
- Identification and development of instrumentation, along with communication, is part of the approach
- Well-planned approach using numerical model and laboratory tests

Question 3: Technical Accomplishments and Progress

- Good progress
- This project is just starting. It is difficult to grade it in terms of accomplishment and progress.
- Baseline has been defined and heave plates have been tested in the lab

Question 4: Project Management

- Appears to be well managed project - but would have been improved if strategies had been defined in advance
- No comment - see also project #18
- However, I have a concern as to whether the progress of this project will delay the planned tests at the Hawaii WETS (Wave Energy Test Site)
- Well-planned project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Very good lab and industry collaboration
- One expects that Sandia will publish and make available a "SAND" report on the results of this effort
- Researchers should be encouraged to submit papers and make presentations at appropriate professional society meetings; for example - Hydro Vision
- Strong collaborative team: OPI (Oscilla Power, Inc.); NREL, NREL and SNL - numerical modeling of the Triton in extreme waves; Glosten - survivability and final system design; OSU (Oregon State University) - 1:30 scale test; DNV-GL - Failure Modes and Effects Analysis

Question 6: Proposed Future Research, if applicable

- The purpose of the future research is not clear
- Potential as a commercial provider of electric energy. What are the criteria by which survivability is determined?
- This approach has a very high CapX (capital expenditures)
- Complete project before considering future research

Question 7: Project Strengths

- Determination of survivability is important to the long term success of WEC
- This project is investigating how best to increase the survivability of the Triton WEC. However, lessons learned for the Triton will have application to some degree to all WECs.

Question 8: Project Weaknesses

- "Schedule: can the time references be given in year and month or year and quarter?
- Can the diagram be revised to show the approximate location of the "heave plate"?"

Question 9: Recommendations

- This project is just starting. It is difficult to grade it in terms of potential as a commercial provider of electric energy. What are the criteria by which survivability is determined?
- Complete project

7.4.6 MHK-2B: Systems

DOE Water Power Technologies Office 2017 Peer Review Project:

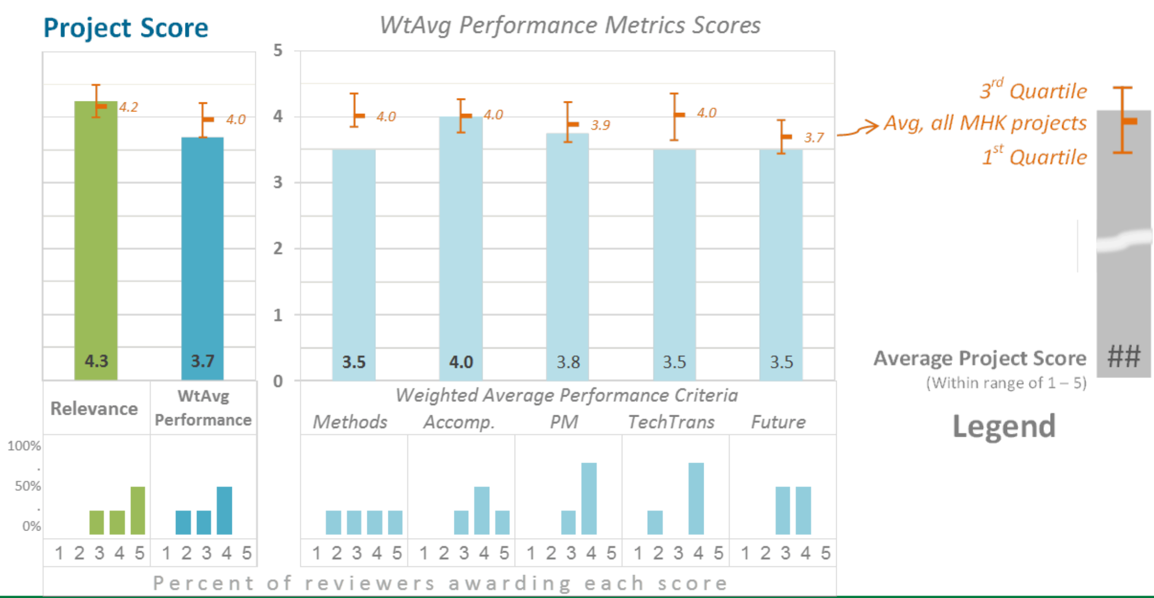
MHK Industry Support

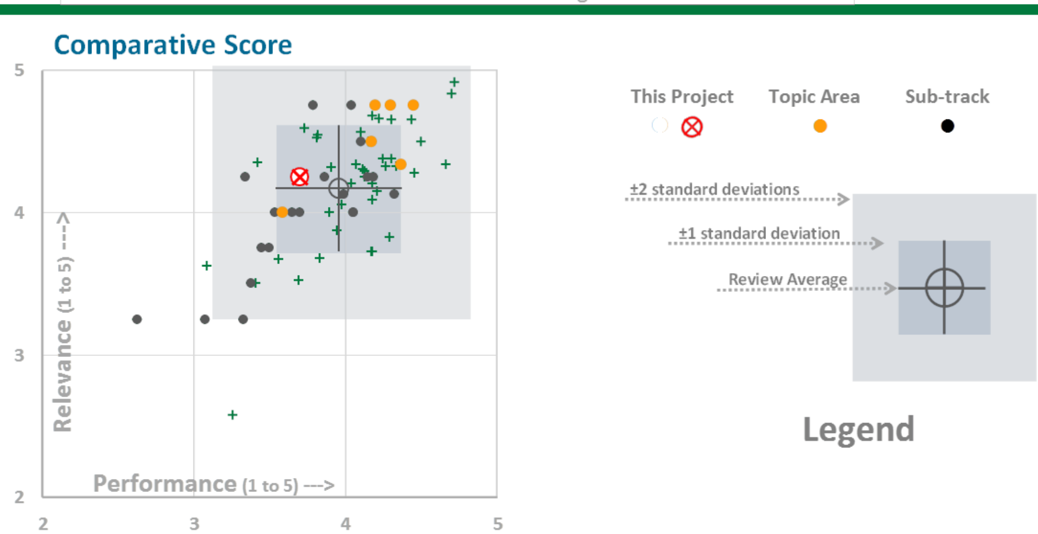
Principal Investigator	Al Livecchi, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Systems

FY 2014-FY 2016 Funding

DOE	$ 1.0 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 1.0 M**	**100%**

Peer Review ID# 4





Comments made by reviewers during the evaluation of this project (PRID 4)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Company-specific support; however with outputs that support other projects such as 67 WEC-Sim validation
- Good alignment with DoE objectives
- A well-intentioned project - with excellent potential for technology transfer - but appears to have had limited impact - maybe its limited because it was only technology of knowledge transfer from the wind sector
- Efforts focused on the cross flow turbine and relevant comparison to wind powered turbines as well as buoy power models are relevant to the MHK program
- The project is relevant because it compares several WEC PTO (power take-off) approaches
- Assistance to industry is essential to the success of the technology

Question 2: Methods and Approach

- Effective for individual companies and improvements to SNL tools but unclear how this impacts the sector as a whole
- On Sandia Website http://energy.sandia.gov/energy/renewable-energy/water-power/. Water Power Personnel offer technical expertise and research experience to develop solution to challenges faced by the water industry (not just individual companies).
- Method seems limited to only have one wave and one tide device
- Use and application of models and approach's from wind-powered generation makes use of relevant approaches when adapted to the WEC projects
- Well-designed method

Question 3: Technical Accomplishments and Progress

- Embedding best practices such as FMECA (Failure mode, effects and criticality analysis); expect this analysis will also provide improvements to NREL FMECA methodology?
- Good feedback comment from Jarlath McEntee which demonstrates company value of this support.
- SNL CACTUS model utilization that informed areas of improvement for ORPC (Ocean Renewable Power Company)
- Unclear how the SNL EFDC was used to develop layouts for optimized AEP (annual energy production)? This should have been demonstrated either through another ORPC project or within this project.
- WEC-Sim validated with OPT's (Ocean Power Technologies') tank test data supporting project 67
- A well-intentioned project - with excellent potential for technology transfer - but appears to have had limited impact - maybe its limited because it was only technology of knowledge transfer from the wind sector
- Cross flow and buoy modeling and evaluation
- Significant assistance to ORPC and OPT

Question 4: Project Management

- The lessons learned surrounding Cooperative Research and Development Agreements (CRADAs) taking longer than anticipated should create opportunity for quality improvement process to address any barriers to CRADAs, which would impact other projects
- Adequate
- No comment, but see project #18
- Well-managed project.

Question 5: Research Integration, Collaboration, and Technology Transfer

- Close coordination of technology transfer with ORPC and OPT. As above this coordination and technology transfer needs holistic review/presentation to determine the impact this project's support had on the individual device maturity development/trajectories.
- This comment for internal recommendation - important that due to the number of projects that impacted OPT and ORPC there needs to be an end presentation from the developer that demonstrates HOW each project align together to demonstrate the impact of the individual projects against progress of technology maturity.
- Not clear how widely the lessons learned have been shared due to industry conflicts
- Preparation and presentation of technical papers at various conferences
- Outstanding due to direct assistance to industry

Comments made by reviewers during the evaluation of this project (PRID 4)

Question 6: Proposed Future Research, if applicable

- The support is company specific and not necessarily technology agnostic
- While the proposed future research is relevant for U.S. sector - the limited number of developers presented as part of this peer review (Not counting WEP developers) does not provide the economies of scale for future research support and thus industry impact. There needs to be a mechanism developed that allows other international developers ability to access Sandia and NREL support.
- Not clear what the future work, if any, will be
- Is it possible for the researchers to prepare and submit technical papers to the IEEE Power Energy Society? Papers on the subject of the electrical characteristics of the PTO should be considered.
- Proposed continued assistance to industry would be helpful

Question 7: Project Strengths

- Individual direct impact (providing recommendations) with a company OPT/OPRC is demonstrated well
- Ability to bring high-tech solutions and methods from wind power technical area to the MHK area
- Direct assistance to industry. The DOE labs have tremendous capabilities and it is good to share those capabilities with industry.

Question 8: Project Weaknesses

- Not knowing the impact of their recommendations and how the individual company has incorporated those recommendations into their designs
- Outputs aligned to individual companies and Sandia tool development and not addressing/presenting outputs for sector challenges as a whole
- Does "array optimization" include optimization of the interconnection of the PTO output to the point of interconnection at the on-shore receiving electrical load or utility power grid?
- What are the electrical characteristics of the PTO output? Is the output alternating current or direct current. If AC then what is the voltage range and what is the nominal frequency?

Question 9: Recommendations

- As above, create mechanisms that increase availability of agnostic technology support.
- Important to pull out the outputs/results of this project and align with the other projects such as 67 WEC Sim validation; this is critical portfolio / program demonstration internally and externally to sector
- OPT and OPRC need to provide presentations at the end that will demonstrate how each of the individual projects hang and impact their development. How did one project influence a TRL step change or was it optimization only?
- This program should be continued because it assists the private sector to overcome difficult technology barriers
- Project complete
- Results would have been more useful if open water tests were done

DOE Water Power Technologies Office 2017 Peer Review Project:

Structured Innovation

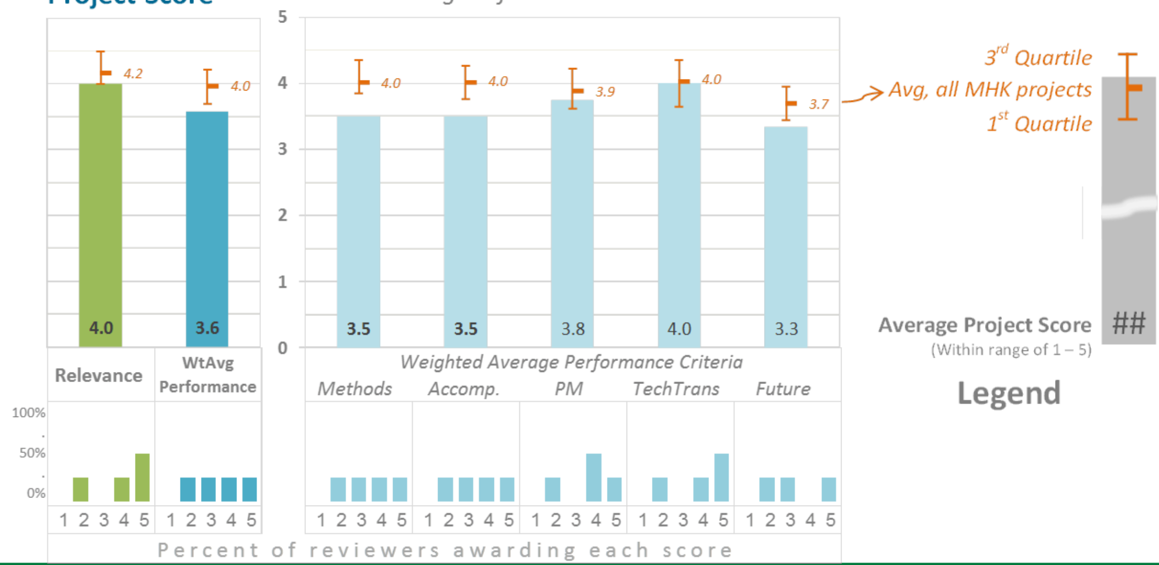
Principal Investigator	Jochem Weber, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Systems

FY 2014-FY 2016 Funding

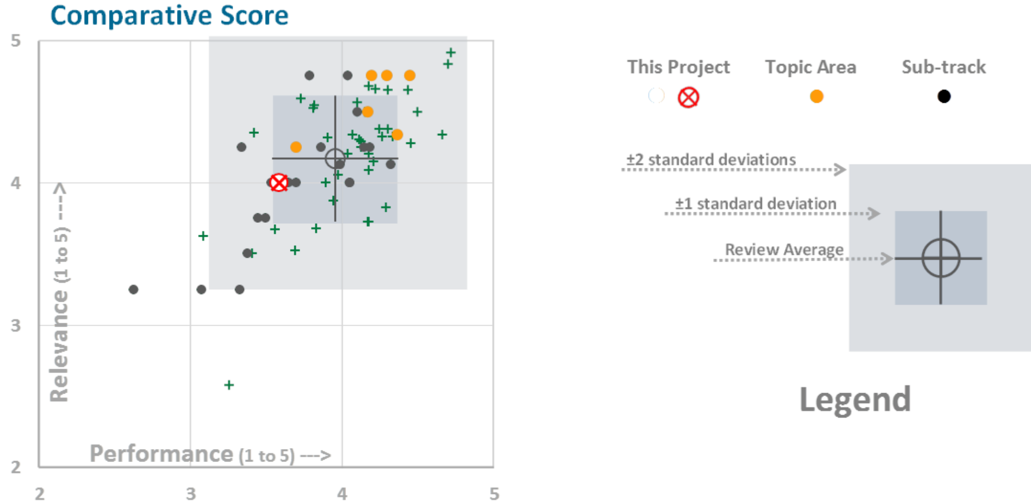
DOE	$ 1.7 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 1.7 M**	**100%**

Peer Review ID# 18

Project Score



Comparative Score



Comments made by reviewers during the evaluation of this project (PRID 18)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Strongly aligned with industry needs through a common platform for technology assessment
- An excellent project which underpins the success of the sector
- It is not clear what role this exercise plays in the MHK program
- This project is developing "high techno-economic performing wave energy converter technology concepts to achieve competitive cost of energy from wave energy ..." These concepts, by definition, will be widely applicable in the MHK industry will provide valuable knowledge and technology to the MHK community.

Question 2: Methods and Approach

- Adaptation of TIPS/TRIZ [inventive problem solving] is of interest to form the wave energy problem statement, could be adapted for a site
- Clean Branch discussion - approach
- Slide 7 there is overlap within Branch 3 U.S. Technology and identification of technology pain points and innovation needs and Clean Sheet with use of problem state of wave energy. Is this doing the same thing twice or just from an alternative perspective?
- The clean sheet approach is what is required - the industry case studies are a distraction from the goal
- The project would benefit from SI (systems integration) experts being involved
- Discussion about TPL (Technology Performance Levels) vs TRL (Technology Readiness Level). This could be the place where the subject of how WEC (wave energy converter) units would/could be connected to a power grid that serves consumers or to a specific electric load like an ocean platform could be added to the evaluation process.
- Well-designed project plan

Question 3: Technical Accomplishments and Progress

- Delivery of a standardized assessment methodology is critical for test sites to pre-determine success of a device during site feasibility studies
- More robust support can be provided that would offload significant deployment tasks on the developer
- It is fully clear what the progress is date
- It is not clear if this exercise has produced any tangible results
- Technology Performance Levels (TPLs) metric developed and used
- Used for the Wave Energy Prize

Question 4: Project Management

- Very well progressed
- Appears a well-managed project
- Not clear how this assignment was managed
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Use of the metric is underway internationally; as evidenced in WETFEET but also engagement with other developers
- This project would benefit from international collaboration
- Given the difference between how the U.S. government funds research and how other countries fund R&D, then is this exercise making a relevant contribution to the USDOE WEC program?
- Three papers/presentation are mentioned; all outside the United States
- Numerous presentations and workshops
- Strong collaborative international team: NREL; SNL; Ecole Central de Nantes, Fr; DNV-GL, UK; WaveVentures, UK; Ramboll, DK

Question 6: Proposed Future Research, if applicable

- Continued engagement at the international level should also be considered and budgeted for
- NA (not applicable)
- No comment
- Complete project before considering future research

Comments made by reviewers during the evaluation of this project (PRID 18)
Question 7: Project Strengths • Well-developed approach and experience behind the approach • The attempt to co-optimize TRL and TPL may be useful • Technology Performance Levels (TPLs) metric developed will be useful to the entire MHK community **Question 8: Project Weaknesses** • Uptake from the developers…there seems to be some misconception and push back from developer community…not sure exactly what but having been involved in the workshops it appears there is miscommunication about the use of the approach. I can't be more specific unfortunately. • Unclear • Methodology is overly restrictive. Who will enforce "structured innovation" segment? • Not clear who funds "structured innovation." If it is DOE, then does DOE not participate afterwards or is it left up to industry? **Question 9: Recommendations** • Continued funding and providing access for developers to be assessed and focus funding for their identified pain points • None • Complete project

DOE Water Power Technologies Office 2017 Peer Review Project:

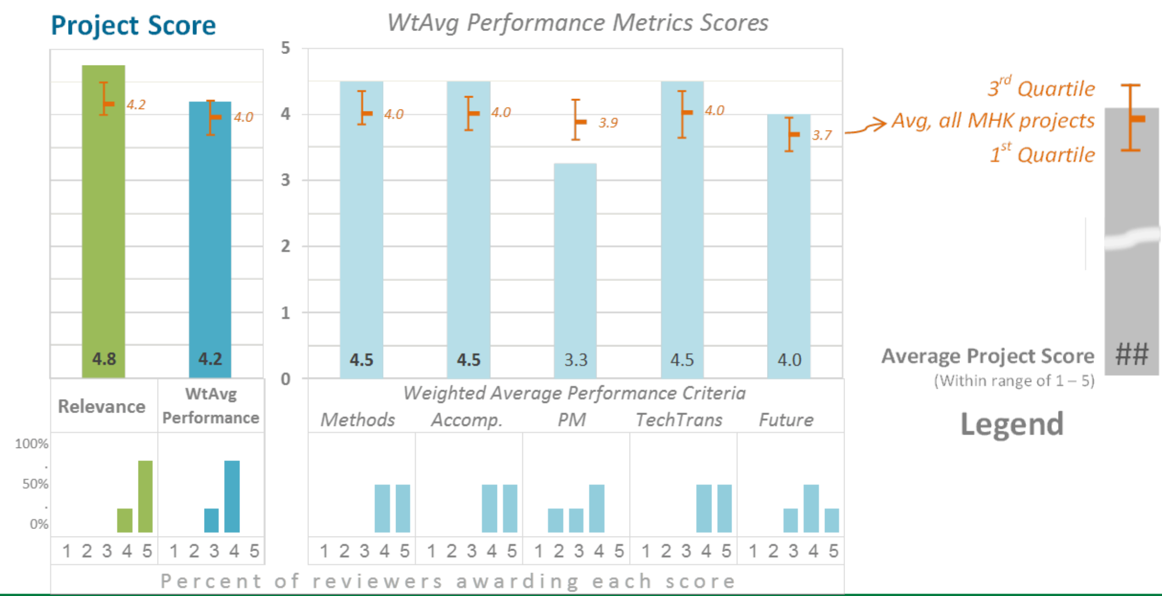
Wave Energy Converter Modeling

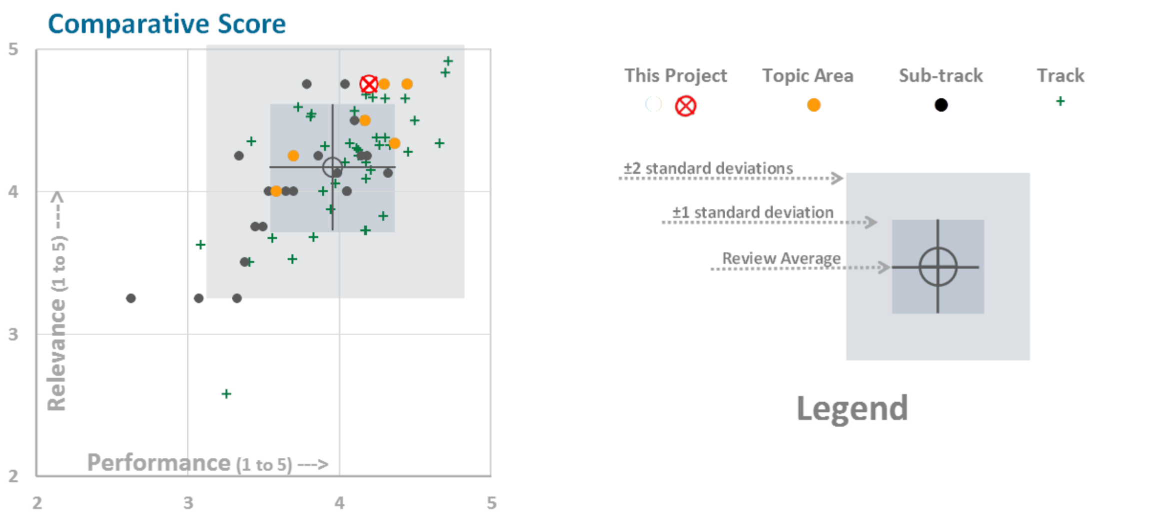
Principal Investigator	Yi-Hsiang Yu, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Systems

FY 2014-FY 2016 Funding

DOE	$ 6.5 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 6.5 M**	**100%**

Peer Review ID# 67





Comments made by reviewers during the evaluation of this project (PRID 67)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Extreme WEC (wave energy converter) modelling is fundamental strategic aim in DoE strategy for optimizing device and ultimately array performance and reliability
- Extreme WEC modelling will also inform controls optimization
- A generic wave device modeling project that is an excellent fit with the sector needs
- Notwithstanding the coding problems, it is essential to have a software model that can evaluate all WEC technologies
- There were other presenters who reported that coding errors were discovered and that this caused delay in those projects
- Development of an accurate wave energy converter model will be a valuable contribution to the MHK community

Question 2: Methods and Approach

- Clear method to develop open-source tools that are validated and customized for users' for WEC power performance and prediction of extreme loading
- Would like to understand better the results of the ECM (extreme conditions modeling) workshop and technical meeting. International collaboration and data sharing will significantly improve understanding of where improvements to the tool (WDRT (WEC Design Response Toolbox)) should be made.
- A well-structured method for code development and testing
- WEC SIM (Wave Energy Converter SIMulator) is open source code and can be used to evaluate R&D efforts
- Well-planned and executed project

Question 3: Technical Accomplishments and Progress

- Overall the accomplishments of delivering an open source model and platform for WEC development is fundamental going forward for DoE to compare results and narrow design consensus
- What were the comments back from WEP (Wave Energy Prize) developers on use of WEC-Sim? This was not evidenced and would help to inform understanding of value of WEC-Sim development. What is feedback from WES (Wave Energy Scotland) on WEC-Sim?
- Good achievements to date demonstrated by wide spread interest and use of the tool
- The availability of the software is an important aspect and allows other researchers, not in the DOE program, to develop and test alternate ideas and approaches. The availability of the software offers the possibility that an independent investigator may find an original approach.
- Project has developed open-source, WEC simulation tools, open-access validation datasets, and documentation. These tools have been designed such that they can be customized by WEC developers.

Question 4: Project Management

- Risks of PM (project management) where not described in detail or mitigation of the resultant delays and slipped milestones
- Appears a well-managed and run project
- No Comment, but see project #18
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Disappointing results from UK in terms of use; understand that there are user friendly issues and limitations for WEC topology/ configurations
- Excellent integration and technology transfer with WEC-Sim site and 20+ pull requests; disappointing that DNV-GL dropped out of partnership
- Good education support transfer in place
- Good webinars provided
- Significant number of peer reviewed papers presented at conferences is a sign that the WEC SIM approach is following a reasonable path
- Workshops and training courses are a major contribution to technology transfer and should be continued

Comments made by reviewers during the evaluation of this project (PRID 67)

- Numerous papers published
- Product is proving popular with the community: "170 unique visits per week, and 20+ pull requests"
- Several courses taught
- Strong collaborative team: NREL, SNL, Oregon State University, Andrews-Cooper, Penn State Applied Research Laboratory, and University of Texas at Austin

Question 6: Proposed Future Research, if applicable

- ECM - statement for 'complete industry support FOA (Funding Opportunity Announcement) projects with reliable and survival analyses of awardee WECs to accelerate development.' The aim is to minimize the design loading uncertainty and deployment risks but this will only be done through considerable deployments of WEC's and or site characterization studies. At the moment there is limited WEC development but there will be deployments in 2017/2018 of WEC's at EMEC (European Marine Energy Center) sites that should contribute data to ECM. There could be an international collaboration agreement in terms of further training on WEC-Sim for these developers if needed and dedicated data collection to determine load cases at the Billia Croo wave site. (move to recommendations)
- Further integration with WES developers who will also be preparing 2020 deployments either at EMEC or other sites should be considered until PMEC (Pacific Marine Energy Center) is up and running
- The FY17 ECM research plan will be of enormous value for industry and presentation should have provided more evidence on what this will entail
- Good next steps in place- it's on Github right now - and the maintenance is planned to serve the community
- Can WEC SIM provide a Fourier series model for wave patterns? If so, then can WEC SIM identify the frequency of the wave pattern that has maximum power?
- Continued workshop and trading should be continued
- Continued development of WEC-Sim would be good if funding permits

Question 7: Project Strengths

- Open Source common platform for industry
- Ongoing software development and training make it possible for R&D efforts to continue and be evaluated
- Project has developed open-source, WEC simulation tools, open-access validation datasets, and documentation. These tools have been designed such that they can be customized by WEC developers.

Question 8: Project Weaknesses

- Functionality issues need to be addressed in terms of user friendly interface
- See recommendations Q9

Question 9: Recommendations

- ECM - international sharing of design load case studies to inform the ECM analysis
- Suggest strong alignment with controls project be made with project 78 future research if not already planned for
- It is not clear from the summary or presentation if the WEC Sims modeling software includes a model of the electric output of the PTO (power take-off)? Is the output alternating current or direct current? If direct current then what is the range of voltage? If alternating current then is it single phase or three phase? If AC (alternating current), then what is the nominal frequency (60 Hz)? IF AC, then what is the range of voltage?
- Complete project
- In project 172 of this Peer Review entitled "Azura Demonstration at the Navy's Wave Energy Test Site," two errors in the WECSim code were mentioned. These errors caused significant delays to that project. I suggest a quality control review of the WECSim code development. Also, how many other projects have been similarly affected?
- Need comparison of WECSim results to field results

DOE Water Power Technologies Office 2017 Peer Review Project:

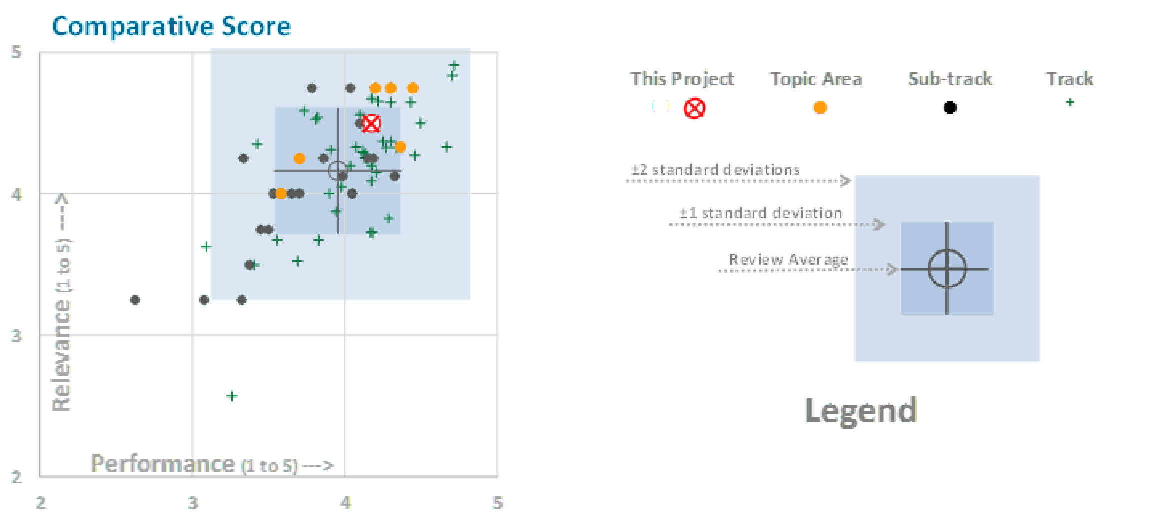
Marine and Hydrokinetics Advanced Materials Program

Principal Investigator	Bernadette Hernandez-Sanchez, Sandia National Laboratories
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Systems

FY 2014-FY 2016 Funding

DOE	$ 0.5 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.5 M**	**100%**

Peer Review ID# 69



Comments made by reviewers during the evaluation of this project (PRID 69)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Outstanding alignment and impact with DoE objectives; specifically testing supply chain products and novel solutions to validate performance and lower risks for design/manufacturing
- A composite data base project that does not have a clear fit with sector needs
- Impact on uninterrupted output of electric energy from PTO (power take-off).
- Necessary effort because it impacts the longevity of materials exposed to salt water. Length of useful life is important to reduced maintenance costs.
- Improvement in WEC (wave energy converter) materials and coatings will be a valuable contribution to the MHK community
- Proper material selection is crucial to the long term survival of WECs in the ocean environment

Question 2: Methods and Approach

- Biofouling approach is not unique or novel but outputs are important to map biofouling in areas for WEC deployments
- Materials approach straight forward and key to addressing technology gaps
- A well-structured approach but does not appear to go far enough to be fully useful to the industry
- How are the coatings coordinated with standards such as ASTM?
- Well-planned project

Question 3: Technical Accomplishments and Progress

- Delivery of open source resources for MHK industry - especially the materials database. Understanding effects of saltwater, loads and manufacturing hindering composite materials uptake.
- Papers on biofouling x2 , structural protection, corrosion protection, all good deliverables
- I can see that it is useful to tidal but appears vague in its outputs
- This is a well-intentioned project that could have potential but as described - it's not clear what this project leads to with regard to certainty that is achieved in this project
- Good coordinated of related efforts with U.S. Navy
- Included consideration of work done by others
- Put an MHK Database on Open EI and Sandia websites
- Worked with stakeholders to define need of the MHK industry with respect to composites and coatings

Question 4: Project Management

- Some slippage but due to the size of the outputs to this project it is an achievement to have coordinated the extensive outputs; data, database, publications, presentations etc.
- Appears to be well run project
- Seems academic in its structure
- No comment, but see project #18
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Good appropriate and close collaboration at the national level. Opportunity for international technology transfer in future was discussed.
- Appears to have good dissemination - not clear that that data in the 2017 database will have enough information to the MHK sector confidence
- Has excellent tech transfer - but as mentioned above does not go far enough in its scope to have impact
- Not clear what the output of the project is doing for the sector
- Significant presentation of papers at technical conferences
- Working well with industry members
- Also worked with U.S. Navy, oil and gas, and marine industries
- Held composite material workshop to define industry needs
- Numerous publications
- Strong collaborative team: Sandia National Laboratories, Pacific Northwest National Laboratory, Montana State University, North Dakota State University, Brigham Young University

Comments made by reviewers during the evaluation of this project (PRID 69)

Question 6: Proposed Future Research, if applicable

- Biofouling coatings not so much of a need - Navy has a good coating why do we have to continue to use funds to coat test plates to see what grows?
- Composite future research is very relevant and from a lego - building block perspective of industry interest
- Good future work but appears to be too limited in its scope
- Future research is necessary as new materials in electrical components are adopted as part of in-ocean equipment
- Will this program also evaluate corrosion effects on electric cable insulation and exterior protective jackets and seals at locations where electric cables exit the housing and enter the ocean environment?
- Continue FY 17 work on substructure testing, saltwater effects, and corrosion between carbon fiber and metal interconnects

Question 7: Project Strengths

- Open Source database
- This is an essential activity and is being done in coordination with other R&D efforts that are focused on energy conversion. Ultimately the success of the best WEC technologies will need appropriate materials that can "stand up" to the ocean environment.
- Strong collaboration

Question 8: Project Weaknesses

- Coatings continue to be funded when the navy has a coating (grey paint) that should be shared with industry. Is it?
- How will the project or future work be used to build the database?
- No comment

Question 9: Recommendations

- Biofouling maps in locations where commercial scale WEC deployments will potentially occur. Technology Transfer with work underway internationally.
- Develop structural integrity validation/verification methodologies for material composites
- Testing of composite material components at full scale under load conditions. Either dry or wet testing.
- At the appropriate time need to do R&D on seals related to electric conductors and cables
- Continue FY 17 work on substructure testing, saltwater effects, and corrosion between carbon fiber and metal interconnects

DOE Water Power Technologies Office 2017 Peer Review Project:

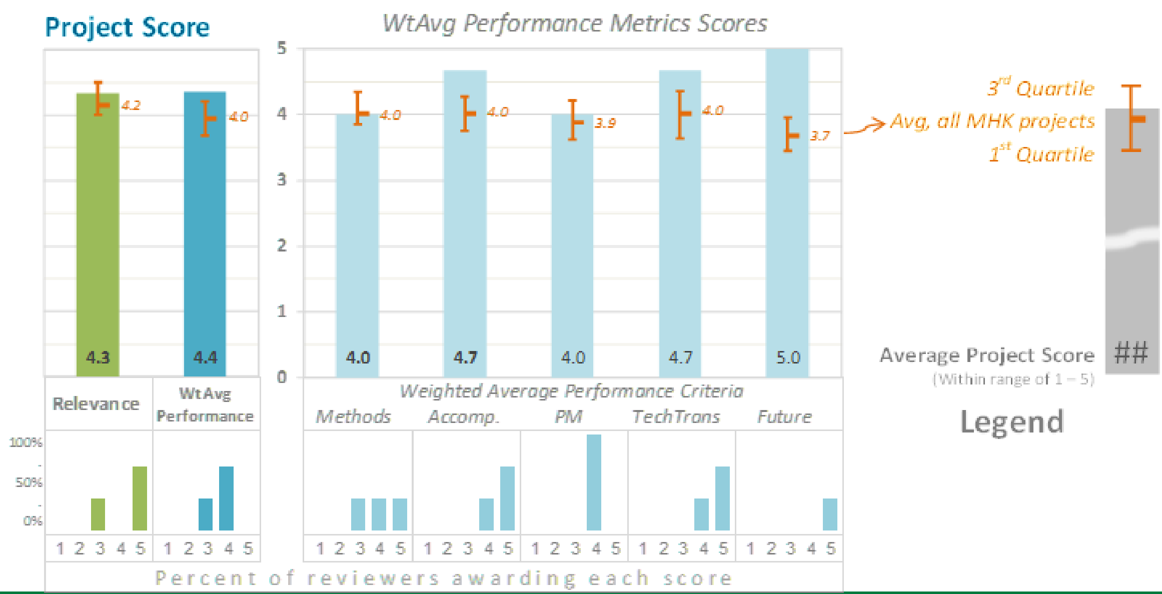
DTOcean (Optimal Design Tools for Ocean Energy)

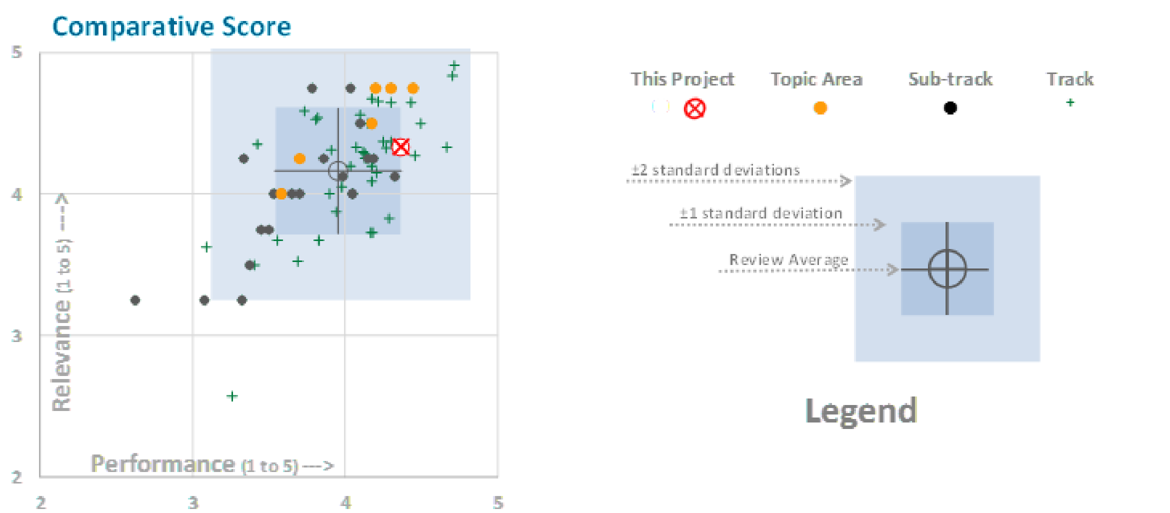
Principal Investigator	Jesse Roberts, Sandia National Laboratories
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Systems

FY 2014-FY 2016 Funding

DOE	$ 0.8 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.8 M**	**100%**

Peer Review ID# 75





Comments made by reviewers during the evaluation of this project (PRID 75)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- DTOcean outputs were design tools, which is aligned with objectives, however the industry feedback is poor outcomes in terms of usability of these tools
- Should also include cross cutting approaches in terms of exchange of data information and expertise
- Significant impact across multiple priorities which creates robustness in program
- Conflicted
- How is the term "arrays" being used here? Does it mean a collection of WEC (wave energy converter) devices in an area of several acres that are connected to a floating substation? If not, then please define what an "array" is in this presentation.
- The effort associated with "Electrical sub systems" is important to the achievement of the goal of delivering electric power and energy generated by WEC units to on-shore electric power system loads and consumers
- The inclusion of an item dedicated to the electric sub systems makes this a very relevant effort
- Goal of the project is to automate the design of an MHK array. This seems to be several years ahead of when it would be needed.

Question 2: Methods and Approach

- No data management plan was discussed. This would be an important aspect of the global database management.
- WEC array deployments are expected by 2023 (seven years away potentially) and thus tool may be obsolete by time arrays are deployed. There will need to be a period of version updates to keep tool valid as field data becomes available to improve the modular architecture; concerns ownership of system specifically the global database will falter or be diluted.
- Development of open source DTOcean software database and tool kit
- Strategic advisory board is a good idea
- Well-designed approach to the problem

Question 3: Technical Accomplishments and Progress

- Clear understanding of overall CAPEX (capital expenditure) costs that impact LCOE (levelized cost of energy) but understanding of these cost breakdowns was not evidenced
- Outstanding accomplishments from Sandia; but overall outcomes of the DTOcean modules for installation, O&M (operations and maintenance) including moorings and foundations were limited according to some industry feedback. Review of moorings module report was not robust and significant gaps remain to improve this module.
- A standard methodology to determine the LCOE and other benchmark quantities is necessary to the overall program
- Over 20,000 website visits and over 10,000 document downloads
- Scheduled to deliver the DTOcean MHK array design tool and all associated manuals and tutorials per the original project plan in 1st quarter FY17
- Verified the moorings and foundation module

Question 4: Project Management

- Overall coordination is good; lessons learnt from coordinator should have been included in the presentation
- Sandia project management good as all milestones met on time and on budget
- No comment but see project #18
- Well-managed participation in an international effort

Question 5: Research Integration, Collaboration, and Technology Transfer

- Close coordination; however integration was suboptimal in order to deliver an effective user friendly set of tools. This comment is based on feedback.
- Disappointing that current research is limited to U.S. industry outreach
- Good international collaboration
- Excellent international collaboration between 17 European institutions and Sandia National Laboratories
- Numerous workshops, tutorials, and publications

Comments made by reviewers during the evaluation of this project (PRID 75)

Question 6: Proposed Future Research, if applicable

- NA (Not applicable) HOWEVER Sandia will use the tool on a wave and tidal site to improve the tool and then publish to U.S. MHK community - important to disseminate back across to Europe so that there is continued uptake of the tool. Unclear how the tool will be maintained.
- UEDIN (University of Edinburgh) is underway in improving the identified 'bugs' in the tool. There is also discussion of a DTOcean 2 project at the EU level and this should include inputs/outputs with Sandia for overall improvements and uptake in industry.
- Can a future effort be established that describes the characteristics of the electrical output of the PTO (power take-off)?
- If AC (alternating current), then is the output single or three phase, what is the range of voltage and what is the nominal frequency in Hz?
- If DC (direct current), then what are the voltage ranges?
- Specifically; is the electrical output alternating or direct current?
- Complete project as planned

Question 7: Project Strengths

- CEC (current-energy capture) wake tool with CFD (computational fluid dynamics) model
- Development of algorithms for hydrodynamic array layout optimization
- Publications outreach; and open source software all positive strengths
- Inclusion of other efforts at the international level is also a strength
- The fact that this is an open source effort is a major strength
- Includes modules that model the following components of an array design and installation: Hydrodynamics, Electrical Sub-Systems, Moorings and Foundations, Installation, Operations and Maintenance
- Open source software
- Project addresses the complete system of an MHK energy array

Question 8: Project Weaknesses

- Large consortium: integration of deliverables from respective organizations was not well presented
- How is the term "arrays" being used here? Does it mean a collection of WEC devices in an area of several acres that are connected to a floating substation and an onwards connection to an on-shore substation? If not, then please define what an "array" is in this presentation.
- Goal of the project is to automate the design of an MHK array. This seems to be several years ahead of when it would be needed.

Question 9: Recommendations

- As above; in proposed future research
- Continue and expand this effort to include submission of technical papers to industry organizations including the IEEE Power Energy Society
- Complete project as planned

DOE Water Power Technologies Office 2017 Peer Review Project:

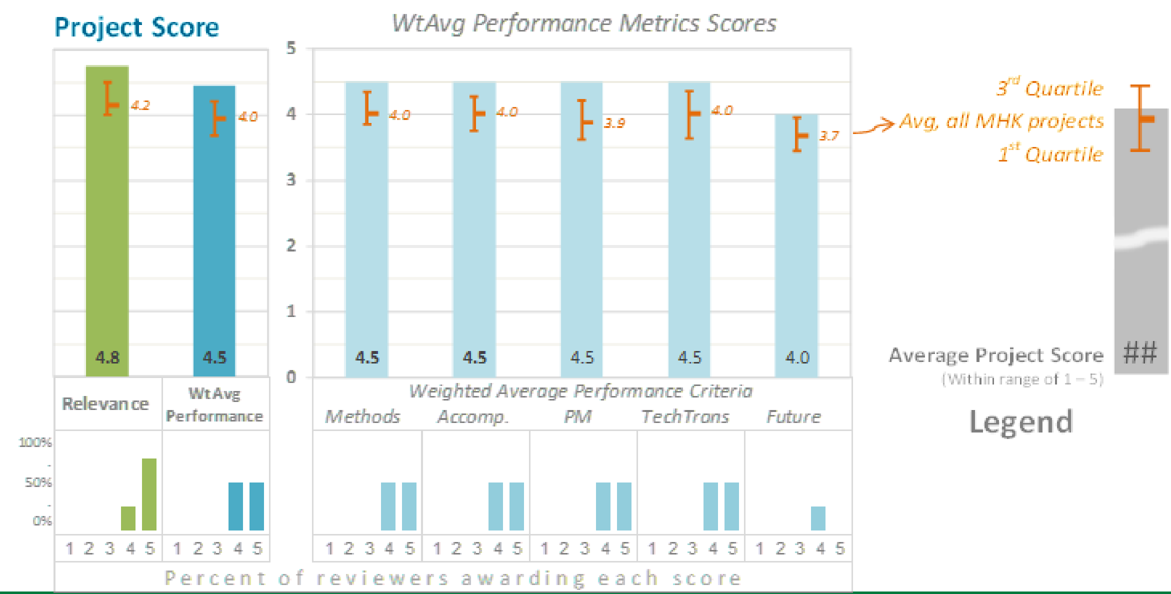
Wave Energy Prize: Testing and Data Analysis

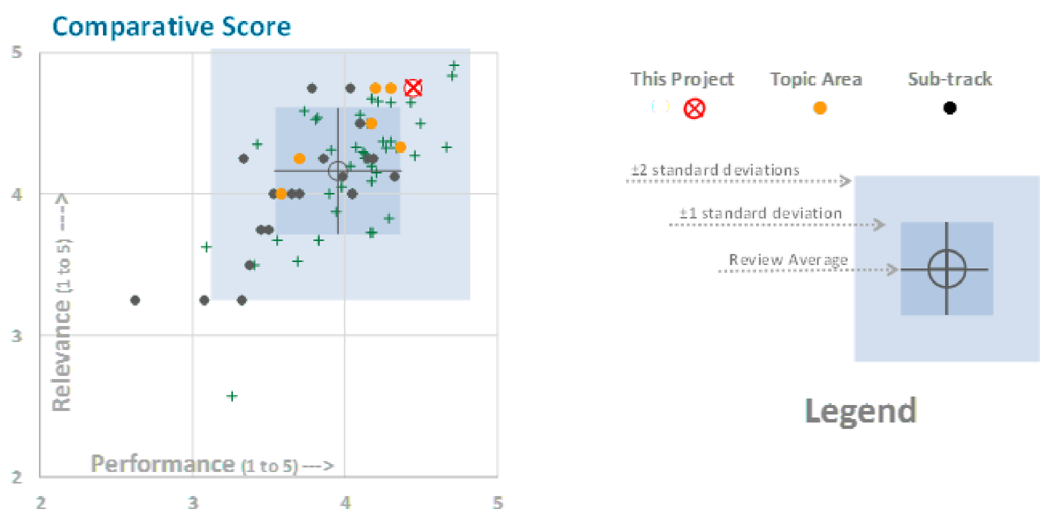
Principal Investigator	Rick Driscoll, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Systems

FY 2014-FY 2016 Funding

DOE	$ 9.7 M	94%
Cost Share	$ 0.6 M	6%
Total	**$ 10.3 M**	**100%**

Peer Review ID# 80





Comments made by reviewers during the evaluation of this project (PRID 80)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Deployment barriers - How will the key challenge of scaling and learnings from the WEP (Wave Energy Prize) results be used against the barrier of infrastructure needs and possible approaches to bridge the gaps?
- The program demonstrated and hit a large number of the challenge areas which demonstrates the power and impact of the program
- A supporting project to the WEP and in direct alignment with the sector needs
- Comprehensive and detailed testing process. Provides an economic way to evaluate new WEC (wave energy converter) as well as modifications to WEC applications under development.
- The WEC Prize accomplished its goal of inspiring innovative WEC devices, which is a critical DOE objective

Question 2: Methods and Approach

- Providing a dedicated data analyst for each team also provides third party data quality assurance checks
- Quality assurance for data handling was well integrated throughout the testing program; having a data processing script to ensure consistency in calculation of 1:20th scale results was important for analysis across the number of developers with unique designs
- Testing program well staged and prepared for
- A well-structured approach to the process and scoring but the validation process for the metrics is not clear
- How are the wave frequencies determined for the tests? Is the selection of test wave magnitude and frequency linked to the process described in project #78?
- Excellent planning and execution of the WEC Prize

Question 3: Technical Accomplishments and Progress

- Available data generated by project will be uploaded to the MHKDR (Marine and Hydrokinetic Data Repository) in FY17
- Data sets 'traceable' to standards
- Improvements of 30% in power capture was presented but not evidenced in summary or presentation
- The beginnings of sector metrics have been started in this project
- Recognize efforts relevant to project objectives
- Established test wave conditions, metrics, data analysis techniques
- The WEC Prize accomplished its goal of inspiring innovative WEC devices, which is a critical DOE objective

Question 4: Project Management

- High level and quality of outputs demonstrated a well-run and successful project
- Lessons Learnt for the project were not discussed or data security handled during competition
- A well-managed process
- No comment, but see project #18
- Coordinated contestants, testing facilities, and technical evaluation efforts
- Extremely well-run project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Ability of multiple organizations from the test facilities, national labs and project management teams to coordinate for outstanding outputs is clearly evidenced by the results of the project
- Good collaboration in place
- International collaboration would have a useful addition to this project
- Can a Fourier series model of test tank waves be prepared and compared to the frequency spectrum for actual ocean waves? This may be a way to determine how closely tank testing is to actual ocean conditions.
- Strong collaborative team: National Renewable Energy Laboratory (NREL), Sandia National Laboratory (SNL), Naval Surface Warfare Center (NSWC) Carderock Division, Ricardo

Comments made by reviewers during the evaluation of this project (PRID 80)

Question 6: Proposed Future Research, if applicable

- None presented; this successful project process should be replicated for sub system development for control systems, further PTO (power take-off) development, moorings etc…
- NA (not applicable)
- Can a metric be developed that rewards on the basis of overall input wave energy to electric energy output of the PTO?
- Project complete

Question 7: Project Strengths

- Project coordination by DoE; clear aim, scope, budget and schedule, Data quality assurance followed throughout
- Incentive to individual researchers
- Facilitated coordination between competitors and wave test facilities
- Inspired many contestants and many innovative ideas

Question 8: Project Weaknesses

- None evidenced or made aware of
- No comment

Question 9: Recommendations

- As mentioned in previous WEP competition reviews continue competition for WEC subsystems. Also the competition process should be packaged and branded as best practice for competitions similar to a TEDEx-branded style for knowledge exchange.
- Develop an overall WEC output to input energy conversion metric
- Project complete

DOE Water Power Technologies Office 2017 Peer Review Project:

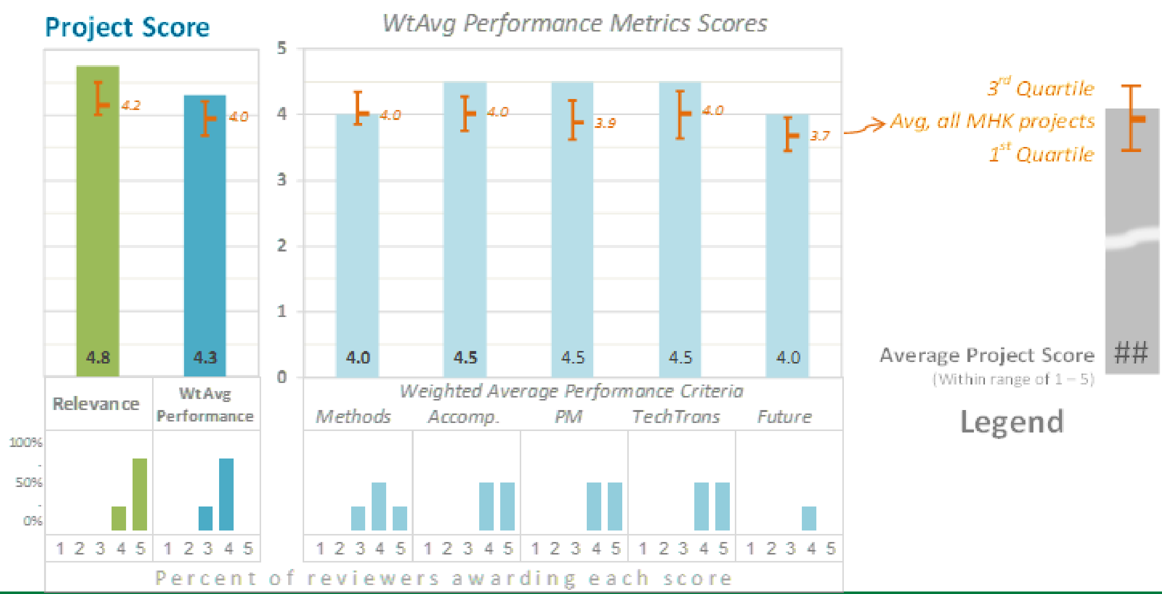
Administration of the Wave Energy Converter (WEC) Prize

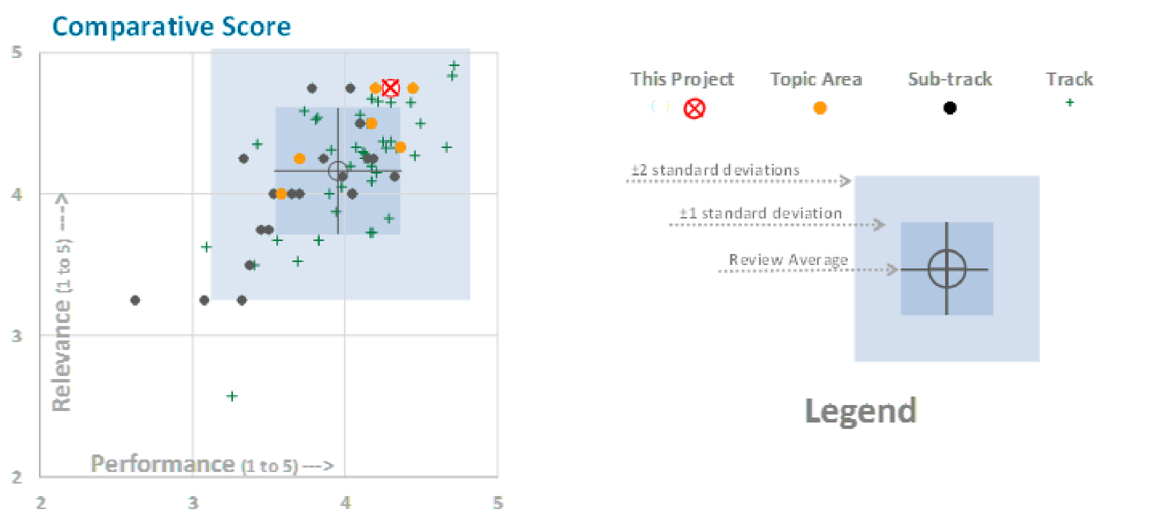
Principal Investigator	Wesley Scharmen, Ricardo, Inc.
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2B: Technology Research and Development
Topic Area	Systems

FY 2014-FY 2016 Funding

DOE	$ 0.0 M
Cost Share	$ 0.0 M
Total	**$ 0.0 M**

Peer Review ID# 164





Comments made by reviewers during the evaluation of this project (PRID 164)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Competition is fundamental to rising industrial ideas and talent, the WEP (Wave Energy Prize) was instrumental in bridging across each of the DoE MHK strategic aims
- Very good program. Provides an added incentive to WEC industry.
- The WEC Prize accomplished its goal of inspiring innovative WEC devices, which is a critical DOE objective

Question 2: Methods and Approach

- Defining Metrics fundamental to evaluate/assess designs against a target metric. Would have been good to present an example for HPQ (Hydrodynamic Performance Quality) metric, and ACE against TPL (Technology Performance Level) the winning company.
- It wasn't clear that the metrics used had been validated for success
- Wasn't entirely clear why 50th and 20th were used
- No comment
- Excellent planning and execution of the WEC Prize

Question 3: Technical Accomplishments and Progress

- Outstanding achievements against goals for teams/submissions/testing and devices exceeding the ACE threshold
- Over subscription for this prize was instrumental in demonstrating demand from the technology sector
- The project indirectly has led to many technology developments and learnings by all of the WEP participants
- Identification of metrics by which to evaluate competing WEC devices; for example input wave energy to electric energy output
- The WEC Prize accomplished its goal of inspiring innovative WEC devices

Question 4: Project Management

- Significant value for money in terms of small scale testing; was MASK (Naval Surface Warfare Center's Maneuvering and Seakeeping Basin) basin wave tank included in this cost?
- Sound timeline and delivery program
- Appears to be a very well managed process
- The prize recognizes good project management
- Extremely well-run project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Outstanding use of social media
- The website was well developed and the access for supply chain to input their services to support the teams was of great value
- Excellent that all the data will be released to progress the entire sector
- Good education of national infrastructure capabilities on MHK testing
- Will essential points (metrics) be published and presented at appropriate conferences?
- Strong collaborative team: Ricardo Inc., JZ Consulting LLC, Polaris Strategic Communications LLC

Question 6: Proposed Future Research, if applicable

- None presented - see recommendations
- NA (not applicable)
- No comment
- Project complete

Question 7: Project Strengths

- Focused competition providing funds for game changing performance, engagement with U.S. stakeholders and abroad, access to state of the art test facilities such as MASK, including availability of data to industry
- Identification of most promising WEC approaches
- Inspired many contestants and many innovative ideas

Comments made by reviewers during the evaluation of this project (PRID 164)

Question 8: Project Weaknesses

- None that can be determined
- Can the electrical characteristics of the PTO (power take-off) output be provided? Is the electric output alternating current or direct current? If alternating current then what is the nominal frequency (60Hz) and what is the range of output voltage?

Question 9: Recommendations

- As mentioned Fund a similar challenge for WEC subsystems; controls, PTO, moorings or WEC modeling that creates synergies across other industrial sectors, IT (information technology), Automotive, and O&G (oil and gas) for example
- See Q8 response about electrical PTO output characteristics
- Project complete

7.4.7 MHK-2C: Demonstration

DOE Water Power Technologies Office 2017 Peer Review Project:

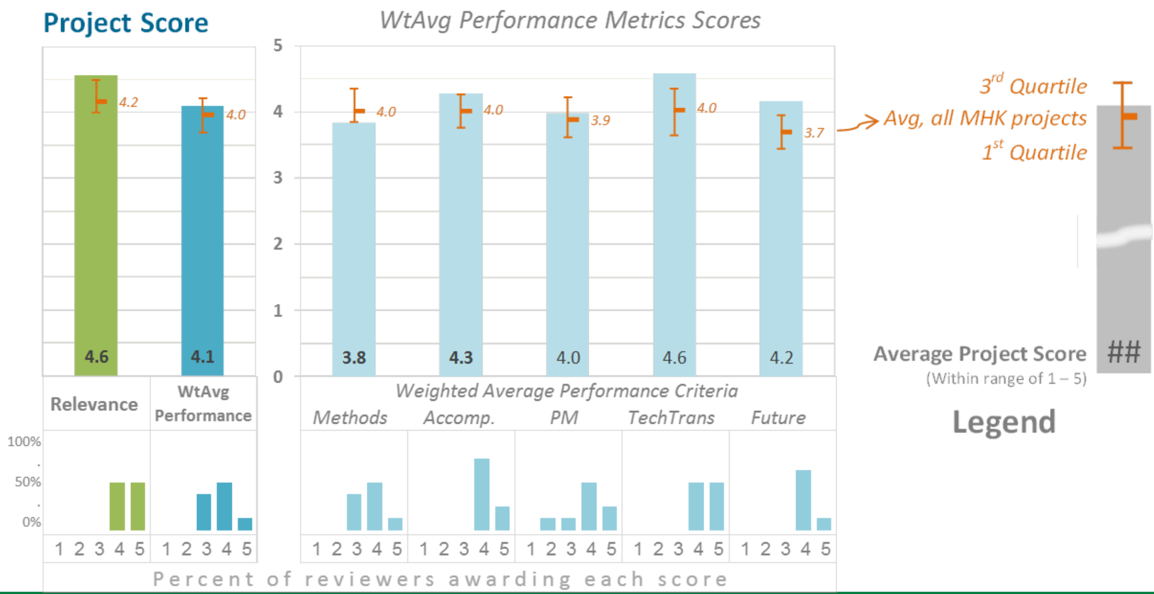
Wave Energy Test - New Zealand Multi-Mode Technology Demonstration at the US Navy's Wave Energy Test Site

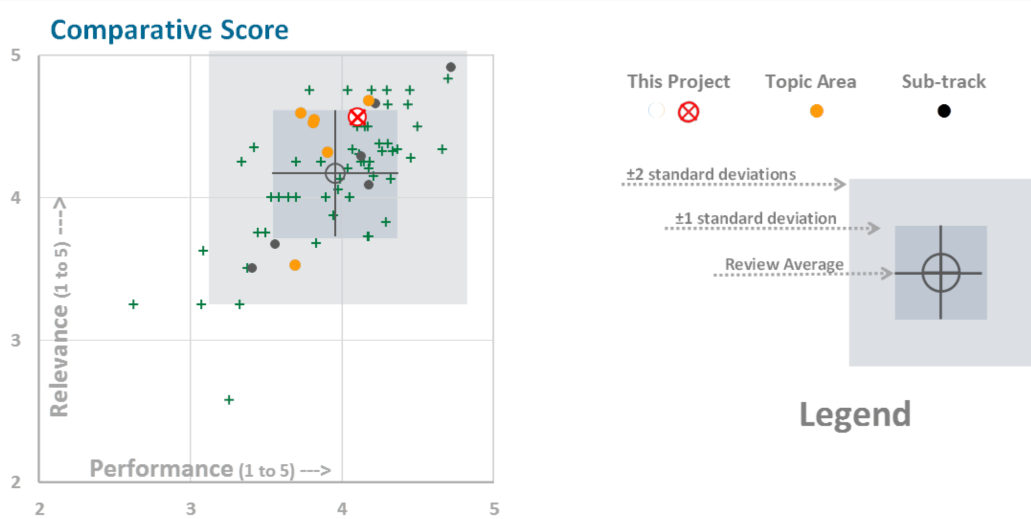
Principal Investigator	Steven Kopf, Northwest Energy Innovations
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Demo

FY 2014-FY 2016 Funding

DOE	$ 0.7 M	82%
Cost Share	$ 0.2 M	18%
Total	**$ 0.9 M**	**100%**

Peer Review ID# 145





Comments made by reviewers during the evaluation of this project (PRID 145)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- This is a good example of getting technology (or "steel") in the water and tested over a long term (~18-month deployment)
- Aligns well with goals and objectives
- !BP Demonstration Project with environmental data collected by expert third party (U Hawaii) over nearly 12 months of data
- BP! Prompt use of additional funding allowed developer to immediately upgrade the WEC (wave energy converter) design by adding heave plate and float, demonstrating value of rapid follow-on funding to achieve immediate upgrades
- BP! Evolution of project technology, from GoNZ technology license to U.S. company, and USDOE funding, is representative of strong collaborative effort to access best available technology globally to accelerate development of RE (renewable energy) on least cost curve
- Project fully consistent with critical DOE goal of accelerating market deployment through 1/2 scale prototype model testing/model validation
- A good demonstration project fitting well with sector needs for real sea experience
- Getting 'steel' wet is crucial to DOE objectives
- Concerned with all of the challenges of working in Hawaii especially logistics. A lot of project dollars were spent just on logistics.
- Important to test devices in the open ocean environment
- Experience gained will be useful to ongoing WEC projects and designs
- Since this WEC installation was grid connected, then this project is clearly relevant to the DOE objectives
- This project was a successful demonstration of a grid-connected WEC in the open ocean. This meets one of the critical objectives of the Water Power Office.

Question 2: Methods and Approach

- 3rd party review of data is necessary and commend NWEI (Northwest Energy Innovations) for working with the University of HI to incorporate this into their methodology
- It is assumed that the additional shipping of the PowerPod to NZ and then back to HI increased the cost, also increased the risk of equipment damage
- Appears that approach or plan for development had gaps. Approach should have included detailed feasibility and risk analysis studies for interconnection, and transportation/logistics.
- CD! Failure to anticipate grid interconnection issue is critical project learning. Valuable learning from one of first in space projects that should be incorporated in future DOE grant calls to require detailed analysis of test site interconnection requirements.
- Good overall plan, but valuable lessons learned about difficulty of island deployment, including use of island grids
- Successful deployment project using early stage design WEC, providing valuable data validation (high fidelity motion data) and helpful (unplanned!) demonstration of survivability through 2 hurricanes
- A good logical and structured approach to real sea testing
- Having the UH (University of Hawaii) as the third party data analysis and validator is a key strength in this approach
- Challenges of deployment needs to be identified
- Successful ocean testing
- Third party testing is important for results that can be trusted
- Working with DOD (Department of Defense) seems to be a good avenue to get devices tested
- Is this project at the stage that it can go commercial without additional DOE support?
- Were grid interconnection studies done with HECO (Hawaiian Electric Company) according to FERC (Federal Energy Regulatory Commission) Small Generator Interconnection Agreement? Who prepared system studies models for use by HECO in the preparation of System Impact Studies?
- What software did HECO use for the system impact studies? What was the unit basic "nameplate" rating? If software models were developed as a separate activity, then will they be available as open access software?
- 3rd party verification added greatly to the impact of the project on the MHK community

Comments made by reviewers during the evaluation of this project (PRID 145)

- Excellent project planning of a very complicated project

Question 3: Technical Accomplishments and Progress

- To the credit of NWEI, this project exceeded the proposed deployment timeline (12 months), enabling more data to be gathered
- Good evidence of deliverable reports
- Survivability of device was an important milestone. Demonstrates design robustness.
- Two body design not efficient at energy capture - concerned that going back to drawing board will start new trajectory of design. Concept should be rigorously modeled and simulated.
- Adjusted for two rounds of discovery of errors in design modeling software, and produced viable tank design, with further upgrades in design based on lessons learned
- Nearly one year of data enabling developer to determine optimal design and likely costs of production
- Good validation of analytical tools - no control system yet - but just have controls contract
- Very good real sea lessons learnt and good proving of the reliability of the technology
- Some delays due to weather and shipping damage, but great progress
- Why was the interconnection not seen as a hurdle at the beginning? Is this an issue/concern that has been raised with WETS (Wave Energy Test Site) to make sure this is not an issue in future projects (i.e. this is not so much a comment for Azura, but more for WETS/DOE).
- Testing for 18 months
- First step is to get hard information and data. Identified issues to be used as an outline for evaluation of other WEC projects. Full system from wave energy to energy delivered to shore.
- See summary and presentation for a list of substantial accomplishments
- The installation survived major storms and two hurricanes
- Clean safety record
- Data uploaded into the MHK Repository
- Grid-connected, open ocean test, 3rd party verification, 18 months of testing with 98% availability, survived two hurricanes
- Outstanding accomplishments as noted below

Question 4: Project Management

- After the DOE funding NAVFAC (Naval Facilities Engineering Command) contributed additional funds to this project. NWEI did not identify how much additional funds were contributed.
- Concerns that budget overrun was related to geographic shipping
- After action reports of key value - lessons learnt and how they can be generalized for industry
- IO&M (Installation, operations and maintenance) plan and dimensions of the commercial scale machine and challenges in installation connections
- Issues evidenced but lessons learnt not presented. This would have been important for others planning on deploying at WETS.
- Slippages due to logistics and site infrastructure not fit for purpose
- !BP Excellent safety record noted; assure safety practices are shared as lessons learned with other applicants for in water testing
- Strong management allowed applicant to respond/adjust to WEC-SIM (Wave Energy Converter SIMulator) program errors
- A well-managed project
- Budget is difficult to evaluate because of partner contributions
- Project is complete and final report is available
- Project took longer than expected due to weather conditions
- Some delays were reported having to do with logistics
- Excellent project management, particularly in the way various setbacks were handled

Question 5: Research Integration, Collaboration, and Technology Transfer

- This project demonstrated a good collaboration between federal agencies, device developer and local (HI) supply chain industry partner for the actual deployment
- Appropriate partners in place for development of the project. Not sure if cost was the issue during transportation planning and thus a lower cost option with higher risk was followed.
- Excellent effort to use USN (U.S. Navy) site and use of University of Hawaii for third party

Comments made by reviewers during the evaluation of this project (PRID 145)

environmental monitoring
- Use of international partners had strong points of prior experience with device, expertise in space and foreign exchange, but introduced significant transport related delays and device damages
- Good industrial partners but could have benefited from lab collaboration
- Again, best aspect is having an academic partner as third party data collection and validation
- Good collaboration with industry, academia, Navy
- Great collaboration with DOD and UH
- A significant number of publications and presentations are reported
- What software did HECO use for the system impact studies? What was the unit basic "nameplate" rating? If software models were developed as a separate activity, then will they be available as open access software?
- Numerous papers and presentations
- Strong collaborative team: Energy Hydraulics Ltd – PTO (power take-off) development; Sea Engineering – Marine construction and operations; UH/HNEI (Hawaii Natural Energy Institute) - Data collection, analysis, and reporting ; NREL - instrumentation and data acquisition system

Question 6: Proposed Future Research, if applicable
- NA (not applicable) - Project completed
- Once they scale up how will they deploy the device with crane lift and small boat deployments?
- Continue work to apply test learning in device upgrades, so long as progress on LCOE (levelized cost of energy) continues on pace
- Good future research identified
- Heave plate and float to improve performance and more testing
- Modification of design based on lessons learned
- Does the device have "stops" on the float? If so, then will these be retained or removed in future?
- Was reverse power flow from shore to PTO necessary to power on-board aux power needs?
- NA

Question 7: Project Strengths
- Identification of the risks and issues
- Significant design advancement from USDOE investment
- Important to do these field tests and learn as much as possible about performance in all weather conditions
- The accomplishment of the installation is an indication that the technology can be made to work in a commercial setting
- In-water test
- Operational 98% of time

Question 8: Project Weaknesses
- No evidence on how Azura will limit the risks and or document the lessons learnt for future deployments
- The greatest project weaknesses - failure to anticipate grid interconnection and international device transport resulting in damages and delays are important learning points for MHK community.
- Although the summary and the presentation mention that the WEC was grid connected, there is no information about the way electric power and energy that was delivered to the on-shore point of interconnection was metered or paid for
- If HECO paid for the power delivered, then what were the terms of the payment and $/kWh paid?
- Would like to have seen power production and LCOE figures

Question 9: Recommendations
- Azura/Columbia Power integration opportunities?
- Did not want to use telemetry and wanted fiber connections - not use Wireless
- Requirements understanding and early communications to address alternative solutions. Lessons Learnt!
- Scaling up and draft issue from shallow to deep water and design. BP2 (Budget Period 2) Go/No Go decision should include options for test site deployments
- DOE should work with test centers to assure centers are proactive in addressing interconnection

Comments made by reviewers during the evaluation of this project (PRID 145)
issues with potential developers • In competitive funding rounds, DOE should require applicants to specifically address compatibility of test site with all applicant requirements for deployment and build in budget to address same • This project highlights the difficulties in developing a test site that is flexible enough to meet the unique requirements of each device developer. To avoid cost overruns and delays in the future, there should be concerted efforts early on with detailed discussions between the device developer, the test site and DOE to identify any problems and allocate appropriate time and budget to these issues • DOE should look to build out test areas that have the basic infrastructure to support testing including two-way power, anchoring, power cables for input, support for instrumentation for monitoring - in other words plenty of extension cords • DOE test facilities should take into consideration how components will be transported and deployed • The details of the interconnection with an on-shore power system need to be described and submitted for presentation at appropriate professional meetings • Project complete

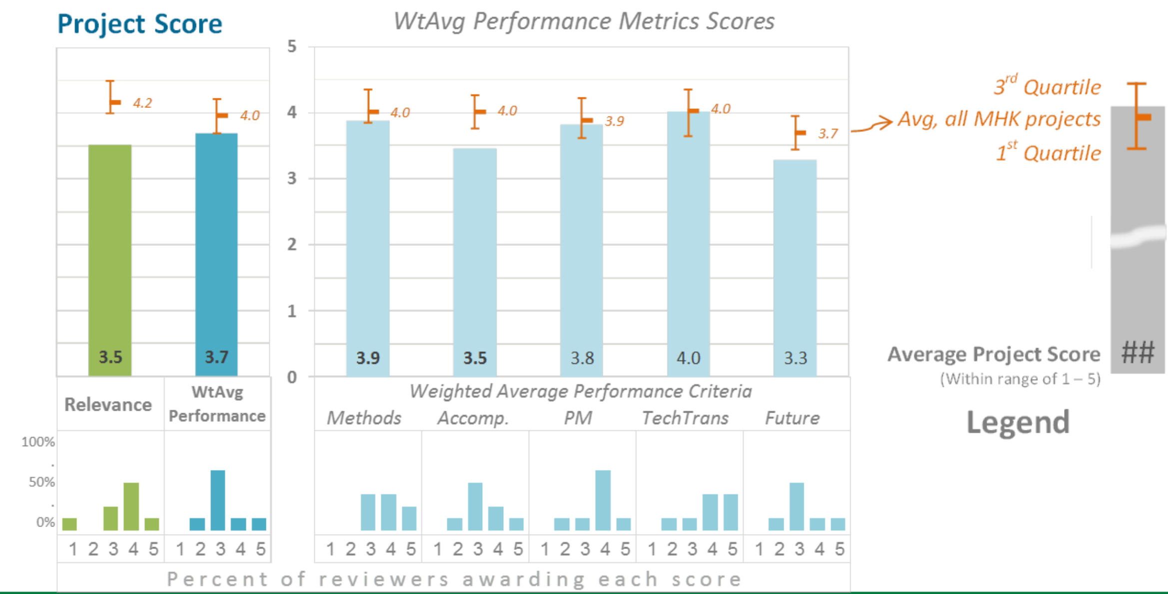
DOE Water Power Technologies Office 2017 Peer Review Project:
Current Energy Harnessing Using Synergistic Kinematics of Schools of Fish-Shaped Bodies

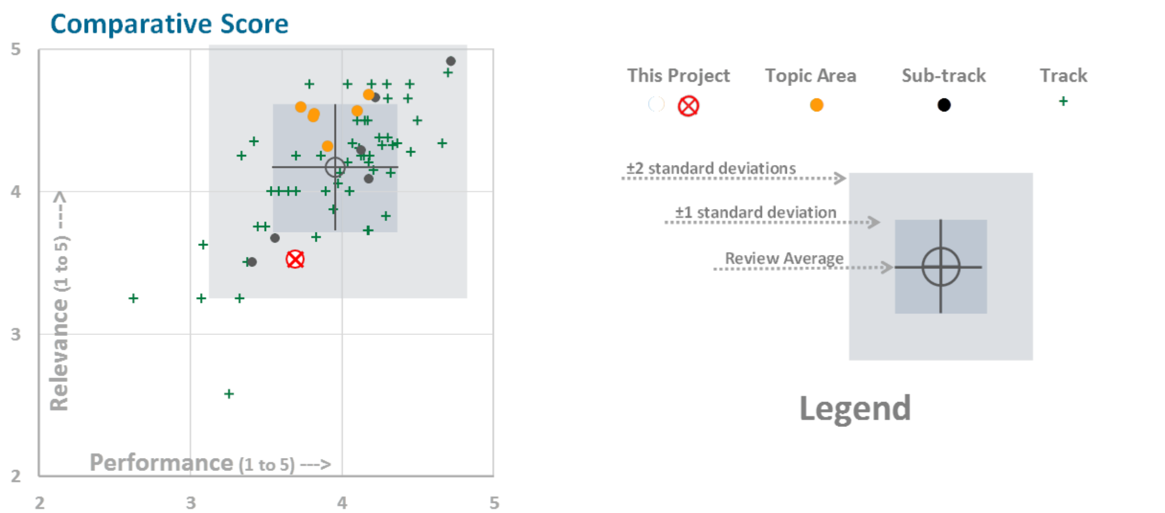
Principal Investigator	Michael Bernitsas, Vortex Hydro Energy, LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Demo

FY 2014-FY 2016 Funding

DOE	$ 1.0 M	87%
Cost Share	$ 0.2 M	13%
Total	**$ 1.2 M**	**100%**

Peer Review ID# 165





Comments made by reviewers during the evaluation of this project (PRID 165)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- A good example of technology harnessing slow moving currents, enabling it to be utilized in new, untapped areas previously ignored because of technology limitations
- See below in weakness comments
- Innovative technology for low energy environment, supported by strong University of Michigan ecosystem of expertise, facilities and co-funding opportunities
- Not clear what this adds to the technology mix in the program
- Support of R&D to explore new potential MHK technology fits well within DOE objectives
- Not sure if it is just an interesting concept or has practical application
- Novel approach for design
- Since this project converts mass flow (water flowing at three knots) to electric power and energy, then it meets the basic goals of the MHK program
- This project is developing a multi-body Flow Induced Motions (FIM) MHK device. This is a unique application and, if successful, will provide an interesting new path of MHK development.

Question 2: Methods and Approach

- A good design approach
- Approach appears to be smaller steps to create research and understanding on a small theoretical/practical scale. Compared to the other developers this project is or should be in earliest TRL (Technology Readiness Level) stages 1-2 concept stage. Benefits to the design are not well presented.
- Extract more energy between cylinders as they are moved closer together. Adjust with springs and dampers to adjust. Hydrodynamics are complicated when cylinders are brought closer together.
- Numerator asking the question to develop a 3D device - schools of fish idea....to address the ratio Power/Volume
- Understanding the interactions between cylinders they do it with alternating lift not steady lift
- Well designed, effective implementation
- They appear to have structured approach but it is not fully clear what they are trying to achieve
- Combination of lab and field testing seems appropriate for this stage of the technology
- Interesting concept that takes from the design of fish
- Looks like it can gather energy more efficiently than other designs
- The summary and presentation indicate that one of the WEC (wave energy converter) units has a power capacity rating on the order of 4kW. However when multiple units are placed on a platform (array) in a particular geometric configuration, then there is a multiplier effect.
- Well-designed project plan. Will compare CFD (computational fluid dynamics) model with field results.

Question 3: Technical Accomplishments and Progress

- The deployment did demonstrate limited environmental impacts; however, further biological investigations should be incorporated with future field tests
- Current lower than 3 knots; St Clair at 1.18m/s
- Still a lot of theoretical assumptions to be confirmed; not sure why this was in this session. Might have been better to discuss this project in terms of concept development and application of this concept to TPL (Technology Performance Level)/TRL perspective
- Technical objectives achieved, with progress toward understanding optimal power production scenarios
- How does the resonance change as you extract power and benefits over bladed turbines
- The LCOE (levelized cost of energy) is stated as being very very attractive - but it is really not clear how and when this will be achieved
- Seems like good progress. Seals seem to be the failure point. What are the plans to address this issue?
- Deployed and collected performance data to identify next steps
- A full scale installation has been made
- Used Computational Fluid Dynamics analytic tool to model the four cylinder module
- Performed Computational Fluid Dynamics (CFD) modeling, lab tests, and successfully executed a three-month deployment in the St. Clair River

Comments made by reviewers during the evaluation of this project (PRID 165)

Question 4: Project Management

- Recognized funding was split between federal, state and private funding partnership
- Project Management planning is unclear as stated above smaller research steps are indicated instead of appropriate target setting such as LCOE/AEP (annual energy production)
- The project is adequately managed
- Project is on schedule and within budget
- No comment but see project #18
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Results from this work have been well documented in peer review papers, conferences, and public media
- Searching for similar research has not proven successful. This appears to be a standalone project and not value in terms of contributing across all projects.
- Given baseline information of 10 yr old study by Harvard, MTI et al that fish are not adversely impacted, it makes sense to defer on environmental monitoring until design is more mature
- Hopefully, applicant can leverage heavy industrial and academic Michigan ecosystem to find more strategic partners and investors, including State of Michigan
- Collaboration with a lab, academia, local contractors, but no biologists for monitoring effects. Obviously not the focus of this project, but should be considered in future work.
- Good outreach and technology transfer
- Partnering with MREL (Marine Renewable Energy Laboratory) is a strength
- Can/will the researchers publish the result of the simulations prepared with the Computational Fluid Dynamics software tool in a peer reviewed journal?
- Indicates nine journal publications and 11 conference papers
- Numerous publications and news reports
- Partnering with University of Michigan, Marine Renewable Energy Laboratory

Question 6: Proposed Future Research, if applicable

- Cost of including 3 or 4 cylinders in the device
- Proposed future research is applicable to individual project and does not widen benefits necessarily to other projects. If there can be alignment with ORPC (Ocean Renewable Power Company) RivGen then I would see supporting this work by DOE.
- Development of low energy technology is an important objective, especially given projected .05 USD/kwh as feasible target by 2019
- Perhaps I missed this?
- Not discussed
- Can the analytical methodology of this effort be used to evaluate other WEC devices with multiple units on a single platform?
- Can the fish school analogy be extended to an array of multiple platforms each with four cylinders?
- Is this project able to be commercial without further funding?
- Complete project before considering future research

Question 7: Project Strengths

- Device potentially opens up new markets that allows users to harness areas with slow moving currents
- Unique elevator pitch - interesting in terms of idea to concept formulation
- Technology application in low energy environment, with minimal impacts on fish, would be strong MHK application
- Interesting concept that may be worth pursuing further
- Increased power output and reduced LCOE
- Applicable to remote villages with a nearby river
- Combination of numerical modeling, lab tests, and field tests
- Operates even with low flow speeds

Comments made by reviewers during the evaluation of this project (PRID 165)

Question 8: Project Weaknesses

- Does not provide significant impact to overall DOE strategic objectives and aims in terms of technology maturity
- Limited understanding of power capture range (2.7-7.5 x)
- Can the WEC device power output capacity be scaled up to the hundreds of kilo Watt level?
- How is the electrical output of the PTO (power take-off) transmitted or delivered to an on-shore metered point of interconnection?

Question 9: Recommendations

- Incorporate additional biological (fisheries-focused) studies into future deployments
- Deselect from program
- Encourage applicant to broaden partnerships with potential strategic investors who understand manufacturing R&D and can accelerate project scale-up
- Are there concerns with debris flowing through the device? This is not a concern unique to this device, but wonder if the unique design makes it less or more of a concern over other designs?
- Can the nature of the components of the PTO that convert water flow to electric energy be described?
- What are the characteristics of the PTO electric output? Is the output alternating or direct current? If AC (alternating current), then what is the nominal frequency? What is the range of voltage?
- Complete project

DOE Water Power Technologies Office 2017 Peer Review Project:

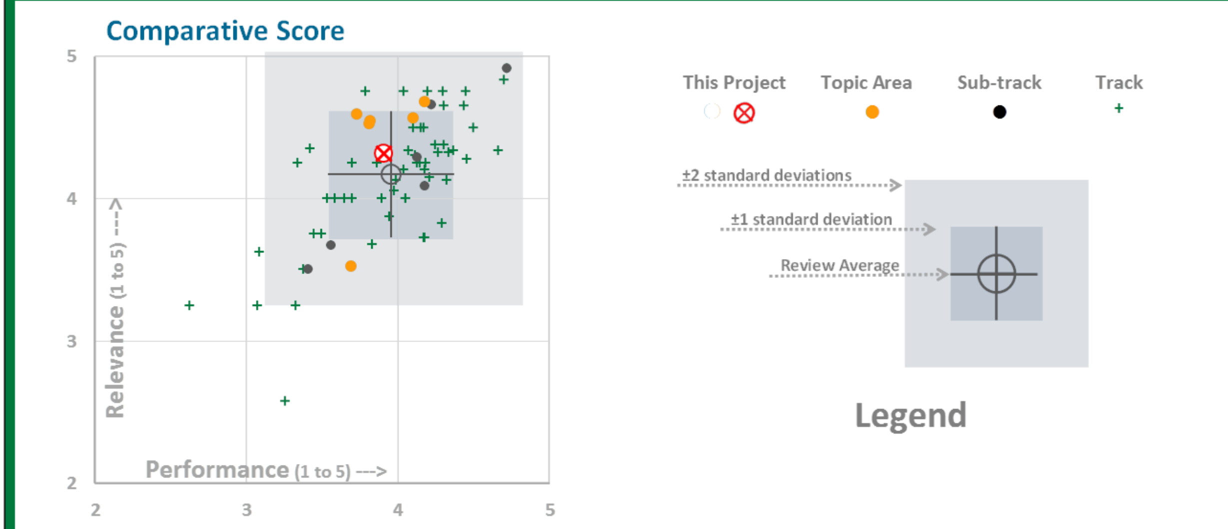
Azura™ Demonstration at the Navy's Wave Energy Test Site

Principal Investigator	Steven Kopf, Northwest Energy Innovations
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Demo

FY 2014-FY 2016 Funding

DOE	$ 5.3 M	96%
Cost Share	$ 0.2 M	4%
Total	**$ 5.5 M**	**100%**

Peer Review ID# 172



Comments made by reviewers during the evaluation of this project (PRID 172)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Based on findings from deployment, NWEI's (Northwest Energy Innovations) redesign appears similar to Columbia Power's StingRay. It's concerning that NWEI may potentially be playing "catch up" with their design and may need to investigate potential IP (intellectual property) conflicts that may result with their redesign
- Aligns with technology maturity aim
- Project objective of 1 yr deployment of MHK device at USN (U.S. Navy) Hawaii site with LCOE (levelized cost of energy) target of less than $500/MWh is high priority for DOE tech development
- A good fit with the demonstration part of the program
- Again, getting 'metal' in the water and building experience/confidence is key to DOE objectives
- Field testing of designs is critical to determine what will work best
- Objective is 12 months of field testing
- In regards to the capacity rating, the WEC (wave energy converter) device is well within the DOE objectives and goals
- The proposed power/capacity rating of the WEC device in the range of 500 kW to 1,000kW=1MW is at a comparable level with that of early wind powered generators
- This project will demonstrate a full-scale (0.5 to 1 MW) WEC in the open ocean. This meets one of the critical objectives of the Water Power Office.

Question 2: Methods and Approach

- Well-designed approach
- A clear link with the previous projects results to feed into and evidence the newly developed hydrodynamic shape would be important to understand
- Approach is standard straight forward; but understanding the lessons learnt from previous project should provide discussion on the approach and why the evaluation of alternative hull geometries and analysis
- Project well managed, but emphasizes the significant incremental risk and complexity of sourcing components and transporting devices from many nations
- A well-structured and logical approach
- There would appear to be an opportunity to collaborate with the materials and control calls that does not appear to be in place
- From the talk, I get the impression that the design of the unit needed complete reworking from the original small scale test design. Does this mean that nothing was learned from the original small scale design and that designs can't be scaled up? This calls into question the value of small scale demonstrations.
- Still planning on using UH (University of Hawaii) third party data collection/analysis when the unit gets wet. This should be encouraged/supported.
- Challenging to identify a design that captures the maximum energy from waves
- Testing at 80 meter site
- Given the cost to transport test rigs from North America to Hawaii, then would it be more economical to have a test site on the Pacific coast?
- Two body devices are or are not the best? Needs clarification.
- Plan to compare field test results with WECSim (Wave Energy Converter SIMulator) results. This will aid all future users of WECSim.
- Well-designed project plan

Question 3: Technical Accomplishments and Progress

- Significant accomplishments with design modifications
- New hull designs presented but no clear winner. Use of the TPL (Technology Performance Level) approach for assessment?
- Project would enable validation of WEC-Sim design, an important progression on commercial development
- Good progress made although distracted by WECSIM errors

Comments made by reviewers during the evaluation of this project (PRID 172)

- Had the advantage of a good validation for WECSIM
- Serious hurdles from WEC sim software encountered. How do this and other programs learn from this?
- Had issues with design
- Need time to test different designs
- Completed several designs using WEC SIM software, and is now preparing for tank testing
- Good progress despite issues with WECSim errors

Question 4: Project Management

- Project on budget although slippage in schedule
- Unfortunate slips due to WEC-Sim errors
- Strong design phase and good use of USN (U.S. Navy) CRADA (Cooperative Research and Development Agreement) and facilities
- A well-managed project
- Challenging to develop and modify designs
- There were set backs due to coding problems with WECSIM software
- What is the TRL (Technology Readiness Level) and TPL for this? Why use RCN as the metric instead of TRL and TPL? See project #18
- Well-managed project, particularly the way the team persevered through the discovery of two significant WECSim errors

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good public/private partnership
- Good continued partnership from one project 145 to current
- Important potential technology for transfer to USN WEC site deployment, and good integration with USN resources
- Limited tech transfer other than with NREL code
- Good collaboration
- Can the researchers be encouraged to present technical papers with the results of their work?
- Indicates that a web site has been established
- Strong collaborative team: Energy Hydraulics Ltd – PTO (power take-off) development; Makai Engineering - detailed design (BP2 (Budget Period 2)); Sea Engineering - Marine construction and operations; UH/HNEI (University of Hawaii/Hawaii Natural Energy Institute) - Data collection, analysis, and reporting; NREL - instrumentation and data acquisition system

Question 6: Proposed Future Research, if applicable

- As part of the next steps of NWEI development of a full-scale device, it was unclear as to what their targeted PTO efficiency is going to be with this proposed project
- The ability for the advanced controls research to optimize the design and create another iterative feedback into the numerical modelling will be important
- If project successful, it will be among priority technology development projects for DOE to produce WEC for USN wave sites
- Extensive future research planned
- Advanced controls are the logical next step
- None presented
- Complete project before considering future research

Question 7: Project Strengths

- Identification of the risks and issues to improve understanding
- Overcame setbacks due to software coding glitches
- Combination of numerical modeling (WECSim), lab testing (OSU (Oregon State University)), and field demonstration (WETS (Wave Energy Test Site))

Question 8: Project Weaknesses

- Unclear as to what their targeted PTO efficiency is
- Advanced controls work not introduced earlier on in this project
- Lack of presentation of results at professional meetings

Comments made by reviewers during the evaluation of this project (PRID 172)
Question 9: Recommendations • Recommend checking that there is no IP conflict with the redesign of the WEC • Continue trajectory but ensure that advanced controls work is integrated quickly into the design process • If the WEC SIM studies and tank testing produce information and data about the power/capacity of the PTO electric output, then this should be provided • What are the electrical characteristics of the PTO electric output? Is the output alternating current or direct current? If AC (alternating current), then what is the nominal frequency (Hz), and what is the range of voltage? • Complete project • Go/No-Go decision needs to consider 60m or 80m site

DOE Water Power Technologies Office 2017 Peer Review Project:

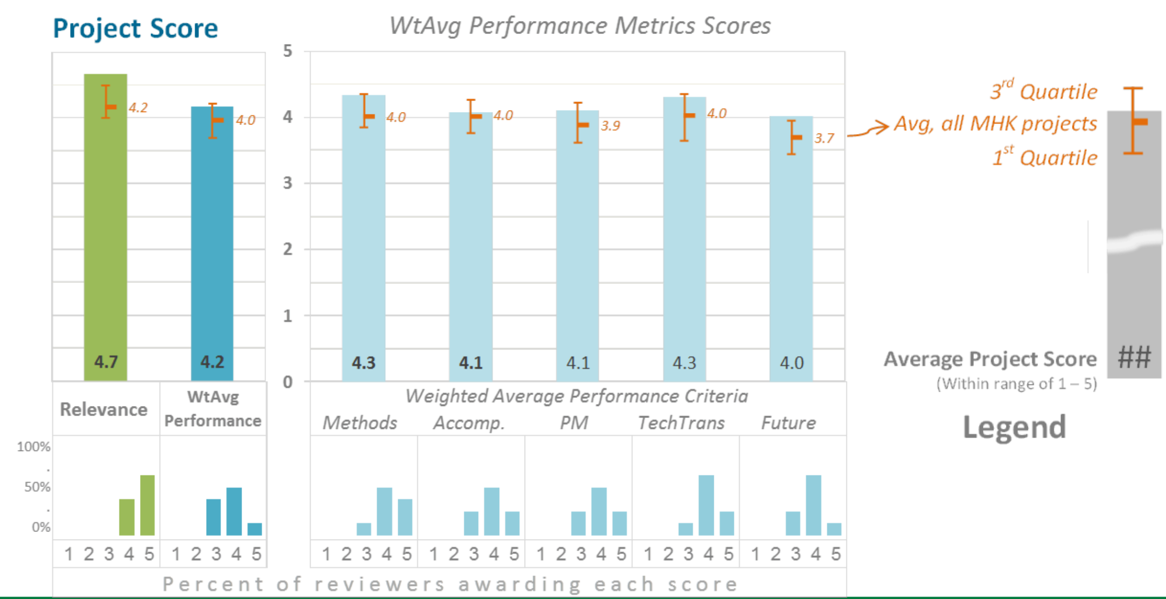
Demonstration of the Ocean Energy (OE) Buoy at US Navy's Wave Energy Test Site

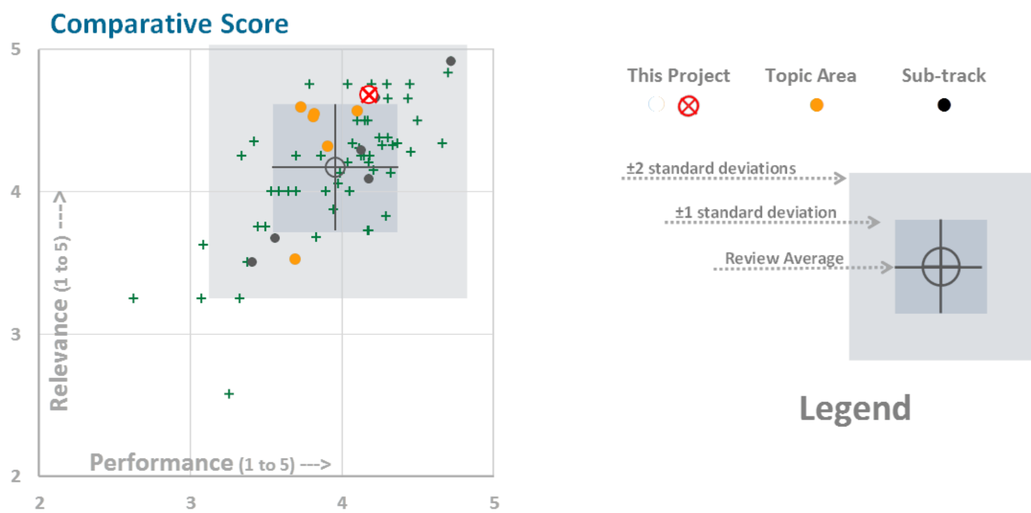
Principal Investigator	Tony Lewis, Ocean Energy USA LLC
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Demo

FY 2014-FY 2016 Funding

DOE	$ 5.0 M	98%
Cost Share	$ 0.1 M	2%
Total	**$ 5.1 M**	**100%**

Peer Review ID# 173





Comments made by reviewers during the evaluation of this project (PRID 173)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- This project will demonstrate 1) the effectiveness of deploying a "near-full scale" device and 2) utilizing the U.S. supply chain to develop and deploy this device
- Deployment of near full-scale Ocean Energy Buoy (deep water oscillating water column device) for one year at open sea test site to validate performance predictions, reliability, and LCOE (levelized cost of energy) estimates will significantly advance WEC (wave energy converter) on commercialization curve and demonstrate compatibility with Grid ops
- Fits well with the demonstration area of the program
- Steel' in water key to DOE objectives
- Getting workable designs is critical to the success of the MHK program
- Important to support testing of different designs to determine which has the best potential for commercialization
- This project is in line with the DOE objectives with regard to WEC unit capacity and connection to a power grid
- Yes, the power/capacity rating of the WEC devices are on the order of 135kW to 500 kW and are being connected to a functioning electric power grid
- This project will be a demonstration of a grid-connected WEC in the open ocean. This meets one of the critical objectives of the Water Power Office.

Question 2: Methods and Approach

- 3rd party data review is necessary and commend Ocean Energy incorporating this into their design
- 3rd Party validation of design and approach with B&V (Black & Veatch)
- FMEAC (Failure, mode, effects, and criticality analysis)- and use as feedback loop
- Weight increase 15% floatation tanks increase the draft and thus the stability won't be an issue
- Excellent project management; strong risk reduction strategy through use of third party highly skilled engineering consultant to validate design
- Good approach it is not clear how this fits with their materials project with Revision
- Good installation strategy
- Scaling up, testing, validating
- Good that they are working with UW (University of Washington) to test monitoring equipment simultaneously as well as begin to address environmental concerns
- Good that they did third party validation and used risk reduction strategies
- Good they evaluate launch and recovery modes
- Did the LCOE analysis include the cost of Interconnection to the POI (point of interconnection) with the Grid Operator system?
- Does this process involve a two-step mechanical energy conversion process? That is, one step for buoy motion to compress air and a second step to use the compressed air to drive a turbine? Is the two-step process, more efficient, as compared to other processes that convert wave energy to mechanical power in one step?
- "What is the lower kilo Watt capacity limit for the “large scale” WEC that is mentioned?
- Can an IEEE paper be presented at an upcoming IEEE PES (Power and Energy Society) General Meeting?
- What software and models will be used to make the system impact studies?
- Using Siemens Dresser Rand to supply the air powered turbine and electric generator?"
- What is the TC114 (Technical Committee 114) standard? Has the receiving electric utility been selected, and if so then who is it?
- Who is the “local Grid Operator”? How was the WEC PTO (power take-off) modeled in the Grid Operator interconnection and system impact studies?
- Will Black & Veatch be doing the system impact studies required for an interconnection with an on-shore electric utility? If so, what software will be used for the system impact studies and are the necessary models available to the public?

Comments made by reviewers during the evaluation of this project (PRID 173)

- Impressive attention to detail is exhibited, as in the following: "Technical risk reduction measures implemented including tank testing of ocean towing in extreme wave conditions, model testing of novel launching strategy, independent third party validation of designs completed"
- Well-designed project plan

Question 3: Technical Accomplishments and Progress

- Appreciate using "local" (U.S.) supply chain to build and deploy their MHK device
- Appreciate utilizing industry codes and standards during the design period
- No flooded chamber; pumping system for ballasting from dry to wet. Wider operational / calm waters and towing in fully ballasted position potential to increase towing time/and thus cost.
- Basis for additional 1MW project at more exposed site (EMEC (European Marine Energy Center))
- BP! - Over 9M USDOE investment has cost share match from Sustainable Energy Authority of Ireland, so MOU (Memorandum of Understanding) between projects to enable deployment
- Detailed design process nearing completion and planning progressing on schedule for fabrication, deployment, and O&M (operation and maintenance)
- Appear to be a lot of changes in the development program
- Seems like good progress to date
- Appear to have made good progress with all aspects for deployment including fabrication, transport, and environmental permitting
- Project is moving along and providing results
- Detailed design of the OE35 Structure nearing completion; 3-point mooring system and electrical umbilical system complete; Integration of HydroAir turbine nearing completion; preferred fabricator identified engaged; environmental permits secured; grid connection permit being finalized; marine operations planning on-going, including ocean towing and launching

Question 4: Project Management

- Subcontractor budgets were modified and additional cost share support was provided by Sustainable Energy Authority of Ireland, overall project on budget/on time
- The project will be improved with lessons learnt from WETS (Wave Energy Test Site) testing for 1MW deployments. Will improve the IO&M (installation, operations and maintenance).
- Excellent project management to address logistical challenges of Hawaii site and fabrication of the prototype, while adjusting for potential additional opportunity for deployment of same device with higher output at a more exposed location as follow-up project
- Strong project management to evolve deployment method to allow shallow water deployment and reduce risks of deployment
- Unclear why this is being tested outside the United States
- Cost share with Ireland is a strength
- Some redesign issues that are causing delays
- Completed comprehensive project planning and scheduling
- Well-managed project, particularly considering the size and complexity of the WEC system

Question 5: Research Integration, Collaboration, and Technology Transfer

- An extensive private/public teaming partnership
- Broad collaboration with USN (U.S. Navy) on test site and with strong private sector equipment/engineering consultants, including use of highly skilled marine offshore operations expertise for WEC deployment
- Very good link with the Dresser Rand project - can this be done with other projects in the DOE program
- MOU between DOE and Irish Govt is to be commended as it has provided additional funding
- Solid group of industry collaborators
- Third party validation by engineering firm. Is that better/worse/equivalent to having an academic third party validator?
- Loading data into MHK database
- Lots of partnering

Comments made by reviewers during the evaluation of this project (PRID 173)

- Project engineers and researchers should be supported in their efforts to prepare and submit technical papers to IEEE - PES, NHA (National Hydropower Association) and other applicable professional societies
- Strong collaborative team: Re Vision Consulting -Technical support, Real-time wave measurement; Tritec Marine USA - Structural and Mooring Design; HydroGroup - Umbilical System Design; Dresser Rand (Siemens) - HydroAir Turbine Integration; RG Consulting - Marine Operations; Black & Veatch - Third Party Validation and Technical Support

Question 6: Proposed Future Research, if applicable

- Commend Ocean Energy with their design whereby a significant redesign of the device is not required to change the PTO from 500 kW to 1 MW
- If project successful, and if LCOE reductions are satisfactory, proposed future R&D on power controls optimization would be part of high priority technology development funding strategy
- Limited future research identified
- Going from HI to a more exposed site
- Optimizing power performance
- No comment
- Complete project before considering future research

Question 7: Project Strengths

- Deployment of near full-scale prototype will allow analysis of accuracy of OE Buoy design assumptions and learning about operations at USN Hawaii site
- Subcontracting of different components/aspects of design/manufacturing, rather than keeping everything in house is encouraging as this is more likely to lead to supply chains needed for commercialization
- Partnering with testing environmental observation project
- Well thought out for all aspects of the project including deployment, recovery, permitting, and connections
- Established and developed electric power connections to functioning bulk power grid
- Ability to vary draft to enable launch and recovery is a significant capability
- Grid-connected, open-ocean test, 3rd party verification, near full scale WEC

Question 8: Project Weaknesses

- First phase project seems fine, but follow on project at high energy site assumes only generator upgrade; no pause to evaluate whether device design, construction need adjustment
- None were noted

Question 9: Recommendations

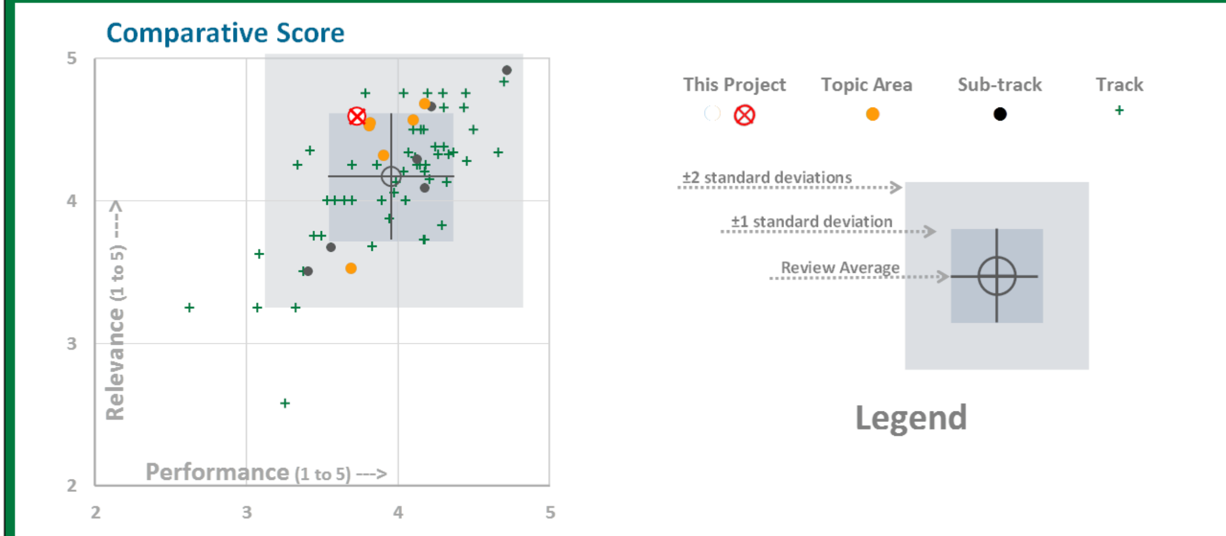
- Prepare a description of the electrical characteristics of the PTO electrical output. Is the output alternating or direct current? If AC (alternating current), then what is the nominal frequency? For AC or DC (direct current) what is the range of output voltage?
- Complete project
- Continue to monitor project adherence to the schedule. Need to ensure minimal delays in getting into the WETS site.
- Will full-scale flow rate testing be done on the vessel to verify that it meets the specs of the Dresser-Rand turbine?

DOE Water Power Technologies Office 2017 Peer Review Project:

Reduction of System Cost Characteristics Through Innovative Solutions to Installation, Operations, and Maintenance

Principal Investigator	Ken Rhinefrank, Columbia Power Technologies		
Track	Marine & Hydrokinetic (MHK)		
Sub-track	MHK-2C: Demonstrations and Infrastructure		
Topic Area	Demo		
FY 2014-FY 2016 Funding			
	DOE	$ 0.4 M	91%
	Cost Share	$ 0.0 M	9%
	Total	**$ 0.4 M**	**100%**

Peer Review ID# 188



Comments made by reviewers during the evaluation of this project (PRID 188)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Looking at ways to reduce installation, operation, maintenance, and recovery
- Development of IO&M (Installation, operation and maintenance) cost effective - specific to Cpower device how will the lessons learnt be made available to rest of industry?
- Excellent follow on to earlier R&D identifying needs to reduce costs, increase energy output, and assure safe and efficient IO&M
- Support reduction in complexity/cost of harbor-to-site deployment and installation by including variable ballast in the WEC (wave energy converter)
- Ideal that the developers have support in separate projects across different areas
- This is good fit with program
- Identifying and addressing areas for cost reductions is important to support
- May be early to focus on until viable device designs are available
- Project summary, in text format, was not provided and details about relevance are not easily documented
- The experience with logistics, installation and maintenance for WEC units is an important part of the overall MHK program
- This project will demonstrate a full-scale (0.5 to 1 MW) WEC in the open ocean. This meets one of the critical objectives of the Water Power Office.

Question 2: Methods and Approach

- Appreciate the number of areas of improvements Columbia Power is investigating. For example, the PTO (power take-off) "lockout" addresses a significant safety issue that has previously been difficult to resolve.
- Investigation of this project included determining optimal materials to build the device
- Key project understandings at each design/process improvement stage were well evidenced; Seals, ballasting, mooring and umbilical modularity, PTO lockout etc.
- PTO lockout - all sea states will keep drive shaft engaged…work area during maintenance needs to be locked for safe works
- Requirement of additional floats to transit the device from harbor to site; ballast requirement at test site and solution cost prohibitive
- Seals, ballasting, mooring and umbilical modularity; handling, deployment including reduction of shipping/transit costs
- Working with Navy to understand the integration process for moorings and connections demonstrates strong collaboration with experienced industry
- CPT (Columbia Power Technologies) identified and promptly addressed the lack of project team resources needed to enable it to scale up; instructive for other projects that additional time may be required
- Good approach to select 10 topic areas for improvement
- It is not fully clear what the actual method for making these improvements is
- Methodical approach to evaluating and bringing down costs
- Good summary of the different aspects that should be analyzed for cost reductions
- A straight forward approach to the goals of the task was followed
- Well-planned project

Comments made by reviewers during the evaluation of this project (PRID 188)

Question 3: Technical Accomplishments and Progress

- Although delays have occurred because of resource constraints, desktop studies have been completed
- Desktop study of improvements is complete
- Mooring and umbilical modularity - connections to made require time and weather windows
- There are numerous lessons learnt in terms of accomplishment and progress; as described in other comments these need to be chronicled, prioritized and further support necessary from DOE to encourage OEM (original equipment manufacturer) collaboration/investment in design stages
- Variable ballast; flood/deflooding; hard ballast replacement - costly steel requirements; water ballast approach provided reduced cost but reduced performance; modification of whole structure - remodification needed to balance the LCOE (levelized cost of energy) improvements - Question why this is learnt at such a late stage in design? Could this have been avoided?
- Impressive list of potential areas for study to lower LCOE
- Limited progress so far but still time to go in the project
- Not clear when the improvements happen - nor the prioritization method to select these topics
- Desktop studies complete
- It is hard to evaluate this project given the presentation focused on the first couple of slides
- In progress and difficult to determine accomplishments
- Good summary of significant cost factors needed to establish O&M (operations and maintenance) costs
- Desk top study complete

Question 4: Project Management

- Project is on budget
- Challenges to the project overall and supply chain/OEM integration is critical; DoE should evaluate mechanisms for OEM to engage with developers in a synergistic way not as a supplier only
- BP! Corporate requirement to certify the project before installation as important risk reduction strategy
- Effective response by CPT to address project delays due to lack of resources, putting Year 1 Budget workplan back on schedule
- Important lessons learned on challenges/time required for scale-up from small-scale prototype testing company staffing to large-scale model testing company, and securing specialized skill sets needed on board early is important and takes time
- Appears to be a well-managed project
- Project is moving along slowly and looking for cost reductions
- The logistics and O&M tasks for this project were well managed
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- A good public/private partnership
- Could Sandia/NREL have been included in evaluation stages (TPL (Technology Performance Level) /TRL (Technology Readiness Level) evaluation) to improve trajectory?
- Industry integration is well supported; however not sure if all design manufacturing decisions are collaborative (shared cost liabilities if something goes wrong)
- Excellent partnerships with Siemens, DNV GL, and RG Consulting
- Not clear what the tech transfer are in this project
- Good collaboration with many groups
- Some sharing of experience
- Can the experience gained with this project be transferred to a similar facility on the Pacific coast? If so, then would the use of a facility on the Pacific coast be more economical?
- Provide a description of the map on slide 6 of the presentation. Describe the electrical characteristics of the electrical interconnection and the facilities at the point of interconnection on-shore.
- Strong collaborative team: RG Consulting – Marine operations consultant; Ershigs – Hull design and manufacture; Siemens – Electric plant manufacture; Sea Engineering – WETS (Wave Energy Test Site) Marine operations; DNV GL – WEC Certification

Comments made by reviewers during the evaluation of this project (PRID 188)

Question 6: Proposed Future Research, if applicable

- NA (not applicable) - Recommend completing this project before considering future research
- If there is opportunity for Cpower to 'slow down' and reevaluate the design and manufacturing work on critical components such as the seals before manufacturing at scale should improve results; I realize this may be unrealistic; however the progress to date for Cpower should not be a 'race' to scale up
- Critical to advance technology development if current project demonstrates feasibility of CPT technology
- Not clear what the future research will be other than the open water demo
- Continuing ongoing project
- None provided in summary
- Complete project before considering future research

Question 7: Project Strengths

- The learning from the desk top studies are critical for preparations for deployment
- This project even with the setbacks has created strong lessons learnt opportunities for Full Scale Deployments. These need to be chronicled, prioritized in terms of further actions to reduce costs and ultimately provide more input to O&M guidance/best practices.
- Well planned project to address key cost drivers in the WEC IO&M essential to lowering LCOE of final product
- Good management
- Goal is to make the field test at WETS more successful

Question 8: Project Weaknesses

- As above the ballast should have been understood earlier in the design so costly modifications could have been avoided. Problematic of rushing through TRL stages to full scale design.
- Mention of resource constraints that delayed initiation of design and process investigation
- The modifications that the WEC design will have to undergo based on the deployment studies are costly
- Difficult trade-off between deploying at ultimate DOD (Department of Defense) WETS site, vs significantly higher costs and time delays of deploying on Hawaii, but DOD contribution mitigates this concern
- Project summary, in text format, was not provided

Question 9: Recommendations

- Ballasting studies should be informed across all other projects with similar challenges
- Cannot emphasize enough the issues to these studies occurring at earlier TRL's. These results should have been evaluated during project 163.
- Creating calls based on the issues with seals for MHK should provide DoE with solutions that can be evaluated against the needs of developers. This is an approach that WES (Wave Energy Scotland) is incorporating and should be valuable in the long run.
- Early engagement for design and investigation is critical- there needs to be a mechanism to provide this support in the demo projects
- DOE should adopt lessons learned in project evaluations, focusing on realistic time/$ estimates for company scale-up to implement project
- DOE team should evaluate with project developers and supply chain vendors whether there is a low cost, third party platform that could serve as effective virtual marketplace for talent/vendors with specialized skills needed by MHK? Perfect for private sector solution - (e.g. MHK Community LinkedIn)
- Support CPT's evaluation of future research at alternative mainland sites for interim tests to lower costs
- This is a necessary activity and is needed to develop means and methods for construction and follow on maintenance for future "grid connected" projects
- What is the effect on the WETS deployment if this project is not picked up by DOE at the Go/No-Go decision point?

DOE Water Power Technologies Office 2017 Peer Review Project:

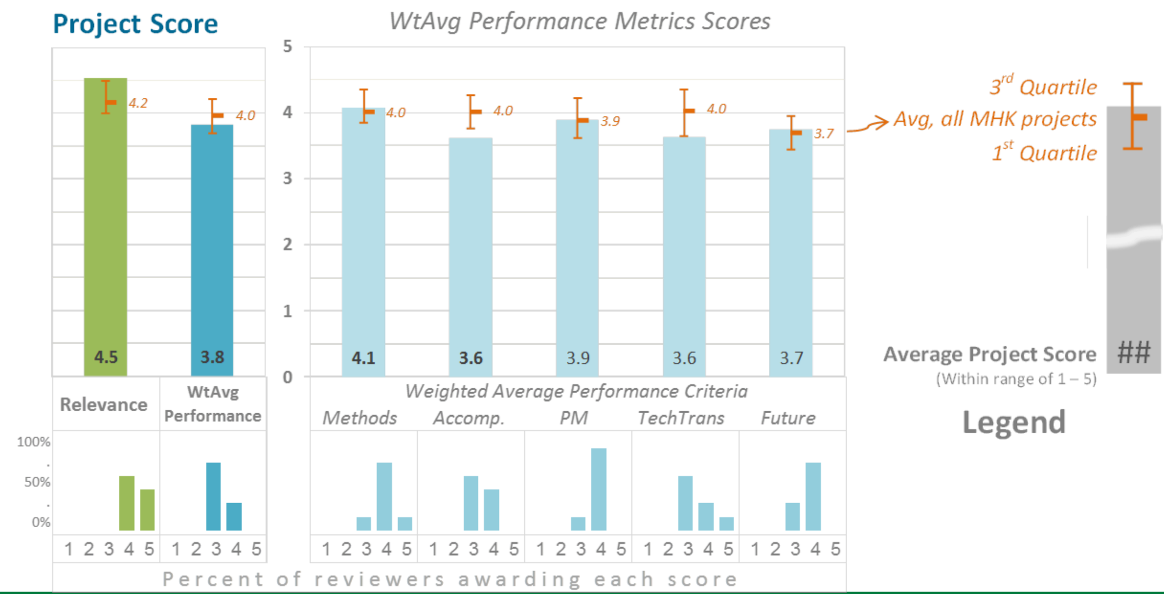
Next Generation MHK River Power System, Optimized for Performance, Durability and Survivability

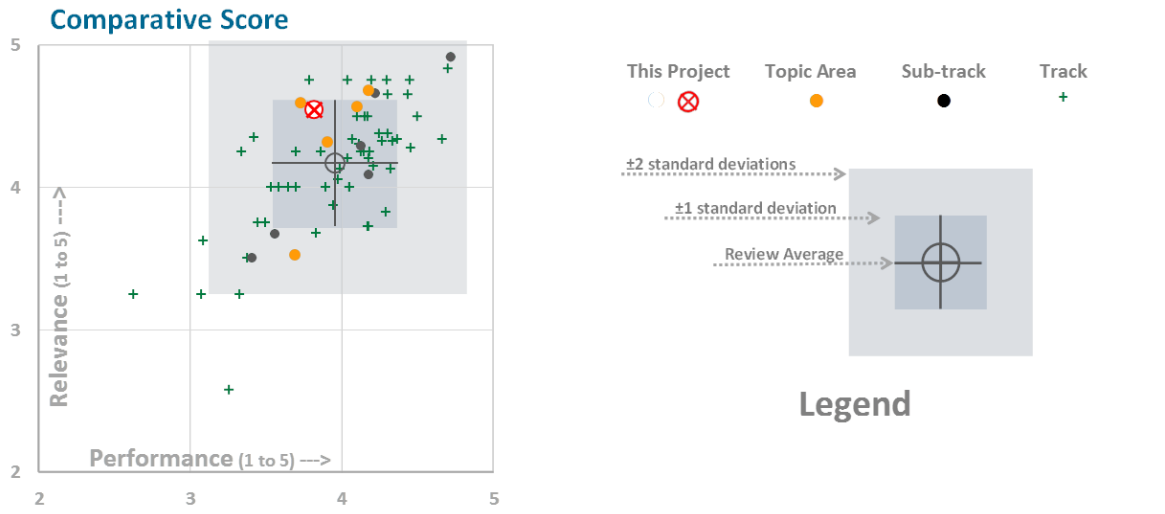
Principal Investigator	AlexAnna Salmon, Igiugig Village Council
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Demo

FY 2014-FY 2016 Funding

DOE	$ 0.4 M	95%
Cost Share	$ 0.0 M	5%
Total	**$ 0.4 M**	**100%**

Peer Review ID# 189





Comments made by reviewers during the evaluation of this project (PRID 189)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- This project is an excellent example of how MHK technology can team to support a remote community's power needs
- Project aims and objectives are in line with DoE objectives
- Project also aligns with Market Development: assess and communicate potential MHK market opportunities, including off-grid and non-electric with the stakeholder engagement in the Igiugig Village and addressing need to reduce energy costs and offset diesel generation at Igiugig
- Good fit with program
- Getting a device in the water and having it be driven by a local community seems like a win-win for DOE objectives
- Important to support deployment of projects
- In addition to the supply of electric energy to the village of Igiugig the installation has added benefits. The added benefits are all associated with the fact that the electric energy supplied by the cross flow driven turbine displaces energy that would have been supplied by oil diesel driven generators. The reduced use of diesel fuel has benefits in the form of reduced cost, and associated climate change and air quality benefits.
- This application of a cross-flow water wheel driven electric generator in a remote village in Alaska is an ideal one and meets the DOE MHK objectives
- This project will perform a field test of the RivGen® Power System. If successful, this technology could be a significant source of power to remote locations.

Question 2: Methods and Approach

- A well-designed project
- Modular approach is important in terms of complex site conditions with ice. Also modular approach should improve the availability of the system during ice out conditions.
- The design exercises and evaluations are almost complete but none were described as most efficient or acceptable. This would have improved demonstration of project accomplishments below.
- Good methodology of how they will implement the tasks but not clear what the methodology was to select the focus areas
- Good to hear that there will be use of previous (10 year) fish dataset to help inform fish interactions
- Technical advisory group seems like a key component to moving this project forward
- Addressing environmental considerations such as salmon
- Good project with an identified end user
- Reasonable goals to reduce costs
- How/when will the electric power and energy from the water wheel generator be delivered to the village distribution system? If this aspect is part of the present project, then what is the approach to be followed with regard to coordinating supply of the variable output from the water wheel generator with daily load variation and other existing generation with frequency and voltage regulation?
- The focus is on minimizing damage to the turbine from ice and other debris
- This is an important item as it relates to availability and continuity of service
- Technical Advisory Committee is a good idea
- Well-designed project plan

Question 3: Technical Accomplishments and Progress

- As above limited evidence of the designs for deployment/retrieval methods that would improve device availability during ice out conditions
- Limited progress to date but project still only part way through
- Seems more about the salmon smolt rather than O & M (operations and maintenance)
- Good progress to date
- In progress and seems to be on schedule
- Technical advisory committee that includes local community and key stakeholders
- Field work is underway with regard to ice damage. See other accomplishments described in summary and presentation.
- Project is in the first year
- Too early in project

Comments made by reviewers during the evaluation of this project (PRID 189)

Question 4: Project Management

- Although Igiugig Village was the PI (principal investigator), the majority of the budget is directed to ORPC (Ocean Renewable Power Company), as it is essentially an ORPC project
- At this point, project is on budget/on time
- It is unclear as to what the overall benefit was to the PI. For example, what was as a cost benefit in terms of fuel consumption savings (diesel versus tidal energy) during the course of the deployment?
- As BP (Budget Period) 1 appears to be nearly complete and on time on budget the rest of the project deliverables in BP 2/3 if down selected will be critical
- The other projects presented by ORPC should positively influence this project, but alignment was not evidenced during the presentation
- The advisory board adds value to the management of this project
- Good project management with clear milestones
- No comment but see project #18
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- This is an ORPC project and not an Igiugug Village project. As such, ORPC is the beneficial recipient in this research.
- Would like to see incorporation of more local team members (e.g,. the UA-F (University of Alaska – Fairbanks) fisheries instead of U of Maine, as they may offer more local experience and knowledge)
- As mentioned the project does not establish links with the previous ORPC funded projects. Ability for peer review to oversee how the projects have progressed the overall technology maturity would be important in future.
- Outstanding stakeholder engagement; with the Igiugig village. Support and development of supply chain opportunities for the fishing industry along the river is critical for the local success of the project.
- Limited tech transfer
- Good collaboration
- No communications yet, but are planned
- Several good collaborators
- Project is in the first year. Researchers should be encouraged (required) to submit, present and publish technical papers at appropriate conferences.
- Strong collaborative team. ORPC Solutions, University of Alaska –Fairbanks, University of Maine School of Marine Sciences, Maine Marine Composites. Involvement of Igiugig Village Council (IVC) is a plus.

Question 6: Proposed Future Research, if applicable

- This project is providing valuable system design research to ORPC, enabling them to assess deployment needs in an extreme river system and develop baseline LCOE (levelized cost of energy). This project should be completed before future research is refined/considered.
- Anticipate that the results of the deployment and retrieval system and modular system designs will provide confidence to continue funding into BP2/3
- Limited detail of future research
- Next steps included system validation and design refinements
- Are there reactive power and voltage regulation issues associated with the operation of the WEC (wave energy converter) when it is operated in parallel with diesel and wind powered generation? If so, then how will these be addressed and how will the cost for the reactive power solution be dealt with?
- How is the MHK electric power output coordinated with the on-shore diesel generation? Is the diesel generation dispatched to account for the imbalance between the MHK power output and the village electrical load? Confirm if there is an electrical interconnection with a larger power grid. Is the AEA (Alaska Energy Authority) involved with the projects; if so, then what is its role?
- How much will the project reduce air pollution if diesel generation operating time is reduced?
- What about the potential for damage from spring flood debris?
- Complete project before considering future research

Comments made by reviewers during the evaluation of this project (PRID 189)

Question 7: Project Strengths

- Teaming with an end user (i.e., IVC)
- Modular approach and engagement with the local community. Critical to capabilities development at the local level as support during operations will be critical at the local level...this is apparent in the engagement with the village.
- Partnership with the village and the TAG (technical advisory group)
- Compared to other electric energy generation technologies the River Power system appears to have fewer and simpler O&M issues. However the validity of this impression requires confirmation by actual field experience.
- One of the strengths of the River Power System is that it can be moved on floats up and down rivers
- Field tests
- Potential to bring renewable energy to underserved regions of the country
- Tremendous cooperation with local groups

Question 8: Project Weaknesses

- This is an ORPC project, not an IVC as such, the benefits to the Village (the PI) of this particular project were hard to determine
- Limited understanding on which deployment and retrieval methodology was rated most likely to succeed. This would have been important to understand to score the project higher.
- It seems like there is a possibility that the decade of fish data from an external group may not happen. This is a concern.
- No external validation?
- None noted

Question 9: Recommendations

- Share the local stakeholder lessons learnt. Stakeholder engagement at the local level is critical for the success of tidal projects. Sharing any positive outcomes and evaluating how to improve any negative roadblocks during engagement is important to keep industry aware of.
- For advancing MHK, this type of project is perfect because there is an end user of the electricity that reaps major benefits from reducing dependence on diesel generation. Also, the size of the project is appropriate for both demonstration and function. Getting success with small scale, high impact projects may be a good path forward.
- This technology may be able to play a role in the IEEE Smart Village program; see: http://ieee-smart-village.org/
- Complete project

DOE Water Power Technologies Office 2017 Peer Review Project:

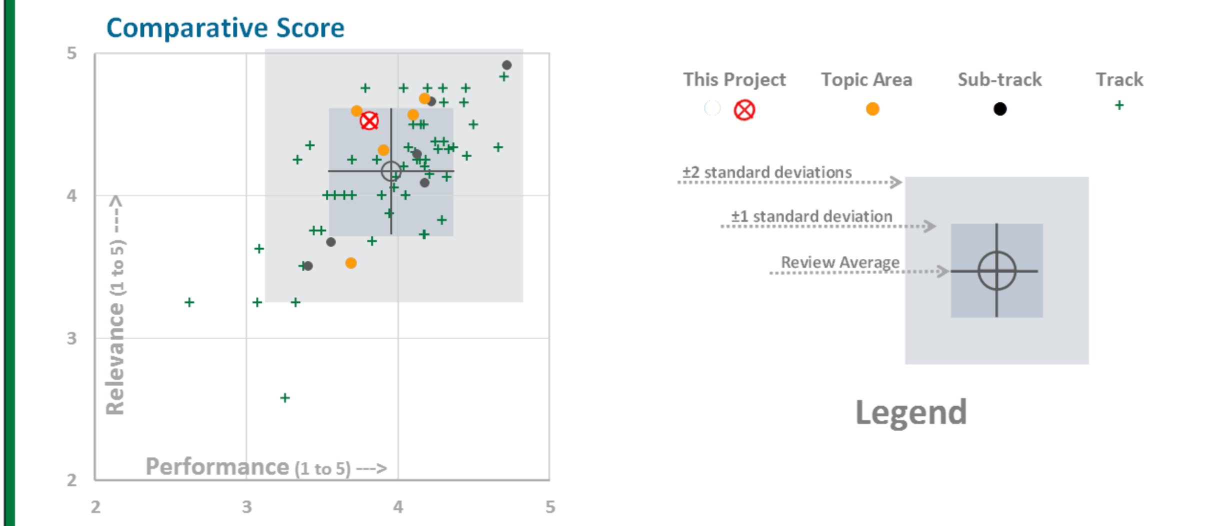
Integrated Development and Comprehensive IO&M Testing at RITE of a KHPS TriFrame Mount

Principal Investigator	Dean Corren, Verdant Power Inc.
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Demo

FY 2014-FY 2016 Funding

DOE	$ 0.4 M	90%
Cost Share	$ 0.0 M	10%
Total	**$ 0.4 M**	**100%**

Peer Review ID# 190



Comments made by reviewers during the evaluation of this project (PRID 190)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- As Verdant approaches a commercial scale array, a reduction in LCOE (levelized cost of electricity) is essential to enable it to be cost competitive
- Development of a tri-frame system reduces the deployment costs of individual devices previously used
- Working on/in the water is extremely costly - investigating ways to reduce these costs is essential
- FOA (Funding Opportunity Announcement) 13 cost reductions for IO&M; Verdant needed a cost effective platform for installations; move from monopile to tri frame mount
- It is not clear how this project is informing standards in terms of design and operating experience other than Jonathon Colby being CTO (Chief Technology Officer) of Verdant Power
- Important project to validate new Triframe and deployment design assumptions and modeling data with significant step toward commercialization
- Low cost foundations are an excellent for with program
- Driving down LCOE meets DOE objectives
- Operational expenditures are an area for cost reduction that should be focused on after a reasonable design is accomplished
- The experience with a grid connected installation and coordinated operation with a, presumable, commercial electric distribution company is also important
- The forward looking objectives of this effort appear to be in keeping with the MHK program
- Planning "open-water testing of the three 5m diameter grid-connected KHPS turbines with a total rating of 105 kW." In-water tests are of great importance to the development of the MHK industry.
- The focus they are putting on improving the installation, operations and maintenance (IO&M) costs will benefit the entire MHK community. These costs are not always given the importance they deserve.

Question 2: Methods and Approach

- Methodology was not identified as to how drag of the tri-pod/mooring design was determined
- Considered suitable for 10 m turbine deployments
- Limited to East River TRL (Technology Readiness Level) 3 scale and TRL 8 development of the triframe mount
- Main drive is OPEX (operating expenditures); working on and around water drives up OPEX and thus looking at the tri-frame as the most efficient reduction in OPEX for turbine installation
- Well-designed project that appears to be technically feasible with potential for significant design improvements
- It appears a high risk approach not to have empirical tests
- It is not clear how they can develop this concept without empirical testing
- Seems an appropriate iterative approach to drive down LCOE
- If one turbine malfunctions, you have to take out all three to fix, is this the best approach?
- The project is well thought out and certainly has benefited from a lot of trial and error
- Will the design in the location actually be able to produce an impacting level of electricity?
- The design and development of various tools and related refinements of the basic designs are in line with the project objectives
- Well-designed project plan

Comments made by reviewers during the evaluation of this project (PRID 190)

Question 3: Technical Accomplishments and Progress

- At 65 tons for the tripod, it is unclear what the cost threshold is before the tripod is not cost-effective for the placement of the devices
- The details of the mooring/ballast of the tripod structure were unclear. It was difficult to determine how a tripod would stabilize on various substrates.
- Issue is after frame and turbines are scaled up (10m) the cost reductions will be lost due to requirement for several marine interventions compared to the current project installation of 1 marine intervention
- LARS (Launch and retrieval system) system is a gap system on frame; deploying three turbines at one time on the triframe. Successful for specific location and turbine size (5m).
- Strong list of areas for cost reduction
- It doesn't seem credible to have this design without having done empirical tests
- It is really not clear how this gravity solution will be successful
- On track
- Project is progressing according to schedule
- The project is in its first year and accomplishments are in the mobilization stage
- Preliminary "TriFrame" design spec developed which integrates IO&M methods
- TriFrame Positioning System (TFPS), Launch and Retrieval System (LARS), Long-Term TriFrame Monitoring System

Question 4: Project Management

- Project on budget/on time
- Is on time and on budget but March is Go/No Go assessment for funding demonstration
- Excellent project management work to address the company readiness to deploy the project, assuring compliance with project deadlines
- Appears a well-managed project
- Budget is on track as well as milestones
- Project will be reviewed in April 2017 and has a plan should they get the go ahead
- See project #18
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- This is a good team selection of private firms to accomplish this project
- Strong industry partnerships evidenced
- Excellent collaboration with skilled private vendors for services and engineering, and with Cornell on environmental issues
- Strong contribution to technology transfer from project results through DOE sites and publications
- Limited tech transfer
- Tri frame appears a novel solution
- Any external review/validation of data?
- Good collaborations
- Will be contributing to data repository
- Working with Cornell, NYSERDA (New York State Energy Research and Development Authority) and other key collaborators
- Participants should be encouraged (required) to prepare technical papers for publication and presentation at appropriate professional meetings
- The reference to a grid connected WEC (wave energy converter) unit is a topic that operators of electric distribution companies and regulators should be interested in, and in this regard the participants should share their understanding of the interconnection process as well as the applicability of electric rates and payment methods for delivered electric power and energy
- Strong collaborative team: Ramboll –TriFrame Design; Mojo Maritime - TF (TriFrame) IO&M Expertise; Kleinschmidt Associates – Regulatory; Kens/KT Marine - Marine Contractors; Cornell University, MRI (Manufacturing Resources Inc.), New York State Energy Research and Development Authority

Comments made by reviewers during the evaluation of this project (PRID 190)

Question 6: Proposed Future Research, if applicable

- Would like to see this effort completed but investing future funds, as there are questions surrounding the mooring of the tripod
- TF scale up for 10m turbines will have to demonstrate other LCOE reductions in terms of OPEX as I am not convinced the project will have similar results
- The additional request for resource assessment and standards development does appear to be add-ons for budget. The proposed future research is a TRL technology maturity demonstration.
- If project successful in proving tri-mount frame, move forward with additional funding to finalize commercialization
- Good future research planned
- Project is ongoing
- Working on creating standards is a strength
- If the cable is disconnected from the tri foil so that the platform and generators are taken to shore, then how or where is the cable stored while the tri foil is on shore?
- Is the electric power cable for the LAR (launch and retrieval) system left in place and connected to a buoy after launch? Or is a diver required to attach the LAR cable each time the platform is raised to the surface?
- It is not clear how the electric cable is dealt with when the platform is lifted to the surface as part of an O&M operation. If the electrical cable is disconnected from the platform, then how are the cable terminals protected from sea water while O&M is performed on the generators? Will the generators be hauled to shore for O&M work or is it proposed that all O&M work be performed on the barge?
- Complete project before considering future research

Question 7: Project Strengths

- Mojo experience and use of MERMAID (Metrication and Resource Modeling Aid)
- The WEC units and technology are technically sound and provide an excellent base on which to gain actual operating O&M experience
- FERC (Federal Energy Regulatory Committee)-permitted site
- Field experience of project team

Question 8: Project Weaknesses

- This is specific for small scale 3m turbine install x 3 in one installation; however going to 10m turbines will require x 4 installations, with increased OPEX costs against this project as a baseline. Important to evaluate the LARS as well as it will require a scaled up LARS system.
- Each base will have to be made to fit the bathymetry. This may drive costs up, but relies on both precise bathymetry knowledge and the ability to precisely deploy them multiple times. This may be much more challenging in deeper more energetic sites.
- Questions about how the electrical (cable) connections are made to the on-shore metered point of interconnection.

Question 9: Recommendations

- Continue funding however ensure that the performance verification data is made available on MHK website
- The experience to be gained with regard to the grid connection and day to day operation will be valuable to the industry
- Complete project

7.4.8 MHK-2C: Infrastructure

DOE Water Power Technologies Office 2017 Peer Review Project:

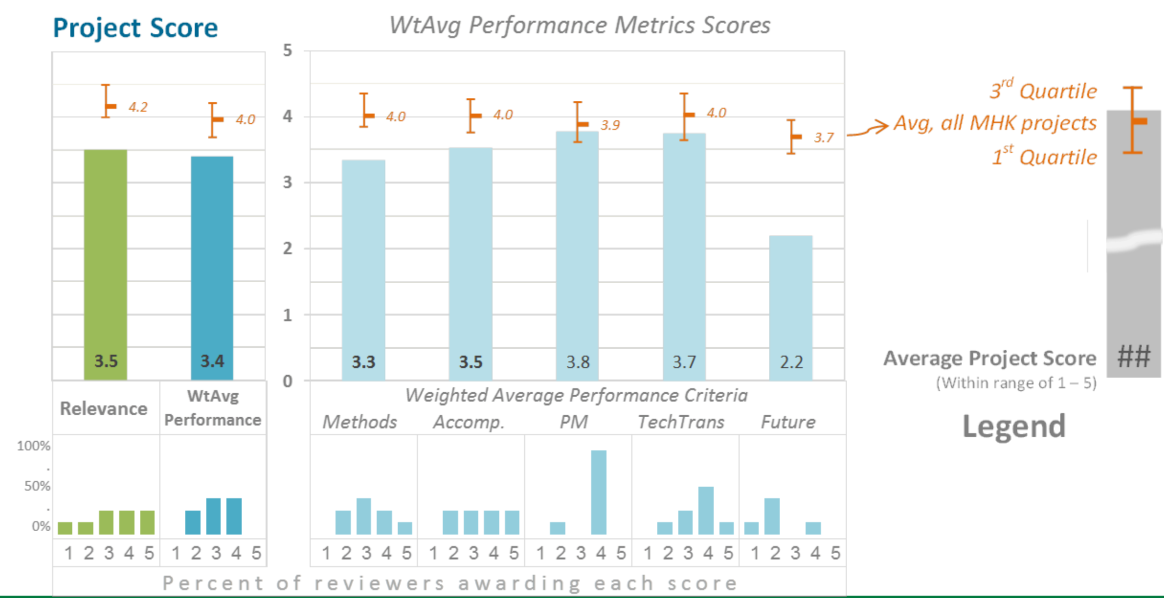
California Wave Energy Test Center (CalWave)

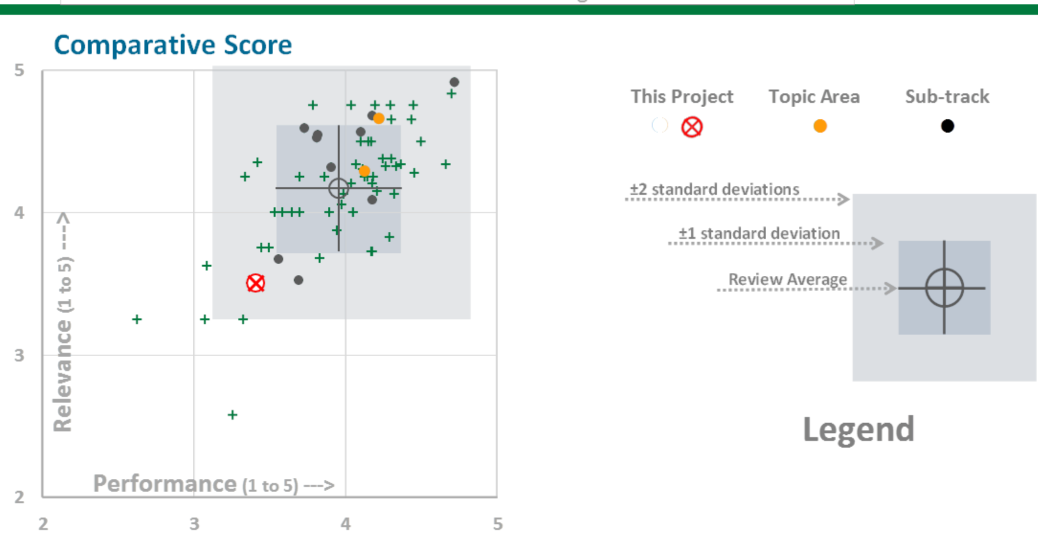
Principal Investigator	Dr. Sam Blakeslee, Cal Poly Corporation
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Infrastructure

FY 2014-FY 2016 Funding

DOE	$ 2.3 M	84%
Cost Share	$ 0.4 M	16%
Total	**$ 2.7 M**	**100%**

Peer Review ID# 160





Comments made by reviewers during the evaluation of this project (PRID 160)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Project appears to be in direct competition of the OSU/NNMREC (Oregon State University/ Northwest National Marine Renewable Energy Center) Test Center
- The aim of the project did not align with the DoE approach under Technology Maturity for conducting R&D for innovate MHK system etc... However it did align well with the Deployment Barriers under identify potential improvements to regulatory processes and requirements. The outcomes/results in the presentation should have demonstrated the lessons learnt which were touched upon.
- California proposal seems to be duplicative of existing wave test sites that are not fully utilized
- Poor use of scarce USDOE funds to fund two duplicative sites for WEC (wave energy converter) testing on west coast; decision should have been made on initial applications
- A good fit with the needs of the program
- Test centers are very important to DOE objectives
- Seems odd to be reviewing this project since it was not successful in continuing to get funding
- Test facilities are critical to the advancement of MHK to allow the various designs to be proven and improved for commercialization
- With this proposed test center, the point of interconnection for the MHK generators is not to a regulated utility. If the ultimate objective is to deliver WEC output to a power grid and supply electric service to consumers, then the point of interconnection should be at and into a regulated distribution system that serves residential and commercial customers. A regulated distribution system provides a test bed that operates according to established commercial electric service industry standards, which the air force base is not.
- The development, installation and operation of another wave energy test site, this one off the coast of California with its high wave energy environment, will benefit the entire MHK WEC industry

Question 2: Methods and Approach

- An average approach that does not appear to build off experiences from either HI or OR
- It was apparent there was a lot of stakeholder engagement up front and dominated the project activities to the detriment of the other technical approach and methods listed on slide 9. There was not much detail in the outcomes of the benchmarking exercises; and when asked if CalWave evaluated other business models that would not be in direct competition with PMEC (Pacific Marine Energy Center) or WETS (Wave Energy Test Site) there was not a clear answer. It is understood this was a competition however it is recommended that at the Go/No Go critical phase of an infrastructure project there is opportunity to give the 2nd choice project the ability to rescope their proposal so they can address other test demonstration opportunities.
- Project was well implemented, involving the many regulators and stakeholders in this difficult regulatory environment, but project design was duplicative of PMEC project
- An adequate methodology in place
- Seems appropriate
- All stakeholders are engaged, especially Tribes and fisheries, who are critical to have at the table to ensure they are aware and involved
- Overall approach is excellent including benchmarking, regulatory agency engagement, and engagement of a suite of stakeholders
- Potential PPA (power purchase agreement) is also critical for success
- Minimal effort
- Well-designed approach

Question 3: Technical Accomplishments and Progress

- It is optimistic for the Project to develop an effective permitting pathway, as California is known for having a complex and strict regulatory environment
- It was stated the permitting process would eliminate regulatory burdens but this was not elaborated on in detail and should be wrapped up as a post action lesson learnt to inform California regulatory agencies an improvement to their process for permitting

Comments made by reviewers during the evaluation of this project (PRID 160)

- There was a list of technical accomplishments in 2015 with no actual results shown. The final report of the feasibility study for CalWave could have been presented here. It would have been important to have demonstrated an estimated cost to deploy and connect between the sites proposed.
- Created a regulatory plan and a backup plan to use existing infrastructure if needed to hook into existing platform
- Identified potential sources of resistance in California Coastal Commission, tribal, and marine sanctuary proposals, but the positions of both could have been resolved by pre-application consultations at considerable cost savings
- Identified Vandenberg Air Force Base as candidate site and began shore-side and water project design as well as preliminary design studies
- An adequate plan in place for a test centre development
- Good progress
- Great progress on addressing all aspects from technology needs to permitting needs
- Reaching out to stakeholder groups is critical for success in California
- This is how to do it!
- Average
- The project team has accomplished much: ocean test site selection; infrastructure assessment; grid interconnection assessment ; permitting and stakeholder consultation; cost estimates; establishment of stakeholder advisory group and marine industry technical advisory group; regulatory agency meetings; stakeholder meeting; draft preliminary design

Question 4: Project Management

- Well managed - the project team coming under budget in Phase 1 should be acknowledged and commended
- The performance of the project looked as if scope creep was a factor. The budget was fulfilled but not on time.
- Well executed to get the information required
- A well-managed project
- Seems good given the large number of collaborators
- Project is on time and on budget with the exception of PGE (Pacific Gas & Electric Company)
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- A strong group of private collaborators
- Large number of partners involved. However no demonstration of the results of collaboration it appeared to be driven by few individuals.
- Not an effective use of DOE technology development funds to fund 2 competing state applications for test sites.
- Pre-DOE grant submission consultation with CA regulators and key stakeholders would have revealed barriers to development at this location, including the CA Coastal Commission and the planning for proposal for a marine sanctuary by Tribes
- Good collaboration in place
- Good collaboration with academia, industry, labs and DOD (Department of Defense)
- Broad range of partners and seemingly the right people to have at the table
- No examples of dissemination of results
- Numerous reports and presentations
- Strong collaborative team: Cal Poly – San Luis Obispo, Kearns & West, Leidos, CH2M, Protean Wave Energy LLC, Omega Engineers, Virginia Tech, UCSD (University of California-San Diego) - Scripps Institute of Oceanography, UK Wave Hub, Electric Power Research Institute, Sandia National Laboratories, National Renewable Energy Laboratories, Pacific Gas & Electric Company, California Natural Resources Agency, Columbia Power Technologies, UC (University of California) Davis, William Lyte

Comments made by reviewers during the evaluation of this project (PRID 160)

Question 6: Proposed Future Research, if applicable

- With the renewable energy funding competition in CA, it appears that financial support for this project (either at a federal or state level) is optimistic, limiting the progress of this project
- When asked if there were other testing demonstration opportunities close to the grid, not in direct competition with the other test sites the answer appeared there would be limited opportunities. This should be explored considering the apparent relationship with PG&E.
- No future funding contemplated or merited
- NA (not applicable)
- Permitting and construction phase
- Phase III is permitting and construction
- Project is complete and no funding to move to Phase III
- None provided
- Complete project

Question 7: Project Strengths

- Assumption of regulatory hurdles overcome should be further evaluated
- Strong stakeholder engagement
- Appealing concept to develop a center for MHK deployment near Vandbenberg Air Base where electricity could be sold to Base
- Outreach to many different stakeholders (legislature, regulators, tribes, NGOs (nongovernmental organizations), utility, etc.)
- None
- A full-scale wave energy test site will be a tremendous boost to the MHK industry
- Strong regulatory agency engagement

Question 8: Project Weaknesses

- It appears that CalWave did not submit a strong proposal to the DoE and thus why they were not the chosen site
- No future funding contemplated or merited
- Difficult coast line and access issues

Question 9: Recommendations

- If there is opportunity for the site to be reevaluated as a commercial site this might be a step from WETS to PMEC to CalWave as first commercial site. There were synergies from Atlantis testing at EMEC (European Marine Energy Center) and then securing the Pentland Firth MeyGen commercial site for as close as you can get apples to apples deployment.
- For future test site proposals, DOE should work with DOC (Department of Commerce) and other economic development funding sources to assure funding sources are better aligned with economic development drivers for these projects that extend well beyond MHK
- If and when MHK technology is ready for deployment, consider DOE support for collaborative effort by state/municipal/private developers to create an "industrial park" with pre-permitted space designed to accelerate deployment in areas preferred for development, serviced by grid ready to accept load
- No further funding for WEC test sites
- None
- Complete project

DOE Water Power Technologies Office 2017 Peer Review Project:

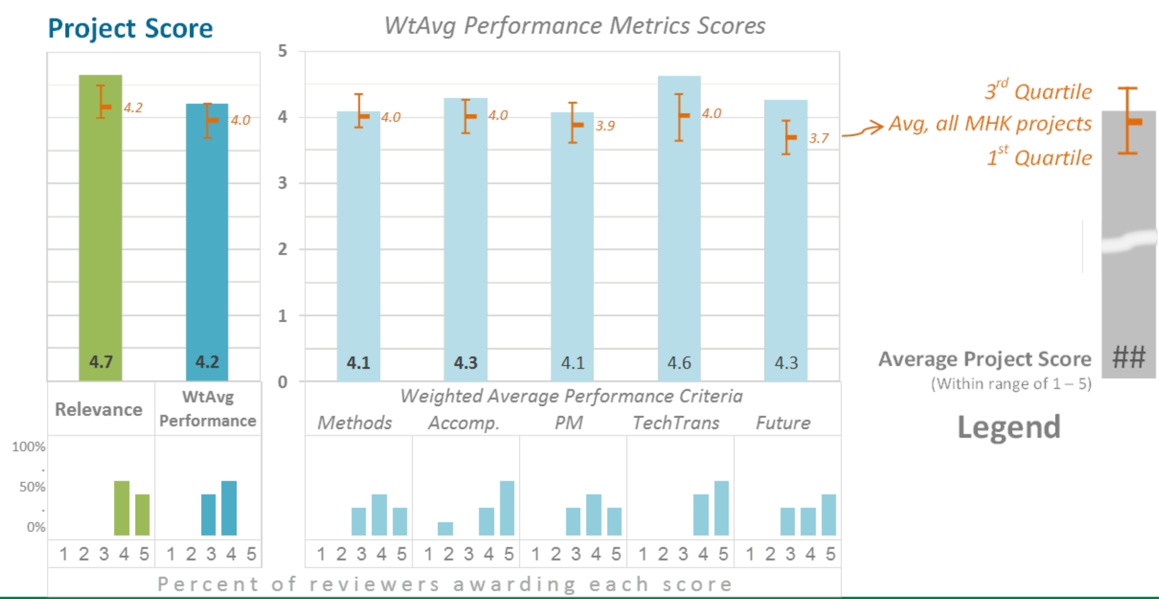
Pacific-Marine Energy Center South Energy Test Site (PMEC-SETS)

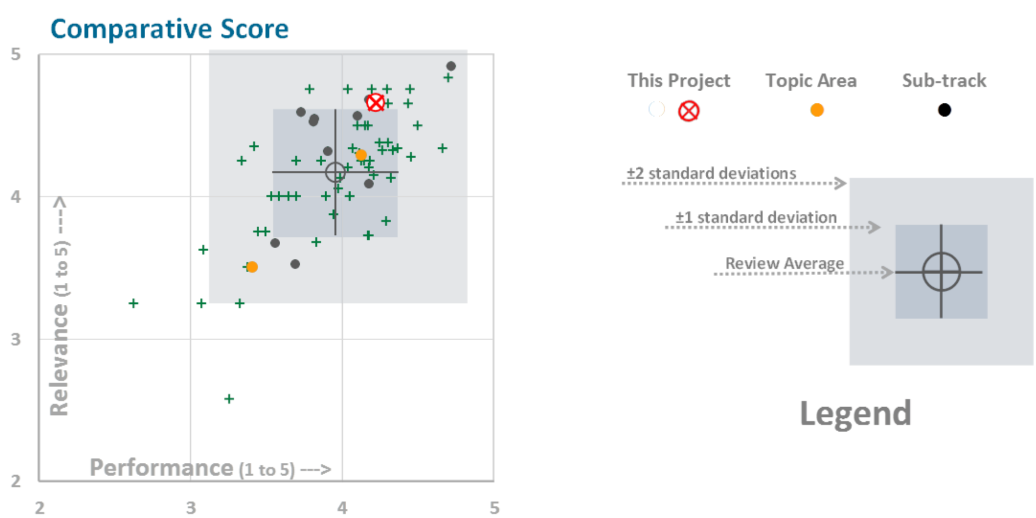
Principal Investigator	Belinda Batten, Oregon State University
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Infrastructure

FY 2014-FY 2016 Funding

DOE	$ 2.3 M	82%
Cost Share	$ 0.5 M	18%
Total	**$ 2.7 M**	**100%**

Peer Review ID# 161





Comments made by reviewers during the evaluation of this project (PRID 161)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- A comprehensive assessment of techniques to support the MHK industry
- A valuable consortium that addresses and potentially mitigates risks associated with the deployment of an array of devices
- Helpful to have test site for testing of WEC (wave energy converter) technology to full commercialization, but no detailed scoping study to determine whether there is likely industry demand for testing slots that would justify size and scale of the full 20 device project within next decade, given other testing resources
- Some developers will prefer to test on/near the preferred development site in early stage small scale projects, which is possibly the most efficient option rather than transport to test center. How will DOE address this in funding decisions?
- An excellent fit with a supporting test center to benefit device testing
- A test site is key to DOE objectives
- The planned size of the test site is rather ambitious. Is that really needed at this point?
- A grid-connected facility for testing technologies is critical for the advancement of the technology
- Need to balance funding to ensure that there are also devices being developed to test
- The need for a testing site that is based along the west or east coast of the United States is an essential part of a continuing DOE MHK program. This site is an excellent candidate.
- The development, installation and operation of another wave energy test site, this one in the Pacific Northwest with its high wave energy environment, will benefit the entire MHK WEC industry

Question 2: Methods and Approach

- Concerned about the large scale initially proposed (i.e., 20 berths). There is a concern that "build it and they shall come" may not happen. A phased approach to building out this site might be more prudent.
- Supporting device developers with reducing monitoring costs by developing "off the shelf" technology
- Excellent use of collaborative approach, using Alternative Licensing Process at FERC (Federal Energy Regulatory Commission) and reaching out to stakeholders in test site area and regulators
- Project raises concern that DOE may be over-funding test sites at expense of direct technology development, resulting in overbuilding of test sites
- Well designed to complement existing WEC test site in Hawaii and to enable PMEC South Energy Site to serve need for later stage testing needs
- While industry consulted, there is no clear assessment of potential industry demand that would justify a 20 device site, even taking into account array testing
- A well-structured approach
- Seems appropriate. Focused on designs and regulatory permissions.
- Process where the community determined the location is a great approach to have support for development
- Selected by including the fishing community resulting in an accepted site
- PMEC site offers a potential cash benefit in terms of reduced transport costs as compared to the cost to ship WEC devices to the Navy's WETS (Wave Energy Test Site) facility in Hawaii?
- The project has been in the design stage for several years and has carried out investigation of sea bottom cable routes
- Project presentation states the site will be “for up to 20 utility-scale WECs, up to 20MW, within four berths.” This is an extremely ambitious goal. Suggest a phased installation plan.
- Well-designed approach

Question 3: Technical Accomplishments and Progress

- There is slow but effective permitting progress being made
- Project execution is very well done
- I question the outcome that there is a need for this size of test infrastructure for a still emerging sector - 20 devices seems excessive
- Project is successful as it was selected for continued funding
- Site evaluation including cable routing and identification of cable landing locations
- The proposed receiving utility (Lincoln) is an operating electric distribution utility
- Significant accomplishments: permitting process, PMEC-SETS site selection, preliminary cost model

Comments made by reviewers during the evaluation of this project (PRID 161)

Question 4: Project Management

- Well managed
- BP! PMEC captured lessons learned in earlier projects, including federal/state permitting agencies in permit planning process. Trade-off of longer permitting timeframe for generally more successful outcome with less opposition to permitting
- Excellent project design to include maximum collaboration, essential to successful permitting outcome
- A well-managed project
- Some delays due to complexity of the project
- Overall on schedule and within budget
- The managing entity has ongoing experience with the MHK program and has an established track record
- Coordination with community and permitting agencies is a large effort that is being executed extremely well. This is a very complicated project with many moving parts.
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- A strong academic team working with several wave and tidal device developers
- Excellent collaboration with FERC and with stakeholders in the permitting process
- Excellent collaborative effort, tapping experts in key fields for project design and permitting
- Strong collaboration with potential WEC developers to understand need for array testing and potential need for flexibility at site to permit that type of testing
- Good collaboration with a range of international partners
- Wide collaboration with academia, labs, industry
- As necessary, many meetings with the public
- Large, diverse team involved and necessary for the success of the project
- Undertaken efforts to build public awareness of the project including benefits
- Extensive coordination activities with community and regulators
- Strong collaborative team: Oregon State University; Pacific Energy Ventures; University of Washington; 3U Technologies; H.T. Harvey & Associates; HDR Engineering; Stoel Rives; National Renewable Energy Laboratory. Sandia National Laboratories, University College Cork; Oregon Wave Energy Trust; Sustainable Energy Authority Ireland

Question 6: Proposed Future Research, if applicable

- Look at options of stitching together all 6 tools
- PMEC won the Sept 2016 FOA (Funding Opportunity Announcement) for open water, grid connected test facility; this project should be completed in step-wise fashion geared to actual industry demand
- Good forward plan in place - but I question the need for a 20 device center at this stage of the industry
- Complete permitting, final design, and construction of the facility over the next five years
- Given that the receiving utility (Lincoln Electric) will have an interconnection with BPA (Bonneville Power Administration) it will be possible that the facility can provide a test bed for future MHK research. The proximity to PNNL offers an additional opportunity for MHK related research.
- Concur with proposed future research if funds permit

Question 7: Project Strengths

- Very positive stakeholder outreach being conducted
- Logical to permit for maximum buildout to 20 device site, so long as PMEC uses a step-wise build-out of the site, dependent upon and responsive to actual developer demand
- Very well implemented to involve regulatory agencies and stakeholders in planning process
- Will result in a fully licensed test center
- Bathymetric studies necessary for installation of electric power cables appear to have been carried out. An important factor in the establishment of an undersea route for power cables is the quality of a suitable cable landing site. It appears that a workable cable landing site has been identified and this should avoid unexpected extra costs associated with cable terminal design and construction.

Comments made by reviewers during the evaluation of this project (PRID 161)

- The availability of an interconnection to the BPA bulk power grid provides the MHK owner/developer the opportunity to sell the electric power and energy into a power market and earn revenue
- The proposed site has advantages in that it provides a point of interconnection for electric power and energy from MHK sources to be delivered to an operating electric distribution entity with residential and commercial customer as well as an interconnection to the BPA bulk power transmission grid. The proposed site has ability to grow from an initial installation of one or two MHK facilities to several future MHK plants.
- The receiving utility (Lincoln Electric) has an interconnection with the BPA power system. This offers the possibility of necessary assistance with design and interconnection issues at the point of interconnection.
- The site has the potential to accommodate several MHK plants
- A full-scale wave energy test site will be a tremendous boost to the MHK industry
- Extensive coordination with the community

Question 8: Project Weaknesses

- Uncertain whether there will be sufficient demand within next ten years to use even 10 of the 20 planned device sites
- None are noted

Question 9: Recommendations

- If resistance is encountered, PMEC may need to contract to smaller project proposal, leaving open potential for future expansion if demand justifies
- PMEC might consider publication on lessons learned re Alternative Licensing Process under FERC permitting for benefit of MHK community
- BPA can develop necessary vendor neutral open source electric power system impact study models for the PTO (power take-off) and WEC. In this case the BPA system impact study models could be made available to electric utilities as open access software. This would encourage the development of MHK installations along coastal areas.
- PMEC is a competitive alternate to the Vandenberg Air Force base site on the California coast. PMEC has similar characteristics to the California site. Advantages of the PMEC site include: connection to an operating electric distribution system with interconnect to the BPA transmission grid and proximity to Pacific Northwest National labs. This site has the advantage that the Point of Interconnection is not on a military base and therefore will not be a security barrier to access by contractors and construction equipment etc.
- The PMEC site as proposed is for 20 MHK sites (arrays). These sites could be constructed in stages of one or two as needed and would allow some flexibility and accommodate changes in the nature of WEC units as they evolve.
- The PMEC site offers a potential cash benefit in terms of reduced transport costs as compared to the cost to ship WEC devices to the Navy's WETS (Wave Energy Test Site) facility in Hawaii?
- Continue project
- Project presentation states the site will be "for up to 20 utility scale WECs, up to 20MW, within four berths." This is an extremely ambitious goal.
- Will moorings be part of the plan? This is a concern because moorings will be a significant added cost to the WEC developers if they have to provide their own moorings.

DOE Water Power Technologies Office 2017 Peer Review Project:

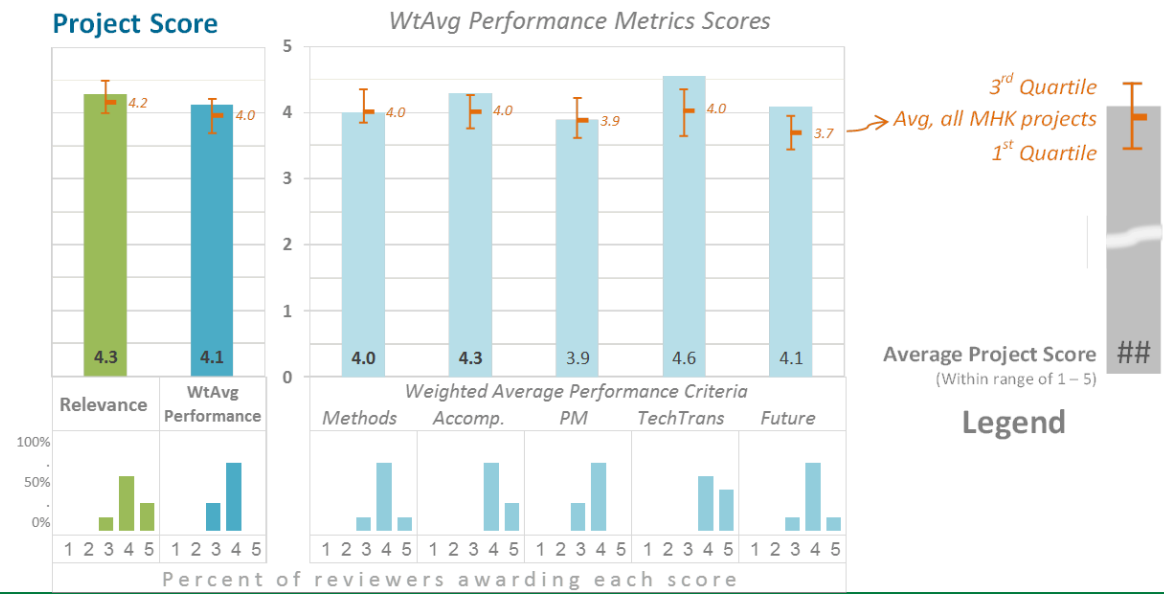
Advanced Laboratory and Field Arrays (ALFA)

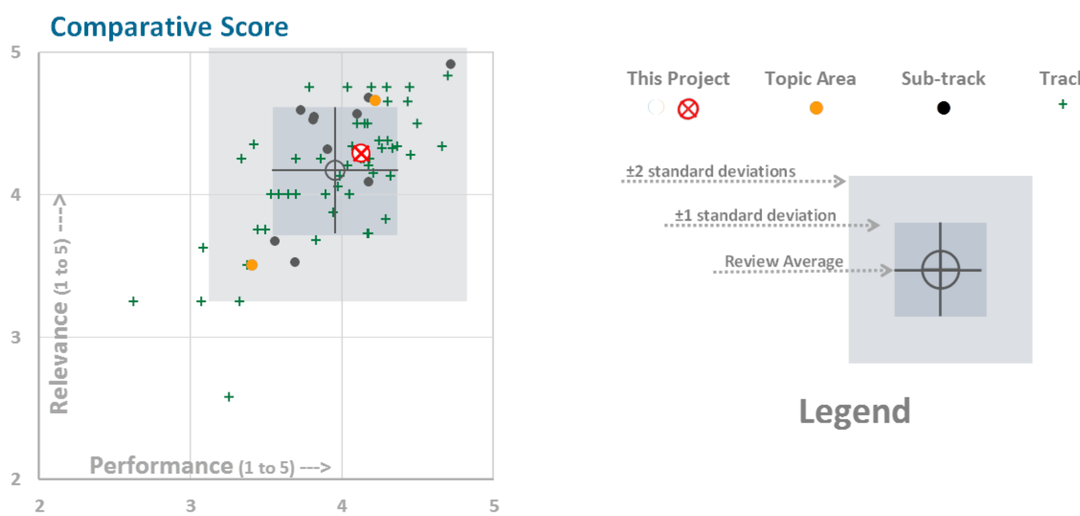
Principal Investigator	Belinda Batten, Oregon State University
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Infrastructure

FY 2014-FY 2016 Funding

DOE	$ 4.0 M	86%
Cost Share	$ 0.6 M	14%
Total	**$ 4.6 M**	**100%**

Peer Review ID# 171





Comments made by reviewers during the evaluation of this project (PRID 171)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- The development of a test facility enabling device to test in an environment is a perfect complement to WETS (Wave Energy Test Site) in HI
- Alliance of Universities of Alaska/Fairbanks, Oregon and Washington to conduct testing in 6 areas of advanced laboratory and field arrays, all of which could be helpful to environmental monitoring associated with site permitting or debris identification and avoidance
- Some tasks do not appear to be well conceived to build upon existing technology developed and available
- These tasks go to reduction of obstacles to deployment of MHK devices, once developed. But all tasks in this project are lower priority than direct technology development assistance
- An excellent with the program, supporting tool development for the entire sector
- Using universities to provide disparate tools in a unified forum is an excellent way to assist the MHK industry with a variety of challenges
- Finding ways to reduce the LCOE (levelized cost of energy) using R&D and testing facilities in the northwest along the pacific coast appears to be consistent with the DOE MHK program scope
- Given the location of the ALFA in the North West and proximity to the Pacific Coast and the Pacific Marine Energy Center, then ALFA is an ideal choice
- This project is developing many diverse technologies that, if successful, will make provide valuable knowledge and technology to the MHK community

Question 2: Methods and Approach

- A positive designed methodology to address the complexities of project of this magnitude
- Good collaboration among universities with marine expertise to align and share information and to consult with private developers on technology needs
- Not clear that there was sufficient due diligence to determine if other federal agencies or private sector had already developed Task 1 (river debris identification) and Task 2 AUV (autonomous underwater vehicle) guidance software for off the shelf AUV technology purchased. Likely duplicative of USN (U.S. Navy)/DOD (Department of Defense)/NOAA (National Oceanic and Atmospheric Administration) technology
- A good overall structure - but effort will be needed so each tool is developed and managed so that it is coordinated tool for the overall sector
- All projects produced useful tools or results
- Developing a small AUV for basic O&M (operations and maintenance) is an excellent idea to save industry costs
- Fish telemetry study was successful
- Marine debris tool using active sonar is useful
- Swift wave measurements is another valuable tool
- Identifying and implementing a method to protect sturgeon and their habitat is an important environmental goal
- Items 1, 2 3 and 4 in the technical approach section of the summary are issues that impact on WEC (wave energy converter) availability and reduction of outage time; each of these can have a positive impact on the reduction of LCOE
- Well-designed approach

Question 3: Technical Accomplishments and Progress

- Numerous reports, lab tests, as well as physical and biological monitoring
- Application of PMEC (Pacific Marine Energy Center) site fish passive acoustic array survey results enabled applicant to eliminate requests for post installation green sturgeon monitoring
- Projects progressed well and made good progress toward objectives
- Good progress to date
- Each of the tasks produced useful tools that the industry could use to save costs
- See list of accomplishments in item 5 of the summary for numerous significant accomplishments in the 2015 and 2016 budget years
- Debris study, autonomous underwater vehicle, extreme wave conditions; coupling of anchoring and mooring systems, energy converter arrays, biological monitoring
- Significant number of reports, lab tests, and field tests

Comments made by reviewers during the evaluation of this project (PRID 171)

Question 4: Project Management

- A successfully managed project
- Great coordination by Oregon of the university alliance, and great project coordination of grants awarded
- No explanation of what analysis was conducted to determine whether six project technology might have already been developed by U.S. public/private development projects or by other international projects, raising concern that DOE may be paying for duplicative technology, especially given shared problems
- A well-managed project - this however will need to be closely managed to ensure the success of such a multi-facetted project
- Some delays. IACUC (Institutional Animal Care and Use Committee) approvals do not usually take that long.
- Projects are on schedule for the most part and conducted within budget
- The Principal Investigator for this task is a dynamic leader and this leadership capability is reflected in the many accomplishments of the R&D team
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- Credit to NNMREC (Northwest National Marine Renewable Energy Center) for pulling together a team of experienced regulatory team, navigating a complex regulatory environment
- Excellent collaborative approach among universities
- Good multi partner collaboration
- Good collaboration between academia and outreach to industry on some sub tasks
- Large team of academics to address the broad range of projects
- Significant number of peer-reviewed publications
- This R&D team has an impressive and meaningful list of publications and presentations
- Numerous presentations and publications
- Strong collaborative team of many researchers from OSU (Oregon State University), UAF (University of Alaska – Fairbanks), and UW (University of Washington; plus an industry partner network

Question 6: Proposed Future Research, if applicable

- NNMREC will provide a perfect testing area to investigate potential biological impacts related to MHK technology. The findings of these studies may support future permitting efforts on other MHK projects.
- Careful analysis of whether alternative technologies exist should be conducted before further grants given; also should be secondary to device development funding
- Very good future validation plans for the tools against industry devices
- Want to test the tools on full scale WECs, when the opportunity arises which is the perfect use of the project outcomes
- Arrays for MHK. What is the definition of an “array”? Is this a group of WEC units whose electric output is connected to a central point of interconnection with an electric distribution system?
- Can the electric power system engineering department at University of Washington be tasked with an assignment to investigate grid interconnection issues and associated electric power quality issues? For example, Professor Anjan Bose.
- Evaluation of WEC arrays to maximize overall power production and minimize potential damage from rough waves
- What is the definition of the term "array" in time 5? Is this an array of several WEC units that are connected to a central location (floating substation) and then via a single dedicated cable to an on-shore point of interconnection with a power grid? If so, then such a description should be provided. If the term array as described here is incorrect, then a proper definition should be provided.
- Agree with field tests of tools if funding permits

Comments made by reviewers during the evaluation of this project (PRID 171)

Question 7: Project Strengths

- Conducting numerous studies that will help support the MHK industry progress
- Strong partnership collaboration
- Comments
- For whatever reason the DOE WEC MHK program does not address the electrical interconnection from the PTO (power take-off) on-board power output terminals to a metered point of interconnection with an on-shore power grid electric distribution system. Is this an issue to be addressed in future or by a different department within DOE? If not, then can this be considered as a future task as part of the MHK program?
- The project is supporting many students
- This project is developing many diverse technologies that, if successful, will make provide valuable knowledge and technology to the MHK community

Question 8: Project Weaknesses

- Can the debris identification system be used at conventional hydro plant reservoirs as a way to reduce risk of damage to turbines if the trash rack is not in place or has otherwise failed to do its job?
- Comments

Question 9: Recommendations

- What is DOE's vision on how instrumentation and software are transferred from academia to industry or commercialized? This seems a crucial long term link.
- Complete project

7.4.9 MHK-2C: Sensors and Measurement

DOE Water Power Technologies Office 2017 Peer Review Project:

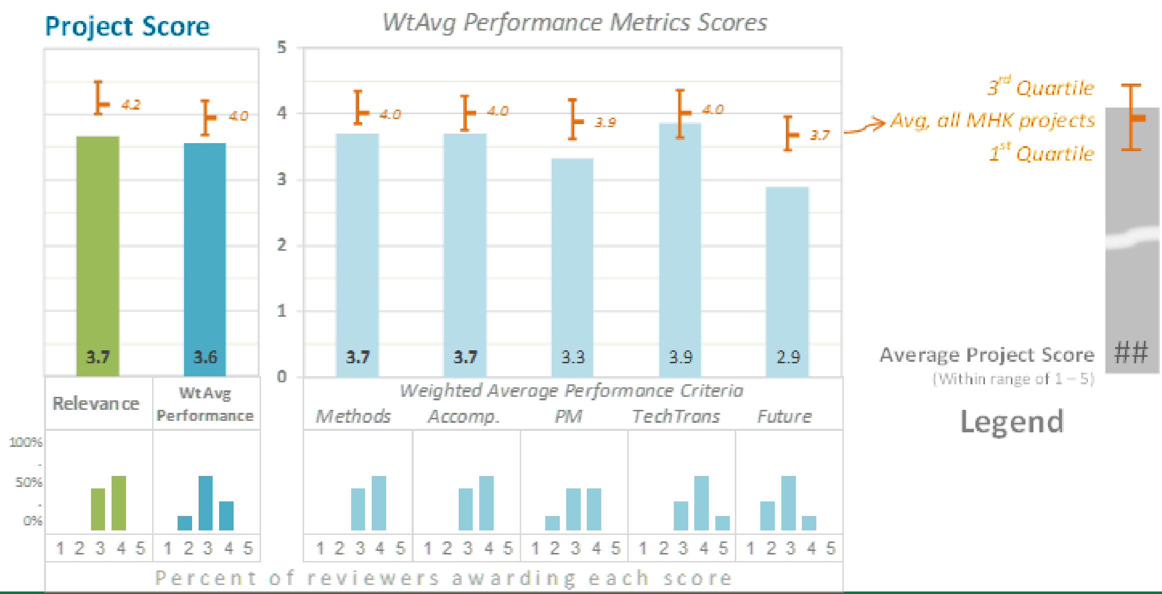
Tidal Device Field Measurement Campaign (FMC)

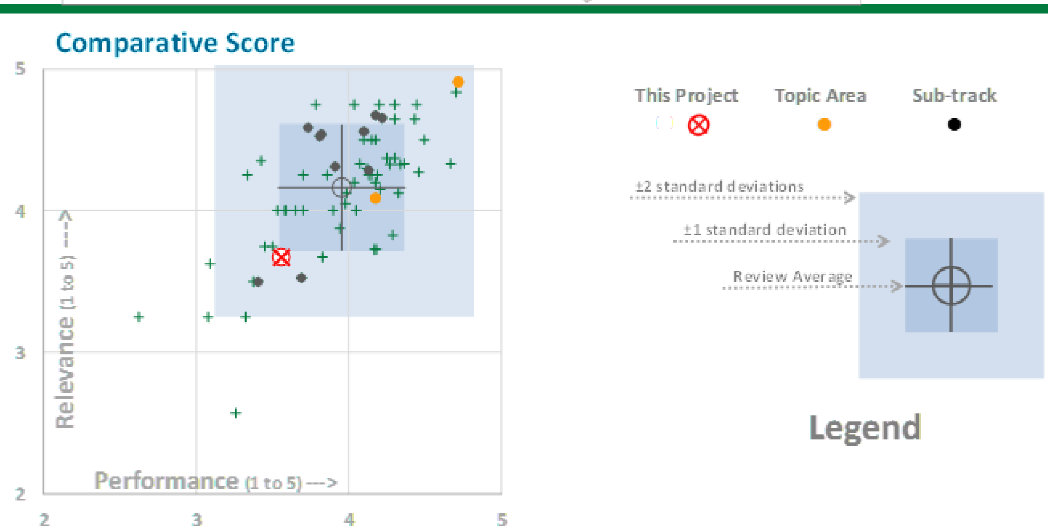
Principal Investigator	Vincent Neary, Sandia National Laboratories
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Sensors and Measurement

FY 2014-FY 2016 Funding

DOE	$ 0.5 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.5 M**	**100%**

Peer Review ID# 16





Comments made by reviewers during the evaluation of this project (PRID 16)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- With a lot of resources going into wave energy, it is good to see National Lab research working tidal turbine design
- Industry NEEDS cross flow modeling
- Could the project have been reconfigured to produce an easily useable product for all tidal technologies?
- Important project to improve tidal device field measurement instrumentation and deployment strategies, and deliver non-proprietary model to allow tidal power developers to validate their models and designs
- Unfortunately, the CACTUS deliverable is apparently not very usable for cross-flow turbine category
- Conflicted as UoE (University of Edinburgh) are a partner
- Do developers use CACTUS? Presumably they have used some models to optimize their turbine, so not clear that this is needed.
- Model validation is critical for ensuring that the models can be used
- This type of project should be evaluated as to relevance in having commercially viable devices
- The relevance of this effort appears to be the application of sophisticated techniques and analytical methods focused on improved design of in-water flow devices
- Cross flow turbines can be a significant source of renewable energy

Question 2: Methods and Approach

- A well-designed effort
- It appears the results of the second phase of the project; led by PNNL to develop novel instrumentation and deployment strategies was very successful
- Good use of existing methods/approach from wind sector and experienced personnel as basis for models and improvement
- Would a different approach/project method have enabled model development easily useable for cross-flow turbines, as well as axial turbine designs?
- Seems appropriate
- Had to refocus effort because there was not a turbine in the water
- The team adjusted by developing their own device in a test tank that could be used for model validation
- Unfortunately, used some laboratory measurements so not meeting the goal
- The analytical approach using Doppler, and other open source analysis codes appears to be in line with the objectives
- Well-executed project

Question 3: Technical Accomplishments and Progress

- Several "firsts" and accomplishments as a result of this project (e.g., fiber Bragg grating, improved CACTUS, published model validation data set)
- CACTUS usable for axial flow simulation; but for cross flow turbines not accurate
- Open source data valuable but the presentation did not highlight the number of downloads of the open sourced data. This should indicate industry value.
- The project produced CACTUS model, non-proprietary and available to public for use, with some delays
- Improved knowledge of turbulent flow in the coastal environment
- The team was successful for a wave tank system
- Desk top analysis supported by in-water testing
- Field data collection: Puget Sound, Kvichak River, AK
- First ever fiber Bragg Grating application
- Improved CACTUS

Question 4: Project Management

- It is refreshing to see a project spending significantly less than what was received
- Appears there were struggles keeping the project on time and budget
- CACTUS model component one year late due to staff shortages
- Good work to pivot and reframe the project after private industry partner could not be engaged
- Field testing largely didn't happen due to lack of MHK partners
- Project budget was underspent due to lack of industry partner
- No comment
- Well-managed project

Comments made by reviewers during the evaluation of this project (PRID 16)

Question 5: Research Integration, Collaboration, and Technology Transfer

- The team has been able to distribute the project findings through numerous publications and as open source data
- With a team made up of experts from the national labs and academia, it is unfortunate that an industry partner was able to be identified to support the CACTUS effort
- Appropriate technology transfer across universities involved
- Good collaboration with PNNL, U Washington; not clear whether the delayed portion of the contract could have been shifted to university partners to remain on time
- Good collaboration between labs and academia and industry
- Collaboration with other institutions is good but lack of an industry partner resulted in not meeting goals
- Several papers, presentations and publications on the results of the work
- Excellent project team. UNH (University of New Hampshire), UW University of Washington, UoE, ORPC (Ocean Renewable Power Company).
- Numerous publications

Question 6: Proposed Future Research, if applicable

- Proposed future research appears narrowly focused. There should be the integration of FMC with a tidal developer.
- No further funding until careful review with private sector target users to determine whether the additional work will directly and quickly benefit the target users and achieve intended project objective to provide tidal industry with effective performance and load models
- Will continue to refine the model
- Based on the budget history it appears that this project has reached an end point
- While continued work on foil characteristics would be valuable, more field tests would have a higher priority

Question 7: Project Strengths

- FBG (fiber Bragg grating) novel sensor with low SNR (signal to noise ratio) is an important improvement over strain gauges
- Development of new cross ADV (acoustic Doppler velocimeters)
- Strong analytic basis
- CACTUS is an open-source program
- Collaboration with industry partner Ocean Renewable Power Company
- Field data collection: Puget Sound, Kvichak River, AK

Question 8: Project Weaknesses

- There is no clear alignment from this project to project #4. There appears to be two budgets utilized for CACTUS development which is ok; but there needs to be a distinction of SW (software) development outputs. This improves understanding of how efficiently the product/SW development is progressing.
- The lack of an industry partner and ability to acquire data in the field resulted in the project not meeting the intended goals
- Applicability of results to manufacturers and industry
- None

Question 9: Recommendations

- ADCP (acoustic Doppler current profiler) turbulence and instrumentation will be improved with future deployments. Test planning and sensor build should improve with further testing.
- Further marinization of the FBG sensor including deployments on or integrated in turbine blades would be of value in terms of demonstrating its commercial opportunity
- Continue to look for an opportunity to work with an industry partner
- How can the results of this work be translated into an efficiency index. For example electric energy output to mechanical input metric.

DOE Water Power Technologies Office 2017 Peer Review Project:

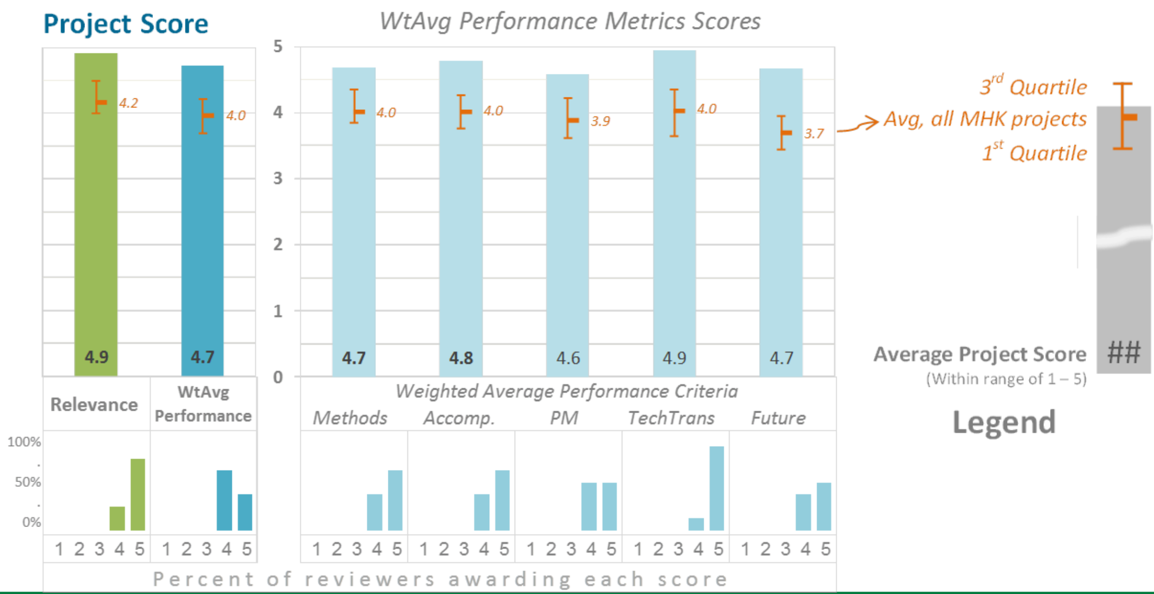
Standards Development, IEC TC 114, IEA-OES Annual Contribution

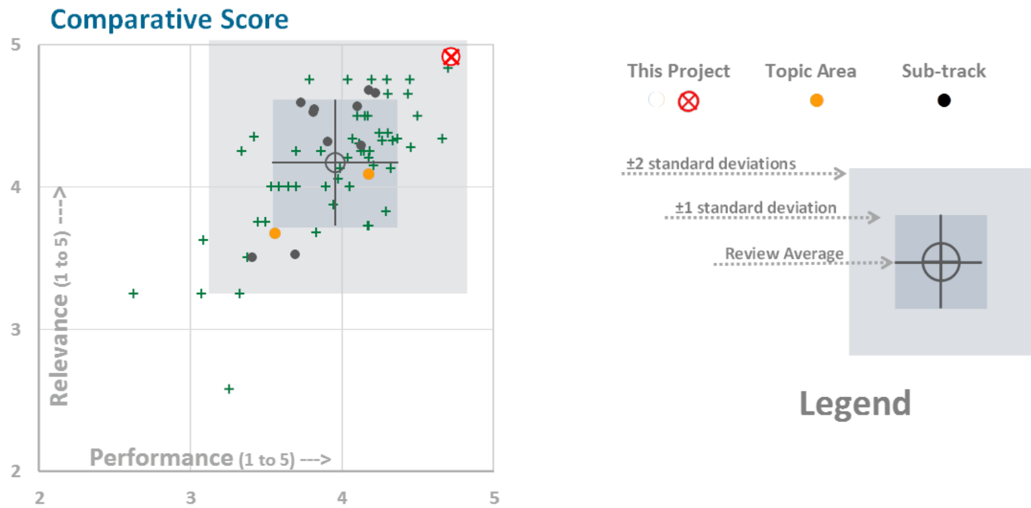
Principal Investigator	Walt Musial, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Sensors and Measurement

FY 2014-FY 2016 Funding

DOE	$ 2.0 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 2.0 M**	**100%**

Peer Review ID# 33





Comments made by reviewers during the evaluation of this project (PRID 33)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- Developing these standards reduces potential project risk for future investors in this industry
- IEA-OES (International Energy Agency – Ocean Energy Systems) provides a safety standard which this industry will be able to conform to. An important component to advance this industry.
- Significant alignment across a range of MHK program strategic priorities
- Key to Market Development goals of DOE and ability of the companies to design to standards that will be accepted in areas of project deployment
- Meets safety standards, removal of market barriers and enables high-quality, reproducible test results
- Project is essential to ultimate successful deployment of MHK technologies in U.S. and global markets
- Excellent fit with program
- Seems very important to the DOE objectives
- Standards development is critical for the advancement of the industry and enables regulators to evaluate projects in a consistent manner
- Wondering if standards can be developed if device designs are not determined
- Development of design, manufacturing, testing and safety standards is an essential part of the ultimate goal of MHK electric power and energy installations in commercial service
- The focus of the Standards effort is at the international level. However, when it comes to the interconnection of MHK powered electric generation apparatus to the United States or North American grid, then it will be necessary to have standards that are U.S.- and North-American-based. These include NERC (North American Electric Reliability Corporation), IEEE, ASME (American Society of Mechanical Engineers), ASTM, NESC (National Electrical Safety Code), RUS-REA (Rural Utilities Service-Rural Electrification Administration), as well as ISO/RTO (independent service operator/regional transmission operator) and FERC (Federal Energy Regulatory Commission) interconnection rules. The FERC interconnection rules include Small and Large Generation Interconnection Agreements (aka LGIA and SGIA).
- Concur with project presentation statement that "The development of international recognized standards is critical for the commercialization of marine energy technology."

Question 2: Methods and Approach

- U.S. representation well represented including strong leadership of Johnathon Colby
- Budget $700K w 25% carryover annually 80 standards and 20% to IEA Ocean Energy Systems Exec Comm; budget enables the United States to remain a leader by paying stipends to TAGs (Technical Advisory Groups)
- For topics that treat emerging technologies, need to add process that will allow improvement inputs on standards
- Selection of candidates is supported by review of technical advisers/ Executive Committee, conveners, technical advisors for each Committee
- Very strong project structure assuring extensive collaboration of U.S. private and public sectors (132 members in TAGs) with strong leadership from private sector with strong collaboration with other energy sectors (wind), building upon standard certification methodology from other energy and manufacturing sectors
- A good method is in place for the selection of experts
- The reward systems is exemplar internationally
- Seems well developed with multiple different levels and groups
- The process of developing standards is well established
- The focus of the Standards effort is at the international level. However, when it comes to the connection of MHK powered electric generation apparatus that is or will be connected to the United States or North American grid, then it will be necessary to have standards that are U.S.-based. These include IEEE, ASME, ASTM, NESC, RUS-REA, as well as ISO/RTO and FERC interconnection rules. The FERC rules would be SGIA and LGIA.

Comments made by reviewers during the evaluation of this project (PRID 33)

- Will there be an effort to work with the Institute of Electrical and Electronics Engineers (ANSI/IEEE)? Since the DOE effort is focused on U.S.-based efforts, then shouldn't there be standards that are used by U.S. electric utilities? When the PTO (power take-off) output is delivered to on-shore points of interconnection, then, according to voltage, the interconnection will be required to meet prevailing U.S. and state interconnection standards and rules. Also, there are NERC compliance requirements that include cyber security standards as well as transmission and distribution system operating requirements and procedures.
- Well-planned approach

Question 3: Technical Accomplishments and Progress

- Outstanding dissemination of work to U.S. stakeholders
- To note mixed reviews with developers in terms of standards utilization at this stage in developing the industry. There is limited participation of developers in TC114. There needs to be more representation.
- Five new Technical Standards during last three years; in addition to three prior standards; other technical standard development well underway
- Strong publication of results through public workshops, forums and website
- Strong sustainable structure to continue initial development and new structures to assure QA/QC input to improve established standards
- Good impact at an international level
- Seems like good progress made
- Excellent progress in engaging people and moving forward with methods development
- Established operating arrangements with relevant international and U.S.-based entities
- See list of accomplishments provided in project summary and presentation
- Numerous specifications published

Question 4: Project Management

- Significant outputs for industry evidenced through the five TS (technical standards) published
- Steady collaborative approach to involving U.S. industry and synchronizing work with IEA
- Unclear what the project management process is but appears to be working well
- Project costs are reasonable
- Work is ongoing and on track
- NREL appears to be in the lead position on the liaison with relevant entities both at the international and national levels
- Well-executed project. Excellent results.

Question 5: Research Integration, Collaboration, and Technology Transfer

- A perfect example of international collaboration in the industry
- Strong collaboration and appears technology transfer through Annex IV and OES workshops and meetings.
- 80 Int Standards/20% Ocean Energy Systems 20%
- Excellent project structure allowing local country groups that feed input into international committee
- This project provides an excellent interface with industry research and government
- Great collaboration between labs, academia, industry and international stakeholders
- By the nature of the effort, it must be collaborative and transferable
- Several publications and participation in professional society meetings
- Numerous publications and workshops
- Strong international team

Question 6: Proposed Future Research, if applicable

- Future FOA (funding opportunity announcement) that provides testing against standards and informing the TC's as below recommendation
- The TC114 priority list of future standards development is in alignment with project proposed future research
- The United States needs to remain a leader in the standards development process
- NA (not applicable)
- Next steps are identified for standard creation

Comments made by reviewers during the evaluation of this project (PRID 33)

- Coordinate with IEEE-Power Energy Society and relevant committees, sub committees, working groups and task forces whose scope descriptions include actual MHK topics as well as associated equipment and apparatus that are essential to the MHK effort Review IEEE Interconnection Distribute Resources with Electric Power Systems - IEEE 1547 Series of standards
- Agree with proposed future work to continue international efforts

Question 7: Project Strengths

- The development of international standards is essential to the progress of this industry
- Strong representation and leadership; highly valued reporting and continued future support
- Strong leadership from NREL
- International cooperation

Question 8: Project Weaknesses

- The project organization and process for membership (loosely termed here) appears not to reach far out into other sectors such as O&G (oil and gas). The ability to pull in subject matter experts from other sectors into TC114 should be encouraged.
- Hopefully other countries will contribute more cost share through time
- Rather than a weakness one can comment on the challenge faced by experts who have the necessary knowledge and experience to prepare, review and upgrade standards. Many of these individuals are employed in industry and are faced with scheduling and financial challenges associated with participation in face-to-face meetings.

Question 9: Recommendations

- MET CERT (Development of International Standards and Certification Schemes for Marine Energy Technologies) is an EU funded project bringing together partners from Belgium, Netherlands, Sweden, UK, and France to test and improve the standards surrounding Tidal Energy. This project launched in Feb 2017 and is a three year programme led by National Energy Centre from Netherlands.
- Mirror MET CERT project for testing against the standards for the United States. The recommendations from EU will influence IEC standards and impact U.S. tidal developers.
- Provide U.S. (JC) support for MET CERT
- It looks like most group conveners are from English speaking countries. Does this restrict access to expertise? Are translations of the standards available for other languages?
- Can the DOE program provide financial support or stipends to address the financial burden (barriers) faced by experts who are employed in the industry?
- Continue this important work

DOE Water Power Technologies Office 2017 Peer Review Project:

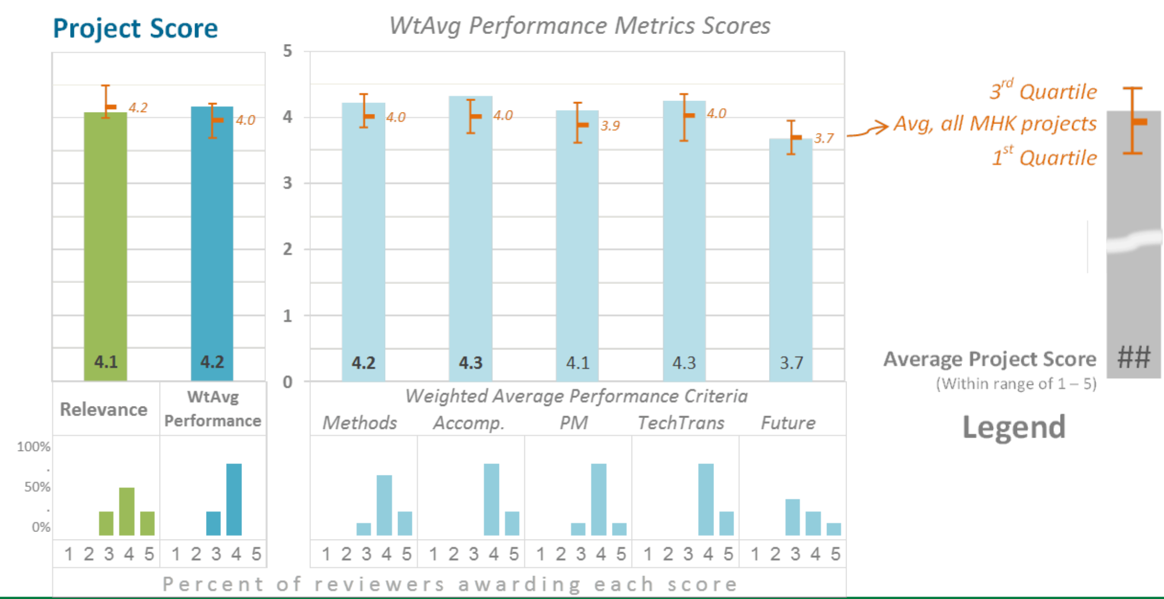
Modular Ocean Instrumentation System (MOIS)

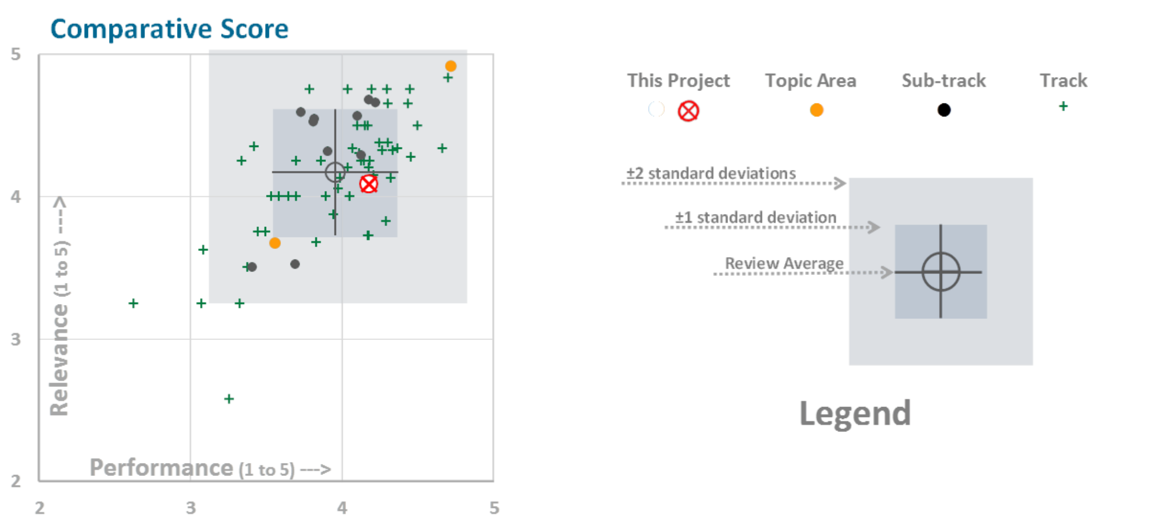
Principal Investigator	Eric Nelson, National Renewable Energy Laboratory
Track	Marine & Hydrokinetic (MHK)
Sub-track	MHK-2C: Demonstrations and Infrastructure
Topic Area	Sensors and Measurement

FY 2014-FY 2016 Funding

DOE	$ 0.2 M	100%
Cost Share	$ 0.0 M	0%
Total	**$ 0.2 M**	**100%**

Peer Review ID# 88





Comments made by reviewers during the evaluation of this project (PRID 88)

Question 1: Relevance to Water Power industry needs and overall DOE objectives

- A stand-alone data logger system with multiple sensors will be a benefit to future MHK deployments
- The project aligned better under the Technology Maturity approach to develop tools to optimize device and array performance as the results of the MOIS (Modular Ocean Instrumentation System) on Azura device provided valuable feedback data
- Bundling project for instrumentation will help to lower the costs of monitoring and obtaining critical permit information
- Development of the advanced instruments is important, but has advanced more quickly than MHK
- An excellent fit with the program needs
- This seems like it could be useful for developers, but I'm dubious that a 'one size fits all' approach will end up being widely adopted by developers
- Monitoring the wave energy devices during testing is critical to provide needed performance data to understand how the device is operating in the marine environment
- Ocean Instrumentation Systems. Provides a technical base for future use as Machine Condition Monitoring (MCM) input to SCADA (supervisory control and data acquisition) for MHK units in commercial service.
- Testing and monitoring facilities are essential to operation and maintenance of WEC (wave energy converter) units. It is also necessary to do analysis of why some designs fail or are damaged by storms and rough waves.
- The development of the Modular Ocean Instrumentation System (MOIS) for WEC on-device testing to characterize device performance, validate numerical models, and develop WEC testing methodologies will benefit the entire MHK community

Question 2: Methods and Approach

- The use of "off the shelf" instruments is commended
- The ability to buy off the shelf and repackage for device integration is a cost effective approach. A description of failed components if any would be of use including a more detailed output of the data.
- A well-structured approach to product development and industry needs
- Seems reasonable
- The device collected the information that it intended
- See detailed description of technical approach in the project summary
- The accomplishments indicate that the methods/approach resulted in useful results
- Well-planned approach

Question 3: Technical Accomplishments and Progress

- A successful deployment
- It was evidenced that the MOIS provided feedback on the AZURA for the Hull Heave but how Azura utilized this and demonstrated the integration of this project in the Azura presentation is critical to demonstrate value of feedback systems. EMEC (European Marine Energy Center) experience is that developers expect tools to be provided and not every system is fit for purpose. The MOIS as a generalized feedback system could be easily mass produced as a package/tool for each developer as they win funding from the DoE. The idea is DoE once awarding funds for deployment provides an added value tool such as MOIS and value back to DoE is the U.S. sector is utilizing a standardized tool and data collection feedback system.
- Not clear what safeguards have been taken to ensure cyber-security of data pulled from device, especially with remote access by MOIS Operator
- Excellent technical outcome - with a fit for purpose product being developed to support the sector's instrumentation needs
- The motion sensors have been key for key WECSim (Wave Energy Converter Simulator) model validation
- Good progress
- The device was successful and collected the information it intended

Comments made by reviewers during the evaluation of this project (PRID 88)

- The MOIS devices are in operation at several locations
- From summary: "Developers that have used MOIS during the project development period are Northwest Energy Innovations, Big Moon Power, Freeflow Power, SWAY, and FloDesign." This demonstrates that the system is being used.
- Successfully operated in the field with the NWEI (Northwest Energy Innovations) WEC at the WETS (Wave Energy Test Site).

Question 4: Project Management

- Project on budget/on time
- Favorable feedback from developers after in water demonstration projects
- A well-managed project
- All funds expended. The project is on budget and on schedule.
- Appears to be well managed
- Well-managed project

Question 5: Research Integration, Collaboration, and Technology Transfer

- A strong lab/private team
- It is positive to see other WEC developers starting to use this instrumentation system
- It is demonstrated that the uptake of the MOIS is being utilized by Azura/WETs/Cpower and Big Moon Power. I think there is opportunity to utilize MOIS at the EMEC site and will pursue joint collaboration.
- There is potential for further use of the system to cost effectively be scaled up and installed / available at other test sites
- Understanding the design constraints and recommendations will be critical for design improvements. This could have been further touched upon.
- Good project collaboration with private developers in in situ testing
- Presented indicated modular system available for hire at any time and available to MHK community
- Good links with industry and the WETNZ (Wave Energy Technology New Zealand) device
- It's extremely valuable that all the drawings are on the DOE MHK database for the sector to use
- Good collaboration between labs, industry and academia
- Data are going into the MHK database
- Partnering with industry to use the data for device evaluation
- The design uses off the shelf instrumentation and provides directions for others to build
- CAD software is available on a DOE web page
- Provides necessary input to IEC (International Electrotechnical Commission) and other industry standards
- Have worked very successfully with several developers

Question 6: Proposed Future Research, if applicable

- With the development of a final product, no commercial production or revenue recuperation was identified
- How next gen can be incorporated into controls system will be of interest
- Integration of other data streams and SW (software) package that integrates/processes and QC's the data streams in real time
- NA (not applicable)
- Limited future research planned
- The project is finished. Capability is being maintained but no new or additional efforts are proposed.
- Can/how are MOIS results sent to an on-shore monitoring station?
- Provide a description of how the MOIS is or can be part of a WEC unit SCADA system
- Provides a technical base for future use as Machine Condition Monitoring (MCM) input to SCADA for MHK units in commercial service
- Continue to support WEC developers in the field as funds permit

Comments made by reviewers during the evaluation of this project (PRID 88)

Question 7: Project Strengths

- Clear scope, and deliverables
- Testing and operation of a MOIS system at U S Navy's Wave Energy test site (WETS)
- Successful in the field at WETS site for over a year

Question 8: Project Weaknesses

- None observed
- It is not clear if the MOIS outputs can be shared with an on-shore SCADA monitoring system such that an owner operator of an interconnected array of WEC units can use the information to identify units that require repair or maintenance

Question 9: Recommendations

- Continued communication of the MOIS system to international sector will improve awareness of the value of this device
- Commercialization plan should be required for any additional MHK instrumentation funding to assure technology not stranded and abandoned
- MHK instrumentation devices have been developed more quickly than the MHK devices; MHK devices need to be prioritized over further instrument refinements
- Is there a possibility that an industry standard data format can be established such that any manufacture can design and build monitoring equipment for each type of WEC technology and interface with the MOIS system?
- Project is complete

Appendix A Peer Review Lessons Learned

This section contains representative comments and actionable recommendations from the peer reviewers, staff of DOE's Wind Energy Technologies Office and Water Power Technologies Office,[12] and peer review organizers regarding the peer review planning and execution process. These lessons learned will help support improvement and optimization of future peer reviews.

General Feedback on the Peer Review Process

- The order of the presentations in each program was fantastic.
- Incorporating aspects of a "conference atmosphere" to the peer review was a very good idea. It created a rigorous atmosphere in which to conduct a conference of broad stakeholders. Having a keynote speaker worked very well.
- Next time, add time for side meetings and networking. Perhaps the next peer review and/or department meetings would include breakout groups, and invite new experts (not just engineers) to discuss ways to approach multi-disciplinary, multi-pronged science and engineering program areas.
- Very well-managed event. The agenda was controlled well throughout the program. Good job done by all. Overall execution was on-time and high quality. Feedback was great.
- Most of the time the instructions were clear. There were certainly a few communication issues (during the planning stage), but the frequent team update calls really helped alleviate this.
- List the Principal Investigator on the agenda and have the moderator handle changes of presenter at the peer review. Principal Investigators may want to have colleagues and partners gain recognition.
- Would be helpful to have a more clearly delineated "roadmap" for all internal staff that summarizes process, goals, deliverables, quality metrics, and lessons learned from previous peer reviews.
- By-product of peer review process was that colleagues were able to get broad perspective on the larger program, which is invaluable.
- It would be helpful for orienting if we had a funding stream graphic, where each project clusters with others.

Opportunities for Improving the Peer Review Process

Project Templates and Guidance for Principal Investigators

- Project presentations were well documented using a standard format.
- Suggest summarizing for the reviewers the rationale behind how the presentations and project summary templates were developed and completed by Principal Investigators.
- Include a "definition of terms" page in the Principal Investigator Instructions, and include instructions for incorporating video into presentations as part of Principal Investigator Template Package.

[12] The Wind Energy and Water Power Technologies Offices held their respective peer reviews concurrently. Content and lessons learned in this appendix represent feedback about both peer reviews, since many aspects of the reviews (e.g. planning efforts, agenda, presentation templates) were identical or similar.

- Provide mechanism to allow Principal Investigators to incorporate project developments into their presentations that occurred subsequent to their initial submission. Perhaps a "Latest Project Developments" or "Stay Tuned" slide in the presentation template to make reviewers and audience members aware of recent accomplishments and/or planned work.

- Ensure uniformity of project-related data such as budgets, annual spending, cost share and start/end dates in both content and format, perhaps utilizing a “key data” form, including instructions, that the office technical leads and the Principal Investigators concur on and update as needed, prior to and separate from the slide presentation.

- Provide stringent guidance about use of acronyms to help ensure reader understanding.

- Reviewers received presentations prior to the review in order to prepare, but those files alone did not provide sufficient understanding of projects. The live presentations with PIs did, however, fill in the gaps.

- Instead of only "Project Title" on the Presentation and Project Summary templates, indicate the original AOP/FOA project title (lead project, if part of a group of projects), current working project title, and peer review presentation title, if different.

- Consider a simplified way to capture and report budget figures among projects so that comparisons are easier for reviewers, e.g. capture total project budget, total project duration, and yearly annual spend in a uniform way. Having a single page with scope and funding and goals would be good, as some projects didn't cover those things as well as others.

- During the planning phase for multi-lab presentations, the "Labs Project List" should be shared with the Principal Investigators of sub-labs/partners in addition to the Principal Investigators of the Lead Lab/partner.

- Project summary sheets were helpful but varied in quality. Presentations were more of a repackaging of the two pagers; provide PIs with more detailed instructions about the type of content to include so that the presentations can stand alone more readily.

Reviewer Guidance

- The evaluation sheet worked very well due to the way it was laid out and the fact that logistics information was incorporated directly in the Excel workbook. Reviewers reported that it was easy to navigate between the project summary, presentations, the agenda, and the evaluation sheet, even with multiple projects.

- Program managers engaged with reviewers and listened but also highlighted in advance for reviewers those areas about which the program itself has questions. This type of open engagement helped reviewers to pay additional attention to those topics, which stimulated good dialog and feedback to the program.

- The process and communications channels within the office related to disseminating project-specific information, including version tracking, could be improved.

- Suggest a pre-review meeting to better understand the areas that each reviewer on a panel considers themselves to be expert in, and address any concerns they have regarding comments on other topics. Define what "expert" means and develop succinct guidance for reviewers. For instance, the NIH process has the peer reviewer state their expertise and comfort for each answer.

- Conduct a pre-review group session with reviewers to identify information, such as budget details, that they consider important to be able to answer evaluation form questions.
- Need more clarity on scoring and commenting on new versus existing projects.

At Review

- More informal time, such as breakfast meetings, for reviewers to interact with one another would be useful.
- DOE might consider a manned poster session in order to manage the volume of project-specific content. This has occurred in other peer reviews and allows individual Principal Investigators of multiple similar projects to avoid making multiple presentations, and still prepare adequate material for review purposes.
- Would be good to have more discussion time. The reviewers really didn’t get much time to interact with PIs; it would have been great to hear more of their feedback.
- Audience input was fantastic and helped generate great dialogue.

Appendix B Program Evaluation Form: Hydropower

The subsequent two pages contain the **Program-level** scoring sheet used by Hydropower reviewers.

U.S. DEPARTMENT OF ENERGY — Energy Efficiency & Renewable Energy	U.S. DOE Water Power Peer Review Hydropower Program Evaluation Form	Page 1 of 3

Program Name:	**DOE Water Power Program**	**Reviewer:**		*Agenda*
Presenter Name:	**WPTO Program Manager & Team**	**Presenter Org:**	**DOE WPTO**	
Input Cells	*Provide specific, concise comments to support your evaluation.*			

Q1 **Program Objectives**

How well do Program objectives align with industry needs and Administration Goals?
- Improve Technology Costs and Performance
- Develop Environmentally Sustainable Hydropower
- Optimize Regulatory Processes
- Enhance Revenue and Market Structures

5 - Outstanding	All Program objectives fully support industry needs.	
4 - Good	Most Program objectives fully support industry needs.	**score**
3 - Average	Program objectives marginally support industry needs.	
2 - Fair	Some Program objectives do not support industry needs.	
1 - Poor	Few or none of Program objectives support industry needs; objectives should be re-evaluated and revised.	
Score ?'s / Notes:		

Key Finding	Comments

Q2 **R&D Portfolio**

Is the Water Program investment portfolio appropriately balanced across research areas and recipient organizations to achieve the program's mission and goals?

5 - Outstanding	Program investment portfolio is excellent across research areas and organizations to achieve program mission & goals	
4 - Good	Program investment portfolio is fairly balanced across research areas and organizations to meet program mission & goals	**score**
3 - Average	Program investment portfolio mix and diversity is adequate	
2 - Fair	Program investment portfolio has some weaknesses in balance across research areas and recipients	
1 - Poor	Program investment portfolio will not enable program to achieve its mission & goals	
Score ?'s / Notes:		

Key Finding	Comments

Q3 **Management & Operations**

Please evaluate the quality of the Water Program's team, management practices, and operations.

5 - Outstanding	Program has excellent leadership, personnel, and program operation practices.	
4 - Good	Program management and operations appears mostly effective.	**score**
3 - Average	Program management and operations is adequate.	
2 - Fair	Some of the Program team and practices reduce its effectiveness.	
1 - Poor	Program team and practices are not effective.	
Score ?'s / Notes:		

Key Finding	Comments

Project Name:	DOE Water Power Program	Reviewer:	
Presenter Name:	WPTO Program Manager & Team	Presenter Org:	DOE WPTO

Input Cells — *Provide specific, concise comments to support your evaluation.*

Q4 **Communications & Outreach**

How effective is the Program at engaging with industry, universities, other agencies, international actors, and other stakeholders?

5 - Outstanding	Program is extremely effective in communications, coordination, and outreach with relevant stakeholders.	**score**
4 - Good	Program does a good job with communications, coordination, and outreach to relevant stakeholders.	
3 - Average	Program communications, coordination, and outreach is adequate.	
2 - Fair	Program needs improvement on communications, coordination, and outreach activities.	
1 - Poor	Program's ineffective communications, coordination, and outreach impede its overall success.	
Score ?'s / Notes:		

Key Finding	**Comments**

Q5 **Program Strengths**

Discuss the aspects of the program that support successful outcomes or that provide an advantage to the program. Factors may be internal or external.

Key Finding	**Comments**

Q6 **Program Weaknesses**

Discuss the aspects of the program that hinder successful outcomes or that disadvantage the program. Factors may be internal or external.

Key Finding	**Comments**

Q7 **Recommendations**

Key Finding	**Comments**

Appendix C Program Evaluation Form: Marine and Hydrokinetics

The subsequent two pages are the blank MHK **Program-level** scoring sheet used by reviewers.

Marine and Hydrokinetic Program Evaluation Form

Program Name:	**DOE Water Power Program**	**Reviewer:**		*Agenda*
Presenter Name:	**WPTO Program Manager & Team**	**Presenter Org:**	**DOE WPTO**	

Input Cells — *Provide specific, concise comments to support your evaluation.*

Program Objectives

How well do Program objectives align with industry needs and Administration Goals?

MHK Program Mission: Support the development of safe, reliable, and cost-competitive MHK technologies and reduce deployment barriers
DOE's MHK program portfolio also simultaneously pursues early market and longer-term utility scale market opportunities

Program goals:
• Cost Reduction: Reduce the levelized cost of energy (LCOE) by 80% compared to the 2015 baseline LCOE values for wave (0.84 $/kWh) and current (0.58 $/kWh) technologies by 2030.
• Reduce Deployment Barriers: Enable the industry to rapidly increase MHK technology deployments by supporting research and stakeholder outreach activities to reduce deployment barriers and to accelerate project permitting processes

Major Phases of Activities (as identified in Draft Strategy):
• Phase I (~2009-~2015):Complete critical foundational work to determine existing technology costs and performance, R&D needs, resource opportunities and deployment barriers
• Phase II (~2015-~2020):Aggressive technology innovation and demonstration of Marine and Hydrokinetic systems for multiple resource and market applications

5 - Outstanding	All Program objectives fully support industry needs.
4 - Good	Most Program objectives fully support industry needs.
3 - Average	Program objectives marginally support industry needs.
2 - Fair	Some Program objectives do not support industry needs.
1 - Poor	Few or none of Program objectives support industry needs; objectives should be re-evaluated and revised.

score

Comments

R&D Portfolio

Is the Water Program investment portfolio appropriately balanced across research areas and recipient organizations to achieve the program's

5 - Outstanding	Program investment portfolio is excellent across research areas and organizations to achieve program mission & goals
4 - Good	Program investment portfolio is fairly balanced across research areas and organizations to meet program mission & goals
3 - Average	Program investment portfolio mix and diversity is adequate
2 - Fair	Program investment portfolio has some weaknesses in balance across research areas and recipients
1 - Poor	Program investment portfolio will not enable program to achieve its mission & goals

score

Comments

Management & Operations

Please evaluate the quality of the Water Program's team, management practices, and operations.

5 - Outstanding	Program has excellent leadership, personnel, and program operation practices.
4 - Good	Program management and operations appears mostly effective.
3 - Average	Program management and operations is adequate.
2 - Fair	Some of the Program team and practices reduce its effectiveness.
1 - Poor	Program team and practices are not effective.

score

Comments

Project Name:	DOE Water Power Program	Reviewer:	
Presenter Name:	WPTO Program Manager & Team	Presenter Org:	DOE WPTO

Input Cells — *Provide specific, concise comments to support your evaluation.*

Communications & Outreach

How effective is the Program at engaging with industry, universities, other agencies, international actors, and other stakeholders?

5 - Outstanding	Program is extremely effective in communications, coordination, and outreach with relevant stakeholders.	**score**
4 - Good	Program does a good job with communications, coordination, and outreach to relevant stakeholders.	
3 - Average	Program communications, coordination, and outreach is adequate.	
2 - Fair	Program needs improvement on communications, coordination, and outreach activities.	
1 - Poor	Program's ineffective communications, coordination, and outreach impede its overall success.	

	Comments

Q5 Program Strengths

Discuss the aspects of the program that support successful outcomes or that provide an advantage to the program. Factors may be internal or external.

Key Finding	**Comments**

Q6 Program Weaknesses

Discuss the aspects of the program that hinder successful outcomes or that disadvantage the program. Factors may be internal or external.

Key Finding	**Comments**

Q7 Recommendations

Key Finding	**Comments**

Appendix D Project Evaluation Form

The subsequent three pages feature the blank WPTO **Project-level** scoring sheet used by both MHK and Hydropower reviewers.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

U.S. DOE Water Power Peer Review

Project Evaluation Form for

Project Title

Agenda

Presenter Name:		Reviewer:	
Presenter Org:		PR Project ID:	
Enter comment in green shaded cells		Conflict?	

Provide specific, concise comments to support your evaluation.

Q1 **Relevance to Water Power industry needs and overall DOE objectives**
The degree to which the project aligns with objectives and goals of the Water Power Office and meets the needs of the Water power industry at large.

Stand Alone Metric

score

5 - Outstanding	Project is critical to objectives and goals of the Water Power Office and meeting Water industry needs.
4 - Good	Project has valuable impact to Water Power Office goals and objectives and meeting Water industry needs.
3 - Average	Project has moderate relevance with objectives and goals of the Water Power Office and Water industry needs.
2 - Fair	Project is marginally relevant to the objectives and goals of the Water Power Office and Water industry.
1 - Poor	Project has little relevance to Water Power Office goals and objectives and Water industry needs.

Score ?'s / Notes:

Key Finding	Comments	Comment Category

Q2 **Methods/Approach**
the degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers.

Weight 30%

score

5 - Outstanding	Excellent project design and technically feasible; approach will likely be successful.
4 - Good	Well designed and technically feasible; continue to move forward with this approach.
3 - Average	Generally effective.
2 - Fair	Has significant weaknesses in methods; requires significant improvement.
1 - Poor	Ineffective approach to meet project objectives; new methods should be developed.

Score ?'s / Notes:

Key Finding	Comments	Comment Category

Q3 **Technical Accomplishments and Progress**
The degree to which the project has delivered results and/or progressed technically compared to the stated project schedule and goals.

Weight 30%

score

5 - Outstanding	Excellent accomplishments and progress; little to no monitoring needed for excellent project results.
4 - Good	Good progress; successful outcome is likely.
3 - Average	Adequate accomplishments and progress. Continue monitoring.
2 - Fair	Accomplishments and progress appear behind schedule or short of original goals; extra project monitoring needed to improve outcome.
1 - Poor	Little or no demonstrated progress made. Major course correction needed to achieve success.

Score ?'s / Notes:

Key Finding	Comments	Comment Category

Project Title

Presenter Name:		**Reviewer:**	
Presenter Org:		**PR Project ID:**	

Enter comment in green shaded cells — *Provide specific, concise comments to support your evaluation.*

Project Management

The effectiveness of the project's management, including project planning, project execution, and allocation of resources to complete the project within scope, on-time, and within budget.

Weight 20%

5 - Outstanding	Excellent project management demonstrated that should result in well-run, successful project.
4 - Good	Project management appears successful and should result in an in-scope, on-time, within-budget project.
3 - Average	Project management should result in completion of objectives mostly within scope, on-time, and within budget.
2 - Fair	Project management evidence indicates project may have issues with executing within scope, on-time, and/or within budget.
1 - Poor	Poor project management demonstrated. Project likely to have significant overruns in schedule or budget, and may need re-scoping.

score

	Comments	Comment Category

Research Integration, Collaboration, and Technology Transfer

With industry/universities/other laboratories – the degree to which the project successfully interacts, interfaces, or coordinates with other institutions and projects, and the degree to which projects are disseminating the results of the R&D.

Weight 10%

5 - Outstanding	Close coordination with other institutions strengthens project impact; results well-documented and being communicated to appropriate audiences.
4 - Good	Close, appropriate coordination with other institutions; results reaching appropriate audiences.
3 - Average	Some coordination across institutions; some technology transfer and communications demonstrated.
2 - Fair	Little coordination exists across institutions, to the detriment of the project; weak evidence of technology transfer and/or communications.
1 - Poor	No collaboration or coordination with other institutions significantly weakens the project; no evidence of technology transfer and/or communications.

score

	Comments	Comment Category

Proposed Future Research (if applicable)

The degree to which the future research proposed is relevant, well-planned, and worthwhile of continued funding.

Weight 10%

5 - Outstanding	Proposed future research is critical for Water Power Office and industry success, appears well-planned and achievable, and should be prioritized for funding.
4 - Good	Proposed future research aligns well with Water Power Office and industry needs, and appears likely to deliver results.
3 - Average	Proposed future research is moderately relevant to Water Power Office and industry needs, with moderate likelihood for impact.
2 - Fair	Proposed future research is marginally relevant and may achieve its intended impact.
1 - Poor	Proposed future research is not relevant or does not appear likely to achieve results. Consider de-funding.
NA - Not Applicable	Project is complete, so no future research is proposed.

score

	Comments	Comment Category

U.S. DOE Water Power Peer Review

Project Evaluation Form for

Project Title

Agenda

Presenter Name:		**Reviewer:**	
Presenter Org:		**PR Project ID:**	

Enter comment in green shaded cells — *Provide specific, concise comments to support your evaluation.*

Q7	**Project Strengths** Discuss the aspects of the project that support successful outcomes or that provides an advantage to the project. Factors may be internal or external.	**Not Scored**
Key Finding	**Comments**	Comment Category

Q8	**Project Weaknesses** Discuss the aspects of the project that hinder successful outcomes or that disadvantages the project. Factors may be internal or external.	**Not Scored**
Key Finding	**Comments**	Comment Category

Q9	**Recommendations**	**Not Scored**
Key Finding	**Comments**	Comment Category

Appendix E Calculation for Weighted Average Performance Score

Figure D-1 represents the formula used to calculate the overall weighted average scores of WPTO projects in order to provide a means for comparing a project's final overall score equivalently to other projects:

$$
\begin{aligned}
\text{Weighted Overall Average Score} \\
&= \left[\left(\frac{\sum_1^n \text{Score 1}}{n}\right) \times (0.3)\right] + \left[\left(\frac{\sum_1^n \text{Score 2}}{n}\right) \times (0.3)\right] + \left[\left(\frac{\sum_1^n \text{Score 3}}{n}\right) \times (0.2)\right] \\
&+ \left[\left(\frac{\sum_1^n \text{Score 4}}{n}\right) \times (0.1)\right] + \left[\left(\frac{\sum_1^n \text{Score 5}}{n}\right) \times (0.1)\right]
\end{aligned}
$$

Figure D-1: Equation used to calculate the weighted average performance scores.

Note: n equals the number of reviewers per scoring metric.

Appendix F Meeting Attendee List

Note that some attendees in this list were registered to attend both the 2017 Water Power Technologies Office Peer Review and the concurrent 2017 Wind Energy Technologies Office Peer Review, as noted. Attendees are listed in alphabetical order, first by organization name and then by last name.

First Name	Last Name	Organization	Registered to attend
Steven	Englebretson	ABB Inc.	Both Wind and Water
V R	Ramanan	ABB Inc.	Both Wind and Water
Raphael	Tisch	Allegheny Science and Technology	Wind Peer Review
Audun	Botterud	Argonne National Laboratory	Wind Peer Review
Guenter	Conzelmann	Argonne National Laboratory	Wind Peer Review
Aaron	Greco	Argonne National Laboratory	Wind Peer Review
Scott	Winneguth	Avangrid Renewables	Wind Peer Review
Cris	Hein	Bat Conservation International	Both Wind and Water
Evan	Adams	Biodiversity Research Institute	Wind Peer Review
Andrew	Gilbert	Biodiversity Research Institute	Wind Peer Review
Charles	Butterfield	Boulder Wind Consulting	Wind Peer Review
Maurice	Falk	Bureau of Ocean Energy Management	Both Wind and Water
Darryl	Francois	Bureau of Ocean Energy Management	Both Wind and Water
Angel	McCoy	Bureau of Ocean Energy Management	Both Wind and Water
Ian	Slayton	Bureau of Ocean Energy Management	Both Wind and Water
John	Cushing Jr.	Bureau of Safety and Environmental Enforcement	Both Wind and Water
Steven	Barras	Bureau Veritas Offshore	Both Wind and Water
Roger	Bagbey	Cardinal Engineering	Both Wind and Water
Peter	Drown	Cleantech Analytics LLC	Both Wind and Water
Johan	Enslin	Clemson University	Wind Peer Review
Patrick	Hipp	Composite Technology Development, Inc.	Both Wind and Water
Joy	Page	Defenders of Wildlife	Wind Peer Review
Neil	Kern	Duke Energy	Both Wind and Water
Heather	Rhoads-Weaver	eFormative Options	Wind Peer Review
Joseph	Dillon	Electricity Research Centre, University College Dublin	Wind Peer Review
Michael	Kelly	Ensemble Energy Services, LLC	Wind Peer Review
Chris	Wissemann	Fishermens Energy	Wind Peer Review
Fraser	Dalgleish, PhD	Florida Atlantic University	Both Wind and Water
William	French	French Development Enterprises, LLC	Both Wind and Water
Myron	Miller	Frontier Wind	Wind Peer Review
Debbie	Mursch	GE Renewable Energy	Both Wind and Water
Kathryn	Rominger	General Electric Company	Wind Peer Review
Johnathon	Marmillo	Genscape	Both Wind and Water
Richard	Rocheleau	HNEI/Univ of Hawaii	Both Wind and Water
Gabriel	Ilevbare	Idaho National Labatory	Both Wind and Water
Jake	Gentle	Idaho National Laboratory	Wind Peer Review
Richard	Hess	Idaho National Laboratory	Both Wind and Water
Yusheng	Luo	Idaho National Laboratory	Both Wind and Water
Timothy	McJunkin	Idaho National Laboratory	Wind Peer Review

First Name	Last Name	Organization	Registered to attend
Manish	Mohanpurkar	Idaho National Laboratory	Both Wind and Water
John	Bonds	Independent Consultant	Both Wind and Water
Stu	Webster	Independent Consultant	Wind Peer Review
John	Meissner	U.S. Department of Energy/Independent Consultant	Both Wind and Water
Craig	Jones	Integral Consulting	Both Wind and Water
Eric	Smith	Keystone Tower Systems	Wind Peer Review
Ben	Hoen	Lawrence Berkeley National Laboratory	Wind Peer Review
Ryan	Wiser	Lawrence Berkeley National Laboratory	Wind Peer Review
Dave	Karpinski	LEEDCo	Wind Peer Review
Rick	Williams	Leidos Maritime Solutions	Both Wind and Water
David	Duquette	Littoral Power Systems	Both Wind and Water
Dan	Dolan	Moffatt and Nichol	Wind Peer Review
David	Muchow	Muchowlaw	Both Wind and Water
Sue Ellen	Haupt	National Center for Atmospheric Research	Wind Peer Review
William	Mahoney	National Center for Atmospheric Research	Wind Peer Review
Jim	Wilczak	National Oceanic and Atmospheric Administration	Wind Peer Review
Ian	Baring-Gould	National Renewable Energy Laboratory	Both Wind and Water
Aaron	Bloom	National Renewable Energy Laboratory	Wind Peer Review
Dave	Corbus	National Renewable Energy Laboratory	Wind Peer Review
Frederick	Driscoll	National Renewable Energy Laboratory	Both Wind and Water
Katherine	Dykes	National Renewable Energy Laboratory	Wind Peer Review
Johney	Green	National Renewable Energy Laboratory	Both Wind and Water
Scott	Hughes	National Renewable Energy Laboratory	Wind Peer Review
Mark	Jacobson	National Renewable Energy Laboratory	Wind Peer Review
Jonathan	Keller	National Renewable Energy Laboratory	Wind Peer Review
Daniel	Laird	National Renewable Energy Laboratory	Both Wind and Water
Eric	Lantz	National Renewable Energy Laboratory	Wind Peer Review
Eduard	Muljadi	National Renewable Energy Laboratory	Both Wind and Water
Walter	Musial	National Renewable Energy Laboratory	Both Wind and Water
Amy	Robertson	National Renewable Energy Laboratory	Wind Peer Review
Robi	Robichaud	National Renewable Energy Laboratory	Both Wind and Water
Dave	Simms	National Renewable Energy Laboratory	Wind Peer Review
Karin	Sinclair	National Renewable Energy Laboratory	Wind Peer Review
Brian	Smith	National Renewable Energy Laboratory	Both Wind and Water
Michael	Sprague	National Renewable Energy Laboratory	Wind Peer Review
Suzanne	Tegen	National Renewable Energy Laboratory	Both Wind and Water
Robert	Thresher	National Renewable Energy Laboratory	Both Wind and Water
Jeroen	van Dam	National Renewable Energy Laboratory	Wind Peer Review
Alan	Wright	National Renewable Energy Laboratory	Wind Peer Review
Yingchen	Zhang	National Renewable Energy Laboratory	Wind Peer Review
Jason	Fields	National Renewable Energy Laboratory National Wind Technology Center	Wind Peer Review
Miguel	Quintero	Naval Surface Warfare Center Carderock	Both Wind and Water
John	Anderson	Nossaman, LLP	Wind Peer Review
Dominic	Lee	Oak Ridge National Laboratory	Wind Peer Review

First Name	Last Name	Organization	Registered to attend
Tony	Lewis	Ocean Energy USA LLC	Both Wind and Water
Nathan	Johnson	Ocean Renewable Power Company	Both Wind and Water
Daniel	O'Connell	Office of Renewable Energy Programs	Both Wind and Water
Belinda	Batten	Oregon State University	Both Wind and Water
William	Toman	Pacific Marine Renewables	Both Wind and Water
Andrea	Copping	Pacific Northwest National Laboratory	Both Wind and Water
Samuel	Harding	Pacific Northwest National Laboratory	Both Wind and Water
Genevra	Harker-Klimes	Pacific Northwest National Laboratory	Both Wind and Water
Shari	Matzner	Pacific Northwest National Laboratory	Both Wind and Water
Will	Shaw	Pacific Northwest National Laboratory	Wind Peer Review
Chitra	Sivaraman	Pacific Northwest National Laboratory	Wind Peer Review
Jason	Busch	Pacific Ocean Energy Trust	Both Wind and Water
Kevin	Koudela	Pennsylvania State University	Both Wind and Water
Kevin	Banister	Principle Power	Wind Peer Review
Mirko	Previsic	Re Vision Consulting, Inc.	Both Wind and Water
D. Todd	Griffith	Sandia National Laboratories	Wind Peer Review
Amy	Halloran	Sandia National Laboratories	Both Wind and Water
Bernadette	Hernandez-Sanchez	Sandia National Laboratories	Both Wind and Water
David	Minster	Sandia National Laboratories	Wind Peer Review
Brian	Naughton	Sandia National Laboratories	Wind Peer Review
Joshua	Paquette	Sandia National Laboratories	Wind Peer Review
Jesse	Roberts	Sandia National Laboratories	Both Wind and Water
David	Womble	Sandia National Laboratories	Wind Peer Review
Ralph	Nichols	Savannah River National Laboratory	Wind Peer Review
Brad	Romano	Shoener Environmental, Inc.	Wind Peer Review
P.J.	Doughterty	SMI	Both Wind and Water
Paul	Gay	SMI	Both Wind and Water
David	Moore	Smith, Gambrell & Russell, LLP	Both Wind and Water
Herbie	Johnson	Southern Company	Both Wind and Water
Stephanie	McClellan	Special Initiative on Offshore Wind	Wind Peer Review
Andrea	Eugster	Statoil	Wind Peer Review
Henrik	Stiesdal	Stiesdal A/S	Wind Peer Review
Amanda	Hale	Texas Christian University	Wind Peer Review
John	Schroeder	Texas Tech University	Wind Peer Review
Craig	Christenson	Turbine Technology Partners, LLC	Wind Peer Review
Jim	Ahlgrimm	U.S. Department of Energy	Both Wind and Water
Bret	Barker	U.S. Department of Energy	Both Wind and Water
Jocelyn	Brown-Saracino	U.S. Department of Energy	Both Wind and Water
Charlton	Clark	U.S. Department of Energy	Both Wind and Water
Michael	Derby	U.S. Department of Energy	Wind Peer Review
Rajesh	Dham	U.S. Department of Energy	Both Wind and Water
Alana	Duerr	U.S. Department of Energy	Wind Peer Review
Arlene	Fetizanan	U.S. Department of Energy	Both Wind and Water
Jian	Fu	U.S. Department of Energy	Wind Peer Review
Liz	Hartman	U.S. Department of Energy	Wind Peer Review
Alexsandra	Lemke	U.S. Department of Energy	Both Wind and Water
Megan	McCluer	U.S. Department of Energy	Wind Peer Review

First Name	Last Name	Organization	Registered to attend
Sara	Paredes	U.S. Department of Energy	Both Wind and Water
Michael	Robinson	U.S. Department of Energy	Wind Peer Review
Roderick	Sampson	U.S. Department of Energy	Wind Peer Review
Jose	Zayas	U.S. Department of Energy	Wind Peer Review
Maggie	Yancey	U.S. Department of Energy	Both Wind and Water
Lillie	Ghobrial	U.S. Department of Energy/Allegheny Science and Technology	Both Wind and Water
Richard	Tusing	U.S. Department of Energy/Allegheny Science and Technology	Both Wind and Water
Fredric	Beck	U.S. Department of Energy/CSRA	Both Wind and Water
Gary	Norton	U.S. Department of Energy/CSRA	Both Wind and Water
Sandyn	Skudneski	U.S. Department of Energy/CSRA	Both Wind and Water
Devan	Willemsen	U.S. Department of Energy/The Hannon Group LLC	Wind Peer Review
Hoyt	Battey	U.S. Department of Energy/Water Power Technologies Office	Both Wind and Water
Matthew	Grosso	U.S. Department of Energy/Water Power Technologies Office	Both Wind and Water
Joel	Cline	U.S. Department of Energy/Wind & Water Power Technologies Offices	Both Wind and Water
Daniel	Beals	U.S. Department of Energy/Wind Energy Technologies Office	Both Wind and Water
Shane	Beichner	U.S. Department of Energy/Wind Energy Technologies Office	Wind Peer Review
Gary	Nowakowski	U.S. Department of Energy/Wind Energy Technologies Office	Both Wind and Water
Richard	Bowers	U.S. Energy Information Administration	Wind Peer Review
Christy	Johnson-Hughes	U.S. Fish and Wildlife Service	Wind Peer Review
Bonnie	Ram	University of Delaware	Both Wind and Water
Habib	Dagher	University of Maine	Wind Peer Review
Michael	Bernitsas	University of Michigan and Vortex Hydro Energy	Both Wind and Water
Wei	Qiao	University of Nebraska-Lincoln	Wind Peer Review
Jonathan	Bird	University of North Carolina at Charlotte	Wind Peer Review
Jim	McCaa	Vaisala, Inc.	Wind Peer Review
John	Banigan	Verdant Power	Both Wind and Water
Jephathai	Boontanom	Virginia Tech	Both Wind and Water
Xiaofun	Li	Virginia Tech	Both Wind and Water
Changwei	Liang	Virginia Tech	Both Wind and Water
Susan	Ma	Virginia Tech	Both Wind and Water
Adam	Wise	Virginia Tech	Both Wind and Water
Lei	Zuo	Virginia Tech	Both Wind and Water
Hannele	Holttinen	VTT Technical Research Center of Finland	Wind Peer Review
Michael	Booth		Wind Peer Review
Motunrayo	Kemiki		Wind Peer Review
Justin	Klure		Both Wind and Water
Michael	Martin		Both Wind and Water
Robert	Parker		Both Wind and Water
Paul	Veers		Wind Peer Review

Appendix G Meeting Agenda

This section includes the meeting agenda only. The full 2017 WPTO Peer Review program, including DOE and reviewer bios, is available on the DOE website at: https://energy.gov/eere/wind/downloads/program-guide-wind-energy-technologies-office-and-water-power-technologies.

TUESDAY GENERAL SESSION AGENDA

Tuesday, February 14				
Start Time	**Presentation Title**	**Room**	**Presenter**	**Presenter Org**
8:00 AM	Joint Breakfast with Wind and Water Attendees	Commonwealth Ballroom		
8:45 AM	Facilitator Welcome	Commonwealth Ballroom	Alex Lemke	U.S. Department of Energy
9:00 AM	Wind Director Welcome	Commonwealth Ballroom	Jose Zayas	Wind Energy Technologies Office
9:25 AM	Water Director Welcome	Commonwealth Ballroom	Alejandro Moreno	Water Power Technologies Office
12:30 PM	Lunch Keynote	Commonwealth Ballroom	Guest Speaker	
5:30 PM	Poster Session	Foyer		

WATER AGENDA - BY TRACK

Tuesday, February 14

Start Time	Presentation Title	Room	Session	Presenter	Presenter Org
8:00 AM	Joint Breakfast with Wind and Water Attendees	Commonwealth Ballroom			
8:45 AM	Facilitator Welcome	Commonwealth		Alex Lemke	U.S. DOE
9:00 AM	Wind Director Welcome	Commonwealth		Jose Zayas	U.S. DOE
9:25 AM	Water Director Welcome	Commonwealth		Alejandro Moreno	U.S. DOE
9:55 AM	Program Lead Presentation	Cavalier A		Tim Welch	U.S. DOE
10:15 AM	Chairperson Welcome and Intro to Panel	Cavalier A		Herbie Johnson	Chair / Southern Company
10:30 AM	Overview of Growth	Cavalier A	Growth	Tim Welch	U.S. DOE
10:45 AM	Modular Pumped Storage Hydropower Feasibility and Economic Analysis	Cavalier A	Growth	Boualem Hadjerioua	Oak Ridge National Laboratory (ORNL)
11:10 AM	Standard Modular Hydropower (SMH)	Cavalier A	Growth	Brennan Smith	ORNL
11:35 AM	Workforce, Education, and Training Needs Assessment for U.S. Hydropower	Cavalier A	Growth	Jay Paidipati	Navigant Consulting, Inc.
12:00 PM	Hydro Research Foundation University Research Awards Program	Cavalier A	Growth	Brenna Vaughn	Hydro Research Foundation
12:30 PM	LUNCH KEYNOTE	Commonwealth Ballroom		Guest Speaker	
1:30 PM	The 45 Mile Hydroelectric Project	Cavalier A	Growth	Jim Gordon	Earth by Design Inc.

1:55 PM	SLH100 Demonstration Project at Monroe Hydro	Cavalier A	Growth	Abe Schneider	Natel Energy, Inc.
2:20 PM	Demonstration of Variable Speed Permanent Magnet Generator at Small, Low-Head Hydro Site	Cavalier A	Growth	David Brown Kinloch	Weisenberger Mills, Inc
2:45 PM	Demonstration of a New Low-Head Hydropower Unit	Cavalier A	Growth	Wayne Krouse	Hydro Green Energy, LLC
3:10 PM	South Fork Powerhouse Project	Cavalier A	Growth	David Hanson	Sacramento Municipal Utility District
3:35 PM	Harnessing the Hydroelectric Potential of Engineered Drops	Cavalier A	Growth	Jerry Straalsund	Percheron Power, LLC
4:00 PM	BREAK	Foyer			
4:15 PM	Cellular Cofferdam for Hydropower Use	Cavalier A	Growth	Marte Gutierrez	Trustees of the Colorado School of Mines
4:40 PM	Cement Changes and Solutions to the Industry	Cavalier A	Growth	Todd Sirotiak	North Dakota State University
5:05 PM	Optimized Composite Prototype for Archimedes Turbine Manufacture	Cavalier A	Growth	Jerry Straalsund	Percheron Power, LLC
5:30 PM	The Design and Development of a Composite Hydropower Turbine Runner	Cavalier A	Growth	Pat Hipp	Composite Technology Development, Inc.
5:30 PM	POSTER SESSION	Foyer			

WATER AGENDA - BY TRACK

Wednesday, February 15

Start Time	Presentation Title	Room	Session	Presenter	Presenter Org
8:00 AM	Joint Breakfast with Wind and Water Attendees	Commonwealth Ballroom			
8:45 AM	Daily Recap	Commonwealth Ballroom		Alex Lemke	U.S. DOE
9:05 AM	Recap – Growth	Cavalier A	Growth	Tim Welch	U.S. DOE
9:10 AM	Modular Low-Head Hydropower System	Cavalier A	Growth	David Duquette	Littoral Power Systems, Inc.
9:35 AM	French Modular Impoundment	Cavalier A	Growth	Bill French	French Development Enterprises, LLC
10:00 AM	Cost-Optimization Modular Helical Rotor Turbine-Generator System for Small Hydro Power Plants	Cavalier A	Growth	David Yee	Eaton Corporation
10:25 AM	Rapidly Deployable Advanced Integrated Low Head Hydropower Turbine Prototype	Cavalier A	Growth	Arnie Fontaine	Pennsylvania State University
10:50 AM	BREAK	Foyer			
11:05 AM	Magnetic Gears for Hydropower Drivetrains	Cavalier A	Growth	Emily Morris	Emrgy, Inc.
11:30 AM	Overview of Optimization	Cavalier A	Optimization	Tim Welch	U.S. DOE
11:40 AM	Hydropower Manufacturing and Supply Chain Analysis	Cavalier A	Optimization	Jason Cotrell	National Renewable Energy Laboratory (NREL)
12:05 PM	National Hydropower Asset Assessment Program (NHAAP)	Cavalier A	Optimization	Shih-Chieh Kao	ORNL
12:30 PM	LUNCH KEYNOTE	Commonwealth Ballroom		Guest Speaker	

1:30 PM	U.S. Hydropower Market and Trends Report	Cavalier A	Optimization	Rocio Uria Martinez	ORNL
1:55 PM	Cost Data Collection and Modeling for Hydropower	Cavalier A	Optimization	Patrick O'Connor	ORNL
2:20 PM	Hydropower Asset Management Research	Cavalier A	Optimization	Brennan Smith	ORNL
2:45 PM	Low-Head, Short-Intake Flow Measurement Research	Cavalier A	Optimization	Marshall Richmond	Pacific Northwest National Laboratory (PNNL)
3:10 PM	Basin Scale Opportunity Assessment Initiative	Cavalier A	Optimization	Kyle Larson	PNNL
3:35 PM	BREAK	Foyer			
3:55 PM	Hydropower Regulatory and Permitting Information Desktop (RAPID) Toolkit	Cavalier A	Optimization	Aaron Levine	NREL
4:20 PM	Facilitating Regulatory Process Improvements (Federal Interagency Collaborative)	Cavalier A	Optimization	Shelaine Curd	ORNL
4:45 PM	PSH Transient Simulation Modeling	Cavalier A	Optimization	Eduard Muljadi	NREL

WATER AGENDA - BY TRACK

Thursday, February 16

Start Time	Presentation Title	Room	Session	Presenter	Presenter Org
8:00 AM	Joint Breakfast with Wind and Water Attendees	Commonwealth Ballroom			
8:45 AM	Daily Recap	Commonwealth Ballroom		Alex Lemke	U.S. DOE
9:05 AM	Recap – Optimization	Cavalier A	Optimization	Tim Welch	U.S. DOE
9:10 AM	Iowa Hill Pumped-storage Project Investigations	Cavalier A	Optimization	David Hanson	Sacramento Municipal Utility District
9:35 AM	Integrated Hydropower and Storage Systems Operation for Enhanced Grid Services	Cavalier A	Optimization	Rob Hovsapian	Idaho National Laboratory
10:25 AM	BREAK	Foyer			
10:35 AM	Overview of Sustainability	Cavalier A	Sustainability	Hoyt Battey	U.S. DOE
10:50 AM	Monitoring Technology Development for Sensitive Species (Juvenile Eel / Lamprey Tag Development)	Cavalier A	Sustainability	Daniel Deng	PNNL
11:15 AM	Environmental Performance Analysis and Testing Campaign for New Technologies	Cavalier A	Sustainability	Alison Colotelo	PNNL
11:40 AM	Environmental Metrics for Hydropower	Cavalier A	Sustainability	Shelaine Curd	ORNL
12:05 PM	Water Quality Modeling Improvements at Columbia and Cumberland River Basins	Cavalier A	Sustainability	Boualem Hadjerioua	ORNL
12:30 PM	LUNCH KEYNOTE	Commonwealth Ballroom		Guest Speaker	

1:30 PM	Biologically-Based Design and Evaluation of Hydro-Turbines (BioDE)	Cavalier A	Sustainability	Gary Johnson	PNNL
2:20 PM	Report to Congress-Potential Climate Change Impacts on Federal Hydropower	Cavalier A	Sustainability	Shih-Chieh Kao	ORNL
2:45 PM	CERC-WET Topic 3: Improving Sustainable Hydropower Design and Operations	Cavalier A	Sustainability	Soroosh Sorooshian	University of California, Irvine
3:10 PM	Informing Hydropower Investment and Operational Decisions Under Changing Hydrologic Conditions	Cavalier A	Sustainability	Mark Wigmosta	PNNL
3:35 PM	HydroNEXT NPD and PSH FOA	Cavalier A		Tim Welch	U.S. DOE
4:00 PM	Closing Thoughts-Chair	Cavalier A		Herbie Johnson	Chair / Southern Company
4:15 PM	Closing Thoughts-Director	Cavalier A		Alejandro Moreno	U.S. DOE
4:30 PM	Panel Debrief - Hydro (closed session)	Cavalier A		Herbie Johnson	Chair / Southern Company

WATER AGENDA - BY TRACK

Tuesday, February 14

Start Time	Presentation Title	Room	Session	Presenter	Presenter Org
8:00 AM	Joint Breakfast with Wind and Water Attendees	Commonwealth Ballroom			
8:45 AM	Facilitator Welcome	Commonwealth		Alex Lemke	U.S. DOE
9:00 AM	Wind Director Welcome	Commonwealth		Jose Zayas	U.S. DOE
9:25 AM	Water Director Welcome	Commonwealth		Alejandro Moreno	U.S. DOE
9:55 AM	Program Lead Presentation	Stars		Alison LaBonte	U.S. DOE
10:10 AM	Chairperson Welcome and Intro to Panel	Stars		Cameron Fisher	Chair / 48 North Solutions
10:30 AM	Overview of Site and Resource Characterization	Cavalier B	Site and Resource	Joel Cline	U.S. DOE
10:40 AM	National Wave Energy Resource Refinement Using 30-year Hindcast	Cavalier B	Site and Resource	George Scott	NREL
11:05 AM	Wave Resource Model Integration	Cavalier B	Site and Resource	Zhaoqing Yang	PNNL
11:30 AM	Model Validation and Site Characterization for Early Deployment Marine and Hydrokinetic Energy Sites and Establishment of Wave Classification Scheme	Cavalier B	Site and Resource	Levi Kilcher	NREL
11:55 AM	Wave Environmental Characterization at Wave Test Sites	Cavalier B	Site and Resource	Vincent Neary	Sandia National Laboratories (SNL)
12:30 PM	LUNCH KEYNOTE	Commonwealth Ballroom		Guest Speaker	

1:30 PM	DoD Marine and Hydrokinetic Energy Deployment Opportunity Identification	Cavalier B	Site and Resource	Robi Robichaud	NREL
1:55 PM	Marine and Hydrokinetic Energy Metocean Data-use, Sources, and Instrumentation	Cavalier B	Site and Resource	Senu Sirnivas	NREL
2:20 PM	Overview of Environmental Research	Cavalier B	Environmental	Hoyt Battey	U.S. DOE
2:30 PM	Improvements to Hydrodynamic and Acoustic Models for Environmental Prediction	Cavalier B	Environmental	Jesse Roberts	SNL
3:05 PM	Evaluating Potential for Impacts from Seal Collisions with Tidal Turbines	Cavalier B	Environmental	Andrea Copping	PNNL
3:30 PM	Acoustics Exposure Experimentation for Sensitive Fish Species	Cavalier B	Environmental	Mark Bevelhimer	ORNL
3:55 PM	BREAK	Foyer			
4:10 PM	Interactions of Aquatic Animals with the ORPC OCGen in Cobscook Bay, Maine	Cavalier B	Environmental	Gayle Zydlewski	University of Maine
4:30 PM	Informing a Tidal Turbine Strike Probability Model through Characterization of Fish Behavioral Response using Multibeam Sonar Output	Cavalier B	Environmental	Mark Bevelhimer	ORNL
4:55 PM	Current Ability to Assess Impacts of Electro Magnetic Fields Associated with Marine and Hydrokinetic Energy Technologies on Marine Fishes in Hawaii	Cavalier B	Environmental	Jeremy Claisse	Vantuna Research Group
5:15 PM	Evaluating the Potential for Marine and Hydrokinetic Devices to Act as Artificial Reefs or Fish Aggregating Devices	Cavalier B	Environmental	Sharon Kramer	H.T. Harvey and Associates
5:30 PM	POSTER SESSION	Foyer			

MARINE AND HYDROKINETIC ENERGY 2A: ENVIRONMENTAL RESEARCH, RESOURCE CHARACTERIZATION, AND ANALYSIS

WATER AGENDA - BY TRACK

Wednesday, February 15

Start Time	Presentation Title	Room	Session	Presenter	Presenter Org
8:00 AM	Joint Breakfast with Wind and Water Attendees	Commonwealth Ballroom			
8:45 AM	Daily Recap	Commonwealth Ballroom		Alex Lemke	U.S. DOE
9:05 AM	Recap – Environmental Research	Cavalier B	Environmental	Hoyt Battey	U.S. DOE
9:15 AM	Effects of EMF Emissions from Cables and Junction Boxes on Marine Species	Cavalier B	Environmental	Manhar Dhanak	Florida Atlantic University
9:40 AM	Assessment of Potential Impact of Electromagnetic Fields from Undersea Cable on Migratory Fish Behavior PR-146	Cavalier B	Environmental	Ximena Vergara	Electric Power Research Institute, Inc.
10:05 AM	Marine Mammal Behavioral Response to Marine Energy Converter Sound	Cavalier B	Environmental	Brian Polagye	University of Washington
10:30 AM	Annex IV and Tethys: International Environmental Data Sharing Initiative	Cavalier B	Environmental	Andrea Copping	PNNL
10:55 AM	BREAK	Foyer			
11:05 AM	Marine and Hydrokinetic Energy Regulator Trainings	Cavalier B	Environmental	Ian Baring Gould	NREL
11:30 AM	Overview of Environmental Monitoring Instrumentation Research	Cavalier B	Environmental	Samantha Eaves	U.S. DOE
11:40 AM	Automatic Optical Detection and Classification of Marine Animals around Marine and Hydrokinetic Energy Converters using Machine Vision	Cavalier B	Environmental	Steven Brunton	University of Washington
12:05 PM	Nekton Interaction Monitoring System	Cavalier B	Environmental	Kenneth Ham	PNNL

12:30 PM	LUNCH KEYNOTE	Commonwealth Ballroom		Guest Speaker	
1:30 PM	Unobtrusive Multi-static Serial LiDAR Imager (UMSLI) for Wide-area Surveillance and Identification of Marine Life at Marine and Hydrokinetic Energy Installations	Cavalier B	Environmental	Gabriel Alsenas	Florida Atlantic University Board of Trustees
1:50 PM	An Intelligent Adaptable Monitoring Package for Marine Renewable Energy	Cavalier B	Environmental	Brian Polagye	University of Washington
2:15 PM	Triton Initiative	Cavalier B	Environmental	Genevra Harker-Klimes	PNNL
2:40 PM	FY16 FOA Awards: Innovation, Testing and Validation of Marine and Hydrokinetic Energy Environmental Monitoring Instrumentation	Cavalier B	Environmental	Samantha Eaves	U.S. DOE
3:05 PM	Overview of Market and Industry Development, Analysis, and Data Dissemination	Cavalier B	Market, and Industry Development, Analysis, and Data Dissemination	Alison LaBonte	U.S. DOE
3:15 PM	Marine and Hydrokinetic Energy Manufacturing and Supply Chain Needs Assessment	Cavalier B	Market, and Industry Development, Analysis, and Data Dissemination	Jason Cotrell	NREL
3:40 PM	Marine and Hydrokinetic Energy Risk Management Framework	Cavalier B	Market, and Industry Development, Analysis, and Data Dissemination	Jochem Weber	NREL
4:05 PM	BREAK	Foyer			
4:20 PM	Marine and Hydrokinetic Energy Levelized Cost of Energy (LCOE) Analysis	Cavalier B	Market, and Industry Development, Analysis, and Data Dissemination	Scott Jenne	NREL
4:45 PM	Marine and Hydrokinetic Energy Data Repository and Instrumentation Database	Cavalier B	Market, and Industry Development, Analysis, and Data Dissemination	Rick Driscoll	NREL
5:10 PM	Closing Thoughts	Cavalier B		Hoyt Battey	U.S. DOE

MARINE AND HYDROKINETIC ENERGY 2A: ENVIRONMENTAL RESEARCH, RESOURCE CHARACTERIZATION, AND ANALYSIS

WATER AGENDA - BY TRACK

Tuesday, February 14

Start Time	Presentation Title	Room	Session	Presenter	Presenter Org
8:00 AM	Joint Breakfast with Wind and Water Attendees	Commonwealth Ballroom			
8:45 AM	Facilitator Welcome	Commonwealth		Alex Lemke	U.S. DOE
9:00 AM	Wind Director Welcome	Commonwealth		Jose Zayas	U.S. DOE
9:25 AM	Water Director Welcome	Commonwealth		Alejandro Moreno	U.S. DOE
9:55 AM	Program Lead Presentation	Stars		Alison LaBonte	U.S. DOE
10:10 AM	Chairperson Welcome and Intro to Panel	Stars		Cameron Fisher	Chair / 48 North Solutions
10:30 AM	Overview of Controls Technology	Stars	Components	William McShane	U.S. DOE
10:40 AM	Passive Control for WECs (NASA CDOF)	Stars	Components	Vincent Neary	SNL
11:05 AM	Optimal Control of a Surge-Mode WEC in Random Waves	Stars	Components	William Staby	Resolute Marine Energy, Inc.
11:30 AM	Advanced Controls for the Multi-Pod Centipod WEC device	Stars	Components	Allan McCall	Dehlsen Associates, LLC
11:55 AM	Controls Optimization of Three Different WEC Devices	Stars	Components	Mirko Previsic	ReVision Consulting, LLC
12:30 PM	LUNCH KEYNOTE	Commonwealth Ballroom		Guest Speaker	
1:30 PM	Advanced Energy Harvesting Control Schemes for Marine Renewable Energy Devices	Stars	Components	Jarlath McEntee	Ocean Renewable Power Company, LLC
1:55 PM	Advanced WEC Controls	Stars	Components	Ryan Coe	SNL

2:20 PM	Assimilation of Wave Imaging Radar Observations for Real-Time Wave-by-Wave Forecasting	Stars	Components	Merrick Haller	Oregon State University
2:45 PM	Overview of Systems	Stars	Systems	Alison LaBonte	U.S. DOE
2:55 PM	Wave Energy Converter Modeling	Stars	Systems	Yi-Hsiang Yu	NREL
3:20 PM	DTOcean (Optimal Design Tools for Ocean Energy)	Stars	Systems	Jesse Roberts	SNL
3:45 PM	BREAK	Foyer			
4:00 PM	Marine and Hydrokinetic Energy Industry Support	Stars	Systems	Al LiVecchi	NREL
4:25 PM	Marine and Hydrokinetic Energy Advanced Materials Program	Stars	Systems	Bernadette Hernandez-Sanchez	SNL
4:50 PM	Administration of the Wave Energy Converter (WEC) Prize	Stars	Systems	Wesley Scharmen	Ricardo, Inc.
5:15 PM	Wave Energy Prize: Testing and Data Analysis	Stars	Systems	Rick Driscoll	NREL
5:30 PM	POSTER SESSION	Foyer			

MARINE AND HYDROKINETIC ENERGY 2B: TECHNOLOGY RESEARCH AND DEVELOPMENT

WATER AGENDA - BY TRACK

Wednesday, February 15

Start Time	Presentation Title	Room	Session	Presenter	Presenter Org
8:00 AM	Joint Breakfast with Wind and Water Attendees	Commonwealth Ballroom			
8:45 AM	Daily Recap	Commonwealth Ballroom		Alex Lemke	U.S. DOE
9:05 AM	Overview of Components	Stars	Components	Alison LaBonte	U.S. DOE
9:15 AM	Direct Drive Wave Energy Buoy	Stars	Components	Ken Rhinefrank	Columbia Power Technologies, Inc.
9:40 AM	Wave Energy Converter Structural Optimization Through Engineering and Experimental Analysis	Stars	Components	Ken Rhinefrank	Columbia Power Technologies
10:00 AM	Optimization of Hull Shape and Structural Design for OE Buoy	Stars	Components	Mirko Previsic	Ocean Energy USA LLC
10:25 AM	Net Shape Fabricated Low Cost Marine and Hydrokinetic Energy Pass-Through-The-Hub Turbine Blades with Integrated Health Management Technology	Stars	Components	Kevin Koudela	The Applied Research Laboratory (ARL) - The Pennsylvania State University
10:50 AM	BREAK	Foyer			
11:00 AM	Build and Test of a Novel, Commercial-Scale Wave Energy Direct-Drive Rotary Power Take-off Under Realistic Open-Ocean Conditions	Stars	Components	Ken Rhinefrank	Columbia Power Technologies, Inc.
11:25 AM	Advanced Direct-Drive Generator for Improved Availability of Oscillating Wave Surge Converter Power Generation Systems	Stars	Components	V.R. Ramanan	ABB, Inc.
11:50 AM	HydroAir Power Take Off System	Stars	Components	George Laird	Dresser-Rand, A Siemens Business
12:10 PM	Power Take-off System for Marine Renewable Devices	Stars	Components	Jarlath McEntee	Ocean Renewable Power Company, LLC

12:30 PM	LUNCH KEYNOTE	Commonwealth Ballroom		Guest Speaker	
1:30 PM	Advanced Technology Integration and Demonstration (FY16 FOA 1418 Topic Area 1 Awards Overview)	Stars	Components	Alison LaBonte	U.S. DOE
1:50 PM	Efficient and Reliable Power Take-Off for Ocean Wave Energy Harvesting	Stars	Components	Lei Zuo	Virginia Polytechnic Institute and State University
2:15 PM	System Agnostic Switched Reluctance Linear Generator for WECs	Stars	Components	Alan McCall	Dehlsen Associates, LLC
2:40 PM	BREAK	Foyer			
2:55 PM	Overview of Survivability	Stars	Survivability	William McShane	U.S. DOE
3:05 PM	Improved Survivability and Lower Cost in Submerged Wave Energy Device	Stars	Survivability	Mike Morrow	M3 Wave LLC
3:30 PM	Numerical Modeling and Experimental Validation of Extreme Conditions Response for the Centipod WEC	Stars	Survivability	Alan McCall	Dehlsen Associates, LLC
3:55 PM	Survivability Enhancement of a Multi-Mode Point Absorber	Stars	Survivability	Tim Mundon	Oscilla Power, Inc.
4:20 PM	BREAK	Foyer			
4:35 PM	Recap - System Innovation Session	Stars	Systems	William McShane	U.S. DOE
4:45 PM	Structured Innovation	Stars	Systems	Jochem Weber	NREL
5:10 PM	Closing Thoughts - Program Manager	Stars		Alison LaBonte	U.S. DOE

MARINE AND HYDROKINETIC ENERGY 2B: TECHNOLOGY RESEARCH AND DEVELOPMENT

WATER AGENDA - BY TRACK

Thursday, February 16

Start Time	Presentation Title	Room	Session	Presenter	Presenter Org
8:00 AM	Joint Breakfast with Wind and Water Attendees	Commonwealth Ballroom			
8:45 AM	Daily Recap	Commonwealth Ballroom		Alex Lemke	U.S. DOE
9:05 AM	Program Manager Track Intro and Overview of Demonstrations	Stars	Demo	Alison LaBonte Tim Ramsey	U.S. DOE
9:30 AM	Wave Energy Test - New Zealand Multi-Mode Technology Demonstration at the US Navy's Wave Energy Test Site	Stars	Demo	Steven Kopf	Northwest Energy Innovations
9:55 AM	Azura™ Demonstration at the Navy's Wave Energy Test Site	Stars	Demo	Steven Kopf	Northwest Energy Innovations
10:20 AM	Demonstration of the Ocean Energy (OE) Buoy at US Navy's Wave Energy Test Site	Stars	Demo	Tony Lewis	Ocean Energy USA LLC
10:45 AM	BREAK	Foyer			
10:55 AM	Current Energy Harnessing Using Synergistic Kinematics of Schools of Fish-Shaped Bodies	Stars	Demo	Michael Bernitsas	Vortex Hydro Energy, LLC
11:20 AM	Reduction of System Cost Characteristics Through Innovative Solutions to Installation, Operations, and Maintenance	Stars	Demo	Ken Rhinefrank	Columbia Power Technologies
11:45 AM	Next Generation Marine and Hydrokinetic Energy River Power System, Optimized for Performance, Durability and Survivability	Stars	Demo	AlexAnna Salmon	Igiugig Village Council
12:10 PM	Integrated Development and Comprehensive IO&M Testing at RITE of a KHPS TriFrame Mount	Stars	Demo	Dean Corren	Verdant Power Inc.

12:30 PM	LUNCH KEYNOTE	Commonwealth Ballroom		Guest Speaker	
1:30 PM	Overview of Infrastructure	Stars	Infrastructure	Steven DeWitt	U.S. DOE
1:40 PM	Standards Development, IEC TC 114, IEA-OES Annual Contribution	Stars	Sensors and Measurement	Walt Musial	NREL
2:05 PM	Tidal Device Field Measurement Campaign (FMC)	Stars	Sensors and Measurement	Vincent Neary	SNL
2:30 PM	Modular Ocean Instrumentation System (MOIS)	Stars	Sensors and Measurement	Eric Nelson	NREL
3:00 PM	Pacific-Marine Energy Center South Energy Test Site (PMEC-SETS)	Stars	Infrastructure	Belinda Batten	Oregon State University
3:25 PM	California Wave Energy Test Center (CalWave)	Stars	Infrastructure	Sam Blakeslee	Cal Poly Corporation
3:50 PM	Advanced Laboratory and Field Arrays (ALFA)	Stars	Infrastructure	Belinda Batten	Oregon State University
4:20 PM	BREAK	Foyer			
5:00 PM	Closing Thoughts-Chair	Stars		Cameron Fisher	Chair / 48 North Solutions
5:15 PM	Closing Thoughts-Director	Stars		Alejandro Moreno	U.S. DOE

MARINE AND HYDROKINETIC ENERGY 2C: DEMONSTRATIONS AND INFRASTRUCTURE

U.S. DEPARTMENT OF
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For more information, visit:
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