U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

WIND AND WATER POWER TECHNOLOGIES OFFICE

2014 Water Power Peer Review Report

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Wind and Water Power Technologies Office

August 2014
Arlington, VA

Hydropower cover photo is courtesy of the National Renewable Energy Laboratory (David Hicks). McNary Dam hydroelectric plant generating 980 megawatts of clean energy.
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Hydropower Panel Chair
2014 Water Power Peer Review Panel

Cameron Fisher
Marine and Hydrokinetic Panel Chair
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Prologue

Dear Colleague:

On behalf of the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy, Wind and Water Power Technologies Office, I am pleased to announce the release of the 2014 Water Power Peer Review Report. The Water Power Peer Review Meeting was held February 24-28, 2014 in Arlington, VA. Principle investigators from the national labs and academic and industry representatives presented the progress of their DOE-funded research. This report documents the formal, rigorous evaluation process and findings of nine distinguished, independent reviewers who examined the technical, scientific, and business results of 96 projects of the Water Power Program, as well as the productivity and management effectiveness of the Water Power Program itself.

The Program is extremely grateful to the reviewers for undertaking a thorough examination of the Program, and their comments and recommendations were candid and constructive. Included in the report are Program responses to the Reviewers’ comments that indicate our careful consideration of their input and that describes actions already underway to address issues of concern.

The Water Power Program is committed to developing and deploying a portfolio of innovative technologies for clean, domestic power generation from resources such as hydropower, waves, and tides. The Water Power Program's vision is to support 15% of our nation's electricity needs from water power by 2030.Consistent with the Under Secretary of Energy’s direction, regular peer reviews are held to ensure the program is investing taxpayer dollars in the most effective and efficient manner in order to realize the primary mission of the Program.

Sincerely,

Jose Zayas
Program Director
Wind and Water Power Technologies Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Executive Summary

Meeting Logistics

On February 24 – 28, 2014, the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Wind and Water Power Technologies Office (herein referred to as the "Water Power Program" or the "program") conducted its Water Power Peer Review at the DoubleTree Crystal City Hotel in Arlington, VA. The purpose of the review was to evaluate DOE-funded projects for their contribution to the mission and goals of the program, to assess progress made against stated objectives, and to assess the program's overall management and performance. Principal Investigators (PIs) working on existing and new Marine and Hydrokinetic (MHK) and Hydropower projects came together to disseminate information, progress, and results to panels of independent subject matter experts (also referred to as reviewers) as well as attendees. The Hydropower Panel consisted of six subject matter experts and was chaired by Greg Lewis. The MHK Panel consisted of five subject matter experts and was chaired by Cameron Fisher.

The Marine and Hydrokinetic program area included projects from the following research areas:

- Computational Modeling and Analysis;
- Technology Advancement;
- Market Acceleration and Deployment;
- National Marine Renewable Energy Centers;
- Testing Infrastructure and Instrumentation; and
- Resource Characterization.

The Hydropower program area included projects from the following research areas:

- Existing Hydropower;
- New Hydropower Development;
- Pumped-Storage Hydropower and Integration; and
- Market Acceleration and Deployment.

Evaluation Methodology

Program Evaluations

As part of the 2014 Water Power Peer Review process, reviewers were asked to perform a quantitative and qualitative analysis of the MHK and Hydropower Programs based on the four aspects listed below:

1. Program Objectives;
2. Research and Development (R&D) Portfolio;
3. Management and Operations; and
4. Communications and Outreach.

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 corresponds to a "Fair" rating, 3 corresponds to an "Average" rating, 4 corresponds to a "Good" rating, and 5 corresponds to an "Outstanding" rating).

Existing Project Evaluations

Projects that were awarded or funded in FY2012 or earlier were referred to as "existing" for the purposes of the 2014 Water Power Peer Review. Each of the "existing" Hydropower and MHK projects received two cumulative scores. The first score reflected the project's relevance to industry needs and overall DOE objectives. The second score is comprised of the weighted average of the following metrics: 1) methods/approach, 2) technical accomplishments and progress, 3) project management, 4) research integration, collaboration, and technology transfer, and 5) proposed future research (if applicable).

For “existing” project evaluations, 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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating).

Refer to Section 1.4 Evaluation Criteria for additional details including a description of the previously mentioned evaluation metrics and their weightings.

New Project Evaluations

Projects that were recently awarded or funded in FY 2013 were referred to as “new” for the purposes of the 2014 Water Power Peer Review. Each of the “new” Hydropower and MHK projects received two cumulative scores. The first score reflected the project’s relevance to industry needs and overall DOE objectives and the second score was based on the evaluation of the technical approach of the project.

For “new” project evaluations, 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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating).

Refer to Section 1.4 Evaluation Criteria for additional details.

Scoring Analysis Methodology

The formula listed below was used to calculate the overall weighted average scores of the existing projects for Hydropower and MHK in order to provide a means for comparing a project’s final overall score equivalently to other projects:

$$\begin{aligned} &Weighted\ Average\ Overall\ Score \\ &= \left[\left(\frac{\sum_1^n Score\ 1}{n}\right) \times (0.3)\right] + \left[\left(\frac{\sum_1^n Score\ 2}{n}\right) \times (0.3)\right] + \left[\left(\frac{\sum_1^n Score\ 3}{n}\right) \times (0.2)\right] \\ &+ \left[\left(\frac{\sum_1^n Score\ 4}{n}\right) \times (0.1)\right] + \left[\left(\frac{\sum_1^n Score\ 5}{n}\right) \times (0.1)\right] \end{aligned}$$

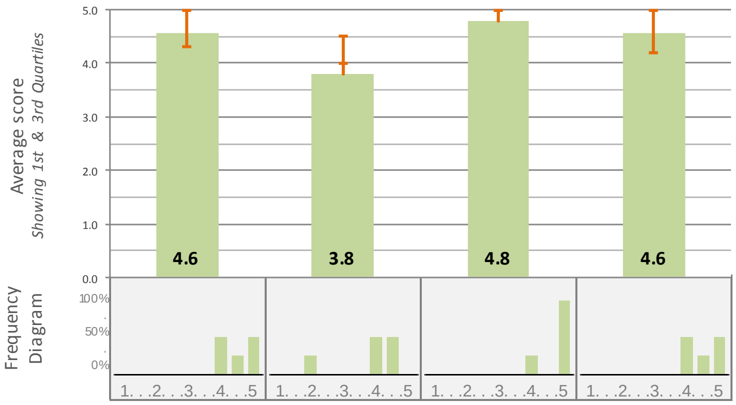
Equation 1: n equals the number of reviewers per scoring metric

New projects were evaluated on two stand-alone metrics: 1) Relevance to Industry Needs and overall DOE Objectives and 2) Technical Approach. The weighted average overall score for new projects is the Technical Approach score.

Summary of Scoring Results for MHK

The figure below summarizes the MHK panelists' quantitative evaluation of the performance of MHK program. Detailed qualitative feedback on the MHK Program can be found in Section 8.0 of this report.

Marine and Hydrokinetic				
ReviewerID	**Program Objective**	**R&D Portfolio**	**Management & Operations**	**Communications & Outreach**
Reviewer07	4.5	4.5	5.0	4.6
Reviewer08	5.0	2.0	4.0	5.0
Reviewer09	4.0	4.0	5.0	5.0
Reviewer10	5.0	4.0	5.0	4.0
Reviewer11	4.3	4.5	5.0	4.2
avg	**4.6**	**3.8**	**4.8**	**4.6**



MHK Program evaluation scoring results

The table below provides an overview of the reviewer scoring for all new and existing MHK projects that were reviewed in 2014. Projects that were awarded or funded in FY2012 or earlier are referred to in the "Funding Status" column as "Existing," and projects that were recently awarded or funded in FY 2013 are referred to as "New." The first two rows show the results of all MHK projects broken out by "Funding Status" and the subsequent rows of the table provide an overview of the technology area scores. The table includes the number of projects, the average number of reviewers to evaluate those projects, the average relevance score, and the weighted average scores of all of the projects combined (average, minimum, and maximum) per technology area.

Summary scoring of MHK technology areas

Technology Area	Funding Status	Number of Projects Reviewed	Average Number of Reviewers Per Project	Average Relevance Score	Average Weighted Average Score	Minimum Weighted Average Score	Maximum Weighted Average Score
Marine and Hydrokinetic	**New**	**14**	**4.9**	**4.0**	**3.7**	**2.6**	**4.7**
	Existing	**38**	**4.6**	**4.2**	**3.8**	**2.7**	**4.8**
Computational Modeling and Analysis	New	4	5.0	3.4	2.9	2.6	3.1
	Existing	6	5.0	3.5	3.1	2.7	3.3
Technology Advancement	New	4	4.8	4.0	3.9	3.3	4.6
	Existing	15	4.5	4.3	3.7	3.0	4.8
Market Acceleration and Deployment	New	2	5.0	4.9	4.6	4.4	4.7
	Existing	10	4.4	4.5	4.1	2.9	4.8
National Marine Renewable Energy Centers	New	-	-	-	-	-	-
	Existing	3	3.7	4.8	4.5	4.2	4.8

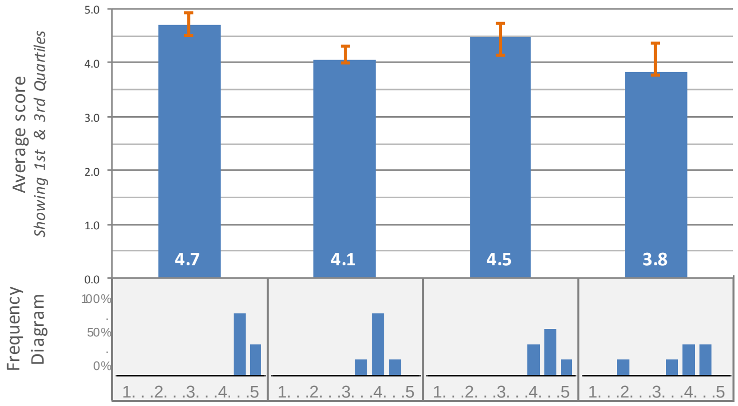
Technology Area	Funding Status	Number of Projects Reviewed	Average Number of Reviewers Per Project	Average Relevance Score	Average Weighted Average Score	Minimum Weighted Average Score	Maximum Weighted Average Score
Testing Infrastructure and Instrumentation	New	2	5.0	3.7	3.6	3.1	4.1
	Existing	3	4.7	3.6	3.7	3.0	4.4
Resource Characterization	New	2	5.0	4.4	4.2	4.1	4.2
	Existing	1	5.0	3.9	3.8	3.8	3.8

A comprehensive list of reviewer comments and individual MHK project scoring evaluations can be found in Section 6.0 of this report.

Summary of Scoring Results for Hydropower

The figure below summarizes the Hydropower panelists' quantitative evaluation of the performance of Hydropower program. Detailed qualitative feedback on the Hydropower Program can be found in Section 8.0 of this report.

	Hydropower			
ReviewerID	Program Objective	R&D Portfolio	Management & Operations	Communications & Outreach
Reviewer01	4.5	4.0	5.0	4.5
Reviewer02	4.5	3.5	4.0	4.0
Reviewer03	4.7	4.4	4.8	4.7
Reviewer04	4.5	4.0	4.5	3.7
Reviewer05	5.0	4.0	4.0	4.0
Reviewer06	5.0	4.5	4.5	2.0
avg	**4.7**	**4.1**	**4.5**	**3.8**



Hydropower Program evaluation scoring results

The table below provides an overview of the reviewer scoring for all new and existing Hydropower projects that were reviewed in 2014. Projects that were awarded or funded in FY2012 or earlier are referred to in the "Funding Status" column as "Existing," and projects that were recently awarded or funded in FY 2013 are referred to as "New." The first two rows show the results of all Hydropower projects broken out by "Funding Status" and the subsequent rows of the table provide an overview of the technology area scores. The table includes the number of projects, the average number of reviewers to evaluate those projects, the average relevance score, and the weighted average scores of all of the projects combined (average, minimum, and maximum) per technology area.

Summary scoring of Hydropower technology areas

Technology Area	Funding Status	Number of Projects Reviewed	Average Number of Reviewers Per Project	Average Relevance Score	Average Weighted Average Score	Minimum Weighted Average Score	Maximum Weighted Average Score
Hydropower	**New**	**11**	**5.5**	**4.3**	**3.9**	**3.4**	**4.4**
	Existing	**33**	**5.5**	**4.0**	**3.6**	**2.1**	**4.5**
Existing Hydropower	New	3	6.0	4.4	4.1	4.0	4.4
	Existing	13	5.8	4.1	3.8	3.0	4.2
New Hydropower Development	New	2	5.5	4.0	3.5	3.4	3.6
	Existing	11	5.2	3.6	3.1	2.1	3.9
Pumped-Storage Hydropower and Integration	New	2	5.0	4.4	3.9	3.9	4.0
	Existing	3	5.0	4.5	3.8	3.4	4.0
Market Acceleration and Deployment	New	4	5.5	4.3	4.0	3.8	4.2
	Existing	6	5.7	4.2	4.0	3.6	4.5

A comprehensive list of reviewer comments and individual Hydropower project scoring evaluations can be found in Section 7.0 of this report.

Progress Noted by the Peer Review Panelists

The MHK and Hydropower Peer Review Panelists believe the Water Power Program has made notable progress in the following areas:

- DOE’s Water Power Program leadership, personnel, and support team performance and achievements are excellent. The approach, breadth, and growth of the program are fantastic. Leadership and staff are top notch.
- DOE is helping developers continue to move forward in a very difficult U.S. market caused by the lack of clear national energy policy, low energy costs due to natural gas pricing, and a very difficult regulatory environment.
- Steps that are being undertaken to transition from project "grants" to co-managed projects are excellent strategic actions to better align the program’s funding activities in meeting set goals.
- The program is built on a solid foundation of cooperation between DOE, industrial partners, national laboratories, and academia. While not perfect, this foundation provides the best path for the U.S. to succeed in the international marketplace.

Potential Issues Identified by the Peer Review Panelists

The MHK and Hydropower Peer Review Panelists identified the following issues that they feel are worthy of discussion or consideration by the Water Power Program:

- DOE's traditional focus on research may distract program efforts meant to inform and influence energy policy.
- The overall program alignment is good but there are still some gaps, especially with regards to licensing uncertainty and time required.
- Regulatory issues delayed many DOE co-funded projects causing cash-flow issues for the DOE program.
- The program needs to review Federal and State regulatory processes to identify research required to streamline permitting processes.

- A trend toward heavy reliance on national labs to originate projects may lead to blind spots in the practical hydropower industry and in applied research since it is atypical to see lab principal investigators in the field.

Specific Recommendations of the Peer Review Panelists

The MHK Peer Review Panelists believe that addressing the comments and recommendations below could add significant value and help the program achieve future successes:

- Rebalance the portfolio to prioritize advancement of leading technology to the full commercialization stage and addressing the barriers to full deployment. National Lab reference model, open-source software development, and hydrographic research projects with little near-term value should be low priority.
- Finish the mission on the nearest-to-market technology and secure successful deployment of that technology within the U.S. and globally. This will generate valuable cost reduction lessons for wave technologies on manufacturing, operations and maintenance, and supply chain development.
- Reconsider funding emphasis for wave technology development and instead offer parity funding to tidal and wave power technology.
- Maintain an emphasis on in-water demonstrations by industrial partners (including small ones), i.e. "fund industry, not technologies."
- Opening test centers and getting first projects in the water are very important.
- Utilize lab resources and contractors more effectively. Ensure lab projects consult with industry on study protocols and integrate industry feedback on deliverables. Ensure more streamlined process for lab-company intellectual property agreements.
- Build off of existing or ongoing research done by the Oil and Gas Industry or the Navy and reach out to the global communities and review what the Europeans have done.
- Develop consistent funding lines to support commercialization of specific, promising technology by developers, disbursed only upon achievement of performance metrics, and where feasible, matching funds.
- Carefully evaluate projects related solely to infrastructure development, particularly the fourth Test Site, to assure that they do not take resources from in-water demonstrations (exceptions include those efforts that are intended to enhance U.S. competitiveness in the global MHK community).

The Hydropower Peer Review Panelists believe that addressing the comments and recommendations below could add significant value and help the program achieve future successes:

- Address the following issues that are holding Hydropower back:
    - High cost, long duration, and a lack of schedule certainty in licensing and permitting processes;
    - Deficient market design and inadequate market valuation of hydropower/pumped storage attributes that are key to integrate variable renewables and provide grid reliability; and
    - Failure to monetize the ancillary benefits of hydropower to the public when compared to other competing technologies being built to integrate renewables.
- Accelerate and improve schedule certainty of licensing process by informing policy makers with findings and recommendations and by developing computerized processes that can improve the quality as well as reduce the time for agency (e.g., EPA, States, F&WS) reviews and informing policy makers with findings and recommendations.
- Establish and own a robust and neutral Low Impact Hydro Certification Program.
- Assess current methods and viability of getting fish upstream and downstream of physical barriers.
- Establish an outreach and stakeholder involvement to environmental community on expansion announcements to mitigate potential categorical future push back.
- Provide guidance on removing market barriers and promoting efficient market design.

- Consider a role for DOE as an arbitrator of environmental considerations and public good.
- Expand the ongoing climate change study to also address non-federal hydro.

Summary of Water Power Program Response to Reviewer Feedback

The Water Power Program Peer Review Panel feedback provides an excellent opportunity for the Water Power Program to identify opportunities for improvement as well as areas of strength in its current portfolio of water power projects.

In particular, certain key themes emerged from the reviewer feedback. Based on these themes, the Water Power Program has identified the following areas for improvement that will help improve the direction and impact of the Program into the future.

In the area of MHK technology, the Water Power Program intends to: increase the emphasis of technology transfer; more clearly define the role for the national labs; and increase engagement with the international community. In the area of MHK market acceleration, the Program intends to: increase international engagement; expand the role for cross-agency work; and broaden the scope of market acceleration projects.

In the area of Hydropower technology, the Program intends to: increase communication regarding ancillary benefits and environmental impacts of hydropower; emphasize the importance of siting and permitting of hydropower projects; conduct more proactive outreach to key hydropower stakeholders; and increase the use of partnerships with industry. In the area of market acceleration, the Program will emphasize increased communication and dissemination of R&D results as well as more clearly communicate the impacts of hydropower on water quality.

1.0 Introduction

Objective review and advice from peers—"peer review"—provides Department of Energy (DOE) managers, staff, and researchers with a powerful and effective tool for enhancing the management, relevance, effectiveness, and productivity of all Office of Energy Efficiency and Renewable Energy (EERE) research, development, demonstration, deployment, and supporting business management programs. The 2004 EERE Peer Review Guide[1] defines a peer review as:

> *A rigorous, formal, and documented evaluation process using objective criteria and qualified and independent reviewers to make a judgment of the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects.*

This definition is drawn from definitions used by the U. S. Department of Energy, National Academy of Sciences (NAS), the White House Office of Management and Budget (OMB), the U.S. General Accounting Office (GAO), and other federal agencies and institutions. It clearly distinguishes in-progress peer review from other types of peer review, such as merit review to select winners of competitive solicitations or readiness (stage gate) reviews to determine when a technology is ready to move to the next phase of development, as well as from other management activities such as quarterly milestone reviews or budget reviews.

On February 24 – 28, 2014, the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Wind and Water Power Technologies Office (herein referred to as the "Water Power Program" or the "program") conducted its Water Power Peer Review at the DoubleTree Crystal City Hotel in Arlington, VA. In accordance with the EERE Peer Review Guide, the review provides an independent, expert evaluation of the strategic goals and direction of the program and is a forum for feedback and recommendations on future program planning. The purpose of the review was to evaluate DOE-funded projects for their contribution to the mission and goals of the program, to assess progress made against stated objectives, and to assess the program's overall management and performance.

The following document represents the observations and findings of the Water Power Peer Review Panelists, the response from the Water Power Program to these findings, and the supporting meeting materials, including an agenda and list of participants. In accordance with the DOE Peer Review Guide Section 6.0[2], peer reviewers provided both quantitative and narrative evaluations of the materials and projects presented at the Peer Review. The comments herein are the most direct reflection of reviewers' written evaluations, and where possible have been included verbatim.

Ninety six (96) projects, representing a total DOE value of approximately $190 million were reviewed by 11 external expert reviewers from industry, academia, other government agencies, and the private sector. Each project was reviewed by a minimum of three expert reviewers who provided both numeric evaluations and written comments. As part of the 2014 U.S. DOE Water Power Peer Review, projects in two overall program areas, Marine and Hydrokinetic (MHK) and Hydropower, were evaluated by the eleven expert reviewers.

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[1] Peer Review Guide, Based on a Survey of Best Practices for In-Progress Peer Review, August 2004

[2] Peer Review Guide, Based on a Survey of Best Practices for In-Progress Peer Review, August 2004

The two overall program areas included projects from the following research areas:

Marine and Hydrokinetic	Hydropower
Computational Modeling and Analysis	Existing Hydropower
Technology Advancement	New Hydropower Development
Market Acceleration and Deployment	Pumped-Storage Hydropower and Integration
National Marine Renewable Energy Centers	Market Acceleration and Deployment
Testing Infrastructure and Instrumentation	
Resource Characterization	

Two chairpersons were selected to oversee the entire peer review process. Greg Lewis presided over the Hydropower panel, and Cameron Fisher presided over the Marine and Hydrokinetic (MHK) Panel. They provided oversight and guidance to ensure consistency, transparency, and independence throughout the review process.

Results of the 2014 Peer Review will be used to help inform programmatic decision making, modify or discontinue existing projects, guide the future funding and direction of newly funded projects and future opportunities, and support other budget and strategic planning objectives.

1.1 2014 Peer Review Objectives

The objectives of the 2014 Peer Review meeting were to:

- Review and evaluate the strategy and goals of the Wind and Water Power Technologies Office;
- Review and evaluate the progress and accomplishments of the Office's projects funded in FY2012 and FY2013; and
- Foster interactions among the national laboratories, industry, and academic institutions conducting research and development on behalf of the program.

A rigorous peer review was conducted as a four-and-a-half-day event. The first three-and-a half days focused on presentations given by Water Power Program staff and the principal investigators (PIs) of the 96 projects that were evaluated. On the final day, reviewers convened in a separate location to provide an initial summary of their findings to the Water Power Program staff, and to discuss their initial impressions of the reviewed projects as well as the overall function and management of the Wind and Water Power Technologies Office Water Power portfolio.

1.2 Peer Review Panelists

Peer review panels were commissioned to conduct the formal peer review aspect of the meeting. The peer review panels (hereafter called reviewers or panelists) were comprised of experts from a variety of water power-related backgrounds and organizations, including laboratories, industry, and academia. Reviewers evaluated the progress and relevance of Water Power-funded projects, as presented by the principal investigators of those projects during the meeting. The projects were evaluated according to a defined set of criteria in this document. Reviewers also provided a detailed quantitative and qualitative evaluation of the management of the Water Power Program Portfolio.

Reviewers were screened to ensure no conflicts of interest existed with regard to the specific projects for which they submitted reviews. Reviewers recused themselves if they worked on projects, had other relationships with project team members, or if they had a financial interest in the subject matter. Tables 1.2.1 and 1.2.2 list the 2014 Water Power Peer Review Panelists.

Table 1.2.1 Hydropower panelists

2014 Hydropower Panel	
Name	**Affiliation**
Greg Lewis*	Duke Energy Corporation
Ghassan AlQaser	CA Department of Water Resources
Kerry McCalman	Bureau of Reclamations
David Moller	Pacific Gas and Electric Company
Jim Ruane	Reservoir Environmental Management, Inc.
Edith Zagona	University of Colorado

**Served as the panel chair*

Table 1.2.2 Marine and Hydrokinetic panelists

2014 Marine and Hydrokinetic Panel	
Name	**Affiliation**
Cameron Fisher*	48 North Solutions
Elizabeth Butler	Butler Law Offices, LLC
James Downer	Independent Contractor
Tim Oakes	Kleinschmidt
Philip Vitale	U.S. Navy

**Served as the panel chair*

Reviewers received briefing materials via email and a Microsoft SharePoint site approximately four weeks prior to attending the meeting. This information included a 2014 Water Power Peer Review Plan (reviewer instructions), an agenda, the PowerPoint presentations submitted to the panel members by the principal investigators, two-page project summary documents, a review of the overall goals of the program, conflict of interest forms, honorarium and travel reimbursement forms, and the Microsoft Excel evaluation workbooks (electronic format) for their assigned projects and an overall programmatic review.

1.3 Project Selection Process

Below is a description of the processes used by the Wind and Water Power Technologies Office for selecting the Water Power projects that were reviewed as part of the 2014 Peer Review process:

1. **The Office evaluated all projects funded in FY 2012 and FY 2013**
    - The Office used budget data, contracts with laboratories and industry recipients, and the program’s project inventory database.

2. **The Office Director provided high-level guidance from on time allocation for Projects versus Office information, and priority projects to present**
    - Office Director gave high-level direction on the total number of hours to allocate for Project presentations.
    - Office Director also determined what subject areas were to be presented at a Program-level instead of as individual projects (for example, the 20% by 2030 projects are presented at an overview Program-level).
    - Office Director noted some priority projects (such as ARRA university consortia) as mandatory for presentation.

3. **Federal team leads/technology managers were provided with the project list and ranked those projects that they wanted to be presented at the review (1 = present; 2=optional; 3=exclude)**

- Team leads selected projects based on following criteria – magnitude of funding, relevance/importance of research, and desire for peer review feedback on project. They also factored in project stage and diversity of the program portfolio in selection.

4. **Team leads' rankings were synthesized**
   - All Priority 1 projects were added to the agenda. Priority 2 projects were added where/when possible depending on other constraints.

5. **Additional criteria further narrowed project selection**
   - 80% of the FY 2012-2013 budget needed to be presented to comply with EERE peer review guidelines. Some funding was presented at a project-level and other areas were presented at a program-level.
   - Every national lab funded in FY 2012-2013 presented at least one project at the review.
   - The allocated projects and subject matter areas accommodated a two-track session agenda.
   - The team strived for the event agenda to reflect overall Water Power Portfolio priorities and priority funding areas.

6. **Agenda details were negotiated with Principal Investigators**
   - The Office adjusted presenters and presentation time as needed for individual schedule availability.
   - As appropriate, time allocations were adjusted to accommodate more complex versus simpler projects for presenting.

1.4 Evaluation Criteria

In accordance with DOE EERE Peer Review Guide Section 6.0[3], the peer review panelists were asked to submit both quantitative (i.e., numerical scores) and qualitative (i.e., narrative accounts) evaluations as part of their review of the materials and projects presented, although not every reviewer provided narrative evaluations for every project or review category. The evaluation workbooks were distributed to the peer review panel members prior to the meeting, along with detailed guidance on how to complete the forms.

Existing Project Evaluations

Projects that were awarded or funded in FY2012 or earlier were referred to as "existing" for the purposes of the 2014 Water Power Peer Review. Each of the "existing" Hydropower and MHK projects received two cumulative scores. The first score reflected the project's relevance to industry needs and overall DOE objectives. The second score is comprised of the weighted average of the following metrics: 1) methods/approach, 2) technical accomplishments and progress, 3) project management, 4) research integration, collaboration, and technology transfer, and 5) proposed future research (if applicable).

An overall score for each "existing" Hydropower and MHK project was calculated using a consistent weighting methodology for some of the scored criteria. Below are the weightings that were applied to each criterion:

1. **Relevance to Industry Needs and Overall DOE Objectives:** the degree to which the project aligns with objectives and goals of the Water Power Program and meets the needs of the Water industry at large. (Stand Alone Metric)
2. **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%)
3. **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%)

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[3] Peer Review Guide, Based on a Survey of Best Practices for In-Progress Peer Review, August 2004

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. (Weight = 20%)
5. **Research Integration, Collaboration, and Technology Transfer:** 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%)
6. **Proposed Future Research (if applicable):** the degree to which the future research proposed is relevant, well-planned, and worthwhile of continued funding. (Weight = 10%)

In addition to the above six criteria, peer reviewers were asked to provide an overall qualitative assessment of the project in a written narrative. Reviewers were asked to comment on overall strengths and weaknesses and to include recommendations for ways to improve the projects.

For “existing” project evaluations, 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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating).

New Project Evaluations

Projects that were most recently awarded or funded in FY 2013 were referred to as “new” for the purposes of the 2014 Water Power Peer Review. Each of the “new” Hydropower and MHK projects received two cumulative scores. The first score reflected the project’s relevance to industry needs and overall DOE objectives and the second score was based on the evaluation of the technical approach of the project. Below is a more detailed description of the evaluation criterion applied to the “new” projects:

1. **Relevance to Industry Needs and overall DOE Objectives:** the degree to which the project aligns with objectives and goals of the Water Power Program and meets the needs of the Water industry at large. (Stand Alone Metric)
2. **Technical Approach:** the degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers. (Stand Alone Metric)

In addition to the above two criteria, peer reviewers were asked to provide an overall qualitative assessment of each of the “new” projects by commenting on the aspects of the project that support successful outcomes or that provides an advantage to the project, the aspects of the project that hinder successful outcomes or that disadvantages the project, and recommendations for ways to improve the projects.

For “new” project evaluations, 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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating).

Program Evaluations

As part of the 2014 Water Power Peer Review, reviewers were also asked to provide comments and numeric scores as part of an overall performance evaluation of the Water Power Program based on the four aspects listed below:

1. **Program Objectives:** how well do Program objectives align with industry needs and 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:** evaluate the quality of the Water Program'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?

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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating). Reviewers were also asked to provide qualitative feedback on program strengths, program weaknesses, and any additional recommendations.

1.5 Scoring Analysis Methodology

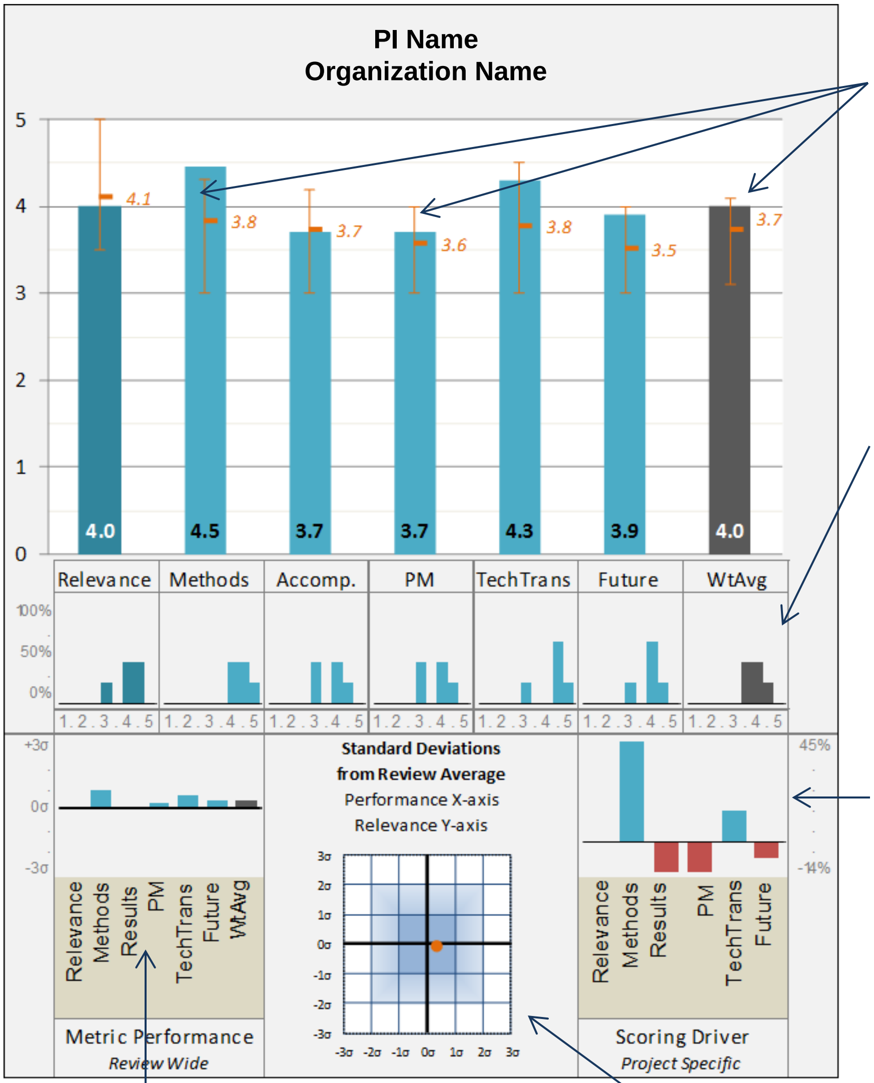
The formula listed below was used to calculate the overall weighted average scores of the existing projects for Hydropower and MHK in order to provide a means for comparing a project’s final overall score equivalently to other projects:

$$\begin{aligned} &Weighted\ Average\ Overall\ Score \\ &= \left[\left(\frac{\sum_1^n Score\ 1}{n}\right) \times (0.3)\right] + \left[\left(\frac{\sum_1^n Score\ 2}{n}\right) \times (0.3)\right] + \left[\left(\frac{\sum_1^n Score\ 3}{n}\right) \times (0.2)\right] \\ &+ \left[\left(\frac{\sum_1^n Score\ 4}{n}\right) \times (0.1)\right] + \left[\left(\frac{\sum_1^n Score\ 5}{n}\right) \times (0.1)\right] \end{aligned}$$

Equation 1: n equals the number of reviewers per scoring metric

New projects were evaluated on two stand-alone metrics: 1) Relevance to Industry Needs and overall DOE Objectives and 2) Technical Approach. The weighted average overall score for new projects is the Technical Approach score.

Figure 1.5.1 represents an example project scoring graphic. The error bars on the scoring graph show the average for the review and the first and third and quartile for each metric. The reviewer scoring histogram portion of the scoring graphic shows the distribution of reviewer scores across all evaluation metrics. The project review performance section of the scoring graphic shows how the project performed relative to other reviewed projects. The relevance versus performance section illustrates how the project performed in regards to those two evaluation metrics. Finally, the metric performance ratio section of the scoring graphic shows the ratio of relevance to performance and which performance metric(s) most contributed to the project performance (weighted average overall score).



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

Reviewer Scoring Histogram: These show score distributions of the individual reviewers for each metric. Taller bars indicate more reviewers gave a specific score, e.g. this project's "Relevance" was scored a "3" by one reviewer, a "4" by two reviewers, and a "4.5" by two reviewers. Wide distributions may indicate disparate reviewer opinions.

Metric/Performance Ratio: This bar graph shows the scoring drivers for this project. The values are based on a simple ratio of the metric score and the weighted average score. Red bars, such as "Results" and "PM" below the axis indicate metrics that were scored lower than the project's "Weighted Average Score."

Project Review Performance: This graph shows how each metric of this project performed compared to the averages for all projects. For example, this project was exactly average in the "Results" metric and about 0.5 standard deviations above the "Tech Trans" average.

Performance versus Relevance: These graphs show how this project performed compared to the review averages for "Relevance" (y-axis) and "Weighted Average Score" (x-axis). The origin is exactly average for each score and each box is one standard deviation from the average. In the above example, it is seen that this project scored slightly below average for "Relevance" and approximately 0.25 standard deviations above the mean of the "Weighted Average Score."

Figure 1.5.1 Sample project scoring graphic

For clarification, consider a hypothetical review in which only six projects were presented and reviewed in a technology area. Table 1.5.1 displays the number of reviewers per project, the average scores for each of the project's six rated criteria, and the weighted average overall score for each project. The table also includes average scoring results based on multiple populations to provide a comparative basis. The population areas are: all projects reviewed, all existing projects, all existing MHK projects, all existing Hydropower projects, all new projects, all new MHK projects, and all new Hydropower projects.

Table 1.5.1 Sample project scoring table

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing (MHK *and* Hydro) Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing Program Area (MHK *or* Hydro) Projects			4.6	4.2	3.9	3.8	3.5	3.9	3.6	**3.8**
Average for Existing Technology Area Projects			5.0	3.5	3.3	3.2	2.9	3.0	2.5	**3.1**
Project A Title	PI Name	Organization Name	5.0	3.9	3.6	3.4	3.3	2.6	2.8	**3.3**
Project B Title	PI Name	Organization Name	5.0	3.5	3.5	3.2	3.2	3.4	3.1	**3.3**
Project C Title	PI Name	Organization Name	5.0	3.5	3.2	3.4	3.1	2.8	2.7	**3.2**
Project D Title	PI Name	Organization Name	5.0	3.5	3.5	3.0	2.8	3.2	2.7	**3.1**
Project E Title	PI Name	Organization Name	5.0	3.6	3.2	3.2	2.6	2.8	1.5	**2.9**
Project F Title	PI Name	Organization Name	5.0	3.3	3.0	2.8	2.2	3.1	2.2	**2.7**

Finally, the reviewers were asked to provide qualitative comments indicating specific strengths or weaknesses of the project, along with recommendations for additions/deletions to the work scope. These comments, along with the quantitative scores, were placed into a database for easy retrieval and analysis. These comments are summarized in the following sections of this report. The qualitative analyses provided in this report are individual comments made by the reviewers, as consolidated by the U.S. DOE for brevity and merging comments with commonalities, and do not represent consensus opinion on the subject matter.

The following sections of this report provide:

- information on the Water Power Program structure and budget,
- the program's response feedback from the panelists,
- programmatic scoring results and key findings and recommendations of the panelists,
- overall summary results by program area,
- Marine and Hydrokinetic Panel results and individual project evaluations ,
- Hydropower Panel results and individual project evaluations,
- detailed qualitative program evaluations (comments) by the panelists,
- lessons learned from the 2014 Water Power Peer Review Meeting process,
- panelist feedback on the peer review process,
- a list of acronyms,
- a sample existing project evaluation form,
- a sample new project evaluation form,
- a sample program evaluation form,
- the meeting agenda, and
- the meeting attendee list.

2.0 Water Power Program Structure and Budget

The U.S. Department of Energy's (DOE) Water Power Program researches, tests, evaluates, and develops innovative technologies capable of generating renewable, environmentally responsible, and cost-effective electricity from water resources. This includes hydropower as well as marine and hydrokinetic energy (MHK) technologies. The program works with national laboratories, industry, universities, and other federal agencies to conduct research and development activities through competitively selected, cost-shared projects. Greater use of the nation's water power resources for electric power generation will help stabilize energy costs, enhance energy security, and improve our environment.

The Water Power Program conducts work in four key areas at the forefront of water power research. The program is structured to help the United States (U.S.) meet its growing energy demands sustainably and cost-effectively by developing innovative renewable water power technologies, breaking down market barriers to deployment, building the infrastructure to test new technologies, and assessing water power resources for integration into our nation's grid.

Research and Development

- Introduce and advance new MHK technologies to provide sustainable and cost-effective renewable energy from the nation's waves, tides, currents, and ocean thermal gradients.
- Research and develop innovative hydropower technologies to sustainably tap the diverse water resources of the U.S. including rivers, non-powered dams, conduits and canals.
- Demonstrate the ability of technologies like the Alden fish-friendly turbine to improve the environmental performance of hydropower.

Market Acceleration and Deployment

- Break down barriers to deployment through sound science that ensures the water power technologies that are promoted are sustainable and cost-effective.
- Develop and distribute the information developers need to obtain a permit or license to demonstrate their innovative new technologies.
- Invest in Pumped-Storage Hydropower facilities to accelerate the deployment of the world's only commercially available utility-scale energy storage technology.
- Revitalize the hydropower industry by investing in the scientists and engineers at our nation's universities that will shape the future clean energy economy

Testing and Certification

- Design and build facilities where MHK devices can be tested at scale and certified in a controlled environment before deployment.
- Develop centers of excellence and education at our nation's universities to build the expertise and infrastructure necessary to make the U.S. is a leader in water power.
  - National Marine Renewable Energy Centers currently exist at:
    - Northwest National Marine Renewable Energy Center co-located at Oregon State University and University of Washington,
    - Hawaii National Marine Renewable Energy Center at the University of Hawaii, and
    - Southeast National Marine Renewable Energy Center at Florida Atlantic University.

Resource Characterization and Grid Integration

- Assess the potential to produce energy from our nation's waves, tides, river and ocean currents, non-powered dams, and new hydropower resources.

- Investigate hydropower's potential to integrate variable renewable energy sources such as wind and solar power into the U.S. energy mix.
- Characterize hydropower's value beyond energy production by quantifying its contribution to the stability and flexibility of the nation's grid.

The DOE has allocated $58.6 million in fiscal year 2014 funds for the Water Power Program to research and develop marine and hydrokinetic (MHK) and hydropower technologies. Current activities supported by this budget include:

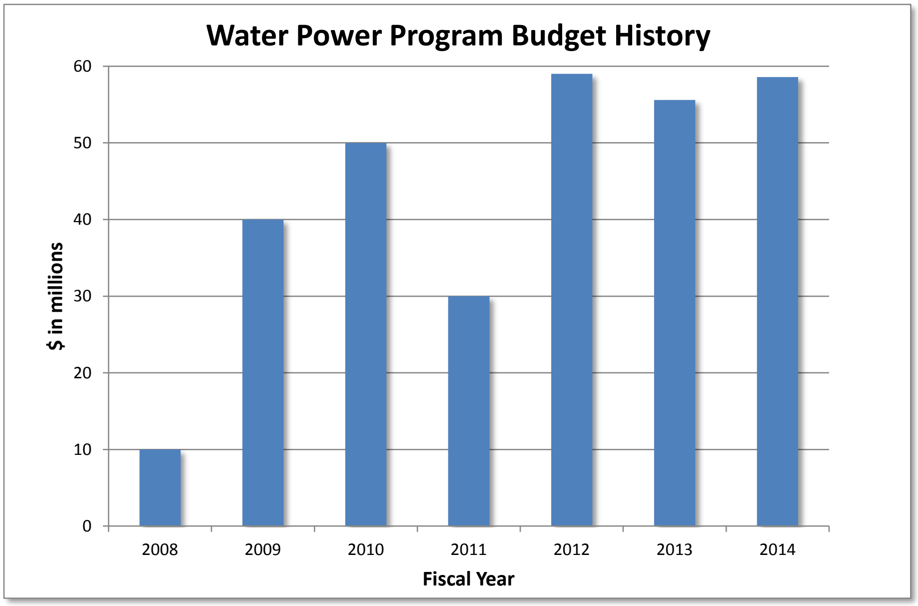


Figure 2.1 Water Power Program budget history

- **MHK Technology Systems and Components Research and Development (R&D):** R&D to develop advanced MHK systems and component technologies to increase energy capture, reliability, and survivability for lower costs.
- **Hydropower R&D:** Develop advanced hydropower technologies that drive down the cost of new hydropower project development, including standardized generating units with improved energy performance, high efficiency electrical components, and low environmental impact technologies.
- **Pumped-Storage Hydropower:** Study and develop new, smaller, pumped-storage designs that will leverage manufacturing economies of scale and open new markets by avoiding many constraints associated with larger-scale deployments.
- **Manufacturing R&D:** Develop advanced manufacturing for making hydropower technologies lightweight and modular to reduce the cost of the construction, deployment, and maintenance.

Figure 2.1 represents the budget history of the Water Power Program from FY 2008 to FY 2014 (in nominal dollars).

For the MHK projects presented at the 2014 Water Power Peer Review, projects aligned with one or more of the below objectives:

- Advancing the state of MHK technology,
- Developing key MHK testing infrastructure, instrumentation, and/or standards,
- Characterizing and increasing access to high resource sites, and/or
- Reducing deployment barriers and environmental impacts of MHK technologies.

For the Hydropower projects presented at the 2014 Water Power Peer Review, projects aligned with one or more of the below objectives:

- Advancing new hydropower systems and/or components for demonstration or deployment,
- Optimizing existing hydropower technology, flexibility, and/or operations,
- Enabling next generation pumped storage technologies to facilitate renewable integration, and/or
- Reducing deployment barriers and environmental impacts of hydropower.

Figure 2.2 illustrates the breakout of the Water Power Program technology panel budgets (DOE funding only) for Fiscal Years 2012, 2013, and 2014 for all MHK and Hydropower projects that were reviewed in 2014.

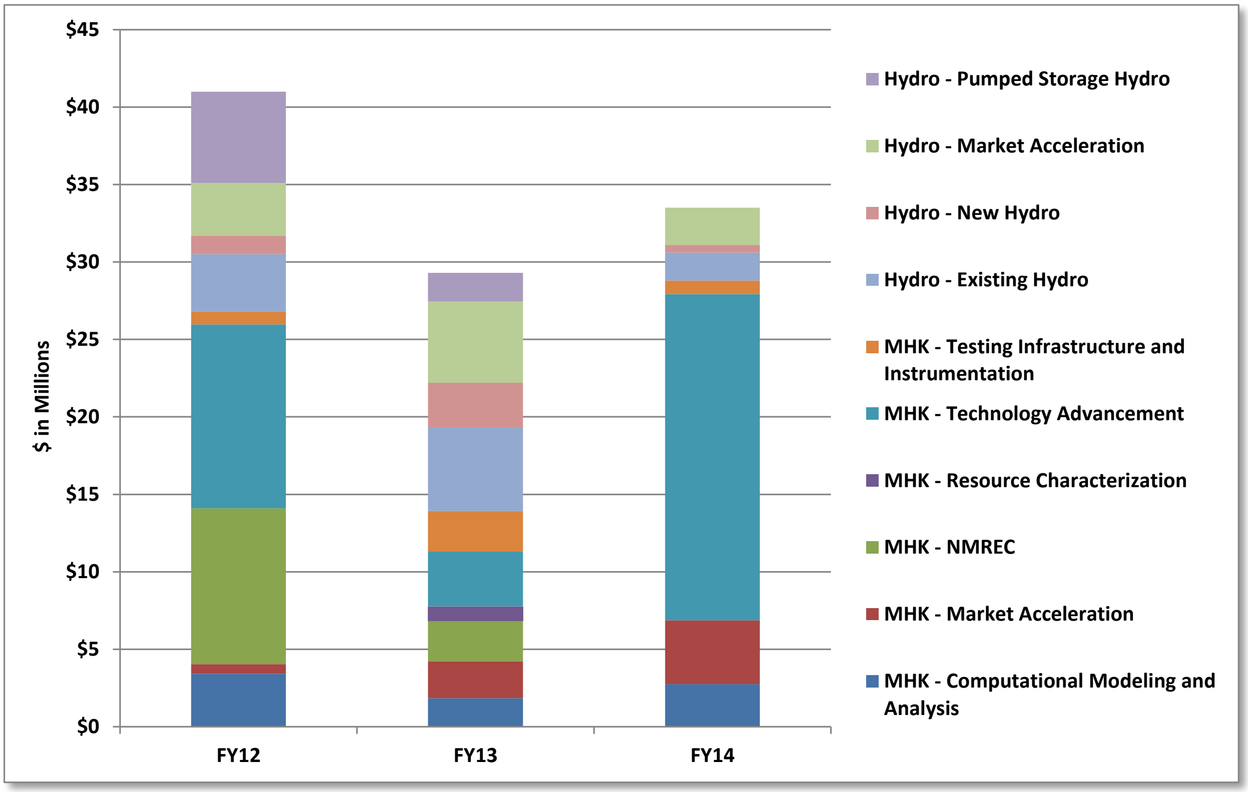


Figure 2.2 Water Power Program technology panel budgets (DOE funding) of MHK and Hydropower projects reviewed in 2014

3.0 Programmatic Scoring Results and Key Findings and Recommendations of the Panelists

As part of the 2014 Water Power Peer Review process, reviewers were also asked to perform a quantitative and qualitative analysis of the Water Power Program based on the four aspects listed below:

1. Program Objectives;
2. Research and Development (R&D) Portfolio;
3. Management and Operations; and
4. Communications and Outreach.

ReviewerID	Program Objectives	R&D Portfolio	Management & Operations	Communications & Outreach
Reviewer01	4.5	4.0	5.0	4.5
Reviewer02	4.5	3.5	4.0	4.0
Reviewer03	4.7	4.4	4.8	4.7
Reviewer04	4.5	4.0	4.5	3.7
Reviewer05	5.0	4.0	4.0	4.0
Reviewer06	5.0	4.5	4.5	2.0
Reviewer07	4.5	4.5	5.0	4.6
Reviewer08	5.0	2.0	4.0	5.0
Reviewer09	4.0	4.0	5.0	5.0
Reviewer10	5.0	4.0	5.0	4.0
Reviewer11	4.3	4.5	5.0	4.2
avg	**4.6**	**3.9**	**4.6**	**4.2**

Specifically, panel members were asked to evaluate: 1) how well Program objectives align with industry needs and Administration goals, 2) if the Water Power Program investment portfolio is appropriately balanced across research areas and recipient organizations to achieve the program's mission and goals, 3) the quality of the Water Power Program's team, management practices, and operations, and 4) the effectiveness of the Program at engaging with industry, universities, other agencies, international actors, and other stakeholders. Panel members were also asked to comment on the strengths and weakness of the program.

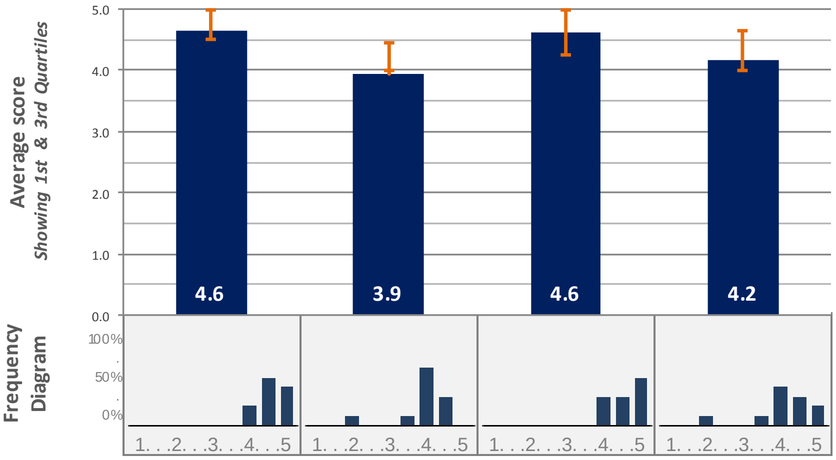


Figure 3.1 Program scoring results

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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating). Figure 3.1 summarizes the panelists’ overall quantitative evaluation of the performance of the program.

Figure 3.2 summarizes the Marine and Hydrokinetic (MHK) panelists’ quantitative evaluation of the performance of program, and figure 3.3 summarizes the Hydropower panelists’ quantitative evaluation of the performance of the program.

Marine and Hydrokinetic				
ReviewerID	**Program Objective**	**R&D Portfolio**	**Management & Operations**	**Communications & Outreach**
Reviewer07	4.5	4.5	5.0	4.6
Reviewer08	5.0	2.0	4.0	5.0
Reviewer09	4.0	4.0	5.0	5.0
Reviewer10	5.0	4.0	5.0	4.0
Reviewer11	4.3	4.5	5.0	4.2
avg	**4.6**	**3.8**	**4.8**	**4.6**

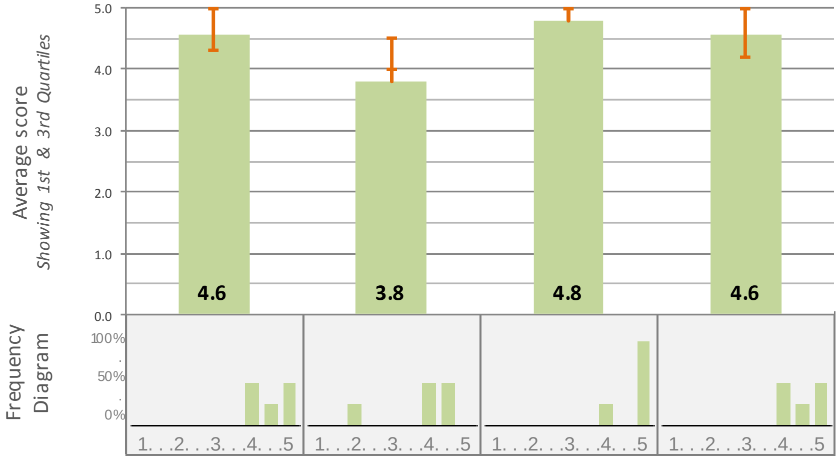


Figure 3.2 MHK Program evaluation scoring results

Hydropower				
ReviewerID	**Program Objective**	**R&D Portfolio**	**Management & Operations**	**Communications & Outreach**
Reviewer01	4.5	4.0	5.0	4.5
Reviewer02	4.5	3.5	4.0	4.0
Reviewer03	4.7	4.4	4.8	4.7
Reviewer04	4.5	4.0	4.5	3.7
Reviewer05	5.0	4.0	4.0	4.0
Reviewer06	5.0	4.5	4.5	2.0
avg	**4.7**	**4.1**	**4.5**	**3.8**

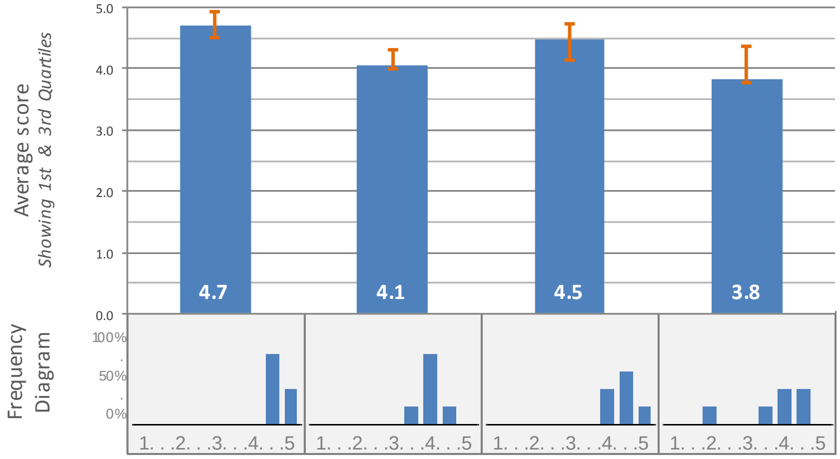


Figure 3.3 Hydropower Program evaluation scoring results

Below are the key findings, recommendations, and opportunities for improvement suggested by the Hydropower and Marine and Hydrokinetic (MHK) panelists. The comments presented below are focused on overall observations and impressions of the Water Power Program portfolio and program management aspects. All detailed reviewer comments on the program are included in Section 8.0 of the report. Additionally, all detailed reviewer comments and scoring evaluations on individual projects are included in Sections 6.0 and 7.0 of the report.

Key Findings of the Peer Review Panelists

Hydropower

Programmatic Summary

- DOE's Water Power Program leadership, personnel, and support team performance and achievements are excellent. The program has done a terrific job of showing that hydropower is a vital resource and still has a lot to offer with a key role in future energy solutions.
- Steps that are being undertaken to transition from project "grants" to co-managed projects are excellent strategic actions to better align the program's funding activities in meeting set goals.
- DOE's traditional focus on research may distract program efforts meant to inform and influence energy policy.
- Regulatory issues delayed many DOE co-funded projects causing cash-flow issues for the DOE program. DOE's Hydropower Program needs to review Federal and State regulatory processes to identify research required to streamline permitting processes.
- A trend toward heavy reliance on national labs to originate projects may lead to blind spots in the practical hydropower industry and in applied research since it is atypical to see lab principal investigators (PIs) in the field.

Portfolio Summary

- The program's current mix of existing, new, and pumped-storage projects is about right.
- The overall program alignment is good but there are still some gaps, especially with regards to licensing uncertainty and time required. The Hydropower Program could contribute significantly to improving the permitting and licensing process.
- Research that develops new algorithms for modeling hydropower operations is an important part of the research portfolio and meets industry wide applications and needs. However, research is also needed for enhanced applications of modeling to improve the permitting processes.

Marine and Hydrokinetic

Programmatic Summary

- The approach, breadth, and growth of the program are fantastic. Leadership and staff are top notch. They seem to share a passion for advancing the industry and are accomplishing quite a bit with a limited number of individuals.
- The program is built on a solid foundation of cooperation between DOE, industrial partners, national laboratories, and academia. While not perfect, this foundation provides the best path for the U.S. to succeed in the international marketplace.
- DOE is helping developers continue to move forward in a very difficult U.S. market caused by the lack of clear national energy policy, low energy costs due to natural gas pricing, and a very difficult regulatory environment.

Portfolio Summary

- DOE should rebalance the portfolio to prioritize advancement of leading technology to the full commercialization stage and addressing the barriers to full deployment. National Lab reference model, open-source software development, and hydrographic research projects with little near-term value should be low priority.
- The program has maintained a portfolio of system and component development efforts by industry that are still at the research and development (R&D) stage, allowing smaller U.S. companies to grow.
- Projects related solely to infrastructure development, particularly the fourth Test Site, should be carefully evaluated to assure that they do not take resources from in-water demonstrations (exceptions include those efforts that are intended to enhance U.S. competitiveness in the global MHK community).
- In a few specific cases, the national labs were used on projects that industry would have been better positioned to perform.

Recommendations and Suggested Opportunities for Improvement

Hydropower

Programmatic Management

- Use DOE's technical clout to inform Congress of the need for policy changes that drive hydropower forward. Make the technical case to Congress in order to set the policies to incentivize development of hydropower resources as the primary resource needed to integrate variable renewables onto the grid.
- Research that comes up with new methods for things like hydrologic forecasting and environmental health of rivers may not be well aligned with DOE’s energy-focused objectives.
- Downscaling for climate change is a large and duplicative effort. DOE could spend the resources leveraging existing datasets and on modeling the specifics of systems that focus on the hydropower resources.
- Although good forecasts help optimize hydropower value, there are many other agencies already working in this area and many methods that are widely used and accepted.
- Software should be developed based on ultimate user needs. It is more likely that software developed under research grants will be "research" software, usable mainly by research projects and not so much by industry.

Address the issues that are holding Hydropower back:

- High cost, long duration, and a lack of schedule certainty in licensing and permitting processes.
- Deficient market design and inadequate market valuation of hydropower/pumped storage attributes that are key to integrate variable renewables and provide grid reliability.
- Failure to monetize the ancillary benefits of hydropower to the public when compared to other competing technologies being built to integrate renewables.

Address the following gaps in the Hydropower Portfolio:

- Accelerate and improve schedule certainty of licensing process by informing policy makers with findings and recommendations.
- Assess current methods and viability of getting fish upstream and downstream of physical barriers. The R&D is all on turbine passage.
- Consider a role for DOE as an arbitrator of environmental considerations and public good.

Marine and Hydrokinetic

Programmatic Management

- Advancing the state of MHK technology by in-water demonstrations should be the highest priority for the MHK Program.
- When building partnerships between labs and industry going forward, DOE should ensure lab projects consult with industry on study protocols and integrate industry feedback on deliverables. DOE should work to ensure more streamlined process for lab-company intellectual property agreements.
- Take a balanced approach to the MHK portfolio. Don't focus too many resources on initiatives whose results won't be seen for a number of years at the expense of projects/initiatives that are close to success.

Continue to support the Industry through:

- Participating in international organizations.
- Transferring scientific knowledge within the national labs to avoid "reinventing the wheel."
- Addressing regulatory issues by having the national labs provide solid scientific data to address environmental concerns when possible.

Address the following gaps in the MHK Portfolio:

- Continue to allocate MHK funds to support R&D efforts and increase the MHK focus on R&D studies.
- Build off of existing or ongoing research done by the Oil and Gas Industry or the Navy.
- Reach out to the global communities and review what the Europeans have done.
- Prepare for concerns that will be coming down the track regarding site selection for WECs.
- Best value for U.S. taxpayers is for DOE to develop consistent funding lines to support commercialization of specific, promising technology by developers, disbursed only upon achievement of performance metrics, and where feasible, matching funds.

Future focus areas:

- Maintaining an emphasis on in-water demonstrations by industrial partners (including small ones), i.e. “fund industry, not technologies.”
- Opening test centers and getting first projects in the water are very important.
- Market Acceleration should focus on the needs of the industry as well as what is required to continue to progress the industry.

Future focus areas: ➢ Accelerating and improving schedule certainty of licensing process by developing computerized processes that can improve the quality as well as reduce the time for agency (e.g., EPA, States, F&WS) reviews and informing policy makers with findings and recommendations. ➢ Establishing and owning a robust and neutral Low Impact Hydro Certification Program. ➢ Establishing outreach and stakeholder involvement to environmental community on expansion announcements to mitigate potential categorical future push back. ➢ Providing guidance on removing market barriers and promoting efficient market design. ➢ Expanding the ongoing climate change study to also address non-federal hydro.	➢ Continuing to improve the project selection process and determining how the laboratories are funded. ➢ Utilizing lab resources and contractors more effectively. There seems to be a lot of overlap on what a contractor can do versus what a lab can do, i.e. there are things that DOE can give to a contractor that will allow for better utilization of lab resources. ➢ University partnerships are excellent and should pay dividends in ideas and talent for years to come. ➢ The near-to-market commercialization status of tidal power technology suggests that DOE should reconsider funding emphasis for wave technology development, and instead offer parity funding to tidal and wave power technology. ➢ The quickest path forward for MHK sector development overall is to finish the mission on the nearest to market technology and secure successful deployment of that technology within the US and globally. Will generate valuable cost reduction lessons for wave technologies on manufacturing, operations and maintenance (O&M), and supply chain development.

4.0 Program Response to Programmatic Scoring Results and Key Findings and Recommendations of the Panelists

The following section details key comments recorded by the Water Power Peer Review Panel as well as responses to these comments from WWPTO management and staff in the areas of Hydropower and Marine and Hydrokinetics.

4.1 Program Response - MHK

TOPIC AREA: Program Objectives and Strategy

- *The approach, breadth, and growth of the program are fantastic.*
- *The program is built on a solid foundation of cooperation between DOE, industrial partners, national laboratories, and academia. While not perfect, this foundation provides the best path for the U.S. to succeed in the international marketplace.*
- *DOE is helping developers continue to move forward in a very difficult U.S. market caused by the lack of clear national energy policy, low energy costs due to natural gas pricing, and a very difficult regulatory environment.*
- *Advancing the state of MHK technology by in-water demonstrations should be the highest priority for the MHK Program.*

Reviewers' confirmed that program objectives align well with industry needs and recognized that in-water demonstrations are an important part of the strategy to drive progress in the MHK industry. DOE works diligently to interface regularly with industry representatives, ensuring that its labs and other funded partners are working on the most important priorities for the industry at large.

TOPIC AREA: Management and Operations

- *When building partnerships between labs and industry going forward, intellectual property issues may arise as a device progresses from an early technology readiness level through commercialization.*
- *DOE should work to devise solutions to the "no mortgage" prohibition on multiyear funding stream in order to address the most serious barrier to development - adequate funding to bring a promising technology to commercialization.*
- *Joint federal agency partner approach to developing a streamlined standard permit with conditions blessed by each agency (e.g. the National Pilot Project Permit by Rule) would be a game changer in terms of moving pilot projects ahead, and developing the data needed to address both environmental and engineering design issues.*
- *In a few cases, delays were noted with regard to the execution of agreements between the Labs and Industry. This may be a unique aspect of Governmental organizations and there may be no obvious solution. The time for executing a simple NDA was an order of magnitude longer than I am used to.*

Reviewers applauded the management and operations of the Program's R&D activities; the Program will continue to encourage partnerships between its national laboratories and industry. The difficulty of this kind of formal relationship has been recognized at all levels within the DOE system and currently, the program is engaged in a broader initiative to develop a Technology To Market (T2M) Strategy. The

T2M Strategy will identify specific activities through which the office can encourage technology transfer between national labs and industry. This strategy will include opportunities to address issues around the mortgage policy at DOE as well as the time requirements of entering into research agreements with national labs.

TOPIC AREA: Portfolio Balance

- *The program has maintained a portfolio of system and component development efforts by industry that are still at the research and development (R&D) stage, allowing smaller U.S. companies to grow.*
- *Projects related solely to infrastructure development, particularly the fourth test site, should be carefully evaluated to assure that they do not take resources from in-water demonstrations (exceptions include those efforts that are intended to enhance U.S. competitiveness in the global MHK community).*
- *Take a balanced approach to the MHK portfolio. Don't focus too many resources on initiatives whose results won't be seen for a number of years at the expense of projects/initiatives that are close to success.*
- *Build off of existing or ongoing research done by the Oil and Gas Industry or the Navy.*
- *DOE should rebalance the portfolio to prioritize advancement of leading technology to the full commercialization stage, addressing the barriers to full deployment.*
- *The Program Portfolio investments in open-source software are problematic. MHK developers have expressed the concern that existing, proven proprietary software exists and there is not a barrier to development posed by software availability.*

It is very encouraging to see the reviewers' feedback regarding the importance of in-water demonstrations to the progress of this industry. Encouraging the success of companies, specifically small businesses, in the MHK industry is of utmost importance to the Program and to DOE. Based on reviewer feedback, the program will carefully consider developing additional test sites when the opportunity cost of that development may be additional in-water demonstrations. The program will examine and re-evaluate the benefits of developing software tools within our portfolio of National Lab projects; however, DOE recognizes the intrinsic value of open-source tools to the extent that the current costs of available software tools prohibit start-up companies or new adopters from developing novel designs and/or entering the market. In addition, the program carefully considers research conducted for complimentary industries, inclusive of offshore wind, oil and gas, and others. Much of the program's offshore wind work is also applicable to the MHK industry and the program uses these technical overlaps to the extent possible in setting research priorities. Finally, the program understands the need to balance short-term and long-term research priorities. To the extent possible, the program attempts to fund short-term research priorities that will benefit long-term industry goals.

TOPIC AREA: Role of the National Laboratories

- *In a few specific cases, the national labs were used on projects that industry would have been better positioned to perform.*
- *Continuing to improve the project selection process and determining how the laboratories are funded.*
- *Utilizing lab resources and contractors more effectively. There seems to be a lot of overlap on what a contractor can do versus what a lab can do, i.e. there are things that DOE can give to a contractor that will allow for better utilization of lab resources.*

- *DOE will need to add specific project requirements to ensure active outreach by the National Labs to determine the state of research in other research centers globally (not just a desktop review of research publications, which do not capture ongoing or unpublished work). Also, the Labs should be required to interview the MHK developers to learn about their needs on any given project, or to beta test any proposed deliverable (models, software, etc.).*
- *It appears that at times there has been too much free reign to the labs to pursue projects that they think are in best interests of the industry without upfront and regular interaction with industry to make sure it will help them*

The Water Power Program strives to maintain a well balanced portfolio that leverages the unique capabilities and skills resident in both Industry and the National Laboratory infrastructure. In FY2015, the Water Power Program will be implementing a Merit Review Process for all new projects initiated as part of our Annual Operating Plan with the National Labs. While the details of the process have yet to be fully defined, a strong emphasis could be placed on such items as: Relevance to Industry; Ability/applicability of the National Lab to engage/collaborate with Industry on the project; and duration of the project such that timely results are attained and pushed to industry. Additionally, in FY2015 EERE will be launching the T2M Strategy to ensure that the work performed under the guidance of the National Laboratories has a clear path to integration in industry. This should alleviate the issue that was identified where laboratories have had the freedom to initiate and pursue projects that are not necessarily relevant to industry.

4.2 Program Response – Hydropower

TOPIC AREA: Program Objectives and Strategy

- *The current mix of existing, new, and pumped-storage projects is about right.*
- *Research that develops new algorithms for modeling hydro operations is an important part of the research portfolio.*
- *The overall program alignment is good but there are still some gaps, especially with regards to licensing uncertainty.*
- *The Market Barriers and Financial Performance areas should be divided.*
- *Need more focus on increasing the efficiency and certainty of Hydro licensing/permitting and improving market valuation of Hydropower and Pumped Storage attributes.*
- *Gaps exist in highlighting licensing and permitting difficulties that create uncertainty for future investment for hydro. Additional program engagement in driving comprehensive energy policy would be a positive for our country - not just hydro.*
- *Environmental barriers (ESA, etc.) have been extensively well documented and mapped out, but as an industry, we haven't done nearly as good a job of touting the non-generating benefits that many reservoirs and hydropower dams provide. I would like to see a little more balance to this evaluation.*

Reviewers confirmed that program objectives align well with industry needs in specific areas, and finding a proper balance between existing, new, and pumped storage projects is of utmost importance to the program. As the program shifts towards a strategy that quantifies the benefits of hydropower in the

U.S., assigning proper market valuation to these assets will be a significant piece of this strategy. The program has already added additional research in this area over the past several years and plans to continue this trend into the future. In addition, the program plans to more actively engage with and inform permitting and regulatory processes as possible in the coming years in order to help shorten and/or remove inefficiencies in the permitting process for new hydropower. The Water Program is actively evaluating how we will manage the Financial Performance portion of the Hydropower Portfolio in upcoming annual plans. Currently this is a cross-cutting function within the sister Wind Program and strong consideration is being given to separating Financial Performance from the Market Barriers work. The program is aware of how important these efficiencies will be for the addition of new hydropower to the U.S. electrical grid. Finally, it is encouraging to hear that reviewers place high value on the program's market acceleration and deployment activities specific to environmental performance and fish passage. The program will continue to engage in these types of activities into the future.

TOPIC AREA: Management and Operations

- *Steps are being taken to address transition from project "grants" to co-managed projects. This is an excellent step forward.*
- *In the R& D space and demonstration projects, it would be helpful to seek advice from experts in the industry, early on.*
- *I would like to see/verify that there is more upfront outreach to industry end users during the scoping and development stages of a project. This was mentioned in several presentations and may be happening but these solicitations are apparently not well publicized.*
- *Many projects do not have clear measures of success.*
- *All projects should be evaluated against the question, "How will this help grow hydropower in the US?" and should focus on the deliverable to the end user.*
- *Risky projects like new inventions should be monitored more closely and by people who have some expertise in the technical details.*
- *Get end-users involved on the front end.*
- *Make sure the data and modeling projects don't go too far into the realm of diminishing returns. Make sure the high value issue to be addressed or answer to be sought is clearly defined, and then stop the project once the issue or answer is addressed.*

In large part, reviewers support current management and operations practices of the Program's R&D activities as the Program moves towards high utilization of cooperative research agreements (CRADA's) rather than grants. The involvement of end-users and industry experts early on in the project scoping process is something that the program is actively developing as it embarks on a new effort for merit review. In this new merit review process, projects will be more closely evaluated early on in the development stage. These merit reviews will have a forward looking component and will supplement the Peer Review process, which will continue to be a retrospective into the program's funded work. It is the intent of this merit review process to more actively engage industry perspectives in the project development phase. This will also help identify and define success metrics for R&D projects and will help to answer the above-noted question, "How will this help grow hydropower in the US?" Finally, merit reviews, peer reviews, and the Program's continued robust process for Active Project Management (APM) will ensure that projects are completed on time and do not experience diminishing returns to scale.

TOPIC AREA: Portfolio Balance

- *Use DOE's technical clout to inform Congress of the need for policy changes that drive hydropower forward. Make the technical case to Congress in order to set the policies to incentivize development of hydro resources to integrate variable renewable onto the grid.*
- *Regulatory delays continually cause cash-flow issues. Emphasis needs to go up the chain to Congress.*
- *Research that comes up with new methods for things like hydrologic forecasting and environmental health of rivers may not be well aligned with DOE objectives.*
- *Downscaling for climate change is a large and duplicative effort. DOE could spend the resources on modeling the specifics of systems that focus on the hydro resources.*
- *Although good forecasts help optimize hydro value, there are many other agencies already working in this area and many methods that are widely used and accepted.*
- *Software should be developed based on user needs. It is more likely that software developed under research grants will be "research" software, usable mainly by research projects and not so much by industry.*
- *Establish a robust Low Impact Hydro Certification program.*

The Department of Energy has a well-defined role in developing new energy technologies that will secure America’s energy independence and security. To the extent possible, the Program actively engages Congress by providing unbiased, technical information that has the possibility for informing policy debates around a particular energy source or issue. However, it must be emphasized that the Program is limited in scope by the extent to which it may lobby for any given technology and must maintain its role as an unbiased arbiter of information. In addition, Congress maintains full latitude to call upon DOE to conduct research that addresses a very specific technical concern within a given policy debate, independent of that research project’s implicit value to the industry at large (i.e., climate change).

Resource Characterization is a key area of the Water Power Program. While more emphasis has been placed on the development of new hydropower technology, the Program does work collaboratively with other agencies and the National Laboratories to better understand the impact of better forecasts on hydropower production. A Low Impact Hydro Certification program will be seriously considered under the scope of this the program’s technology development role as the program looks to identify new projects for the future.

TOPIC AREA: Role of the National Laboratories

- *A trend toward heavy reliance on national labs to originate projects may lead to blind spots in practical research since it is atypical to see lab principal investigators (PIs) in the field.*
- *There appears to be a trend toward heavy investment (almost exclusive investment) in work for the National Labs in 2014.*
- *There are a number of very talented, creative and productive scientists in the Labs that carry a disproportionate part of the research. This contributes to continuity and reliability of results, but may limit the creative input somewhat. Perhaps more collaboration between these people and agency or university scientists and engineers would have even better outcomes.*

- *The Labs contribute significant and valuable science, but also have projects with deep funding levels that don't seem to be generated by industry need or alignment with the goals.*
- *Get more technical work performed outside the labs, especially modeling, and share and interact more with outside professionals and other organizations.*

The Water Power Program strives to maintain a well balanced portfolio that leverages the unique capabilities and skills resident in both Industry and the National Laboratory infrastructure. In FY2015, the Water Power Program will be implementing a Merit Review Process for all new projects initiated as part of our Annual Operating Plan with the National Labs. While the details of the process have yet to be fully defined, a strong emphasis could be placed on such items as: Relevance to Industry; Ability/applicability of the National Lab to engage/collaborate with Industry on the project; and duration of the project such that timely results are attained and pushed to industry.

5.0 Overall Summary Results by Program and Technology Panel Areas

This section looks at the average overall scoring and average scoring per metric for Marine and Hydrokinetic (MHK) and Hydropower projects in relation to the following statistical populations: all projects reviewed, all existing projects, all existing MHK projects, all existing Hydropower projects, all new projects, all new MHK projects, and all new Hydropower projects. 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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating).

Overall, all populations scored high in both relevance (between 4.0 and 4.3) and weighted average overall score (between 3.6 and 3.9). Additionally, panelists consistently rated relevance slightly higher than the weighted average overall score across all populations. The “New Hydropower Projects” scored the highest in average relevance (4.3) and the highest in weighted average overall score (3.9). It should be noted (as described in Section 1.5 Scoring Analysis Methodology) that the weighted average overall scores for “New” projects are based solely on the “methods/technical approach” metric since relevance is scored as standalone. The “Existing Hydropower Projects” scored the lowest in relevance (4.0) and weighted average overall score (3.6), but as previously mentioned these are still excellent scores based on a five-point scale. Existing Hydropower and New Hydropower Projects had the highest average number of reviewers per project at 5.5. The average number or reviewers per project ranged from 4.6 to 5.5 across the populations.

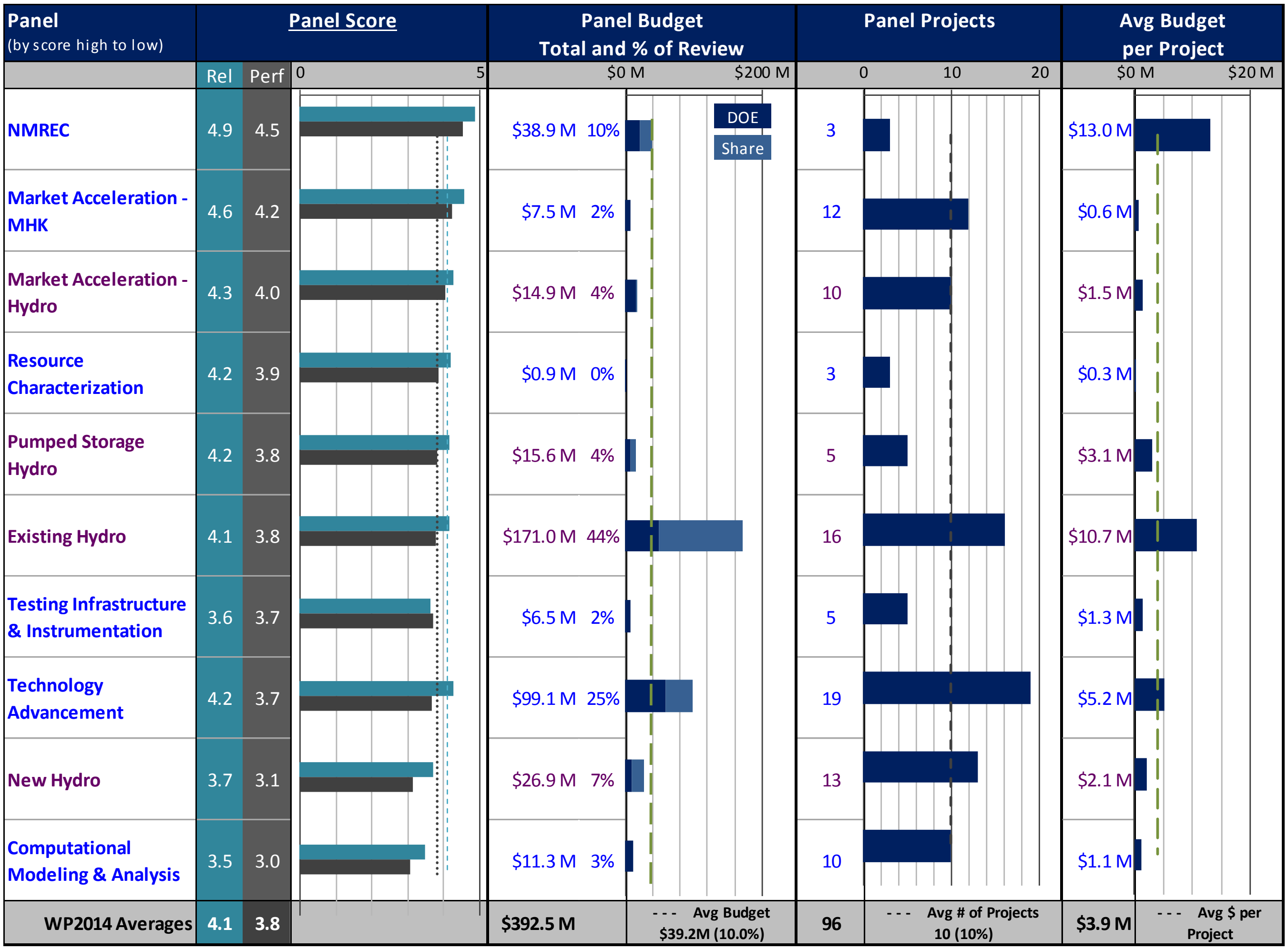
Table 5.1 lists the overall average scoring results and average score per metric for all projects reviewed, all existing projects, all existing MHK projects, all existing Hydropower projects, all new projects, all new MHK projects, and all new Hydropower projects.

Table 5.1 Overall summary peer review scoring results

	Total Reviewers	Relevance	Methods	Accomplish-ments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review	5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing Projects	5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing MHK Projects	4.6	4.2	3.9	3.8	3.5	3.9	3.6	**3.8**
Average for Existing Hydropower Projects	5.5	4.0	3.7	3.6	3.6	3.7	3.4	**3.6**
Average for New Projects	5.2	4.2	3.8					**3.8**
Average for New MHK Projects	4.9	4.0	3.7					**3.7**
Average for New Hydropower Projects	5.5	4.3	3.9					**3.9**

The MHK and Hydropower program areas were organized into technology panels for the 2014 Peer Review Meeting. Column one in Figure 5.1 lists the technology panel areas that were reviewed. Column two illustrates the average relevance and performance scores per panel (performance is the weighted average overall score for the panel). Column three shows the cumulative budget for all projects in each panel (including cost share) as well as the panel budget as a percentage of the total budget for all projects reviewed. Column four shows the number of projects per panel, and column five shows the average budget per project per panel.

The average relevance score for all of the panels was 4.1, and the average performance score for all of the panels was 3.8. The National Marine Renewable Energy Centers (NMREC) scored the highest in relevance (4.9) and performance (4.5). Computational Modeling and Analysis scored the lowest in relevance (3.5) and performance (3.0). Sections 6 and 7 delve further into the results (scoring and detailed comments) on an individual project basis for the MHK and Hydropower Program Areas.



Panel (by score high to low)	Panel Score Rel	Panel Score Perf	Panel Budget Total	Panel Budget % of Review	Panel Projects	Avg Budget per Project
NMREC	4.9	4.5	$38.9 M	10%	3	$13.0 M
Market Acceleration - MHK	4.6	4.2	$7.5 M	2%	12	$0.6 M
Market Acceleration - Hydro	4.3	4.0	$14.9 M	4%	10	$1.5 M
Resource Characterization	4.2	3.9	$0.9 M	0%	3	$0.3 M
Pumped Storage Hydro	4.2	3.8	$15.6 M	4%	5	$3.1 M
Existing Hydro	4.1	3.8	$171.0 M	44%	16	$10.7 M
Testing Infrastructure & Instrumentation	3.6	3.7	$6.5 M	2%	5	$1.3 M
Technology Advancement	4.2	3.7	$99.1 M	25%	19	$5.2 M
New Hydro	3.7	3.1	$26.9 M	7%	13	$2.1 M
Computational Modeling & Analysis	3.5	3.0	$11.3 M	3%	10	$1.1 M
WP2014 Averages	**4.1**	**3.8**	**$392.5 M**		**96**	**$3.9 M**

Figure 5.1 Technology panel summary results

6.0 Marine and Hydrokinetic Panel Results and Individual Project Evaluations

Testing in Oregon - Wave Energy Technology New Zealand
http://images.nrel.gov/viewphoto.php?imageId=6980555

The Water Power Program supports the development of marine and hydrokinetic (MHK) devices, which capture energy from waves, tides, ocean currents, the natural flow of water in rivers, and marine thermal gradients, without building new dams or diversions. In order to meet its generation goals, the program supports the design, development, testing, and demonstration of technologies that can capture energy from waves, tides, and currents. Additionally, the program funds the creation of instrumentation, modeling, and simulation tools to enable real-condition testing of technologies.

The MHK research and development (R&D) efforts focus on advancing technologies that capture energy from the nation's oceans and rivers. Unlike hydropower, marine and hydrokinetics represent an emerging industry with hundreds of potentially viable technologies. The program is therefore leading efforts to prove functionality; evaluate technical and economic viability; and generate cost, performance, and reliability data for a variety of devices.

For the purposes of the 2014 Peer Review, MHK projects were organized into the following six technology panels: Computational Modeling and Analysis, Technology Advancement, Market Acceleration and Deployment, the National Marine Renewable Energy Centers, Testing Infrastructure and Instrumentation, and Resource Characterization. Each panel was further split into “existing” and “new” categories. Existing projects are those that received funding in FY2012 and FY2013. The new projects are those that were most recently awarded (FY2014). The existing and new populations were used for the comparative statistical analyses that were conducted on the quantitative evaluations submitted by the panelist.

Figure 6.0.1 illustrates funding levels based on “new” and “exiting” MHK projects while figure 6.0.2 shows funding levels based on the MHK technology panels that were reviewed in 2014. The funding levels in these figures span budgets from multiple years.

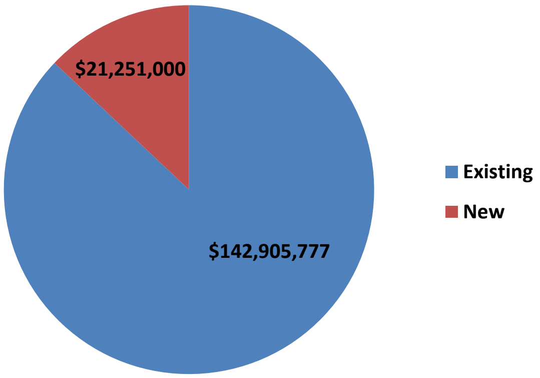


Figure 6.0.1 Funding for new and existing MHK projects

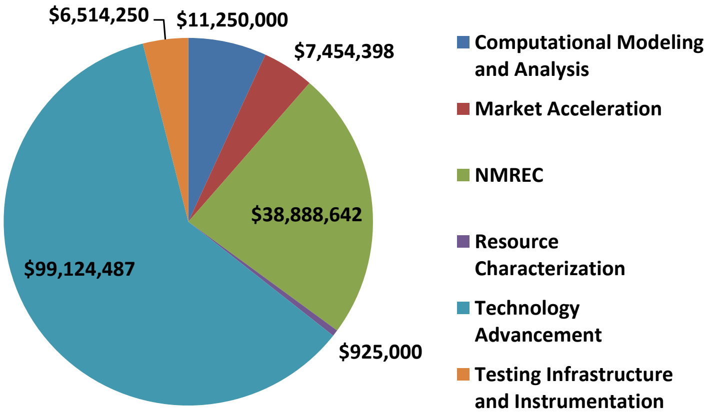


Figure 6.0.2 Funding based on MHK technology panels

Figure 6.0.3 illustrates the weighted average overall scores and the relevance to Water industry needs and overall DOE objectives scores for all existing MHK projects that were reviewed in the 2014 Water Power Peer Review.

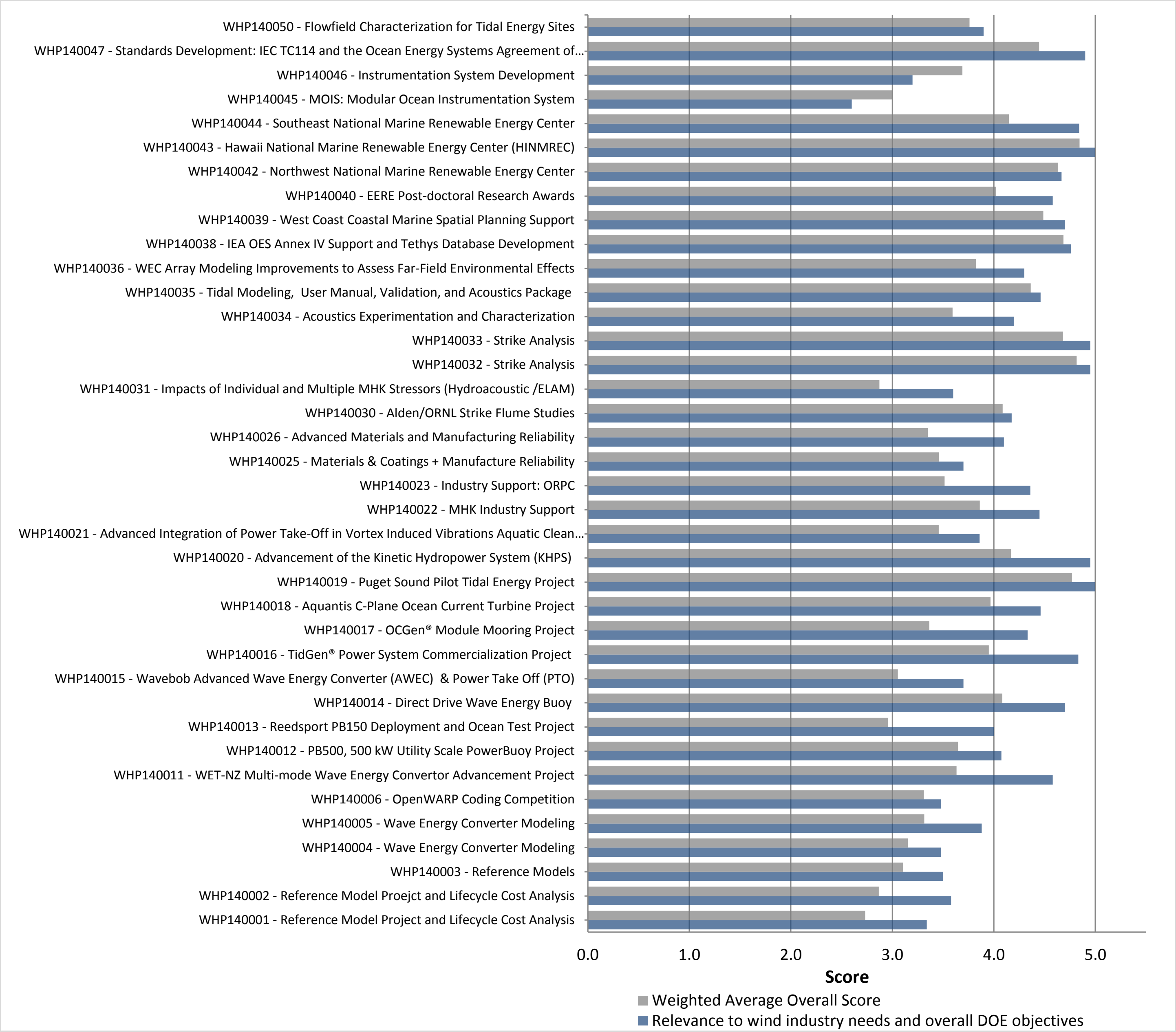


Figure 6.0.3 Relevance and weighted average overall scores for all existing MHK projects

Figure 6.0.4 illustrates the weighted average overall scores and the relevance to Water industry needs and overall DOE objectives scores for all new MHK projects that were reviewed.

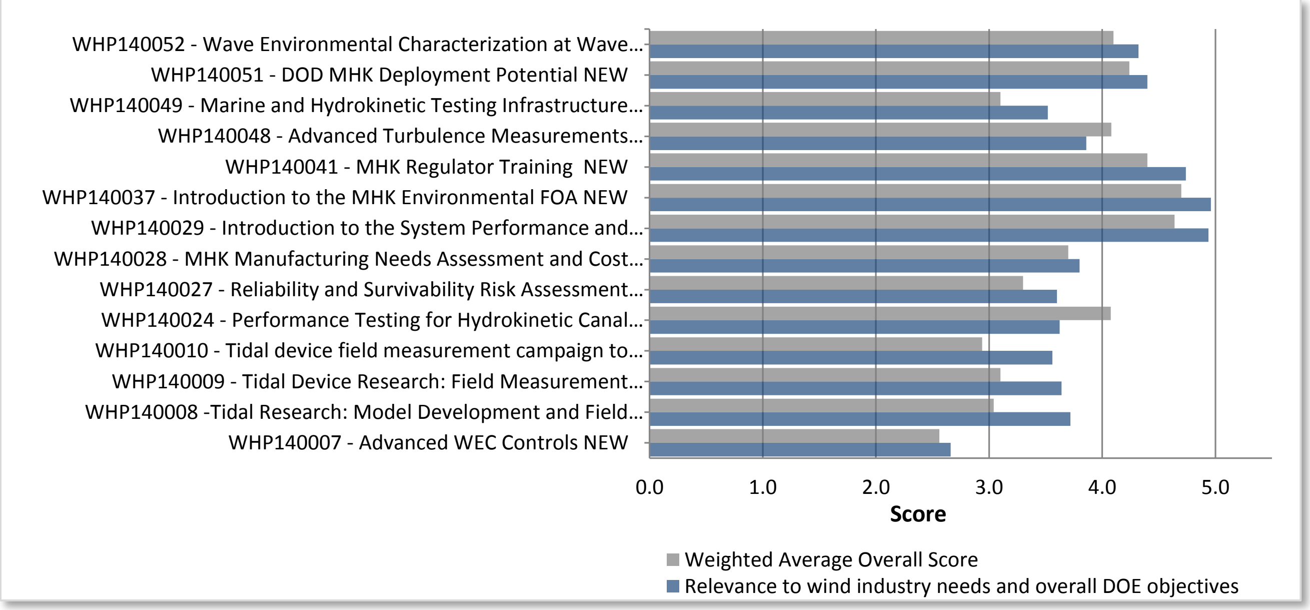


Figure 6.0.4 Relevance and weighted average overall scores for all new MHK projects

Individual MHK project evaluations, including scoring results and detailed verbatim comments from the panelists, are included in the following technology panel sections.

6.1 Computational Modeling and Analysis

The program actively pursues research and development efforts in modeling and simulation to provide tools to optimize device and component design decisions, inform prioritization efforts for device development, and inform strategic planning for the program and its partners. Modeling tools and access to laboratory expertise may enable developers to reduce their overall costs, reduce their design iterations, and gather information on optimal configurations and locations for devices. Well-designed modeling tools can provide baseline information on operation and installation costs and environmental impacts. These tools increase user and investor confidence by providing an opportunity to simulate full deployment scenarios, estimate costs, and optimize reliability and overall performance.

Table 6.1.1 lists the existing Computational Modeling and Analysis MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.1.1 illustrates the standard deviation of scoring of the existing Computational Modeling and Analysis MHK projects in relation to the scoring of all projects that were reviewed in 2014.

Addressing Comments for Computational Modeling and Analysis
The MHK Peer Review Panelists recorded many useful and actionable comments during their review of the Office's Computational Modeling and Analysis projects. These comments will be used to make key decisions and recommendations to those projects that will still be receiving continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy into the future.

The program recognizes the constructive feedback received regarding the multi-lab Reference Model project. Reviewers addressed two primary concerns: namely, that these projects may not necessarily be of high value to the MHK industry in its current state, and that the project itself has been time-consuming and costly.. The program has considers that the peer reviewer recommendations support the program strategy to not continue the Reference Model project, and instead disseminate the results from completed reference models.

Peer reviewers also questioned the inherent value that other Computational Modeling and Analysis provided to the industry at large. Reviewers made it known through their commentary on these projects that the Program's involvement in software tool development is of questionable value. The larger Wave Modeling Program has already worked with industry to gather feedback on development through pre-releases of the code, and a questionnaire on value of possible additional features. In the future the program will participate in a larger DOE initiative that will emphasize engaging industry in the earliest phases of a project through a merit review process. This, along with DOE's newly enacted Active Project Management process, will ensure that DOE projects provide the most value possible to industry. Finally, the Program is also developing a Technology to Market (T2M) Strategy that will assist with the technology transfer of completed or ongoing DOE-funded projects out to industry.

Table 6.1.1 Existing Computational Modeling and Analysis MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing MHK Projects			4.6	4.2	3.9	3.8	3.5	3.9	3.6	**3.8**
Average for Existing Computational Modeling and Analysis Projects			5.0	3.5	3.3	3.2	2.9	3.0	2.5	**3.1**
Wave Energy Converter Modeling	Kelley Ruehl	Sandia National Laboratories	5.0	3.9	3.6	3.4	3.3	2.6	2.8	**3.3**
OpenWARP Coding Competition	Andy LaMora	TopCoder	5.0	3.5	3.5	3.2	3.2	3.4	3.1	**3.3**
Wave Energy Converter Modeling	Michael Lawson	National Renewable Energy Laboratory	5.0	3.5	3.2	3.4	3.1	2.8	2.7	**3.2**
Reference Models	Andrea Copping	Pacific Northwest National Laboratory	5.0	3.5	3.5	3.0	2.8	3.2	2.7	**3.1**
Reference Model Project and Lifecycle Cost Analysis	Robert Thresher	National Renewable Energy Laboratory	5.0	3.6	3.2	3.2	2.6	2.8	1.5	**2.9**
Reference Model Project and Lifecycle Cost Analysis	Vincent Neary	Sandia National Laboratories (Lead)	5.0	3.3	3.0	2.8	2.2	3.1	2.2	**2.7**

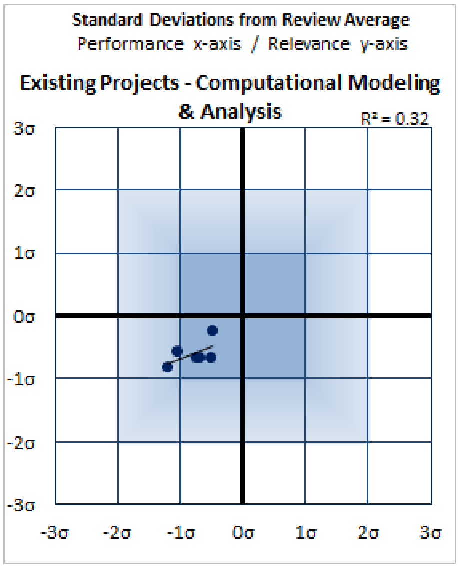


Figure 6.1.1 Existing Computational Modeling and Analysis MHK projects

Table 6.1.2 lists the new Computational Modeling and Analysis MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.1.2 illustrates the standard deviation of scoring of the new Computational Modeling and Analysis MHK projects in relation to the scoring of all projects reviewed in 2014.

Table 6.1.2 New Computational Modeling and Analysis MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Weighted Average Score
Average for Review			5.1	4.1	3.8	**3.7**
Average for all New Projects			5.2	4.2	3.8	**3.8**
Average for New MHK Projects			4.9	4.0	3.7	**3.7**
Average for New Computational Modeling and Analysis Projects			5.0	3.4	2.9	**2.9**
Tidal Research: Model Development and Field Measurement Campaign NEW	Bob Thresher	National Renewable Energy Laboratory	5.0	3.7	3.0	**3.0**
Tidal Device Research: Field Measurement Campaign to Validate Modeling Tools NEW	Marshall Richmond	Pacific Northwest National Laboratory	5.0	3.6	3.1	**3.1**
Tidal device field measurement campaign to validate tools includes upkeep of tools for industry use NEW	Vincent Neary	Sandia National Laboratories	5.0	3.6	2.9	**2.9**
Advanced WEC Controls NEW	Tim Crawford	Sandia National Laboratories	5.0	2.7	2.6	**2.6**

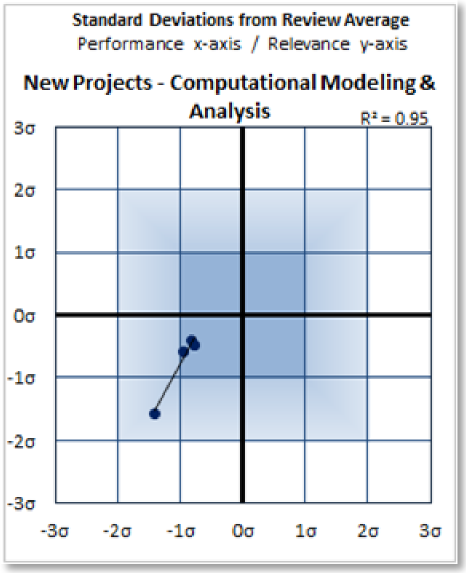


Figure 6.1.2 New Computational Modeling and Analysis MHK projects

WHP140001

Project Title:

Reference Model Project and Lifecycle Cost Analysis

Principal Investigator:

Vincent Neary

Organization:

Sandia National Laboratories (Lead)

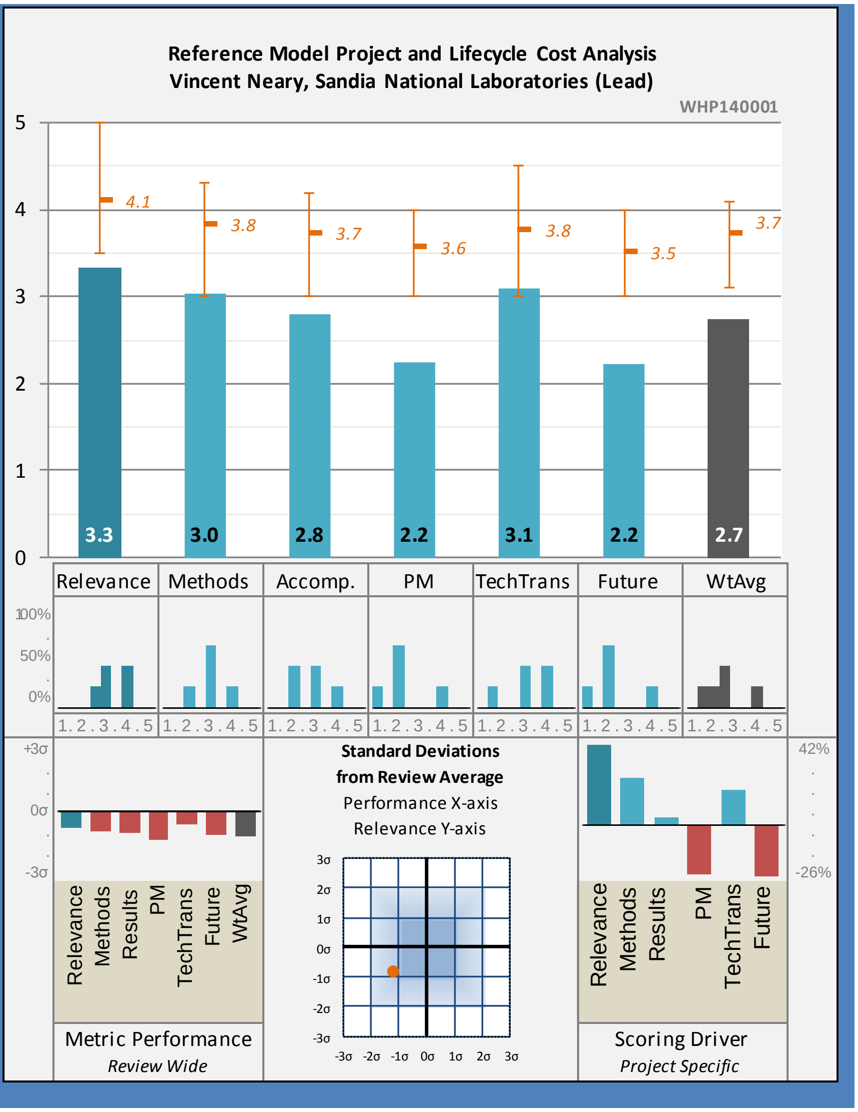
Panel:

Computational Modeling & Analysis

Budget:

$4,699,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.3** for its Relevance to water industry needs and overall DOE objectives.

- Creating a Reference Model is a positive - particularly when standardizing methods to measure LCOE; however, this project is focused on the application to academia until there is a practical application to support it.
- Valuable project in theory, but lengthy development period has minimized value. The planned project products would be helpful to MHK industry by providing open source methodology to assess technical and economic viability of MHK technologies, saving significant annual license costs of proprietary software. But the long development time (more than five years) has left gap for industry, driving up costs of development for companies.

- This project has provided value to the MHK program by developing a set of reference models against which the performance of developmental systems can be compared.
- Emphasis on non-proprietary design is an excellent approach. Invites others to participate in the field and bring their talents and ideas.
- The concept of developing reference models to look at the impact of various aspects of the design and how they contribute to LCOE makes sense and could be helpful in focusing areas where greatest cost improvements are possible. The idea of a standardized method for determining LCOE is also useful, provided it is not overly complex and can readily applied to multiple sites.
- It was difficult to see how this is applied to getting steel in the water and how either a device developer or project developer will use this model - a clearer discussion on what is the End Point would have been helpful.
- Agree with DOE plan to taper off funding for reference models. Eventually, data from field measurement studies may be used to refine the models, but this is relatively lower priority to more urgent needs of industry.
- This project has developed an organized and structured methodology for calculating costs that will be useful for industry to use in the future.
- However it is not clear how useful the open source models will be to device or project developers, particularly since many aspects of the design have been assumed or purposefully simplified and there are so many variables on actual unit performance that cannot be determined from the model. Some actual operational experience is needed to verify model assumptions.
- Given the existence of proprietary software to accomplish these same project objectives, development of open source software does not address a total barrier to industry development. In terms of funding priorities, this project does not address an existential threat to industry development, but it is helpful to encourage greater participation by many entrants.
- This project has limited value in the near future. It should be kept going at a very low level and revisited at the next Peer Review, or as data from in-water demonstrations are available for comparison to model predictions.
- Important to remember that every open source project has the strength of "floating all boats," including global competitors to US industry, in contrast to targeted projects to advance specific technology and site development in US.
- Product evaluation will be vital to determining the true value of this product. Will it be used by the actual designers of MHK devices? If designers eventually revert to proprietary software in order to access superior features, DOE must re-evaluate the feasibility and value of this type of large project to develop open source software for industry development.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.0** on its methods/approach.

- While not needing to know the "nuts and bolts" of the methodology, the presentation was limited on providing information on the approach.
- Not clear from presentation whether the Project Design fully leveraged available international open source resources to reduce costs of this project. Including the University of Cork as experimental test site is a positive contribution to the project method and approach. But given the significantly more advanced state of MHK industry in the EU nations, the long-time involvement of top European engineering universities, and significant EU early funding, it logically seems that there should have been significant foundational EU work that could have been incorporated into the design development phases of the project, thereby lowering the cost and delivery time.
- The approach of developing Reference Models based on simple and robust point designs for "typical" MHK applications is a reasonable approach given the lack of domestic, non-proprietary information.
- Program is well run.

- The concept is good but there are many variables that are difficult to account for. For example, so much of the actual cost depends on the energy output and efficiency of the device as well as capacity factors on an annual basis which are a function of both resource and unit availability.
- Important that DOE assure that the researchers perform more than just a "literature search" to determine existence of work. Using DOE's contacts, it is essential that the national labs reach out directly to the top EU centers of excellence to investigate state of research (including ongoing research work not published and invisible in literature search) to avoid duplication of efforts.
- The Reference Models would probably have benefited from comparison to foreign MHK designs
- Without actual information from real world experiences of operating devices there is no way to validate how correct these numbers are.
- The cost-estimation methodology requires validation by industry.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.8** based on technical accomplishments and progress.

- Difficult to determine how the end product that would benefit the MHK industry as a whole at this stage of the industry development.
- The open source model will be helpful for small, thinly funded companies and will be very helpful for the academic centers training students.
- The goals of the project were achieved, but only after substantial delays.
- The breakdown of costs will be very helpful to others.
- Key end products are standardized methodology for LCOE and point designs themselves including geometry. This was over 2-3 million dollar effort and it is no clear exactly how useful this information will be to people trying to put devices in the water. Usefulness remains to be seen.

Question 4: Project Management

This project was rated **2.2** on its project management.

- A very large and complex project with a lot of moving parts.
- This project, consuming more than 5 years and $2.5M, is not yet complete. DOE "lessons learned" may be that greater value can be gained from more compressed project schedule.
- Project was substantially delayed.
- Well-coordinated with other labs.
- Project is nearly complete after multiple years and I am not familiar with original scope, schedule or budget so it is difficult to say how well it was managed. The fact that it is nearly complete is a positive but it seems like a considerable amount of money has been spent to only have some CAD drawings and excel sheets as key products.
- Not clear that all international sources were fully leveraged as foundational knowledge, perhaps leading to duplication of effort in developing reference models and sites, as well as methodology to assess technical and economic viability of MHK technologies.
- The roles of the collaborators appear to not have been well defined in the baseline as evidenced by the statement "Changing collaborator role delayed coordination in project completion”.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.1** for research integration, collaboration, and technology transfer.

- A good mix of lab and academic members; although more industry involvement is needed (I'm assuming this is a problem because of Intel. Property).
- Helpful to involve the different National Labs with relevant expertise, but need to coordinate project implementation more closely to avoid delays. Strong marks for including the University of Cork in experimental testing of RM6.
- There appears to have been no collaboration with system developers either domestic or foreign
- Good collaboration with other labs and industry.
- Almost all laboratory and academic participation with no apparent developer input. Would have been good to see development community validating at least some of the inputs and outputs.
- Not clear that international learning from first-in-field countries was fully leveraged in design development phases of the project.
- Good efforts to collaborate between laboratories, universities, and Re-Vision, but would have benefited from more firmly developed statements of work.
- Some validation against actual experiences of operating devices in other parts of the world would also be useful.
- Technology transfer has not yet fully been performed, but is likely to benefit industry as the methodology is tried and validated.
- Researchers have presented results at technical conferences in Denmark and are now planning to go to technical conferences in Japan and Australia in 2014 - these are naval hydrodynamics and wave conferences that are unlikely to be attended by US development industry. How does this help US development industry?
- I suggest that this information should be presented in a workshop format to developers at some easily accessible location in the United States.

Question 6: Proposed Future Research

This project was rated **2.2** for proposed future research.

- This is an expensive effort (over $2 million dollars) and it is no clear exactly how useful this model is as there is no "steel in the water" to verify it.
- Taper off funding and close with RM6 conceptual design and assessment methodology.
- There seems to be very little benefit to any near-term efforts other than to transfer the methodology to industry.
- Maintenance of web site as a data clearing house is would be useful tool for researchers and developers.
- Proposed future research looks like it is just completing 2014 studies.
- When relevant data from industry becomes available, the reference models should be revisited and be updated
- There was mention of advanced controls being next step.

Strengths and Weaknesses

Project Strengths

- Although not an expert in this field, I can certainly see the benefits these RM's will provide this industry in the long-term.
- The project provided the Labs with a valuable learning experience that would not have otherwise been available.
- Open source software is a positive goal and will encourage other to continue work.
- Discussed in comments above.
- The project produced a tool that will hopefully be usable to DOE and industry.

Project Weaknesses

- This is a general comment for the project as a whole - not Dr. Neary's individual presentation - I believe there will be difficulties getting a device "off the shelf" for field testing (regardless of which RM is being tested) and results published in a public forum because of the issue of intellectual property.
- This project provides important experience for DOE in MHK sector on management of long term, large contracts with multiple national labs. The lessons learned on actual performance of specific labs, and on the cause and cures of project delays and increased expenses will be very valuable as new projects are undertaken.
- The project team suffered from a lack of focus.
- Discussed in comments above.
- This is not my area of expertise and I do not have a strong understanding of what it would entail; however, the limited types of technologies demonstrated in the presentations would seem to preclude a number of devices already in the water from using this reference model.

Specific recommendations for additions or deletions to the work scope

- Suggest "shelving" work on the RM's until there is "steel in the water". Once active projects are progressing, and then start the development of these models again so they can then be field tested.
- Project presentation indicated that the key objective and success of the project was that the nonproprietary software systems are currently being used by academic centers. DOE should require that the project managers monitor and report to DOE on actual website traffic data and to actively seek feedback on the consumer experience with the product in various applications to gain insights into how well the software meets the public's needs. This will be important for project design on future conceptual design work.
- Recommend that the methodology for cost estimation be rolled out to industry for evaluation and possibly used for future FOAs.
- I realize there was not enough time in this presentation, but a "workshop" type presentation that showed how someone would use this would be helpful.
- Developing open source models can be useful to the industry but they need to be designed with the end user in mind and need to help clear specific hurdles.
- Instead of presenting this model at overseas academic conferences, focus on getting this effort into the hands of US developers.
- Very important that the DOE team give a forensic review to this project structure and implementation and capture the lessons learned going forward for future large project design involving national labs and collaborative teams. Candid sharing of the lessons learned by DOE with partners at the national labs and other academic centers is important to the strengthening of the MHK research cluster.
- Recommend that the program be substantially cut back to a very low level of support and revisited at the next Peer Review, or as data from in-water demonstrations are available for comparison to model predictions
- Wrap up reference model work by getting it to a stage where the models can be used by industry and graduate students. These follow-on efforts will more than likely lead to incremental improvements in the models. In this manner, DoE will have made a great contribution to the MHK industry.
- I would recommend that more active (i.e., being a partner on this project) role by device developers would strengthen the development of these models.

WHP140002

Project Title:

Reference Model Project and Lifecycle Cost Analysis

Principal Investigator:

Robert Thresher

Organization:

National Renewable Energy Laboratory

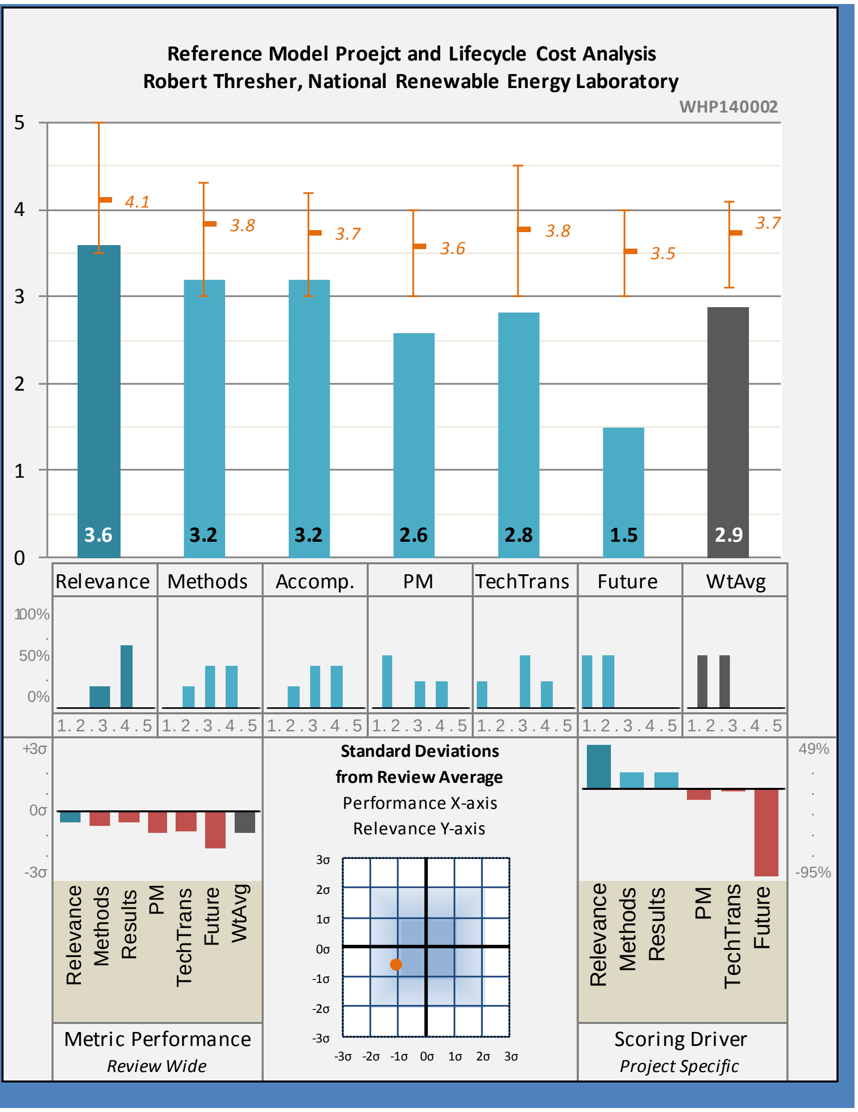
Panel:

Computational Modeling & Analysis

Budget:

$1,745,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- Long-term, RM's such as these would benefit the MHK industry, but without devices in the water, these models cannot be "field tested"; therefore, it is hard to see how these conceptual designs are (currently) advancing the industry.
- Dr. Thresher's presentations were excellent, and helped the panel better understand the Reference Model Project and its value to the industry. These comments apply to the NREL contributions on development of the technology assessment methodology addressed by Dr. Thresher's presentation, as distinguished from the overall project comments provided under the worksheet on the Sandia National Lab overall project presentation (Dr. Neary).

- This project has provided value to the MHK program by developing reference models for Tidal-current Turbines (RM1), Point Absorbers (RM3), Ocean Current Turbines (RM4) and Surge-pitch WECs. These models can be compared to the performance of developmental systems as data becomes available.
- Emphasis on non-proprietary design is an excellent approach. Invites others to participate in the field and bring their talents and ideas.
- Conceptual designs of devices that have already been designed to final levels by others seems redundant and it is not clear if these conceptual designs advance the current state of the industry or are useful to developers with devices in the water.
- Dr. Thresher's point that the open-source reference technologies have already identified the key technical hurdles and cost-drivers as Manufacturing and O&M costs confirms the learning of MHK device developers, and provides important guidance for future DOE future budget planning.
- This project has provided LCOE analysis for RM5 and for Ocean-wave conversion (RM6) as well as supporting the organized and structured methodology for calculating life-cycle costs. This will be useful for industry to use in the future.
- See comments on previous presentation all related but if so much of actual costs and operational outputs etc. are assumed and not validated how reliable is it?
- Dr. Thresher's point that tidal power technology is significantly more advanced, and close to full commercialization, than Wave Energy Converter development is essential. Tidal power represents the ability of US industry to leverage Wind Industry R&D and commercialization lessons. Tidal power clearly represents the most near-to-market commercialization scenario for MHK, and likely offers the most economical industry scale-up pathway, as the lessons learned from tidal can be folded into wave development.
- This project has limited value in the near future. It should be kept going at a very low level and revisited at the next Peer Review, or as data from in-water demonstrations are available for comparison to model predictions.
- A key finding presented at the session was that higher MW output covers fixed costs better. Wasn't this a pretty clear fact at the outset? This is why the offshore wind industry is moving to bigger and bigger turbines as they get into deeper and deeper water where the fixed costs of deployment are higher.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.2** on its methods/approach.

- There is no developer input into these models - as the end user, wouldn't their input be essential?
- The approach of developing Reference Models based on simple and robust point designs for "typical" MHK applications is a reasonable approach given the lack of domestic, non-proprietary information.
- Program is well run.
- It seems that the labs involved could have reached out to developers in the US and abroad to understand their experiences and try to leverage that.
- The Reference Models, however, would probably have benefited from comparison to foreign MHK designs.
- The cost-estimation methodology requires validation by industry.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.2** based on technical accomplishments and progress.

- For the amount of money and personal effort put into developing these RM's, it was hard to determine what the deliverables are.
- NREL appears to have accomplished all of its work without the delays noted for SNL.
- The breakdown of costs will be very helpful to others.

- Conceptual designs and spreadsheets can be produced cheaply and easily - those seem to be the only products.

Question 4: Project Management

This project was rated **2.6** on its project management.

- A LOT of money ($2+ million for the whole RM project) has been invested in this project with very little to show, namely conceptual designs.
- NREL identifies similar difficulties with distracting efforts to those reported by SNL, but without the delays incurred at SNL.
- Well-coordinated with other labs.
- The project started in 2010 but budget only shown for '12-14 and that is almost 2 million dollars. So this project has been going for 4 years and has maybe cost 4 million? End result is conceptual designs - our company has designed entire hydroelectric power plants - civil, structural, electrical, and mechanical for much less money and much less time.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.8** for research integration, collaboration, and technology transfer.

- A very good mix of staff from the national labs; however, there is a lack of device developer input.
- There appears to have been no collaboration with system developers either domestic or foreign
- Good collaboration with other labs and industry.
- Presenting findings at technical polar and arctic engineering conferences in the Netherlands and in Maui - these are not conferences that many US developers can afford to attend. If these reference models and life-cycle cost analyses are intended to benefit US developers they should be more directly presented to US developers perhaps at a workshop in a more easily accessible location.
- Good efforts to collaborate between laboratories, universities, and Re-Vision, but would have benefited from more firmly developed statements of work.
- Technology transfer has not yet fully been performed, but is likely to benefit industry as the methodology is tried and validated.

Question 6: Proposed Future Research

This project was rated **1.5** for proposed future research.

- No future research has been proposed.
- NREL states that there is no future work, but this is not entirely consistent with the SNL presentation
- None suggested.
- Without operational experience from actual devices to validate models it is not worth further work on models. I believe they should be put on a shelf and revived in the future if it makes sense.
- There seems to be very little benefit to any near-term efforts other than to transfer the methodology to industry.
- When relevant data from industry becomes available, the reference models should be revisited and be updated.

Strengths and Weaknesses

Project Strengths

- See comments on WHP140001.
- The project provided the Labs with a valuable learning experience that would not have otherwise been available.
- Open source software is a positive goal and will encourage other to continue work.
- The project produced a tool that will hopefully be usable to DOE and industry.

Project Weaknesses

- See comments on WHP140001.
- No obvious weakness for NREL work.

Specific recommendations for additions or deletions to the work scope

- See comments on WHP140001.
- The near-to-market commercialization status of tidal power technology suggests that DOE should reconsider funding emphasis for wave technology development, and instead offer parity funding to tidal and wave power technology. The quickest path forward for MHK sector development overall is to finish the mission on the nearest to market technology and secure successful deployment of that technology within the US and globally. Demonstrate success with your most viable product. If DOE commits to completion of tidal power commercialization ASAP, it will not only have a success story for the MHK sector, but it will also generate very valuable cost reduction lessons learned for wave technologies on Manufacturing, O&M, and supply chain development.
- Recommend that the methodology for cost estimation be rolled out to industry for evaluation and possibly used for future FOAs.
- Wrap up reference model work by getting it to a stage where the models can be used by industry and graduate students. These follow-on efforts will more than likely lead to incremental improvements in the models. In this manner, DoE will have made a great contribution to the MHK industry.
- Important to encourage NREL to obtain actual consumer information on application of the technology assessment methodology, so that the real value of the technology to the industry can be assessed, and the technology can be refreshed if valuable to the industry in the future.
- Recommend that the program be substantially cut back to a very low level of support and revisited at the next Peer Review, or as data from in-water demonstrations are available for comparison to model predictions.

WHP140003

Project Title:

Reference Models

Principal Investigator:

Andrea Copping

Organization:

Pacific Northwest National Laboratory

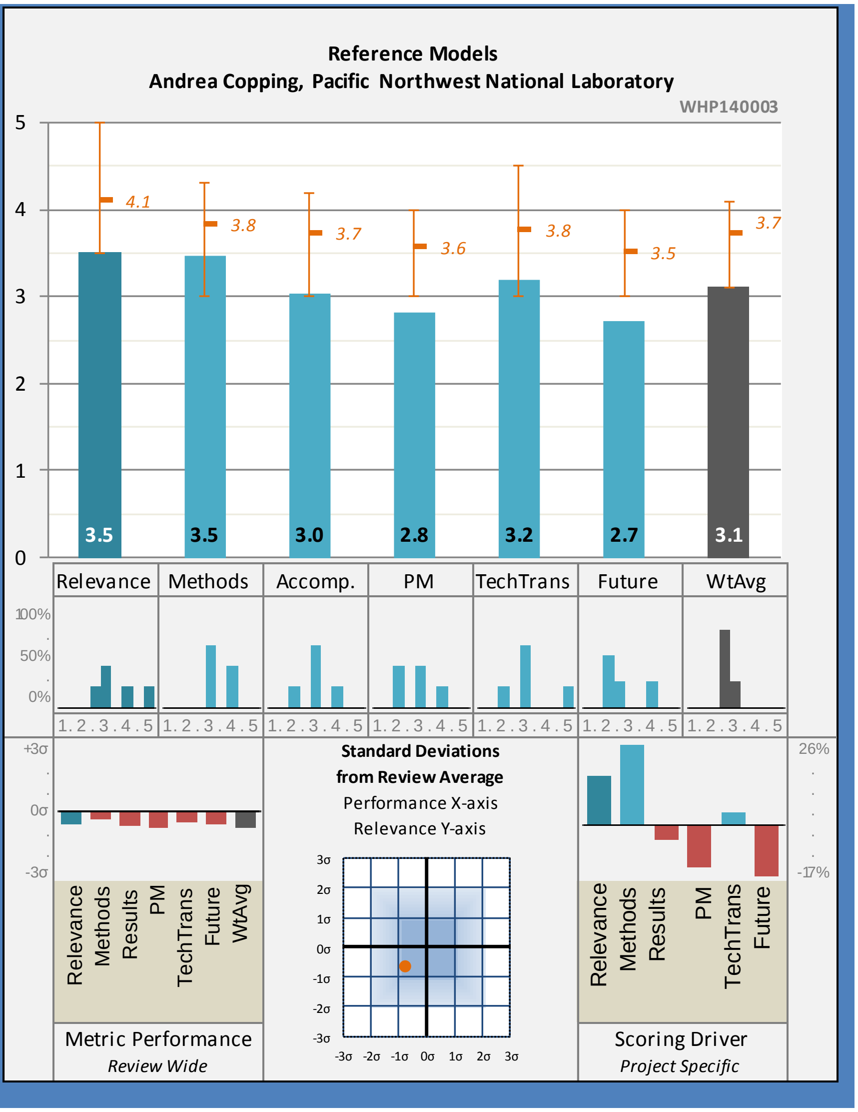
Panel:

Computational Modeling & Analysis

Budget:

$607,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.5** for its Relevance to water industry needs and overall DOE objectives.

- It will help in the long term to have a "road map" for the permitting environment, but it was difficult to understand how this is not a repeat of what is currently being done by the private industry supporting a device deployment.
- Comments on architecture of overall project are included in worksheet on Dr. Neary presentation. Comments on the specific component of environmental permitting component of the project are included here.
- As part of the Reference Model effort, PNNL has studied the impact of environmental siting & permitting on LCOE. This will provide valuable insights for industry as evidenced by issues noted in virtually all in-water demonstrations.

- Anticipating the environmental impacts of the reference models will be extremely helpful to the MHK industry.
- See previous comments on reference models. Device specific estimates of environmental permitting costs based on models are of questionable value. Permitting costs will largely be driven by site location and proper siting will always be the best way to reduce cost of environmental permitting and studies.
- The feasibility and accuracy of this model remain to be determined, given the significant variation in environmental and permitting costs for projects, even those with the same permit requirements.
- PNNL provided feedback to the rest of the Reference-model team, but the details of how RM5 were revised is not stated.
- Permitting costs can also be expected to change over time with a larger cost for the first devices and arrays that are installed and hopefully lower costs in the future as issues are understood and either dismissed or properly avoided or mitigated.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.5** on its methods/approach.

- A positive step is involving the regulatory agencies (I like this methodology). NMFS was mentioned, however, I would recommend involvement of the USACE as well in future dialogue.
- Good those researchers consulted with federal environmental regulators to ensure that federal regulatory requirements would be accurately represented. But lack of state regulatory outreach is a weakness. Not clear how the variable state environmental requirements and permitting costs can effectively be projected in the model.
- The "Technical Approach" that is defined on Page 4 of the presentation is reasonable.
- Program is well run.
- Though I don't agree with the objective, their approach to trying to complete it seems sound.
- Inclusion of "MHK practitioners" and "regulatory agencies" in Peer Reviews is particularly valuable.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.0** based on technical accomplishments and progress.

- Work completed and results input into larger RM's.
- The accomplishments listed on Page 5 represent important work.
- Consideration of environmental effects will be very helpful to others.
- They completed scope and contributed to model development.
- While the accomplishments were good, the milestone schedule on Page 6 indicates that all tasks were delayed; some only briefly, but many for a full quarter.

Question 4: Project Management

This project was rated **2.8** on its project management.

- Little focus during the presentation on PM approach - appeared this role was overseen by V. Neary (see WHP140001).
- Failure to consult state regulators is a real weakness in the project design and management.
- PNNL describes delays as "waiting for information from engineering teams…" This seems consistent with the SNL presentation.
- Well-coordinated with other labs.

- Seems like was work was accomplished for a reasonable cost compared to other aspects of the modeling effort.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.2** for research integration, collaboration, and technology transfer.

- There appeared to be limited industry partnership (H.T.Harvey); a significant role lead by PNNL and other labs. This may have limited the expertise on the regulatory side.
- Helpful that the researchers reached out to federal regulators and developers, but experience teaches that state regulators can have a significantly different perspective and information requirements in environmental permitting scenarios. The complexity on a state-by-state basis likely outstrips the capacity of the model to accurately reflect permitting costs.
- The entities listed on Page 8 are all important collaborators.
- Collaboration is excellent. Worked with regulators and engineering team.
- Results were peer reviewed and presented to industry at GMREC '12.
- It was difficult to determine how the team reached out to the regulators and which agencies were contacted.
- The core value of the project may have been to work with federal regulators to understand the effect of monitoring requests and baseline assessments on project costs, but this value will be lost as regulatory personnel change. The planned regulatory training of MHK regulators will be helpful follow-on to this project.
- The lack of Industry representation (MHK Practitioners) on Page 8 is worrisome and is not consistent with Page 4.
- Held webinars and meetings.
- The lack of specificity on "regulatory agencies" on Page 8 is also worrisome, but may simply be an oversight in the presentation.

Question 6: Proposed Future Research

This project was rated **2.7** for proposed future research.

- Uncertain how futures would contribute to reducing permitting costs from a developer perspective.
- As noted in general project notes, researchers should track actual use of site and actively survey MHK device developers to determine the actual level of use and the public's perception of the utility and value of product. This information is critical to understanding whether this type of reference model project has any future utility.
- Slide 9 states that this effort is proposed to be completed in FY14. Since all of the industry participants seem to have had delays due to regulatory issues, there might be benefit to allowing this task to continue on a low level as proposed.
- I did not understand their proposed future research.
- Not clear what would be done or how this effort could reduce permitting costs.
- Consider carefully whether the costs of completing the RMs 5 and 6 are justified by consumer reviews on environmental components of the product already produced on RMs 1 through 4.
- In the future, if a reference model project is proposed, USDOE should consider alternatives to National Lab large project, long term budget. Such alternatives might include atomization of the software development as in recent USDOE initiatives, or competitive procurement to design the reference model and software.
- USDOE should challenge the environmental team to evaluate whether the research supports a finding that a standard set of terms and conditions could be developed for endorsement by all federal agencies for pilot projects as a "permit by rule" approach to FERC pilot projects and USDOE NEPA internal reviews. The

approach would streamline the costs and assure best practices (value of information, manner of gathering, reporting, etc.) in information requirements to standardize and streamline costs for both regulator and regulated communities. This is alluded to in the Next Steps portion of the presentation.

Strengths and Weaknesses

Project Strengths

- The careful study undertaken of the various information collection requirements for environmental permitting could serve as the basis for a Permit by Rule approach initiative within federal government for pilot projects, whereby all the federal agencies agree on a standard set of information requirements that should be sufficient for the light footprint of a pilot project. This would make a great contribution to reduction of barriers to MHK development and advance the industry.
- PNNL is studying an important issue for MHK, the cost and schedule impact of environmental siting and permitting.
- Collaboration with others is excellent.

Project Weaknesses

- It was hard to understand how the findings from this effort are incorporated into the RM's. This is a very qualitative and subjective topic, while the other portions of the RM's are very quantitative and precise.
- The great diversity in federal and state requirements for baseline assessments, post-installation monitoring, project documentation and other environmental planning and compliance requirements will likely defeat any reference model attempt to capture and calculate environmental "soft" cost contribution to LCOE.
- It is unclear that Industry has been adequately represented in this study.

Specific recommendations for additions or deletions to the work scope

- As noted above, follow on monitoring of actual use of the product and outreach to MHK developer user community to obtain consumer feedback on product will be instructive for future planning of similar projects or any work to validate this model.
- This is an aspect of CMA that should be continued at a low level of support as it is likely to provide guidance to industry.
- Wrap up reference model work by getting it to a stage where the models can be used by industry and graduate students. These follow-on efforts will more than likely lead to incremental improvements in the models. In this manner, DoE will have made a great contribution to the MHK industry.
- USDOE should carefully examine whether the project data could support a cross agency initiative to simply and expedite pilot project development through a standard permit by rule process with standardized best practices requirements.
- Industry MUST be more tightly integrated into this effort.

WHP140004

Project Title:

Wave Energy Converter Modeling

Principal Investigator:

Michael Lawson

Organization:

National Renewable Energy Laboratory

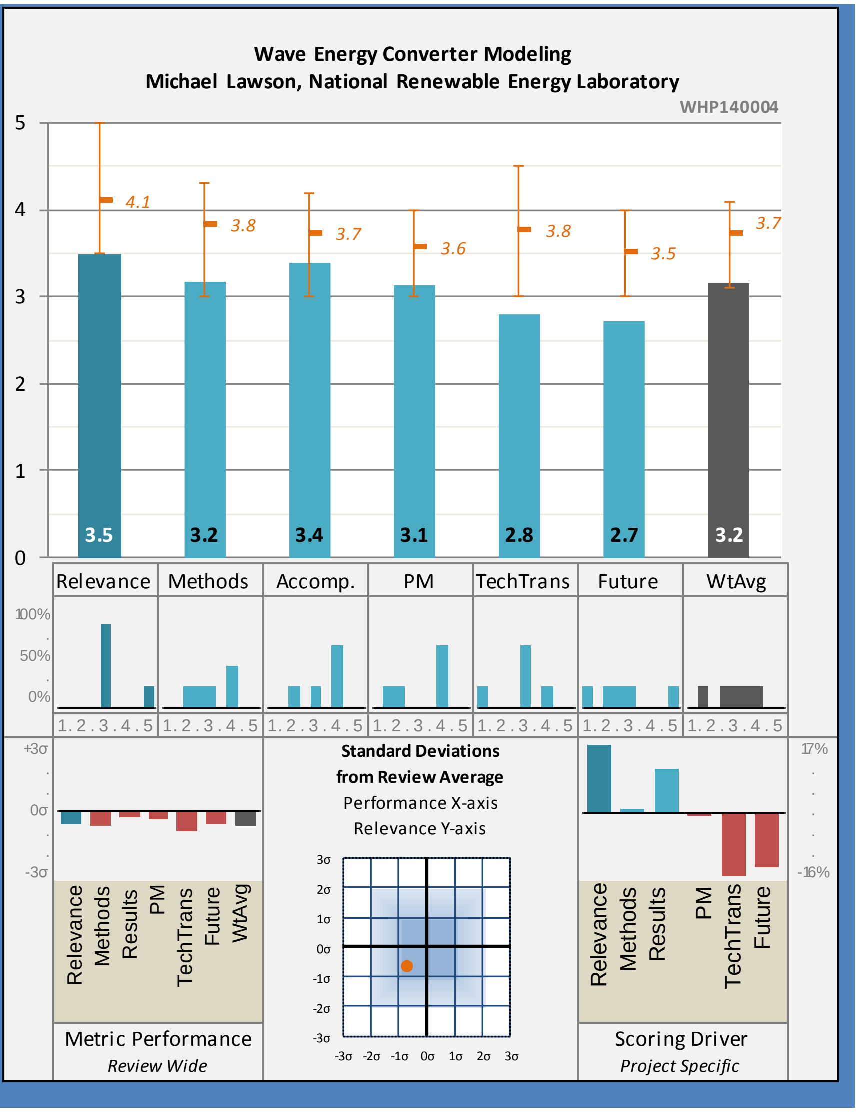
Panel:

Computational Modeling & Analysis

Budget:

$1,500,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.5** for its Relevance to water industry needs and overall DOE objectives.

- Positive: Providing open source models to developers is a very good approach. I would assume late stage developers (TRL 6+) would be able to use some of this conceptual information already.
- Helpful to have open software product to model WEC devices, and allow access to under-funded potential designers and developers. Written presentation was not clear whether the existing proprietary software is so expensive as to create a true barrier to design of reliable and cost-competitive WEC device. Response to follow up question provided an estimate of $40,000 a year for the proprietary software of choice, which tends to confirm the usefulness of the product, but the open source product benefits the global industry, not just the US industry. A business case statement evaluation should be required on the existing options before any

decision to proceed with this type of open source project in future, including options to creatively engage the companies that have invested in proprietary software.

- The project develops open-source software to assess the performance of WEC devices under operational and extreme conditions.
- Open-source tools will be of great benefit to field.
- Concept of providing open source models to developers and others sounds reasonable but it's not clear how helpful this will be to developers who are still struggling with improving the technology of their devices and proving that they won't have environmental effects.
- Negative: It is not clear how this will help early stage developers (TRL 1-5).
- Big ticket project; value of the product to MHK industry development must be evaluated in terms of public receptivity to product.B40.
- There is probably some value to DOE in having a resource (NREL) that is able to make independent assessments of industrial claims, it seems likely that Industry is already making these calculations as a part of "good design practices" using whatever in-house or commercial tools suit the needs of the developer. In other words, the value of this effort to Industry is questionable.
- Simulation capability will improve estimates of how much energy can be produced by wave energy converters. This will lead to more realistic expectations.
- Models are being run with reference models that have not been validated by actual operating machines.
- Modeling extreme conditions will be very useful. A major drawback to ocean energy is the uncertainty of whether the devices can survive hurricanes and other extreme ocean storms.
- There appears to be no interaction with industry to determine if this will meet their needs or even if they have this need.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.2** on its methods/approach.

- Positive: Using information developed in other industries (oil & gas) to help build the model
- Presentation did not document how the labs accessed prior research and learning by other labs, including ongoing research that may not be reflected in a published literature search, especially on WEC extreme events modeling.
- NREL applies complex numerical analysis tools early on in the design process. Unfortunately this is the direction that the general practice of engineering seems to be taking, even when a relatively simple analysis based on first principles is adequate.
- Code competition is a great idea.
- Not sure if this is correct but in reading information and hearing presentation I believe the government labs are buying commercially produced codes and trying to come up with ways to duplicate them and make them publically available, and are using the commercial codes to validate their work. Seems like this should be looked at closely by some patent attorneys as I would think the commercial code developers would not view this favorably.
- Negative: As I understand it, the governments labs are buying publicly produced codes and then duplicate them. These duplicates will then be publically available. Are the commercial code developers ok with this?
- Code development included encouraging use of atomized approach and use of code competitions as innovative approaches to tap existing code expertise.
- There does not appear to be any interaction with industry to determine if this is useful. The length of time it will take may make it less useful to developers who are trying to put devices in the water now.
- Negative: There appears to be no device developer input, but they are the end user.

- Purpose is to save developers money from having to purchase rights to use code or pay someone else to do analysis. What if instead of this DOE set up a fund to help developers pay for code, provided free consulting to developers using commercial codes, and/or funded fellowships, post docs to work with developers?

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on technical accomplishments and progress.

- Similar to the RM's, it is hard for me to understand what the products are from the efforts to date.
- NREL has completed in-house code development and demonstrated it for an RM5 pitching WEC
- Code-to-Code comparison is a good idea.
- For the money spent this doesn't seem like much.

Question 4: Project Management

This project was rated **3.1** on its project management.

- Will this project really be completed within the project timeline? I find it hard to believe.
- NREL's part of the effort appears to be on schedule and (possibly) underspent. Care should be taken to assure that future efforts be reviewed with an eye toward possible cost recovery by DOE
- Good coordination between the two labs.
- Have spent over 2.5 million so far with more costs anticipated? Tough to understand budget but important to compare value if it is primarily to save developers from buying a 40K license to use commercial software. Developers will still need to hire someone to run the models which are a big part of their cost.
- Hard to determine what exactly was the budget for this portion of the greater budget.
- As with most of the budget slides, it is difficult to make an assessment, but the FY14 budget estimate seems high for the potential contribution of this effort. Based on the wrap-up, the distinction between costs and allocated funding is often difficult to see.
- Supposed to be complete in 2014 but it doesn't seem like it will be.
- NREL has accomplished its milestones on time and in one case a full quarter early, if I read the 8th line on Page 4 correctly.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.8** for research integration, collaboration, and technology transfer.

- No input from industry who would ultimately be the end user.
- Strong inter-lab research coordination and strong communications and technology transfer effort documented in presentation.
- NREL/SNL collaboration seems reasonable.
- Good coordination between the two labs.
- No interaction with industry who this is supposed to be benefitting.
- Distribution of WEC-SIM through github and listed webpages will be helpful, and USDOE should work with SNL to refine the planned WEC-SIM user outreach and training planned for WEC developers and research institutions to assure that the product end user support is adequate.
- No collaboration with Industry partners is noted other than papers, presentations, and workshops. Industrial partners are likely to provide the best guidance on the value of open-source tools versus COTS and in-house methods.

Question 6: Proposed Future Research

This project was rated **2.7** for proposed future research.

- What is the difference between the proposed SOW of this project and what was presented "evaluate the pros/cons of moving to a fully open-source code"? Wasn't this the intent of this study?
- USDOE should request that the grant recipients gather end user review of the product so that USDOE can evaluate the utility of the product, and whether it meets MHK developer needs, or whether they revert to proprietary software. The product should be useful for academic teaching applications in any event.
- In the near term, there seems to be limited value for pursuing this effort beyond what is already funded for FY14. The funds would be better spent on efforts that will assist in "getting steel in the water."
- Lab test validation is a great idea and is essential. Then follow on to field validation.
- Presentation says "Evaluate the pros/cons of moving to a fully open-source code" will be a future research need. I thought that was the original intent of this project.
- Any future research should be carefully coordinated with USN, NOAA, and USACE as well as other academic centers which have extensive learning on the Extreme Event modeling topics.
- Extreme events modeling would provide valuable information to the MHK field.

Strengths and Weaknesses

Project Strengths

- If the business case has been made of the need for open source software, and if the product is evaluated as useful by the public, these would be the project strengths. Enabling universal access to design tools is strength.
- There is clear precedent for Government to develop open-source software for analyzing important problems when Industry didn't see the need to do it.
- Planned wave tank validation.
- Atomization approach is innovative approach to project and provides helpful learning for future coding projects.

Project Weaknesses

- Non-open-source, but validated, software already exists and can be used by skilled practitioners to make reliable calculations. While this software is widely perceived to be expensive, it is far from certain that there will be an acceptable return on the Government's investment in creating open-source versions.

Specific recommendations for additions or deletions to the work scope

- Extreme Events modeling component should include a FY14 milestone to include outreach to federal and academic centers of excellence in the field to assure that current research at those institutions is fully leveraged (not just published literature review of past research).
- I would recommend that the scope of WEC-Sim be either substantially reduced or eliminated in favor of efforts that are directed more directly to "getting steel in the water."
- Continue.
- Consider a peer review of the product before launch.
- Require the labs to include public feedback loop in the open source publication space so that users can comment on the strengths and weaknesses of the product, and product can be updated if useful.

WHP140005

Project Title:

Wave Energy Converter Modeling

Principal Investigator:

Kelley Ruehl

Organization:

Sandia National Laboratories

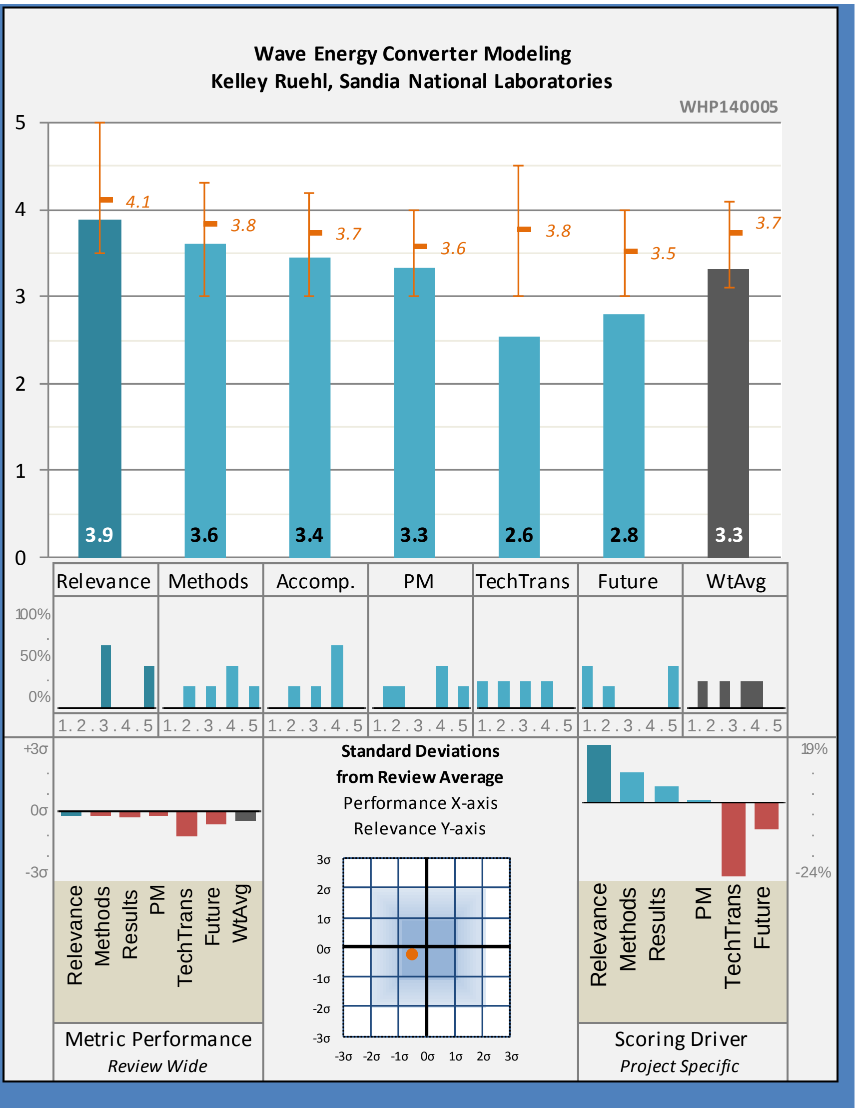
Panel:

Computational Modeling & Analysis

Budget:

$1,200,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.9** for its Relevance to water industry needs and overall DOE objectives.

- See WHP14004 comments - very similar project in both concept and approach.
- Excellent presentation with clear explanation of the rationale for the project design to include TopCoder community.
- The project addresses the performance of Point Absorber WEC devices under operational and extreme conditions and is developing open-source tools & techniques to do that.
- Open-source tools will be of great benefit to field.
- Concept of providing open source models to developers and others sounds reasonable but it's not clear how helpful this will be to developers who are still struggling with improving the technology of their devices and proving that they won't have environmental effects. Will it be done in time to help them?

- Innovative approach to include GitHub and Top Coder communities as innovative resources to accelerate MHK tools and industry development.
- While there is probably value to DOE in having a resource (NREL) that is able to make independent assessments of industrial claims, it seems likely that Industry is already making these calculations as a part of "good design practices" using whatever in-house or commercial tools suit the needs of the developer. In other words, the value of this effort to Industry is questionable.
- Simulation capability will improve estimates of how much energy can be produced by wave energy converters. This will lead to more realistic expectations.
- Models are being run with reference models that have not been validated by actual operating machines.
- This is some of the most innovative, exciting work by the young members of the USDOE and federal laboratory teams to leverage innovation resources to accelerate development.
- Modeling extreme conditions will be very useful. A major drawback to ocean energy is the uncertainty of whether the devices can survive hurricanes and other extreme ocean storms.
- There appears to be no interaction with industry to determine if this will meet their needs or even if they have this need.
- These comments go to the execution of this component of the WEC modeling project - an excellent and creative project design and execution, which will build the community of contributors to MHK tools and industry development - the overall project need and design is addressed in the framework presentation review above.
- Comments on this are same as previous since information provided for both was the same.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.6** on its methods/approach.

- See WHP14004 comments - very similar project in both concept and approach.
- Excellent project design; going forward it will be important to capture the learning of the other academic and federal centers of learning on the substantive learning, and any applications of prior code products in the context of Extreme Events Modeling.
- SNL applies complex numerical analysis tools early on in the design process. Unfortunately, this is the direction that the general practice of engineering seems to be taking even when a relatively simple analysis based on first principles is adequate.
- Code competition is a great idea.
- Not sure if this is correct but in reading information and hearing presentation I believe the government labs are buying commercially produced codes and trying to come up with ways to duplicate them and make them publically available, and are using the commercial codes to validate their work. Seems like this should be looked at closely by some patent attorneys as I would think the commercial code developers would not view this favorably.
- There does not appear to be any interaction with industry to determine if this is useful. The length of time it will take may make it less useful to developers who are trying to put devices in the water now.
- Purpose is to save developers money from having to purchase rights to use code or pay someone else to do analysis. What if instead of this DOE set up a fund to help developers pay for code, provided free consulting to developers using commercial codes, and/or funded fellowships, post docs to work with developers?

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on technical accomplishments and progress.

- See WHP14004 comments - very similar project in both concept and approach.

- It will be important for USDOE to assure that the publication of the product on Github and other sites capture public feedback to assess product utility for MHK industry.
- SNL has achieved good agreement between 1 DOF results from WEC-Sim and three commercial codes. They have also produced 3D results that agree well with one of the three commercial codes and which are not easily extracted from the other two.
- Code-to-Code comparison is a good idea.
- Appears to be a lot left to do to accomplish original objectives.

Question 4: Project Management

This project was rated **3.3** on its project management.

- See WHP14004 comments - very similar project in both concept and approach.
- SNL states that "All WEC modeling tasks are currently on schedule", but doesn't provide an individual schedule.
- Good coordination between the two labs.
- Have spent over 2.5 million so far with more costs anticipated? Tough to understand budget but important to compare value if it is primarily to save developers from buying a 40K license to use commercial software.
- As with most of the budget slides, it is difficult to make an assessment, but the FY14 budget estimate seems high for the potential contribution of this effort. Based on the wrap-up, the distinction between costs and allocated funding is often difficult to see.
- Supposed to be complete in 2014 but it doesn't seem like it will be.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.6** for research integration, collaboration, and technology transfer.

- No active private industry partnership.
- Good progress, but USDOE should assure Extreme Events Modeling fully leverages existing federal agency and academic center knowledge and current research. More outreach is needed than Literature Review - active outreach to USN, USACE and NOAA is vital.
- NREL/SNL collaboration seems reasonable.
- Good coordination between the two labs.
- No real interaction with industry.
- Workshops will be vital to support end user access to product. Consider evergreen workshop presentation for end user access, such as YouTube or other platform.
- No collaboration with Industry partners is noted other than papers, presentations, and workshops. Industrial partners are likely to provide the best guidance on the value of open-source tools versus COTS and in-house methods.

Question 6: Proposed Future Research

This project was rated **2.8** for proposed future research.

- See WHP14004 comments - very similar project in both concept and approach.
- Completion of this component for the Extreme Event Modeling is high priority, in order to capture the value of work to date.
- In the near term, there seems to be limited value for pursuing this effort beyond what is already funded for FY14. The funds would be better spent on efforts that will assist in "getting steel in the water."

- Lab test validation is a great idea and is essential. Then follow-on to field validation.
- Presentation says "Evaluate the pros/cons of moving to a fully open-source code" will be a future research need. I thought that was the original intent of this project.
- Extreme events modeling would provide valuable information to the MHK field.

Strengths and Weaknesses

Project Strengths

- Looking to incorporate a cross-culture of experts during the workshops.
- There is clear precedent for Government to develop open-source software for analyzing important problems when Industry didn't see the need to do it.
- Planned wave tank validation.

Project Weaknesses

- Not clear that other federal and academic centers of excellence in Operational and Extreme Event modeling have been fully tapped and active outreach to coordinate is needed.
- Non-open-source, but validated, software already exists and can be used by skilled practitioners to make reliable calculations. While this software is widely perceived to be expensive, it is far from certain that there will be an acceptable return on the Government's investment in creating open-source versions.

Specific recommendations for additions or deletions to the work scope

- Consider expert independent peer review evaluation of product prior to live publication on GitHub.
- I would recommend that the scope of WEC-Sim be either substantially reduced or eliminated in favor of efforts that are directed more directly to "getting steel in the water."
- Continue.
- Assure portal for public feedback on product.

WHP140006

Project Title:

OpenWARP Coding Competition

Principal Investigator:

Andy LaMora

Organization:

TopCoder

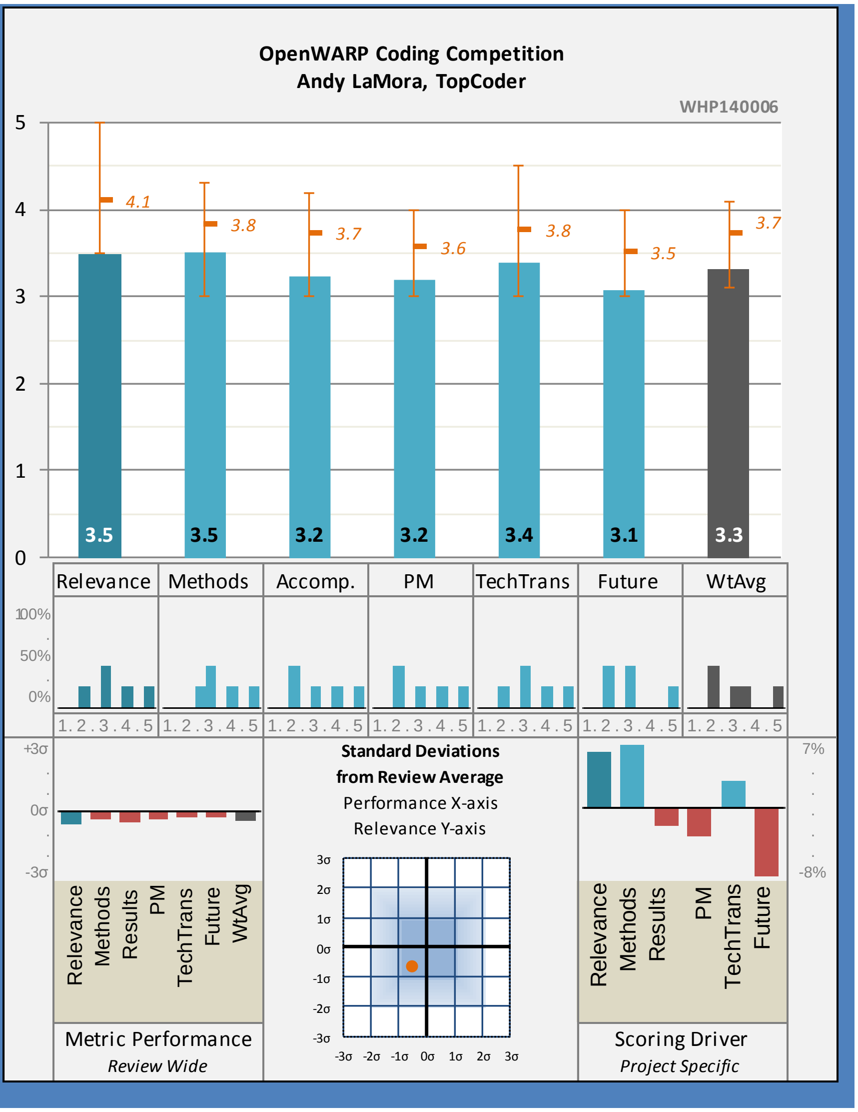
Panel:

Computational Modeling & Analysis

Budget:

$399,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.5** for its Relevance to water industry needs and overall DOE objectives.

- As noted in Review of Ruehl presentation, the TopCoder component of the project is an outstanding innovation in USDOE Water Power Program project design and management, allowing USDOE to better leverage existing expert resources in the coding community.
- This project seeks to provide an open-source Boundary Element Method (BEM) module for WEC-Sim based on contests between "Top Code Competitors." This module is identified as the most expensive portion of WEC-Sim, but COTS modules exist. It is unclear that this is a productive effort.
- Interesting concept. If successful, results will be very useful.
- See comments on the other aspects of the WEC modeling.

- Encourage follow up presentation in next review round with evaluation of the strengths and weaknesses of the TopCoder component in retrospect at conclusion of the WEC modeling project. Current presentation of the project indicates that this was a strong upgrade, allowing USDOE to access public and private expertise quickly and economically.
- An offshoot of modeling program - but that program cost has been over 3 million? And now is going out to the coding community to try and solve code issues through a competition and finding NEMO - a model that was previously developed and may supply some of the required info.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.5** on its methods/approach.

- Careful evaluation of the pilot project should be encouraged by project participants and USDOE staff with sharing of lessons learned to enable other USDOE projects to adopt the atomization and TopCoder approach, as well as other avenues to tap the "Cognitive Surplus" in MHK and other disciplines.
- This approach is certainly unique, but it is too early to say how effective it is.
- Very innovative.
- Seems like an interesting way to try and find a solution but with all the great mathematical minds and supercomputing ability of the national labs available to do this why go out to basement computer programmers?

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.2** based on technical accomplishments and progress.

- Found a model that may (or may not) work.
- There doesn't appear to be a great deal of progress.
- Good response from the non-MHK community.
- Primary accomplishment so far is finding Nemo which may or may not be useful to the work.
- The presentation states "87 participants new to WEC have learned about the technology and library". This statement is highly misleading because only7 of the participants attempted an implementation. This implies that the remaining 80 were not qualified.
- Schedule issues addressed under Q4.

Question 4: Project Management

This project was rated **3.2** on its project management.

- Hard to follow what the exact budget for this effort was and if the project was managed on time and within budget.
- USDOE's staff did excellent work in reaching out to the TopCoder and GitHub resources. This is best in class thinking and innovation to leverage limited federal resources for a top quality product.
- Presentation states "On time for Milestone 1 (Mesh Generator)", but the schedule shows a slip of a full quarter from the original plan.
- Well executed project.
- Very little budget info provided - only in presentation as no project summary was provided and from the slide it looks like they will be under budget but it was not clear.
- Presentation states "Milestone 2 on-time (but untested)". This statement is meaningless unless it is clear if Testing should have been part of Milestone 2.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.4** for research integration, collaboration, and technology transfer.

- Everyone from national lab experts to basement modelers are working on this. Not sure if this is a good thing or bad.
- This project seems reasonably integrated into the overall development of WEC-Sim
- Collaborative project.
- Some prestigious names attached to the effort (Harvard, NASA) but not much clear involvement from these groups and outreach is primarily to a largely anonymous group hoping they will supply answers instead of dissemination of results to others.
- Collaboration with "87 participants" is misleading. Most appear unqualified based on only 7 submitting.
- As with the rest of the WEC-Sim effort, there is no collaboration with Industrial partners, who are listed as the ultimate users of the product.

Question 6: Proposed Future Research

This project was rated **3.1** for proposed future research.

- More competitions planned or is the PI planning to review and refine the information already gathered?
- Careful evaluation of the strengths and weaknesses of this project is important to capture lessons learned and assure that the most effective possible use is made of the TopCoder project model in future projects.
- Several discrepancies noted between Project Plan and future Research. Some items shown as complete are included in Future Work.
- Some additional competitions planned?
- Some Future Research items are not identified on the Scope Statement.
- In the near term, there seems to be limited value for pursuing this effort beyond what is already funded for FY14. The funds would be better spent on efforts that will assist in "getting steel in the water."

Strengths and Weaknesses

Project Strengths

- Great pilot project. Seems to be important to create a relatively steady flow of projects to encourage the well-qualified coders who have been cultivated by the projects and systems.
- The concept of developing software based on contests between qualified, independent suppliers who would not normally be able to bid on Federal Contracts has a great deal of merit in some applications.
- Collaboration with non-MHK programming community.

Project Weaknesses

- Will be interested in project managers' assessment of whether the increased administrative load of the atomization approach pays off with the product and cost reductions.
- Non-open-source, but validated, software already exists and can be used by skilled practitioners to make reliable calculations. While this software is widely perceived to be expensive, it is far from certain that there will be an acceptable return on the Government's investment in creating open-source versions.

Specific recommendations for additions or deletions to the work scope

- Detailed review of project by USDOE for lessons learned and TopCoder 2.0 Project in near term to advance the project model if feasible on other Water Power Program projects.
- I would recommend that the scope of WEC-Sim be either substantially reduced or eliminated in favor of efforts that are directed more directly to "getting steel in the water."
- Continue.

WHP140007

Project Title:

Advanced WEC Controls NEW

Principal Investigator:

Tim Crawford

Organization:

Sandia National Laboratories

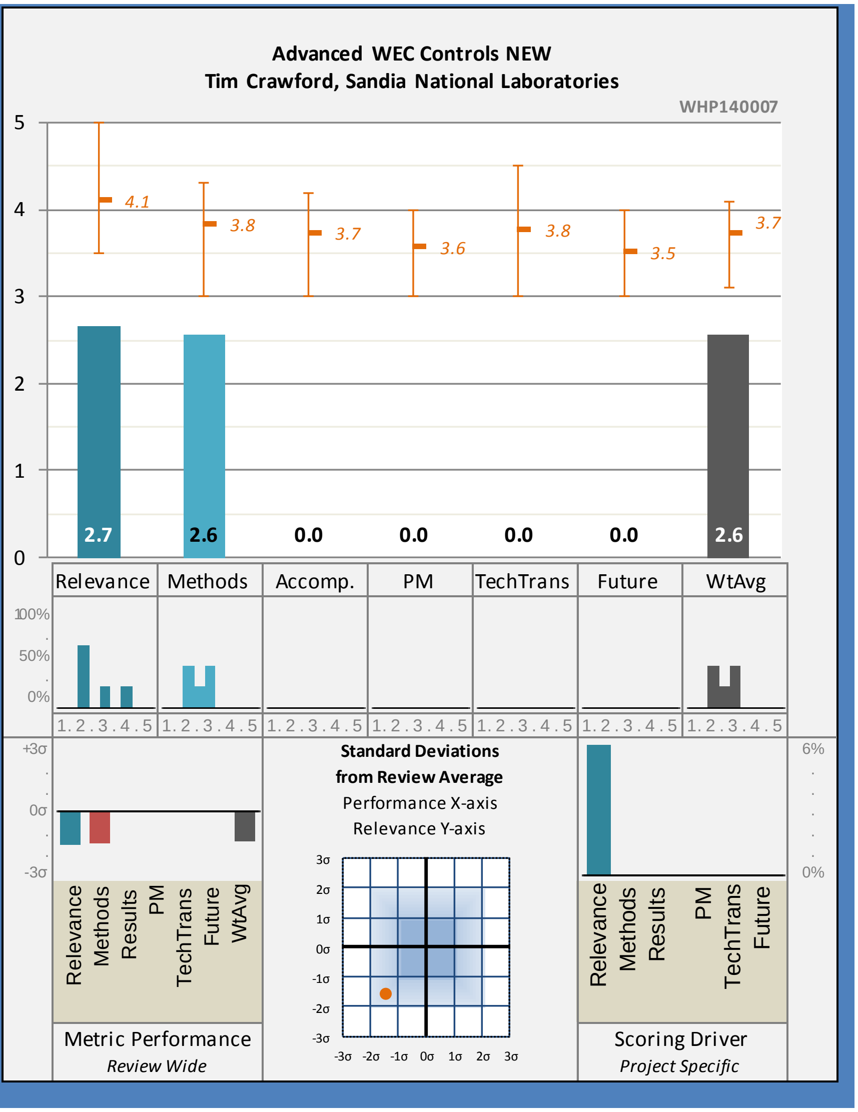
Panel:

Computational Modeling & Analysis

Budget:

$500,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **2.7** for its Relevance to water industry needs and overall DOE objectives.

- It is hard to understand what the actual controls will be.
- The stated purposes of the project - to reduce the LCOE of WEC's through improvement of power conversion characteristics is a very high priority for MHK industry.
- The stated objective of a 50% reduction in LCOE based on the use of advanced controls appears to be based on an observation that a particular type of WEC is tuned for a narrow band of wave energy and not on any estimate of what can be achieved thru controls.
- If the project goal of a 50% reduction in LCOE is successful, it will be very helpful to the MHK field. Not clear that development of open source software is best path forward for this purpose. No clear reason that the

existing US investment through DARPA or other resources could not be best applied through NITC and Manufacturing Extension Partnerships on specific MHK developers.

- This program makes grand promises to double output of all wave energy devices through development of better control systems but doesn't provide much detail on how this will be accomplished. This is an issue that already has seen a substantial amount of work from the academic and development community but the information supplied on this work does not indicate it will build on any of that work.
- Very vague as to how the controls will double output of a device.
- This project appears (from a very high level) to duplicate an OPT effort being funded under SBIR/STTR
- Examples of other work on controls were presented during the peer review including a number of awards under the SPA FOA, a poster from OPT that discusses their work on this issue, OSU presentation discussed work on controls and concerns about whether increased controls could lead to increased O&M issues for operating devices. That type of analysis does not appear to be part of this effort. To what extent will this work build on the work that has already been done in this area?
- Right goal - unconvinced this is the right strategy to achieve the goal.
- Not clear what type of actual controls would be looked at.

Question 2: Methods and Approach to performing the research and development

This project was rated **2.6** on its methods/approach.

- While the approach is vague, it is (in theory) applicable to the whole industry and is not a specific design.
- Not clear that this objective would not have been better achieved through competitive procurement to existing proprietary software providers in the space, or through competitive procurement to US MHK developers.
- The approach is very vague and no specific control technique is identified.
- Goal seers overly optimistic and perhaps not feasible. Can we really get a 50% reduction?
- The approach is somewhat vague - the project summary seems to suggest largely numerical modeling work but also building an actual wave energy device and testing it in a tank. It would seem like more progress would be made if researchers partnered with existing device developers and used those devices instead of creating a new one.
- It was difficult to distinguish what the aim of this project is doing versus individual developers testing their devices during tank tests.
- Access to MHK company proprietary information will be essential to project completion, but raises significant IP protection concerns for the companies.
- There is no indication that this work will build on results already discovered by others in the wave energy field and seems to be relying more on expertise developed for DOD work.
- Partners have not yet been identified.
- This is a 5 year program with 800K+ in first year, no budget info for future years shown. This should be closely monitored to determine if it should continue to be funded.

Strengths and Weaknesses

Project Strengths

- Excellent strategy to "Leverage advanced controls expertise from past DOD/DARPA projects to address inherent nonlinearities of WECs."
- Clearly there is a knowledgeable staff within SNL for this work and their expertise would benefit the MHK effort.
- Excellent strategy to employ validation testing.

Project Weaknesses

- Major potential weakness of project is found in the concern/hesitation of WEC developers to share proprietary data on their respective power conversion controls performance. USDOE should work as honest broker between the Labs and MHK developers to surface and address any IP/know-how confidentiality concerns and efficiently address same with legal counsel. This will avoid the delays and expense involved in lengthy negotiations.
- This effort would be much better performed by OPT or another qualified industrial partner.
- Goals seem overly optimistic.
- No clear strategy to leverage prior EU or other international funded projects on power controls. Later presentation by OPT reviews major EU grant to develop power takeoff controls - will that project data be available to this project?
- The project will produce publicly available results, applicable to the whole industry - therefore the USDOE is advancing global MHK industry, using performance data from US companies that may be most advanced in this field already. This suggests that a better alternative would be to control and channel the know-how/product to US industries.
- No case was made that there is a shortage of proprietary software or other private sector expertise to achieve this same objective. No business case evaluation was performed to determine whether MHK industry of US would be better advanced by proprietary investment in specific technologies, rather than advancing global competitors as same pace.

<u>Specific recommendations for additions or deletions to the work scope</u>

- Detailed interviews with MHK developers to determine their willingness to share essential data and the utility of the planned project output is essential to understand whether this project will end up advancing, or disadvantaging US developers by eliminating their advantages in the power conversion controls space.
- I believe that this is a case where a National Lab is not the best choice for undertaking a specific task. More benefit would likely accrue from assigning Mr. Crawford to oversee the SBIR/STTR work at OPT.
- Continue.
- Detailed interviews with major players in supply chain in this space will reveal whether the project is duplicative of private sector services and products.

WHP140008

Project Title:

Tidal Research: Model Development and Field Measurement Campaign NEW

Principal Investigator:

Bob Thresher

Organization:

National Renewable Energy Laboratory

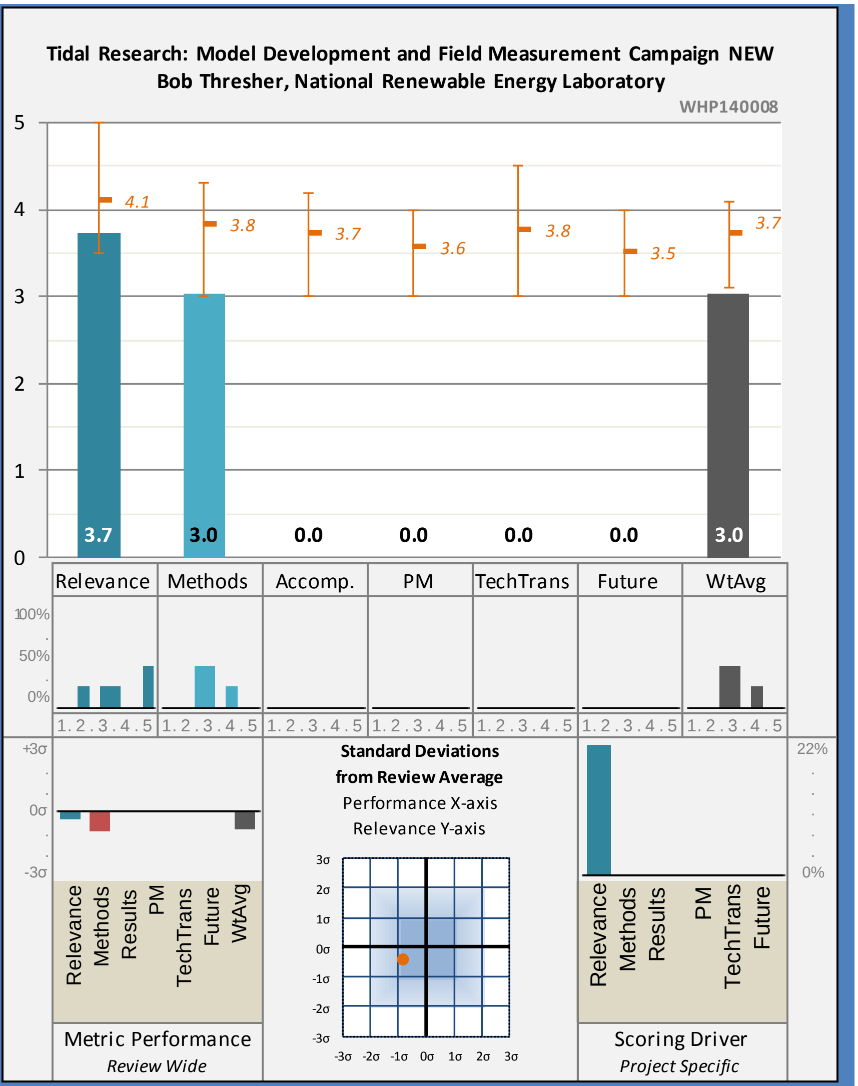
Panel:

Computational Modeling & Analysis

Budget:

$225,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.7** for its Relevance to water industry needs and overall DOE objectives.

- Good to see a project gathering field data to verify models.
- The stated goal of developing performance and load simulation tools and in depth field measurements to validate those tools to enable accurate prediction of the commercial viability, performance, and reliability of marine current turbines is a high priority for advancement of MHK industry.
- The Project seeks to validate the performance of open-source simulation tools via field measurements. This would have value for the industry as a whole, if issues of proprietary information can be resolved, but it is not clear why the MHK Industrial Partners would not do this as a part of their normal development process
- Good to see field measurements on a full scale device.

- Good to get field data that can help validate and calibrate models.
- The project cost (approx. $1.9 mill) seems very excessive, considering labs may be able to piggy back off of industry.
- Not clear from presentation whether any business case evaluation was conducted by USDOE on whether private sector alternatives existed, and would have been more cost effective as stand-alone or blended project.
- Not clear if models are being developed concurrently as part of this project or in other effort. Would be good to have models reviewed by hydrodynamic modeling experts - using wind model as a base seems like it could be problematic, especially with all the good hydrodynamic models that have been developed.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.0** on its methods/approach.

- Somewhat vague on how this work will be performed.
- Excellent leverage of prior DOE investments in wind power turbine models and national lab expertise, but unclear whether there has been active outreach to USN or other federal agencies on their current research in these areas.
- The overall testing program as defined by NREL is reasonable and matches with the work reported by SNL and PNNL
- Good plan.
- They haven't identified an actual field site yet. Conceptual sketch of field parameters to be measured includes tower ADVs and a ADVs mounted on a subsurface float but it not clear how these would be anchored or attached to the bottom which is not an easy thing to do in a dynamic tidal environment. The grid scanning with boat mounted ADCP can also be a very difficult thing to do in a dynamic tidal environment and the tight grid of these measurements shown on the schematic would be difficult to achieve in the field.
- Unclear whether any effort is made to capture prior international research work or data generated on these topics.

Strengths and Weaknesses

Project Strengths

- Leveraging of prior USDOE investments in wind turbine research.
- Well-planned validation of open-source models.
- Field data.
- Getting actual data around operating turbines will be key information for model validation.

Project Weaknesses

- Labs will need proprietary data from MHK developers in field measurement campaign. This is likely to cause extended delays as MHK developers raise concerns about proprietary data and rejection if shared with the labs for this study.
- Lack of industrial participation significantly reduces its usefulness.
- I am concerned that we are spending funds on a turbine that can then be proprietary. But I understand that this is sometimes necessary.
- Progress is minimal. A turbine supplier has not been identified.

Specific recommendations for additions or deletions to the work scope

- To eliminate the project delays and legal expenses for both MHK developers and labs, USDOE should take an active honest broker role to ensure that the IP issues are fully addressed in efficient manner to expedite the project while reassuring the MHK developers that their concerns have been addressed.
- Expedite the overall program with the full participation of an industrial partner or consider cancellation
- Continue.

WHP140009

Project Title:

Tidal Device Research: Field Measurement Campaign to Validate Modeling Tools NEW

Principal Investigator:

Marshall Richmond

Organization:

Pacific Northwest National Laboratory

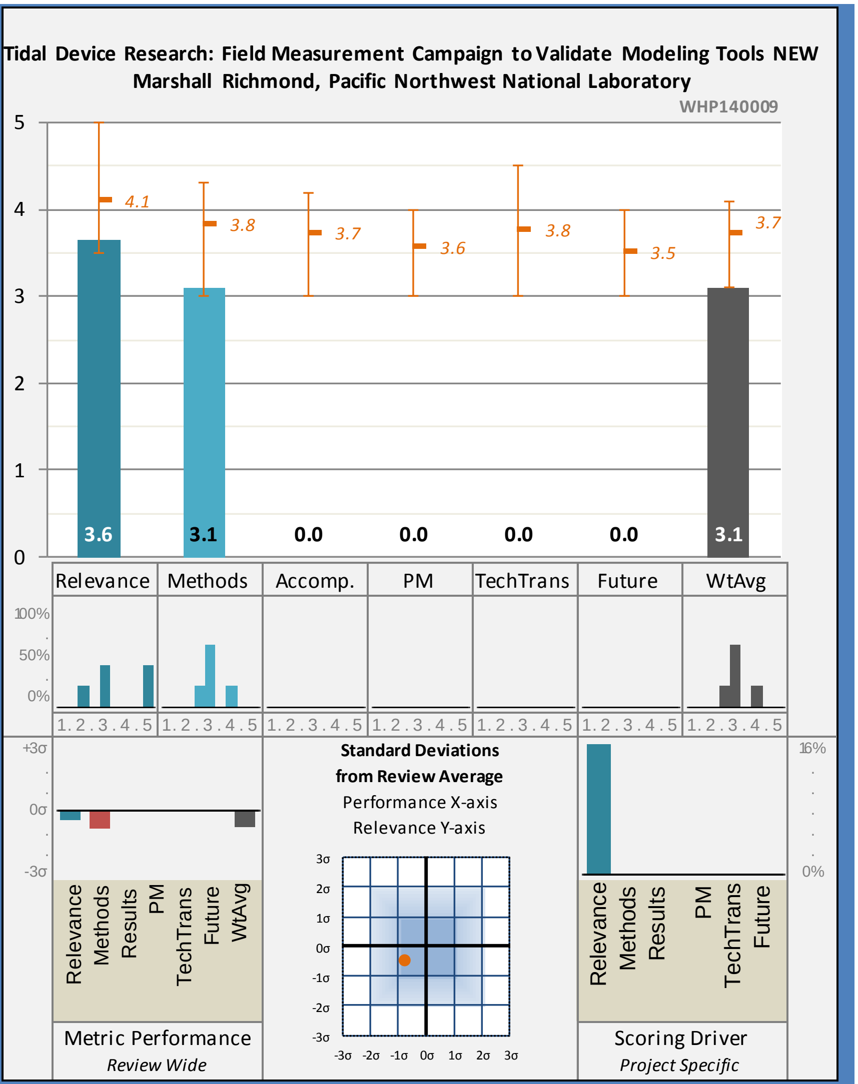
Panel:

Computational Modeling & Analysis

Budget:

$150,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- Good to see field measures proposed to validate models.
- Fully validated model for prediction of velocity distributions around operating tidal turbines will be essential to design of arrays of tidal turbines and environmental permitting.
- This Project will provide fluid-velocity measurements near a "typical" turbine to validate the performance of open-source simulation models. This would have value for the industry as a whole, if issues of proprietary information can be resolved, but it is not clear why the MHK Industrial Partners would not do this as a part of their normal development process.
- Good to see field measurements on a full scale device.

- It will be important to collect data at actual operating turbines.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.1** on its methods/approach.

- Not clear whether the project will fully leverage prior or ongoing research on current studies by other federal agencies and academic research centers, especially USACE and NOAA.
- Using ADCP units is a reasonable method.
- Good plan.
- Industry partner not identified yet so not clear when or if this work would actually be done. Conceptual sketches don't show how ADCPs will be anchored - and that could be challenging in the field.
- Not clear whether the limited validation data that may be available from deployed products of industry partners will be sufficient for model validation.
- Not clear whether the proprietary data from industry can be collected and "stripped" of identifying information so as to make industry comfortable with use of the data for public models.

Strengths and Weaknesses

Project Strengths

- The project investigators incorporating data from USACE at the damns along the Columbia R. The USACE has completed a numbers of ADCP surveys downstream of these damns (John Day, Bonneville etc.).
- Strong need for model in order to advance the MHK industry and site tidal arrays.
- Well-established approach to flow characterization.
- Field data.

Project Weaknesses

- Likely that National Labs will encounter strong MHK developer concern about sharing proprietary data, delaying project implementation with lengthy negotiations around NDAs and CRADAs.
- Lack of industrial participation significantly reduces its usefulness.
- I am concerned that we are spending funds on a turbine that can then be proprietary. But I understand that this is sometimes necessary.
- Progress is minimal. A turbine supplier has not been identified.

Specific recommendations for additions or deletions to the work scope

- USDOE should serve as honest broker to assure that labs and MHK developers are able to address the IP issues and NDA issues promptly in efficient manner to avoid delays.
- Expedite the overall program with the full participation of an industrial partner or consider cancellation
- Continue.
- USDOE should assure that research plan includes active outreach to key federal agency and international test centers to assure that this project is not duplicating prior work on MHK devices (or other USN work on turbine/propeller wake recovery and inflow measurements.

WHP140010

Project Title:

Tidal device field measurement campaign to validate tools includes upkeep of tools for industry use NEW

Principal Investigator:

Vincent Neary

Organization:

Sandia National Laboratories

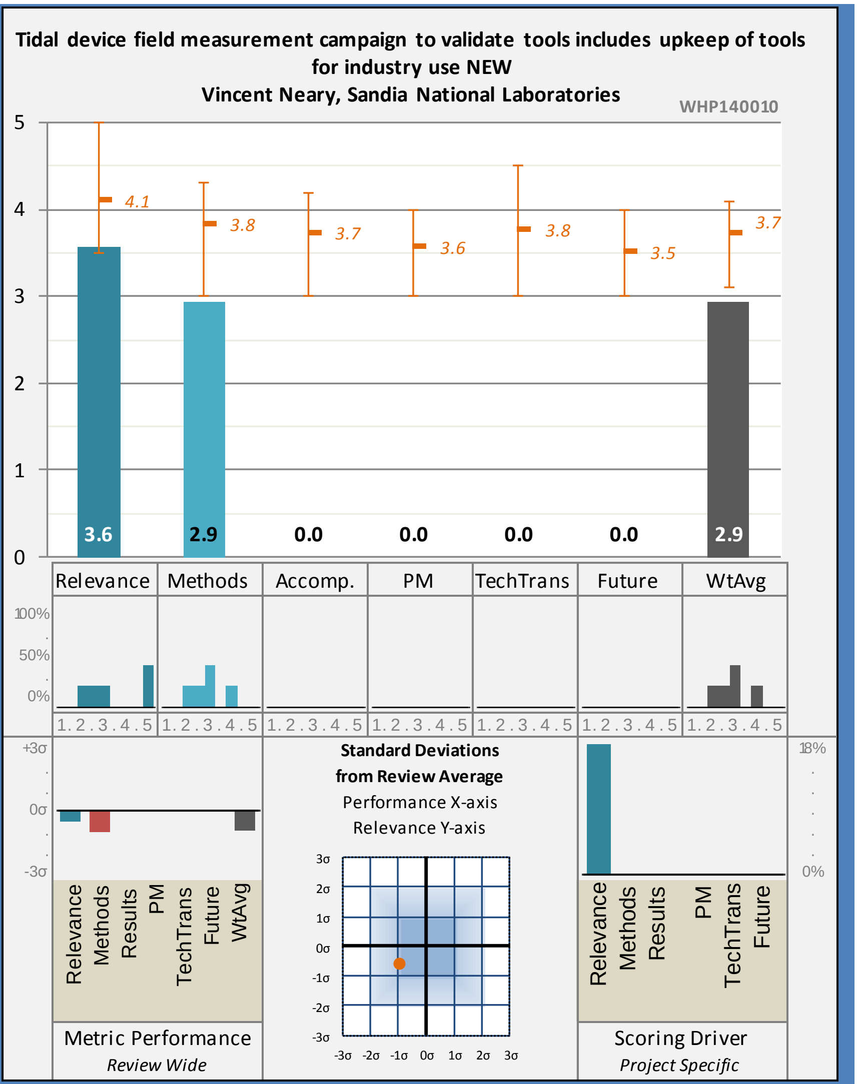
Panel:

Computational Modeling & Analysis

Budget:

$225,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- While this is a positive approach and needed by industry to refine their tidal devices, haven't other industries such as the Navy or Oil and Gas already developed technology that would support this effort?
- The MHK industry has a critical need to validated tool for tidal turbine rotor design and blade load distribution measurements.
- The Project will provide blade loading measurements to validate the performance of open-source simulation tools based on techniques that are used in the Wind Industry. This would have value for the industry as a whole, if issues of proprietary information can be resolved, but it is not clear why the MHK Industrial Partners would not do this as a part of their normal development process.

- Good to see field measurements on a full scale device.
- Part of same project as previous two presentations. Installing sensors on turbine blades and determining loads on blades.
- Blade load measurements are a good addition to the Field Measurement Campaign (FMC) program.

Question 2: Methods and Approach to performing the research and development

This project was rated **2.9** on its methods/approach.

- No industry partners were identified, but as stated above, I would expect groups such as the Navy or Oil and Gas to have at least looked into this.
- This project logically leverages significant prior DOE investment in wind energy turbine blade design for application to tidal rotor technology, but the Summary and Presentation do not make clear that the project will fully leverage prior or current USN and international research on related topics.B106.
- Application of proven technology from the Wind Industry is a reasonable and reliable method of making the measurements as long as the differences between marine and land-based applications are carefully considered
- Good plan.
- Industry partner not identified.

Strengths and Weaknesses

Project Strengths

- Leveraging of existing national lab expertise in wind power technology to near term commercialization of tidal energy technology.
- Well-established approach to blade-load measurement.
- Field data.

Project Weaknesses

- Not clear that project design will allow the project to fully leverage USN or other international work on related topics.
- Lack of industrial participation significantly reduces its usefulness.
- I am concerned that we are spending funds on a turbine that can then be proprietary. But I understand that this is sometimes necessary.
- Labs likely to encounter IP and NDA issues discussed in prior reviews.
- Progress is minimal A turbine supplier has not been identified.

Specific recommendations for additions or deletions to the work scope

- Include partners outside of the national labs.
- Assure that effective active outreach to USN and international MHK research community o review prior and current related work on marine blade structural response to steady and unsteady hydrodynamics and related blade forces.
- Expedite the overall program with the full participation of an industrial partner or consider cancellation.
- Continue.
- DOE should facilitate labs and MHK developer agreement on NDAs needed for model validation data from proprietary MHK units.

6.2 Technology Advancement

The Water Power Program's technology development activities center on reducing the technical barriers to marine and hydrokinetic device development, improving device reliability and performance, and understanding and evaluating various technology types. The program is currently supporting the design, development, testing, and deployment of marine and hydrokinetic devices and components in laboratory and open-water settings, developing tools and models that support the design, development, and optimization of marine and hydrokinetic devices, and evaluating and assessing information on the cost and performance of marine and hydrokinetic device designs.

Table 6.2.1 lists the existing Technology Advancement MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.2.1 illustrates the standard deviation of scoring of the existing Technology Advancement MHK projects in relation to the scoring of all projects reviewed in 2014.

Addressing Comments for Technology Advancement

The MHK Peer Review Panelists recorded many useful and actionable comments during their review of the Office’s Computational Modeling and Analysis projects. These comments will be used to make key decisions and recommendations to those projects that will still be receiving continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy into the future.

There was clear consensus among reviewers that there is significant value in the Technology Advancement projects. In-water demonstrations came out as one of the most valuable efforts that DOE could pursue on behalf of the broader MHK industry. The program is encouraged by this feedback and will continue to pursue in-water demonstrations as an important piece of the MHK development strategy.

With this benefit in mind, properly managed and executed projects become a key component of this strategy, as an unsuccessful demonstration project could prove to be equally detrimental to the MHK industry as a whole. Several of the DOE demonstration projects received critical feedback in the areas of project management, scheduling, cost estimates, etc, which signifies that the Program needs to continue upon recent improvements to its project management strategy. There have been considerable improvements in this strategy as the Program embarks upon a new process for Active Project Management. It is clear that the Technology Advancement projects will benefit significantly from this practice, and in turn, will provide more value to the industry.

Reviewers also noted the importance of capturing lessons learned and other benefits from these Technology Advancement Projects. As the Program embarks upon the development of a new Technology to Market (T2M) Strategy, capturing these lessons learned and disseminating them to the broader industry will be a key component based on this constructive feedback.

Table 6.2.1 Existing Technology Advancement MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing MHK Projects			4.6	4.2	3.9	3.8	3.5	3.9	3.6	**3.8**
Average for Existing Technology Advancement Projects			4.5	4.3	3.9	3.7	3.3	3.8	3.6	**3.7**
Puget Sound Pilot Tidal Energy Project	Kim Moore	Snohomish Public Utilities District #1	5.0	5.0	5.0	4.7	4.8	4.6	4.5	**4.8**
Advancement of the Kinetic Hydropower System (KHPS) to Department of Energy (DOE) Technology Readiness Level (TRL) 7/8	Mary Ann Adonizio	Verdant Power Inc.	4.0	5.0	4.4	4.0	3.9	4.2	4.7	**4.2**
Direct Drive Wave Energy Buoy	Ken Rhinefrank	Columbia Power Technologies	4.0	4.7	4.1	3.8	3.9	4.7	4.8	**4.1**
Aquantis C-Plane Ocean Current Turbine Project	Alex Fleming	Dehlsen Associates, LLC	5.0	4.5	4.0	4.6	3.0	4.3	3.7	**4.0**
TidGen® Power System Commercialization Project	Christopher R. Sauer	Ocean Renewable Power Company	3.0	4.8	4.3	3.5	3.7	4.5	4.2	**4.0**
MHK Industry Support	Albert LiVecchi	National Renewable Energy Laboratory	4.0	4.5	4.0	4.0	3.3	4.3	3.9	**3.9**
PB500, 500 kW Utility Scale PowerBuoy Project	Mike Mekhiche	Ocean Power Technologies	4.0	4.1	4.1	3.4	3.6	3.2	3.8	**3.6**
WET-NZ Multi-mode Wave Energy Convertor Advancement Project	Steven Kopf	Northwest Energy Innovations	5.0	4.6	3.5	3.6	3.1	4.2	4.5	**3.6**
Industry Support: ORPC	Vincent Neary	Sandia National Laboratories	5.0	4.4	3.9	3.4	2.9	4.1	3.3	**3.5**
Advanced Integration of Power Take-Off in Vortex Induced Vibrations Aquatic Clean Energy	Rebecca Alter	Vortex Hydro Energy	5.0	3.9	3.8	3.4	3.2	3.7	3.0	**3.5**
OCGen® Module Mooring Project	Jarlath McEntee	Ocean Renewable Power Company	3.0	4.3	4.0	3.3	2.3	3.2	4.0	**3.4**
Advanced Materials and Manufacturing Reliability	George Bonheyo, Ph.D.	Pacific Northwest National Laboratory	5.0	4.1	3.2	3.8	3.3	3.0	3.0	**3.4**
Materials & Coatings + Manufacture Reliability	Bernadette A. Hernandez-Sanchez	Sandia National Laboratories (Lead)	5.0	3.7	3.2	4.0	2.7	2.9	3.1	**3.5**
Wavebob Advanced Wave Energy Converter (AWEC) & Power Take Off (PTO)	L.E. (Ted) Lesster	RCT	5.0	3.7	3.4	2.9	3.3	3.4	1.8	**3.1**
Reedsport PB150 Deployment and	Mike	Ocean Power	5.0	4.0	3.5	3.1	2.3	3.1	2.2	**3.0**

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Ocean Test Project	Mekhiche	Technologies								

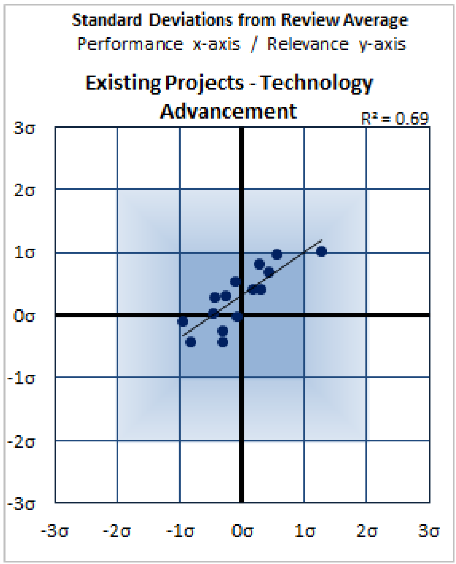


Figure 6.2.1 Existing Technology Advancement MHK projects

Table 6.2.2 lists the new Technology Advancement MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.2.2 illustrates the standard deviation of the new Technology Advancement MHK projects in relation to the scoring of all projects reviewed in 2014.

Table 6.2.2 New Technology Advancement MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Weighted Average Score
Average for Review			5.1	4.1	3.8	**3.7**
Average for all New Projects			5.2	4.2	3.8	**3.8**
Average for New MHK Projects			4.9	4.0	3.7	**3.7**
Average for New Technology Advancement Projects			4.8	4.0	3.9	**3.9**
Introduction to the System Performance and Advancement (SPA) FOA NEW	Ryan Sun Chee Fore	DOE (Multiple Projects)	5.0	4.9	4.6	**4.6**
Performance Testing for Hydrokinetic Canal Effects NEW	Vincent Neary	Sandia National Laboratories	4.0	3.6	4.1	**4.1**
MHK Manufacturing Needs Assessment and Cost Database NEW	Derek Petch	National Renewable Energy Laboratory	5.0	3.8	3.7	**3.7**
Reliability and Survivability Risk Assessment Framework NEW	Walt Musial	National Renewable Energy Laboratory	5.0	3.6	3.3	**3.3**

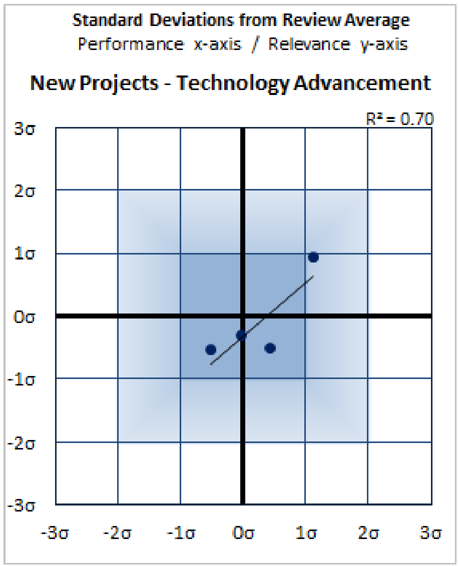


Figure 6.2.2 New Technology Advancement MHK projects

WHP140011

Project Title:

WET-NZ Multi-mode Wave Energy Convertor Advancement Project

Principal Investigator:

Steven Kopf

Organization:

Northwest Energy Innovations

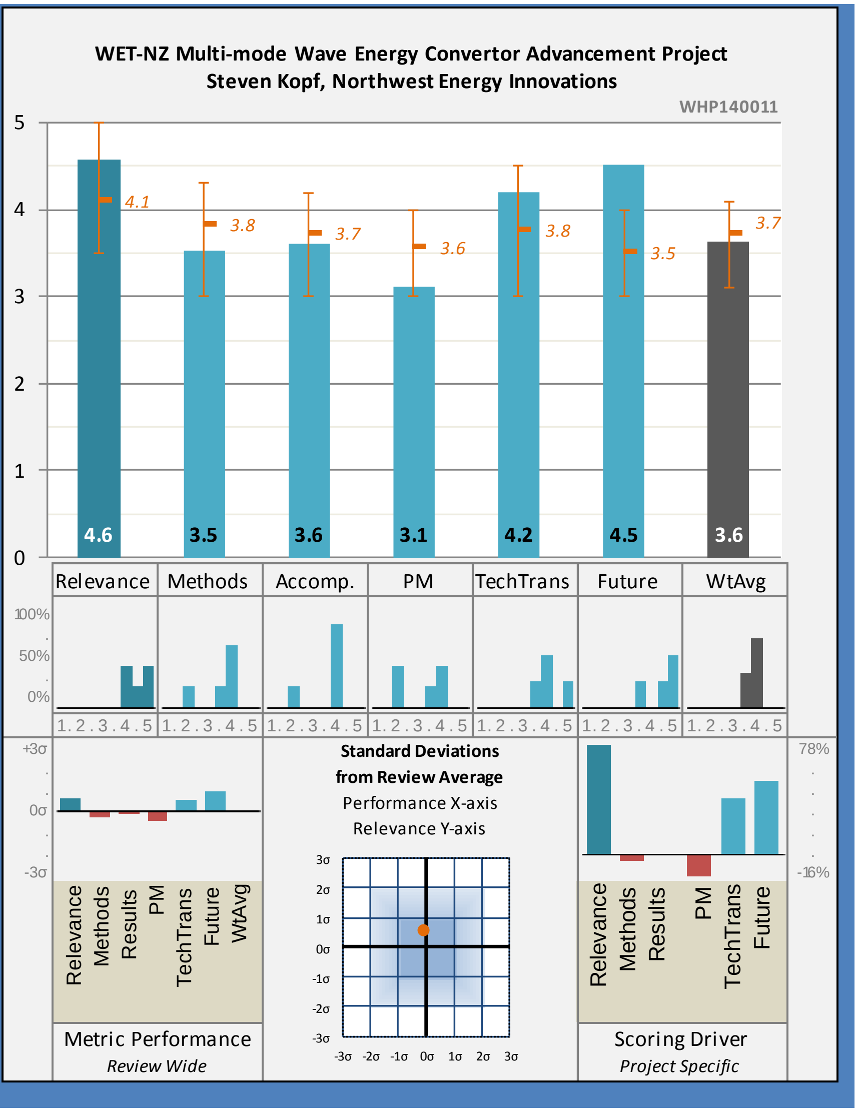
Panel:

Technology Advancement

Budget:

$2,517,528 DOE

$1,212,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.6** for its Relevance to water industry needs and overall DOE objectives.

- Applaud WET-NZ for getting their device in the water and able to measure the efficiency of their wave energy device.
- Critical to move WEC device toward commercialization.
- The goal of increasing TRL is vital to DOE objectives since in-water demonstrations, preferably grid-connected, are the only path to acceptance of MHK.
- This is an important project. If successful, it will be a boost to the MHK industry.
- Goal was to validate TRL 5-6 - get correlation between expected and field conditions.
- Excellent example of federal agency cooperation in USN and DOE collaboration on project, and excellent collaboration with OSU test site in project development.

- Was a little unclear which part of project we are looking at as there has been a good deal of prior work and this was presented, including 2012 field deployment at OSU but budget and schedule information is focused on planned Hawaii deployment.
- This is an actual project being installed at the wave energy test centers at OSU and in Hawaii. Researchers are gaining valuable real world experience with deploying devices, including modifying moorings and components.
- Good use of the wave sentinel device at OSU.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.5** on its methods/approach.

- Failure of NREL DAQ software suggests that there should have been more emphasis on software testing in integrated setting prior to deployment.
- The sequence of steps: wave-tank testing, manual ocean testing in Oregon, redesign, and controlled ocean testing in Hawaii was a reasonable plan with reasonable probability of success.
- Behind schedule and over budget.
- Putting devices in the water at the DOE test sites is exactly what the industry needs to gain information on deployment, operations, component life and also validate computer models and lack of environmental impacts.
- Delay due to software issues with NREL sampling device - need redundancy and backup in field data collection methods when dealing with such critical and expensive time windows.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.6** based on technical accomplishments and progress.

- Problems were encountered, but the lessons that were learned will prove valuable.
- Behind schedule, over budget.
- Successes - deployment went great, OSU good to work with, collected useful power data, can-do attitude important.
- Minor criticism: there was an over-reliance on a single piece of developmental test equipment in the Oregon test without a backup.
- Problems with software in measuring device supplied by NREL.
- Device in water for 8 weeks in OR - captured a good range of wave conditions.
- Have gotten environmental and interconnection approvals for HI work. Have modified mooring system.

Question 4: Project Management

This project was rated **3.1** on its project management.

- Good to honesty with their project - sometimes projects overrun their budgets. Although this will be a concern when finalizing deployment in Hawaii.
- Project is $250k over budget, but the Presenter explained a reasonable plan for acquiring additional funding to complete the effort.
- Behind schedule over budget.
- Project went over budget by 250K. Original 500K - added 199K. Getting money from private investors. Refreshing to see someone admit that they ran into unanticipated problems - still have accomplished a good deal for the amount of money spent especially as compared to some other projects.

- Project delays were presented and explained as being related to NEPA issues. These delays need to be studied and captured as lessons learned for future endeavors. Greater understanding of these delays will aid not only Northwest Energy Innovations, but the entire MHK community.
- Was a little unclear which part of project we are looking at as there has been a good deal of prior work and this was presented, including 2012 field deployment at OSU but budget and schedule information is focused on planned Hawaii deployment.
- While Northwest Energy Innovations seems to have done a reasonable job of managing the effort, failure could have serious ramifications to the entire MHK industry.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.2** for research integration, collaboration, and technology transfer.

- A positive relationship developed by WET-NZ with research institutes (OSU and WETS).
- Northwest Energy Innovations has a sound team from industry (primarily), academia, and Government.
- Collaboration with many other organizations.
- Working in collaboration with the test centers and a number of industry partners as well as NREL. Making results readily available to development community.
- The amount of technology transfer via an academic thesis, an academic report, and a conference paper provides good exposure of the larger Energy community to MHK.
- Testing experience at test centers will directly benefit future deployments.

Question 6: Proposed Future Research

This project was rated **4.5** for proposed future research.

- Strong support to continue commercialization of the technology is warranted.
- Proposed Future Work makes good use of work at National Laboratories to advance TRL.
- 12 months of testing planned at Hawaii test center should yield valuable data as well as operational experience. Data can be used to validate models.
- A grid-connected demonstration is vital to moving MHK to higher levels of TRL.

Strengths and Weaknesses

Project Strengths

- A vast and strong group of team members from both the public and private sectors.
- Significant advancement toward commercialization of WEC technology.
- The performer has put "steel in the water", learned from errors, and is planning for a second iteration of in-water testing.
- Important goals.
- Steel in the water and use of test sites.

Project Weaknesses

- Cost overrun of $250k may inhibit completion in HI.
- The project has incurred both schedule and cost issues. While these are to be expected during initial demonstrations, there is a danger of negative over-reaction to failures.
- Behind schedule and over budget.

Specific recommendations for additions or deletions to the work scope

- Support the upcoming test in Hawaii (and other in-water demonstrations) in any way possible.
- Continue if budget problems can be resolved.

WHP140012

Project Title:

PB500, 500 kW Utility Scale PowerBuoy Project

Principal Investigator:

Mike Mekhiche

Organization:

Ocean Power Technologies

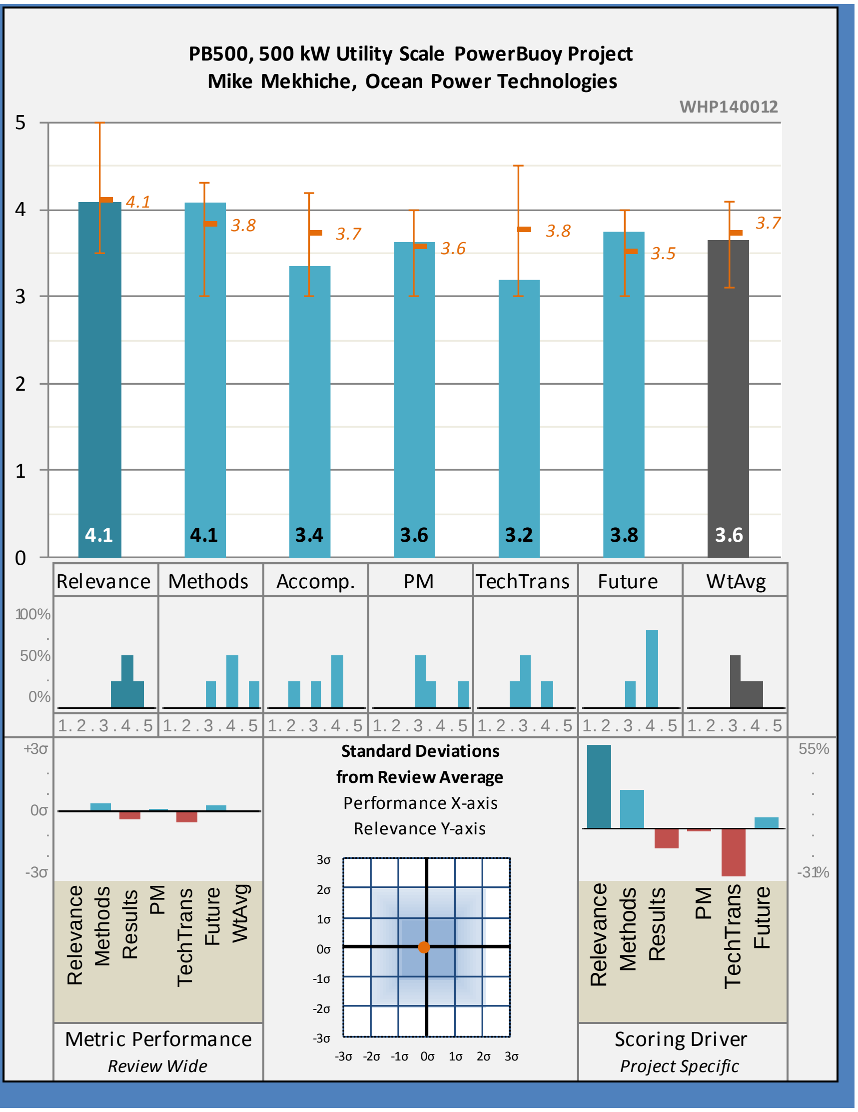
Panel:

Technology Advancement

Budget:

$2,400,000 DOE

$2,400,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.1** for its Relevance to water industry needs and overall DOE objectives.

- Funding to develop an efficient PTO is essential for the development of the MHK industry.
- Because the PTO is such a large part of the OPT system design, improvements to this component are important to reducing LCOE.
- I was not present for this presentation.
- This is very important work that has leveraged public and private funds to look at comprehensive improvements to the PTO system of a Wave Energy Converter - focusing on a number of aspects to lower costs while increasing efficiency and longevity. Should provide benefits to other types of devices and other research.
- Research like this is very much in line with the industry's needs to achieve a more competitive LCOE.

- Company provides helpful model of how to build scalable PTO component that can be used across product lines; reduce costs of production.
- The value of this effort is that the improved MPTO is being deployed in an EU demonstration. While a US-based demonstration would be preferred, any opportunity for demonstrating MHK is a plus.
- Learned that PB wouldn't be cost effective in deeper water.
- Only being able to generate in 30 M water depth could limit usefulness in some areas where there are more user conflicts in shallower water.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.1** on its methods/approach.

- Positive: Using off the shelf components where possible and implementing a stage gate process will hopefully keep costs in check as the project moves forward.
- Project approach included a balanced approach between risk mitigation and cost, focusing on testing and validation of the subcomponent parts that could benefit multiple OPT systems.
- OPT follows a rigorous development methodology that includes stage-gate reviews and incremental testing. While costly initially, this approach generally provides the most reliable path to a successful demonstration of new technology.
- Staged gate decision process, using off the shelf components when possible.
- Peer review on defined deliverables.
- Use of tank testing to validate components of numerical models and improve them.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on technical accomplishments and progress.

- System performance and reliability improvements appear to be on target for a summer 2014 deployment.
- OPT has designed the MPTO for manufacturability, overall system performance, and reliability. While the effort stops with design optimization, as long as the results will be used in a different project, there is value.
- Intelligent monitoring system consumed less power.
- Brake system that allows for lock down during high wave conditions.
- O&M improvements reduce down time.

Question 4: Project Management

This project was rated **3.6** on its project management.

- Everything appears to be on target, based on this presentation - I look forward to reading about their July 2014 deployment.
- Generally, the project plan seems to be well thought-out and shows linkages at the major-task level.
- Leveraging tank testing and modules.
- Minor point: the first task of Phase III is simply the development of a Project Charter and System Requirements Specification, but it seems to take an unusually long period of time.
- Fabrication, manufacturability was incorporated into design.
- Looks like good approach tough to tell how previous work did vs budget.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.2** for research integration, collaboration, and technology transfer.

- I appreciate the international collaboration, but with so much DOE and EU financial support, it was uncertain as to who OPT has teamed with on this project.
- Proprietary technology, so limited publication possible, but OPT has pledged to publish non-proprietary data.
- For the DOE-funded portion of the effort, OPT appear to be acting as a stand-alone entity.
- Doing some work with international community, delivering data to labs to help validate models.
- OPT is clearly drawing upon both US and EU funding sources to finance PTO technology, and integrating that research in device development. Can US access the field measurement data from the recently funded EU project in Spain in order to advance other DOE field measurement projects, given that the underlying device development is partially funded by US?
- As long as the MPTO will be integrated into an EU-funded demonstration, the DOE-developed technology is being well used.
- will be testing unit in Spain - DOE work leveraged ability for them to be competitive internationally
- Good coordination with Lockheed on POT studies.

Question 6: Proposed Future Research

This project was rated **3.8** for proposed future research.

- The July 2014 deployment will provide invaluable data for OPT to progress and further help them refine their PTO development.
- The PTO design optimization supports an in-water demonstration, indicating good alignment with the needs of the MHK industry.
- Continuing to optimize PTO and next stages will be to deploy and test prototype which should be very beneficial.

Strengths and Weaknesses

Project Strengths

- Looking to develop a PTO that would reduce material costs, while increasing its efficiency is essential for this industry to progress.
- Solid engineering development processes have been applied to optimizing a key component of the OPT system.
- Developer using DOE and private funds to look at comprehensive improvements to real device.
- The component is planned for deployment under separate funding.

Project Weaknesses

- OPT seems to have made a conscious decision to not take advantage of the resources in the larger DOE/MHK team, such as the National Laboratories and universities.

Specific recommendations for additions or deletions to the work scope

- This project seems to represent a DOE investment that will pay off for the MHK industry if the EU-funded demonstration is successful.

WHP140013

Project Title:

Reedsport PB150 Deployment and Ocean Test Project

Principal Investigator:

Mike Mekhiche

Organization:

Ocean Power Technologies

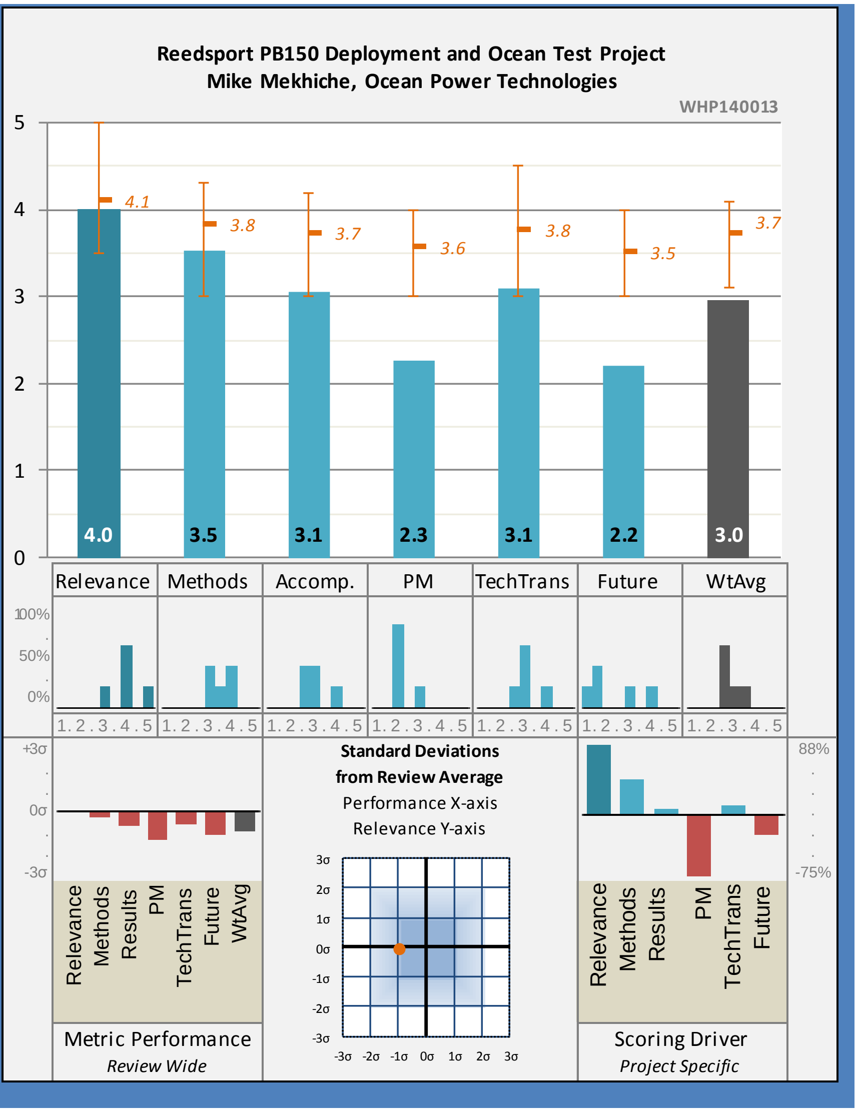
Panel:

Technology Advancement

Budget:

$2,409,293 DOE

$2,409,707 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.0** for its Relevance to water industry needs and overall DOE objectives.

- From an industry perspective, this project was very important in that it was one of the first wave project to complete the permitting process.
- Project addresses critical objective of moving current generation WEC device toward utility scale deployment, incorporating Design for Manufacturing approach.
- Deploying a 150kW PowerBuoy for relevant ocean testing would align well with Program Goals
- I was not present for this presentation.
- This is first FERC licensed commercial wave energy project - this project represents a critical first step for the industry in terms of technology demonstration and regulatory and environmental acceptance.

- Unfortunately it does not appear that the United States will benefit from the product deliverable given lack of current OPT plan to complete and deploy WEC device in US, and to shift emphasis to EU project instead. Disappointing that project technology will be deployed in Spain instead of US.
- Reducing LCOE by improvements to manufacturing processes aligns reasonably well with Program Goals.
- OPT presentation emphasized that OPT wants to finish the project, and that OPT and DOE are in discussions to accomplish that goal. Not clear whether delays on environmental permitting and USDOE NEPA review delays caused project costs to increase, or whether the matching funds from OPT were allocated to other product development, contrary to project plan. Encourage USDOE to continue to work with OPT to deploy project in US as proposed, given importance of gathering data from field tests as proposed.
- Deployment seems to have become secondary to manufacturing process improvements and other research. It is not clear to me that this re-emphasis is in good alignment with the prioritized Program Goals. This uncertainty lowered the score.
- Even if later stage technology data may be available after EU project in Spain, the original PB150 technical project plans for data collection on PB150 for power production, reliability, mooring system performance, and sea-state responsiveness, as well as acoustic and EMF testing in accordance with the Reedsport Settlement Agreement Study Plans, may be valuable.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.5** on its methods/approach.

- I appreciated the phase approach proposed, this would allow for environment impacts to be assessed at a more consistent level.
- Following a dual track of deployment and product improvement has allowed progress to be made on one front (manufacturing) when delays in deployment occurred. Unfortunately, the delays have called the deployment into question due to a perception that the equipment proposed for deployment has been superseded
- Developing modular components to expand supply chain and drive costs down.
- Reedsport project uses previous PTO technology - PB150.
- Phased installation to test environmental and other factors.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.1** based on technical accomplishments and progress.

- Completed all the environmental studies and regulatory efforts to deploy the PB150 device off of Oregon. It is disappointing to see OPT not follow through and deploy the device.
- While project schedule has slipped, the technical accomplishments and progress appear to be on pace
- The manufacturing improvements seem to have improved the product design.
- Have not yet deployed technology and are being very evasive about whether they will deploy without having to significantly amend their existing license. OPT made decision/commitment to pursue a commercial license instead of a pilot license which implied they thought their technology was commercially viable. If it's not they should surrender the license or see if they can change it to a pilot somehow or plan to deploy at the test centers until they are truly ready to propose a commercial project.
- Have made considerable progress on device and device components.
- Have secured regulatory approvals including FERC license and have conducted some required environmental studies.

Question 4: Project Management

This project was rated **2.3** on its project management.

- It was vague as to why there were delays and eventually no deployment
- Project delay causes are not clear, although attributed to permitting delays in presentation
- The deployment has been seriously delayed. The presentation and summary imply that there were delays by both OPT and the regulatory agencies
- Logistics of deployment not complete
- It is vital that the lessons that OPT has learned by these delays be captured. In particular, questions such as "how could the process been more effectively managed?" should be asked in a non-judgmental way.
- debating whether or not to deploy technology at Reedsport
- The baseline scope of the effort seems to have changed. It is unclear if the change in emphasis from deploying the 150kW PowerBuoy in favor of the "Proposed Future Research" are warranted.
- There have been substantial cost overruns. While covered by OPT cost share, they are still overruns. No analysis of the reason for the variance was provided.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.1** for research integration, collaboration, and technology transfer.

- Good collaboration with Lockheed
- Good use of supply chain vendor Lockheed, and plans to publish non-proprietary data
- Collaboration beyond suppliers (OSU seems to be treated as a subcontractor for the EMF study) is minimal.
- Using Lockheed Martin to assist in aspects of design
- Publications have been minimal, with sparse detail
- Sharing results of project and studies with others in the industry
- OPT appears to prefer to be a monolithic commercial entity that holds proprietary information tightly. While completely understandable for business reasons, this probably makes management of their efforts challenging for DOE

Question 6: Proposed Future Research

This project was rated **2.2** for proposed future research.

- With all of the regulatory effort completed, it is frustrating to see OPT not deploy this (or the PB500) device in Oregon. Even if OPT is not going to deploy the PB150 in Oregon, as they have all their permits in hand, why not amend them and deploy the PB500 here instead?
- OPT and USDOE must work to address any funding deficits caused by permitting delays or USDOE NEPA review delays, but OPT must assure that earmarked OPT funds for OPT project are made available.
- The presentation and summary state that future scope is under negotiation. OPT appears to be advocating for the deployment plans to be modified, but no specific recommendation was provided
- Need to understand what OPT is now proposing to do. If their 150 device is not economically feasible to deploy they should not have pursued and accepted commercial license. If they are not going to deploy at Reedsport they will have wasted a lot of agency time and it could become a black eye for the industry.
- As OPT has essentially abandoned this deployment and pursued their PB500 deployment in Spain instead, it appears they are focused on their profitability more than supporting the industry development.
- OPT should finish the project even if the technology is not the most current, given the promise to undertake the work, and the valuable information that can be gathered

- The proposed future research does not support a near-term deployment
- DOE should be very cautious about continuing to fund this. If they are proposing a completely different device in terms of size and environmental footprint they may be entering into a long and costly license amendment process. It might be wiser to deploy 1-2 PB units in a good faith effort while they assess economics of deploying newer units.

Strengths and Weaknesses

Project Strengths

- OPT made significant progress towards achieving their objectives (e.g., obtaining all necessary permits for deployment).
- The system is making progress toward deployment via design improvements.

Project Weaknesses

- The presentation was very vague on specific details on what created the delays and their overall approach to the project.
- OPT is not pushing for deployment, stating that better systems are ready to deploy. Is the 150kW PowerBuoy really ready for deployment or is there risk that it will fail in ocean testing?
- presenter defensive about not fulfilling agreements about deployment - if funding is not there what impact does that have on industry
- Delays in the regulatory process coupled with design improvements have weakened the project by scope changes that may or may not be necessary

Specific recommendations for additions or deletions to the work scope

- Important for DOE and OPT to demonstrate success with a product deployment given significant funding commitments
- DOE must carefully weigh the relative risks of (1) deploying the 150kW PowerBuoy and having an unsuccessful demonstration versus (2) cancelling the deployment. Both risks have serious consequences for the MHK industry
- Suggest DOE gains a thorough understanding of the license realities and options as well as the financial strength of OPT to carry this project out. Perhaps the license could be sold or transferred to an entity that would be able to fulfill the obligations if OPT can't do it.

WHP140014

Project Title:

Direct Drive Wave Energy Buoy

Principal Investigator:

Ken Rhinefrank

Organization:

Columbia Power Technologies

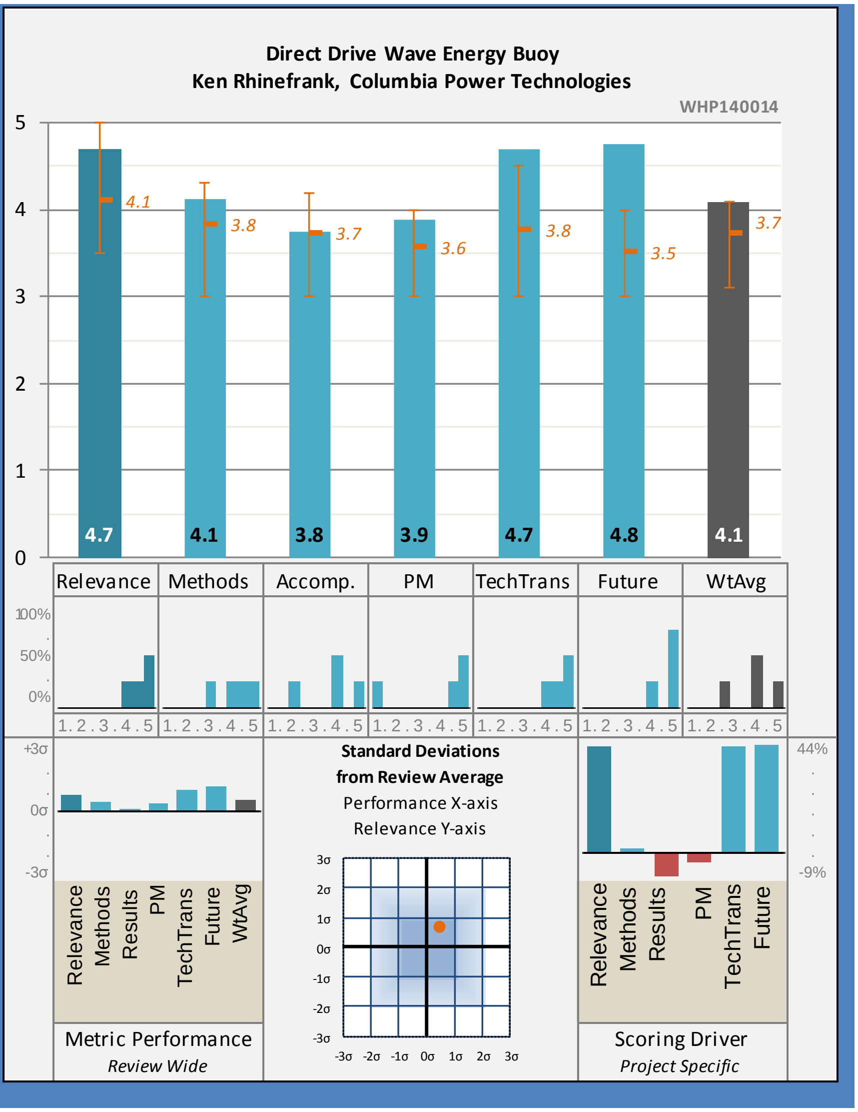
Panel:

Technology Advancement

Budget:

$,2917,990 DOE

$1,500,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.7** for its Relevance to water industry needs and overall DOE objectives.

- Excellent project to move utility scale, low-environmental impact WEC device toward commercialization
- The project aligns with 4 Program objectives, principally "Advance the state of MHK technology"
- Very relevant. Will be a great contribution to the field.
- Impressive company going through thorough detailed design, having design basis reviewed and certified by the leading international certification companies at multiple steps throughout design, involving experienced offshore marine construction expertise into design.
- WEC structure designed for all seas, including high energy sites.
- The design improvement of unlimited angular motion does "increase access to high resource sites", but is primarily an advancement in the WEC design.

- Size of device is large 25-30 meter beam lengths etc.
- Single point mooring system design testing for environmental data.
- CPT has integrated COTS equipment to develop a reasonable test infrastructure.
- Direct drive wave energy buoy - trying to get a certifiable design. Certification standards integrated into design. SCADA controls.
- Strong presentation and project summary.
- Looking to be able to operate in ALL wave conditions? Achievable? Device turns over in high wave environments and continues to generate?
- 8.5 meter nacelle - new design (3.2) can go in shallower water - this creates potential environmental and recreation, nav issues.
- Single point mooring system to reduce env impacts.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.1** on its methods/approach.

- The approach is conservative, comprising design and limited experiments.
- Project is being run very well.
- Design basis being reviewed by GL/DNV - getting concurrence on design basis is key up front.
- comprehensive approach looking at multiple facets of deployment.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.8** based on technical accomplishments and progress.

- There have been some good design results, but the schedule has had unacceptable slippage, which seems to be related to "analysis paralysis."
- Good results so far. Good progress towards field test in HI.
- Changing mooring interface at WETS.
- SCADA SDD in progress.
- 1/33 scale analysis completed and contributed to significant improvements but 2Q delay as they got through it all.

Question 4: Project Management

This project was rated **3.9** on its project management.

- Excellent project planning and management to include partners who have manufacturing and component expertise and mooring expertise.
- The revised schedule provides little confidence that CPT will recover from delays.
- Comprehensive project management.
- Delayed but no budget impacts.
- The fact that roughly half of the budget has been expended indicates that increased spending on level-of-effort tasks (due to delays) are taking a toll. Careful, regular review is required.
- complete design and design assessment.
- 50% funded by DOE - rest by outside sources.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.7** for research integration, collaboration, and technology transfer.

- Good example of constructive collaboration with Oregon State University, and data sharing with NREL.
- CPT is clearly well integrated with the larger MHK community (including the TC-114 TAG) and are sharing information.
- Good collaboration with others in preparatory work.
- Partnering with others in areas where they don't have expertise.
- Lots of outside collaboration - industry, academic, and government labs plus stakeholder outreach, industry dissemination and education.
- Outreach to young people is a sign of good corporate citizenship.

Question 6: Proposed Future Research

This project was rated **4.8** for proposed future research.

- Strong contender for future research funding.
- The near-term tasks need to be completed on-time to provide confidence for the ultimate goal of "build and open-ocean deployment of grid-connected WEC."
- Open-ocean deployment at test site in Hawaii will be a great contribution to the MHK industry.
- Will deploy and test device at wave energy test center - critical for continued development of test centers as well as knowledge base of WEC technology.

Strengths and Weaknesses

Project Strengths

- Excellent project design and implementation for utility scale WEC.
- Good technical work, an apparently good system design, and good testing infrastructure for evaluating the performance of the equipment.
- Comprehensive project management.
- Taking a very systematic and intelligent approach to design - getting outside review at multiple points including marine construction expertise.
- Good collaboration with the larger MHK community, particular with regard to participation in standards development.

Project Weaknesses

- Schedule delays do not provide confidence that CPT is ready for the effort associated with a grid-connected, in-water deployment.

Specific recommendations for additions or deletions to the work scope

- In spite of good engineering, industry collaboration, and market evaluation; DOE should monitor the progress of this project and the related effort under the SPA FOA very carefully, perhaps assigning a dedicated resource if the budget allows.
- Continue.

WHP140015

Project Title:

Wavebob Advanced Wave Energy Converter (AWEC) & Power Take Off (PTO)

Principal Investigator:

L.E. (Ted) Lesster

Organization:

RCT

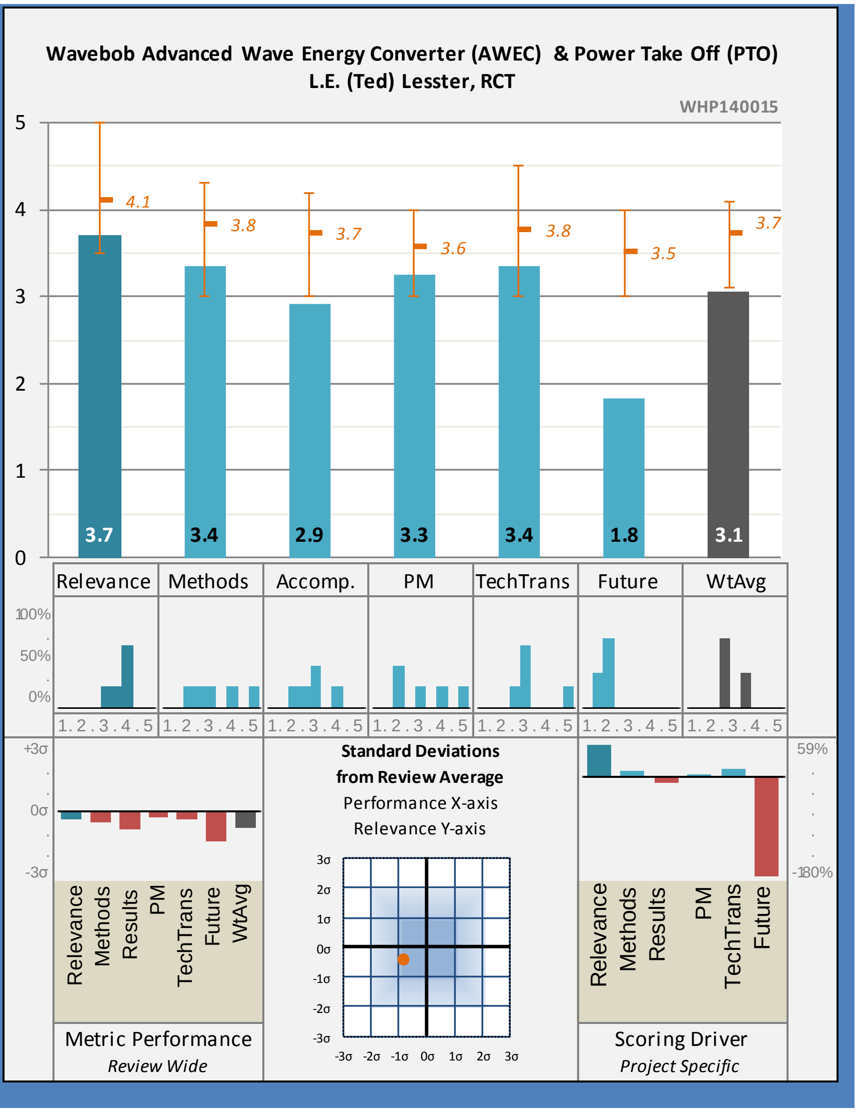
Panel:

Technology Advancement

Budget:

$2,400,000 DOE

$2,319,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.7** for its Relevance to water industry needs and overall DOE objectives.

- PTO would be applicable for both wave and tidal machines.
- Although PTO design was stranded with bankruptcy of WaveBob this component of PTO subcontract to RCT successfully explored PTO performance improvement and use of linear to rotary converter option and demonstrated potential for good performance.
- Project is developing a power conversion system based on a switched reluctance machine. This is an interesting choice that may prove beneficial in the long term. While it is not clear that this is the "ultimate perfect" choice, it deserves very serious considerations.
- Could be very helpful to industry if switch-reluctance machine proves successful.

- RCT was sub to Wavebob - scope was to design and construct a scalable switched reluctance machine to wave bob requirements.
- Good project, good subcontractor performance in spite of lead contractor bankruptcy.
- Project employs a proven, available inverter from the former parent company as the interface to the grid. Although the former parent company is no longer in business, other competitive products can be readily substituted with suitable engineering interface development.
- Project was halted early due to Wavebob insolvency and not clear if it has applicability to other projects
- Hard to make high torque low speed machine small.
- reluctance machine safer no excitation, not subject to the whims of the rare earth market.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.4** on its methods/approach.

- The company has followed an excellent approach for developing the power conversion system.
- Good project plan, but then Wavebob became insolvent.
- Seemed like it had good approach going.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.9** based on technical accomplishments and progress.

- At no fault of RCT, their progress has been limited by Wavebob's insolvency.
- PTO component was completed well, but challenge will be to assuring that others can take advantage of the work.
- The project is on indefinite hold and should perhaps be considered to have completed successfully.
- The project was producing good results up until the time Wavebob became insolvent.
- Switched reluctance machine drive appears to provide some inherent advantages over other generators.
- Looked at costs associated with desired design - was too high - developed carbon fiber reinforced belt based lower weight module. Linear to rotary converter.

Question 4: Project Management

This project was rated **3.3** on its project management.

- Wavebob's insolvency has stopped the progress of this project.
- The cancellation seems to have been beyond the control of RCT and they have given visibility to the issue.
- Project Management by RCT Systems was good. However, Wavebob became insolvent.
- ISO 9000 process - used design process for year 1.
- RCT made a very reasonable "mid-course correction" by executing a revised or "RDR" design that met a need for increased force capacity near zero velocity. In an early-stage industry like MHK, errors in initial specifications must be expected and addressed.
- on budget through June 1 2012 - wavebob insolvency stopped work then and results never completed.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.4** for research integration, collaboration, and technology transfer.

- RCT was able to accommodate a significant specification change by the Prime.

- It will be interesting to see if any other firms pick up on the technology for their WEC devices.
- Looks like some good research and information that could be transferred to other projects as appropriate - would like to see if there are other device developers who could benefit.

Question 6: Proposed Future Research

This project was rated **1.8** for proposed future research.

- General Comment: Adding this PTO to a future device would support the developing of the MHK industry
- Project ended.
- There was no discussion of future research.

Strengths and Weaknesses

Project Strengths

- DOE has been able to recover the design of the PTO from RCT.
- The power conversion design is an important step for MHK and needs to be demonstrated.

Project Weaknesses

- The cost of the direct drive ($3m) for 550 kW is excessive - although the efficiencies of the machine are very good.
- The power conversion design will not be demonstrated on this project.

Specific recommendations for additions or deletions to the work scope

- The value of the PTO subcontract will likely be lost unless DOE and subcontractor can push information to the industry and enable others to pick up the technology.
- Not much to recommend for the Wavebob effort, but monitor how RCT performs under the SPA FOA.
- Close out project. Produce a summary of the results of RCT Systems work on the Switched Reluctance Machine.

WHP140016

Project Title:

TidGen® Power System Commercialization Project

Principal Investigator:

Christopher R. Sauer

Organization:

Ocean Renewable Power Company

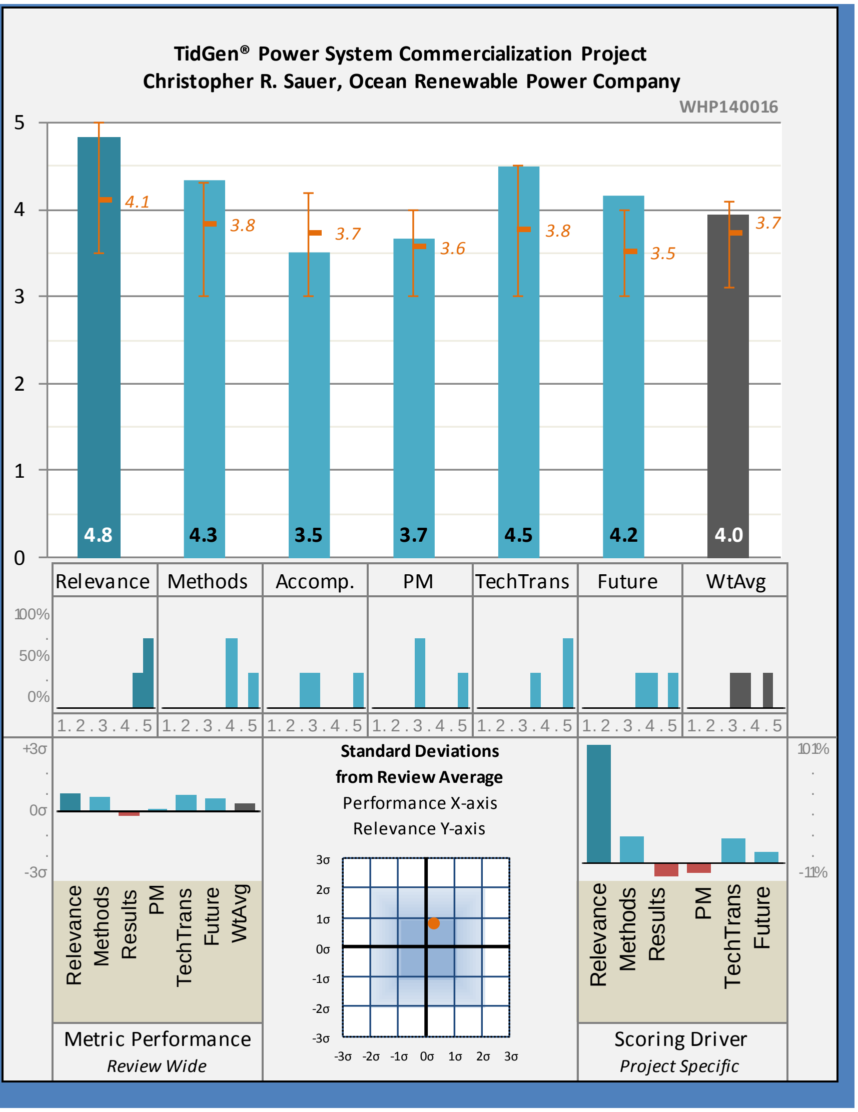
Panel:

Technology Advancement

Budget:

$10,000,000 DOE

$11,145,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.8** for its Relevance to water industry needs and overall DOE objectives.

- Able to develop key environmental protocols that could be applicable to other MHK projects.
- First grid-connected demonstration has advanced the experience level with Tidal Energy.
- First federally licensed grid connect tidal project.
- Not reviewed due to potential conflicts.
- Getting "steel in the water" and grid connected has provided a lot of commercial media coverage for the MHK industry as a whole.
- Long term purchase agreement.
- Power purchase agreement approval received from the Maine Public Utilities Commission.
- FERC License.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.3** on its methods/approach.

- Using existing equipment for new uses when implementing environmental monitoring.
- Well-designed demonstration at an appropriate scale.
- Well planned and very collaborative.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.5** based on technical accomplishments and progress.

- Teaming partners wasn't covered in great detail in this presentation.
- Actual experience of "steel in the water", is partly offset by reliability issues that stopped the demonstration early.
- Great project! Successful grid connected, FERC-licensed pilot project.

Question 4: Project Management

This project was rated **3.7** on its project management.

- Positive: Made us budget overrun through private funding.
- No relevant data on actual versus budgeted cost/schedule was available. ORPC got equipment through the regulatory process and into the water.
- Very successful project management. Included working with many stakeholders.
- Failures of early-stage equipment are to be expected, but in-process testing might have avoided the embarrassment of taking the equipment out of the water early.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.5** for research integration, collaboration, and technology transfer.

- ORPC has reached out to academic institutes.
- ORPC has learned a lot and seems to have shared it well with the larger MHK community.
- Great collaboration with industry, academia, and government.

Question 6: Proposed Future Research

This project was rated **4.2** for proposed future research.

- The lessons learned from this project will form a strong basis for future work for PTO studies.
- While the last slide is clearly an advertisement, it is mostly true.
- If funds are available, their proposed future project of a commercialized tidal power system would be well worth pursuing.

Strengths and Weaknesses

Project Strengths

- ORPC designed, built, and installed equipment for an in-water demonstration.

- Grid-connected, FERC-licensed, PPA.
- ORPC successfully completed many regulatory milestones.
- ORPC delivered power to the grid.

Project Weaknesses

- The installed equipment had reliability issues that caused an early termination of the demonstration.

Specific recommendations for additions or deletions to the work scope

- Monitor in-process verification efforts on future ORPC efforts.
- Continue.
- Monitor adherence to Quality Control and Quality Assurance procedures at ORPC and their suppliers.

WHP140017

Project Title:

OCGen® Module Mooring Project

Principal Investigator:

Jarlath McEntee

Organization:

Ocean Renewable Power Company

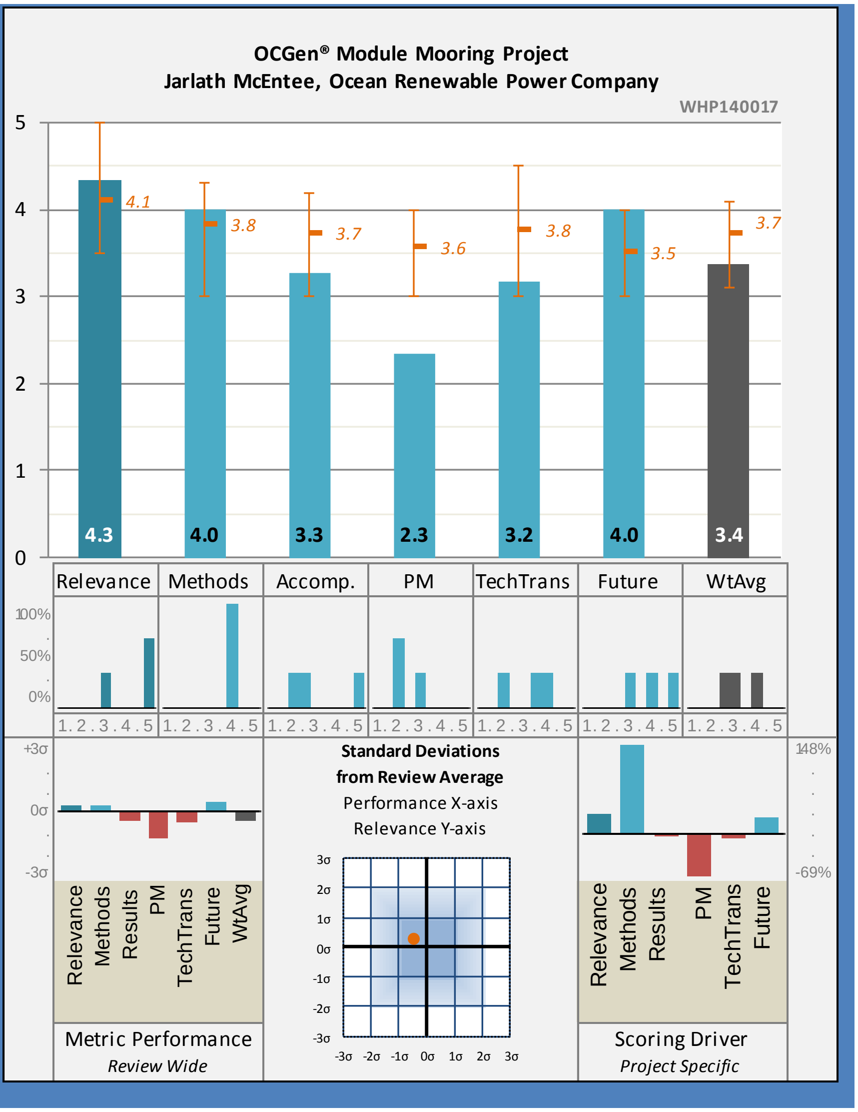
Panel:

Technology Advancement

Budget:

$1,034,534 DOE

$1,034,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.3** for its Relevance to water industry needs and overall DOE objectives.

- While this is a positive step forward for the MHK industry, with the limited funds available, why wouldn't ORPC focus time/money/and team's efforts on perfecting the TidGen's efficiency?
- The project, if successful, will demonstrate extraction of power from ocean currents at an approved test site.
- Planed field demonstration of a tidal turbine will be very useful to the MHK industry.
- Not reviewed due to potential conflicts.
- Does not generate power. Mainly looking at moorings and performance of structure.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- Able to build off experience from ORPC's deployment of the TidGen device.
- The method that ORPC is following is a reasonable approach to developing a new product.
- Well planned.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.3** based on technical accomplishments and progress.

- The project has accomplished some of its goals, but has been delayed. Not all of the delays appear to be related to receipt of NEPA categorical exclusion as stated in the comments.
- Successful use of a CFD program.
- Successful scale model tests.

Question 4: Project Management

This project was rated **2.3** on its project management.

- Significant variances from schedule were not well explained.
- Two tasks slipped over a year: (1) Dynamic Analysis of Mooring System and Lines, and (2) Cable and Mooring Design.
- Cost variances, if any, were not discussed.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.2** for research integration, collaboration, and technology transfer.

- Collaborating with Uni. of Washington and Maine as well as private industry.
- Apparently little collaboration other than with suppliers and University of Washington. An unpublished MS thesis and a Patent Application don't constitute a great deal of technology transfer. Although ORPC is making a substantial financial investment, more should be expected from a half million dollars DOE investment.
- Good collaboration with industry and academia.

Question 6: Proposed Future Research

This project was rated **4.0** for proposed future research.

- The demonstration planned for Summer '14 is an important milestone, but there remains a lot to do.
- Field tests at Cobscook Bay Tidal Energy Project site would be very worthwhile.

Strengths and Weaknesses

Project Strengths

- ORPC has done a good job of developing a variant of their core technology for ocean-current applications.
- Use of CFD code.

- ORPC has an important milestone coming in the Summer.
- Successful scale model tests.

Project Weaknesses

- The project has experienced regulatory delays, but not all the delays appear to be related to regulatory issues.

Specific recommendations for additions or deletions to the work scope

- This project has high risks and high upside potential. Careful monitoring of schedule is imperative.
- Continue.
- Another reliability-related failure would be a severe blow to the industry (see recommendations for Tide-Gen).

WHP140018

Project Title:

Aquantis C-Plane Ocean Current Turbine Project

Principal Investigator:

Alex Fleming

Organization:

Dehlsen Associates, LLC

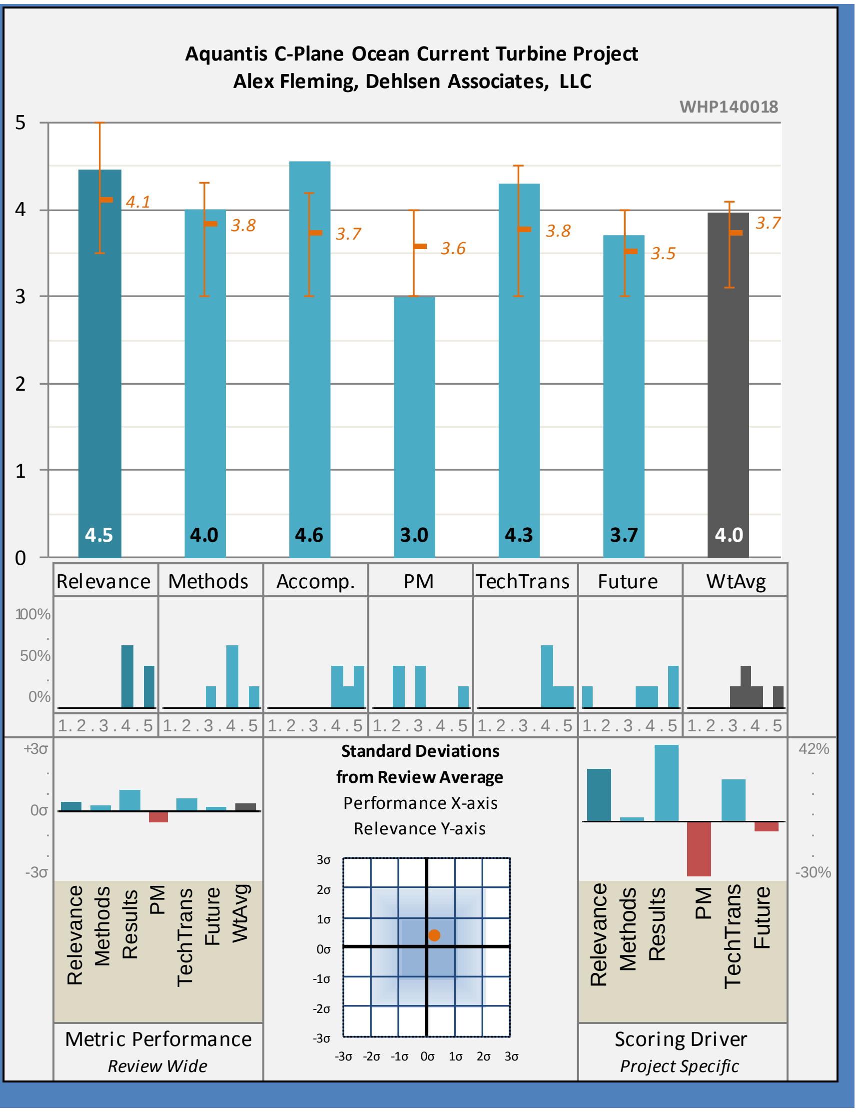
Panel:

Technology Advancement

Budget:

$2,400,000 DOE

$5,734,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.5** for its Relevance to water industry needs and overall DOE objectives.

- Excellent example of "best and brightest" team compilation - well worth DOE drilling down to fully understand the nature of obstacles to use of National Lab personnel; Why could they work with NavSea but not National Labs?
- The Dehlsen Team is advancing the state of MHK technology by developing a system design for extracting power from the Gulf Stream.
- The type of data being collected will be very relevant to the development of ocean current turbines.
- Very detailed and integrated systems approach to development of the turbine generating system - using naval and marine experience and understanding, CFD and other modeling, tank testing to refine and develop workable system - using both DOE and private funding sources - focused on capturing marine current power.

- Strong team building of outstanding personnel.
- Very comprehensive project: hydrodynamic analysis, dynamic simulation analysis, mooring analysis, tow tank testing, marine composites analysis, drivetrain and bearing design.
- Appears to be a good deal of prior research.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- Positive: Utilizing experience from previous wind experience and applying it to the Aquantis design.
- Thoughtful design and strong collaboration with partners.
- The overall methodology is sound from a technology-development perspective.
- Impressive team of industry, government, and university experts.
- Looks to be a very advanced design and being developed in a strong, iterative fashion.
- Very complete approach to project.
- Environmental and siting impacts will be huge for marine current systems and will be a lengthy process to get regulators comfortable with deployments of these, particularly large arrays - should start to understand environmental concerns and incorporate environmental monitoring features into design if possible.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.6** based on technical accomplishments and progress.

- Secured project objectives and list of accomplishments achieved for this innovative technology.
- The Team has accomplished a reasonable amount of component-technology design and verification activities.
- Hydrodynamic and dynamic simulation analyses, mooring analysis, tow tank testing.
- Lots of progress noted.
- CFD studies - going quickly.
- validating using Navy and GL/DNV models.
- Tow tank testing - successful scale testing (video clip).
- Mooring system design has been fairly well advanced.
- Marine components and rotor design have gone through a number of revision.

Question 4: Project Management

This project was rated **3.0** on its project management.

- The size of the team presents some challenges in itself.
- Significant schedule delays.
- Very behind schedule - need to understand more about reasons for this but 1 year delay due to contract negotiations with DOE.
- The project experienced a one-year delay because of contractual issues.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.3** for research integration, collaboration, and technology transfer.

- A strong list of partners (public & private) on this project.

- Issue of protection of Intellectual Property is essential for success of projects; USDOE can play important role to facilitate national lab/MHK developer collaboration and avoid project delays (and related costs) on NDA and CRADA IP issues to assist MHK developers to have ability to protect IP that is critical to device commercialization and attraction of private investment based on strength of IP.
- In addition to collaboration within the Team, this project has validated analysis codes with those of the USN and NREL.
- Good collaboration with industry and academia.
- Good team of experts - industry, academic, and Navy partners, using proven model software to test and improve designs.
- This appears to be a good candidate project for Dehlsen to work with the labs and utilize their RM.

Question 6: Proposed Future Research

This project was rated **3.7** for proposed future research.

- Hopefully, DOE can provide for prompt follow up funding to avoid costs and disruptions to company of project ramp up and ramp down, given the apparently significant markets available for the product.
- Dehlsen proposes only a substantial ($8.7M) suite of follow-on component design/test activities without an in-water system demonstration.
- Proposed future research would be very helpful to the development of ocean current energy technology.
- Detailed design and testing of various components.
- What is being done to look at environmental impacts of device and are they looking for actual deployment is US waters? If not FL testing site they should be working on a location and starting permitting soon if they intend to field test units.

Strengths and Weaknesses

Project Strengths

- Strong collaboration of hydrodynamics combined with wind experience.
- Good component technology advances for the C-Plane concept.
- Very comprehensive project: hydrodynamic analysis, dynamic simulation analysis, mooring analysis, tow tank testing, marine composites analysis, drivetrain and bearing design.
- low RPMs - how low? 2-5 rpm. This could be very important environmentally.
- A wide team list balanced with public and private partners.
- Applicable to the Gulf Stream off the coast of Florida.
- 2-3 MW size - economic models based on 100 MW deployment - 50 units.

Project Weaknesses

- No near-term in-water system demonstrations.

Specific recommendations for additions or deletions to the work scope

- Priority for funding to accelerate near term market deployment.
- This concept is in need of substantial private investment in order to get to an in-water demonstration. DOE is unlikely to be able to pay for the up-front component engineering that is needed.
- Continue.

WHP140019

Project Title:

Puget Sound Pilot Tidal Energy Project

Principal Investigator:

Kim Moore

Organization:

Snohomish Public Utilities District #1

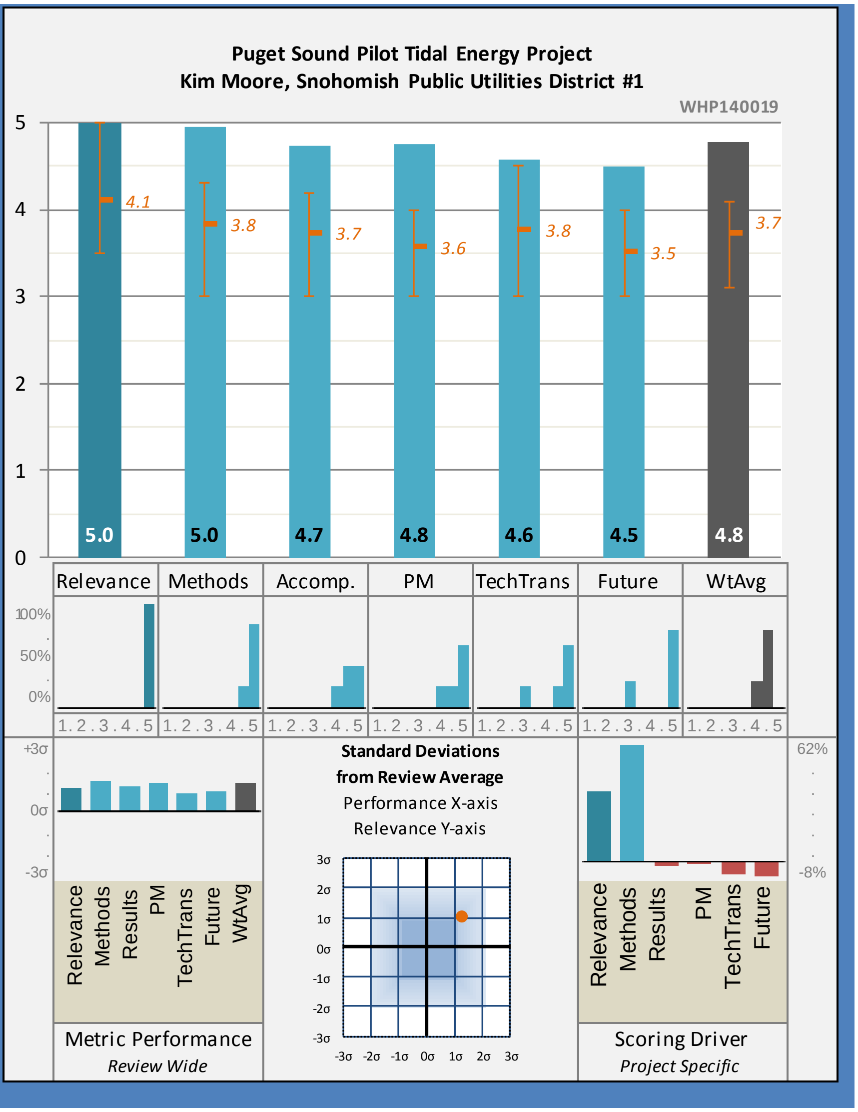
Panel:

Technology Advancement

Budget:

$10,000,000 DOE

$10,111,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **5.0** for its Relevance to water industry needs and overall DOE objectives.

- This project shows a huge success to the MHK industry. The success of this project will benefit both tidal and wave energy nationally and support future utility involvement in this industry.
- Strong example of open, transparent, accountable project planning by utility in high public visibility environment.
- This planned in-water demonstration will provide necessary data for regulatory authorities and utilities about the issues of siting and permitting of future MHK resources.
- Field test to collect data on tidal turbines. This will be a tremendous accomplishment and will provide very valuable data to the tidal energy industry.

- This is an ambitious and important undertaking that will help define the technology and the environmental acceptance of tidal power in the U.S. This will directly benefit wave development in the Pacific NW as well by establishing regulatory precedents and monitoring. This pilot project could also pave the way for significant tidal energy development in Puget Sound.
- Strong example of use of National Labs personnel to address critical market barrier in killer whale impacts analysis.
- Includes development of a life-cycle risk analysis.
- The leadership and vision and resources of Snohomish PUD has been extraordinary and DOE providing support to help make this work is key.
- Excellent project site, with high potential as utility-scale grid connected project.

Question 2: Methods and Approach to performing the research and development

This project was rated **5.0** on its methods/approach.

- The utility has conducted a very thorough and detailed approach to this project.
- Well planned, extensive consultation with all affected stakeholders.
- SnoPUD has followed an effective path to achieving approval for an in-water demonstration in a very environmentally-sensitive area.
- Successfully executing a very complicated plan.
- Went through site selection process, competition for turbines, FERC licensing process, property acquisition, and other major steps to ready themselves for a pilot project deployment in a high energy site with unique environmental resources present.
- Innovative use of project documents and deliverables.
- SnoPUD has made excellent use of resources within the larger MHK Team (specifically National Labs) to solve a potentially show-stopping issue (Orca strikes).
- Not clear exactly how environmental resources were factored into siting process.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.7** based on technical accomplishments and progress.

- It has been a long road for this utility but they have obtained all their regulatory approvals - working with industry, academics, and national labs to support the progress of this project.
- SnoPUD reports 95% across-the-board completion of regulatory steps. This is a significant accomplishment.
- Very complicated project, but they have made great progress.
- Secured FERC and other regulatory acceptance for deployment. Developed plans for infrastructure and grid connection. Evaluated numerous tidal turbines and selected technology best suited to the site. Worked with industry, academia, and government labs to put together all the pieces of a major development effort.
- Environmental data collection system is good component - developed by NNMREC - has applicability to other projects.
- using mechanical braking instead of electrical due to line limitations.
- O&M cost determination over multi-year basis.
- using battery storage for excess electricity produced.

Question 4: Project Management

This project was rated **4.8** on its project management.

- While this has been a costly project for the utility, it is also the first of its kind.
- Good compliance with project schedule.
- The project seems to be progressing through the permitting processes. This is still a little-understood area with a lot of uncertainty. SnoPUD should carefully document and share their experiences with the larger MHK community.
- Project is well being well managed through a very complicated process.
- Comprehensive approach to permitting and all components of project siting.
- It has and continues to overcome numerous environmental and regulatory challenges to get to this point - likely thanks to strong utility leadership of the course of this project.
- Innovative project works and project insurance documentation upgrades with potential cost reduction learning for entire industry.
- Probably because of the large amount of non-Federal money involved, there is little detail that can be used to make a fair assessment of the effectiveness of the PM effort.
- Self-insured and extending to all contractors working on site.
- Have overcome a number of technical and environmental obstacles and challenges to get to where they are - fiber optic cable issues, orca whales.
- Schedule may slip a year due to water work windows.
- Have a dedicated staff and resources of investor owned utility.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.6** for research integration, collaboration, and technology transfer.

- Many of the supporting studies have included academics, national lab, and industry input.
- Good work in making all Plans and lessons learned available on the site.
- National Laboratory efforts in support of SnoPUD should be a benchmark for future Lab-Industry collaboration on the MHK Team.
- Tremendous coordination with many stakeholders.
- Good use of labs to deal with Orca impact analysis.
- Important lesson learned about potential challenges of near-shore deployment.
- I would like to have seen more public presentations at industry conferences and in the popular media
- Partnerships with several groups including PMEC and private developer, labs - projects that the entire US industry knows about and is following.
- Careful efforts to work collaboratively with federal resource agencies will hopefully raise understanding of MHK development projects and simplify future permitting.

Question 6: Proposed Future Research

This project was rated **4.5** for proposed future research.

- The results from the monitoring plans will be vital for other MHK deployments around the country.
- High priority for future permitting.
- A successful demonstration of MHK technology with relevant data collection in an environmentally-sensitive area would be a significant "win" for the industry.
- The suggested Iterative improvements in design would be worthwhile if funds are available.
- implementation of monitoring plans will be critical for assessing how well these projects can be compatible with environment.
- Deployment next step.

Strengths and Weaknesses

Project Strengths

- Excellent, consistent project management by experienced utility.
- This is an important demonstration that appears to be well managed and on track.
- Field test of a working tidal turbine will be a tremendous contribution to the tidal energy industry.
- Utility backing and resources.

Project Weaknesses

- There is no guarantee that regulatory hurdles will be cleared (but this seems likely).
- Sheer costs of siting a project in Puget Sound may make future development prohibitive but this project has the potential to significantly reduce those costs.

Specific recommendations for additions or deletions to the work scope

- Once approvals are received, carefully monitor the fabrication/deployment for adherence to cost, schedule, and quality requirements.
- Continue.

WHP140020

Project Title:

Advancement of the Kinetic Hydropower System (KHPS) to Department of Energy (DOE) Technology Readiness Level (TRL) 7/8

Principal Investigator:

Mary Ann Adonizio

Organization:

Verdant Power Inc.

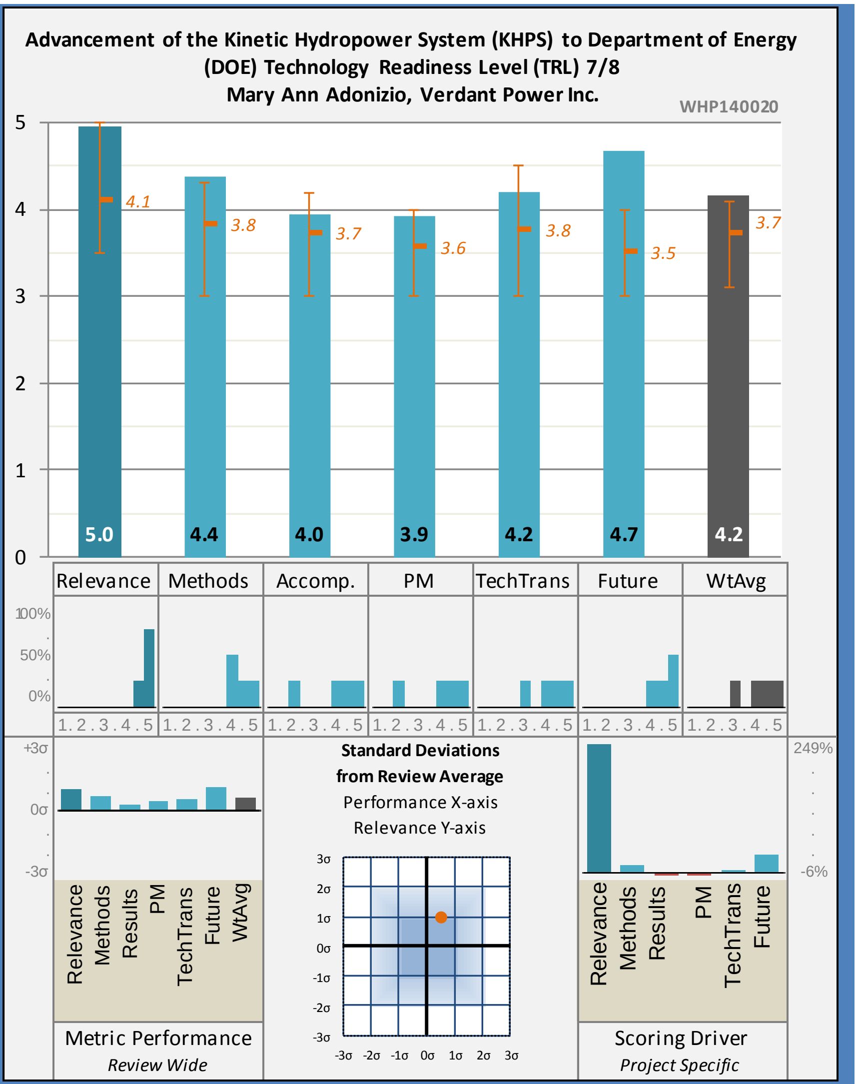
Panel:

Technology Advancement

Budget:

$2,620,830 DOE

$1,500,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **5.0** for its relevance to water industry needs and overall DOE objectives.

- Another huge success for the MHK industry.
- DOE should consider advancing near-to- market tidal power devices as a top priority for Water Power Program to deliver a mature RE generation source as product of Water Power Program investments and to gather environmental and O&M information useful for all other MHK device developers.
- The project supports environmental compliance, component tests, as well as O&M projections for the RITE Pilot Project.

- The environmental compliance instrumentation implementation, component testing, and O&M projections will provide important data to the tidal energy community.
- Not allowed to comment due to work on project.
- Verdant has made great strides forward working with the regulatory agencies to achieve this successful deployment.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.4** on its methods/approach.

- Careful project design, building upon prior research funded by USDOE that addresses both the technical and environmental permitting barriers facing the project in this FERC-licensed site.
- The methods are well thought out and should yield good scientific, technical, and cost information in support of the RITE Pilot Project.
- Project is well planned and is being well executed.
- Excellent work to leverage IBM work with SmartBay – Galway IRE.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.0** based on technical accomplishments and progress.

- This project has allowed Verdant to refine their device design and successfully initiate post-deployment monitoring methods.
- Excellent accomplishments to meet each of 3 Tasks. Impressive work on environmental monitoring using NREL fish tracking study to characterize fish populations and interaction. Significant accomplishments in leveraging NY supply chain to develop Task 2 and 3 component development and obtain certification.
- The project is behind schedule and has requested a no-cost extension.
- Progress satisfactory.

Question 4: Project Management

This project was rated **3.9** on its project management.

- Verdant has managed its product development very well, getting full value from USDOE funds and leveraging those funds effectively to secure additional State funding from NYSERDA and from private investors. Successful project results, building sound foundation to progress to TRL 7/8 levels and deployment of pilot project.
- Schedule variances are not explained. Very little of the funding has been spent. The schedule does not give any indication of the baseline plan; only the revised one.
- Project on time and within budget.
- Very thoughtful and effective Verdant efforts to obtain regulator and USDOE inputs on project protocols to assure that project results will meet environmental and technical barriers to development.
- The statement that the project will complete within budget is not supported.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.2** for research integration, collaboration, and technology transfer.

- A good collaboration with NREL as well as private partners, including manufacturing and supply chain specialists.
- Effective use of national lab expertise in blade design and test stand development (NREL/NWTC) and fish studies.
- NREL participates as a team member for composite blade testing. This is good use of the capabilities of a National Laboratory.
- Good collaboration with stakeholders.
- Impressive collaboration with multiple supply chain vendors (IBM Research Project; SmartBay Project) and others.
- Verdant states that they intend to be a part of the Field Measurement Campaign, assuming that the RITE Pilot Project moves forward.

Question 6: Proposed Future Research

This project was rated **4.7** for proposed future research.

- Based on the results from this deployment (both from a data gathering perspective and regulatory approach), the next deployment of Verdant's Gen5 KHPS will continue to further the MHK industry in the US.
- USDOE should prioritize funding for actual deployment of the RITE Project deployment scheduled for FY 2015.
- Future efforts support the RITE Pilot Project, which is a key in-water demonstration of MHK.
- Proposed RITE pilot project would be worthwhile if funds are available.

Strengths and Weaknesses

Project Strengths

- Exciting to see concrete progress on refinement of commercial beta project at FERC licensed site in urban setting
- Supports the RITE Pilot Project
- Good coordination.
- Manufacture and O&M cost reduction focus to reduce LCOE

Project Weaknesses

- While the noise study component is needed to enable Verdant to address critical market barrier of environmental permitting requirements, it is frustrating to see $75K of DOE money and private match of $200K bled off from project critical needs to fund noise study in one of the noisiest marine environment settings in the world. This is an excellent example of where USDOE could be working with federal and state regulators to strategically plan where noise studies could be performed to yield highest value and maximum application to all MHK developers.
- Project is behind schedule with no suitable explanation.

Specific recommendations for additions or deletions to the work scope

- This project represents one of the nearest-to-market technologies in USDOE Water Power Program portfolio and the technology should be prioritized for future funding to complete full commercial deployment.
- Continue to monitor this effort carefully to assure that further delays do not impact the RITE Pilot Project.
- Continue.

WHP140021

Project Title:

Advanced Integration of Power Take-Off in Vortex Induced Vibrations Aquatic Clean Energy

Principal Investigator:

Rebecca Alter

Organization:

Vortex Hydro Energy

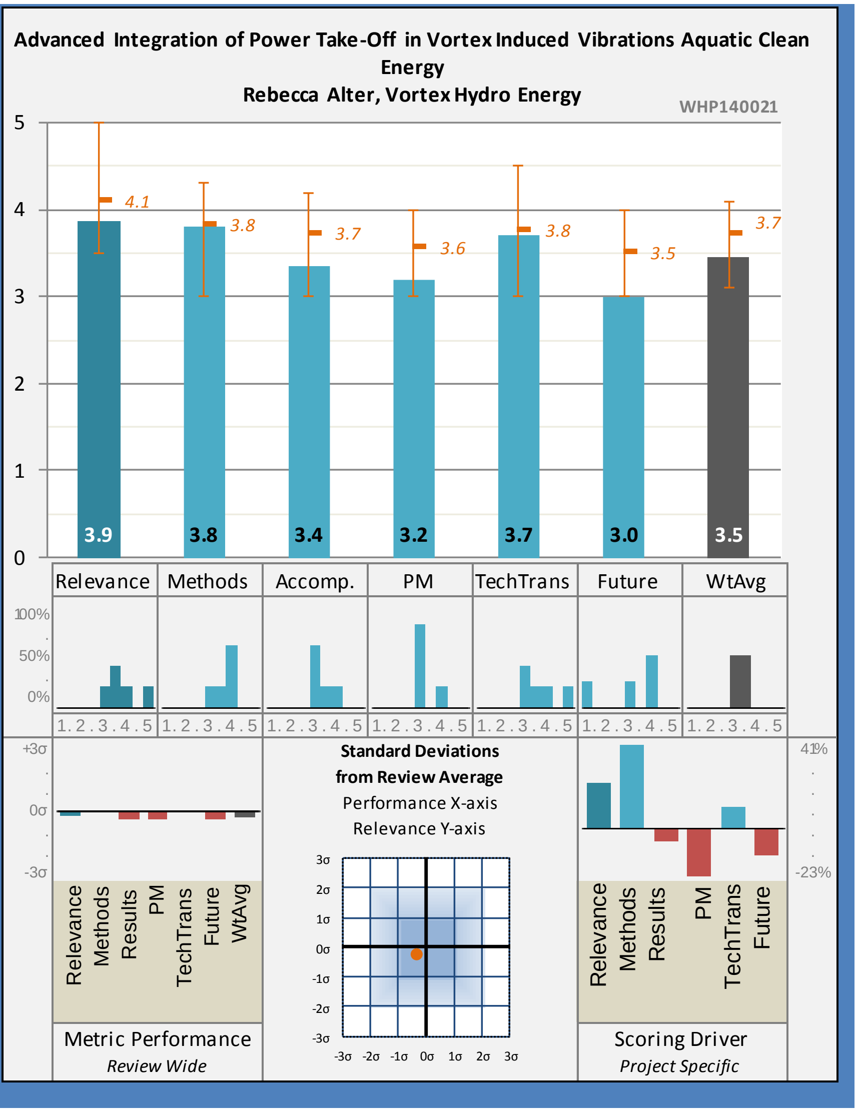
Panel:

Technology Advancement

Budget:

$999,955 DOE

$673,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.9** for its relevance to water industry needs and overall DOE objectives.

- A good, albeit different, approach to harnessing river energy.
- Effective use of DOE funds to supplement SBIR award to advance promising alternative MHK technology in TRL 3 to 4 stage.
- The project supports the early-stage development of an MHK technology that is unique in the industry.
- This is a unique technology based on vortex-induced vibrations. Whether or not it can produce significant amounts of energy is not as yet established. That is what this project is meant to determine.
- Different concept - interesting but not clear how the PTO works or how much power it will be able to produce.
- Can be used in low velocity sites.

- Based on fish biomimetics - using vortex induced by motion.
- Cylinders can either be deployed horizontally or vertically.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.8** on its methods/approach.

- Uncertain as to how the PTO operates, but it positive to see this device being deployed and operational.
- The project follows a sound methodology of analysis and experimental verification.
- Well executed project.
- PTO looks like a very complex gear driven system but difficult to tell much more about it from schematic provided.
- It looks like they are going about trying to develop the right way but lack of outside investors makes me wonder what fatal flaws are.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on technical accomplishments and progress.

- They have a device in the water - that is a major milestone.
- The results that have been obtained are good, but the schedule has slipped significantly.
- Lab and field tests done.
- Installation in St. Clair River in MI in 2012.
- Use of multi-cylinders created synergistic result - more output from closely spaced cylinders.
- Trying to raise from TRL 4 to higher - now between TRL 5 and 6.

Question 4: Project Management

This project was rated **3.2** on its project management.

- The schedule shows a 9-month schedule variance without explanation.
- Well managed project.
- Project largely complete?
- Unable to assess cost performance.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.7** for research integration, collaboration, and technology transfer.

- A good team of collaborators including academic, public, and private partners.
- Great to have a University of Michigan spinoff technology as basis of research collaboration.
- Vortex Hydro is a university spin-off that has taken VIVACE from the lab to the water. The culture supports substantial publications.
- Working with industry and academia but 2013 did not include funding from outside sources.

Question 6: Proposed Future Research

This project was rated **3.0** for proposed future research.

- A large scale deployment, combined with advanced PTO, may provide very exciting results.
- Would be helpful for USDOE to introduce the recipient to USN and Manufacturing Extension Partnership to assure that they have been able to tap all publicly available research within federal government applicable to the technology.
- No discussion of future plans beyond the two SBIR projects.
- The synergistic optimization is interesting if it could lead to greater output from smaller area.
- How would this device operate in the tidal/marine environment?

Strengths and Weaknesses

Project Strengths

- VIVACE is a unique concept that deserves low-level support.
- High power density, that is, power generated per weight of device.
- Can work at low speeds.

Project Weaknesses

- Not clear how the Vivace Power Takeoff System research can/will tap into and build upon the ongoing national lab research on same topic.
- VIVACE is a long way from a significant demonstration and the Vortex Hydro Team seems unlikely to be able to pull one off without a serious industrial partner.
- Uncertain whether or not this will develop into a practical device for extracting MHK energy.
- Does the requisite expertise reside within academic communities, or would this project benefit from more robust participation of manufacturing and engineering firms expert in the area?

Specific recommendations for additions or deletions to the work scope

- It might be good to see the Vortex team solicit national lab input (i.e., V. Neary).
- I don't see this going very far without a serious industrial partner.
- Continue.

WHP140022

Project Title:

MHK Industry Support

Principal Investigator:

Albert LiVecchi

Organization:

National Renewable Energy Laboratory

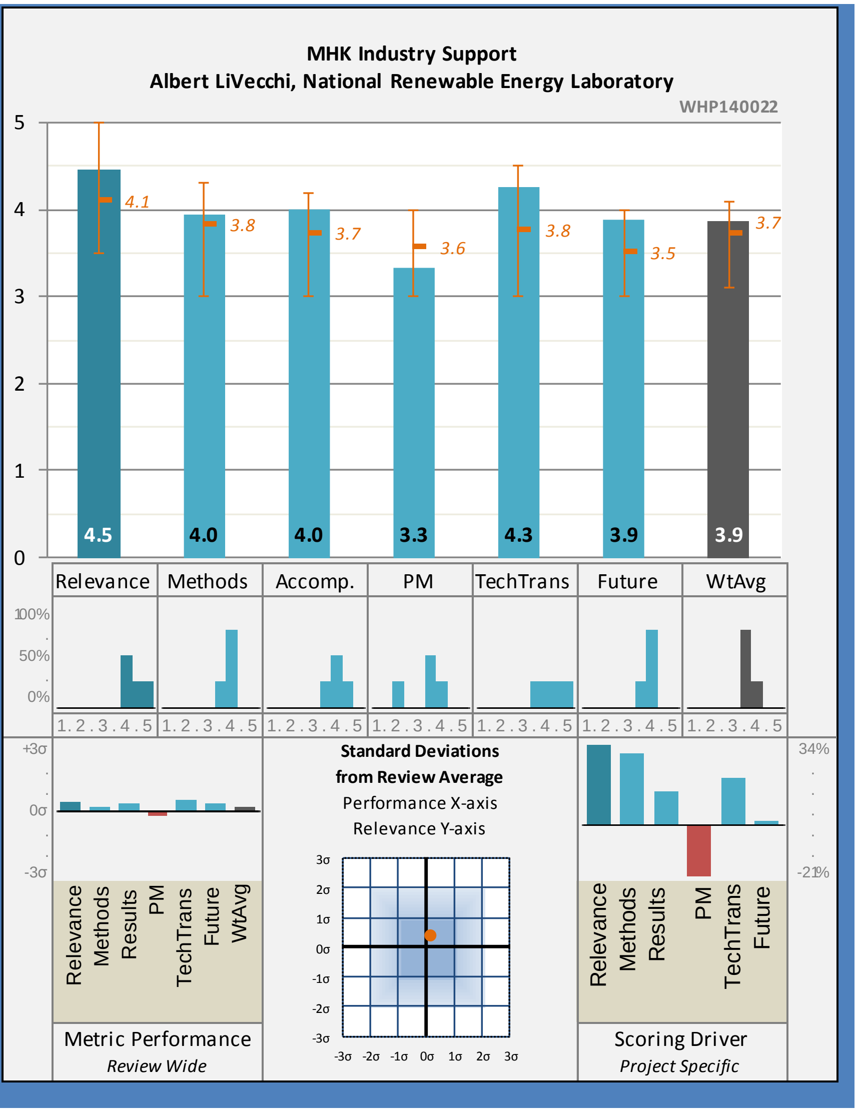
Panel:

Technology Advancement

Budget:

$1,100,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.5** for its relevance to water industry needs and overall DOE objectives.

- This is a good collaboration between the national labs and industry to advance TRL 7/8 projects.
- Project provides support to RITE Pilot Project by performing tests on composite blades for Verdant Power
- Very relevant. Brings DOE lab experience to MHK firms. Leverages relevant experience to de-risk MHK projects in support of industry.
- This effort attempts to leverage lessons learned from water energy industry through National labs working directly with Project developers. This seems like a very good use of the brains and other resources of the labs - working directly on projects with developers allows for experiences to be directed at specific problem solving.

- Project provides support to TideGen Demonstration Project by performing reviews of the system design and findings from in-water testing for ORPC.
- Applying wind engineering experience.
- Support to OPT has been delayed by difficulty in executing a CRADA.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- Positive: Building off experience from other industries.
- This project makes good use of the resources of the National Laboratories in support of MHK industrial partners.
- Methods worked well for Verdant Power and Ocean Renewable Power Corporation.
- Building off knowledge and tools that were developed in support of the wind industry is a good approach to avoid repeating mistakes and/or redoing work.
- Collaboration with two leading tidal energy developers.
- A process exists for selecting the projects to be helped.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.0** based on technical accomplishments and progress.

- NREL provided support for testing of composite blades to Verdant Power based on Wind Power experience.
- Good results for Verdant Power and Ocean Renewable Power Corporation.
- Verdant - applied blade testing from wind to hydrokinetic ORPC - helped identify system refinements.
- NREL & SNL provided design and test data review to ORPC.

Question 4: Project Management

This project was rated **3.3** on its project management.

- This is basically a level of effort task in support of industry, with spending that is far below available funding
- Well managed.
- Budget summary difficult to understand but it looks like work is being accomplished for less than the budget allocated which should be a positive.
- Project appears to be on schedule.
- Spend Plan for FY14 is not realistic and simply indicates that available funds will be spent. It doesn't appear to be tied to the planned scope of work.
- Support to TC-114 TAG should be allocated to separate project reviewed later.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.3** for research integration, collaboration, and technology transfer.

- A strong collaboration of national labs working with industry.
- This project is a very low-cost way to utilize the talents in the National Laboratories for the benefit of the MHK Industry.
- Good collaboration with industry. (Verdant Power, Ocean Renewable Power Corporation).
- Good collaboration with some of leading US developers.

Question 6: Proposed Future Research

This project was rated **3.9** for proposed future research.

- FY14 tasking effectively supports industry (now including OPT).
- Continue laboratories assistance to industry into the future if funding is available.
- Future research anticipates continued partnerships with developers.

Strengths and Weaknesses

Project Strengths

- Applies the technical and scientific talent in the National Labs to real problems facing the MHK Industry.
- Direct assistance to MHK industry by leveraging what has been learned in wind energy development.
- By partnering with Industry and understanding the challenges that they face, the National Labs are better able to support the needs of the MHK Industry.

Project Weaknesses

- This project is challenging to effectively manage. The scope was unknowable at the time of initiation, but has evolved.
- Budgeting has clearly been difficult and a fair amount of funds are allocated, but are unlikely to be spent.

Specific recommendations for additions or deletions to the work scope

- While this is a productive effort that should continue, DOE should also be aware of possible unnecessary efforts and consider this project as a possible source for recoverable funding.
- Continue.

WHP140023

Project Title:

Industry Support: ORPC

Principal Investigator:

Vincent Neary

Organization:

Sandia National Laboratories

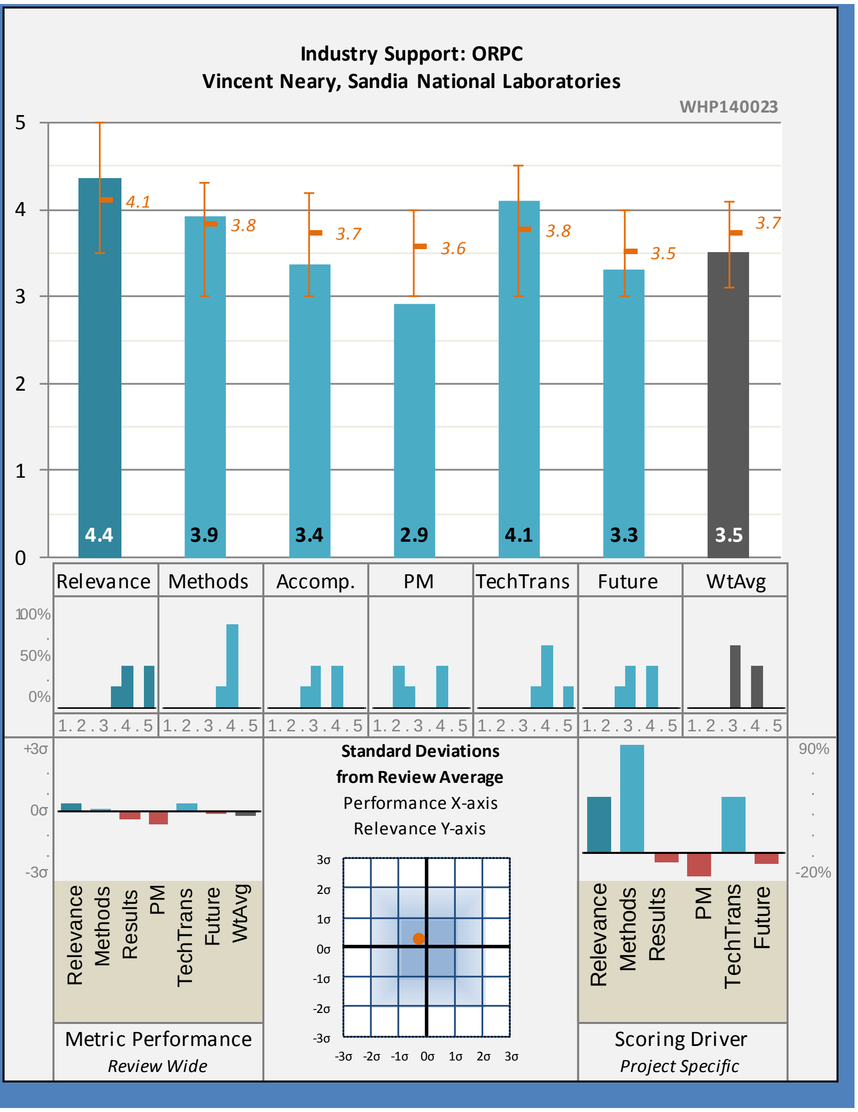
Panel:

Technology Advancement

Budget:

$910,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.4** for its Relevance to water industry needs and overall DOE objectives.

- This project is a good example of a device designer (ORPC) leveraging the national labs expertise.
- Project provides critical information to accelerate potential near-term commercialization of MHK technology in canal deployment.
- Leverages DOE experience in wind energy to increase probably of success.
- Very relevant. Brings DOE lab experience to MHK firms. Leverages relevant experience to de-risk MHK projects in support of industry.
- Focusing on use of models developed for wind and applicability to marine hydrokinetics - providing analysis of structural strength and other aspects. Not clear if this is summary of one aspect of previous presentation or

a distinct and separate project. In any event appears to be a positive collaboration between lab and private developer, leveraging information and models gained through wind program to advance MHK.

- Applying wind engineering experience.
- Cross-flow turbine models from wind.
- Using array optimization model from Sandia to improve site performance.
- Potential straight blade design?

Question 2: Methods and Approach to performing the research and development

This project was rated **3.9** on its methods/approach.

- This is a good example of leveraging the knowledge bases from another industry (i.e., wind) to enhance a tidal device.
- Well-designed approach to test both the device performance and impacts on the water operations in the canals using actual HK device of Instream Energy System, and to develop best practices manuals on these topics, but limiting study to only one device may limit study value.
- Applying CACTUS model to TidGen provides a capability that the Company might not otherwise have
- Methods worked well for Verdant Power and Ocean Renewable Power Corporation.
- Appears to be a well-designed approach.
- Positive: looking at how models from other industries can be used for the tidal industry and not re-inventing the wheel.
- Subject matter expert-level review of TidGen design provided important manufacturing comments.
- A process exists for selecting the projects to be helped.
- Using validated hydrodynamic models to optimize turbine arrays will be critically important for developers as they seek to build out commercial arrays - this will inform the size and environmental footprint of the site as well as energy output and could have direct relation to fish and marine mammal interactions.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on technical accomplishments and progress.

- It is somewhat confusing - straight blades on the ORPC turbine? Wouldn't ORPC have already investigated this? It seems somewhat of a backtrack and not an advancement.
- Good progress on project planning; most project work to be done.
- Expertise in the National Labs appears to have been put to productive use and has achieved good results
- Good results for Ocean Renewable Power Corporation.
- Potential straight blade design for ORPC turbine? Models suggesting consideration of a complete design change and this is under further investigation. Could yield a new and better design or could be a wild goose chase so tough to evaluate.
- Field validation is paramount - it is good to see the national lab getting sensors on a deployed device.
- Delays in identifying suitable tasks for the Lab are understandable.
- The findings from array optimization appear positive.

Question 4: Project Management

This project was rated **2.9** on its project management.

- The national labs and industry need to refine the contracting process - this is obviously causing delays in the progress of these projects.

- Schedule variances are significant, but explained adequately.
- Well managed.
- Behind schedule due to contract negotiations. Perhaps alternate design considerations have also delayed. Project summary discusses testing of composite material in seawater. Not clear if this was part of original scope or if it will impact schedule.
- Project Backlog (available budget including carryover) is growing to the point where it is unlikely to be spent. This indicates that annual budget requests have been excessive.
- Future (FY14 and beyond) is not reflected in the schedule.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.1** for research integration, collaboration, and technology transfer.

- Good industry and lab collaboration.
- Good collaboration with US Bureau of Reclamation, Device owner (Instream Energy System), and consultant team in project design.
- This project is a very low-cost way to utilize the talents in the National Laboratories for the benefit of the MHK Industry.
- Good collaboration with Ocean Renewable Power Corporation.
- Appears to have solid industry and lab collaboration.

Question 6: Proposed Future Research

This project was rated **3.3** for proposed future research.

- It will be difficult for labs to do additional research if no device is going in the water in the near future, such as with ORPC.
- Emphasis should shift to actual product testing, rather than model development.
- The FY14 tasking is surprising; it seems to contain scope that would be better performed within ORPC
- Continue laboratories assistance to industry into the future if funding is available.
- Not clear if there will be future research - may depend on whether ORPC wants to consider alternate design.
- Proposed Future Research seems quite speculative and may not have been adequately coordinated with ORPC.

Strengths and Weaknesses

Project Strengths

- Applies the technical and scientific talent in the National Labs to real problems facing the MHK Industry.
- Direct assistance to MHK industry by leveraging what has been learned in wind energy development.
- By partnering with Industry and understanding the challenges that they face, the National Labs are better able to support the needs of the MHK Industry.

Project Weaknesses

- Project backlog is at an unacceptable level relative to prior annual spending. These funds should be freed up for other efforts.

Specific recommendations for additions or deletions to the work scope

- Any future funding should shift to actual product testing.
- While this is a productive effort that should continue, DOE should be aware of possible unnecessary efforts and consider this project as a possible source for recoverable funding.
- Continue.

WHP140024

Project Title:

Performance Testing for Hydrokinetic Canal Effects NEW

Principal Investigator:

Vincent Neary

Organization:

Sandia National Laboratories

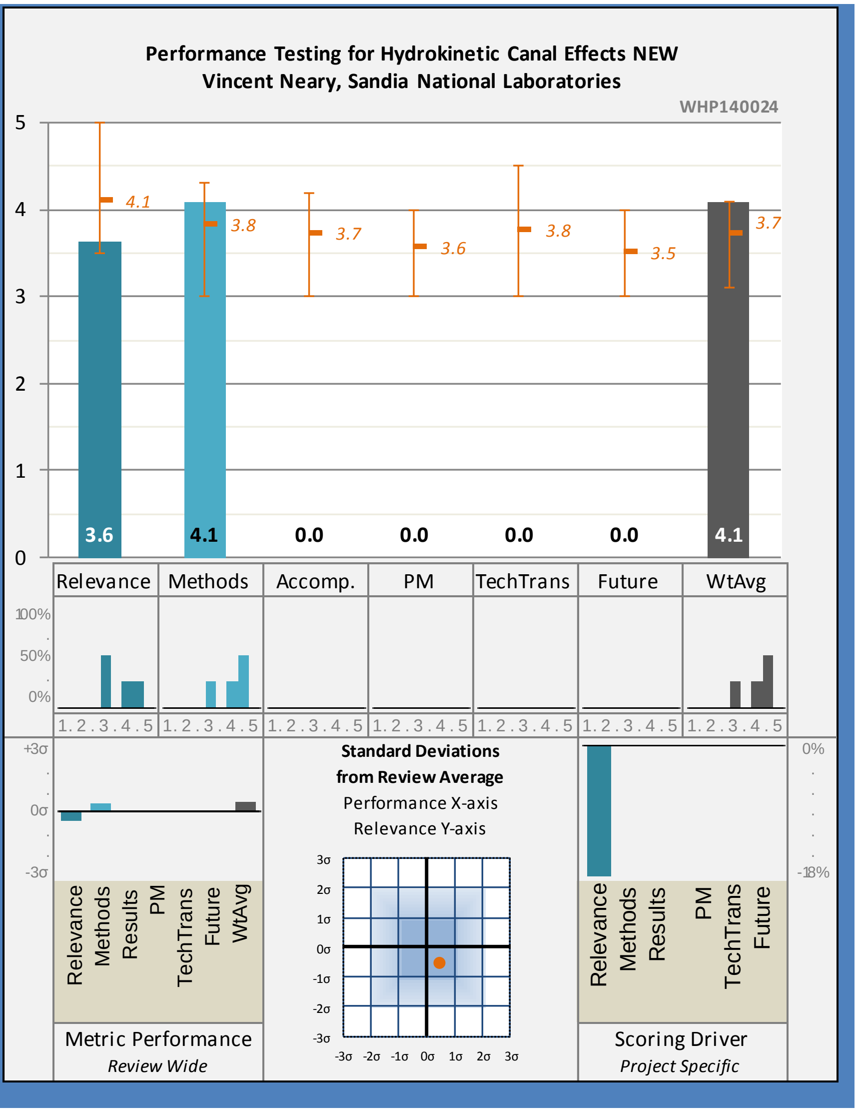
Panel:

Technology Advancement

Budget:

$900,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- This is a very good use of existing infrastructure to support microgeneration projects.
- The Project will provide guidance for predicting the performance of MHK installations in canals to produce power for local needs.
- This is a unique technology application in that it is based on extracting energy from canal flows. Whether or not it can produce significant amounts of energy is not as yet established. That is what this project is meant to determine.
- Hydrokinetic devices in canals and waterways an important potential source of energy. Gathering data on an existing device and its impact to water conveyance and upstream or downstream conventional hydropower will be important and useful information.

- The Project will also provide an approach for quantifying the impact on the waterway.
- Performance testing and analysis in controlled yet natural environment provides a unique opportunity to control potential variables that would occur in river or tidal situation.
- Applicable to canals - lot of canal resources available - potential to measure headlosses at existing hydros.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.1** on its methods/approach.

- SNL has surveyed a canal and produced a test plan.
- Good plan.
- It appears to be a very well thought out approach, based on field reconnaissance last year, measurements will be taken during a few times of the year that will bracket expected conditions (i.e. min and max flows), and with turbine in and out of water. This should yield excellent data for use in validating models and other purposes.
- Working with an existing site great way to piggyback data collection.

Strengths and Weaknesses

Project Strengths

- Effectively uses National Lab resources to support an effort that might be undertaken by the BOR or USACE.
- Measurement of flow recovery in the wake of the turbine will help other developers.
- Using an existing site, partnering with industry and government (BuRec).
- Head loss measurements will be valuable, particularly if it is shown to be negligible.

Project Weaknesses

- It is unclear that there is a market for the power.

Specific recommendations for additions or deletions to the work scope

- Continue at a low level.
- Continue.

WHP140025

Project Title:

Materials & Coatings + Manufacture Reliability

Principal Investigator:

Bernadette A. Hernandez-Sanchez

Organization:

Sandia National Laboratories (Lead)

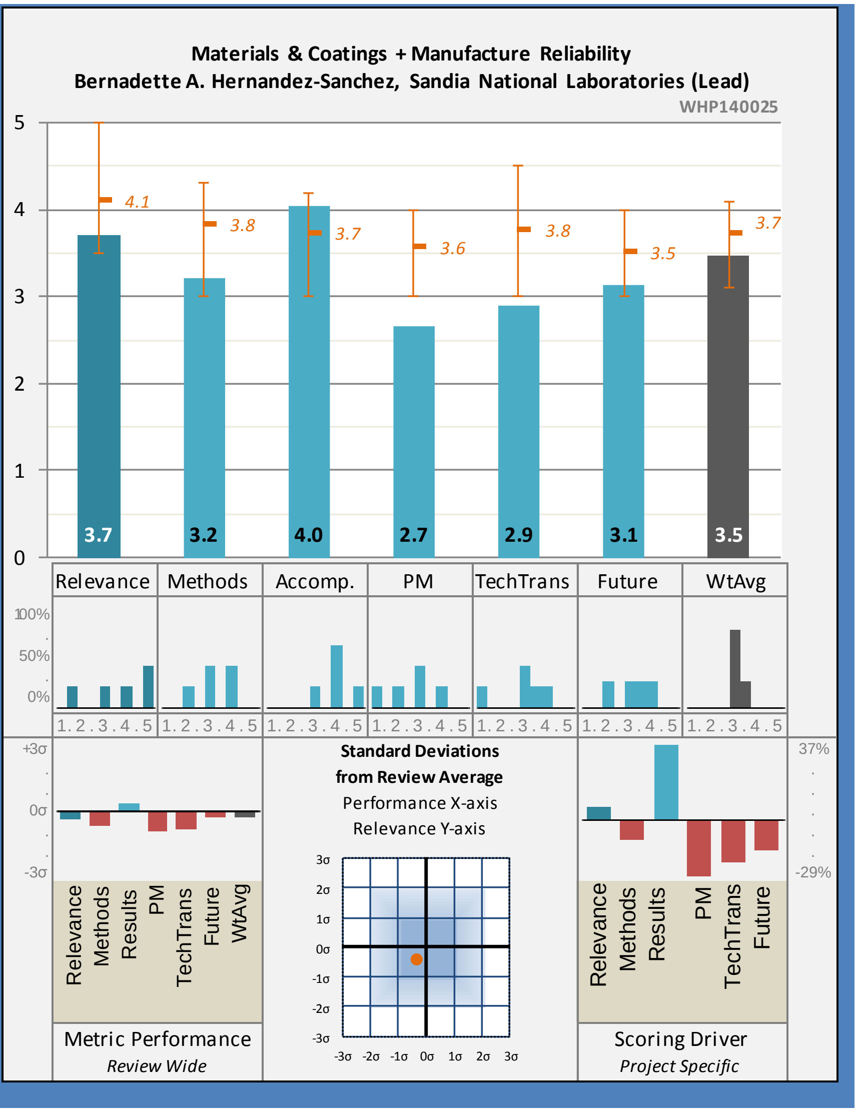
Panel:

Technology Advancement

Budget:

$2,279,650 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.7** for its Relevance to water industry needs and overall DOE objectives.

- I understand how this research will benefit MHK; however, this research would support any marine-based industry and does not necessarily meet DOE's overall objectives.
- Critical to MHK industry future and sustainability, but project needs to be reframed and restructured to include new partners and approach.
- This Project seeks to assist the MHK Industry with material problems that have been experienced during in-water deployments.
- Very relevant because materials biofouling and corrosion affects all MHK devices.
- Very useful to test coatings to prevent biofouling and corrosion - could help developers considerably.

- Why is so much MHK funds going to this research that is concurrently being done by the navy, oil & gas, and shipping industries?
- Toxicity issues need to be solved so beneficial.
- Are we leveraging enough off of work done by oil and gas industry and Navy?

Question 2: Methods and Approach to performing the research and development

This project was rated **3.2** on its methods/approach.

- The approach appears to be well thought out and very logical.
- Excellent use of Sandia expertise to leverage experience in wind and other industries to solve coatings and biofouling issues for MHK.
- SNL is likely to be performing work that the Navy and the Commercial Shipbuilding Industry have already performed.
- It is crucial that the Department of Defense and the oil industry are being consulted on this project. Both groups have been dealing with materials in the ocean environment for many decades.
- Started with lit search and sitting in on MHK review - also reaching out to developers to understand issues
- But project methodology and approach is not effective with regard to assessing prior research and identifying most likely antifoulants and anticorrosion agents. The project summary makes clear that Sandia plans to start consultation with USN after extensive preliminary research. That should have been first step.
- Need to determine international research outcomes to date in MHK field and beyond.
- Need a more cost-effective, powerful collaboration in project design, creating cost-sharing approach and avoiding use of MHK scarce research dollars where the outcomes will benefit many industries.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.0** based on technical accomplishments and progress.

- The team has done a vast amount of work and testing, incorporating a large number of teaming partners.
- The results of the scientific work to date have been impressive.
- Some significant results already found.
- Developing and testing new materials based on review of existing and needed.
- Developed database of coatings and composites to provide guidance to industry.
- Looking at effects of salt water on composites - composite material that has been diffused.
- No acute toxicity with freshwater fish.

Question 4: Project Management

This project was rated **2.7** on its project management.

- It is hard to determine how much of the budget presented was specifically for this project. If all the funds were dedicated to this project, the results do not justify the effort. As there appears to be duplication of efforts from other industries working on the same problem.
- Project may well have issues with executing within scope and on-time if extensive first generation testing is needed to identify likely materials for antifouling applications. Much more effective to start with USN work to date.
- Schedule variance was explained.
- Need to ensure DoD and oil industry are consulted.

- Sizable sums of money spent and some small amounts leveraged from other areas. How much does some of this original research benefit Navy and/or oil and gas industry and are there funds available from there?
- Unable to evaluate the comment "No variance from spend plan for FY12, 13" based on the data given.
- Unless the budget numbers include carryover (likely), the spending is very high for the results obtained.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.9** for research integration, collaboration, and technology transfer.

- Positive: Team worked with paint manufacturers.
- Good effort to coordinate among labs, but not with other federal agencies or private/academic sectors.
- An impressive team of researchers and publications.
- Need to ensure DoD and oil industry are consulted.
- Teaming with a number of universities - chose ND State because of direct marine experience.
- This research needs the input of the Navy and Shipbuilding Industry.

Question 6: Proposed Future Research

This project was rated **3.1** for proposed future research.

- Research is needed, but on more collaborative basis.
- Current effort is a logical conclusion to the effort. The proposed future research doesn't seem helpful for the MHK Industry at this time.
- Proposed future research is worthwhile.
- Determining costs will be important as materials and coatings that are affordable to industry will be key to their usefulness.

Strengths and Weaknesses

Project Strengths

- An impressive scientific team has taken a look at material problems facing the MHK Industry. I am a bit perplexed as to why the MHK System Developers haven't done this in-house.
- Good technical results.

Project Weaknesses

- The Team has apparently not reached out to people who have probably been working on these problems for decades.
- Collaboration seems limited.

Specific recommendations for additions or deletions to the work scope

- I do not see this as a "MHK-specific" project; this is a marine industry-specific project that will need to be addressed by the Navy, USCG, shipping industry, and oil & gas, etc.
- USDOE research dollars for MHK industry are not likely to cure this issue alone effectively. USDOE should coordinate work of DOD, Coast Guard, and international MHK sector, inviting private sector participation
- At this point, feedback from System Developers is essential. If Systems Developers consider this helpful continue it, otherwise consider completing the ongoing research and stopping the effort.
- Continue. Expand collaboration.

- Funding should be supported by other industries as well, not just MHK.
- Continue. Expand collaboration.

WHP140026

Project Title:

Advanced Materials and Manufacturing Reliability

Principal Investigator:

George Bonheyo, Ph.D.

Organization:

Pacific Northwest National Laboratory

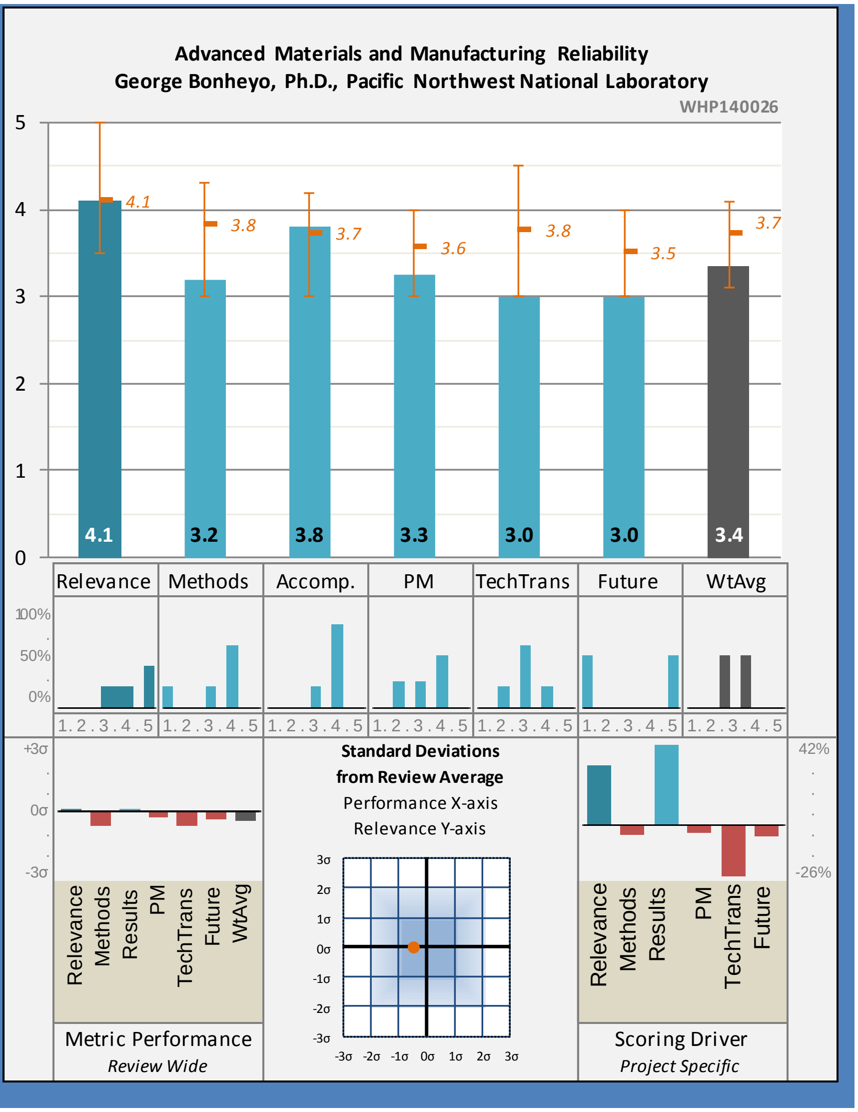
Panel:

Technology Advancement

Budget:

$100,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.1** for its Relevance to water industry needs and overall DOE objectives.

- For a reasonable cost to the overall MHK budget, this is a very effective study.
- Project of developing advanced materials and manufacturing reliability for biofouling issues is critical, but not clear that project is designed to avoid duplication and to tap prior research funded by federal government, private sector and MHK international community.
- The Project compares experimental anti-biofouling materials against commercially-available products, but there is no stated reason to believe that the commercial products are inadequate.
- Very relevant because biofouling is a common problem for all MHK devices.
- field testing of anti-fouling compounds.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.2** on its methods/approach.

- Same concerns as listed under Biofouling study; this project is designed without an overview analysis of prior and current ongoing research in the field by other federal, international and academic centers and completely misses the USN ongoing programs.
- The scientific approach is sound.
- It is crucial that the Department of Defense and the oil industry are being consulted on this project. Both groups have been dealing with biofouling of materials in the ocean environment for many decades.
- Uses state of the art approaches.
- Looking at both non-velocity and high velocity (and in-between).
- Developing toxicity assays.
- Assessing areas exposed to sunlight and not exposed to sunlight - big differences.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.8** based on technical accomplishments and progress.

- The implementation of the project as designed seems to have good progress, but project design is limited.
- The Project is just getting started, but seems to be progressing well with only a few normal material procurement delays.
- Laboratory tests ongoing.
- Project just started.

Question 4: Project Management

This project was rated **3.3** on its project management.

- Management of project as designed appears good, but the project management should have assured that the state of play in research was fully understood and referenced.
- The scope is well defined and of low cost; risk is negligible.
- Need to ensure DoD and oil industry are consulted.
- Schedule staggered and based on testing schedules - appears to be well thought out.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.0** for research integration, collaboration, and technology transfer.

- No results to share as of yet.
- Serious lack of creativity in designing truly integrated research approach for a project that affects so many marine industries.
- Solid research team. Too early to have publishable results.
- Need to ensure DoD and oil industry are consulted.
- Working with universities, Sandia, potential collaboration with Navy, oil industry.
- No results yet to disseminate.

Question 6: Proposed Future Research

This project was rated **3.0** for proposed future research.

- Not applicable.
- High funding priority for a revised collaborative project approach in cost sharing with other federal agencies, private sector.
- No Proposed Research beyond FY14.
- None mentioned.
- Not Applicable - doesn't seem to be future research proposed.

Strengths and Weaknesses

Project Strengths

- This Project represents a low-risk, low-cost, independent look at anti-biofouling materials by a highly qualified research team
- Good technical results.

Project Weaknesses

- There is no apparent urgent need for improvements to commercial products.
- Collaboration seems limited.

Specific recommendations for additions or deletions to the work scope

- Suspend project, hold consultations with DOD, coast guard, international community and private sector and re-design if possible for collaborative approach.
- Despite the lack of urgency, this is a very low-cost research project that will expose academic researchers and their students to the MHK Industry.
- Continue. Expand collaboration.
- There is an upside opportunity that an improved material is identified that could be a benefit to shipbuilding as well as MHK which makes this a sound investment.

WHP140027

Project Title:

Reliability and Survivability Risk Assessment Framework NEW

Principal Investigator:

Walt Musial

Organization:

National Renewable Energy Laboratory

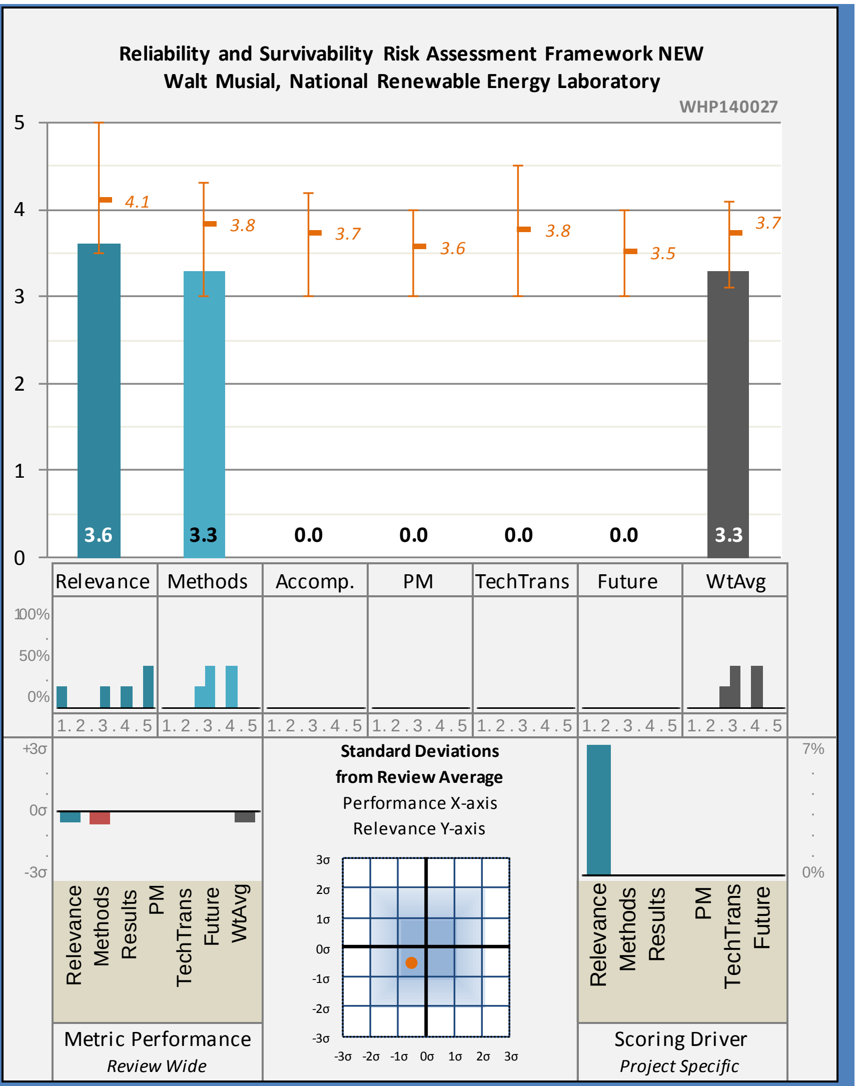
Panel:

Technology Advancement

Budget:

$300,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- The development of standards and instrumentation is key for the MHK industry to move forward.
- The project objectives are critical to the development of the MHK industry, by learning from the failures encountered in the R&D process for all MHK companies.
- The Project seeks to develop an MHK-specific Risk Management Framework. Risk Management is a well-established process with procedures that are documented in military and industrial standards. The case for developing a procedure specific to MHK has not been made.
- Risk management is applicable to all MHK projects. Results from this work will provide crucial information to MHK developers as well as potential investors.

- Understanding failure modes and effects from MHK to reduce/mitigate risks - can't really argue with the concept, no one wants projects to fail, but it doesn't seem like this has been really well-thought out yet and not clear that it will develop anything new that the industry is not already aware of.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.3** on its methods/approach.

- Interview of industry failure participants may not prove feasible, but no options at this stage.
- The approach begins with a literature survey. This implies to me that NREL personnel are familiarizing themselves with Risk Management. The NREL Team is clearly capable of reaching a high level of competence quickly, but I do not think that this is a good use of their scientific capability.
- Well planned.
- Project is largely conceptual at present but will include some outreach to developers.
- No Industrial Partner is listed as having signed on. I would be very surprised if most do not have a Risk Management process that is suited to their products. OPT is particularly process-oriented.
- This effort should involve FERC - they have novel approaches for assessing potential failure modes at dams that may be useful to MHK developers - and could also help develop supporting design report needed for FERC license applications.
- The "risk cube" shown in the presentation is not a traditional one. I've never seen so many squares marked Red and the use of a fourth, but Green category is very unusual.
- Discusses reviewing international failures but does not discuss seeking out international design standards and basis for development which would be important.
- The future work proposed is not consistent with my understanding of the process of Risk Management. It seems to cross the line into Quality Control/Assurance.

Strengths and Weaknesses

Project Strengths

- Quality has clearly been a problem in early in-water demonstrations. Having Industrial Partners follow established and documented Risk Management procedures throughout the development cycle is one of many things that will produce higher Quality in the long run.
- Risk management is applicable to all MHK projects. Results from this work will provide crucial information to MHK developers as well as potential investors.

Project Weaknesses

- Risk Management is a well-established process and most of the Industrial Partners undoubtedly have established procedures in place. Solicitations always require an initial Risk Assessment.

Specific recommendations for additions or deletions to the work scope

- In my opinion, the scientific resources within NREL could be put to better use. I recommend that this effort not continue beyond the current tasking.
- Continue.

WHP140028

Project Title:

MHK Manufacturing Needs Assessment and Cost Database NEW

Principal Investigator:

Derek Petch

Organization:

National Renewable Energy Laboratory

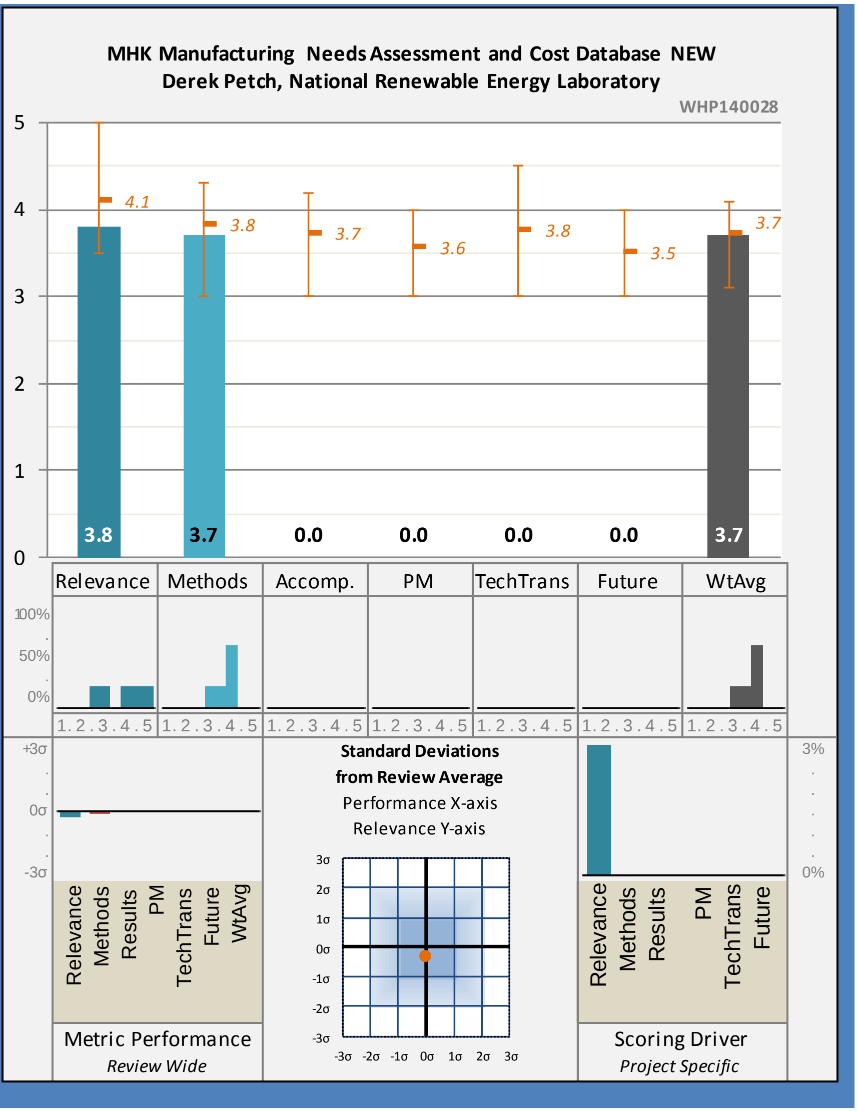
Panel:

Technology Advancement

Budget:

$400,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.8** for its Relevance to water industry needs and overall DOE objectives.

- Manufacturing needs assessment and manufacturing supply chain development would be valuable to MHK industry development, but not clear if this level of project funding is required to complete the assessment.
- The Project seeks to ensure that the US can competitively manufacture MHK devices. This Goal will only be achieved with significant participation from the Industrial Partners and there is no indication of buy-in.
- Producing a manufacturing needs assessment and a cost database will be extremely helpful to the MHK industry.
- How to help get US Manufacturing industry engaged in domestic and international marketplace for MHK devices. This seems a little premature without a viable commercial market for these devices established. Need to significantly reduce cost of energy and simultaneously increase regulatory acceptance for arrays of

devices before any mass production could occur. As demand for devices goes up there would be more entrants to the marketplace but who enters and which components are being made would be highly dependent on what's going on at that time in other industries where manufacturers would likely come from (i.e. defense, oil and gas, etc.). In my opinion, any results would be highly speculative at this point in time.

- The Project also seeks to provide DOE with a database of manufacturing and device costs for the purposes of strategic decision making. While this seems to be a secondary objective, it is probably of a higher priority.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.7** on its methods/approach.

- What happens when a "need" has been identified?
- Not clear how the international manufacturing supply chain will be assessed and evaluated in this project, except in the SWOT analysis segment.
- The approach for the US Manufacturing Needs Assessment is sound for a study that is beginning from "square one".
- Well planned.
- Started with literature review - down select technology.
- The approach for the CBS database is to build from work previously performed for other types of devices.
- Will interview and work with stakeholders to identify needs.

Strengths and Weaknesses

Project Strengths

- Encompasses all MHK device needs and applicable to all MHK industry (wave, tidal, instream, etc.).
- Developing manufacturing capacity assessment is helpful for MHK developers.
- The Goals of both sub-projects align well with DOE priorities for MHK.
- Addresses two significant needs of the MHK industry: manufacturing needs and cost database.
- The Manufacturing Needs Assessment could benefit the US MHK Industry if they participate openly.

Project Weaknesses

- Needs a stronger direction as to how the team will reach out to the industry.
- Not clear that the granular detail of manufacturing supply chain can be captured in this study.
- The Manufacturing Needs Assessment will be more likely to succeed if the Industry Partners are "bought in." Past issues related to IP cast doubt onto open participation.
- Need greater collaboration with states (which have generally invested significant funds in profiling their manufacturing base) and industry groups which have worked to map the manufacturing supply chain and MHK cluster participants throughout the US.

Specific recommendations for additions or deletions to the work scope

- Outreach to States and Manufacturing Extension Partnership, as well as trade groups is essential.
- DOE should encourage participation by Industry in the Manufacturing Needs Assessment.
- Continue.
- DOE should carefully monitor the progress of the necessary legal agreements for the Manufacturing Needs Assessment, expediting where necessary.
- DOE should proceed with the Cost Database regardless of the results of the Manufacturing Needs Assessment.

- Why are the results of a study that is aimed at making the US more competitive being presented at a "Global" forum? I may be missing something, but this seems to defeat the purpose of the effort.

WHP140029

Project Title:

Introduction to the System Performance and Advancement (SPA) FOA NEW

Principal Investigator:

Ryan Sun Chee Fore

Organization:

DOE (Multiple Projects)

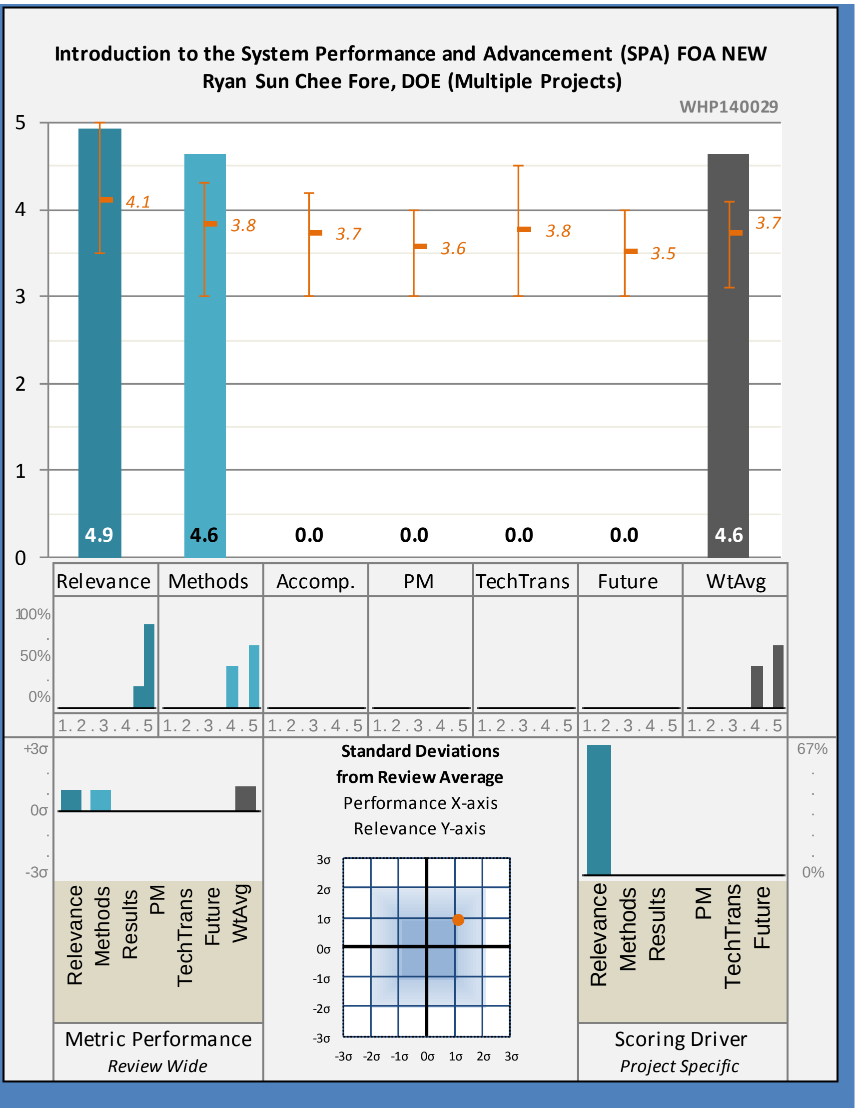
Panel:

Technology Advancement

Budget:

$13,397,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.9** for its Relevance to water industry needs and overall DOE objectives.

- Positive: This is a focused and targeted project supporting the advancement of the reliability of devices being developed.
- FOA is well designed to meet most urgent development needs of MHK industry.
- The SPA FOA targets improvements to the performance of specific generic components of existing MHK Systems. The FOA targets improvements that will lead to higher PWR and lower LCOE.
- Concentration on advanced controls, power take off, and optimized structures will benefit many different types of MHK devices. In other words, the results should be broadly applicable.

- These are significant and major projects that should directly benefit development of the industry. A number of private developers teaming with other members of industry, national renewable energy lab, and universities to develop specific aspects of a number of near commercial machines.
- The SPA FOA directly supports DOE Goals and increased numbers of in-water demonstrations.
- Research in controls, PTOs, and structures focused on increasing power and system availability, reducing costs.
- Good to get industry participation, reaching out internationally - looking at developing component and hardware aspects.
- Some projects still in negotiation 6+ mos. after award but reasons put forth - metrics, accountability, make sense.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.6** on its methods/approach.

- Strong emphasis on development of targeted existing systems to move technology to commercialization is pragmatic and effective.
- The approach of improving performance of existing systems provides a good path to increased numbers of in-water demonstrations.
- Agree with the three focus areas: advanced controls, power take-off, and optimized structures.
- ORPC - Following what wind would do with Lidar - looking at what turbulence will do - improve device.
- Wave - Dehlsen Assoc. = software only. Multipod centipede device - looking at controls for rapid tuning and phase control. Optimizing performance for various wave heights and periods.
- Resolute - WEC control system software and hardware - deterministic controls with foreknowledge of waves. How do they get 67% and 41% numbers - seem more specific than they should be?
- PTO - ABB -creating a direct drive generator to replace hydraulic hose to shore - looking at advanced generator with integrated magnetic bearing.
- Columbia Power technologies - looking at existing direct drive generator - how to reduce size and still get output - 630 kw direct drive.
- ORPC - PTO - full scale demo of wet gap generator - reduces risk bearings to reduce friction in extreme environments.

Strengths and Weaknesses

Project Strengths

- A technology-incentive funding mechanism that will allow industry to advance.
- Significant progress to enable MHK developers to advance technology development and address most critical barriers.
- The SPA FOA emphasizes improvements of near-term systems leading to greater numbers of in-water demonstrations.
- I like the plan to improve the components of MHK devices.
- Ocean energy USA - first project they've had in US. - looking at manufacturing - steel vs concrete hull design for Oscillating water column - geometric optimization of interior of structure - engages US shipbuilders and marine construction.
- Good range of technologies funded and PTO types.
- OPT - Maximized power to weight ratio looking at composites in design. Reduce friction of key components of spar and float to increase power and reduce cost.
- How proprietary is info - each would be - secondary benefits.

- Schedule drivers on contracts - due to negotiating metrics for how to evaluate.

Project Weaknesses

- Inability to create funding lines that will take the companies through the full development cycle; gated by performance milestones leaves companies at risk of stranded funding, and possible failure due to lack of private investment, even though technology is sound.
- No obvious weaknesses at this time.
- I am concerned about the proprietary nature of the work.

Specific recommendations for additions or deletions to the work scope

- It appears some of the research funded under this FOA could be applicable to the RM's discussed in the first session on Monday. For example, ORPC's advanced energy harvesting control schemes appeared to overlap some of the work being proposed by NREL's field testing (see: WH140008). Is there an opportunity to connect/consolidate these types of studies?
- Consider funding options that would enable company to have access to DOE funding to bring technology through full development, subject to matching funds and successful performance of milestones. Lack of private investment makes USDOE funding critical through successful beta test demonstration of commercial pilot project.
- This is a very high profile effort with a great deal of upside potential. Monitor progress of the performers carefully.
- Continue.
- Consider a DARPA-like model that encourages collaboration between the Industrial Partners, but only if this is not too great a departure from existing corporate cultures.

6.3 Market Acceleration and Deployment

The Water Power Program works to reduce the time and costs associated with siting water power projects; to better quantify the potential magnitude, costs, and benefits of water power generation; and to identify and address other barriers to deployment. The program is currently funding studies that examine the potential effects of marine and hydrokinetic technologies on specific marine species and their ecosystems, assessing the total amount of recoverable energy that can be obtained from the nation's waves, tides, ocean currents, undammed rivers and streams, and ocean thermal gradients, and conducting economic analyses to quantify the benefits of the widespread deployment of effective and cost-competitive marine and hydrokinetic systems.

Table 6.3.1 lists the existing Market Acceleration and Deployment MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.3.1 illustrates the standard deviation of scoring of the existing Market Acceleration and Deployment MHK projects in relation to the scoring of all projects reviewed in 2014.

Addressing Comments for Market Acceleration and Deployment Projects

The MHK Peer Review Panelists recorded many useful and actionable comments during their review of the program's Market Acceleration and Deployment projects. These comments will be used to make key decisions and recommendations to those projects that will still be receiving continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy into the future.

In general, the Program's Market Acceleration and Deployment activities were well-received by reviewers. Most of the critical feedback received regarding the Market Acceleration and Deployment activities focused on: involving stakeholders, particularly the regulatory community, during the project development stages; validating the findings of specific efforts with external parties, or ensuring the proper transfer of the information derived from specific projects. These comments are all addressed specifically through the program's new emphasis on merit reviews, active project management, and tech to market activities that have been or will be incorporated into program operations. Additionally, in the coming years, the Program's Annex IV international environmental sharing initiative will be strategically focused on developing a community of practice regarding MHK environmental research to help ensure data is actively disseminated and that input from a broad range of stakeholders in incorporated into the Program's environmental portfolio development. Finally, the Program's work with the Federal Renewable Ocean Energy Working Group helps ensure that the Program's environmental research portfolio is developed with input from the broader Federal community, especially the MHK regulatory community, and the Program plans to continue to work with this group to ensure that the Portfolio meets the needs of decision makers who will be utilizing the outcomes of the research.

Table 6.3.1 Existing Market Acceleration and Deployment MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing MHK Projects			4.6	4.2	3.9	3.8	3.5	3.9	3.6	**3.8**
Average for Existing Market Acceleration (MHK) Projects			4.4	4.5	4.2	4.2	4.0	4.2	3.9	**4.1**
Strike Analysis	Andrea Copping	Pacific Northwest National	4.0	5.0	4.9	5.0	4.8	4.4	4.6	**4.8**

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
		Laboratory (Lead)								
IEA OES Annex IV Support and Tethys Database Development	Andrea Copping	Pacific Northwest National Laboratory	5.0	4.8	4.7	4.7	4.3	4.9	4.9	**4.7**
Strike Analysis	Rich Jepsen	Sandia National Laboratories	4.0	5.0	4.8	4.9	4.5	3.9	4.8	**4.7**
West Coast Coastal Marine Spatial Planning Support	Simon Geerlofs	Pacific Northwest National Laboratory	5.0	4.7	4.5	4.7	4.4	4.7	4.0	**4.5**
Tidal Modeling, User Manual, Validation, and Acoustics Package	Jesse Roberts	Sandia National Laboratories	5.0	4.5	4.2	4.6	4.2	4.5	4.3	**4.4**
Alden/ORNL Strike Flume Studies	Mark Bevelhimer	Oak Ridge National Laboratory	4.0	4.2	4.1	4.4	4.0	4.4	3.0	**4.1**
EERE Post-doctoral Research Awards	Hoyt Battey	ORISE	5.0	4.6	4.3	3.7	4.1	4.7	3.4	**4.0**
WEC Array Modeling Improvements to Assess Far-Field Environmental Effects	Jesse Roberts	Sandia National Laboratories	5.0	4.3	3.6	4.0	3.9	3.6	4.2	**3.8**
Acoustics Experimentation and Characterization	Mark Bevelhimer	Oak Ridge National Laboratory	4.0	4.2	3.7	3.7	3.6	4.0	2.7	**3.6**
Impacts of Individual and Multiple MHK Stressors (Hydroacoustic /ELAM)	Mark Grippo	Argonne National Laboratory	3.0	3.6	3.2	2.8	2.7	2.6	2.8	**2.9**

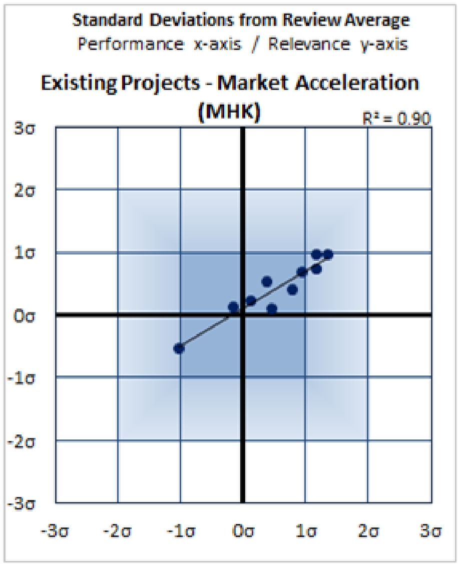


Figure 6.3.1 Existing Market Acceleration and Deployment MHK projects

Table 6.3.2 lists the new Market Acceleration and Deployment MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.3.2 illustrates the standard deviation of scoring of the new Market Acceleration and Deployment MHK projects in relation to the scoring of all projects reviewed in 2014.

Table 6.3.2 New Market Acceleration and Deployment MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Weighted Average Score
Average for Review			5.1	4.1	3.8	**3.7**
Average for all New Projects			5.2	4.2	3.8	**3.8**
Average for New MHK Projects			4.9	4.0	3.7	**3.7**
Average for New Market Acceleration (MHK) Projects			5.0	4.9	4.6	**4.6**
Introduction to the MHK Environmental FOA NEW	Hoyt Battey and Jocelyn Brown-Saracino	DOE (Multiple Projects)	5.0	5.0	4.7	**4.7**
MHK Regulator Training NEW	E. Ian Baring-Gould	National Renewable Energy Laboratory	5.0	4.7	4.4	**4.4**

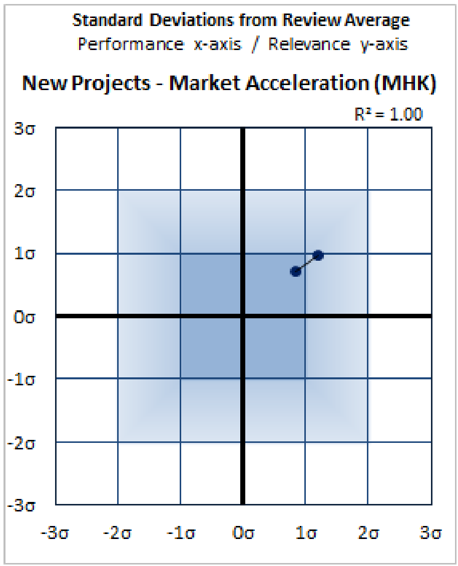


Figure 6.3.2 New Market Acceleration and Deployment MHK projects

WHP140030

Project Title:

Alden/ORNL Strike Flume Studies

Principal Investigator:

Mark Bevelhimer

Organization:

Oak Ridge National Laboratory

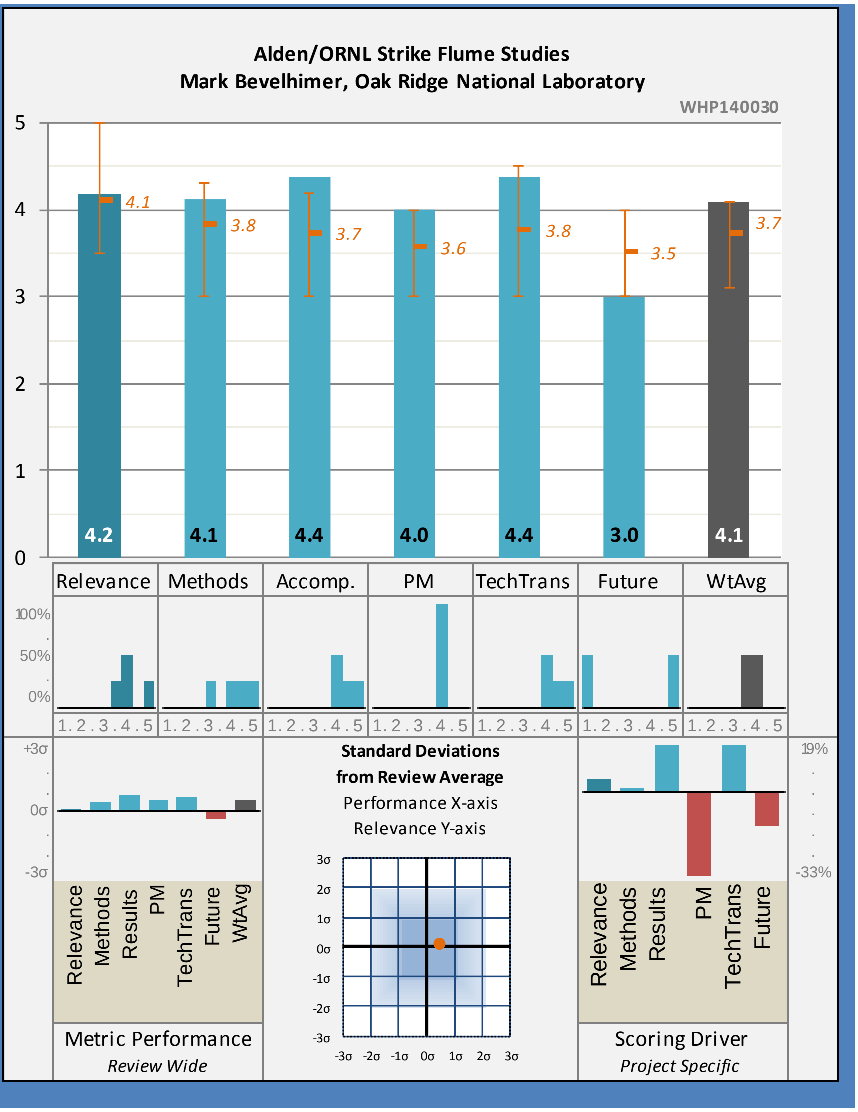
Panel:

Market Acceleration

Budget:

$100,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.2** for its Relevance to water industry needs and overall DOE objectives.

- This study will help the regulatory agencies understand more of the limited impacts select MHK devices would have on fish.
- Accurate characterization of the potential for fish interaction with various MHK devices is very important to advancement of industry permitting.
- This Project evaluated a potential environmental concern (injury to fish by MHK devices) and is an excellent step toward reducing deployment barriers.
- I was not present for this presentation.
- This type of information is helpful to prove to agencies that hydrokinetic devices won't adversely affect fish populations. Most fishery scientists that I know agree that fish will avoid turbines but regulators need to see

demonstrated proof of this before they will be comfortable agreeing to installations. This information helps to show that fish introduced directly into turbines would avoid the blades.

- Found pretty high survival rates.
- Survival and behavior of fish exposed to hydrokinetic turbines

.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.1** on its methods/approach.

- Obviously limited by space of the fume the study was conducted in, but methodology was accurate.
- Fish size and range of blade speeds not addressed; what additional research needed to address these issues?
- The two-fold approach of studying avoidance and mortality (due to lack of avoidance) is very thorough
- Used an actual turbine in a flume where fish could be observed going through the unit - used both night and day testing.
- Important to discuss method and approach of study with federal services agencies to determine their receptivity to the data - if they will require in situ testing of specific marine device, this study method and approach will have limited or no utility to resolving the environmental permitting issues.
- Developed introduction system with net behind to keep fish directed through the unit.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.4** based on technical accomplishments and progress.

- The progress was excellent, the results were presented, and only the publication of the report remains.
- Very useful data - can be used in conjunction with the numerous studies that have been done at conventional hydroelectric sites and used to show that fish strike and mortality risk should be very low.
- The fact that the results were favorable (in the sense that mortality is low and avoidance is good) is a plus.

Question 4: Project Management

This project was rated **4.0** on its project management.

- The only minor delay was explained.
- Work accomplished for very reasonable budget.
- It was noted that there were delays in getting report done which delayed journal publication.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.4** for research integration, collaboration, and technology transfer.

- A good mix of lab, private, and non-profit on the team.
- Valuable findings re survival rates of turbine passed fish and minimal impacts on fish. Will EPRI study publication be public, or available only for fee? Important to be sure federal and state regulators can access report.
- It is imperative that these results be widely disseminated in professional organizations and they seem to have been.
- Information has been presented at a number of US conferences.
- Important to have communications and technology transfer plan include outreach to federal and state regulators so that they are fully briefed on outcomes.

- Additional outreach to the more mainstream popular media might be appropriate.
- Work included industry partners, including Free Flow Power, EPRI and Alden working with Oak Ridge National Labs.

Question 6: Proposed Future Research

This project was rated **3.0** for proposed future research.

- Not Applicable.
- Switch to testing that will enable understanding of fish avoidance mechanisms and in situ testing to demonstrate that there is a low likelihood of any fish interaction with the MHK devices in the ordinary course in marine environment.
- Not Applicable - none proposed.

Strengths and Weaknesses

Project Strengths

- The project has produced scientific findings that will aid the MHK Industry by answering environmental concerns with solid data that (1) fish avoid turbines more often than not and (2) even those who do not avoid are almost entirely unharmed.

Project Weaknesses

- None obvious.

Specific recommendations for additions or deletions to the work scope

- The flume testing does not enable complete study of fish ability and tendency to avoid MHK device in natural marine setting for tidal and wave devices; future research should focus on demonstrating the likelihood of any interaction and what mechanism is at work in the fish to enable avoidance.
- This is an excellent example of DOE making effective use of the scientific resources within National Labs.

WHP140031

Project Title:

Impacts of Individual and Multiple MHK Stressors (Hydroacoustic /ELAM)

Principal Investigator:

Mark Grippo

Organization:

Argonne National Laboratory

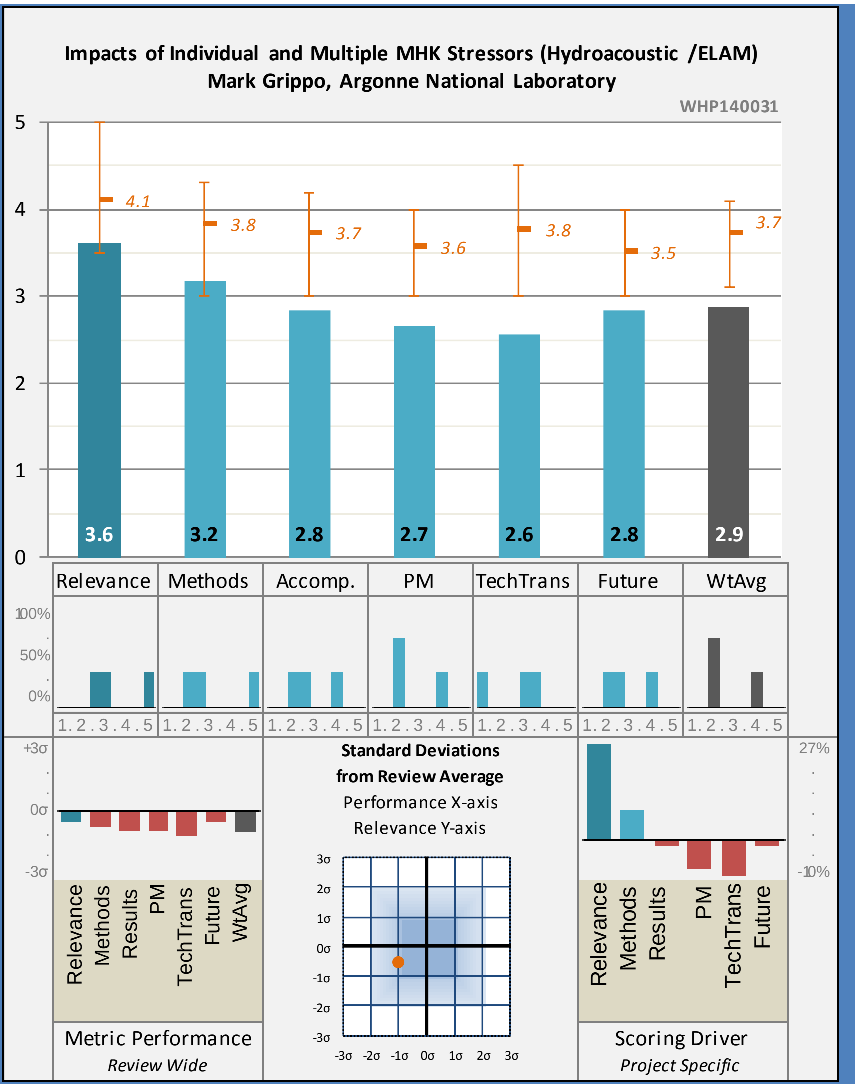
Panel:

Market Acceleration

Budget:

$92,900 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- There is a disconnect with an ecosystem issue (e.g., how does noise relate to fish avoidance).
- The Project assesses the impact of a number of possible stressors on fish in order to answer environmental concerns regarding MHK devised. The Project will provide scientific data that reduce deployment barriers for the MHK Industry.
- I was not present for this presentation.
- Overall concept is fine but without observed fish data at an array the results will be difficult to accept. I question whether it is worth proceeding with this work at this stage or if you would be better waiting until there was an array in the water.

- It looks like this model should tie in to the optimization/array model that has been developed by Sandia but it is not completely clear if it does. Eventually, being able to optimize for both efficiency and fish will be important but the danger will be having invalidated models for both.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.2** on its methods/approach.

- Delay in field data gathering.
- The Project applies a sound combination of experimental observation and hydrodynamic modelling to accomplish the goal.
- Planned to do hydroacoustics in 2013 - didn't happen.
- Plan to extrapolate data from device to assess potential impacts from an array.
- Developing intense hydrodynamic model - need supercomputer to run it.
- Only going to look at one unit and then infer what might happen with an array - that is a fatal flaw.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.8** based on technical accomplishments and progress.

- The progress has been good except for unavoidable issues related to the availability of the MHK device.
- haven't done much of the work yet.
- Issues related to the computational power required to achieve the desired 2m resolution could have been estimated during the proposal stage.

Question 4: Project Management

This project was rated **2.7** on its project management.

- Project delays and a majority of funds spent on models.
- Delays were explained and appropriate actions were taken.
- Project delays.
- Have spent a lot of money to develop model.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.6** for research integration, collaboration, and technology transfer.

- A good example of a national lab working with federal entities and academic institute.
- No Technology Transfer is indicated. The results of this research should be published extensively.
- Not clear how transferable this info will be to other species, other locations.
- Good to have ACOE and Universities involved.

Question 6: Proposed Future Research

This project was rated **2.8** for proposed future research.

- Would assume future work would require the presence of an array of devices.

- Assuming that the study is successful, the suggested future research could have a valuable impact on MHK sitings.
- Simulations to forecast effects for siting cannot be done until model is validated somehow at an actual array.

Strengths and Weaknesses

Project Strengths

- The project will produced scientific findings that will aid the MHK Industry by answering environmental concerns regarding the response of fish to perceived stressors associated with MHK devices.

Project Weaknesses

- No major weaknesses.

Specific recommendations for additions or deletions to the work scope

- This is an excellent example of DOE making effective use of the scientific resources within National Labs and academic institutions.

WHP140032

Project Title:

Strike Analysis

Principal Investigator:

Andrea Copping

Organization:

Pacific Northwest National Laboratory (Lead)

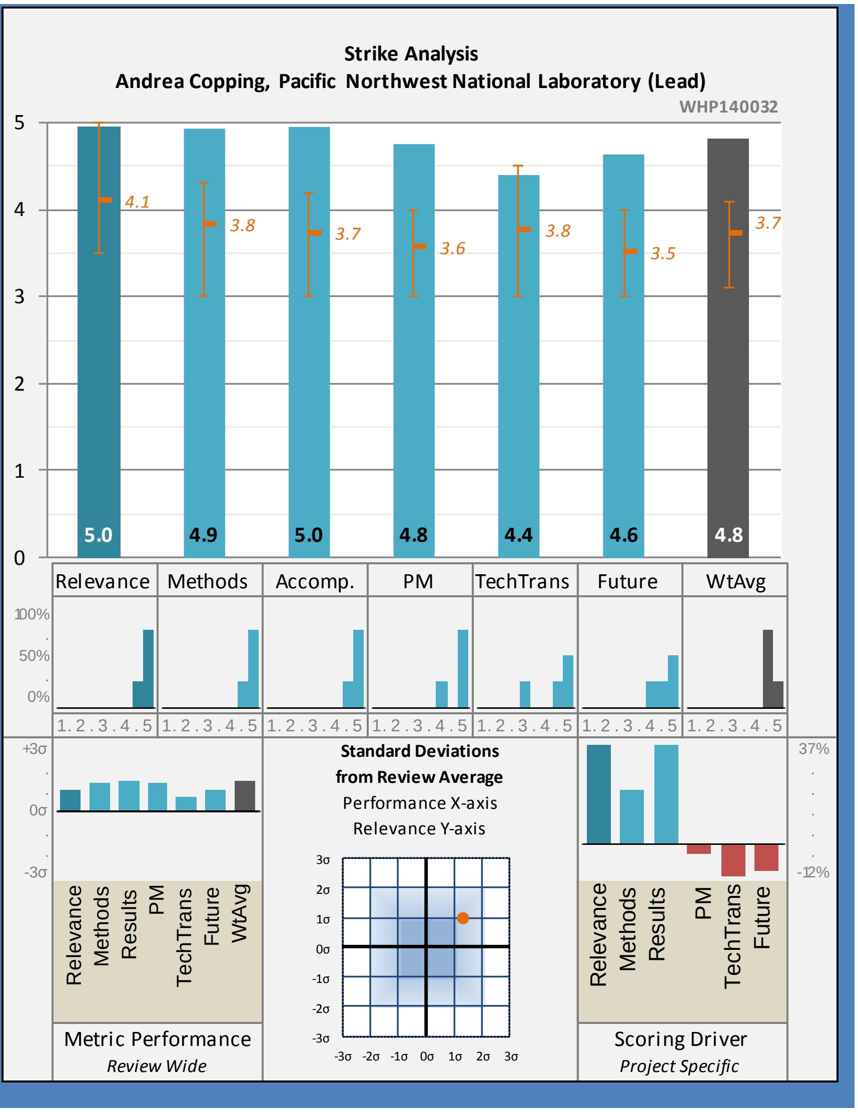
Panel:

Market Acceleration

Budget:

$417,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **5.0** for its Relevance to water industry needs and overall DOE objectives.

- A very relevant study that supports the deployment of a tidal device the incorporates the involvement of national labs, regulatory agents, and a utility.
- High marks to DOE for playing a convening role to bring all key players and outstanding talent to the project and to fund the project to find a science-driven response to the regulator's concerns about and requests for information on the potential for marine mammal interaction with MHK devices.
- The Project reduces deployment risk by answering concerns about the consequences of an endangered Southern Resident Killer Whale striking an MHK device, specifically the OpenHydro turbine planned for deployment by the Snohomish PUD.
- I was not present for this presentation.

- This project was instrumental in getting regulators over the acceptance hurdle and helped keep one of the few (maybe only?) utilities in the game.
- This study can be applied to other areas around the US where marine mammals are a concern.
- Outstanding result at excellent value addressing major permitting barrier to deployment of MHK devices
- Excellent transfer of information nationally and internationally.
- The next phase will be critical - how to expeditiously and economically apply the model to other species of concern and other devices?

Question 2: Methods and Approach to performing the research and development

This project was rated **4.9** on its methods/approach.

- Preliminary assessment of probability showed low risk of interaction; project adopted multiple layers of worst case scenarios to model the interaction likelihood and consequences to address regulator's extremely conservative approach.
- PNNL and SNL followed a rigorous process of experimentation and modelling.
- Great approach to first determine low probability and then answer the what if question? Use of biological and physical info to determine that curious whale might get boo-boo great way to counter ultra-conservative mindset/responsibility of regulators.
- Important that publication of the project emphasize this worst case scenario approach in the unusual context of this permitting proceeding, with the conservative assumptions.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **5.0** based on technical accomplishments and progress.

- Not clear why the NOAA and other marine mammal experts did not agree that Killer Whale transient species could be an adequate surrogate for flesh and tissue analysis for "materials" analysis in order to refine the model, rather than deteriorated condition tissue of resident Killer Whale species.
- The goals of the study were achieved with only minor delays that are expected in scientific investigations.
- Project was probably not going to get favorable response from NMFS absent this research.

Question 4: Project Management

This project was rated **4.8** on its project management.

- Terrific team composition and project management to bring top talent to the problem and to address regulator inputs during project.
- Minor delays were explained. Spending has been within funding limits and was presented in an understandable manner.
- on schedule and under budget and already delivered important results in a timely fashion to assist SNOPUD licensing.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.4** for research integration, collaboration, and technology transfer.

- Excellent collaboration, and careful integration of federal regulators in the protocol development, to assure acceptance of project conclusions.

- The Technology Transfer effort is OK for now, but it should be increased as the project proceeds.
- lots of good integration with multiple partners government and industry.

Question 6: Proposed Future Research

This project was rated **4.6** for proposed future research.

- Need "buy off" from NMFS - are other studies necessary?
- Other two species to be considered will be important, but will be interesting to determine if the result from three species can be distilled into a bounded type analysis on device impacts in event of interaction between categories of marine mammals and MHK devices.
- Ongoing and future work represent a reasonable extension to the original research and should continue to reduce deployment barriers.
- Potential to use on additional marine mammals - additional turbines.
- Could inform turbine design going forward.
- Need to make sure agencies - particularly NMFS marine mammal experts are engaged in future efforts and buy in to results.

Strengths and Weaknesses

Project Strengths

- Outstanding leveraging of existing expertise and resources in timely fashion.
- This Project and associated ones are reducing barriers to deployment by providing scientific data to answer environmental concerns.

Project Weaknesses

- How do you distinguish a strike from a tidal device versus a strike from another man-made object?
- None.
- The results should be more widely disseminated.

Specific recommendations for additions or deletions to the work scope

- Instead of looking at impacts to different species, what about looking at potential impacts of blade strike from different device types. You could extrapolate from the results on the SRKW and infer similar results on other marine mammals (based on similar tissue density, etc.).
- Follow through on extension of modeling effort to other species of concern, coordinating with the same group, including regulators and biologists from federal regulators and develop any bounding analysis possible so that regulators can draw conclusions more broadly than single species basis.
- This is an excellent example of DOE making effective use of the scientific resources within National Labs and academic institutions.
- Potentially collaborating with European counterparts as they are likely addressing the same issues.
- Work to include this in MHK workshops for federal regulators to demonstrate how problems can be solved and resources available, as well as specific outcome.

WHP140033

Project Title:

Strike Analysis

Principal Investigator:

Rich Jepsen

Organization:

Sandia National Laboratories

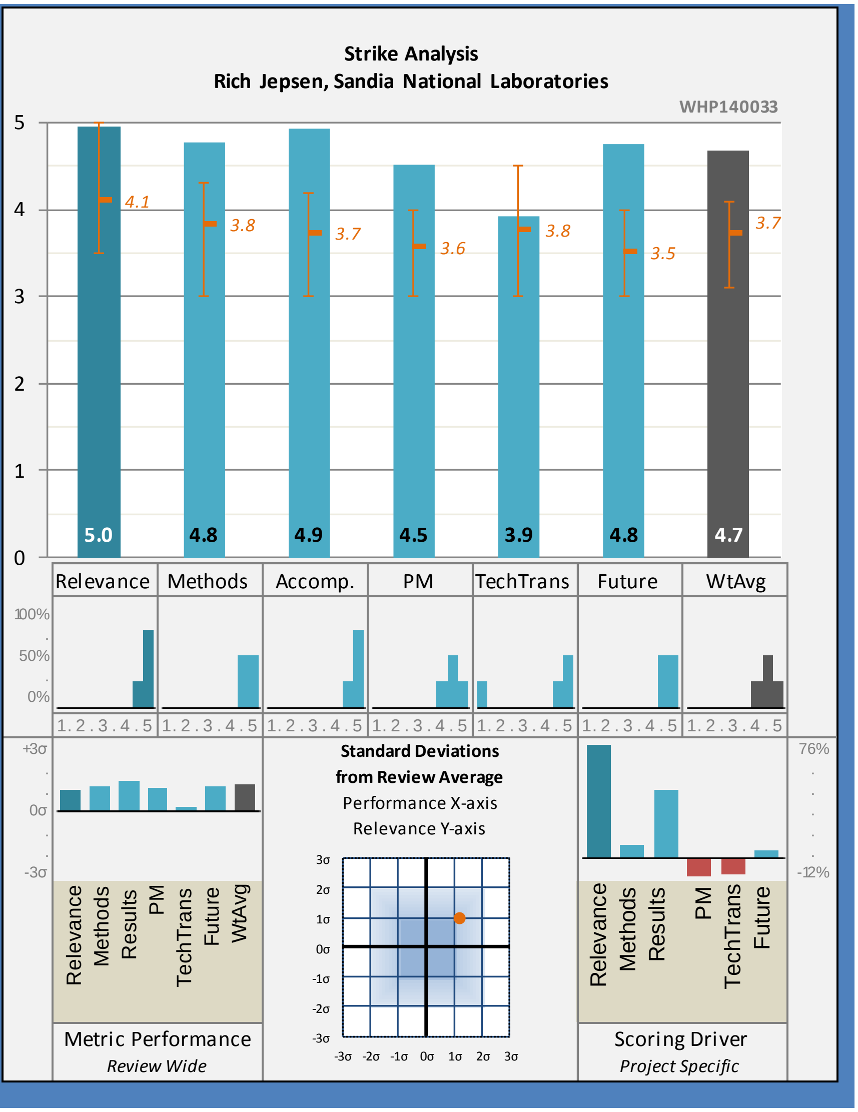
Panel:

Market Acceleration

Budget:

$190,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **5.0** for its Relevance to water industry needs and overall DOE objectives.

- An excellent study that will help NMFS understand the potential impacts to marine mammals from tidal energy devices.
- Same comments as given on Simon Geerlofs presentation.
- This Project has already reduced deployment barriers for the SnoPUD device in Washington State by answering regulatory concerns with scientific data. Expansion of the research to other species and different MHK devices should continue to support this important goal.
- I was not present for this presentation.

- This is the only information that NMFS has to base a Biological opinion on - for the unique environments that contain unique species where the industry is looking to site these devices this type of research is essential to resolve catch 22 questions about potential impacts.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.8** on its methods/approach.

- Excellent project design.
- PNNL and SNL have followed a rigorous process of experimentation and modelling to date. The continuing efforts follow the same processes.
- Perfectly filled need with SRKW - will be important to have NOAA Fisheries buy-in for planned work on other marine mammals (i.e. maybe they're worried about swimming in from side, backing in, various injuries, behaviors, life stages, etc. and worst case scenario modeling may not be adequate).
- Not clear why federal regulators would not agree to substitute tissue samples from transient Killer Whale DPS, instead of Resident Killer Whale DPS - wouldn't they be a more accurate predictor of blade strike impact on flesh and bone of the marine mammals than the deteriorated samples?

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.9** based on technical accomplishments and progress.

- Outstanding result, answering regulator questions and enabling project to move forward.
- These results have already been used to support the permitting process for the SNOPud/OpenHydro project in Washington State.
- moved a real project from dead in the water to going forward.
- The goals of the study were achieved with only minor delays that are expected in scientific investigations.
- Stretching dead whale skin and blubber to breaking point - did anyone anticipate this in their career?

Question 4: Project Management

This project was rated **4.5** on its project management.

- The material provided by SNL didn't have the well-disclosed variance analysis and expenditure data that was found in the PNNL presentation.
- Some delays but primarily due to sudden availability of whale carcasses, which was a good reason to delay - otherwise on target.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Collaboration with academia is good.
- Great collaboration to develop results.
- Collaboration with industry is addressed, but only as far as development of NDAs is concerned. While this is a good first step, integration with the MHK Industry needs to be a priority for this effort.
- No Technology Transfer Plan is provided. The results of this research need to have wide dissemination.

Question 6: Proposed Future Research

This project was rated **4.8** for proposed future research.

- Will need NMFS support for future research.
- Can follow on research tackle not only the two additional species, but attempt to describe in broader terms what degree of impact and blade shape would be needed to have a significant impact on marine mammals of specific sizes?
- Future research is a logical next step and should continue to reduce deployment barriers for MHK.
- For future aspects - need to involve NOAA Fisheries, NMFS to makes sure they will accept results for BiOps.

Strengths and Weaknesses

Project Strengths

- The Project has already answered an environmental concern relative to the SRKW population in WA State. This research is key to providing solid scientific data to answer the concerns of regulators about endangered species.

Project Weaknesses

- Technology Transfer to Regulators and the general public need to be increased.
- Integration with Industrial Partners seems to be slow and should be expedited.

Specific recommendations for additions or deletions to the work scope

- Follow on research is recommended, but not species by species, given the expense. Can there be an effort to categorize by type and strength of blade impact and size/type of mammals?
- This is an excellent example of DOE making effective use of the scientific resources within National Labs and academic institutions.
- This research now needs the full participation of the Industry Partners. DOE is best positioned to assist in this integration.

WHP140034

Project Title:

Acoustics Experimentation and Characterization

Principal Investigator:

Mark Bevelhimer

Organization:

Oak Ridge National Laboratory

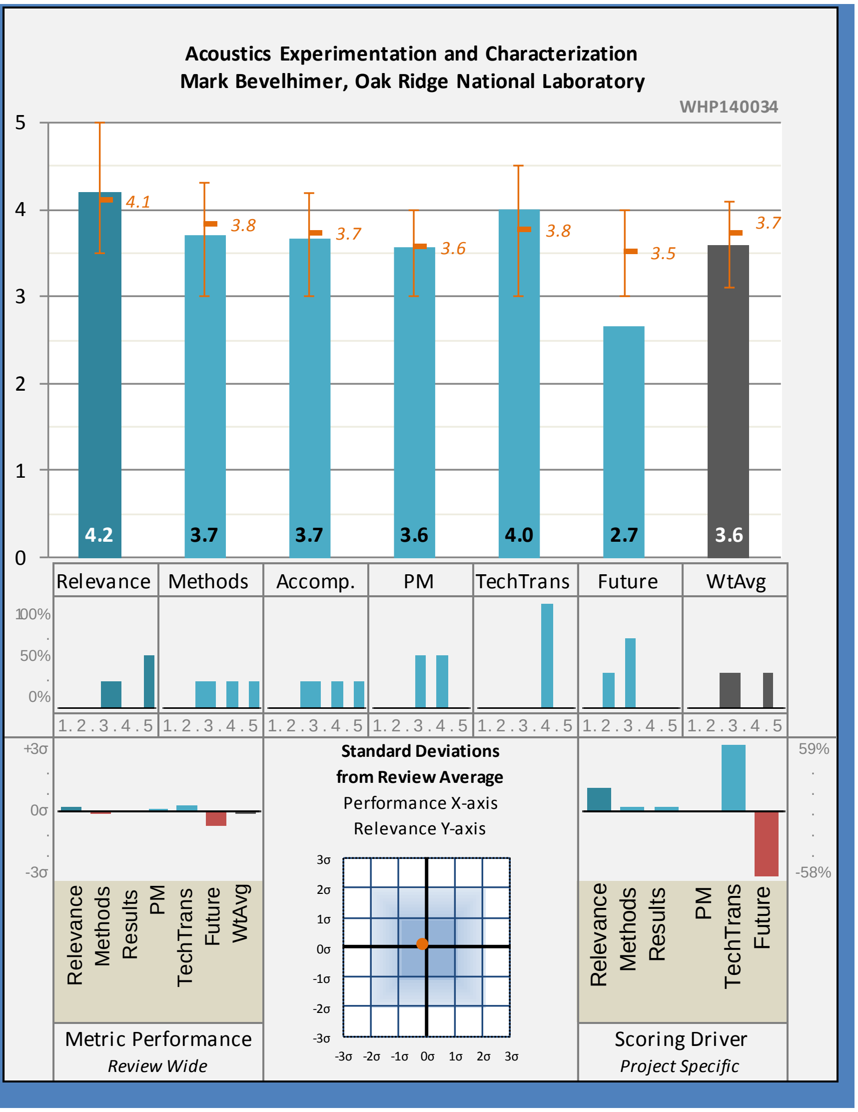
Panel:

Market Acceleration

Budget:

$360,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.2** for its Relevance to water industry needs and overall DOE objectives.

- A good study that will help regulators understand the limited acoustic impacts MHK devices produce when in operation.
- This Project seeks to reduce deployment barriers by providing scientific data on the acoustic emissions of MHK devices and the impact on aquatic species. This data will fill in gaps in knowledge and assist in answering regulatory concerns.
- This information will be useful for all similar projects.
- Going to look at array effects - that will be very positive for industry.
- Would be good to state professional opinions about the "realness" of this issue.
- Use of freshwater species probably limits ability to transfer results to marine and estuarine environments.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.7** on its methods/approach.

- ORNL has followed a rigorous process of field measurements and sound exposure studies.
- Well planned.
- Fish were surgically tagged and in a net pen so does not represent natural conditions.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.7** based on technical accomplishments and progress.

- No turbines were in the water, so results are limited in possible understanding of potential impacts.
- Initial results relative to the TideGen device have been favorable.
- Results will be very useful for environmental documentation and permit applications for tidal turbines.
- Unable to get actual measurements because turbines weren't in water and available.
- Delays have occurred, but seem to have been resolved.
- Found no responses to sound in fish - positive but methods could be questioned.
- Determined through existing data that noise signature would be very low.

Question 4: Project Management

This project was rated **3.6** on its project management.

- The Project was delayed by funding issues. ORNL explained the issue and seems to have recovered
- Well executed project.
- Some delays caused by funding and lack of field data.
- The Project was also delayed by issues related to the TideGen deployment in Maine. ORNL has explained the delay and found a work-around to maintain progress.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- A good mix of national lab, device developers, and academic institutions.
- Good collaboration between academia, a National Lab, and Industrial Partners.
- Good collaboration with industry.
- Good to use industry partners and data.
- A good start to Technology Transfer.
- ongoing work on simulated array will be very useful and important - even if biological data can be questioned will be good to get noise signature of array established and accepted - need to make sure corrections for closed water environment vs open water environment are made with respect to physics of sound propagation.

Question 6: Proposed Future Research

This project was rated **2.7** for proposed future research.

- Future research would likely be driven by regulatory process.

- Future research is stated as being dependent on discussions with DOE. The need for additional studies will depend on how the results to date are accepted by regulatory agencies.
- None suggested.
- Additional research has not yet been determined - will be based on existing results.

Strengths and Weaknesses

Project Strengths

- This solid scientific data should answer some of the concerns of Regulators about acoustic stress caused by MHK devices.
- Important data being collected.

Project Weaknesses

- It is not obvious that this research can be wrapped up. Regulatory input is needed to assist in future funding decisions.

Specific recommendations for additions or deletions to the work scope

- DOE has a difficult decision to make regarding future research. While the results seem conclusive, more studies may be required depending on how Regulators react to what has already been done.
- Continue.

WHP140035

Project Title:

Tidal Modeling, User Manual, Validation, and Acoustics Package

Principal Investigator:

Jesse Roberts

Organization:

Sandia National Laboratories

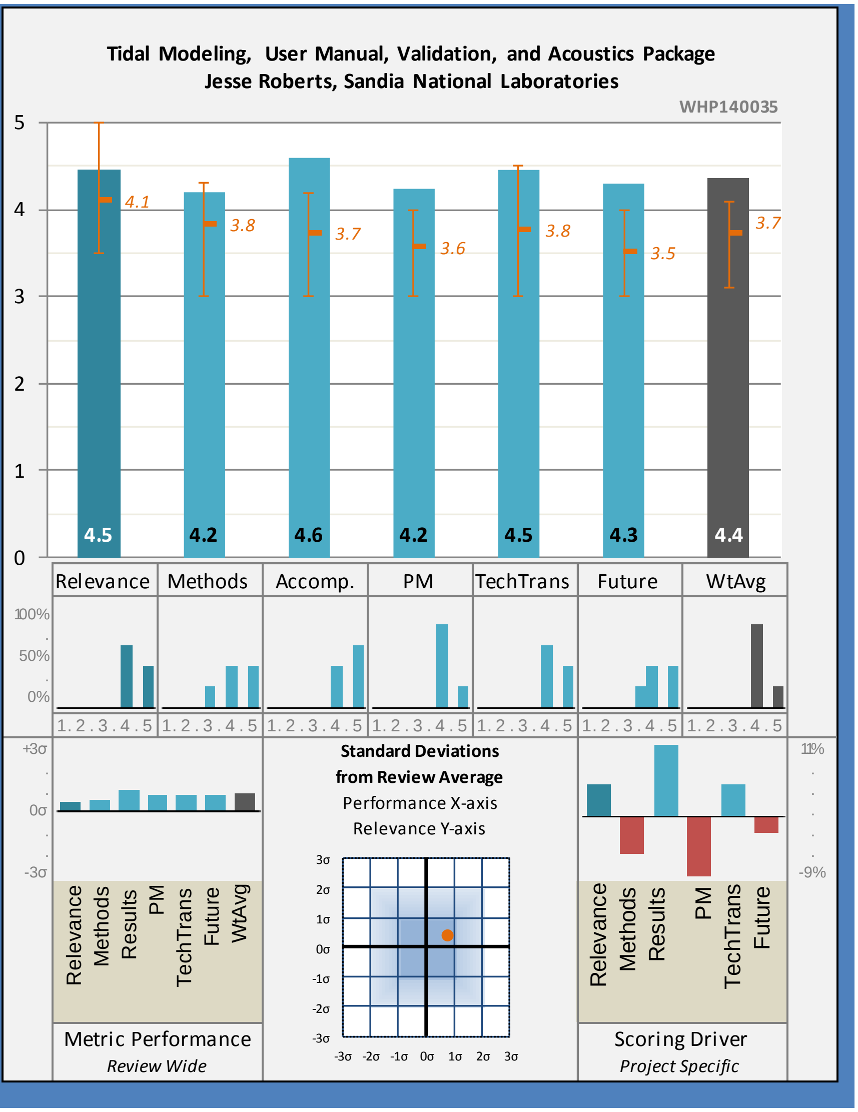
Panel:

Market Acceleration

Budget:

$250,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.5** for its Relevance to water industry needs and overall DOE objectives.

- The project focus is essential for MHK industry to advance, and the project is very well designed to leverage existing advanced tools on noise and power optimization in marine environment from USN - optimal design and siting tools
- Project seeks to allow Industrial Partners to develop quieter devices so as to reduce barriers to deployment.
- Developing open source MHK noise generation and propagation models will be very useful to the MHK community.
- Acoustics part - this is a regulatory issue that needs to be addressed through better education of regulators about the noise signature and impacts of MHK devices.
- Strong collaboration among industry, labs, while leveraging USN background knowledge.

- Project seeks to allow Industrial Partners to place CEC devices in optimal locations to improve LCOE.
- Optimized siting model could be very useful to developers - always concern about believing the model when it may have some flaws.
- Optimization component of the model will be essential to enable companies to get benefit of project - DOE should assure that SNL successfully works with MHK device providers to acquire data needed for optimization.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.2** on its methods/approach.

- Persuading MHK device providers to cooperate in technical assistance components will be essential.
- Integrating a Current Energy Converter (CEC) model into its Environmental Fluid Dynamics Code (EFDC) is a reasonable step toward a simulation tool for optimally placing these devices.
- Well planned project.
- Use of existing accepted EPA model provides so much credibility/acceptability as opposed to starting from scratch.
- Sediment transport models have been used extensively by USACE and should not be reinvented.
- Developing an approach to assessing generation and transmission of acoustic noise will build on the research related to how aquatic species are stressed by this input.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.6** based on technical accomplishments and progress.

- Results to date have been encouraging for both aspects of the project.
- Scaled flume tests past operating turbines.
- Appears to be a very good tool that will have direct relevance to the industry.
- Results to date have already been used by ORPC as part of a FERC application.
- Developed computer models.
- Optimization will be great for developers - sound -great for regulatory community if they accept methods/process.
- Developed training courses and user's manuals.

Question 4: Project Management

This project was rated **4.2** on its project management.

- Concern that intellectual property issues may hinder full participation of MHK device providers; DOE may need to provide leadership to ensure that MHK device providers concerns on MHK are addressed with labs and common understanding reached to ensure collaboration can proceed.
- Model-to-data comparison was delayed, but explained.
- Well run project.
- Have produced results and stayed within budget. Budget does seem generous though.
- Actual spending appears to be commensurate with the plan.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.5** for research integration, collaboration, and technology transfer.

- Good collaboration between PSU/ARL, National Labs, and a contractor. The fact that ORPC used the results seems to indicate Industry Partner participation.
- Collaboration with other labs and academia.
- Lot of interaction between developers and labs.
- Technology transfer and wide dissemination of the results should provide a solid base of data for answering environmental concerns from Regulatory Agencies.
- Training of developers is an excellent way to encourage use of models and gain valuable input.

Question 6: Proposed Future Research

This project was rated **4.3** for proposed future research.

- Exposing Industry to SNL-EFDC in the near-term is a good goal.
- Proposed future research to measure flow and noise around MHK devices in the field will be extremely useful.
- Validating around actual projects is key.
- A substantial multi-year acoustics effort may be premature depending on other research.
- Array optimization very important for energy production as well as environmental footprint - need to make sure optimization and fish behavior models (different DOE project) that are being developed concurrently are cross-referenced in some fashion so that both power and environmental impacts are considered.

Strengths and Weaknesses

Project Strengths

- Excellent leveraging of existing federal and national lab expertise in marine power generation optimization and noise minimization.
- Provides a tool for placing CEC devices for optimal power extraction.
- The models that are being developed will be very useful.
- Provides a tool for estimating acoustic generation and transmission from CEC devices.

Project Weaknesses

- Project needs strong outreach component to assist MHK providers to understand that participation in model validation and technical assistance phase will not expose MHK device company to risks of loss of confidential data.
- SNL should reach out to USACE for their input on sediment transport dynamics.

Specific recommendations for additions or deletions to the work scope

- Be sure to include regulatory agencies in education about the model and application so that they will accept the final model products.
- Aside from concerns about possibly reinvention of the wheel relative to a sediment-dynamics model, this work appears useful for developing a tool that Industry can use.
- Continue.
- Since other research seems to indicate that acoustic stress to aquatic species is not a significant issue, significant future research may not be required and DOE should carefully gage the response of regulators to work already performed.

WHP140036

Project Title:

WEC Array Modeling Improvements to Assess Far-Field Environmental Effects

Principal Investigator:

Jesse Roberts

Organization:

Sandia National Laboratories

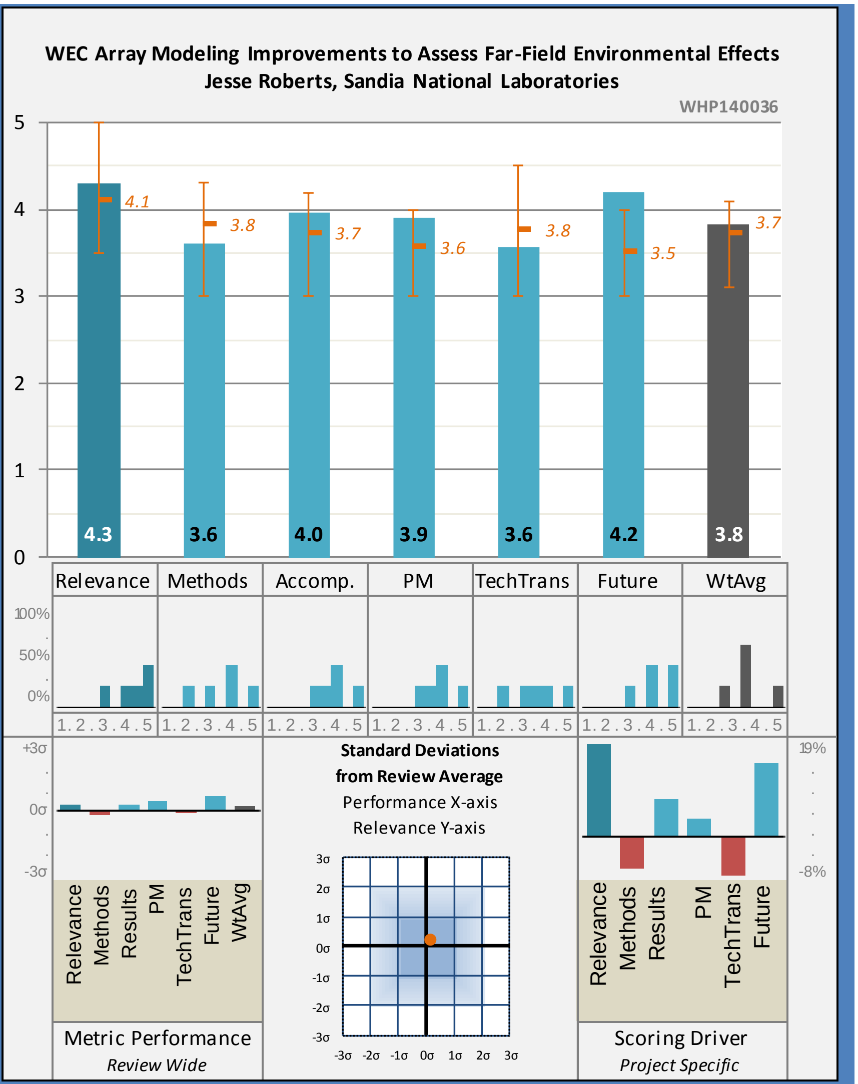
Panel:

Market Acceleration

Budget:

$1,050,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.3** for its Relevance to water industry needs and overall DOE objectives.

- This project deliverable - the far-field effects model - will be tremendously important to MHK industry deployment. It will have direct impact on critical siting decisions.
- Project seeks to allow Industrial Partners to accurately assess the energy available for WEC devices at specific sites.
- The goal is to accurately model the effect of energy extraction by WEC devices on the overall wave climate at a given location. This energy extraction will in turn affect the nearshore currents and sediment transport. The ability to model these phenomena is important to the design of a WEC array and the preparation of environmental documents.

- This is important to industry as it will help address key questions but there are so many variables in the open ocean that it may be dangerous to rely too much on this without substantial validation.
- Vital that the model be robust, and well validated, but also rigorously peer-reviewed by top experts in the field, including Army Corps of Engineers experts; Encourage DOE to add additional project component if needed to assure peer review, given significance of product for future siting decisions.
- Project will also provide a trusted tool for assessing environmental impact along with available power output
- Assure that the model addresses any unique traits of regional current and sediment transport systems.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.6** on its methods/approach.

- Given the importance of this model, need to add a final step to have independent peer review by experts in the field.
- SNL develop a module for SNL-SWAN that will accurately model energy extraction via a "typical" WEC (CPT Manta 3.1), verify the predictions against experimental data from OSU, and revise the model accordingly. This is a reasonable and rigorous process.
- Well planned.
- Used Navy data to base model on - good use of existing data.
- We don't have adequate information to determine whether the method and approach of merging modeling projects has effectively produced an accurate and helpful model.
- SNL will perform a sample environmental assessment using available and new tools.
- Results not favorable to industry - need to understand parameters better - this was worst case and maybe site-specific so would be careful about broadcasting results.
- Using worst case situation okay but need to make sure other scenarios and more realistic ones are given equal play. Assuming user conflicts will be higher within 2 miles of shore anyway, what happens when they are moved out to 3 miles?

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.0** based on technical accomplishments and progress.

- Project is on track, but impossible to judge from information available in summary and presentation whether the model development was technically sound or delivers results.
- Good results to date on both efforts.
- Project has shown some very good results in the running of the SNL-SWAN model.
- Developing model is important and concept good but it really needs to be validated somehow in open ocean
- Getting some external review will be important.

Question 4: Project Management

This project was rated **3.9** on its project management.

- As noted, significant flaw in project design that failed to include rigorous model peer review.
- Project has had no delays and is on budget.
- Well executed project.
- Have met schedule deliverables on budget.
- Appears that the project could have been improved by greater collaboration and leveraging of other federal expertise (e.g. ACE, NOAA).

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.6** for research integration, collaboration, and technology transfer.

- Very limited coordination among existing institutions.
- The team integrates a National Lab (SNL), an academic institution (OSU), an MHK Developer (CPT) and software developers.
- Collaborating with industry and academia.
- Good private sector and academic partnerships.
- Assure that if peer reviewed model is determined to be accurate, release is accompanied by teaching support both in live and evergreen web presentations so that end users and regulators will have good understanding of model application.
- Plans for technology transfer are appropriate.
- The Coastal Hydraulic Laboratory of the Army Corps of Engineers has been doing wave and sedimentation modeling for decades. They should be consulted on this project.
- Dissemination of results good but worry about what the message is - if it's on the mechanisms involved in developing and applicability of model good, but if it's that WEC's will substantially change sediment dynamics, ecosystems near shore then please stop presenting until you have validation and/or present what less than worst case is as well.

Question 6: Proposed Future Research

This project was rated **4.2** for proposed future research.

- At minimum, add rigorous peer review component, and, as needed, funding to upgrade model.
- The proposed future research is a logical continuation of the past and ongoing efforts.
- Proposed future research seems worthwhile.
- Is there a way to validate against a deployed project this year? Maybe outside of the U.S.?
- Consider whether model will need to be improved through time as new data is collected and revisit efficacy of model.
- Expansion of the effort to off-shore wind is beyond the scope of MHK.

Strengths and Weaknesses

Project Strengths

- Topic is essential for MHK siting decisions.
- SNL-SWAN should be beneficial to Developers and Regulators if it becomes generally accepted.
- Good results to date.
- Leverages existing models that have been well developed.
- The methods described should lead to a valuable tool that is being widely disseminated.

Project Weaknesses

- Project does not appear to have adequately tapped existing world class expertise in other federal agencies and academic centers on far-field environmental effects, including sediment transport.
- Only OPT is mentioned as an Industrial Partner.
- Need to consult with Army Corps of Engineers on modeling, particularly the sedimentation modeling.

Specific recommendations for additions or deletions to the work scope

- Propose an external review of final model before publishing it for general use.
- Add Independent Peer Review by experts in the field to assure that the model will be accurate, or is distributed with appropriate limitations or caveats on accuracy of model in certain applications.
- Monitor acceptance of SNL-SWAN by Industry and assess the confidence of Regulators with the results obtained from it. Decide on future work based on how well it is accepted.
- Continue.
- Encourage Industrial Partners to evaluate SNL-SWAN and participate in module development efforts.
- The Coastal Hydraulics Laboratory of the Army Corps of Engineers has been doing wave and sedimentation modeling for decades. They should be consulted on this project.

WHP140037

Project Title:

Introduction to the MHK Environmental FOA NEW

Principal Investigator:

Hoyt Battey and Jocelyn Brown-Saracino

Organization:

DOE (Multiple Projects)

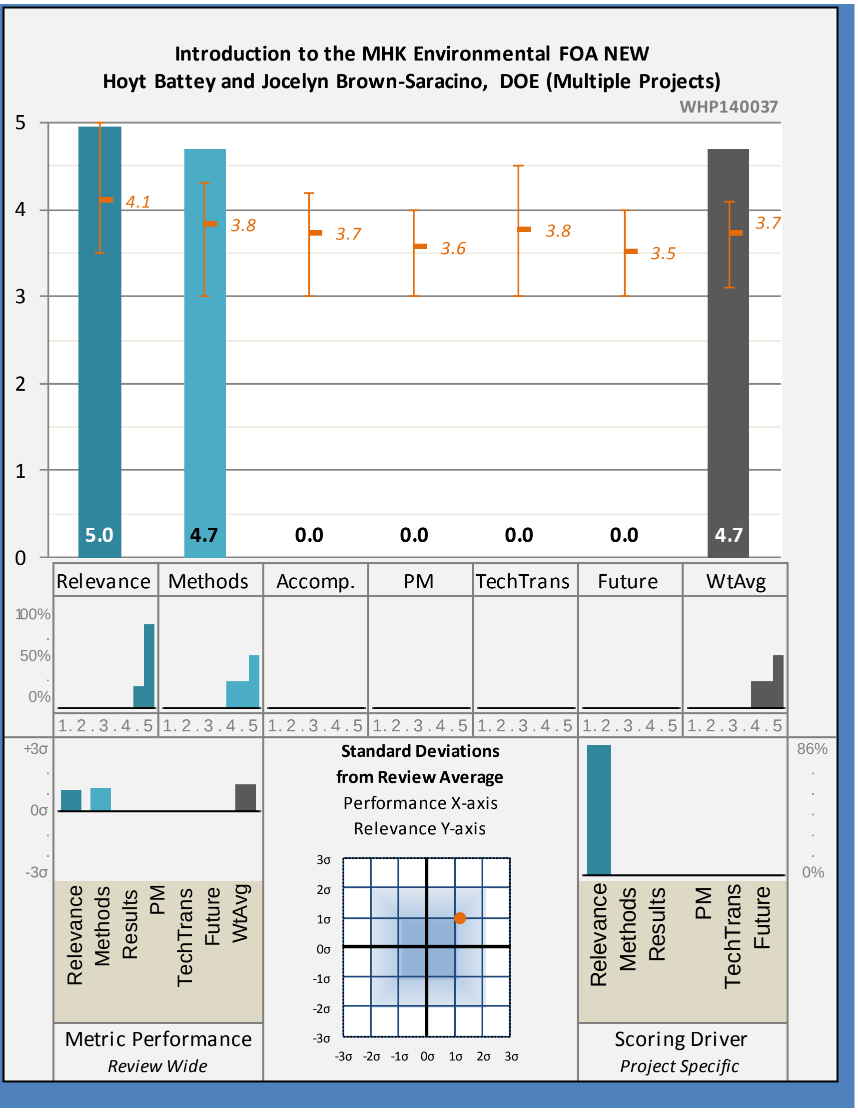
Panel:

Market Acceleration

Budget:

$2,400,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **5.0** for its Relevance to water industry needs and overall DOE objectives.

- Funding under this FOA is either building on existing data gathered by device developers or looking at key concerns previously identified by regulators during previous deployments.
- This group of projects addresses one of the highest priorities for DOE - to address gaps in scientific understanding of environmental effects of MHK devices and provide a detailed body of scientific information that can guide regulatory decision makers.
- The FOA funds projects that will (1) develop Environmental Monitoring of MHK Projects and (2) Analysis of Environmental Effects of MHK Surrogate Technologies.
- These projects will be helpful in documenting the effects of MHK on aquatic animals.

- New strategy in environmental approach - working with developers to understand what types of regulatory and environmental questions are ubiquitous - good approach using real world and not just perceived needs.
- The Environmental FOA directly supports DOE Goals to "reduce deployment barriers and environmental impacts."
- Marine mammal behavioral response to sound an important area to get better data on.
- Fish community work around OSU devices.
- ORPC fisheries work - BACI confirmation - concerns about BACI - Gail explained directed strictly at fish positioning in water column.
- EMF studies for FAU.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.7** on its methods/approach.

- Addresses critical permitting barriers, through regional, in-situ work on MKH devices.
- The approach of improving environmental monitoring and analyzing environmental effects provides a good path to accelerated deployment of MHK.
- Well planned.
- Really like the idea of trying to get data from existing projects and real world situations - disappointing that more devices aren't in water.
- DOE should assure that each project includes regulators in developing protocols for studies and receive detailed reports on findings.
- FAU EMF studies - using diver observations and other methods - unique and useful.
- Cal Davis Study excellent use of existing infrastructure and studies to address MHK problem/issue.
- Use of existing data and previous work really helps further the knowledge base without reinventing the wheel.

Strengths and Weaknesses

Project Strengths

- Strong collaborative approach, addressing critical permitting blockages; encouraging collaboration between BOEHM and NOAA on research projects
- The Environmental FOA emphasizes improvements in monitoring and assessment that will reduce barriers to greater deployment of MHK
- Partnership with BOEM.
- Using existing data, existing structures.
- Good effort to leverage existing data and focus projects on MHK device impacts.
- Interaction with BOEM to leverage study usefulness.
- Good diversity - geographically and issue wise.

Project Weaknesses

- Important to assure that federal and state wildlife agencies are involved to give input on project protocols to assure buy-in, and ask federal wildlife agencies to assure that project results are distributed throughout the regulator ranks of their department.
- No obvious weaknesses at this time.

Specific recommendations for additions or deletions to the work scope

- Consider webinars, science workshops with federal regulators to keep them updated on the results of the DOE funded projects.
- This is an important effort with a great deal of upside potential. Monitor progress of the performers carefully.
- Continue.
- Since there is little involvement of Industrial Partners, encourage System Developers to monitor the results of the Projects through participation in Reviews.

WHP140038

Project Title:

IEA OES Annex IV Support and Tethys Database Development

Principal Investigator:

Andrea Copping

Organization:

Pacific Northwest National Laboratory

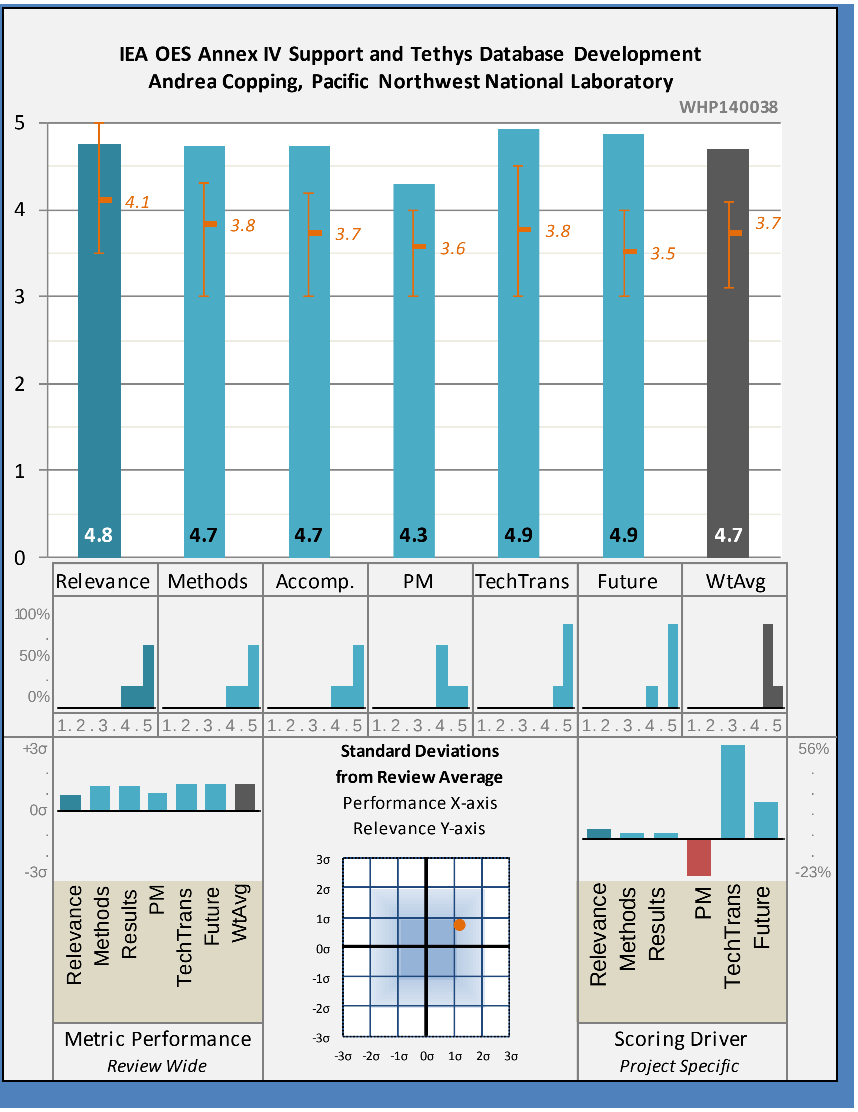
Panel:

Market Acceleration

Budget:

$1,292,100 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.8** for its Relevance to water industry needs and overall DOE objectives.

- Tethys is a key tool to distribute environmental data related to the MHK industry.
- Excellent project essential to moving MHK industry forward and lowering costs of permitting, while sharing lessons learned on publications.
- Tethys seeks to reduce deployment barriers and environmental effects by making information on environmental effects, which is typically dispersed, accessible to developers, regulators and researchers in common base of knowledge.
- This is important work and is essential to the successful development of the MHK industry.
- Great to have international collaboration and bringing information in from other projects around the world.
- Tethys seeks to support efficient siting and permitting to accelerate the industry.

- Having central clearinghouse of info will hopefully help people from repeating studies.
- Amount of info already collected and rate that it is coming in shows what a large body of knowledge exists already.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.7** on its methods/approach.

- Excellent step wise development over long term, including key constituencies.
- The data for inclusion in Tethys has been collected from numerous sources and archived.
- Well planned project.
- Good that we are we tapping into offshore wind knowledge and studies as well as MHK.
- International participation in Annex IV is outstanding. Agree that it needs a different name.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.7** based on technical accomplishments and progress.

- Very impressive progress on building federal database, while including international partners.
- The amount of data that has been collected is impressive.
- Great work is being done on both projects.
- Developed good infrastructure and have people using it – Tethys.

Question 4: Project Management

This project was rated **4.3** on its project management.

- Impressive technical support and organization of international contributors.
- Project Management data is difficult to assess, but the project appears to be running smoothly with an appropriate budget.
- Well executed project.
- On schedule and budget.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.9** for research integration, collaboration, and technology transfer.

- The collaboration on Tethys is substantial among US National Labs, Universities, US Government Agencies, and organizations in foreign countries.
- Tremendous domestic and international collaboration with industry, academia, and government.
- Lots of partners around the world - excellent level of cooperation.
- US-based Industrial Partners are conspicuous by their absence. Are they planning to simply consume the data, rather than contribute to the database?

Question 6: Proposed Future Research

This project was rated **4.9** for proposed future research.

- Future work is simply to continue the effort.

- The proposed future research is very worthwhile.
- Seems like platform is built and major work done so now keeping it current will be ongoing task that should be manageable and well worth effort and expense.

Strengths and Weaknesses

Project Strengths

- The database puts a great deal of information in one place where it can be used by Industry, Regulators, and other stakeholders.
- International collaboration.

Project Weaknesses

- Industry doesn't appear to be contributing.

Specific recommendations for additions or deletions to the work scope

- DOE should support this effort and encourage Industry to contribute as much as possible subject to competition issues. Clearly Industry has data to share that would not unduly compromise competitive advantage.
- Continue.

WHP140039

Project Title:

West Coast Coastal Marine Spatial Planning Support

Principal Investigator:

Simon Geerlofs

Organization:

Pacific Northwest National Laboratory

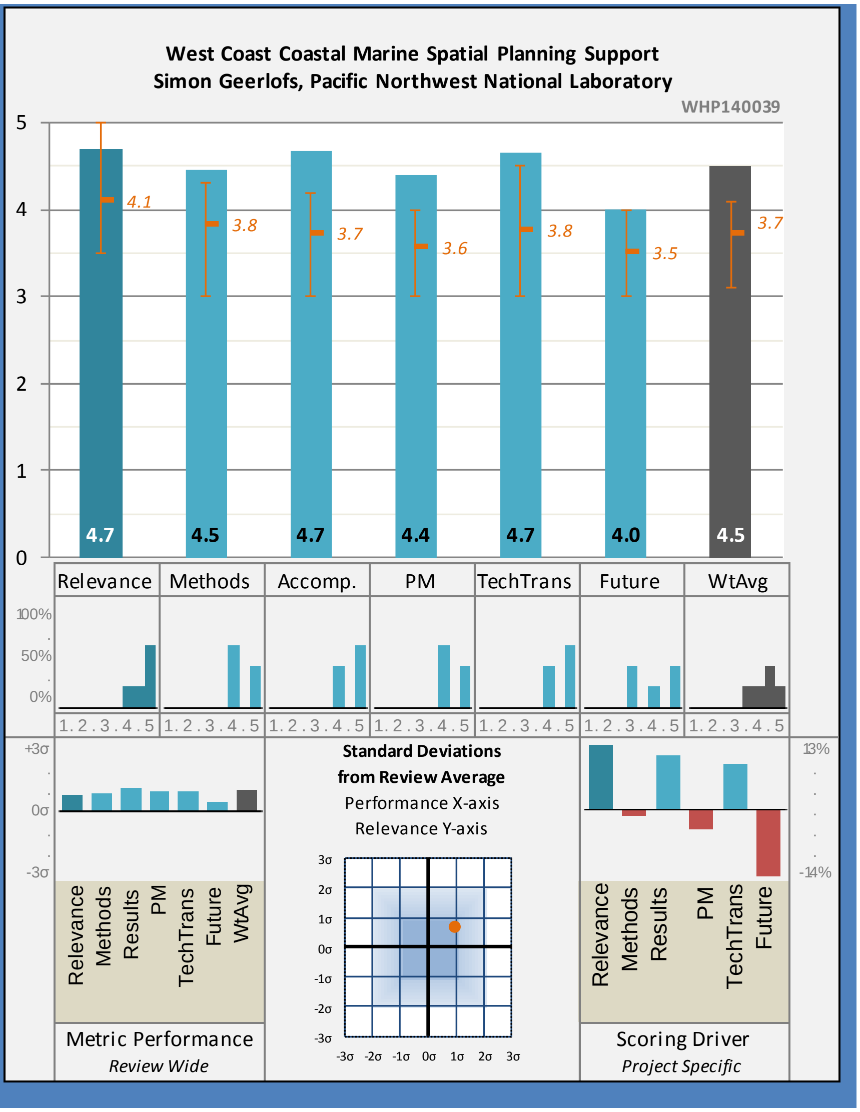
Panel:

Market Acceleration

Budget:

$280,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.7** for its Relevance to water industry needs and overall DOE objectives.

- A low cost-highly effective study that will help conflict resolution between multiple users.
- Excellent approach to visualize the industry siting priorities and to share with state planning process. This is a good first step. Understand that project is dependent on state coastal planning process. Important to evaluate where DOE can implement similar program in other state processes to assure industry needs are represented.
- The Project seeks to reduce deployment barriers by (1) engaging with coastal marine spatial planning processes in support of MHK deployment and (2) partnering with stakeholders relative to suitability analyses on the west coast.

- It is absolutely essential that MHK technologies are considered in any Coastal and Marine Spatial Planning (CMSP). PNNL's task is to ensure that MHK is considered in the West Coast CMSP.
- Site suitability criteria developed and applied into MSP.
- Industry needs to be involved with this effort.
- Important for industry to be involved in MSP efforts - would be very easy to be overlooked or forgotten and some of best sites could be dedicated to other purposes without due consideration.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.5** on its methods/approach.

- Given limitations imposed by state planning process, the approaches were good, especially the outreach to industry to get data. Unfortunate that it came too late to affect Oregon planning process early stage process.
- PNNL's approach is broad-based and should be effective in providing the MHK perspective to CMSP activities
- Well planned.
- Developing wave energy criteria to be input into a decisional GIS tool is the right approach instead of trying to develop overall comprehensive tool but would be good to make sure screening criteria also take into account environmental constraints, access to transmission etc. if possible.
- Focusing on states with active processes and high wave resources makes sense.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.7** based on technical accomplishments and progress.

- The Team has provided suitability analyses for a substantial section of the West Coast.
- PNNL has executed many coordination activities with the West Coast CMSP on behalf of the MHK industry.
- Seems like DOE involvement has been well received and expenses fairly low.

Question 4: Project Management

This project was rated **4.4** on its project management.

- This is basically a level-of-effort task that is on budget.
- Well managed project.
- It appears input is being supplied to state groups in a timely fashion. This isn't DOE's train to drive and you have to ride on their schedule which appears to be the case.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.7** for research integration, collaboration, and technology transfer.

- By its nature, this is a highly collaborative effort that is transferring information relative to MHK to a larger audience of planners.
- PNNL has been collaborating with many stakeholders in the West Coast CMSP.
- Good cross-section of groups appear to be involved in this effort.

Question 6: Proposed Future Research

This project was rated **4.0** for proposed future research.

- Future plans are a bit vague.
- The proposed future research is very worthwhile.
- Future involvement depends on state processes so tough to measure.

Strengths and Weaknesses

Project Strengths

- The Project provides advocacy for MHK in CMSP activities.
- Great collaboration.

Project Weaknesses

- None obvious

Specific recommendations for additions or deletions to the work scope

- Important for DOE to monitor other opportunities to explain the MHK industry needs in State Coastal Planning processes throughout US.
- This appears to be a low-cost method of advocacy for MHK. Its effectiveness will become apparent as time goes on (assuming that planned and future in-water demonstrations are successful).
- Continue.

WHP140040

Project Title:

EERE Post-doctoral Research Awards

Principal Investigator:

Hoyt Battey

Organization:

ORISE

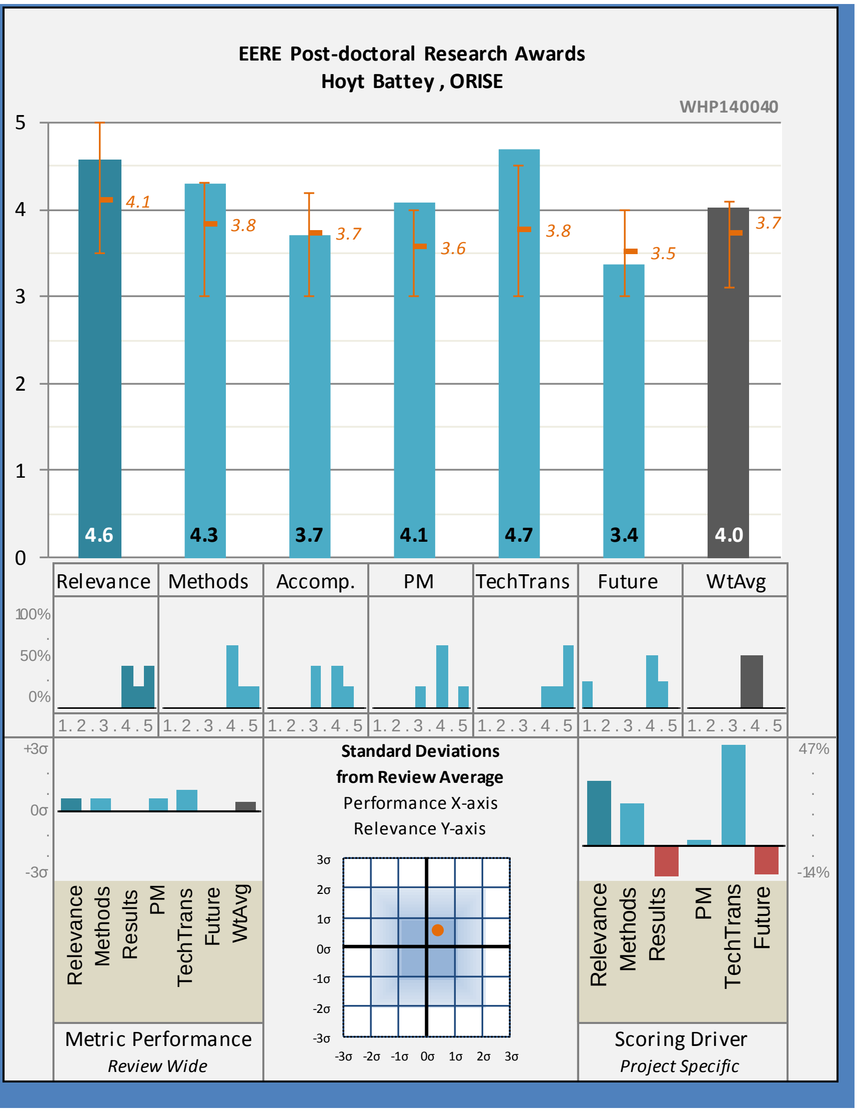
Panel:

Market Acceleration

Budget:

$822,398 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.6** for its Relevance to water industry needs and overall DOE objectives.

- I wish all the success to this program - it is a positive move to develop collaboration in the international community.
- Strong contribution to future Workforce Development and sensible path to tapping the strong academic centers and institutional knowledge of international MHK centers.
- EERE Post-doctoral Fellowships support the goal of advancing the state of MHK technology by encouraging highly-qualified researchers to enter and remain in the Industry.
- Great idea. Hopefully it will catch on. International institutions are doing some very good work.
- Great concept to get US people engaged in other countries where there are active projects - helps bridge the gap that we have in being behind rest of the world.

- The Fellowships also expose the Fellows to areas of the world with more established MHK Industries
- Should think about combining with hydro research fellowship program and/or modeling after that and possibly doing something similar with offshore wind so that we have the expertise in this country.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.3** on its methods/approach.

- WPTO is piloting an opportunity for MHK researchers to participate in an EERE-wide post-doctoral research program.
- Well planned.
- Funding for involvement of mentors as well as students.
- Good to have go/no go built in in-between 1st and 2nd year.
- Still a pilot program - maybe need to spread the word better - surprising that response was low in 2013.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.7** based on technical accomplishments and progress.

- To date, 3 awards have been made, but one was withdrawn.
- Slow start to program.
- Still too early to tell

Question 4: Project Management

This project was rated **4.1** on its project management.

- Encourage DOE staff to continue their early program outreach to assure all US academic centers are aware and key professors champion the DOE program; consider specifically strong outreach to the maritime academies, especially those which have developed strong engineering programs and MHK focus (e.g. Maine Maritime Academy).
- No FY13 awards were made due to weak responses to the opportunity announcement.
- Well executed.
- Fairly limited program but it looks like funding is there to support students who have been committed to.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.7** for research integration, collaboration, and technology transfer.

- Excellent collaboration with Ireland and international partners.
- This Fellowship is likely to produce a net transfer of technology to the US MHK Industry.
- Collaborating with international research centers.
- Working with international partners to leverage their expertise gained and being gained on projects in the water is excellent. Much better than desktop theoretical approaches.

Question 6: Proposed Future Research

This project was rated **3.4** for proposed future research.

- The future of this Fellowship is unclear.
- Need to figure out how to make this a sustainable and ongoing effort.

Strengths and Weaknesses

Project Strengths

- The Fellowships promote international cooperation and exchange of information. They should benefit the nascent MHK Industry in the US.
- Great concept.

Project Weaknesses

- Post-docs may not come back after completing their studies.
- Weak research proposals for FY13 may indicate a lack of interest by US researchers
- Slow start.

Specific recommendations for additions or deletions to the work scope

- WPTO's decision to re-evaluate participation in the Fellowship seems appropriate
- Continue.
- Consider adding a component to assure the training and skills are returned to the United States; consider medical profession models where post docs have the degree bundled with employment as post doc in total package to assure that academic center benefits from skilled worker for some period.

WHP140041

Project Title:

MHK Regulator Training NEW

Principal Investigator:

E. Ian Baring-Gould

Organization:

National Renewable Energy Laboratory

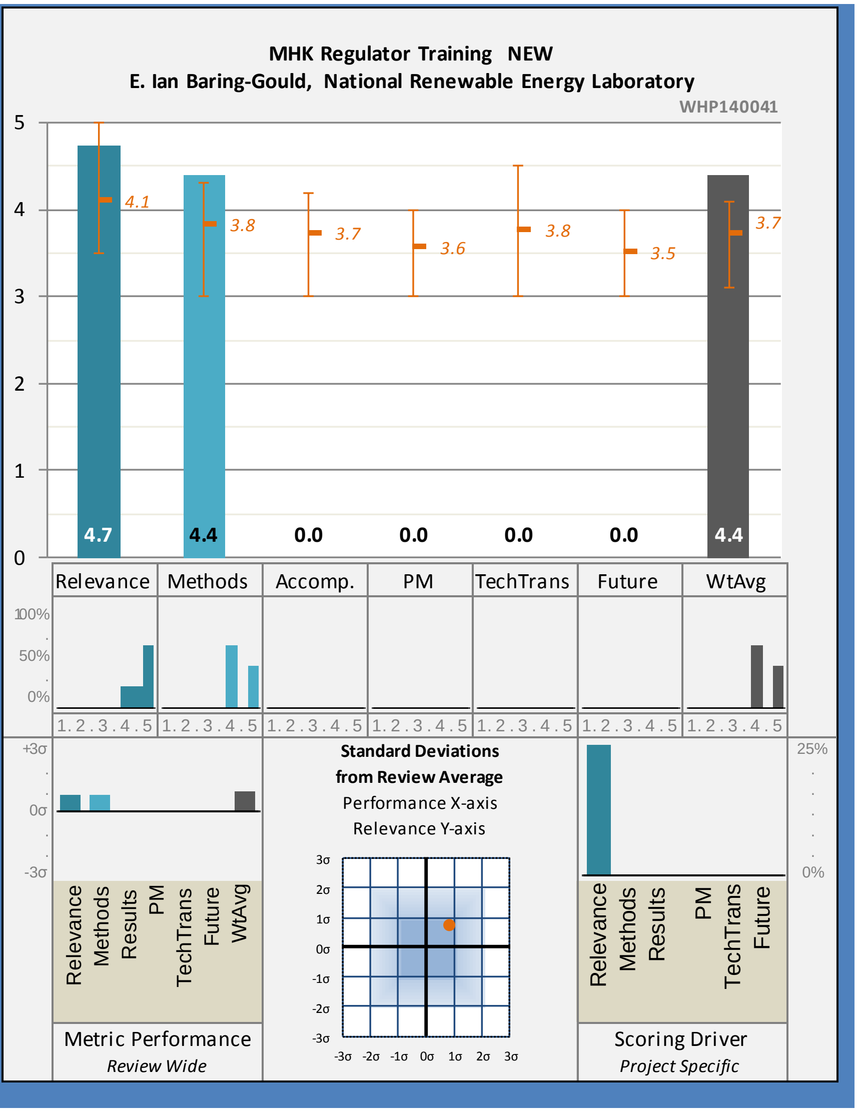
Panel:

Market Acceleration

Budget:

$200,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.7** for its Relevance to water industry needs and overall DOE objectives.

- A positive step forward in educating regulators of the potential issues surrounding the industry.
- Outstanding work by DOE to take leadership role in forging a collaborative partnership with sister agencies to assure regulators are familiar with the MHK industry information, regulatory process of federal and state agencies, and environmental effects studies.
- The Project seeks to reduce deployment barriers and environmental impacts of MHK by providing training that will familiarize Regulators with MHK technology and its potential impact.
- Great idea. This will help to make the permitting process go more smoothly.
- Great opening presentation on asking everyone to think like a regulator.

- Concern that we don't build expectations among regulators too high and/or get them back on their heels expecting a "wave" of new applications. Need to make sure you accurately portray state of industry and financial difficulty associated with commercial scale projects under present environment.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.4** on its methods/approach.

- Good use of NREL resources to provide independent lab expertise as learning resource for all federal MHK agency.
- The approach is to design and conduct workshops (with suitable materials) for federal and state regulatory agencies.
- Well planned.
- Hasn't really started yet **-** just beginning.
- Lot of good ideas on how this could be improved but it sounds like they already have a lot of good ideas, approaches.

Strengths and Weaknesses

Project Strengths

- The Project appears to have the potential to educate regulators and eventually facilitate permitting for future MHK in-water demonstrations.
- Workshops are a very effective way to reach the regulator audience.

Project Weaknesses

- The project was slow to start.

Specific recommendations for additions or deletions to the work scope

- Consider providing regulators with template pilot project review decisions based upon prior agency decisions.
- Closely monitor the Project and be prepared to take action if it continues to be delayed.
- Continue.
- Consider inviting regulators to engage in planning to further reduce administrative burden on regulators and unnecessary review effort by devising a Permit by Rule or similar standardized protective license protection, with lower administrative input requirements, for use in pilot projects.

6.4 National Marine Renewable Energy Centers

The program has partnered with four universities to create three testing sites to incubate advanced marine and hydrokinetic technologies. The Northwest National Marine Renewable Energy Center (NNMREC), operated jointly by Oregon State University and the University of Washington, focuses on wave and tidal energy conversion devices through test berth design and permitting, community outreach and education, characterization of testing sites, and acoustic monitoring and deterrence capabilities. The Hawaii National Marine Renewable Energy Center (HINMREC), operated by the University of Hawaii, emphasizes wave energy and ocean thermal energy conversion and boasts a collaborative wave energy test site with the U.S. Navy. The Southeast National Marine Renewable Energy Center (SNMREC), operated by Florida Atlantic University, focuses on ocean currents and ocean thermal energy conversion and specializes in environmental baseline observation systems.

Table 6.4.1 lists the National Marine Renewable Energy Centers MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.4.1 illustrates the standard deviation of scoring of the National Marine Renewable Energy Centers MHK projects in relation to the scoring of all projects reviewed in 2014.

Addressing Comments for National Marine Renewable Energy Centers and Testing Infrastructure and Instrumentation Projects

The MHK Peer Review Panelists recorded many useful and actionable comments during their review of the Office’s National Marine Renewable Energy Centers and Testing Infrastructure and Instrumentation projects. These comments will be used to make key decisions and recommendations to those projects that will still be receiving continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy into the future.

The reviewers rated with high marks the National Marine Renewable Energy Center (NMREC) projects. With funding for NMREC research and development projects coming to an end, however, the reviewers suggested that some of the work should have a mechanism for continued funding. The Program will consider this suggestion as it plans its out-year funding opportunities.

For testing infrastructure, a general theme of the reviewers was for the program not to duplicate work that was already being done by industry. For MHK test instrumentation systems, the program will have a better understanding of the adequacy of system design and its usefulness following wave device deployments that will occur in fiscal year 2015. The reviewers also cautioned about investing in large-scale test facilities. The program should carefully consider permitting and infrastructure cost, and use of international facilities in lieu of a domestic testing capability. In response, the Program intends to continue its partnership with the U.S. Navy at the Hawaii wave energy test site, as it is the only permitted open-ocean test site currently available in the U.S. Before additional open-water test sites are pursued, the Program will collect design and cost information, and consider the project against all the other program priorities.

Table 6.4.1 Existing National Marine Renewable Energy Centers MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing MHK Projects			4.6	4.2	3.9	3.8	3.5	3.9	3.6	**3.8**
Average for Existing NMREC Projects			3.7	4.8	4.7	4.5	4.4	4.6	4.6	**4.5**
Hawaii National Marine Renewable Energy Center (HINMREC)	Richard Rocheleau	Hawaii Natural Energy Institute (HNEI)	5.0	5.0	4.9	4.8	4.8	4.8	5.0	**4.8**
Northwest National Marine Renewable Energy Center	Belinda Batten	Oregon State University	3.0	4.7	4.7	4.7	4.3	5.0	4.7	**4.6**
Southeast National Marine Renewable Energy Center	Susan H. Skemp	Florida Atlantic University	5.0	4.8	4.4	4.1	4.0	3.9	4.1	**4.2**

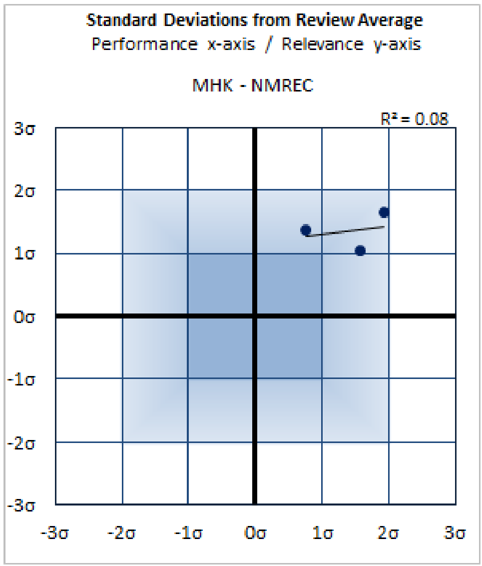


Figure 6.4.1 National Marine Renewable Energy Centers MHK projects

WHP140042

Project Title:

Northwest National Marine Renewable Energy Center

Principal Investigator:

Belinda Batten

Organization:

Oregon State University

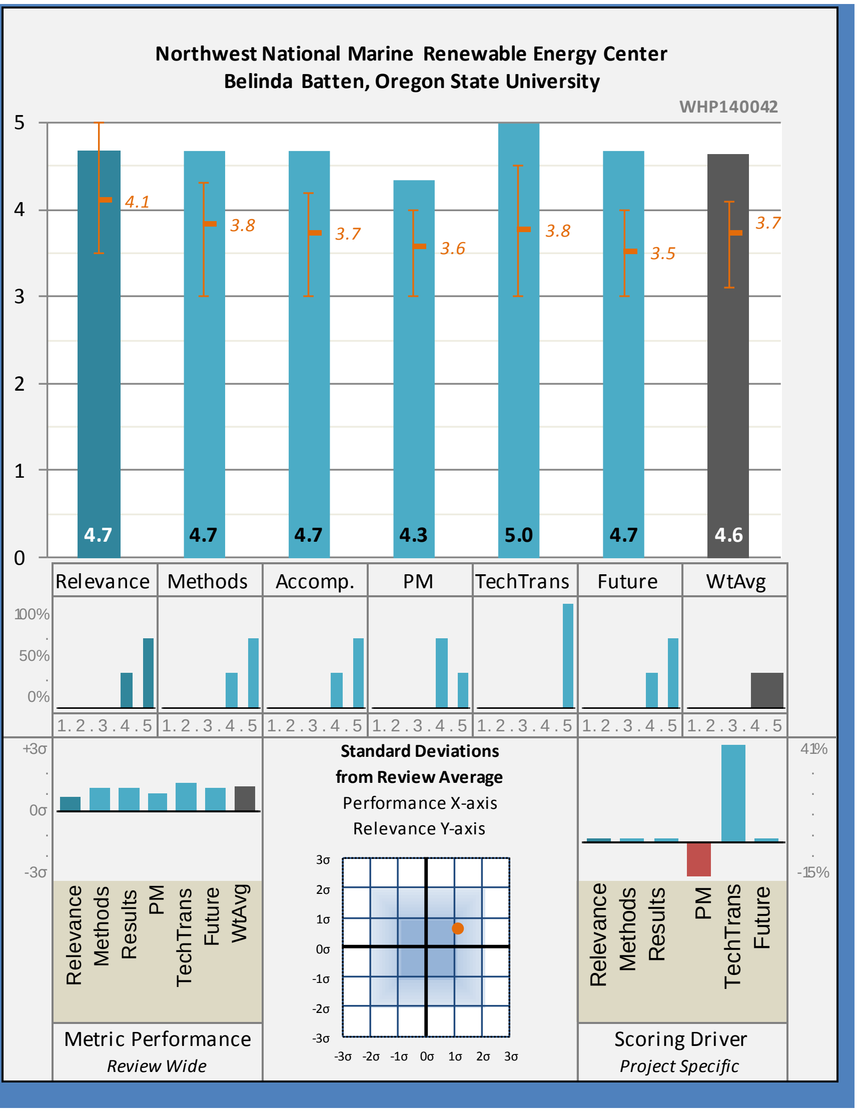
Panel:

NMREC

Budget:

$10,249,995 DOE

$8,081,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.7** for its Relevance to water industry needs and overall DOE objectives.

- Project objectives are good in theory, but project delays have significantly increased costs and decreased value to industry. The near-term value of the NWMREC test sites will be as a center of learning for workforce and students, at least in the tidal power arena. Unfortunately the test center deployment has been so long delayed in deployment due to permitting delays that existing tidal developers, and many wave developers, have had to invest in permitting private sites and testing there.
- The NNMREC seems to be an amazing national resource for the development of the MHK industry that supports all of the MHK objectives and priorities.
- The success of our National Marine Renewable Energy Centers will contribute to the success of the MHK industry.

- Not reviewing as our company is currently bidding on work with OSU.
- The Center appears to support all of the MHK objectives and priorities.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.7** on its methods/approach.

- Not clear from presentation and lengthy project summary, but it appears that many components of the test site accomplishment represent joint projects with national labs and others on environmental and ecosystem impacts, optimization of devices and arrays, and reliability and survivability (demonstration of antifoulants). This cooperation and collaborative approach is very valuable.
- NNMREC supports the MHK industry via (1) numerical modeling, (2) field studies, (3) scale-model testing, a (4) at-sea testing.
- NNMREC is very well organized and extremely active.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.7** based on technical accomplishments and progress.

- The presentation provided a large number of examples of accomplishments by NNMREC. Repeating it here seems unnecessary.
- Many successful projects, such as the Ocean Sentinel.
- NNMREC clearly recognizes importance of working with the community.

Question 4: Project Management

This project was rated **4.3** on its project management.

- Permitting delays and extremely burdensome environmental monitoring requirements have delayed the test site being open for business and significantly increased costs over time for this first-in-space multiple device applicant. Little ability to control the stringent and evolving permit interpretations through project management.
- The presentation format is not appropriate for a $20M Project; the information is not adequate for establishing the effectiveness with which the results to date were accomplished. The achievements have clearly occurred and the Deliverables List in the backup slides was somewhat helpful.
- Well run center.
- Impressive efforts to coordinate and leverage assets through cooperation with other parties.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **5.0** for research integration, collaboration, and technology transfer.

- This facility has been a focal point for many of the other efforts described during this Peer Review.
- Collaborates with industry, academia, and government.
- Technology transfer, as evidenced by the fact that the two-page "summary" ran for 14 pages, has been extraordinary.

Question 6: Proposed Future Research

This project was rated **4.7** for proposed future research.

- The facilities appear to be well used in the foreseeable future.
- Many worthwhile future research projects are suggested.

Strengths and Weaknesses

Project Strengths

- NNMREC is a world-class facility that can support the MHK Industry as it grows.
- Technical excellence.
- Collaboration with all stakeholders.

Project Weaknesses

- None obvious .

Specific recommendations for additions or deletions to the work scope

- Special effort should be made by DOE and NMREC to capture the huge DOE investment and the learning of the permitting process both for MHK developers and for federal regulators in an effort to streamline future permitting processes for other sites.
- Honestly, I have never been so impressed by a facility. Undoubtedly there are issues that are not obvious, but I can't make any recommendation other than to make the best possible use of NNMREC.
- Continue.

WHP140043

Project Title:

Hawaii National Marine Renewable Energy Center (HINMREC)

Principal Investigator:

Richard Rocheleau

Organization:

Hawaii Natural Energy Institute (HNEI)

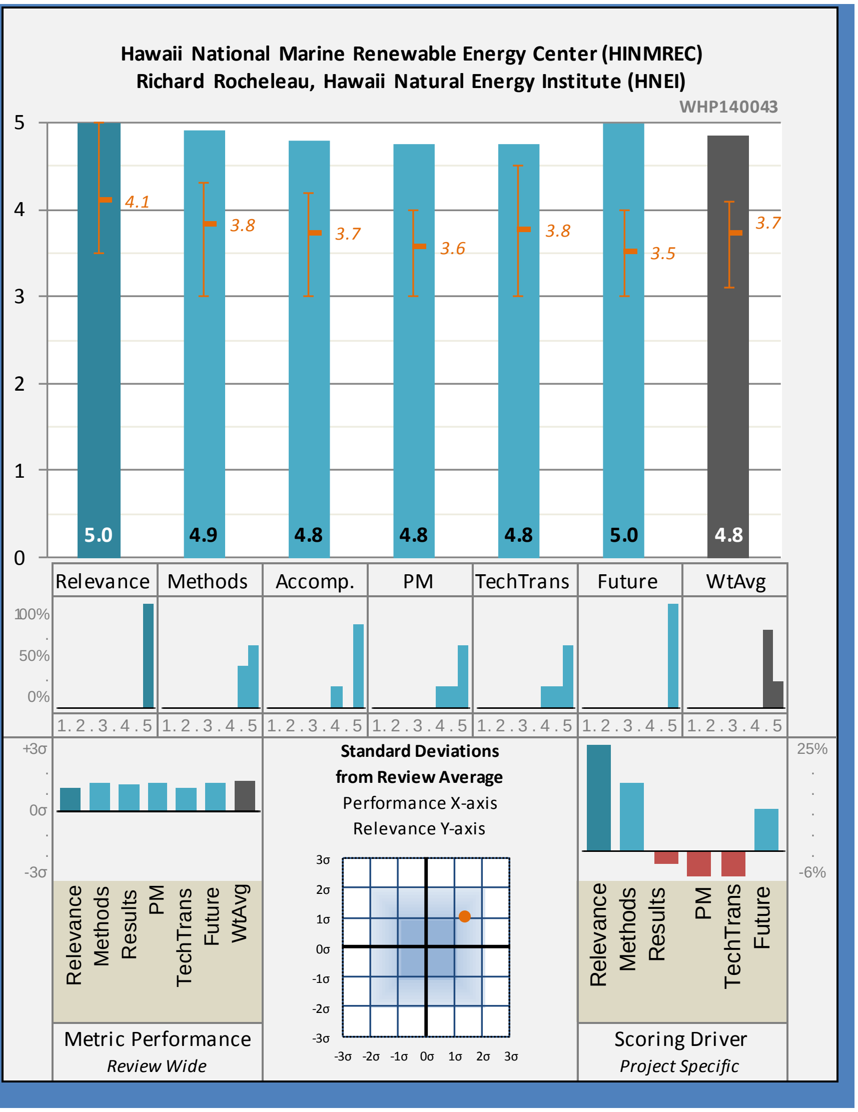
Panel:

NMREC

Budget:

$7,999,647 DOE

$8,018,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **5.0** for its Relevance to water industry needs and overall DOE objectives.

- The aim of this project is to get devices in the water to achieve TRL 8/9.
- Critical to OTEC and Wave Energy industry advancement to have test sites and large demonstration sale site; project permitting for NavyDOE 3 berth grid connected site by 2014 will be timely for most of the later stage commercialization testing of wave devices.
- HNEI has worked with DOE and Navy to develop a wave-energy test site (WETS) that will allow for demonstration of grid-connected WEC devices at various representative depths.
- The success of our National Marine Renewable Energy Centers will contribute to the success of the MHK industry.

- Having a grid connected wave energy testing center in the US is a huge accomplishment. The partnership with the Navy to make this happen is excellent. Good to see that deployments are already planned and starting to happen.
- Supports the Navy's needs to develop independent and renewable energy - an extremely successful partnership between a national test center and the Navy.
- WETS serves an important role that is different from NNMREC in that the wave environment is more benign and conducive to early-stage development prior to subjecting a device to severe sea states
- Up to 1 MW.
- Pre-permitted for 2 different types - oscillating water column and overtopping devices.
- Wave climate diverse.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.9** on its methods/approach.

- Excellent approach to coordinate with USDOD in site development of wave testing, sharing resources and advancing USDOD RE goals.
- The plan for developing and commissioning the facility integrates DOE & NAVFAC requirements very well
- HNMREC is very well organized and extremely active.
- Appears to be a very well-thought out approach with emphasis on environmental monitoring and independent performance evaluations of devices, should yield good information to support future deployments in other locations.
- Although project encountered significant environmental permitting challenges, delays were limited to two years and no cost extensions and expert team remained intact.
- Diver/ROV inspections.
- Numerical wave tank model in development.
- Wave forecasting with real time buoys.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.8** based on technical accomplishments and progress.

- Close working consultation between HNEI/HINMREC has resulted in steady progress in environmental permitting.
- Site design is complete, environmental impact measurements are scheduled, and independent performance assessment is underway.
- Many successful projects, such as the Wave Energy Test Site and the 100 kw turbine at the OTEC facility.
- 3 berths at different depths available for testing, 30, 60, 80 M up to 1 MW peak.
- Robust project plan and schedule for WETS.
- Permitted - have FONSI - going through Navy reduced permitting issues that face other centers - DOE NEPA combined.

Question 4: Project Management

This project was rated **4.8** on its project management.

- Although project encountered significant environmental permitting challenges, delays were limited to two years and no cost extensions and expert team remained intact.

- The presentation format is not appropriate for a $10M Project; the information is not adequate for establishing the effectiveness with which the results to date were accomplished. PM performance was well explained at a very high level in the backup slides.
- Well run center.
- Have vessel availability and logistics well developed.
- Schedule slipping some due to NEPA issues.
- Raised significant budget through DOE, Navy, and State of HI.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.8** for research integration, collaboration, and technology transfer.

- A strong partnership between a university, the Navy, and private industry.
- Excellent collaboration model with USDOD and State of Hawaii providing matching funds and expertise.
- Technology transfer to the MHK Industry is impressive.
- Collaborates with industry, academia, and government.
- Collaboration between public, private, and academic community successful to date and planned going forward.
- Good collaboration with the NNMREC team (UW and OSU) to assess noise and EMF.
- Providing link between DOE and Navy funding.
- Many papers and publications have come out of this already.
- OTEC work has informed some sea water air conditioning assessments.

Question 6: Proposed Future Research

This project was rated **5.0** for proposed future research.

- Bring on the testing!
- This project represents top level collaborative research meeting DOE and DOD project goals and Hawaii economic development and RE goals and should be prioritized in future funding.
- The facilities appear to be well used in the foreseeable future.
- None suggested.
- Now that the test center is available it can be a center of research. Having three different berths and other infrastructure and monitoring in place will allow for rapid advancements in research - particularly looking at critical O&M and longevity issues of components.

Strengths and Weaknesses

Project Strengths

- WETS will be a world-class facility that can support early-stage, in-water demonstrations of Wave Energy
- Technical excellence.
- Partnership with Navy and use of existing naval facilities was huge in making this happen.
- Collaboration with all stakeholders.

Project Weaknesses

- Costs to transport a device to HI may not make this location cost competitive for developers (compared to testing at either NNMREC or in Europe).
- None obvious.

<u>Specific recommendations for additions or deletions to the work scope</u>

- Biofouling and corrosion studies should be coordinated with other USDOD and federal studies.
- DOE & Industry Partners should make maximum use of this facility.
- Continue.

WHP140044

Project Title:

Southeast National Marine Renewable Energy Center

Principal Investigator:

Susan H. Skemp

Organization:

Florida Atlantic University

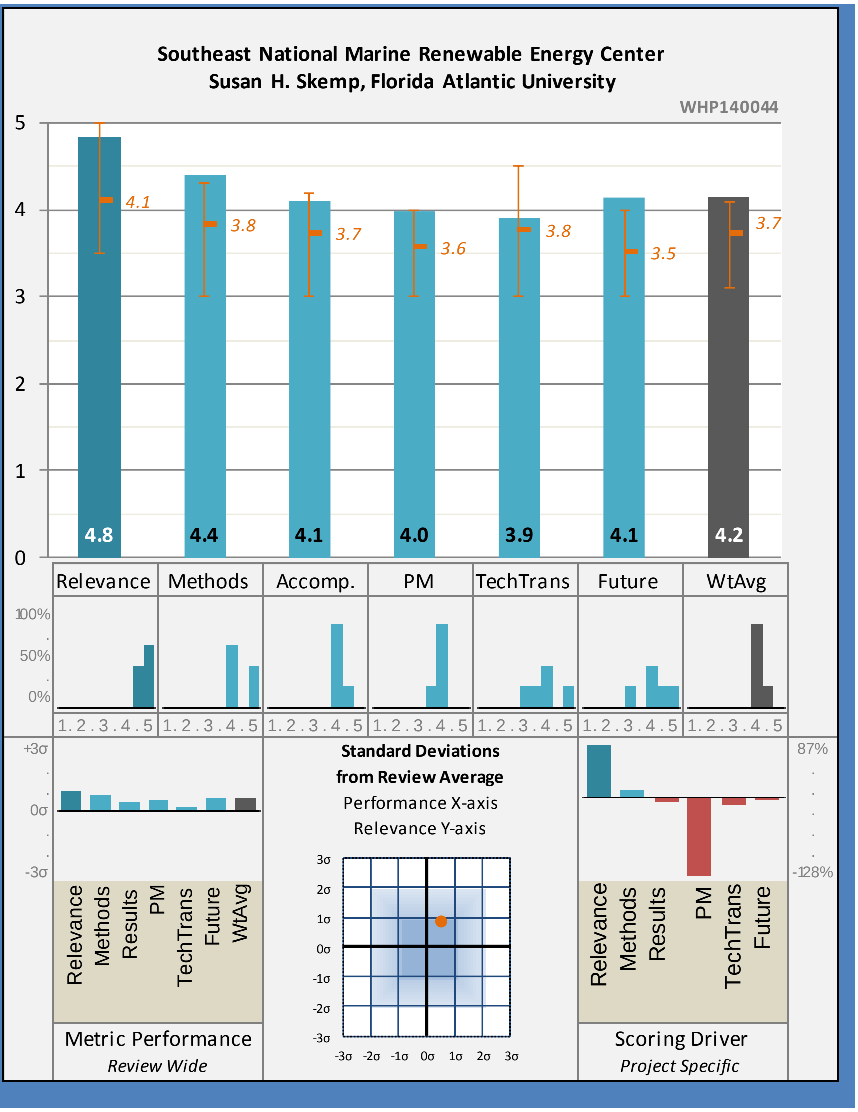
Panel:

NMREC

Budget:

$2,000,000 DOE

$2,540,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.8** for its Relevance to water industry needs and overall DOE objectives.

- Strong interest from international companies to test at this facility.
- Development of an ocean current energy test sites and academic center of excellence is essential, especially given the tremendous challenges of permitting deep water sites.
- Development of an open-ocean test facility of CEC devices meets all of the Program Objectives. The scale of the facility, although smaller than the other two, as well as the lack of grid connection are appropriate due to emphasis on Tidal and Wave Energy in the near term.
- The success of our National Marine Renewable Energy Centers will contribute to the success of the MHK industry.

- Having a location where developers of marine current generating technology can deploy and test turbines and components is very useful to the industry.
- Leader in field on permitting MHK on Outer Continental Shelf. In spite of delays on NEPA permitting, this test site for devices through TRL 5/6 is still timely for industry development, because other options do not exist.
- Up to 100 kW per deployment.
- Unique test site in world - Stellenbosch University, Japan, and Korea exchanges to date demonstrate potential for this test site to emerge as true international leader to attract device developers
- Barge testing.
- Only current testing center in the world.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.4** on its methods/approach.

- Good method and approach to look for gaps in knowledge, and then collaborate with experts in field to conduct research.
- The approach of developing a non-grid-connected, 100kW test berth for TRL 5/6 devices is appropriate to the near-term needs of CEC.
- SNMREC is well organized.
- Developed small 20 kW 3 meter turbine to test concepts, measurement and provide something that developers can use.
- The steady, patient approach to work with regulators to procure necessary permits, in spite of lack of MHK permitting experience on OCS, is essential.
- The 20kW "representative" turbine will support component development, controls development, and environmental assessment of CEC impact.
- Getting this developed in a convoluted and changing regulatory environment (BOEM, FERC) has been a real challenge.
- Future challenges will be to involve transmission and utility industry to discuss collaboration for cost reduction on delivery of OCS power onshore.
- The ocean-current characterization vis moored ADCP devices is a good approach to "calibrating" the facility.
- Development of test site for mature device designs in more protected location will be important to complete the test site potential.
- Excellent work to coordinate with NREL and other experts in field to create basic turbine design, but project should make effort to include USN which has extensive expertise.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.1** based on technical accomplishments and progress.

- Creating the first test center to test ocean current systems.
- Environmental permitting delays of over a year and a half have delayed accomplishments, but progress made on turbine design and assembly and data collection.
- Good progress seems to have been made in spite of NEPA hold.
- Significant work on ocean current turbine.
- 1st FONSI under interim lease process for BOEM.
- Seeking first BOEM MHK lease.
- Sea trials completed, test turbine developed.

Question 4: Project Management

This project was rated **4.0** on its project management.

- USDOE should review with test sites and federal regulators whether a different permitting approach, whether phased, incremental addition of test berths, after initial data gathering and assessment of single device at location, or whether more professional resources earlier in the permitting process, could have made permitting process less painful.
- Schedule was severely impacted by NEPA hold, but FAU seems to have done as well as they could under the circumstances and is operating on a revised timeline.
- Well run center.
- Appears to be on schedule and on budget though there were some NEPA delays.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Strong efforts to create collaborative partnerships and to provide for technology transfer.
- Collaboration to date has only been with Embry-Riddle & NREL; making technology transfer to date limited, but information is available on line.
- Collaborating with industry and academia.
- International community showing interest - developers and academics as this is only marine current testing center in the world.
- Not much collaboration with industry demonstrated to date.

Question 6: Proposed Future Research

This project was rated **4.1** for proposed future research.

- Important to develop mature technology testing capacity especially given challenges in OCS environment.
- Future work appears to be related solely to facilities development. No usage by Industry is identified.
- Many future research projects are suggested. Should be considered after present task are completed.
- Continuing to build resource and environmental data that will support full scale demonstration and testing - this seems like a smart approach that recognizes the potential environmental opposition that could occur.

Strengths and Weaknesses

Project Strengths

- Key site, given expense of OCS permitting.
- This facility will provide support for development of CEC devices.

Project Weaknesses

- Will be helpful to shift to actual device testing, once site permitted, to realize full potential of site.
- There is no apparent usage of the facility by Industry at this time. This probably indicates the relatively low emphasis that is be placed on ocean-current energy.

Specific recommendations for additions or deletions to the work scope

- USDOE should explore with SNMREC and other national tests sites whether future funding should be given to develop a strong distance learning, or joint degree program for students throughout the United States, leveraging educational potential of all 3 test sites and their respective teaching capacities and testing facilities. Consider DOE and NSF combined grant to fund a pilot long distance learning with other university partners contributing local teaching support and guidance in engineering schools.
- Although tidal and wave energy are receiving the greatest emphasis, this relatively-low-cost facility will support the needs of the ocean-current portion of MHK as it develops.
- Continue.
- Consider DOE and NSF support for extending the existing work of Southeast and Northwest in developing curriculum for STEM in 5 through 12 and informal learning challenge.
- DOE should host a high level USN ONR meeting with SNMREC to assure that USN knowledge and priorities are fully leveraged for technology support and funding the test site.

6.5 Testing Infrastructure and Instrumentation

In order to perform rigorous device testing to validate and optimize prototypes, developers require comprehensive test facilities. The program has provided funding to identify 20 tank testing operators in the U.S. with capabilities suited to the marine and hydrokinetic technology industry. These facilities are compiled in the Hydrodynamic Testing Facilities Database. The program supports the development of open-water, grid-connected testing facilities, as well as resource assessments that will improve simulations in dry-dock and closed-water testing facilities. The program also supports instrumentation development to enhance the testing capacities of these facilities.

Table 6.5.1 lists the existing Testing Infrastructure and Instrumentation MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.5.1 illustrates the standard deviation of scoring of the existing Testing Infrastructure and Instrumentation MHK projects in relation to the scoring of all projects reviewed in 2014.

Addressing Comments for National Marine Renewable Energy Centers and Testing Infrastructure and Instrumentation Projects

The MHK Peer Review Panelists recorded many useful and actionable comments during their review of the Office’s National Marine Renewable Energy Centers and Testing Infrastructure and Instrumentation projects. These comments will be used to make key decisions and recommendations to those projects that will still be receiving continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy into the future.

The reviewers rated with high marks the National Marine Renewable Energy Center (NMREC) projects. With funding for NMREC research and development projects coming to an end, however, the reviewers suggested that some of the work should have a mechanism for continued funding. The Program will consider this suggestion as it plans its out-year funding opportunities.

For testing infrastructure, a general theme of the reviewers was for the program not to duplicate work that was already being done by industry. For MHK test instrumentation systems, the program will have a better understanding of the adequacy of system design and its usefulness following wave device deployments that will occur in fiscal year 2015. The reviewers also cautioned about investing in large-scale test facilities, stating that the program should carefully consider permitting and infrastructure cost, and use of international facilities in lieu of a domestic testing capability. In response, the Program intends to continue its partnership with the U.S. Navy at the Hawaii wave energy test site, as it is the only permitted open-ocean test site currently available in the U.S. Before additional open-water test sites are pursued, the Program will collect design and cost information, and consider the project against all the other program priorities.

Table 6.5.1 Existing Testing Infrastructure and Instrumentation MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Existing MHK Projects			4.6	4.2	3.9	3.8	3.5	3.9	3.6	**3.8**
Average for Existing Testing Infrastructure and Instrumentation Projects			4.7	3.6	3.8	3.6	3.6	4.1	3.6	**3.7**
Standards Development: IEC TC114 and the Ocean Energy Systems Agreement of the IEA	Walt Musial	National Renewable Energy Laboratory	5.0	4.9	4.5	4.4	4.1	5.0	4.8	**4.4**
Instrumentation System Development	Bernadette A. Hernandez-Sanchez	Sandia National Laboratories	4.0	3.2	3.9	3.5	3.9	3.7	3.5	**3.7**
MOIS: Modular Ocean Instrumentation System	Eric Nelson	National Renewable Energy Laboratory	5.0	2.6	3.1	2.9	2.9	3.5	2.6	**3.0**

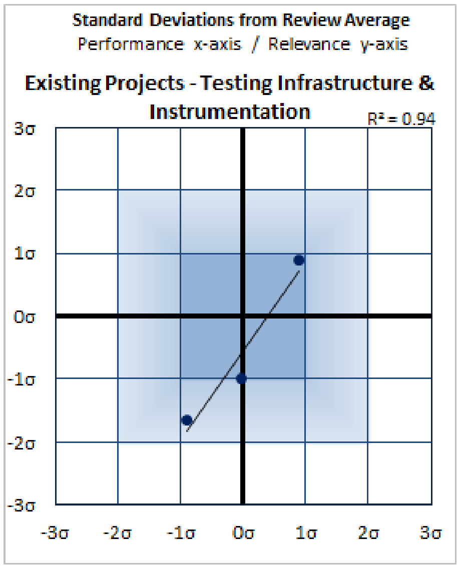


Figure 6.5.1 Existing Testing Infrastructure and Instrumentation MHK projects

Table 6.5.2 lists the new Testing Infrastructure and Instrumentation MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.5.2 illustrates the standard deviation of scoring the new Testing Infrastructure and Instrumentation MHK projects in relation to the scoring of all projects reviewed in 2014.

Table 6.5.2 New Testing Infrastructure and Instrumentation MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Weighted Average Score
Average for Review			5.1	4.1	3.8	**3.7**
Average for all New Projects			5.2	4.2	3.8	**3.8**
Average for New MHK Projects			4.9	4.0	3.7	**3.7**
Average for New Testing Infrastructure and Instrumentation Projects			5.0	3.7	3.6	**3.6**
Advanced Turbulence Measurements Methodology Development NEW	Robert Thresher	National Renewable Energy Laboratory	5.0	3.9	4.1	**4.1**
Marine and Hydrokinetic Testing Infrastructure Development NEW	Jim Ahlgrimm	DOE, (Multiple Projects)	5.0	3.5	3.1	**3.1**

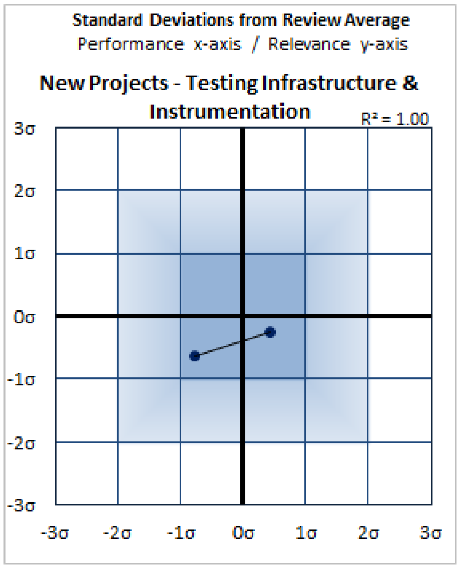


Figure 6.5.2 New Testing Infrastructure and Instrumentation MHK projects

WHP140045

Project Title:

MOIS: Modular Ocean Instrumentation System

Principal Investigator:

Eric Nelson

Organization:

National Renewable Energy Laboratory

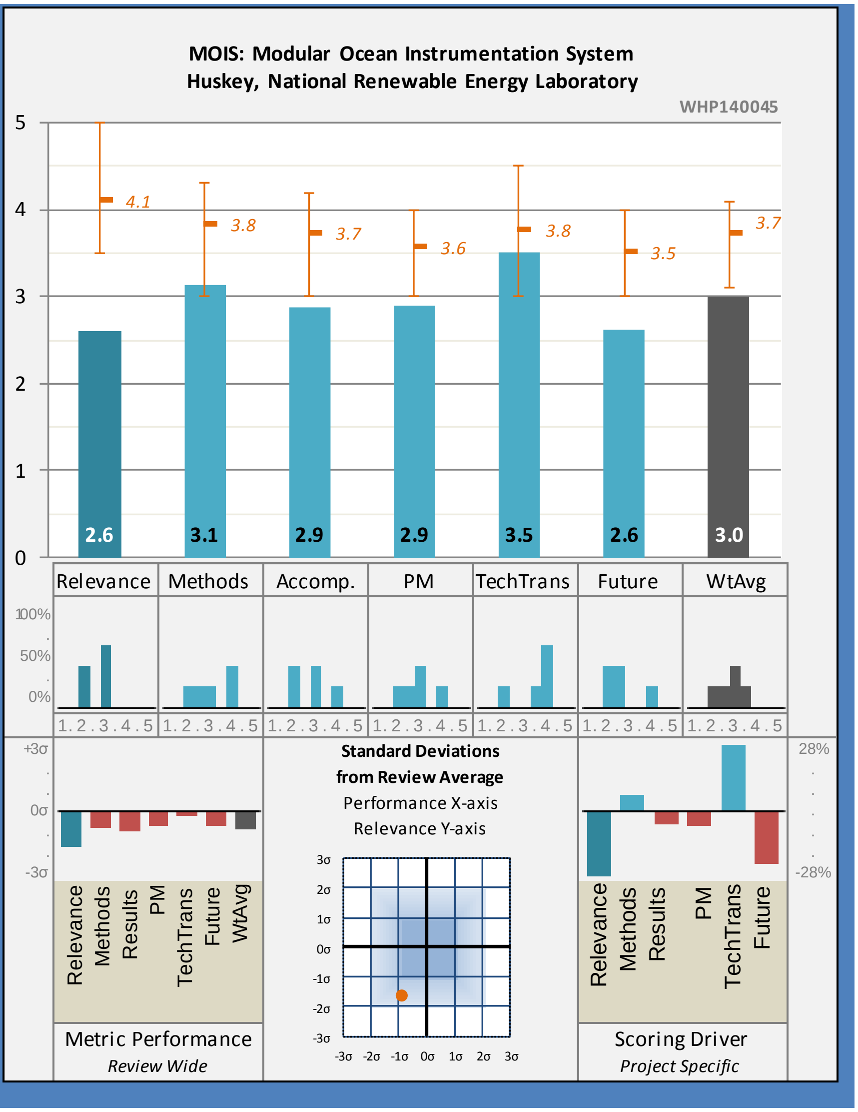
Panel:

Testing Infrastructure & Instrumentation

Budget:

$1,856,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **2.6** for its Relevance to water industry needs and overall DOE objectives.

- A lot of money spent that may not be applicable to all MHK devices/situations.
- Not clear whether a "gaps" analysis was done to determine what products existed in proprietary and military world that could accomplish these goals without complete re-creation of a new instrumentation system
- Although this effort appears to support the need for testing infrastructure, it also appears to duplicate efforts that are being performed by Industry and is developing equipment that is already available in the maritime community.
- An open-source-design instrumentation system will be valuable to some MHK devices. However, this technology will probably not be universally useful to the MHK community.

- Developing IEC testing system specifically to validate models - model validation is very important but this is a great deal of money to spend developing something that was created out of off the shelf components - not clear that this couldn't have been done with several separate existing systems instead of combining them all into one package.
- Not clear whether the project is needed to meet MHK industry needs, or whether this project is an overly expensive route. Was there an analysis to determine whether the industry needs could be met with minimal adjustments to existing products?
- The need for short term testing data acquisition is real need; not clear this project was well engineered to meet that objective.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.1** on its methods/approach.

- As noted above, not clear that this was the most efficient route to developing a robust test package for short term testing purposes at test sites.
- Spiral-development was a sound approach, but the implementation could have been more rigorous.
- Well planned project.
- Assessed available data acquisition systems and used these in combination - would it have been better to do a cost/benefit analysis of developing this system integration instead of just using existing monitoring equipment? Developing a standard monitoring protocol for all devices using existing components might be more useful.
- Is it wise to have all your sampling eggs in one basket? Do you increase risk of failure and/or compromise functionality? How do you back it up?

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.9** based on technical accomplishments and progress.

- Good that this has been field tested with WetNZ.
- There was neither a UPS backup nor a backup OS disk, so a battery failure on the MOIS hampered data collection for the WET-NZ in-water deployment.
- Several versions of MOIS have been developed and used on several field projects.
- Software failure on wetNZ deployment delayed that projects deployment.
- Good that it has been used in the field and has been improved based on experiences.

Question 4: Project Management

This project was rated **2.9** on its project management.

- A lot of money spent on something that was deployed on one device.
- Real confusion around actual and budgeted expenditures; how much has this cost to develop and was the project budget well-constructed and developed?
- The Project has met schedule milestones.
- Well executed project.
- Have spent 1.5 million so far on this effort. Not clear what product is other than testing system that can be deployed on one device at a time.
- Once the budget slides were explained, the cost history made sense. The estimate for FY14 appears to simply be the remaining funds and not the result of a bottom-up estimate to complete.

- The costs seem very high for producing a DAQ system, even a ruggedized one.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.5** for research integration, collaboration, and technology transfer.

- A good mix of public and private partnerships.
- While chief researchers involved come with deep expertise in field, it is not clear that planning phase included specific directed inquiries to center of excellence to determine available technology to address this technology need.
- There seems to have been good collaboration between NREL, academia, and industry.
- Collaborates with industry, academia, and government.
- Working with a number of industry members and test centers.
- Technology transfer is minimal to date, but appropriate.

Question 6: Proposed Future Research

This project was rated **2.6** for proposed future research.

- Is proposed future research necessary?
- The project should provide for industry feedback on the ease of use and reliability of this package as deployed in test centers.
- The MOIS is planned to be deployed for WET-NZ testing and Gen3 development is underway
- Proposed future research may not be necessary. After this project is complete, industry should decide if they want to use the system.
- Money on system is already spent so if it works and can be economically deployed and gain good results then it will be beneficial. If it is still a work in progress and may delay deployments or not successfully collect key data then DOE should consider pulling plug on this effort.

Strengths and Weaknesses

Project Strengths

- NREL has learned a lot about developing in-water test instrumentation from the spiral development process.
- Several successful demonstrations.

Project Weaknesses

- This seems to duplicate efforts by some of the Industrial Partners to develop in-water test instrumentation systems.

Specific recommendations for additions or deletions to the work scope

- DOE should assure that there is specific feedback from test centers and private sector on the efficacy of new product.
- I find a recommendation difficult. NREL has clearly come up to speed in this area, but I am still in doubt about it being an appropriate use of the skills of the National Labs as it seems to duplicate work that Industry is doing or should be doing.
- Wrap up project and let industry continue the development if there is a need.
- Since MOIS is being used and will be re-deployed (in a later generation) for WET-NZ, DOE should simply be aware of potential duplication and encourage collaboration if necessary.

WHP140046

Project Title:

Instrumentation System Development

Principal Investigator:

Bernadette A. Hernandez-Sanchez

Organization:

Sandia National Laboratories

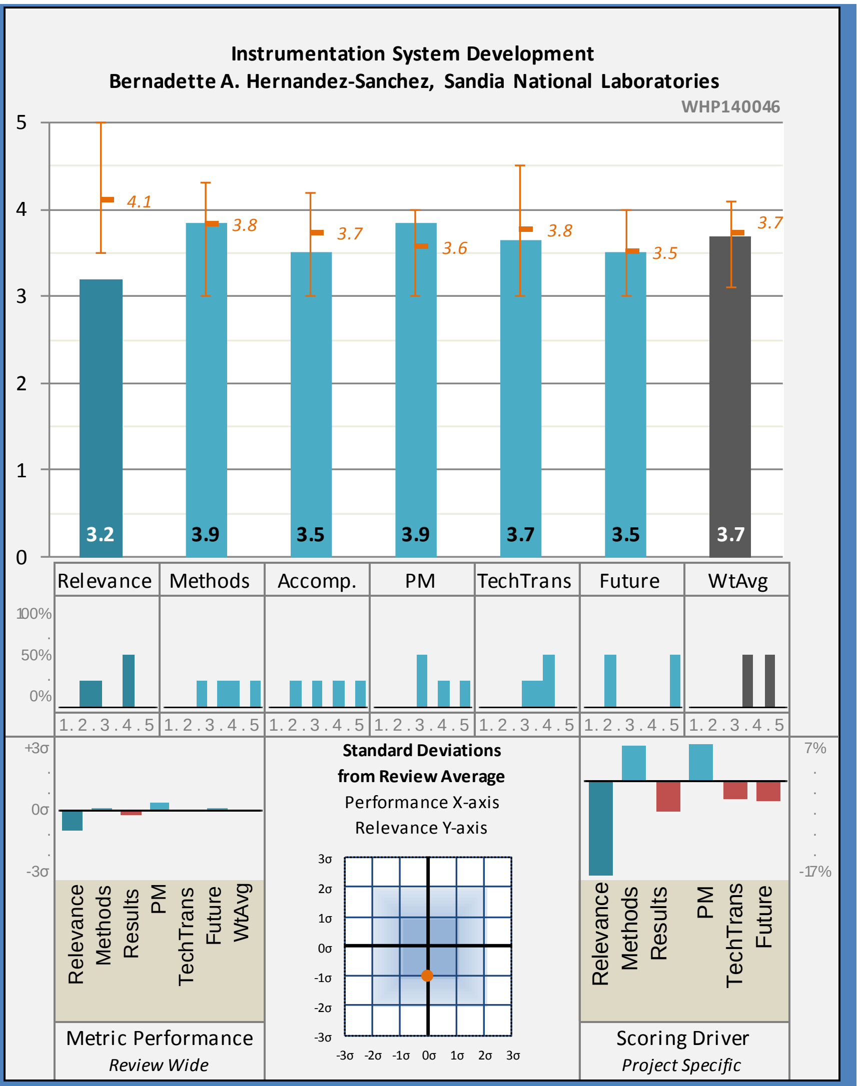
Panel:

Testing Infrastructure & Instrumentation

Budget:

$130,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.2** for its Relevance to water industry needs and overall DOE objectives.

- This testing is applicable to more than just the MHK industry - why is funding from this program supporting this testing? Let's use results from Oil & Gas industry, or the America's Cup team instead.
- This seemed to be a very reasonable use of SNL technology developed for Wind Power being applied to an MHK problem.
- Interesting work that will be applicable to tidal and ocean current turbines.
- Conditioning assessment of sensors - fairly low budget compared to other programs but wondering if sensors from wind blades are appropriate for marine environment. Does Navy or oil and gas industry have any

technology to measure/monitor health and performance of structures in marine environment? Not clear if this has been looked at before pursuing this research.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.9** on its methods/approach.

- Good to see knowledge from other industries being used to develop this.
- There have been some valuable results to date in understanding the water absorption by the composite material. The results are valuable for a wide variety of applications.
- Well planned project.
- Seeing how adhesive works in a marine environment to externally mount sensors. There is no reference to a literature search and/or outreach to Navy and Oil & Gas industry to see if comparable work has been done before pursuing this research.
- Leveraging wind turbine research.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.5** based on technical accomplishments and progress.

- The Project met the goal of answering an important question.
- Completing tests now.
- No results yet have just started some in-water performance testing.

Question 4: Project Management

This project was rated **3.9** on its project management.

- Good results for short money.
- Well executed project.
- Looks to be on schedule and on budget and finishing soon.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.7** for research integration, collaboration, and technology transfer.

- A good team of collaborators.
- Very good collaboration between a National Lab, a university, a technology developer, and an instrumentation supplier.
- Collaborating with industry, academia and other national labs.
- Worked with labs, university, and industry. Publishing results.

Question 6: Proposed Future Research

This project was rated **3.5** for proposed future research.

- Not Applicable - this work should be considered complete.
- Proposed future research may not be necessary. Consider after this work is done.

Strengths and Weaknesses

Project Strengths

- Utilizes expertise at SNL to develop technology for MHK.

Project Weaknesses

- No significant weaknesses.

Specific recommendations for additions or deletions to the work scope

- Another excellent example of good use of the resources of a National Lab.
- Continue.

WHP140047

Project Title:

Standards Development: IEC TC114 and the Ocean Energy Systems Agreement of the IEA

Principal Investigator:

Walt Musial

Organization:

National Renewable Energy Laboratory

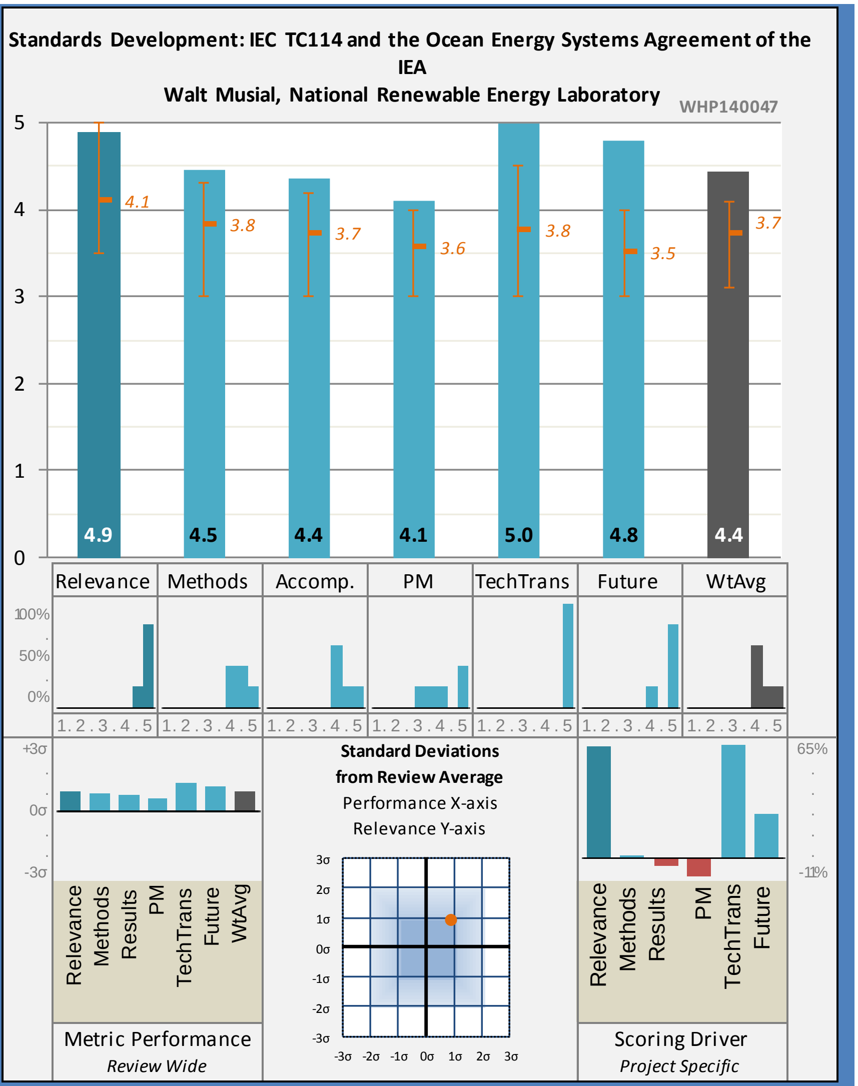
Panel:

Testing Infrastructure & Instrumentation

Budget:

$2,599,250 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.9** for its Relevance to water industry needs and overall DOE objectives.

- Very applicable to the advancement of the MHK industry.
- Compliance standards development is essential to MHK industry development, providing guidance to device developers, utilities, and regulators.
- US participation in international organizations will be critical to our country's ability to compete in this marketplace.
- This is important work and absolutely essential to the development of an MHK industry.
- International Standards - very important for US to be involved in this effort to make sure there are standards that are bankable and insurable and that US developers can compete internationally.

- International collaboration is essential to assure compatible US and international standards; essential to create global marketplace for US developers.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.5** on its methods/approach.

- Project method and approach is very well designed, building upon established international approach to standards development in mature electricity and marine industries.
- This Project funds participation in the committees, allowing the US to have "voices at the table."
- Well planned project.
- Providing leadership and technical expertise to development of standards and funding industry involvement - seems like a great approach and creates great opportunities for international collaboration in other areas.
- Developing standards that will be applicable internationally - not duplicative with IEEE.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.4** based on technical accomplishments and progress.

- This is a long-term project and process, but surprising near-term progress has been made.
- Participation in TC-114 TAG & IEA OES Annex V has been productive.
- Many standards already written or being written.
- Have made some limited progress to date but appear to have set the stage for development of standards in the future.
- Two workshops held. Annual report published.

Question 4: Project Management

This project was rated **4.1** on its project management.

- As meeting scheduling and participation is very regular and predictable, management efforts are minimal.
- Well executed project.
- Over 1.5 million spent so far - not a small amount. Not clear where all the money is going if support for industry is primarily expenses and small stipends but international travel is expensive. Worth looking at.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **5.0** for research integration, collaboration, and technology transfer.

- Important international work to assure high level participation and acceptance by nations.
- This Project basically defines "collaboration." The funding allows the US to be represented on international committees. The resulting standards comprise the "technology transfer."
- Tremendous international collaboration.
- That's what this is all about - international collaboration.
- Organized and held workshops, regularly updated website.

Question 6: Proposed Future Research

This project was rated **4.8** for proposed future research.

- The important work for setting standards in the MHK industry that must be maintained.
- Proposed future participation is anticipated.
- Continued work on standards is important.
- Important to continue to work to develop and set standards now that framework for involvement and decisions has been established.

Strengths and Weaknesses

Project Strengths

- Excellent feature to have website developed and maintained to publicize the products of the TAGs.
- The Project gives US National Labs, academics, and industry the ability to participate in international committees that are influencing the future of MHK.
- International collaboration.
- Strong and consistent outreach to MHK development community and electric power sector institutional actors to include key stakeholders.

Project Weaknesses

- This is an expensive effort, running in excess of $1/2M per year

Specific recommendations for additions or deletions to the work scope

- Assure that regulator community is fully briefed in US and international forums.
- DOE should continue to monitor this effort to assure that the US is well represented at a reasonable cost.
- Continue.

WHP140048

Project Title:

Advanced Turbulence Measurements Methodology Development NEW

Principal Investigator:

Robert Thresher

Organization:

National Renewable Energy Laboratory

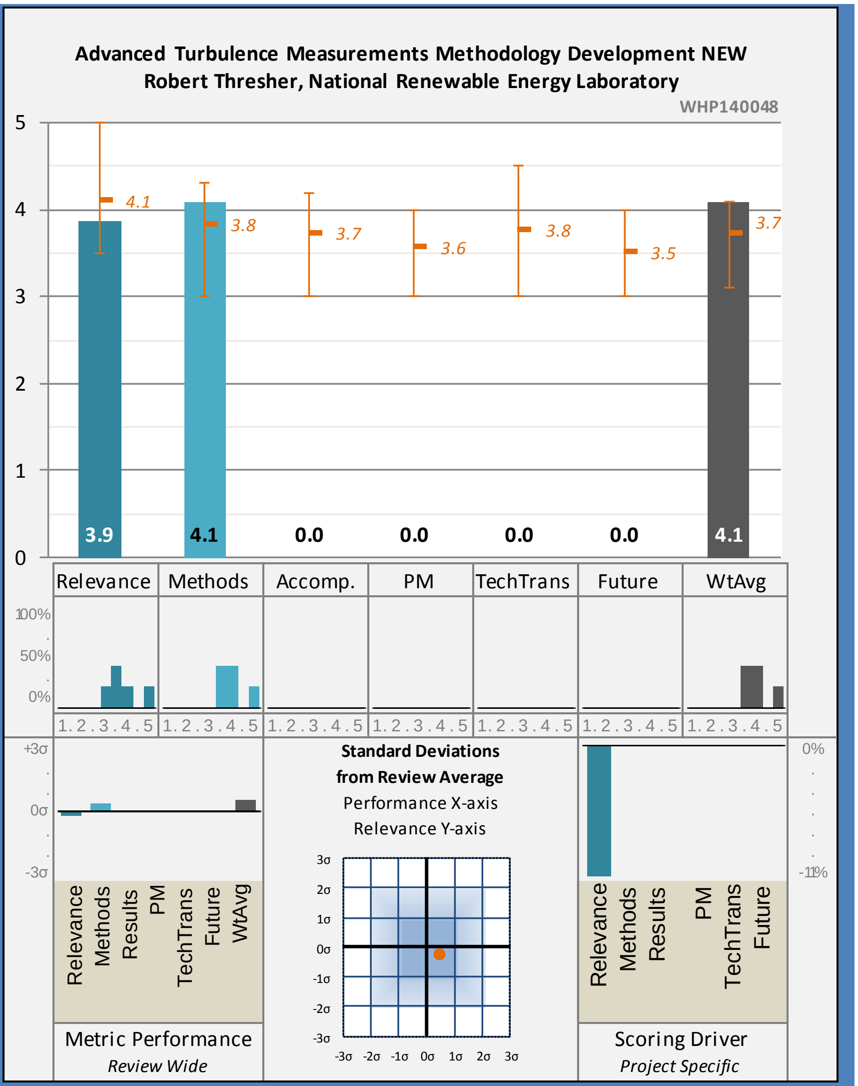
Panel:

Testing Infrastructure & Instrumentation

Budget:

$429,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.9** for its Relevance to water industry needs and overall DOE objectives.

- A cost-effective methodology that will help tidal development progress by identifying turbulence-induced fatigue.
- The MHK industry needs a reliable low cost method to accurately gauge tidal turbulence conditions at potential sites and to determine fatigue loading on devices. This project will address the spatial coherence parameter that does not have a low cost estimate technique, and will develop reliable instrumentation and measurement best practices measurement protocols.
- Having a standard method for measurement of turbulent flow that is applicable to various MHK systems is important to verification and validation of computational models.

- This turbulence-induced fatigue loading study is only helpful to turbine blades. And even for turbine blades, this seems to be a small potential problem when compared to other turbine issues.
- Collection of turbulence data using buoy system to help inform models and designs. Seems like useful information to industry but unclear how turbulence will change with the introduction of systems or even measuring devices in the water column.
- Companies are looking to the National Labs for determining what is important to consider in designs
- Provides wind experience to MHK industry partners.
- Future application in modeling - validating models that show wake turbulence - will be important to understand for array optimization.
- Good leverage of wind industry learning at National Labs.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.1** on its methods/approach.

- It is good to see they are using "off the shelf" devices (with slight modifications) to complete this work
- Dr. Thresher's 2 page Project Summary on Advanced Turbulence Methodology Development project gives a good basis for how the project approach builds upon the current state of research knowledge with regard to low cost estimation techniques for three other tidal turbulence parameters and carefully references research done to date to gather relevant data. Good leveraging of University of Washington tidal turbulence mooring research project and good planning to include PI Thompson from UW in the project. This was not clear from the Kilcher presentation alone.
- Use of COTS IMU/ADV pair seems to provide good measurements of turbulence.
- Well planned project.
- Seems like a good system design that will yield useful information. The concept of designing a low cost system for developers to use is good.

Strengths and Weaknesses

Project Strengths

- High value project objective, well-conceived plan, full use of existing research sources and centers of expertise.
- Provides MHK with experience that NREL has gained during Wind programs.
- Sophisticated experimental plan and instrumentation.

Project Weaknesses

- The public outreach and education component of the project appears weak in the written materials and presentation. Ramp up the focus on providing the end users to be benefited with the evergreen teaching system to support the estimation system and best practices.
- The Project languished for a full year, trapping financial resources.
- Limited usefulness.

Specific recommendations for additions or deletions to the work scope

- Add a component part that the researchers present not only at current MHK and academic conferences, but also create and post some innovative long distance learning options, such as a You Tube presentation or other lecture on NREL web site. Assure multiple postings of the product in open source websites sponsored by USDOE. "Push" to academic oceanographic centers for student training.
- Monitor the work closely to assure that adequate attention is being paid to it.

WHP140049

Project Title:

Marine and Hydrokinetic Testing Infrastructure Development NEW

Principal Investigator:

Jim Ahlgrimm

Organization:

DOE, (Multiple Projects)

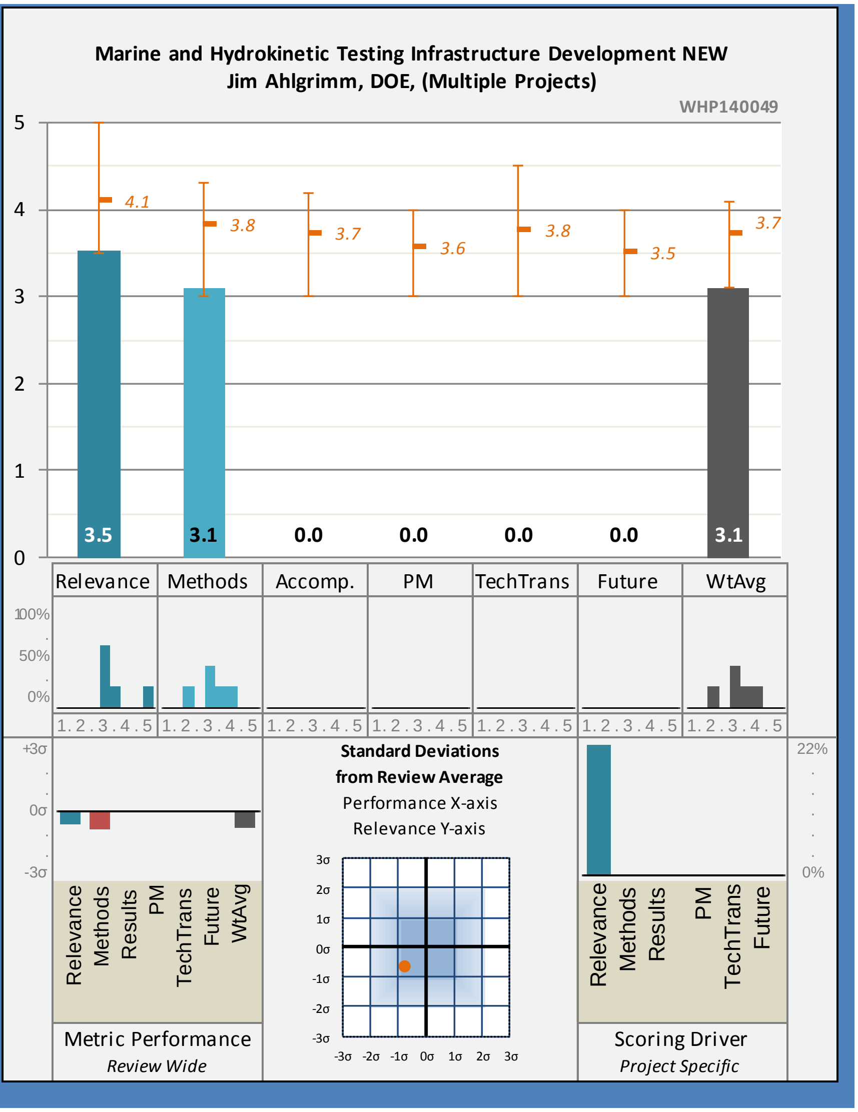
Panel:

Testing Infrastructure & Instrumentation

Budget:

$1,500,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.5** for its Relevance to water industry needs and overall DOE objectives.

- I question the need for a third wave energy test center. Those in Hawaii and Oregon are making great strides to developing these infrastructures - what would a third center do?
- The premise of the project is that the international MHK high energy test sites are fully booked, and that no privately permitted fully energized sites are large enough to accommodate multiple devices and, therefore, this additional initiative to develop a fully energized US site is needed. Agree that US MHK developers will need access to highly energized test site, but a careful business case analysis should be performed before creating one or more new test sites. Is it accurate that there is no access to international test site, or would it be cheaper for US to ask international site to expand for short period and support same? Experience to date is

that permitting of test sites has been extraordinarily expensive, slow, and difficult, so best to use existing assets if possible.

- The project appears to fill a gap, but there seems to be some disagreement as to whether a fourth test facility is needed at this time.
- This fully energetic wave energy test site will greatly benefit device developers.
- The concept of another test center is very interesting but I question spending this much money to look at 2 potential new test centers at this time. The HI center is just now opening and work continues to get PMEC-SETS open for business. Would want to see those fully utilized and a clear need for a third site before more money is spent on this. It could take a long time and a great deal of resources to develop, particularly at a new location.
- California site is based on PG&E's waveconnect project. Maybe there is potential to get PG&E re-engaged in this as an industry partner and develop as they originally intended for a commercial project that could be an interim test center. Doing something at existing site (OSU or HI) would seem to make more sense than starting another new test center.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.1** on its methods/approach.

- I would assume the money spent on the CA site would be better spent to develop either the OR or HI site
- Revise to require business case analysis of all existing highly energized test sites and why they are not sufficient to meet anticipated US developer demand.
- Fair and open competition is the only reasonable approach, but the lack of an independent cost assessment is a concern.
- Well planned FOA. Two excellent teams selected.
- Considerable amount of funding to pursue 2 new test centers when it is clear that at the most only 1 is needed. Would want to see clear need and interest from the development community for a new deep berth site before spending too much more on this.

Strengths and Weaknesses

Project Strengths

- Good idea to create competitive site design approach.
- Two well qualified teams are being funded.
- Selection of two separate teams makes it more likely that a good design will be obtained.
- OSU - Pacific Marine Energy Center South Energy Test Site.
- Cal Polytechnic State university, California Wave Energy Test Center (CalWave).

Project Weaknesses

- Need business case analysis to fully inventory options and costs of new US site, given history to date with test center permitting.
- The selection relies on contractors' estimates of cost.
- The selection process will cost $1.5M that could be put to better use in funding in-water demonstrations.

Specific recommendations for additions or deletions to the work scope

- Revise project plan to undertake business case analysis as first step before test sites develop their proposals.
- Carefully determine if there is greater need for near-term in-water demonstrations or for this facility.

- Continue.
- Prior to a final selection (if DOE chooses to move forward) assemble a team to develop an independent life cycle cost estimate for the test facility.

6.6 Resource Characterization

The geographies, resources, technologies, and even nomenclature of the U.S. marine and hydrokinetic technology industry have yet to be fully understood or defined. The program characterizes and assesses marine and hydrokinetic devices, and then organizes the collected information into a comprehensive and searchable Web-based database, the Marine and Hydrokinetic Technology Database. The database, which reflects intergovernmental and international collaboration, provides industry with one of the most comprehensive and up-to-date public resources on marine and hydrokinetic devices.

Table 6.6.1 lists the existing Resource Characterization MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.6.1 illustrates the standard deviation of scoring of the existing Resource Characterization MHK projects in relation to the scoring of all projects reviewed in 2014.

Addressing Comments for Resource Characterization

The MHK Peer Review Panelists recorded many useful and actionable comments during their review of the Office's Resource Characterization projects. These comments will be used to make key decisions and recommendations to those projects that will still be receiving continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy into the future.

Peer reviewer comments regarding current and new resource characterization projects focused on the extent to which these projects plan to tap into existing sources of resource data for waves, currents, and tides. Increased interagency and international collaboration along with greater industry involvement were also encouraged to more effectively develop MHK technologies. It is the intent of these projects to complement existing sources of public data, specifically for the purpose of developing the MHK industry. Resource characterization is an important part of the industry's ability to understand the potential for energy capture, loads, design requirements, and more. Though there is currently available public data on ocean conditions and resources, more often than not it was collected and/or recorded for purposes other than the development of MHK technologies. The resource characterization projects will take a look at this existing as well as new information through the lens of MHK development in order to contribute the most value to the industry as a whole.

Table 6.6.1 Existing Resource Characterization MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing MHK Projects			4.6	4.2	3.9	3.8	3.5	3.9	3.6	**3.8**
Existing Projects - Resource Characterization			5.0	3.9	3.7	4.0	4.0	4.0	2.5	**3.8**
Flowfield Characterization for Tidal Energy Sites	Marshall Richmond	Pacific Northwest National Laboratory	5.0	3.9	3.7	4.0	4.0	4.0	2.5	**3.8**

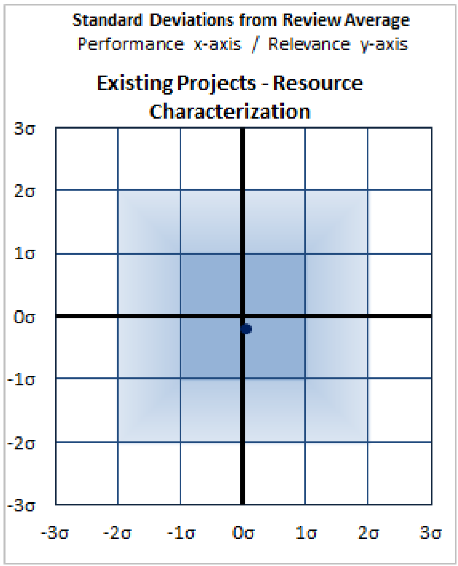


Figure 6.6.1 Existing Resource Characterization MHK projects

Table 6.6.2 lists the new Resource Characterization MHK projects that were reviewed during the 2014 Peer Review meeting. Figure 6.6.2 illustrates the standard deviation of scoring of the new Resource Characterization MHK projects in relation to the scoring of all projects reviewed in 2014.

Table 6.6.2 New Resource Characterization MHK projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Weighted Average Score
Average for Review			5.1	4.1	3.8	**3.7**
Average for all New Projects			5.2	4.2	3.8	**3.8**
Average for New MHK Projects			4.9	4.0	3.7	**3.7**
New Projects - Resource Characterization			5.0	4.4	4.2	**4.2**
DOD MHK Deployment Potential NEW	Mark Jacobson	National Renewable Energy Laboratory	5.0	4.4	4.2	**4.2**
Wave Environmental Characterization at Wave Test Sites NEW	Vincent Neary	Sandia National Laboratories	5.0	4.3	4.1	**4.1**

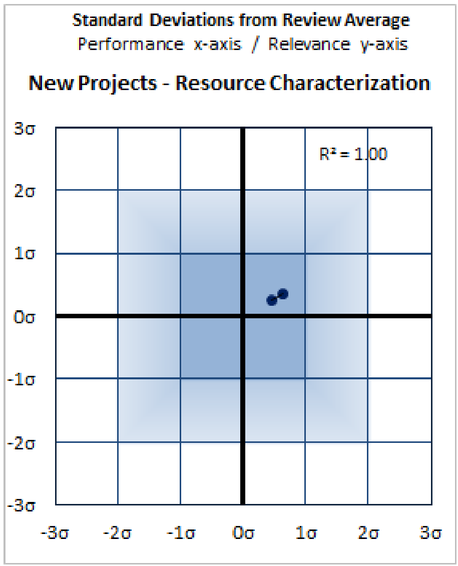


Figure 6.6.2 New Resource Characterization MHK projects

WHP140050

Project Title:

Flowfield Characterization for Tidal Energy Sites

Principal Investigator:

Marshall Richmond

Organization:

Pacific Northwest National Laboratory

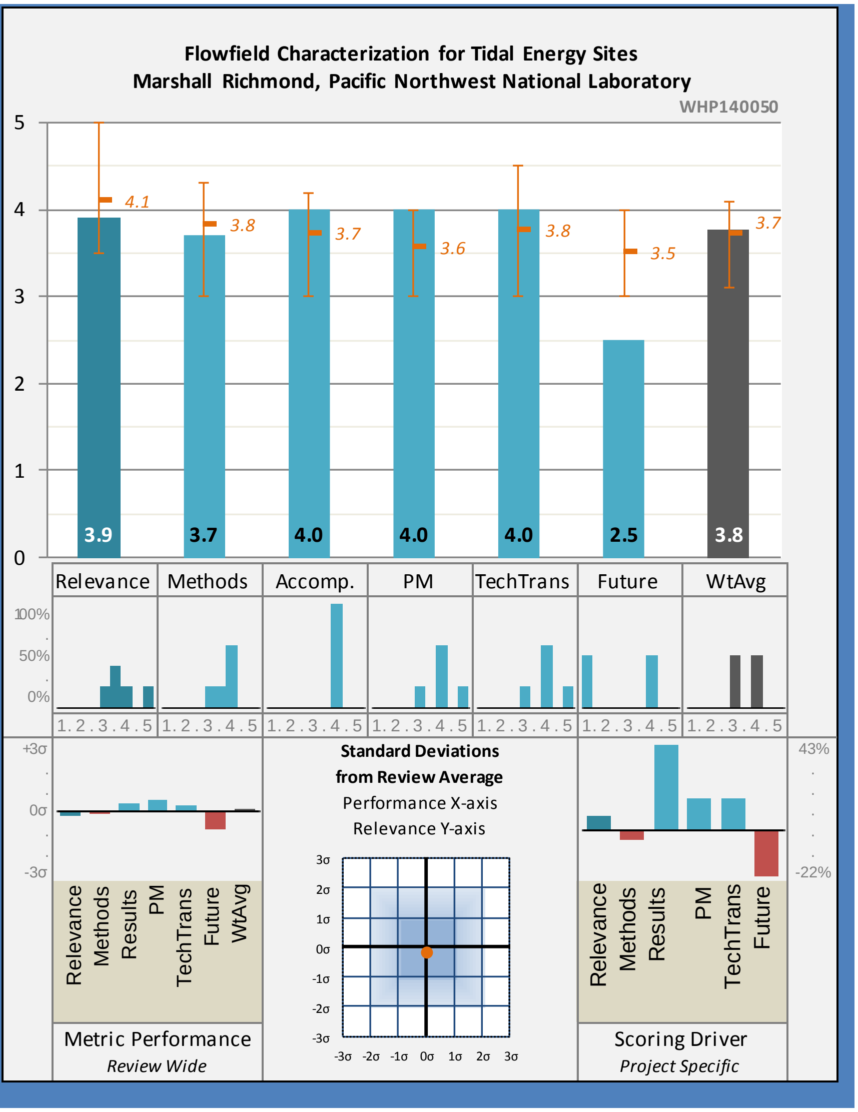
Panel:

Resource Characterization

Budget:

$300,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.9** for its Relevance to water industry needs and overall DOE objectives.

- Important for future project planning and siting, and overall industry growth, to obtain accurate detailed turbulence data and to develop standardized testing instrumentation and measurement methods.
- The project provides key test infrastructure for assessment of inflow conditions at MHK devices.
- This turbulence-induced fatigue loading study is only helpful to turbine blades. And even for turbine blades, this seems to be a small potential problem when compared to other turbine issues.
- Tidal turbulence measurements in Admiralty inlet using turbulence tripod and tethered moorings - seems like it will be useful "before" data that can be used to measure how operating device affects turbulence patterns. Also good data for validating hydrodynamic models.

- Helpful to develop best practices on which instruments to use to measure for rapid site characterization vs long term monitoring.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.7** on its methods/approach.

- A good example of using existing scientific equipment to achieve results.
- Not clear that the project approach will effectively tap all the international work on tidal characterization and measurement by MHK developers in UK and Europe, and by USACE, NOAA, and USN.
- The approach will provide operational experience with performance of existing instrumentation at MHK sites.
- Well planned project.
- Performing field measurements using a couple of different systems at 2 sites and over a range of tidal conditions.
- Measured turbulence intensity - came up with 10% number.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.0** based on technical accomplishments and progress.

- Good field data gathered.
- Development of mooring buoy device to gather data is helpful.
- PNNL has completed evaluation of instruments for characterization of flow.
- Valuable field data collected.
- Collected data that has been useful in understanding turbulence, validating models, and establishing methods for data collection.
- Development of more refined understanding of application of turbulence is essential to MHK device design, deployment and site selection decisions.
- Developed new mooring system that will be used in project described earlier.

Question 4: Project Management

This project was rated **4.0** on its project management.

- Work well done and completed.
- Not clear whether extensive prior research on these topics by USACE, NOAA and others will be fully captured with the project plan implementation.
- The project returned some funding due to underspending while staying on schedule.
- Well executed.
- Project has been going on for a few years but budget seems reasonable. Project largely complete now.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- A good example of a lab (PNNL) teaming with a university studying a proposed commercial tidal site (i.e., Snohomish County PUD's project area).
- The project needs to refine its efforts to tap prior and ongoing research in this area throughout the world and in US federal and academic centers.

- Good collaboration between 3 National Labs and the University of Washington has produced an impressive list of publications.
- Collaboration with academia and other labs.
- A number of labs and Univ of WA involved. Benefits industry project. A number of publications and presentations have resulted from this work.

Question 6: Proposed Future Research

This project was rated **2.5** for proposed future research.

- Work completed - results enables future research to be more focused and narrow down which instruments would be more effective for future sampling.
- Effort is transitioning to FMC.
- Project complete. Transitioning to Field Measurement Campaign projects 140008, 140009 and 140010.

Strengths and Weaknesses

Project Strengths

- Project provided a key test infrastructure that is being transitioned to the FMC.

Project Weaknesses

- None.
- Limited usefulness.

Specific recommendations for additions or deletions to the work scope

- USDOE should emphasize the requirement of leveraging existing research as part of application process for this type of broad characterization study.
- NA, the effort will be covered under the FMC.

WHP140051

Project Title:

DOD MHK Deployment Potential NEW

Principal Investigator:

Mark Jacobson

Organization:

National Renewable Energy Laboratory

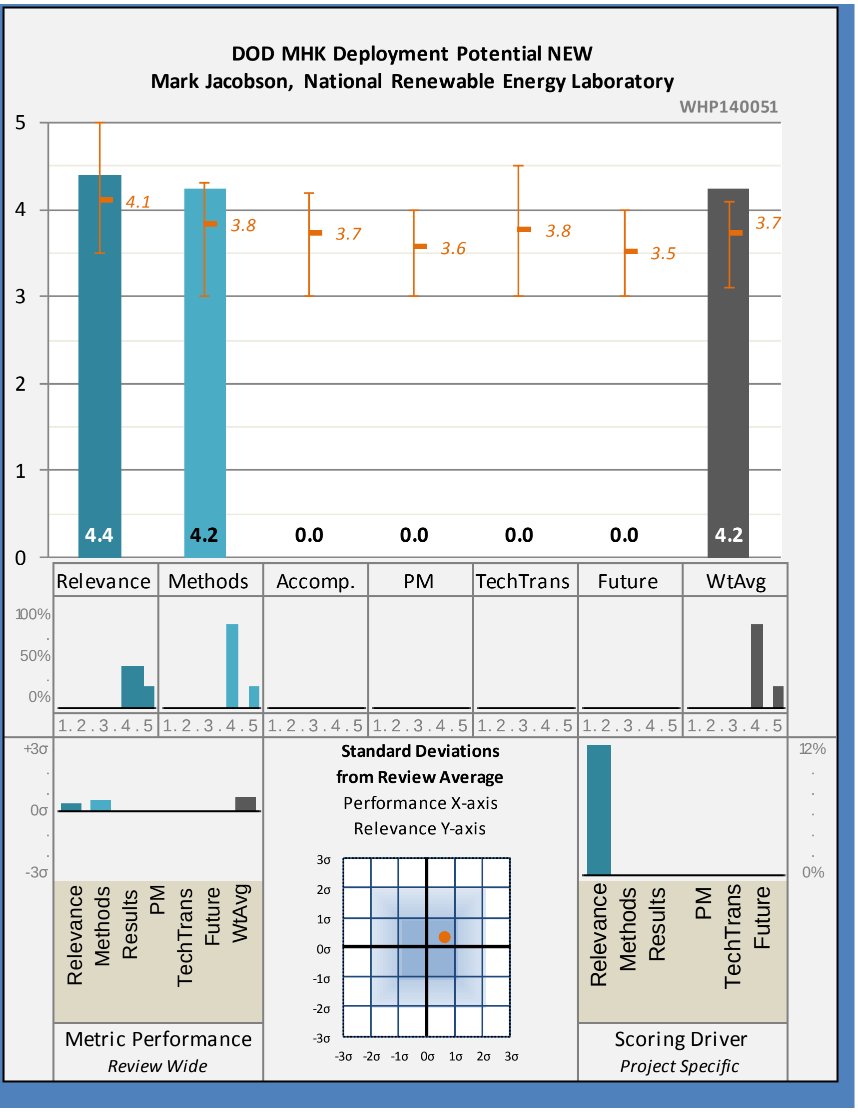
Panel:

Resource Characterization

Budget:

$325,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.4** for its Relevance to water industry needs and overall DOE objectives.

- The Navy (and DOD as a whole) is an extremely valuable partner that would enable the MHK industry to advance.
- Great cooperative effort with DOD to meet DOE's MHK objectives and DOD objectives, creating a white paper with rank order of potential high value MHK deployment sites within DOD naval installations.
- The Project has made an important contribution by studying the potential for MHK resource deployment at DOD sites.
- This work will mainly benefit the Navy. Advantage to industry is indirect.

- Screening DOD sites looking for potential resources for tidal, wave, and ocean current viability for project development - this could help identify sites that the Navy could work with private developers to install commercial projects. Maybe easier regulatory process on naval sites.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.2** on its methods/approach.

- Excellent project design, making use of available data and expert personnel within DOD and NREL.
- Conducting a survey of downselected military bases is a very reasonable approach.
- Well planned project.
- Looking at 7 Navy sites, restricting information to others due to potential sensitivity.
- Focused on US - 70 layer GIS used as screening/search tool.
- Downselected to 10 sites (7 actually chosen).

Strengths and Weaknesses

Project Strengths

- Great DOE-DOD cooperation and sharing of resources and tapping NREL expertise for planning purposes.
- DOD bases represent a potentially useful site for in-water demonstrations.
- Strong collaboration with Navy.

Project Weaknesses

- Low priority for international sites may need to be revisited, as may provide easiest deployment path forward in light of permitting requirements and costs at US bases.
- There is minimal downside risk to evaluating DOD bases as potential MHK sites.

Specific recommendations for additions or deletions to the work scope

- Exploring possibility of cooperation with DOD to locate a high energy test site in DOD facility makes great sense, given the success of Hawaii effort.
- Monitor the project and make sure that resources are not spread so thin that this effort interferes with other in-water demonstrations.
- Continue.

WHP140052

Project Title:

Wave Environmental Characterization at Wave Test Sites NEW

Principal Investigator:

Vincent Neary

Organization:

Sandia National Laboratories

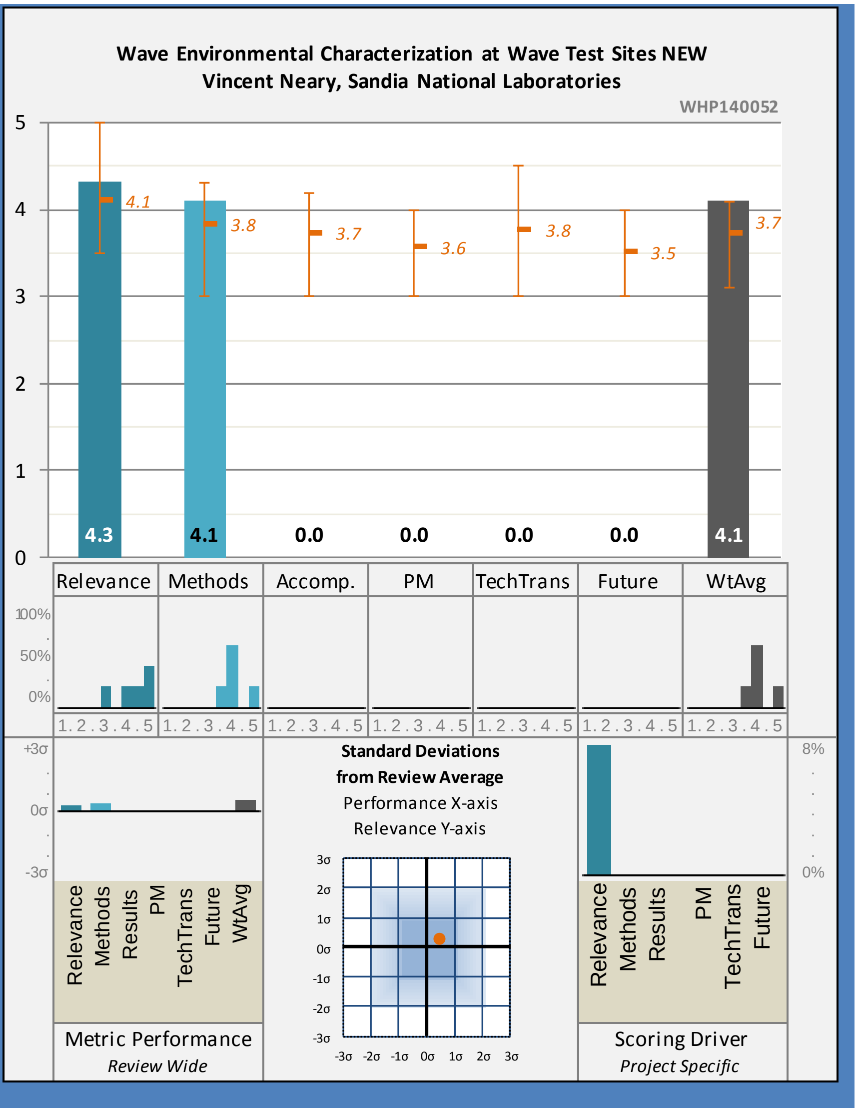
Panel:

Resource Characterization

Budget:

$300,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.3** for its Relevance to water industry needs and overall DOE objectives.

- Provides a uniform test approach at various wave sites.
- Catalogue of wave resource characterization at Tier 1 level and development of a framework for wave classification will be helpful to advance site selection and device planning by device manufacturers
- The Project is developing a standard classification system for characterizing the potential of a given site
- Characterizes wave climate at the various wave energy test sites. This information will be extremely helpful to the planning efforts of wave energy converter developers.
- Wave energy characterization at wave energy test centers - getting consistent information on test centers to supply to developers.

- Wave classification system development is discussed as an objective but it won't be a product of this effort and in my opinion it does not really fit this effort. A wave classification system seems like something that should be developed by international standards group and shouldn't be strictly US based or derived only from test center wave regimes.
- Information that will result from this study will assist WEC developers as they choose which site/time frames they want to test devices in - this should be useful for developers.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.1** on its methods/approach.

- Working closely with both private industry (i.e., Columbia Power) and the wave test centers to refine this approach.
- Good approach to focus on planning coordination with test centers and outreach to private sector to determine needs of industry.
- The Project is putting existing data from past efforts to good use.
- Standard wave resource classification system.
- Leveraging existing work and not reinventing wheel is very positive.
- Leveraging information from NMRECs.
- consistency in order to directly compare sites.
- Common display of data, including wave power plots.
- This information can be used to estimate power outputs for grid connected devices - could be useful for developers in assessing potential electricity revenue that could result from test deployment.
- Weather window information is very important to the operation of a test site.

Strengths and Weaknesses

Project Strengths

- Will characterize and facilitate access to wave resource at 3 Tier 1 wave sites, including the Hawaii and Oregon test sites, advancing the WEC device commercialization work at those sites. This is a near term deliverable of concrete value.
- The Project will eventually allow Developers to select sites in a consistent manner.
- Will produce data that is absolutely essential for any company considering using one of the wave energy test sites.
- Collaborating with test centers.

Project Weaknesses

- Not clear what the existing wave classification systems of academic and defense research are not adequate for WEC developer use, and not clear how even the initial steps toward wave classification envisioned by this project, or the follow-on more detailed wave characterization work, will build upon the enormous existing body of knowledge developed by expert centers. A literature search is the only planned connection.
- No Industrial Partners are included in the study to assure that the wave characterization system is useful to them.
- This project has a certain "Not Invented Here, So Doesn't Exist" mindset.

Specific recommendations for additions or deletions to the work scope

- Strongly encourage USDOE to require the project to reframe its approach and to do active outreach on national sources, including USN, USACE, NOAA and other centers of learning within federal government, as well as physical oceanographic centers of excellence, as well as other international centers of excellence on wave studies to determine what research and characterization research has been done or is in process, and whether that is sufficient for the planned wave characterization objective for MHK developers. Where possible, include federal partners or other academic research experts in the project. The planned outreach to USN to begin a partnership appears to be in the context of site characterization at Hawaii site.

- Suggest that Industrial Partners be exposed to the results of this project.
- Continue.

7.0 Hydropower Panel Results and Individual Project Evaluations

Ice Harbor Dam - Low Snake River
http://images.nrel.gov/viewphoto.php?imageId=6315789

The Water Power Program's hydropower research and development (R&D) efforts focus on advancing technologies that produce electricity from falling or flowing water. For more than 100 years, hydropower has been an important source of flexible, low-cost, and emissions-friendly renewable energy. The program is currently leading efforts to increase the generating capacity and efficiency at existing hydropower facilities; add hydroelectric generating capacity to non-powered dams; and improve the environmental compatibility of hydropower.

For the purposes of the 2014 Peer Review, Hydropower projects were organized into the following four technology panels: Existing Hydropower, New Hydropower Development, Pumped-Storage Hydropower and Integration, and Market Acceleration and Deployment. Each panel was further split into “existing” and “new” categories. Existing projects are those that received funding in FY2012 and FY2013. The new projects are those that were most recently awarded (FY2014). The existing and new populations were used for the comparative statistical analyses that were conducted on the quantitative evaluations submitted by the panelists.

Figure 7.0.1 illustrates funding levels based on “new” and “exiting” Hydropower projects while figure 7.0.2 shows funding levels based on the Hydropower technology panels that were reviewed in 2014. The funding levels in these figures span budgets from multiple years.

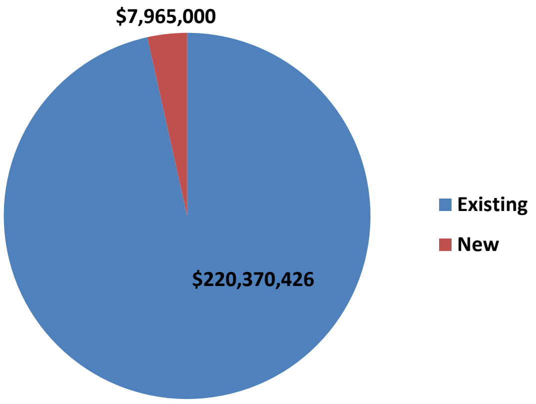


Figure 7.0.1 Funding for new and existing Hydropower projects

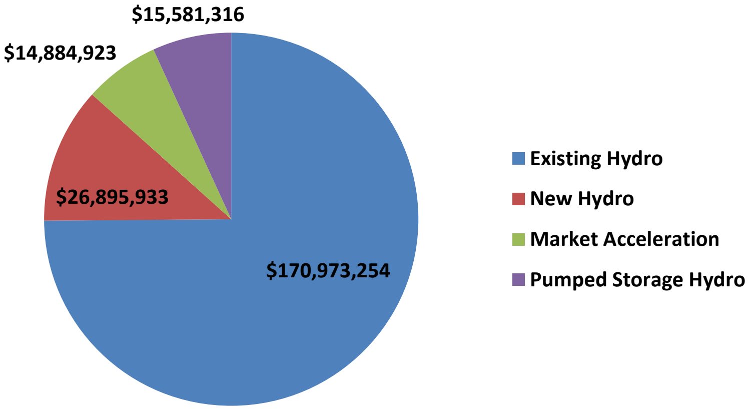


Figure 7.0.2 Funding based on Hydropower technology panels

Figure 7.0.3 illustrates the weighted average overall scores and the relevance to Water industry needs and overall DOE objectives scores for all existing Hydropower projects that were reviewed.

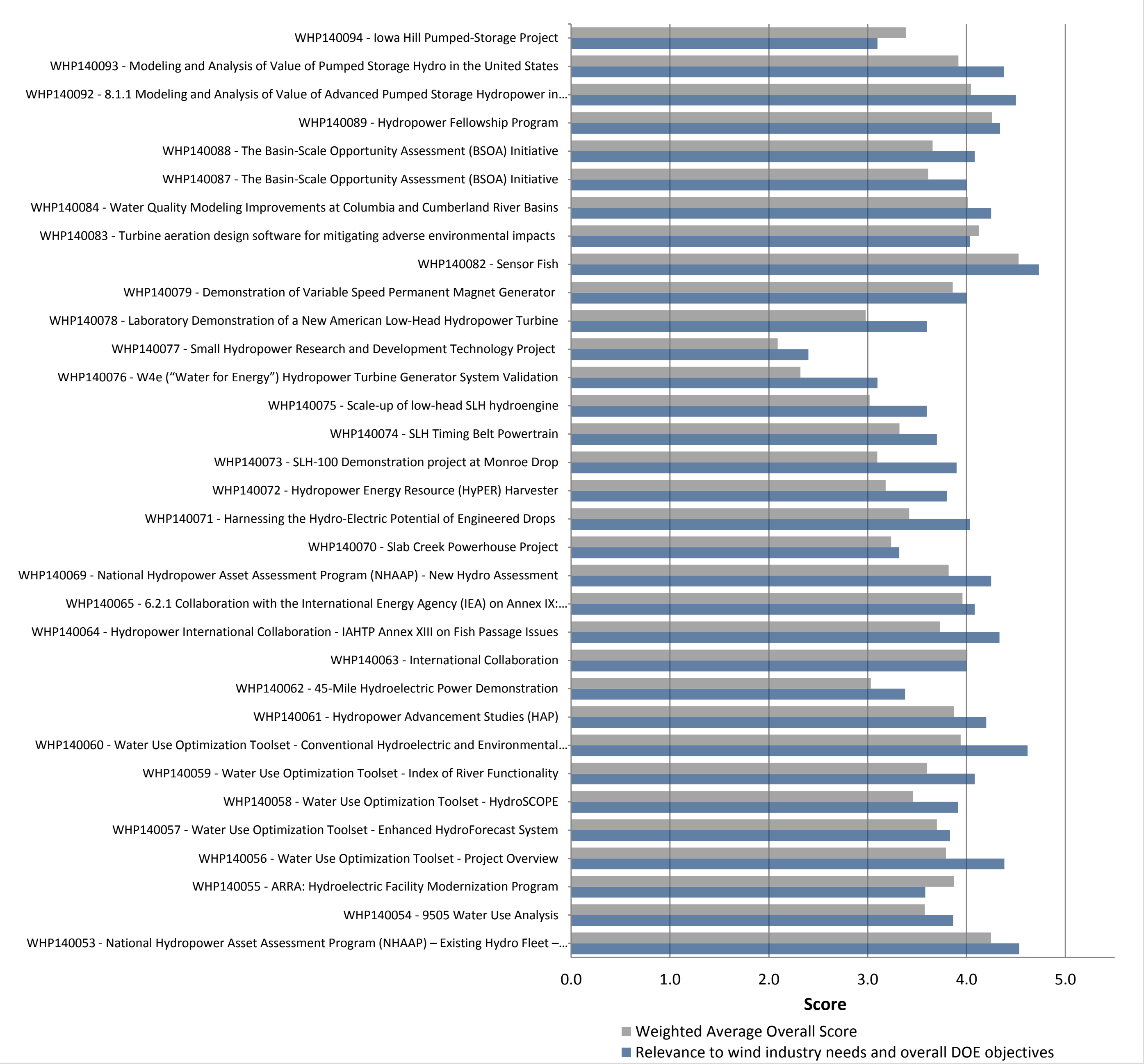


Figure 7.0.3 Relevance and weighted average overall scores for all existing Hydropower projects

Figure 7.0.4 illustrates the weighted average overall scores and the relevance to Water industry needs and overall DOE objectives scores for all new Hydropower projects that were reviewed in the 2014 Water Power Peer Review.

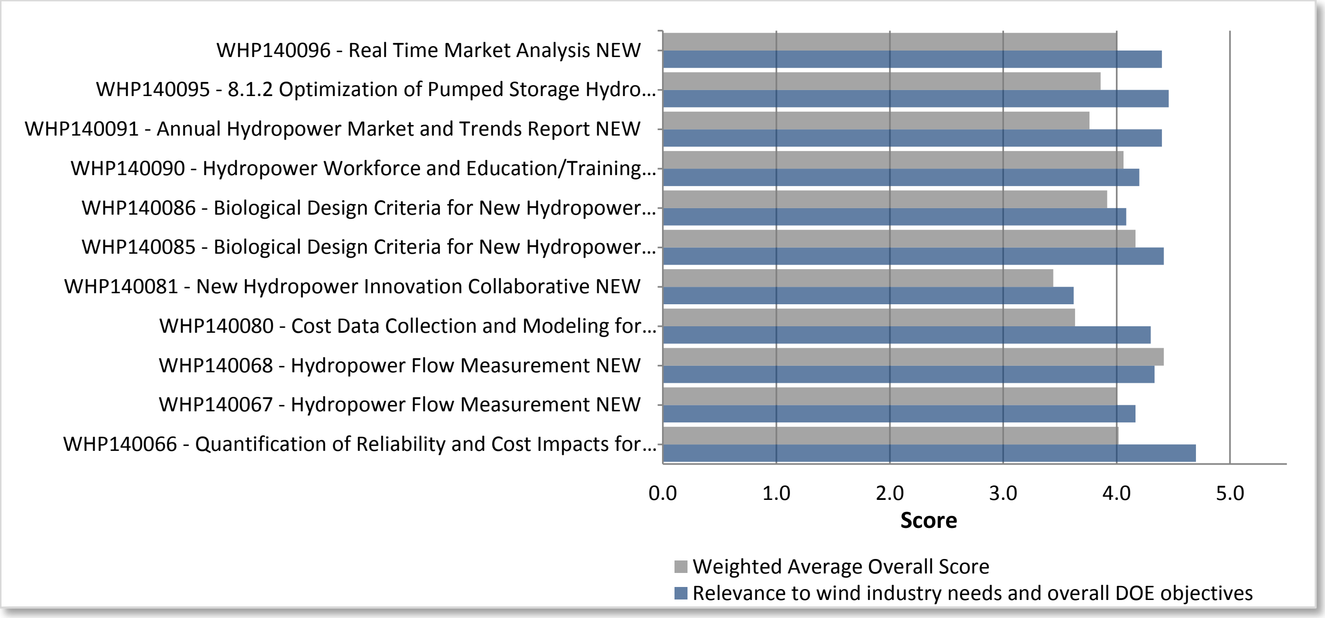


Figure 7.0.4 Relevance and weighted average overall scores for all new Hydropower projects

Individual Hydropower project evaluations, including scoring results and detailed verbatim comments from the panelists, are included in the following technology panel sections.

7.1 Existing Hydropower

The Water Power Program helps industry harness this renewable, emissions-friendly resource to generate environmentally sustainable and cost-effective electricity. Through support for public, private, and nonprofit efforts, the Water Power Program promotes the development, demonstration, and deployment of advanced hydropower devices and Pumped-Storage Hydropower applications. These technologies help capture energy stored by diversionary structures, increase the efficiency of hydroelectric generation, and use excess grid energy to replenish stored water reserves for use during periods of peak electricity demand. In addition, the Water Power Program works to assess the potential extractable energy from domestic water resources to assist industry and government in planning for our nation's energy future.

Addressing Comments for Existing Hydropower

The Hydropower Peer Review Panelists recorded many useful and actionable comments during their review of the Office's Existing Hydropower projects. These comments will be used to make key decisions and recommendations to those projects that will still be receiving continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy for the future.

It was particularly encouraging to read that, in relation to most of the recently initiated Existing Hydropower projects, Peer Review Panelists had relatively positive comments regarding the scope, intent, and value of these new projects. Holistically, these new projects received relatively high scores regarding their relevance to industry needs. Many of the key observations made by Panelists refer to incorporating end-users into the scoping process early on in the project development lifecycle to ensure the appropriate level of value transfer to industry. The Program fully intends to incorporate this feedback into its project planning process.

Several comments focused on the difficulty of conducting broad industry-wide studies on issues that may be very site or situation-specific, such as flow measurement and quantification of reliability and cost impacts for hydropower assets. DOE plans to actively engage industry in these studies, and has already begun forming partnership with industry groups to solicit feedback and ensure maximum value to the broader industry. In addition, the DOE has a role to fund high-risk, high reward projects that may not be conducted solely by the private sector, and transfer those results to hydropower owners and operators. These projects fit that description, as recognized by the high “relevance” score provided by the panelists. However, DOE will take steps to ensure these projects do not take unnecessary risks and produce results that are useful to and vetted by the hydropower industry.

Another set of comments received from the Hydropower Peer Review Panelists in the area of Existing Hydropower projects focused on the extent to which any of the results or products of any given project can be successfully transferred to other stakeholders within the hydropower industry. DOE places a strong priority on technology transfer, and has integrated technology transfer components within the project management deliverables for each of these projects, while protecting any proprietary data contained within the datasets or models. To achieve this goal, the DOE has been actively engaged with industry through a variety of avenues, including partnerships with industry groups such as CEATI, EUCI, and NHA, which comprise the majority of hydropower ownership in the United States. In addition, the DOE is actively leading the Hydropower Vision Project, where existing data will be vetted from industry experts and additional data solicited to improve tools.

Based on this feedback, the Office will, in the future, more carefully weigh the value of projects to ensure maximum value for the broader hydropower industry. Modeling capabilities will be given close scrutiny to ensure that there is an end-goal in sight, and that the tools are developed with greater levels of industry input and involvement throughout all stages of the model development. DOE’s recent forming of industry partnerships demonstrates a commitment to ensuring this takes place.

Table 7.1.1 lists the existing Hydropower projects that were reviewed during the 2014 Peer Review meeting. Figure 7.1.1 illustrates the standard deviation of scoring of those projects in relation to the scoring of all projects reviewed in 2014.

Table 7.1.1 Existing (FY 2012 and FY 2013) Hydropower Panel projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing Hydropower Projects			5.5	4.0	3.7	3.6	3.6	3.7	3.4	**3.6**
Average for Existing (FY 2012, FY 2013) Hydropower Panel Projects			5.8	4.1	3.8	3.7	3.7	3.9	3.6	**3.8**
National Hydropower Asset Assessment Program (NHAAP) – Existing Hydro Fleet – Database and Analyses	Shih-Chieh Kao	Oak Ridge National Laboratory	6.0	4.5	4.2	4.3	4.4	4.0	4.1	**4.2**
International Collaboration	Brennan Smith	Oak Ridge National Laboratory	5.0	4.0	4.5	3.7	3.7	4.3	3.9	**4.0**
6.2.1 Collaboration with the International Energy Agency (IEA) on Annex IX: Hydropower Services	Vladimir Koritarov	Argonne National Laboratory	6.0	4.1	3.8	4.1	4.0	4.0	3.9	**4.0**
Water Use Optimization Toolset - Conventional Hydroelectric and Environmental Resource Systems	Tom Veselka	Argonne National Laboratory (Lead)	6.0	4.6	4.3	3.8	3.5	4.3	3.9	**3.9**
ARRA: Hydroelectric Facility Modernization Program	Multiple	Multiple Projects	6.0	3.6	4.0	4.2	4.3	3.0	2.5	**3.9**
Hydropower Advancement Studies (HAP)	Brennan Smith	Oak Ridge National Laboratory	6.0	4.2	3.8	4.0	4.0	4.2	3.4	**3.9**
Water Use Optimization Toolset - Project Overview	John Gasper	Argonne National Laboratory (Lead)	6.0	4.4	3.8	3.7	3.6	4.3	4.0	**3.8**
Hydropower International Collaboration - IAHTP Annex XIII on Fish Passage Issues	Simon Geerlofs	Pacific Northwest National Laboratory	6.0	4.3	3.8	3.6	3.6	4.1	3.9	**3.7**
Water Use Optimization Toolset - Enhanced HydroForecast System	Mark Wigmosta	Pacific Northwest National Laboratory	6.0	3.8	3.7	3.8	3.6	3.9	3.7	**3.7**
Water Use Optimization Toolset - Index of River Functionality	John W. Hayse	Argonne National Laboratory (Lead)	6.0	4.1	3.7	3.5	3.6	3.7	3.6	**3.6**
9505 Water Use Analysis	Shih-Chieh Kao	Oak Ridge National Laboratory	6.0	3.9	3.4	3.3	3.8	4.2	3.8	**3.6**
Water Use Optimization Toolset - HydroSCOPE	Thomas S Lowry	Sandia National Laboratories	6.0	3.9	3.6	3.3	3.3	3.9	3.5	**3.5**
45-Mile Hydroelectric Power Demonstration	Jim Gordon	Earth by Design	5.0	3.4	3.2	3.0	2.9	3.0	2.8	**3.0**

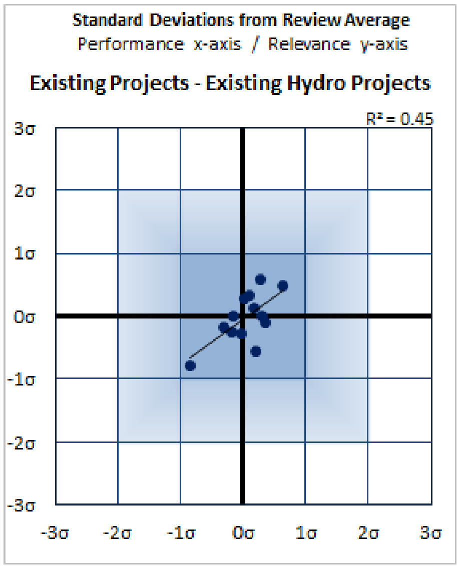


Figure 7.1.1 Existing (FY 2012 and FY 2013) Hydropower Panel projects

Table 7.1.2 lists the newly-funded Hydropower projects that were reviewed during the 2014 Peer Review meeting. Figure 7.1.2 illustrates the standard deviation of scoring of those projects in relation to the scoring of all projects reviewed in 2014.

Table 7.1.2 Newly-funded Hydropower Panel projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Weighted Average Score
Average for Review			5.1	4.1	3.8	**3.7**
Average for all New Projects			5.2	4.2	3.8	**3.8**
Average for New Hydropower Projects			5.5	4.3	3.9	**3.9**
Average for Newly-funded “Existing” Hydropower Projects			6.0	4.4	4.1	**4.1**
Hydropower Flow Measurement NEW	Marshall Richmond	Pacific Northwest National Laboratory	6.0	4.3	4.4	**4.4**
Quantification of Reliability and Cost Impacts for Hydropower Assets – NEW	Brennan Smith	Oak Ridge National Laboratory	6.0	4.7	4.0	**4.0**
Hydropower Flow Measurement NEW	Brennan Smith	Oak Ridge National Laboratory	6.0	4.2	4.0	**4.0**

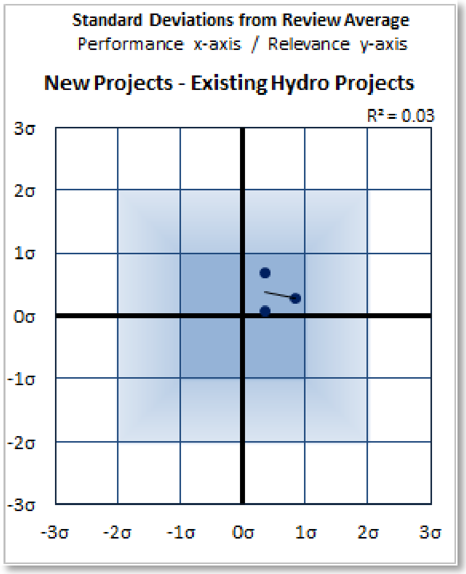


Figure 7.1.2 Newly-funded Hydropower Panel projects

WHP140053

Project Title:

National Hydropower Asset Assessment Program (NHAAP) – Existing Hydro Fleet – Database and Analyses

Principal Investigator:

Shih-Chieh Kao

Organization:

Oak Ridge National Laboratory

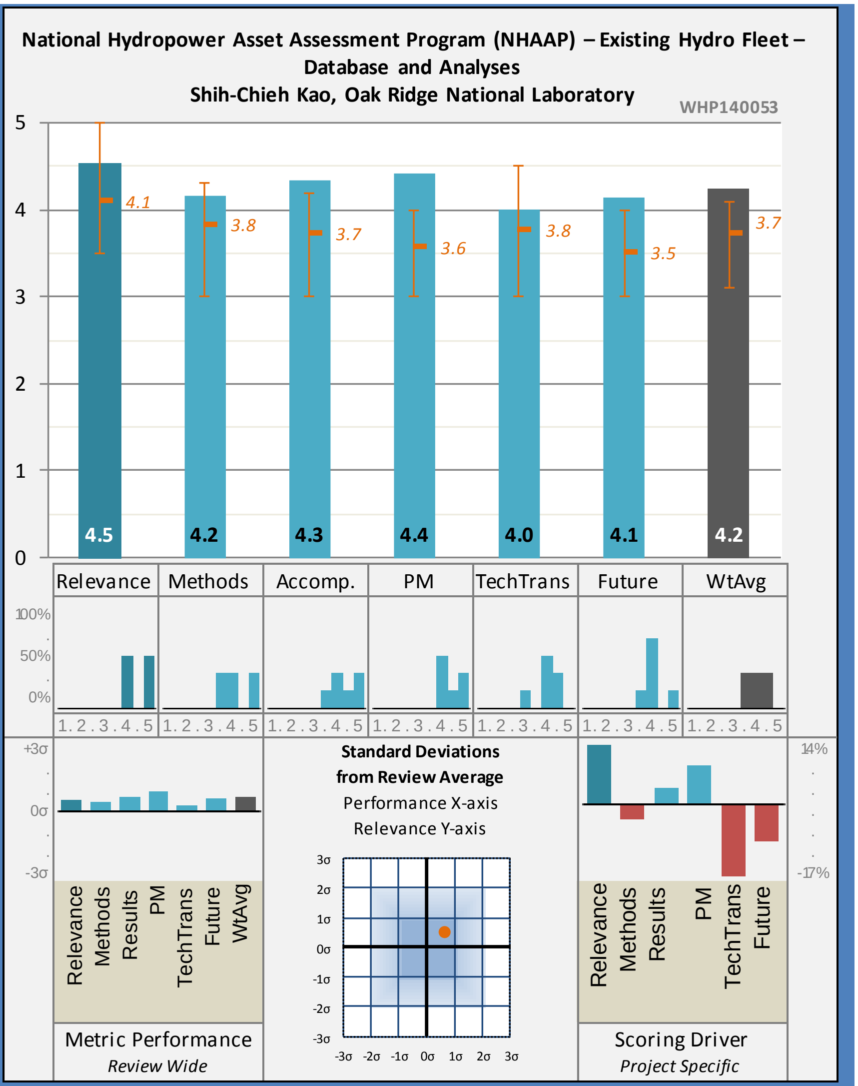
Panel:

Existing Hydro

Budget:

$1,850,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.5** for its Relevance to water industry needs and overall DOE objectives.

- Critical to success of Water Power program – foundational.
- The existence of the NHAA Existing Hydro Fleet Database is important in principle, certainly to guide DOE in the research agenda and of use for informing policy (potential use to executive and legislative branches). The main use to date seems to be support of DOE R&D efforts. Although the DB is accessible to the public, it may be of limited use for market acceleration due to lack of detail for specific sites, lack of cost/financial information. Also, use for R&D by the public and academic sectors is limited as well.

- It is not clear why the confidential information is being collected when it will be difficult to make the information publicly available. If this is true, would a partial set of data on the existing hydro fleet is still useful in performing planning studies.
- There is value in understanding the existing hydro assets and the environmental challenges but also need to do more to highlight the environmental benefits associated with each one.
- Critical information for future development of hydro and management of assets.
- This is a great project. It is important for DOE to continue to develop this program for USA hydropower development. But it is recommended that the scope be limited to highest priority information and results that are significant and can be predicted with relatively high degree of confidence. The scope should be limited to address specific objectives with guidance by developers, including their consultants. The return on investment would be greatest with wide-spread use by developers and Federal, State, and local governments that develop hydro projects.
- To address the objective of reducing deployment barriers data is needed that goes beyond environmental impact / ecosystem information. In many or most locations in the US, dams have multiple purposes that often conflict with generation, e.g., supply, flood control, etc. Information about these uses are necessary in considering potential hydropower development.
- Database needs to include planned capacity additions, refurbishments, efficiency improvements, major planned outages (multiyear), retirements, transmission and interconnection limitations, etc.
- Basis for further investigation of environmental attributes.
- I reviewed the water quality information that is provided through the public portal, and I found references only to 303d list information. Using only 303d listings for identifying water quality issues for hydro projects would be misleading for broad-scale assessments. Information that is useful includes water quality data (sources: BASINS 4.1 and STORET), water quality criteria, NPDES permits, wasteload allocation models, watershed studies and management plans, and monitoring programs. Models are available to predict changes in water quality due to new hydro as well as other waterway uses. The main water quality issues facing hydro are identified through obtaining State 401 Certificates, so emphasis on these requirements is an important consideration for every dam.
- Most of the Hydro fleet is meant to capture energy incidental to water delivery obligations, and that should be reflected in the dataset. So, Residual Capacity and Operating Availability could be assessed as that data get to be used.
- Addresses need for a more common representation of data for future analysis of power facilities, resource assessments, and integration.
- In the design of the dataset, the utility value of the collected data and granularity of the data need to be kept at the level that the intended user would need to conduct future research or studies.
- Question: does non-[powered dam assessment contain any sensitivity to potentially reduced flows due to climate change.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.2** on its methods/approach.

- Continual updating of data is important.
- Good contributions in terms of establishing standard formats for the hydropower data and cross-referencing. More information about use of metadata would be useful for this evaluation.
- The approach was not clear, as the presentation was not focused on developing the dataset but rather on the NHAAP program as a whole.
- Environmental attributes - Is it intended to highlight environmental and societal benefits also? Too often, the benefits of reservoirs are ignored and "not mapped". These reservoirs mitigate billions of dollars in flood damage, provide drinking water supplies and water for aquatics during severe droughts, store water for

recreation releases, access areas and parks, provide fishing, skiing, etc. etc. etc. Better educating the public on the benefits would help them make more objective assessments of the cost/benefit balance for hydropower projects, especially when comparing hydro to other choices of generation, their challenges, and benefits.

- Logical approach starting with resource assessments, base layers for existing facilities with provisions for more detailed owner proprietary information.
- The methods applied to this project are very good overall for hydropower planning studies...the most advanced studies ever undertaken, applying advanced computer modeling to highly variable hydraulic, aquatic life, and water quality systems and providing the best available information attainable providing significant access to information and data for existing and new hydro projects across the country.
- Need to continually validate.
- There are many complex issues that may not have yet been addressed: For sensitive data, there is a need for carefully structured and managed multi-level access. It would be useful to include all data that constrains hydropower development including other uses of water in addition to environmental services.
- Non-disclosure: need consistent policy and cooperation of private utilities. It may be possible to present sensitive data in an aggregated form or other mechanisms to be useful.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.3** based on technical accomplishments and progress.

- Impressive progress. Keep sharp focus on this.
- Much data has been collected, the data formats have been developed, dynamical updating procedures have been developed, very nice web access.
- Solid information compilation for existing hydro.
- Started in 2010. Good, orderly progress consistent with resources available.
- Reports have been produced, the models and model applications have been demonstrated, model inputs have been developed building on what other agencies have produced in a cooperative effort integrating all the work and inputs. The modeling system can address challenges to hydropower development. Much has been learned through the work completed to date. The end products have been very useful for DOE applications as well as to other agencies.

Question 4: Project Management

This project was rated **4.4** on its project management.

- Progress to date indicates good PM. Don't back off. This is a critical project that needs to be maintained and expanded.
- This sizable project is on time or ahead of schedule and on budget.
- Good compilation of background data.
- Excellent project management is evident by reviewing the accomplishments; the models developed and documented reports, and meetings with those outside DOE.
- Not sure what is intended by "supply chain analysis" but want to be wary of roads that can lead to lots of project costs but with little general benefit.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- Good collaboration in data acquisition. Need to do more outreach to advise industry, academia, and environmental communities of availability of information.
- Good collaboration with all major public hydro entities and FERC. Ultimate success will depend on cooperation of private utilities as well with NDAs.
- Good extraction/compilation of information from multiple databases.
- Connection with federal and private owners of the federal hydropower fleet.
- I think this project serves as a great example of research integration and collaboration. The public portal for providing information is good, but needs review by likely users of this modeling system, e.g., the "water quality" inputs point addressed under Q1.
- Need to loop in other federal resource agencies involved in hydro - FWS, NMFS, USFS, etc.
- Use of academic institutions for assistance seems ok; we have no way to evaluate the efficacy.
- User support is important (presentation claims this advice is available).

Question 6: Proposed Future Research

This project was rated **4.1** for proposed future research.

- Need to keep this up-to-date.
- Continued development and support of this effort by DOE is of paramount importance. Future funding is not yet proposed.
- Suggest compilation of positive "environmental attributes" in addition to the issues that are often framed, or attempted to be framed, as negatives against hydro (ESA issues, GHG, etc.). This suggestion has recently been submitted and will be followed up by DOE.
- Evaluation of economic and environmental benefits of existing fleet needed.
- The "Next Steps and Future Research" are good next steps; I would encourage 1- to 3-day workshops for training developers and/or their consultants.
- Focus on improving quality of key data as a priority over adding less valuable layers.
- Need to develop and coordinated future project plan.
- I see diminishing return on investment going forward. Mitigation, especially for water quality requirements, depends on site-specific considerations that are not well-developed until developers show they can predict water quality related to new hydro, including effects of regulations and operations. Aeration systems can result in excessive TDG levels under site-specific conditions for inflowing water as well as turbine system design. Perhaps a tiered process could be developed to first characterize water quality and then as the design advances and water quality requirements are defined, mitigation could be considered.

Strengths and Weaknesses

Project Strengths

- Foundational to industry policy makers.
- Addresses a great need and potentially very useful. Technological approaches seem advanced and maintainable. Much progress has been made and strong collaboration with other agencies is key to future benefits.
- Useful accumulation of data sources.
- This is foundational to the hydropower industry. Good first steps to putting together data for existing hydro fleet.
- Will be very useful for future analysis and investigation.
- Good collaboration with hydropower industry.
- Commitment to keeping database updated.

Project Weaknesses

- Data can be used by hydro opponents -- be thoughtful on what is presented and how it's presented
- May not contain enough or right kinds of data to be really useful. Need to identify uses more specifically to "test" usability. Plan for sensitive data and levels of access should be developed.
- More should be done to transfer use of the modeling system to the private sector==> to developers and/or their consultants
- Improve non-federal outreach and outreach to non-hydropower stakeholders.
- Have not have captured non-federal fleet as fully as federal fleet.
- Protection of confidential information.

<u>Specific recommendations for additions or deletions to the work scope</u>

- Very important to protect confidential and critical energy infrastructure information.
- DOE should continue to support this effort in future.
- Look at cataloging the positive attributes of particular hydro locations and assessing what can be multi-billion dollar value benefits of reservoirs - including hydropower reservoirs. There have been numerous studies of where the ESA issues are nationally, but there has not been much balance to the societal benefits discussions of hydro - drought mitigation, flood mitigation, recreation, water supply, etc. on a national scale.
- Increase outreach with industry.
- Please see lines 16, 17, and 99.
- Beef up outreach to non-federal owners and environmental community.
- Recommend development of a list of specific representative questions or inquiries to the DB and documentation of how the DB will support these. This may guide the focus of development.
- Develop and communicate outyear plan.
- Be sure to mine data developed during non-federal hydro relicensing.
- Integrate data that outlines the environmental and economic benefits of the fleet.
- Need to include positive attributes: flood control, water supply, recreation, etc.
- Further discussion on how deep to go with this; i.e., maintaining confidentiality of information.
- Be sure to assess how data will be used -- the value of the data to maintaining and growing hydro -- in deciding what information to add. Focus on the highest value data to drive policy. Don't keep piling on lower value data. Focus on the high value data.
- Direct outreach by DOE to non-federal owners may get better engagement than going through NHA.

WHP140054

Project Title:

9505 Water Use Analysis

Principal Investigator:

Shih-Chieh Kao

Organization:

Oak Ridge National Laboratory

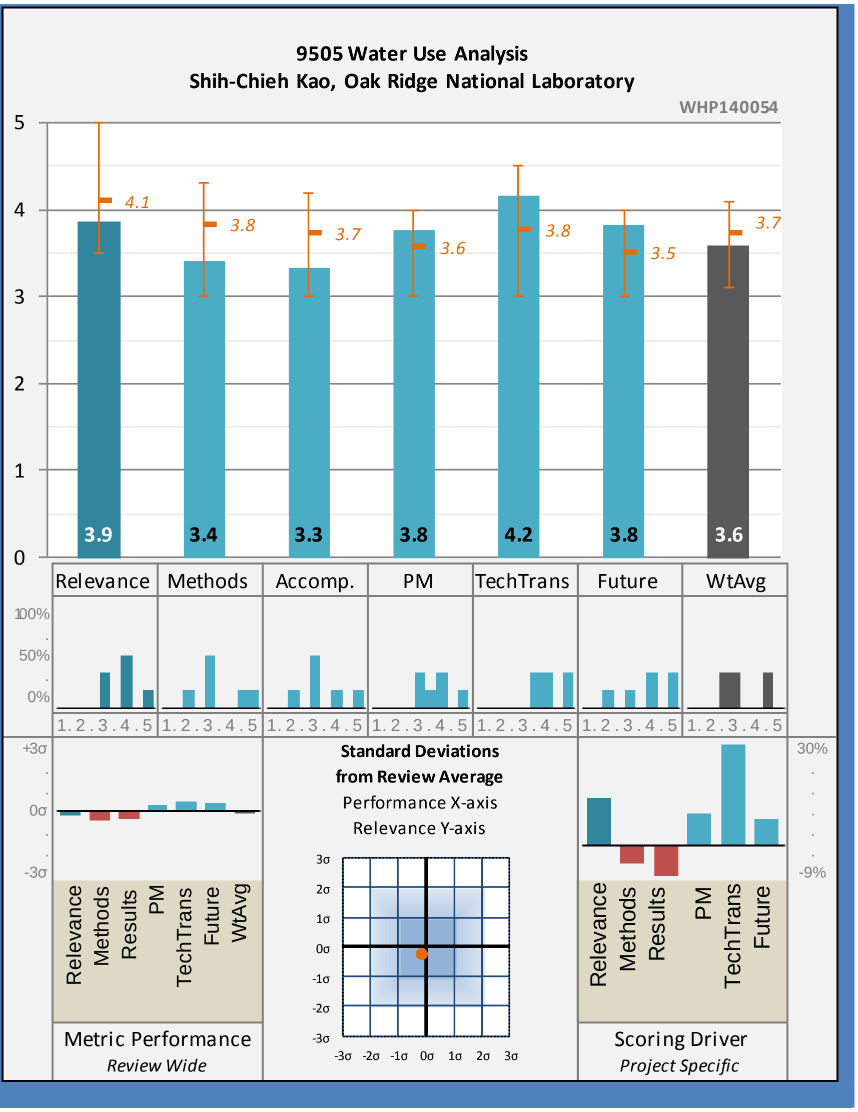
Panel:

Existing Hydro

Budget:

$1,000,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.9** for its Relevance to water industry needs and overall DOE objectives.

- Would be of even more value by expanding key findings to non-federal hydropower -- the other 50%
- The idea of a climate change study is vitally important for the hydropower industry in understanding the range of possible future conditions and developing strategies to deal with the future as it evolves.
- One should look at other climate change model results/scenarios that are being adopted in Integrated water management plans throughout the US.
- Climate change impacts to Federal Hydropower – Congressional Required Report - Who are the end users? What are the expected action plans for these end users? And what is the impact and revised plan if the predicted forecasts are in error?
- Need to know the risk of climate change to future hydropower deliveries and development.

- The Value of this project is scored less than 5 considering the 30-year forecast provides buffer for waiting for future forecasts.
- One should focus on developing and demonstrating a methodology that allows different planning groups to model available Climate Change scenarios to identify system improvements and added flexibility needs in their adaptation efforts for potential climate change impacts.
- A relatively expensive initiative at $1M for this study. Will different hydro planning decisions actually be made based on the outcome of this study? I have trouble seeing that. Based on statistical average variation in rainfall, the PMAs should already be hedging their bets regardless of the forecast of climate change. It would be very difficult to make a major financial commitment based on what, in spite of today’s best technology, must be considered a speculative forecast with significant uncertainty.
- Question as to usefulness because of inaccuracies of models.
- Project provides valuable impact to hydro goals for Federal projects as well as other hydro projects. Climate change impacts to hydro need to be better understood as well as forecasted for planning and operational decisions going forward.
- Relicensing for non-Federal hydro can benefit from this project. All basins in the USA are having to address this issue.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.4** on its methods/approach.

- Good use of available climate change data.
- The first assessment was flawed in projecting only 30 years - not long enough to see significant changes. The reasons stated for this short timeframe such as unknown future policy decisions and short lifespan of hydro equipment are simply not good reasons. All climate change studies mandated by the Secure Water Act are subject to great uncertainties, not the least of which are the climate projections themselves, but also future demands, economic states, technology, policy etc. The purpose of these studies is to try to anticipate a range of futures and understand how sensitive the future is to various drivers. Whereas it is not possible to assign probabilities to these future scenarios, it is useful in formulating adaptation strategies and plan for monitoring the future.
- There is no need to start from the downscaling stage in model development, as this been done already, and adapting different technique may not add great value in meeting objectives or provide more confidence in the results.
- Particularly in the private sector, I doubt that this report could drive significant near-term directional change regardless of the forecast outcome.
- Built of Section 9503 analysis that Reclamation performed.
- This is a relative score considering the state of model development. The approach used for this study is sound, but improvements over time will likely allow even better results.
- Need to keep updating as climate change data/models improve.
- This study opted to sink a lot of resources into downscaling, but did not expend the effort needed to consider detailed site-specific project information such as conflicting water uses. The priorities do not seem appropriate for a DOE Hydropower study; other studies have provided good downscaled data which could be used for this study, but no other study would consider specific hydropower issues.
- The approach should focus on the utility value of the techniques that are being proposed relative to what's available. Unless there would be value from the proposed approach, one should focus on demonstrating the value from early planning needs to mitigate potential impacts from climate change.
- Built on current methods of determining impacts of climate change. Question the true accuracy of these models.

- Unless there is a tangible benefit that could be demonstrated from starting this effort from the downscaling level, one should use what is already available to speed up progress of the case studies.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.3** based on technical accomplishments and progress.

- Progress was made via two key publications: the report to Congress and the technical manual that describes the methods and results. This result is adequate but falls short of the technical results that could have been produced with a more comprehensive study.
- Slow in delivering the first report.
- Results of the assessment were developed using sound approaches that were reviewed and coordinated with agencies having technical expertise and responsibilities in climate change science and modeling.

Question 4: Project Management

This project was rated **3.8** on its project management.

- The project management itself appears to be competent, having completed the study in the timeframe.
- Need future plan and budget. Since it required by Congress, may not be much latitude to not do this but there could be a more collaborated approach.
- Results and end-products are state-of-the-art and well presented for the federal portion of the US hydropower portfolio. A consistent approach was applied to all parts of the US.
- Current PMA contracting mechanisms were found to be sufficient to deal with climate change variability.
- Specific recommendations were presented to the PMA's to proceed through climate change.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.2** for research integration, collaboration, and technology transfer.

- The research was done in collaboration with other agencies and PMAs. This is very good but could have gone farther in using downscaled data produced by others.
- Results of the assessment were developed using sound approaches that were reviewed and coordinated with agencies having technical expertise and responsibilities in climate change science and modeling. End products were presented using effective graphs, charts, and tables.

Question 6: Proposed Future Research

This project was rated **3.8** for proposed future research.

- Outreach to hydro owners is essential.
- The 9505 assessments must be carried out every 5 years. The August 2013 report to Congress proposes establishing ongoing monitoring and data collection in cooperation with the PMA and federal hydro owners, and would include financial information. This could be integrated with the NHAAP to avoid duplication. The other plans for the next assessment reflect the type of climate change study that could be useful: integrate water resources planning, explore interactions among power systems with PMA and between PMAs and the larger markets. See also recommendations.
- Not sure of the value of highly uncertain forecasts and how much stock to put in the results. This is a significant amount of funding ($1M) just to say that we need to remain flexible and monitor the situation.

- Need to improve climate modeling that feeds into this if we are going to continue.
- Next steps and future research was presented. It is comprehensive regarding scope for developing better modeling results, considering science as well as application. The overall focus is on developing assessment end-points that are relevant to PMAs, the Corps, and Bur Reclamation regarding management decision-makers.
- The remainder of the current project involves planning for the next assessment.

Strengths and Weaknesses

Project Strengths

- Important question to ask.
- Produced the documents required by the Secure Water Act; recognizes in the report to Congress that much more is needed.
- Climate change is one of the most challenging problems facing integrated resources and water management plans. There is a great need for standard approach that help planners to assess system needs in their efforts to develop adaptation plans for climate change impacts.
- Good start.
- This project is well-focused on the objectives for the project.

Project Weaknesses

- Doesn't address non-federal hydropower. Even if depth is less for non-federal hydropower, it could still be of high value.
- Timeframe not long enough to consider many climate change scenarios. Too much project resources spent on hydrology (downscaling) that could have been spent on details of hydro facilities, economics, future projections of the market, etc.
- Time is the essence in conducting these studies, as others are engaged in parallel efforts. So, one should limit the scope to what's actually needed and will add value.
- All forecasts are wrong - the extent to which they are wrong can only be determined after the fact. This is a very complex global situation to attempt to forecast out 30 or more years.
- Looked at 132 federal plants, (Reclamation, USACE, and IBWC). Did not look at private or TVA.
- Uncertainty of future climate conditions.
- Have you heard anything from Congress.
- Need future plan and budget.
- Need to improve timeliness.

Specific recommendations for additions or deletions to the work scope

- Find ways to share key findings with non-federal hydro owners.
- Enhance the NHAAP for the data needed for the next assessment rather than duplicating DB efforts. On the next assessment, in addition to the specific plans listed in the report to Congress, consider the following: use hydrologic projections produced by other agencies; extend the timeframe out at least 50 years; incorporate projections of increased Hydro (goals of DOE for 2030); consider increased need for integration of other renewables; consider all other conflicting uses of water that will be affected by climate change; focus on scenarios and characterizing the sensitivity of the system with respect to dominate forcings.
- Survey the end users to see how they will use the results of this study and put them into action. If they do not have specific implementable action plans, the study must gain their confidence or the study can be dropped.
- Coordinate with other agencies/owners that are also doing climate change modeling and assessment of impacts.

WHP140055

Project Title:

ARRA: Hydroelectric Facility Modernization Program

Principal Investigator:

Multiple

Organization:

Multiple Projects

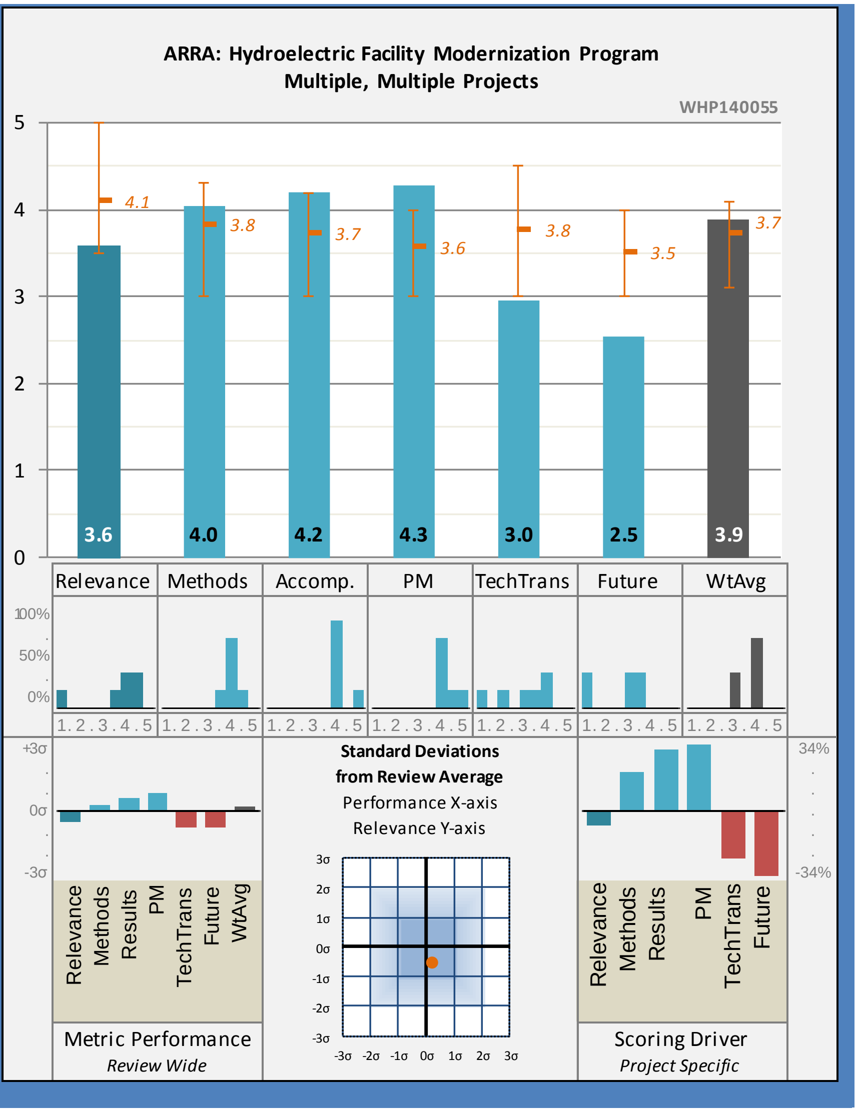
Panel:

Existing Hydro

Budget:

$29,850,599 DOE

$117,761,700 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- Great to actually build additional hydropower. Would be more valuable if lessons learned were shared.
- Consistent with DOE objectives of increasing quantity and value of hydro; also with ARRA objective of stimulating the economy.
- Aging infrastructure is a very challenging area for the existing hydropower fleet, as most installations are facing end of life cycle refurbishment/replacement needs.
- Encourages development of high return hydro rehab projects.
- Benefit limited to those that were successful in receiving the FOA award.
- Good use of ARRA funds toward upgrading facilities to increase generation at non-federal projects and improve environmental performance. Limited benefit to R&D.

- Economic viability should be demonstrated based on project's economics before DOE's funding, to encourage other utilities to follow suit.
- developing capacity incidental to low flow releases and technology upgrades to enhance the range of operation of a plant/unit are excellent areas to focus on in future demonstrations.
- Although not every similar project will end up with a federal nexus, it would be good to develop a roadmap that shows processes, permitting, etc. and the milestones that need to achieved.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- Good diversity of projects, technologies and geographic distribution.
- Beneficial use of high cost share; projects selected that would both create jobs and increase hydro.
- This is funding that encourages efficiency projects and has delivered tangible in-the-field results.
- Project was well conducted. Addition of aeration for the small unit addition at Abiquiu Hydro was good. Other measures at selected projects enhanced biological benefits by reducing fish injury and mortality while increasing capacity and reliability, and reducing maintenance costs.
- Great way to leverage federal funds.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.2** based on technical accomplishments and progress.

- Fantastic that the projects were actually built!
- The projects have generally succeeded and objectives have been met; efficiency has been documented
- At Cushman No. 2 Dam owned by City of Tacoma where fish passage has been blocked since the late 1920's, the DOE ARRA co-funding helped develop an innovative fish collection and passage system that supported the reintroduction of Washington's endangered steelhead and salmon upstream from the dam.
- Good example of public/private partnership.
- Projects demonstrated power generation improvements using modern turbine technologies to upgrade existing facilities.

Question 4: Project Management

This project was rated **4.3** on its project management.

- Not clear what DOE's PM role was. Sounds like it was more monitoring than PM. Good PM got the projects successfully completed.
- Appears to be effective - some projects were cancelled; others found to substitute. Projects completed on time for most part.
- Project Management from the participating utilities was apparent.
- Projects using $32 million of Federal co-funding with the private sector were completed on schedule within budget. Active management resulted in successful redirections of funds to other alternatives.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.0** for research integration, collaboration, and technology transfer.

- Doesn't sound like this was part of project. Seems like a missed opportunity.

- This project has been inherently collaborative; is not really research. It is possible that reports could benefit others.
- Not a lot of coordination required from the output of this initiative. Sharing of lessons learned will be tbd.

Question 6: Proposed Future Research

This project was rated **2.5** for proposed future research.

- Still an opportunity to catalog and widely share lessons learned.
- No future research proposed.
- Project completed.
- Some reinforcement of opportunities to increase benefits from existing facilities.
- Not Applicable.
- Analysis of any lessons learned and technology transfer.

Strengths and Weaknesses

Project Strengths

- Great to move these shovel-ready projects ahead.
- Objectives were met to increase hydropower and create new jobs.
- Active management of projects was apparent.
- Increase in hydropower efficiencies, capacity, and production. 135,000 MWh.
- Fulfilled mission of economic stimulus and job creation. 337 FTE.
- Allowed projects to move forward that were stalled by economic conditions in U.S.
- Some environmental benefit from Skokomish project (Steelhead and Salmon).
- Historic preservation of Boulder Canyon project (Colorado).

Project Weaknesses

- Cataloging and sharing of lessons learned should have been part of project design.
- Targeted but limited applications of subsidies.
- Benefit limited to those that received the FOA award and companies that supported those projects
- Analysis of the sustainability of jobs created and any lessons or technology transfer opportunities.

Specific recommendations for additions or deletions to the work scope

- Always look for opportunities to broaden benefits of all projects by sharing lessons learned.

WHP140056

Project Title:

Water Use Optimization Toolset - Project Overview

Principal Investigator:

John Gasper

Organization:

Argonne National Laboratory (Lead)

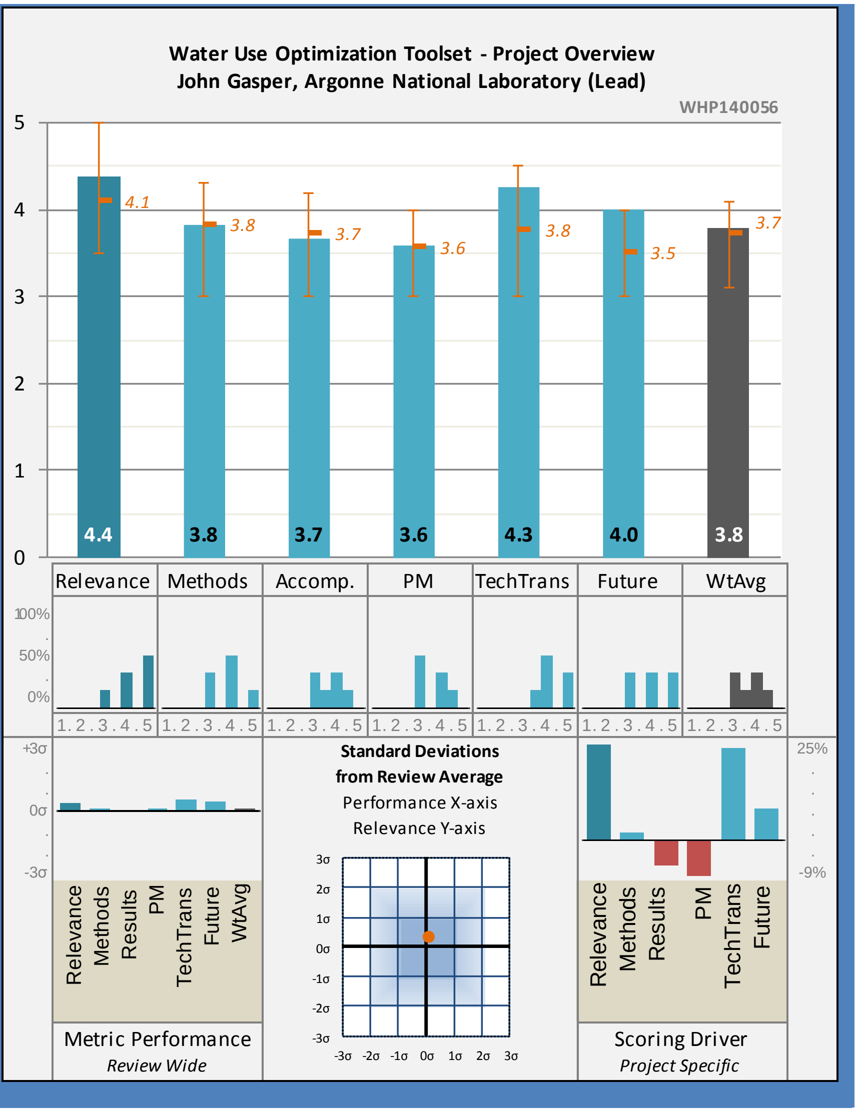
Panel:

Existing Hydro

Budget:

$4,325,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.4** for its Relevance to water industry needs and overall DOE objectives.

- The scope of this effort is much more than individual operators could have undertaken.
- Tools to improve the efficiency of operations of hydro facilities are highly relevant to DOE objectives. Factors such as constraints on water management, value of power and need to integrate highly variable renewables challenge operators. The need for accountability - to document and justify operational decisions - will be increasingly important as more legal restrictions on operations are implemented. Also, PMAs and utilities are under increasing pressure to demonstrate that they operate according to best practices. All of this is possible with the use of software tools and unlikely without such tools.

- The toolset need to be robust to allow for integrating/modeling business process for different entities/assets, as that process may change based on ownership/objectives/obligation, geographic location, hydrologic behavior, etc.
- A very high cost project (~$10M to date) MUST get used and needs to be able to deliver tangible high dollar returns.
- This project has the promise of delivering on of the most beneficial tools to hydropower operators that has come along in a long time.
- "The objective of WUOT project is to develop, demonstrate and transfer to users, an advanced analytical toolset that facilitates the production of more energy and grid services from available water while enhancing environmental benefit from improved hydropower operations and planning."
- Potentially very high value, but value is very dependent on adoption by operators --need to address change management.
- One should keep in mind that in a utility environment the ultimate users for the toolset are spread over different functional areas, so more effort should be spent on developing the modules as standalone products rather than an integrated ensemble.
- Begin with the end in mind. Establish end user group and incorporate their feedback at the onset as part of the toolset development. "Usable and useful" but will it be used?
- The ability to optimize all project purposes and requirements is huge.
- This is a very successful project with objectives met by highly qualified team participants as well as demonstration partners.
- Presenter mentioned, “Hasn’t seen a lot of usage because the demonstration sites have real jobs to do". Sounds like a red flag... What is being done to minimize the data input requirements in the field? If the requirement to "feed the beast" is greater than the perceived payback, it will not get used.
- Regarding the statement under Comments at the bottom of slide 10 of file <06a. Wate_Argonne_Gasper.pdf>: "Challenges - scope expansion, development and testing realities, Non-Disclosure Agreements, data acquisition and quality": DOE has invested a lot of funds in the WUOT Project, and these challenges should in large part or entirely be paid for by the user's organization. These organizations are benefiting a lot from the WUOT Project. Similar programs that are less advanced than the WUOT system are used by other water resource system organizations, and they pay for these programs and related services. Programs like WUOT used by other water resource management organizations continually face similar challenges as an ongoing process. Perhaps reaching out to consultants and bringing them along might help increase the application of WUOT at other sites. Perhaps this is what is planned for the workshops in 2014.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.8** on its methods/approach.

- Most of the tools developed under this project are redundant with other tools that have been developed in the private sector or by other agencies. It does not appear that any of the components contribute unique or novel approaches. The linking of the components may be novel, but also limited in usability in that many hydro managers have similar components in place.
- Seasonal outlook may have little applicability to dynamic operations (particularly east of the Mississippi) that tend to have smaller reservoirs and respond to system changes minute by minute. Weather and precipitation predictions are short term at best and effect hydro operations both from a fuel supply and also from the customer load demand. Exact placement of thunderstorms and intensity of rainfall require dynamic decision processes. Interconnected system operations may require quick start hydro operations to support unexpected loss of a large fossil or nuclear generating unit.
- Similar commercial software products exist for several facets of this project. Is this duplicative of other efforts that already exist?

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.7** based on technical accomplishments and progress.

- Need a strong focus on technology transfer/adoption.
- Software development is completed (alpha and beta); test sites have been identified and some demonstrations completed. The results of these are not known to the reviewers. Currently software refinement and transfer ongoing.
- USBR is beginning to use this tool and is pleased with progress.

Question 4: Project Management

This project was rated **3.6** on its project management.

- Sounds like the effort is being well managed.
- The project has suffered delays - not completely unexpected in view of the extensive scope and the challenges of software development.
- Remains to be seen how useful and used this high cost product will be.
- Project Management is very good. It could be enhanced greatly if users paid for the services they receive, or in some other way contributed funds for covering the cost of developing and implementing WUOT programs for their water resource systems.
- Management has improved over past years in the establishment of demo sites and a Review Board.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.3** for research integration, collaboration, and technology transfer.

- Collaborations among several federal labs and with several agencies.
- On a positive note, lots of labs working together - But still reserving judgment while waiting on this to deliver huge value results in multiple real world applications.

Question 6: Proposed Future Research

This project was rated **4.0** for proposed future research.

- Likely to deliver results if widely adopted.
- The upcoming phases of the project will continue to be challenging and the effort to deploy the software may be underestimated.
- This toolset will continue to require significant on-going annual DOE funding support to maintain the myriad of software tools and provide user support if it remains with DOE, so an effort to outplace the toolset to a commercial vendor for future development and maintenance must be considered soon.
- Requiring cost-share contributions from other organizations would help identify high priority needs for further WUOT development.

Strengths and Weaknesses

Project Strengths

- High value.

- Addresses key needs of the hydro industry; collaboration of several labs; identification of several demonstration sites.
- In an era of increased competitive uses, this tool is long overdue. Very much needed focus on power, environment and water.
- This project has been strong and successful based on the summary information and presentations made by John Gasper, Mark Wigmosta, Thomas Lowry, John Hayse, and Tom Veselka. They had 7 demonstration-site partners including a wide range of governmental organizations, a private utility. Four National Laboratories were involved. They applied the WUOT to a wide range of water resource issues. They laid the groundwork for addressing additional issues and challenges as they develop.
- Integration with other WUOT tools.
- Enhancing environmental benefits in conjunction with other project needs.
- Designing it to be user friendly and installed on a PC is of great benefit to hydro operators, especially at remote locations.
- Significant practical/real world application with good work towards getting it implemented in those applications.
- The DOE labs working together to achieve a common goal.

Project Weaknesses

- Value is based on adoption.
- The effort and cost to create software tools to meet the needs identified by this project are likely greater than funding. (Software development is often underestimated). Some of the components are redundant with existing tools developed by other agencies. The software should be deployed in one or more operational settings and used with current functionality before much funding is invested in enhancements to extend the functionality. There is no plan for maintenance of the software nor continued user support and training. Not enough information was provided to evaluate the methodologies or the results of the demonstrations.
- Could be overwhelming to "feed the beast" with the constantly changing data that is needed to continuously optimize performance. If not easily applicable, will go on the shelf unused for many end users.
- Not moving progressing fast enough.
- See earlier comments.

Specific recommendations for additions or deletions to the work scope

- Be sure to utilize and benchmark against best practices (other models in use).
- All lab developed software products should have clear implementation, rollout, and ongoing maintenance plans (and ongoing funding, if necessary) for these products.
- This project needs to be accelerated as much as practical. The need exists and there is significant interest from all hydropower stakeholders.
- Need to address change management to encourage adoption.
- With so much data intertwining in these toolsets, data validation and data QA/QC processes must be in place.
- Time to move from development to deployment.
- The model over-simplifies the environmental performance; may be impossible to model the actual complexity.
- Need to be able to weigh different environmental attributes.

WHP140057

Project Title:

Water Use Optimization Toolset - Enhanced HydroForecast System

Principal Investigator:

Mark Wigmosta

Organization:

Pacific Northwest National Laboratory

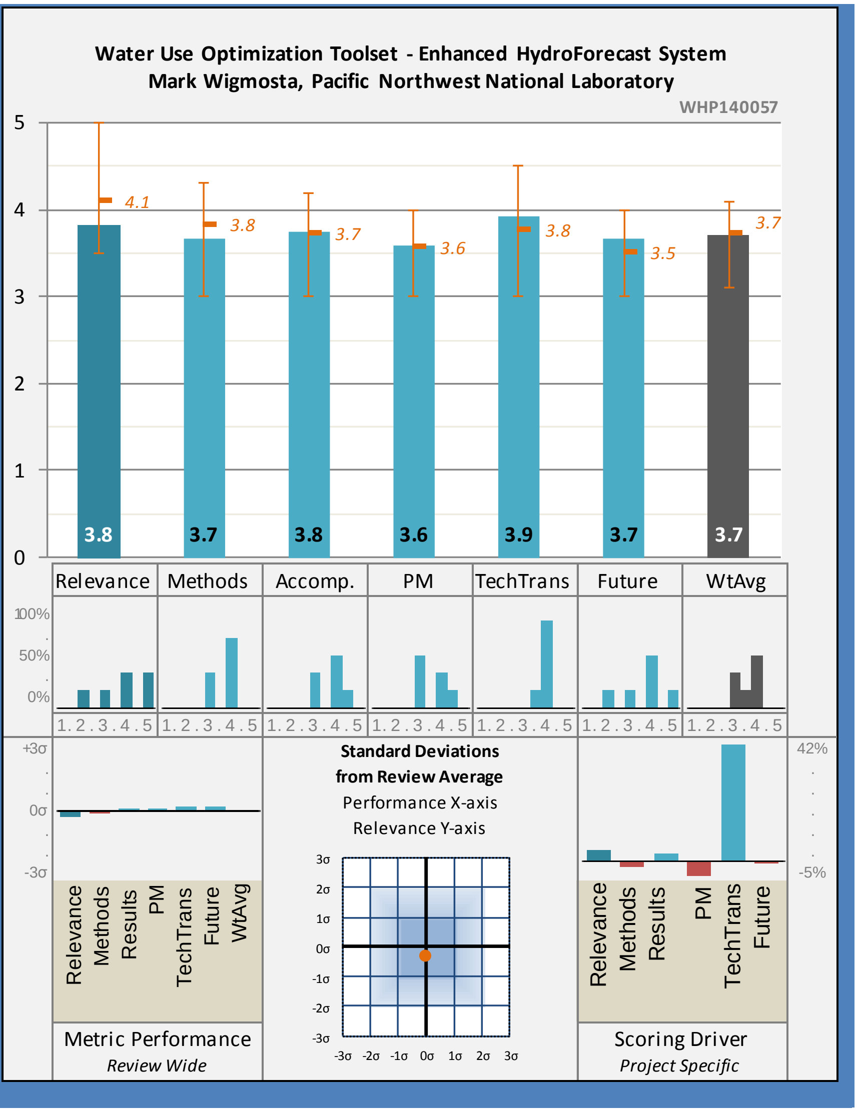
Panel:

Existing Hydro

Budget:

$2,480,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.8** for its Relevance to water industry needs and overall DOE objectives.

- Although good forecasts are needed by hydro schedulers, there are already excellent scientific federal agencies dedicated to producing them. This does not seem like a good use of DOE research funds.
- Waiting on results from demonstration projects. What feedback have you received? Will the input be automated or require much care and feeding? Better applicability for long term snowpack and baseload generation situations.
- Improvement to inflow forecasting is much needed.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.7** on its methods/approach.

- May be over-relying on prior work done by lab rather than best practices of benchmarked entities
- Details about the method/approach are not provided. A physics-based, distributed hydrologic model is expensive and difficult to develop and calibrate. It is not a realistic method for many agencies and utilities. The results do not show a comparison with existing forecast methods. What effort was needed to create the models for the demonstrations? How much of the budget was dedicated to general methodology and how much to development of the demonstration models? How well does the technology transfer to another basin?
- Very complex with multiple interfaces required.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.8** based on technical accomplishments and progress.

- Results look solid.
- The project fell behind schedule and should be carefully monitored.
- Seasonal outlook may have little applicability to dynamic operations (particularly east of the Mississippi) that tend to have smaller reservoirs and can change minute by minute. Weather and precipitation predictions are short term at best and effect hydro operations both from a fuel supply and also from the customer load demand. Exact placement of thunderstorms and intensity of rainfall require dynamic decision processes. Interconnected system operations may require quick start hydro operations to support unexpected loss of a large fossil or nuclear generating unit.
- Two days for training to use the toolset speaks to the complexity of the model and project.

Question 4: Project Management

This project was rated **3.6** on its project management.

- PM appears appropriate.
- There is not sufficient information to assess the management.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- The value will be in wide adoption/technology transfer.
- Includes collaboration among labs and with Universities as well as other federal agencies. Demonstration projects involve collaboration with state agencies.
- Multiple handoffs needed.

Question 6: Proposed Future Research

This project was rated **3.7** for proposed future research.

- An assessment should be made about the realistic applicability of this work to other basins considering technical expertise, resources and detailed data requirements. Also to be considered are the existing forecast tools.

- Ability to input other forecast systems.

Strengths and Weaknesses

Project Strengths

- An essential part of WUOT.
- Provides funding for extension of the University of Washington forecast methodology.
- Builds on existing forecasting capabilities.
- Applications at 5 watersheds with a wide range of climate and waterbasin characteristics provides sound demonstrations for evaluating the EHFS, especially with the retrospective evaluations.
- Very much needed in the midst of much hydrological uncertainty.

Project Weaknesses

- Not sure it adequately utilizes existing best practices.
- Not likely to be of great use to the hydropower industry; need has not been demonstrated; quality of results compared to existing forecast techniques not provided; quite costly and behind schedule.

Specific recommendations for additions or deletions to the work scope

- Make sure to benchmark against best practices.
- Assess the value of this project and carefully consider future funding.
- Accelerate the Water Optimization Tool Set project.

WHP140058

Project Title:

Water Use Optimization Toolset - HydroSCOPE

Principal Investigator:

Thomas S Lowry

Organization:

Sandia National Laboratories

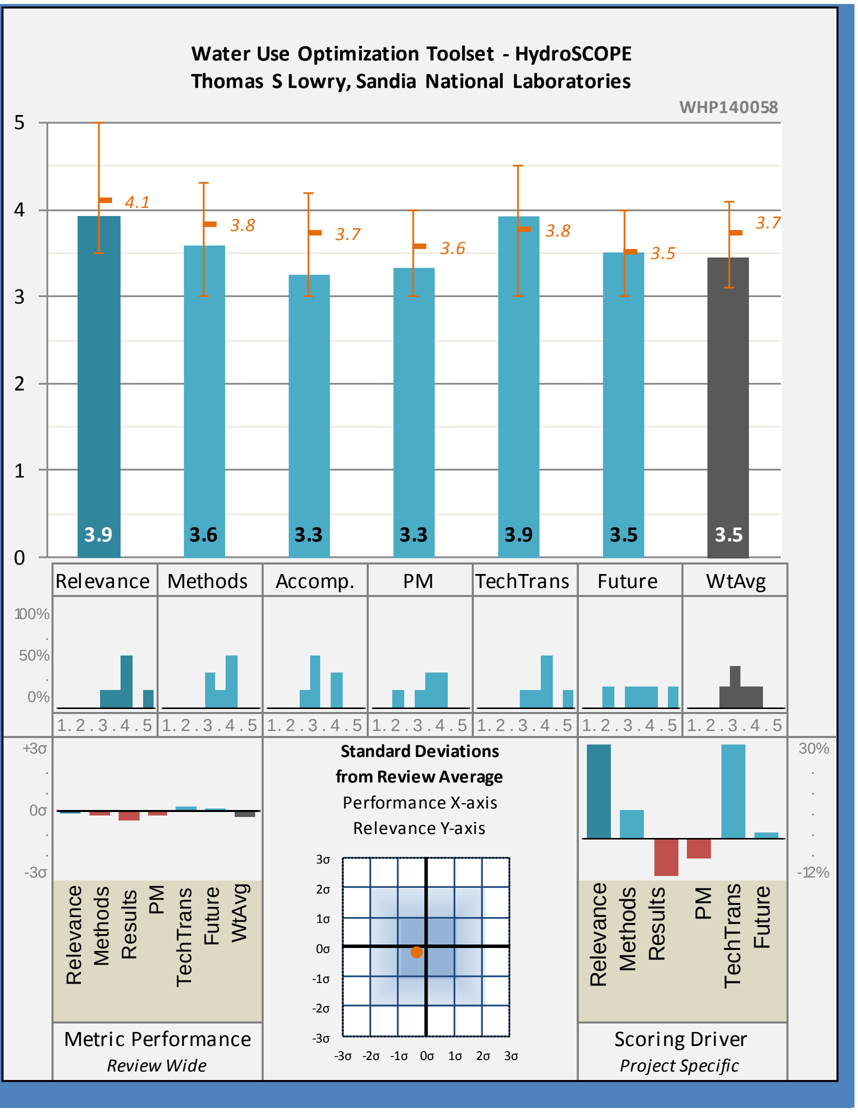
Panel:

Existing Hydro

Budget:

$2,280,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.9** for its Relevance to water industry needs and overall DOE objectives.

- Will be of high value if it can be done. I'm skeptical about the amount of data needed and the accuracy of results.
- Although it would be useful for hydro operators to have optimal seasonal forecasting of operations, the utility is quite limited without uncertainties (which it appears have been considered but not implemented in the software). It is not clear how the tradeoffs provided by the Pareto optimal (deterministic) solution could be used for forecasting operations.
- Robustness of the developed WUOT is a key concern. Ease of adaptation of the developed tool by generic user for a specific site should be the objective and not by the developers of the tool, as this implies difficulty in application by universal users/sites.

- Making the tool easy to use is an effort but is what is needed to integrate it into actual hydropower operations
- This project is part of the Toolset for WUOT, and considerable development is planned by the end of FY 2014; and, I raise concerns regarding the use of a 1-D model for the reservoir.
- Although all developed modules are important and needed, the integration of all the modules in one suite may complicate application in highly constrained sites.
- Please see comments under Q1 for WHP140056.
- The utility value of the final product and the targeted audience/users should drive the development of the scope for any project.
- Duplicate efforts should be minimized and better integrated across different DOE programs and ORNL, PNNL, etc.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.6** on its methods/approach.

- Approach is likely appropriate, goal is very complicated.
- The method is potentially efficient; if uncertainties can be captured, it would be more useful. Other relevant questions about the method would address how easy/difficult it is to model the system and formulate and express the constraints and objectives.
- Difficult to determine real world effectiveness of this model from a 15 minute presentation.
- One-D models for reservoir simulations can result in systematic error for temperature and not include the effects of wind on forebay mixing that allows more hypolimnetic water to exit the reservoir--this concern mainly applies to elongated reservoirs. DO and GHGs in turbine discharges likely would be in error. A 2-D model could provide inputs to HydroSCOPE at short time intervals (e.g., 15-min. to 3-hr depending on model run time). I think these time-lagged inputs would not be significant since water quality in reservoirs changes slowly, especially those that tend to be 2-D in nature.
- Most reservoirs experience changes in water quality that can be represented only by an ecosystem model that includes the effects of many factors that are not linear and that occur erratically, the effects of which are reflected in cumulative changes that define water quality in the water body. I would be surprised that a code that uses an object-oriented design could simulate water quality in outlets from a reservoir except for short periods like 1-2 or 3-4 days.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.3** based on technical accomplishments and progress.

- Impressive to see some accomplishments.
- The method was implemented on two demonstration projects. The results are not well understood: was the optimal solution computed with knowledge of the hydrology? If so, the comparison is with the actual operations for which there is forecast uncertainty. Not enough information was provided to evaluate the progress from this perspective.
- See slides 10, 11, and 14 of the presentation.
- benefits measured on demonstrations are so low, I wonder if they are in the range of accuracy of method
- The project is behind schedule and there is not an end date listed (listed as TBD). The project timeline presented does not correlate with the dates provided in the presentation. It is uncertain where the project stands and when it will be completed.

Question 4: Project Management

This project was rated **3.3** on its project management.

- PM seems adequate.
- The lack of definition of timeline and overruns are not a sign of good management. Ambitious additional features are anticipated without proper vetting of existing software.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Integration with WUOT is good.
- The project is executed in cooperation with other labs and demonstration projects involve Reclamation and California DWR.

Question 6: Proposed Future Research

This project was rated **3.5** for proposed future research.

- To minimize risk, future enhancements to the project could be contingent on further testing and successful deployment of the software in an actual hydro operations setting. Otherwise, investments in costly enhancements could end up as academic exercises.
- Before extending this tool into further additional complicating areas, it would be beneficial to survey the end users to determine the extent of current utilization and the benefits/necessity of extending the model beyond the existing base cases.

Strengths and Weaknesses

Project Strengths

- Develops software that provides potentially useful information to hydro operators about seasonal operations and tradeoffs of objectives.
- Ease of use.
- Develops a novel solution method that solves quickly.
- Easily updated to add new inputs, models, etc.
- Optimization across multiple scales of time and space.
- Positive revenue and environmental improvements.

Project Weaknesses

- Does not include uncertainty, which would be needed for the solution to be useful. Not enough information has been provided to assess the results of the demonstration – it looks like it may be comparing historical operations (with forecast uncertainty) with optimized operations with a known forecast.
- Delay.
- Project is behind schedule and future enhancements may be too ambitious to undertake before it can be established that the software may be useful in practice.

Specific recommendations for additions or deletions to the work scope

- Find an agency or utility willing to use the software in an operational setting for long enough to evaluate the usability. Postpone funding enhancements until basic functionality is established as useful.
- Additional work needed on environmental modeling. DO, sediment, nitrogen saturation.

WHP140059

Project Title:

Water Use Optimization Toolset - Index of River Functionality

Principal Investigator:

John W. Hayse

Organization:

Argonne National Laboratory (Lead)

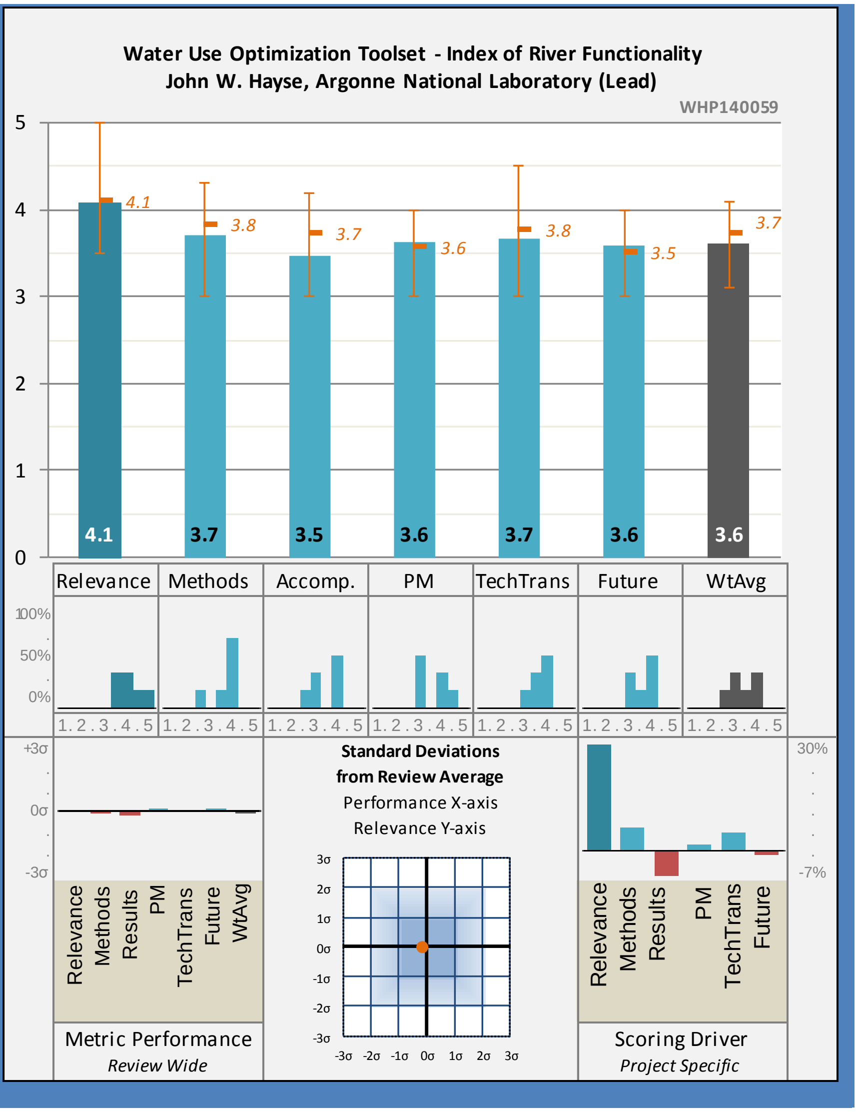
Panel:

Existing Hydro

Budget:

$0 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.1** for its Relevance to water industry needs and overall DOE objectives.

- Potentially high value, especially if environmental performance can be improved with minimal impact on generation.
- Addresses the objective of reducing environmental impacts of hydropower.
- It is not clear how the model and a single overall environmental score will be used to reshape and optimize operation, especially when "compliance triggers" in many cases are instantaneous and at a predefined location/station.
- First tool that I know of that considers operational effects on environmental performance
- Please see comments under Q1 for WHP140056.
- Optimizing hydropower across multiple project needs.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.7** on its methods/approach.

- Having users set environmental objectives is a strong approach.
- Approach seems feasible, but does not consider a wide range of types of environmental operating regulations and constraints.
- Concerns remain about model's extreme complexity. Actual sustained utilization by end users will determine if this project is a sound investment.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.5** based on technical accomplishments and progress.

- Success likely for the algorithms developed, but these will not likely respond to many real life requirements.

Question 4: Project Management

This project was rated **3.6** on its project management.

- N/A

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.7** for research integration, collaboration, and technology transfer.

- Need to loop in environmental community to validate concepts.
- I believe they are working well at keeping industry informed of their tool.

Question 6: Proposed Future Research

This project was rated **3.6** for proposed future research.

- Incorporation of end user feedback is a plus but actual implementation and use by end users remains to be seen.

Strengths and Weaknesses

Project Strengths

- Important to consider environmental goals.
- Environmental objectives are defined by the user.
- Provides a tool that allows optimization between hydropower generation value and environmental performance. Allows use of biological metrics that can be chosen to reflect the effects of a range of DO levels.
- Slight improvement realized in environmental performance based on flow magnitude and timing.

Project Weaknesses

- Need to address many more aspects than flow -- likely to get very complicated.

- There are many biological opinions and records of decision as well as other environmental limitations that should also be addressed by this tool. Its performance indicator is interesting, but may not be acceptable to all concerned.
- Nitrogen saturation would be hard.

Specific recommendations for additions or deletions to the work scope

- Could be useful for scenario analyses. Keep it simple for others to use.
- Need to add environmental modules, nitrogen saturation, D.O. sediment.
- Provide capability to weight different environmental factors differently.
- What goes into the environmental performance score (magnitude and timing of flow, frequency over environmental time, reach specific or species specific) (temperature).

WHP140060

Project Title:

Water Use Optimization Toolset - Conventional Hydroelectric and Environmental Resource Systems

Principal Investigator:

Tom Veselka

Organization:

Argonne National Laboratory (Lead)

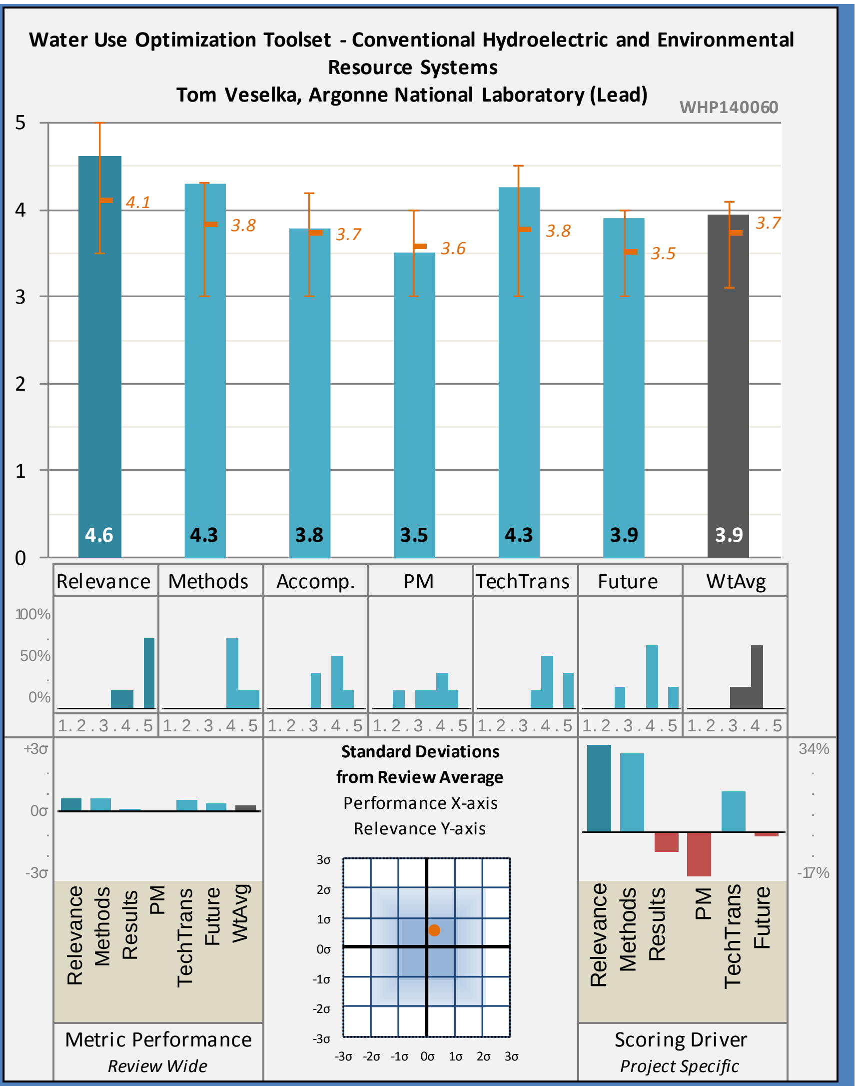
Panel:

Existing Hydro

Budget:

$0 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.6** for its Relevance to water industry needs and overall DOE objectives.

- High value if adopted.
- Optimal day ahead scheduling addresses DOE's objective of optimizing existing hydro resources.
- It is not clear how the model generates its DA and RT price forecast, especially in complex nodal markets such as CAISO, which should be one of the drivers in optimizing the objective function.
- Shows some optimization promise as a river management software package but remains to be seen how often used.
- Real world benefits to optimizing hydropower.

- CHEERS provides guidance for water use, power generation, customer requirements, buying/selling energy and ancillary services on the market, and managing energy exchanges, including consideration for environmental requirements and other water users.
- CHEERS has demonstrated success stories that are convincing.
- Please see comments under Q1 for WHP140056.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.3** on its methods/approach.

- Uses appropriate solution techniques.
- Appears to be capable of optimizing generation choices among multiple stations or optimizing the provision of ancillary services from any number of sources. This could benefit hydro owners that have multiple stations with flexible output options.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.8** based on technical accomplishments and progress.

- Demonstration at Aspinall appears to have impressive results (difficult to assess without more information).
- Looks to be the most widely applicable of the tools in the WUOT. Results study shows positive benefits clearly indicated in at least one case. Additional use case demonstrations would be beneficial.
- Project is far behind original schedule.

Question 4: Project Management

This project was rated **3.5** on its project management.

- PM appears to be adequate.
- Project seems well developed technically, but behind original schedule.
- Need a longer term plan.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.3** for research integration, collaboration, and technology transfer.

- Good to connect w/ WAPA.
- Project involves other labs and participating agencies.
- Roll out and integration has been very good and collaborative.

Question 6: Proposed Future Research

This project was rated **3.9** for proposed future research.

- Plan to do additional site.
- Proposed future research aligns with industry needs, but should be based on successful use of the software as is.
- Looks to have potential capability for more widespread use.

Strengths and Weaknesses

Project Strengths

- High value if it works.
- Addresses important industry need, uses proven mathematical formulation.
- Optimization of existing fleet..
- Real world benefits have been realized.
- Ability for plant and system operators and dispatchers to input their knowledge and goals.
- Less ramping and starts and stops of generators.
- Improved efficiency and higher revenues.

Project Weaknesses

- Software may not be "user ready" and may be difficult to use in practice.

Specific recommendations for additions or deletions to the work scope

- Deploy the software in an operational setting before further major investments in enhancements.
- The Water Use Optimization Toolset is a multifaceted project but it is one project with all of those facets needed to maximize its usefulness to industry. No need to break each part out in individual review panel assessment sheets.
- Benchmark hydro operators for best practices.

WHP140061

Project Title:

Hydropower Advancement Studies (HAP)

Principal Investigator:

Brennan Smith

Organization:

Oak Ridge National Laboratory

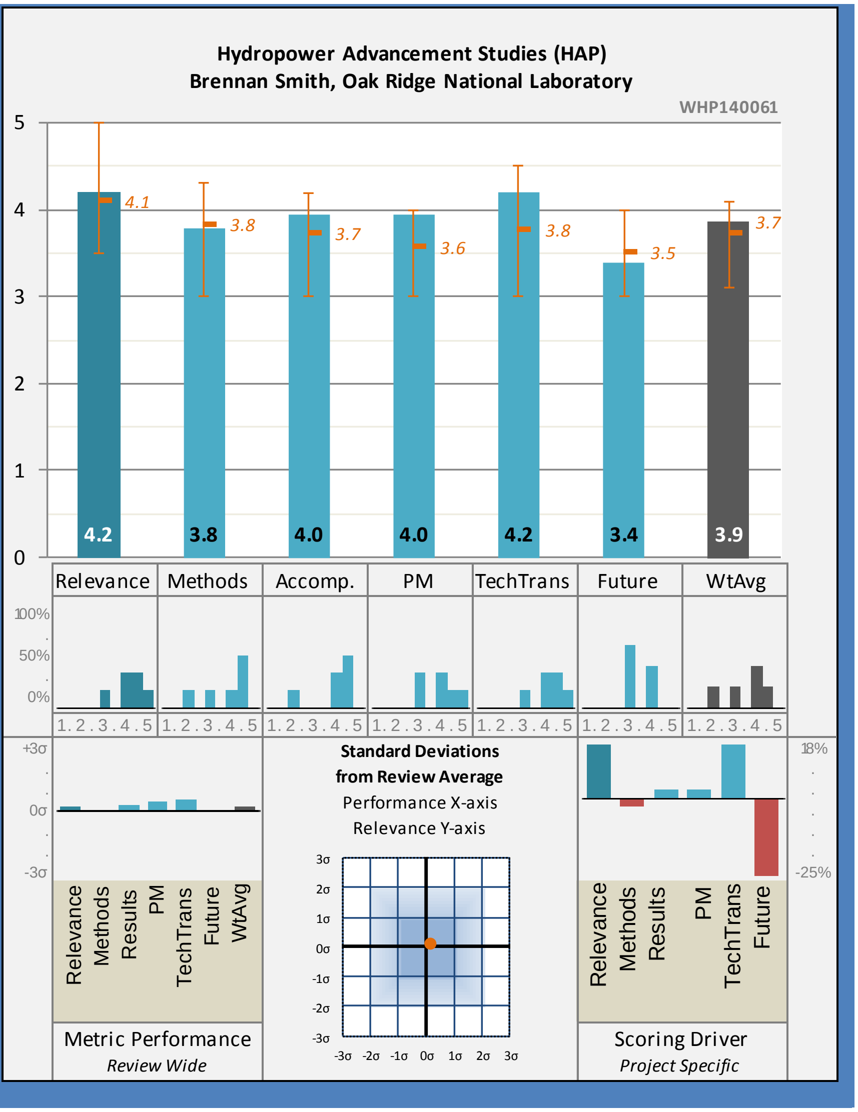
Panel:

Existing Hydro

Budget:

$5,200,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.2** for its Relevance to water industry needs and overall DOE objectives.

- The objective is to stimulate and accelerate increases in hydropower asset performance and value. It has potentially great value to the program goals and aligns with optimizing existing hydropower technology, flexibility, and/or operations.
- Many existing power plants are reaching the end of their life cycle. There is a need for critical benchmarking tools, assessment methodology, best practices, and lessons learned that are needed to better inform and speed up the decisions to undertake these projects.
- Tangible in the field support to industry is excellent.
- Helps with asset management of existing fleet.

- This project was a great success. In addition to learning best practices for 20 power plant component systems and that there is potential for increases of 7% on average of annual generation from existing hydro, much progress was made towards providing a pathway for maximizing energy production by the existing fleet--see slide 18 of presentation. The budget was eliminated for continuing the HAP project, but I recommend DOE consider finding a role to play in this kind of effort by adding leadership and funding.
- Adding 40 or 50 yrs. to the historical hydrology and operational record, and past & future system changes and obligations will most likely reveal different yield/capacity of a specific site. It would be very helpful if the optimization and computation engines were designed to allow/help assess the optimal capacity of a specific Hydro site.
- Improving efficiency.
- Losses in existing power plants due to leaks resulting from wear and tear of equipment could not be overstated. There is a great deal of loss of revenues and in some cases further damage to equipment because of the lack of attention to the difference between IPL and CPL.
- Would it be possible to sync the continuation of this program with future funding such as ARRA to provide potential incentive to owners to participate as many of them are aware of the condition of their assets but may not appreciate the opportunity cost associated with improved efficiency, added range of operations, etc.?

Question 2: Methods and Approach to performing the research and development

This project was rated **3.8** on its methods/approach.

- The approach had serious flaws as described in project summary.
- Excellent work to develop Best Practices and Condition assessment methodology that has usefulness and applicability to hydro operators of any size.
- Mostly well thought out. Very resource intensive.
- A strong team was assembled to design the testing and analyses to be conducted on selected, representative hydro projects. As work progressed, challenges arose as revealed by actual results from the field and analyses, but the project team developed logical solutions and made significant progress.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.0** based on technical accomplishments and progress.

- Strong results.
- Accomplishments were short of goals.
- Additional rollout and sharing with industry could be beneficial.
- Good.
- The presentation presents this information.

Question 4: Project Management

This project was rated **4.0** on its project management.

- Seems adequate.
- Shortcomings of project do not appear to be due to inadequate project management.
- Well-coordinated and executed plan with involvement of industry and end users.
- See presentation.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.2** for research integration, collaboration, and technology transfer.

- Good idea to transfer best practices to NHA HPC.
- Project involved several consultants and utilities.
- Good coordination with contractors and industry support.
- Best practices catalog is beneficial.
- Owners/operators have found it beneficial.

Question 6: Proposed Future Research

This project was rated **3.4** for proposed future research.

- None planned, but good to see results fed into other projects.
- This program should continue with a refined focus that could be developed leveraging the response from industry to what was produced in the past, and though surveys and discussions with owners/operators.
- Project completed.

Strengths and Weaknesses

Project Strengths

- Important to document this information.
- Boots on the ground, in the field approach, provided insight into why improvement opportunities have not always automatically been pursued.
- Helps optimize existing hydropower fleet, very good potential generation increases identified average 7.1%.
- This project was a great success. In addition to learning best practices for 20 power plant component systems and that there is potential for increases of 7% on average of annual generation from existing hydro, much progress was made towards providing a pathway for maximizing energy production by the existing fleet--see slide 18 of presentation. The budget was eliminated for continuing the HAP project, but I recommend DOE consider finding a role to play in this kind of effort by adding leadership and funding.
- Hydropower Best Practices Catalog and Condition Rating Workbooks are very good reference materials.
- May help prioritize research.
- Helps capture best practices.
- Helps assess constraints to power generation that have occurred since project inception.
- Gets project owners/operators thinking more about plant performance and how to improve that.

Project Weaknesses

- Assessments are resource intensive/expensive.
- Resource intensive from a data gathering and condition assessment standpoint.

Specific recommendations for additions or deletions to the work scope

- Make condition assessment more focused to be more cost-effective.
- Is there a way to minimize initial resource impact in gathering data, assessing condition, etc.?
- This project was a great success. In addition to learning best practices for 20 power plant component systems and that there is potential for increases of 7% on average of annual generation from existing hydro, much progress was made towards providing a pathway for maximizing energy production by the existing fleet--see

slide 18 of presentation. The budget was eliminated for continuing the HAP project, but I recommend DOE consider finding a role to play in this kind of effort by adding leadership and funding.

- Tap into performance data being developed by others (EUCG).
- Perform additional assessments.
- Proceed with handing best practices to NHA's Hydraulic Power Committee.
- Need to share with federal power customers.
- Move into next phase based on results from first phase.

WHP140062

Project Title:

45-Mile Hydroelectric Power Demonstration

Principal Investigator:

Jim Gordon

Organization:

Earth by Design

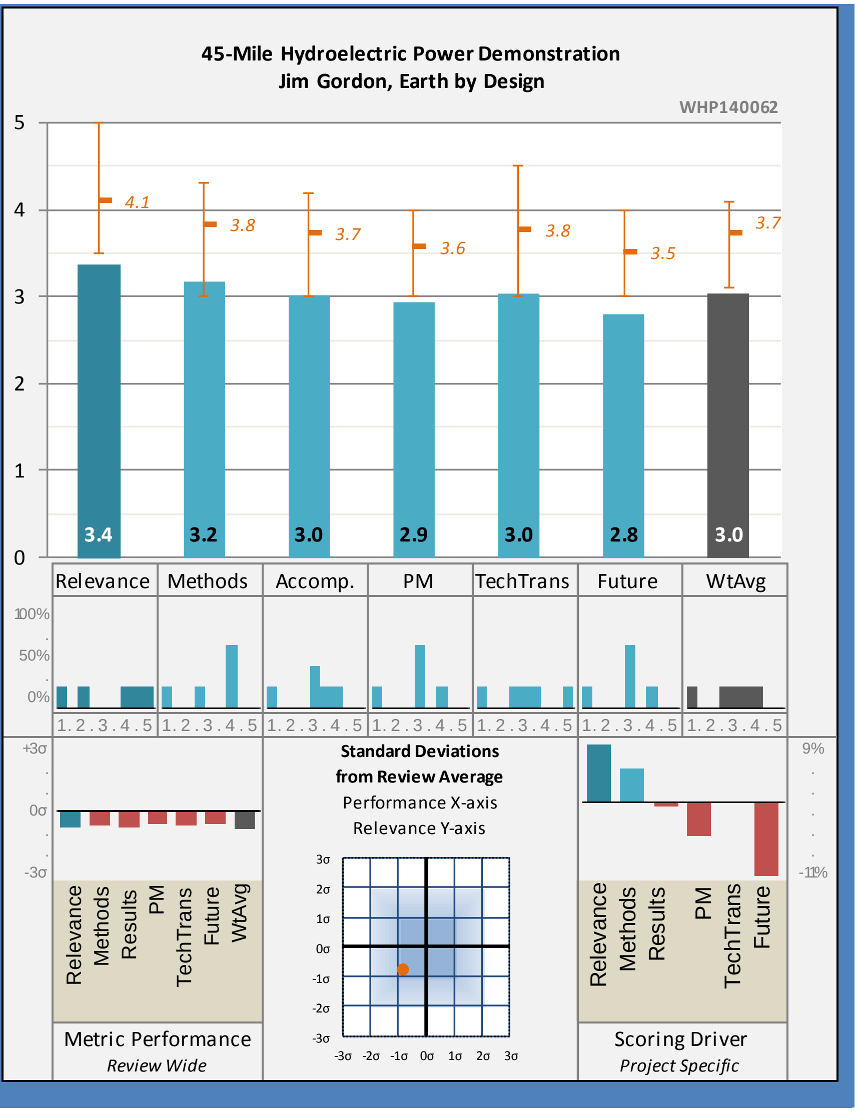
Panel:

Existing Hydro

Budget:

$1,500,000 DOE

$3,525,955 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.4** for its Relevance to water industry needs and overall DOE objectives.

- Don't see anything unique or innovative about the technology or solutions. Seems like challenges are the normal challenges all hydropower project developers have to go through.
- Aligns with goal to advance new hydropower systems and/or components for demonstration or deployment.
- Presentation was vague at best, and failed to convey the added value from this project.
- A solid demonstration project, but this design does not appear to be radically different from those of traditional hydro manufacturers. What makes it lower cost to fabricate the turbine/ generator and install? How was estimated LCOE established? What is expected MWH per year and total cost? Efficiency?
- Goal to demonstrate new low head hydropower technology in the U.S.

- There was not any information on the turbine that is being proposed and what are the unique features of the technology, over what is readily available.
- Lower cost small hydropower development.
- There was no information on the LCOE or details on the economics value of the project.
- The scope was overstated, specially mentioning "testing" of different technologies when in fact it was merely cursory review of one technology.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.2** on its methods/approach.

- Don't see anything unique or innovative about the technology or solutions. Seems like challenges are the normal challenges all hydropower project developers have to go through.
- Goal to introduce low head hydro with low LCOE to canal and go through permitting in order to serve as a model for other applications seems feasible.
- Applicability may be somewhat limited but is encouraging for new low head development in a similar situation.
- Implementation of new innovative low head hydropower technology.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.0** based on technical accomplishments and progress.

- Delays due to site relocation, technology reassessment and permitting delays.
- Turbine design is completed. Testing remains to determine actual efficiency and output.
- On schedule.

Question 4: Project Management

This project was rated **2.9** on its project management.

- Initial scoping apparently inadequate. Change to new demonstration site may be a good project management decision

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.0** for research integration, collaboration, and technology transfer.

- Might happen in the future, but hasn't happened yet.
- Limited collaboration.
- Team of Nat Lab, DOE, and consultants working together to achieve project results.
- High potential to provide lessons learned and prove new technology for low head hydropower development.

Question 6: Proposed Future Research

This project was rated **2.8** for proposed future research.

- After construction, no further funding required, but can be studied as a prototype.
- Unclear as to how/why this design will be lower cost than alternatives.

- Adds to knowledge base for new low head canal and conduit hydropower.
- Determination of sustained performance over time.

<u>Strengths and Weaknesses</u>

Project Strengths

- Good as a demonstration project.
- Demonstrating new low head, low cost hydropower.
- Well vetted up front to stay on schedule.

Project Weaknesses

- Doesn't seem like either the technology or solutions are highly unique or innovative.

<u>Specific recommendations for additions or deletions to the work scope</u>

- See this through as a demo project. Really press for lessons learned rather than innovation, which it doesn't seem to be.

WHP140063

Project Title:

International Collaboration

Principal Investigator:

Brennan Smith

Organization:

Oak Ridge National Laboratory

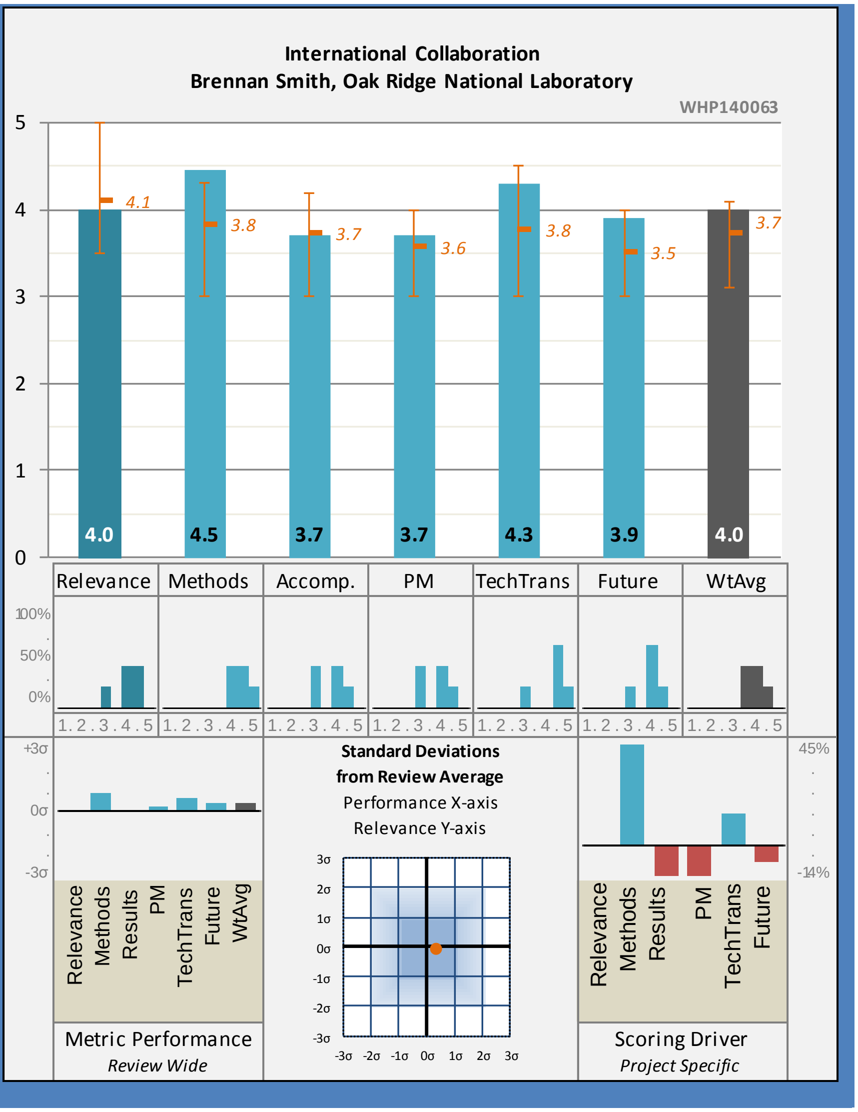
Panel:

Existing Hydro

Budget:

$150,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.0** for its Relevance to water industry needs and overall DOE objectives.

- DOE should be involved with, and leverage with, these other entities.
- Perhaps not critical, but highly valuable to DOE research goals to collaborate with international organizations.
- International collaboration is key to US success in implementing its vision and achieving its goal of greater dependence on renewable/clean energy. It is important to support efforts meant to help forge international partnerships and forums to deal with global challenges, such as GHG, climate change, etc.
- Relatively low cost approach to minimizing duplication of efforts and consumption of limited manpower and financial resources in the hydro industry.
- Opportunity to discuss new research and practices outside of U.S.

- As the levels of penetration of renewables reach projected targets, challenges in renewable integration will manifest themselves and will need more robust market designs, network upgrades, etc. Europe's experience is vital to US markets and will provide great insight into what they adapted in terms of market design, best practices, and lessons learned.
- Sharing of best practices.
- How to value non-power benefits or services.
- GHG Emissions.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.5** on its methods/approach.

- Areas of focus seem appropriate.
- Selection and level of interaction appears to be relevant and effective.
- Engaging other organizations having potentially overlapping areas of interest or even overlapping studies may help to prevent "re-inventing the wheel".
- Collaboration with existing entities; i.e., CEATI, EUCG, IEA creates some economies and prevents duplication of efforts.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.7** based on technical accomplishments and progress.

- Good progress with IEA Annexes synthesized and plan for additional collaborations.
- Work just beginning but potential benefits are large compared to cost of project.

Question 4: Project Management

This project was rated **3.7** on its project management.

- PM appears to be effective.
- Just beginning.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.3** for research integration, collaboration, and technology transfer.

- Information dissemination plan sounds appropriate.
- Collaboration is the entire objective of this project. Additional involvement of several labs is an added benefit
- Excellent leveraging of available resources.

Question 6: Proposed Future Research

This project was rated **3.9** for proposed future research.

Strengths and Weaknesses

Project Strengths

- Great leveraging opportunities!

- Low cost, low risk leveraging.
- International collaboration.
- Assessment of non-power benefits.
- GHG research.

Project Weaknesses

- None.

Specific recommendations for additions or deletions to the work scope

- Be careful not to be drawn into international protocols that may not apply to US.
- Continue to support this effort in the future. It is minimal funding and high value to DOE research program.

WHP140064

Project Title:

Hydropower International Collaboration - IAHTP Annex XIII on Fish Passage Issues

Principal Investigator:

Simon Geerlofs

Organization:

Pacific Northwest National Laboratory

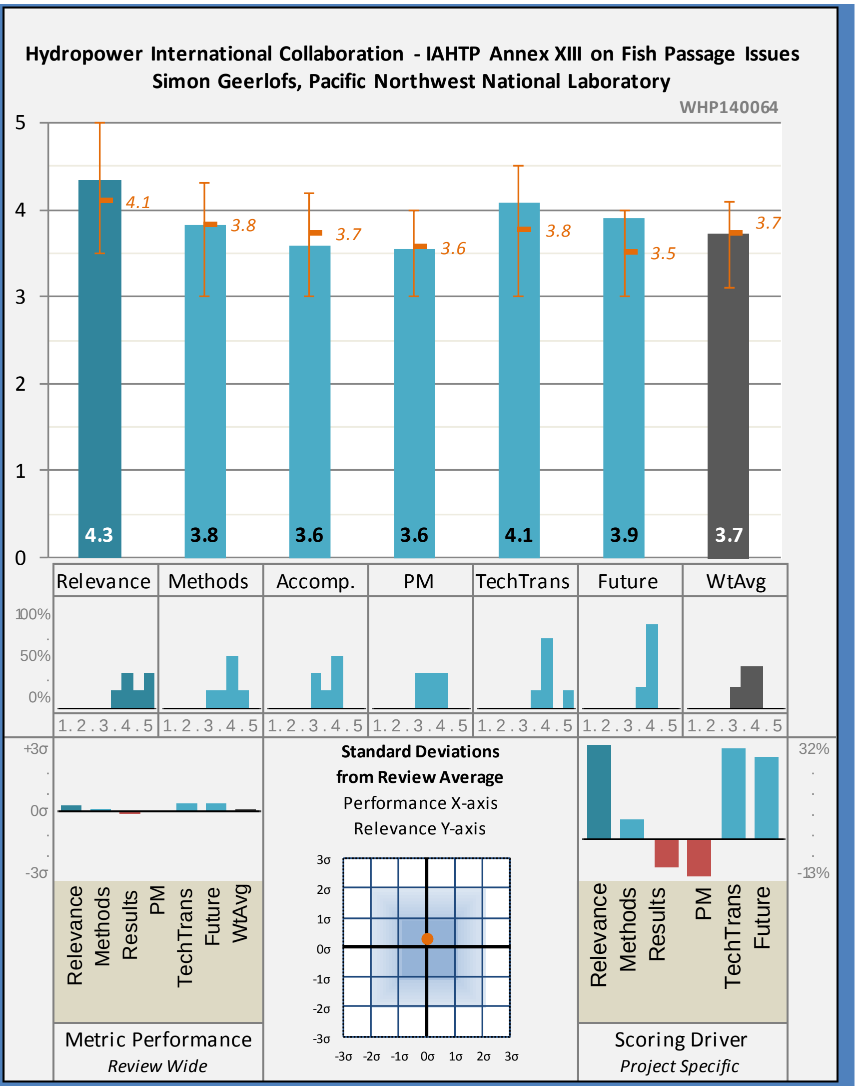
Panel:

Existing Hydro

Budget:

$75,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.3** for its Relevance to water industry needs and overall DOE objectives.

- Good opportunity to leverage both ways.
- Not critical, but highly valuable impact to DOE goals and objectives, especially to leverage external efforts in reducing deployment barriers and environmental impacts of hydropower.
- Low cost international collaboration effort.
- Leverage learning on significant environmental issue, fish passage.
- The more we learn from others, we benefit. The more others use what we come up with, we learn from their applications of our solutions and ideas. Together, we solve problems better and quicker. The benefits of this

activity far outweigh the costs, especially considering the scope of all the DOE projects involved in international collaboration.

- Reduces deployment barriers and increases environmental attributes.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.8** on its methods/approach.

- Seems appropriate.
- Simple and appropriate approach - participates in the IEA-IAHTP Annex XIII activities and reports to ORNL.
- International sharing should help reduce combined costs and develop scientific consistency.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.6** based on technical accomplishments and progress.

- Remains to be seen.
- Just getting off the ground at end of 2013.
- Clear communication of info brought back from international conferences is an expectation for all attendees. Project benefits need to be carefully reviewed and continuously justified since international travel may be viewed as an unnecessary luxury if results are not clearly demonstrated.

Question 4: Project Management

This project was rated **3.6** on its project management.

- Seems adequate.
- Too early to evaluate but looks promising.
- On schedule.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.1** for research integration, collaboration, and technology transfer.

- This project is all about collaboration.
- Good plan for information sharing at relatively low cost.
- Broad application world-wide.

Question 6: Proposed Future Research

This project was rated **3.9** for proposed future research.

- Effort to continue in 2014.
- Still developing plan.

Strengths and Weaknesses

Project Strengths

- Great opportunity to leverage both ways.
- International participation benefits DOE.
- Removing deployment barriers and decreasing environmental impacts.
- The more we learn from others, we benefit. The more others use what we come up with, we learn from their applications of our solutions and ideas. Together, we solve problems better and quicker. The benefits of this activity far outweigh the costs, especially considering the scope of all the DOE projects involved in international collaboration.

Project Weaknesses

- None.
- None.
- Not well planned yet.

Specific recommendations for additions or deletions to the work scope

- Need to figure out ways to disseminate information to, and engage, non-federal entities.
- Continue to fund PNNL to participate in IEA-IAHTP Annex XIII activities.
- Reduce cost to the taxpayer by minimizing international travel.
- Continue with this project.
- Take advantage of existing international meetings like Hydrovision International.

WHP140065

Project Title:

6.2.1 Collaboration with the International Energy Agency (IEA) on Annex IX: Hydropower Services

Principal Investigator:

Vladimir Koritarov

Organization:

Argonne National Laboratory

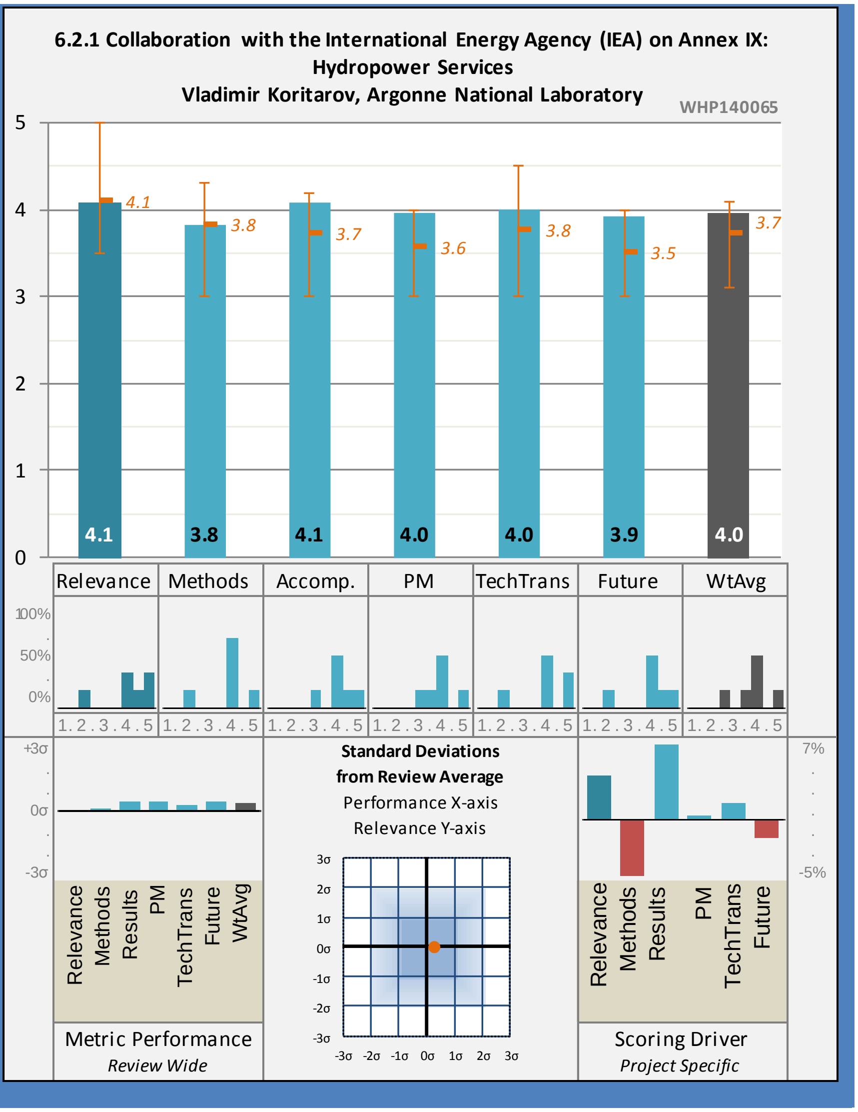
Panel:

Existing Hydro

Budget:

$75,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.1** for its Relevance to water industry needs and overall DOE objectives.

- Very important not only for better understanding of industry but also for advising policy makers.
- Although not critical, it is of great value to DOE and aligns with objectives of optimizing existing hydropower technology, flexibility, and/or operations.
- Collaboration in International forums should be leveraged to develop insight into lessons learned, best practices, demonstration of new technology, market design, renewable integration, etc.
- Relatively low cost collaboration to learn from experiences of other countries in valuing pumped storage, ancillary services, social values.
- Analysis of how hydropower services are valued in different countries.
- This project is laying a great foundation from which to operate in coming years.

- Great opportunity to leverage both ways.
- Leverages work that DOE has funded already.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.8** on its methods/approach.

- US involvement with international experts is a win-win.
- Clear communication of info brought back from international conferences is an expectation for all attendees. Project benefits need to be carefully reviewed and continuously justified since international travel may be viewed as an unnecessary luxury if results are not clearly demonstrated.
- Dynamic simulation models of PSH plants.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.1** based on technical accomplishments and progress.

- The study produced a range of useful analysis results with very small DOE investment.
- Reviewing case studies of ancillary service valuations in other countries. This is important to understand the differences and educate policy makers on these issues.
- Prototype model is developed for PSH technology.
- Improved PSH models in PLEXOS, CHEERS, etc.

Question 4: Project Management

This project was rated **4.0** on its project management.

- Early in the project but looks to be a promising approach.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- High potential.
- The project focuses on international collaboration and includes other labs and private sector experts.
- International markets may provide real world examples of appropriate values for ancillary services.

Question 6: Proposed Future Research

This project was rated **3.9** for proposed future research.

- There appears to be enough funding to support the upcoming effort to collaborate with other countries on the synthesis report.

Strengths and Weaknesses

Project Strengths

- Good opportunity to leverage both ways.
- Analyses have been done by other programs, funding for international meetings, synthesis report, etc.

- Good opportunity to advance US understanding.

Project Weaknesses

- Don't forget regulatory component of issue.

Specific recommendations for additions or deletions to the work scope

- Continue this collaboration.
- Consider engagement in Task 2 - Water Management services and socio-economic contributions. Educating the public and policy makers in this area is critically important to the future success and sustainability of hydro.
- Need to focus on policy over technology. The technology won't matter if it's not deployed.
- Loop-in ISO's/RTOs and regional orgs such as WAPA - focus on CA and the west is a good idea due to action there.
- Be sure to recognize regional differences in US.
- Be sure to loop in policy makers such as NARUC.

WHP140066

Project Title:

Quantification of Reliability and Cost Impacts for Hydropower Assets – NEW

Principal Investigator:

Brennan Smith

Organization:

Oak Ridge National Laboratory

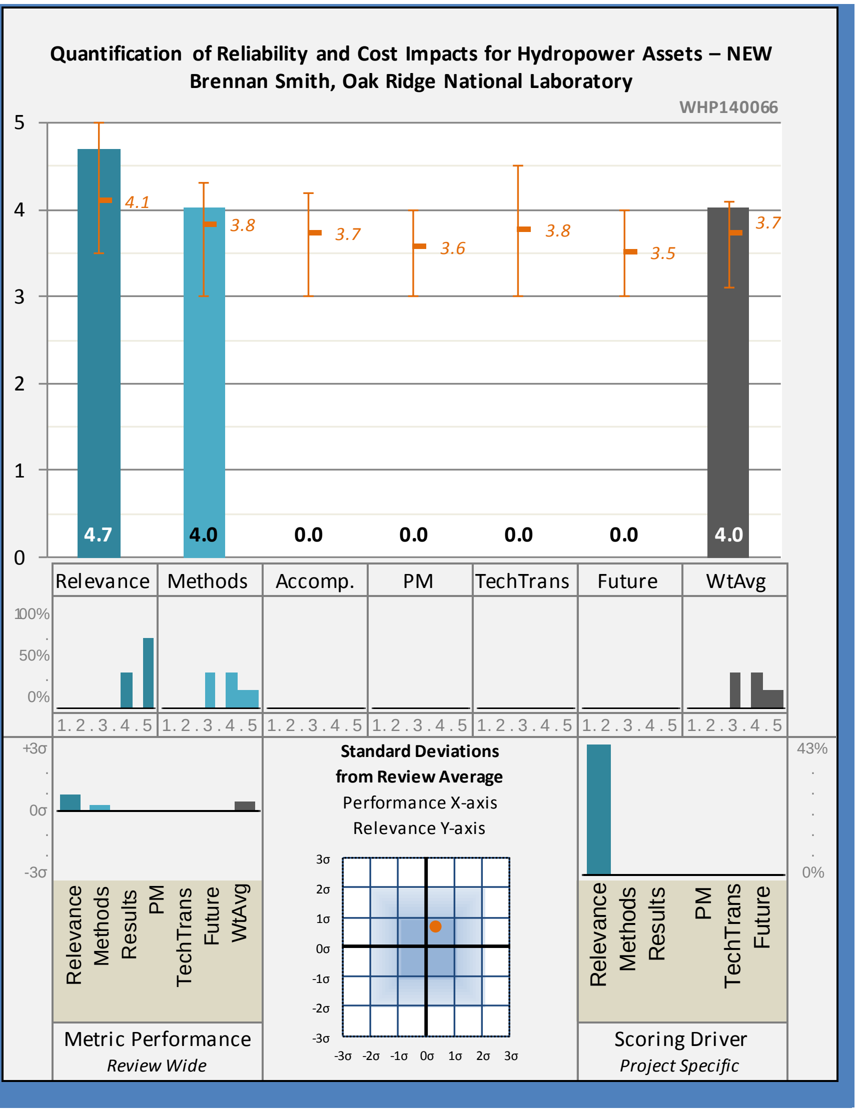
Panel:

Existing Hydro

Budget:

$300,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.7** for its Relevance to water industry needs and overall DOE objectives.

- A very important study and relatively inexpensive!
- With increasing dependence on hydro as the balancing resource for variable renewables, the answer to this research question is critical for understanding how to optimize existing hydropower technology, flexibility, and/or operations.
- Although the project is very much needed to better inform market design and owner’s reluctance to participate in providing integration services, the needed data is confidential across utilities, and may not be collected in sync with the project's objectives.

- Cost based evaluation of providing these flexible operation services does not necessarily coincide with the value of these services. It would also be beneficial to determine what is the "next best alternative" to get these services, if not provided by hydro, and how much does that cost?
- New project.
- This project addresses a number of concerns regarding reliability and cost impacts for hydropower projects: effects of recent changes to operations at hydropower projects to address environmental issues: aeration, minimum flow requirements, changes in average operating tailwater elevations, effects of dissolved gases in intake water (including corrosive hydrogen sulfide). It also addresses the issues of maintenance and repairs considering fewer staff and higher turnover of personnel.
- Timely as Asset Management gets more widely utilized.
- How to move to a flexible dispatch model.
- The results of this project could lead to manuals and standards of practice across the industry.
- Quantification of hydropower flexibility risks and costs.
- Reliability of hydro is increasing considering the mix of energy sources and the need for hydro to serve as a backup source in the mix.
- How to integrate variable generation resources and quantification of impacts.
- Optimizing systems and reducing deployment barriers.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- Probably makes sense to start w/ Federal Hydro in NW as pilot, but don't wait too long to disseminate and expand.
- The technical approach is detailed and well thought-out and seems to address relevant questions. It goes beyond analysis to development of a structure for future ongoing analysis.
- A very difficult issue to address. Backward looking analysis cannot be expected to accurately determine key reliability contributors or their associated costs with much certainty. The four keys to equipment reliability - The right design, the right installation, the right operation, and the right maintenance - any less than optimum performance in any of these key areas can lead to future reliability and cost impacts. Usually the life of equipment has been reduced by numerous combinations of unknown impacts in these four areas.
- In scoping process. Focus on Pacific Northwest system.
- The project plan provides for a comprehensive but step-by-step review that will lead to a foundation for addressing identified issues.
- The project plan leads to a thorough review of the issues that will have high value even if the issues are found to be unworthy of further evaluation.
- The proposed personnel and organizations to be involved in the project are highly qualified for conducting this project, probably the best regarding the environmental issues.

Strengths and Weaknesses

Project Strengths

- Important topic that needs quantification.
- Detailed plan, federal partners and plan for non-fed participation, relatively low funding to address key flexibility questions.
- Needed in the industry.
- A strong robust plan. Project will provide very useful information, regardless of what they find. A strong project team with federal and non-federal partners.

- What metrics do you use for change? What has changed operations, what is your flexibility.

Project Weaknesses

- Watch out for getting buried in data.

Specific recommendations for additions or deletions to the work scope

- Likely makes sense to start with Federal Hydro in NW, but don't wait too long to disseminate and expand
- This is an elusive issue and has been around for many, many years. Engage industry and end users in the early stages of this effort.
- Pick key expected impacts and focus on them. Don't get buried in detail and data.
- Be sure to loop in and leverage CEATI and EUCG.

WHP140067

Project Title:

Hydropower Flow Measurement NEW

Principal Investigator:

Brennan Smith

Organization:

Oak Ridge National Laboratory

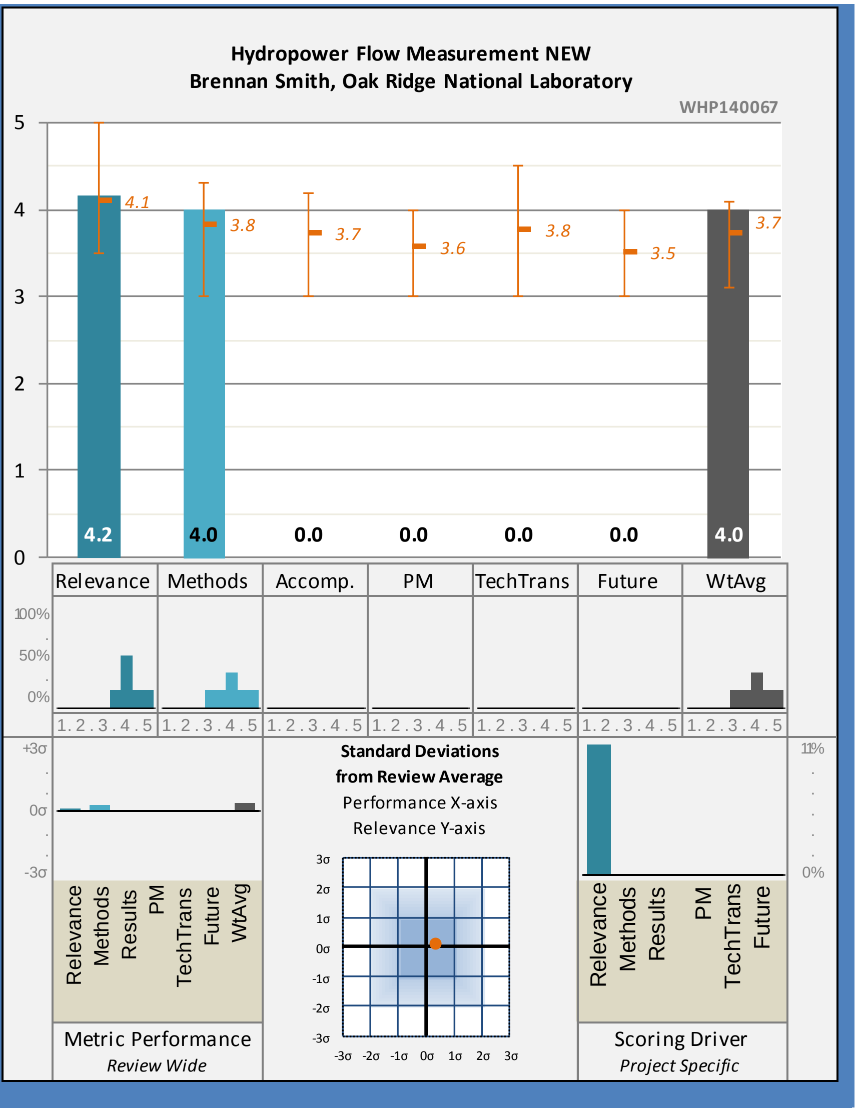
Panel:

Existing Hydro

Budget:

$300,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.2** for its Relevance to water industry needs and overall DOE objectives.

- Solution would be of high value but I'm skeptical it can be found. Too many installation-specific variables.
- This project could potentially contribute to the objective of optimizing existing and new hydropower resources, subject to results of return on investment analysis.
- Assessing unit performance, maintenance need, refurbishments, and modernization all need accurate flow measurement, new technologies, and computer processing power. This project may very well lead to more robust tools to achieve that.
- Short converging intakes have long been a measurement and economic challenge.
- ORNL and PNNL identify an issue that needs research: unsteady state water currents at turbine intakes can cause power losses, and these might be reduced if these water currents were better understood. Considering

that many hydros might be affected by these unsteady state water currents and that very little is known about why these occur, this new project is worthy of the proposed level of effort.

- The application of the proposed HFM is unlimited and will provide a valuable and robust field tool/technique that is currently not available.
- I gave this project a score of 5 because of the potential benefits in comparison to the level of effort that is proposed, plus at the minimum some new information on this issue will be provided.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- I like the approach of first assessing how much you can afford to spend, but I'm skeptical economic solutions will be found.
- Approach includes modeling, testing devices and cost analysis - covers the range of flow measurement issues. The model produces sensitivities of flow characteristics which inform the uncertainty of flow measurements.
- Will be difficult to find economical measurement solutions for small and medium hydro units less than 50 MW.
- The approach that is laid out in the presentations for this project (including the presentation for WHP140068 by PNNL), present a comprehensive approach involving a review and summarization of measurement technologies and intake designs, a flow calculator, and some initial CFD simulations. In addition, the results will be shared and reviewed by MOU agency partners USACE and Bureau of Recreation, public and private utilities, and ASME PTC-18 and IEC TC-4.
- Cataloging current technologies and doing +/- sounds like a good first step.

Strengths and Weaknesses

Project Strengths

- Worth periodically looking at this.
- Seeks to improve flow measurement but also analysis of the value of flow measurement. Involves several labs and hydro agencies.
- Much needed for future analyses, operations, etc. A foundational item for future studies.
- The approach that is laid out in the presentations for this project (including the presentation for WHP140068 by PNNL), present a comprehensive approach involving a review and summarization of measurement technologies and intake designs, a flow calculator, and some initial CFD simulations. In addition, the results will be shared and reviewed by MOU agency partners USACE and BRec, public and private utilities, and ASME PTC-18 and IEC TC-4.

Project Weaknesses

- Prior efforts have not succeeded in providing highly accurate flow measurement. Installation variability makes success unlikely.

Specific recommendations for additions or deletions to the work scope

- I like the idea of first assessing what you can afford to spend, but there also needs to be an early assessment of prospects for improving flow measurement accuracy if that amount is spent.
- In case they have not thought about the influence of transient water currents in upstream reservoir forebays, I recommend they consider effects of thermal stratification in the forebay pool in combination with forebay features that affect formation of stable withdrawal zones (e.g., upstream submerged

barriers/walls/berms/coffer dam, abutments, wind effects on mixing of the forebay area, bathymetric constrictions miles upstream from the hydropower intake, etc.).

- Partner with CEATI, HRF, others.

WHP140068

Project Title:

Hydropower Flow Measurement NEW

Principal Investigator:

Marshall Richmond

Organization:

Pacific Northwest National Laboratory

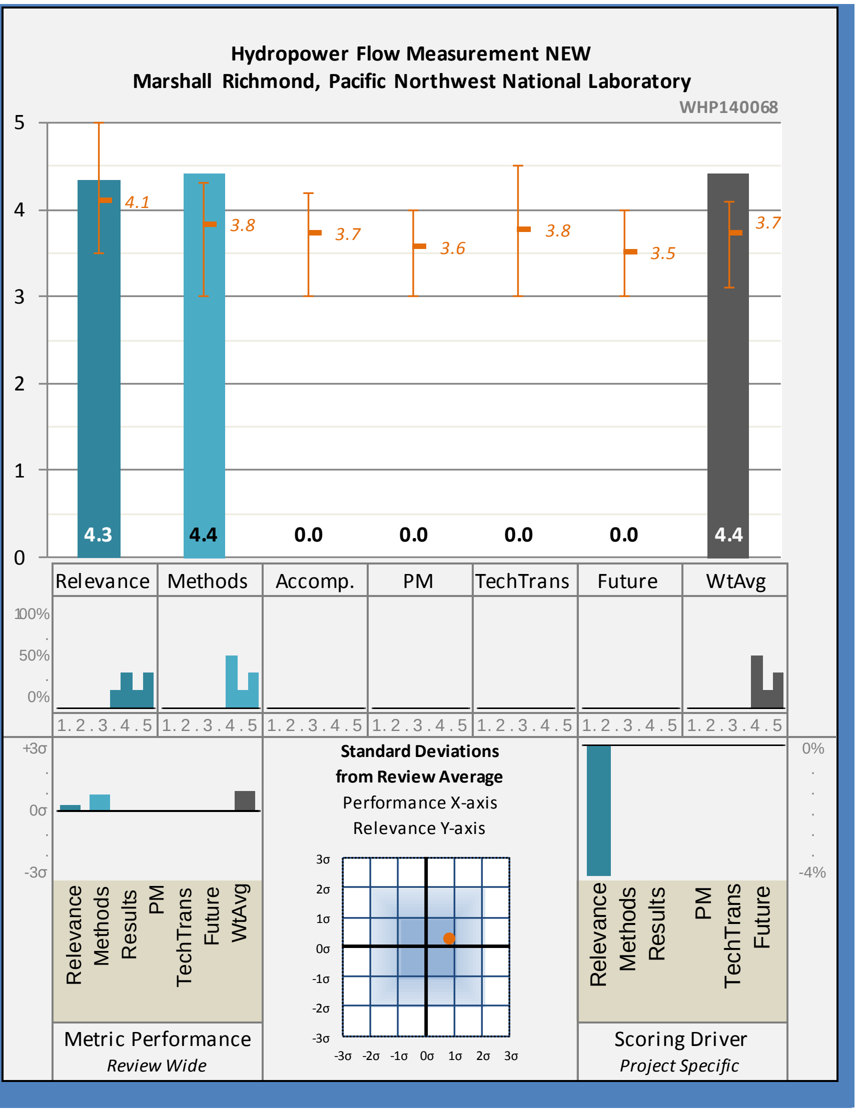
Panel:

Existing Hydro

Budget:

$300,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.3** for its Relevance to water industry needs and overall DOE objectives.

- Solution would be of high value but I'm skeptical it can be found. Too many installation-specific variables.
- This project could potentially contribute to the objective of optimizing existing and new hydropower resources.
- CFD models provide excellent and robust tool/utility in dealing with different hydraulics and hydrodynamics problems at hydropower sites.
- Long standing measurement problem that has not been economically attractive to perform for most small to medium size units with short converging intakes.
- Accurate flow measurement is crucial for analyses of hydrogenerator performance, especially in conjunction with perturbations in the flow field.

- Please see comments in WHP140067.
- Foundational for future study and data gathering.
- Increased scientific integrity due to more accurate data.
- What is the value proposition for adding accurate flow measurement to existing hydro units?

Question 2: Methods and Approach to performing the research and development

This project was rated **4.4** on its methods/approach.

- I like the approach of first assessing how much you can afford to spend, but I'm skeptical economic solutions will be found.
- Technical approach appears to be solid, i.e., "good science."
- I like the use of CFD for better understanding flow changes since it could enhance further modelling for understanding flow losses. For instance, I have seen significant cross-river flows leading across the face of the trash racks then making a 90 degree turn to enter the short converging intake.
- DOE has lots of experience in this type of modeling.
- Please see comments in WHP140067.
- Cataloging current technologies and doing +/- sounds like a good first step.

Strengths and Weaknesses

Project Strengths

- Worth periodically looking at this.
- The project is likely to result in good data about flow measurement.
- Good foundational work for future studies.
- Please see comments in WHP140067.
- Identifying value proposition for adding flow measurement will be a great tool.
- Look at new technologies for flow measurement.

Project Weaknesses

- Prior efforts have not succeeded in providing highly accurate flow measurement. Installation variability makes success unlikely.
- It is not clear to what extent this research will result in more efficient operations. The previous project analysis will shed light on that.
- Some benefits of accurate flow measurement may not be quantifiable; i.e., trust in data and information, meeting stream flow requirements and downstream deliveries.
- Some information may be of a confidential nature to plant owners.

Specific recommendations for additions or deletions to the work scope

- I like the idea of first assessing what you can afford to spend, but there also needs to be an early assessment of prospects for improving flow measurement accuracy if that amount is spent.
- Consideration of flow characterizations outside of the trashrack; i.e., forebay flows, restrictions and losses
- Please see comments in WHP140067.
- Partner with CEATI, HRF, others.
- Analyses of adjacent unit effects.

7.2 New Hydropower Development

The Water Power Program works to develop, demonstrate, and test new technologies and techniques that can improve the energy efficiency and environmental performance of hydropower. The program's activities support industry by reducing capital and operations and maintenance costs, increasing unit availability and plant capacity factors, reducing risk through enhanced system reliability, and improving the quality—environmental performance attributes as well as ancillary power benefits—and quantity of the energy produced. Areas of focus include water-use optimization, the application of advanced materials and manufacturing methods, and modeling and prediction of water power grid services.

Addressing Comments for New Hydropower Development

The Hydropower Peer Review Panelists recorded many useful and actionable comments during their review of the Office’s New Hydropower projects. These comments will be used to make key decisions and recommendations to those projects that will still be receiving continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy into the future.

Most of the New Hydropower projects, with the exception of several lab projects, focused on the development and demonstration of innovative hydropower systems. As is typically the case with high risk research, many of these projects faced unanticipated permitting and regulatory difficulties leading to project delays and additional costs. Both WWPTO and the Panelist feedback recognize that this is an inevitable part of innovation and the deployment of new hydropower. However, it is also recognized that certain measures can be taken during the planning phase to anticipate these delays. One of the most valuable aspects of these demonstration projects will be in transferring these lessons learned to industry, including technical, permitting, and financing lessons learned. This was a major theme of the New Hydropower project panelist feedback and something that the WWPTO plans to take into account in future years.

In addition, many of these new hydropower projects had proposed or planned efficiency improvements that did not receive sufficient scrutiny in advance of funding. Critical panelist feedback suggested that DOE engage in a more detailed evaluation of these claims in advance of project funding to ensure the selection of projects with the best chances for success. In future years, WWPTO will to engage in a merit review process for its projects that will address this concern expressed by the Panelists. DOE will incorporate lessons learned from these projects to develop sound investment strategy going forward.

Several data-gathering initiatives, including the Market Report, the National Hydropower Asset Assessment Program (NHAAP), and the Cost Data Collection and Modeling projects, are multi-year data gathering efforts with a constant focus on improving the granularity of the data presented, and the usefulness of the tool. The DOE places a strong priority on technology transfer, and understands the importance of private sector involvement throughout the tool’s development. To this end, the performer for all three of these projects, Oak Ridge National Laboratory, has been actively engaged with industry through a variety of avenues, including partnerships with industry groups such as CEATI, EUCI, and NHA, which comprise the majority of hydropower ownership in the United States. In addition, ORNL has reached out to individual developers, and is currently engaged in the Hydropower Vision Project, where cost/resource data will be vetted among experts across the hydropower industry and additional data provided to improve the tools.

The New Hydropower Innovative Collaborative is an exciting new project, at a very affordable cost, that brings together industry experts to stimulate bold, innovative ideas to reduce hydropower cost. Peer review comments made the point that utilities will only seek implementable proposals. While this is certainly true of utilities, the NHIC is designed specifically for developers and policymakers and is focused on out-of-the-box proposals, not traditional ways of implementing hydropower. It is however critically important to focus these proposals on methods that could fit physically (mechanically, hydraulically, electrically, etc.) within the confines of potential new site development boundaries.

Table 7.2.1 lists the New Hydropower Development projects funded in FY 2012 and FY 2013 (“Existing” projects) that were reviewed during the 2014 Peer Review meeting. Figure 7.2.1 illustrates the standard deviation of scoring of those projects in relation to the scoring of all projects reviewed in 2014.

Table 7.2.1 New Hydropower Development Projects funded in FY2012 and FY2013

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing Hydropower Projects			5.5	4.0	3.7	3.6	3.6	3.7	3.4	**3.6**
Average for New Hydropower Development Projects Funded in FY 2012 and FY2013			5.2	3.6	3.3	3.1	3.0	3.1	2.8	**3.1**
Demonstration of Variable Speed Permanent Magnet Generator at Small, Low-Head Hydro Site	David Brown Kinloch	Weisenberger Mills	5.0	4.0	4.2	3.7	3.6	3.9	3.8	**3.9**
National Hydropower Asset Assessment Program (NHAAP) - New Hydro Assessment	Shih-Chieh Kao	Oak Ridge National Laboratory	6.0	4.3	3.7	4.1	3.8	3.9	3.2	**3.8**
Harnessing the Hydro-Electric Potential of Engineered Drops	Sharon Atkin	Percheron Power	6.0	4.0	3.4	3.4	3.4	3.4	3.5	**3.4**
SLH Timing Belt Powertrain	Abe Schneider	Natel Energy	5.0	3.7	3.6	3.6	3.3	2.9	2.2	**3.3**
Slab Creek Powerhouse Project	Scott Flake	Sacramento Municipal Utility District	5.0	3.3	3.4	3.2	3.5	2.8	3.0	**3.2**
Hydropower Energy Resource (HyPER) Harvester	Nadipuram (Ram) R. Prasad	New Mexico State University	5.0	3.8	3.2	3.3	2.9	3.4	3.1	**3.2**
SLH-100 Demonstration project at Monroe Drop	Abe Schneider	Natel Energy	5.0	3.9	3.4	3.2	2.8	3.2	2.5	**3.1**
Scale-up of low-head SLH hydroengine	Abe Schneider	Natel Energy	5.0	3.6	3.2	3.0	3.1	2.9	2.5	**3.0**
Laboratory Demonstration of a New American Low-Head Hydropower Turbine	Wayne Krouse	Hydro Green Energy	5.0	3.6	3.3	2.9	2.4	3.3	3.1	**3.0**
W4e (“Water for Energy”) Hydropower Turbine Generator System Validation	Henry Russell	Walker Wellington	5.0	3.1	2.7	2.1	2.5	2.1	1.7	**2.3**
Small Hydropower Research and Development Technology Project	Callum Sullivan	Near Space Systems	5.0	2.4	2.5	1.8	2.0	2.0	2.0	**2.1**

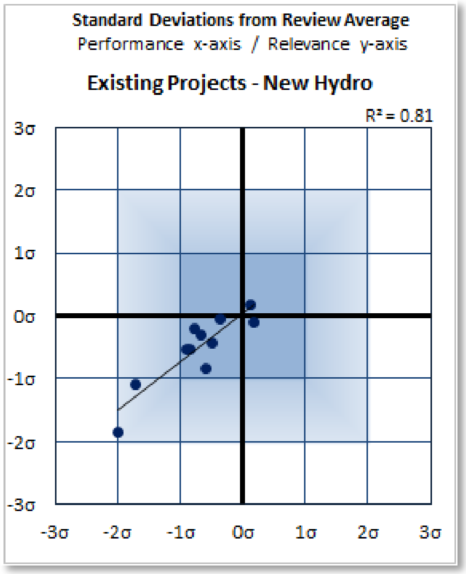


Figure 7.2.1 New Hydropower Development Projects funded in FY2012 and FY2013

Table 7.2.2 lists the newly-awarded ("New" projects) New Hydropower Development projects that were reviewed during the 2014 Peer Review meeting. Figure 7.2.2 illustrates the standard deviation of scoring of those projects in relation to the scoring of all projects reviewed in 2014.

Table 7.2.2 Newly-awarded "New" Hydropower Development Projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Weighted Average Score
Average for Review			5.0	4.1	3.8	**3.7**
Average for all New Projects			5.2	4.2	3.8	**3.8**
Average for New Hydropower Projects			5.5	4.3	3.9	**3.9**
Average for Newly-award "New" Hydropower Development Projects			5.5	4.0	3.5	**3.5**
Cost Data Collection and Modeling for Hydropower NEW	Qin Fen (Katherine) Zhang	Oak Ridge National Laboratory	6.0	4.3	3.6	**3.6**
New Hydropower Innovation Collaborative NEW	Brennan Smith	Oak Ridge National Laboratory	5.0	3.6	3.4	**3.4**

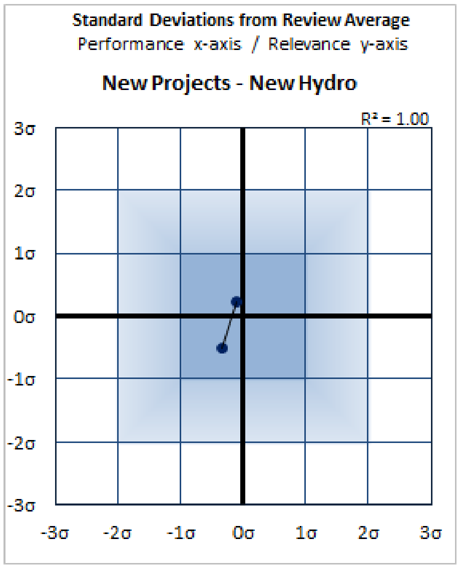


Figure 7.2.2 Newly-awarded "New" Hydropower Development projects

WHP140069

Project Title:

National Hydropower Asset Assessment Program (NHAAP) - New Hydro Assessment

Principal Investigator:

Shih-Chieh Kao

Organization:

Oak Ridge National Laboratory

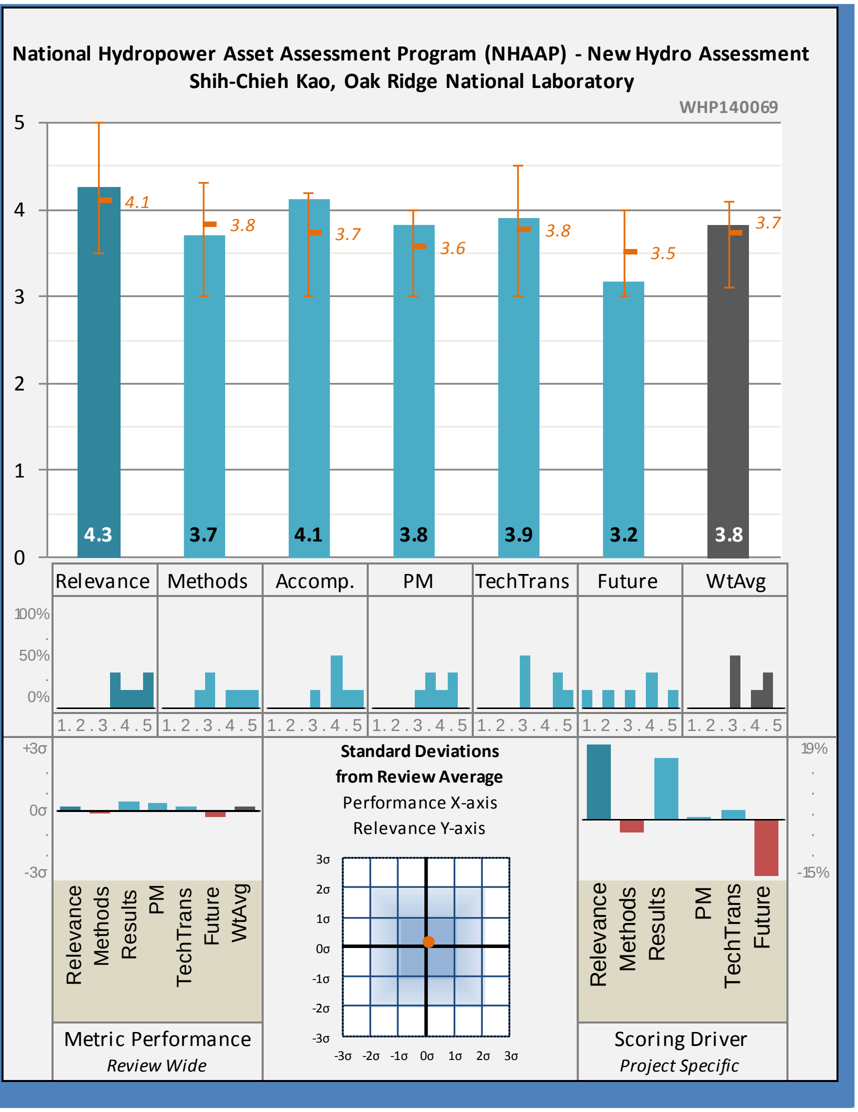
Panel:

New Hydro

Budget:

$1,546,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.3** for its Relevance to water industry needs and overall DOE objectives.

- The project, when completed, is likely most useful for policy makers, i.e., determination of overall potential for new hydropower. It is possible, but not likely that utilities looking to expand would use this data to identify potential sites for deployment of new projects. The environmental metadata is useful in terms of eliminating sites from consideration that are quite sensitive; however, it is not likely that the level of detail of environmental information would reduce deployment barriers or environmental impacts.
- Q30 should be based on hourly data to provide the information needed for the capacity determination, as the monthly data will normalize the peaks.
- Outstanding overview of all potential hydro sites in US. Slide 8 also identifies water uses on the benefits side versus the potential ESA issues which would be great to capture. Other values such as flood mitigation,

aquatics protection during drought, recreation enhancement (or loss); GHG reduction impacts, water supply opportunities now and in the future, etc. etc. will ultimately become determining factors in the development decisions.
- Further analysis on undeveloped stream reaches.
- If new hydro designs using the Q30 flow at the 30% exceedence quintile and the 100-year FEMA flood elevation are cost-effective, this project is very important for significant growth in hydro development. I think DOE should consider continuing over foreseeable future to keep improving the database, but also prepare to reduce efforts as sufficient information is attained. I think this project needs continual review by potential users to keep focused on the most important information. Consider the value of each level of information added.
- Transmission interconnection and proximity to load need to be considered as a screening parameter, and it may be looked at in the context of aggregated sites within the same reach.
- Reducing deployment barriers through identifying challenging "environmental attributes" is a positive but also being combined with a water storage/supply benefit could also be a positive.
- Advances new hydro and removes barriers by identifying sites that have better environmental attributes
- EPA was not one of the collaborating agencies. Since EPA and State water pollution control agencies regulate all waterways regarding water uses, water quality, point and nonpoint pollution discharges, and drinking water supplies, their input should have been helpful for this analysis. The states and EPA have identified water uses for all waterways in the USA, and these will need to be considered, with legal implications.
- Pondage impact on reshaping flow profiles and conflicts with downstream water rights/users need to considered and constraints should be applied before sizing and screening.
- Screening criteria could be developed to reflect economic viability without the need to go through specifics of each site. Example a 1MW capacity that needs one mile transmission or more will very likely be not viable, and so on. Same could be applied for civil works vs. potential capacity.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.7** on its methods/approach.

- The concept of using Q* H * slope for capacity is a good start, but not an adequate indicator. Q30 based on monthly flow averages is a rough indicator. A variability factor based on daily flows should be considered. Proximity to transmission seems like a key factor but is not mentioned in the study nor figured in the algorithm. This information would presumably be available from the spatial data. It is not clear how the overall capacity estimate is reduced in consideration of limitations due to environmental sensitivity and transmission proximity. This is a flaw that could be addressed for example by categorization of capacity into groups characterized by levels of environmental sensitivity or transmission proximity.
- Detailed assessment of 3 million sites clearly shows what is possible, if there were no other issues.
- Head, Flow, Stream Reach selection, Calculation of capacity, energy, storage, inundation, environmental attribution. QC process.
- Without considering discharges from municipal and industrial wastewater treatment plants and sources of organic matter and nutrients from agricultural operations, DOE will over-estimate the number of potential new hydro projects.
- Water temperature is an issue that needs to be addressed. All waterways tend to increase in temperature as they move downstream; however, with new hydro added, water surface area is increased and water moves slower through the waterway possibly leading to increased temperatures.
- I reviewed the water quality information that is provided through the public portal, and I found references only to 303d list information. Using only 303d listings for identifying water quality issues for hydro projects would be misleading for broad-scale assessments. Information that is useful includes water quality data

(sources: BASINS 4.1 and STORET), water quality criteria, NPDES permits, wasteload allocation models, watershed studies and management plans, and monitoring programs. Models are available to predict changes in water quality due to new hydro as well as other waterway uses. The main water quality issues facing hydro are identified through obtaining State 401 Certificates, so emphasis on these requirements is an important consideration for every dam.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.1** based on technical accomplishments and progress.

- The project appears to on schedule and reports have been published.
- Effective project demonstrates what is holding back hydro.
- 56 GW and 28 GW.
- The initial methodology workshops were peer-reviewed.
- 302 TWh and 157 TWh.

Question 4: Project Management

This project was rated **3.8** on its project management.

- Overall management has resulted in on-time and within budget. The scope may be deficient.
- Appears to be well managed.
- Final report before NHA.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Good use of existing data.
- Reports have been published, but it is not clear who the audience for the information is. Several institutions were involved in the project.
- Excellent outreach to collaborating agencies and external reviewers.

Question 6: Proposed Future Research

This project was rated **3.2** for proposed future research.

- Don't get carried away with this project. Basic data is good for driving policy, but developers would need much more site-specific data and will need to develop this themselves. There are many more considerations than can be included in this project.
- There is not a specific plan for further work other than suggestion for continued refinement and mention of outreach (to whom?). Due to deficiencies, further work should be proposed.
- Cost model coming including transmission and interconnection.

Strengths and Weaknesses

Project Strengths

- Includes environmental attributes.
- Uses national data sets to estimate potential for new hydro.

- A very, very useful document for BOTH technical and policy decisions.
- Provide comprehensive environmental attributes.
- The NSD approach allowed a rapid resource assessment to identify new hydropower potential from approx. 3 million undeveloped stream reaches.
- Focus on run of river.

Project Weaknesses

- Can't catalog all considerations, especially non-technical ones.
- Methodology does not result in a good estimate. Further refinement of the information is needed in order to be useful. Audience is not identified.
- Repeat of previous study.
- Water quality issues were not sufficiently addressed regarding impacts to NSD. Every major wastewater discharger in the US is provided a WLA (waste load allocation), and WLAs are sensitive to hydraulic characteristics of receiving waters. These WLAs are likely to impact results of NSD resource assessments
- Doesn't consider transmission attribute -- this is often the cost driver.
- The project, when completed, is likely most useful for policy makers, i.e., determination of overall potential for new hydropower. It is possible, but not likely that utilities looking to expand would use this data to identify potential sites for deployment of new projects. The environmental metadata is useful in terms of eliminating sites from consideration that are quite sensitive; however, it is not likely that the level of detail of environmental information would reduce deployment barriers or environmental impacts.
- May not be considering transmission.

Specific recommendations for additions or deletions to the work scope

- Very useful data set for driving policy, but I doubt developers will use it. Developers already know the top sites and would need much more data than the NHAAP can provide.
- What is the difference between this and the one the INL did several years ago (Doug Hall).
- Possibly do outreach to environmental community in advance of issuing report and also to get their input on non-technical issues.
- Use as much information that is possible from previous studies.
- Identify and focus on apparently highest potential sites.
- Are you considering publishing the tool so that developers can adjust parameters for particular sites?
- Don’t need a lot of additional data or refinement, but a cost element would be helpful in identifying highest potential sites.
- Develop a communication plan for report roll-out. Considerable risk of push-back from environmental community.

WHP140070

Project Title:

Slab Creek Powerhouse Project

Principal Investigator:

Scott Flake

Organization:

Sacramento Municipal Utility District

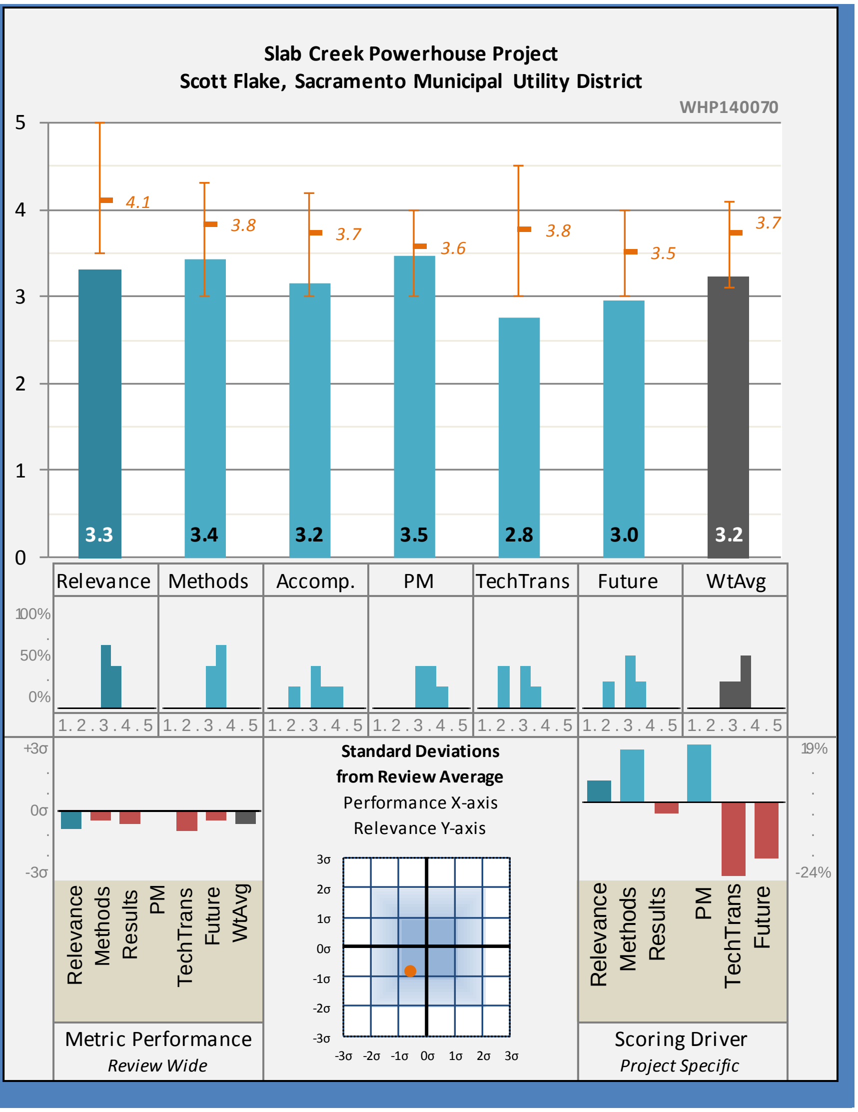
Panel:

New Hydro

Budget:

$1,484,750 DOE

$11,302,297 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.3** for its Relevance to water industry needs and overall DOE objectives.

- A very common set of circumstances.
- This is a demonstration project that is somewhat aligned with the objective of increasing efficiency of existing projects and reducing environmental impacts.
- The SMUD project is a demonstration of the challenges that may face a developer of a specific site in securing the required permitting, specifically 401 certification.
- A good and interesting demonstration project but of limited knowledge transfer to the industry.
- Incremental increases on existing power plants.
- Value as a demonstration project.

- There is a lesson to be learned from using creative configuration to develop hydropower potential associated with minimum flow releases and to mitigate site limitation issues.
- Helps reduce deployment barriers and environmental impacts.
- Regulatory challenges are significant in some cases, and not always predictable. This Slab Creek Powerhouse Project experienced obtaining a 401 Certificate in over 8 yrs., 5 years longer than other studies and permits, and approvals etc. SMUD was requested to add a powerhouse downstream from dam to provide water for a bypass reach. They developed a project to add water to the bypass, but this project was slowed up due to 401 Certificate. Reason for the hold up for the 401 Certificate was "slowness" of state water quality agency, including staff turnover, ineptitude. Need to share more of these experiences--very significant to attaining 2030 goal for hydro.
- Use of minimum flows to generate power.
- 2.7 MW, 10.5 GWH, $0.074/kwh.
- From 36 cfs constant to variable 63 to 415 cfs, plus kayak/rafting flows of 850 to 1,500 cfs.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.4** on its methods/approach.

- Good design/concept.
- Innovative approach to a demonstration project that captures flows that otherwise would be wasted.
- One of objectives is to streamline approach to licensing. But the project hasn't started because of license delay. What does this tell us? Answer: the streamlining worked but the licensing is still held up. Major licensing issues.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.2** based on technical accomplishments and progress.

- Many license/permitting processes completed. No final design approved yet. Delays in spite of efforts to expedite permitting.
- Progress has been limited due to regulatory slippage.

Question 4: Project Management

This project was rated **3.5** on its project management.

- Probably as good as possible, but good management could not address permitting problems.
- Project Management appears to be adequate given the regulatory circumstances.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.8** for research integration, collaboration, and technology transfer.

- Potential for lessons learned. This needs to be a requirement of DOE funding.
- None so far.
- Not a lot of technology transfer but a positive demonstration of how hydro can grow.

Question 6: Proposed Future Research

This project was rated **3.0** for proposed future research.

- Mostly sharing of lessons learned.
- Proposed completion of project is aligned with goals same as original project.
- DOE was to aid in design and construction but has been delayed due to regulatory delays.

Strengths and Weaknesses

Project Strengths

- Solid demonstration project of a very common situation (increased minimum streamflow requirements)
- Demonstrates imaginative solution to increase hydro without environmental impacts.
- A good demonstration of hydro growth potential but also highlights the challenges of regulatory issues that can derail even positive projects.
- Shows some different ways of modifying dams to change flow patterns and deliver boating flows.
- Demonstrates innovative sighting concepts to make a project viable.

Project Weaknesses

- Nothing very innovative about the project or process.
- Demonstration not particularly applicable to others; permitting issues have greatly delayed the project.
- Very slow moving due to delays in FERC licensing.
- Project will proceed even w/o DOE funding.
- Did not streamline the licensing process as originally anticipated.

Specific recommendations for additions or deletions to the work scope

- Fund at a modest level as a demonstration project. Require identification and dissemination of generic lessons learned that can be used by others.
- Water quality certification is one of the biggest concerns that stakeholders have as they contemplate participating in developing minimum flow releases at a dam site, and probably the main reason why they would not be interested. So, some efforts should be spent through DOE and NHA to explore options on streamlining the water quality recertification process and limit stakeholders/water rights owners exposure to potential change in requirements.
- Greater value for DOE funding would be to help streamline the permitting process.

WHP140071

Project Title:

Harnessing the Hydro-Electric Potential of Engineered Drops

Principal Investigator:

Sharon Atkin

Organization:

Percheron Power

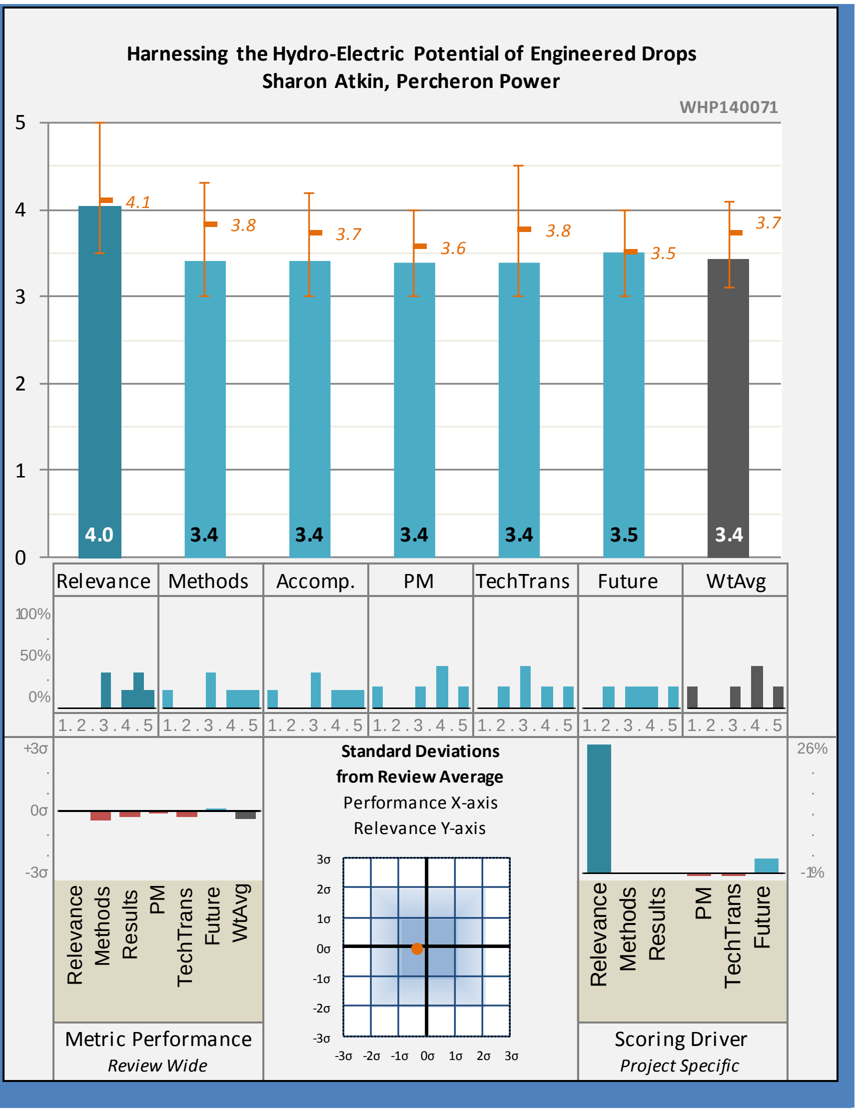
Panel:

New Hydro

Budget:

$1,495,427 DOE

$4,269,060 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.0** for its Relevance to water industry needs and overall DOE objectives.

- Aligns strongly with DOE goal to advance new hydropower systems and/or components for demonstration or deployment.
- This technology is not new, and the challenge to deployment in the US is due to its high LCOE, as it requires extensive civil works.
- Excellent demonstration of innovative low head technology that has been used internationally but has not been deployed in the US. $4M for 4000 MWH per year presents challenging economics with current US energy prices as compared with Europe. If future US energy prices rise, this is a viable option.
- Demonstration of Archimedes screw technology for low head canal development.

- Good demonstration project for USA. Applicable to canals, mainly in western USA. To get buy-in by operators. To go thru process of decision making and share experience with others in USA. Performance bond, guaranteed for 2 years for everything.
- LCOE of the proposed project needs to be determined to assess economic viability, and provide comparative analysis versus competing technologies.
- 1 MW and 4000 MWhrs.
- DOE 1.1 M--but PP retained top turbine engineer from GE to maximize power.
- LCOE of deploying the Archimedes screw if it were to be manufactured in the US should also be assessed and reported to provide the justification needed for the current demonstration project.
- Rehart turbine, have 59 plants already operating, constructed in USA.
- There is no lack of technologies that can use hydropower potential at a modified drop structure, especially with extensive civil works.
- Aeration considerations for sites that originally aerated? Placed on drop 16 ft. high. Likely a site-specific consideration. Needs to be considered. Bureau of Reclamation in Denver (Chris Holdren) good contact.
- Small hydro on canals will in some cases face the need for aerating water passing through their turbines. This will be a site specific need. Bureau of Reclamation in Denver (Chris Holdren) good contact.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.4** on its methods/approach.

- Selected a site with appropriate head and flow regime, ease of interconnection, absence of environmental impacts, and support of the local irrigation system owners and operators. In addition, all NEPA work, including an EA and a FONSI, had already been completed Reclamation manufacturer from Europe will attend installation. Solid analysis of flow/head and design of civil works.
- Raising awareness of a viable technical solution that has international deployment experience.
- Good demonstration of technology in USA and the process to go thru.
- Needs some cost analysis: how low can cost go? Has there been an analysis to determine how low cost would have to be to be cost effective (or how much power would have to be worth)? This is successful in Europe but power is more expensive there.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.4** based on technical accomplishments and progress.

- All design, analysis, permitting and bidding/selection steps have been completed. Construction scheduled for fall 2014 appears to be on track.
- A truly innovative turbine introduction to the US. Not completely mature technology and one that has not completely maximized efficiency.

Question 4: Project Management

This project was rated **3.4** on its project management.

- Management seems to be competent and effective.
- Appears to be on track.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.4** for research integration, collaboration, and technology transfer.

- Make sure the lessons learned are widely disseminated.
- Collaboration with Reclamation and water users, AE firm and manufacturers. No presentations, papers or external outreach yet.
- Bringing successful design from Europe to the US market.

Question 6: Proposed Future Research

This project was rated **3.5** for proposed future research.

- Continuation of the project to completion in coming year. Project should continue as planned.
- Modular AHS to reduce costs.
- Determination of reliability of this technology.

Strengths and Weaknesses

Project Strengths

- New application of known technology.
- Good demonstration of low head technology that is successful elsewhere and not previously used in US. The technology has many advantages - fish friendly, passes trash, low maintenance. The project planning and coordination are effective. Site selected minimized time for permitting.
- Fish friendly.
- Lots of lessons to learn.
- Will handle trash and debris.
- Utilized site assessment data.

Project Weaknesses

- May prove too costly.
- Poor collaboration with water users and local power customers.
- A model of how not to approach a project with stakeholders.

Specific recommendations for additions or deletions to the work scope

- Catalog and widely disseminate all lessons learned. Not just technical but also permitting and financing
- Need cost analysis - what is needed for cost effectiveness? A cost analysis should be done at end of project to provide DOE with information about the potential to apply this technology in other places.

WHP140072

Project Title:

Hydropower Energy Resource (HyPER) Harvester

Principal Investigator:

Nadipuram (Ram) R. Prasad

Organization:

New Mexico State University

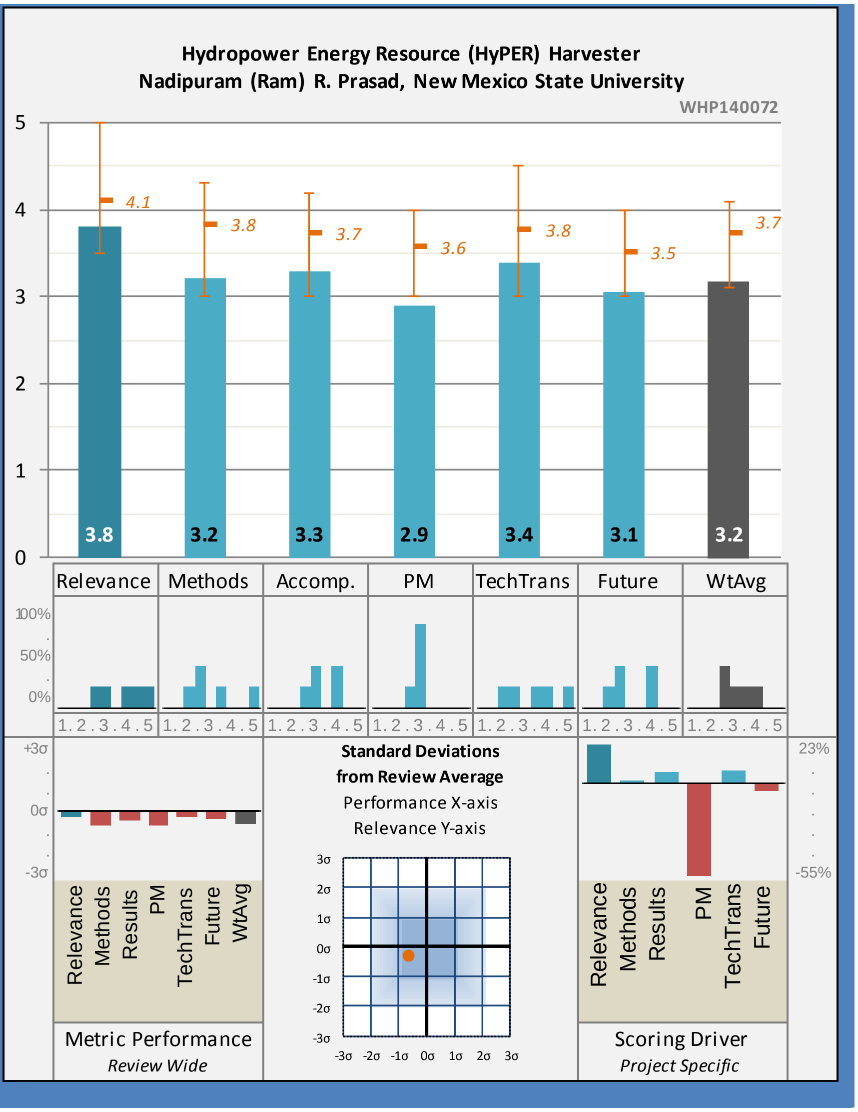
Panel:

New Hydro

Budget:

$299,305 DOE

$74,828 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.8** for its Relevance to water industry needs and overall DOE objectives.

- Good relevance, but seems like a long shot that this technology can be successful.
- Aligns strongly with DOE goal to advance new hydropower systems and/or components for demonstration or deployment.
- There is a lot of focus on the modular aspects of the proposed turbine design but very little consideration to demonstrating the efficiency of the turbine.
- These irrigation drops and Kaplan turbine technology have been around for about 100 years and were never developed due to economics. Major turbine manufacturers have also experimented with various lightweight materials. Looking for a breakthrough but this remains to be seen.
- Demonstrates low head hydropower on drop structures that can meet NEPA requirements.

- It is not clear why the turbine is designed to capture only a fraction of the energy potential at the proposed site.
- Modular architecture.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.2** on its methods/approach.

- Many unsolved/unaddressed problems.
- Appears to be well designed both the turbine and the "drop in" modularity. It is difficult to assess technical feasibility. There does not seem to be a viable plan for protecting the turbines from trash and rocks.
- Unproven assertions as the basis for LCOE projections.
- Solid CFD approach.
- Unique water passage design for this specific drop may not be best example of "plug and play".
- There are a number of maintenance challenges that may arise with this submarine generator design and cooling system.
- Calculated efficiency and "Maximum Power Transfer" quoted appear to be far below other conventional methods.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.3** based on technical accomplishments and progress.

- Good progress, somewhat behind schedule. Success is likely.
- Specific design for this application has been modelled extensively. Cost effectiveness of real world prototype remains to be seen.
- Good progress, 5 months behind.

Question 4: Project Management

This project was rated **2.9** on its project management.

- Seems like a blind eye to some important issues: trash, civil works for draft tube penetration of water barrier at sites with different civil geometry.
- Management seems effective - but innovation is usually fraught with glitches and a few have been encountered.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.4** for research integration, collaboration, and technology transfer.

- Irrigation District is strong partner. Turbine manufacturer participates. Especially nice is the undergrad capstone project at NMSU, cost shared by the University. Several publications done and in progress.
- Lots of peripheral benefits in the academic realm for student engagement.
- High degree of applicability to many other sites due to modular design, no need for civil works, inexpensive manufacturing techniques, off-the-shelf AC generator.

Question 6: Proposed Future Research

This project was rated **3.1** for proposed future research.

- Poor chance of success.
- Proposed continuation of the project aligns well with and is likely to deliver results.
- Will likely struggle to deliver on LCOE particularly when considering connection requirements to an electrical transmission system for many of these very remote locations.
- Performance testing and reliability determination.

Strengths and Weaknesses

Project Strengths

- Trying to address an important issue of developing canal drops.
- Strong EBID collaboration, extensive analytics and design, innovative turbine design that can be applied to low hear irrigation drops. Student project sponsored by University.
- Fits in with historic value of the structure.
- Modular architecture.
- Turbine made out of Kevlar.

Project Weaknesses

- Important issues not addressed.
- Truly innovation - much to be discovered by the implementation. Some technical problems not yet sorted out, especially the trash problem.
- This is probably not going to be successful as a cost effective and "revolutionary" breakthrough approach with low installation and maintenance costs that can deliver the promised LCOE.

Specific recommendations for additions or deletions to the work scope

- Require focus on key issues to be solved.
- Continue the project to completion and monitor thereafter.

WHP140073

Project Title:

SLH-100 Demonstration project at Monroe Drop

Principal Investigator:

Abe Schneider

Organization:

Natel Energy

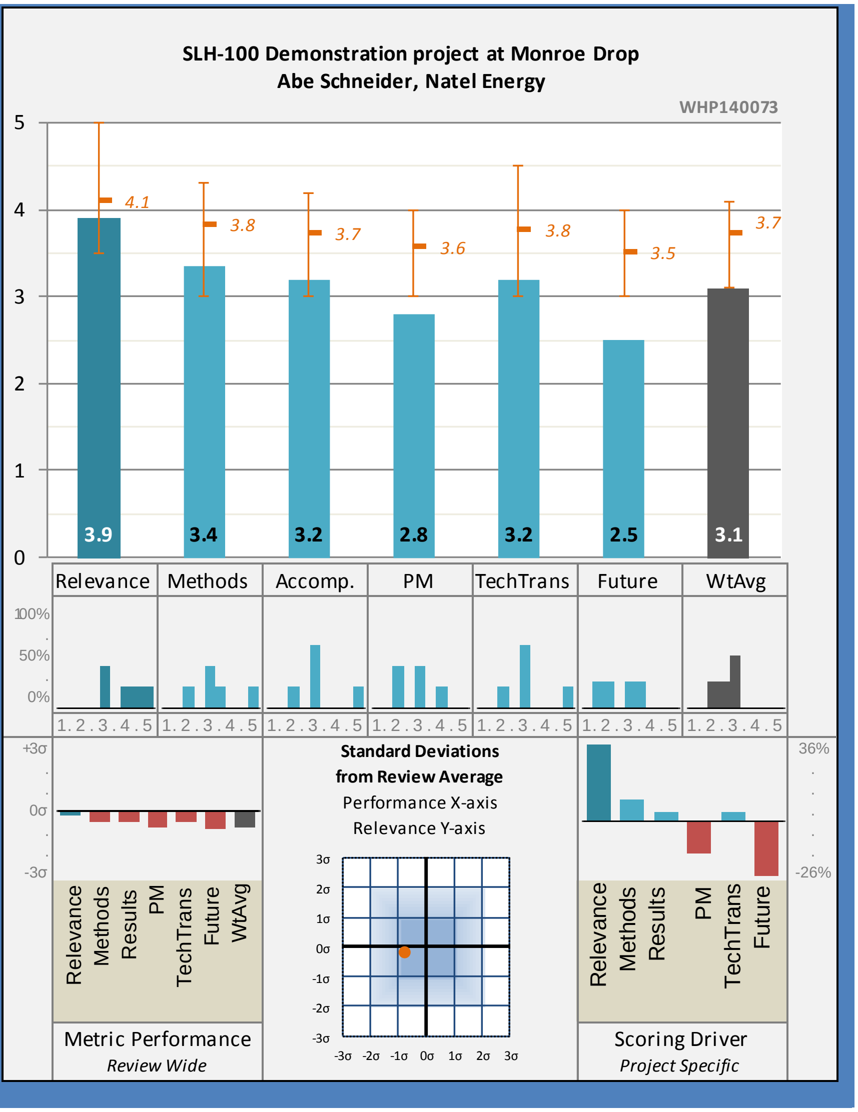
Panel:

New Hydro

Budget:

$746,042 DOE

$746,042 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.9** for its Relevance to water industry needs and overall DOE objectives.

- Need to demonstrate viability of this new technology.
- Aligns strongly with DOE goal to advance new hydropower systems and/or components for demonstration or deployment.
- There is a need for Natel Energy to think about the economic viability of developing a site using their turbine. It seems that more attention needs to be directed to savings in civil works and interconnection cost than savings from improving the mechanical efficiency.
- Looks like about $2M for this installation of 100kw? (guessing 876 MWH per year at 100% capacity factor times $70.4/MWH is $65K per year or 30 years to recover initial investment without consideration of additional O&M costs) What is the LCOE for this? There are numerous moving parts with the mechanism as

designed. In real world applications with lots of leaves, twigs, silt, plastic bottles, aluminum cans, and trash, complex mechanisms can have trouble.
- Demonstrate new technology for low head canal hydropower.
- Great opportunity for lessons learned, both technical and regulatory.
- Remove barriers to development.
- Modular.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.4** on its methods/approach.

- Good focus on keeping costs low and minimizing impacts to water flow.
- Generally solid design: run of river to minimize impact to normal operations; obernyer gate; power house is in bypass.
- Not seeing a lot of hydraulic design information about the mechanism or why it would be significantly more efficient than traditional designs or require less maintenance. Little assurances in the "design" phase.
- Good recognition that this is a demonstration project and will have special needs (oversized PH building).

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.2** based on technical accomplishments and progress.

- Accomplished a lot, but stuck on permitting.
- Behind schedule due to permitting delays.
- Has not gotten to the point of being a demonstration site over the course of several years.
- Unproven assertions of the LCOE particularly including future maintenance needs for this mechanism.

Question 4: Project Management

This project was rated **2.8** on its project management.

- Seems good, but are now up against wall.
- Project management and project planning could have been better.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.2** for research integration, collaboration, and technology transfer.

- Collaboration with irrigation district. No pubs or other collaborations.

Question 6: Proposed Future Research

This project was rated **2.5** for proposed future research.

- Little chance that this will become the product of choice for low head installations.

Strengths and Weaknesses

Project Strengths

- Looking for solution that can be applied at many other sites with same civil structure.
- Out of the box innovative approach but probably not economical or maintenance friendly.
- Modular installation.
- New technology.
- Recognizes challenges.

Project Weaknesses

- Innovative in concept but design flaws of an excessively complex mechanism will face many operational challenges due to debris, fatigue, water quality, inefficiency, and maintenance issues.
- No FERC exemption.
- NEPA not complete.

Specific recommendations for additions or deletions to the work scope

- Keep the funding going as long as good progress being made.
- Misrepresentation of the facts of the permitting process.

WHP140074

Project Title:

SLH Timing Belt Powertrain

Principal Investigator:

Abe Schneider

Organization:

Natel Energy

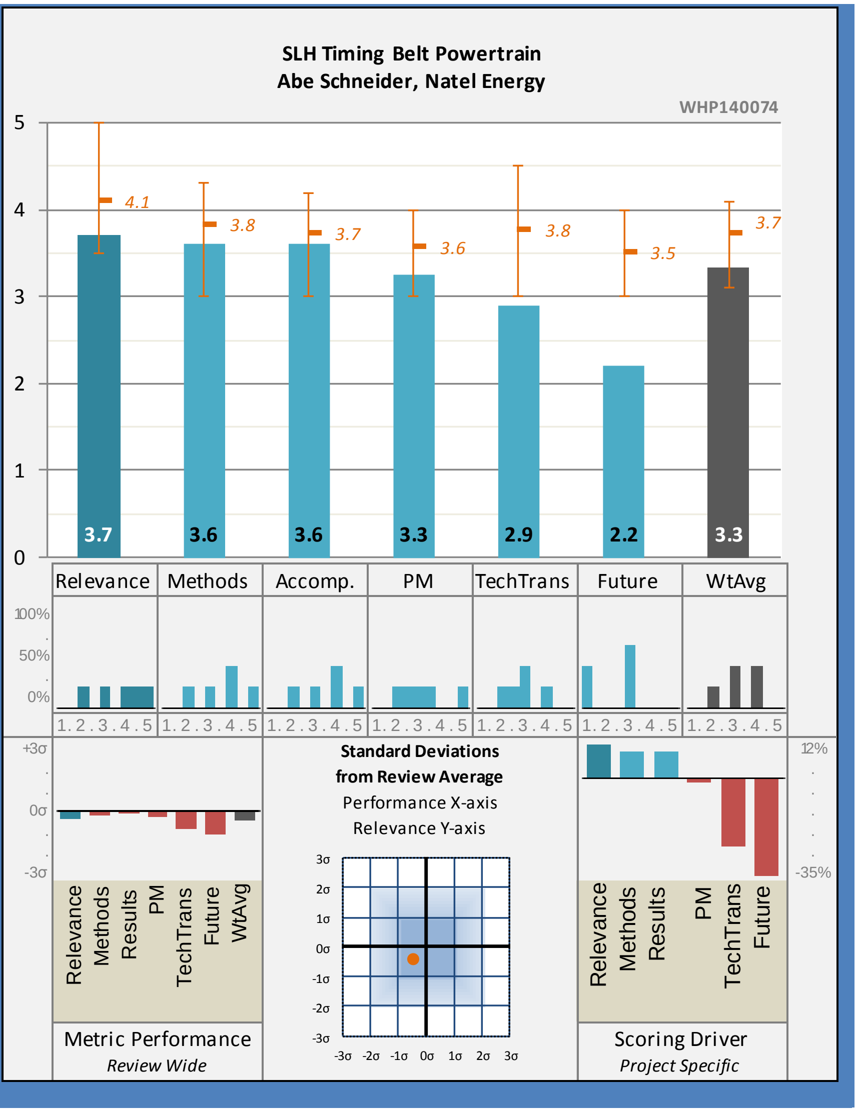
Panel:

New Hydro

Budget:

$300,000 DOE

$153,767 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.7** for its Relevance to water industry needs and overall DOE objectives.

- An essential improvement to this new technology -- fewer moving parts in power train.
- Developing a "completely different and new type of hydro machine": Aligns strongly with DOE goal to advance new hydropower systems and/or components for demonstration or deployment.
- Innovative and non-traditional design of equipment but with very low probability of successful deployments.
- Completely new technology.
- Shows promise of lower cost.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.6** on its methods/approach.

- Technical approach seems to be good: built hydraulic test facility, significant math modeling; extensive tests to create cost effective product with low maintenance.
- Design flaws are apparent.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.6** based on technical accomplishments and progress.

- Good progress with good potential for success.
- Project is completed.
- Focused on making a better belt to insert into a flawed concept. Every belt flexure and belt contact represents lost internal energy due to flexure and external friction losses due to drive slippage, essentially lowering the efficiency to the point of becoming an uncompetitive alternative. In addition, points having relative motion can trap debris and lead to mechanism jams or overstress of the connections.

Question 4: Project Management

This project was rated **3.3** on its project management.

- Good recognition of key issue.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.9** for research integration, collaboration, and technology transfer.

- Built own test facility.
- Collaborates with Alden Labs.

Question 6: Proposed Future Research

This project was rated **2.2** for proposed future research.

- Limited applicability other than to this one technology.
- None.
- Not likely to be the product of choice for low head applications.

Strengths and Weaknesses

Project Strengths

- Recognizes key issue to success of technology.
- Key focus on cost reduction.
- Clear understanding of real world operational criteria.

Project Weaknesses

- Uncertain outcome, but that's inherent in R&D.
- Complex mechanism with fatigue concerns in a clean water environment can only get worse in real world application with silt, leaves, debris, plastic bottles, etc.
- Has already been demonstrated.

Specific recommendations for additions or deletions to the work scope

- Follow up on this when it is installed and tested.

WHP140075

Project Title:

Scale-up of low-head SLH hydroengine

Principal Investigator:

Abe Schneider

Organization:

Natel Energy

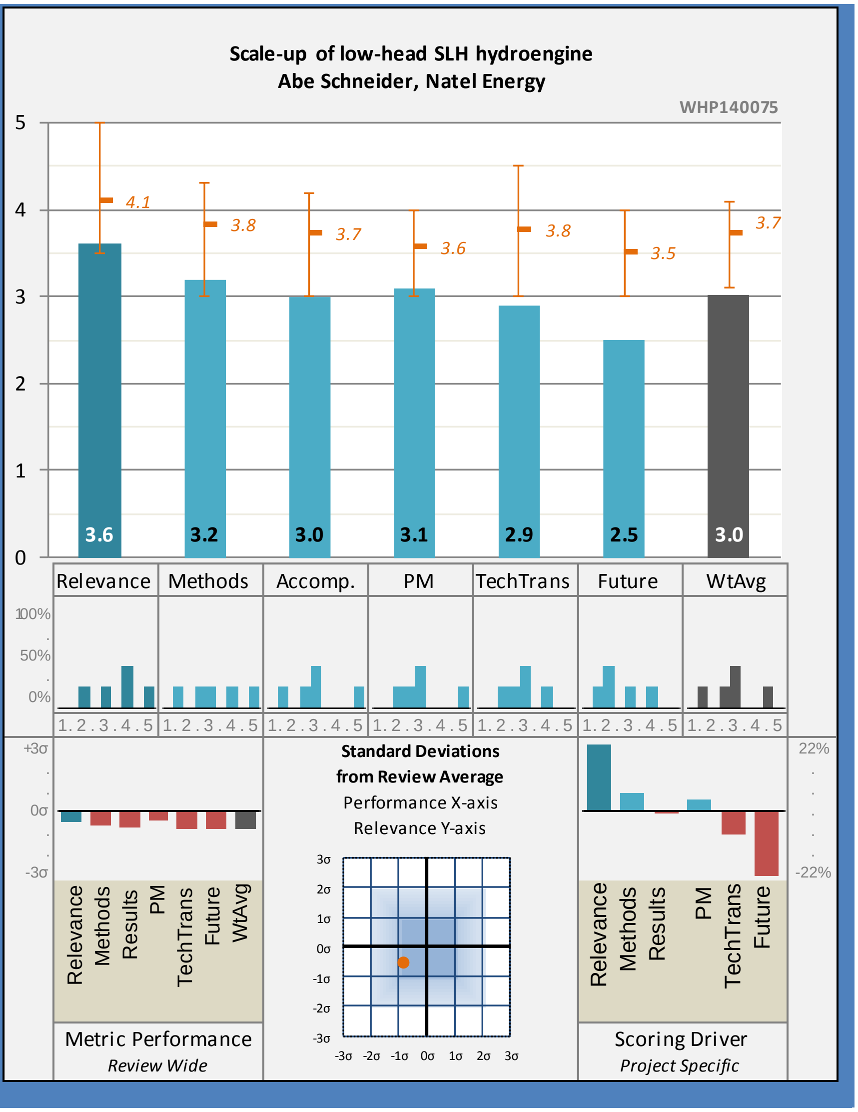
Panel:

New Hydro

Budget:

$951,058 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- Developing a "completely different and new type of hydro machine": Aligns strongly with DOE goal to advance new hydropower systems and/or components for demonstration or deployment. This project capitalizes on the previous 2; it develops a full scale prototype and was funded partly under the SBIR grant.
- A technology has to be proven and accepted first before scaling up efforts should be initiated.
- An overly complex energy conversion mechanism with unknown efficiency characteristics and significant maintenance concerns when applied in real world applications as well as unproven ability to deliver at $0.07/kwh, make this a very difficult sale.

- More critical evaluation of proposed projects in a real world environment could help DOE select those projects most likely to succeed. Appears to offer no advantage over conventional hydro systems for low head and many drawbacks are envisioned.
- Before scaling up, make sure the first prototype actually delivers efficiency improvement beyond traditional design alternatives and delivers on promised LCOE including longer term maintenance costs.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.2** on its methods/approach.

- The design is complex with many parts. This test has resulted in recommendation for further research, presumably because of design inadequacies. More detailed information is needed.
- Tremendous effort went in to belt testing of this mechanism. Many moving components and relative motions that offer points for friction, binding, foreign material entrapment, efficiency losses, etc.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.0** based on technical accomplishments and progress.

- It appears that the goals were not met although the project is completed.
- Little evidence of following traditional "design" process but rather appears closer to trial and error development of necessary belt properties.

Question 4: Project Management

This project was rated **3.1** on its project management.

- Although project is not at the stage expected upon completion, it is not clear that project management is the problem. The invention process is always uncertain.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.9** for research integration, collaboration, and technology transfer.

- Possibly limited opportunity to apply lessons learned to other hydro applications.
- Collaboration only with Alden pending patent applications.

Question 6: Proposed Future Research

This project was rated **2.5** for proposed future research.

- Mostly focused on SLH technology.
- DOE should analyze the status of this work carefully from a technical and financial perspective before making a decision to fund it further. In concept, further work is aligned with DOE objectives, but risks of high costs and not completing should be considered.
- Prototype product must deliver on promises of cost, efficiency, and maintainability BEFORE considering scale up.

Strengths and Weaknesses

Project Strengths

- New technology, new application of materials.
- Cost share funding and collaboration with highly regarded Alden Research lab.
- U.S. supply chain.

Project Weaknesses

- Real world loads likely to be different and more variable than lab tests.
- Project completed but goals not yet met. Also, costs of civil works need to be addressed.

Specific recommendations for additions or deletions to the work scope

- Maybe hold off on scaling up until Monroe is built and demonstrated to be viable. Incorporate lessons learned on Monroe as part of scale-up.
- DOE should analyze the status of this work carefully from a technical and financial perspective before making a decision to fund it further. In concept, further work is aligned with DOE objectives, but risks of high costs and not completing should be considered.
- Need to focus on civil works which is where the big costs are.

WHP140076

Project Title:

W4e (“Water for Energy”) Hydropower Turbine Generator System Validation

Principal Investigator:

Henry Russell

Organization:

Walker Wellington

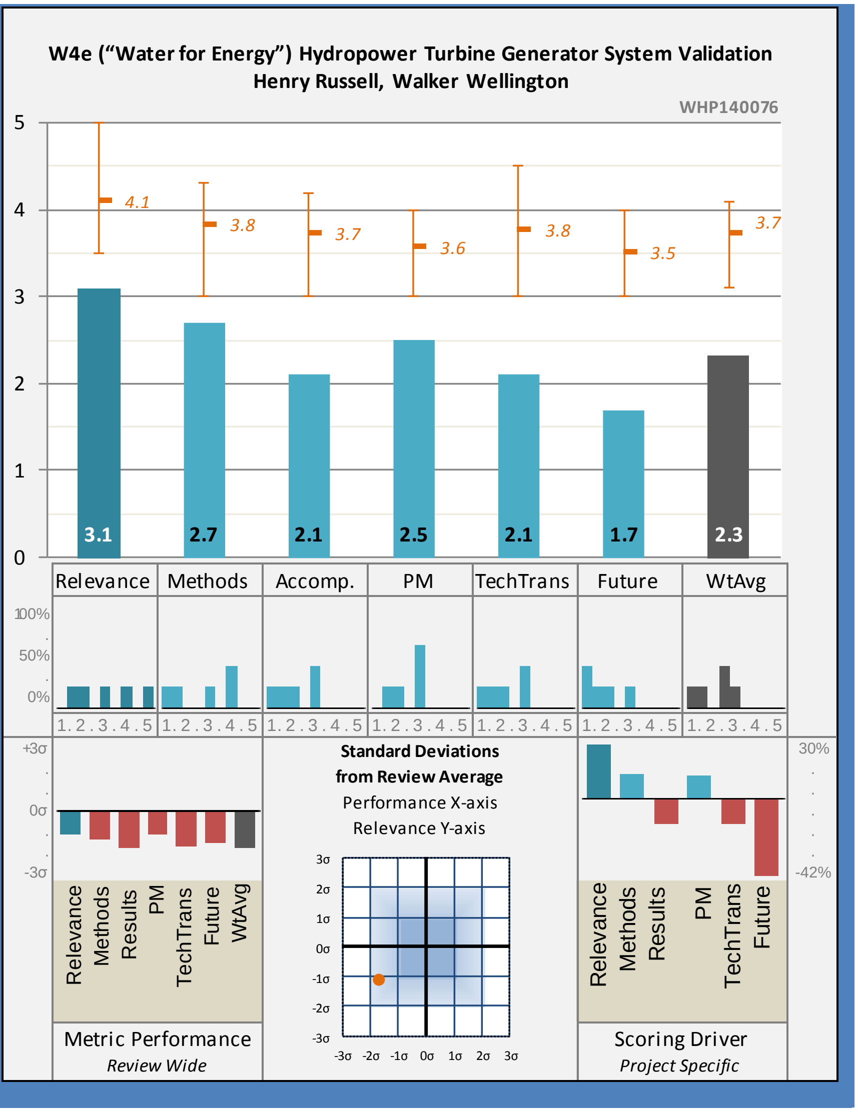
Panel:

New Hydro

Budget:

$93,000 DOE

$23,250 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.1** for its Relevance to water industry needs and overall DOE objectives.

- W4e turbine seems to have design flaws that need to be resolved/mitigated before further testing
- Turbine efficiencies of 20% and lower are not very impressive but I applaud the effort to get unbiased efficiency performance testing.
- Prove a direct drive, modular low head conduit turbine-generator.
- PI did not attend to clarify concerns relevant to the low efficiencies revealed during the earlier testing of the unit.
- Characterized under various flow conditions.

Question 2: Methods and Approach to performing the research and development

This project was rated **2.7** on its methods/approach.

- Not much delivered to the panel for evaluation. Unproven assertions and absence of presenter speak volumes of the project's expected viability.
- ASME testing for hydroturbines.
- Little evidence of hydraulic design processes. Laboratory test results can only get worse in real world installations with debris, silt, and other difficulties.
- Flow from 3 to 12 cfs and 9 to 34 feet of head.
- Independent analysis of data.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.1** based on technical accomplishments and progress.

- Measured efficiency way lower than predicted (20% v. 85%).
- Very little in the way of encouraging progress was presented and the company's representative chose not to attend.

Question 4: Project Management

This project was rated **2.5** on its project management.

- Completed within original schedule.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.1** for research integration, collaboration, and technology transfer.

- Report is available at OSTI.gov.
- OSTI ID 1096577.

Question 6: Proposed Future Research

This project was rated **1.7** for proposed future research.

- None Not warranted based on test results.
- Project completed at modest DOE share cost.

Strengths and Weaknesses

Project Strengths

- Good to investigate new technologies.

Project Weaknesses

- Forecast efficiencies were way off.

Specific recommendations for additions or deletions to the work scope

- No further investigation warranted.

WHP140077

Project Title:

Small Hydropower Research and Development Technology Project

Principal Investigator:

Callum Sullivan

Organization:

Near Space Systems

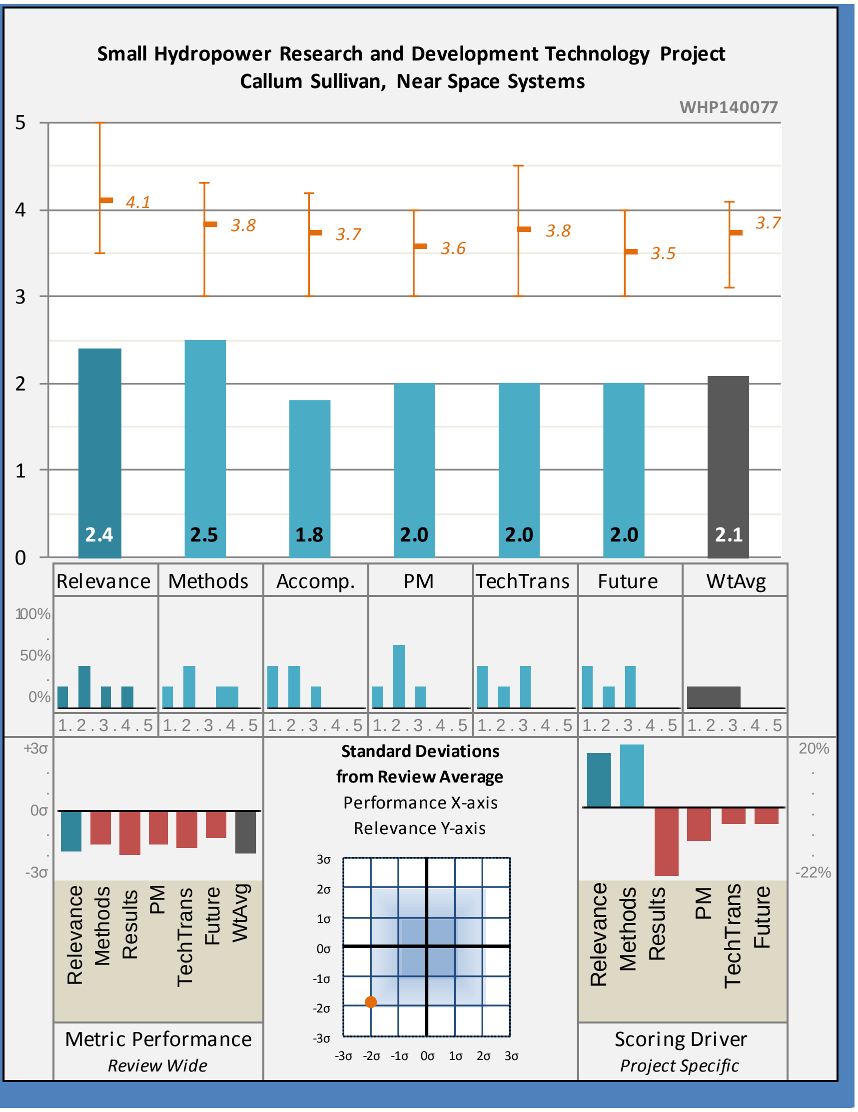
Panel:

New Hydro

Budget:

$300,000 DOE

$265,000 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **2.4** for its Relevance to water industry needs and overall DOE objectives.

- This project aligns with DOE objective of advancing new hydro systems. It is not clear how the results will be used.
- The project objective is vague, and not enough details were offered, especially when the PI did not attend
- Project closed - Unsubstantiated claims of reduced LCOE (how does one calculate and arrive at a 500% reduction in LCOE???) and unknown performance in real world situations with trash, high water, unbalance or impact loads. Unknown efficiency.
- There should not be a new turbine design before specifying what the intended site or application looks like.

Question 2: Methods and Approach to performing the research and development

This project was rated **2.5** on its methods/approach.

- I like the clean sheet approach, picking the best of existing technologies.
- Unsubstantiated words without demonstrated results. Company representation chose not to attend presentation.
- Clean sheet approach to all aspects of small hydroturbine design and performance.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **1.8** based on technical accomplishments and progress.

- Sounds like a list rather than a product at this point.
- Unclear about the accomplishments.
- Not much tangible in the presentation to demonstrate real progress toward the claimed achievements.
- Prototypical design.
- On time, but no report.

Question 4: Project Management

This project was rated **2.0** on its project management.

- Not enough information.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.0** for research integration, collaboration, and technology transfer.

- Some potential if a real project.
- No research integration, collaboration, tech transfer.

Question 6: Proposed Future Research

This project was rated **2.0** for proposed future research.

- Some potential if a real project.
- Not Applicable.
- Unconvincing progress to date.
- Construction of next generation hydroturbine.

Strengths and Weaknesses

Project Strengths

- Identification of best practices has value and should be shared with existing equipment manufacturers.

Project Weaknesses

- Doesn't seem to offer new technology. Existing manufacturers are working on these same issues.

- Report not done.
- Wish list of good stuff and promises.

Specific recommendations for additions or deletions to the work scope

- No further funding -- seems like a dead end, with little chance of producing new technology.
- Closed. Without tangible demonstrated progress, would not recommend further funding.

WHP140078

Project Title:

Laboratory Demonstration of a New American Low-Head Hydropower Turbine

Principal Investigator:

Wayne Krouse

Organization:

Hydro Green Energy

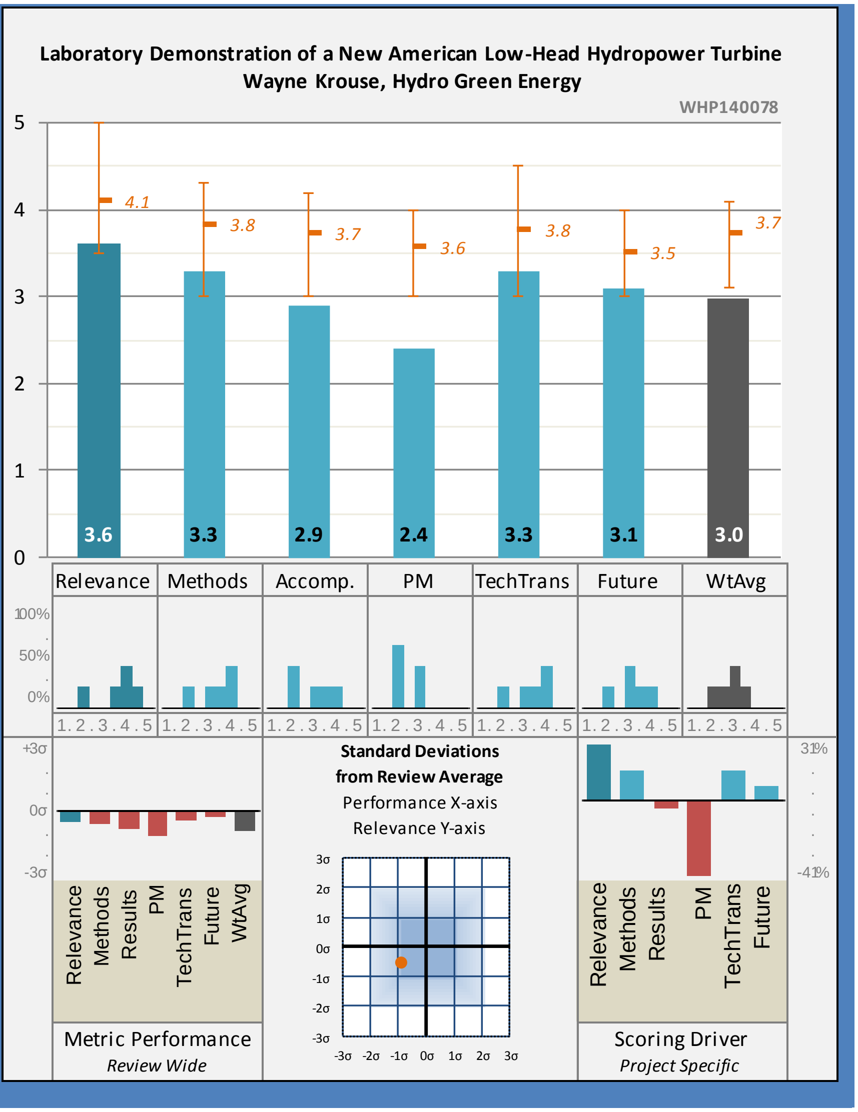
Panel:

New Hydro

Budget:

$300,000 DOE

$119,029 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- Good concept.
- Aligns strongly with DOE goal to advance new hydropower systems and/or components for demonstration or deployment.
- Project PI did not show up to the meeting.
- A viable technology that appears well suited to existing lock and dam locations with low heads.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.3** on its methods/approach.

- Matrix turbine installation concept has been around for a number of years but not yet successfully utilized in the US.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **2.9** based on technical accomplishments and progress.

- Work collaborated by Engineering consulting firm and Independent lab testing.

Question 4: Project Management

This project was rated **2.4** on its project management.

- Costs have significantly overrun.
- Major cost overruns indicate initial scoping and cost estimating was poor. Calls into question the initial LCOE estimates.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.3** for research integration, collaboration, and technology transfer.

- Good engagement with others.

Question 6: Proposed Future Research

This project was rated **3.1** for proposed future research.

Strengths and Weaknesses

Project Strengths

- Good concept. Modularity could significantly reduce cost of civil works/installation.

Project Weaknesses

- Relatively low efficiency achieved to date.

Specific recommendations for additions or deletions to the work scope

- Keep a close eye on this one. It seems close to the feasibility brink due to the low efficiency.

WHP140079

Project Title:

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

Principal Investigator:

David Brown Kinloch

Organization:

Weisenberger Mills

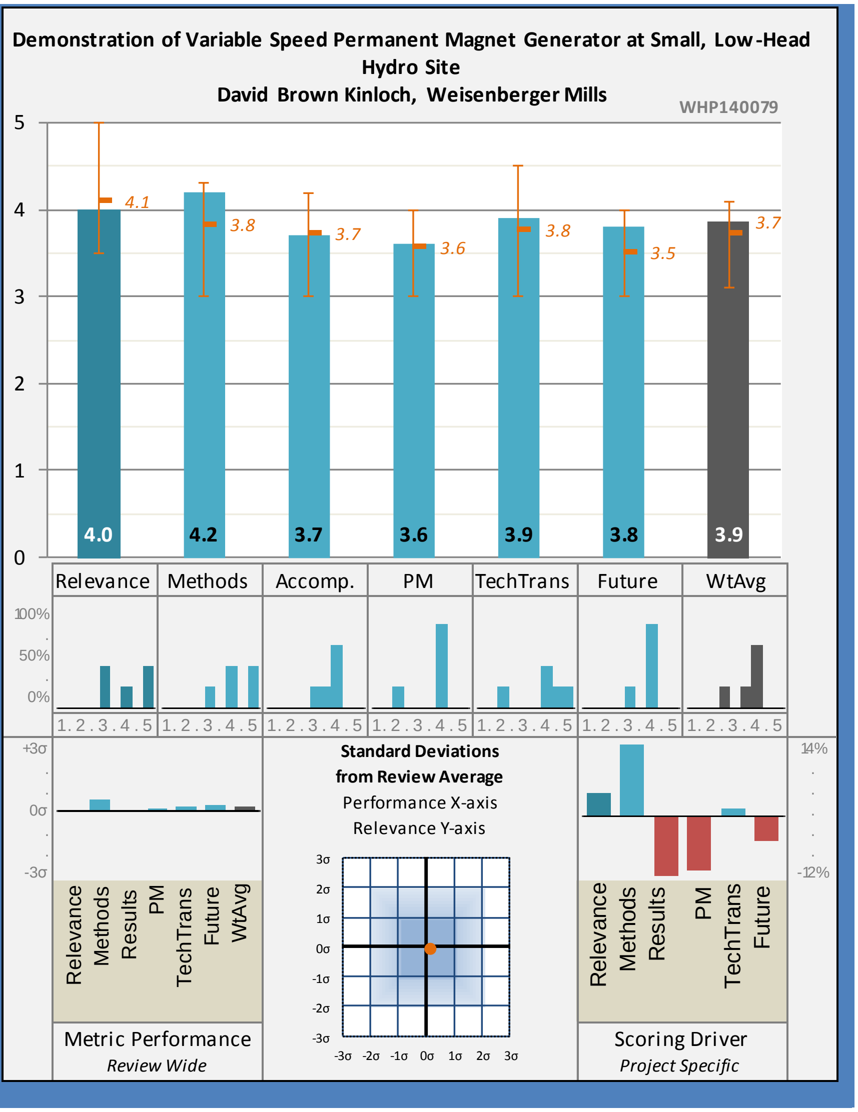
Panel:

New Hydro

Budget:

$56,000 DOE

$56,078 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.0** for its Relevance to water industry needs and overall DOE objectives.

- High value and low cost.
- Aligns strongly with DOE goal to advance new hydropower systems and/or components for demonstration or deployment.
- variable speed conversion is a very timely project, and much needed for both existing and future small hydro sites, especially in the context of renewable integration.
- Relatively low cost share. May have applicability for new small hydro but remains to be seen.
- Most low head sites have fixed blade turbines and fixed speed generators unable to respond to head variation
- Good application of new technology from wind industry.
- Demonstrates how much better a variable speed permanent magnet generator would be.

- New hydropower systems.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.2** on its methods/approach.

- Like the approach of changing only one component.
- Methodology looks solid; flood modification for "apples to apples" comparison.
- Innovative concept apparently used in the wind industry. May have limited applicability.
- Apples to apples approach with the only change being the induction generator to the PMG.
- Like the self-calibrating system.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.7** based on technical accomplishments and progress.

- Delays due to drought (can't test high flows); inverter change - etc.; will finish this spring. Success likely.
- Results significantly delayed.
- 4% losses in inverter.

Question 4: Project Management

This project was rated **3.6** on its project management.

- PM appears strong and competent. Delays could not be avoided. Additional costs (due to floor problems) will be absorbed by company; cost share % will go up.
- Perhaps not thoroughly thought out since powerhouse required modification for the loads associated with equipment.
- Behind schedule for cause.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Good opportunity.
- Well integrated with industry and Center for Applied Energy Research; one conference paper.
- Not likely a lot of transferability but worth minimal investment experimentation.
- Could be very beneficial to small hydro developers.
- Costs slightly higher than an induction system but still a lot cheaper than a synchronous system.
- Off the shelf ABB variable speed drive for the inverter.

Question 6: Proposed Future Research

This project was rated **3.8** for proposed future research.

- Plan to ramp up if successful.
- Future efforts to ramp up from 50 KW to 2.64 MW at each of 2 new sites and add new Norwegian "Turbinator"; high likelihood of success.
- Much cheaper than synchronous generators, may have a niche in small hydro.

- Looking at ramping up by adding two new plants. Talking to the "Turbinator" manufacturer about changing generator to PMG.

Strengths and Weaknesses

Project Strengths

- Great concept.
- Low cost to DOE, good design and methodology, preserves a valuable historic and ongoing business.
- Self-calibrating (bump up, bump down).
- Low cost.
- Good approach.
- High potential for application.

Project Weaknesses

- Delayed; however, for good reasons.

Specific recommendations for additions or deletions to the work scope

- Watch out for arc flash risks in increasing voltage of controls to 480v.

WHP140080

Project Title:

Cost Data Collection and Modeling for Hydropower NEW

Principal Investigator:

Qin Fen (Katherine) Zhang

Organization:

Oak Ridge National Laboratory

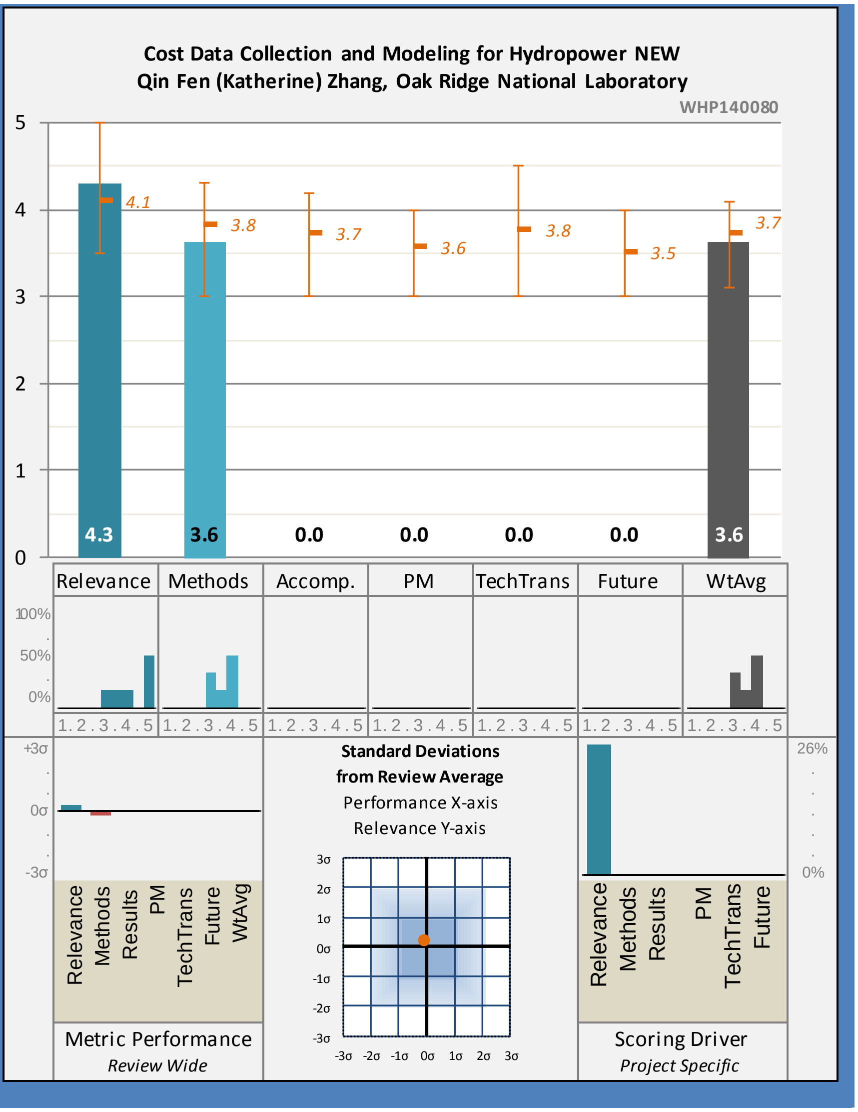
Panel:

New Hydro

Budget:

$2,000,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.3** for its Relevance to water industry needs and overall DOE objectives.

- An important addition to the Data Base.
- This project aligns with all of DOE's goals and objectives because ultimately cost will be central to all transitions in the hydro industry. This project addresses the recognition of the gaps in data and in cost analysis and would primarily support DOE's R&D effort.
- The "cost inventory and database" leveraging what is already available would be useful, however, the two modeling objectives seem to be research oriented more than industry need.
- A $2M project with some value although a wide range of cost uncertainty would be possible because application to specific sites is highly site dependent.
- Improvement in the accuracy of estimating costing of new hydropower resources, including new technologies.

- This project can help focus DOE plans for future research. It can also help developers by providing greater perspective regarding costs as well as consideration of a range of site-specific requirements. The focus initially is on NPD and ROR projects. It meets a need for a consistent way to develop costs for representative turbine base case conditions, fish-friendly turbines, aerating wheels, alternatives, and operations.
- Primary use may be to support policy. May also have value for relative feasibility screening. Developers will do their own cost analysis.
- when it comes to hydropower development, It is very difficult to generalize, as every site is unique in development needs/costs.
- Quantification of cost drivers and barriers.
- It would be more efficient to re-scope the modeling components of this project to leverage readily available cost tools and try to improve on their shortcomings and gaps.
- Possibility of new technologies reducing cost.
- Lack of water quality conditions at non-powered dams and new sites can be a barrier to development. These sites often require water quality modeling and, sometimes, additional data.
- Advanced statistical techniques are not needed when the sample size is very small
- Costs for aeration requirements are very site-specific because of project DO conditions (DO range, <0-8 mg/L) as well as regulatory requirements (DO range, 4-10 mg/L), so there is a wide cost range. Consider a range of aeration requirements: none, low, moderate, high, extreme. Also, need to consider whether aeration is sufficient or oxygen is required.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.6** on its methods/approach.

- Approach seems appropriate, be careful to stay at high level appropriate for relative screening purposes
- Technical approaches look solid; data structure and collection; new modeling capabilities (strong component); integrated model validation; new technology? Life-cycle costs considered. Quantification of uncertainty would be useful. Approach can be better assessed and informed by development of a specific list of questions that can be answered by the data and analysis tools.
- Difficult to use generic data to make forward cost estimates of any specific sites.
- Sharing agreements with industry and owners.
- Focus on NPD and ROR sites initially is good.
- Important to tie into EUCG both for data and lessons learned in gathering and validating data
- Overall approach is good, but highly recommend engaging developers early in process as well as intermittently during the project to ensure DOE is responsive to their requirements. For example, I understand that Chinese manufactured turbine systems are being considered by some, if not many, developers.
- Given the variability between project sites and developers' needs, I would think breadth of analysis in the integrated model will be more important than the results of the baseline cost model.

Strengths and Weaknesses

Project Strengths

- Adding high-level cost information to data base is of value at least for getting ranges and possibly for relative screening.
- This kind of data is greatly needed; plan for cooperation with hydro industry; addition of analysis tools.
- Could be helpful to have general cost estimate but would have limited application.

- Improved cost estimating would be very useful to developers and those performing resource assessments of hydropower potential. This is especially true for new technologies that might be less costly.
- This project can help focus DOE plans for future research. It can also help developers by providing greater perspective regarding costs as well as consideration of a range of site-specific requirements. The focus initially is on NPD and ROR projects. It meets a need for a consistent way to develop costs for representative turbine base case conditions, fish-friendly turbines, aerating wheels, alternatives, and operations.
- Case study on the Alden Fish Friendly Turbine is beneficial since it is the initial cost of that design and associated increased excavation that has kept those projects from moving forward.
- Feeds the cost model for the NHAAP.
- Useful for policy and screening level decisions.

Project Weaknesses

- High number of site-specific variables can overwhelm this project.
- Need to be able to determine variability or uncertainty for both data and model output.
- Difficulty using other recently constructed hydro plants to determine an appropriate estimate for construction of a new plant. Site differences, equipment selection differences (overseas manufacturers with little history vs. tier 1 supplier), builder strategy (build to sell or build to operate), actual location and regulatory environment for that location, etc. etc. all make major differences in cost for new plants.
- $2 million.
- High risk of getting buried in data or having to make so many assumptions that results are not valuable.
- There is so much that is site dependent for most every hydropower project that I have been involved with, so cost is a hard thing to nail down. There is a point of diminishing returns.

Specific recommendations for additions or deletions to the work scope

- Important to distinguish between different kinds of facilities
- Emphasize high level uses of cost data with large uncertainty bands. Digging too deep may not deliver incremental value.
- Important for DOE to engage developers early in process as well as intermittently during the project to ensure DOE is responsive to their requirements.
- Design the project and keep cost data at very high level appropriate for relative screening, identifying trends and supporting policy.

WHP140081

Project Title:

New Hydropower Innovation Collaborative NEW

Principal Investigator:

Brennan Smith

Organization:

Oak Ridge National Laboratory

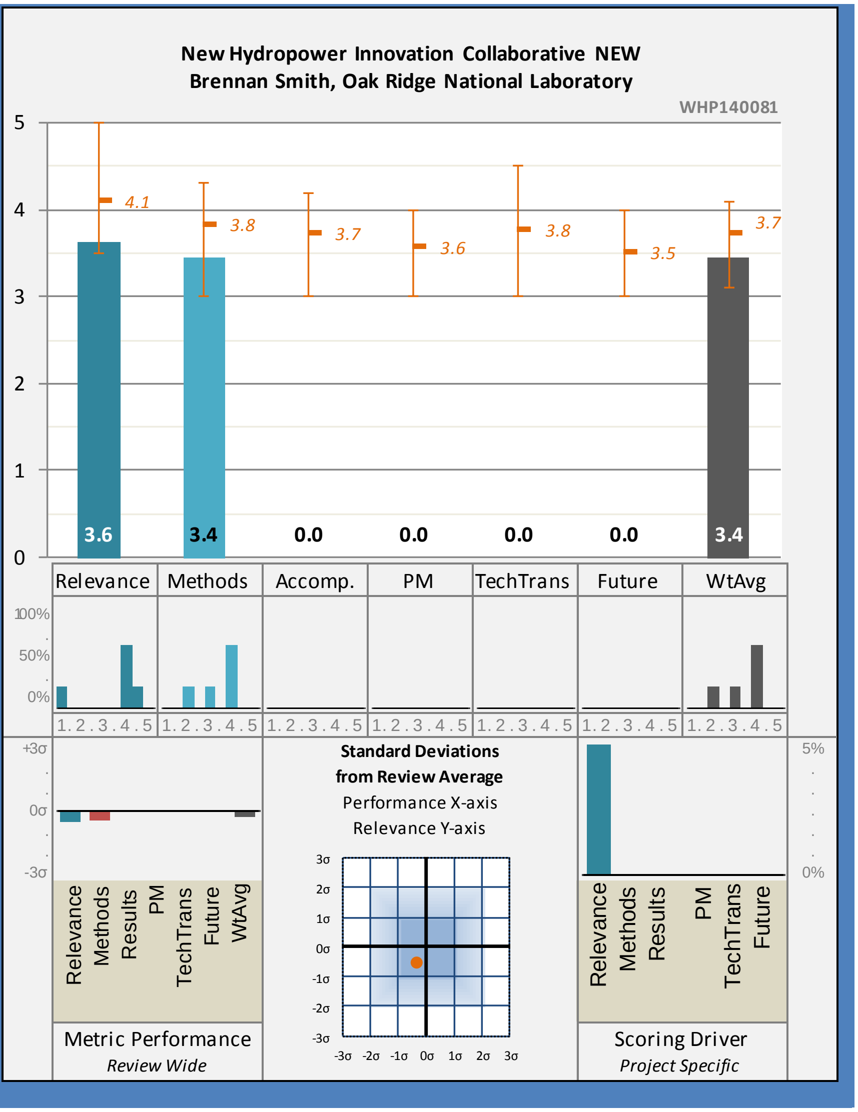
Panel:

New Hydro

Budget:

$315,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.6** for its Relevance to water industry needs and overall DOE objectives.

- Concept of a center for aggregating innovation is a great idea.
- This project aligns with the goals of advancing new hydropower systems and/or components for demonstration or deployment.
- The utility value of the final product and the targeted audience/users should drive the development of the scope for any project.
- Interesting concept that merits further work. Comprehensive energy policy and strategy could go a long way toward supporting and sustaining all renewables.
- Traditional economies favor large hydropower; traditional financing mechanisms do not.

- Duplicate efforts should be minimized and better integrated across different DOE programs and ORNL, PNNL, etc.
- Reports New Pathways to Hydropower Feasibility (project) and A New Agenda for Hydropower Transformation (policy).
- Studies that are meant to inform policy level decisions need to be conducted so that results are at the granularity needed to report in a policy setting.
- How do you deal with failure in an innovative industry.
- There is a need to find creative ways to incentivize development of small hydropower projects beside technology innovation.
- From industry perspective, one should keep in mind that utilities only seek implementable proposals/ideas, whether it relates to technology, regulatory process, development roadmap, lessons learned, best practices, etc.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.4** on its methods/approach.

- Need to maintain collaborative approach to identifying ideas.
- The approach is innovative (not typical analysis) and risky, but applaud that DOE is willing to fund this. This score reflects the innovative approach and uncertainty of the success.
- The policy and advocacy pieces are critical to future development and sustainability of hydro resources.

Strengths and Weaknesses

Project Strengths

- Great concept, could be of high value.
- Innovative approaches in this area are needed. Great that DOE is supporting this.
- Bringing together innovative collaborators and thinkers.

Project Weaknesses

- Will thought leaders share their most innovative ideas?
- Risky in terms of ultimate use.
- Fairly narrow group of individuals involved.
- Have not addressed greenhouse gas reduction and possibly pump storage.
- Question what we are going to get out of this that we don't already know.

Specific recommendations for additions or deletions to the work scope

- Might be more valuable as a forum than a product. Who is going to use the product?
- Continue to support and follow up project with evaluation of usefulness.
- Steer toward more specific topic and gathering of experts and new innovators to discuss ideas and concepts
- Do any of the other renewable technologies have this? How about wind? If so, how is it working? Is it of value?

7.3 Pumped-Storage Hydropower and Integration

Conventional and pumped-storage hydropower can increase the flexibility and stability of the U.S. electric grid and support the integration of variable renewable resources like wind and solar. The Water Power Program quantifies the benefits of effective and cost-competitive hydropower technologies and communicates those benefits to stakeholders. The Water Power Program is collaborating with Argonne National Laboratory to model the vast range of advanced pumped-storage hydropower capabilities with the aim of quantifying its full economic value. Studies like this one will help demonstrate the numerous and varied services hydropower can provide for today's modern electric grid.

Addressing Comments for Pumped-Storage Hydropower and Integration

The Hydropower Peer Review Panelists recorded many useful and actionable comments during their review of the Office's Pumped Storage Hydropower projects. These comments will be used to make key decisions and recommendations to those projects that will still be receiving continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy into the future.

Due to the nascent nature of WWPTO's pumped storage hydropower work, Panelist feedback focused on the intent of this new body of work as well as the importance of properly valuing the benefits of this largely untapped resource in the United States. In particular, Panelists encouraged projects that focus on the importance of hydropower for integrating variable renewables onto current U.S. electric grids.

As WWPTO further develops its Pumped Storage Hydropower portfolio, the Panelist feedback recorded herein will contribute to the development of that strategy and the expansion of this area of work.

Table 7.3.1 lists the existing Pumped-Storage Hydropower and Integration projects that were reviewed during the 2014 Peer Review meeting. Figure 7.3.1 illustrates the standard deviation of scoring of the existing Pumped-Storage Hydropower and Integration projects in relation to the scoring of all projects reviewed in 2014.

Table 7.3.1 Existing Pumped-Storage Hydropower and Integration projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing Hydropower Projects			5.5	4.0	3.7	3.6	3.6	3.7	3.4	**3.6**
Average for Existing Pumped-Storage Hydropower Projects			5.0	4.0	3.8	3.9	3.9	3.6	3.3	**3.8**
8.1.1 Modeling and Analysis of Value of Advanced Pumped-Storage Hydropower in the U.S.	Vladimir Koritarov	Argonne National Laboratory (Lead)	5.0	4.5	3.9	4.3	4.0	4.1	3.8	**4.0**
Modeling and Analysis of Value of Pumped Storage Hydro in the United States	Erik Ela	National Renewable Energy Laboratory	5.0	4.4	4.0	4.0	4.0	3.8	3.4	**3.9**

Iowa Hill Pumped-Storage Project	Scott Flake	Sacramento Municipal Utility District	5.0	3.1	3.5	3.5	3.6	3.0	2.7	**3.4**

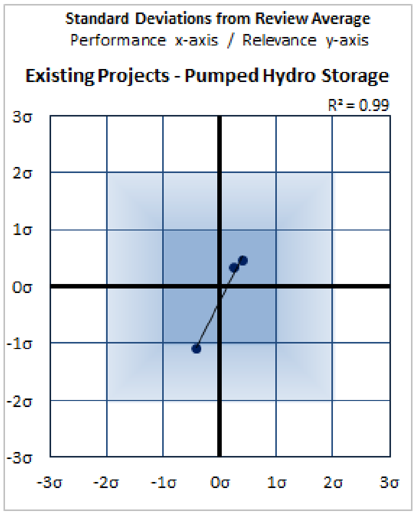


Figure 7.3.1 Existing Pumped Storage Hydropower and Integration projects

Table 7.3.2 lists the new Pumped-Storage Hydropower and Integration projects that were reviewed during the 2014 Peer Review meeting. Figure 7.3.2 illustrates the standard deviation of scoring of the new Pumped-Storage Hydropower and Integration projects in relation to the scoring of all projects reviewed in 2014.

Table 7.3.2 New Pumped-Storage Hydropower and Integration projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Weighted Average Score
Average for Review			5.0	4.1	3.8	**3.7**
Average for all New Projects			5.2	4.2	3.8	**3.8**
Average for New Hydropower Projects			5.5	4.3	3.9	**3.9**
Average for New Pumped-Storage Hydropower Projects			5.0	4.4	3.9	**3.9**
Real Time Market Analysis NEW	Erik Ela	National Renewable Energy Laboratory	5.0	4.4	4.0	**4.0**
8.1.2 Optimization of Pumped Storage Hydro Operation in Real Time Markets NEW	Vladimir Koritarov	Argonne National Laboratory (Lead)	5.0	4.5	3.9	**3.9**

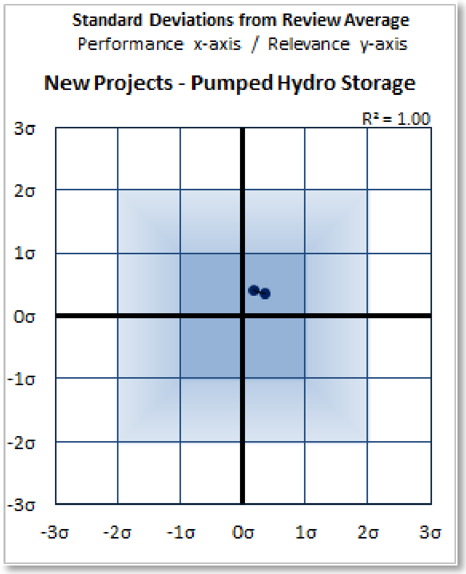


Figure 7.3.2 New Pumped-Storage Hydropower and Integration projects

WHP140092

Project Title:

8.1.1 Modeling and Analysis of Value of Advanced Pumped Storage Hydropower in the U.S.

Principal Investigator:

Vladimir Koritarov

Organization:

Argonne National Laboratory (Lead)

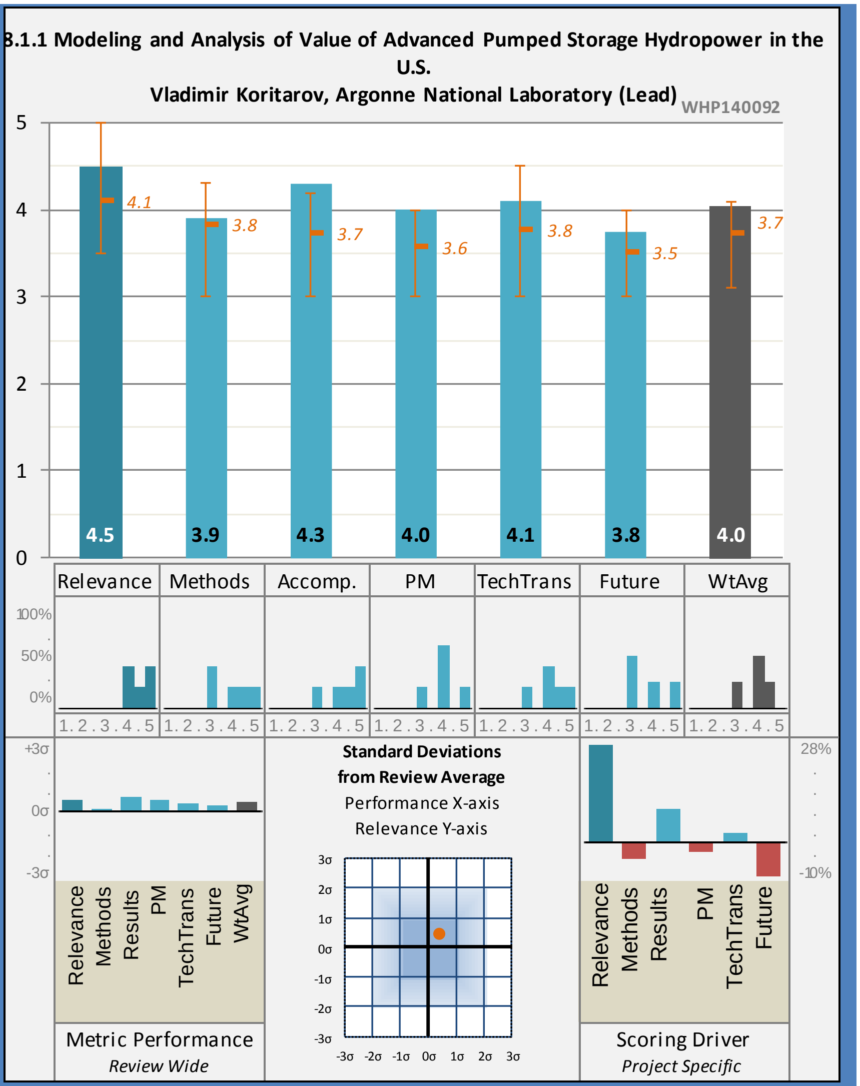
Panel:

Pumped Storage Hydro

Budget:

$1,875,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.5** for its Relevance to water industry needs and overall DOE objectives.

- Need to promote PSH and its appropriate valuation.
- This project is highly relevant to DOE objectives of enabling the next generation pumped storage technologies to facilitate renewable integration.
- PLEXOS model shows % cost savings with PSH.
- Necessary information to help with decisions for new APSH.
- Helps answer important questions.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.9** on its methods/approach.

- Methods address critical questions about PSH and will provide models that represent the operation and value of PSH under different timescales and market conditions. The result will be cost free dynamic model components that can be integrated with any other system model. The tools also include modeling of adjustable speed PSH, a promising technology used elsewhere in the world but not yet in the US. The modelers and modeling methods and tools are proven and highly likely to succeed.
- Strong industry advisory panel.
- Advisory team was a good idea.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.3** based on technical accomplishments and progress.

- Accomplishments include modeling, data regarding the PSH technical and operational characteristics and services and contributions; also completed were simulations of real systems and a total of 7 reports of all data and results. Good quantity and quality of results.
- Several published technical reports.

Question 4: Project Management

This project was rated **4.0** on its project management.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.1** for research integration, collaboration, and technology transfer.

- Good utilization of other DOE models/data and coordination w/other PSH projects.
- This project involves labs, private companies, and an advisory board that includes most of the larger utilities, agencies, PMAs, EPRI, NHA, etc. Seven reports have been issued and several papers. Four advisory working group meetings were held.

Question 6: Proposed Future Research

This project was rated **3.8** for proposed future research.

- Future research would align well with DOE's objectives w.r.t. PSH.
- Modular and small scale PSH.

Strengths and Weaknesses

Project Strengths

- Need to promote PSH and its appropriate valuation.
- Very important PSH dynamical operations and market models developed and made available as well as data. Much was accomplished with relatively small budget. Advisory board representing most of hydro industry and research.

- Helps answer some key questions.

Project Weaknesses

- None noted.

<u>Specific recommendations for additions or deletions to the work scope</u>

- Keep the focus on the importance of hydro for integrating the variable renewables and the appropriate valuation of HPS in the market.
- Fund the same investigators for the proposed follow on study of small PSH.
- I think this is important information as we work to integrate variable resources into the grid.
- I think there would be benefit of a more focused steering committee that understand markets to directs all of the pump storage research.

WHP140093

Project Title:

Modeling and Analysis of Value of Pumped Storage Hydro in the United States

Principal Investigator:

Erik Ela

Organization:

National Renewable Energy Laboratory

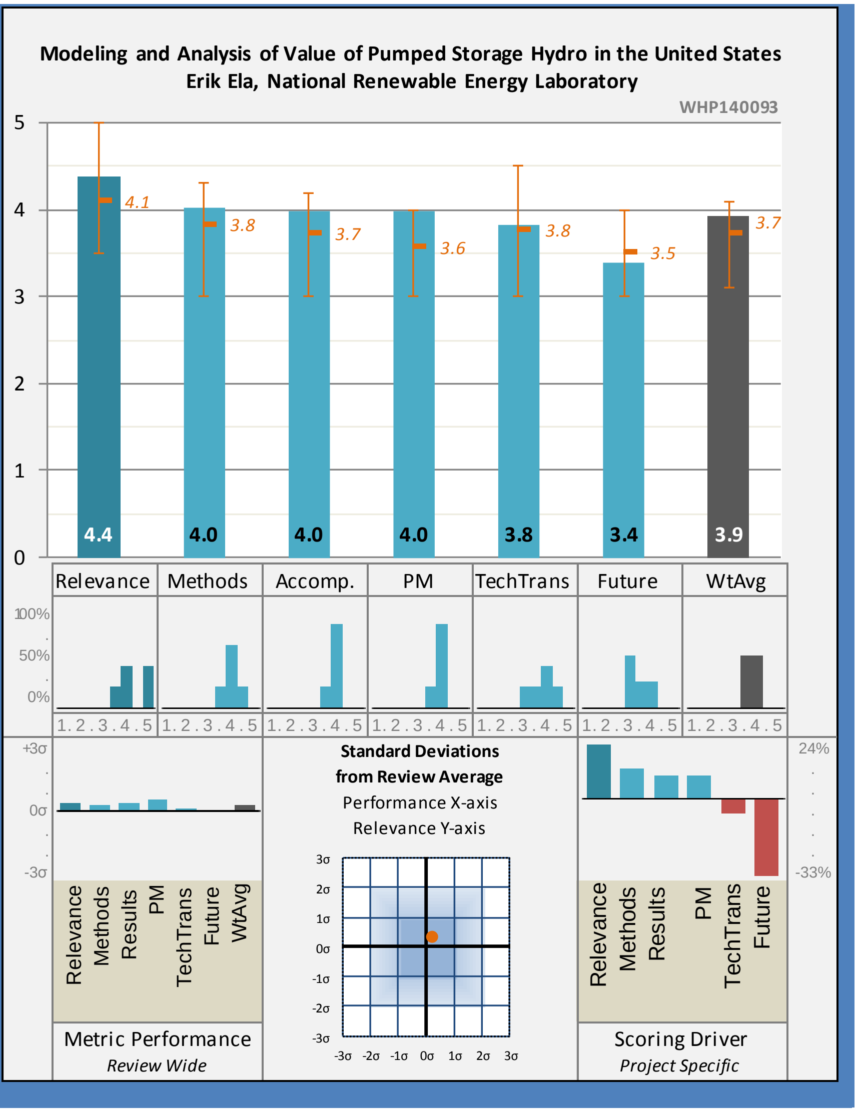
Panel:

Pumped Storage Hydro

Budget:

$0 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.4** for its Relevance to water industry needs and overall DOE objectives.

- High value.
- This project is relevant to DOE objectives of enabling the next generation pumped storage technologies to facilitate renewable integration.
- In addition to available capacity, modeling Pumped storage need to be driven by price volatility and hourly shape factors.
- SMUD system savings of $370K per week (~$20M per year), with existing valuation methodologies, is insufficient to create an attractive payback period with PSH. Additional value reimbursement mechanisms will be needed.
- Critical to understanding how to integrate renewables into the grid.

- Constraints in operating the existing Pumped storage fleet need to be represented.
- In dispatching existing Pumped storage fleet, one should adhere to owners/operators criteria and not optimization engine results, specially transient concerns and its impact to mechanical and structural setup
- Production models should not be wired to preference adding pumped storage over using combined cycle or combustion turbines.
- Results should be representative of the seasonal and locational variation.
- One should start by adding planned pumped storage capacity at their intended location on the grid before randomly assuming new capacity.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- Good idea to focus on WECC.
- Integrated portfolio approach and owners willingness to participate outside their BA and/or ISO should be reflected in the model.
- Clearly, explains the economic challenges of pumped storage development that will continue unless there are changes in the existing valuation mechanisms for reliability premiums/benefits and long term avoided costs to the system.
- Looking at lost opportunity costs, other ancillary services that have not been historically part of the U.S. Market.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.0** based on technical accomplishments and progress.

- Key objective was to "develop a business case for new investment in PSH". Was this accomplished?
- One contribution is the modeling setup for analysis.
- Avoided costs to the other assets in the system or portfolio are not adequately recognized. Production costs are only one piece… a much larger piece is the avoidance of wear and tear expenses to other assets in the system fleet and their shortened life expectancy resulting from cyclic operation.

Question 4: Project Management

This project was rated **4.0** on its project management.

- No comments.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.8** for research integration, collaboration, and technology transfer.

- Good integration w/ other PSH projects. Good collaboration with stakeholders.
- Excellent collaboration and apparent use of industry advisory group.
- Can be applied to other control areas.

Question 6: Proposed Future Research

This project was rated **3.4** for proposed future research.

- NA - project completed.

Strengths and Weaknesses

Project Strengths

- Need to promote PSH and its appropriate valuation.
- Helps answer some key questions.

Project Weaknesses

- Final Report not available.

Specific recommendations for additions or deletions to the work scope

- Keep the focus on the importance of hydro for integrating the variable renewables and the appropriate valuation of HPS in the market.
- Avoided costs to the other assets in the system or portfolio are not adequately recognized. Production costs are only one piece… a much larger piece is the avoidance of wear and tear expenses to other assets in the system fleet and the shortened life expectancy resulting from cyclic operation.
- Don't say you have a final report when you have a draft.
- High value to "make the business case for new investment in PSH".

WHP140094

Project Title:

Iowa Hill Pumped-Storage Project

Principal Investigator:

Scott Flake

Organization:

Sacramento Municipal Utility District

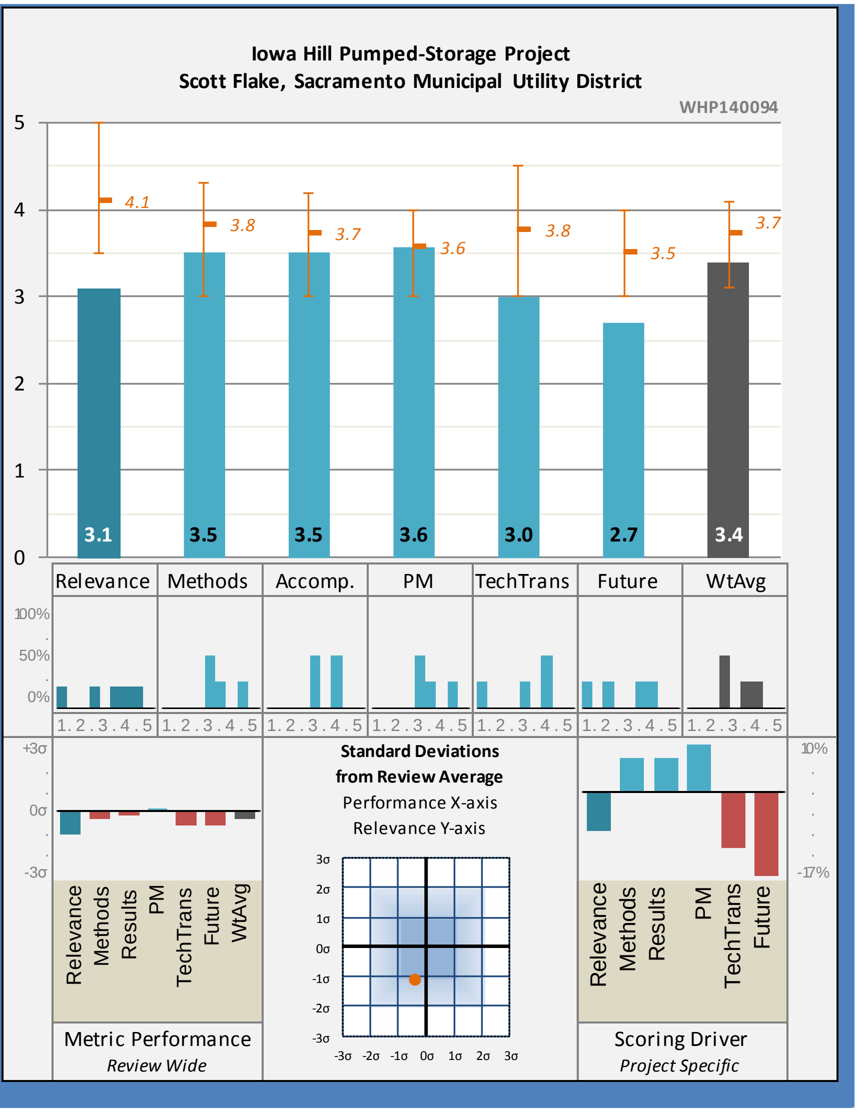
Panel:

Pumped Storage Hydro

Budget:

$5,461,138 DOE

$7,845,178 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **3.1** for its Relevance to water industry needs and overall DOE objectives.

- Appropriate to select an advanced/probable HPS project and support its success -- need to build a new HPS
- Although the geotechnical challenges of developing PSH are an issue, this part of the study aligns with DOE's objectives only marginally. The modeling study aligns with the goal of enabling the next generation pumped storage technologies to facilitate renewable integration. The study has more specific than general project implications.
- The study results are underestimating the value of PSH assets, especially in CA, assuming that SMUD is allowed to offer AS into CAISO.

- Project improves the understanding of existing value streams credited to pumped storage. Estimated savings of $53M per year, with existing valuation methodologies, would make payback of building PSH quite challenging.
- Adjustable speed turbine provides 65% more savings in high wind penetration over fixed speed turbines.
- Please validate your model results using historical LMP for a specific node near a load pocket, as average prices will normalize peaks and dips, which are the basis for PSH dispatch.
- One should be careful in publishing findings from models that are not designed to discover the actual value and need of PSH, especially in the context of renewable integration. As this will send the wrong message on the actual future need for PSH installations.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.5** on its methods/approach.

- The value stream modeling approach addressed the key questions about integrating renewables, variable vs. fixed speed, and effects on the thermal system. The results provide useful information. The analysis, using plexos, seems well conceived and well executed. The geotech analysis is not as clear as to the methodology.
- Subsidizing the geotechnical exploration as part of a demonstration project does not have great transferability for the R&D program but the value stream analysis should be useful.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.5** based on technical accomplishments and progress.

- The geotechnical part of the project is delayed; the model part is completed.
- Good progress on value stream analysis and initial borings.

Question 4: Project Management

This project was rated **3.6** on its project management.

- No comments.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.0** for research integration, collaboration, and technology transfer.

- Taking good advantage of lessons learned on other recent PSH projects abroad.

Question 6: Proposed Future Research

This project was rated **2.7** for proposed future research.

- Makes sense to nudge this project forward.
- Funding for the geotechnical part of the project should be carefully monitored; cost overruns probable.

Strengths and Weaknesses

Project Strengths

- SMUDs unique circumstances make this one of the highest probability HPS projects.
- This study could result in deployment of a new PSH unit. Modeling analysis indicates significant benefits.
- Met purpose of accelerating ongoing pump storage development.

Project Weaknesses

- The geotech part of project is behind schedule, of uncertain cost, and not central to DOE objectives.
- Benefit fairly limited to SMUD.

Specific recommendations for additions or deletions to the work scope

- Emphasize the unique set of circumstances that add value to this project and helped it get selected.

WHP140095

Project Title:

8.1.2 Optimization of Pumped Storage Hydro Operation in Real Time Markets NEW

Principal Investigator:

Vladimir Koritarov

Organization:

Argonne National Laboratory (Lead)

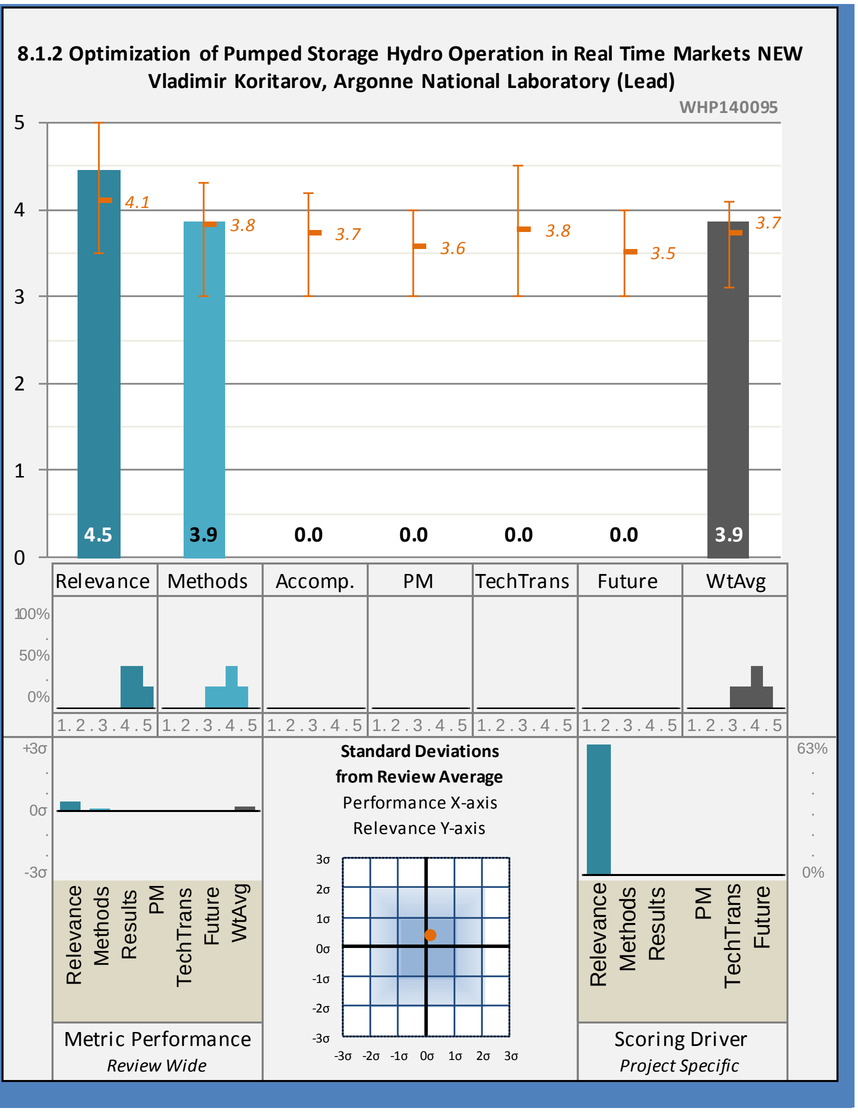
Panel:

Pumped Storage Hydro

Budget:

$250,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.5** for its Relevance to water industry needs and overall DOE objectives.

- High value project.
- Highly relevant - how much value can come from optimization of PSH.
- The study results are underestimating the value of PSH assets, especially in CA.
- Project may provide insight into why pumped storage is often undervalued in de-reg markets and how market drivers unintentionally encourage suboptimization of pumped storage performance.
- Please validate your model results using historical LMP for a specific node near a load pocket, as average prices will normalize peaks and dips, which are the basis for PSH dispatch.

- One should be careful in publishing findings from models that are not designed to discover the actual value and need of PSH, especially in the context of renewable integration. As this will send the wrong message on the actual future need for PSH installations.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.9** on its methods/approach.

- Too DOE/Nat'l lab - centric. Utilize results of other studies and involve industry stakeholder, including PSERC.
- Compares traditional operation with optimized operation of PSH in DA and RT markets using a production cost model with sub-hourly timestep for the optimized case. This is a good, useful approach.

Strengths and Weaknesses

Project Strengths

- An important topic for better utilization of PS.
- Good method defined and will answer important questions about potential value of PSH.
- Involved Colorado Springs Utilities as a real life test of a small but diverse system.
- Possible direct benefit to the knowledge stream on Mt. Elbert PSH since they are one of the resources for Colorado Springs Utilities.

Project Weaknesses

- Uncertain if system operators will adopt the results of study.

Specific recommendations for additions or deletions to the work scope

- Keep the focus on the importance of hydro for integrating the variable renewables and the appropriate valuation of HPS in the market.
- Same comment. Need a focused steering committee to keep them going in the needed direction and answer the right questions.

WHP140096

Project Title:

Real Time Market Analysis NEW

Principal Investigator:

Erik Ela

Organization:

National Renewable Energy Laboratory

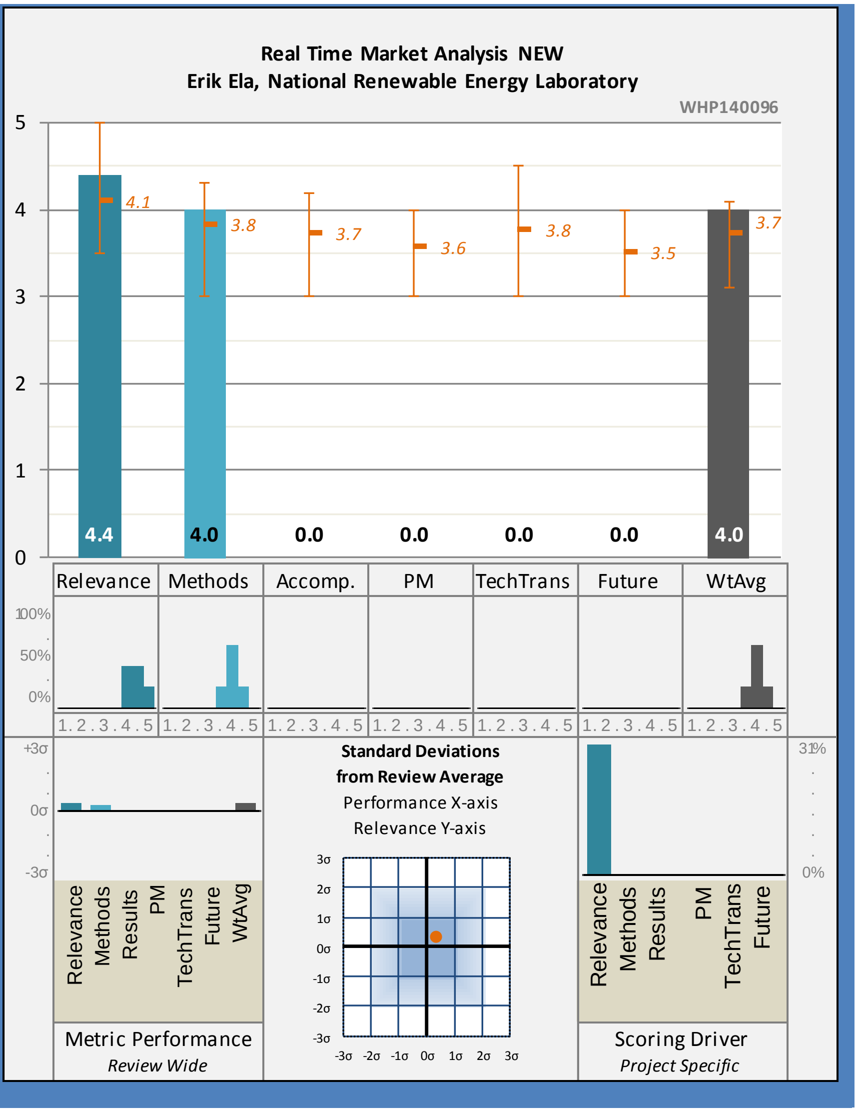
Panel:

Pumped Storage Hydro

Budget:

$150,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.4** for its Relevance to water industry needs and overall DOE objectives.

- High value project.
- This aligns well with DOE's objectives of enabling the next generation pumped storage technologies to facilitate renewable integration. In particular it looks to break through the limitations of traditional PSH market behavior to arrive at a new optimized behavior.
- Project could assist in understanding current valuation processes. Different time resolutions show these units are being used for load regulation as well as load following.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- Utilizes results of other studies and involves many stakeholders, including PSERC.
- NREL will subcontract the development of the modeling algorithm to PSERC (ASU and Wichita State U) for the development. This will presumably make the development more efficient.

Strengths and Weaknesses

Project Strengths

- An important topic for better utilization of PS.
- Developing an algorithm to address a problem that can help PSH to realize greater value. These types of projects are of great value and worthwhile for DOE to fund. Continued development of mathematical models to represent the hydro/market system are recommended as these provide tools much needed to establish actual benefits and guide in efficient operations.
- Information that you are trying to use to schedule PSH may be wrong but the decisions you make based on that wrong data impacts what you can do later in real time.

Project Weaknesses

- Uncertain if system operators will adopt the results of study.

Specific recommendations for additions or deletions to the work scope

- Keep the focus on the importance of hydro for integrating the variable renewables and the appropriate valuation of HPS in the market.

7.4 Market Acceleration and Deployment

The Water Power Program works to reduce the time and costs associated with permitting hydropower projects; to better quantify the potential magnitude, costs, and benefits of hydropower generation; and to identify and address other barriers to hydropower deployment. The program is currently assessing the potential size of the nation's hydropower resources, including the potential for generating capacity additions at existing hydropower facilities and non-powered dams, as well as the potential for new low-impact and small hydropower generation, designing, developing, and testing new ways of reducing the environmental effects of hydropower, and working to quantify the benefits of effective and cost-competitive hydropower technologies.

Addressing Comments for Market Acceleration and Deployment

The Hydropower Peer Review Panelists recorded many useful and actionable comments during their review of the Office’s Market Acceleration and Deployment projects. These comments will be used to make key decisions and recommendations to those projects that will receive continued funding into future fiscal years, and will help guide Water Power Program decision making and strategy into the future.

The majority of the Hydropower Market Acceleration and Deployment activities were well received by the Panelists. Of particular note was the Sensor Fish project, which reviewers encouraged the program to bring to the manufacturing stage.

Most of the constructive feedback received from Panelists was in relation to the proprietary nature of certain information and whether or not this information could be distributed in some capacity to the broader industry. In addition, questions of broader national applicability were raised regarding several of the projects that have a specific regional focus. The Market Acceleration and Deployment activities are intended to provide intrinsic value to the Hydropower industry at large; working with proprietary information complicates this value to some extent, as the data is unavailable for dissemination. In addition, regional variations in the scheduling of hydropower also affect the extent to which certain research can have broader applicability. WWPTO will, in the future, more fully consider the broader applicability of projects along with the transfer of information to the industry at large during the proposal phase of future work.

Table 7.4.1 lists the existing Market Acceleration and Deployment projects that were reviewed during the 2014 Peer Review meeting. Figure 7.4.1 illustrates the standard deviation of scoring of the existing Market Acceleration and Deployment projects in relation to the scoring of all projects reviewed in 2014.

Table 7.4.1 Existing Market Acceleration and Deployment Hydropower projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Accomplishments	Project Management	Technology Transfer	Future Research	Weighted Average Score
Average for Review			5.1	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for all Existing Projects			5.0	4.1	3.8	3.7	3.6	3.8	3.5	**3.7**
Average for Existing Hydropower Projects			5.5	4.0	3.7	3.6	3.6	3.7	3.4	**3.6**
Average for Existing Market Acceleration Hydropower Projects			5.7	4.2	4.1	4.1	3.9	4.0	3.8	**4.0**

Sensor Fish	Z. Daniel Deng	Pacific Northwest National Laboratory	6.0	4.7	4.6	4.5	4.6	4.6	4.5	**4.5**
Hydropower Fellowship Program	Deborah Linke	Hydro Research Foundation	5.0	4.3	4.3	4.3	4.3	4.4	3.8	**4.3**
Turbine aeration design software for mitigating adverse environmental impacts resulting from conventional hydropower turbines	John Gulliver	Regents of the University of Minnesota	6.0	4.0	4.2	4.2	3.9	4.2	4.1	**4.1**
Water Quality Modeling Improvements at Columbia and Cumberland River Basins	Boualem Hadjerioua	Oak Ridge National Laboratory	6.0	4.3	4.0	4.1	3.8	4.3	4.0	**4.0**
The Basin-Scale Opportunity Assessment (BSOA) Initiative	Mark Bevelhimer	Oak Ridge National Laboratory	6.0	4.1	3.9	3.7	3.6	3.5	3.1	**3.7**
The Basin-Scale Opportunity Assessment (BSOA) Initiative	Simon Geerlofs	Pacific Northwest National Laboratory (Lead)	5.0	4.0	4.0	3.7	3.4	3.1	3.4	**3.6**

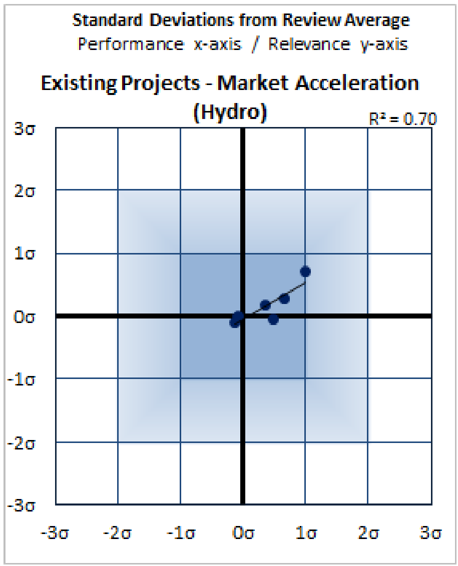


Figure 7.4.1 Existing Market Acceleration and Deployment projects

Table 7.4.2 lists the new Market Acceleration and Deployment projects that were reviewed during the 2014 Peer Review meeting. Figure 7.4.2 illustrates the standard deviation of scoring of the New Market Acceleration and Deployment Hydropower Projects in relation to the scoring of all projects reviewed in 2014.

Table 7.4.2 New Market Acceleration and Deployment Hydropower projects

Project Title	PI Name	Organization	Total Reviewers	Relevance	Methods	Weighted Average Score
Average for Review			5.1	4.1	3.8	**3.7**
Average for all New Projects			5.2	4.2	3.8	**3.8**
Average for New Hydropower Projects			5.5	4.3	3.9	**3.9**
Average for New Market Acceleration Hydropower Projects			5.5	4.3	4.0	**4.0**
Biological Design Criteria for New Hydropower Turbines NEW	Gary Johnson	Pacific Northwest National Laboratory	6.0	4.4	4.2	**4.2**
Hydropower Workforce and Education/Training Needs Assessment NEW	Jay Paidipati	Navigant	5.0	4.2	4.1	**4.1**
Annual Hydropower Market and Trends Report NEW	Rocío Uría-Martínez	Oak Ridge National Laboratory	5.0	4.4	3.8	**3.8**
Biological Design Criteria for New Hydropower Turbines NEW	Mark Bevelhimer	Oak Ridge National Laboratory	6.0	4.1	3.9	**3.9**

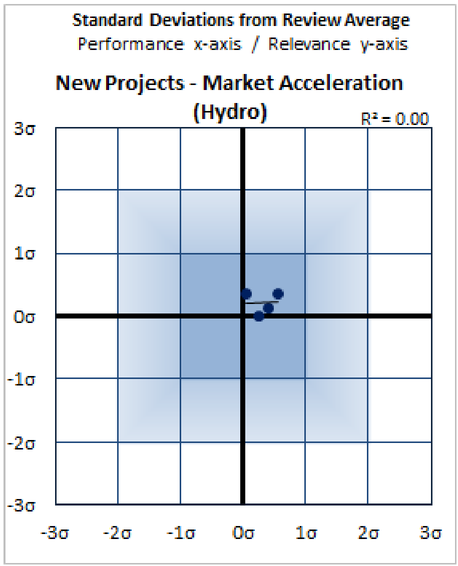


Figure 7.4.2 New Market Acceleration and Deployment Hydropower projects

WHP140082

Project Title:

Sensor Fish

Principal Investigator:

Z. Daniel Deng

Organization:

Pacific Northwest National Laboratory

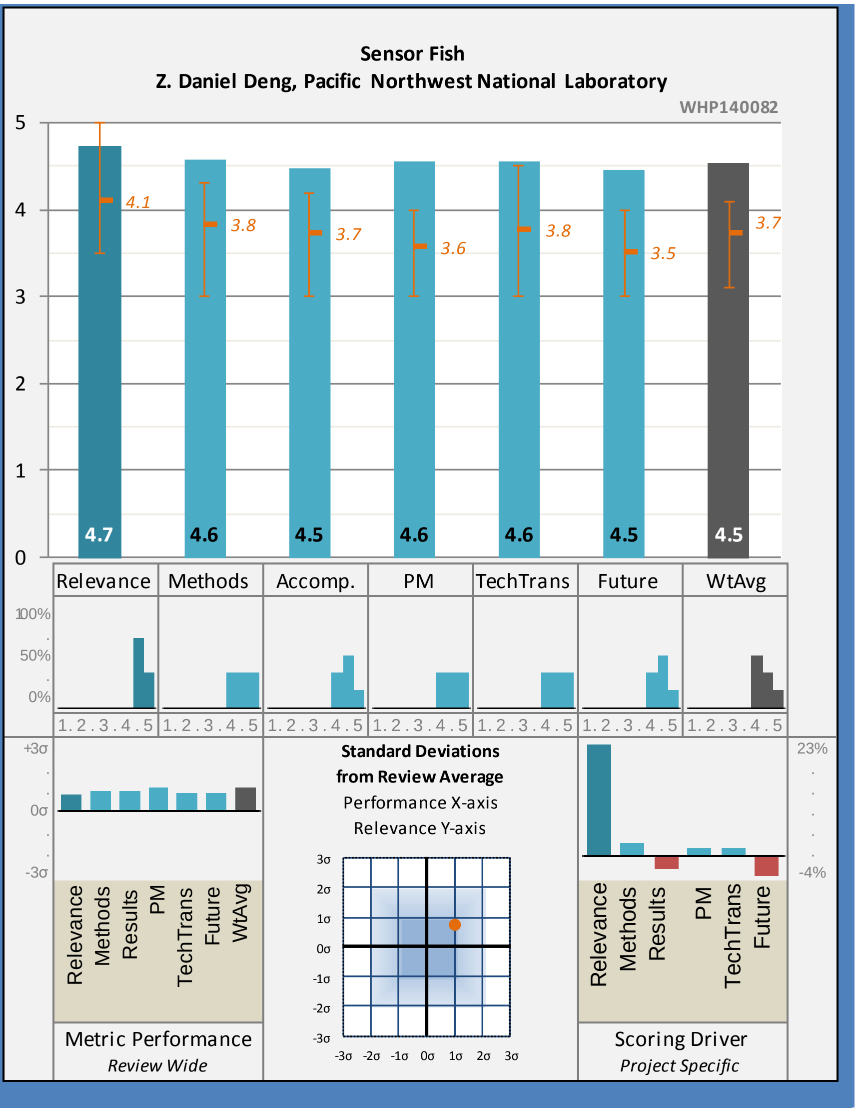
Panel:

Market Acceleration

Budget:

$299,906 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.7** for its Relevance to water industry needs and overall DOE objectives.

- A good companion to live fish studies.
- This project is highly relevant to the objectives of reducing deployment barriers and environmental impacts.
- As the Sensor fish device get further developed for low head applications, it would be good to develop similar more compact devices for fish screened pump applications.
- I see this as a perfect research project that only DOE could fund but that is very relevant to the industry
- Aids in reducing deployment barriers.
- This is a shining example of research leading to a solution to a costly issue for existing projects as well as new projects.

- The sensor fish device has unlimited potential in helping improve environmentally friendly design and performance in hydraulic structures and hydropower installations.
- Reduces cost and time to develop fish friendly turbines.
- What I like about this is it addresses a real need of being able to determine impacts to fish from hydropower but does that while trying to keep cost and time investment to a minimum.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.6** on its methods/approach.

- The approach is systematic and includes testing and procurement. The new device is more robust and cost effective.
- I like he approach. Appears to be well thought out.
- Involved the redesign of a previous sensor. Followed a five-step, logical process to move from identifying the range of applications to prototype testing of the new sensor.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.5** based on technical accomplishments and progress.

- Design, prototypes and laboratory testing accomplished. Ice Harbor Dam testing upcoming.
- I think holding the cost down to $1000 per sensor fish is pretty amazing, delivering clearly tangible results for the project.
- Design features met the original technical targets.

Question 4: Project Management

This project was rated **4.6** on its project management.

- Finished ahead of schedule, delivered tangible results that will clearly benefit the industry.
- Project was on schedule and completed.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.6** for research integration, collaboration, and technology transfer.

- Much interest in this product in foreign countries as well as DOE partners.
- Technology transfer to small business to continue future manufacturing.
- Final article/report due in a couple of weeks.

Question 6: Proposed Future Research

This project was rated **4.5** for proposed future research.

- Could be applied to many structures/facilities; i.e., small hydro, irrigation, pumps, spillways.

Strengths and Weaknesses

Project Strengths

- Good value information - strong compliment to live fish data.
- Highly useful and cost effective technology, demonstrated by wide interest. Likely to be of great use for environmental analysis.
- Very useful research to promote understanding and problem solving for one of hydro's greatest environmental challenges.
- Positive results for relatively low cost.
- It is a success on a very challenging issue.
- Solid improvements to earlier model.
- Practical application that has successfully been moved from research to implementation.

Project Weaknesses

- Need to recover the sensor fish to extract the data.
- No notable weaknesses.
- Hard to see anything that could be improved.

Specific recommendations for additions or deletions to the work scope

- Get it to commercial production ASAP to reduce production costs.
- Follow up on future use and benefits of this product.
- Very impressive, results oriented project.
- Worthy of a special feature video/YouTube, to show what DOE accomplished and how DOE and hydro industry addresses complex issues.

WHP140083

Project Title:

Turbine aeration design software for mitigating adverse environmental impacts resulting from conventional hydropower turbines

Principal Investigator:

John Gulliver

Organization:

Regents of the University of Minnesota

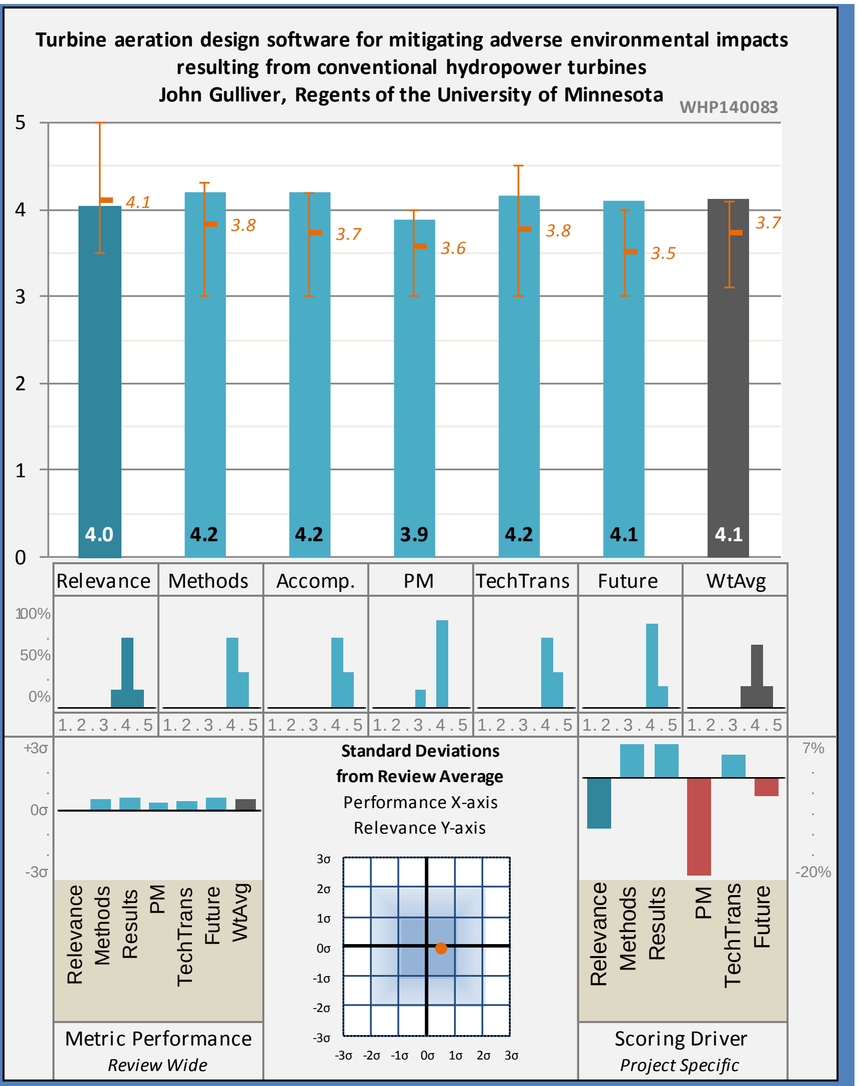
Panel:

Market Acceleration

Budget:

$250,000 DOE

$312,969 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.0** for its Relevance to water industry needs and overall DOE objectives.

- High probability of valuable results.
- The objectives are related to environmental impacts of hydropower.
- Good research aimed at improving aquatic habitat by new aeration approach. May not be needed in all areas of the country.
- D.O. improvement from hydropower discharges.
- This project supports research on bubble size and gas transfer at a laboratory water tunnel to simulate DO uptake in draft tubes and tailraces. It provides information that is impossible to observe in full-scale draft

tubes. It is a unique facility for laboratory-scale testing of draft tube aeration, the most common aeration approach for hydropower projects.

- Helps remove barriers to development.
- Already being implemented with industry (Alstom) to improve turbine performance.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.2** on its methods/approach.

- Significant and detailed design and evaluation of code.
- Impressive combination of computer modelling and hydraulic lab verification of results.
- Testing in their own test stand (water tunnel).
- While it is the best facility available for such studies, bubble coalescence apparently does not occur as it is suspected to occur in actual draft tubes. However, gas transfer at the early stages of gas bubble formation and transport may be represented by the SAFL facility.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.2** based on technical accomplishments and progress.

- Very good proves!
- Search for a low cost opportunity to improve dissolved oxygen is in line with industry and DOE goals.
- Numerical code results closely matched actual D.O. measurements.
- Early model simulations are reasonable. Bubbles sizes are likely similar to those bubbles that first form as air is aspirated into the water.

Question 4: Project Management

This project was rated **3.9** on its project management.

- Looks to be well managed with experienced PI's that understand the need for numerical modelling being paired with actual field data.
- Complete end of March 2015, delayed due to proprietary issues with Alstom.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.2** for research integration, collaboration, and technology transfer.

- Good cost sharing model.

Question 6: Proposed Future Research

This project was rated **4.1** for proposed future research.

- Assists in predicting the efficacy of aeration methods and devices.

Strengths and Weaknesses

Project Strengths

- An issue of increasing importance. Project has good prospect for improving environmental performance.
- Detailed technical analysis and development of model will provide data needed for designing aeration equipment.
- Impressive consortia of academic research and turbine manufacturing.
- Trying to determine the physics of two phase bubble flows with mass transfer.
- Research is being conducted at a laboratory that has significant experience with this type of research.
- Software can be generally applied.
- Well recognized lab.
- Code substantiated with physical measurement.

Project Weaknesses

- The project should consider the usability of code - how it will or can be made available to designers.
- Geometry of foil is not the same as real world geometries.
- No analysis of impacts to efficiency.
- Federal funds going toward a proprietary product for a specific vendor.
- Draftube effects are not addressed.

Specific recommendations for additions or deletions to the work scope

- Does evaluation of bubble patterns and development of code have other applications in flow dynamics? Improved efficiency? Reduced cavitation?
- Need to separate the proprietary part from federal funding.

WHP140084

Project Title:

Water Quality Modeling Improvements at Columbia and Cumberland River Basins

Principal Investigator:

Boualem Hadjerioua

Organization:

Oak Ridge National Laboratory

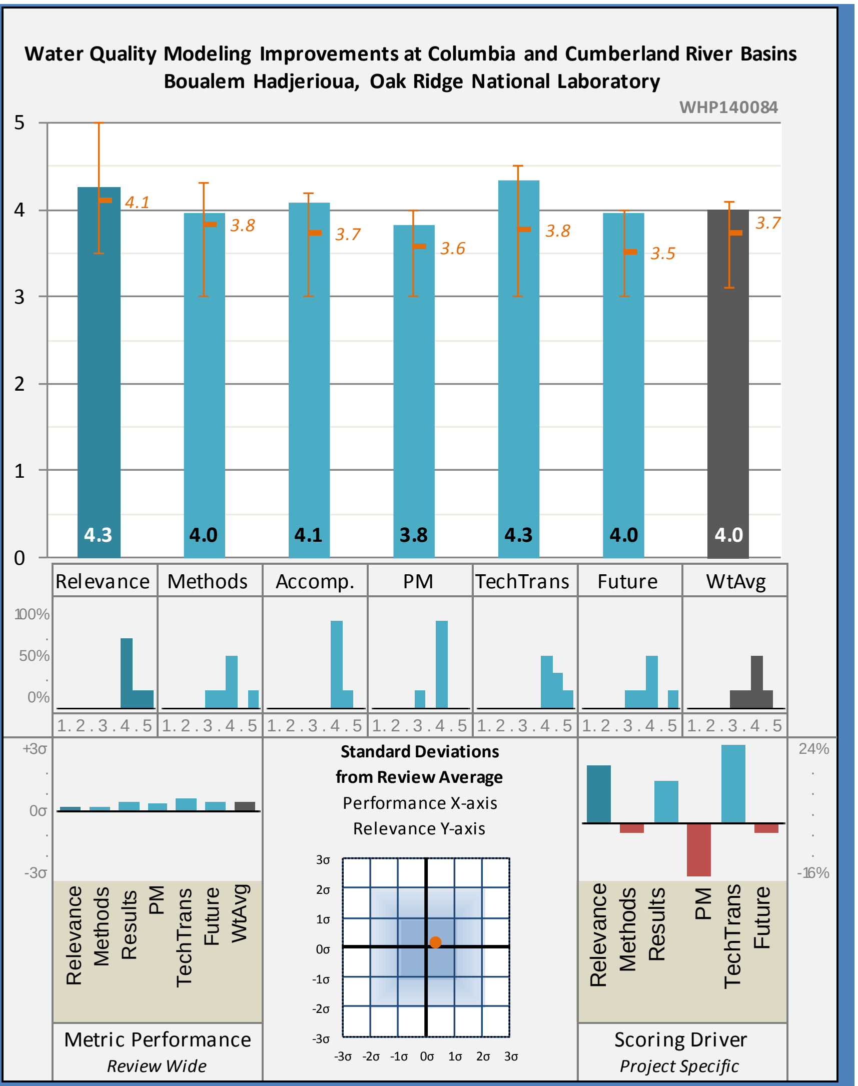
Panel:

Market Acceleration

Budget:

$1,337,073 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.3** for its Relevance to water industry needs and overall DOE objectives.

- A useful tool and fairly low-cost to complete.
- Highly relevant to addressing environmental impacts of hydropower and optimizing existing hydropower technology, flexibility, and/or standards.
- Predictive DO and TDG mathematical modelling could be helpful for many hydro generators.
- Removing barriers to continued operation of existing facilities on a system-wide basis.
- Optimizing existing hydropower.

- This project addresses water quality management issues on major existing hydropower river systems that are affected by reservoir operations. The two issues addressed are common: provision of river flow for assimilating thermal loads from power plants, and alleviating TDG levels downstream from spill operations. Reservoir models can be run on these systems to make water management decisions, but these often require too many model runs, taking too much time to optimize hydropower operations. This project is developing supplemental mathematical approaches that can be run much faster for optimization decisions that can minimize water use and off-peak generation for alleviation of water quality concerns.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- Seems appropriate.
- The technical approach is solid in terms of understanding and characterizing the physical processes and addressing how to represent these processes mathematically in operations/scheduling tools that allow optimal use of hydro resources while meeting the water quality constraints.
- Models appear to be well synced up with actual field data.
- End result to come up with a ready to use real-time scheduling tool.
- Shows proof of supplemental models successfully representing Temperature and TDG at study sites.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.1** based on technical accomplishments and progress.

- Good progress. Will approach be applicable to other basins?
- Developed and delivered models to operators, developed the TDG constraint database and documented approach. Appears that TDG modeling and report are a bit behind schedule.
- Would like to see the hydro operator's (end-user) process for how this is actually used in the field for decision making.
- Corps is happy with results.

Question 4: Project Management

This project was rated **3.8** on its project management.

- On schedule.
- Approx. $630 K.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.3** for research integration, collaboration, and technology transfer.

- Wide range of research, academia and agencies.
- Multiple universities engaged with educational side benefits/dissertations. Also several papers to share results.
- see presentation: reasonable next steps.

Question 6: Proposed Future Research

This project was rated **4.0** for proposed future research.

- May not have applicability to all hydro producers but could be an advance for those with DO or TDG issues.
- Need to work on how to get these integrated into real-time optimization like the optimization tool set.

Strengths and Weaknesses

Project Strengths

- Will provide tools that can be used by hydro operators to increase efficiency, i.e., get more hydro out of the system without risk of environmental violations.
- Helps preplan flows on the system to minimize negative impacts and maximize positive impacts
- If successful, an important tool for dispatchers.
- Critical to the efficient optimization of the Columbia system.

Project Weaknesses

- Hard to reduce complexity sufficiently to integrate with other dispatch considerations.
- Can't be pulled into real-time yet.

Specific recommendations for additions or deletions to the work scope

- Include recommendations on how to integrate with other tools used for dispatch decisions.
- Continue to pursue the dynamic real-time solution that can be implemented at the facility level.
- I suggest cost-share funds be sought or possibly required from the reservoir operations organizations since I suspect they benefit from these savings in operations.

WHP140085

Project Title:

Biological Design Criteria for New Hydropower Turbines NEW

Principal Investigator:

Gary Johnson

Organization:

Pacific Northwest National Laboratory

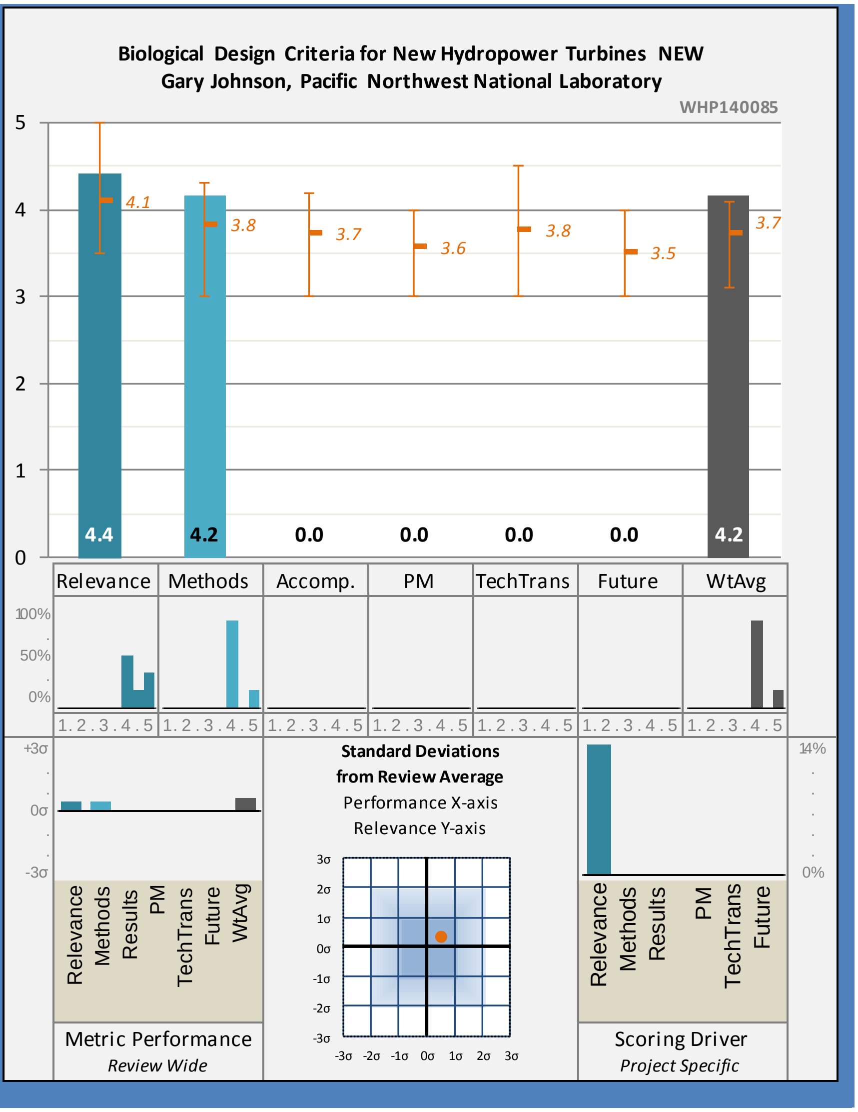
Panel:

Market Acceleration

Budget:

$1,500,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.4** for its Relevance to water industry needs and overall DOE objectives.

- Mostly valuable in concert with other related projects, expensive.
- This new project is relevant DOE's objective of addressing the environmental impacts of hydropower
- Great opportunity to further develop the sensor fish and develop CFD model that get validated thru real measurements.
- One of the greatest challenges for hydro remains the understanding and mitigation of impacts to fish.
- Removes barriers to development by improving the biological design for new hydroturbines.
- Bio turbine design--appears to be a very good approach for a complex issue.
- Other applications should be considered beside the low head hydro to include pumping station intakes including the fish screens.

- It is good to think about these things ahead of time and get environmental aspects incorporated up front
- providing guidance to buyers of turbines and the turbine manufacturer, assisting Grant County
- Developing a methodology/design criteria may be considered for the different application of the concept presented here.
- Improved turbine performance and fish performance are going hand and hand BioPA.
- Products: software for assisting manufacturing, buyers; BioPA's are available to users; packages of info and specs and relationships for Bio PA's; reduce uncertainty for decision makers; reducing field studies needed to what's needed specifically; vendors know what they are bidding on etc. better understand thru "standards" for "guarantying" what they can deliver by focusing on specs that are definable for meeting requirements;
- They use their data for developing the BioPA's.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.2** on its methods/approach.

- Good use of existing data.
- The project will leverage previous work; it is relevant by identifying combinations of turbines and fish that are common. Also will use a database of environmental regulations. This introduces the notion of putting biological requirements into turbine specs.
- Ability to predict fish impacts before turbine is installed would be an impressive step forward.
- $1.5 million.

Strengths and Weaknesses

Project Strengths

- An important issue in some regions.
- Many partners. Combines models/design aids and data to develop performance criteria for turbines; will obviate need for extensive field studies. Creates a tool that can be applied to assess any turbine.
- I like starting out with a literature review so as to limit duplication of effort.
- They are applying what they have learned through experience up to this point.
- Hydraulic performance seems to be improving as fish passage is increasing.
- Puts tools in hands of turbine manufacturers and published report delivered. Meshes with the sensor fish.

Project Weaknesses

- Not a key issue in many regions.

Specific recommendations for additions or deletions to the work scope

- Very important to get buy-in of turbine manufacturers.
- Could expand analysis of fish passage issues to undeveloped areas that could help developers.
- Back end feeds into the front end worries me.
- Good as long as we keep performance and efficiency in mind.
- I like this project.

WHP140086

Project Title:

Biological Design Criteria for New Hydropower Turbines NEW

Principal Investigator:

Mark Bevelhimer

Organization:

Oak Ridge National Laboratory

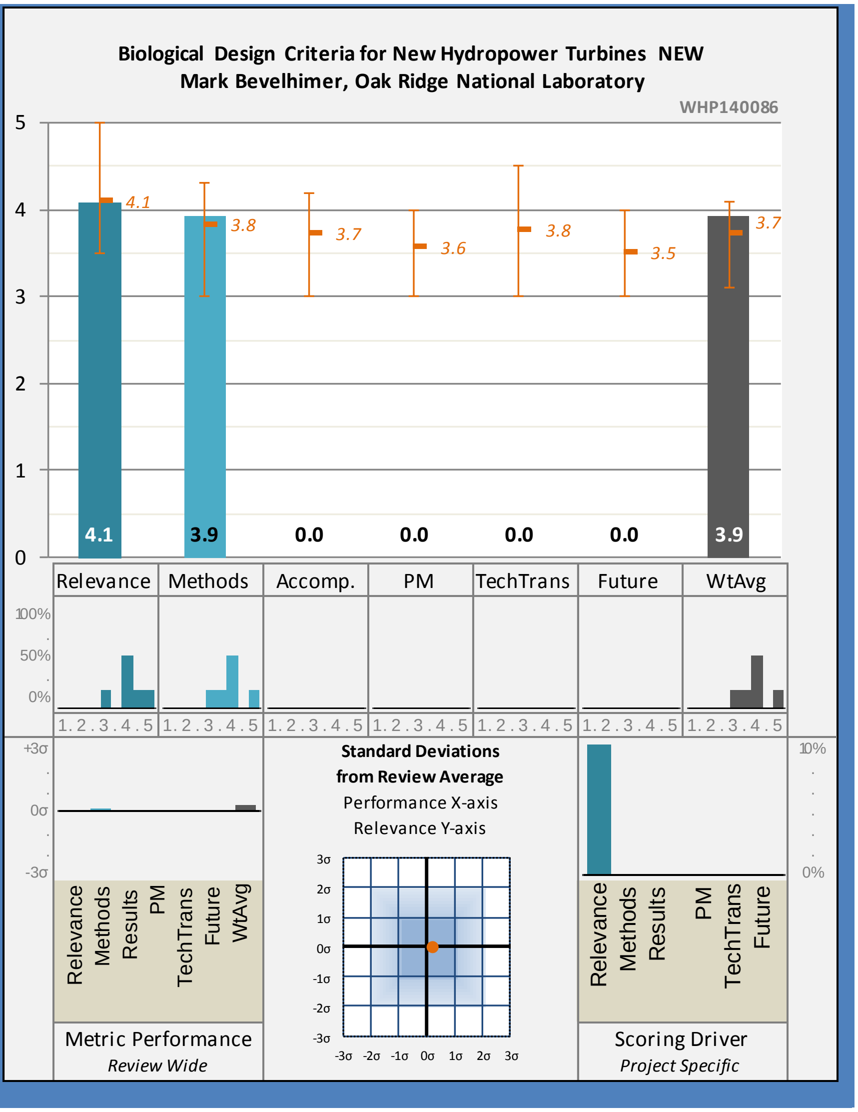
Panel:

Market Acceleration

Budget:

$600,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.1** for its Relevance to water industry needs and overall DOE objectives.

- Good information, valuable in concert with other projects, expensive.
- This new project is relevant DOE's objective of addressing the environmental impacts of hydropower.
- This effort has great deal of application in mitigating environmental impacts at specific sites and provide the information needed to optimize operations.
- Understanding and mitigating fish impacts are critical to future hydro sustainability.
- Complements project WHP140085 by PNNL.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.9** on its methods/approach.

- Approach of matching species susceptibility and turbine types and focusing on high risk areas is spot on
- The approach is multi-faceted: it includes a spatial database, a traits-based information system, and a fish effects modeling effort. It is not clear exactly how the data will be used and by whom and how these independent products can be used together.
- Goal is to be able to develop numerical predictions of fish impacts rather than need to do exhaustive field studies.
- Updating biological design criteria for new turbine types and more fish species. Employing a traits-based approach using relevant biological characteristics to infer sensitivity to turbine passage stressors. Conducting a spatial analysis regarding fish passage issues using data from FERC in NHAAP and contacting regulatory and resource agencies.
- Good use of existing data.
- Not sure if traits based approach can provide 100% conclusive data for those that might have preconceived notions that would not agree with and accept this approach.
- He will use fish trait information to provide a broader interpretation of biological effects based on measured (SF) and modeled (CFD) physical conditions. (In collaboration with PNNL).
- He will develop a fish effects model that will use time series of stressor exposure as predicted by CFD modeling and SF observations to predict probability of injury and mortality for a variety of turbine conditions and designs. (In collaboration with PNNL).

Strengths and Weaknesses

Project Strengths

- A reasonable approach with high probability of success.
- Reduces uncertainty of impacts.

Project Weaknesses

- None given.

Specific recommendations for additions or deletions to the work scope

- Keep focus on highest value areas to control costs.
- Important to get buy-in of turbine manufacturers.

WHP140087

Project Title:

The Basin-Scale Opportunity Assessment (BSOA) Initiative

Principal Investigator:

Simon Geerlofs

Organization:

Pacific Northwest National Laboratory (Lead)

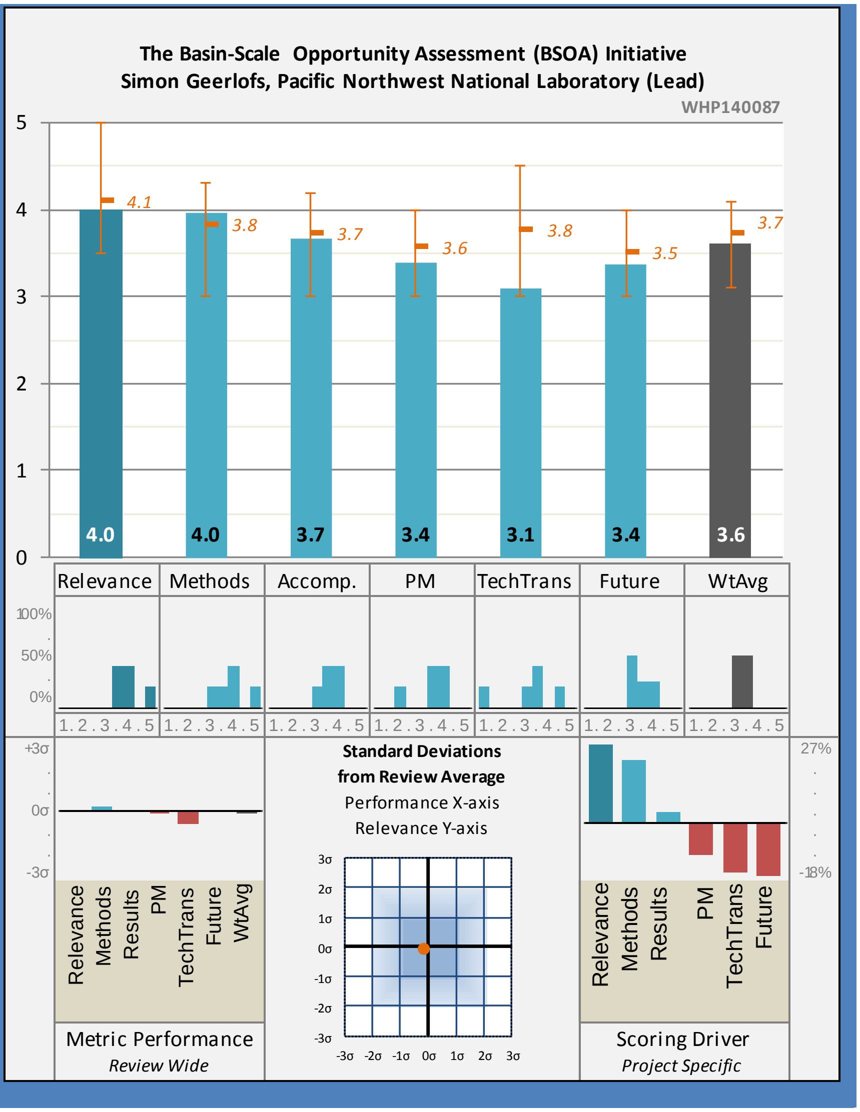
Panel:

Market Acceleration

Budget:

$2,020,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.0** for its Relevance to water industry needs and overall DOE objectives.

- Great concept but limited applicability -- only those basins where broad consensus of stakeholders want the assessment.
- Any opportunity must be very carefully targeted since complex issues exist in many basins that would be difficult to resolve without a lot of acrimony and legal wrangling.
- Highly supported by many stakeholders. NHA, American Rivers.
- I think the overall approach is sound. However, I did not see how water quality was considered. If only the 303d list was considered, than much more needs consideration, i.e., drinking water supplies, NPDES permits, WLAs (wasteload allocations involving water quality modeling for significant distances involving upstream as well as downstream from NPDES permits), changes in water quality caused by the new dams and hydro

added to NPDs. Also, it would be best to consider new hydro and hydro added at NPDs in light of requirements for 401 Certificates. In some states, nutrients and eutrophication may be a consideration.

- In many basins there would be serious downside risk to non-federal hydro operators with limited upside benefit.
- If the basin's assets are not under the control of one owner, this could be very problematic.
- Please see comments made on WHP140069 in answer to Q1 and Q2.
- Has a lot of similarities to the very expensive and arduous FERC re-licensing process for utility owned hydro assets.
- Basin plans can be good, but it takes effort, energy, a basis (usually a legal basis like the Clean Water Act) and motivation. Water users/WTPs/WWTPs/industrial development/land owners often have significant inputs/requirements, and are reluctant to change the status quo etc.
- I suspect success will be more likely in undeveloped basins where hydro development plans might be acceptable to land owners.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.0** on its methods/approach.

- Generally good. Need to emphasize screening criteria for applicability to a basin.
- While the cumulative cost of this project appears to be approaching $5M, it may be quite limited in applicability for various reasons.
- Great stakeholder involvement.
- The approach is logical and takes advantage of NHAAP. However, I have a concern re: water pollution control agency involvement, EPA, wastewater discharges?
- It would be helpful if stakeholders were identified. 3-6 months for Phase 2 Stakeholder engagement is a relatively short period of time. For example, FERC relicensing can take a few years for one project.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.7** based on technical accomplishments and progress.

- Solid demonstration in Deschutes basin shows the methodology.
- It is impressive to see how much could be accomplished is such short time. However, the states and EPA have identified water uses for all waterways in the USA, and these will need to be considered, with legal implications.

Question 4: Project Management

This project was rated **3.4** on its project management.

- Stayed relatively on scope and on budget but not on schedule.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.1** for research integration, collaboration, and technology transfer.

- Based on, and requires good collaboration.
- Results have not been well communicated.
- Good integration of other tools.

Question 6: Proposed Future Research

This project was rated **3.4** for proposed future research.

- Not sure if this needs much more development. Useful as a tool in the toolbox when it's the right tool to use
- While interesting to talk about these basin scale opportunities for new generation, limited applicability and legal difficulties make it challenging to advance this project more widely.
- Quick assessment tool will be beneficial for assessment of other basins.

Strengths and Weaknesses

Project Strengths

- Strong concept and very valuable under the right circumstances.
- Brought stakeholders together and identified new hydropower opportunities.
- DOE and the labs have much technical capability and NHAAP and NSD allows them to assess basin situations quickly.
- Potential to get stakeholders to think more broadly and seek win-win solutions.
- Water users on the Reclamation project were happy with the results.
- May identify high value, doable opportunities that would have gone un-identified.

Project Weaknesses

- FERC will not approve off-site mitigation. I've tried.
- Appears to be lacking action plans to capture the identified opportunities.
- Communication of progress and results to decision makers was largely ineffective.
- State water quality agencies do not appear to be engaged and water use classifications do not appear to be included in the basin analyses.
- If forced on an inappropriate basin, could do more harm than good.
- Phase one only identifies possible hydropower and environmental opportunities, it does not give any indication of the value, need or interest in those opportunities.
- Does not consider economic feasibility of opportunities to increase generation.

Specific recommendations for additions or deletions to the work scope

- Highlight screening criteria for applicability to a given basin, especially known development opportunity and positive stakeholder relationships.
- Think this is a good start at trying to get to a place where hydropower development and environmental attributes can be improved simultaneously.
- As discussed above, water quality needs to be more thoroughly addressed.
- May be more applicable for federal hydro as a tool to drive Congressional authorization and appropriation
- Improve communication of results.
- Recommend wrapping it up (after completing the 3 basins) as a ready-to-use tool for future application where appropriate.

WHP140088

Project Title:

The Basin-Scale Opportunity Assessment (BSOA) Initiative

Principal Investigator:

Mark Bevelhimer

Organization:

Oak Ridge National Laboratory

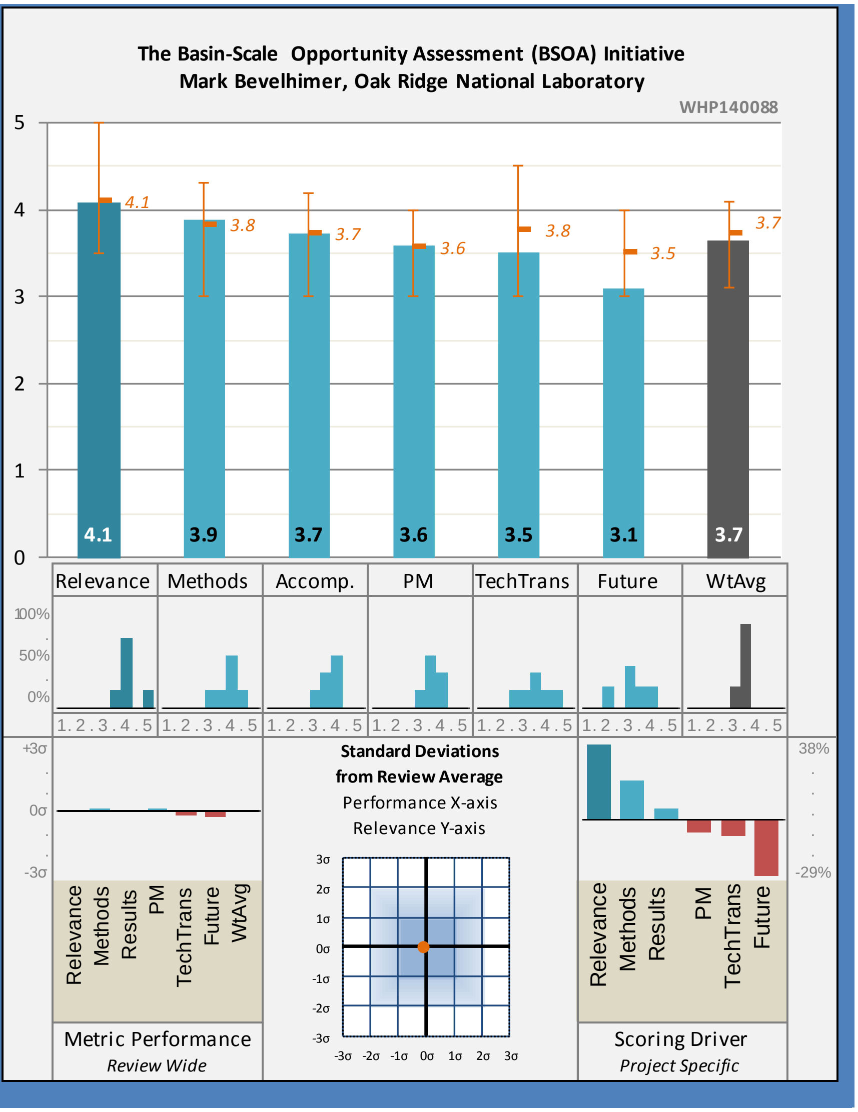
Panel:

Market Acceleration

Budget:

$1,115,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.1** for its Relevance to water industry needs and overall DOE objectives.

- Great concept but limited applicability -- only those basins where broad consensus of stakeholders want the assessment.
- This new project is relevant DOE's objective of addressing the environmental impacts of hydropower
- Good effort to show what is possible with addition of hydro but lacks action plan or recommendation as to how to implement. Can be extremely difficult to achieve consensus when basin has multiple asset owners. Without further push, could become another study on the shelf.
- I think the overall approach is sound. However, I did not see how water quality was considered. If only the 303d list was considered, than much more needs consideration, i.e., drinking water supplies, NPDES permits, WLAs (wasteload allocations involving water quality modeling for significant distances involving upstream

as well as downstream from NPDES permits), changes in water quality caused by the new dams and hydro added to NPDs. Also, it would be best to consider new hydro and hydro added at NPDs in light of requirements for 401 Certificates. In some states, nutrients and eutrophication may be a consideration.

- In many basins there would be serious downside risk to non-federal hydro operators with limited upside benefit.
- Analyses of national databases from a distance - ranked a few hundred basins and Roanoke and Connecticut were high.
- Please see comments made on WHP140069 in answer to Q1 and Q2.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.9** on its methods/approach.

- Generally good. Need to emphasize screening criteria for applicability to a basin.
- This approach is effective in identifying different levels of basin assessment; which can be incrementally applied or applied independently; the scenario approach to stakeholder involvement has proven to be effective. The assumption of win-win (shared opportunities) is the most promising approach to bringing together groups with traditionally conflicting points of view.
- The approach is logical and takes advantage of NHAAP. However, I have a concern re: water pollution control agency involvement, EPA, wastewater discharges?
- It would be helpful if stakeholders were identified. 3-6 months for Phase 2 Stakeholder engagement is a relatively short period of time. For example, FERC relicensing can take a few years for one project.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **3.7** based on technical accomplishments and progress.

- Formulated the procedures for rapid assessment, collected data and applied to two basins. The Phase 2 analysis has been proposed but no proof of concept yet.
- It is impressive to see how much could be accomplished is such short time. However, the states and EPA have identified water uses for all waterways in the USA, and these will need to be considered, with legal implications.

Question 4: Project Management

This project was rated **3.6** on its project management.

- The project appears to be on schedule, but only 45% of the budget has been spent and there is only 6 months left of the project. The remaining tasks do not appear to be costly, so it is not clear how the funding will be spent.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.5** for research integration, collaboration, and technology transfer.

- Based on, and requires good collaboration.
- This is a project for which collaboration could have happened, but PNNL has collaborated only with USACE and not in a major way.
- Good integration of other tools.

Question 6: Proposed Future Research

This project was rated **3.1** for proposed future research.

- Not sure if this needs much more development. Useful as a tool in the toolbox when it’s the right tool to use.

Strengths and Weaknesses

Project Strengths

- Strong concept and very valuable under the right circumstances.
- DOE and the labs have much technical capability and NHAAP and NSD allows them to assess basin situations quickly.
- Potential to get stakeholders to think more broadly and seek win-win solutions.
- May identify high value, doable opportunities that would have gone un-identified.

Project Weaknesses

- FERC will not approve off-site mitigation. I've tried.
- State water quality agencies do not appear to be engaged and water use classifications do not appear to be included in the basin analyses.
- If forced on an inappropriate basin, could do more harm than good.
- Does not consider economic feasibility of opportunities to increase generation.

Specific recommendations for additions or deletions to the work scope

- Highlight screening criteria for applicability to a given basin, especially known development opportunity and positive stakeholder relationships.
- More basin assessment projects should be considered and designed to deal with issues not as complex as Deschutes, but more so than the rapid assessment cases of Roanoke. Stakeholder participation would be informative to the process. A study of basin assessments done by others and a set of guidelines that extend the methodology and lessons learned report that will be written for this project.
- As discussed above, water quality needs to be more thoroughly addressed.
- May be highly applicable for federal hydro as a tool to drive Congressional authorization and appropriation.

WHP140089

Project Title:

Hydropower Fellowship Program

Principal Investigator:

Deborah Linke

Organization:

Hydro Research Foundation

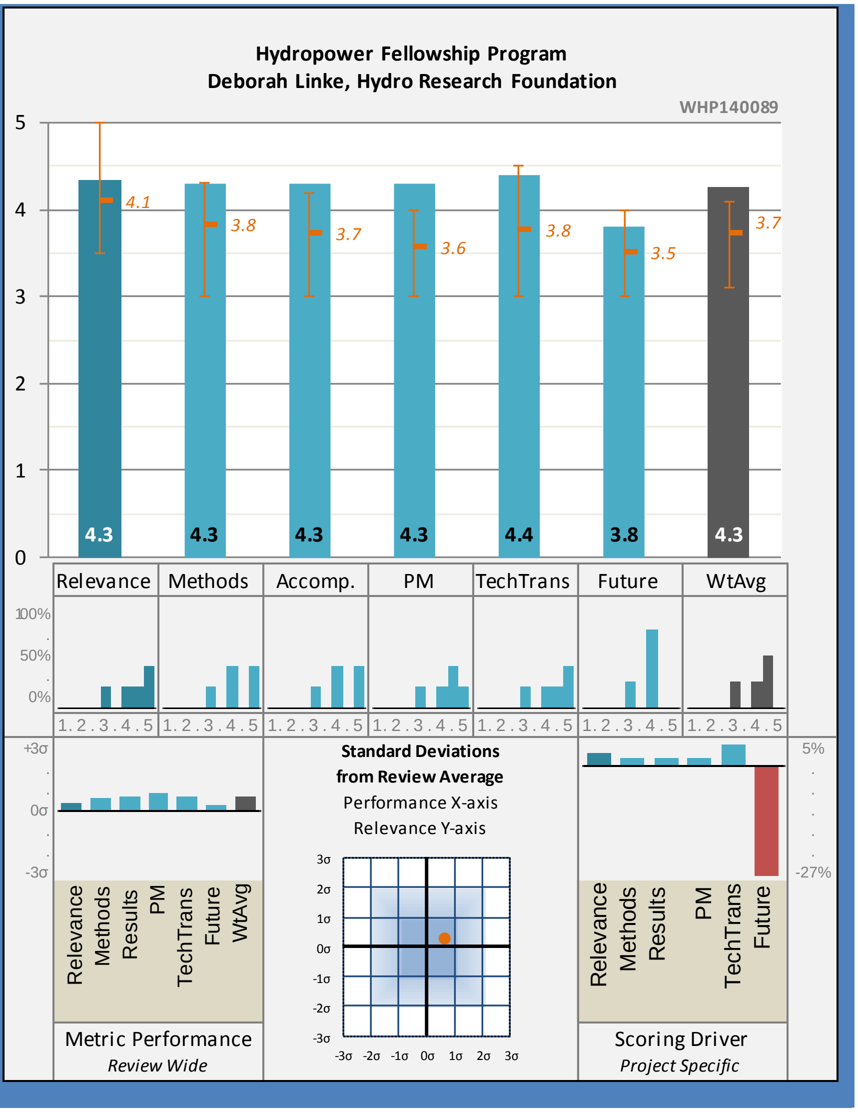
Panel:

Market Acceleration

Budget:

$5,199,975 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.3** for its Relevance to water industry needs and overall DOE objectives.

- One of the best projects DOE has funded.
- Highly relevant to DOE objectives - brings hydropower expertise. Coordinate research topics with industry.
- Great program to stimulate interest in the hydropower discipline, and engage industry and universities in collaborative research.
- Very important to sustainability of hydro industry workforce long term.
- Funded 43 researchers 19 entering workforce.
- Universities have different structures in expending research funding, and there is a need to examine how the funds will be expended before awards.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.3** on its methods/approach.

- Would be good to tie areas of research to DOE's areas of research.
- Provides graduate level fellowships to students in universities; each student is assigned collaboration with an industry rep, and participation in conferences is highly effective. The Fellowship structure insured that the students receive most of the funds. This program has proven to be highly successful.
- If funding shifts more to university research, watch out for a bigger portion going to university overhead.

Question 3: Technical accomplishments and progress toward project and DOE goals

This project was rated **4.3** based on technical accomplishments and progress.

- The project has graduated a large number of grad students with high levels of hydropower expertise.
- Demonstrated successful program.

Question 4: Project Management

This project was rated **4.3** on its project management.

- Well organized and managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.4** for research integration, collaboration, and technology transfer.

- Collaboration with universities and hydro industry, linking students with industry mentors. All students present at Hydrovision. Most students publish peer reviewed journal papers as well as their theses.
- Excellent collaboration with multiple universities and several companies providing mentors and internships.

Question 6: Proposed Future Research

This project was rated **3.8** for proposed future research.

- Tie-in to DOE's areas of research.
- Provides graduate level fellowships to students in universities; each student is assigned collaboration with an industry rep, and participation in conferences is highly effective. The Fellowship structure insured that the students receive most of the funds. This program has proven to be highly successful. Recommended that the program be continued however possible.
- NA program not funded going forward.

Strengths and Weaknesses

Project Strengths

- Great way to build future hydro leaders and to draw in universities.
- Excellent effort on the education front to help with sustainability of hydro workforce and also perform research through the university systems.
- Has resulted in 75% placement rate within hydropower.

Project Weaknesses

- End of DOE funding?
- Does not address real need in hydropower workforce which is replacement of a an aging craft and facility engineer workforce and knowledge transfer of that workforce.

Specific recommendations for additions or deletions to the work scope

- Find a way to maintain this program going forward. Industry funding may help, but don't rely on it. DOE funding is appropriate and essential.
- Continue this program if possible. An important initiative with demonstrated results.

WHP140090

Project Title:

Hydropower Workforce and Education/Training Needs Assessment NEW

Principal Investigator:

Jay Paidipati

Organization:

Navigant

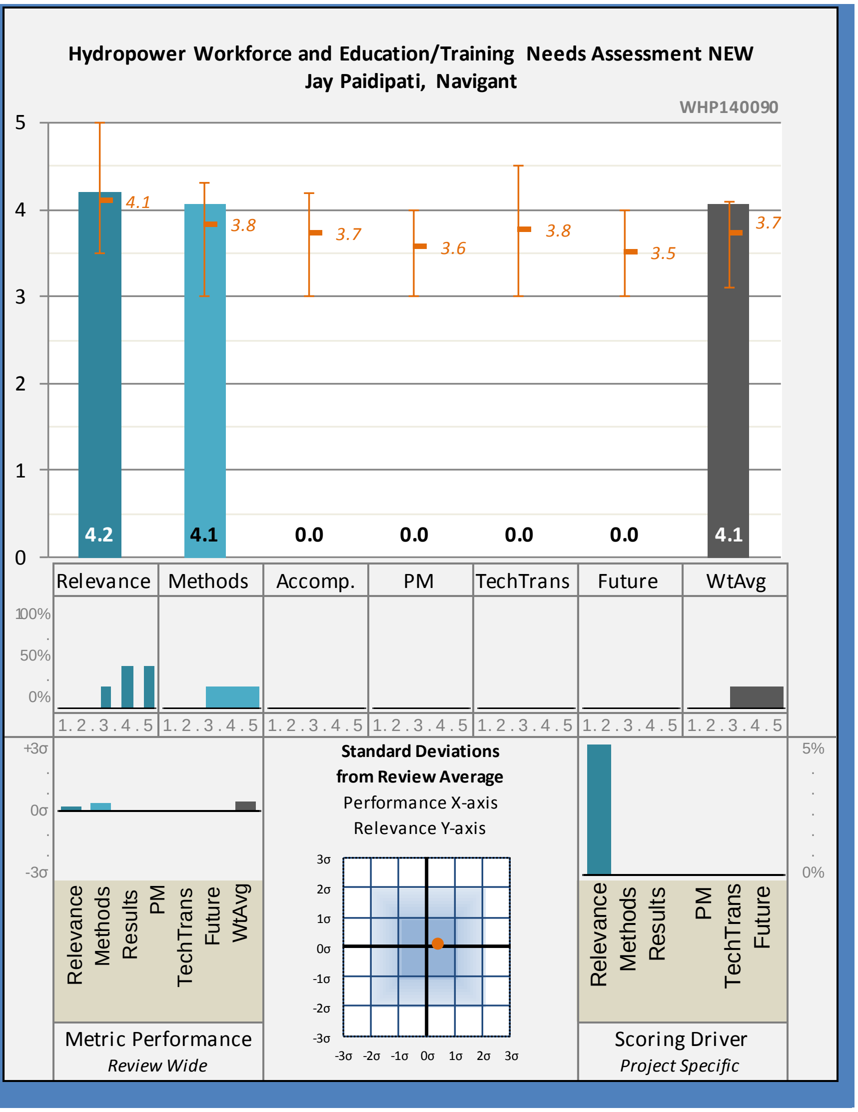
Panel:

Market Acceleration

Budget:

$250,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.2** for its Relevance to water industry needs and overall DOE objectives.

- Hi value to industry and in driving policy.
- This is a strategic project, the results of which can inform future decisions about capacity building in the hydropower industry.
- Business models vary across entities in the hydropower industry which lead to different staffing, retention, and training strategies, and should be considered in the design of the study.
- Preparing to train the next generation of hydro workers is an important sustainability initiative.
- Addresses and is a great first step towards resolving the problem of training needs in hydropower.
- The project is potentially useful to the hydro industry.
- PowerPoint presentation was not submitted in time for preview by panel. Deduction imposed.

Question 2: Methods and Approach to performing the research and development

This project was rated **4.1** on its methods/approach.

- Navigant did a survey for NHA 5 years ago - will use that as well. NREL is involved in surveys for other renewals.
- Other organizations (CEATI HPLIG) have looked at hydro training resources available in the market and should be consulted.
- Seems like a solid consistent needs based approach to a training needs assessment.
- PowerPoint presentation was not submitted in time for preview by panel. Deduction imposed.

Strengths and Weaknesses

Project Strengths

- A very timely project.
- Work has been done previously which will be leveraged.
- Addresses the real staffing needs in hydro.
- March-April 2015.

Project Weaknesses

- Project will not look at specific areas of expertise or benchmarking for best practices for education/skills and job training.
- PowerPoint presentation was not submitted in time for preview by panel. Deduction imposed.

Specific recommendations for additions or deletions to the work scope

- For assessing pipeline, need to discount preliminary permits and strongly distinguish between preliminary permits and licenses issued.
- Great project and a great first step. Highly recommend continuing this project.
- Need to consider needs for craft positions too.

WHP140091

Project Title:

Annual Hydropower Market and Trends Report NEW

Principal Investigator:

Rocío Uría-Martínez

Organization:

Oak Ridge National Laboratory

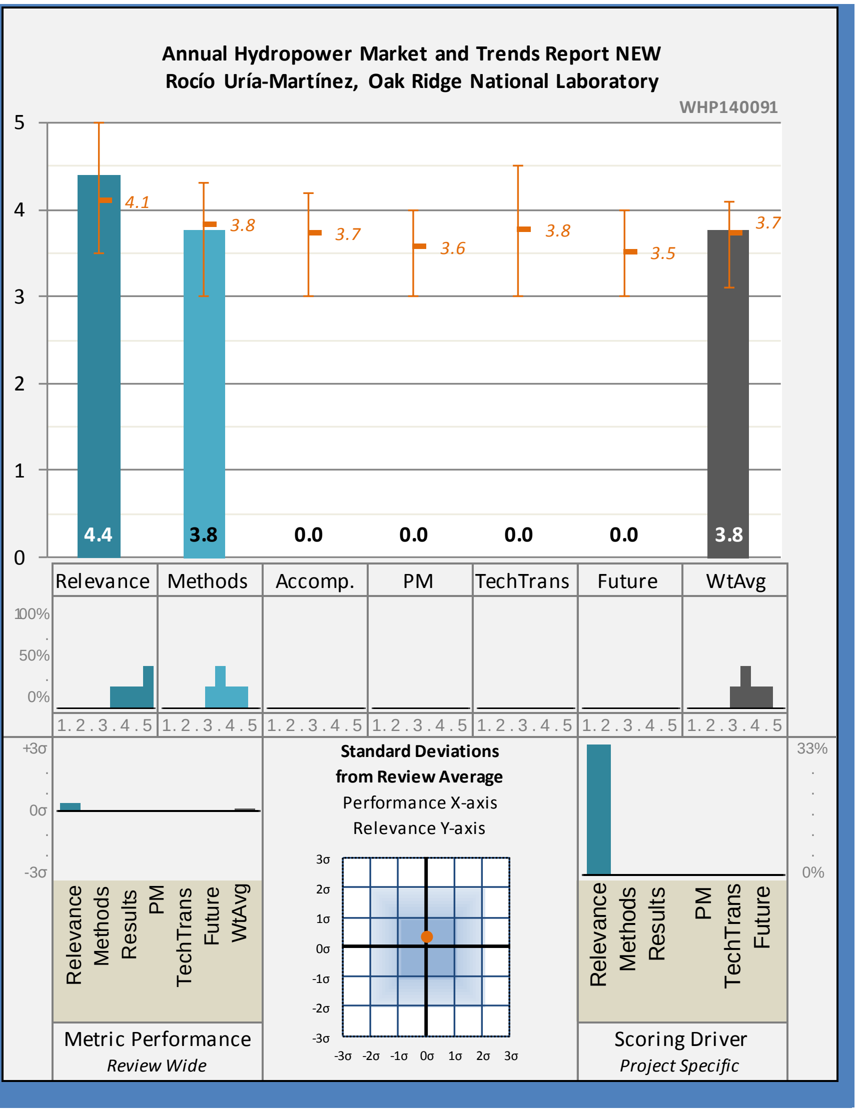
Panel:

Market Acceleration

Budget:

$2,000,000 DOE

$0 Cost-Share



The bullets below are a compilation of comments made by individual panel members during the evaluation of this project.

Question 1: Relevance to water industry needs and overall DOE objectives

This project earned a score of **4.4** for its Relevance to water industry needs and overall DOE objectives.

- Very high value for industry and to drive policy.
- Highly relevant - information can be used for policy makers and other decision makers at other levels
- Market report for hydro - development activity, supply chain evolution, fleet performance (modernization) - Many of these are covered in EIA (energy info agency), NHA jobs studies, Hydro Review development updates, and other publications. This is a report to be compiled and available for policy makers.
- Similar to what has been done in other renewable energy areas. Helps even the playing field in renewable energy. Should be great from a policy standpoint.
- Optimizing existing fleet.

Question 2: Methods and Approach to performing the research and development

This project was rated **3.8** on its methods/approach.

- Identify highest value data and start issuing it ASAP.
- Good analysis but shares with other database/assessment project the need to identify specific needs as a place to start, i.e., guaranteeing usability in the first version.
- Need clear rollout plan for how this information will be disseminated to those policy makers that will benefit from this compilation.

Strengths and Weaknesses

Project Strengths

- Severe lack of this type of information. Can really help drive policy.
- Capitalizes on other efforts.

Project Weaknesses

- It's going to take time to get it going.
- I would like to see a focused roll-out plan with this - once it is compiled, who will take this data and convey it to policy makers?

Specific recommendations for additions or deletions to the work scope

- Add in socio-economic benefits?
- Continue project, thinking about specific uses ("use cases") that can demonstrate the value of the product.
- Consider environmental performance in addition to other performance parameters
- Start issuing high value data ASAP, well ahead of comprehensive report (e.g. number of projects and MW under construction).
- Consider socio-economic performance factors.
- Seems like EIA and NERC GAD's would have some beneficial benchmark information for this.
- Make sure you look at all the existing data sources out there before you recreate one.

8.0 Detailed Qualitative Program Evaluation by the Panelists

As part of the 2014 Water Power Peer Review process, reviewers were asked to perform a detailed qualitative analysis of the Water Power Program based on the four aspects listed below:

1. Program Objectives;
2. Research and Development (R&D) Portfolio;
3. Management and Operations; and
4. Communications and Outreach.

Specifically, panel members were asked to evaluate: 1) how well Program objectives align with industry needs and Administration goals, 2) if the Water Power Program investment portfolio is appropriately balanced across research areas and recipient organizations to achieve the program's mission and goals, 3) the quality of the Water Power Program's team, management practices, and operations, and 4) the effectiveness of the Program at engaging with industry, universities, other agencies, international actors, and other stakeholders. Panel members were also asked to comment on the strengths and weakness of the program.

Below are the detailed comments provided by the individual panelists.

8.1 Marine and Hydrokinetic Qualitative Program Evaluation

Question 1. PROGRAM OBJECTIVES: How well do Program objectives align with industry needs and Administration Goals?

- The 4 listed MHK Program Objectives fully support industry needs. But it will be the actual funding and allocations among these Objectives that actually determines the progress to be made in achieving these four objectives.
- The breadth and depth of the MHK program is very impressive. I believe it is having a significant impact on the development of the MHK industry.
- DOE's commitment to advancing the MHK industry in the U.S. has been impressive, to say the least. Without their support, this industry will not evolve and be competitive with other power generators. The current awards by DOE acknowledge the needs of the industry (e.g., supporting the establishment of test centers and regulatory/permitting training).
- However, I am unsure if the national labs should be involved as much as they are. For example, the modeling efforts may not be the best way to spend the limited funds at this time, instead DOE may want to focus getting "steel in water" that will then allow labs to model.
- Advancing the state of MHK technology by in-water demonstrations should be the highest priority for the MHK Program.
- All other objectives support the primary objective above with reduction of deployment barriers being a key secondary objective as regulatory delays are clearly delaying in-water demonstrations
- Overall I think the department is doing some amazing work in a number of areas. Considering the budget was $0 just 6-7 years ago the progress made has been even more astounding. The private and public partnerships that have been brought to the table have significantly increased the effectiveness of the budget expended by DOE. Some of the recent awards that were presented clearly show the department is heading in the right direction both in advancing technology and in reducing environmental/regulatory barriers.
- There are some areas that could perhaps be improved upon. In particular I find some of the modeling work done solely by the labs to be of questionable value to the industry. I think the work is being done with great intentions but without actual operating devices in the water it will be difficult to validate some of the models and it seems that other approaches could have been taken to address some of the issues instead of building models. There doesn't seem to be much outreach to and interaction with the development community in the decisions to pursue these efforts or during the model development.

<u>Question 2. R&D PORTFOLIO: Is the Water Power Program investment portfolio appropriately balanced across research areas and recipient organizations to achieve the program's mission & goals?</u>

- DOE has done extraordinarily fine staff work in reaching out to the industry and National Labs to understand the requirements to grow the MHK industry. The resulting DOE MHK Program Objectives reflect this fine work. However, the historical funding has been disproportionately invested in the large-scale National Lab reference cost model, open-source software development, and hydrographic research projects that have little near-term contribution for MHK industry development. DOE should rebalance the portfolio to prioritize advancement of leading technology to the full commercialization stage, addressing the barriers to full deployment. This will best support job creation and full MHK cluster development within the U.S., and eventually integration of MHK technology into the U.S. generation base.
- DOE, working with the industry and National Labs, can best tap the excellent talents of the National Lab scientists in accelerating deployment of first and second generation technology as the prime Program objective.
- The Program Portfolio investments in open-source software are problematic. MHK developers have expressed the concern that existing, proven proprietary software exists and there is not a barrier to development posed by software availability. The available software programs are well suited to industry needs, and the price of the software reflects development costs. There is a concern that DOE may unwittingly adversely impact the availability of top quality design software by undermining private software developer interest in serving the MHK industry, thereby adversely impacting the MHK technology development sector in the long term.
- The program is fairly balance across the R&D spectrum. I suggest continued future emphasis on in-water demonstration projects.
- DOE has, and is, making great strides in advancing the industry. Their support for in-water demonstrations can only be described as invaluable. However, as funds are limited I would recommend DOE assess the merits of funding $750,000 to third wave test center on the West Coast - it maybe more beneficial to fund the current projects through to completion before addressing the needs of another center.
- Also, is current research building off of other industries knowledge and their R&D? For example, should DOE funds from the MHK program support the investigation into biofouling paints when both the Navy and oil & gas have spent millions looking into the same issue?
- The MHK Team has made effective use of financial resources to fund in-water demonstrations.
- The MHK Team has generally made effective use of the talents within National Labs to support industry, but in a few specific cases, the National Labs were used on projects that industry would have been better positioned to perform.
- The R&D efforts generally support in-water demonstrations with a few minor exceptions as mentioned in individual reviews.
- Projects related solely to infrastructure development, particularly the 4th Test Site, should be carefully evaluated to assure that they do not take resources from in-water demonstrations.
- Exceptions to the above comments include those efforts that are intended to enhance U.S. competitiveness in the global MHK community (international standards for instance).
- Overall great direction in a number of areas. I think there is a lot of merit in leveraging lessons learned from the wind industry but this needs to be tempered by the facts that the marine environment presents significantly different challenges than on-shore wind generation faced and that regulatory acceptance to these technologies will take time and patience and "steel in the water" deployments at a small scale before they can be widely adopted.
- A concern that was raised repeatedly was whether research is adequately building off of existing or ongoing research done by the oil and gas industry or the Navy and that the MHK industry should not be leading marine research in areas where there are common problems (i.e. biofouling etc.). These institutions have already figured out how to do almost anything in the underwater environment, MHK's challenge is to adopt the most cost effective ways to enhance the industry.

Question 3. MANAGEMENT & OPERATIONS: Evaluate the quality of the Water Power Program's team, management practices, and operations.

- DOE Water Power Program has assembled a top-notch staff, with excellent leadership, personnel and program operation practices. The Program currently is responding to historical priorities on National Lab funding, and is working to phase out the large scale National Lab studies that do not contribute directly in near term to industry development.
- DOE leadership as an honest broker between industry and the labs to encourage and facilitate greater collaboration, and assure that any National Lab research and planning fully consults and integrates industry feedback in study protocols and planned deliverables (e.g. open-source software) would ensure that taxpayers get the maximum value from their investments.
- In order to improve the relevance of any National Lab research project, DOE will need to add specific project requirements to ensure active outreach by the National Labs to determine the state of research in other research centers globally (not just a desktop review of research publications, which do not capture ongoing or unpublished work). Also, the Labs should be required to interview the MHK developers to learn about their needs on any given project, or to beta test any proposed deliverable (models, software, etc.).
- It was very clear to me that the MHK program has excellent leadership which is totally committed to its success.
- The leadership and operations of this program is very impressive - it was a privilege to work alongside such a talented group of individuals.
- The MHK Team has shown excellent leadership simply by holding this Peer Review.
- The MHK Leadership has made exceptional use of the National Laboratories to augment their staff and make progress on important research initiatives.
- The MHK Leadership has chartered the Labs to assist industry with selected regulatory issues (the orca-strike analysis stands out).
- Leadership and staff are top notch. They seem to share a passion for advancing the industry and are accomplishing quite a bit with a limited number of individuals.

Question 4. COMMUNICATIONS & OUTREACH: How effective is the Program at engaging with industry, universities, other agencies, international actors, and other stakeholders?

- DOE has invested considerable resources in communications and outreach. The presence of DOE staff at industry events, the DOE work to convene stakeholder workshops are all great contributions to assuring effective communications.
- The MHK program does a very good job in communicating with all its key stakeholders.
- Most of the funded projects included an extensive collaborative team of private and public partnerships.
- Well done!
- The only change I would suggest is that the publishing findings from the National Labs research not just focus on peer review papers and international conferences, but also trade publications as well.
- The only area that could be improved is the collaboration between System Developers and the National Labs. This is not easy and will require a lot of sensitivity to Industry's concerns.
- There is a great deal of excellent collaboration on most of the projects in the portfolio - with industry and the development community working closely with universities, national labs and others in the industry - including the Navy. The international standards work is important to be involved in but I wonder if there is more that could be done to gain information and insights from the international community. Some of the lab efforts appeared to lack good and consistent communication with industry. Overall the program does a great job of reaching out to industry and presenting results and progress reports at national events.

Question 5. 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.

- Consistent, high quality effort to remain current with MHK industry needs and developments.
- Careful planning to address barriers to development, drawing on resources and skills of many stakeholders.
- Excellent communication with industry on opportunities for funding.
- Leadership.
- Communication with stakeholders.
- This program has a strong foundation that an industry can be built on. The collaboration between public and private groups is highly commendable, particularly the team with the Navy, FAU, and OSU to develop national test centers.
- The programs support to develop system and components is also a program strength - this is needed if this industry is to progress.
- The Program is built on a solid foundation of cooperation between DOE, the Industrial Partners, the Labs, and academia. While not perfect, this foundation provides the best path for the U.S. to succeed in the international marketplace.
- As mentioned previously, the scientific expertise within the Labs is a strength of the Program.
- The SPA FOA is an excellent vehicle for making progress toward in-water demonstrations of existing systems without over specifying the technology.
- The MHK Program has also maintained a portfolio of system and component development efforts by industry that are still at the R&D stage. This allows smaller U.S. companies to grow.
- For the United States, getting test centers open and getting first projects in the water is huge. The university partnerships are excellent and should pay dividends in ideas and talent for years to come. DOE is helping developers continue to move forward in a very difficult U.S. market caused by the lack of clear national energy policy, low energy costs due to natural gas pricing, and a very difficult regulatory environment.

Question 6. WEAKNESSES: Discuss the aspects of the program that hinder successful outcomes or that disadvantages the program. Factors may be internal or external.

- Disproportionate funding for National Lab projects with little near term impact to reduce barriers to MHK deployment. Continued DOE leadership in migrating the National Lab talent to applied research to eliminate those barriers (e.g. Puget Sound Resident Killer Whale project) will strengthen the DOE MHK program progress.
- DOE focus on funding Technology, with limited emphasis on capacity of technology developer to commercialize the technology through a viable company may result in stranding the Technology. This may easily result in the global competitors buying the technology at discount prices.
- DOE should work to develop a continuous funding track for the most promising technology to enable predictable funding of technology development needs, eliminating down time and associated costs while the Company seeks new R&D funding. DOE should work to devise solutions to the "no mortgage" prohibition on multiyear funding stream in order to address the most serious barrier to development - adequate funding to bring a promising technology to commercialization.
- Continued DOE leadership in convening all needed stakeholders to address the permitting challenges is essential in order to reduce the permitting barriers. The "project by project" approach to address pilot projects throughout the U.S. is too slow and costly. Joint federal agency partner approach to developing a streamlined standard permit with conditions blessed by each agency (e.g. the National Pilot Project Permit by Rule) would be a game changer in terms of moving pilot projects ahead, and developing the data needed to address both environmental and engineering design issues.
- The national labs offer an amazing resource to this industry; however, it appears - at least at the surface - that their involvement is to cater to their personal needs and goals, not address the needs to progress this industry to commercial reality.

- In a few specific cases, I felt that the Labs were being used for efforts that were better suited for Industry. This may have simply been due to expediency.
- Again, in a few cases, delays were noted with regard to the execution of agreements between the Labs and Industry. This may be a unique aspect of Governmental organizations and there may be no obvious solution. The time for executing a simple NDA was an order of magnitude longer than I am used to.
- Industrial Partners are inherently distrustful of each other and smaller companies seem to consider the Labs as a competitor for R&D funding. Open technology transfer will always have challenges.
- It appears that at times there has been too much free reign to the labs to pursue projects that they think are in best interests of the industry without upfront and regular interaction with industry to make sure it will help them. There are some very smart people at the labs who may think they know best (and they may) but bringing in some other perspectives in the planning stages of projects would likely be helpful.

Question 7. RECOMMENDATIONS

- Keep up the great work!
- Emphasis on in-water projects.
- Get steel in water! Without DOE's help, this will not happen - that is the reality of this nascent industry. It maybe be more effective to fund more shorter termed physical projects than longer termed theoretical projects.
- When identifying funding ask "will this advance the MHK industry, or will it advance the marine industry (whatever it maybe)?"
- Maintain an emphasis on in-water demonstrations by Industrial Partners (including small ones). In short, "Fund Industry, not Technologies".
- Continue to support Industry with regulatory issues by having the Labs provide solid scientific data to address environmental concerns when possible.
- Continue to support Industry by transfer of scientific knowledge within the Labs to avoid "reinventing the wheel." This may involve expediting legal paperwork such as NDAs.
- Use the question "Does this proposed effort support rapid deployment of an MHK system or device?"
- Continue to support the U.S. industry through participation in international organizations.
- Don't focus too many resources on initiatives whose results won't be seen for a number of years at the expense of projects/initiatives that are close to success and just need a little help. Take a balanced approach (sort of like financial investing) with some resources spent in areas where a longer term return is expected but significant resources to those that have more immediate and easier to see returns.

8.2 Hydropower Qualitative Program Evaluation

Question 1. PROGRAM OBJECTIVES: How well do Program objectives align with industry needs and Administration Goals?

- Program is doing a solid job on all technical fronts. Gaps exist in highlighting licensing and permitting difficulties that create uncertainty for future investment for hydro. Additional program engagement in driving comprehensive energy policy would be a positive for our country - not just hydro.
- Environmental barriers (ESA, etc.) have been extensively well documented and mapped out, but as an industry, we haven't done nearly as good a job of touting the non-generating benefits that many reservoirs and hydropower dams provide. I would like to see a little more balance to this evaluation. For instance, in some extended drought situations, some ESA species would not likely have survived, if it were not for the storage releases from hydro impoundments upstream. Same could be true for major flooding situations where hydro impoundments often mitigate damage to aquatic habitats that could lead to loss of species.
- The first three objectives have good value in the "better, faster, cheaper" category, but they won't drive new hydro development. Three things are holding hydro back: (1) high cost and lack of certainty in licensing/permitting processes, (2) inadequate market valuation of Hydropower and Pumped Storage attributes that help integrate variable renewables and provide grid reliability; and (3) low natural gas

price. The DOE program objectives should have additional focus on the first two areas that are holding hydro back.

- The research program funds a variety of projects that align with all four of the major objectives.
- A few projects align with the objective of supporting the research program itself, which in turn aligns with the projects.
- Only a very few projects do not align well with the objectives because they are too site-specific, or address an ancillary concern.
- Hydropower development and deployment starts from well informed policy on gaps between what's needed and what's available, efforts to reconcile policy gaps would be very helpful.
- Robust regulatory process is key in reducing upfront planning cost, uncertainty, and lead time that are making developers reluctant in undertaking hydropower projects .
- Efficient market design is needed to provide incentives, economics signals, and assurances to developers, investors, banks to participate in hydropower development.
- Existing hydropower fleet encumbrance by contractual obligations, water delivery, aging infrastructure, reduced operating availability, environmental, physical and hydraulics limitations needs to be taken into account in assessing availability and future needs of flexible hydropower assets, especially in the context of renewable integration.
- The need for future pumped storage development should be addressed from reliability, sustainability, operating reserve perspective rather than direct competitive market opportunities.
- One should recognize that the hydropower industry is mature enough that innovation has to come from creative deployment and improvement of existing technologies rather than from breakthrough technology.
- I think this program has gone a long way to advance new hydropower systems and components and optimize existing facilities.
- All the projects we reviewed in the Hydro Program align with industry needs and Administration goals.

<u>Question 2. R&D PORTFOLIO: Is the Water Power Program investment portfolio appropriately balanced across research areas and recipient organizations to achieve the program's mission & goals?</u>

- I believe the investment portfolio is pretty well balanced across research areas but there appears to be a trend toward heavy investment (almost exclusive investment) in work for the National Labs in 2014.
- It is hard to understand the details of all the modeling projects and how they are supposed to fit together, but some overlap and redundancy in models appears to be possible.
- Generally yes, but make sure the data and modeling projects don't go too far into the realm of diminishing returns. Make sure the high value issue to be addressed or answer to be sought is clearly defined, and then stop the project once the issue or answer is addressed.
- Utilize stage gates and keep a close eye on research projects. If they start to go downhill; it's time to pull the budget.
- Need more focus on increasing the efficiency and certainty of Hydro licensing/permitting and improving market valuation of Hydropower and Pumped Storage attributes. These two areas are underfunded at present. Such an increased focus would provide DOE with a significant objective/goal by which to improve management decisions regarding research projects, funding, timeframes, priorities, etc consistent with doubling hydropower production. DOE is well-positioned as an agency to represent a major water user (hydropower) regarding licensing/permitting to improve these regulatory processes, and these improvements will benefit every water user in the USA as well as all over the world.
- Program investment is somewhat balanced across research areas. The balance across organizations does not seem balanced. Very few university funded projects. Perhaps more large projects to the labs. (This may be a policy issue).
- There are a number of very talented, creative and productive scientists in the Labs that carry a disproportionate part of the research. This contributes to continuity and reliability of results, but may limit

the creative input somewhat. Perhaps more collaboration between these people and agency or university scientists and engineers would have even better outcomes.

- Although R&D will always be needed, more efforts should be spent on creative integration and deployment of existing hydropower technologies to meet emerging trends in power market needs
- It is recognized that R&D carries extra cost and economics of a specific demonstration may not follow fundamentals. Economics of future deployment and potential savings from economy of scale need to be identified and assessed early. Contribution of technological advancement in future development may not be enough to offset the gap in a project's economic viability. Example, 5 % improved mechanical efficiency may only result in 1% reduction in LCOE, which may not be enough to encourage future deployment.
- Demonstration projects need to be carefully and strategically selected to benefit the hydropower industry as a whole, notwithstanding the difference between what's meant to be for Research and others meant for development. Either way, viability of future deployment needs to be demonstrated in every stage.
- Creative deployment is a key, as market design and developers participation in the power market is different from one market to another. Example, deployments meant to offset retail price exposure and serve native load of an entity may prove to be economical versus deployment to participate in the wholesale market for the same technology.
- Economics of a specific technology should include life cycle cost, and should not be limited to initial capital cost. Future maintenance, refurbishment and replacement needs should be taken into account.
- The Basin Scale Opportunity Assessment needs to receive more funding. This program is vital to doubling hydro but faces many challenges to accomplish the goals for implementing this plan across the country.

Question 3. MANAGEMENT & OPERATIONS: Evaluate the quality of the Water Power Program's team, management practices, and operations.

- Excellent DOE personnel and support team. Steps are being taken to address transition from project "grants" to co-managed projects. This is an EXCELLENT step forward.
- Very impressed with leadership, staff and strong commitment to advance US Hydropower generation.
- The DOE team seems highly qualified, engaged and passionate about the research agenda.
- The program operations practices were explained to the panel briefly, but there is still much about this that is not understood.
- The new business/funding model that the program is adopting (cooperative agreement concept) is a very positive change and should provide the level of scrutiny needed to monitor progress of different projects.
- It may be helpful to develop a project management plan template that all PIs will adhere to, allowing tracking of progress and meeting milestones and deliverable requirements would be easier to manage and correct in a timely manner.
- End user needs of the undertaken efforts/projects should be the key driver to setting the objectives and scope of each project.
- One should always start from what is already been done and readily available and identify gaps that need to filled to provide a product that would be more robust and useful from an end user perspective.
- Projects that are meant to demonstrate hydropower potential for future development need to be balanced with other competing interests, early on. So the findings of these studies will be better received and would not trigger pushback from other groups, such as environmental, water rights, NGO, etc.
- I think the program has helped the labs work together toward common goals instead of competing against each other. This is the best direction for the industry and the taxpayer.
- Challenged to get more research done with similar funding levels. The "grant" approach has its benefits, but the "cooperative" approach Jose discussed on Feb 28 sounds like it would provide advantages.
- While the national labs provide continuity in expertise, their costs for projects is very high. Costs for work like modeling could be reduced by retaining small contractors.

Question 4. COMMUNICATIONS & OUTREACH: How effective is the Program at engaging with industry, universities, other agencies, international actors, and other stakeholders?

- From the industry perspective, this is an area for continual improvement. It is very difficult to reach all the parties that may be of assistance as possible members of "Technical Advisory Committees" that represent end users, but distribution lists from NHA, Pennwell, and other organizations may help to better engage industry for these initiatives. Also, distribution of reports through OSHI and other government websites are often unknown to the non-federal hydro producers and need better visibility.
- Outreach/partnering with NHA and other industry organizations is on right track and should be increased. The peer review concept and process are excellent!
- Need to increase outreach to environmental community both to influence direction and avoid surprise/push-back.
- The program does a pretty good job of communicating through reports and products available.
- Communication with the review panel could be more effective (see recommendations).
- The program is doing an excellent job in engaging industry participants through seeking advisory groups, peer reviews, case studies, demonstration projects, reports, conferences, etc.
- In the R& D space and demonstration projects, it would be helpful to seek advice from experts in the industry, early on.
- More frequent updates and engagement of the review panel would help identify concerns with progress and may provide recommendations that will lead to higher levels of success.
- More focus should be given to communicating non-monetary benefits from hydro installation that are of great benefits to communities from a socioeconomics perspectives.
- In developing toolsets, it would be very helpful to design the final product to fit business processes that typical utilities use in managing their hydropower assets. There is no need to spend efforts to integrate modules in one suite, unless the utility benefits of the final product is recognized by the end-user.
- Good, but outreach and communications could be improved.
- I think much more could be done to interact and share more information with those outside DOE and the labs. I knew very little about the Hydro Program prior to the review, even though I know (and have known for many years) professional staff at the labs.

Question 5. 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.

- Overall the program has done a terrific job of showing that hydro still has a lot to offer and MUST be a part of future energy solutions.
- A number of recommendations from previous Peer Reviews have been adopted and numerous process improvements have been put in place that greatly enhance the effectiveness and efficiency of the Peer Review process.
- DOE’s aggregation of data to support the conclusion that US hydro can double its clean energy contribution has been hugely helpful in convincing Congress to develop and pass supportive legislation.
- DOE's clear efforts to understand align with, and support industry direction is essential to successful outcomes. DOE's Hydro Vision process will greatly strengthen the linkage between DOE and industry.
- Linkage with other industry organizations: IEA, CEATI, EUCG, NHA. How about EPRI? Maximize leverage!
- DOE funds a certain number of new inventions - new turbines or other devices that will be patented or brought to market. This is appropriate and ultimately of value. The hydro industry needs creative new ideas now. This is very much like the NIH funding new medical technology, which has resulted in many very successful inventions.
- Research that develops new algorithms for modeling hydro operations is an important part of the research portfolio. These allow more efficient use of hydro, greater market value, and fewer violations of other water-related constraints and objectives, and great potential for integration of variable renewables.

- The Hydro Research Foundation has been a great program, turned out many remarkable young engineers and scientists with a passion for hydropower.
- The basin assessment projects are aligned with DOE objectives, but can be fraught with difficulties. There is much experience in other agencies with these. DOE look to be focusing on defining hydro-specific processes that can find win-win opportunities in basins where there is a great potential for additional hydro.
- Several "assessment" projects - development of databases - are responding to the great need for more data about hydro - the existing fleet, the potential market, the value, etc. DOE's commitment to long term funding/upkeep of these is important.
- DOE's research portfolio is forward thinking and visionary - it funds some projects that will help define major shifts in the energy future.
- The program has a coherent set of goals and objectives that meets the ever evolving and diverse energy market.
- There is a genuine commitment to hear hydropower industry experts and participants to efficiently manage outcome.
- The program is clearly focused on working toward industry needs and advancement of hydropower deployment.
- Has progressed the industry.
- Good stakeholder involvement.
- Great sense of direction for the program with projects lined up with goals and objectives. Very professional team leading the program as well as very professional technical personnel.

Question 6. WEAKNESSES: Discuss the aspects of the program that hinder successful outcomes or that disadvantages the program. Factors may be internal or external.

- A trend toward heavy reliance on National Labs to originate projects may lead to blind spots in practical research since it is atypical to see lab PI's in the field. Sometimes these projects can be blind crunching of databases and statistical analyses without a strong connection to end users.
- DOE's traditional focus on research likely distracts from its potential impact on influencing policy. As Congress' technical advisor on energy matters, DOE can have a huge impact on policy. A great example of this is how DOE's work on the growth potential of hydropower supported passage of two hydro bills in 2013. The focus on research also can lead to diving too deeply (beyond the needs of the high value issue or question) or continuing to support projects that are sinking and should be terminated.
- Development of software that is intended to be used by hydro operators in production cannot be fully developed under a research grant. Software products should be developed according to accepted standards, undergo rigorous QA testing, and have budgets for continued software maintenance, infrastructure for reporting and fixing issues, help desk support, etc. Further, software should be developed based on user needs to a certain point, then tested and deployed. Continued development should be considered after initial functionality is accepted by users. It is more likely that software developed under research grants will be "research" software, usable mainly by research projects. The expectations and future funding are quite different.
- Research to develop new methods in areas such as hydrologic forecasting and environmental health of rivers may not be well aligned with DOE objectives. Although good forecasts help optimize hydro value, there are many other agencies already working in this area and many methods that are widely used and accepted. Environmental health of rivers is determined by biological opinions, records of decision and many other scientific efforts carried out by many agencies and organizations. Similarly, downscaling for climate change is a large and duplicative effort; DOE could spend the resources on modeling the specifics of systems that focus on the hydro resources. The weakness here is in not recognizing when a portion of the research is a duplication of work done elsewhere by agencies that have specialization in those areas.

- The need to support the labs seems to dominate the program. The Labs contribute significant and valuable science, but also have projects with deep funding levels that don't seem to be generated by industry need or alignment with the goals.
- Program is underfunded resulting in slower schedule and progress than what's needed, as energy market is evolving at a much faster pace.
- Peer reviews are too far apart and not designed to provide early intervention to help the program identify potential problems in some of the projects.
- Need to make sure projects aren't just a redo of something that has already been done.
- Think about the point of diminishing returns.
- Build on what has already been done instead of building a new wheel.
- Could get a lot more work done if costs were lower.

Question 7. RECOMMENDATIONS

- Intervals between Peer Reviews are too long. Perhaps status reports, already required of the PI's, could be sent to the Panel at 6 month intervals. Use of the Merit Review process at interim intervals could be of great assistance for engaging the industry in the steering process for many projects.
- I would like to see/verify that there is more upfront outreach to industry end users during the scoping and development stages of a project. This was mentioned in several presentations and may be happening but these solicitations are apparently not well publicized. I also believe that better upfront engagement by the Peer Review panel during the selection process might have redirected funds away from some projects that had very high probabilities of failure.
- For many projects, I would like to see an "End user Evaluation/Customer Satisfaction Survey" that would help DOE evaluate the value and performance of ongoing projects. Simple "Survey Monkey" questions could request end users to provide their expected cost savings that have resulted from the implementation of a particular project. This also sets the stage for the PI to make sure that they know who the end users are and will reinforce the need to engage the end users throughout the process.
- Many projects do not have clear measures of success. In my company, we have a "Check Investment" process that can be required of any project and requires the receiver of funds to show how their project is actually paying off compared to what they promised. As part of their proposals, a few new technology projects made exaggerated claims and completely baseless LCOE projections, and unfortunately, there was no accountability mechanism for failure to deliver on these promises.
- Improve sharing with industry via webinars and industry distribution lists from NHA, CEATI, EPRI, etc.
- All lab developed software products should have clear implementation, rollout, and ongoing maintenance plans (and ongoing funding, if necessary) at the onset for these products.
- Increase DOE's focus on addressing the issues that are holding Hydro back: (1) high cost and lack of certainty in licensing/permitting processes, (2) inadequate market valuation of Hydropower and Pumped Storage attributes that help integrate variable renewables and provide grid reliability; and (3) low natural gas price. Use DOE's technical clout to inform Congress of the need for policy changes that drive Hydro forward,
- All projects should be evaluated against the question, "How will this help grow hydropower in the US?", and should focus on the deliverable to the end user.
- Separate the objective areas of reducing deployment barriers and reducing environmental impacts. While it's true that environmental impacts can sometimes be a deployment barrier, the much greater need for reducing environmental impacts is centered on existing hydro and the biggest deployment barriers (lack of certainty in licensing/permitting and inadequate valuation) have little to do with environmental impacts.
- Engage in the water/power nexus, with a strong focus on climate change impacts. Expand the ongoing climate change study to also address non-federal hydro.

- Establish a robust Low Impact Hydro Certification program, or at least set the objective criteria for such programs by others. DOE (not LIHI) should own this!
- Peer review process improvements: (1) make it more prospective than retrospective, (2) shorten interval to one year? (3) provide quarterly status reports on key projects.
- Risky projects like new inventions should be monitored more closely and by people who have some expertise in the technical details.
- New databases are needed, but often the data that is gathered may not add up to a set that is very useful. For all database projects, it would be useful to identify specific questions that can be answered, to insure some basic utility upon which to build. Analysis tools could also compliment these inquiries.
- Many projects will end, i.e., not have continued funding. Does DOE keep track of the lasting effects of projects? How are the results used in the future? This should be built in to the program.
- The review process is good and gets better each time, but still has some room for improvement. The following could improve the process: 1) omit presentations on projects that are purely demonstrations or very small budgets; 2) provide extra time for projects that are complex and/or have large budgets; the current process sometimes does not allow the panel to get enough information to make provide useful feedback; there often are not enough time for questions; perhaps the presenters can be available later for more questions.
- There is a need to educate the public, and inform policy on the benefits that the hydropower industry provides, beyond electricity. Also, there is a need to recognize that the existing hydro fleet is not available to provide the very much needed renewable integration services.
- There is a need to recognize that the existing hydro fleet is not available to provide the very much needed renewable integration services. Competing energy storage technologies are either a better fit for Transmission and Distribution needs, or they are a high GHG emission resources that render their use as a self-defeating notion in the context of clean renewable energy.
- One should be careful in publishing findings from models that are not designed to discover the actual value and need of Pumped Storage Hydro, especially in the context of renewable integration. As this will send the wrong message about the value and need of PSH. In CA the expected stream of revenues for a standalone PSH assets should range between $150 to $200 per KW-Yr, for the year 2020.
- The peer review for the most part looks at projects that are well underway to almost complete. A review before the project is started or earlier in the process would be beneficial. Get end users involved on the front end.
- Don't forget existing infrastructure. New development is great but the benefit cost ratio of improvements to existing infrastructure is usually significantly better than new construction.
- Keep the end goal and end user in mind. How will this be used in the field to solve a problem?
- We can always look deeper when it comes to research but is there always value in that deeper look?
- Focus on benefitting industry as whole. Be careful about just benefitting one vendor.
- Get more technical work performed outside the Labs, especially modeling, and share and interact more with outside professionals and other organizations.

9.0 Lessons Learned from the 2014 Water Power Peer Review Meeting Process

The 2014 Water Power Peer Review meeting took place on February 24 – 28, 2014 at the DoubleTree Crystal City Hotel in Arlington, VA. A Marine and Hydrokinetic Peer Review Panel consisting of five members (including a chair) and a Hydropower Peer Review Panel consisting of six members (including a chairperson), participated in the 2014 Peer Review process. The purpose of the review was to evaluate DOE-funded projects for their contribution to the mission and goals of the program, to assess progress made against stated objectives, and to assess the program’s overall management and performance. Principal Investigators (PI), leading approximately 96 projects, and federal program staff came together to disseminate information, progress, and results. The following is a list of comments and actionable recommendations, made by the individual panelists, aimed at improving the process for future peer review meetings.

9.1 General Feedback on the Peer Review Process

- Communications with the Peer Review Team have been excellent.
- A number of recommendations from previous peer reviews have been adopted and numerous process improvements have been put in place that greatly enhances the effectiveness and efficiency of the peer review process.
- The Excel agenda with embedded score sheet tabs and quick links to the presentations and two-page project summaries were terrific enhancements.
- Getting the PowerPoint presentations early was a huge benefit to the panelists’ preparation. Having everything electronically on a thumb drive was fantastic and it made sure that the final presentations were all in one place. Please hold the line on discouraging/refusing any late presentations – otherwise, “you can expect to get what you are willing to accept.”
- The standardized templates that all presenters must use with objectives, budget information, proposed work, etc. is much easier to understand and compare then the sometimes rambling, wide-ranging presentations that existed a few years back.
- Found the two-page project summaries very useful, both for prep on the project as well as for review after the presentations. One recurring theme was that the two-page summary be just that – two pages.
- The time clock for presenters was helpful and very successful. The awareness of the clock helped the presenters understand that they didn’t have time to get into minutia and that they needed to focus on their key points.
- The poster session was an excellent idea to allow more informal engagement of the panel with some speakers.
- The panel dinner before the first day was also a very good idea and helped to build team chemistry. The dinner with DOE staff was also beneficial and very well received.
- Notes of appreciation are always helpful to panelists when communicating with their management about the time they spent during the peer review process.

9.2 Opportunities for Improving the Peer Review Process

Suggestions from Hydropower Panelists:

- Scheduling
    - Intervals between peer reviews are too long. Perhaps status reports, already required of the PIs, could be sent to Panelists at six month intervals. Use of the merit review process at interim intervals could be of great assistance for engaging the industry in the steering process for many projects.
- Presentations

  - Omit presentations on projects that are purely demonstrations or have very small budgets.
  - Provide extra time for projects that are complex and/or have large budgets. The current process sometimes does not allow the panel to get enough information to provide useful feedback.
  - There often is not enough time for questions; perhaps the presenters can be available later for more questions.
  - All projects should be evaluated against the question, "How will this help grow hydropower in the U.S.?" and should focus on the deliverable to the end user.
  - Final presentations from the PIs should be frozen about four weeks before the meeting so that a single complete assembled final version can be sent to the panelists three weeks in advance. Avoiding last minute revisions and omissions is very helpful to the process. In fact, because the panelists had the presentations in hand early this year, many did not need to rely nearly as much on the two page summary documents.
- Pre-review Planning
  - Before panelists are vetted and chosen, projects for review should be selected and a summary Excel spreadsheet of previous and future cash flows for all selected projects should be compiled. This knowledge can help tailor the selection of panelists to better fit the more significant projects being evaluated.
  - DOE goals and objectives, as well as DOE “Questions for Peer Reviewers,” should be included in early materials sent to panelists (and emphasized by the chair).
  - Educate panelists about the project process including selection, monitoring, and execution phases. This could be a handout/presentation included with the Water Power Peer Review Plan or kickoff conference call.
  - Develop an automated spreadsheet that can populate a list of the scores for all projects in a matrix that can be easily viewed by the panelist for verifying their own scoring calibration.
  - For many projects, would like to see an "End user Evaluation/Customer Satisfaction Survey" that would help DOE evaluate the value and performance of ongoing projects. Simple "Survey Monkey" questions could request end users to provide their expected cost savings that have resulted from the implementation of a particular project. This also sets the stage for the PI to make sure that they know who the end users are and will reinforce the need to engage the end users throughout the process.
- Logistics
  - Presentations should wrap up by 4:00 pm (4:30 pm at the latest) to allow an hour or more for panel de-briefing time before dinner.
  - Presentations could start earlier at 8:30 am with an hour for lunch and two 15 minute breaks. This allows for six hours of presentation per day.
  - More low dollar and low risk projects could be sent to the poster session. If the poster session starts at 4pm, it would be nice to stop the presentations no later than 3pm to allow time for the daily panel de-brief. It was suggested that a cash bar during the poster session would make it more of a “social” that would also facilitate mingling and beneficial interaction that otherwise might not occur.
- Wrap-up and Post-review
  - Automate the accumulation of marked program key findings so that these could be compiled Thursday evening to prepare for the Friday closed door meeting. This is dependent on allowing time for panelists to meet on Thursday to discuss programmatic key findings.
  - It would be great if outstanding panelists could be recognized in some incremental way for time and effort expended beyond the norm.

Suggestions from MHK Panelists:

- Pre-review Planning

  - Use the question "Does this proposed effort support rapid deployment of an MHK system or device?" as an evaluation metric.
  - Consider consolidating some of the individual projects at the national labs into a single presentation of an overarching program/portfolio.
    - The Field Measurement Campaign might have been reviewed in one presentation rather than three individual ones with a fair amount of repetition.
    - In the extreme case, the entire portfolio for the national labs could be reviewed in one day with presentations on individual programs rather than individual efforts at each Lab.
- Presentations
  - The budget presentation was a little difficult to decipher regarding what was allocated to a particular project versus the program.
  - The presentations on Technology Advancement by Industry could have been longer, but the danger is that the presenters will go into obscure technical details. For these efforts the MHK team recommends:
    - A greater emphasis on adherence to cost/schedule.
    - A discussion on the important lessons learned.
    - A discussion on the delays and costs related to regulatory matters are key to understand as they seem to be keeping “steel out of the water.”
  - The presentation slides titled “Project Plan and Schedule” and “Project Budget” in the presentations are standardized and concise, but the content is easy to misinterpret. A proposed different approach for “significant” projects/programs is to include:
    - What milestones were planned to be completed during the reporting period and what was the expected cost to complete them (Budgeted Cost of Work Scheduled [BCWS]).
    - What milestones were actually completed during the reporting period and what was the expected cost to complete them (Budgeted Cost of Work Performed).
    - What cost was actually incurred (Actual Cost of Work Performed [ACWP]).
    - The charts as they currently exist allow a comparison of BCWS & ACWP. While vitally important to DOE for allocating funds to performers and for the senior management of the performing corporations to understand revenue variances, such a comparison is not considered good practice for the purposes of evaluating a project.

9.3 Guidance and Suggestions for Future Peer Review Chairs

- Emphasize the DOE program goals, objectives, and questions for peer reviewers during discussions with the panelists.
- Emphasize the need for substantive, constructive, actionable comments on the evaluation forms during discussions with the panelists.
- Prepare for the Friday closed door session by focusing the panel on key findings that are program wide or those that need immediate attention. Get key findings identified by end of day Thursday in time to prep for the Friday closed door session.
- Remind panelists they should not expect to have much time for their “real job back home” during the review week.
- Remind panelists they should expect to spend time daily for the panel de-brief and also to get a jump on individual scoring.
- Chair should facilitate and lead the daily panel de-brief to discuss individual merits of a project.
- Chair should bring a higher level view to facilitate the discussions and help panelists avoid getting mired in the minutia.
- Chair should reminder panelists to submit Conflict of Interest, Nondisclosure agreements, Workbook submittals, W9 and expense reimbursement requests in a timely manner.
- Chair should assist with time management for sessions.

APPENDICES

Appendix A. Acronyms

Abbreviations

Abbreviation	Description
ARRA	American Recovery And Reinvestment Act
AWEC	Advanced Wave Energy Converter
BSOA	Basin-Scale Opportunity Assessment Initiative
FOA	Funding Opportunity Announcement
FY	Fiscal Year
GW	Gigawatts
HAP	Hydropower Advancement Studies
IEA	International Energy Agency
IP	Intellectual Property
KHPS	Kinetic Hydropower System
kW	Kilowatt
kWh	Kilowatt Hour
LCOE	Levelized Cost Of Energy
LLC	Limited Liability Company
MOIS	Modular Ocean Instrumentation System
MW	Megawatt
MWh	Megawatt Hour
NHAAP	National Hydropower Asset Assessment Program
NMREC	National Marine Renewable Energy Centers
O&M	Operations & Maintenance
OEM	Original Equipment Manufacturer
PI	Principle Investigator
PPA	Power Purchase Agreement
PTC	Production Tax Credit
PUC	Public Utilities Commission
R&D	Research And Development
RFI	Request For Information
SPA	System Performance and Advancement
TRL	Technology Readiness Level
UK	United Kingdom
US	United States Of America
WARP	Wave Analysis and Response Program
WEC	Wave Energy Conversion
WWPP	DOE Wind and Water Power Technologies Office
W4e	Wave For Energy

National Laboratories

Abbreviation	Description
ANL	Argonne National Laboratory
INL	Idaho National Laboratory
LANL	Los Alamos National Lab
LBNL	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
NREL	National Renewable Energy Laboratory
ORNL	Oak Ridge National Laboratory
PNL	Pacific Northwest National Laboratory
PNNL	Pacific Northwest National Laboratory
SNL	Sandia National Laboratories

Government Agencies

Abbreviation	Description
DHS	Department of Homeland Security
DOD	Department of Defense
DOE	Department of Energy
EERE	Energy Efficiency and Renewable Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service

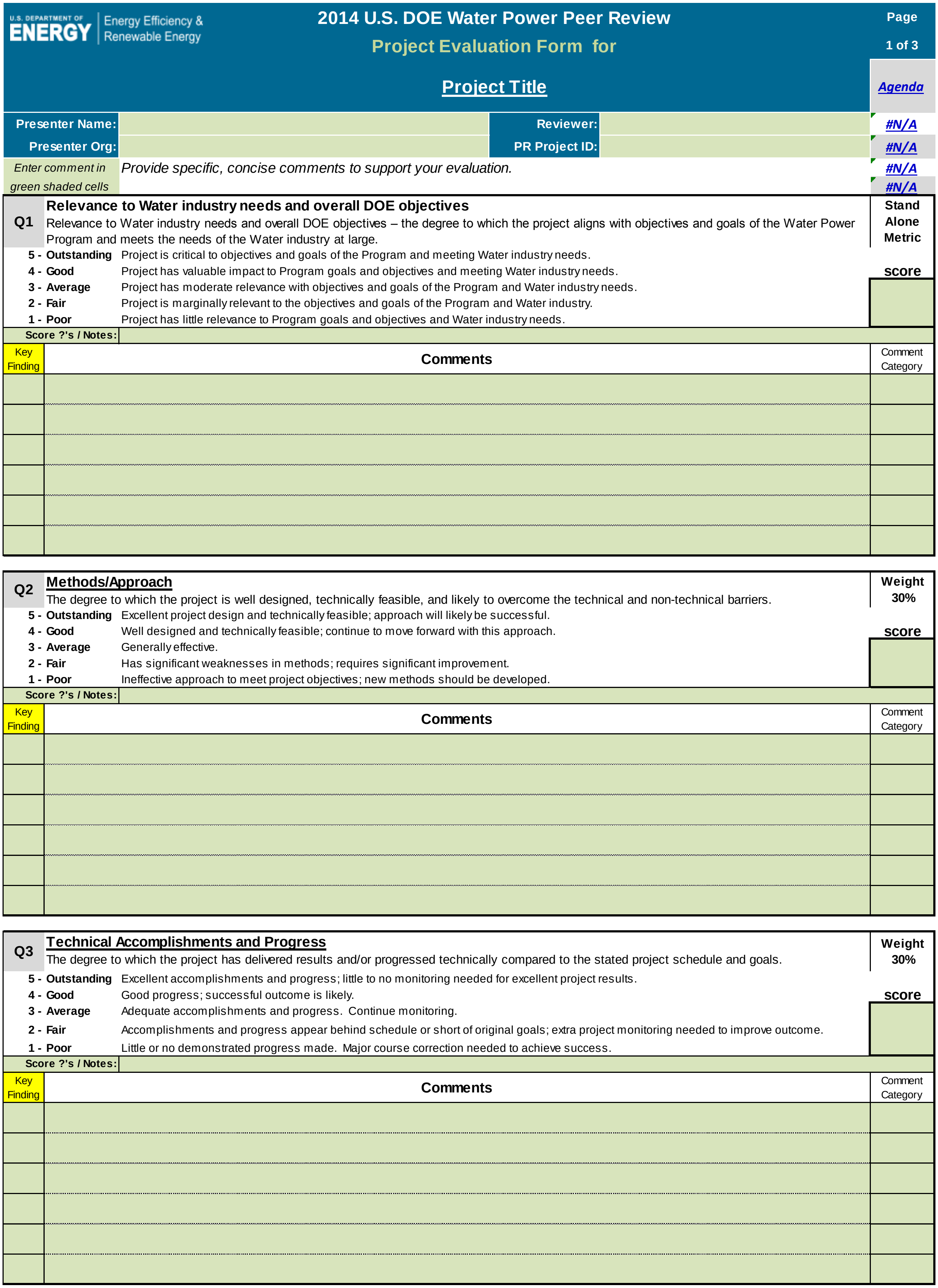
Appendix B. Existing Project Evaluation Form Template

The evaluation forms were the only means by which reviewers documented their quantitative and qualitative project evaluations. The panelists were asked to rate existing Marine and Hydrokinetic and Hydropower projects on the following metrics:

1. **Relevance to Industry Needs and Overall DOE Objectives:** the degree to which the project aligns with objectives and goals of the Water Power Program and meets the needs of the Water industry at large. (Stand Alone Metric)
2. **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%)
3. **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%)
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. (Weight = 20%)
5. **Research Integration, Collaboration, and Technology Transfer:** 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%)
6. **Proposed Future Research (if applicable):** the degree to which the future research proposed is relevant, well-planned, and worthwhile of continued funding. (Weight = 10%)

In addition to the above six criteria, peer reviewers were asked to provide an overall qualitative assessment of the project in a written narrative. Reviewers were asked to comment on overall strengths and weaknesses, and to include recommendations for ways to improve the projects.

For “existing” project evaluations, 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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating).



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Presenter Name:		**Reviewer:**	
Presenter Org:		**PR Project ID:**	

#N/A
#N/A
#N/A
#N/A

Enter comment in green shaded cells — *Provide specific, concise comments to support your evaluation.*

Q1 **Relevance to Water industry needs and overall DOE objectives**

Relevance to Water industry needs and overall DOE objectives – the degree to which the project aligns with objectives and goals of the Water Power Program and meets the needs of the Water industry at large.

Stand Alone Metric

score

5 - Outstanding	Project is critical to objectives and goals of the Program and meeting Water industry needs.
4 - Good	Project has valuable impact to Program goals and objectives and meeting Water industry needs.
3 - Average	Project has moderate relevance with objectives and goals of the Program and Water industry needs.
2 - Fair	Project is marginally relevant to the objectives and goals of the Program and Water industry.
1 - Poor	Project has little relevance to Program 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.

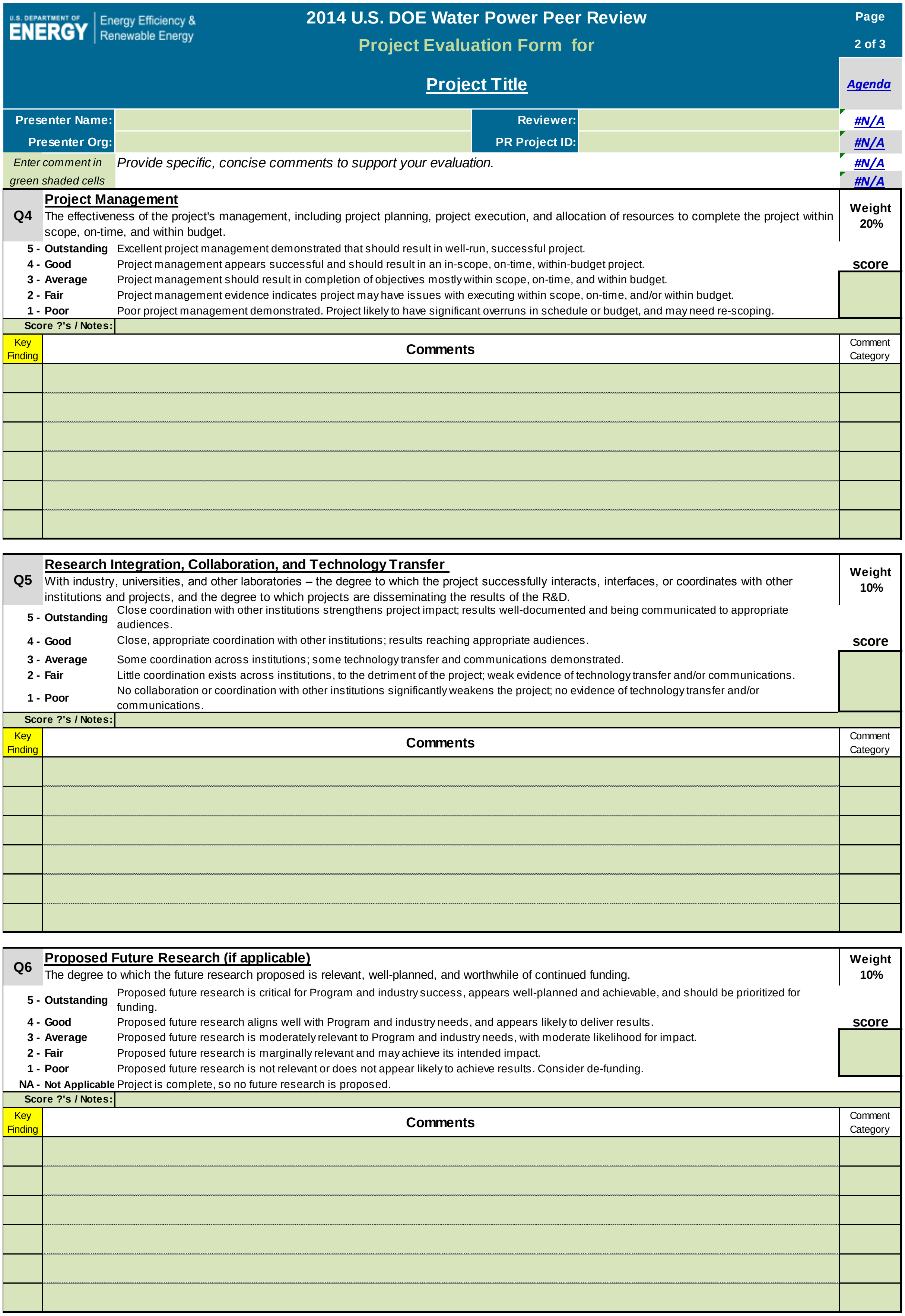
Weight 30%

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



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Presenter Name:		**Reviewer:**		#N/A
Presenter Org:		**PR Project ID:**		#N/A
Enter comment in green shaded cells	*Provide specific, concise comments to support your evaluation.*			#N/A #N/A

Q4 **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.	**score**
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 ?'s / Notes:		

Key Finding	**Comments**	Comment Category

Q5 **Research Integration, Collaboration, and Technology Transfer**

With industry, universities, and 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.	**score**
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 ?'s / Notes:		

Key Finding	**Comments**	Comment Category

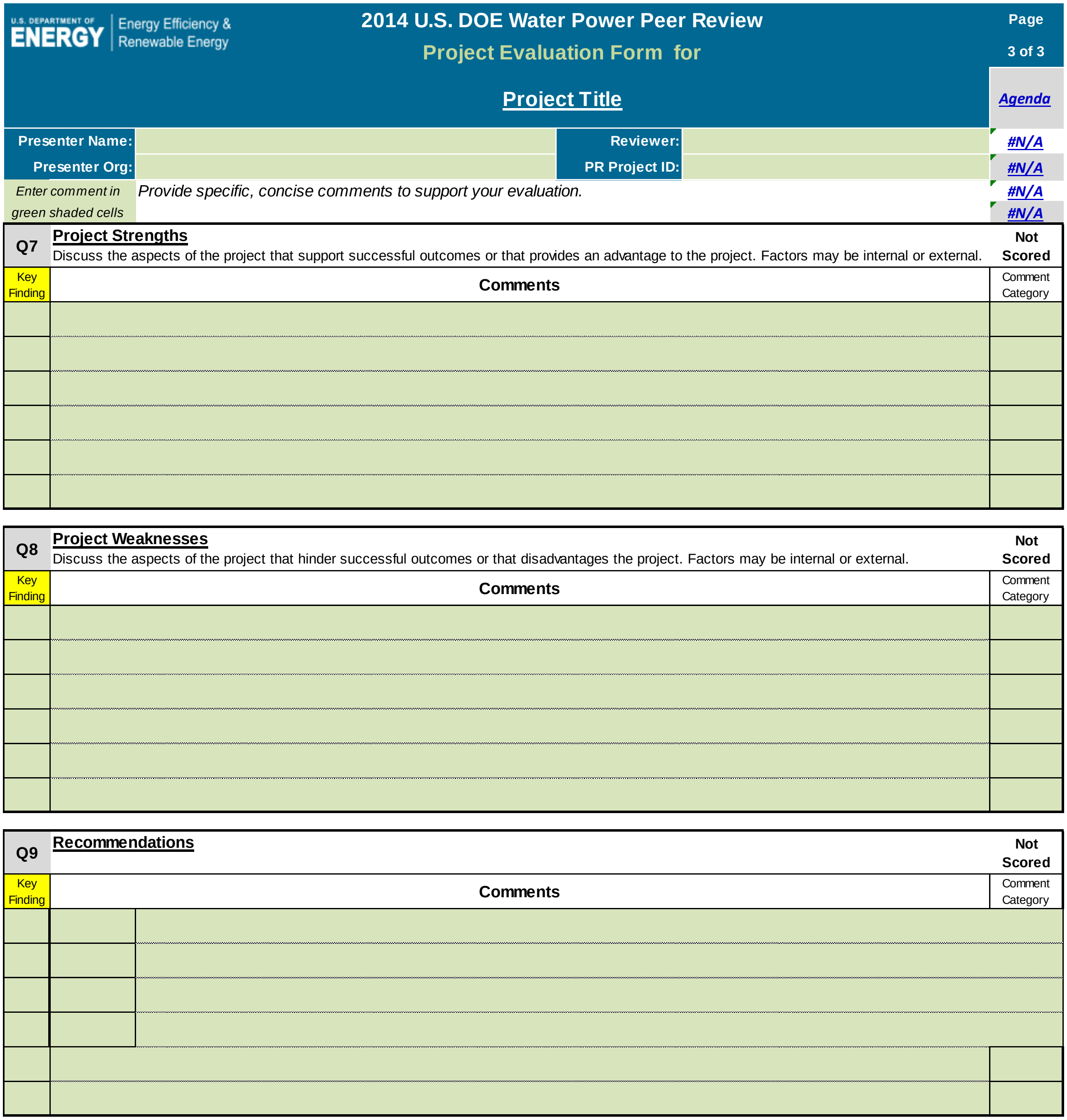
Q6 **Proposed Future Research (if applicable)**

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 Program and industry success, appears well-planned and achievable, and should be prioritized for funding.	
4 - Good	Proposed future research aligns well with Program and industry needs, and appears likely to deliver results.	**score**
3 - Average	Proposed future research is moderately relevant to Program 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 ?'s / Notes:		

Key Finding	**Comments**	Comment Category



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Presenter Name:		**Reviewer:**		#N/A
Presenter Org:		**PR Project ID:**		#N/A
Enter comment in green shaded cells	*Provide specific, concise comments to support your evaluation.*			#N/A #N/A

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

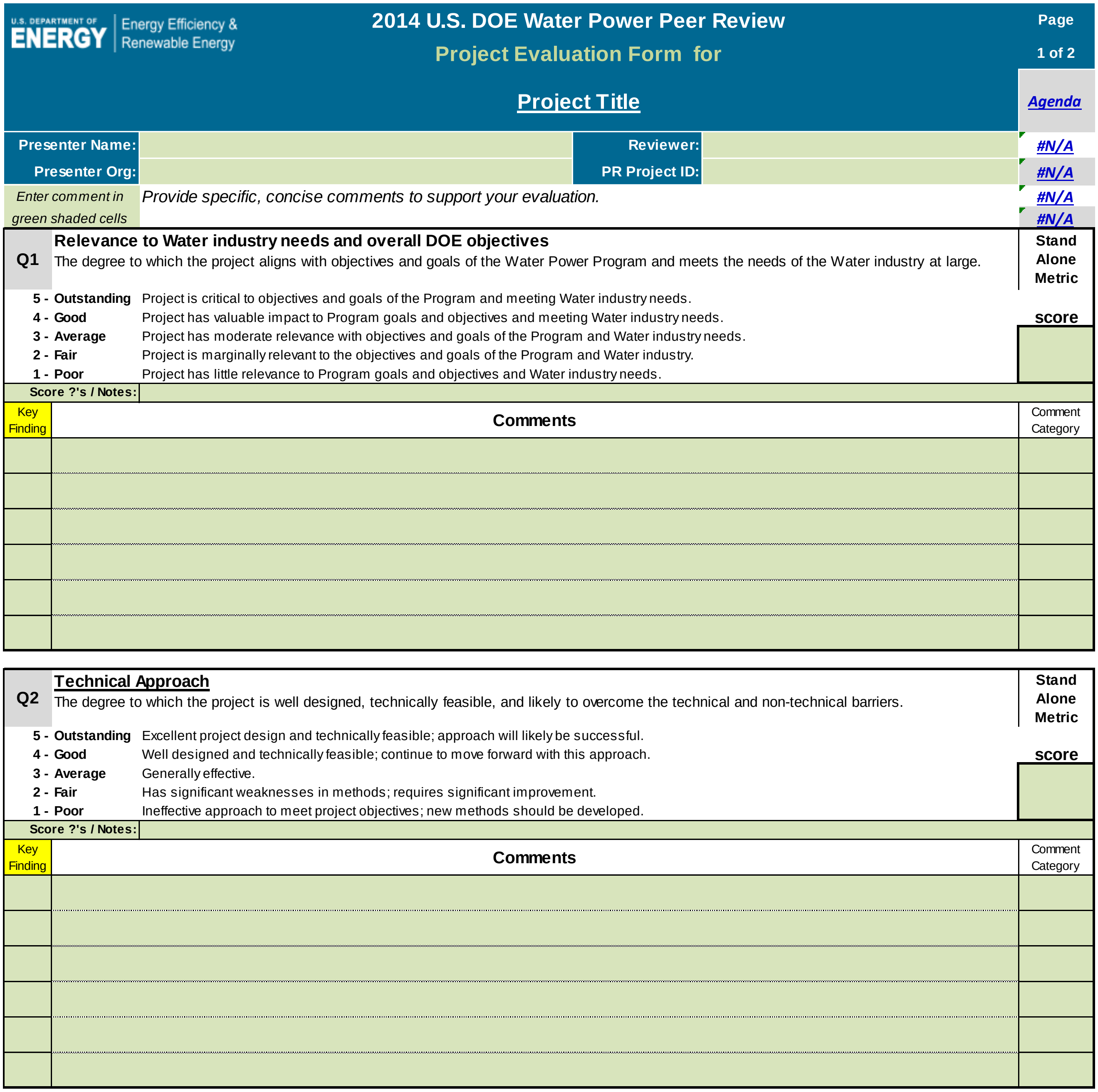
Appendix C. New Project Evaluation Form Template

The evaluation forms were the only means by which reviewers documented their quantitative and qualitative project evaluations. The panelists were asked to rate new Marine and Hydrokinetic and Hydropower projects on the following metrics:

1. **Relevance to Industry Needs and overall DOE Objectives:** the degree to which the project aligns with objectives and goals of the Water Power Program and meets the needs of the Water industry at large. (Stand Alone Metric)
2. **Technical Approach:** the degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers. (Stand Alone Metric)

In addition to the above two criteria, peer reviewers were asked to provide an overall qualitative assessment of each of the “new” projects by commenting on the aspects of the project that support successful outcomes or that provides an advantage to the project, the aspects of the project that hinder successful outcomes or that disadvantages the project, and recommendations for ways to improve the projects.

For “new” project evaluations, 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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating).



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Presenter Name:		**Reviewer:**		#N/A
Presenter Org:		**PR Project ID:**		#N/A
Enter comment in green shaded cells	*Provide specific, concise comments to support your evaluation.*			#N/A #N/A

Q1 **Relevance to Water industry needs and overall DOE objectives**

The degree to which the project aligns with objectives and goals of the Water Power Program and meets the needs of the Water industry at large.

Stand Alone Metric

score

5 - Outstanding	Project is critical to objectives and goals of the Program and meeting Water industry needs.
4 - Good	Project has valuable impact to Program goals and objectives and meeting Water industry needs.
3 - Average	Project has moderate relevance with objectives and goals of the Program and Water industry needs.
2 - Fair	Project is marginally relevant to the objectives and goals of the Program and Water industry.
1 - Poor	Project has little relevance to Program goals and objectives and Water industry needs.

Score ?'s / Notes:

Key Finding	**Comments**	Comment Category

Q2 **Technical Approach**

The degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers.

Stand Alone Metric

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

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Presenter Name:		**Reviewer:**		#N/A
Presenter Org:		**PR Project ID:**		#N/A
Enter comment in green shaded cells	*Provide specific, concise comments to support your evaluation.*			#N/A #N/A

Q3	**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

Q4	**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

Q5	**Recommendations**	**Not Scored**
Key Finding	**Comments**	Comment Category

Appendix D. Program Evaluation Form Template

The evaluation forms were the only means by which reviewers documented their quantitative and qualitative evaluations of the Water Power Program. The panelists were asked to rate the Water Power Program based on the metrics listed below:

1. **Program Objectives:** how well do Program objectives align with industry needs and 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:** evaluate the quality of the Water Program'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?

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 corresponds to a “Fair” rating, 3 corresponds to an “Average” rating, 4 corresponds to a “Good” rating, and 5 corresponds to an “Outstanding” rating). Reviewers were also asked to provide qualitative feedback on program strengths, program weaknesses, and any additional recommendations.

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2014 U.S. DOE Water Power Peer Review

Program Evaluation Form

Page
1 of 3

Program Name:	**DOE Water Power Program**	**Reviewer:**		*Agenda*
Presenter Name:	**WWPP Program Manager + Team**	**Presenter Org:**	**DOE Wind and Water Power Program**	
Input Cells	*Provide specific, concise comments to support your evaluation.*			

Q1

MHK Program Objectives

How well do Program objectives align with industry needs and Administration Goals?

- Advance the state of MHK technology
- Develop key MHK testing infrastructure, instrumentation, and/or standards
- Characterize and increase access to high resource sites
- Reduce deployment barriers and environmental impacts of MHK technologies

Hydro Program Objectives

How well do Program objectives align with industry needs and Administration Goals?

- Advance new hydropower systems and/or components for demonstration or deployment
- Optimize existing hydropower technology, flexibility, and/or operations
- Enable next generation pumped storage technologies to facilitate renewable integration
- Reduce deployment barriers and environmental impacts of hydropower

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

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 & 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
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

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.
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

Score ?'s / Notes:

Key Finding	**Comments**

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2014 U.S. DOE Water Power Peer Review

Program Evaluation Form

Page

2 of 3

Project Name:	**DOE Water Power Program**	**Reviewer:**	
Presenter Name:	**WWPP Program Manager + Team**	**Presenter Org:**	**DOE Wind and Water Power Program**

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.	
4 - Good	Program does a good job with communications, coordination, and outreach to relevant stakeholders.	**score**
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**

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2014 U.S. DOE Water Power Peer Review

Program Evaluation Form

Page
3 of 3

Project Name:	**DOE Water Power Program**	**Reviewer:**	
Presenter Name:	**WWPP Program Manager + Team**	**Presenter Org:**	**DOE Wind and Water Power Program**

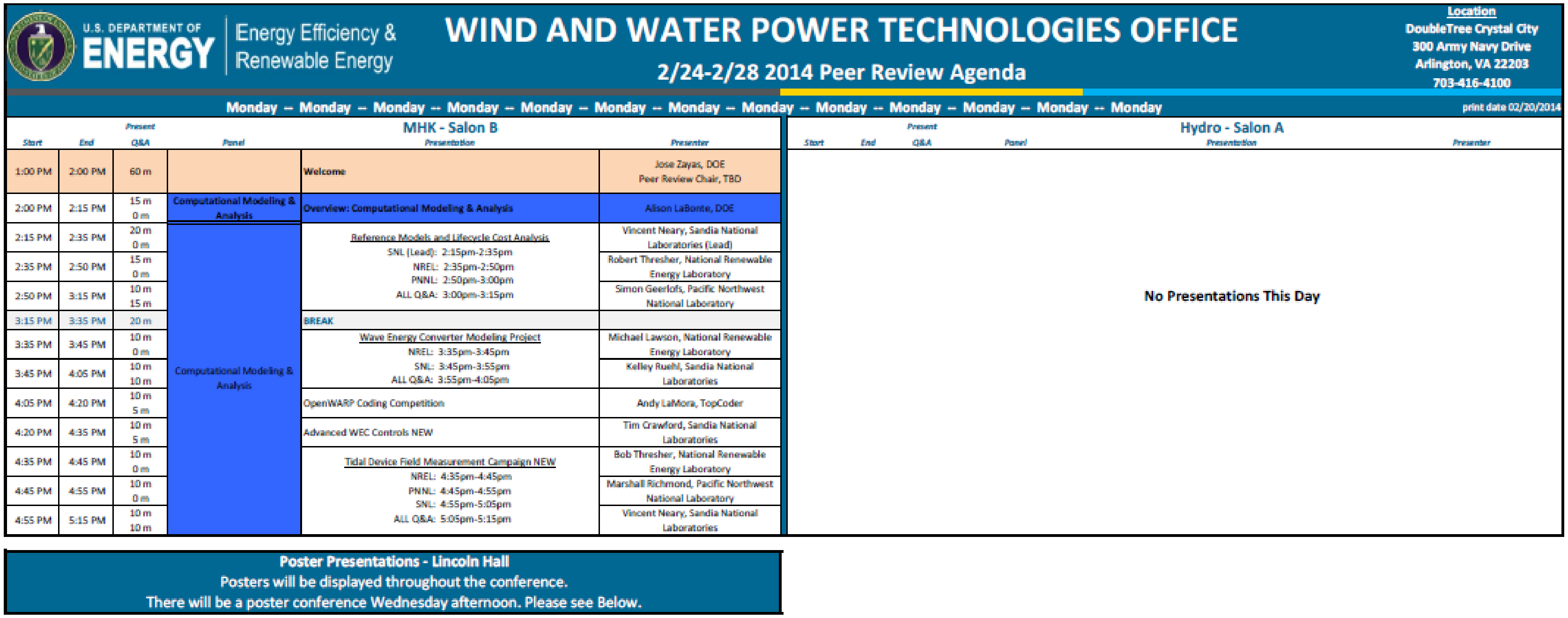
Input Cells	*Provide specific, concise comments to support your evaluation.*

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 E. Meeting Agenda



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WIND AND WATER POWER TECHNOLOGIES OFFICE

2/24-2/28 2014 Peer Review Agenda

Location
DoubleTree Crystal City
300 Army Navy Drive
Arlington, VA 22203
703-416-4100

Monday -- Monday -- Monday -- Monday -- Monday -- Monday -- Monday -- Monday -- Monday -- Monday -- Monday -- Monday -- Monday

print date 02/20/2014

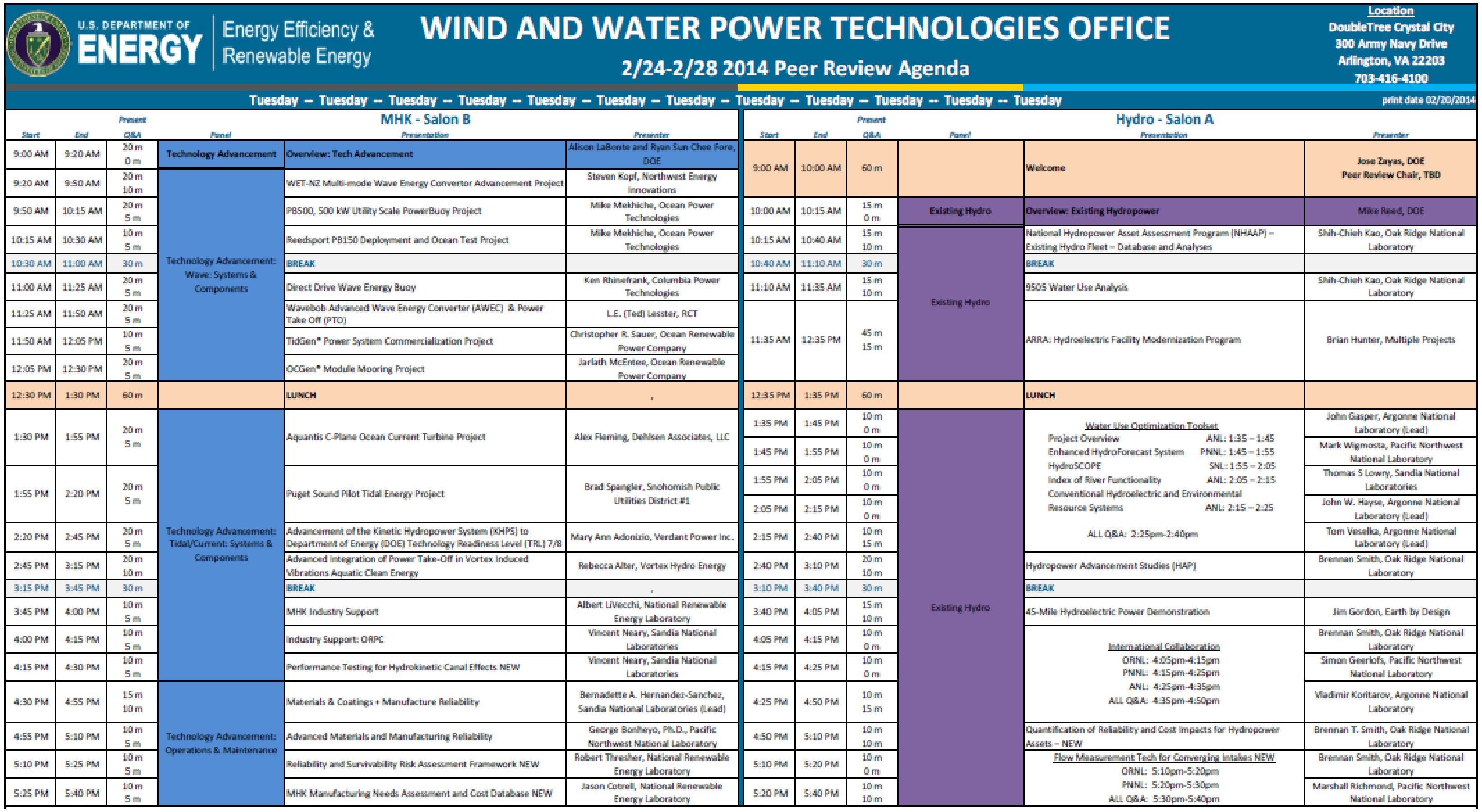
MHK - Salon B

Start	End	Present Q&A	Panel	Presentation	Presenter
1:00 PM	2:00 PM	60 m		**Welcome**	Jose Zayas, DOE Peer Review Chair, TBD
2:00 PM	2:15 PM	15 m 0 m	Computational Modeling & Analysis	Overview: Computational Modeling & Analysis	Alison LaBonte, DOE
2:15 PM	2:35 PM	20 m 0 m	Computational Modeling & Analysis	Reference Models and Lifecycle Cost Analysis SNL (Lead): 2:15pm-2:35pm NREL: 2:35pm-2:50pm PNNL: 2:50pm-3:00pm ALL Q&A: 3:00pm-3:15pm	Vincent Neary, Sandia National Laboratories (Lead)
2:35 PM	2:50 PM	15 m 0 m			Robert Thresher, National Renewable Energy Laboratory
2:50 PM	3:15 PM	10 m 15 m			Simon Geerlofs, Pacific Northwest National Laboratory
3:15 PM	3:35 PM	20 m		BREAK	
3:35 PM	3:45 PM	10 m 0 m		Wave Energy Converter Modeling Project NREL: 3:35pm-3:45pm SNL: 3:45pm-3:55pm ALL Q&A: 3:55pm-4:05pm	Michael Lawson, National Renewable Energy Laboratory
3:45 PM	4:05 PM	10 m 10 m			Kelley Ruehl, Sandia National Laboratories
4:05 PM	4:20 PM	10 m 5 m		OpenWARP Coding Competition	Andy LaMora, TopCoder
4:20 PM	4:35 PM	10 m 5 m		Advanced WEC Controls NEW	Tim Crawford, Sandia National Laboratories
4:35 PM	4:45 PM	10 m 0 m		Tidal Device Field Measurement Campaign NEW NREL: 4:35pm-4:45pm PNNL: 4:45pm-4:55pm SNL: 4:55pm-5:05pm ALL Q&A: 5:05pm-5:15pm	Bob Thresher, National Renewable Energy Laboratory
4:45 PM	4:55 PM	10 m 0 m			Marshall Richmond, Pacific Northwest National Laboratory
4:55 PM	5:15 PM	10 m 10 m			Vincent Neary, Sandia National Laboratories

Hydro - Salon A

Start	End	Present Q&A	Panel	Presentation	Presenter
				No Presentations This Day	

Poster Presentations - Lincoln Hall
Posters will be displayed throughout the conference.
There will be a poster conference Wednesday afternoon. Please see Below.



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703-416-4100

Tuesday -- Tuesday -- Tuesday -- Tuesday -- Tuesday -- Tuesday -- Tuesday -- Tuesday -- Tuesday -- Tuesday -- Tuesday -- Tuesday

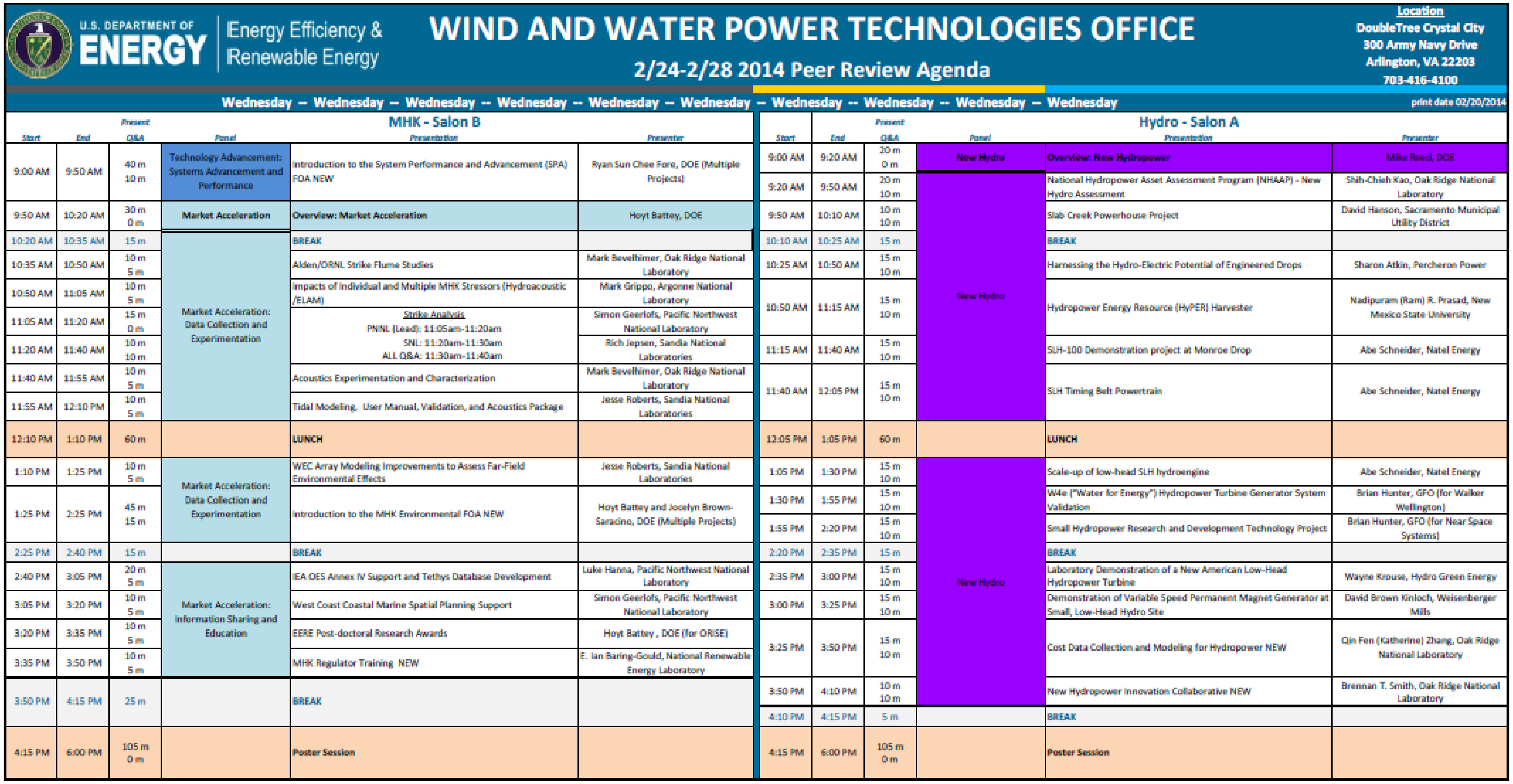
print date 02/20/2014

MHK - Salon B

Start	End	Present Q&A	Panel	Presentation	Presenter
9:00 AM	9:20 AM	20 m 0 m	**Technology Advancement**	**Overview: Tech Advancement**	Alison LaBonte and Ryan Sun Chee Fore, DOE
9:20 AM	9:50 AM	20 m 10 m	Technology Advancement: Wave: Systems & Components	WET-NZ Multi-mode Wave Energy Convertor Advancement Project	Steven Kopf, Northwest Energy Innovations
9:50 AM	10:15 AM	20 m 5 m		PB500, 500 kW Utility Scale PowerBuoy Project	Mike Mekhiche, Ocean Power Technologies
10:15 AM	10:30 AM	10 m 5 m		Reedsport PB150 Deployment and Ocean Test Project	Mike Mekhiche, Ocean Power Technologies
10:30 AM	11:00 AM	30 m		**BREAK**	
11:00 AM	11:25 AM	20 m 5 m		Direct Drive Wave Energy Buoy	Ken Rhinefrank, Columbia Power Technologies
11:25 AM	11:50 AM	20 m 5 m		Wavebob Advanced Wave Energy Converter (AWEC) & Power Take Off (PTO)	L.E. (Ted) Lesster, RCT
11:50 AM	12:05 PM	10 m 5 m		TidGen® Power System Commercialization Project	Christopher R. Sauer, Ocean Renewable Power Company
12:05 PM	12:30 PM	20 m 5 m		OCGen® Module Mooring Project	Jarlath McEntee, Ocean Renewable Power Company
12:30 PM	1:30 PM	60 m		**LUNCH**	,
1:30 PM	1:55 PM	20 m 5 m	Technology Advancement: Tidal/Current: Systems & Components	Aquantis C-Plane Ocean Current Turbine Project	Alex Fleming, Dehlsen Associates, LLC
1:55 PM	2:20 PM	20 m 5 m		Puget Sound Pilot Tidal Energy Project	Brad Spangler, Snohomish Public Utilities District #1
2:20 PM	2:45 PM	20 m 5 m		Advancement of the Kinetic Hydropower System (KHPS) to Department of Energy (DOE) Technology Readiness Level (TRL) 7/8	Mary Ann Adonizio, Verdant Power Inc.
2:45 PM	3:15 PM	20 m 10 m		Advanced Integration of Power Take-Off in Vortex Induced Vibrations Aquatic Clean Energy	Rebecca Alter, Vortex Hydro Energy
3:15 PM	3:45 PM	30 m		**BREAK**	,
3:45 PM	4:00 PM	10 m 5 m		MHK Industry Support	Albert LiVecchi, National Renewable Energy Laboratory
4:00 PM	4:15 PM	10 m 5 m		Industry Support: ORPC	Vincent Neary, Sandia National Laboratories
4:15 PM	4:30 PM	10 m 5 m		Performance Testing for Hydrokinetic Canal Effects NEW	Vincent Neary, Sandia National Laboratories
4:30 PM	4:55 PM	15 m 10 m	Technology Advancement: Operations & Maintenance	Materials & Coatings + Manufacture Reliability	Bernadette A. Hernandez-Sanchez, Sandia National Laboratories (Lead)
4:55 PM	5:10 PM	10 m 5 m		Advanced Materials and Manufacturing Reliability	George Bonheyo, Ph.D., Pacific Northwest National Laboratory
5:10 PM	5:25 PM	10 m 5 m		Reliability and Survivability Risk Assessment Framework NEW	Robert Thresher, National Renewable Energy Laboratory
5:25 PM	5:40 PM	10 m 5 m		MHK Manufacturing Needs Assessment and Cost Database NEW	Jason Cotrell, National Renewable Energy Laboratory

Hydro - Salon A

Start	End	Present Q&A	Panel	Presentation	Presenter
9:00 AM	10:00 AM	60 m		**Welcome**	**Jose Zayas, DOE Peer Review Chair, TBD**
10:00 AM	10:15 AM	15 m 0 m	**Existing Hydro**	**Overview: Existing Hydropower**	Mike Reed, DOE
10:15 AM	10:40 AM	15 m 10 m	Existing Hydro	National Hydropower Asset Assessment Program (NHAAP) – Existing Hydro Fleet – Database and Analyses	Shih-Chieh Kao, Oak Ridge National Laboratory
10:40 AM	11:10 AM	30 m		**BREAK**	
11:10 AM	11:35 AM	15 m 10 m		9505 Water Use Analysis	Shih-Chieh Kao, Oak Ridge National Laboratory
11:35 AM	12:35 PM	45 m 15 m		ARRA: Hydroelectric Facility Modernization Program	Brian Hunter, Multiple Projects
12:35 PM	1:35 PM	60 m		**LUNCH**	
1:35 PM	1:45 PM	10 m 0 m	Existing Hydro	<u>Water Use Optimization Toolset</u> Project Overview ANL: 1:35 – 1:45 Enhanced HydroForecast System PNNL: 1:45 – 1:55 HydroSCOPE SNL: 1:55 – 2:05 Index of River Functionality ANL: 2:05 – 2:15 Conventional Hydroelectric and Environmental Resource Systems ANL: 2:15 – 2:25 ALL Q&A: 2:25pm-2:40pm	John Gasper, Argonne National Laboratory (Lead)
1:45 PM	1:55 PM	10 m 0 m			Mark Wigmosta, Pacific Northwest National Laboratory
1:55 PM	2:05 PM	10 m 0 m			Thomas S Lowry, Sandia National Laboratories
2:05 PM	2:15 PM	10 m 0 m			John W. Hayse, Argonne National Laboratory (Lead)
2:15 PM	2:40 PM	10 m 15 m			Tom Veselka, Argonne National Laboratory (Lead)
2:40 PM	3:10 PM	20 m 10 m		Hydropower Advancement Studies (HAP)	Brennan Smith, Oak Ridge National Laboratory
3:10 PM	3:40 PM	30 m		**BREAK**	
3:40 PM	4:05 PM	15 m 10 m		45-Mile Hydroelectric Power Demonstration	Jim Gordon, Earth by Design
4:05 PM	4:15 PM	10 m 0 m		<u>International Collaboration</u> ORNL: 4:05pm-4:15pm PNNL: 4:15pm-4:25pm ANL: 4:25pm-4:35pm ALL Q&A: 4:35pm-4:50pm	Brennan Smith, Oak Ridge National Laboratory
4:15 PM	4:25 PM	10 m 0 m			Simon Geerlofs, Pacific Northwest National Laboratory
4:25 PM	4:50 PM	10 m 15 m			Vladimir Koritarov, Argonne National Laboratory
4:50 PM	5:10 PM	10 m 10 m		Quantification of Reliability and Cost Impacts for Hydropower Assets – NEW	Brennan T. Smith, Oak Ridge National Laboratory
5:10 PM	5:20 PM	10 m 0 m		<u>Flow Measurement Tech for Converging Intakes NEW</u> ORNL: 5:10pm-5:20pm PNNL: 5:20pm-5:30pm ALL Q&A: 5:30pm-5:40pm	Brennan Smith, Oak Ridge National Laboratory
5:20 PM	5:40 PM	10 m 10 m			Marshall Richmond, Pacific Northwest National Laboratory



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WIND AND WATER POWER TECHNOLOGIES OFFICE

2/24-2/28 2014 Peer Review Agenda

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Wednesday -- Wednesday -- Wednesday -- Wednesday -- Wednesday -- Wednesday -- Wednesday -- Wednesday -- Wednesday -- Wednesday

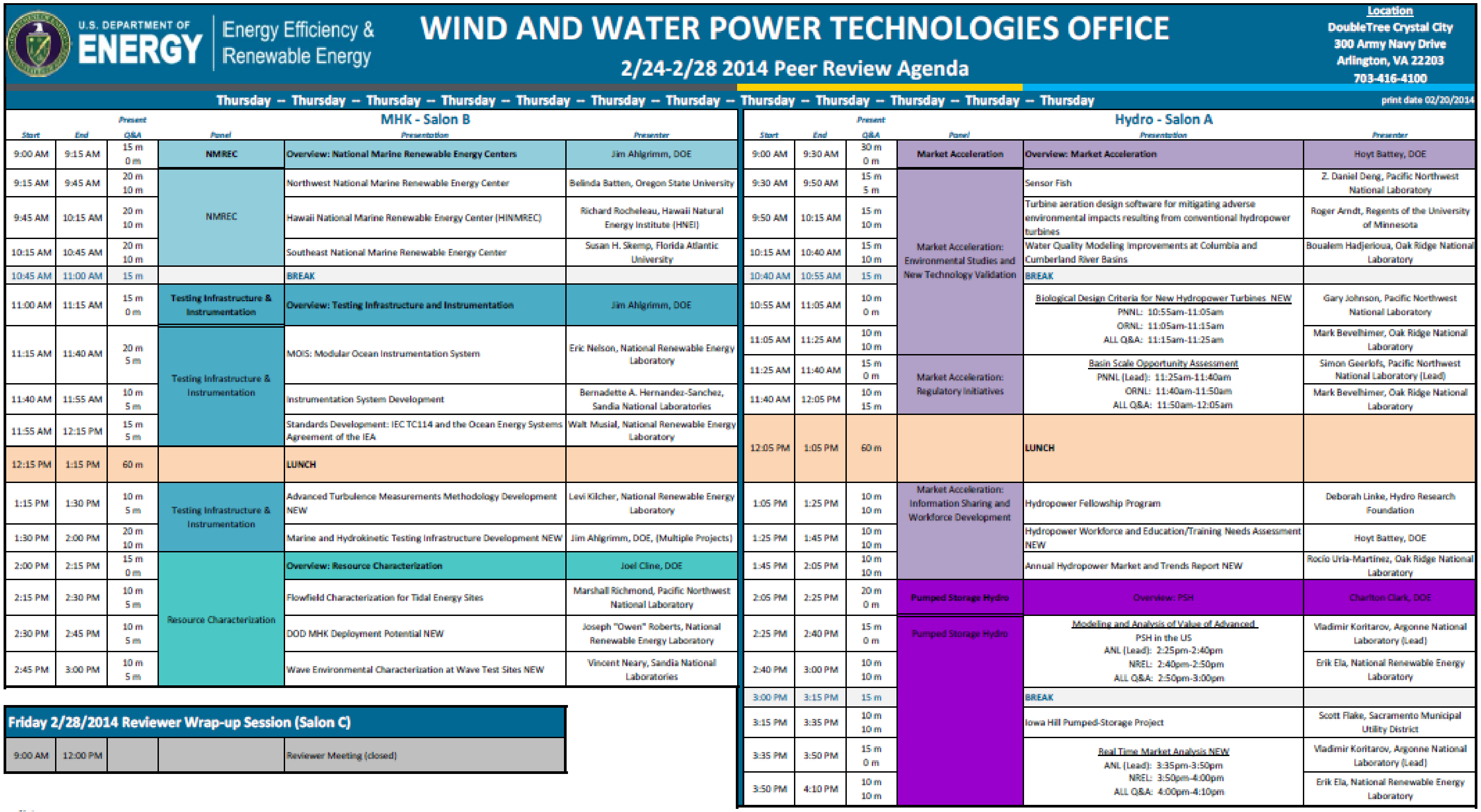
print date 02/20/2014

MHK - Salon B

Start	End	Present Q&A	Panel	Presentation	Presenter
9:00 AM	9:50 AM	40 m 10 m	Technology Advancement: Systems Advancement and Performance	Introduction to the System Performance and Advancement (SPA) FOA NEW	Ryan Sun Chee Fore, DOE (Multiple Projects)
9:50 AM	10:20 AM	30 m 0 m	**Market Acceleration**	**Overview: Market Acceleration**	Hoyt Battey, DOE
10:20 AM	10:35 AM	15 m	Market Acceleration: Data Collection and Experimentation	**BREAK**	
10:35 AM	10:50 AM	10 m 5 m		Alden/ORNL Strike Flume Studies	Mark Bevelhimer, Oak Ridge National Laboratory
10:50 AM	11:05 AM	10 m 5 m		Impacts of Individual and Multiple MHK Stressors (Hydroacoustic /ELAM)	Mark Grippo, Argonne National Laboratory
11:05 AM	11:20 AM	15 m 0 m		Strike Analysis PNNL (Lead): 11:05am-11:20am SNL: 11:20am-11:30am ALL Q&A: 11:30am-11:40am	Simon Geerlofs, Pacific Northwest National Laboratory
11:20 AM	11:40 AM	10 m 10 m			Rich Jepsen, Sandia National Laboratories
11:40 AM	11:55 AM	10 m 5 m		Acoustics Experimentation and Characterization	Mark Bevelhimer, Oak Ridge National Laboratory
11:55 AM	12:10 PM	10 m 5 m		Tidal Modeling, User Manual, Validation, and Acoustics Package	Jesse Roberts, Sandia National Laboratories
12:10 PM	1:10 PM	60 m		**LUNCH**	
1:10 PM	1:25 PM	10 m 5 m	Market Acceleration: Data Collection and Experimentation	WEC Array Modeling Improvements to Assess Far-Field Environmental Effects	Jesse Roberts, Sandia National Laboratories
1:25 PM	2:25 PM	45 m 15 m		Introduction to the MHK Environmental FOA NEW	Hoyt Battey and Jocelyn Brown-Saracino, DOE (Multiple Projects)
2:25 PM	2:40 PM	15 m		**BREAK**	
2:40 PM	3:05 PM	20 m 5 m	Market Acceleration: Information Sharing and Education	IEA OES Annex IV Support and Tethys Database Development	Luke Hanna, Pacific Northwest National Laboratory
3:05 PM	3:20 PM	10 m 5 m		West Coast Coastal Marine Spatial Planning Support	Simon Geerlofs, Pacific Northwest National Laboratory
3:20 PM	3:35 PM	10 m 5 m		EERE Post-doctoral Research Awards	Hoyt Battey , DOE (for ORISE)
3:35 PM	3:50 PM	10 m 5 m		MHK Regulator Training NEW	E. Ian Baring-Gould, National Renewable Energy Laboratory
3:50 PM	4:15 PM	25 m		**BREAK**	
4:15 PM	6:00 PM	105 m 0 m		**Poster Session**	

Hydro - Salon A

Start	End	Present Q&A	Panel	Presentation	Presenter
9:00 AM	9:20 AM	20 m 0 m	**New Hydro**	**Overview: New Hydropower**	Mike Reed, DOE
9:20 AM	9:50 AM	20 m 10 m	New Hydro	National Hydropower Asset Assessment Program (NHAAP) - New Hydro Assessment	Shih-Chieh Kao, Oak Ridge National Laboratory
9:50 AM	10:10 AM	10 m 10 m		Slab Creek Powerhouse Project	David Hanson, Sacramento Municipal Utility District
10:10 AM	10:25 AM	15 m		**BREAK**	
10:25 AM	10:50 AM	15 m 10 m		Harnessing the Hydro-Electric Potential of Engineered Drops	Sharon Atkin, Percheron Power
10:50 AM	11:15 AM	15 m 10 m		Hydropower Energy Resource (HyPER) Harvester	Nadipuram (Ram) R. Prasad, New Mexico State University
11:15 AM	11:40 AM	15 m 10 m		SLH-100 Demonstration project at Monroe Drop	Abe Schneider, Natel Energy
11:40 AM	12:05 PM	15 m 10 m		SLH Timing Belt Powertrain	Abe Schneider, Natel Energy
12:05 PM	1:05 PM	60 m		**LUNCH**	
1:05 PM	1:30 PM	15 m 10 m	New Hydro	Scale-up of low-head SLH hydroengine	Abe Schneider, Natel Energy
1:30 PM	1:55 PM	15 m 10 m		W4e ("Water for Energy") Hydropower Turbine Generator System Validation	Brian Hunter, GFO (for Walker Wellington)
1:55 PM	2:20 PM	15 m 10 m		Small Hydropower Research and Development Technology Project	Brian Hunter, GFO (for Near Space Systems)
2:20 PM	2:35 PM	15 m		**BREAK**	
2:35 PM	3:00 PM	15 m 10 m		Laboratory Demonstration of a New American Low-Head Hydropower Turbine	Wayne Krouse, Hydro Green Energy
3:00 PM	3:25 PM	15 m 10 m		Demonstration of Variable Speed Permanent Magnet Generator at Small, Low-Head Hydro Site	David Brown Kinloch, Weisenberger Mills
3:25 PM	3:50 PM	15 m 10 m		Cost Data Collection and Modeling for Hydropower NEW	Qin Fen (Katherine) Zhang, Oak Ridge National Laboratory
3:50 PM	4:10 PM	10 m 10 m		New Hydropower Innovation Collaborative NEW	Brennan T. Smith, Oak Ridge National Laboratory
4:10 PM	4:15 PM	5 m		**BREAK**	
4:15 PM	6:00 PM	105 m 0 m		**Poster Session**	



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2/24-2/28 2014 Peer Review Agenda

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Thursday -- Thursday -- Thursday -- Thursday -- Thursday -- Thursday -- Thursday -- Thursday -- Thursday -- Thursday -- Thursday -- Thursday

print date 02/20/2014

MHK - Salon B

Start	End	Present Q&A	Panel	Presentation	Presenter
9:00 AM	9:15 AM	15 m 0 m	**NMREC**	**Overview: National Marine Renewable Energy Centers**	Jim Ahlgrimm, DOE
9:15 AM	9:45 AM	20 m 10 m	NMREC	Northwest National Marine Renewable Energy Center	Belinda Batten, Oregon State University
9:45 AM	10:15 AM	20 m 10 m		Hawaii National Marine Renewable Energy Center (HINMREC)	Richard Rocheleau, Hawaii Natural Energy Institute (HNEI)
10:15 AM	10:45 AM	20 m 10 m		Southeast National Marine Renewable Energy Center	Susan H. Skemp, Florida Atlantic University
10:45 AM	11:00 AM	15 m		**BREAK**	
11:00 AM	11:15 AM	15 m 0 m	**Testing Infrastructure & Instrumentation**	**Overview: Testing Infrastructure and Instrumentation**	Jim Ahlgrimm, DOE
11:15 AM	11:40 AM	20 m 5 m	Testing Infrastructure & Instrumentation	MOIS: Modular Ocean Instrumentation System	Eric Nelson, National Renewable Energy Laboratory
11:40 AM	11:55 AM	10 m 5 m		Instrumentation System Development	Bernadette A. Hernandez-Sanchez, Sandia National Laboratories
11:55 AM	12:15 PM	15 m 5 m		Standards Development: IEC TC114 and the Ocean Energy Systems Agreement of the IEA	Walt Musial, National Renewable Energy Laboratory
12:15 PM	1:15 PM	60 m		**LUNCH**	
1:15 PM	1:30 PM	10 m 5 m	Testing Infrastructure & Instrumentation	Advanced Turbulence Measurements Methodology Development NEW	Levi Kilcher, National Renewable Energy Laboratory
1:30 PM	2:00 PM	20 m 10 m		Marine and Hydrokinetic Testing Infrastructure Development NEW	Jim Ahlgrimm, DOE, (Multiple Projects)
2:00 PM	2:15 PM	15 m 0 m	Resource Characterization	**Overview: Resource Characterization**	Joel Cline, DOE
2:15 PM	2:30 PM	10 m 5 m		Flowfield Characterization for Tidal Energy Sites	Marshall Richmond, Pacific Northwest National Laboratory
2:30 PM	2:45 PM	10 m 5 m		DOD MHK Deployment Potential NEW	Joseph "Owen" Roberts, National Renewable Energy Laboratory
2:45 PM	3:00 PM	10 m 5 m		Wave Environmental Characterization at Wave Test Sites NEW	Vincent Neary, Sandia National Laboratories

Hydro - Salon A

Start	End	Present Q&A	Panel	Presentation	Presenter
9:00 AM	9:30 AM	30 m 0 m	**Market Acceleration**	**Overview: Market Acceleration**	Hoyt Battey, DOE
9:30 AM	9:50 AM	15 m 5 m	Market Acceleration: Environmental Studies and New Technology Validation	Sensor Fish	Z. Daniel Deng, Pacific Northwest National Laboratory
9:50 AM	10:15 AM	15 m 10 m		Turbine aeration design software for mitigating adverse environmental impacts resulting from conventional hydropower turbines	Roger Arndt, Regents of the University of Minnesota
10:15 AM	10:40 AM	15 m 10 m		Water Quality Modeling Improvements at Columbia and Cumberland River Basins	Boualem Hadjerioua, Oak Ridge National Laboratory
10:40 AM	10:55 AM	15 m		**BREAK**	
10:55 AM	11:05 AM	10 m 0 m		Biological Design Criteria for New Hydropower Turbines NEW PNNL: 10:55am-11:05am ORNL: 11:05am-11:15am ALL Q&A: 11:15am-11:25am	Gary Johnson, Pacific Northwest National Laboratory
11:05 AM	11:25 AM	10 m 10 m			Mark Bevelhimer, Oak Ridge National Laboratory
11:25 AM	11:40 AM	15 m 0 m	Market Acceleration: Regulatory Initiatives	Basin Scale Opportunity Assessment PNNL (Lead): 11:25am-11:40am ORNL: 11:40am-11:50am ALL Q&A: 11:50am-12:05am	Simon Geerlofs, Pacific Northwest National Laboratory (Lead)
11:40 AM	12:05 PM	10 m 15 m			Mark Bevelhimer, Oak Ridge National Laboratory
12:05 PM	1:05 PM	60 m		**LUNCH**	
1:05 PM	1:25 PM	10 m 10 m	Market Acceleration: Information Sharing and Workforce Development	Hydropower Fellowship Program	Deborah Linke, Hydro Research Foundation
1:25 PM	1:45 PM	10 m 10 m		Hydropower Workforce and Education/Training Needs Assessment NEW	Hoyt Battey, DOE
1:45 PM	2:05 PM	10 m 10 m		Annual Hydropower Market and Trends Report NEW	Rocio Uria-Martinez, Oak Ridge National Laboratory
2:05 PM	2:25 PM	20 m 0 m	**Pumped Storage Hydro**	Overview: PSH	Charlton Clark, DOE
2:25 PM	2:40 PM	15 m 0 m	Pumped Storage Hydro	Modeling and Analysis of Value of Advanced PSH in the US ANL (Lead): 2:25pm-2:40pm NREL: 2:40pm-2:50pm ALL Q&A: 2:50pm-3:00pm	Vladimir Koritarov, Argonne National Laboratory (Lead)
2:40 PM	3:00 PM	10 m 10 m			Erik Ela, National Renewable Energy Laboratory
3:00 PM	3:15 PM	15 m		**BREAK**	
3:15 PM	3:35 PM	10 m 10 m		Iowa Hill Pumped-Storage Project	Scott Flake, Sacramento Municipal Utility District
3:35 PM	3:50 PM	15 m 0 m		Real Time Market Analysis NEW ANL (Lead): 3:35pm-3:50pm NREL: 3:50pm-4:00pm ALL Q&A: 4:00pm-4:10pm	Vladimir Koritarov, Argonne National Laboratory (Lead)
3:50 PM	4:10 PM	10 m 10 m			Erik Ela, National Renewable Energy Laboratory

Friday 2/28/2014 Reviewer Wrap-up Session (Salon C)

9:00 AM	12:00 PM			Reviewer Meeting (closed)

Appendix F. Meeting Attendee List

Last Name	First Name	Company	Email
Ahlgrimm	Jim	US Department of Energy	jim.ahlgrimm@ee.doe.gov
AlQaser	Ghassan	CA Department of Water Resources	Ghassan.Alqaser@water.ca.gov
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