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

Wind and Water Power Program

Water Power

2010 Peer Review Report

October 2010
Denver, CO

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U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Wind and Water Power Program
2010 Water Power Peer Review Report
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Executive Summary

The U.S. Department of Energy (DOE) Wind and Water Power Program (also referred to as the Program) convened a peer review meeting of conventional hydropower experts, national laboratory researchers, and DOE program staff from October 19-21, 2010 at the Hilton Garden Inn located in Denver, Colorado. The purpose of the meeting was to review the progress and accomplishments of conventional hydropower technology development, market acceleration, and American Recovery and Reinvestment Act (ARRA) projects funded by the Program, as well as to provide input on the strategic direction of the program. Peer review provides Program managers, staff, and researchers with objective review and advice to enhance the management, relevance, effectiveness, and productivity of the Program's research, development, demonstration, deployment, and supporting business management activities.

Some of the key findings of the 2010 Water Power Peer Review Panel are listed below:

- The global objectives of the Program are well established, directionally correct, and considered by the review panel to be heading in the right direction.
- The use of the peer review process by the Program is a very commendable approach to continuous improvement, especially the inclusion of both programmatic and technical reviews.
- Each area of the Program should be reviewed on an annual basis. The Panel feels that two years between reviews is too long.
- The Program should attempt to quantify the costs of certain efforts that rely on Program staff time to ensure that true costs of such efforts can be compared with projects receiving direct financial awards.
- The Program should establish quality assurance and quality control (QA/QC) protocols for data and information and require projects to address these issues, comment on the quality of data and information, and understand how results may be affected by QA/QC issues.
- The Program should improve its focus on transfer of information, both from its research projects to end-users and stakeholders as well as from the Program to Peer Reviewers.
- The Program should improve the coordination between projects early on to reduce the potential overlap of efforts and improve integration with internal and external activities.
- Project deliverables should be linked to specific end user needs.
- The Program should recognize that hydropower facility owners and operators contend with multiple resource objectives and priorities that are subject to change over time.
- Project presentations should be given with a results-driven focus. "Soft" deliverables such as workshops, reports, etc. should clearly describe anticipated products, relevance to task and action items resulting from workshops.
- The Program's modeling projects could be improved through verification via peer review to provide a "reality check" of model intent and design along with underlying assumptions, the declaration of model inputs, and equations and independently generated outputs.

Some of the lessons learned from the 2010 Water Power Peer Review process are listed below:

- Future project reviews should clearly distinguish the methods or tools for broad scale/regional analyses versus the tools intended for site specific evaluation of trade-offs, mitigation planning, and alternative operating strategies.
- The information being produced by the Program has potential value beyond the boundaries of the

DOE. For example, the Program could potentially supply information that would allow hydro power generation to be included in and evaluated against a list of generation alternatives as part of a program funded by the Office of Electricity. Studies of the various futures can provide information as to the hydro power sites that may be chosen and the forecasted operation of those sites. Sensitivity scenarios also could determine the subsidies that would be needed to move hydro power into a competitive position in the choice of generation alternatives and could help evaluate policy that would enable hydro power to be constructed.

- Having a national economic evaluation of the hydropower projects would bring focus onto those projects with the highest likelihood of being developed. A utility or group of utilities may become aware of the potential and do the work required to bring a project to the permitting stage. Rather than just identifying the projects, a conclusion about the future of hydropower on a national scale could be developed.
- The Review Panel enrollment process, including the modification of the consulting agreement and reimbursement process should be evaluated for improvement.
- Some of the presentations and materials handed out prior to the review were late, incomplete, and could have been better prepared.
- Some panel members suggest distributing the information packets (presentations, evaluation forms, etc.) to the reviewers earlier in the peer review process.

The following document represents the Peer Review Panel's detailed observations and findings, the response from the Water Power Program to those findings, and supporting meeting materials, including agendas and a list of participants. Peer Reviewers provided both quantitative and narrative evaluations of the materials and projects presented at the meeting. The comments herein are the most direct reflection of the reviewers' written evaluations, and where possible have been included verbatim. Consistent with DOE's guidance and best practices for peer review, there was no requirement for the group to reach a consensus on recommendations.

Program Response

Dear Colleague:

This document summarizes the comments provided by the peer reviewers at the U.S. Department of Energy (DOE) Wind & Water Power Program Fiscal Year (FY) 2010 Water Power Annual Peer Review meeting, held on October 19-20, 2010 in Denver, CO. In response to direction from the Under Secretary of Energy, this review process provides evaluations of the Program's projects in applied research, development and demonstration, and analysis of conventional water power technologies.

We on the DOE Water Power Team have thoroughly studied the recommendations of the reviewers, and they will be taken into consideration in the generation of future work plans. The tables below list the projects presented at the review, the final evaluation scores, and a summary of major actions to be taken by the Program during the upcoming fiscal year. The projects have been grouped according to Program Element (Technology Development or Market Acceleration) and then by the five evaluation criteria. The weighted scores are based on a 4-point scale. To furnish all principal investigators (PIs) with direct feedback, all evaluations and comments are provided to each presenter; however, the authors of the individual comments remain anonymous. The PI of each project is instructed to fully consider these summary evaluation comments, as appropriate, in their FY 2011 plans.

I would like to express my sincere gratitude to the reviewers. You make this report possible, and we rely on your comments to help make project decisions for the new fiscal year. I would also like to express my admiration and appreciation of the tremendous efforts on the part of the PIs, their partners, and all of their colleagues in the conventional hydropower industry. It is your dedication and commitment that will allow these technologies to succeed.

We look forward to your participation in the FY 2011 Wind & Water Power Program Annual Peer Review meeting. Thank you for participating in the FY 2010 Peer Review meeting.

Sincerely,

Alejandro Moreno
Water Power Technologies Lead
U.S. DOE Wind & Water Power Program

Conventional Hydropower – Technology Development Projects

Project Title	Rele-vance Score	Final Score	Cont	Dis-Cont	Other	Summary Comment	Program Response
EPRI-Alden Fish-Friendly Turbine	3.8	3.6	X			Focuses on DOE objectives to bring new conventional hydropower technologies into commercial readiness that will improve energy and environmental performance and reduce barriers to new development such as regulatory risks and expenses. This project builds on extensive (and expensive) previous research and now provides for demonstration in the real world. Combination of experimental science and development of tables/relationships that can be easily used to improve turbine design and hydropower operations to minimize impact on fish.	No response.
Lab Water Use Optimization	3.3	2.5				The project is at risk to succeed as a usable toolbox because: 1) needs assessment and requirements have not been done; 2) some of the components are not likely to be generally applicable; 3) the toolset would be difficult to integrate into a utility's data/model/operational processes; 4) the design of the integrated system is complex and possibly beyond the budget and timeframe of the project; 5) no provision has been made in the schedule for documentation, tech transfer and long-term maintenance, all requisites for a usable software tool.	1) The Program agrees that meeting the needs of the end user is vital to the success of the tool. The project has established an advisory panel that represents non-federal and federal hydropower project owners to ensure that the project is meeting the needs of the end user. Further, the project has at least two project owners who are interested in deploying the toolset for demonstration purposes. These project owners are also on the advisory panel. 2) The components of the toolset may not apply to all potential customers and is designed to use the tools that are important to the customer. 3) The toolset is being designed to provide optimization guidance based on the utility's input data and requirements. 4) The Program has a dedicated task focused on the integration of the system within the timeframe and budget provided. 5) The Program agrees that technology transfer and documentation is vital to the widespread acceptance of the tool. The Program is spreading the word around through conference participation and making presentations to stakeholders and will consider funding these aspects of the tool development once the demonstration results are known.
Day-ahead Scheduling	3.3	2.8				The formulation of the problem will be difficult for many users. The solution may not be guaranteed. Optimization comes with many pitfalls for the naive user. Software needs to be particularly robust. The	The Program agrees that the model is complex and will require user experience and training. The Program has employed a capable modeling team that is aware of the mathematical challenges posed

Project Title	Relevance Score	Final Score	Cont	Dis-Cont	Other	Summary Comment	Program Response
						idea of using several solvers is nice in theory, but each solver has a different API, different parameters needed, etc. Solvers do not tend to be plug and play. Also, there are a number of mathematically tricky issues with reservoirs that are smaller and more dynamic, where head and tail water can vary greatly in the course of a run. To address this, a functional requirements and design should precede development and be based on needs and understanding of skills of people who will use the tools.	by this project and has experience with solving difficult hydropower optimization problems. They also have considerable experience training others how to properly use models and have transferred other modeling systems for others to implement. During the demonstration process, the PI will initially be the user of the model to uncover and correct modeling issues. Staff at the demonstration sites will then undergo comprehensive training. The Program has implemented several mechanisms in the process that will identify solutions that are infeasible and alert the user to potential problem areas. The modelers understand issues associated with small, rapidly changing reservoirs. The mathematical formulation is using integer programming to optimize reservoir operations where both generation levels and head water can vary significantly during the course of a model run.
Hydrologic Forecasting	3.3	2.9				The approach is sound and is an extension of a proven model. However, data requirements and calibration issues may be a barrier to widespread use of this tool. Combines a number of parameters into a model that can be used as part of a forecasting model. Complex system. Appears it will require extensive coordination with other team members. Using well established hydrologic modeling techniques. Need a way to make sure that the stream flow forecast nodes (from this piece of the WUO toolkit) match up with the data requirements of the other pieces of the WUO.	The project team is using a model where all required data sets are available from national, self-consistent datasets. Through the toolset application at demonstration sites, the team has adopted a systematic, repeatable calibration method that has been proved in other basins. The need to ensure that stream flow forecast nodes match up with the needs of other modules of the toolset is understood and at the forefront of the integration process to ensure that data provided to other modules meets specified requirements.
Environmental Performance	3.1	2.4				This will add a major and much needed component to river system analytical tools. This has considerable value as a suite of environmental performance models representing present knowledge as part of the tool box. The approach presented is good for fish compliance, but does not address other environmental issues.	The Program has ensured that environmental performance component is being designed so that users will be able to evaluate environmental performance for various types of metrics, not just fish. The tool will allow evaluation environmental metrics where performance would be a function of the magnitude, timing, frequency, and duration of flows or water temperature characteristics that affect that metric. This could include metrics for plants, invertebrates, fish, or other response variables, including responses of riparian communities.
Unit & Plant Efficiency	3.5	2.8				There is scope overlap with Hydropower Advancement Project (HAP).This is now being	The HAP is conducting static evaluations of unit and plant performance. Results and assessment tools

Project Title	Rele-vance Score	Final Score	Cont	Dis-Cont	Other	Summary Comment	Program Response
						consolidated with HAP. Make sure HAP produces a plant optimization tool which will by default have unit optimization. Fits very well with the other components of the WUO.	developed by the HAP will be used to identify opportunities for improved unit and plant efficiency at WUO demonstration sites. WUO modeling at the sites will include evaluation of the impact of these efficiency improvements on unit, plant and system optimization.
Seasonal Hydrosystems Analysis	3.3	2.6				Allows for rapid evaluation of new technologies and environmental performance as well as evaluate new development within the regulatory framework. Uniqueness of approach focus is in the dynamics between hydrology, competing water needs, energy production, environmental performance, and operations and is scalable from a single project to basin-scale, multi-project systems. Also combines the simulation with multi-objective optimization. There are many technical issues that would affect actual development potential, as the Principal Investigators (PIs) have pointed out. These are difficult to quantify with reasonable accuracy (such as head, flow, environmental issues, etc.). Some thought should be given to what a reasonable level of resource investment is in a first level analysis. Perhaps initial filter such as head estimate and yield at some reasonable reliability level.	The Program intends this module of the water use optimization toolset to balance reservoir operations with environmental performance, hydrology and competing water uses. The depth of analysis and output will be consistent with the other modules of the toolset and appropriate given the uncertainty of the input.
Hydropower Advancement Program (HAP)	3.6	2.5				The approach sounds reasonable, but needs further scrutiny given the very large budget and fact that no acceptable proposals were submitted. Development and Testing of Process, Application of Assessment Process and Detailed Design of Improvement Activities. Includes a broad advisory panel of industry, utilities. Seems promising, not really far enough along to evaluate. Industry engagement is a key part of this project. This will be done in part through coordination with NHA.	The Program has instituted an intense project management effort for this project to provide additional scrutiny. The project scope and budget is revised to be consistent with industry needs and practice(s). The Program has plans for outreach and will be issuing an RFI for industry participation in designing future assessments of existing hydropower projects.
ARRA-funded Projects	3.8	3.4				Project seems to be more about getting recovery act money into the economy while boosting renewable energy generation. Meets the recovery act goal but does not do much to address overall Water Power Program goals. Encourages and emphasizes efficiency gains and near term improvements with clear real world results. Excellent. Good approach to support	The Program sees great value in the ARRA projects. These projects are directly increasing hydropower generation in the United States. The projects provide excellent examples of the potential for increased generation at existing hydropower stations at reasonable cost of energy. These projects have generated date cost data that can be used to determine research and development priorities. The

Project Title	Rele-vance Score	Final Score	Cont	Dis-Cont	Other	Summary Comment	Program Response
						implementation of upgrades to existing projects. It seems that regulatory issues will always be a factor in putting projects like this behind schedule. Maybe this could have been anticipated better.	Program understands that appropriate allowance(s) need to be made to address regulatory issues.

Conventional Hydropower – Market Acceleration Projects

Project Title	Rele-vance Score	Final Score	Cont	Dis-Cont	Other	Summary Comment	Program Response
National Hydropower Asset Assessment	3.5	3.0	X			This project focuses on the objective of increasing total combined heat and power (CHP) by providing a database to support research and planning. It supports the approach of identifying potential sites for new or enhanced hydro projects and provides general analysis capabilities to DOE. This project is relevant to DOE objectives also in providing a tool and data that can be used by other projects in the program, making them more effective. Design and development of the analysis tools does not seem to have a detailed technical plan based on known future needs, although general outputs have been identified. It is recommended that an inventory is developed of possible uses and possible questions to be answered. This could be used both to prioritize data gathering activities and to define the capability of the analysis tools that will access the data.	The Program has initiated a plan for yearly update and maintenance of the NHAAP database, which will include a survey of possible users in order to assess areas for improvement.
Pumped Storage	3.5	2.8		X		This project is quite broad in terms of analyzing all factors and identifying sites and determining the cost is certainly needed. Purpose is to identify the technical and readily developable potential for new large scale pumped storage hydropower (PSH) facilities in the U.S. This deals with costs for pumped storage. Another effort funded by DOE being performed by EPRI will deal with value of pumped storage. These two efforts should have some level of coordination.	The Program has decided to discontinue this project for the time being, based on availability of resources and careful evaluation of the project's overall usefulness to DOE and the hydropower industry.

Constructed Waterways	3.2	2.4	X			The purpose of the study is to develop methodologies for assessing HP on constructed waterways and to understand the scope of a nation-wide assessment. The approach addresses only the first part of this. Provide an economic screening for the top candidates found the Midwest ISO area if the generation parameters can be determined. Other than identification, cannot see the information being used to produce projects unless someone reads the report and determines to pursue the project. Gross head will overestimate power potential. Could be lots of head loss in the systems resulting in small net head available for producing power-a consequence of the existing waterways. Would be good to provide for some estimate of Net Head.	The Program is satisfied with the progress of this project to date. Progress has been made in collaborating with Bureau of Reclamation for case studies of canal infrastructure.
Resource Availability	3.4	2.8			X	Focuses on DOE objective of increasing the total contribution of conventional hydropower plants. Also provides data (potential sites) for bringing new hydropower technologies into commercial readiness. The project supports the following approaches: feasibility studies to identify additional opportunities (including policy scenarios) and decision tools to assess integrated planning/operational decisions. Thirty years of data may not be enough to accurately represent hydrologic potential. Also some uncertainty of should be included as well as thought about potential effects of climate change. It is possible for example to estimate a 10-20% decrease in reliable yield due to climate change. Most areas of US have some projections that can be averaged for a representative estimate.	This project, along with the project to determine “Technically Feasible Generation” has been re-scoped. Work on completing a nationwide assessment of Non-Powered Dam resources is continuing as an independent project, and an effort to assess new sites for hydropower development will become a second, independent project (after considerable revision to the project’s proposed methodology).

Technical Feasibility Generation	3.4	2.7			X	This project focuses on the DOE objective of increasing total combined heat and power (CHP). This is perhaps the most potentially useful of the Resource Assessment projects as it is more likely to add hydro to an existing project than to develop a new project. Development of environmental indices rather than complete rejection screening should help make more informed cost/benefit decisions. The identification that hydrologic data is a fundamental need is laudable. This project could greatly advance the understanding of systems through demonstrations of hydrodynamic modeling through a river basin. Demonstrate the importance of understanding the hydrology as the driver in assessing cumulative effects among multiple projects as well as the determinate of water quality, habitats and aquatic wellbeing throughout a system. Such a demonstration would promote the use of simulations for evaluating possible future siting.	This project, along with the project to determine "Resource Availability" has been re-scoped. Work on completing a nationwide assessment of non-powered dam resources is continuing as an independent project, and an effort to assess new sites for hydropower development will become a second, independent project (after considerable revision to the project's proposed methodology).
Economic Analysis and Market Development Overview	3.5	3.4	X			Identification of specific end users and what they will be doing with these models would benefit this project. Both projects seem to have clear ideas about the work to be done in the future.	The Program is satisfied with all progress on this project to date.
Hydroelectric Modeling in ReEDS	3.4	2.8	X			Identification of National scenarios and initial screening of data input to more detailed Interconnection studies such as EWITS2 and EIPC, also WECC and Texas through DOE/OE studies would tie hydro goals to utilities involved in the studies. Additional feedback to policy would be provided by the study. The Hydro programs would provide the input for futures (generation cost, fuel assumptions, and other assumptions) or generation scenarios. The cost to penetrate the market could be obtained from these studies if hydro is forced into a generation scenario or future. Usually futures have a generation forecast that is optimized for a particular set of assumptions. Scenarios are usually sensitivities on a generation forecast. Produces enlightening information about future possibilities for hydro in an environment of competing resources. Estimates of market penetration prices rather than $/kWh could be produced. The market penetration prices are probably location specific and probably do not reduce to one overall number.	Updated hydropower supply curves will be incorporated into the ReEDS model with the completion of other program activities delayed beyond the control of the ReEDS team.

Jobs and Economic Development Impacts Models for Water Power	3.2	2.8	X			Governors weigh heavily the value and visible recognition of jobs and projects in their states for wind. The JEDI type information is being used but the source is state universities or wind advocacy groups. JEDI data for hydro should be made available to governor staff and governor organizations such as the Midwest Governors Association and the Western Governors Association. The new JEDI models will support the acceleration of water power deployment by assisting stakeholders and policymakers with important economic impact information.	The program will highlight the completed JEDI model to facilitate its use by relevant government and industry stakeholders.
DOE-DOI-ACOE-MOU Overview	3.5	3.0	X			It supports many program approaches including feasibility studies to identify and publicized additional low-cost, advanced technology opportunities, and generation of data to more accurately correlate generation and water use with environmental impacts. The projects are focused on the needs of the incumbent hydro users. This is good as they know the business. The overall impacts can be determined on environment by summing the outputs of the projects with totalizing information supplied by ReEDS for carbon reduction and other pollutants. The impact of the hydro community on the overall generation fleet and environment can be determined. Impacts besides money measured merits are addressed. The Hydropower MOU initiatives create a partnership of key federal agencies to prioritize hydropower development in the U.S. as a clean, renewable, and reliable energy source. The MOU will facilitate a collaborative approach with Bureau of Reclamation (BOR), DOE, and the Army Corps of Engineers (ACOE).	The Program is satisfied with work completed for this effort to date.

Basin-Scale Opportunity Assessment /Green Hydro	3.1	2.7	X			This project serves to reduce barriers to new development by engaging stakeholders. It also helps to identify resources and address technology/policy needs to maximize longer-term opportunities. Useful in watersheds where there has been little or no planning and where no relicensing are currently ongoing. The goals seem well defined - to develop methods/processes for basin-scale assessment that can be applied in any/many basins. However, it is not clear that the approach will result in the desired approach. In fact, the technical approach is not clearly articulated. It appears to be series of practice experiences that result in some generalizations. Also not clear who will use this when the study is complete.	A detailed project plan with concrete deliverables has been developed for all FY2011 efforts, and the project is on track. A communications protocol concerning basin stakeholders and the dissemination of results has also been included in project work-plan. This is a higher-risk project, which, if successful, will demonstrate success of a stakeholder-driven, consensus based process that can significantly increase both generation and environmental benefits and can be used as a model for other basins.
Technology Demonstration	3.2	2.5	X			Meets objectives of DOE to engage regulators and stakeholders. Purpose is technology workshops to identify factors that are barriers to hydro development and to identify potential innovations in cost reductions, environmental mitigations, and new development. Difficulty in defining and implementing demonstrations that will be useful.	The Program is satisfied with the progress of this effort to date, especially in light of collaborations with Bureau of Reclamation on a jointly-funded solicitation topic area and with the USACE and BOR regarding the HAP and HMI studies.
Regulatory Process	3.6	2.7	X			Meets objectives to engage regulators and stakeholders and to reduce time of permitting. Particular interest in promoting private development at federal facilities by identifying technical areas that need to be understood, e.g., the permitting processes at federal facilities. Reduce regulatory delay and expense. In the Federal Energy Regulatory Commission (FERC) licensing process or have been. Licensing a private project at a federal facility. The project has worthy goals. Regulatory processes are one key concern in getting a project up and running in a cost effective manner. Take up lots of time and add considerably to project cost. Streamlined process would help improve Hydro implementation.	The Program is satisfied with work on this effort to date. This is an effort which could produce valuable results, although DOE has a limited ability to influence change.

Inland Hydro Working Group	3.1	2.9	X			Purpose is to establish a group in order to promote interagency information sharing and cooperation related to hydropower development. Working group supports efforts of the Water Power Program. Established working group and two meeting held. No findings were presented. Care must be taken to document accomplishments and self-assess for progress. Develop and incorporate a communications protocol for dissemination of results.	The Program has made efforts to more carefully document accomplishments, and has engaged researchers at ORNL to help identify concrete areas for future collaborative efforts.
Renewable Energy Integration	3.4	2.5	X			Work on assessing energy storage is definitely needed. Could use more clarity on deliverables and action plans to deliver them. Approach seems to not allocate high energy to this important project. The fact that it is behind schedule seems to support this assessment. Step it up. Modify approach to get more energy into the effort. May have overlap with other project areas. Outlines what needs to be done but it isn't clear who/how this will get done without further scoping.	Recent Program solicitation (FY2011 FOA) will likely result in the award of projects that will help to meet the goals of this portion of the Hydropower MOU. The program is collaborating with the Office of Energy on energy storage.
Climate Assessment at Federal Facilities	3.5	2.8	X			This effort appears to be generating regional synthesis documents that have potential utility for policy development. Meet DOE's requirement under the Secure Water Act to report the effects of climate change on federal hydro projects. Section 9505 of the Secure Water Act requires DOE to report to Congress on climate change effects at federal hydropower facilities and repeat this every five years. Highly collaborative and will be communicated to public and congress. This project claims to get info from other agencies (as it should) but no mention of utilizing this information in any other project. This could be quit valuable beyond the requirement to report to Congress.	The Program is satisfied with all progress on this project to date.
Education Program Overview	3.5	2.7	X			The Department of Energy (DOE) funds two fellowship programs to attract graduate students to research and careers related to hydropower. These fellowships will help develop the next generation of hydropower specialists. Excellent program aimed toward recruitment of young professionals into the industry. Not focused on specific goals.	The Program is satisfied with all progress on this project to date. Effort will be made to consider how these programs can be sustained after DOE award has ended.

Hydro Research Fellowships	3.7	3.7	X			Encourage interdisciplinary training and exposure to professor and professionals in various academic departments. Students that can communicate and conduct analyses from different disciplines will be the most sought after for employment. Funding of grad student research is an effective way of getting grads interested in Hydropower. A problem with timing - students must be identified many months before funding is available. This is a bit awkward for academic process.	The Program is satisfied with all progress on this project to date.
Environmental Flow Requirements	3.4	2.4	X			Stated goal is to advance the science of environmental flows. There is a wealth of literature on more holistic approaches to Riverine assessments. To advance the science the project must employ the integration of hydrology, geomorphology, water quality, aquatic biology, habitats and their connectivity. Much integration is needed across the various projects within this environmental performance and siting program but more specifically with the river system level tool box. The development of tools for integration across hydrology, geomorphology, water quality, biology and connectivity is a very critical need for advancing the science of environmental flows. This integration is what environmental flow assessments are all about. Continuing to seek simplistic rules and relations that could be applied to multiple sites does not advance the science. This has been the approach repeated several time over the past half century.	The Program has provided significant comments to the project team about areas of concern. This project will be reviewed again during the next Program Peer Review to assess progress.
Fish Passage Mitigation	3.5	3.0	X			This is primarily a synthesis project and case study. Product should be useful for reevaluation of old project and for new construction. Focuses on DOE objectives to bring new hydro technologies into commercial readiness that will improve energy and environmental performance and reduce barriers to new development such as regulatory risks and expense.	Program is generally satisfied with progress on this project to date. Efforts will be made to seek greater input from industry.

Green House Gas Emissions from Reservoirs	3.3	2.9	X			The approach is good to measure the gasses coming off of reservoirs, and compare to values found in the literature. The problem is that this type of field work is expensive; consequently, the number of reservoirs which can be sampled will be small. A needed project to introduce objective science to resolve a shaky political argument. Measurement of true NET emissions is a very difficult task that may be necessary to end this debate.	The Program is satisfied with all progress on this project to date. Results of this project along with other ongoing efforts around the world will help determine what type of further research will be needed in this area.
Ancillary Services Market Analysis	3.5	2.9	X			Admission that the presence of more than one set of interests (constraints) makes the modeling much more difficult represents reality. Suggest reviewing Reclamation projects on the Yakima and Trinity rivers where hydro, irrigation and fisheries are important players in balancing. Also in Norway they have been balancing hydro with Atlantic salmon, both important to local economies. Surveying the markets is necessary and a good approach. Since the California ISO allows an outside supplier to participate in the Ancillary Services market, it may be interesting to investigate using some of the HVDC Pacific Intertie capacity to export wind variability or ancillary services to Los Angeles Department of Water and Power (LADWP).	The Program is satisfied with all progress on this project to date. The project team on this and other grid services tasks are attempting to incorporate European experiences into the analysis.
Effects of Systematic Operating Constraints	3.4	2.9	X			Interesting results to date. Appear to be on the right track. Using real life constraint examples with environmental and power system challenges. Case studies: identify the top two constraints at specific sites. Public report on linkages between power grid services and water availability along with research needs to enable regional and national modeling. After U.S. understood, take a look at Europe to see similarities and differences and evaluate if those differences may show up in U.S. eventually?	The Program is satisfied with all progress on this project to date.

Hydro plant case studies	3.5	3.1	X			Provides insight into opportunities that can help generators become more efficient immediately. Documents behavior and consequences/impacts of operation. Provides data for cost of operation. Could benefit by looking at plant behavior in Europe as renewable penetration high there and looks like U.S. in 2020-25. Suggest that project at experiences from Norway. This would be particularly relevant to your task of providing examples to hydro industry e.g., examining environmental operations effects on hydro energy production and distribution. Norway has very sophisticated modeling for several years at times subordinating (seasonally) hydro production in favor of Atlantic salmon spawning and rearing. Hydro production and delivery to Europe via grid. Excellent case for looking at the interplay of these equally important values to the local economy. SINTF at the University in Trondheim, Norway is a good contact as they have done most of the modeling.	The Program is satisfied with all progress on this project to date. The project team on this and other grid services tasks are attempting to incorporate European experiences into the analysis.
Hydro cost data-based development	3.7	3.0	X			Hydro cost data is severely dated in the RTO world. Any engineering-based, supportable data for which the assumptions are known would be welcome. Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives. Develop a data base of current and projects hydro costs. Deliverables are listed as reports, but the real value seems to be the data base itself. Understanding the range of new project costs is valuable to developers looking to add hydro projects. Costs important to evaluate future direction.	Delivery of the report and data has been delayed by 8 months and is serving as a bottleneck on other program activities (JEDI, ReEDS).

Modeling of WECC (includes policy scenarios)	3.5	2.8	X			Similar data produced for wind and solar by NREL studies with similar programs were produced without intensified hydro input verification. This study should fill in the blanks for hydro. Purpose of this is task is to quantify revenue streams from energy and ancillary services in future scenarios to support investment decisions. Investigating options for increasing hydropower capacity and locating new pumped-storage plants. Use additional modeling to fill gap at short timeframes typical of advanced pumped storage being used in Europe to meet the high penetration of wind and solar there. Compilation of potential uses of the database and list of analysis capabilities motivated by these uses.	The Program is satisfied with the progress on this project to date. This project team has contacted many of the PSH owners in WECC to accurately characterize the ability of these facilities to provide ancillary services. This accurate characterization will enable more robust future modeling efforts.
Hydro Fellowships	3.7	3.5	X			Excellent support of program goals. Addresses need for future hydropower expertise. •Amazing progress in such short period of time. Very successful to date - have recruited great students and initiated research. Six projects have been initiated and ongoing. Quality of students seems excellent. Don't need another test lab. There is unused capacity. Small lab to support experiments would complement the R&D work being done by the students.	The Program is satisfied with all progress on this project to date.

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.

The Wind and Water Power Program (the Program) mission is the responsible stewardship of national resources to increase the development and deployment of reliable, affordable, and environmentally sustainable wind and water power technologies to realize the benefits of domestic renewable energy production. The Program supports research and development (R&D) on a wide range of advanced water power technologies, with the objective of better understanding their potential for energy generation, and identifying and addressing the technical and non-technical barriers to achieving this potential.

Advanced water power technologies include:

- Conventional hydropower, which uses dams, diversionary structures, or impoundments to generate electric power from water resources, and
- Marine and hydrokinetic technologies, 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.

Congress has supported research and development for both conventional and new emerging water power technologies through the Energy Policy Act of 2005 and the Energy Independence and Security Act. The budget history for water power activities begins in 2008 because the Wind and Water Power Program's hydropower activities were closed out after 2006. Funding resumed in 2008, at which time the program restructured its water power activities to include both conventional hydropower and marine and hydrokinetic technologies. In FY2010 Congress appropriated

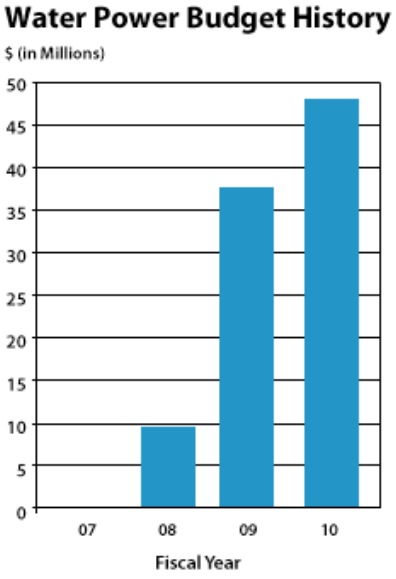


Figure 1.1 Water Power Budget History

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

nearly $50 million towards the development of conventional and new emerging water power technologies. Figure 1.1 illustrates the recent Water Power budget history.

The 2010 DOE Water Power Peer Review, conducted on October 19-21, 2010 at the Hilton Garden Inn located in Denver, Colorado, focused exclusively on Technology Development and Market Acceleration activities currently underway in the Conventional Hydropower technologies program focus area. Marine and Hydrokinetic activities were not included in the 2010 Water Power Peer Review. The findings from the Peer Review will be considered by program managers, staff, and researchers in setting priorities, conducting operations, and improving projects.

The objectives of the 2010 meeting were to:

- Review and evaluate the strategy and goals of the Water Program;
- Review and evaluate the progress and accomplishments of the Program's conventional hydropower research and development projects funded in FY2008 through FY2010; 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 three-day event. The first day focused on reviewing and evaluating conventional hydropower projects regarding Resource Assessment, Economic Analyses and Market Development, Department of Energy-Department of Interior-Army Corp of Engineers Memorandum of Understanding (DOE-DOI-ACOE-MOU), and Education Programs. The second day focused on reviewing and evaluating projects related to the Electric Power Research Institute (EPRI) Water Power Grid Services, Technology Development and Deployment, Lab Water Use Optimization, the Hydropower Advancement Program, and Hydro Fellowships. On the third day, reviewers convened in a separate location to provide an initial summary of their findings to the Water Power Technologies Lead and other program staff, and to discuss their initial impressions of the reviewed projects.

The following document represents the Peer Review Panel's observations and findings, the response from the Water Power Technologies Lead 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.

1.1 Peer Review Panel

Peer Review Panel members (hereafter called Reviewers or Panel Members) are peer experts from a variety of water power-related backgrounds and organizations, including laboratories, industry, and academia. Reviewers were screened to ensure no conflicts of interest 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.

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

Table 1: Peer Review Panel Members

Name	Affiliation
Michael Murphy (Chair)	HDR Engineering Incorporated
Richard Fisher	Voith Hydro, Inc.(retired)
Greg Lewis	Duke Energy
Steven Markstrom	United States Geological Survey
Dale Osborn	Midwest ISO
Clair Stalnaker	United States Geological Survey (retired)
Edith Zagona	University of Colorado Center for Advance Decision Support for Water and Environmental Services (CADSWES)

Reviewers received briefing materials via email and a Microsoft SharePoint site three to four weeks prior to attending the meeting to aid in the program review process. This information included a 2010 Water Power Peer Review Plan (reviewer instructions), an agenda, the PowerPoint presentations submitted to date to the panel members by the Principal Investigators for the projects to be reviewed, 2-page project summary documents, a review of the overall goals of the Program, conflict of interest forms, nondisclosure agreement forms, honorarium and travel reimbursement forms, and the Microsoft Excel Evaluation Workbooks (electronic format) for conventional hydropower projects, American Recovery and Reinvestment Act (ARRA)-funded projects, and an overall programmatic review. Programmatic plans such as a Multi-Year Program Plan or Strategic Program Plan were not available prior to the peer review.

1.2 Analysis Methodology

In accordance with DOE EERE Peer Review Guide Section 6.0[3], the Peer Review Panel chose 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. The comments herein are the most direct reflection of their written evaluations, and where possible have been included verbatim. The project evaluation forms were distributed to the Peer Review Panel members prior to the meeting, along with detailed guidance on how to complete the forms.

Since the "relevance to overall DOE objectives," or the degree to which the project supports the objectives, goals, and approaches of the Water Power Program, is included as a stand-alone metric in this analysis, each project received two cumulative scores. The second score is comprised of the weighted average of the following metrics: 1) approach, 2) technical accomplishments and progress, 3) research integration, collaboration, and technology transfer, and 4) proposed future research.

The panel was asked to rate the projects in the following weighted categories:

1. **Relevance to Overall DOE Objectives:** the degree to which the project supports the objectives, goals, and approaches of the Water Power Program. (Stand Alone Metric)
2. **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:** degree to which the project has progressed compared to the latest project schedule and goals. (Weight = 30%)

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

4. **Research Integration, Collaboration, and Technology Transfer:** with industry/universities/other laboratories – the degree to which the project interacts, interfaces, or coordinates with other institutions and projects, and the degree to which projects are disseminating the results of the R&D. (Weight = 20%)
5. **Proposed Future Research:** the degree to which the project has effectively and logically planned future work by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and when sensible, mitigating risk by providing alternate development pathways. (Weight = 20%)

The panel was asked to rate the ARRA funded projects in the following weighted categories:

1. **Relevance to Overall DOE Objectives:** the degree to which the project supports the objectives, goals, and approaches of the Water Power Program. (Stand Alone Metric)
2. **Approach**: the degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers. (Weight = 50%)
3. **Technical Accomplishments and Progress:** degree to which the project has progressed compared to the project schedule and goals. (Weight = 50%)

Additionally, the Program Evaluation forms were designed to capture input regarding the following criteria:

1. **Objectives:** how well do Program objectives align with industry needs?
2. **Barriers:** has the Program identified the critical barriers to sustaining hydropower development and deployment?
3. **Approaches:** are current Program approaches appropriately and effectively designed and implemented in order to achieve objectives and overcome technical and non-technical barriers?
4. **Projects:** has the Program formed an effectively balanced portfolio of projects that will contribute to achieving its goals and objectives?
5. **Communication & Collaboration:** the degree and impact that Program interaction has on industry, universities, federal agencies, as well as comparable international actors and other stakeholders.

For project evaluations, numerical scores were based on a four point scale, with the following qualitative descriptors given for the numerical scoring index:

- **4 – Outstanding**. Project is critical to supporting the objectives, goals, and approaches of the Program.
- **3 – Good**. Most project aspects support the objectives, goals, and approaches of the Program.
- **2 - Fair**. Project partially supports the objectives, goals, and approaches of the Program.
- **1 – Poor**. Project provides little support to the objectives, goals, and approaches of the Program.

For the Program evaluation, numerical scores were based on a four point scale, with the following qualitative descriptors given for the numerical scoring index:

- **4 – Outstanding**. All Program objectives fully support industry needs.
- **3 – Good**. Most Program objectives support industry needs.
- **2 – Fair**. Some Program objectives support industry needs.
- **1 – Poor**. Very few Program objectives support industry needs; objectives should be re-evaluated and revised.

A maximum final overall score of 4 signifies that the project satisfied the above mentioned four criteria to

the fullest possible extent, while a minimum score of 1 implies that the project did not satisfactorily meet any of the requirements of the five criteria mentioned above.

The individual criterion scores for the conventional hydropower projects are reflected in the bar graphs in Section 4.1 and Section 5 .1. Additionally, the formula listed below was used to calculate the overall weighted average score in order to provide a means for comparing a project's final overall score equivalently to other projects:

*Final Project Score = [Reviewer 1 (Score1*0.30 + Score2*0.30 + Score3*0.20 + Score4*0.20) +*
*Reviewer 2 (Score1*0.30 + Score2*0.30 + Score3*0.20 + Score4*0.20) +*
*Reviewer 3 (Score1*0.30 + Score2*0.30 + Score3*0.20 + Score4*0.20) +*
*Reviewer 4 (Score1*0.30 + Score2*0.30 + Score3*0.20 + Score4*0.20) +*
*Reviewer 5 (Score1*0.30 + Score2*0.30 + Score3*0.20 + Score4*0.20) +*
*Reviewer 6 (Score1*0.30 + Score2*0.30 + Score3*0.20 + Score4*0.20) +*
*Reviewer 7 (Score1*0.30 + Score2*0.30 + Score3*0.20 + Score4*0.20)]/7*

The individual criterion scores for the ARRA-funded projects are also reflected in the bar graphs in Section 6 .1. Additionally, the formula listed below was used to calculate the overall weighted average score in order to provide a means for comparing a project's final overall score equivalently to other projects:

*Final Project Score = [Reviewer 1 (Score1*0.50 + Score2*0.50) +*
*Reviewer 2 (Score1*0.50 + Score2*0.50) +*
*Reviewer 3 (Score1*0.50 + Score2*0.50) +*
*Reviewer 4 (Score1*0.50 + Score2*0.50) +*
*Reviewer 5 (Score1*0.50 + Score2*0.50) +*
*Reviewer 6 (Score1*0.50 + Score2*0.50) +*
*Reviewer 7 (Score1*0.50 + Score2*0.50) +]/7*

The project comparisons illustrated in the report are criteria based. Figure 1.2 represents a sample project score graph. Each rectangular blue bar in the chart represents that project's average score for one of the five designated criteria. These scores (blue bars) are then compared with the related maximum, minimum, and average scores for the same criterion across all Technology Development and Market Acceleration projects. The black line bars, which overlay the blue rectangular bars, illustrate the maximum, average, and minimum scores (range of scores) for each metric for all of the projects evaluated.

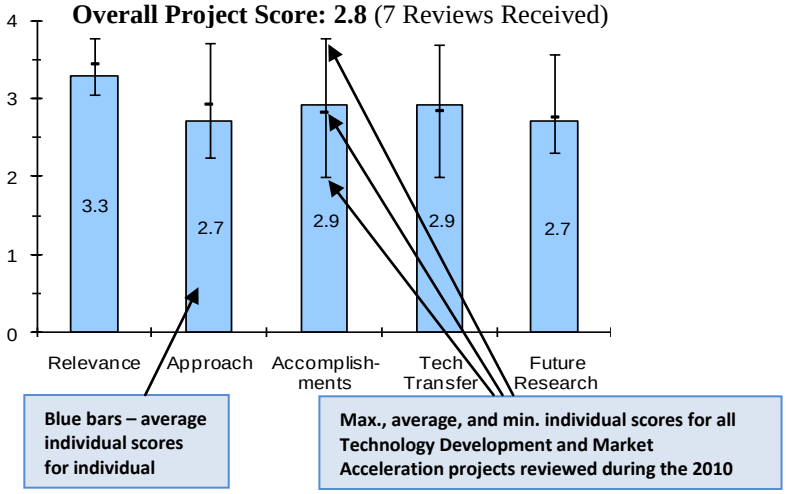


Figure 1.2. Project Score Graph with Explanation

For clarification, consider a hypothetical review in which only five projects were presented and reviewed in a sub-program; Table 2 displays the average scores for each of the project's five rated criteria.

Table 2: Sample Project Scores

	Relevance (stand alone)	Approach (30%)	Accomplishments (30%)	Tech Transfer (20%)	Future Research (20%)
Project A	3.4	3.3	3.3	3.2	3.1
Project B	3.1	2.8	2.7	2.7	2.9
Project C	3.0	2.6	2.7	2.8	2.9
Project D	3.4	3.5	3.4	3.2	3.3
Project E	3.6	3.7	3.5	3.4	3.4
Max	3.6	3.7	3.5	3.4	3.4
Average	3.3	3.2	3.1	3.0	3.1
Min	3.0	2.6	2.7	2.7	2.9

The Project A chart would contain five blue rectangular bars to represent the values listed for Project A above. A black line bar indicating the related maximum, minimum, and average values for each criterion would overlay each of the blue bars to facilitate comparison with other projects in the sub-program. In addition, each project's criterion scores would be weighted and combined to give a final, overall project score that could be meaningfully compared with those of other projects.

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 Principal Investigators were allotted 15 minutes to give their presentations.

The following sections of this report provide:

- an overview of the Peer Review Meeting Agenda,
- key findings of the Peer Review Panel,
- an overall review of the 2010 Water Power activities,
- quantitative and qualitative analyses of the Conventional Hydropower and ARRA-funded projects that were reviewed. Analyses include a summary of qualitative reviewer comments as well as graphs and tables showing overall scores for each of the projects,
- quantitative and qualitative analysis of the Peer Review Panel's overall evaluation of the Program,
- lessons learned from the 2010 Water Power Peer Review Meeting Process,
- a meeting attendee list, and
- general project and program evaluation forms.

1.3 Water Program Peer Review Agenda

Tuesday, October 19, 2010

8:00 AM	Meeting Objectives and Program Overview *8:20 AM: Panel Q&A*	Alejandro Moreno, DOE-HQ
8:30 AM	Resource Assessment Overview *8:40 AM: Panel Q&A*	Hoyt Battey, DOE-HQ
8:50 AM	• National Hydropower Asset Assessment Program *9:10 AM: Panel Q&A*	Brennan Smith / Bo Hadjerioua, ORNL
9:20 AM	• Pumped Storage *9:30 AM: Panel Q&A*	Brennan Smith, ORNL
9:40 AM	• Constructed Waterways *9:50 AM: Panel Q&A*	Doug Hall, INL
10:00 AM	Break	
10:20 AM	• Resource Availability *10:35 AM: Panel Q&A*	Doug Hall, INL
10:45 AM	• Technically Feasible Generation *11:00 AM: Panel Q&A*	Brennan Smith, ORNL
11:10 AM	Economic Analyses and Market Development Overview *11:25 AM: Panel Q&A*	Hoyt Battey, DOE-HQ
11:20AM	• ReEDS Modeling *11:35 AM: Panel Q&A*	Walter Short, NREL
11:45AM	• JEDI Modeling *12:00 PM: Panel Q&A*	Suzanne Tegen, NREL
12:10 PM	Lunch	
1:30 PM	DOE-DOI-ACOE MOU Overview	Hoyt Battey, DOE-HQ
1:40 PM	• Basin-Scale Opportunity Assessments / Green Hydro Certification	Simon Geerlofs, PNNL
2:10 PM	• Technology Demonstration	Rajesh Dham, DOE-HQ
2:15 PM	• Regulatory Process	Gina Krump, DOE-HQ

2:20 PM	• Inland Hydro Working Group	Gina Krump, DOE-HQ
2:25 PM	• Renewable Energy Integration	Hoyt Battey, DOE-HQ
2:30 PM	• Climate Assessment at Federal Facilities *2:35 AM: Panel Q&A*	Mike Sale, ORNL
2:40 AM	Education Programs Overview	Hoyt Battey, DOE-HQ
2:45 AM	• Hydro Research Fellowships *3:00 PM: Panel Q&A*	Deborah Linke, Hydro Research Foundation
3:10 PM	Break	
3:30 PM	Environmental Performance & Siting Overview *3:40PM: Panel Q&A*	Mark Bevelhimer, ORNL
3:45 PM	• Environmental Flow Requirements *4:00 PM: Panel Q&A*	Mark Bevelhimer, ORNL
4:10 PM	• Fish Passage Mitigation *4:25 PM: Panel Q&A*	Marshall Richmond, PNNL
4:35 PM	• Greenhouse Gas Emissions from Reservoirs *4:50 PM: Panel Q&A*	Mark Bevelhimer, ORNL (for Pat Mulholland, ORNL)
5:00 PM	• Peer Review Panel General Q&A (as needed)	All Principal Investigators
5:30 PM	Adjourn	

Wednesday, October 20, 2010

8:00 AM	EPRI Water Power Grid Services Overview *8:10 AM: Panel Q&A*	Tom Key, EPRI
8:10 AM	• Ancillary Services Market Analysis *8:20 AM: Panel Q&A*	Verne Loose, SNLA
8:30 AM	• Effects of Systematic Operating Constraints *8:40 AM: Panel Q&A*	Michael Starke, ORNL
8:50 AM	• Hydro plant case studies *9:00 AM: Panel Q&A*	Pat March, HPPi
9:10 AM	• Hydro cost data-based development *9:20 AM: Panel Q&A*	Steve Brown, HDR-DTA
9:30 AM	• Modeling of WECC (includes policy scenarios) *9:45 AM: Panel Q&A*	Srinivas Jampani, LCG
9:55 AM	• New Methodology Development *10:05 AM: Panel Q&A*	
10:15 AM	• Integration & Products *10:25 AM: Panel Q&A*	Tom Key, EPRI
10:35 AM	Break	
10:45 AM	Technology Development & Deployment Overview *10:55 AM: Panel Q&A*	Rajesh Dham, DOE-HQ
11:00 AM	EPRI-Alden Fish-Friendly Turbine *11:15 PM: Panel Q&A*	Doug Dixon, EPRI
11:25 AM	ARRA Projects *11:55 PM: Panel Q&A*	Rajesh Dham, DOE-HQ
12:15 PM	Lunch	
1:25 PM	Lab Water Use Optimization *1:35 PM: Panel Q&A*	John Gasper, ANL
1:40 PM	• Day-ahead Scheduling *1:50 PM: Panel Q&A*	Tom Veselka, ANL
1:55 PM	• Hydrologic Forecasting *2:05 PM: Panel Q&A*	Mark Wigmosta, PNNL
2:10 PM	• Environmental Performance *2:20 PM: Panel Q&A*	John Hayse, ANL

2:25 PM	• Unit & Plant Efficiency *2:35 PM: Panel Q&A*	Brennan Smith, ORNL
2:40 PM	• Seasonal Hydrosystems Analysis *2:50 PM: Panel Q&A*	Tom Lowry, SNL
2:55 PM	• Integration & Products *3:05 PM: Panel Q&A*	John Gasper, ANL
3:15 PM	Break	
3:40 PM	Hydropower Advancement Program (HAP) *4:00 PM: Panel Q&A*	Brennan Smith, ORNL
4:15 PM	Hydro Fellowships *4:30 PM: Panel Q&A*	John Cimbala, Penn State
4:40 PM	Peer Review Panel General Q&A (as needed)	All Principal Investigators
5:30 PM	Adjourn	

2.0 Water Power Peer Review Panel Recommendations and Key Findings

Key Findings and Opportunities for Enhancement

1. **The global objectives of the U.S. Department of Energy (DOE) Water Power Program (the Program) are well established.** The main points are on target, the research teams are focused on their objectives, and the Memorandum of Understanding with the Army Corps of Engineers and the Bureau of Reclamation is an excellent initiative that needs to grow and deliver concrete results. The use of the peer review process by the Program is also a very commendable approach to continuous improvement, especially the inclusion of both programmatic and technical reviews.
2. **Each area of the Program should be reviewed on an annual basis.** The Panel feels that two years between reviews is too long.
3. **The Program should attempt to quantify the costs of certain efforts that rely on Program staff time to ensure that true costs of such efforts can be compared with projects receiving direct financial awards**. This would allow for project prioritization and evaluation of the value added by individual projects.
4. **The program should establish quality assurance and quality control (QA/QC) protocols for data and information and require projects to address these issues, comment on the quality of data and information, and understand how results may be affected by QA/QC issues.** Further, projects that include quantitative planning and analysis or developing models that perform quantitative planning and analysis should be required to address risk and reliability due to the uncertainty of future conditions such as climate variability and change, water availability, changing land use and future economic conditions.
5. **The Program should improve its focus on transfer of information, both from its research projects to end-users and stakeholders as well as from the Program to Peer Reviewers.** Communication protocols and strategies should be developed and followed to ensure that end-users can utilize the data and tools developed by the Program's research projects. The Program should also provide project information to the Peer Review Panel in a timelier manner to improve the effectiveness of the Review, and should ensure consistency of the presentation format by requiring Principal Investigators to use a template with key project information and results.
6. **The Program should improve the coordination between projects early on to reduce the potential overlap of efforts and improve integration with internal and external activities**. This could be achieved through the establishment of, as part of the funding award process, joint meetings among investigators and advisory boards or technical review committees with defined meeting schedules. Meetings should be well planned with agendas distributed in advance, and should conclude with clear assignment of action items and due dates for follow-up activities. Feedback must be diligent. Proper planning and follow-through are critical, and facilitators are a good option for encouraging participation.
7. **Project deliverables should be linked to end-users.** Use-cases should identify product applications in order to guide the development of the project. An understanding of the end-user in a real-world context should also be maintained, and projects should incorporate processes for bringing end-users into product development.

8. **The Program should recognize that hydropower facility owners and operators contend with multiple resource objectives and priorities that change over time**. Looking at hydropower issues as a tradeoff between energy production and environmental quality leads to oversimplification of the issues and does not account for other resource objectives, such as drinking water, irrigation, recreation, fishing, downstream development, and others.
9. **Project presentations seemed to fall into two classes: 1) tangible or technology-focused efforts dealing with modeling, turbine development, etc.; and 2) administrative efforts with "soft" deliverables such as workshops, reports, etc.** Separating these two types of presentations could allow for a more expedient review. Presentations should be given in a results-driven manner, especially for "soft" deliverables where it is difficult to show metrics of measurement. "Softer" tasks without tangible results should not simply state accomplishments (such as "held a meeting"), but should clearly describe anticipated products, and display the findings, relevance to the task, and action items resulting from these meetings.
10. **The Program's modeling projects could be improved through verification via peer review to provide a "reality check" of model intent and design along with underlying assumptions, the declaration of model inputs, equations, and independently generated outputs**. Models could be validated by examining the correlation between model and real-world results. Project milestones can be set and base prototypes can be demonstrated throughout the model development process to show status. Projects could also develop model documentation and adhere to a "Functional Requirements" document, which is essential for models with multiple parts developed by different organizations to avoid model miscommunication. Finally, projects could create a "straw man" scenario that presents actual data in order to engage and stimulate developers.
11. **Metrics for project performance were unclear on some projects.**

3.0 Water Power Activities

To take this country in a new direction, the President is working with Congress to pass comprehensive legislation to protect our nation from the serious economic and strategic risks associated with our reliance on foreign oil and the destabilizing effects of a changing climate. Policies to advance energy and climate security should promote economic recovery efforts, accelerate job creation, and drive clean energy manufacturing by:

- Investing in the Clean Energy Jobs of the Future,
- Creating new Jobs in the Clean Energy Economy, and
- Investing in the Next Generation of Energy Technologies.

The U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) works to strengthen the United States' energy security, environmental quality, and economic vitality through public-private partnerships. The goals of the EERE Office are to support the development of clean, affordable, reliable, and domestic energy resources and technologies.

The Office of Energy Efficiency and Renewable Energy supports this goal through:

- Enhancing energy efficiency and productivity,
- bringing clean, reliable and affordable energy technologies to the marketplace, and
- making a difference in the everyday lives of Americans by enhancing their energy choices and their quality of life.

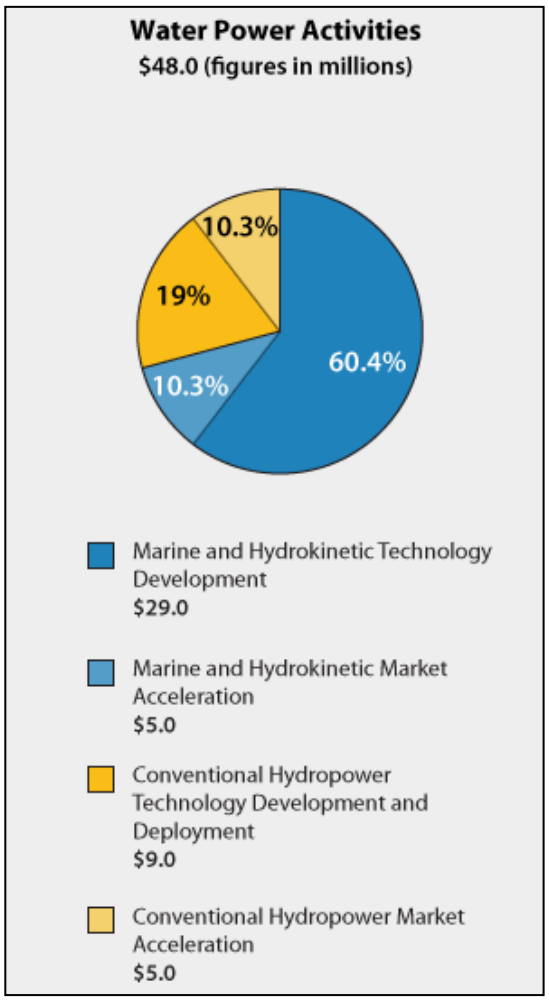


Figure 3.1 FY 2010 Water Power Activities

The Wind and Water Power Program (the Program) is one of ten programs within EERE and includes the Water Power Activities. The mission of the Wind and Water Power Program is the responsible stewardship of national resources to increase the development and deployment of reliable, affordable, and environmentally sustainable wind and water power technologies to realize the benefits of domestic renewable energy production. The mission of the U.S. DOE Water Power activities is to develop and employ novel technologies, improved operational procedures, and rigorous analysis to assess the potential extractable energy from domestic rivers, estuaries and coastal waters and help industry harness these renewable, emissions-free resources through environmentally sustainable and cost-effective electricity generation.

The Wind and Water Power Program conducts research into two advanced water power technologies: marine and hydrokinetic technologies and conventional hydropower technologies. Conventional hydropower uses dams, diversionary structures, and impoundments to generate electric power from water resources. Marine and hydrokinetic technologies capture energy from waves, tides, ocean currents, the natural flow of water in rivers, and marine thermal gradients without building new dams or diversions.

Figure 3.1 illustrates the budget breakdown for water power activities in FY2010. The program focuses on the development of each technology, addressing technical barriers to device design, development, testing, evaluation, and integration; and market acceleration, which addresses nontechnical barriers to the development, siting, and deployment of the technologies.

The 2010 Peer Review focused on Technology Development, Market Acceleration, and American Recovery and Reinvestment Act (ARRA) funded activities that were currently underway in Conventional Hydropower. Marine and Hydrokinetic activities were not included in the 2010 Peer Review. Figure 3.2 illustrates the current structure of the Water Power Program.

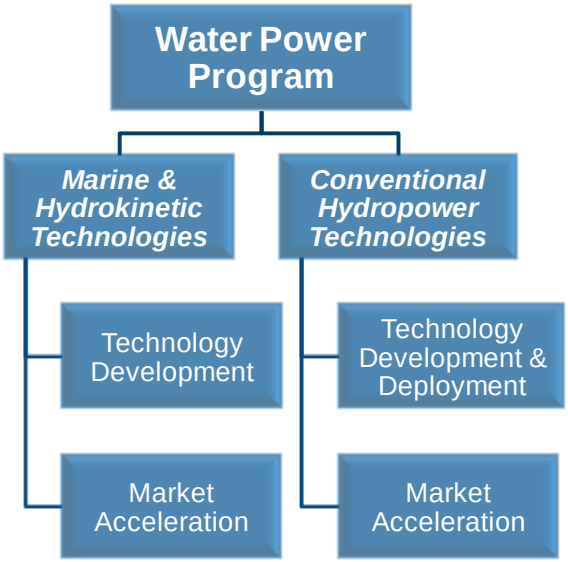


Figure 3.2 Water Power Program Structure

According the Program, the areas of focus for Conventional Hydropower Technology Development and Deployment are:

- Increasing the total contribution of conventional hydropower plants to the renewable energy portfolio in the U.S.
- Bringing new hydropower technologies that have improved energy and environmental performance characteristics into commercial readiness
- Reducing barriers to new development, such as regulatory risks and expense

The key barriers facing Conventional Hydropower activities are:

1. **Development incentives not aligned with resource value and potential**
   - High capital costs and long payback periods
   - Lack of markets for grid services
   - Public power sold below market price
   - Competing water uses get priority
   - Limited policy support

2. **Expensive regulatory process**
   - Time-consuming and costly permitting process and associated litigation
   - Limited incentive to research and demonstrate advanced technologies

- Renewed licenses often reduce generation and operational flexibility

3. **Technology costs remain high in certain sectors**
   - Small hydropower and pumped storage technologies remain expensive
   - Most innovative research and development (R&D) is occurring in Europe and Asia

The approaches taken by the Program to overcome these barriers are to:

1. **Support immediately-available, low-cost upgrades and feasibility studies to:**
   - Identify deployment support for immediate, least-cost opportunities
   - Publicize additional low-cost, advanced-technology opportunities along with targeted deployment support to catalyze private sector investment
   - Develop operational tools to maximize generation at existing and new facilities

2. **Identify resources and address technology/policy needs to maximize medium- to long-term opportunities**
   - Integrate resource assessments and cost curves with key pumped storage and small hydro technology needs to identify critical cost of electricity drivers
   - Conduct market analyses to accurately quantify and monetize hydropower ancillary services

3. **Engage regulators and environmental stakeholders to reduce license time and cost**
   - Align energy generation and environmental priorities across river basins to facilitate development
   - Generate data to more accurately correlate electricity production and water use with environmental impacts

Future Conventional Hydropower activities focus:

1. **Quantifying and Communicating Hydropower's Value Compared to the Power Mix**

   Need to develop objective criteria for measuring and valuing hydropower's non-power attributes. Criteria should be based on internationally recognized standards, should permit comparisons across generation sources, should recognize emissions as well as effects on aquatic and land resources, and should take into account the entire life cycle of facilities associated with electricity production.

2. **Continuing Advanced Hydro Turbine Development and Deployment**

   Achieve progress on advanced hydro technology, which aims to reduce mortality of fish passing through turbines. Recommended new areas of emphasis include improving water quality without compromising energy generation efficiency.

3. **Developing a Business Model for Operations and Maintenance (O&M) Decision Support Based on Condition Monitoring**

   Condition monitoring equipment and systems are increasingly being used. However, the availability of new information poses the question of how to optimally use this information for making both major and minor business decisions in support of facilities operation and maintenance.

4. **Improving Methods to Quantify Costs and Benefits from Ancillary Services**

   Hydro plant owners and operators recognize that the ancillary services provided by their facilities are valuable; however, market structures often fail to appropriately recognize these values. As a consequence, returns to owners and projects are often less than they would be if these values were appropriately acknowledged.

5. **Communicating with Stakeholders about Hydropower**

   Constituents must be suitably informed about hydro issues. It is necessary then to identify effective educational methods and content, research the best ways to transfer knowledge, update and maintain factual content and methods, and develop communication networks to inform policymakers, non-governmental organizations, and the public.

6. **Supporting Green Power Acceptance for Hydropower**

   In some regions, electricity is marketed as "green," meaning it is generated from sources that are environmentally beneficial compared to the alternatives. Projects in this area include determining how to gain acceptance for hydro within green marketing programs.

7. **Developing a Hydropower Competency Management Program**

   Workforce issues are increasing in priority, especially because of loss and projected loss of personnel due to retirements. Projects in this area include inventories of the skills and competencies needed for hydro facilities operation and the development of techniques and strategies for addressing identified needs.

8. **Promoting Hydro-Related R&D Technology Transfer**

   Much information is available that is, or may be, applicable to problems and areas of need. However, better tools and processes are needed for communicating and sharing information, both from research activities and operational experience.

9. **Determining Operating Life Effects Due to More Severe Load Operations**

   In recent years, many hydro projects have begun operating in ways not envisioned during their original design. Work is needed to determine how equipment is affected, and also to identify actions and tools for predicting and preventing failures.

10. **Developing Protocols for Measuring Mitigation Effectiveness**

    In recent years, hydro project owners have engaged in many instances of implementing environmental mitigation measures. However, it is not generally known whether the measures have been effective. Knowledge gained from research in this area could help in designing future mitigation measures and in avoiding ineffective mitigation.

The following sections of this report provide summaries and analyses of the Conventional Hydropower activities that were reviewed during the 2010 Water Power Peer Review meeting. Analyses include a summary of qualitative reviewer comments as well as graphs and tables showing overall scores for each of the projects. The qualitative analyses provided in the following sections 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 specific projects or presentations.

4.0 Conventional Hydropower Technology Development Activities

The Wind and Water Power Program (the Program) works to increase the nation's incremental hydroelectric generation, to quantify and maximize conventional hydropower's ancillary benefits to the U.S. electric grid, and to improve the environmental performance of the U.S. hydroelectric infrastructure. Incremental increases in generation can be achieved through efficiency and capacity gains at existing power stations, as well as the placement of power stations at existing non-powered dams and in constructed waterways.

Conventional Hydropower Technology Development & Deployment Goals

FY 50: Increase Capacity by 100 GW

FY 30 : Reduce LCOE to $0.07/kWh for powering existing non-powered dams and building new small hydropower.
(Program CH TD goals are focused on increasing deployment of low-LCOE resources and reducing installed cost for higher LCOE resources)

FY 15: Support up to 500 MW of incremental capacity deployment through efficiency upgrades, capacity upgrades, and powering non-powered dams

FY 12: Support the deployment of 150 MW of hydropower upgrades; Conduct 100 upgrade audits of existing facilities

Figure 4.1 Technology Development & Deployment Goals

Advanced Turbine Development and Deployment
The Program supports the development of more efficient and environmentally friendly hydropower turbines that can compete with traditional designs. This project will produce sufficient engineering data for a new turbine to be designed and constructed for one or more demonstration sites.

Basic and Materials Research
The Program funds research and development (R&D) to identify and test new materials and manufacturing techniques that improve the performance and lower the costs of conventional hydropower. These include materials or coatings that reduce the life-cycle cost of turbine runners, draft tubes, penstocks, and ways to improve generator efficiency and prevent failures.

Sensors and Controls
The Program works to develop, demonstrate, and test new sensors and controls that can improve the energy efficiency and environmental performance of conventional hydropower. These activities support industry by reducing capital and operations and maintenance costs, increasing unit availability and plant capacity factors, mitigating 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.

Table 4.1 below lists the Conventional Hydropower Technology Development projects reviewed during the 2010 Peer Review meeting, including the Principal Investigator and budget for each project.

Table 4.1 Conventional Hydropower Technology Development Projects

Project Name	Principal Investigator	FY09 (DOE Funds)	FY10 (DOE Funds)	Total Funding	Duration (Years)
Technology Development and Deployment					
EPRI-Alden Fish-Friendly Turbine	Douglas Dixon, EPRI	NA	$1.2 Million	$2.6 Million	1
Lab Water Use Optimization	John Gasper, ANL	$2 Million	$2 Million	$6 Million	3
• Day-Ahead Scheduling	Thomas Veselka, ANL	$550,000	$550,000	$1.65 Million	3
• Hydrologic Forecasting	Mark Wigmosta, PNNL	$500,000	$500,000	$1 Million	2
• Environmental Performance	John Hayes, ANL; Yetta Jager, ORNL; Kenneth Ham PNNL	$300,000	$300,000	$900,000	3
• Unit & Plant Efficiency	Brennan Smith, ORNL				
• Seasonal Hydrosystems Analysis	Thomas Lowry, SNL	$300,000	$300,000	$900,000	3
• Integration & Products	John Gasper, ANL	$200,000	$200,000	$600,000	3
Hydropower Advancement Program	Brennan Smith, ORNL		$10.5 Million	$10.5 Million	1

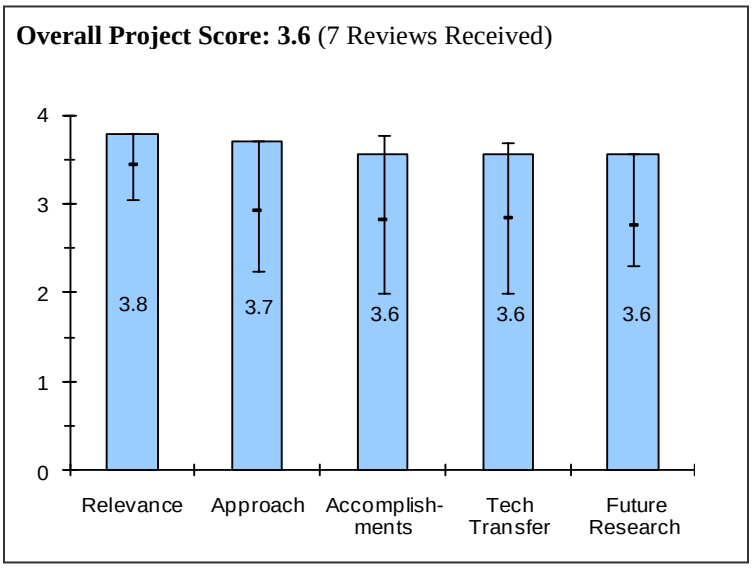
4.1 Conventional Hydropower Technology Development Project Evaluations

Table 4.2 below lists the average score per category and the averaged weighted score for each Technology Development project that was evaluated by the Peer Review Panel.

Table 4.2 Technology Development Project Scores

Technology Development Projects	Relevance to Overall DOE Objectives	Approach	Technical Accomplishments and Progress	Research Integration, Collaboration, and Technology Transfer	Proposed Future Research	Averaged Weighted Score
EPRI-Alden Fish-Friendly Turbine	3.8	3.7	3.6	3.6	3.6	**3.6**
Lab Water Use Optimization	3.3	2.3	2.4	3.1	2.4	**2.5**
Day-ahead Scheduling	3.3	2.7	2.9	2.9	2.7	**2.8**
Hydrologic Forecasting	3.3	2.9	2.8	3.2	2.9	**2.9**
Environmental Performance	3.1	2.5	2.3	2.3	2.6	**2.4**
Unit & Plant Efficiency	3.5	2.3	3.0	3.0	3.0	**2.8**
Seasonal Hydrosystems Analysis	3.3	2.7	2.5	2.6	2.3	**2.6**
Hydropower Advancement Program (HAP)	3.6	2.8	2.0	2.4	2.8	**2.5**

Project Name: EPRI-Alden Fish-Friendly Turbine
Doug Dixon; Electric Power Research Institute



Brief Summary of Project

This project is the second phase in the development of a commercially competitive, "fish-friendly" turbine that, when installed, will reduce the risk to fish passing through a conventional hydropower facility's turbines. Impacts to downstream migrating fish are one of the principal concerns associated with hydropower operation and new development. This turbine could contribute to a more environmentally protective use of hydropower resources and an expansion of hydropower development. The goal of the project is to complete the remaining developmental engineering required of the new turbine concept, including conversion from the conceptual to a buildable design and construction and testing of a physical model to evaluate its structural engineering, power production, and economic performance. To date, the model turbine has been fabricated and assembled, and the first round of model testing has been completed. The project will culminate with a Fish Friendly Turbine Workshop tentatively planned for late first quarter or early second quarter of 2011.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.8** for its relevance to DOE objectives.

- Outstanding example of a solution to a problem.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the Department of Energy (DOE) and Water Power Program objectives.
- True innovative research and development (R&D).
- Incorporating a demonstrated fish-friendly turbine into the hydro industry directly supports the environmental goals.
- Focuses on DOE objectives to bring new conventional hydropower technologies into commercial readiness that will improve energy and environmental performance and reduce barriers to new development such as regulatory risks and expenses.

Question 2: Approach to performing the research and development

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

- This project builds on extensive (and expensive) previous research and now provides for demonstration in the real world.
- Combination of experimental science and development of tables/relationships that can be easily used to improve turbine design and hydropower operations to minimize impact on fish.
- The test will tell.
- Good approach to develop and test fish-friendly turbine.
- Build a better turbine for fish.
- Several designs.
- Preliminary design.
- Physical model.
- Test physical model.

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

This project was rated **3.6** based on accomplishments.

- Design, fabrication and phase 1 testing are complete and ready for installation and demonstration/testing under real world operations.
- The project is on schedule and results so far have exceeded expectations.
- Progress appears to be on schedule.
- Completed conceptual design.
- Preliminary design completed.
- Fabrication completed.
- Initiated initial model testing.
- Everything seems good.

Question 4: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.6** for technology transfer and collaboration.

- Multiple industry funding partners. Interest in application and actual deployment is excellent technology transfer.
- The project has a range of collaborators with EPRI and private industry. EPRI plans to see through the demonstration efforts, testing and making the turbine ready for market.
- The cost will probably be a determination if this solution is adopted. This appears to be a final demonstration project but it is likely that information will be learned that requires more research and development.
- High visibility project.
- Numerous sponsors.
- Workshops with other groups developing turbines.
- Demonstration project.

Question 5: Proposed future research

This project was rated **3.6** for proposed future work.

- Future activity will come from the identified need to educate agencies, non-governmental organizations, and industry of the viability of this new turbine technology.
- Applications for additional demo sites are in progress. Continuation of the project past DOE involvement - to final engineering design and turbine/site construction and performance testing are planned and supported by EPRI.
- More incremental development than research.
- Clear approach for moving forward.
- Second round of model testing: Late October 2010 including witness tests by all funders (on-site project meeting at Voith Hydro in York, PA), revised preliminary engineering & final report: February 2011, Advanced turbine workshop: 2nd Quarter 2011; date and location to be determined (TBD) (joint initiative of the Electric Power Research Institute (EPRI), DOE, and the National Hydropower Association (NHA).
- Future work: deploy and test.
- Tentative demonstration at Brookfield's School Street Project, Mohawk River, near Albany, NY
- December 2010: Announce selection of additional demonstration site (related program funded by EPRI).
- Testing.
- Final report.
- Workshop.
- Choosing another test site.

Strengths and weaknesses

Strengths

- This effort came about from a well documented need after many years of monitoring fish losses due to turbine stress.
- Excellent engineering effort with high success to date.
- Strong support of EPRI to see project through to proof of concept.
- Has significant potential to address barriers to increased hydropower.
- Appears to be a shining example of a solution to a problem and will be very visible.
- Good industry interaction.
- High visibility project.
- Value for industry.
- A unique and worthy initiative.

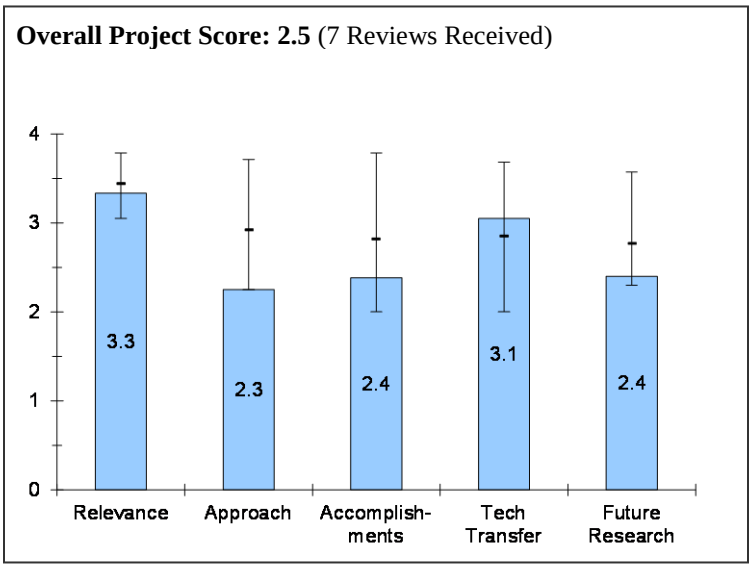
Weaknesses

- None.

Specific recommendations and additions or deletions to the work scope

- Cost evaluations would be interesting or is this in with Oak Ridge National Laboratory (ORNL)?
- Could this machine also be aerating if needed therefore balancing fish passage, energy generation and water quality improvements? Look into it.

Project Name: Lab Water Use Optimization
John Gasper; Argonne National Laboratory



Brief Summary of Project

This multi-part project will develop and demonstrate a hydropower water use optimization toolset that links water supply, power generation and ancillary services, and environmental performance for hydropower planning and operations in order to increase the production of energy and grid services from the available water and to enhance the environmental benefits from improved hydropower operations and planning. The five tasks under this project will develop modeling systems and tools for day-ahead scheduling and real-time operations; hydrologic forecasting; environmental performance; unit and plant efficiency; and seasonal hydro systems analysis. This project will also demonstrate improvements in power generation, ancillary services, and environmental performance through the application of this toolset in varied hydro-climatic and operational environments.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.3** for its relevance to DOE objectives.

- Comments for PD-041 are also incorporated here. Tool development, if transferred to outside users, would be a valuable contribution. If PD-020 truly provides state-of-the-science tools for incorporating all the critical components of environmental flows (hydrology, geomorphology, water quality, biology and connectivity of habitats), then this project could truly advance water use optimization.
- This project is intended to focus on objectives of increasing hydropower generation and bringing new technologies into readiness that have improved energy and environmental performance, and to support the approach of developing operational tools to maximize generation at existing and new facilities.
- However, this particular set of tools may not be generally applicable, hence may not support the objectives.
- Goal is to help assure development and demonstration of a useful, useable and used Water Use Optimization Tool Set. This supports objectives of the Water Power program.
- To be used for both operational and planning.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

- Supports objectives, but has very ambitious goal which can be oversold leading to unreasonable expectations.

Question 2: Approach to performing the research and development

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

- The project is at risk to succeed as a usable toolbox because: 1) needs assessment and requirements have not been done; 2) some of the components are not likely to be generally applicable; 3) the toolset would be difficult to integrate into a utility's data/model/operational processes; 4) the design of the integrated system is complex and possibly beyond the budget and timeframe of the project; 5) no provision has been made in the schedule for documentation, tech transfer and long-term maintenance, all requisites for a usable software tool.
- Modeling and methods are complex and need to be well coordinated with other team members.
- Appeared that there needed to be more understanding of end users with the tools being considered and created.
- Approach seems to be integrated and focused, however not sure if total effort for integration with all tools has been assessed by team members.
- Includes industry users in toolbox development for demonstrations.
- When systems like this are applied, lots of local expertise is required to get the models set up and working at the specific site.
- Bad real time data (i.e. climate, stream flow) can be a big problem.
- End user support of this system will be a big issue.
- Common nodes, as well as temporal and spatial resolution (methods for data aggregation and disaggregation) must be addressed to pass data between the Water Use Optimization (WUO) component models.
- It will be a big job to program the common data base and all of the query and data sharing algorithms used to pass data between the WUO component models.
- Very complex approach - effectiveness for the user remains to be seen.
- The technical feasibility of having such a wide ranging overreaching tool set is questionable. Yes parts can work, and it can be used in lite versions to guide operations. The elements have value.

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

This project was rated **2.4** based on accomplishments.

- Well laid out scope of work.
- System architecture design was scheduled to be done in FY10, but it does not appear to be done yet (presenter said that the system design is still evolving). To be effective, the design must consider detailed design of the components, which are not yet complete.
- Progress has been made on identifying review committee and demonstration sites.
- The timeframe for development of the toolset is quite optimistic for the scope of the project; the delay in completing the design could put the project at risk.
- It is unclear where the unit and plant efficiency project stands and how this component will be provided.
- Tool set demonstration and development.

- Met FY10 milestones of: initial development of tool set component model frameworks and designs development of initial design for component integration software.
- Met FY10 milestone of identification of initial technical review team members.
- Significant progress on FY10 milestone to identify candidate demonstration site.
- Not very far along for a three year project.
- There wasn't a lot of discussion about the "prototype of the integration software."
- Much work remains.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Good collaboration across labs and well integrated sub-project design. Investigator of PD-038 and PD-021 need to collaborate on site specific environmental flow modeling. See the Instream Flow Council (IFC) 2008 book on Integrated Approaches to Riverine Stewardship, particularly Chapter13 for discussion and review of approaches for assessing hydrology, geomorphology, water quality, aquatic biology, and connectivity all being critical components for developing environmental/instream flow mitigation plans.
- The project brings together several labs, universities, government agencies and utilities.
- Several other projects under DOE's Combined Heat and Power (CHP) program intend to collaborate with this project.
- Project does not include plan for dissemination and technology transfer.
- Develop and incorporate a communications protocol for dissemination of results.
- Coordination with other team members is important.
- The list of partners (Bureau of Reclamation, Army Corp of Engineers, California Department of Water Resources, National Oceanic and Atmospheric Administration, etc.) are great. This is by far the strong point of this project.
- WUO component models should work well together.
- Could be problems with user support when the system is delivered to demonstration sites.
- Planned use of multiple cooperating labs.

Question 5: Proposed future research

This project was rated **2.4** for proposed future work.

- Suggest the following references be reviewed:
    - Bartholow, J.M. and seven others, 2003. Evaluating water management strategies with the Systems Impact Assessment Model: SIAM Version 3. USGS Open File Report 03-82. Fort Collins, CO;
    - Bovee, K.D. et al. 2007. A decision support system for water management in the upper Delaware River. Open File Report 2007-1172. USGS [online] www.fort.usgs.gov/Products/Publications/21938/21938;
    - Heggenes, J. and A. Harby. 1995. HABITAT-User's Manual.
    - A. Killingtvelt, K. Alfredsen and T.H. Bakken. Eds. The River System Simulator-User's manual and program guide. Norwegian Hydro technical Laboratory Report.
    - Oregon WRD 2010 report on instream flow standards for discussion of a 3 tiered approach for establishing project related flow requirements (www1.wrd.state.or.us/pdfs/EFTAG Final.pdf).

- Although some of the first year goals were completed, the project seems to be behind with respect to software design; hence the development will also lag. Because this is a risky schedule, the project should have (but does not now have) decision points and alternative pathways to mitigate the risk failure to complete the software to a useable level.
- Next steps clearly identified.
- There is a lot of work to be done if the WUO toolbox is going to be applied in FY 2012.

Strengths and weaknesses

Strengths

- This series of presentations and plan for integration was well done. True integration of the component studies is critical. Little attention to the integration issue at this early stage. Investigators must examine previous work on such integration. See the work that USGS, Fort Collins has done on the Klamath River. Also see Chapter 9, in the 2008 IFC book. Example of the Trinity River, CA. for different water year schedules for restoring Pacific salmon populations.
- The concept of a toolbox for forecasting and optimizing is useful.
- Many excellent collaborators.

Weaknesses

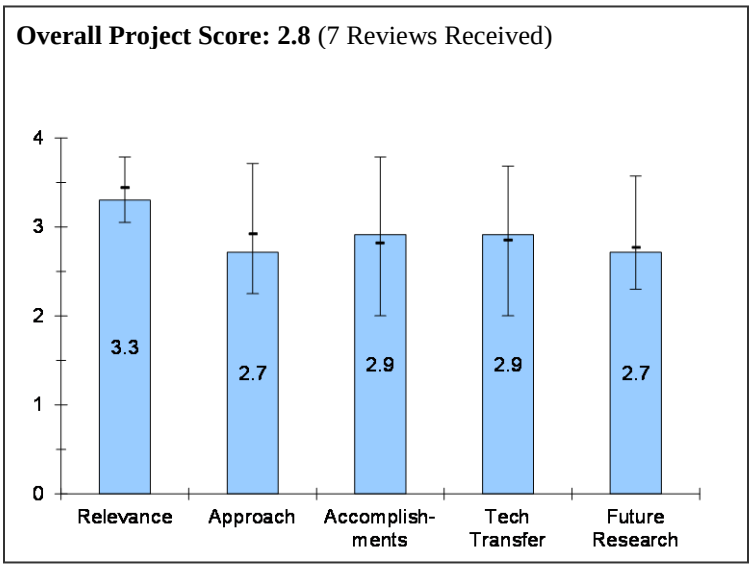
- Little discussion of how integrated models will be useful in routing and assessing water quality and aquatic habitat throughout a river system under alternative scenarios. Estimating the river bathymetry throughout the system is an important part of environmental analyses and was not specifically addressed.
- No needs analysis or requirements documentation exists to guide development of the toolbox.
- The scope is great compared to the budget and timeframe for development.
- It would require considerable effort to integrate the tool set into a utility's business process for planning and operations.
- Software is not being developed according to industry standards (e.g. International Organization for Standardization (ISO) standards, Institute of Electrical and Electronics Engineers (IEEE) standards, or Civil, Mechanical and Manufacturing Innovation (CMMI) standards). This could result in a product which is unreliable and difficult to maintain.
- To get these demonstration applications running, it is going to take a lot more time and money than is listed for the "Integration and Products" section of the presentations.
- This work is very complex and requires numerous interfaces. It will be very challenging to develop a product that is user-friendly and on-budget.
- Can lead to unattainable expectations.

Specific recommendations and additions or deletions to the work scope

- Examine IFC book Chapter 13 for integration ideas and specifics for addressing river system hydrology, including routing throughout the river system of interest allowing modeling of water quality (critical to include temperature and DO at minimum) and habitat down the system. Also for alluvial stream consideration of sediment flushing and periodic high flows to cleanse and reset the habitat conditions. See IFC book Chapter 9 of the Trinity River, CA case study on the use of a salmon population model and the integration of the five critical riverine components.
- Needs analysis, documentation of requirements, and development of use cases. Select and design components based on needs.

- Embed contingency plan into schedule.
- Change goal to develop a prototype rather than a usable product; this is more likely to succeed.

Project Name: Day-Ahead Scheduling
Tom Veselka; Argonne National Laboratory



Brief Summary of Project

This task under the Water Use Optimization (WUO) project will develop and apply an enhanced day-ahead hydropower scheduling and real-time operation tool. This tool will help schedulers and operators generate more power with the same amount of water, improve the economic value of hydropower generation and ancillary services, increase habitat quality, and support power grid operations, including wind and solar energy integration. The tool will simultaneously solve energy and environmental objectives, maximizing energy production and economics within environmental operating constraints while optimizing environmental quality, resulting in a temporal sequence of dam water releases. The tool has been designed for a broad range of applications to ensure wide adoption by industry.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.3** for its relevance to DOE objectives.

- Looks like a good overall set of objectives.
- This project focuses on the objective of increasing hydropower production by developing operational tools to maximize generation. Optimization is broadly recognized among hydropower producers as an effective approach to increasing the value of hydro. But optimization tools are not available to all. This project endeavors to address that.
- Improve the performance of hydroelectric and environmental resources through the development and application of an enhanced day-ahead scheduling and real-time operation tool. The tool is consistent with DOE's objective to increase the contribution of conventional hydropower to the U.S. renewable energy portfolio.
- Will be integrated with other toolkit components.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

Question 2: Approach to performing the research and development

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

- Emphasis on environmental and energy objectives is unique and needed.
- A dual objective (hydropower and environmental flows) does not allow for other objectives such as water supply, flood control, navigation, recreation, etc. These are not treated simply as constraints by most operators of project as with conservation storage. Further, developing weights for the dual objectives is not simple.
- The formulation of the problem will be difficult for many users. The solution may not be guaranteed. Optimization comes with many pitfalls for the naive user. Software needs to be particularly robust. The idea of using several solvers is nice in theory, but each solver has a different API, different parameters needed, etc. Solvers do not tend to be plug and play. Also, there are a number of mathematically tricky issues with reservoirs that are smaller and more dynamic, where head and tailwater can vary greatly in the course of a run. To address this, a functional requirements and design should precede development and be based on needs and understanding of skills of people who will use the tools.
- How will the unit efficiency module fit into the problem formulation?
- The formulation in presentation does not include economic value of hydro and ancillary services, power grid operations including wind and solar. How will these be included in the problem/solution?
- Problem size is important. Report of fast solution of Glen Canyon model is encouraging, but for more complex systems with multiple reservoirs, the problem will increase in size exponentially.
- Using existing software where possible – good.
- Know that other reviewers had issues with the optimization methodologies that were presented. However, think it's good to research this.
- "Research models" and "deployable models" are often two different things. Be sure of which type of models you are developing for this project and be sure that expectations are in line with this decision.
- The operation of a hydro system and a power system is often very dynamic with constantly changing inputs. Have real doubts that this can be made real-time useful to some system operators sitting in the "hot seat."

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

This project was rated **2.9** based on accomplishments.

- On or ahead of schedule.
- Evaluation of mathematical techniques and solvers is somewhat behind schedule, but framework and design are on schedule.
- Demonstration for one reservoir only, issues of scale not yet addressed.
- Completed initial tool framework and design (on schedule). Reviews of the framework and design document (on schedule). Work in progress on the graphical user interface (GUI) and data input screens (ahead of schedule),
- Solver is behind schedule.
- There are lots of pieces to this project (GUI, solver, network builder, data /O). All of these will have to be coordinated carefully to prevent slippage.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Integration with other toolbox components is built into project scope.
- This module will interface with other components of the toolbox.
- Demo sites have been arranged and interested collaborators are working with investigators.
- Even though the software is in R&D phase, a plan needs to be developed for documentation, deployment, and support for end users.
- A lot of work still needs to be done on how this tool will interact with the other tools in the WUO toolkit.

Question 5: Proposed future research

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

- Future application of toolbox will be through demonstration projects.
- Next steps are general to entire toolbox; next steps for day-ahead scheduling are not explicit. Plan mentions hiring of more optimization experts - what tasks will they undertake?
- The design and functionality of the final tool (product) is not described and it is not known what further work needs to be done to complete the work.
- Decision points and contingency plans should be developed. A user-friendly optimization tool is not easy; risks should be identified and alternate pathways thought out.
- Coordination with domo site staff includes learning operations, business processes, challenges and needs. But this should have been done initially, before designing the tool.
- Next steps clearly articulated.
- Get this tool into beta testing as soon as possible.

Strengths and weaknesses

Strengths

- This is an important piece of the overall development of a toolbox of models.
- Good prototype MIP solution on Glen Canyon looks promising.

Weaknesses

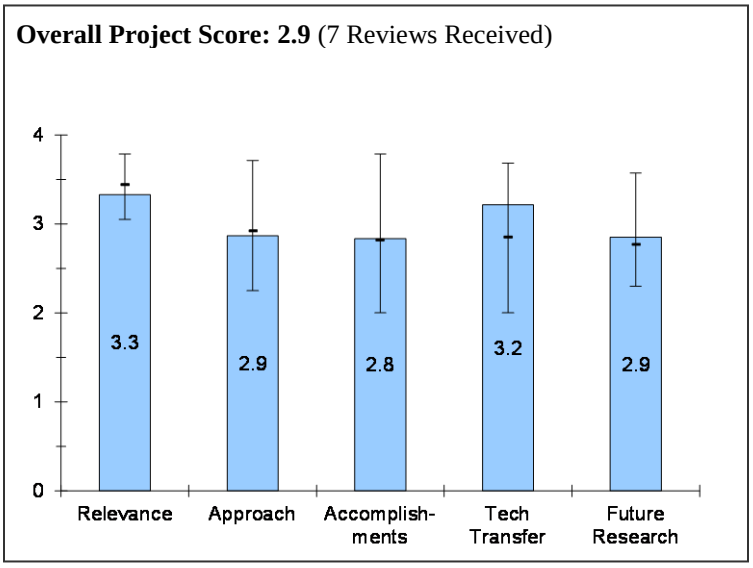
- Only two objectives are possible and they must be weighted (could alternatively be prioritized).
- Fast solver is needed - Lingo is not a good choice for final version; offering many solvers is not really practical.
- Design is not described, possibly has not been done, for full functionality. Also, have not designed connections to other components.
- The Glen Canyon prototype is good, but it would be good to test this approach with a much larger problem to explore performance and data issues.
- Biggest challenge is how to input changing conditions on a continuous basis without the "feeding" process becoming overwhelming.
- Relatively expensive project.

Specific recommendations and additions or deletions to the work scope

- Requirements and design should be documented with respect to end-user needs and business processes.
- Suggest the planned scope of the project be sent to various hydro operating entities (end-users) to get their feedback on the system. If not user-friendly and effective for real-time users, changes need to be made.

Project Name: Hydrologic Forecasting

Mark Wigmosta; Pacific Northwest National Laboratory



Brief Summary of Project

This task will develop a national, multi-scale streamflow forecasting system for the Water Use Optimization (WUO) toolbox. The tool will generate an ensemble of meteorological and streamflow forecasts, at multiple user-defined temporal and spatial scales that will capture the uncertainty in weather forecasts. These forecasts will give hydropower plant operators longer lead times with reduced forecast uncertainty for unit scheduling and planning; will allow for relaxation of system operating constraints without increasing risk; and will provide an increased opportunity for plant- to system-level optimization. To build this forecasting system, the task will integrate and enhance existing Pacific Northwest National Laboratory (PNNL) and University of Washington/Princeton University (UW/PU) ensemble forecast systems. The system will address the principle components of forecast uncertainty by assimilating remotely-sensed snow cover and streamflow data and by using an ensemble of meteorological forecasts.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.3** for its relevance to DOE objectives.

- This is perhaps the most important component of the toolbox development project.
- Although accurate forecasting benefits efficient reservoir operations, it has not been demonstrated to what extent improved real-time forecasts would benefit hydropower efficiency or whether a new forecasting technique would be used by utilities or agencies. There are a variety of forecasting tools currently in use. Some agencies such as Reclamation rely on National Weather Service forecasts. What is the need/gap that drives the development of another? Is it realistic that agencies and utilities will abandon their current forecasting techniques to develop a complicated, data intensive one?
- Seems like necessary information. This is not in my area of expertise.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

Question 2: Approach to performing the research and development

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

- Good to build on existing capabilities as much as possible. See the thorough discussion of hydrology and hydrologic analyses in the National Research Council 2008 report "Hydrology, Ecology, and Fishes of the Klamath River Basin. Also the Chapter 13 of the IFC book "Integrated Approaches to Riverine Stewardship."
- The approach is sound and is an extension of a proven model. However, data requirements and calibration issues may be a barrier to widespread use of this tool.
- Combines a number of parameters into a model that can be used as part of a forecasting model.
- Complex system. Appears it will require extensive coordination with other team members
- Using well established hydrologic modeling techniques.
- Need a way to make sure that the streamflow forecast nodes (from this piece of the WUO toolkit) match up with the data requirements of the other pieces of the WUO.
- When the WUO is applied at specific sites, will the National Oceanic and Atmospheric Administration (NOAA) provide forecasts, assimilation, etc. to support the ongoing operational setting? If so, make sure that forecasts will be provided at all necessary nodes. Also make sure that these forecasts will be provided frequently enough to support the operational aspects of the rest of the components in the WUO toolkit.
- A very complex approach to a difficult forecasting problem.

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

This project was rated **2.8** based on accomplishments.

- Appears to be on schedule. This is basically a one year funded project. Therefore it is important to build on existing knowledge.
- FY10 milestones have been met.
- FY11 schedule is very ambitious - much to be accomplished in short timeframe.
- Completed Forecast System Design Document.
- Completed evaluation of remote sensing and alternative ensemble forecast methodology.
- Installation of UW/PU forecast system on PNNL computer cluster.
- Ongoing modernization and optimization of core software. Prototype integration of PNNL and UW/PU forecast systems is ongoing.
- The presentation indicates that the hydrologic model is running with assimilation.
- Some progress evident.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Project design identifies considerable collaboration and well integrated with other projects.
- Developers interact extensively with other labs and agencies.
- Not know to what extent results are disseminated.
- Good on-going collaboration.
- Excellent collaboration with NOAA.

- Need to get this model running on the same test basin as the rest of the tools in the WUO toolkit so that forecast information can be evaluated.

Question 5: Proposed future research

This project was rated **2.9** for proposed future work.

- Continual interaction with NOAA and forecasting community in next generation Community Hydrologic Prediction System is laudable. The final integration with other tasks will determine the value of this toolbox development effort.
- Future tasks are outlined. Although go/ no go points are named, barriers and contingencies are not made explicit.
- Will require further work as has been identified.
- May require additional collaboration and checks in addition to that mentioned.
- Need to include evaluation of the calibration of this model in the demonstration basins.
- How are the forecast ensembles going to be generated, stored, and passed along to the other tools in the WUO toolkit?
- Revised plan has been outlined but still does not solve problem. A new approach is needed.

Strengths and weaknesses

Strengths

- The attempt to integrate hydrology modeling with hydro project operations and downstream environmental assessments.
- Good coordination with other agencies.
- Model is extension of earlier R&D that has been tested.

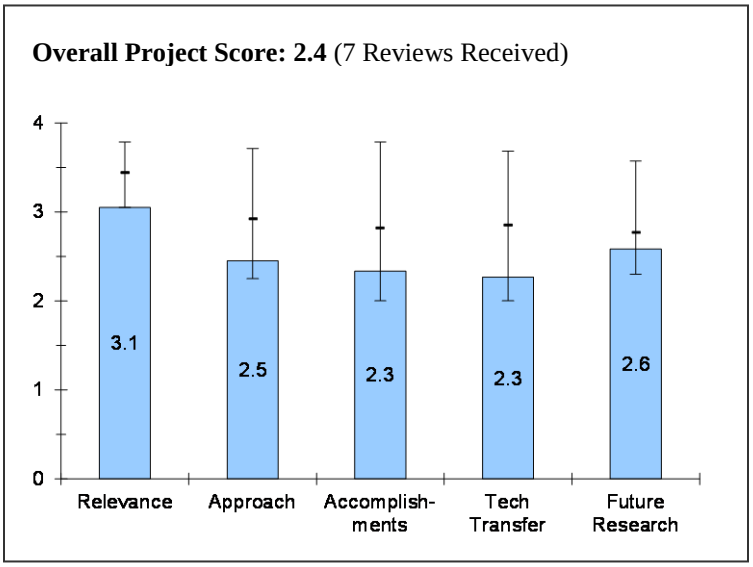
Weaknesses

- Model is data intensive, probably difficult to apply and calibrate.
- It is unlikely that many hydro plant operators would be able to use this tool.
- Not sure how this model will be used in the hydro industry or if it has a place.

Specific recommendations and additions or deletions to the work scope

- Needs analysis to determine what forecasting problems exist and to what extent they have an effect on hydropower.

Project Name: Environmental Performance
John Hayse; Argonne National Laboratory



Brief Summary of Project

This task under the Water Use Optimization (WUO) project will develop tools that consider environmental objectives as part of an integrated suite of models. These tools will allow hydropower facility operators to explicitly consider environmental performance and hydropower value during operational planning to simultaneously consider potentially conflicting objectives and to evaluate different operational scenarios. The task will identify suitable methods for linking hydropower operation and environmental responses, most notably instream flow conditions and environmental parameters. These methods will build on accepted evaluation methodologies and will be applicable to demonstration sites, yet consider different hydroclimatic regions. These relationships will then be incorporated into the integrated toolset by developing algorithms and methods and linking to seasonal and near-term, day-to-day planning models. Finally, the tools will be applied to demonstration sites to optimize operational strategies, evaluate the costs of meeting environmental objectives, and analyze and compare different operational scenarios.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.1** for its relevance to DOE objectives.

- This will add a major and much needed component to river system analytical tools.
- Ability to quantify environmental compliance is important to DOE in the interest of acceptance as a renewable energy. The approach developed here is a limited to fish, i.e., weighted usable area and bioenergetics model. It does not address other environmental needs such as temperature or other purely flow requirements.
- Objectives:
    - Identify suitable methods for linking hydropower operation and environmental responses.
    - Incorporate environmental considerations into the integrated suite of models.
- Integrate with Instream Flows Tasks (CH_MA 4.1.2).
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Appears to be directed to a very specific case with minor transferability.
- This will add a major and much needed component to river system analytical tools.

Question 2: Approach to performing the research and development

This project was rated **2.5** on its approach.

- This has considerable value as a suite of environmental performance models representing present knowledge as part of the tool box. See IFC book case studies on Trinity River, CA (example of integrating the critical components of instream flows) and Terror River. Alaska (example of implementing variable instream flow requirement to pristine river with no determined impact after 15+ years).
- The approach presented is good for fish compliance, but does not address other environmental issues.
- It is unknown what the effect this technique has on the numerical optimization formulation or solution.
- Approach is to identify/develop methods for linking environmental parameters and instream flow conditions.
- Build on accepted evaluation methodologies, applicable to demonstration sites and consider how different hydroclimatic regions integrate with instream flows project (CH_MA 4.1.2). Incorporate relationships into integrated toolset develop and test algorithms and methods link to seasonal and near-term/day-to-day planning models.
- Apply to demonstration sites optimization of operational strategies evaluate costs of meeting environmental objectives analysis and comparison of operational scenarios.
- Not clear if all end users have been considered in developing approach.
- For this type of analysis to be effective, it must be very site specific. It is unclear how the end users will accomplish this.
- Will this part of the WUO toolkit allow users to enter their own evaluation methods?
- Is this a tool or a case study?
- Does not look to be generically applicable without major modifications.
- Seems very ambitious. Be careful of setting too high of expectations. Good step to have.

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

This project was rated **2.3** based on accomplishments.

- Good effort in planning, but much needs to be done to represent the state-of-the-art.
- It is unexplained as to how the large budget through 2010 has been spent. It appears that the majority of effort is yet to be spent with a minority of the budget.
- Integration and planning with other subtasks and projects.
- Preliminary formulations for environmental constraint methods.
- May be behind schedule for the amount of work to be done.

Question 4: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.3** for technology transfer and collaboration.

- Recommend reviewing and building on the IFC efforts in their books outlining the hydrology, geomorphology, water quality, biology and connectivity components of instream flows before presenting project progress during the next IFC conference. See Trinity River, CA case study for examples of seasonally adjusted environmental performance rules as well as water year type (supply based) rules.

- No plans for dissemination of results.
- No collaborations with others doing environmental flows techniques, only with other labs working on other aspects of the toolbox. Also, there has not been a study or needs analysis that confirms the value of this approach.
- Appears to be an integration with ORNL environmental efforts.
- Working with other groups in the WUO tool development -- good.
- User manual or report? How will user figure out how to use this?

Question 5: Proposed future research

This project was rated **2.6** for proposed future work.

- Adequate plans but considerable work remains. Consider including passage indices for sites with riffles/rapids that may become partial barriers during drought or low flow seasons.
- Upcoming tasks are listed, but decision points or barriers have been identified.
- Next steps clearly identified.
- The development of specific methodologies (ie. Weighted Usable Area) is good, but there seems to be a lot of work remaining to get this tool integrated with the rest of the WUO toolkit.

Strengths and weaknesses

Strengths

- Plans to incorporate several environmental performance measures within the overall tool box.
- Incorporate environmental flow targets in hydropower optimization.
- Working with other ORNL activities to support integration of efforts.

Weaknesses

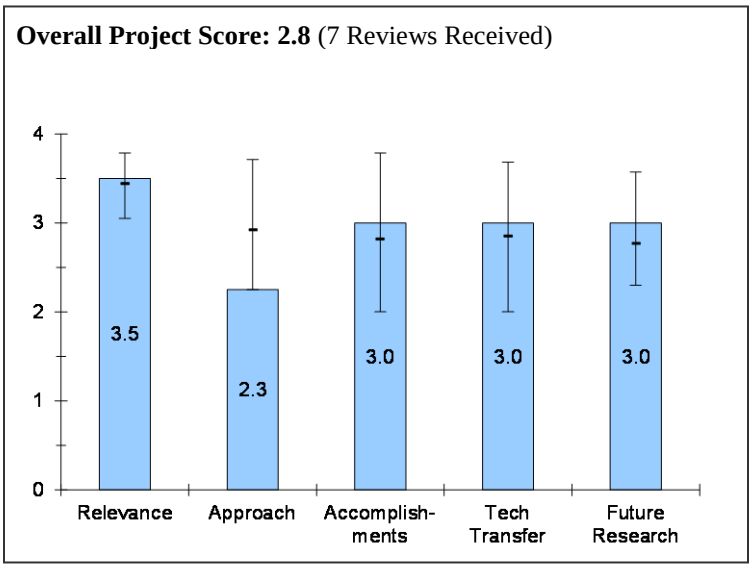
- Appears to be focusing on environmental performance at selected index points in the river. Much better to build in capability to extrapolate from representative sample sites to estimates for the entire river area being modeled. This coverage is needed for fish population modeling as driven by dynamic habitat and temperature conditions.
- Low level of interaction with other agencies modeling environmental flows.
- Needs analysis for modeling environmental flows has not been done.
- Challenges have to do with obtaining site-specific data. Most projects have environmental flows in terms of flow targets. This is likely to be a problem in general implementation.
- Looks to be very location specific, therefore will have fairly limited usefulness to the industry at large.

Specific recommendations and additions or deletions to the work scope

- Recommend that project review U.S. Geological Survey (USGS) efforts (Fort Collins) on habit/temperature driven Chinook salmon modeling done on the Klamat/Trinity river. Also U.S.GS has Salmonid Population Model (SALMOD) applications for both brown and rainbow trout. Review Ch. 13 "Advancing the State of the Practice" in the 2004 book by the Instream Flow Council " Integrated Approaches to Riverine Resource Stewardship". This presents the state-of-the-art for addressing the major components for environmental/instream flows, namely hydrology, geomorphology, water quality, biology (habitat and life history) and connectivity.

- Conduct a needs analysis for modeling environmental flows with hydropower optimization to understand what approach would be useful in a generalized tool.
- Develop and incorporate a communications protocol for dissemination of results.

Project Name: Unit & Plant Efficiency
Brennan Smith; Oak Ridge National Laboratory



Brief Summary of Project

No presentation was submitted prior to the review.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- There is scope overlap with Hydropower Advancement Project (HAP).This is now being consolidated with HAP.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Good project, but stopped as it is superseded by HAP.
- Having a tool is important for the overall Project to work together.
- Make sure HAP produces a plant optimization tool which will by default have unit optimization.

Question 2: Approach to performing the research and development

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

- Currently being revisited with HAP effort.
- The approach was not defined.
- The program needs to define the relationship of this project with the HAP project.
- Will the HAP project provide a tool for the WUO toolkit?
- Not applicable. Project inside HAP.

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

This project was rated **3.0** based on accomplishments.

- N/A

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Fits very well with the other components of the WUO.

Question 5: Proposed future research

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

- Integrate into the HAP efforts.

Strengths and weaknesses

Strengths

- N/A

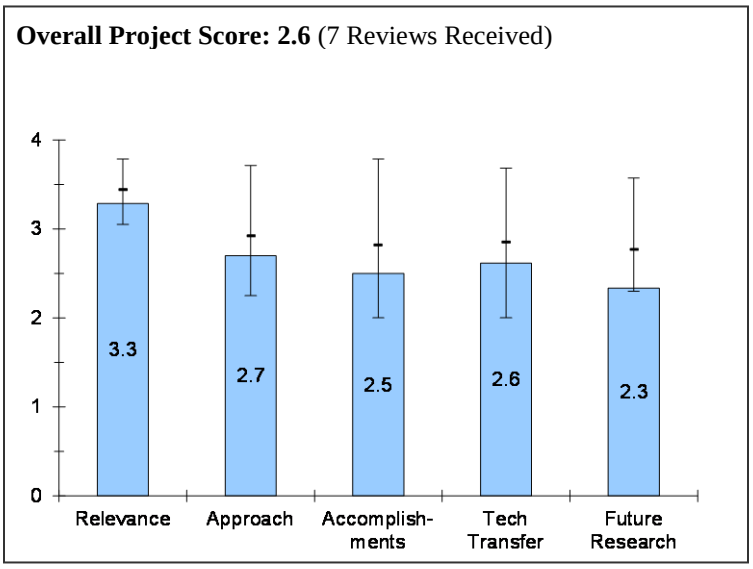
Weaknesses

- N/A

Specific recommendations and additions or deletions to the work scope

- No recommendations.

Project Name: Seasonal Hydrosystems Analysis
Tom Lowry; Sandia National Laboratories



Brief Summary of Project

This task under the Water Use Optimization (WUO) project will create a simulation and optimization tool for seasonal hydropower planning that balances forecasts for energy demand, water availability, and water demand against power generation capacity, operational constraints, competing water uses, and environmental performance of hydropower systems. The task will create a system dynamics model to simulate the effects of reservoir operations on environmental performance. The model will optimize hydropower operations to meet energy, water, and environmental needs. To date, the task has created a reservoir simulation model that simulates temperature and power production as a function of inflows, outflows, and meteorological conditions, and verified and validated the model using historical data from the Willamette Basin in Oregon. Once the simulation model is complete, an optimization approach (either black-box or algebraic) will be selected.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.3** for its relevance to DOE objectives.

- Create a simulation and optimization tool for seasonal to multi-seasonal planning that balances forecasts of energy demand, water availability and water demand, against power generation capacities, operational constraints, competing water users, and environmental performance. This is in line with supporting the objectives of the program by working to increase power production by optimizing operations within the myriad of constraints.
- Allow for rapid evaluation of new technologies and environmental performance as well as evaluate new development within the regulatory framework.
- All programs/projects scored as outstanding. Compared to research programs in other agencies, all programs/projects are well aligned with the DOE and Water Power Program objectives.
- Will provide a better picture of total releases.
- Important to look at other uses of water.
- The tool box development is a critical component of the overall effort.
- The focus is on the DOE objective of increasing total combined heat and power (CHP) capacity. This is perhaps the most potentially useful Resource Assessment project as it is more likely to add hydro to an existing project than to develop a new project.
- There appears to be duplicated effort in the Resource Availabiltiy project.

Question 2: Approach to performing the research and development

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

- Approach is to create a physics-based, system dynamics basic scale model to simulate the effects of reservoir operations on environmental performance. Employ a heuristic approach to optimize operations to meet energy, water, and environmental needs. This is a piece of the larger toolbox, but is designed to run individually.
- Uniqueness of approach focus is in the dynamics between hydrology, competing water needs, energy production, environmental performance, and operations and is scalable from a single project to basin-scale, multi-project systems. Also combines the simulation with multi-objective optimization.
- Model seems to incorporate most of the key short term and long term parameters.
- Unsure if integration with other tools has been assessed by team members.
- Very different approach than the "day ahead" component.
- Similar to the "rapid prototype" method that is used to determine what works and what doesn't.
- Other reviewers had issues with the methodologies that were presented, but it is good to research this.
- "Research models" and "deployable models" are often two different things. Be sure of which type of models you are developing for this project and be sure that expectations are in line with this decision.
- Very complex issue that will be difficult to convert to a useable real-time optimization system.
- Water routing approach not well defined. To be useful must be capable of driving water quality and habitat models throughout the river system of concern.
- There are many technical issues that would affect actual development potential, as the Principal Investigators (PIs) have pointed out. These are difficult to quantify with reasonable accuracy (such as head, flow, environmental issues, etc.). Some thought should be given to what a reasonable level of resource investment is in a first level analaysis. Perhaps initial filter such as head estimate and yield at some reasonable reliability level.
- Quantification of risk/reliability should be included as well as consideration of the potential effects of climate change. It is possible, for example, to estimate a 10-20% decrease in reliable yield due to climate change. Most areas of U.S. have some projections that can be averaged for a representative estimate.
- Again, in this project the practice of not embedding policy in the data (i.e., not filtering out environmentally sensitive sites) is followed in order to have flexibility of analysis in the future.

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

This project was rated **2.5** based on accomplishments.

- Working on two approaches for optimization, however there are pros and cons to each which are currently being assessed.
- It was not clear what progress has been made, so difficult to evaluate.
- Using existing software (Matlab, etc.) – good.
- Would appear that feeding the constantly changing inputs could be an overwhelming task.
- It appears that some 2010 tasks are not on schedule such as the statistical model for streamflow, and that the technical challenges may cause delays in the coming months. The end date of March 2011 seems optimistic.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- This project relies on input from the other sub-projects. Overall, much collaboration is indicated.
- No evidence of collaboration with others except the labs involved in the project. Developers should be aware of other optimization software that is used by the hydropower industry.
- Documentation is being developed, but not necessarily a user's manual.
- Collaborating well with other tasks in the WUO toolbox.

Question 5: Proposed future research

This project was rated **2.3** for proposed future work.

- Not a lot of detail about the "framework." The PI will need more than a common Structured Query Language (SQL) database for the WUO tools to communicate with each other.
- To start testing the WUO, suggest that the PI put some of the climate forecast data ("Hydrologic Forecasting" project) and some stream gauge data into a data base, query it out, and see if this (the "Seasonal Hydrosystems" tool can run with it. Then put the output from this tool into the database. The Hydrologic Forecasting and the Seasonal Hydrosystems tools should be used to R&D the database that will hold all of the tools together.
- Ensembles of meterology are an effective way to deal with uncertainty
- Next steps clearly identified. The integration step with the other tasks will be the significant product.
- Future research needs have been identified well, especially the need to consider climate change and updating the data.
- No decision points or plans for mitigating the risk of not completing the project are given. This is important because there seems to be much work left to do, with little time remaining.

Strengths and weaknesses

Strengths

- It appears that this suite of models would be useful for real time operations given differing seasonal objectives driven by forecasts.
- Heuristic optimization has some excellent advantages, but need more detail on the design.

Weaknesses

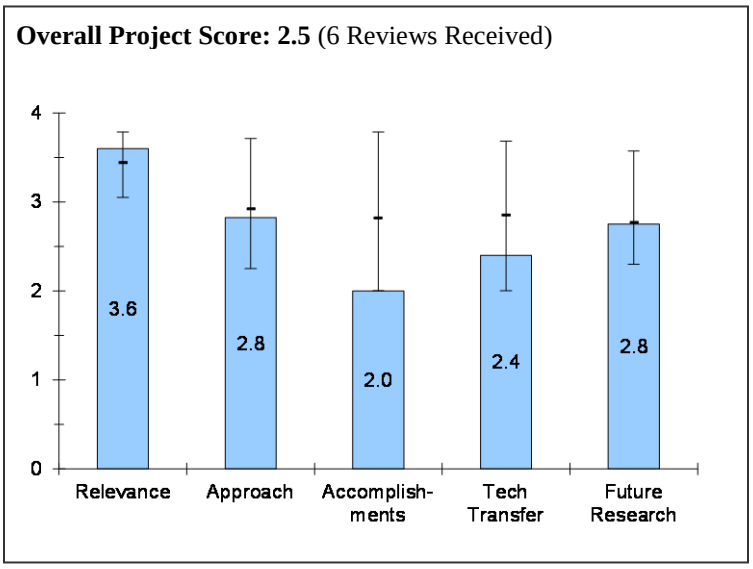
- Needs and design not clear - how will reliability (stochastic output from ensembles) be produced using heuristic optimization? How will hydro plants or units be modeled?
- Need to start thinking about a common way to define the nodes and network among all of the components of the Optimization Toolbox.

Specific recommendations and additions or deletions to the work scope

- As an example of environmental constraints model package should be able to accommodated seasonally variable downstream releases for different water supply conditions. See instream flow schedules implemented on the Trinity River, CA described in the Instream Flow Council 2008 book "Integrated Approaches to Riverine Resource Stewardship".

- Perform a needs assessment in advance of further work on design.

Project Name: Hydropower Advancement Program (HAP)
Brennan Smith; Oak Ridge National Laboratory



Brief Summary of Project

This project will provide the hydropower industry with new information on the costs and benefits of adopting best hydropower practices in order to promote the modernization of existing hydropower facilities. The project will develop a methodology for auditing the performance of existing hydropower projects; identify potential candidate sites for demonstration facility audits; and provide support for a nationwide hydropower energy audit team. The project may also include engineering design studies for modernization efforts at selected facilities, based on the outcome of the reports from the trial audits.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.6** for its relevance to DOE objectives.

- Offered suggestions for this type of work. If there are projects in the Midwest ISO area, should work together as much as possible. This is important information for stakeholders.
- Purpose is to lower cost and return on investment (ROI) uncertainty of operations improvements and equipment upgrades.
- Purpose is to lower cost and ROI uncertainty of operations improvements and equipment upgrades.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Will lead to improved use and more energy.
- Promotes objectives of DOE and is highly collaborative with other agencies.

Question 2: Approach to performing the research and development

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

- The approach sounds reasonable, but needs further scrutiny given the very large budget and fact that no acceptable proposals were submitted.
- Development and Testing of Process, Application of Assessment Process and Detailed Design of Improvement Activities.
- Includes a broad advisory panel of industry, utilities.

- Seems promising, not really far enough along to evaluate.
- Vague about the assessment process.
- HAP team members are good, but such a large team may be difficult to coordinate.
- Did not score because the project just started.
- Determining feasibility as a result of an audit is not the issue (many consulting firms already offer this service). The issue is getting funding or subsidies to make the upgrades more attractive.
- This project has meetings and reports on results.

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

This project was rated **2.0** based on accomplishments.

- The project is behind due to failure to contract.
- Just started.
- First deliverables to be submitted in the next month or two.
- Initial outreach to industry was not as successful as hoped. Will need to revisit approach.
- Just started, so not much progress.
- Did not score because the project just started.
- Just getting started.
- Project is on schedule. Two meetings held so far.

Question 4: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.4** for technology transfer and collaboration.

- No real integration or collaboration thus far.
- Vague.
- Will integrate with Water Use Optimization Project and Grid Services Project.
- Industry engagement is a key part of this project.This will be done in part through coordination with NHA.
- It is good that this project will use the WUO toolbox.
- Engaging with industry, other agencies, MOU partners, etc.
- The project is all about collaboration.

Question 5: Proposed future research

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

- Revised plan has been outlined, but still does not solve problem. A new approach is needed.
- Can see the use of this type of information. Why the commitment to continue the work?
- This is recently integrated with other projects and work just getting underway and team still being pulled together.
- Request for information and and request for proposals were not successful so ORNL reaching out to industry to get information.
- Lots of work still to do.
- Will require lots of coordination with the WUO tool team.
- Anticipated products are very ambitious.

- Is $10M for 50 site assessments realistic?
- More working group meetings in addition to meeting deliverable schedules.

Strengths and weaknesses

Strengths

- If completed, information would be enormously useful.
- Adequate funding to accomplish the goals.
- Provides badly needed analysis.
- It is needed and has potential to stimulate improvements which will add generation capability and address environmental needs.
- Highly collaborative - creates channels of communication and collaborative efforts.

Weaknesses

- No contractor to carry out the work.
- Vague.
- Schedule slipped 9 months because of poor response from industry to the RFIs.
- Just starting.
- Care must be taken to document accomplishments and self-assess progress.

Specific recommendations and additions or deletions to the work scope

- Need an alternative plan.
- Work with those who will work with you and establish ties to the industry.
- Revist approach on industry outreach. Engage with industry leaders to see what approach would work best.

5.0 Conventional Hydropower Market Acceleration Activities

Conventional hydropower contributes significantly to the nation's renewable energy portfolio. The Wind and Hydropower Technologies Program works to assess and quantify the current value of the nation's hydroelectric infrastructure, to assess the environmental impacts of hydropower and to develop new methods to minimize or mitigate those impacts, and to increase the value that hydropower confers to the electricity grid through its ability to integrate other variable renewable energy technologies.

Environmental Impacts and Mitigation
Conventional hydropower can produce adverse environmental impacts on fish populations and migrations, on water quality in reservoirs and downstream from dams, and on river habitats both upstream and downstream from dams. The program works to design, develop, and test new ways of reducing these adverse impacts, which have constrained the development of new incremental hydropower generation and improvements in operational flexibility.

Conventional Hydropower Market Acceleration Goals

FY 50: Increase Capacity by 100 GW

FY 30: Reduce LCOE to $0.07/kWh for powering existing non-powered dams and building new small hydropower.
(Program CH MA are focused on reducing licensing cost and cost of capital)

FY 15: Reduce LCOE of three environmental mitigation technologies identified through FY10 workshop and FY11 FOA

FY 16: Reduce license time in half for projects under 5 MW

FY 10: Hold technology-specific workshops to identify key cost and performance drivers for suite of environmental mitigation technologies

Figure 5.1 Market Acceleration Goals

Areas of focus include:

- Fish passage issues – Research on the passage of fish through and around hydroelectric structures, including development of baseline biological methodologies and data for key species that can be used for improvements in dam infrastructure, such as turbines, fishways, and fish screens that increase fish passage and survival; demonstrations of new technology to determine fishway effectiveness in real-world applications; methods to measure and predict indirect fish mortality and non-lethal injury rates.
- Instream flow requirements – Studies to better understand and predict the effects of variable stream flows on fish and wildlife, especially those that occur downstream of hydropower projects; synthesis and integration studies to gather data from experiences across multiple, existing projects.
- Cumulative impact assessment – Development and demonstration of new methods to predict the cumulative effects of multiple stresses on the fish and wildlife affected by hydropower projects; methods for comprehensive evaluation of all possible routes of fish passage at dams (e.g., turbine passage, fishways, and spillage), for use in optimizing dam operations.
- Environmental performance measurement methods – Development and testing of improved methods for measuring fish passage mortality (direct and indirect) for use in evaluating the performance of advanced turbines.

- Greenhouse gas emissions from reservoirs – Development, testing, and demonstration of methods to measure and predict greenhouse gas emissions from reservoirs at hydropower projects.

Asset Management
Existing hydropower facilities in the United States show signs of deterioration, including declines in electricity generation, capacity factors, and facility availability, but the data to evaluate these facilities, which include both federal and non-federal assets, are scattered and outdated. Integrated and updated information is needed to understand the causes and potential solutions to the large annual variation of hydropower generation.

Grid Services
Conventional hydropower has the potential to increase the flexibility and stability of the U.S. electric grid and to support the integration of variable renewable resources. The program seeks to maximize this potential value by developing and deploying technologies that increase operational flexibility, including pumped storage, as well as the modification of regional computer models to better assess the potential capacity expansion of pumped storage and facilitate introduction of other variable renewable resources into the market.

Table 5.1 below lists the Conventional Hydropower Market Acceleration projects reviewed during the 2010 Peer Review meeting, including the Principal Investigator and budget for each project.

Table 5.1 Conventional Hydropower Market Acceleration Projects

Project Name	Principal Investigator	FY09 (DOE Funds)	FY10 (DOE Funds)	Total Funding	Duration (Years)
Resource Assessment					
National Hydropower Asset Assessment Program	Brennan Smith, ORNL		$500,000	$500,000	1
Pumped Storage	Boualem Hadjerioua, ORNL		$834,000	$834,000	1
Constructed Waterways	Douglas Hall, INL	`	$375,000	$375,000	1
Resource Availability	Douglas Hall, INL		$1.06 Million	$1.06 Million	1
Technically Feasible Generation	Boualem Hadjerioua, ORNL		$589,000	$589,000	1
Economic Analyses and Market Development					
ReEDS Modeling	Walter Short and Andrew Martinez, NREL	$60,000	$165,000	$225,000	2
JEDI Modeling	Suzanne Tegen, NREL	$83,000	$2,000	$85,000	2
DOE-DOI-ACOE-MOU					
Basin-Scale Opportunity Assessments / Green Hydro Certification	Simon Geerlofs, PNNL		$135,000	$135,000	1
Technology Demonstration	Rajesh Dham, DOE-HQ			$98,000	1
Regulatory Process	Gina Krump, DOE-HQ		Not Finalized	Not Finalized	1
Inland Hydro Working Group	Gina Krump, DOE-HQ		No Additional Funds	No Additional Funds	NA
Renewable Energy Integration	Hoyt Battey, DOE-HQ		Not Finalized	Not Finalized	NA
Climate Assessment at Federal	Mike Sale, ORNL		$500,000	$500,000	1

Project Name	Principal Investigator	FY09 (DOE Funds)	FY10 (DOE Funds)	Total Funding	Duration (Years)
Facilities					
Education Programs Overview					
Hydro Research Fellowships	Deborah Linke, Hydro Research Foundation		$852,050	$852,050	2
Hydro Fellowships	John Cimbala, PSU	$1 Million	$1 Million	$3 Million	3
Environmental Performance and Siting					
Environmental Flow Requirements	Mark Bevelhimer, ORNL		$1.04 Million	$3.09 Million	3
Fish Passage Mitigation	Marshall Richmond, PNNL	$300,000	$300,000	$900,000	3
Greenhouse Gas Emissions from Reservoirs	Mark Bevelhimer, ORNL		$350,000	$700,000	2
EPRI Water Power Grid Services					
Ancillary Services Market Analysis	Verne Loose, SNLA		$1 Million	$3.2 Million	2
Effects of Systematic Operating Constraints	Michael Starke, ORNL				
Hydro plant case studies	Pat March, HPPi				
Hydro cost data-based development	Stephen Brown, HDR-DTA				
Modeling of WECC (includes policy scenarios)	Srinivas Jampani, LCG				

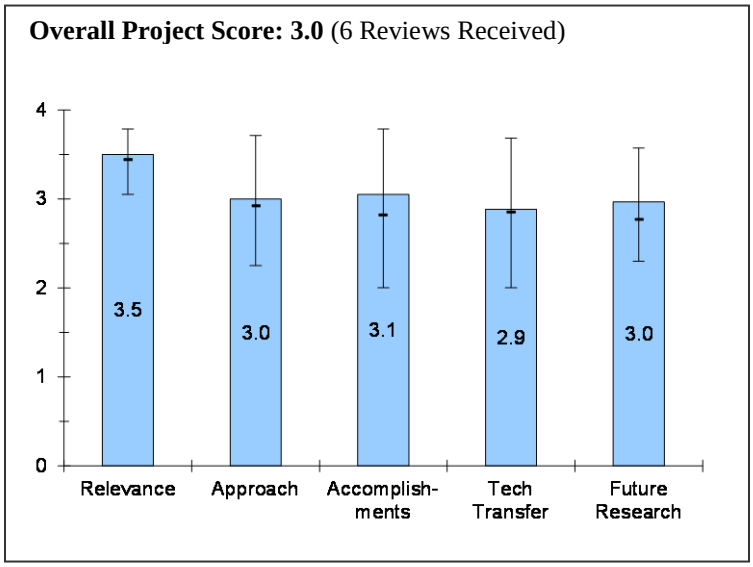
5.1 Conventional Hydropower Market Acceleration Project Evaluations

Table 5.2 below lists the average score per category and the averaged weighted score for each Market Acceleration project that was evaluated by the Peer Review Panel.

Table 5.2 Market Acceleration Project Scores

Market Acceleration Projects	Relevance to Overall DOE Objectives	Approach	Technical Accomplishments and Progress	Research Integration, Collaboration, and Technology Transfer	Proposed Future Research	Averaged Weighted Score
National Hydropower Asset Assessment	3.5	3.0	3.1	2.9	3.0	**3.0**
Pumped Storage	3.5	3.0	2.8	2.6	2.5	**2.8**
Constructed Waterways	3.2	2.8	2.0	2.7	2.3	**2.4**
Resource Availability	3.4	2.9	2.9	2.8	2.5	**2.8**
Technical Feasibility Generation	3.4	2.9	2.8	2.4	2.6	**2.7**
Economic Analysis and Market Development Overview	3.5	3.5	3.5	3.0	3.5	**3.4**
Hydroelectric Modeling in ReEDS	3.4	3.1	2.8	2.5	2.8	**2.8**
Jobs and Economic Development Impacts Models for Water Power	3.2	2.7	2.8	2.9	2.9	**2.8**
DOE-DOI-ACOE-MOU Overview	3.5	3.2	2.9	3.1	2.9	**3.0**
Basin-Scale Opportunity Assessment /Green Hydro	3.1	2.8	2.6	2.8	2.6	**2.7**
Technology Demonstration	3.2	2.6	2.5	2.4	2.5	**2.5**
Regulatory Process	3.6	2.7	2.6	2.8	2.5	**2.7**
Inland Hydro Working Group	3.1	2.9	2.8	3.0	2.7	**2.9**
Renewable Energy Integration	3.4	2.7	2.4	2.6	2.4	**2.5**
Climate Assessment at Federal Facilities	3.5	2.8	2.8	2.9	2.7	**2.8**
Education Program Overview	3.5	2.5	2.8	3.0	2.5	**2.7**
Hydro Research Fellowships	3.7	3.7	3.8	3.7	3.4	**3.7**
Environmental Flow Requirements	3.4	2.3	2.5	2.6	2.3	**2.4**
Fish Passage Mitigation	3.5	3.1	3.0	3.2	2.8	**3.0**
Green House Gas Emissions from Reservoirs	3.3	3.0	2.9	2.9	2.7	**2.9**
Ancillary Services Market Analysis	3.5	3.0	3.0	3.0	2.7	**2.9**
Effects of Systematic Operating Constraints	3.4	3.1	2.8	2.8	2.9	**2.9**
Hydro plant case studies	3.5	3.4	3.0	3.0	2.8	**3.1**
Hydro cost data-based development	3.7	3.3	2.8	2.9	2.8	**3.0**
Modeling of WECC (includes policy scenarios)	3.5	3.0	2.8	3.0	2.6	**2.8**
Hydro Fellowships	3.7	3.7	3.5	3.5	3.4	**3.5**

Project Name: National Hydropower Asset Assessment
Bo Hadjerioua; Oak Ridge National Laboratory



Brief Summary of Project

The National Hydropower Asset Assessment Program (NHAAP) will identify, communicate, collect, organize, validate, and analyze hydropower-related data from various federal agencies in order to support future hydropower research and planning. The NHAAP will produce a Geographic Information System (GIS)-based and query-enabled database of national hydropower infrastructure details (e.g., turbine, generator, rotor, and stator age and rehabilitation potential); a comprehensive, historical hydropower capacity and generation assessment; and an analysis of how hydrologic variability has affected historical generation. As part of the NHAAP, Oak Ridge National Lab (ORNL) has constructed a water power database to integrate a range of external geospatial and power generation datasets; developed a web-based GIS to explore, summarize, and analyze those datasets; developed a water power visualization tool for viewing monthly and yearly power generation graphs and other time series graphs for selected powered dams; and conducted an analysis of the effect of hydrologic variability on hydropower generation by exploring relationships between historical hydropower generation, streamflow variability, and precipitation patterns for the 18 coterminous U.S. hydrologic regions. The product is designed to assess and analyze the existing national hydropower infrastructure and to provide historical data to study and plan for future potential hydropower upgrades and potential hydropower generation increases in the United States.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- This project focuses on the objective of increasing total combined heat and power (CHP) by providing a database to support research and planning. It supports the approach of identifying potential sites for new or enhanced hydro projects and provides general analysis capabilities to DOE. This project is relevant to DOE objectives also in providing a tool and data that can be used by other projects in the program, making them more effective.
- Reliable data appears to be a key to all the projects. This is a foundation project.
- Supports DOE objectives as it forms basis through a database for planning, decision making, policy and development.
- To provide a single comprehensive database that integrates existing assets, undeveloped resources, water availability, and generation patterns tool.

- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Understanding the total resource potential is very relevant to be able to increase the total contribution of conventional hydropower as well as educate policy makers.
- Good value to Policy Makers.

Question 2: Approach to performing the research and development

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

- That it is developed by database experts at ORNL makes it likely to succeed from technical perspective.
- Design and development of the analysis tools does not seem to have a detailed technical plan based on known future needs, although general outputs have been identified. It is recommended that an inventory is developed of possible uses and possible questions to be answered. This could be used both to prioritize data gathering activities and to define the capability of the analysis tools that will access the data.
- Assuming that the worst performing dams would be the first to be upgraded may not be a valid decision. In our business the best benefit to cost ration would get the first money. If dams are used for ancillary services, it may be that the total water volume passed through the turbines is reduced. If a bias is set at the minimum ancillary services output level-probably the maximum energy level- it may be possible to add more generation with the same water volume as was produced for energy and capacity production. Down stream flows would also have to be investigated. This would be on an individual dam basis and that other projects would do the analysis, but how would the database be updated? There is no feedback loop in the diagram.
- Uses federal maintained databases.
- Integrates a good deal of data. However, there may be additional data available that this approach apparently does access. For example, non-Federal Energy Regulatory Commission (FERC) compliance data at FERC was not identified as being retrieved.
- Not clear how much non-federal information is utilized, only compliance data from FERC.
- Does not include Alaska or Hawaii.
- Key to this is the National Water Power Analysis Tools. Would have been good to provide more specific examples/of what exactly this is. The GIS map was good.
- Focus is on building database.
- Information comes from the U.S. Army Corp of Engineers (ACOE), the Bureau of Reclamation (BOR), and the FERC.
- Limited in that users outside Federal Government need to go through ORNL to use dataset. Not available through web based application.
- On the other hand, likely use is only for Policy Makers who would use ORNL to answer their questions anyhow.
- May be usable to draw attention to the Federal Fleet of Hydro Projects by showing that these are not as efficient as they could be compared to Utility projects. May stimulate modernization of cost of energy, U.S. projects through making funds available for modernization of those underperforming assets.

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

This project was rated **3.1** based on accomplishments.

- First phase of project completed this year - on schedule.
- Good documentation and graphics.
- The preliminary NHAAP dataset has been organized.
- Some reports are written.
- Some GIS tools/maps were demonstrated.
- This is hard to score as the project just started.
- Complex assembly of different data sources will require major validation checks.
- Met proposed delivery schedule.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- The database is slated for DOE use only at this time. This could severely limit the usefulness.
- The project utilizes data from many other sources.
- Other projects in the program can benefit from this data.
- Great diagram of sources and users of the data.
- Coordination is needed to collect data therefore integration and communication is a key part of this task.
- Unclear on how information will be disseminated.
- How are these tools to be delivered and to whom?
- Future will be focused on analysis and engaging customers.
- More thought should have been (should be) given to who will use this and why. That could significantly impact the design and implementation of the system.
- Relies on databases created by others. Therefore integrates with them.
- If the main database used by ongoing projects, this project needs to be on schedule.

Question 5: Proposed future research

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

- Next phase tasks have been identified - will continue data collection, improvement of data quality, and new interfaces and decision points have been identified. This is a project whose value very much depends on future funding to extend, maintain and support the use of the database an analysis tools. Are there mitigation strategies that can be adopted in case future funding is not forthcoming under this program? Perhaps alternative funding for maintenance should be identified.
- It is not clear whether the database will be maintained by ORNL or anyone else.
- Public report.
- Data and tools available to Federal clients.
- Lots of proprietary data.
- ORNL will support technical aspects of this project.
- Ongoing maintenance issues need to be addressed and are being considered now.
- Database maintenance required.

Strengths and weaknesses

Strengths

- Ambitious in terms of variety and extend of data and analysis tools; and high chance of technical success.
- Potentially useful to meet DOE objectives for analysis and planning.
- Serves a need of many.
- Objective is to provide a baseline for industry.
- Builds on existing software and tools.
- An excellent tool for the education of policy makers.
- Cleans up databases and consolidates them. Provides visibility to bad data.

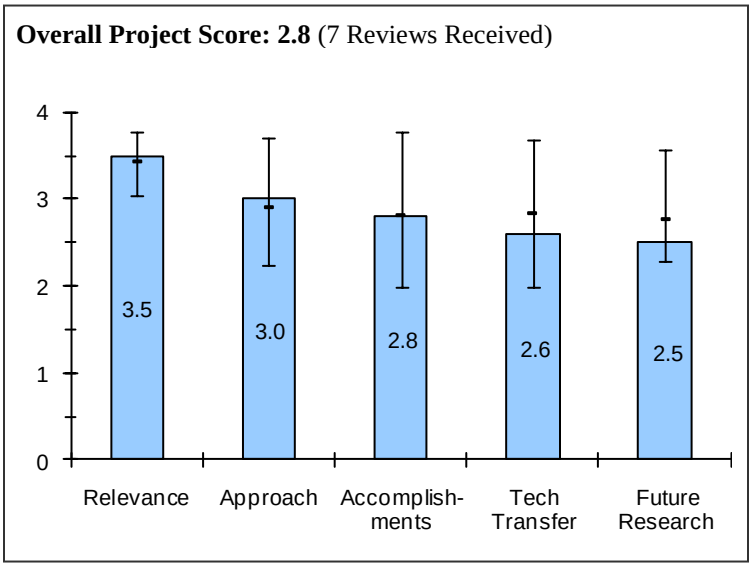
Weaknesses

- Data will not be shared with others outside of DOE.
- Design of analysis tools need more thought.
- Future support funding is critical to success; contingency plans should be considered.
- Continuity.
- Does not include Hawaii or Alaska.
- Non-federal information. Not clear on how much is utilized.
- Unless the system is constantly updated, the proprietary and dynamic nature of some of the data sources will make it difficult to keep the outputs up to date.
- Potential overlap with other projects.
- Usable only by ORNL or DOE.

Specific recommendations and additions or deletions to the work scope

- Compilation of potential uses of the database and list of analysis capabilities motivated by these uses.
- Some way to track projects that have been implemented or recommended.
- Develop a clear communications protocol for results.
- Finish on time and maintain. Use it to influence policy.
- Evaluate its use in three years to decide on future continuation.

Project Name: Pumped Storage
Brennan Smith; Oak Ridge National Laboratory



Brief Summary of Project

The Pumped Storage Hydropower Resource Assessment will identify the technical and readily developable potential for new large- scale pumped storage hydropower facilities in the U.S. The goal of this study will be to identify areas and potential sites best suited for large-scale (greater than 100 MW) pumped storage hydropower development given current technology and project development configurations as well as market conditions, and then to assess the costs of various development scenarios. The project will produce a report assessing the technical development models, costs and site characteristics of existing and planned pumped storage hydropower facilities, detailing the sites and areas in the U.S. where such facilities could be developed, and analyzing the costs and potential environmental impacts of such developments. The project will construct GIS data layers encapsulating all of the above information for incorporation into a geo-referenced resource assessment database. The project will also analyze characteristics of energy, capacity and ancillary service markets in the regions with pumped storage hydropower potential in order to identify incentives or barriers that might help or hinder pumped storage hydropower project development. These products will allow users to assess the amount of energy storage that could feasibly, technically and most cost-effectively be developed at a national level, as well as in regions and at specific sites, and the potential for environmental impacts.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- Product/reports will be valuable for promoting Pump Storage projects.
- Addition of large pumped storage facilities could significantly increase hydro generation - this project support that goal.
- This project is quite broad in terms of analyzing all factors and identifying sites and determining the cost is certainly needed.
- Pumped Storage is important for regional and national integration of renewable energy.
- Purpose is to identify the technical and readily developable potential for new large scale pumped storage hydropower (PSH) facilities in the U.S.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

- Okay for making info available to Policy Makers.
- Likely most good sites already identified by developers, utilities.

Question 2: Approach to performing the research and development

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

- Perhaps looking at only conventional pumped storage is too limiting with regards to real potential; consideration of other forms of pumped storage, e.g., compressed air storage, could add much value to this study.
- The scope seems quite ambitious to be accomplished in such a short timeframe.
- If the size, generation hours, efficiency etc are known, there are programs that could determine the use and estimated revenue that could be used to sort sites in an area by benefit/cost ration. Programs would also provide estimates by year of the amount of pumped storage that could be used economically. Also the pumped storage could be forced into the system. The value of the pumped storage being forced into the system versus the economical expansion might be used to determine subsidies to incent pumped storage to run. The Renewable Energy Development System (ReEDS), EGEAS model (EPRI), Strategist (ABB), etc. are capable of providing economic screenings without too much expense. National databases exist (for a fee) that allow the existing generation fleet to be modeled with existing transmission modeled in a transportation model (areas are circles joined by sticks-transmission power transfer capability between regions). This information would help with the reservoir to generation ratio specifications. If the sites are in the Midwest ISO area, we will run the screens for you. Studies of this type are what we do. Specification of pumped storage sites is almost impossible for us to obtain.
- This deals with costs for pumped storage. Another effort funded by DOE being performed by EPRI will deal with value of pumped storage. These two efforts should have some level of coordination.
- Does include environmental aspects.
- GIS is the appropriate tool for this spatial analysis.
- This approach can work well at the national and regional scale, but there may not be enough resolution in the data sets for detailed site analysis.
- Is pumping energy considered?
- Good approach. Coordination with cost investigation by EPRI Hydro Value to Grid needs to be made if not planned to avoid duplication of work.
- Wind/Hydro coordination also being evaluated in EPRI project.
- Seems like a lot of budget considering how much it overlaps EPRI project.

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

This project was rated **2.8** based on accomplishments.

- Project is on schedule.
- Project recently begun. Some accomplishments to date.
- Just started.
- Has completed literature review, analysis of FERC permits, preliminary market assessment.
- Did not score because the project just started.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- How does this effort interface with PD-06?
- Data will be gathered from other organizations, but no indication that results will be shared outside of DOE.
- Integration into National Hydropower Association and Resource Assessment Database planned.
- As noted above, the value of the information being produced could be formed into a general forecast by year of pumped storage facilities that may be candidates for given areas with a benefit to cost evaluation. If pumped storage is not chosen economically, then a forced schedule could be used to determine the level of incentive (subsidy) required to have the pumped storage built.
- Ultimately would like to provide information to policy makers.
- No clearly defined external communications protocol.
- Will receive input from industry and consultants.
- Engaging industry consultants -- Are these potential customers?
- "Why are there no pump storage projects?" Answering this question seems to be the critical point.
- Coordination with other renewable research (wind development areas and potential) is needed to determine the benefits in economically quantifiable terms. Pumped storage is a great reliability resource but not without cost. Clear revenue streams must be established and understood before anyone will undertake such an investment. Without these investments, grid reliability could be at stake.
- Coordinate with EPRI must be made if not already planned.

Question 5: Proposed future research

This project was rated **2.5** for proposed future work.

- Effort toward non-hydro reservoirs not yet started?
- No decision points, barriers or mitigation strategies have been proposed.
- Not defined.
- There are specific tasks identified but not clear on integration with other DOE tasks.
- Time line is very specific and seems feasible.
- Scope seems good, not over ambitious.
- Not visible from material presented.

Strengths and weaknesses

Strengths

- Concept is good and product could potentially be useful for DOE objectives. The study proposed to look at all the factors relevant to potential pumped storage development.
- Produces data that is almost impossible to obtain for an RTO.
- A good tool for the education of policy makers on the potential of pumped storage.
- Supports Policy Makers.

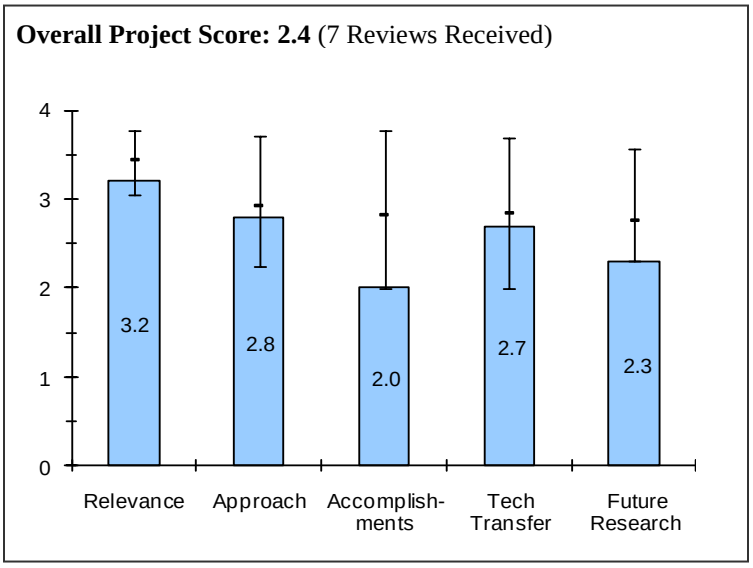
Weaknesses

- Complicated information gathering required in very short timeframe and no mitigation strategies have been articulated for failure to realize objectives in the given timeframe.
- Realistic future potential to pumped storage could lie significantly in non-conventional forms such as compressed air or mine storage; these should be considered at some point.
- Lack of a plan to use the information to move to the evaluation or construction of a plant.
- Is $834,000 too expensive?
- The vast majority of these sites have already been "discovered" by developers who are seeking clarity of regulations and long term market rules before investing.
- Lots of budget with much of project being in the EPRI project.

Specific recommendations and additions or deletions to the work scope

- Ludington (Michigan) has supplied expansion data to us. There is an iron mine south of St. Louis that has been looked at by Ameren for pumped storage. Gregory County in SD was investigated to preliminary design by WAPA or the Corp of Engineers (Upper Missouri River Basin) and the State of South Dakota. CAES estimates are much lower than pumped storage. It could be because no one has build a hard rock CAES and the costs are too optimistic.
- Develop a clear communications protocol to disseminate results.
- Recognize EPRI project work and adjust budget and apply the savings on other programs.

Project Name: Constructed Waterways
Doug Hall; Idaho National Laboratory



Brief Summary of Project

The objective of this project is to assess the gross power potential of selected representative assets and facilities of four types of constructed waterways, namely canals and aqueducts, domestic water supply systems, waste treatment effluents, and industrial effluents, to determine their viability for electricity generation. The project will use three-dimensional flow path information to identify locations with significant hydraulic head, in the case of canals, and to access the available hydraulic head, in the case of the other three types of constructed waterway. For domestic water supplies, it is used to identify locations of pressure suppressors that could be replaced with turbines. The project will then couple hydraulic head data with corresponding flow duration data to compute annual average power and power durations on a weekly or monthly scale. The objective of this pilot study is to evaluate untapped sources of water energy that could add to the hydroelectric supply with little or no environmental impact. If the sources are found to be viable, the study's results will make development opportunities visible to asset and facility owners and private developers and will lay the groundwork for a nationwide assessment.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.2** for its relevance to DOE objectives.

- Products will be useful.
- Supports DOE goals inasmuch as it could identify potential sites for new hydro development.
- Useful in providing flow duration data.
- This is a pilot project and is not planned to achieve a comprehensive outcome.
- Purpose – to demonstrate power potential assessments of various types of constructed waterways
- Consistent with DOE Water Power Program objectives.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Supports increasing the total contribution of conventional hydro plants to the renewable energy portfolio.
- Supports the aspects but may not show much hydro energy generation potential.

Question 2: Approach to performing the research and development

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

- Looks feasible.
- The purpose of the study is to develop methodologies for assessing HP on constructed waterways and to understand the scope of a nation-wide assessment. The approach addresses only the first part of this. How will the investigators estimate the scope of the nation-wide assessment?
- In what form will the information from this study be preserved and presented?
- Provide an economic screening for the top candidates found the Midwest ISO area if the generation parameters can be determined. Other than identification, cannot see the information being used to produce projects unless someone reads the report and determines to pursue the project.
- Incorporation of a pilot study in concept is a good approach.
- How is uncertainty handled?
- This effort will require coordination with ORNL from a related Program effort.
- Lots of work to put data sets together.
- Interesting project.
- Like the fact that the PI is working with the U.S. Bureau of Reclamation and their specific canal system.
- Consider uncertainty of water supply?
- Will be interesting to see results.
- Gross head will overestimate power potential. Could be lots of head loss in the systems resulting in small net head available for producing power-a consequence of the existing waterways. Would be good to provide for some estimate of Net Head.
- Is only using a few projects, but this is okay to set up an approach.

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

This project was rated **2.0** based on accomplishments.

- No score given as project just initiated.
- No progress to date. It is not understood why the project has been delayed 4 months because of lack of technical staff.
- Not started.
- Effort just underway so limited achievements to date.
- Did not score because the project just started.
- Not rated due to late start.
- Just getting started.

Question 4: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.7** for technology transfer and collaboration.

- No score given.
- Will support the MOU by providing Reclamation information about potential HP development.
- Assessment will make development opportunities visible to asset and facility owners and private developers.

- Use of the data other than a report is not clear.
- Effort just underway.
- Collaboration U.S. Bureau of Reclamation (BOR) on pilot study. Very good. Data from/about BOR canal used.
- Seem to have an outside partner.
- Collaboration not obvious.

Question 5: Proposed future research

This project was rated **2.3** for proposed future work.

- No score given.
- Given that this is a pilot project, there should be a potential plan for implementing the full scale project. It is only if this is done that the pilot will be useful. There are no decision points in the schedule.
- Again this seems like a terminal task. The information is in a report.
- Just underway so there are a number of steps to be completed.
- Time line seems viable.
- Just getting started.

Strengths and weaknesses

Strengths

- A potential strength is to produce assessment effort and techniques needed to accomplish a full analysis of HP potential on constructed waterways.
- May identify projects no one thought about.
- Scope of work seems in line with cost.
- Suspect that some of the review panel scored this project low because of their hesitation over the technical merits. That aside, still likes these types of projects where big data sets (developed by others) are pulled together and analyzed. Can get a lot of bank for the buck.
- Provides additional data to policy makers.

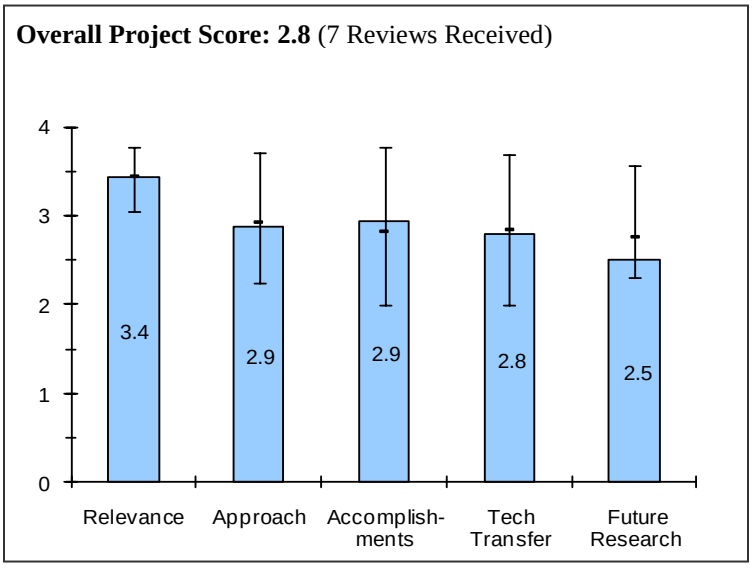
Weaknesses

- Methodology does not fully support objectives in terms of gaining an understanding of the scope of a nationwide assessment.
- Inadequate progress has been made on the project to date.
- The budget seems large compared with the scope.
- Potential integration with others has not been defined.
- Personnel were not available so needed to hire staff before starting effort.
- Hard to get information on constructed waterways. No central location for information to search.
- May not be a lot of low hanging fruit in this area due to poor economics if not subsidized. Cost of project ($375K) may not be commensurate with the deliverable values.
- Likely not a lot of energy there.

Specific recommendations and additions or deletions to the work scope

- Project has much potential.
- Plan is needed for gaining understanding of scope of the nationwide assessment. How will this be done?
- Scope should include a plan for maintenance and presentation of the data and access by others.
- Meet scheduled tasks.

Project Name: Resource Availability
Doug Hall; Idaho National Laboratory



Brief Summary of Project

This project will assess the gross power potential at non-powered dams and greenfield sites on natural streams, and to identify candidate sites for new pumped storage hydropower plants. For non-powered dams, the project will assess gross power potential by coupling an estimate of available hydraulic head, obtained Army Corps of Engineers (ACOE) data or GIS analysis of surrounding topography, with an estimate of the annual average flow rate at the dam, obtained from U.S. Geological Survey data or the Idaho National Laboratory (INL) and the Oak Ridge National Laboratory (ORNL) hydrologic models. For greenfield sites, or stream reaches that are not part of an existing hydroelectric plant and are not the site of an existing dam, gross power potential will be estimated using two development models: a damless small hydro model, and a development model incorporating a dam. The project will couple stream reach hydraulic head with an estimate of stream reach average flow rate to obtain an estimate of power potential. For pumped storage hydropower sites, the project will use GIS analysis to identify existing water bodies in proximity to existing hydroelectric plants, non-powered dams, and greenfield sites on natural streams that might serve as upper reservoirs for new pumped storage hydropower plants. For all three types of sites, the geographic locations and site attributes produced by the assessment will be incorporated into the Virtual Hydropower Prospector for public access. This project will provide policymakers with an assessment of the gross power potential of untapped sources of water energy that could add to the hydroelectric supply, and with little additional environmental impact in the case of non-powered dams. Project results will provide also inform the Technically Feasible Generation project, conducted by ORNL, which will identify the environment issues surrounding potential projects and estimate the cost of development and cost of electricity production.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.4** for its relevance to DOE objectives.

- Focuses on DOE objective of increasing the total contribution of conventional hydropower plants. Also provides data (potential sites) for bringing new hydropower technologies into commercial readiness. The project supports the following approaches: feasibility studies to identify additional opportunities (including policy scenarios) and decision tools to assess integrated planning/operational decisions.
- Objectives are most highly relevant for potential development of non-power projects.

- Appears to duplicate scope of Pumped Storage and Technical Feasibility of Generation Projects.
- Identifies sites that may not be being considered for development.
- Identify and assess non-powered dams, greenfield sites, and sites for new pumped storage plants that can potentially add to the national hydropower generating capacity.
- Consistent with DOE objective, but not sure why INL is doing this and not ORNL.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Understanding the total resource potential is very relevant to be able to increase the total contribution of conventional hydropower as well as educate policy makers.
- Good to firm statistics for Policy Makers.
- Most developable projects are in sights of developers. Economics are dependent on competing energy sources. When economics change, developable potential changes - example, Ohio River Bulb projects were in sight for many years, but only recent economics triggered their go. Today, that may be in question again with cheap gas. Carbon tax again will change the mix.

Question 2: Approach to performing the research and development

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

- How does this effort relate with PD-04?
- What at first seemed like a flaw - not filtering the waterway selections for environmental sensitivity - turned out to be strength in that it is not embedding policy implicitly in the selection of sites.
- 30 years of data may not be enough to accurately represent hydrologic potential. Also some uncertainty of should be included as well as thought about potential effects of climate change. It is possible for example to estimate a 10-20% decrease in reliable yield due to climate change. Most areas of US have some projections that can be averaged for a representative estimate.
- Good to my limited understanding of how this is done. If sites in the Midwest ISO area are identified, we would evaluate the top candidates economically if you could provide us the data.
- Seems to be duplicative to a certain degree with ORNL efforts. Expect that these two entities will be coordinating closely.
- GIS techniques for analysis: good.
- How is this different than the "National Hydropower Assessment" and "Pumped Storage" projects (agenda items 3 & 4)? Is there duplication of effort here?
- Non-powered dams assessment: is average annual flow rate good enough for your study?
- Estimating hydrology at all points of interest is a big job; estimating heads is a big job too.
- This is a lot of work to identify sites & characterize them.
- There has been a lot of hand work to QA/QC the required spatial data sets.
- Good, but gross head being estimated. Net would be better, but is dependent on developed solution chosen.
- Pumped storage at existing dams could be stimulated by this work and its resulting awareness.

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

This project was rated **2.9** based on accomplishments.

- Accomplishments and results reported relate to first milestone - development and validation of NPD dataset. Some difficulties in the results were reported.

- Budget goes only through 2010, but work continues to end of 2011. Also, there is no funding for ORNL in the budget, yet ORNL is described as playing an important role in the work.
- Upgrade of the Virtual Hydropower Prospector was accomplished. (This should be listed as a separate item in the budget).
- INL produced NPD dataset using USGS synthetic hydrography – ORNL validation revealed. erroneous coupling of small dams with large streams, INL produced NPD dataset using medium resolution hydrography and average flow rate estimates from U.S. Geological Survey National Hydrography Dataset (NHD), co-funded upgrade of the Virtual Hydropower Prospector.
- Did not score because the project just started.
- This project represents a lot of work and should be watched to make sure that it stays on time/budget.
- Not rated. Work not started yet.
- Just getting started.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Not clear how this interfaces with PD-04. Information to be provides by each lab is identified, but no real discussion of how the two labs will collaborate. Focus on non-power dams is duplicative.
- The described integration is in support of other projects in the program. How will the information be made available? To whom?
- The role of the Virtual Hydropower Prospector is not described well. Is this the ultimate platform for all the results of this project? Or what is its role?
- Other than lists, do not see the information proceeding to a project unless someone reads the report and takes action.
- Results will go public on web based tool.
- Virtual Hydropower Prospector is used to deliver information generated by this project.
- Not sure who the collaborator/customer of this product is.
- Is highly dependent on collaboration and this is pointed out.

Question 5: Proposed future research

This project was rated **2.5** for proposed future work.

- No score given as this project is just started.
- Scheduled extensions of the work are proposed for greenfield site assessment, extending geographic area, refining hydraulic head estimates.
- No decision points or discussions of barriers or potential risks to the project, which seem considerable both from perspectives of technical approach and volume of information involved.
- This looks like a terminal project.
- Next steps have been clearly identified.
- Very ambitious time line/budget.
- This project should be watched to make sure that it stays on time/budget.
- Hard to assess as this is just getting started.

Strengths and weaknesses

Strengths

- Potential for providing much useful information to other projects and also for planning and policy scenario studies.
- Upgrade of the Virtual Hydropower Prospector may be a benefit; it appears to be a useful tool.
- Does not presume policy in selecting sites.
- Good prospect of identifying prospective projects.
- Good for Policy Makers.

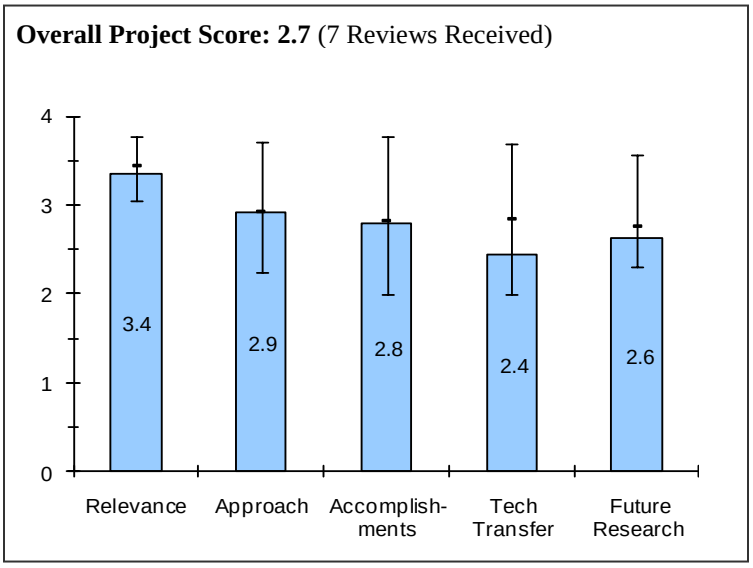
Weaknesses

- This project appears to duplicate the Pumped Storage project and the Technical Feasibility of Generation (NPD) project.
- The budget does not reflect the collaboration with ORNL nor the work on the Virtual Hydropower Prospector tool. This should be addressed.
- Hydrologic analysis does not quantify risk/reliability nor climate change.
- Plan to move information to projects.
- QA/QC. Not sure if best approach for ORNL and INL to be QA/QC each other. Is it truly an independent QA?
- This is a big project. Not sure that the timeline and budgets are big enough.
- Potential overlap with other projects.
- Just getting started.

Specific recommendations and additions or deletions to the work scope

- This and PD-04 should have been combined as one joint project with a clear division of labor of labor between the two labs. How and who is responsible for the final product?
- The hydrologic analysis both greenfield and existing non-powered dams should be done with quantified reliability and climate change impacts considered.
- Refine budget to explain all work and collaborations.
- Explain how it is not a duplicate effort of the Pumped Storage and Technical Feasibility of Generation (for NPD) projects. Either clarify the distinction or remove the scope from this project.
- Incorporate a communications protocol for results.
- Consider consolidating efforts with other like projects.

Project Name: Technical Feasibility Generation
Brennan Smith; Oak Ridge National Laboratory



Brief Summary of Project

This project will assess the amounts of new hydropower energy that can be developed in the U.S. by installing electric generating capacity at existing non-powered dams. The project will use the Army Corps of Engineers' National Inventory of Dams to identify non-powered dams, using the U.S. Geological Survey's High-Resolution National Hydrography Dataset to improve the accuracy of dam locations. The project will use National Inventory of Dams data to estimate hydraulic head, and U.S. Geological Survey data to estimate flow rates. Environmental and economic assessment will be performed to raise the accuracy of the estimates. Project accomplishments include the production of a statistical model to assess monthly, seasonal and yearly variability of streamflow, and the creation of preliminary capacity potential estimates for the U.S. These preliminary estimates suggest that the top 50 non-powered dams have over 60% of the national potential for new generating capacity. Project results will help promote the development of new hydropower generation and strategic planning for future hydropower development.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.4** for its relevance to DOE objectives.

- This project focuses on the DOE objective of increasing total combined heat and power (CHP). This is perhaps the most potentially useful of the Resource Assessment projects as it is more likely to add hydro to an existing project than to develop a new project.
- There appears to be duplicated effort in the Resource Availability project.
- Objective is to assess the amounts of new hydropower energy resources which can be developed in the U.S. by powering existing non-powered dams Identifying best sites for new development of non-powered dam candidates
- Seek for suitable and "easy" alternatives minimize or improve environmental impacts.
- Consistent with DOE objectives.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Development of environmental indices rather than complete rejection screening should help make more informed cost/benefit decisions.
- First, but most developable sites likely currently in sights of developers and utilities.

- Good for Policy Makers, but perhaps not for Industry except through new policies to stimulate development.

Question 2: Approach to performing the research and development

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

- The identification that hydrologic data is a fundamental need is laudable. This project could greatly advance the understanding of systems through demonstrations of hydrodynamic modeling through a river basin. Demonstrate the importance of understanding the hydrology as the driver in assessing cumulative effects among multiple projects as well as the determinate of water quality, habitats and aquatic well being throughout a system. Such a demonstration would promote the use of simulations for evaluating possible future siting.
- There are many technical issues that would affect actual development potential, as the PIs have pointed out. These are difficult to quantify with reasonable accuracy (such as head, flow, environmental issues, etc.). Some thought should be given to what a reasonable level of resource investment is in a first level analysis. Perhaps initial filter such as head estimate and yield at some reasonable reliability level.
- Quantification of risk/reliability should be included as well as thought about potential effects of climate change. It is possible for example to estimate a 10-20% decrease in reliable yield due to climate change. most areas of US have some projections that can be averaged for a representative estimate.
- Again, in this project, the practice of not embedding policy in the data (i.e., not filtering out environmentally sensitive sites) is followed in order to have flexibility of analysis in the future.
- Seems appropriate but not clearly articulated.
- Site selection methodology is good.
- Flow estimation methodology seems reasonable.
- Not sure about head estimation, is this accurate enough?
- Logical approach given available data.
- Environmental and Cost integration will be challenging.

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

This project was rated **2.8** based on accomplishments.

- Appears on track.
- It appears that some 2010 tasks are not on schedule such as the statistical model for streamflow, and that the technical challenges may cause delays in the coming months. The end date of march 2011 seems optimistic.
- Some work completed.
- Updated the existing geospatial assessment of non-powered dams, validate locations, screen for development feasibility, August 2010. Aggregate existing GIS-based environmental information, August 2010.
- Produce a statistical model to assess monthly, seasonal and yearly variability of streamflow, Aug. 2010.
- Did not score because the project just started.
- In progress.
- Environmental and cost integration will be challenging.

Question 4: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.4** for technology transfer and collaboration.

- It appears that the information will be limited to DOE. Why not make it available to industry, other agencies and the public?
- The apparent overlap with other projects is not explained.
- The analysis results from this study will be integrated into ORNL Water Power GIS to provide a way to map existing and undeveloped resource in river basins. However, it is not clear as to how the results will be communicated to the public or end users.
- Is this different than the "Resource Availability" project?
- National/regional type of assessment, not really site by site. This eliminates some of the need for a multi-objective type analysis.
- Coordination is anticipated and is key element to allow success.

Question 5: Proposed future research

This project was rated **2.6** for proposed future work.

- Future research needs have been identified well, especially the need to consider climate change and updating the data.
- No decision points or plans for mitigating the risk of not completing the project are given. This is important because there seems to be much work left to do, with little time remaining.
- Next steps are identified.
- Good plan/time line.
- $589K seems good.
- Identified, but challenging and let’s see how the difficult part develops.

Strengths and weaknesses

Strengths

- Provides data that could be used to develop hydropower without new projects; it would provide enough/relevant data to make realistic assessment of potential sites.
- Good to support policy.
- Adds environmental considerations to the mix.

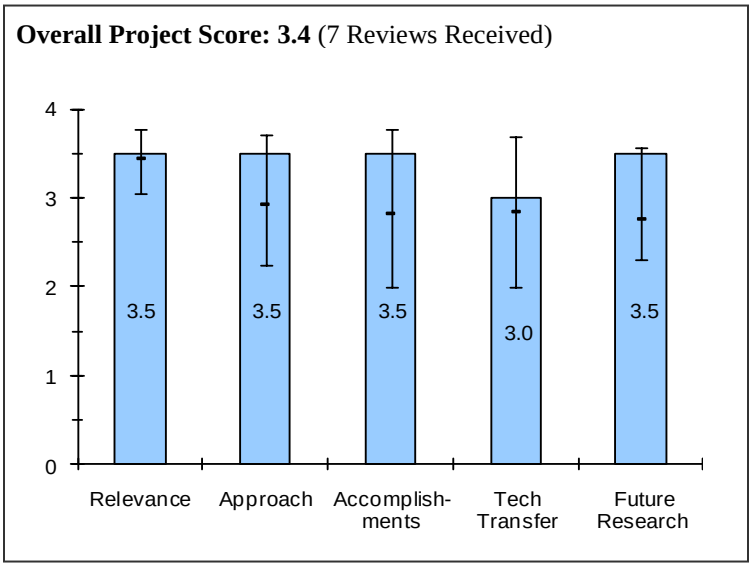
Weaknesses

- Little description of environmental assessment approach.
- Many technical difficulties and complications in analysis to make the data really useful. Needs to consider compressed air options and better analysis of flow including climate change.
- Appears to duplicate work in Resource Availability project.
- Potential overlap with other projects.
- Likely not so useful to developers.

Specific recommendations and additions or deletions to the work scope

- Increasing hydro development as well as improving efficiencies will require cumulative analyses throughout river basins. This project could greatly facilitate such system wide efforts through integrated modeling and simulations.
- Add risk/reliability to analysis and outcomes.
- Reconcile apparent duplication with Resource Availability project.
- Develop and incorporate a communications protocol for dissemination of results
- Consider consolidating efforts with other like projects.
- Keep going. Meet deliverable schedule.

Project Name: Economic Analysis and Market Development Overview
Hoyt Battey; U.S. Department of Energy Headquarters



Brief Summary of Project

The Water Program funds projects to model and quantify the costs and benefits of hydropower generation and to ensure that national energy models accurately represent hydropower.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- Covered in the program worksheet.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Comments rolled into Overall Evaluation.

Question 2: Approach to performing the research and development

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

- See PD-09 and PD-10.
- Really liked both of these models. They seem to be quite useable and useful.

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

This project was rated **3.5** based on accomplishments.

- Both modeling efforts seem to be moving along very well.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Differ to PD-09 and PD-10 for review.
- Identification of specific end users and what they will be doing with these models would benefit this project.

Question 5: Proposed future research

This project was rated **3.5** for proposed future work.

- Both projects seem to have clear ideas about the work to be done in the future.

Strengths and weaknesses

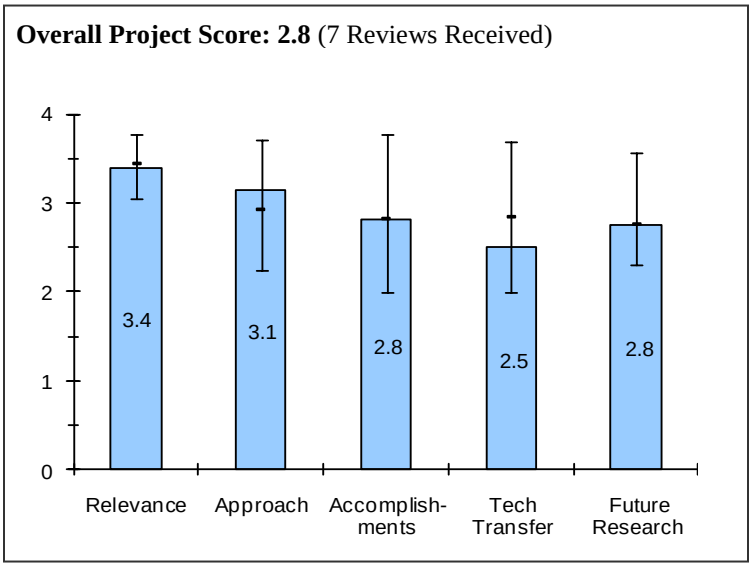
Strengths

Weaknesses

Specific recommendations and additions or deletions to the work scope

Project Name: Hydroelectric Modeling in ReEDS

Walter Short; National Renewable Energy Laboratory



Brief Summary of Project

This project will incorporate new hydropower capacity potential and improve the representation of hydroelectric power and pumped-storage hydropower, especially of its dispatch flexibility, in the Regional Energy Deployment System (ReEDS) model. ReEDS is a capacity and transmission expansion model of the United States electricity sector that models the integration of different electricity generation technologies into the national electric grid by minimizing total system cost within a set of constraints. The project entailed gathering and implementing the appropriate data and constraints to enable ReEDS to more accurately assess the potential of hydropower and pumped-hydro storage and better represent their operational characteristics. The project incorporated resource supply curves for new run-of-river hydropower and pumped-storage hydropower, developed using geographical information pertaining to stream and river reaches (for new hydropower) and using FERC licensing applications (for new pumped-storage hydropower). The project also explored hydropower operations by implementing new or modified constraints to better understand the importance and role of hydroelectric generation on a national and regional level. Sensitivity scenarios were developed to illustrate different aspects of hydropower operation and the interconnection between hydropower's operational characteristics and other generation technologies. The inclusion of hydropower resource potential into ReEDS ensures that hydropower is included in future scenario discussions and studies, and allows the examination of the potential of different hydropower technology options.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.4** for its relevance to DOE objectives.

- This project focuses on the DOE objectives of increasing total hydropower and of reducing barriers to development having to do with expense and regulation. It achieves that by including hydropower in NREL capacity expansion model which can be used for planning and policy analysis. Of particular interest: sensitivity analysis to evaluate flexibility of hydro power operational constraints.
- Potential to assess the value of hydro in providing operating reserves for variable resources like wind and solar.
- Potential to examine the national potential of hydro and pumped hydro storage at a fine regional level
- Identification of National scenarios and initial screening of data input to more detailed Interconnection studies such as EWITS2 and EIPC, also WECC and Texas through DOE/OE studies

would tie hydro goals to utilities involved in the studies. Additional feedback to policy would be provided by the study. The Hydro programs would provide the input for futures (generation cost, fuel assumptions, and other assumptions) or generation scenarios. The cost to penetrate the market could be obtained from these studies if hydro is forced into a generation scenario or future. Usually futures have a generation forecast that is optimized for a particular set of assumptions. Scenarios are usually sensitivities on a generation forecast.

- The purpose is to improve the representation of hydroelectric power and pumped-hydro storage technologies in NREL's Regional Energy Deployment System (ReEDS) model, a multi-region, national, electric sector, capacity expansion model.
- Consistent with supporting DOE Water Power Program objectives.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Gets Hydro more accurately into ReEDS.
- Helps Hydro Policy Makers.

Question 2: Approach to performing the research and development

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

- This model addresses some simplifications in earlier analysis such as fully dispatchable hydropower?
- Not enough detail provided about the methodologies. Results indicate that hydro run of river assumption is not accurate. Data for model needs refinement. Results are inconclusive.
- Will use INL/ORNL information from previous tasks. Supports consistency.
- Sensitivity analysis to find out if "expensive" data is required -- good.
- Seems like a good integration with other projects/evaluation of other energy sources.
- Add simulation capabilities for hydro and pumped storage to Reeds (already existing) model. This is building on and adding capability to work that has already been done.

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

This project was rated **2.8** based on accomplishments.

- Sensitivity study is behind schedule due to data gaps. However, preliminary supply curves were developed for a range of regions and future based on fully dispatchable hydro assumption.
- Ran operational sensitivity scenarios.
- Developed supply curves
- Plan is good
- Evaluations based on historical and drought scenarios -- good.
- Model is running and producing output for evaluation -- good.
- Identify shortcomings in ReEDS.
- Showed some results in presentation.
- Started original plan. Keep it moving.

Question 4: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.5** for technology transfer and collaboration.

- NREL and public dissemination of R&D.

- There seem to be obvious overlap with other projects in the program, specifically in the Resource Assessment project, but this is not addressed.
- Identification of relevant data sources is going to be addressed by DOE - it seems very late in the process for this step.
- How will the results of this project be used by the other projects? This should be clarified.
- Industry and DOE/OE collaboration could be increased. The cost of study would not increase. The cost of communication would increase.
- Will work with ORNL/INL in future.
- What is the plan to get this model to those who could benefit from using it?
- Who is the customer/user of this system? Lots of potential, none mentioned?
- Use cases should be developed for potential customers/users of these systems to help guide development and make sure that their needs can be addressed by these systems.

Question 5: Proposed future research

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

- Proposed over-guidance work with other labs, to obtain data is laudable.
- Future seems to be in improving model with improved data - necessary to make the project worthwhile.
- There are no decision points nor risk mitigation plans.
- Okay if communication of results is to reside in DOE reports and circulated between National Labs. The policy impacts could be amplified by producing the hydro inputs for the DOE/OE studies.
- Next steps were identified however, there seemed to be lack of specific timing and expectations.
- Good plan to add additional useful functionality.
- Identified in the plan.
- Technically challenging and big effort to get it - budget may be questionable. Value may also not fit with budget needs.

Strengths and weaknesses

Strengths

- Include hydro in capacity expansion models and reflect value of hydro for other renewables. This could be a benefit for future policy decisions.
- Produces enlightening information about future possibilities for hydro in an environment of competing resources. Estimates of market penetration prices rather than $/kWh could be produced. The market penetration prices are probably location specific and probably do not reduce to one overall number.
- Will add pumped storage.
- Cost effective: Seems like a lot of work being done for not much money.
- Improves Hydropower modeling in the ReEDS system.

Weaknesses

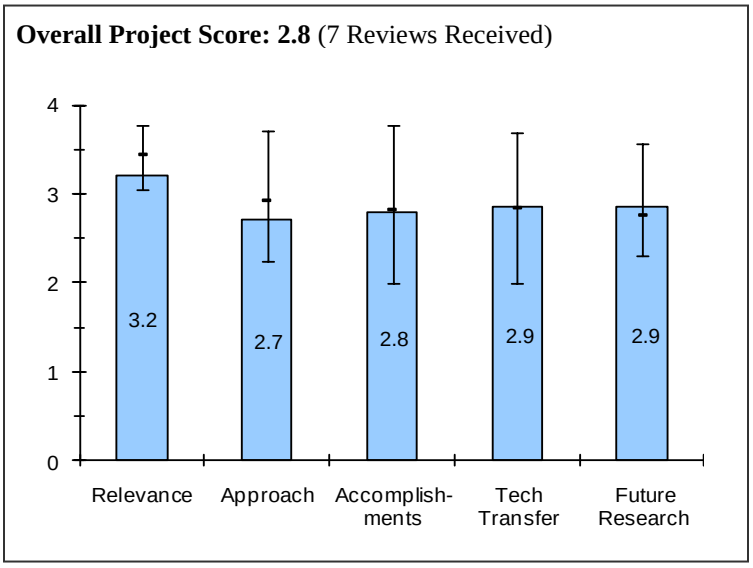
- Data gaps and modeling simplifications need to be overcome.
- Integration with other projects is not apparent but is essential for success.
- The potential use of the information that can be produced is not realized in the present scope.
- Currently only includes expansion of run of river.

- Not clear how the results of the hydro expansion modeling would be turned into actions by whom.

Specific recommendations and additions or deletions to the work scope

- Decision points and contingency plans for failure to meet goals under current budget.
- Coordinate with DOE/Office of Electricity on the interconnection-wide studies. Hydro should have a fair evaluation. The current processes treat hydro with minimum growth.
- Incorporate a communications protocol to disseminate information.

Project Name: Jobs and Economic Development Impacts Models for Water Power
Suzanne Tegen; National Renewable Energy Laboratory



Brief Summary of Project

This project will develop two models for estimating the employment and economic impacts that could come from future electricity generation from water power, both hydropower and marine and hydrokinetic energy. NREL will work with its partners to develop two Jobs and Economic Development Impact (JEDI) models, one for hydroelectric and one for marine and hydrokinetic power. JEDI is a user-friendly spreadsheet-based model that estimates the economic impacts – jobs, earnings, and value of energy output – of constructing and operating power generating facilities. Currently, no model to estimate these data exists that is affordable and available to the public. The new JEDI models will support the acceleration of water power deployment by providing important economic impact information to stakeholders and policymakers.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.2** for its relevance to DOE objectives.

- JEDI modeling necessary for some purposes like state priorities and ARRA funding.
- Governors weigh heavily the value and visible recognition of jobs and projects in their states for wind. The JEDI type information is being used but the source is state universities or wind advocacy groups. JEDI data for hydro should be made available to governor staff and governor organizations such as the Midwest Governors Association and the Western Governors Association.
- The new JEDI models will support the acceleration of water power deployment by assisting stakeholders and policymakers with important economic impact information.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Important because policy makers are interested in creating jobs and DOE would be viewed as a more objective and credible evaluator than a consultant hired to compile the same information for use by the hydro industry.
- Will provide information for policy makers about jobs and other economics.

Question 2: Approach to performing the research and development

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

- The methodologies seem inherently inaccurate and impossible to verify.
- The wind information has made a powerful impact. Whether hydro information will have a similar impact depends on whom and how many times governors hear the information and believe it is in their interests to use it.
- Assesses impacts to jobs and other economic parameters.
- Peer reviewed as part of their internal process.
- Good proven approach (5 years).
- Hard to get/estimated data.
- Missing link to National Hydropower Association (NHA) and Conventional Hydro datasets for new hydro at existing dams.
- Includes a whole suite of models, wind, gas, coal water, etc.

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

This project was rated **2.8** based on accomplishments.

- Progress is held up by lack of data.
- Conventional hydro model still in development.
- Using the Marine and Hydrokinetic (MHK) model as a template.
- Model is working.
- Methodology for developing data sets is established.
- Report in peer review.
- Takes into account construction, material supply, induced (secondary) jobs and earning.
- Presented an example screen shot.
- "Defaults" are based on previous studies.
- Missing link to NHA and Conventional Hydro datasets for new hydro at existing dams.
- Industry would support.
- Good external reviews.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Peer review, sharing with stakeholders, and access to final models on DOE website.
- How will results be used?
- There needs to be a plan to disseminate the information. Presently, a report appears to be the end product.
- Creation of model requires outreach to gather appropriate data.
- Product will be placed for public use on DOE web site.
- Models have web site and are downloadable.
- Need to coordinate better with those who can use the output for decision making.
- Something missing.
- Will be available to the public.

Question 5: Proposed future research

This project was rated **2.9** for proposed future work.

- At this point, future plans are simply to catch up and complete current work. Perhaps future work will be identified later.
- Next steps clearly identified.
- Time line looks good.
- Get data needed.

Strengths and weaknesses

Strengths

- Strength in collaboration and peer review.
- The creation of job numbers is very important to governors.
- User friendly model.
- Consistent methodology to compare economic effects.
- Cost effective: Seems like a lot of benefits for not much money.
- Objective good.
- In addition to labor impacts and supply chain impacts project will address induced impacts, ancillary jobs, etc.

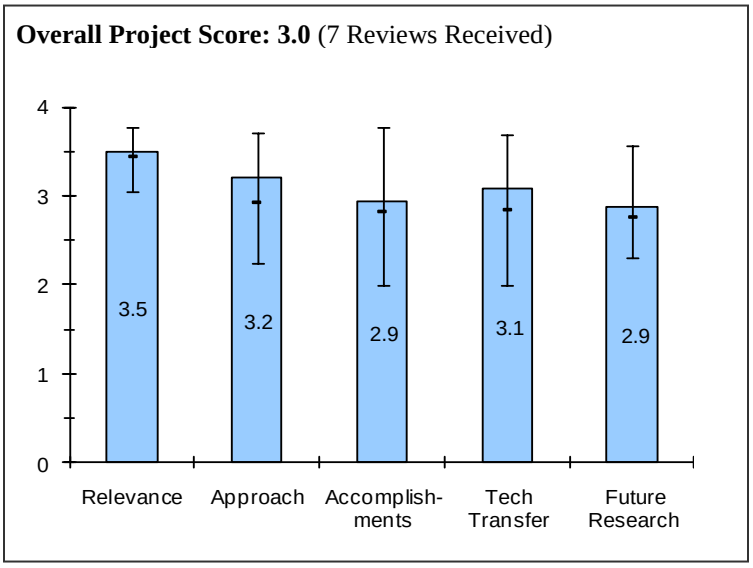
Weaknesses

- Lack of data that has prevented project success.
- Lack of a plan to get the jobs information into the hands of governors.
- Conventional hydro data hard to get. Still in the process of gathering data.
- Model validation for new U.S. hydro construction will have limited data points but this should not stop the estimating process.
- Execution in terms of getting available data.

Specific recommendations and additions or deletions to the work scope

- Produce a plan to put the information into the hands of the industry lobbying group who could distribute the information to governors and their staff. The information may also be important at the congressional level.
- Will need additional funding for ongoing maintenance.
- Industry would support.

Project Name: DOE-DOI-ACOE-MOU Overview
Hoyt Battey; U.S. Department of Energy Headquarters



Brief Summary of Project

On March 25, 2010, the Department of Energy, the Bureau of Reclamation in the Department of the Interior, and the U.S. Army Corps of Engineers signed a Memorandum of Understanding (MOU) to cooperate and align priorities in order to support the development of environmentally sustainable hydropower. This MOU will create a partnership of key federal agencies to prioritize hydropower development in the U.S. as a clean, renewable, and reliable energy source. The key initiatives undertaken by DOE under this MOU include: an assessment of climate change impacts at federal hydropower facilities; a basin-scale hydropower opportunity assessment; a federal inland hydropower working group; technology development and demonstration; renewable energy integration and energy storage activities; and regulatory analysis of private development at federal facilities.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- This group of projects under the MOU focuses on DOE's objectives to increase hydropower and reduce the barriers to new development. It addresses a multitude of barriers including public power prices, lack of markets, limited incentive to research and demonstrate advanced technologies, competing water uses, environmental barriers, limited policy support, and time-consuming permitting.
- It supports many program approaches including feasibility studies to identify and publicized additional low-cost, advanced technology opportunities, and generation of data to more accurately correlate generation and water use with environmental impacts.
- The projects are focused on the needs of the incumbent hydro users. This is good as they know the business. The overall impacts can be determined on environment by summing the outputs of the projects with totalizing information supplied by ReEDS for carbon reduction and other pollutants. The impact of the hydro community on the overall generation fleet and environment can be determined. Impacts besides money measured merits are addressed.
- The Hydropower MOU initiatives create a partnership of key federal agencies to prioritize hydropower development in the U.S. as a clean, renewable, and reliable energy source. The MOU will facilitate a collaborative approach with Bureau of Reclamation (BOR), DOE, and the Army Corps of Engineers (ACOE).

- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Potential of the MOU is good. Coordinates information to help look existing policies and develop improved policies.
- The MOU among the ACOE, BOR, and DOE is excellent in that it stresses throughout that new hydro must be sustainable and maintain healthy river ecosystems. Focusing private development toward federal facilities may be where future development is most feasible.

Question 2: Approach to performing the research and development

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

- The approaches include collaborations, meetings, studies, and an important review of permitting processes (See comments on individual project reviews).
- The MOU has 7 action items in order tackle the larger issue of developing hydropower at federal facilities:
    - Climate Change Assessment
    - Green Hydropower Certification
    - Basin Scale Opportunity Assessment
    - Federal Inland Hydropower Working Group
    - Technology Development and Demonstration
    - Renewable Energy Integration and Energy Storage
    - Regulatory Analysis of Private Development at Federal Facilities
- It would be most helpful to describe the flow of information among these component studies. What info, who delivers what to whom, what entity is responsible for final integrated products from the labs. At first exposure appears to be much overlap and duplication. This would be clarified by better description of the different roles of each lab. Also collaboration with projects PD-035 thru PD-040 seems desirable.

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

This project was rated **2.9** based on accomplishments.

- Although the projects are mostly on schedule, there is much going on and monitoring would be recommended.
- Hydropower technology workshops were completed focusing on market needs and the potential for innovative advances/cost reductions in the areas of (1) Small Hydropower, (2) Environmental Mitigation Technologies, and (3) Pumped Storage. The workshops were completed in FY10. These will help identify key areas of R&D that would benefits MOU agencies.
- A Request for Information (RFI) on specific technologies that could be demonstrated and deployed at federal facilities was released in August 2010.
- Several workshops were conducted. It would be helpful if findings from each were discussed and how influenced project.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- This project exceeds in collaboration and is likely to have much integration with other projects.
- Information kept within the hydro community.
- These efforts will require coordination between agencies and power producers which will enhance each others understandings of respective roles in the industry.
- The seven different projects together offer much promise for promoting private development. It is difficult to judge each study in isolation. Better as an entire integrated package. Fear that what is typical for independent studies is for seven reports to be completed and perhaps some effort "after the fact" will try to pull them together.

Question 5: Proposed future research

This project was rated **2.9** for proposed future work.

- Most projects are looking forward to meeting schedules, but have not considered failure, decision points or contingency plans.
- Will depend on how coordination moves along and the needs identified by the parties.
- Project just getting started, but proposed work considered seems good.
- Too early to judge.

Strengths and weaknesses

Strengths

- This is a real opportunity to collaborate with other agencies in overcoming many of the institutionally-driven barriers to increase hydropower. A many-faceted approach has been identified that addresses the multitude of barriers from various perspectives. The variety of approaches and issues increases the likelihood that some real benefits will be realized from this effort.
- Opportunity for demonstration projects.
- This effort should facilitate private development on or in conjunction with Federal facilities.

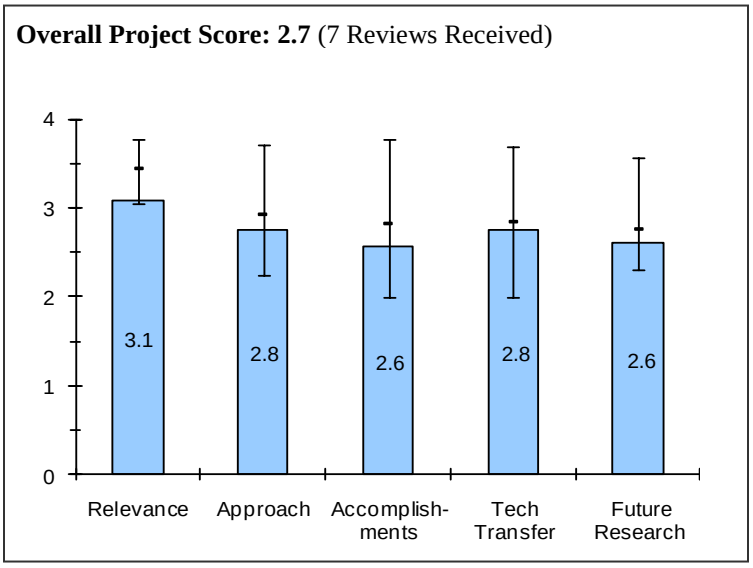
Weaknesses

- Much of the project activities center on meetings and reports. It is essential to constantly monitor the progress and identify explicitly the goals and accomplishments, or the shortcomings with respect to expected results. Also constant documentation of the approaches and their efficacies should be made.
- These sets of projects were very difficult to follow lacking 2 page descriptions and combined power point. However, the MOU description and write-up passed out later cleared up many questions. It would have been better if the five sub-projects had been simply identified as tasks under the DOE-DOI-ACOE MOU. Significant findings to date and work yet to be done for each task and the general approach for each would be sufficient.

Specific recommendations and additions or deletions to the work scope

- Weaknesses for recommendations.
- Including Compressed Air Energy Storage with a water regulating reservoir would probably double to quadruple the amount of hydro generation. This may affect future funding and coordination with other renewable researchers and utilities.
- Need to make sure the correct individuals are involved representing each party.
- Revisit from time to time who the end users of such efforts are and check to see that such efforts will apply to end users.
- Get it done.
- Perhaps focus all seven efforts on one or more basins to demonstrate the collective information that can be brought to bear.

Project Name: Basin-Scale Opportunity Assessment/Green Hydro
Simon Geerloffs; Pacific Northwest National Laboratory



Brief Summary of Project

This project represents one of seven initial action items resulting from the Memorandum of Understanding (MOU) for sustainable hydropower development between the Department of Energy (DOE), the Bureau of Reclamation (BOR), and the Army Corps of Engineers (ACOE). Opportunity assessments would emphasize sustainable low-impact or small hydropower and identify ecosystems or river basins where hydropower generation could be increased while simultaneously improving biodiversity and environmental quality. These assessments would integrate environmental protection and restoration with hydropower generation and optimization opportunity analyses at the systems scale to identify specific actions that could achieve both hydropower and environmental protection goals across a given river basin. Assessments would leverage existing DOE modeling and GIS expertise, as well as non-DOE approaches developed by industry and environmental non-governmental organizations. Models and data would be applied within a basin through consultation with basin stakeholders to develop an assessment of opportunities for both additional hydropower generation and environmental improvements within the river basin. Assessments would present basin stakeholders with scenarios that identify actions that could be taken to achieve the dual goals of improving environmental conditions and increasing hydropower generation within the basin. By leveraging system scale modeling and information tools, opportunity assessments would provide information that could inform future basin scale planning processes.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.1** for its relevance to DOE objectives.

- This project serves to reduce barriers to new development by engaging stakeholders. It also helps to identify resources and address technology/policy needs to maximize longer-term opportunities.
- Useful in watersheds where there has been little or no planning and where no relicensing are currently ongoing.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Great objectives.

Question 2: Approach to performing the research and development

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

- The goals seem well defined - to develop methods/processes for basin-scale assessment that can be applied in any/many basins. However, it is not clear that the approach will result in the desired approach. In fact, the technical approach is not clearly articulated. It appears to be series of practice experiences that result in some generalizations. Also not clear who will use this when the study is complete.
- Need to be clear on what the focus is for rapid assessment.
- Need to also make sure that this effort if implemented in a watershed does not further burden the licensing or permitting process for any hydropower projects.
- How is this different than the Resource Assessment activities?
- Even though this project is not very far along, the presentation was vague about the approach.
- This project would be best evaluated after some work has been done in the case study basin.
- Sounds vaguely like a re-licensing process. Economics must be a significant consideration.
- Approach well stated.

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

This project was rated **2.6** based on accomplishments.

- Much activity - workshops, agreements, committees, lit review and conference, all according to schedule.
- Hydropower MOU, signed March 24, 2010.
- Formation of Basin Scale Steering Committee.
- Scoping Workshop, April 2010.
- Preliminary identification of basins.
- Background research and literature review— Oak Ridge National Laboratory (ORNL).
- Presentation and panel at Hydrovision in July.
- September 8-9, Tools and Methodologies workshop.
- Did not score because the project just started.
- Would be good if a basin was selected.
- On track. This project could gain from working with the toolbox development projects PD-035 thru PD-040.
- Will be interesting to read report of first workshop which is apparently not yet written.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- This project is all about collaboration and technology transfer. However, integration opportunities with other projects are not clear.
- High likelihood for collaboration.
- Could the study basin selected for this project be used as a case study for the Resource Assessment projects?
- Scores high because of the MOU collaboration with Federal Hydropower producing agencies. This is a good thing and may help to bring focus to the entire project.

- Identified that collaboration was difficult and time consuming.
- Highly dependent on collaboration.

Question 5: Proposed future research

This project was rated **2.6** for proposed future work.

- Future is mostly completing case study assessments.
- Selecting an initial case study basin.
- Did not score because there is no budget, no plan yet, so this is very hard to evaluate.
- Case study is not selected.
- Hard to separate basin scale planning from the success of this assessment.
- Choice of basin for demonstration will be vital. Goal of integrating technical tools for "win" "win" scenarios for both hydro and the environment is ambitious and certainly should be done in collaboration with the PD-035 thru PD-040 projects that are building a toolbox for such assessments.
- Let's evaluate when we see some results.

Strengths and weaknesses

Strengths

- System level analysis, cooperation and collaboration among agencies and stakeholders.
- Good to have stakeholder collaboration in watersheds where it is needed.
- Inexpensive (so far).
- Brings coordination where little existed previously.
- May bring funds to ACOE projects which have had little, and where units are clearly showing strongly degraded energy production.
- May bring water quality improvements to ACOE facilities where budgets only were there for maintenance.

Weaknesses

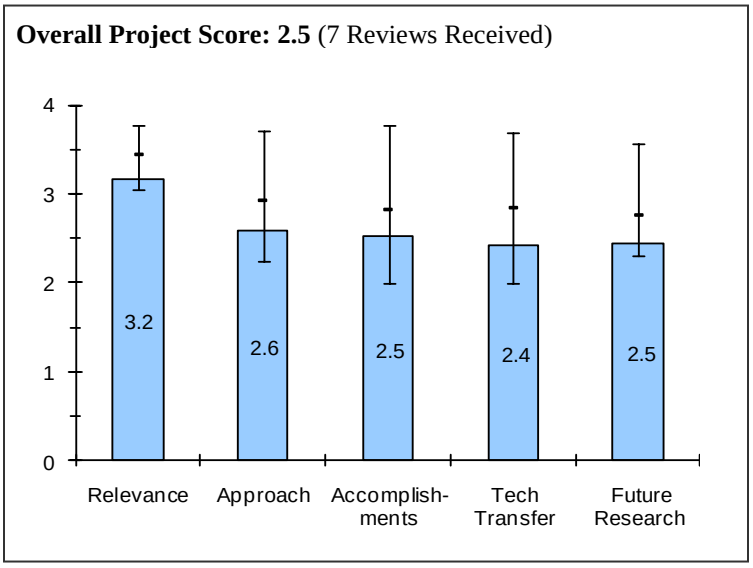
- Outcome (product; deliverable) not well defined. Difficult to develop a methodology that works well for any system.
- Concern may be if implemented at same time there is a licensing effort ongoing in the same watershed, unless applicant supported such activity.
- Danger in getting a successful and meaningful outcome.

Specific recommendations and additions or deletions to the work scope

- Define the ultimate use of the outcome of this project. Clarify distinction between planning and assessment.
- Need to be sensitive to licensing that may be ongoing that have already started their own collaborative process with stakeholders.
- Develop and incorporate a communications protocol for dissemination of results.
- Consider choosing a river basin demonstration effort jointly with the toolbox development group.
- Keep it moving!

Project Name: Technology Demonstration

Rajesh Dham; U.S. Department of Energy Headquarters



Brief Summary of Project

Under this memorandum of understanding (MOU) task, The U.S. Department of Energy (DOE) hosted a series of three hydropower technology workshops to discuss market needs and the potential for innovative advances and cost reductions. The three technologies discussed were small hydropower, environmental mitigation technologies, and pumped storage hydropower. The workshops identified potential technologies for development, as well as the policy and cost barriers associated with the lack of development. These accomplishments will help identify key areas of research and development that would benefit the MOU signatory agencies. As part of this task, DOE also issued a Request for Information on specific technologies that could be demonstrated and deployed at federal facilities.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.2** for its relevance to DOE objectives.

- Meets objectives of DOE to engage regulators and stakeholders. Purpose is technology workshops to identify factors that are barriers to hydro development and to identify potential innovations in cost reductions, environmental mitigations, and new development.
- The slides were combined and it is hard to tell which slides went with which evaluation tab.
- Technology development and deployment at federal facilities is supportive of program goals and objectives.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- This low funded project (just staff time) has worthy goals, if achievable.
- Lots of ideas exist. Identify and implement them.
- Summits good start, but falls short of defining project opportunities.
- Does the public provide guidance requested in identification of opportunities?
- Is the request for information (RFI) providing information expected, or does the process need push by DOE to sharpen input?
- Is the RFI only way to get input? Could DOE convene a group of technical consultants to help?

Question 2: Approach to performing the research and development

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

- Hold workshops to identify issues that are barriers to development.
- Plan demonstration projects.
- Not clearly articulated in presentation.
- Assume that the 3 workshops were effective.
- Effectiveness and outcomes resulting from workshops remains to be seen.

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

This project was rated **2.5** based on accomplishments.

- Three workshops were held.
- Challenge in finding funding for joint demonstration projects and scoping without knowing future funding levels.
- Three hydropower technology workshops were completed focusing on market needs and the potential for innovative advances/cost reductions in the areas of (1) Small Hydropower, (2) Environmental Mitigation Technologies, and (3) Pumped Storage. Will help identify key areas of R&D that would benefits MOU agencies.
- A Request for Information (RFI) on specific technologies that could be demonstrated and deployed at federal facilities was released in August 2010. However little response.
- Not much to evaluate here, but the outcome of workshops was Request for Information on specific technologies.
- Measures of success are not clearly defined.
- Hydro product designers and manufactures have many ongoing R&D programs focusing on product improvement.
- Technology products in many cases being used overseas but not in U.S. due to conservative industry and current hydro market.

Question 4: Research Integration, Collaboration, and Technology Transfer

This project was rated **2.5** for technology transfer and collaboration.

- Collaboration is key element.
- Will require information transfer on resources and potential projects.
- Publish report.
- Work with the other agencies to identify Federal facilities for demonstration projects.
- Scores high because of the MOU collaboration with Federal Hydropower producing agencies.
- The budget for Technology Demonstrations are not clear.

Question 5: Proposed future research

This project was rated **2.4** for proposed future work.

- Challenge in finding funding for joint demonstration projects and scoping without knowing future funding levels.

- Would provide for identification of potential future projects for federal facilities.
- Not sure how effective this approach will be or the actions that it will drive, if any.
- Dependent on uncertain funding.

Strengths and weaknesses

Strengths

- Collaborative processes.
- Will identify potential projects for enhancing hydropower opportunities.
- Identifies opportunities and missing technologies.

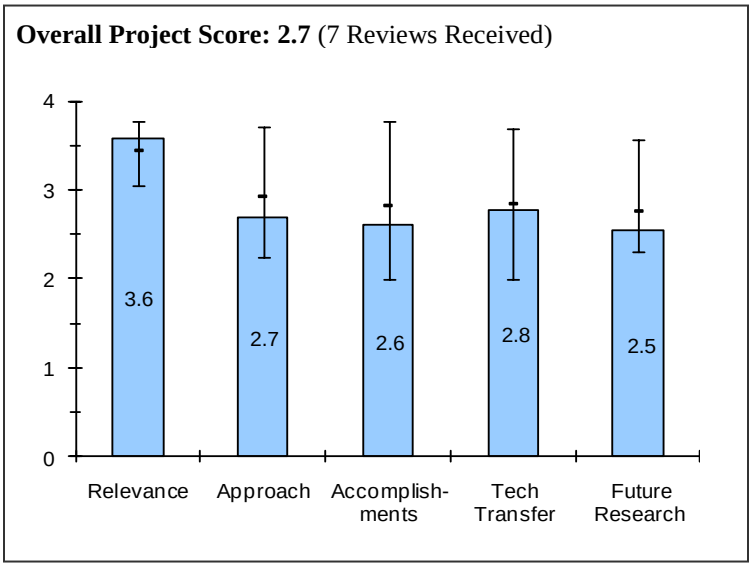
Weaknesses

- Difficulty in defining and implementing demonstrations that will be useful.
- Uncertain funding.
- Develop and incorporate a communications protocol for dissemination of results.
- The RFI may not be well addressed by industry.

Specific recommendations and additions or deletions to the work scope

- Generate a prioritized list of demonstration projects, each with estimated funding levels that can be used to make decisions about future project funding and/or can be used to define the scope once the funding is determined.
- Get the Peer reviewers active in looking at the RFI inputs and assisting DOE in stimulating further inputs for consideration.

Project Name: Regulatory Process
Gina Krump; U.S. Department of Energy Headquarters



Brief Summary of Project

This task, under the interagency hydropower memorandum of understanding (MOU), will review and assess the hydropower permitting processes at federal facilities. This project is not meant to target particular processes as problems, but rather to identify areas that can be further understood in order to further promote private development at federal facilities. To date, the Department of Energy (DOE) has helped to develop the scope, goals and approach for reviewing the hydropower permitting process at federal facilities. The task's Statement of Work and Draft Survey were completed and reviewed by federal agencies in order to facilitate federal collaboration in the permitting process.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.6** for its relevance to DOE objectives.

- This is another low funded project that could influence the regulatory process through interaction among the regulatory agencies.
- Meets objectives to engage regulators and stakeholders and to reduce time of permitting. Particular interest in promoting private development at federal facilities by identifying technical areas that need to be understood, e.g., the permitting processes at federal facilities.
- Reduce regulatory delay and expense. In the Federal Energy Regulatory Commission (FERC) licensing process or have been. Licensing a private project at a federal facility. The project has worthy goals.
- Supports the program by reviewing current process at federal facilities
- Valuable effort to understand challenges and potential for improvements to process
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- An admirable initiative worth pursuing.
- Objectives good.

Question 2: Approach to performing the research and development

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

- Develop and distribute surveys to identify regulatory area that need to be further understood to promote private development at federal projects. Will produce a final product to characterize the state of the permitting process.
- Will create a forum for federal resource and regulatory agencies.
- However, need to make sure the right people from each agency that participates is at a level to be able to talk for the agency.
- It will be a challenge to overcome the non-technical organizational barriers.
- Approach a good start.

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

This project was rated **2.6** based on accomplishments.

- Workshop was held but no findings were discussed.
- Regulatory survey not completed; most milestones completed.
- The plan for the regulatory assessment was presented and discussed during June 30, 2010 Inland Federal Working Group meeting. Statement of Work and Draft Survey were completed and reviewed by federal agencies in order to facilitate federal collaboration in the permitting process.
- FY10 helped to develop scope, goals and approach for reviewing the hydropower permitting process at federal facilities. Discussions during the June meeting established representatives to participate in the Regulatory subcommittee that will help to produce a final product to characterize the state of the permitting process.
- Measures of success are not clearly defined.
- Good start.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- The project is all about collaboration.
- By nature this task will have collaboration with other resource agencies and regulatory bodies
- Scores high because of the MOU collaboration with Federal Hydropower producing agencies.

Question 5: Proposed future research

This project was rated **2.5** for proposed future work.

- Conducting a survey and preparing final report to be completed the year.
- Demonstration projects to be initiated in FY11.
- Further plans for regulatory study are to carry out survey and form a subcommittee of resource agencies in order to provide advice on development of project and results once the survey is completed. The subcommittee would create a forum for federal resource agencies and regulatory agencies to discuss gaps and misunderstandings of regulating hydropower.

- A difficult task to get agencies working co-operatively toward a common goal that may not directly benefit any of them, but certainly an admirable goal worth pursuing.
- Needs further development.

Strengths and weaknesses

Strengths

- Collaborating with the federal regulatory agencies for ideas on streamlining the processes.
- Could lead to better understandings of process and perhaps enhance process.
- Minimal funding required.
- Regulatory processes are one key concern in getting a project up and running in a cost effective manner. Take up lots of time and add considerably to project cost. Streamlined process would help improve Hydro implementation.

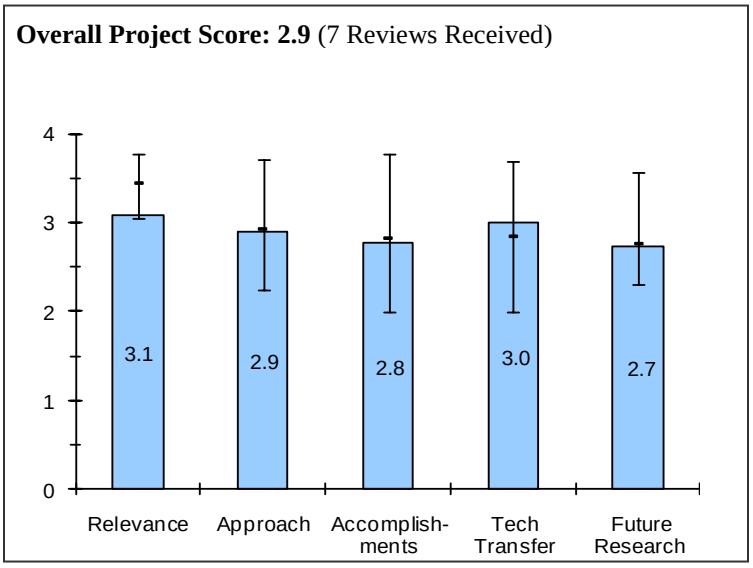
Weaknesses

- Unclear how much authority this project has to make the changes that are needed among somewhat entrenched government agencies.
- Dependant on lots of parties who don't have a win.

Specific recommendations and additions or deletions to the work scope

- Flow chart and information flow diagrams. Swim lane or fish bone charts.
- Develop and incorporate a communications protocol for dissemination of results
- Make sure that the appropriate people are included form each respective agency.
- Put energy behind this.

Project Name: Inland Hydro Working Group
Gina Krump; U.S. Department of Energy Headquarters



Brief Summary of Project

This task, under the interagency hydropower memorandum of understanding (MOU), has created a working group of federal agencies to promote interagency information sharing and cooperation related to hydropower development. This working group will be relevant and beneficial to different types of government entities, including regulatory, resource, and research agencies. The working group meetings thus far have served to facilitate communication about ongoing research and activities between participating agencies, and have highlighted some potential areas of collaboration (for example, multiple agencies are engaged in fish passage research). Two working group meetings were held in FY10 that helped establish a statement of goals and priorities of the group. Agencies involved in the working group include the Army Corps of Engineers, Bureau of Indian Affairs, Bureau of Reclamation, Bonneville Power Administration, Environmental Protection Agency, Federal Energy Regulatory Commission, U.S. Forest Service, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, National Park Service, Southeastern Power Administration, Southwestern Power Administration, U.S. Geological Survey, Western Area Power Administration, and Bureau of Land Management.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.1** for its relevance to DOE objectives.

- Another of the low funded efforts for just one year.
- Promotes objectives of DOE and highly collaborative with other agencies.
- Convene all stakeholders in the regulatory process. Integrate the missions of agencies. Undetermined plan and budget. Just staff time.
- Purpose is to establish a group in order to promote interagency information sharing and cooperation related to hydropower development. Working group supports efforts of the Water Power Program.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Objectives good.

Question 2: Approach to performing the research and development

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

- Established working group and two meeting held. No findings were presented.
- This project has meetings and reports on results.
- Includes signatories and non signatories, however need to confirm that participants are high enough level.
- Workshops seem to be stimulating awareness of what is happening in different organizations.

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

This project was rated **2.8** based on accomplishments.

- Difficult to judge as no findings were presented.
- Project is on schedule. Two meetings held so far.
- Two working group meetings were completed in FY10 that helped establish a statement of goals and priorities of the group in order to promote interagency information sharing and cooperation related to hydropower development.
- Measures of success are not clearly defined.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Establishing the Working Group was a positive approach.
- The project is all about collaboration.
- Facilitates agency collaboration and information sharing.
- Scores high because of the MOU collaboration with Federal Hydropower producing agencies.
- Technology awareness seems to be being transferred.

Question 5: Proposed future research

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

- Work done. Working in place.
- More working group meetings in addition to meeting deliverable schedules.
- The next working group meetings have been set for a second teleconference meeting in January and April 2011 in Washington D.C. (possibly in conjunction with NHA annual meeting).

Strengths and weaknesses

Strengths

- Highly collaborative - creates channels of communication and collaborative efforts.
- Good to get dialog started with signatories and non signatories.
- Establishes a conduit for information sharing.
- Minimal cost.
- Shared awareness.

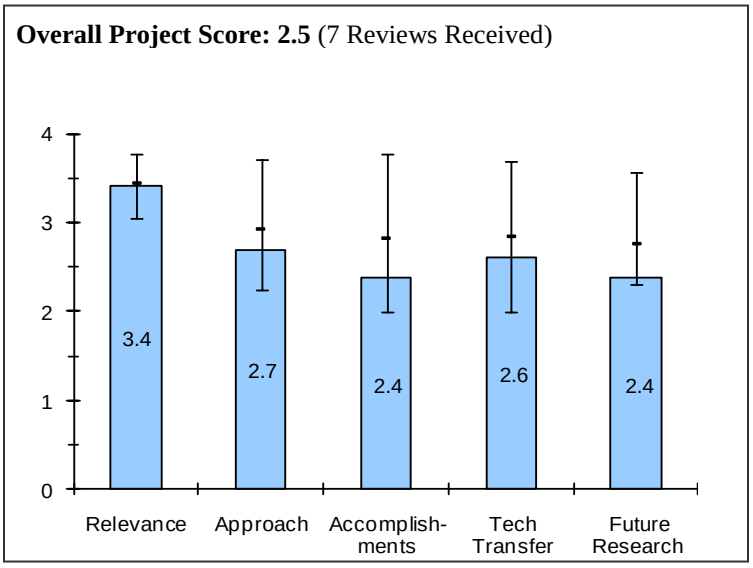
Weaknesses

- Care must be taken to document accomplishments and self-assess for progress.
- Develop and incorporate a communications protocol for dissemination of results.
- Are participants from agencies high enough level to make decisions for agencies?
- "Collaboration and coordination beyond information sharing has yet to be defined." This doesn't sound as if it has much traction or authority to be as effective as desired.
- What will be done with the shared awareness?

Specific recommendations and additions or deletions to the work scope

- Make sure to include the right people on the group from each agency that can speak for and make decisions for agencies.

Project Name: Renewable Energy Integration
Hoyt Battey; U.S. Department of Energy Headquarters



Brief Summary of Project

This task, under the interagency hydropower memorandum of understanding (MOU), focuses on interagency efforts related to hydropower and renewable energy integration. The Bureau of Reclamation has completed an initial draft of a report reviewing previous assessments of potential pumped storage sites at or near their facilities. This information will help validate the Department of Energy (DOE) assessments of potential pumped-storage hydropower resources. An initiative to assess the role of pumped-storage hydropower for integrating other renewables has not yet been scoped.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.4** for its relevance to DOE objectives.

- Meets DOE objective to expand hydro production.
- This is an initiative to assess the role of energy storage for integrating other renewables, which is an extremely important area that needs to have further attention.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

Question 2: Approach to performing the research and development

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

- Approach is to combine effort with the PSH Resource Assessment project.
- Interagency collaboration plan established in June Interagency bi-weekly conference calls. Decision was made to utilize DOE pumped storage hydro (PSH) Resource Assessment produced by Oak Ridge National Laboratory (ORNL) and the Idaho National Laboratory (INL) to fulfill requirements of first action item, utilizing inputs of Army Corp of Engineers (ACOE) and the Bureau of Reclamation (BOR). The ACOE and BOR are to complete review of existing PSH assessments at/near existing federal facilities.
- Collaboration with Pumped Storage Resource Assessment project: good.

- Work on assessing energy storage is definitely needed. Could use more clarity on deliverables and action plans to deliver them.
- Approach seems to not allocate high energy to this important project. The fact that it is behind schedule seems to support this assessment. Step it up. Modify approach to get more energy into the effort.

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

This project was rated **2.4** based on accomplishments.

- Report (Bureau of Reclamation) reviewing previous assessment activities.
- Reclamation completed initial draft of report reviewing previous assessment activities of potential pumped storage sites at or near their facilities.
- Information provided by Reclamation will help validate DOE assessments.
- Did not score because the project just started.
- No money spent.
- Not rated - not yet scoped.
- Seems to be behind plan. Step up the energy.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Collaboration with ORNL and INL.
- Collaborates with Reclamation and integrates with the resource assessment projects.
- Will require additional coordination with other DOE programs.
- Scores high because of the MOU collaboration with Federal Hydropower producing agencies.
- Report on integrated renewables energy storage.
- Will need coordination with other renewables research (wind, solar, etc.) to maximize effectiveness.
- Are right teams involved to make things happen?

Question 5: Proposed future research

This project was rated **2.4** for proposed future work.

- Products are reports to be provided.
- Finalize assessment report; share results of Grid Services project, assess energy storage needs.
- Keep going.
- Fuzzy proposed future steps.

Strengths and weaknesses

Strengths

- Integrates information from other federal agencies.
- Will help validate DOE assessments.
- A good initiative that needs to really get traction.
- Minimal cost initiative to this point.

- Good opportunity for demonstration sites should this work get completed to show some usable to demonstrate energy integration and storage.

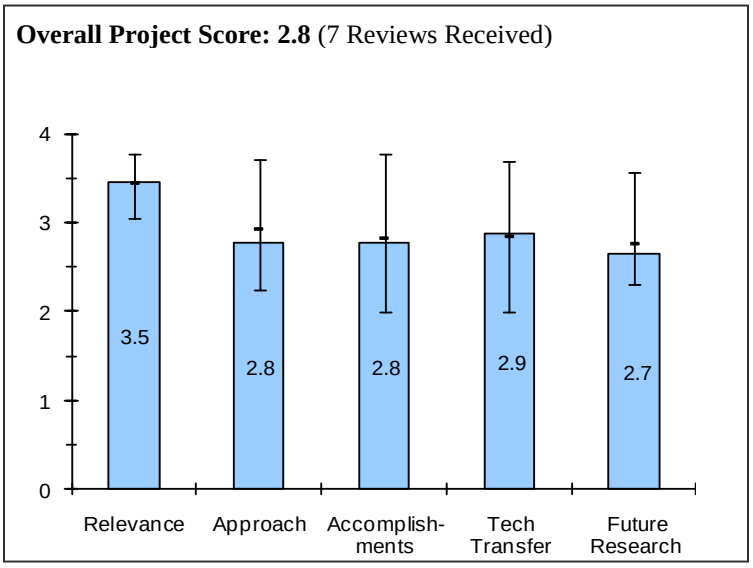
Weaknesses

- Future initiatives have not been identified.
- May have overlap with other project areas. Outlines what needs to be done but it isn't clear who/how this will get done without further scoping.
- Appears to have energy applied to this project through the approach.

Specific recommendations and additions or deletions to the work scope

- Develop and incorporate a communications protocol for dissemination of results.
- Step up the efforts.

Project Name: Climate Assessment at Federal Facilities
Mike Sale; Oak Ridge National Laboratory



Brief Summary of Project

This project represents Department of Energy (DOE) activities in response to Section 9505 of the Secure Water Act of 2009 (P.L. 111-11), which requires DOE, in consultation with other federal agencies, to produce an assessment of the effects of global climate change on water availability and generation at federal hydropower facilities. This report will be produced in consultation with the four federal Power Marketing Administrations, the U.S. Geological Survey (USGS), the National Oceanographic and Atmospheric Administration (NOAA), and relevant state water resource agencies. The report will examine climate change effects on water available for hydropower operations and the future power supplies marketed from federal hydropower projects. It will also include recommendations from the Power Marketing Authorities (PMA) on potential changes in operation or contracting practices that could address these effects and risks of climate change. The first hydropower assessment to be produced through this project will be a synthesis of existing information and will represent the first instance of a federal agency studying the potential effects of climate change on hydropower resources. The assessment will also examine future aspects of federal power marketing, which has significant impacts on the nation's renewable energy portfolio.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- This effort appears to be generating regional synthesis documents that have potential utility for policy development.
- Meet DOE's requirement under the Secure Water Act to report the effects of climate change on federal hydro projects.
- Five year update cycle, 15 year contracts on hydro contracts. This is a required process for international collaboration in setting goals.
- Section 9505 of the Secure Water Act requires DOE to report to Congress on climate change effects at federal hydropower facilities and repeat this every five years.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Required by Congressional mandate.
- Just starting.

Question 2: Approach to performing the research and development

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

- Seems reasonable.
- Look at the water availability aspect of climate change (not value since PMAs market water at favorable rates).
- Assess the data and scientific understanding and identify knowledge gaps.
- DOE to lead, in consultation with Power Marketing Administrations (PMAs), the U.S. Geological Survey (USGS), the National Oceanic and Atmospheric Administration (NOAA), and states.
- Literature review and setting up data bases.

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

This project was rated **2.8** based on accomplishments.

- Preliminary agreements and data and letters of commitment executed on schedule.
- Water Power GIS for NHAAP designed and operational DOE letter of commitment and funding actions to PMAs.
- New relations with PMAs, Bureau of Reclamation, Army Corps of Engineers, USGS (series of meetings in August-September 2010).
- Project management plan was completed.
- Some data collected.
- Not really started yet.
- Did not score because the project just started.
- Not rated work just starting.
- Just getting started. Cannot evaluate.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Good collaboration with other federal agencies.
- Highly collaborative and will be communicated to public and congress.
- Coordination required with numerous agencies to gather information.
- This could be a useful report.
- This will be difficult depending on Power Management Authorities attitude toward this.
- Scores high because of the MOU collaboration with Federal Hydropower producing agencies.
- Seems built into plan.

Question 5: Proposed future research

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

- Project near completion with a report to Congress in June 2011.
- Renew report to congress every five years.
- Task ends in early 2011. No additional research planned.

- It wasn't clear from the presentation if there was going to be any future work, not scored.

Strengths and weaknesses

Strengths

- Meets DOE's obligation to Congress.
- Is the only formal climate assessment project in the program?
- Has authority behind it. Congressional mandate assures project will be completed.

Weaknesses

- This project claims to get info from other agencies (as it should) but no mention of utilizing this information in any other project. This could be quit valuable beyond the requirement to report to Congress.
- These very speculative forecasts have an uncertain value without huge sensitivity analyses. What actions will result from these hypotheses?

Specific recommendations and additions or deletions to the work scope

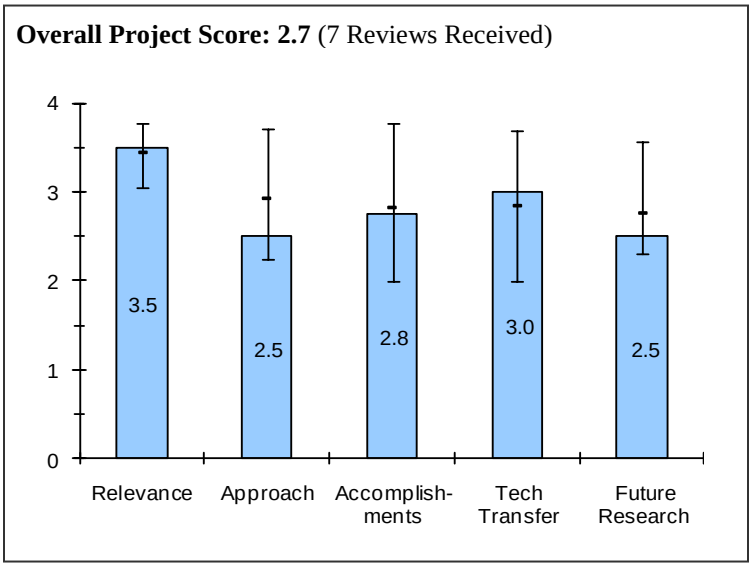
- All of these projects are simply tasks under the MOU and would be better presented as one project with emphasis on findings to date.
- Identify how this information can be used by other projects in the program.
- Develop and incorporate a communications protocol for dissemination of results.

Project Name: Education Program Overview
Hoyt Battey; U.S. Department of Energy Headquarters

Brief Summary of Project

The Department of Energy (DOE) funds two fellowship programs to attract graduate students to research and careers related to hydropower. These fellowships will help develop the next generation of hydropower specialists.

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



Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- Not focused on specific goals.
- Did not score this item, but rather scored "Hydro Research Fellowships" and "Hydro Fellowships" projects separately.
- Excellent program aimed toward recruitment of young professionals into the industry.

Question 2: Approach to performing the research and development

This project was rated **2.5** on its approach.

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

This project was rated **2.8** based on accomplishments.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

Question 5: Proposed future research

This project was rated **2.5** for proposed future work.

- Well presented. This project appears to be in very good control.

Strengths and weaknesses

Strengths

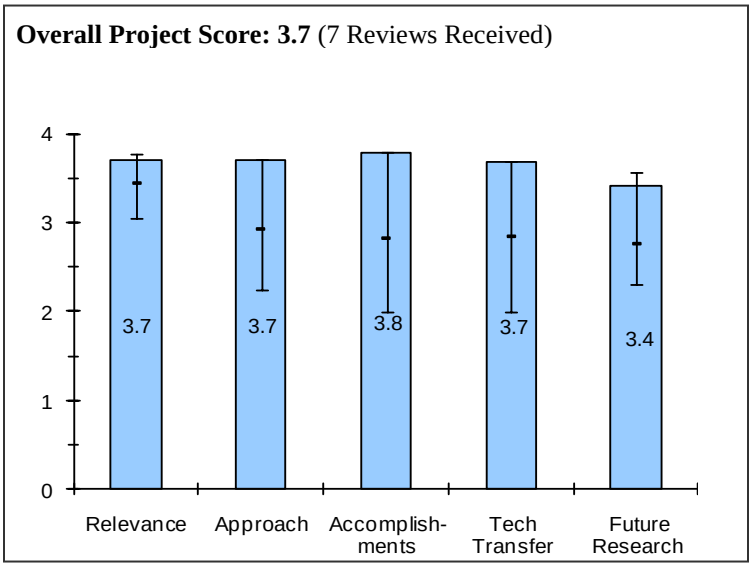
Weaknesses

- Not really well know.

Specific recommendations and additions or deletions to the work scope

- Keep moving forward.
- Great progress to date.
- Clear presentation.

Project Name: Hydro Research Fellowships
Deborah Linke; Hydro Research Foundation



Brief Summary of Project

Under this project, Department of Energy (DOE) funds the Hydro Research Foundation to establish the competitive Hydro Fellowship Program to stimulate new student research and academic interest in research and careers related to conventional and pumped-storage hydropower. The fellowships will develop the next generation of hydropower specialists in response to the large number of retirements expected in the hydropower industry. The program encourages a diverse spectrum of disciplines to participate in the research education of the fellows. To date, the Foundation has established a steering group from a broad array of industry and academic organizations to advise the project, select fellows, and provide entry points into career opportunities. The project has already selected a first class of nine fellows, out of 47 total applications. The fellowships will provide tuition and health insurance allowances, living stipends, professorial discretionary funds, travel allowances for attendance at HydroVision and on-site visits to hydropower facilities, and industry mentors relevant to the fellows' research areas.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.7** for its relevance to DOE objectives.

- This project has great potential for encouraging students to seek employment within the Hydro industry.
- This project addresses all the objectives of DOE's Combined Heat and Power (CHP) program by developing emerging expertise, without which future improvements cannot be made.
- This was the best presentation and easy to obtain the elements needed in the grading.
- Excellent program.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

Question 2: Approach to performing the research and development

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

- Encourage interdisciplinary training and exposure to professor and professionals in various academic departments. Students that can communicate and conduct analyses from different disciplines will be the most sought after for employment.
- Funding of grad student research is an effective way of getting grads interested in Hydropower.
- A problem with timing - students must be identified many months before funding is available. This is a bit awkward for academic process.
- There should be some funding available also for the project, not just the student. In-kind contribution by institution is not always possible. Perhaps collaboration with another funding agency for research support would be possible.
- Allows for numerous opportunities for applicants and institutions to become involved in hydropower.
- Recognizes need to stimulate new academic interest in conventional and pumped storage hydropower.
- This is very good.
- Seems like a lot of fellowships -- good.
- Visionary view - necessary to the long-term sustainability of the hydro industry resources and development of addition research areas.

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

This project was rated **3.8** based on accomplishments.

- Fellowships are well funded ($50K). All milestones have been met.
- Projects are on schedule.
- Has resulted in students.
- Great progress: 47 applications from 34 universities, steering committee, good cross section of research topics, student visits to hydro facilities, nine fellows in program.
- Effective project management.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Steering Group for selecting fellows and providing advice, etc. is good. Coordination across institutions (other Universities, National labs?) was not specifically mentioned. Several levels of sponsorship from industry.
- Integration with the hydropower industry and DOE is evident.
- Works with universities and interested students.
- The whole point of this project is integration and tech transfer.
- Engaging new researchers in industry and academia.

Question 5: Proposed future research

This project was rated **3.4** for proposed future work.

- Specific barriers needing to overcome before reaching success were not identified.

- Plan in place for second year of funding and student proposals.
- Will solicit applications starting in November 2010.
- Plan for future is good: develop industry based sponsors and the next batch of Fellows coming along.
- Keep it going.

Strengths and weaknesses

Strengths

- Nine fellowships at eight Universities. Twelve person steering committee appointed. Will recruit young experts into the hydro industry.
- Highly effective way of improving future hydropower research and improvements.
- Excellent start.
- Very effective presentation.
- Effective project management and use of funds.
- Creating new talent for Hydro Industry.
- Solving some open issues with University research.

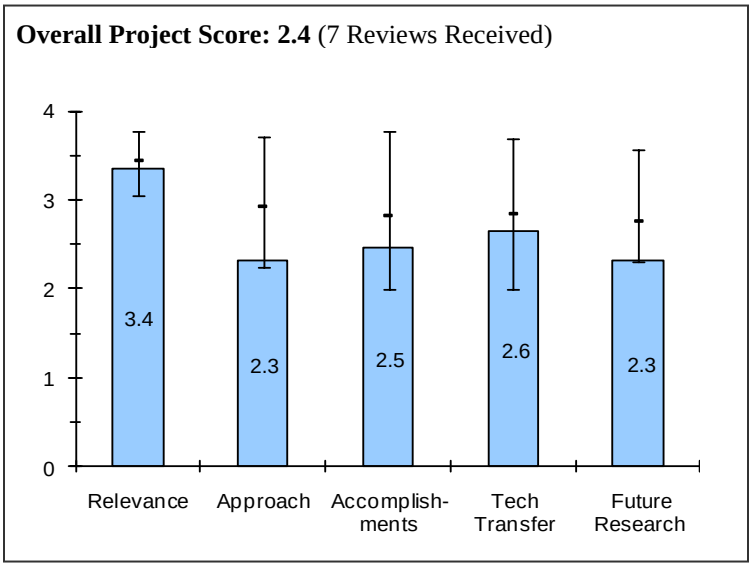
Weaknesses

- Awkward timing of identification of students in advance of funding.
- Hope funding can be secured to keep this going.
- Project results awareness could be increased through articles in Hydro Review and other publications.

Specific recommendations and additions or deletions to the work scope

- Suggest that the project seek collaboration/mentoring with national labs and research centers (e.g. DOE, U.S. Geological Survey, U.S. Environmental Protection Agency) to focus on real world problems and systems analyses.
- Consideration of collaboration with research funders. This perhaps is possible in any case in that it is not prohibited.
- Solicit more mentors.

Project Name: Environmental Flow Requirements
Mark Bevelhimer; Oak Ridge National Laboratory



Brief Summary of Project

This project will analyze and refine quantitative tools for assessing operational flow releases on biological resources; these tools will help simultaneously optimize power production and environmental protection at hydropower facilities. The project will develop a system for characterizing altered flow regimes based on their degree of resemblance to the natural hydrograph; use multiple methods of flow assessment to characterize relationships between various components of natural flow regimes and environmental benefits; use case study sites to compare the predictive capabilities of alternative flow assessment methods; and develop procedures to help operators and regulators select the appropriate flow assessment methodology or approach. To date, the project team has undertaken an industry needs survey and assessment, evaluated a variety of hydrologic metrics for use in characterized operational flow regimes, and began the evaluation of flow assessment methodologies.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.4** for its relevance to DOE objectives.

- Stated goal is to advance the science of environmental flows. There is a wealth of literature on more holistic approaches to Riverine assessments. To advance the science the project must employ the integration of hydrology, geomorphology, water quality, aquatic biology, habitats and their connectivity. Much integration is needed across the various projects within this environmental performance and siting program but more specifically with the river system level tool box development efforts described in projects PD-035 thru PD-041.
- Focuses on the objective of bringing new hydro technologies into commercial readiness that will improve energy and environmental performance and reduce barriers to new development such as regulatory risks and expense.
- Supports approach to generate data to more accurately correlate generation and water use with environmental impacts.
- Purpose of this effort is to develop analytical approaches to characterize flow regimes to better assess their ability to provide efficient power and environmental services and to advance the science of environmental flow development to more fully include hydropower operation considerations.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

- Strong topic with clear industry need. Better economic assessment of the actual incremental environmental benefits of changing toward run of river flow regimes is seriously needed for balanced decision making.

Question 2: Approach to performing the research and development

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

- Again with the stated goal "to advance the science of environmental flow development" it is difficult to accept the statement that integration of fish passage, water quality, and environmental flows is not an objective due to funding. The development of tools for integration across hydrology, geomorphology, water quality, biology and connectivity is a very critical need for advancing the science of environmental flows. Review the Instream Flow Council books (both 2004 & 2008) that emphasize throughout the necessity for integration of hydrology, geomorphology, water quality, biology and connectivity. This integration is what environmental flow assessments are all about. Continuing to seek simplistic rules and relations that could be applied to multiple sites does not advance the science. This has been the approach repeated several time over the past half century. That is the very reason that the IFC was organized and has spent considerable effort in compiling two books to promote integrated analyses and addressing both the intra- and inter-annual aspects of flow regimes essential for sustained aquatic communities. River systems are very complicated and multiple developments and pressures are being added continually. System assessments have become vital for understanding the consequences of future sitings, operational changes, decommissioning, etc. The system scale issues are the drivers for tool development to better meet the need for more efficient hydro development.
- Not clear on objectives. Stated objectives include developing a way to characterized flow regimes to assess their ability to provide both HP and environmental flows, and also to advance the science of environmental flow development to include hydropower operation considerations. Is this intended to be basic science? We should understand why existing methods are not "hyrdo-oriented". Many existing methods are used in conjunction with hydro projects. For example many hydro projects in the US have mandated operating criteria to operate in a particular fashion to satisfy environmental flows. What problem is this project trying to solve?
- The survey for needs assessment was administered to environmental flow experts who identified need for better biotic response models, hydraulic models and validation techniques, and tools to apply these in an easy way. The outcome of the survey is lit review of methods, and in particularly a hydro-related revision to ELOHA framework. However, we don't know why the ELOHA method has been singled out for analysis.
- An important aspect of the assessment was to determine "industry needs". However, team received only limited input from utilities when determining the needs.
- Not far along, but the description of the approach was vague.
- What is the final product: a report, a methodology, an enhanced version of ELOHA?
- Has too much regulatory agency input. Not enough Utility and other hydropower operators. Not well balanced.

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

This project was rated **2.5** based on accomplishments.

- Starting from scratch by sending out questions seeking research needs indicates a lack of previous efforts in identifying such needs and particularly the efforts of the Instream Flow Council in documenting such. See IFC books for discussion of instream flow indices appropriate for planning (regional analyses) and state-of-the-art suite of technical approaches for site specific analyses.
- Needs assessment, characterization of operational flow regimes and evaluation of flow assessment methodologies were carried out and preliminary report issued.
- No schedule was provided except an annual report, so it is not possible to evaluate progress.
- The scope has already been modified as explained in the presentation due to underestimating the complexity of the problem. New steps were outlines, but the only milestone is having a conference. Presumably there will be a report as well.
- FY2010 report.
- Needs assessment.
- Trained up on International Hydropower Association (IHA).
- Evaluate statistical methods of flow regime analysis.
- Chose the Ecological Limits of Hydrologic Alteration (ELOHA) framework for holistic analysis.
- Has too much regulatory agency input. Not enough Utility and other hydropower operators. Not well balanced.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Better coordination with PD-038 environmental performance is necessary. Simple habitat indices, passable width as a function of flow at riffles, and hydrology based flow standards are appropriate for regional level assessments when little or no site specific information is available. For actual permitting efforts like those described in PD-035-041 are very site specific where data is collected and dynamic modeling is necessary. For these site specific environmental flow considerations refer to the Instream Flow Council books describing the critical components of instream flows, namely hydrology, geomorphology, water quality, biology and connectivity. Specifically review the 2008 "Integrated Approaches to Riverine Resource Stewardship" for case studies and discussion of advances in the state-of-the-art. Also collaborate with project PD-035. Seems like a duplication of effort.
- Integration with fish passage and Hydropower optimization toolbox were mentioned.
- Workshop with TNC and FWS on indicators of hydrologic alteration software.
- No mention of dissemination of results other than producing a report and having a conference.
- Needs to have increased outreach to industry to support the needs assessment.
- Work with the other two projects within this group.
- Work with Basin-Scale Opportunity Assessment project.
- Reports and articles on guidance of which tools to use.
- Seems to be lacking input of hydropower operators. Not well balanced.

Question 5: Proposed future research

This project was rated **2.3** for proposed future work.

- A key step in developing such tools will be integrating knowledge across scientific disciplines. Develop flow assessment tools that links hydrology, geomorphology, water quality, and connectivity with persistence of fish/aquatic biota through spatially explicit modeling. Such studies/development, although difficult and time consuming, are necessary to advance the science of environmental flow assessments.
- Finish needs assessment.
- The only milestone is a conference. There does not seem to be a metric to evaluate success or completion.
- Future efforts include developing "information, methods, and tools that are complementary to existing environmental flow methodologies, for the purpose of incorporating specific hydropower operation needs." What does it means to incorporate hydropower in these methods or in what way they are inadequate from a hydropower perspective? Also, there are no decision points.
- Increase outreach to industry users to better determine needs.
- $350k per year: trying to come up with methods that are appropriate to funding/effort level.
- Continue to evaluate statistical methods.
- Modify ELOHA for hydro needs.

Strengths and weaknesses

Strengths

- There is significant opportunity to interface with one of the basin level case studies by incorporating environmental flows as constraints.
- Flow requirements are needed, especially for hydro applications. The project has done an inventory and analysis of methodologies.
- Methods could be used in a toolbox if identified/developed.
- Acknowledgement that the methods must appropriate to funding/effort level.

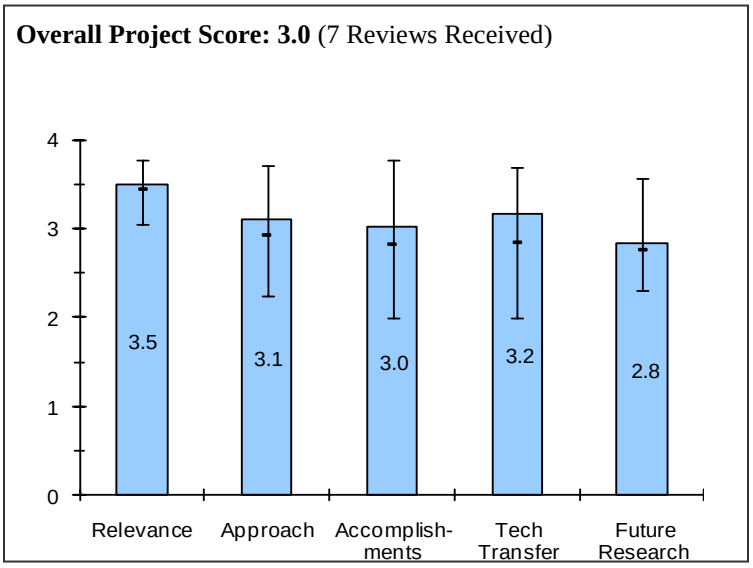
Weaknesses

- Without restructuring the project has little chance to "advance the science of environmental flows". No emphasis on integration across disciplines of hydrology, geomorphology, water quality, biology nor system analyses examining connectivity and important intra- and inter-annual thresholds for sustainable aquatic communities.
- Have not identified (or have not communicated) the shortcoming of environmental flow methodologies that are to be addressed by this project.
- Project was to ambitious, but final goals are more consistent with reasonable expectations.
- Goals are not set as to final results and how they will be communicated and how they will benefit DOE.
- Not sure if the product will meet the needs of industry as there still needs to be more industry outreach to determine/confirm needs.
- A difficult and complex problem that has been around a long time. At the end of the day, the economic quantification of environmental benefits from prescribed flows often remains a mystery that others are reluctant to address.

Specific recommendations and additions or deletions to the work scope

- Project personnel should examine the 2004 IFC book "Integrated Approaches to Riverine Stewardship" as a point of departure for tool development. Chapter 13, Advancing the State-of-the-Practice, provides a template with considerable detail for integrating hydrology, geomorphology, water quality, aquatic biology, and connectivity. suggest that this project be eliminated and efforts combined with PD-038. See extensive comments offered on projects PD-035-PD-040.
- Describe problem that will be solved, including examples of inadequacies.
- Develop goals and milestones with more explicit description of results.
- Include criteria for success - how can the project be evaluated at the end?
- Develop and incorporate a communications protocol for dissemination of results.
- Get more hydropower operator input.

Project Name: Fish Passage Mitigation
Marshall Richmond; Pacific Northwest National Laboratory



Brief Summary of Project

This project will help refine the understanding of turbine and reservoir passage stresses and predicting the responses of a wide range of fish species to those stresses. The goal is to design and operate hydropower projects to minimize downstream passage impacts. The project will improve characterization of the causes of fish injury and mortality during turbine passage; refine expressions of turbine passage stresses on fish via computational fluid dynamics models; develop predictions of passage injury and mortality among untested fish species; and develop and verify models to predict turbine passage survival rates for different species, turbine designs, and operating conditions. To date, project researchers have reviewed project regulatory criteria, hydropower use and development on a national scale, fish-friendly turbine development and other mitigation efforts, and methods for predicting turbine passage mortality of untested fish species.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- This is primarily a synthesis project and case study. Product should be useful for reevaluation of old project and for new construction.
- Focuses on DOE objectives to bring new hydro technologies into commercial readiness that will improve energy and environmental performance and reduce barriers to new development such as regulatory risks and expense.
- Supports the objectives of the Program. Fish passage is an important issue with Riverine hydropower.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Continues long ongoing and still incomplete fish survival efforts.

Question 2: Approach to performing the research and development

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

- Combines both fish facilities and passage through turbines.

- Combination of experimental science and development of tables/relationships that can be easily used to improve turbine design and hydropower operations to minimize impact on fish.
- Seems to be approach that would support the objective of the task.
- Integrate models, field data, and experiments to improve turbine design.
- Improve reservoir operations for fish passage.
- Review studies done by other.
- Extend studies to unstudied species.
- Compile database.
- Moving in the direction of a true risk assessment is a positive approach.
- Clarity could be improved.
- Presentation a bit loose.
- Missing some further data gathering using balloon tagged fished. Tests at Bonneville Dam and Wanapum dam put fish in center of water passageway, and based on CFD simulations, did not get fish into regions of the turbine near hub and blade tip and wicket gate bottom where gaps were eliminated. Therefore tests did not show whether effects of closing up the gaps were as effective as thought to be. Data Needed.

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

This project was rated **3.0** based on accomplishments.

- FY10 goals were accomplished.
- Tasks are being completed in an acceptable schedule.
- Tools for biological performance assessment.
- Linking up fluid dynamic models with biological performance.
- Example of model results in presentation was good.
- Seems to be not of lot of results vs. when the project funding was available. Is it behind original schedule?

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Collaborating with U.S. Army Corp of Engineers.
- Corps of Engineers collaboration, refereed journal article, web site publication of information.
- Interact with water use optimization project.
- Working with Corps of Engineers and turbine manufacturers.
- Working with operators and turbine designers.
- Provide a tool for turban designers.
- Clearinghouse.
- Some coordination with industry indicated. Seems to be less than potentially possible. Is this an industry issue or a PI issue?

Question 5: Proposed future research

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

- Synthesis products to be produce in 2011 appear promising.
- Seek further opportunities to extend research.
- FY 11 tasks are identified with decision points.
- $300k.
- Keep building database.
- Continue working.
- Pretty good plan and want to keep it going.
- Some indicated. Words are soft. Let's make it happen.

Strengths and weaknesses

Strengths

- Problems well defined; application of both experimentation and method surveys to meet goals.
- Plan for dissemination of results.
- This is a good idea-- combining modeling of the turbine dynamics and fish physiology database.
- Open information needs addressed. This program will close some issues.

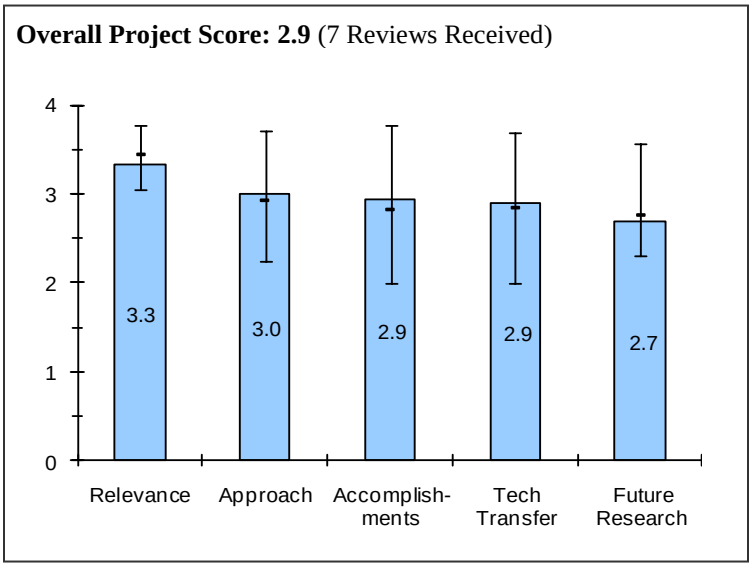
Weaknesses

- Results will be prototype, more funding is needed for full biological criteria data synthesis.
- Economic treatment of benefits and alternatives.
- Cooperation with Industry weak.

Specific recommendations and additions or deletions to the work scope

- Develop and incorporate a communications protocol for dissemination of results.
- Strengthen cooperation with industry. Sources are available.

Project Name: Green House Gas Emissions from Reservoirs
Pat Mulholland; Oak Ridge National Laboratory



Brief Summary of Project

This project will measure and analyze potential emissions of greenhouse gases from hydropower reservoirs in the United States. Some hydropower reservoirs, mostly from tropical and boreal zones, emit large quantities of greenhouse gases, thereby reducing the value of conventional hydropower as a renewable, emissions-free source of electricity. Studies that document seasonal and regional variations in greenhouse gas emissions are underway to develop a predictive understanding of the issue for U.S. reservoirs. The project will develop measurement protocols for greenhouse gas emissions from the reservoir surface, spillway and turbine discharges, and tailwaters; apply those protocols in reservoirs across a range of climate and hydrodynamic settings; develop predictions of reservoir emissions based on climatologic, hydrodynamic, or other environmental characteristics; and work to improve understanding of rates and controls of reservoir greenhouse gas emissions for use in future scientific assessments and by policy makers and resource managers. To date, the project has developed reservoir and tailwater sampling protocols and tested these protocols in a reservoir in the Southeastern United States. Monthly field sampling has been underway since December 2009.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.3** for its relevance to DOE objectives.

- Provides data to support Hydro's being renewable.
- Data needed to support International efforts.
- Settling the issue of emissions is key to green certification of hydro plants.
- Purpose is as follows:
    - 1. Develop and test measurement protocols for measuring GHG emissions from the reservoir surface, spillways and turbines, and tailwaters downstream (Year 1).
    - 2. Demonstrate the efficacy of these measurement protocols by applying them in reservoirs across a range of climate and hydrodynamic settings.
    - 3. Develop predictive relationships that will allow assessment of reservoir GHG emissions based on climatologic, hydrodynamic, or other environmental characteristics (Years 2 and 3).

  - 4. Provide improved understanding of rates and controls of reservoir GHG emissions for use in future scientific assessments and by policy makers and water resource managers (Year 3).
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Do not understand the relevance other than international interest.

Question 2: Approach to performing the research and development

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

- Consistent with International Hydropower Association (IHA) guidelines for data gathering.
- Development of testing procedures is excellent - good science.
- Not able to apply it to enough reservoirs to develop good predictive models.
- How can results be used?
- Methodology did not include terrestrial monitoring to be able to determine differences should that assessment be required.
- However, project will provide advancement in the assessment of GHG emissions from U.S. reservoirs and their importance for considerations of regional GHG emissions.
- The approach is good to measure the gasses coming off of reservoirs, and compare to values found in the literature. The problem is that this type of field work is expensive; consequently, the number of reservoirs which can be sampled will be small.
- Will a couple of years of data at a few reservoirs be enough to draw any conclusions?
- A needed project to introduce objective science to resolve a shaky political argument. Measurement of true NET emissions is a very difficult task that may be necessary to end this debate.
- Developing measurement protocols.

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

This project was rated **2.9** based on accomplishments.

- Schedule does not include any milestones except annual reports.
- UNESCO/IHA conference.
- Will require coordination between ORNL and PNNL should there be west coast assessments.
- Field measurements, data analysis, model development.
- Annual report.
- One year of interesting measurements.
- Developed good process for estimating gross emissions thus far.
- Progress toward measurement protocols and expansion to reservoir area. Also work on flowing streams.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Uses IHA guidelines.
- Missing some projects where H2S generation is providing hints of Methane and CO2 generation. Those projects should be studied too to identify needed mitigation.

- UNESCO/IHA conference.
- Coordination with hydropower optimization project.
- No plan for how results will be disseminated?
- Put into the literature the results of these measurements.

Question 5: Proposed future research

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

- Should have more explicit future milestones.
- Need no-go decision points and contingency plans, especially for lack of EPRI funding.
- This should lead to monitoring at other reservoirs. However, dependant on other funding.
- Adding more sample sites.
- Lack of EPRI funding: will be difficult to keep this going without more funding.
- Develop statistical models.
- Seeking needed additional funding for FY2011.

Strengths and weaknesses

Strengths

- Follows IHA guides.
- Scientific/experimental development to address a well-articulated problem.
- Interfacing with international efforts.

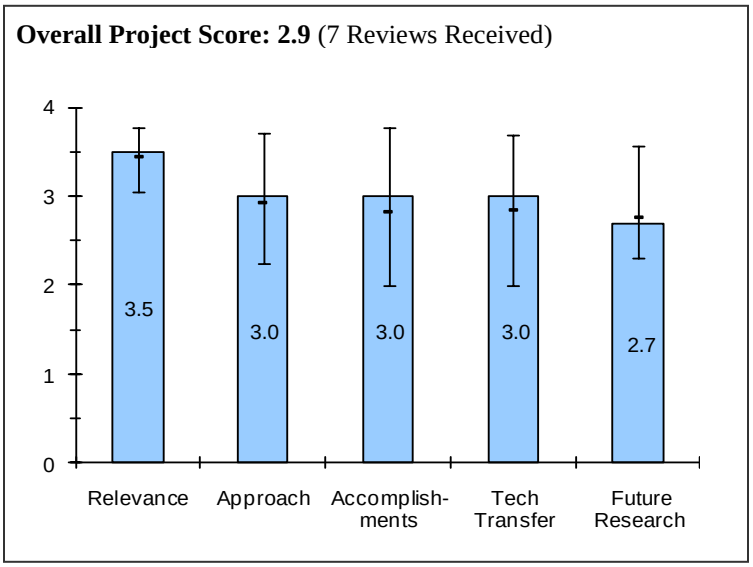
Weaknesses

- Not enough lakes will be tested to develop a predictive model.
- It is uncertain how the results can be used.
- Awaiting additional EPRI funding to support additional efforts.
- Not clear on how results will be communication outside of the federal labs.

Specific recommendations and additions or deletions to the work scope

- Need to identify mitigation.
- Develop and incorporate a communications protocol for dissemination of results.

Project Name: Ancillary Services Market Analysis
Verne Loose; Sandia National Laboratories



Brief Summary of Project

This task under the EPRI Grid Services project will evaluate national hydropower participation in ancillary service markets. The project will produce a report on market and scheduling area treatment and acquisition of generation and ancillary service resources; will provide input to the UPLAN Western Electricity Coordinating Council (WECC) regional simulations; will quantify the characteristics of U.S. ancillary service market and regional scheduling practices; and will identify gaps in ancillary service resource acquisition that, if closed, would improve the role and contribution of hydropower to the national electricity supply. For this task, EPRI has identified independent system operators and scheduling areas; surveyed literature in electric industry economics, restructuring, and markets; and gathered information on FERC-approved tariffs and other operating rules documents. EPRI has also gathered plant- and unit-level data from the Energy Information Administration, Bureau of Reclamation, U.S. Army Corps of Engineers, and North American Electric Reliability Corporation. The case studies developed by EPRI demonstrate the potential for more economical use of hydropower, but it is difficult to generalize because site-specific issues may thwart changes. The data to more carefully identify role of hydropower in the provision of ancillary services does not exist or is not available for every facility. Furthermore, the incomplete evolution to market systems in electricity industry resource acquisition leads to different resource acquisition processes; administered prices and load obligations lead to cost-minimizing behavior that may leave money on the table for system operators.

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- Ancillary services can produce value for hydro with little incremental investment. do not believe that any Federal hydro system is in an Ancillary Services Market. Bilateral systems produce about 85% of the value of a market.
- Understanding the markets is key to forwarding hydro participation moving forward.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Correct valuation of ancillary services is critical to incentivizing additional investments in those generators that can enhance grid reliability through ancillary services support.

Question 2: Approach to performing the research and development

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

- Admission that the presence of more than one set of interests (constraints) makes the modeling much more difficult represents reality. Suggest reviewing Reclamation projects on the Yakima and Trinity rivers where hydro, irrigation and fisheries are important players in balancing. Also in Norway they have been balancing hydro with Atlantic salmon, both important to local economies.
- Surveying the markets is necessary and a good approach. Since the California ISO allows an outside supplier to participate in the Ancillary Services market, it may be interesting to investigate using some of the HVDC Pacific Intertie capacity to export wind variability or ancillary services to Los Angeles Department of Water and Power (LADWP). It is unfortunate that a direct the California ISO tie does not exist. Thru flow to the California ISO via LADWP may be a political bottleneck, but the participation of LADWP and BPA may be interesting to investigate Ancillary Services bi-lateral opportunities. Studies could assume that all of California participated with WECC to see what the value of operating as one control area in a unified market would be worth compared to the multiple balancing areas.
- Using established protocols.
- Seems like a good start.
- National scale evaluation of hydro ancillary services.
- Understand and report hydro scheduling.
- Gather market data and information.
- Gather plant and unit level data (sub-hourly data necessary, but not available).
- Look at ancillary services in the European Market; look at how it has changed over the past 10 years. As wind and solar penetration in the European market is where U.S. is headed in 10 - 15 years, the ancillary services product mix and mix evolution may provide insight as to where U.S. may be going. Ancillary services products change with time and evolve. May help identify Gaps in U.S. ancillary services market acquisition.

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

This project was rated **3.0** based on accomplishments.

- Participation is good.
- Completed their business.
- Prepared a draft report on market and scheduling area treatment and acquisition of generation and AS resources.
- Provide input to the UPLAN WECC regional modeling simulations - current and ongoing.
- On target with schedule.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- See the logic in focusing on WECC because of the size, but only the California ISO has markets. It is difficult to obtain prices without a market. Without prices it is difficult to establish value.
- Working with ISOs and other federal labs. Product will be available publicly.

Question 5: Proposed future research

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

- Use of Plexos outputs by other researchers in other areas may be of help to this project. The California ISO has run Plexos.
- Steps for future work are identified and scheduled.
- Look at Europe and perhaps Japan.

Strengths and weaknesses

Strengths

- Identifies the business models out there.
- Looks at differences and similarities.
- May lead to three business models merging toward a common one.
- Communicates ancillary services products.

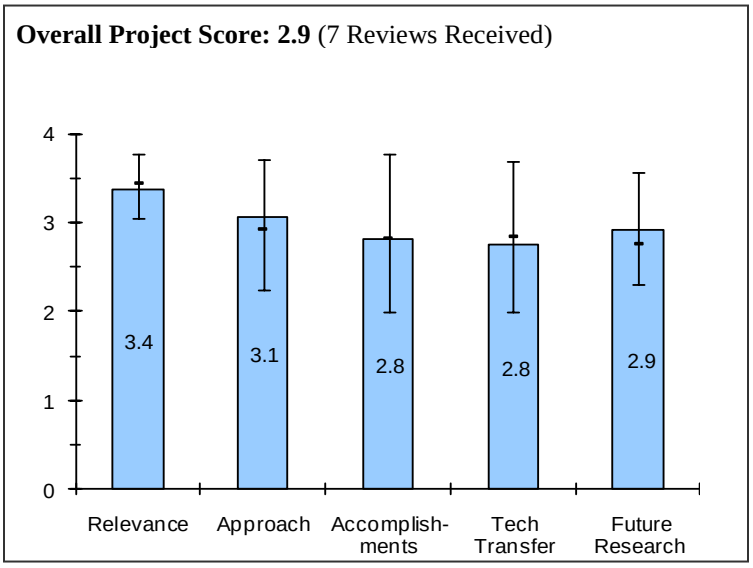
Weaknesses

- Will data be sufficient for what analysis is needed? Data to more carefully identify role of hydro in provision of ancillary services does not exist or not available for every facility.
- Still needs to reach agreement on calculation of pumped storage capacity (or utilization) factor.
- Only North American.

Specific recommendations and additions or deletions to the work scope

- Run PLEXOS in a 5 minute dispatch mode. The water flow and the value may be significantly different than the hourly approximation being done with the UPLAN.
- Add Europe and Asian insights.

Project Name: Effects of Systematic Operating Constraints
Michael Starke; Oak Ridge National Laboratory



Brief Summary of Project

This task under the EPRI Grid Services project will develop case studies to define linkages between water availability and hydropower's ability to provide ancillary services. The case studies of the Osage and Taum Sauk hydropower facilities and the Columbia River hydropower system will examine the use of hydropower resources in providing grid services while considering the plethora of constraints across many different systems affecting hydropower. The top two constraints identified in the case studies were related to environmental factors and the power system, but many others exist. Future actions under this task will be to analyze, correlate, and coordinate existing constraints on the Osage, Taum Sauk, and Columbia River projects and how the constraints affect provision of grid services.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.4** for its relevance to DOE objectives.

- Examining system constraints in hydro is important contribution.
- The specific plant studies produce incentive for others in the area to pursue improvement of hydro operations.
- Effect of constraints is important to understand ultimate resource potential.
- Understand the physical constraints and how it relates to hydro resources.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

Question 2: Approach to performing the research and development

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

- Again suggest reviewing how the Bureau of Reclamation (BOR) is handling salmon, irrigation and hydro on the Yakima river and the Norway hydro producers are handling Atlantic fisheries and hydro.
- Interesting results to date. Appear to be on the right track.
- Using real life constraint examples with environmental and power system challenges.
- Case studies: identify the top two constraints at specific sites.

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

This project was rated **2.8** based on accomplishments.

- Technical accomplishments: Defined initial set of constraints and initial scoping of Osage and Taum Sauk resulting in draft report.
- Deliverables are reports.
- Two case studies under way.
- Developing operation/flow models which implement constraints.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Seems to fit with other efforts. Not sure if this site effort is one of the case studies described in PD-027, if not should be.
- Once the report is out it will be interesting to see what may not be released. Everything looks better than expected so far.
- Because of timing with awards, integration is trying to catch up with other DOE projects.
- Other Riverware model in Columbia.
- This project should collaborate with some of the others: Tool development, basin studies, etc.

Question 5: Proposed future research

This project was rated **2.9** for proposed future work.

- If Columbia River effort is part of the Columbia River case studies, good. Why are all of the site analyses included in case studies?
- More plants being planned is better.
- Steps for future work are identified and scheduled.

Strengths and weaknesses

Strengths

- Public report on linkages between power grid services and water availability along with research needs to enable regional and national modeling.
- Catalog of constraints needed. Understanding of them needed.

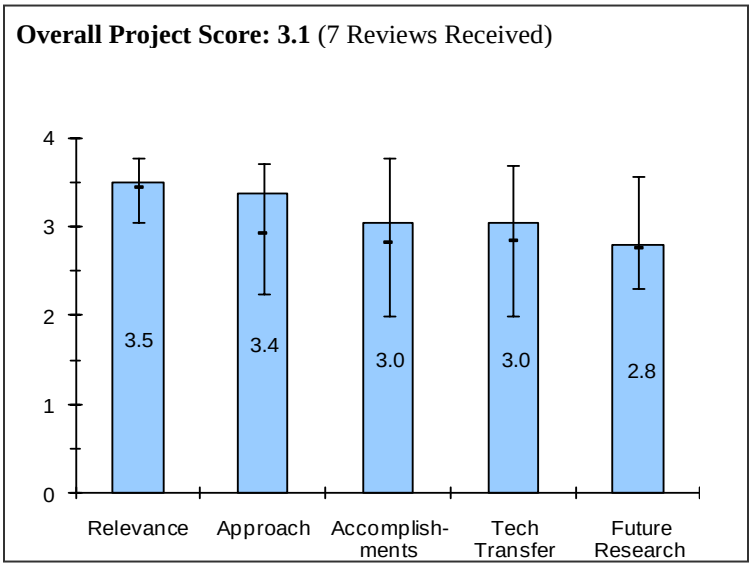
Weaknesses

- Not considering uncertainty yet. Recommendation: consider developing a way to evaluate best and worst case scenarios. Also, some kind of Monte Carlo approach could be considered.
- Could constraints be different in Europe? Could European constraints give hints to future constraints in U.S.?

Specific recommendations and additions or deletions to the work scope

- Increase integration with other Oak Ridge National Lab (ORNL) efforts.
- After U.S. understood, take a look at Europe to see similarities and differences and evaluate if those differences may show up in U.S. eventually?

Project Name: Hydro Plant Case Studies
Pat March; HPPi



Brief Summary of Project

This task under the ERPI Grid Services project will develop case-studies of hydropower plants to identify opportunities for increased generation and to inform power system modeling efforts. The task will include site visits, gathering of operational and market data, detailed performance analyses for each plant, and preparation of confidential reports to utilities on operational patterns. The products developed through this task will help plant operators improve understanding of market-related operational patterns, quantify plant sub-optimization due to these operational patterns, compare near-real-time operations with hourly averages, and investigate consequent additional maintenance costs. To date, the task has negotiated data confidentiality agreements with utilities for several facilities and begun collecting and analyzing the data for those projects. The task will continue negotiations with utilities to for additional case study sites and will coordinate case study investigations with ORNL's task on systemic constraints.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- Case studies are sorely lacking in the industry. The information should be very interesting.
- Case studies are important to verify real vs. expected.
- 'm not qualified to evaluate this project.
- Do the individual operators do this type of optimization analysis themselves? Why do you have to do this?
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- A strong focus on short-term useful results for the hydro industry.
- by developing emerging expertise, without which future improvements cannot be made.

Question 2: Approach to performing the research and development

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

- Incorporates industry information.

- Provides insight into opportunities that can help generators become more efficient immediately.
- Documents behavior and consequences/impacts of operation.
- Provides data for cost of operation.
- Could benefit by looking at plant behavior in Europe as renewable penetration high there and looks like U.S. in 2020-25.

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

This project was rated **3.0** based on accomplishments.

- Negotiated agreements with utilities for multiple projects.
- Negotiations underway for additional projects.
- Data received and detailed analyses underway for multiple projects.
- Progress behind schedule.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Not sure how deliverables from other projects dovetail with one or more of the case studies. Objectives from the other project studies should automatically become sub-objectives of one regarding more case studies.
- Interaction with power producers.

Question 5: Proposed future research

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

- Difficult to assess early in project.
- Tasks identified but are general in nature.
- Add European plant or two.

Strengths and weaknesses

Strengths

- Very knowledgeable, excellent project team.
- Quantifies current behavior.

Weaknesses

- Not looking at Europe misses input as to how things may be in future in U.S.

Specific recommendations and additions or deletions to the work scope

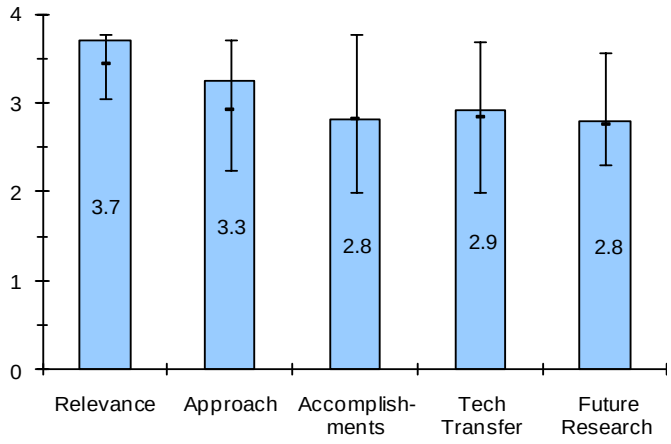
- Suggest that project at experiences from Norway. This would be particularly relevant to your task of providing examples to hydro industry e.g., examining environmental operations effects on hydro energy production and distribution. Norway has very sophisticated modeling for several years at times subordinating (seasonally) hydro production in favor of Atlantic salmon spawning and rearing. Hydro production and delivery to Europe via grid. Excellent case for looking at the interplay of these

equally important values to the local economy. SINTF at the University in Trondheim, Norway is a good contact as they have done most of the modeling. This experience would also be good for the PD-021 and PD-022 projects.

- Add a look at one or two types of plants in Europe which don't exist in U.S.
- Europe also has much move wind and solar penetration. Learn from that.

Project Name: Hydro Cost Data-based Development
Ron Grady; HDR/ Devine Tarbell & Associates, Inc. (HDR-DTA)

Overall Project Score: 3.0 (7 Reviews Received)



Brief Summary of Project

This task under the ERPI Grid Services project will develop a database of current and projected hydropower cost elements and use these data to identify costs for comparison to the identified benefits of hydropower. The task will draw upon cost data and elements identified in previous studies and will develop and apply updating and escalating techniques that build upon procedures developed by the Corps of Engineers and Bureau of Reclamation. The cost results from this analysis will be compared to data available from more recent studies and other. The task will also consider a range of capacity and efficiency options, including increased capacity at existing conventional and pumped storage facilities, other incremental cost opinions, and new greenfield pumped-storage developments. The findings of this task will be released in a public task report on hydropower technologies' cost elements and comparisons with other cost data.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.7** for its relevance to DOE objectives.

- Hydro cost data is severely dated in the RTO world. Any engineering-based, supportable data for which the assumptions are known would be welcome.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.
- Develop a data base of current and projects hydro costs.
- Who will use this data base and for what purpose?
- Deliverables are listed as reports, but the real value seems to be the data base itself.
- Understanding the range of new project costs is valuable to developers looking to add hydro projects.
- Costs important to evaluate future direction.

Question 2: Approach to performing the research and development

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

- Good use of information from previous described studies.

- Being able to determine the cost components of various projects provides an engineering approach to the cost base.
- Get some cost elements for products currently not used in U.S. which may become used in U.S.
- Need good costs to be able to compare pumped storage costs with other storage methods. Need good costs to provide base for which DOE Stimulus to reduce costs can be based.

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

This project was rated **2.8** based on accomplishments.

- Early in project.
- Seems to be just starting.

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Technology transfer is difficult to judge. This similar to the other projects within this overall effort only identify contribution of chapters in the task 9 Summary report.
- The future degree of use of this information will be the proof technology transfer. Numbers are needed before this can be adequately judged. Having one source for cost data is helpful.
- Will provide data into ORNL project.

Question 5: Proposed future research

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

- Difficult to judge.
- Keeping the data up to date is an effort that was not described.
- Just getting started.

Strengths and weaknesses

Strengths

- A comparable database from a single source using the same methods is very positive.
- Now started.
- Coordinated with ONRL project which will use it.

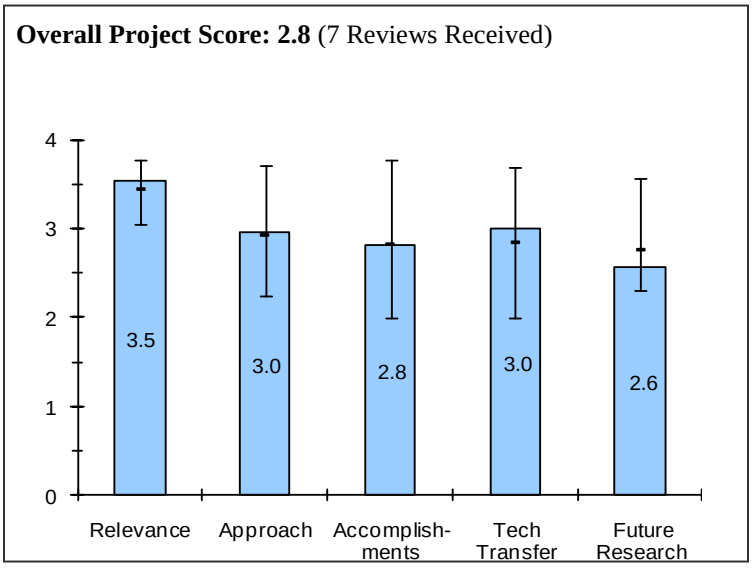
Weaknesses

- Behind schedule.

Specific recommendations and additions or deletions to the work scope

- Find a means to keep the database up to date.
- Look also at cost elements applicable to U.S. from current European experience.

Project Name: Modeling of WECC (includes policy scenarios)
Srinivas Jampani; LCG Consulting



Brief Summary of Project

This task under the ERPI Grid Services project will characterize the current utilization of hydropower in the Western Electricity Coordinating Council (WECC) and will evaluate the effects of alternative policies on value of hydropower grid services in the year 2020. This task will prepare a detailed grid simulation model for the WECC area, using the UPLAN integrated generation and transmission modeling platform. Using the UPLAN platform, the task will create a hydropower model that considers plant constraints, sets schedules to accommodate variable generation, and responds to price signals. The task will also create a pumped storage model that uses price-driven logic and considers energy efficiency, storage limits, and transmission limitations.

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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.5** for its relevance to DOE objectives.

- Similar data produced for wind and solar by NREL studies with similar programs were produced without intensified hydro input verification. This study should fill in the blanks for hydro.
- Purpose of this is task is to quantify revenue streams from energy and ancillary services in future scenarios to support investment decisions. Investigating options for increasing hydropower capacity and locating new pumped-storage plants.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

Question 2: Approach to performing the research and development

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

- Good cross walk with case studies and proposed validation of with ONRL Western Electricity Coordinating Council (WECC) study projects.
- The generation expansion forecast is very important in these studies. It was not quite clear if this forecast came from the ReEDS work? Hourly models cannot differentiate all the benefits that hydro has to offer compared to other generation. Shorter dispatch periods (5 minute) provide hydro more opportunities than a one hour period to participate in ancillary service supply. Larger Balancing Areas also produce more opportunities. It may be interesting to determine the value of larger Balancing

Areas and the impact on hydro and wind in the models. Modeling the high voltage direct current (HVDCO) tie with ancillary services capability may also be interesting since the California ISO (CAISO) allows outside resources in the ancillary services market and the HVDC from BPA has the capability to deliver variable schedules in short time ranges. This is a possible demonstration case for future research.

- Prepare detailed grid simulation model for the WECC Area using UPLAN which is an integrated generation & transmission modeling platform.
- Utilize inputs from other team members on constraints, interconnection, costs and values.
- Baseline and future scenarios -- good.
- Evaluate effects of alternative policies on hydro value.
- Deliver new methodology for planning.
- Based on case studies? Is modeling done at sites or regionally?
- Model addresses current U.S. Ancillary Services but misses ancillary services dealing with shorter time frames (less than minutes) which are present in Europe and not yet present here. With more wind and solar the U.S. in 2025 will look like Europe today. Look at European ancillary services.
- To evaluate current storage value to help firm wind, need good model dealing with shorter timeframes.
- To meet objectives of evaluating future scenarios, need to have capability to model capabilities of Storage which may be used in future having fast response times.

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

This project was rated **2.8** based on accomplishments.

- Evidence as presented on increase in pumped hydro utilization during high wind already shows promise.
- A little behind schedule.
- Baseline scenario is completed. Now working on scenarios.
- Model results look good/useful. Hard for to really evaluate.
- Is model limiting result relevance (1 hour time frame limit)?

Question 4: Research Integration, Collaboration, and Technology Transfer

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

- Good collaboration across labs.
- The value of hourly runs to others is limited.
- Integration with other team members is a key aspect to this task.
- Who will read the final report and what will this information mean to them?

Question 5: Proposed future research

This project was rated **2.6** for proposed future work.

- Assessing different scenarios is ongoing and next steps.

Strengths and weaknesses

Strengths

- Proven modeling tool being used where it is known.
- The fact that project personnel found that PD-039 and PD-042 were somewhat duplicative and decide to merge is strength.
- Ambitious in terms of variety and extend of data and analysis tools; and high chance of technical success.
- Potentially useful to meet DOE objectives for analysis and planning.

Weaknesses

- West coast pumped storage operation is different than east coast operations is this a concern?
- Model not well dealing with shorter time frames (those under 10 minutes).
- Data will not be shared with others outside of DOE.
- Design of analysis tools need more thought.
- Future support funding is critical to success; contingency plans should be considered.

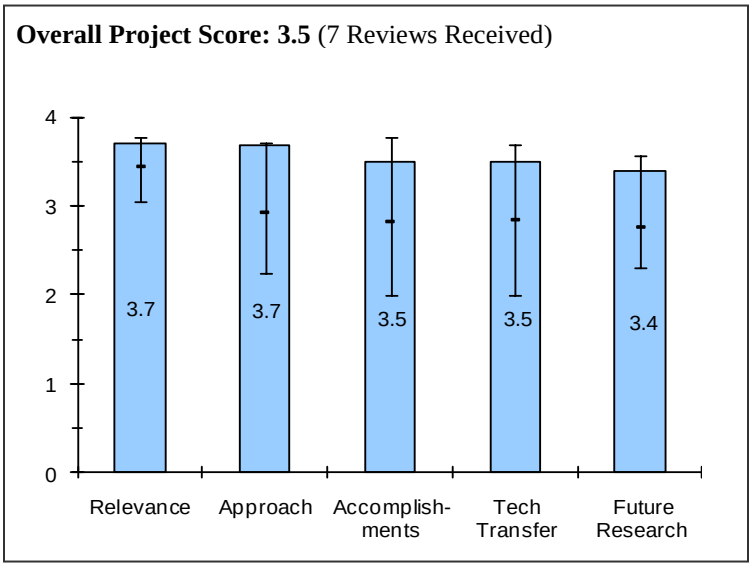
Specific recommendations and additions or deletions to the work scope

- Use additional modeling to fill gap at short timeframes typical of advanced pumped storage being used in Europe to meet the high penetration of wind and solar there.
- Compilation of potential uses of the database and list of analysis capabilities motivated by these uses.

Project Name: Hydro Fellowships
John Cimbala; The Pennsylvania State University

Brief Summary of Project

This project will stimulate academic interest in conventional hydropower by providing research support for graduate-level research projects, each consisting of a graduate student supervised by a faculty member. The project has formed an Advisory/Review Panel to select projects; recruited nine graduate students and provided them with a competitive stipend package; selected faculty and projects from competitive internal proposals within the Penn State University College of Engineering; arranged tours and plant trips for the students; and arranged meetings between students, faculty, and industry.



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

Question 1: Relevance to overall DOE objectives

This project earned a score of **3.7** for its relevance to DOE objectives.

- Excellent support of program goals.
- Addresses need for future hydropower expertise.
- This is a great program to produce people for the hydro industry.
- Purpose is to stimulate academic interest in the conventional hydropower field by providing research support for at least eight individual Master of Science (MS) or Doctoral (PhD) level research projects, each consisting of a graduate student supervised by a faculty member.
- This is supportive of the Water Power program as there is a need to attract people to work in hydropower industry.
- Compared to research programs in other agencies, all programs/projects are very well aligned with the DOE and Water Power Program objectives.

Question 2: Approach to performing the research and development

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

- Fast start up by recruiting students that were already in graduate programs.
- Provide fellowships for grad students. Topics are of interest to industry.
- Approach is to attract top notch graduate students and engage with hydro industry and projects that support hydropower industry.

- Student recruitment methods are very good.
- John Cimbala is very enthusiastic about this.
- Get others supporting rather than keeping it with one manufacturer. Add agencies, Utilities, etc.

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

This project was rated **3.5** based on accomplishments.

- Amazing progress in such short period of time.
- Very successful to date - have recruited great students and initiated research.
- Six projects have been initiated and ongoing.
- Quality of students seems excellent.

Question 4: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.5** for technology transfer and collaboration.

- Excellent collaboration among academia, industry and professional advisors.
- Well integrated with industry and DOE.
- Research and results to be disseminated through publications and conferences.
- This project is the definition of "tech transfer."
- Same goals as HRF project.

Question 5: Proposed future research

This project was rated **3.4** for proposed future work.

- Much thought into future of project and strong support by University administration.
- No barriers to successful completion of projects.
- Opportunities for Future Research/Funding: Follow-up funding for additional years; more students, funding for a hydro test lab at PSU, goal to establish PSU as a center for hydro research.
- Hope the funding will keep going.

Strengths and weaknesses

Strengths

- Developing recruits to the industry.
- Result is graduating students with interest and expertise in hydropower as well as relevant research results.
- Promotes a pipeline for those graduates interested in a career in hydropower design.
- Growing potential talent for the Hydro Industry.

Weaknesses

- The advisory/review panel needs to be actively engaged and carefully selected. Web meetings and video conferencing should be explored to overcome this barrier.

Specific recommendations and additions or deletions to the work scope

- Don't need another test lab. There is unused capacity. Small lab to support experiments would complement the R&D work being done by the students.

6.0 American Recovery and Reinvestment Act Hydroelectric Facility Modernization Projects

Projects funded by the American Recovery and Reinvestment Act (ARRA) are intended to emphasize economic stimulus and job creation. The Hydroelectric Facility Modernization Funding Opportunity Announcement (FOA) projects will modernize existing hydropower infrastructure in the U.S., increase both quantity and value of generation, and address environmental performance. Furthermore, these projects contribute directly to the Office of Energy Efficiency and Renewable Energy (EERE) and the Department of Energy (DOE) missions of improving national, energy, and economic security and increasing the nation's energy diversity.

The seven Hydroelectric Facility Modernization FOA awardees were selected for their ability to begin quickly, to create and retain jobs, and address the nation's renewable energy goals.

Successful and timely completion of the selected projects involves the same basic phases:

- Completion of regulatory activities
- National Environmental Policy Act (NEPA) evaluation and determination
- Engineering design and equipment procurement
- Construction
- Installation
- Start-up/testing

Table 6.1 lists the seven Hydroelectric Facility Modernization FOA awardees. Table 6.2 lists the total budget for each of the seven awardees.

Table 6.1 Period of performance of ARRA-funded projects

Period of Performance		
Recipient	**Project Start**	**Project Finish**
Alcoa, Inc.	1/1/2010	3/31/2012
Alabama Power Company	1/1/2010	1/31/2013
City of Tacoma	1/1/2010	12/31/2011
Incorporated County of Los Alamos	11/1/2009	6/30/2011
City of Boulder	1/1/2010	12/31/2011
Minnesota Power	9/1/2010	8/31/2011
City of North Little Rock	1/1/2010	12/31/2011

Table 6.2 ARRA-funded project budgets.

FY2009 ARRA			
Recipient	**DOE**	**Recipient**	**Total Cost**
Alcoa, Inc.	$12,950,000	$64,652,334	$77,302,334
Alabama Power Company	$6,000,000	$24,000,000	$30,000,000
City of Tacoma	$4,671,304	$22,844,173	$27,515,477
Incorporated County of Los Alamos	$4,558,344	$4,558,344	$9,116,688
City of Boulder	$1,180,000	$3,894,616	$5,074,616
Minnesota Power	$815,995	$1,809,445	$2,625,440
City of North Little Rock	$450,000	$450,000	$900,000
Total	**$30,625,643**	**$122,778,855**	**$153,404,498**

As part of the 2010 Water Power Peer Review process, the Panel Members were asked to evaluate the performance of the ARRA-funded projects. All seven projects were rolled into one overall evaluation of ARRA-funded projects. Figure 6.1 shows the quantitative analysis of the ARRA-funded projects.

The panel was asked to rate the ARRA funded projects in the following weighted categories:

1. **Relevance to Overall DOE Objectives:** the degree to which the project supports the objectives, goals, and approaches of the Water Power Program. (Stand Alone Metric)
2. **Approach**: the degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers. (Weight = 50%)
3. **Technical Accomplishments and Progress:** degree to which the project has progressed compared to the project schedule and goals. (Weight = 50%)

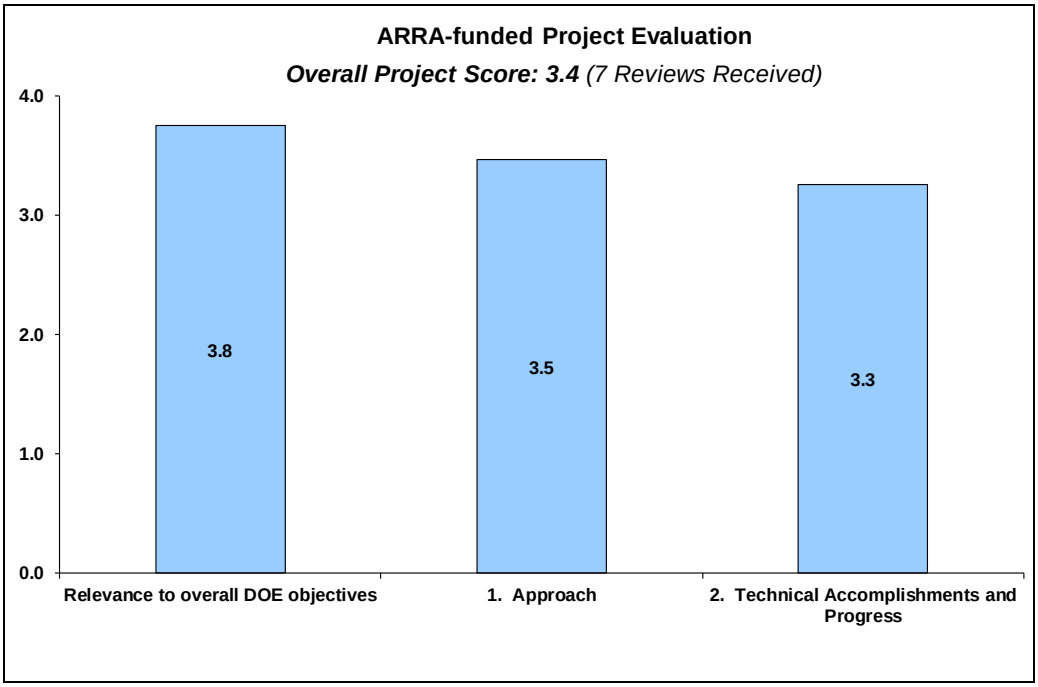


Figure 6.1. ARRA-funded Project Evaluation Results

Question 1: The degree to which the project supports the objectives, goals, and approaches of the Water Power Program.

- Project seems to be more about getting recovery act money into the economy while boosting renewable energy generation.
- Meets the recovery act goal.
- Not doing much to address overall Water Power Program goals.
- Encourages and emphasizes efficiency gains and near term improvements with clear real world results. Excellent.
- Compared to research programs in other agencies, all programs/projects are well aligned with the DOE and Water Power Program objectives.
- Projects support goals of further developing hydro, stimulating the economy and implementing upgrades and efficiencies.
- Accomplished task of putting money into shovel ready projects.
- This project fits well with the Water Power Program goals by modernization of hydro units that are over 50 years of age.
- Projects funded by the American Recovery and Reinvestment Act for job stimulation.
- Project meets ARRA criteria for creating jobs as well as improving infrastructure.

Question 2: The degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers.

- Provides incentives and stimulates deeper reviews of "back burner projects" that were previously not quite attractive enough to get started. This is very positive.
- It seems that regulatory issues will always be a factor in putting projects like this behind schedule. Maybe this could have been anticipated better.
- Good approach to support implementation of upgrades to existing projects.
- Very straight forward.
- Focuses on jobs and national energy goals.
- Projects for infrastructure improvement with cost sharing were selected. Some projects were delays due to unexpected regulatory processes, e.g., NEPA.

Question 3: The degree to which the project has progressed compared to the project schedule and goals.

- Somewhat behind schedule, but seem to be working through it.
- Seven projects selected and awarded. Currently scheduled to complete in 2011, 2012, and one in 2013.
- Projects are moving forward, but some are currently delayed. Good progress for a short project schedule given that permitting is included.
- Given the identified long lead times and permitting requirements considerable progress has been made. Seven project funding awards made.
- Regulatory process issues have been a challenge but many of the projects were "shovel ready".
- Progress is under way on several of the projects.

Project Strengths

- Supports real production improvements quickly.
- Selected projects align well with goals.
- Likeable project because it is a real work project.
- Seems to be creating jobs, which is a goal.
- Would be interesting to use economic data from these projects to validate the Job and Economic

Development Impact (JEDI) model.
- Funds real projects. Construction and implementation of energy benefits.
- Several projects were well along in the legal process allowing rapid response to modernization.
- Efficient investment with cost share.
- Increases hydropower production.

Project Weaknesses
- A relatively small number of beneficiaries but still a very helpful program in the big picture.
- This type of project requires a lot of time, making it hard to accurately plan.
- Projects are sometimes delayed due to regulatory processes.

Recommendations for Additions/Deletions to Project Scope
- Okay for stimulating employment at the moment.
- Not demonstrating new technologies. Most projects would have gone forward by themselves in a stronger economy.
- Require applicants to include discussion on expected environmental issues associated with the proposed project. DOE can then weigh potential issues ahead of time when reviewing proposals. A NEPA environmental assessment is currently required on all award recipients. If there is potential for environmental issues that would delay or prohibit project completion then DOE should know up front of that potential.
- Consider using information on development of these projects to reality check against JEDI model and other assumptions on economic effects of new hydro development.

7.0 Overall Program Evaluation

As part of the 2010 Water Power Peer Review process, the Panel Members were asked to evaluate the performance of Wind and Water Power Program in the Conventional Hydropower focus areas of Technology Development, Market Acceleration, and American Recovery and Reinvestment Act (ARRA) funded projects. Panel Members provided both quantitative and narrative evaluations based on the following criteria:

- Objectives,
- Barriers,
- Approaches,
- Projects, and
- Communication & Collaboration.

Specifically, Panel Members were asked to evaluate: 1) how well Program objectives align with industry needs, 2) if the Program identified the critical barriers to sustaining hydropower development and deployment, 3) if current Program approaches are appropriately and effectively designed and implemented in order to achieve objectives and overcome technical and non-technical barriers, 4) if the Program formed an effectively balanced portfolio of projects that will contribute to achieving its goals and objectives, and 5) the degree and impact that Program interaction has on industry, universities, federal agencies, as well as comparable international actors and other stakeholders. This section represents the Peer Review Panel's quantitative and qualitative analysis of the Wind and Water Power Program. Figure 7.1 shows the quantitative analysis of the Wind and Water Power Program.

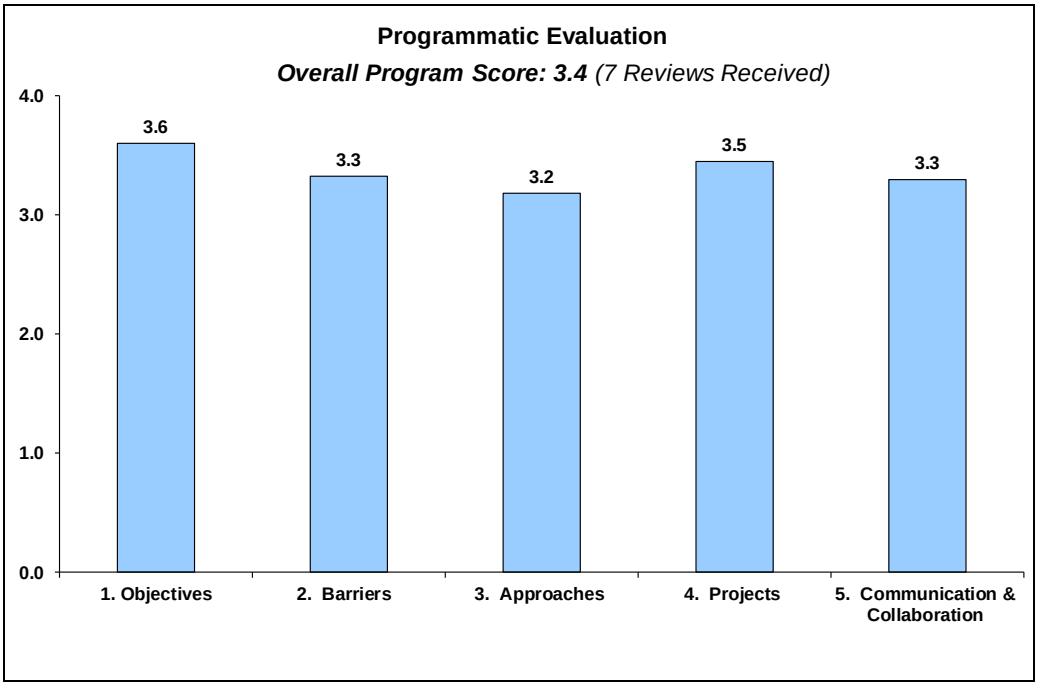


Figure 7.1. Peer Reviewer Program Evaluation Results

Question 1: How well do Program objectives align with industry needs?

- This program is collaborative, getting stakeholder inputs to guide it and a nice improvement on programs of the past.
- Very impressive array of projects that will help the hydro industry in multiple areas.
- Compared to research programs in other agencies, all programs/projects are well aligned with the Department of Energy (DOE) and Water Power Program objectives.
- The managers of this program should be commended for awarding projects which are so well aligned with the agency objectives.
- The managers of this program should be commended for keeping the projects on track and not letting them drift off of the agency objectives.
- The goals of the program are well founded and directly applicable to support the increase in hydropower generation and technology development by focusing on technology, resources, and environmental issues.
- The projects seem to provide the information needed to move hydro. The coordination of the pieces into a final product still needs some work.
- Overall programmatic view of the Water Power Program is very good.
- Most of the projects in the program support industry needs.
- Few projects are of questionable relevancy to industry and are not a result of established industry needs.

Question 2: Has the Program identified the critical barriers to sustaining hydropower development and deployment?

- Yes, the Program has identified the critical barriers. Keep moving forward.
- DOE has a very good handle on all of the barriers to sustaining hydro and creating new hydro development. Some barriers have been and will continue to be difficult to overcome, but this program is making a terrific start.
- Main impression is that the projects have all done a good job of anticipating and/or recognizing barriers to their progress and adapting to these barriers.
- Organization of the individual projects was overall very good, except in certain cases, as were identified in their respective review sheets.
- In addition provides assessment to further identify barriers and the specific challenges within each identified area.
- The value analysis could use more focus. Part of the problem is that the biggest area, WECC, does not lend itself to being analyzed for potential value in its present state. Most of the projects are very practical and focused. To obtain results from the Western Electricity Coordinating Council (WECC) analysis one has to make "Ivory Tower" assumptions that industry will oppose or ignore. Time and money will resolve the issue.
- Several projects have only recently started and need to clearly identify anticipated end products as well as outcomes for any work to date (meetings). Others have identified barriers and adequately provided suggestions.
- Most of the critical barriers have been identified.
- A few important barriers have not been addressed such as 1) risk and uncertainty due to hydrologic variability and change, and 2) conflicting water demands for other purposes such as water delivery/conservation, navigation, flood control, recreation.

Question 3: Are current Program approaches appropriately and effectively designed and implemented in order to achieve objectives and overcome technical and non-technical barriers?

- Approaches generally good. Keep moving forward.
- The non-technical barriers involving regulators and environmental stakeholders are quite challenging. If DOE can successfully use its influence and objective position to improve the regulatory process, it would be a huge step forward for the advancement of additional renewable hydro resources.
- Concerned about some of the software development projects. In general:
  (1) specific end users should be identified;
  (2) use cases should be used to focus the purpose of the software;
  (3) working prototypes should be used to guide development and ward off potential problems before they become large and costly to fix;
  (4) distinction should be made between research and development (R&D) codes versus deployable codes so that expectations are reasonable and can be managed; and,
  (5) all codes which are identified as deployable to end users should have plans for documentation, for means of deployment, and for future support.
- Some of the larger awards under this program have large teams and as a result those teams selected need to be well coordinated and managed in order to assure objectives are met.
- Incorporates a good educational program to increase hydropower visibility and interest with younger generations.
- Use of analytic resources. Who will cooperate with the Hydro Program and have economic tools to do so? May provide missing answers and increase the industry collaboration. The toolbox was not usable in the Midwest Independent Transmission System Operator Inc. (ISO) area because the need to have an EMS vendor implement the programs made it difficult to evaluate and determine who would use the toolbox and if the tools in the box were adequate.
- In many cases it seems that the projects are searching for simple rules of thumb, graphical relations and solutions that can be transferred across sites. Basin scale simulations integrating the various components of project operations, flow, water quality, environmental effects, etc., are now essential to effectively compare system responses to various combinations of project siting, operations, climate change, etc. System "gaming" must become the tool of the future. One of the stated goals of the program is to stimulate hydro development with little or no environmental impact. This is an achievable goal and can be accomplished when all parties agree.
- Most of the approaches are appropriate and effective, but some are not effective enough.
- Projects in general should understand the actual needs of industry before embarking on research. (Or DOE or a panel of experts should help to ensure that the research is responding to industry needs.)
- Some research is naive in terms of industry tools and methods. The projects could benefit from industry input.

Question 4: Has the Program formed an effectively balanced portfolio of projects that will contribute to achieving its goals and objectives?

- Overall very impressive, although there appears to be some overlap in certain project study areas.
- A few projects could benefit by input from real world operations and an advisory team of end users.
- The range of topics covered by the projects is very broad. This is one strength of the program.
- As stated above, some of the larger awards under this program have large teams and as a result those teams selected need to be well coordinated and managed in order to assure objectives are met.

- The program represents a balanced portfolio of projects.
- All the parts and pieces seem to have been included in the projects. Coordinated analysis could answer questions that are not assumptions such as the cost target for hydro. The cost target may be higher if hydro is in a renewable portfolio standard. Financing methods for federal and public agencies need to be considered. Local prices vary considerably. One target may not fit all areas.
- Very diverse set of projects. Need more on why each project was chosen to better judge overall balance. Overall Program appears to be properly focused toward balanced hydro development.
- Portfolio of projects is mostly well-balanced.
- DOE should be discriminating with regard to funding new techniques (e.g., forecasting, environmental flows) and should determine if existing techniques are inadequate.
- Very nice balance of data collection, economic analysis, education, tool development and technology innovations.

Question 5: What degree and impact does Program interaction have on industry, universities, and federal agencies, as well as comparable international actors and other stakeholders?

- Many different labs appear to be working on variations of a similar project. Inter-laboratory communication should improve with some of the latest initiatives as well.
- One of the greatest impediments to hydro advancement and development is dealing with the federal regulatory bureaucracy. An objective DOE "audit" of the federal regulatory process could serve to open some eyes in Washington.
- This is a real strength of this program. This program has projects which interact directly with industry, universities and other federal agencies. This is very good.
- One concern is the internal cooperation/collaboration between the program projects. There were several projects where it appeared that they were doing some very similar things. It was difficult to determine if these projects were collaborating (good) or duplicating efforts (bad).
- The program recognizes the need to interact with stakeholders, however, DOE may want to identify other means to interact with utilities and private power producers as the methods exhibited by some award recipients did not result in as much involvement as one might expect.
- Although DOE has reached out to industry in the past, it is important that DOE continue to reach out and increase industry input.
- Many of the projects seem to be focused on producing a report. There is no money for "selling" the results. Coordinating with the DOE Office of Electricity interconnection wide studies may be a good way to communicate the hydro message to the power industry not directly involved with hydro projects or operations.
- This evaluation form incorporates collective scores for projects PD-02, 02, 08, 18, and 32. Review Panel requested information on specific interfaces among labs and deliverables from one lab to another. What, when and where is responsible for final integrated product(s)? See "Key Findings and Opportunities for Enhancement", a joint statement by the Peer Review Panel for overall opinions and suggestions for improvement.
- Program interaction reflects a close and appropriate coordination with other institutions - industry, universities, federal labs, agencies, industry, and organizations such as the Electric Power Research Institute and WECC. Perhaps could strengthen interaction with non-governmental organizations (NGOs) and foreign entities with special expertise that would be useful.

Program Strengths

- Getting some good programs founded and moving forward to answer needed questions and provide information for policy makers.
- Stimulating new technologies which may not otherwise have moved forward.
- Hopefully encourages labs to start working together more effectively.
- There is some very solid and impressive work being done by the program in a multitude of areas.
- The DOE can provide an objective view in dealings with industry, federal regulatory agencies, and NGOs.
- Highly energetic and committed DOE staff.
- Broad portfolio.
- Educational programs.
- The great diversity of expertise among labs.
- Diverse portfolio of projects and breadth of collaboration and communication with others.
- Strong educational component.

Program Weaknesses

- A lot of national lab involvement. This is not totally bad if non-laboratory involvement also takes place to catalyze work outside the lab which will help the industry.
- Overlapping projects appear to create some inefficiency.
- There appear to be some gaps between a couple of the research projects and practical, real-world situations.
- Get the feeling that there could be more work by recipients to better understanding who end users will be.
- Many projects still at initiation level. Such projects need to clearly identify expected products and outcomes of any efforts to date.
- Failure to look to industry to identify needs with respect to some projects.
- Need a somewhat broader view of conflicting water uses and hydrologic variability in order to meet all challenges to hydropower.

Recommendations

- Get more industry involvement where it makes sense.
- Organize some of the projects with job exchange with industry to lift up industry technologies where it makes sense.
- Peer reviews every two years do not seem appropriate when the projects go only two years in many cases. Too short. Should be one per year.
- Better coordination between SRA and DOE to get better and timelier material to peer reviewers. Had missing material, late deliveries. Numbered agenda and projects were good improvements. The review workbooks could be better prepared to have summaries where wanted and where not. Would eliminate confusion on peer reviewers' part.
- Heartily applaud the DOE efforts and openness with the Peer Review process. By engaging and responding to a broad range of diverse industry perspectives, the DOE Water Power Program will be able to adjust course and stay on a sound path of continuous improvement. Hats off to the Program.
- A lot can happen in two years between reviews and projects could veer significantly away from the peer review anticipated results and expectations. Many projects might wrap up without any additional opportunity for course adjustment or enhancement. It would seem appropriate to have more frequent status reports or web meetings to go over progress and future direction on a semi-annual basis in between the bi-annual face-to-face meetings. The concept of Advisory Boards is

also a very good idea that could pull representatives from across industry and academia along with researchers.

- Increase effort to manage the larger more complex awards.
- Increase ability to monitor for integration amongst team members to reduce potential for duplication.
- Confirm that the appropriate quality assurance and quality control exists for award recipients to assure that data used within the Program is utilized appropriately by recipients.
- Require recipients to have a minimum level of outreach/communications planned to educate outside users of the products that have been created.
- Perhaps focus several projects collectively on one or more river basins and integrate several of the concepts in describing the system in a comprehensive manner. For the site specific tool development, perhaps build a simulation capability for a specific basin as a demonstration and support vehicle for potential users to be able to bring up on their computers for use in understanding the system behavior and possible evaluation of potential sitings, etc. through "gaming", geographic information systems and modeling based analyses.
- The industry (end-users) should play a role in most projects where there are product deliverables.

8.0 Lessons Learned from the 2010 Water Power Peer Review Meeting Process

The 2010 Water Power Peer Review meeting took place on October 19-20 in Denver, Colorado. The Peer Review Panel was comprised of seven conventional hydropower experts. Overall, 37 individual projects were evaluated: eight Technology Development projects, twenty-eight Market Acceleration projects, and one ARRA-funded project. Additionally, the overall performance of the Wind and Water Power Program in the Conventional Hydropower focus areas was evaluated. The following is a list of comments and actionable recommendations aimed at improving the process for future Water Power Peer Review Meetings:

- The entire Peer Review Panel was satisfied with the efforts put-forth in all phases of the review process, including planning, coordinating, facilitating, and report writing.
- Future project reviews should clearly distinguish the method or tool for broad scale/regional analyses versus tools intended for site specific evaluation of trade-offs, mitigation planning, and alternative operating strategies.
- The information being produced by the Program has potential value beyond the boundaries of the DOE. For example, the Program could potentially supply information that would allow hydro power generation to be included in and evaluated against a list of generation alternatives as part of a program funded by the Office of Electricity. Studies of the various futures can provide information as to the hydro power sites that may be chosen and the forecasted operation of those sites. Sensitivity scenarios also could determine the subsidies that would be needed to move hydro power into a competitive position in the choice of generation alternatives and could help evaluate policy that would enable hydro power to be constructed.
- Having a national economic evaluation of the hydropower projects would bring focus on those projects with the highest likelihood of being developed. A utility or group of utilities may become aware of the potential and do the work required to bring a project to the permitting stage. Rather than just identifying the projects, a conclusion about the future of hydropower on a national scale could be developed.
- The Review Panel enrollment process, including the modification of the consulting agreement and reimbursement process should be evaluated for improvement.
- Potential conflict of interest issues and clarifications should be discussed with the panel members earlier in the process.
- Some panel members suggest distributing the information packets (presentations, statement of project objectives, evaluation forms, etc.) to the reviewers earlier in the peer review process. This would enable the reviewers to perform initial qualitative and quantitative analyses prior to attending the meeting and observing the presentation by the principal investigator (PI). Reviewers would then be able to more easily focus on and capture additional key points that they may otherwise miss when trying to comment on and evaluate the projects during the presentations. Evaluations would be modified after the presentations from the PIs.
- Some of the presentations and materials handed out prior to the review were incomplete and could have been better prepared.

APPENDICES

Appendix A. Meeting Attendee List

Appendix B. General Project Evaluation Forms (Technology Development and Market Acceleration.

Appendix A: Meeting Attendee List

U.S. Department of Energy, Wind and Water Power Program Water Power Peer Review, October 19 & 20, 2010 Denver, Colorado		
Last Name	**First Name**	**Organization**
Battey	Hoyt	U.S. Department of Energy
Bevelhimer	Mark	Oak Ridge National Laboratory
Brown	Stephen	
Chajed	Pushkar	LCG
Cimbala	John	Penn State University
Dipi	Sidart	LCG
Dixon	Doug	Electric Power Research Institute
Fisher	Richard	Hydro Insights
Foraker	Erin	U.S.BR
Fry	Christopher	U.S. Department of Energy
Gasper	John	Argonne National Laboratory
Geerlofs	Simon	Pacific Northwest National Laboratory
Hadjerioua	Bo	Oak Ridge National Laboratory
Hall	Doug	Idaho National Laboratory
Hayse	John	Argonne National Laboratory
Hetrick	Shelaine	Oak Ridge National Laboratory
Hoesly	Ryan	SRA International
Jampani	Srinivas	
Jepsen	Rich	
Johnson	Jesse	SRA International
Key	Tom	EPRI
Krump	Gina	SRA International
Lewis	Greg	Duke Energy
Linke	Deborah	Hydro Research Foundation
Lowry	Tom	Sandia National Laboratories
March	Pat	HPPi
Martinez	Andrew	National Renewable Energy Laboratory
Moreno	Alejandro	U.S. Department of Energy
Murphy	Michael	HDR Engineering Inc.
Osborn	Dale	Midwest ISO
Partyka	Eric	SRA International
Ramsey	Tim	U.S. Department of Energy
Richmond	Marshall	
Rogers	Lindsey	Electric Power Research Institute
Rylander	Matthew	EPRI
Sale	Michael	Oak Ridge National Laboratory
Short	Walter	
Smith	Brennan	Oak Ridge National Laboratory
Spray	Michael	Water Power Technology Development
Stalnaker	Clair	United States Geological Survey (retired)
Starke	Michael	Oak Ridge National Laboratory

U.S. Department of Energy, Wind and Water Power Program Water Power Peer Review, October 19 & 20, 2010 Denver, Colorado		
States	Jennifer	Pacific Northwest National Laboratory
Tegen	Suzanne	National Renewable Energy Laboratory
Tisch	Raphael	U.S. Department of Energy
Vaughn	Brenna	Hydro Research Foundation
Veselka	Tom	Argonne National Laboratory
Wigmosta	Mark	Pacific Northwest National Laboratory
Zagona	Edie	University of Colorado
Zayas	Jose	

Appendix B. General Project and Program Evaluation Forms

The evaluation forms were the only means by which Reviewers documented their quantitative and qualitative project evaluations. Separate evaluation forms were used to document reviewer scores and comments regarding: 1) Technology Development and Market Acceleration projects, 2) ARRA-funded projects, and 3) an overall evaluation of the Program.

The panel was asked to rate the Technology Development and Market Acceleration projects in the following weighted categories:

1. **Relevance to Overall DOE Objectives:** the degree to which the project supports the objectives, goals, and approaches of the Water Power Program. (Stand Alone Metric)
2. **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:** degree to which the project has progressed compared to the latest project schedule and goals. (Weight = 30%)
4. **Research Integration, Collaboration, and Technology Transfer:** with industry/universities/other laboratories – the degree to which the project interacts, interfaces, or coordinates with other institutions and projects, and the degree to which projects are disseminating the results of the R&D. (Weight = 20%)
5. **Proposed Future Research:** the degree to which the project has effectively and logically planned future work by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and when sensible, mitigating risk by providing alternate development pathways. (Weight = 20%)

The panel was asked to rate the ARRA funded projects in the following weighted categories:

1. **Relevance to Overall DOE Objectives:** the degree to which the project supports the objectives, goals, and approaches of the Water Power Program. (Stand Alone Metric)
2. **Approach**: the degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers. (Weight = 50%)
3. **Technical Accomplishments and Progress:** degree to which the project has progressed compared to the project schedule and goals. (Weight = 50%)

Additionally, the Program Evaluation forms were designed to capture input regarding the following criteria:

1. **Objectives:** how well do Program objectives align with industry needs?
2. **Barriers:** has the Program identified the critical barriers to sustaining hydropower development and deployment?
3. **Approaches:** are current Program approaches appropriately and effectively designed and implemented in order to achieve objectives and overcome technical and non-technical barriers?
4. **Projects:** has the Program formed an effectively balanced portfolio of projects that will contribute to achieving its goals and objectives?
5. **Communication & Collaboration:** degree and impact that Program interaction has on industry, universities, Federal agencies, as well as comparable international actors and other stakeholders.

For project evaluations, numerical scores were based on a four point scale, with the following qualitative descriptors given for the numerical scoring index:

- **4 – Outstanding**. Project is critical to supporting the objectives, goals, and approaches of the Program.
- **3 – Good**. Most project aspects support the objectives, goals, and approaches of the Program.
- **2 - Fair**. Project partially supports the objectives, goals, and approaches of the Program.
- **1 – Poor**. Project provides little support to the objectives, goals, and approaches of the Program.

For the Program evaluation, numerical scores were based on a four point scale, with the following qualitative descriptors given for the numerical scoring index:

- **4 – Outstanding**. All Program objectives fully support industry needs.
- **3 – Good**. Most Program objectives support industry needs.
- **2 - Fair**. Some Program objectives support industry needs.
- **1 – Poor**. Very few Program objectives support industry needs; objectives should be re-evaluated and revised.

Additionally, all three evaluation forms were designed to capture reviewer input regarding the strengths and weaknesses for a specific project or the Program as a whole.

The following templates represent the Technology Development and Market Acceleration projects, ARRA-funded projects, and Program evaluation forms.

2010 U.S. DOE Water Power Peer Review
Project Evaluation Form

Project Name: | **Reviewer:**

Presenter Name: _____ **Presenter Org:** _____

Provide specific, concise comments to support your evaluation.

Relevance to overall DOE objectives – the degree to which the project supports the objectives, goals, and approaches of the Water Power Program. Please see attached document for program objectives, goals and approaches. **(Stand Alone Metric)**

score

- **4 - Outstanding.** Project is critical to supporting the objectives, goals, and approaches of the Program.
- **3 - Good.** Most project aspects support the objectives, goals, and approaches of the Program.
- **2 - Fair.** Project partially supports the objectives, goals, and approaches of the Program.
- **1 - Poor.** Project provides little support to the objectives, goals, and approaches of the Program.

Comments

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1. 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

- **4 - Outstanding.** Well designed and technically feasible; continue to move forward with this approach.
- **3 - Good.** Generally effective.
- **2 - Fair.** Has significant weaknesses; and requires significant improvement.
- **1 - Poor.** Not effective to meet objectives; a new approach should be developed.

Comments

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2. Technical Accomplishments and Progress – degree to which the project has progressed compared to the latest project schedule and goals. **(Weight = 30%)**

4 - Outstanding. Excellent progress; little to no monitoring needed for project completion(once a month or less).

3 - Good. Significant progress made. The project needs regular monitoring (once a month depending on the project).

2 - Fair. Modest progress made; regular project monitor needed (two times a month).

1 - Poor. Little or no demonstrated progress made. (Project needs to be monitored regularly - once a week or more frequently; OR major course correction needed)

score

Comments

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3. Research Integration, Collaboration, and Technology Transfer – with industry/universities/other laboratories – the degree to which the project interacts, interfaces, or coordinates with other institutions and projects, and the degree to which projects are disseminating the results of the R&D. **(Weight = 20%)**

4 - Outstanding. Close, appropriate coordination with other institutions; partners are full participants.

3 - Good. Some coordination exists; full/needed coordination could be accomplished easily.

2 - Fair. A little coordination exists; full/needed coordination would take significant effort.

1 - Poor. Most work is done at the sponsoring organization with little outside interaction.

score

Comments

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4. Proposed Future Research – the degree to which the project has effectively and logically planned future work by incorporating appropriate decision points, considering barriers to the realization of the proposed technology and when sensible, mitigating risk by providing alternate development pathways. **(Weight = 20%)**

4 - Outstanding. Excellent progress toward objectives; suggests that barrier(s) will be overcome.

3 - Good. Significant progress toward objectives and overcoming one or more barriers.

2 - Fair. Modest progress in overcoming barriers; rate of progress has been slow.

1 - Poor. Little or no demonstrated progress towards objectives or any barriers.

score

Comments

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Project Strengths

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Project Weaknesses

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Recommendations for Additions/Deletions to Project Scope

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Project Number: _____ **Reviewer:** _____

2010 U.S. DOE Water Power Peer Review
ARRA Project Evaluation Form

Project Name: | **Reviewer:**

Presenter Name: _____ **Presenter Org:** _____

Provide specific, concise comments to support your evaluation.

Relevance to overall DOE objectives – the degree to which the project supports the objectives, goals, and approaches of the Water Power Program. Please see attached document for program objectives, goals and approaches. **(Stand Alone Metric)**

score

4 - Outstanding. Project is critical to supporting the objectives, goals, and approaches of the Program.
3 - Good. Most project aspects support the objectives, goals, and approaches of the Program.
2 - Fair. Project partially supports the objectives, goals, and approaches of the Program.
1 - Poor. Project provides little support to the objectives, goals, and approaches of the Program.

Comments

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1. Approach – the degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers. **(Weight = 50%)**

score

4 - Outstanding. Well designed and technically feasible; continue to move forward with this approach.
3 - Good. Generally effective but could be improved.
2 - Fair. Has significant weaknesses; and requires significant improvement.
1 - Poor. Not effective to meet objectives; a new approach should be developed.

Comments

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2. Technical Accomplishments and Progress – degree to which the project has progressed compared to the project schedule and goals. **(Weight = 50%)**

4 - Outstanding. Excellent progress; little to no monitoring needed for project completion(once a month or less).

3 - Good. Significant progress made. The project needs regular monitoring (atleast once a month or more).

2 - Fair. Modest progress made; regular project monitor needed (atleast two times a month; or may be

1 - Poor. Little or no demonstrated progress made. (Project needs to be monitored regularly - once a week or more frequently; OR major course correction needed)

score

Comments

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Project Strengths

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Project Weaknesses

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Recommendations for Additions/Deletions to Project Scope

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Project Number: **Reviewer:**

2010 U.S. DOE Water Power Peer Review
Program Evaluation Form

Program: **U.S. DOE Water Power Program**

Presenter Name: _____ **Presenter Org:** **U.S. Department of Energy**

Provide specific, concise comments to support your evaluation.

1. Objectives - how well do Program objectives align with industry needs?

Objectives	• *Increase the total contribution of conventional hydropower plants to the renewable energy portfolio in the U.S.* • *Bring new hydropower technologies that have improved energy and environmental performance characteristics into commercial readiness* • *Reduce barriers to new development, such as regulatory risks and expense*

4 - Outstanding. All Program objectives fully support industry needs.
3 - Good. Most Program objectives support industry needs.
2 - Fair. Some Program objectives support industry needs.
1 - Poor. Very few Program objectives support industry needs; objectives should be re-evaluated and revised.

score

Comments

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2. Barriers - Has the Program identified the critical barriers to sustaining hydropower development and deployment?

Identified Barriers	**Issues with development incentives**	**Expensive and uncertain regulatory process**
	• *Not aligned with resource value and potential*	• *Time-consuming/costly permitting process and associated litigation*
	• *High capital costs and long payback periods*	• *Renewed licenses often reduce generation and operation flexibility*
	• *Lack of markets for grid services*	**Technology costs remain high in certain sectors**
	• *Competing water uses get priority*	• *Small hydropower and pumped storage technologies remain expensive*
	• *Limited policy support*	• *Limited deployment of innovative R&D*

4 - Outstanding. Program has correctly identified all of the critical barriers.
3 - Good. Program has identified most of the critical barriers.
2 - Fair. Program has identified some of the critical barriers.
1 - Poor. Program has not correctly identified the critical barriers; barriers should be re-evaluated and revised.

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3. Approaches - are current Program approaches appropriately and effectively designed and implemented in order to achieve objectives and overcome technical and non-technical barriers?

Program Approaches	**Support immediately-available, low-cost upgrades and feasibility studies to identify additional opportunities** • *Deployment support for immediate, lowest-cost opportunities (ARRA)* • *Feasibility studies to identify and publicize additional low-cost, advanced-technology opportunities; targeted deployment support to catalyze private sector investment* • *Develop operational tools to maximize generation at existing and new facilities*
	Identify resources and address technology/policy needs to maximize medium-long term opportunities • *Integrate resource assessments and cost curves with key pumped storage and small hydro technology needs to identify critical COE drivers* • *Market analysis to accurately quantify and monetize hydropower ancillary services*
	Engage regulators and environmental stakeholders to reduce license time and cost • *Align energy generation and environmental priorities across river basins to facilitate development* • *Generate data to more accurately correlate generation and water use with environmental impacts*

4 - Outstanding. Program has implemented appropriate and effective approaches.
3 - Good. Most of the approaches implemented by the Program are appropriate and effective.
2 - Fair. Some of the approaches implemented by the Program are appropriate and effective.
1 - Poor. Approaches are not appropriate or effective; Program should be re-evaluate and revise approaches.

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Comments

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4. Projects - has the Program formed an effectively balanced portfolio of projects that will contribute to achieving its goals and objectives?

4 - Outstanding. Extremely effective and well-balanced portfolio of projects.
3 - Good. Generally effective and well-balanced portfolio of projects.
2 - Fair. Project portfolio has significant weaknesses and could be improved.
1 - Poor. Poorly balanced project portfolio; unlikely to contribute to achieving goals and objectives.

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Comments

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5. Communication & Collaboration - degree and impact that Program interaction has on industry, universities, Federal agencies, as well as comparable international actors and other stakeholders.

4 - Outstanding. Close, appropriate coordination with other institutions.
3 - Good. Some coordination exists with other institutions.
2 - Fair. A little coordination exists with other institutions.
1 - Poor. Little to no outside interaction occurs with other institutions.

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Program Strengths

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Program Weaknesses

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Recommendations

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