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

WIND AND WATER POWER PROGRAM

2012 Wind Power Peer Review Report

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

June 2012
Alexandria, VA

Cover photo is courtesy of the U.S. Department of Energy and the National Renewable Energy Laboratory. The Greensburg Wind Farm is comprised of 10 1.25-MW wind turbines, supplying a total of 12.5-MW of renewable wind power to the town.

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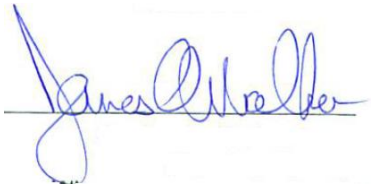

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Prologue

Dear Colleague:

On behalf of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Wind and Water Power Program, I am pleased to announce the release of the 2012 Wind Power Peer Review Report. The Wind Power Peer Review Meeting was held June 19-22, 2012 in Alexandria, VA. Principle investigators from nine national labs and several academic and industry representatives presented the progress of their DOE-funded research. This report documents the formal, rigorous evaluation process and findings of nine distinguished, independent reviewers who examined the technical, scientific, and business results of 67 projects of the Wind Program, as well as the productivity and management effectiveness of the Wind Program itself.

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

The mission of the Wind Program is to enable rapid and responsible expansion of clean, affordable, reliable, and domestic wind power to promote national security, economic vitality, and environmental quality. Consistent with the Under Secretary of Energy's direction, regular peer reviews are held to ensure the program is investing taxpayer dollars in the most effective and efficient manner in order to realize the primary mission of the Program.

Sincerely,

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

1.0 Introduction

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

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

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

On June 19 – 22, 2012, the U.S. Department of Energy (DOE), Office of Energy Efficiency and Renewable Energy (EERE), Wind and Water Power Program (herein referred to as the "Wind Program" or the "program") conducted its biennial Wind Power Peer Review at the Hilton Alexandria Mark Center Hotel in Alexandria, VA. In accordance with the EERE Peer Review Guide, the review provides an independent, expert evaluation of the strategic goals and direction of the program and is a forum for feedback and recommendations on future program planning. The purpose of the review was to evaluate DOE-funded projects for their contribution to the mission and goals of the program, to assess progress made against stated objectives, and to assess the program's overall management and performance. Principal Investigators (PI), leading 67 projects, and federal program staff came together to disseminate information, progress, and results.

As part of the 2012 U.S. DOE Wind Power Peer Review, projects in three overall program areas were evaluated by nine reviewers. The three overall program areas included projects from the following research areas:

General and Cross-Cutting	Technology	Market Acceleration and Deployment
Laboratory Testing Facilities	Characterizing Turbine Inflow	Wildlife and Environment
Large Facilities	Offshore	Outreach and Education
University Consortia	Manufacturing and Materials	Small and Mid-Sized Wind
	Design Tools and System Modeling	Radar Mitigation and Solutions
	Reliability	Market Research and Analysis
	Rotor Technology	Forecasting Improvement
	Controls	Grid System Planning and Operations

Each project was reviewed by a minimum of three expert reviewers who provided both numeric evaluations and written comments. Additionally, one overall chairperson, Dr. James Walker, was selected to oversee the entire peer review process. The chairperson provided oversight and guidance to ensure consistency, transparency, and independence throughout the review process.

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

The objectives of the 2012 peer review meeting were to:

- Review and evaluate the strategy and goals of the Wind Program;
- Review and evaluate the progress and accomplishments of the program's projects funded in fiscal year (FY) 2010 and FY 2011; and
- Foster interactions among the national laboratories, industry, and academic institutions conducting research and development on behalf of the program.

A rigorous peer review was conducted as a four-day event. The first three days focused on presentations given by Wind Program staff and the Principal investigators of the 67 projects that were evaluated. On the fourth day, reviewers convened in a separate location to provide an initial summary of their findings to the Wind Program staff, and to discuss their initial impressions of the reviewed projects.

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

1.1 Peer Review Panel Members

A peer review panel was commissioned to conduct the formal peer review aspect of the meeting. The peer review panel (hereafter called reviewers or panel members) was comprised of experts from a variety of wind power-related backgrounds and organizations, including laboratories, industry, and academia. Reviewers evaluated the progress and relevance of Wind Program-funded projects, as presented by the Principal Investigators (PIs) of those projects during the meeting. The projects were evaluated according to a defined set of criteria in this document. Reviewers also provided a detailed quantitative and qualitative evaluation of the Wind Program. Reviewers were screened to ensure no conflicts of interest existed with regard to the specific projects for which they submitted reviews. Reviewers recused themselves if they worked on projects, had other relationships with project team members, or if they had a financial interest in the subject matter. Table 1.1 below lists the 2012 Wind Power Peer Review Panel Members.

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

Table 1.1: 2012 Peer Review Panel Members

Name	Affiliation
2012 Wind Power Peer Review Chairperson	
Dr. James Walker	enXco
2012 Wind Power Peer Review Panel Members	
Mark Ahlstrom	WindLogics (NextEra)
Blake Butler	Sacramento Municipal Utility District
Dr. P. Barry Butler	University of Iowa and AWEA R&D Committee Co-Chair
Warren Lasher	ERCOT (Electric Reliability Council of Texas, Inc.)
Peter Hauge Madsen	DTU (Technical University of Denmark) Wind Energy
Amir Mikhail	Clipper
Roger Schonewald	GE and AWEA R&D Committee Co-Chair
Darlene Snow	Wind Energy Foundation

Reviewers received briefing materials via email and a Microsoft SharePoint site approximately four weeks prior to attending the meeting. This information included a 2012 Wind Power Peer Review Plan (reviewer instructions), an agenda, the PowerPoint presentations submitted to the panel members by the principal investigators, two-page project summary documents, a review of the overall goals of the program, conflict of interest forms, honorarium and travel reimbursement forms, and the Microsoft Excel evaluation workbooks (electronic format) for their assigned projects and an overall programmatic review.

1.2 Project Selection Process

Below is a description of the processes used by the Wind Program for selecting the projects that were reviewed as part of the 2012 peer review process:

1. **The Program evaluated all projects funded in FY 2011 and FY 2010 (with main focus on FY 2011)**
   - The Program used budget data, contracts with laboratories and industry recipients, and the program's project inventory database.

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

3. **Federal team leads/technology managers were provided with the project list and ranked those projects that they wanted to be presented at the review (1 = present; 2=optional; 3=exclude)**
   - Team leads selected projects based on following criteria – magnitude of funding, relevance/importance of research, and desire for peer review feedback on project. They also factored in project stage and diversity of the program portfolio in project selection.

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

5. **Additional criteria further narrowed project selection**
   - **80% of the FY 2011 budget** needed to be presented to comply with EERE peer review guidelines. Some funding was presented at a project-level and other areas were presented at a program-level.
   - **Every national lab funded in FY 2011 presented** at least one project at the review.
   - The allocated projects and subject matter areas accommodated a **two-track session** agenda.
   - The team strived for the event agenda to **reflect overall Wind Program priorities** and priority funding areas.

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

1.3 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 , although not every reviewer provided narrative evaluations for every project or review category. 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.

Each of the projects received two cumulative scores. The first score reflected the project's relevance to industry needs and overall DOE objectives. The second score is comprised of the weighted average of the following metrics: 1) methods/approach, 2) technical accomplishments and progress, 3) project management, 4) research integration, collaboration, and technology transfer, and 5) proposed future research (if applicable).

An overall score for each General and Cross-cutting, Technology, and Market Acceleration and Deployment project was calculated using a consistent weighting methodology for some of the scored criteria. Below are the weightings that were applied to each criterion:

1. **Relevance to Industry Needs and overall DOE Objectives:** the degree to which the project aligns with the objectives and goals of the Wind Program and meets the needs of the wind industry at large. (Stand Alone Metric)
2. **Methods/Approach:** the degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers. (Weight = 30%)
3. **Technical Accomplishments and Progress:** the degree to which the project has delivered results and/or

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

progressed technically compared to the stated project schedule and goals. (Weight = 30%)

4. **Project Management:** the effectiveness of the project's management, including project planning, project execution, and allocation of resources to complete the project within scope, on time, and within budget. (Weight = 20%)
5. **Research Integration, Collaboration, and Technology Transfer:** the degree to which the project successfully interacts, interfaces, or coordinates with other institutions and projects, and the degree to which the projects is disseminating the results of the R&D. (Weight = 10%)
6. **Proposed Future Research (if applicable):** the degree to which the future research proposed is relevant, well planned, and worthwhile for continued funding. (Weight = 10%)

For project evaluations, numerical scores were based on a five-point scale, with qualitative descriptors given for the numerical scoring index (i.e., a score of 1 corresponds to a "Poor" rating, 2 corresponds to a "Fair" rating, 3 corresponds to an "Average" rating, 4 corresponds to a "Good" rating, and 5 corresponds to an "Outstanding" rating). In addition to the above six criteria, peer reviewers were asked to provide an overall qualitative assessment of the project in a written narrative. Reviewers were asked to comment on overall strengths and weaknesses, and to include recommendations for ways to improve the projects.

As part of the 2012 Wind Power Peer Review, reviewers were also asked to provide comments and numeric scores as part of an overall evaluation of the Wind Program based on the four aspects listed below:

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

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

The formula listed below was used to calculate the overall weighted average scores of the General and Cross-Cutting, Technology, and Market Acceleration and Deployment projects in order to provide a means for comparing a project's final overall score equivalently to other projects:

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

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

The project comparisons illustrated in the report are criteria based. Figure 1.1 represents a sample project score graph. Each rectangular "light" blue bar in the chart represents that project's average score for one of the five designated criteria. The "dark" blue bar on the left is the Relevance (stand-alone) metric, and the "dark" blue bar on the right is the Weighted Average Overall Score for the project. These scores (all blue bars) are then compared with the related maximum, minimum, and average scores for the same criterion across all General and Cross-Cutting, Technology, and Market Acceleration and Deployment 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.

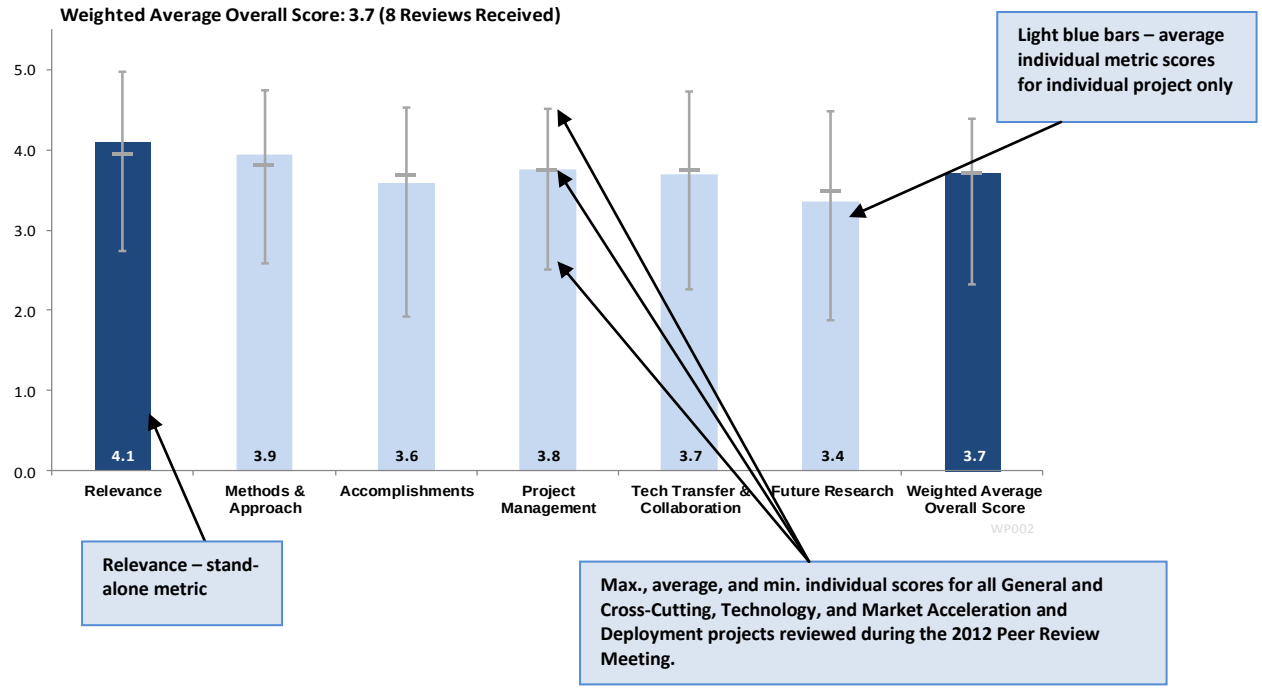


Figure 1.1. Project Score Graph with Explanation

For clarification, consider a hypothetical review in which only five projects were presented and reviewed in a sub-program; Table 1.2 displays the average scores for each of the project's five rated criteria.

Table 1.2: Sample Project Scores

	Relevance (stand-alone)	Methods/ Approach (30%)	Technical Accomplishments and Progress (30%)	Project Management (20%)	Research Integration, Collaboration, and Technology Transfer (10%)	Proposed Future Research (10%)	Weighted Average Overall Score
Project A	3.4	3.0	2.9	2.7	3.2	2.8	2.9
Project B	3.1	2.8	2.7	2.7	2.8	2.5	2.7
Project C	3.0	2.4	2.7	2.9	3.4	2.6	2.7
Project D	3.4	2.6	3.0	3.1	3.0	2.5	2.9
Project E	3.6	2.8	3.1	3.2	2.7	2.7	3.1
Max	3.6	3.0	3.1	3.2	3.4	2.8	3.1
Average	3.3	2.7	2.9	2.9	3.0	2.7	2.9
Min	3.0	2.4	2.7	2.7	2.7	2.5	2.7

The Project A chart would contain seven 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 across all projects evaluated. 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 following sections of this report provide:

- Recommendations and key findings of the peer review panel and program response,
- Wind Program budget and structure,
- Quantitative and qualitative analyses of the General and Cross-Cutting, Technology, and Market Acceleration and Deployment 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 2012 Wind Power Peer Review Meeting Process,
- Acronyms list,
- Project evaluation templates,
- Program evaluation template,
- Meeting agenda, and a
- Meeting attendee list.

2.0 Recommendations and Key Findings of the Peer Review Panels

Below are programmatic findings and recommendations that were compiled from the comprehensive collection of reviewer comments. The comments presented below are focused on the Panel's overall observations and impressions of the Wind Program (also referred to as "the program"). All detailed reviewer comments and scoring evaluations regarding the program are included in Section 7.0 of the report. Additionally, all detailed reviewer comments and scoring evaluations on individual projects are included in Sections 4 through 6 of the report.

Key Findings and Recommendations:

- The 2012 peer review meeting was more engaging, better organized, and had some more exciting presentations compared to previous years.
- The Panel was impressed by the quality, depth, breadth, and relevance of the program.
- Program objectives are complete, but there is some disagreement regarding prioritization and budget allocation issues.
- Now may be the perfect time to refresh a collective vision for the program. A lot has changed since the 2008 20% Wind Energy by 2030 Report, including major improvements in technology and the current downturn in market conditions.
- Many of the projects reviewed involved small scope with small budgets. A more effective and efficient approach would be to fund fewer projects with larger scope and larger budget.
- The program deserves great credit for technology advancement to a lower levelized cost of energy (LCOE).
- *American Recovery and Reinvestment Act (ARRA)* funding appeared to be well invested and well managed.
  - Upgrading of the national testing facilities were good investments.
  - The concept of the university consortia was well conceived, however some have performed better than others and selection criteria for consortia partners could be elaborated upon.
- *Offshore wind* is a strategic national initiative of unprecedented proportions for the wind industry.
  - The initiative appears to total $300 million when accounting for cost-share, testing facilities, etc.
  - The Panel is worried that there may be too much emphasis on offshore wind, perhaps at the expense of the land-based technology. The Panel believes that *offshore wind and land-based wind are complementary*. In the time frame to 2020, land-based wind will provide 125 GW of the 135 GW deployment target.
  - It is really important that these projects are correctly executed and successful. There is a big risk associated with these projects, and the program should consider the downside and/or impacts of failure. Most of the sites are near large, east coast population centers, so the results of these projects are likely to form public perception of the entire wind industry.
  - The Panel strongly believes the program has as vital and justified role in realizing LCOE and deployment goals for land-based wind in the 2020 time frame as it does for offshore. Meeting the technology and deployment goals for land-based wind will require less funding than offshore efforts since major demonstration projects for land-based will not be needed.
- In the area of *technology development*, the program should continue to focus on large machines.
  - A tightening U.S. market will diminish the amount of funding industry is able to put into R&D, and reduced funding will mean reduced opportunity for pushing innovation.

  - The focus should be widened to wind plant optimization, which industry developers won't necessarily address.
  - The program should continue to support the land-based and offshore large turbine optimization focus; include wind plant optimization as well, but keep some money earmarked for wild, radical innovations. Keep this openness. Do not force everything into a systems engineering mindset.
- The *radar mitigation* work by the program is a great success story.
- The Panel believes that *wildlife studies* on a large scale are required to mitigate major barriers.
  - Baseline studies on sage grouse, Indiana bats, prairie chickens, etc. are needed.
  - The next few years of slow/low deployment provides a good window for the program to resolve these wildlife issues.
  - Industry wants a data repository for wildlife information.
- *Grid integration research and transmission* are key areas.
  - The industry is missing a connection between the grid operators and industry with regard to wind integration costs. DOE can play a role in improving this connection.
  - Some of these transmission level issues are serious barriers, and we run the risk of not understanding the issues before the problems hit us. Not addressing these issues could really put a big damper on future wind development.
- *Integration and deployment work* is the best bang for the buck and is currently underfunded. Some of the projects that are making the biggest impacts in removing barriers are under-funded when it comes to deployment.
- There are perceived silos between the Office of Energy Efficiency and Renewable Energy Programs and the Office of Electricity Programs, with respect to integration and transmission activities.
- The *Wind Powering America Initiative* is incredibly valuable and underfunded. The program should consider rebranding this effort. Even though the political climate may not be the best, the program should have a strategy and budget prepared to scale up the outreach program.
- The program has insufficient resources dedicated to *marketing and communication*. The program has funded research and activities resulting in important, valuable results, but these data and findings are not widely available or easily found by industry and academia. Additionally, publishing results is not the same as communicating impact. The program needs to make bigger commitments to making its research results publicly and easily accessible *and* developing strategies and mechanisms for summarizing and effectively communicating impact of this work to its target audiences.
- Clear attention has been paid to defining the appropriate role for the federal government in the following areas:
  - **Standards Development:** The wind industry, due to stop/start policies, is not yet ready to take on this task, which can require several Production Tax Credit (PTC) cycles to complete. It is appropriate for the program to continue these efforts with involvement from industry.
  - **Data Sharing and Data Aggregation:** The program needs to make data easily accessible and available to users.
  - **Modeling and Model Development**: Modeling and model development offers an important public benefit since industry does not have adequate funds or aligned interests to conduct work in this area. The software, database, and models development is outstanding work and is a major asset to the country. The open-source tools are substantially more useful than the proprietary or large, cumbersome tools of the past.

- **Grid Integration:** This work is perfect for the federal government. The Panel believes these studies are most effective with large stakeholder engagement, and NREL and SNL currently stand out as laboratories doing a better job at stakeholder involvement.
- **Design Tools**: The federal government lends credibility and has the funds to push the next generation designs (especially open-source). More emphasis should be given to the validation of tools with field measurements.
- **Wildlife Studies**: These studies are long-term, costly, and unrewarding for the industry to undertake. However, they are vital to furthering the industry, have a large federal role component, and are valuable during an industry downturn. These studies should have an end date, as there is a perception in the industry that these become perpetual projects. The projects should be better communicated to inform the general public and key decision makers that these issues are being studied and progress is being made. Mitigation measures should be improved and approved in cases where the wildlife studies remain long-term. It is an effective use of program money because it would cost the industry approximately one billion dollars for all the studies required to reach 20% wind penetration[4].
- **Small/Distributed Wind Turbine Certification**: Small and community wind are the front door to the industry, and while their output is dwarfed by commercial scale deployments in terms of total megawatts, the marketing and community acceptance aspects of distributed/small/community wind are substantial. The Panel recognizes that small wind is an important component of the portfolio, but believes the cost effectiveness of the certification programs must continue to be improved.
- **Education and Outreach**: There is a strong justification for education and outreach in all of the previously mentioned program areas. For this reason involvement of key universities in the program is supported.

Opportunities for Enhancement:

- The program should clarify the roles of each national laboratory and identify the main area of expertise or core competencies of each laboratory.
- Coordination and use of the new national testing facilities can be improved. In particular, the program should articulate the role for each facility and establish expectations on how they should be collaborating and coordinating.
- A transition strategy for the future of some of the university consortia should be developed by the program, to ensure independence and long-term viability. It is also recommend that future university funding opportunities be available beyond the consortia winners.
- The program needs to re-balance the offshore wind and land-based wind efforts.
- The program should look to increase collaboration in the climate change area. China, Europe, and Brazil will be expanding efforts over the next several years, possibly presenting the program with new opportunities for collaboration.
- In addition to a reduction in LCOE, the program should consider including a "portfolio value" metric that can better capture the grid-aspects of wind and other power generation sources as well as an education objective.
- The program should look to increase collaboration with the Office of Electricity.

[4] To reach 300 GW wind by 2030 (20% wind), 250GW must be installed in addition to the 2012 installed base of ~50GW. With wildlife studies (pre- and post-completion) typically costing $400,000 per 100 MW project, which results in a total of $1 Billion in costs for wildlife studies to reach 20% wind. These figures are consistent with findings from industry developers and the American Wind Wildlife Institute.

- The program should provide user-friendly access (a data clearinghouse) to data systems, data, and studies, and should ensure that these tools remain user-friendly and user-relevant. In addition to establishing a clearinghouse, a push for more marketing and communication efforts is recommended.
- The program should consider some successful mechanisms used in Europe, such as:
  - Mission-oriented research – where groups of industry folks meet with universities and labs to formulate strategy together. This would create more coordination with the laboratories.
  - More information exchange – trade-news consortiums may be useful to the program.

3.0 Program Response

Topic Area: Program Objectives and Strategies

- *The reviewers support the program's overall objectives of LCOE reduction and enabling increased deployment to reach 20% wind by 2030 and agree that they are aligned with industry needs and Administration priorities.*
- *The 20% Wind Energy by 2030 Report has been effective in guiding program strategy since 2008. However, given the time that has elapsed and the substantial industry changes that have occurred since 2008, the reviewers recommend that the program refresh its collective vision. This effort should include industry and public feedback.*
- *One reviewer suggests looking more broadly at a near-term clean energy scenario that includes 100GW wind within 10 years to provide organizing program principles going forward.*

The program appreciates the reviewers' confirmation that the program's objectives align well with industry needs and Administration priorities. The program agrees that the 20% Wind Energy by 2030 Report is dated and due for a refresh. These analyses are costly and resource-intensive, but important for long-term planning for both the program and the industry. In FY 2013 the program will investigate the possibilities of updating this report and re-running the analyses used to derive the 20% by 2030 deployment scenario. We would plan to include industry and other stakeholders in reviewing an updated, current, and comprehensive wind deployment scenario. The Wind Program targeted deployment of 125 GW by 2020 is more aggressive than the recommended 100 GW target in 10 years.

Topic Area: Portfolio Balance and Management

- *The program is funding a lot of projects with small budgets. Reviewers recommend consolidating this to fewer recipients with larger budgets. This can reduce administration costs and increase impact.*
- *In addition to considering a project's contributions to the LCOE and deployment objectives of the program, the reviewers recommend considering other metrics and objectives as follows. A 'portfolio value' metric and an 'education metric' could properly value the diversity of non-technology projects in the portfolio. From a utility perspective, the LCOE at delivery point is the critical number, which includes factors beyond the technology LCOE such as transmission, variability, uncertainty of resource, and market structures. Another reviewer recommended considering a program objective to maximize leverage or impact of limited government funding.*
- *The reviewers are concerned with the balance of offshore vs. land-based investments and also have concerns with the funding levels allocation for integration and market acceleration research.*

The program has taken proactive measures in FY 2012 to rationalize the portfolio into fewer, big budget programmatic thrusts. The Offshore demonstration project is a good example, funded at $20M in FY 2013 with a sustained commitment for four years beyond the initial funding period. This is in contrast to the 20% by 2030 FOA where $23M was spread across 83 different projects. The program is also taking measures to consolidate projects at the national labs. For example, in FY 2012, 137 distinct lab projects were funded. In FY 2013, the number of funded lab projects will be further reduced by 29% to 95 projects, even though overall program funding levels are constant. Additional consolidation of projects will be a continued focus of the Wind Program.

The Wind Program also concurs that additional metrics beyond LCOE and GW are insightful and beneficial for evaluating program effectiveness. The Wind Program is developing a proposed metric which better represents a Utility perspective including transmission costs and variability. The program is also funding an NREL project whose objective is to improve characterization of wind deployment barriers and provide more quantitative data to deployment challenges. The program hopes to utilize these data for further metric development of non-technology

areas in the portfolio.

Finally, balancing the Wind Program portfolio of investments in Technology Development, Offshore, Grid Integration, and Market Acceleration is an ongoing process with a wide range of inputs and prioritizations, and the Wind Program appreciates the reviewers' input. Most of the technology R&D funded by the program is deployment agnostic, and could be beneficial in developing systems need in large turbines, both for land-based and offshore deployment. We further discuss portfolio balance concerns in several sections below.

Topic Area: Management & Operations

- *The program did a better job with the organization and content of the 2012 Wind Power Peer Review relative to prior years.*
- *The reviewers are impressed with the leadership, quality, and enthusiasm of the program team including federal leadership and researchers. The strategic focus is noticeably improved compared with the 2010 Wind Power Peer Review.*
- *Projects with a critical mass of expertise are faring better than isolated researchers, especially when a stakeholder process (technical review committee) is followed early.*
- *The program really delivers unique value when it leads engagement across federal agencies on wind issues. The reviewers strongly support this continued role for the program.*
- *Several projects appeared to lack exit strategies after DOE funding and would benefit from stronger business planning assistance.*

The program appreciates the reviewers' positive feedback on the improvements relative to 2010. The program will maintain its commitment to cross-agency engagement on issues critical to the wind industry, which we recognize is a unique role for the program.

After the publication of this report the program also plans to share the best practices noted by reviewers with all funded recipients, including the practice of early and broad stakeholder engagement and stronger business planning upfront. In future planning sessions with the National Laboratories, the Wind Program will brainstorm on mechanisms to further facilitate the transfer of research efforts to industry. In future FOA opportunities, where appropriate, the program will require applicants to identify an exit strategy as part of a project's initial description and encourage our project managers and technical monitors to place greater focus on recipient business planning, especially as a project nears its funding end. Additionally, in future peer reviews the Wind Program will further emphasize presenting relevant project information related to technology transfer strategies to industry.

Topic Area: Program Information Dissemination and Technology Transfer

- *Reviewers strongly recommended that the program should create a user friendly data clearinghouse/ portal that centralizes the results and findings of program-funded research.*
- *Publishing results, however, is not the same as communicating impact. The program needs to develop better strategies and mechanisms for concisely summarizing project results in order to effectively reach target audiences like industry and stakeholders.*

The program agrees with reviewers' recommendations here and has initiated development of a central repository of project data, final reports and project abstracts. The program envisions this portal to be highly accessible by all interested stakeholders, easily searchable and providing a forum for knowledge sharing that is different from journal papers and conference presentations. The program plans to provide this data repository to an EERE web development team that is developing a web portal intended to support all EERE programs with improved research dissemination. This web portal is intended to be operational in late 2013. The ability to convey the impact of the Wind Program's research is challenging given the variability of stakeholders, but the Wind Program appreciates

the reviewers' feedback and has an internal team working to develop a more strategic, targeted communications strategy for the program.

Topic Area: University Engagement

- *The University Consortia were well-conceived and executed ARRA investments, but not all have performed equally well. The program is encouraged to identify its best partners moving forward to foster development of centers of excellence. For these partners, ensure universities are improving coordination and dialogue with the national laboratories.*

The program appreciates the reviewers' positive feedback on the ARRA investments to develop the three university consortia. Given the objectives of the ARRA investment and the fact that the funding has been allocated, the program will continue to promote the utilization and leveraging of existing project assets and partnerships toward continued wind R&D and educational efforts. The program also recognizes that there are other universities in addition to the three consortia that are conducting important wind R&D. The program will work to develop a more targeted strategy on university engagement for future years.

Topic Area: National Laboratories' Role in the Portfolio

- *The program should clarify roles of each national laboratory and identify core competencies.*
- *The program portfolio is spread too broadly across national labs. Labs with a small effort in renewables research struggle due to lack of critical mass of expertise and weaker engagement with industry and other outside stakeholders. NREL and SNL stand out as laboratories doing a better job at stakeholder engagement and industry engagement. Where it makes sense, the program should consolidate its funding to fewer labs.*
- *National labs should be growing strategic centers of excellence and not spending resources competing for funding against each other or against industry. Encourage focus and stronger inter-lab coordination.*

The Wind Program is working to clarify roles, responsibilities, and core competency areas for all of the National laboratories that participate in the program's R&D efforts. In the first quarter of FY 2013, the program will be hosting an All Labs Summit to improve DOE-lab and lab-lab coordination and collaboration. During this meeting, the program will address several of the concerns raised by reviewers.

The program continues to assess its funding strategy, to improve not only the efficiency of the program, but also to maximize the impact of our national laboratories. The program agrees with the reviewers' recommendation and in FY 2013 has consolidated nine funded labs in FY 2012 down to seven National labs in FY 2013. The program will continue in future years to apply a thoughtful, critical eye toward the number of funding recipients in the portfolio, recognizing the operational efficiencies and research benefits of a targeted portfolio.

Topic Area: International Collaboration

- *The program should consider successful mechanisms used in Europe, such as mission-oriented research groups comprised of industry, university, and lab researchers that meet regularly to formulate collective strategy (TPWind).*
- *The program should consider increased collaboration with China, Europe, and Brazil on climate change efforts.*

The program agrees with the reviewers' recommendation to develop mission-oriented research groups or hubs and will consider implementing such research hubs for projects in FY 2013 and beyond that are sufficiently large in scope and that would benefit from a diverse set of stakeholders. This would necessarily entail soliciting

feedback from lab research groups in order to provide DOE program management with a wider net of expertise to inform program strategic planning.

The program also agrees with the reviewers' recommendation to increase international collaboration. The program has recently sent representatives to Brazil and Argentina to meet with government and industry representatives interested in developing their community wind industries. Collaboration with Europe currently exists through continuing International Energy Agency (IEA) representation and related laboratory R&D projects, but we recognize the program could benefit by further strengthening relationships with European and other international research centers through increased information sharing, personnel exchange, and developing a robust process for co-funding mutually beneficial research.

Topic Area: Testing Facilities and Standards

- *The reviewers strongly support the program's role in developing national testing facilities and standards. This is a proper role for the federal government and much needed given the market instability industry is facing. The ARRA investments in national testing facilities were sound investments.*
- *The program could improve coordination across testing facilities by articulating specific roles for each facility and clarifying expectations on collaboration.*

The program appreciates the reviewers' support for these investments in our national testing facilities infrastructure. The program also recognizes that some specialization at the laboratories and role articulation could be beneficial. The program is making concerted efforts to promote increased collaboration between Clemson University and the NREL NWTC regarding cooperation and sharing of best practices related to drivetrain testing and health and safety. As noted at the 2012 Wind Power Peer Review, MassCEC is a facility oriented more towards direct industry support and services while other testing facilities have a stronger research objective in their mission.

Topic Area: Technology Portfolio

- *The program should be congratulated for its historical accomplishments in supporting development of the Zond Z750, the Enron Wind 1.5 which became the workhorse for GE, and the Clipper 2.5MW. The utility-scale American OEMs today all benefited from the DOE Wind Program.*
- *Model development and design tools are an important public benefit and an appropriate area for federal government funding. These open-source tools are outstanding work and are a major asset to the country.*
- *The reviewers support the program's strategy to focus on wind plant optimization, as this is an area industry may not address alone. The reviewers also support the program's R&D focus on developing bigger machines, especially since private R&D funding will decline with the market downturn.*
- *While the reviewers support the systems engineering framework, they also encourage the program to maintain some commitment to high-risk, radical R&D funding.*

The program appreciates the reviewers' feedback. The program will maintain its commitment to model and design tools development, as well as its strategic focus on wind plant optimization. The program agrees with the reviewers' recommendation to maintain some high-risk R&D in the portfolio. In FY 2013 the Wind Program is planning to allocate approximately 3% of the overall Wind Program budget to very high risk and yet innovative R&D activities. As envisioned now, these activities would be evenly split between academia, industry, and the National Laboratories.

Topic Area: Offshore Portfolio

- *The reviewers are concerned that there may be too much emphasis on offshore wind, at the expense of*

land-based technology and deployment efforts. The reviewers believe that land-based and offshore wind are complementary and land-based wind cost-reduction and deployment targets are more easily achievable with relatively less funding.

- *The focus on deep-water floating platforms instead of shallow fixed-bottom offshore is premature. Even if successful, the work is not protectable IP and will therefore not make significant impact to U.S. manufacturing or exports. The program should instead invest in tools and facilities to jumpstart offshore, allowing industry and the market to influence the direction of development and select the right technologies.*

The program's FY 2013 budget has allocated approximately 40% of its budget specifically to offshore wind R&D activities, half of which funds the offshore demonstration project. While the program appreciates the reviewer concerns, the program is investing in a longer-term strategic view of wind energy given the significant potential of U.S. wind resources in both shallow and deep-water offshore locations. Innovation is as important a DOE objective as our program objectives to lower LCOE and reach deployment targets. The program and DOE leadership believe there is significant innovation and U.S. manufacturing opportunity for the U.S. Wind Industry in offshore wind, especially in deep-water. Finally, a significant portion of the offshore wind funding will address deployment-agnostic issues pertinent to both land-based and offshore wind technology such as smaller and lighter drivetrains, improved condition monitoring and preventive maintenance measures.

Topic Area: Integration Portfolio

- *Grid integration work is an obvious fit for a federal government role.*
- *The grid integration portfolio is a great example of a program area doing an excellent job at stakeholder engagement, outreach, and communicating research results to industry. Given the numerous players and complexity of institutions involved, some reviewers recommend developing a more comprehensive communications plan that could scale up these outreach efforts on short notice.*
- *The integration portfolio gives the program a high return on investment and is currently underfunded. One reviewer believes this work should be equally funded with offshore in the portfolio. Investing further resources could open up significantly more and higher quality wind resource areas for development. The reviewers believe this work is essential to reach the 20% by 2030 target.*
- *Integration studies looking at reserve determination, firming resources, system reliability, and forecasting are all topics of significant interest to operators and planners. A formalized agreement with DOE Solar or Office of Electricity (OE) may enhance funding and provide maximum benefit.*
- *Transmission is a major gap in the portfolio. While some may view this as outside the Wind Program's scope, transmission issues and lack of expansion could become showstoppers on future wind deployment. They block development to many high wind resource areas in the U.S. today. Reviewers would like to see more emphasis on analysis of transmission issues such as local reliability issues, cost-effectiveness of transmission technologies needed to move power over long distances, and cost-effectiveness of local resources vs. distant wind resources.*

The Wind Program increased its funding for the Wind Program Integration Portfolio from 13% of the FY 2012 budget to 18% of the FY 2013 budget. The program agrees with Peer Review Panel that this research is essential to enable further wind deployment. The program appreciates the reviewers' positive feedback on stakeholder engagement effectiveness in this portfolio area. We will take your recommendations for further specific integration studies and transmission issues analyses and work to incorporate them into our research plan for future years. Additionally, the program agrees with the reviewers' recommendation to improve coordination with other EERE Programs, State and Federal agencies, and the Office of Electricity. Program staff participates on a DOE-wide grid technology team as well as the EERE integration task force. Both of these internal DOE working groups have been created to improve collaboration and coordination across DOE on these critical issues.

Overall renewable energy grid integration and transmission planning is currently outside of the program mission space. Grid integration activity responsibility within the Department of Energy is handled by the Office of Electricity while transmission planning is the responsibility of the Federal Energy Regulatory Commission. The Wind Program will continue to fund research on integration issues and transmission issues relevant to renewables and will maintain its broad stakeholder participation that supports larger national leadership efforts in these important areas.

Topic Area: Market Acceleration & Deployment Portfolio

- *Wildlife and radar studies are an appropriate fit for federal government support. These studies are costly, long-term, and unrewarding for industry to undertake. Further baseline studies on wildlife are needed; and the next few years of slow deployment are a good time for the program to resolve these issues.*
- *The radar mitigation research is a great success story for the program.*
- *The Wind Powering America Initiative is incredibly valued and underfunded. Regardless of political climate, the program should maintain commitment to outreach and have a strategy and budget to scale up this program. Reviewers support the intent to shift to a regional strategy.*
- *The Reviewers are concerned that this portion of the portfolio is underfunded, especially relative to offshore. Market acceleration & deployment work will be integral to reach program's 20% by 2030 goal.*

The Wind Program maintained its funding for the market acceleration and deployment portfolio at 7% of the FY 2013 Budget. Market barriers, including radar, environmental, permitting issues impacting access to higher wind classes (affecting LCOE) and constrained siting locations are a priority focal area for the program. When possible, the Wind Program will try to accelerate the pace of research and identifying solutions that can be implemented by the wind industry through increased program focus and funding.

The Wind Program recognizes the value of its outreach and education activities in increasing the public's awareness and acceptance of wind power. The Wind Powering America initiative will be transitioning to a regional focus in lieu of the prior state-based focus and will identify the counties to target, and focus the applicable Regional Resource Center (RRC) to work with those directly to mitigate barriers and accelerate wind deployment. Some benefits of the RRC strategy compared with the historical WPA operation model include: development of localized expertise and information resources to address specific, local issues and train regional entities (local federal and state/county decision makers), and leveraging larger funding pool between states to encourage a regional vision. Large scale wind, distributed wind and community wind will all benefit from the RRC activities.

4.0 Wind Program Structure and Budget

The U.S. Department of Energy's Wind Program leads the nation's efforts to improve the performance, lower the costs, and accelerate the deployment of wind technologies. The mission of the Wind Program is to enable U.S. deployment of clean, affordable, reliable, and domestic wind power to promote national security, economic growth, and environmental quality. The Wind Program has established performance goals for its research and development activities. These performance goals are to:

- Reduce unsubsidized wind land levelized cost of energy (LCOE) to be market competitive with natural gas.
- Reduce unsubsidized fixed bottom offshore wind levelized cost of energy (LCOE) to be market competitive with regional retail electricity pricing.
- Enable increasing annual installations of new wind to reach 20% Wind Energy by 2030 (300 GW deployment).

All activities in the program are targeted toward at least one of these performance goals. The program structures its research and development (R&D) portfolio into two sub-program areas: Technology and Market Acceleration and Deployment. Funding in the Technology sub-program is oriented toward achieving the LCOE cost reduction performance goals for land-based and offshore wind. The Market Acceleration and Deployment sub-program targets the 20% by 2030 deployment goal by funding activities that work to better characterize and reduce market barriers such as grid integration, wildlife, radar, and public acceptance.

For the FY 2010 and FY 2011 projects presented at the 2012 Wind Power Peer Review, projects aligned with one or more of the below objectives:

- Reduce unsubsidized turbine LCOE to be cost-competitive with fossil fuels;
- Reduce deployment barriers and increase outreach to enable 20% wind by 2030;
- Jumpstart a U.S. offshore wind industry;
- Testing, advanced manufacturing, certifications and standards;
- Optimized wind power plant operations and production in the power system;
- Improved resource characterization and understanding of wind phenomena;

The Wind Program performs R&D in three markets:

- **Land-based Utility Wind**
  - 1-5+ MW turbines with a R&D focus on next generation turbine cost reductions, improved energy capture, and conversion at an “Integrated Wind Plant” level, advanced controls, and extended useful life of components.
- **Offshore Wind**
  - 3-10+ MW turbines with a R&D focus on floating platforms to access higher winds; integrated systems designs to reduce full plant LCOE; optimized O&M strategies to reduce O&M costs; and turbine innovations including rotor, and next generation drivetrain and control systems.
- **Small and Distributed Wind**
  - < 1 MW turbines (grid connected on the customer side of the meter) with a R&D focus on optimization for low Class 3/Class 2 wind speeds; reduced maintenance requirements; and a levelized cost of energy (LCOE) reduction to compete with retail electricity prices.

The Wind Program, which has a unique role in the wind industry, tackles priorities that industry players cannot do alone. To accelerate deployment of wind technologies, the program collaborates on permitting barriers with numerous agencies including the Bureau of Ocean Energy Management, the U.S. Fish and Wildlife Service, the Department of Homeland Security, the Department of Defense, and the Federal Aviation Administration.

Additionally, the program collaborates with Federal Energy Regulatory Commission and the Office of Electricity on transmission planning and integration issues. The program also accelerates Administration priorities through investments in manufacturing innovation and U.S. competitiveness, as well as R&D targeted on addressing renewables integration and transmission planning challenges. The Wind Program fosters high-risk/long-term R&D projects involving offshore demonstration, next generation drive train, and next generation wind plants. Finally, the program provides funding to benefit the National Testing Facility infrastructure, certification and standards for small wind, and to publicly available national datasets for wind resource data.

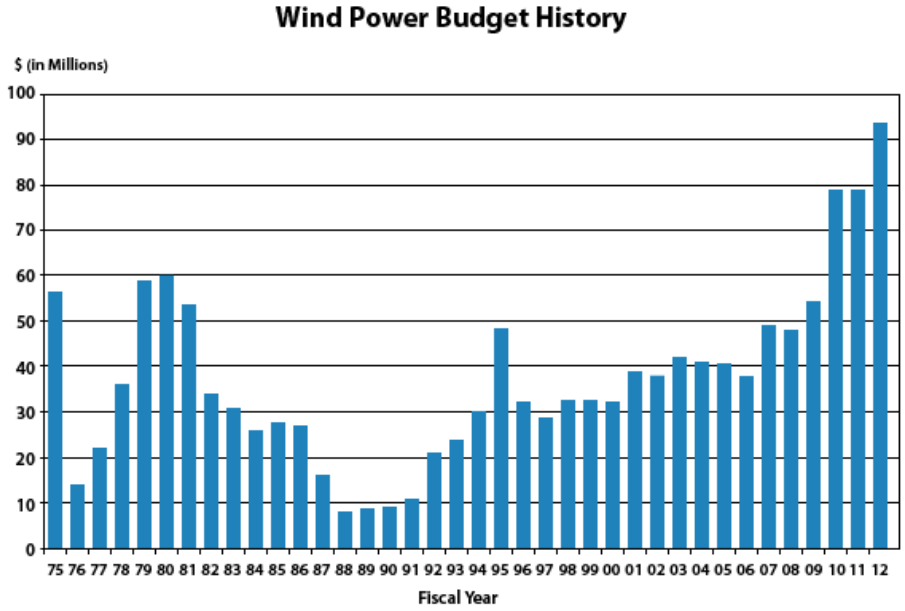


Figure 4.1 Wind Power Budget History (nominal dollars)

The program works with national laboratories, industry, universities, and other federal agencies to conduct research and development activities through competitively selected, cost-shared projects. Greater use of the nation's abundant wind resources for electric power generation will help stabilize energy costs, enhance energy security, and improve our environment. Figure 4.1 represents the budget history of the Wind Program from FY 1975 to the FY 2012 request (in nominal dollars). Figure 4.2 illustrates the Wind Program FY 2011 budget and the total combined budget of all projects reviewed in 2012 Wind Power Peer Review. The 2012 peer review agenda covered 87% ($69M) of the Wind Program's FY2011 Budget ($80M). American Recovery and Reinvestment Act (ARRA)-funded projects were also reviewed but are not included in the budget figure below.

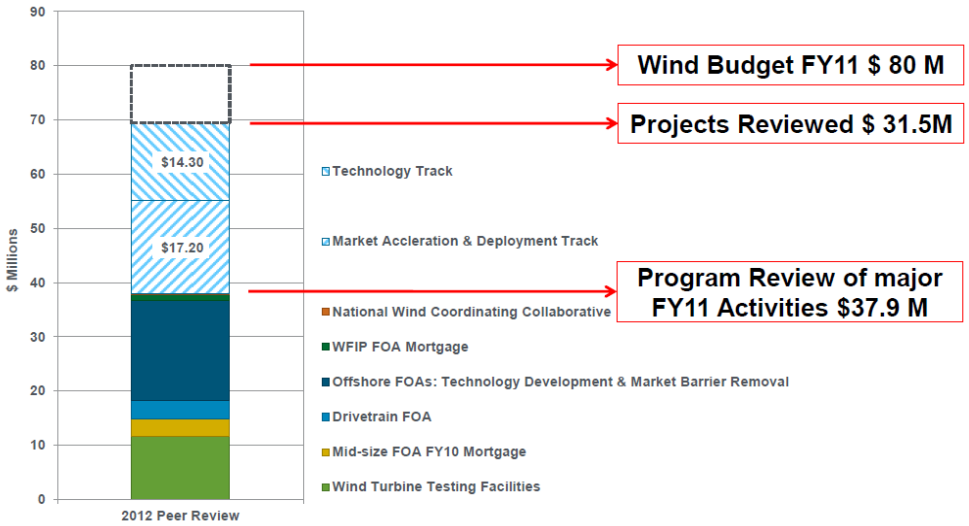


Figure 4.2 Wind Program FY 2011 Budget and Budget of Projects Reviewed in 2012 Wind Power Peer Review

5.0 General and Cross-Cutting Project Evaluations

The priorities of the General and Cross-Cutting projects that were reviewed in FY 2012 aim to build on previous Department of Energy (DOE) investments and provide specialized expertise, capabilities, equipment, and testing facilities specific to wind technologies. Additionally, these projects aim to evolve advanced design/analysis tools and testing methodologies to support research and development (R&D) and industry needs. These projects also aim to build on land-based expertise and experience through modeling, testing, and industry partnerships. The General and Cross-Cutting projects that were reviewed in FY 2012 were funded through the American Recovery and Reinvestment Act (ARRA). ARRA-funded wind projects total approximately $120 million. Those projects reviewed in the 2012 Wind Power Peer Review are highlighted below in Figure 5.1. All General and Cross-Cutting projects in the 2012 Wind Power Peer Review were aligned with the program's FY 2011 priorities.

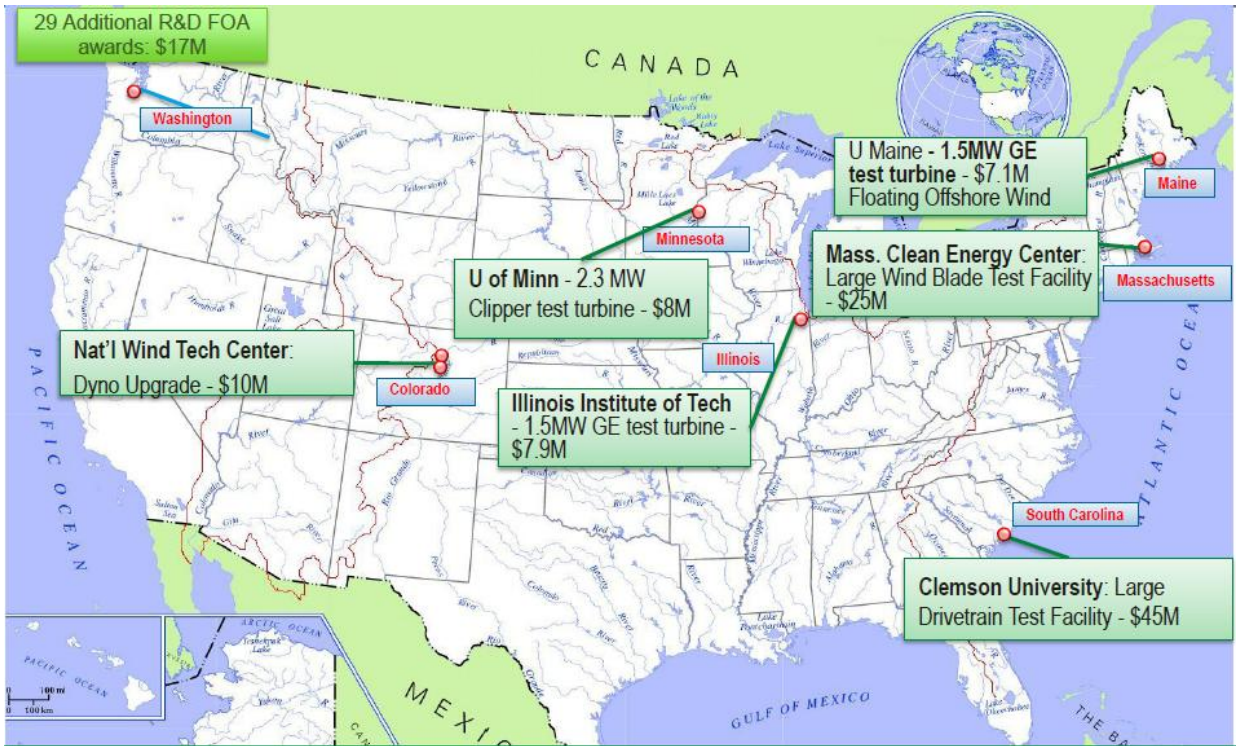


Figure 5.1 ARRA-funded Wind Projects

The following table lists all General and Cross-Cutting projects reviewed during the 2012 Wind Power Peer Review, including the title, organization, Principal Investigator, FY 2011 budget, peer review session, number of reviewers, average score per metric, weighted average overall score, and relevance score for each project.

Table 5.1 General and Cross-Cutting Projects Reviewed in the 2012 Wind Power Peer Review

Project ID	Title	Organization	Principal Investigator	FY 2011 Budget	Peer Review Meeting Session	Number of Reviewers	Methods and Approach (30%)	Technical Accomplis. and Progress (30%)	Project Management (20%)	Research Integration, Collaboration, and Technology Transfer (10%)	Proposed Future Research (10%)	Weighted Average Overall Scores for Projects	Relevance to Wind Industry and Overall DOE Objectives
WP001	5 MW Dynamometer Upgrade	NREL	David Simms	$3.8M	Large Facilities	9	4.0	3.7	3.7	3.5	3.3	3.7	4.3
WP002	Clemson University Wind Turbine Drivetrain Testing Facility	Clemson	Nick Rigas	$48.36M	Large Facilities	8	3.9	3.6	3.8	3.7	3.4	3.7	4.1
WP003	Massachusetts Large Blade Testing Facility	MassCEC	Rahul Yarala	$6.69M	Large Facilities	9	4.0	4.3	4.2	4.0	3.4	4.1	4.4
WP022	University/Industry Consortium: Illinois Institute of Technology	Illinois Institute of Technology	Dr. Mohammad Shahidehpour	$5.77M	University Consortia	8	2.7	2.7	3.0	2.7	2.7	2.8	3.1
WP023	University/Industry Consortium: University of Minnesota	University of Minnesota	Dr. Fotis Sotiropoulos	$7.98M (FY 10)	University Consortia	8	4.0	4.0	4.1	3.8	3.5	3.9	4.2
WP024	DeepCwind Consortium: University of Maine	University of Maine	Anthony Viselli	$3.72M	University Consortia	9	3.7	3.5	3.9	3.7	3.3	3.7	3.6

Figure 5.2 illustrates the weighted average overall scores and the relevance to wind industry needs and overall DOE objectives scores for all General and Cross-Cutting projects that were reviewed in the 2012 Wind Power Peer Review.

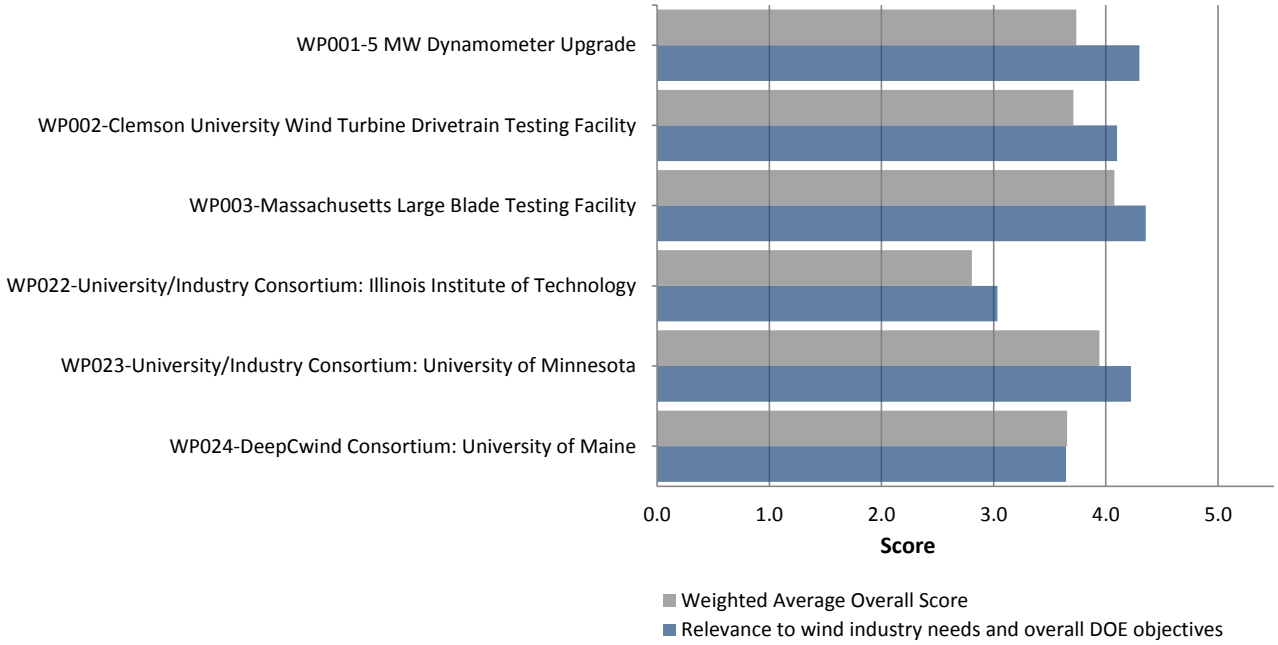
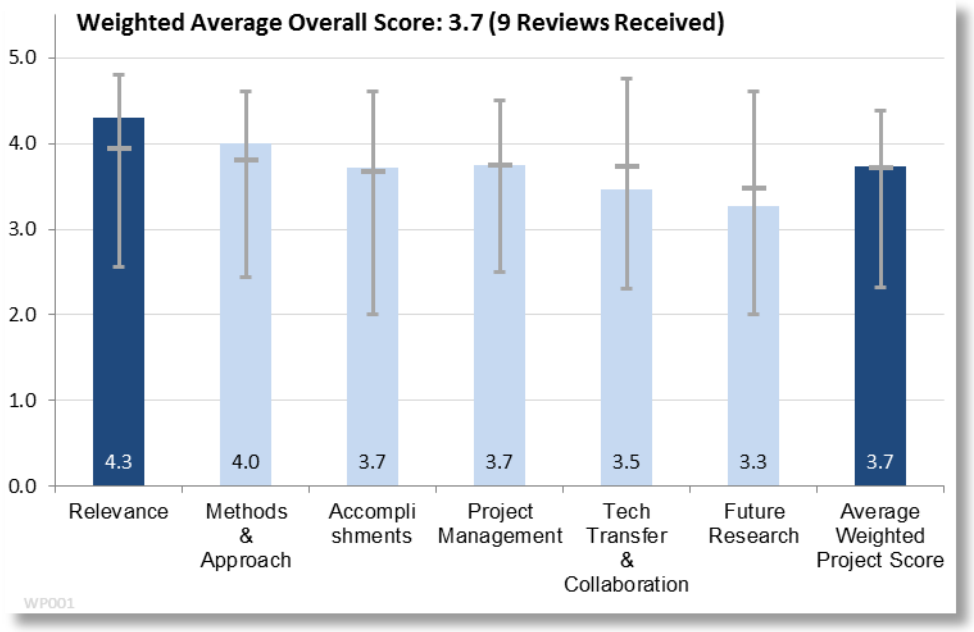


Figure 5.2 Project Scores from General and Cross-Cutting Sessions

WP001: 5 MW Dynamometer Upgrade

Jim Green, NREL – presented by David Simms
FY 10 Budget: $2,100,000 DOE $0 Cost-Share
FY 11 Budget: $3,800,000 DOE $0 Cost-Share
Project Duration: Sep 2009 - Sep 2012

Brief Summary of Project



This dynamometer upgrade will more than double the capacity (rated power) of wind turbine drivetrains that can be tested at the National Wind Technology Center (NWTC), sufficient to test the largest wind turbine drivetrains envisioned for land-based markets. It will have capability to simulate wind loads in six degrees-of-freedom (torque plus 5 non-torque degrees of freedom). A "controllable grid interface" will also be available to test drive train low-voltage ride-through capability, response to faults, and other abnormal grid conditions. These combined capabilities will allow the most complete simulation of wind turbine operating conditions available in North America.

The ARRA project ends with the no-load verification of the entire dynamometer drive line. This will be followed by an Integrated System Test, a collaboration with an industry partner during which the drive line and controllable grid interface will both be commissioned under load.

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

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

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

- Wind industry needs NREL to continue to be a trusted source, which requires cutting-edge equipment and know-how.
- Valuable and timely project.
- Highly needed to verify and improve industry gearbox performance.
- Adds to national drive train testing capability.
- Good that it targets land-based turbines, and the 5 MW size seems appropriate for many new mid- and large-size machines.
- The 5 MW facility covers a significant range of land-based turbines not covered by the 2.5 MW NWTC facility.

- Drive train testing, system or accelerated fatigue testing, can be an important tool for improving reliability of wind turbines. An update, in particular with respect to introducing dynamic rotor loading, is critical, if research on test procedures and interpretation of test results shall be carried out.
- Important program for modernizing NREL's dynamometer test capabilities.
- The need for these testing facilities is clear. Need to ensure that work at the facility is coordinated with other researchers and industry both nationally and internationally.
- Responsive to industry need and trend toward larger turbines.
- Valuable utilization of non torque loading since it is essential to accurate representation of field conditions and need for simulation of grid interface.
- Non torque and grid interface aspects good.
- Concern that they don't have long-term slots filled for testing (perhaps due to the PTC challenges in the U.S. business).
- Very valuable to industry needs.
- The 6 degrees of freedom and "controllable grid interface" are important capability additions.
- Need to ensure continued coordination with Clemson facility. How will projects be allocated to the two different facilities?
- Clear correlations to Program Objectives: reduces LCOE.
- 2013 availability seems late for this scale of land-based turbine. Many 2.5-4.5 MW models already in market.
- Ongoing collaboration/cooperation with Clemson facility will be critical.
- Supports goal to lower LCOE through testing.
- A general note for all the reviews - it is difficult to provide a complete review of a study following a brief summary and a 15 - 30 minute presentation. This is especially true if the presenter is not experienced in public speaking.
- Supports DOE's testing agenda.
- These reviews must be considered in light of the limited ability to fully evaluate the studies given the allocated time, and my limited knowledge of some of the technical areas.

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

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

- Builds on NWTC testing expertise.
- The approach is sound but it is yet to be verified in actual testing.
- Builds on NWTC experience. Good commissioning and testing plan.
- Solid and well proven in approach.
- Some technical challenges encountered, but acceptable for unique program of this type.
- The approach is state of the art, but it is not clear exactly which test programs and load combinations form the basis for the specifications.
- Reduced scope to meet budget meant sacrificing research abilities.
- Leverages expertise and capabilities of NREL with testing and data systems.
- Detail of non torque loadings is not clear and when will it be available.
- Overall technical merit is good.
- Detail and schedule of grid interface.
- Program has engaged the major stakeholders in design process.

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

This project was rated **3.7** based on technical accomplishments and progress.

- Behind schedule.
- Too early to comment on results delivered.
- Good progress on implementation. Performance is yet to be verified.
- Non torque loading systems good capability.
- Challenging design and project management task for a lab to undertake.
- Behind schedule, but could be viewed as acceptable given nature of work and use of sub-contractors.
- Aggressive progress on project timelines (up to manufacturing the gearbox) is impressive.
- Couldn't see comparison of projected budget and actual. Is it over, or meets projected?
- Non-torque loading device well-conceived, responsive to industry needs.
- Long-term goal of thermal control is supportive of industry needs.
- Growth in capability from a 2.5 MW to a 5.0 MW facility is a logical progression; builds on previous experience.

Question 4: Project Management

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

- Not on time or on budget.
- Good project management and ability to meet milestones, given challenges.
- The execution time of 3 years seems a bit long. Could it have been accomplished in a shorter time frame? Unless the issue may have been funding.
- ARRA funding had accelerated schedule. Delays in procurement and construction. Budget status unclear.
- Good work on a very challenging project.
- Other than delays, seems to be well executed.
- Sound strategy utilized in making difficult decisions to stay within available budget. Kept focus on the testing capability.
- Project management appears adequate; delay in gearbox is unfortunate.
- Meeting ARRA documentation requirements.
- Procurement and construction was noted as a very difficult area for the lab procurement office to handle.
- Management of sub-contracts could improve, but delays are not unexpected.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- No indication of technology transfer thus far.
- Need greater clarity on how this facility will work with Clemson facility, and more specific proposal for coordination and collaboration with Clemson.
- The project is integrated with Industry and the GRC project. Future value to the industry is very high since gearbox/bearings failures are an impediment to Industry progress.
- No technology transfer plan. Says stakeholder involvement but no evidence of industry interest such as backlog of testing requests.
- Ongoing sharing of "lessons learned" is critical, and it seems that they are doing a good job of trying to do this.

- Coordination with industry stakeholders is very good.
- Infrastructure project with appropriate suppliers.
- Partners appear to all be subcontractors. What about other research entities and collaborators?
- Coordination with Clemson facility is critical to long-term success of testing in U.S. Overall they appear to be on the right path.

Question 6: Proposed Future Research

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

- Only indication of future research: dynamometer will be available for future research partnerships after commissioning.
- The plan for facility commissioning is clear and valuable.
- Proposed future research cites testing after ARRA completion. Should rather address what research will be done using the facility, not completion of the facility.
- Adding environmental capabilities would be good.
- Partnership with Clipper for first test is positive.
- Proposed research is limited to demonstrating the system. No details on future research.
- Future research utilizing the facility has not been addressed in the presentation fully. Sure there are many tasks that can take advantage of this facility through continued collaboration with the GRC or industry partners or DOE advanced research.
- Expanding to work on test standards would be an appropriate use of this facility.
- Initial planning for future expansion of capabilities (thermal jacket) is positive.

Strengths and Weaknesses

Project Strengths

- NREL holds the reputation as the independent voice on advancing wind technology and characterization. This project increases and serves that interest.
- Alignment with Program objectives and industry needs.
- It is an important facility in terms of size, off axis loading, and grid interaction.
- Fills a gap in national testing capability.
- Valuable for the industry because most manufacturers do not have in-house capability for this extensive type of testing.
- Co-located scientific and technical staff is significant attribute to NREL test facility.
- Access to state-of-the-art facility, where research into the optimal use of a drivetrain test facility can be carried out, independent of the industry's immediate needs. Test procedures and interpretation of results need to be researched.
- NREL expertise in dynamometer testing.
- The commissioning plan for the facility is clear and well planned.
- Uses existing NWTC infrastructure, personnel and industry connections.
- Listening to stakeholders and responding accordingly.
- Leadership and staffing are strong assets.
- Staff at NREL are an asset to the test facility. Development of highly accelerated life testing paradigm and instrumentation requirements?

Project Weaknesses

- Project management suffered. This has been blamed on the procurement process; however, NREL should be used to acquiring non-standard, special equipment and the lengthy procurement process.
- The long term R&D plan for the facility was not communicated.
- Unclear from materials provided what the market demand for use of the facility is. May be vast but not noted.
- Facility is on the smaller side if testing with e.g. 50 % overload or rapid changes in speed shall be performed.
- Not clear how this facility stacks up relative to European Union, China, and industry.

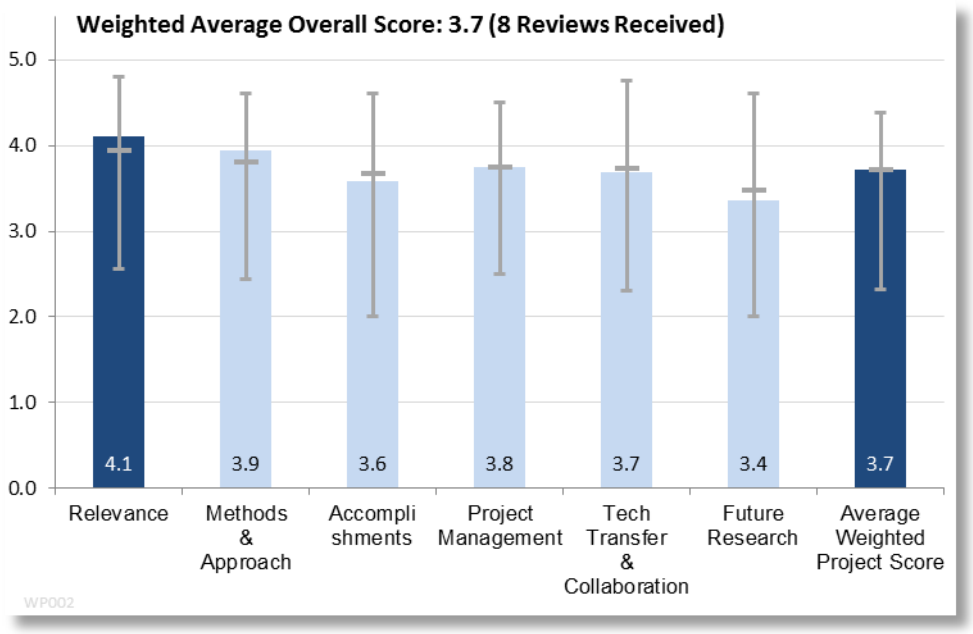
Specific recommendations for additions or deletions to the work scope

- Although the project is highly valuable to industry and NREL's position, it appears that the project's execution was sub-par.
- Devote some resources to marketing facility and proposals for future research and applications.
- Establish and communicate a long term use and R&D plan for the facility.
- Get expressions of interest from industry in use of facility.
- It is practical and useful to upgrade the NREL test facility in this way. Good work.
- Need to work on marketing facility to broader user base.
- Are there general R&D opportunities that could develop for NREL with the dynamometer facility?
- Compare and contrast with other world facilities.
- Continue analysis and planning on need for simulated thermal environment.
- Concern: what is the strategy between this facility and Clemson for long term use? Is each one out to market itself and bring in the business it can? Or is NREL going to take tests that have more of a research slant that leverages NREL resources?
- Get R&D ideas from Gearbox Reliability Workshop.
- Is there some NREL research that could be done at the Clemson facility and a way to drive some more integration?

WP002: Clemson University Wind Turbine Drivetrain Testing Facility
Dr. Imtiaz Haque, Clemson – presented by Nick Rigas
FY 10 Budget: $43,166,000 DOE $0 Cost-Share
FY 11 Budget: $48,359,000 DOE $0 Cost-Share
Project Duration: Jan 2010 - Jan 2015

Brief Summary of Project

Design, construct, commission and operate a world class state-of-the-art testing facility that permits full-scale highly accelerated life testing of advanced drivetrain systems for wind turbines up to 15MW with a 30% overload capacity.



The facility is accessible to all wind turbine innovators to generate new knowledge that will lead to improved designs that increase reliability and lower unsubsidized LCOE to meet the U.S. DOE EERE strategic wind energy initiatives. The facility will serve as a cornerstone for the Energy Systems program at Clemson University to educate the workforce of the future to support the growing renewable energy industry.

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

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

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

- New testing facility for larger drivetrains at this time is on key with for the trend of wind turbines getting bigger and the push for offshore.
- Aligns with DOE objective to reduce LCOE.
- Very important facility especially for offshore technology development and of course for land-based (the smaller facility) technology development.
- Meets LCOE and offshore objectives.
- Very ambitious project, but the business case for supporting this facility is in doubt.
- It's not clear if there is a sufficient demand for a facility of this magnitude.
- Access to large state of the art test facilities is critical for development of higher reliability and lower COE.
- Justification for significant sizes of test machines is not provided - is this consistent with future of industry?
- It is highly needed since the investment is too high for most industry participants and the testing is essential to ensure reliability of existing and new products.
- Expandable.
- Emphasis on offshore turbines - will there be enough to test to keep it busy? This is a risky bet.

- Supports DOE goal of jumpstarting offshore -- i.e., larger machines.
- Essential that the future research includes integrated electrical/mechanical component analysis.
- Having both 7.5 and 15 MW dynamometers gives throughput and flexibility.

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

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

- Turn-key system approach, although often costly, has well integrated project tasks.
- Substantial budget allowed for design and feasibility to meet technical barriers and considerations.
- Excellent planning. Too early to verify performance.
- Good interaction with stakeholders through Industrial Advisory Board and Technical Advisory Board.
- Seems like good design approaches to minimize risk and take advantage of existing infrastructure.
- A number of construction challenges have been identified by the PI. Some are understandable and can be attributed to the unique nature of the equipment. Others should have been flagged (design for earthquake, hurricane, etc.).
- The test facility is state of the art, and advisory board has provided input. Can the staff advice the industry on which are the most appropriate test programs?
- Impressive collaboration with university, port authorities, and government funding.

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

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

- Only hiccup due to redesign requirements.
- Too early to evaluate results.
- Great progress to date. Performance is yet to be verified.
- Fast tracked acquisition and design.
- The inclusion of electrical system for testing is a good and innovative addition to the system.
- Not much to assess at this stage of project.
- State of the art equipment, on schedule.
- State support is great and is clearly helping this project meet its deliverables.
- It is a very positive development to add the non-torque loading to the 7.5 MW dynamometer.
- Appears to be well behind schedule.
- Didn’t ARRA funds expire? Will the timeline of ARRA funds impact project outcomes?

Question 4: Project Management

This project was rated **3.8** on its project management.

- Good approach to project management with use of Technical Advisory Committee, use of commercial technology.
- Outstanding because it is a very complex project and has been and will be executed in record time for such an endeavor, the largest dynamometer in the world.
- Good work structure and approach.
- Seems to be well managed given the project complexity.
- It's not clear how graduate students will be involved once the facility is operational. The facility seems to be a fee-for-service type of operation. This is not likely to lead to graduate research.

- On schedule.
- Construction issues in this area should have been foreseeable (especially geotechnical issues).
- Eight weeks behind schedule.
- Budget overruns are significant.
- $9.3 M over budget.
- Ongoing operational budget seems at risk.
- What is break-even operating budget? This information is critical to the sustainability of the facility.
- Could be better coordinated with NREL facility.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- One key name is missing from the otherwise great collaborative effort: NREL.
- Project has been thoroughly communicated through presentations and Technical Advisory Committee.
- Good progress in identifying industry partners for commissioning both the 7.5 and 15 Mw dynamometers.
- Industrial Advisory Board and Technical Advisory Board good.
- Lack of true collaboration with NREL and others seems obvious.
- Appropriate suppliers, but relation to NREL expertise is not clear. Clemson has limited wind turbine experience.
- Good technology transfer activities to date.
- This project has received substantial funding relative to other testing facilities. Consequently, they appear to have a much higher degree of resources for project management, communication and collaboration. It's difficult to judge this facility against the others due to the funding differential.
- More detailed future plans for the industry need to be identified including R&D in drivetrain technology, collaboration with the GRC and other industry partners.
- First OEMs for both dynamometers obtained or in process.
- Workforce development built in to program.

Question 6: Proposed Future Research

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

- Wind turbine interactions with the grid are highly valuable.
- Clear articulation of future research.
- More detailed future research and collaboration needs to be identified.
- Good plans to increase capability and understand details.
- Appears to be more aimed at commercial testing rather than research (not a bad thing IF you can keep it busy).
- Not Applicable at this stage of project.
- Proposed research is relevant but not as urgent as developing capability for designing test programs and analysis that can be used to document reliability and adequate design of specific turbines.
- Need to ensure relevance of future work activities at facility; discussion provided highlighted specific researchers involved, but no industry partners.
- Need to add plans for high density wind in the loop for other than torque loads.

Strengths and Weaknesses

Project Strengths

- Ultimate goal to offer commercial gearbox testing of mechanical and electrical performance is a great asset for a growing wind industry.
- Generation of PhD and Masters Candidates.
- An essential project for testing and verification of offshore turbines and land-based machines. Require high capital that most industry participants cannot afford.
- Good location, development plan, stakeholder involvement.
- Very ambitious effort and impressive capabilities.
- Uniqueness of facility will be national asset.
- Large facility to be used for a fee that covers operational expenses only.
- Project only 8 weeks behind schedule -- pretty impressive.
- Ability to test large turbines up to 15 MW. Potential for global leadership in drive train testing.
- Positive development to add non torque loading to the 7.5 MW dynamometer.
- Ability to expand.
- Some sub-contractors (e.g., MTS Systems Corporation) have experience in testing.
- Support from the state.
- Positive development to add grid interaction testing.
- Operating costs to be covered by testing revenue.
- Good rationale for federal role.
- Good port infrastructure.
- One of world's largest if not world's largest (Vestas size uncertain).

Project Weaknesses

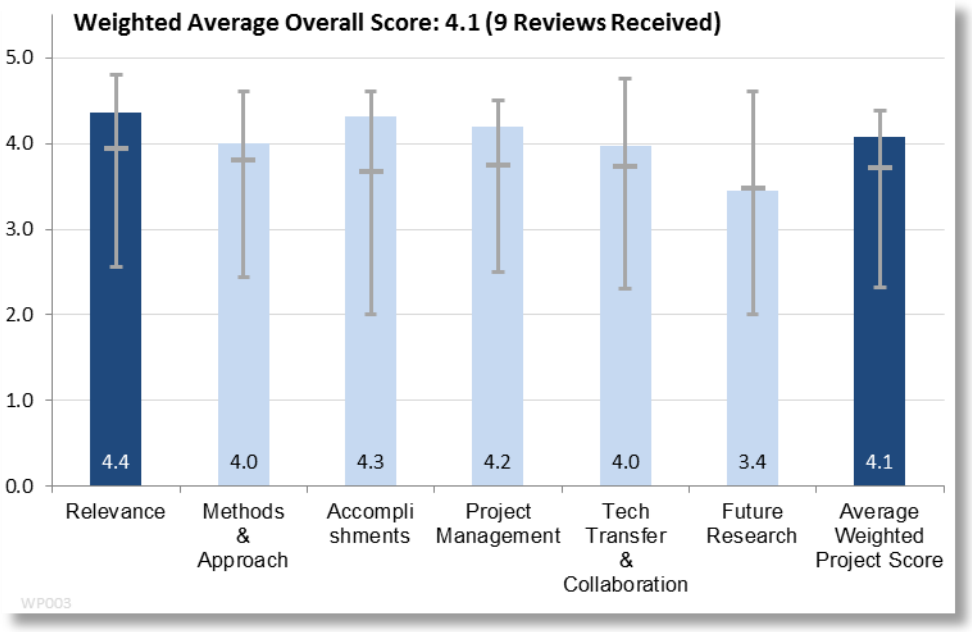
- Sole-sourcing key equipment raises an eyebrow, although it's apparent why the NREL gearbox upgrade was slowed by Supply Chain, and this project was not.
- Redundancy with NWTC. Requires greater coordination and communication to clarify the differences of the two facilities.
- Future detailed R&D plans and industry partnerships need to be detailed and strengthened.
- Slightly behind schedule.
- Ongoing business model seems at risk. Is there really the demand for this type of testing to keep it busy and profitable?
- Behind schedule.
- Experience of operators.
- Collaboration with NREL.
- No comparison to other world facilities.
- Unclear funding stream to break even on operations.

Specific recommendations for additions or deletions to the work scope

- Relationship with NREL in a formalized manner should be facilitated.
- Development collaboration with NREL.
- Work with industry, R&D facilities, GRC and others to establish a long term R&D plan for the facility that can go in parallel with industry utilization.
- Show how this stacks up to other industry and national capabilities.
- Restudy the longer-term business plan for the facility.
- Involve NREL expertise through informal cooperation agreement.

WP003: Massachusetts Large Blade Testing Facility
Rahul Yarala, Massachusetts Clean Energy Center (MassCEC)
FY 10 Budget: $18,065,000 DOE $627,000 Cost-Share
FY 11 Budget: $6,688,000 DOE $6,911,000 Cost-Share
Project Duration: Aug 2009 - Aug 2011

Brief Summary of Project



The Massachusetts Clean Energy Center (CEC) will design, construct, and ultimately have responsibility for the operation of the Large Wind Turbine Blade Test Facility, which is an advanced blade testing facility capable of testing wind turbine blades up to at least 90 meters in length on three test stands.

Wind turbine blade testing is required to meet international design standards, and is a critical factor in maintaining high levels of reliability and mitigating the technical and financial risk of deploying mass-produced wind turbine models. Testing is also needed to identify specific blade design issues that may contribute to reduced wind turbine reliability and performance. Testing is also required to optimize aerodynamics, structural performance, encourage new technologies and materials development making wind even more competitive. This cooperative agreement supports DOE Wind & Water Power Program's strategic objectives to ensure that the U.S. has the necessary wind turbine blade testing capabilities to test current and anticipated next generation blades planned to be deployed in the U.S.

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

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

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

- Valuable project to provide first class, needed services for the American wind industry.
- Good alignment with Program Objective to reduce LCOE.
- Highly needed project since the current NREL facility was the only one capable of testing blades only to 50 m. Most land-based machines now are going beyond that 50 m limit (1.5 MW machines). This facility will allow up to 90 meters. There are already 75 m blades in production.
- Ability to test large blades fits federal role and is important to LCOE, manufacturing and offshore objectives.
- Fills a need for a well-defined space for testing larger blades that was lacking with U.S.-based facilities.
- Working closely with NREL on advancing U.S.A's overall blade test capability (facilities, methodology, workforce, etc.).
- Domestic development of very large blades for e.g. offshore requires testing. Access important.

- Important testing capability for U.S. Excellent use of DOE funds.
- Need for blade testing is apparent; but is this an area where industry could provide more support?
- Offshore blades a plus.
- Does not require CRADAs etc. and can work off customer PO, so accelerated testing.
- Relatively straightforward and solid plan.
- Relevant to DOE program goals.
- Presentation would have benefited from increased discussion of industry partners.
- Limit of NREL to test only up to 50m blades is a critical point for justifying this project.
- Good use of "lessons learned" and consultation with NREL and others.
- Primarily in support of testing. Fee-for-hire type of operation is OK as long as NREL takes lead on advancing test methodology/protocol.
- Presentation could use more "big picture" information.
- Still challenges to achieve and sustain "break even" ongoing operations.

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

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

- Need to figure out best way to apply actuators.
- The project is designed to the best standards of global wind turbine blade facilities. The plan to extend to ground based resonance systems is good since the loads are increasing.
- Consulted with industry, DOE and NREL on needs. Estimated to cover next 5+ years.
- The need to develop ground-based actuators adds risk - would have been good to foresee this requirement.
- Working closely with NREL on advancing U.S.A's overall blade test capability (facilities, methodology, workforce, etc.).
- The approach is based on collaboration with NREL and use of their expertise. The facility can do standardized testing.
- The project had a sound approach with leverage of NREL expertise.
- Implementation methodology appears sound.
- I suggest that a two axis ground based actuation system be developed quickly since this is the state of the art in turbine testing and allows for better representation of actual blade loading and combined flap L-L testing.
- Challenges to use of universal resonance excitation system. Responding to stakeholder's demands on test needs.
- Seems to be responsive to user's needs.

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

This project was rated **4.3** based on technical accomplishments and progress.

- Facility complete, accreditation at hand.
- Relevant blade testing size that should yield valuable data for the next 5 to 10 years of deployment.
- The facility was developed, commissioned and currently in use. Need to develop ground based actuation soon.
- Scaled up NWTC capabilities significantly.
- Good so far, but shortcomings of actuators should have been better anticipated.
- Online and testing. Slow start, but should improve with experience.
- In operation.
- Project is complete and the facility is operational and being used.

- Completion of facility and initial tests lead to "good" rating.
- It is a major accomplishment to get a facility of this magnitude up and running.

Question 4: Project Management

This project was rated **4.2** on its project management.

- The facility was developed, commissioned in record time and has a waiting list of blade tests.
- On line ahead of schedule.
- Needs for more work (ground-based actuators) adds risk.
- Working closely with NREL on advancing U.S.A's overall blade test capability (facilities, methodology, workforce, etc.).
- Project was completed ahead of schedule. Well done.
- Project completion indicates appropriate controls were utilized.
- On budget?
- Ongoing break-even costs could be a challenge.
- Appears to have solid understanding of annual operational budget and break-even point.
- Working closely with stakeholders.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- Score based on the fact that this is a commercial facility meant to provide state of the art blade testing capabilities. Industry has been engaged.
- Good collaboration with NWTC.
- The facility took advantage of the tremendous expertise available at NREL and other laboratories. Blade testing required a high level of technical support to develop the test plans and make sure it represents the life time equivalent of fatigue loads.
- Already serving customers.
- Good collaboration with NREL and on-site NREL staff.
- Operated as fee-for-service testing unit with no clear agenda for advancing test methodology -- this is an OK model for operating the unit.
- Interaction with NREL and successful use by industry. No research content.

Excellent integration with NREL, however, there was not a slide presenting partners and collaborative work.

- The plan to be able to test longer and more slender blade follows the industry's blade technological advances.
- Is facility booked up?
- Excellent collaboration and tech transfer needed in the future for this project to be successful considering the facility needs $3 million per year just to break even.

Question 6: Proposed Future Research

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

- Developing new method to deploy actuators to test longer blades.
- Good articulation of future need -- develop ground based resonance exciter systems.
- The plan to develop ground based two axis resonance fatigue loading should be encouraged to bring the facility close to the state of the art test facilities.

- Proposed projects are useful but do not address ground truthing of test results. Were they accurate in the field?
- Some concern about the need to develop new actuator technology to move forward.
- Working closely with NREL and others to stay current.
- Relevant but not overly ambitious. Can fatigue testing be further accelerated?
- Ground resonance excitation research appears to be useful; the Massachusetts facility presentation did not provide information regarding future activities/research at the facility.
- Application to slender blades and two axis testing with resonance is being pursued.

Strengths and Weaknesses

Project Strengths
- First commercial blade testing facility.
- IP protection.
- State of the art facility with up to 90 meter blade testing in extreme and fatigue.
- Much needed new capability since large and advanced blades critical to LCOE and offshore.
- Fills a need.
- State of the art facility.
- Close collaboration with NREL.
- Can test large blades.
- Coordination with NREL and European testing facilities.
- Developed in record time, one of the earliest ARRA project to be executed on time.
- Simple commercial approach. No CRADAs required.
- Access to testing facility is exceptional.
- Accelerated testing and certification.
- Good partnership with NREL
- Customer driven.

Project Weaknesses
- Costs to keep the facility open are understood; however, an actual plan to engage manufacturers for this business is not immediately apparent.
- Projection of testing demand and customer need (today and in the future).
- Need to expedite the ground based two axis resonance actuation.
- No verification against actual noted.
- Would have been good to anticipate the need for ground-based actuators.
- Limited experience in house for further development of testing.
- Sounds like there is a learning curve to fully meet demanding industry expectations.
- Plans for marketing the facility.
- The Market Acceleration team looks to be solely focused on execution with all R&D capability coming from NREL. From DOE's perspective, need to insure a long-term continuation of that arrangement. DOE may benefit if they fund some R&D of blade testing by the MA team.
- How does the business model impact NREL?

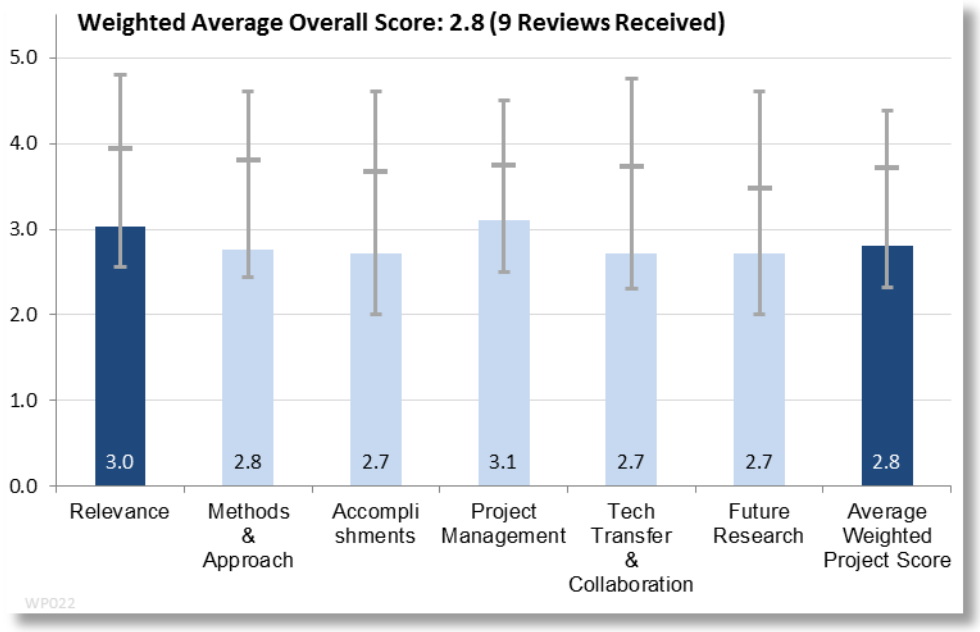
Specific recommendations for additions or deletions to the work scope

- Much needed facility allowing NREL to focus on R&D efforts.
- Develop more specific plans and projections for future use of facility, beyond 90M testing.
- Two axis resonance ground based actuation.

- Revisit the need for additional funding to really make this a world-class test facility.
- Improve turn-around time for users.
- Establish formal collaboration with NREL on development of testing of blades.
- Complete benchmarking against other facilities.
- Restudy the long-term business plan. Will this be a self-sustaining testing facility, or is funding from an additional research agenda needed to make it break even?

WP022: University/Industry Consortium: Illinois Institute of Technology
Dr. Mohammad Shahidehpour, Illinois Institute of Technology
FY 10 Budget: $852,000 DOE $124,000 Cost-Share
FY 11 Budget: $5,766,000 DOE $745,000 Cost-Share
Project Duration: Jan 2010 - Aug 2012

Brief Summary of Project



The consortium's research and development objective are focused on addressing several challenges identified in the "20% Wind Energy by 2030" report, i.e., wind technology, grid system integration, and workforce development. In particular, (1) the consortium member will develop control algorithms for enhancing the reliability of wind turbine components; (2) The consortium member will develop advanced operation and planning tools for accommodating the high penetration of intermittent wind energy in electric power utility systems. (3) The consortium members will educate the stakeholders on critical issues related to the wind energy research and development. (4) The world-class wind energy education and research programs developed by the consortium will outlast the proposed two-year period of the project.

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

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

This project earned a score of **3.0** for its relevance to wind industry needs and overall DOE objectives.

- The idea behind starting a consortium addresses an issue that the United States has been lacking: tying academia, industry, and labs together.
- Aligns with Program Objective of Workforce Development.
- Project achieved its goal of bringing Industry and Universities together and increasing awareness of wind energy in educational institutions.
- Combines R&D with workforce development and education.
- Shows a high degree of collaboration with many partners on the slides, but some of these identified "collaborators" imply that attempts to collaborate have been difficult to get started.
- It is difficult to see any clear connection to DOE goals.
- Involvement of universities in wind energy research seems worthwhile, both with respect to bringing in new ideas, outreach and development of a qualified work force.
- Benefits of this grant, to this party, are not well defined. Benefits will apparently be derived from future research opportunities that are not well described.

- Did not see critical research results displayed in the presentations.
- Little output to date.
- The critical point is "what comes next" in terms the getting to the actual research agenda.
- Not clear on the contributions towards advancement of wind energy program goals.
- Benefit of this turbine purchase, in this location, (as opposed to at NWTC) is not defined.
- Minimal interaction with key stakeholders in U.S. wind industry, labs or universities.
- Money could have been spent to install measurement devices on a turbine at a wind farm being developed by a market participant.
- The only substantive outcome appears to be the purchase of turbines.
- Will this program lead to increased educational opportunities at the Illinois Institute of Technology or nearby organizations?
- There appears to be an overall lack of industry collaboration with the project team.

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

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

- Small wind units seem like they will have the most benefit for the consortium because they will be more readily available for testing and learning.
- Consortium approach allowed high level of stakeholder engagement and ability for universities to cooperate, test and share data.
- Accomplished the installations of prototypes and establishment of research consortiums.
- Combines actual turbine installation and operation, enhancing training and research
- Only measurable success is they bought off-the-shelf equipment.
- The research program overlaps with other projects and stronger coordination with other parts of the DOE program is recommended.
- Consortium vision/mission not well expressed during presentation: seems a bit like the intent was to attack the funding opportunity announcement (FOA) and figure things out later.
- But does not have aggressive plan to utilize resources compared to Minnesota.
- No concrete plan for using consortium to contribute to advancing wind energy.
- Research part seems weak.
- Confused by the decision to install the same unit as the DOE NREL unit.
- Project does not have good high-level strategy for success.
- Plan appears without long term ability to operate and maintain an asset like a wind turbine.
- Unit operated by Invenergy: how does this relationship influence the turbine's use for research?
- Not clear that this GE unit can offer anything beyond the DOE NREL unit in terms of research.

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

This project was rated **2.7** based on technical accomplishments and progress.

- Although project was delayed, the sub-year extension was granted and seems reasonable considering the magnitude of the effort.
- Very light on reporting test results.
- Installed GE 1.5 and 8 kilowatt Viryd plus other systems.
- Shows good progress against plan in the presentation.
- Only outcome is the purchase of a couple of turbines.

- Accomplishment deployment of equipment, courses and studies. It is not clear if PhDs and master degrees follows from the project or would have happened anyway.
- Construction progress is evident; however limited evidence of technical progress was provided. Specific research topics and technical advances not listed.
- Involvement of consortium not well understood.
- Several awards received.
- PI cites 17 advanced degrees completed on consortia funding, yet there are no measurable outcomes (papers, etc.) cited.
- The wind integration study and the education accomplishment most noteworthy.
- Benefit of this grant appears to be educational, which appears to be well documented; and technical research, which is not well documented at this time.
- Not evident what real research results from project.

Question 4: Project Management

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

- Again, although project required extension, it appears that the bulk of work has been completed.
- The project was executed on time and within budget.
- Slight delay due to added features.
- Appears to be sticking to schedule and budget very well given the size and complexity of the project.
- Project manager has not accomplished goal of using the funding to advance wind energy.
- Slight delay.
- This project appears to be well-managed; project timelines maintained throughout
- The presenter did not address the research and engineering tasks in a level of details that shows that the program is on path to achieving research goals.
- Very little to show, no contribution to lowering LCOE.
- Undergraduate courses and degree program still need to be finished.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Consortium members are expansive covering the spectrum of the wind industry from research to development to load serving entities.
- Did not see any research results.
- Consortium not well connected with rest of DOE program.
- Shows a high degree of collaboration with many partners on the slides, but some of these identified "collaborators" imply otherwise and the nature of their ongoing collaboration was not always made clear.
- No major labs or universities with wind energy programs are part of consortium.
- A large consortium and a fair amount of publications and presentations. The role of the labs and the industry partners seems weak and on an ad-hoc basis and the university partners, while international, does not include the most prominent wind energy universities.
- Need to ensure increased and continued collaboration with other researchers and industry.
- For such a capital intensive project, it would seem appropriate that some information/data be made publically available.
- The teams and collaboration is in place to do good future research.
- GE coordination on turbine and Catch the Wind.

- Has been invited several times to present at AWEA, but has not accepted.
- Well attended conferences and Illinois wind conference sponsored.
- Web presence is weak.

Question 6: Proposed Future Research

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

- Declared proposed research is needed -- especially grid interaction studies.
- Additional workshops and conferences.
- The list of future research activities is there. Did not see any preliminary results or specific paths towards achieving these goals.
- Decent list of ongoing R&D at 1.5 and 8 kilowatt turbines.
- Challenging to make the research from these university/industry consortia projects feel as "relevant and meaningful" as the others we are discussing this week.
- Did not see any concrete plans for i) sustaining the program, or ii) advancing program goals.
- Overlaps with other DOE program activities.
- Proposed research is not specific but rather subject areas so it is difficult to judge how useful that research will be at this time.
- Additional courses and workshops planned.

Strengths and Weaknesses

Project Strengths
- Wide breadth of consortium members.
- Workforce development, collaboration, technology transfer.
- The project was successful in implementation of prototype installation and formation of industry and research and university partners.
- Combines operating turbines of different scales.
- Impressive progress - close to plan based on what was presented.
- Includes outreach and education.
- Assets give possibility for numerous research projects.
- The program resulted in 12 PhD degrees and 5 Masters Degrees, which is a good success metric that could be built upon for future proposals.
- Reasonable educational output (degrees awarded and published papers).
- Great for supporting students and course development.

Project Weaknesses
- Owning a 1.5 MW turbine is an expensive asset that is a risk for a university. Presenter implied that "hopefully" DOE funding will be available -- if that were the case then DOE should own the turbine.
- Unclear about future objectives and funding of program.
- No details on technical approaches or preliminary results for all research tasks.
- Expensive to set up. Can it be sustained?
- The value of research (completed, in progress and planned) is not totally engaging. How meaningful is the research agenda?
- No understanding of wind agenda.
- Research is limited in scope and impact and overlaps with other DOE activities.
- Involvement of consortium not well understood.

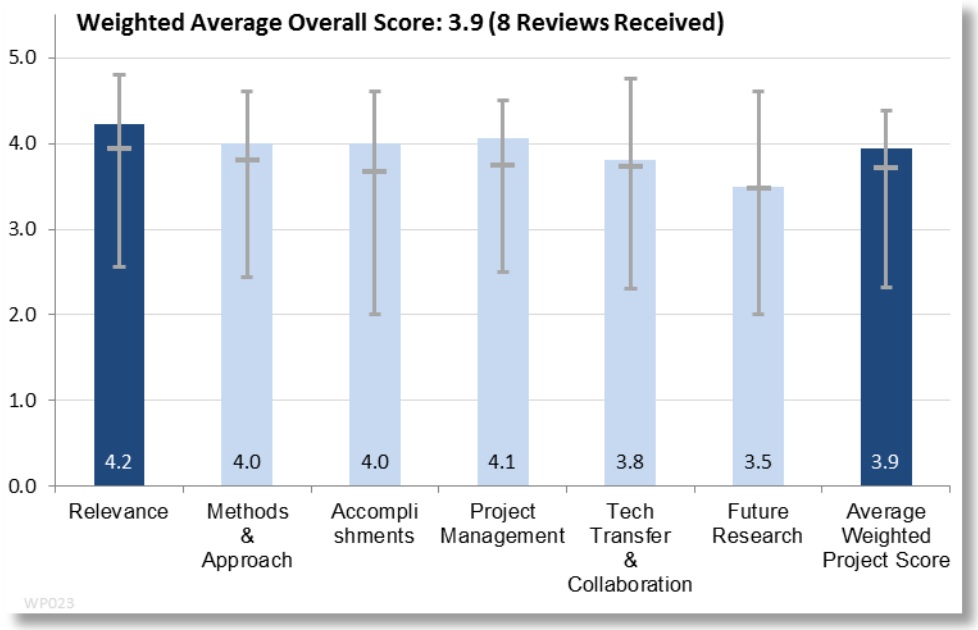
- Enough research results for budget?
- Weak program with no clear strategy for future.

Specific recommendations for additions or deletions to the work scope

- Consortium should provide a formalized process for interested parties to get involved with projects.
- Develop more specific proposal for continuing the research and technology transfer activities.
- Need to share test results.
- Provide future funding plan.
- Now that the first stage of the university/industry projects are being completed (getting the equipment installed), we need to look harder at the research agenda and how further meaningful research will be funded.
- This program never should have been funded.
- If continued, the partnership with labs and other national universities involved in wind energy activities should be formalized and strengthened.
- Plan for long-term O&M should be obligatory of the Consortium and not expected of the DOE.
- Work on a plan for future funding of R&D activities outside DOE funding.
- Try to upgrade performance to level of Minnesota consortium.

WP023: University/Industry Consortium: University of Minnesota
Dr. Fotis Sotiropoulos, University of Minnesota
FY 10 Budget: $7,982,000 DOE $3,202,000 Cost-Share
FY 11 Budget: $0 DOE $0 Cost-Share
Project Duration: Jan 2010 - Dec 2012

Brief Summary of Project



The objective of this project is to develop a consortium of industry and academe led by the University of Minnesota – Twin Cities in order to accelerate the path toward meeting DOE's 20% wind by 2030 goal through cutting-edge, industry-driven research; field-scale demonstration of new technologies; and workforce training. There are three main goals for this project: (1) Develop full-scale and laboratory-scale wind energy research facilities that will allow for the cost-effective development and practical demonstration and testing of a wide range of wind turbine technologies and the related collection of field-scale data sets for validating computational models. (2) Utilize the facilities to execute a research agenda driven by industry needs for more efficient and more reliable wind turbines. (3) Develop new curricula and educational initiatives for training the next generation of wind industry engineering leaders.

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

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

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

- Consortium meant to bring academia, industry and labs together to support the wind industry and educate future job force.
- Good alignment with Program Objectives of Workforce Development, reducing LCOE, reducing deployment barriers.
- Excellent example of engaging industry and universities for program goals.
- High degree of collaboration with many partners and strong education/workforce development.
- Program plan addresses 3 of DOE goals.
- Good example of academia-industry cooperation. Involvement of universities in wind energy research seems worthwhile, both with respect to bringing in new ideas, outreach and development of a qualified work force.
- Good package of research activities tied to the Clipper wind turbine plus education.
- This grant study appears to have significant educational benefits. There needs to be continued emphasis on collaboration with other researchers and industry.

- The critical point is "what comes next" in terms the getting to a larger research agenda and an ongoing R&D program.
- Working well with Clipper, U.S. turbine manufacturer.
- Wind research field test, research coordination, access to wind turbine documentation, strong collaboration with Clipper, and with Clipper, Clipper is open for external cooperation.
- Very good benefit to the University in stimulating Wind research that did not exist before, as well as benefiting the State of Minnesota.
- This project appears to be well managed and focused on promoting research capabilities.

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

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

- Good work planned in all three areas: testing facility, research, and education.
- Field station using Clipper turbine shows strong industry involvement.
- The Clipper turbine has been well instrumented and a solid test field station has been established.
- PI is working well with industry partner and labs in establishing methodology.
- Wind research field test station a significant part, the research potential depends on the coop with Clipper. Test activities standard. The research covers several interesting topics but the relation and coordination to other similar DOE program activities are not clear.
- Development of a turbine with met tower completed. Facility appears to have good monitoring/data collection capabilities.
- Chose larger 2.3 MW turbine.
- R&D and training tied to field station.
- PI has done excellent job of integrating knowledge from other areas (e.g., large eddy simulation for hydro) into wind program.

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

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

- De-scoped to meet project budget, but otherwise tasks presented are near completion.
- Developed wind research field station on time and on budget.
- Installed 2.5 MW turbine.
- Created a good core research infrastructure and high degree of state and regional buy-in.
- Well-balanced contributions in modeling, field station data collection and education/outreach.
- The project has led to a significant research program and cooperation with industry. Not much emphasis on education and outreach.
- As opposed to previous presentation, evidence of results from data acquisition are provided.
- Resulting in a number of useful findings that will improve turbine and wind plant performance.
- Instrumented the turbine, including foundation. LIDAR and met towers included in station.
- Educational benefits appear evident. But the overall benefits of the research activities need to be better communicated.
- Already producing substantial data and research results (e.g. riblets).
- What barrier in implementation of wind power technologies is this investment intended to resolve?

Question 4: Project Management

This project was rated **4.1** on its project management.

- De-scoped the icing element to meet budget and schedule.
- Turbine installed on schedule and budget.
- Effective in solving some major problems along the way and getting the job done for construction of the turbine site and turbine.
- The program appears to be well managed by people with understanding of project management.
- On schedule.
- Good job on managing the program and installation of the turbine.
- Timelines appear to have slipped significantly, but substantial completion of project is shown in the presentation materials.
- Not clear if plan exists for consortia sustainability.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.8** for research integration, collaboration, and technology transfer.

- Good collaboration with others in all three areas.
- Actively publishing and promoting results.
- Showed riblets research as example of early results.
- Work with 3M on riblets is impressive. Has demonstrated good working relationship with several corporate collaborators.
- Well connected with key stakeholders.
- The interaction with industry is commendable and funding from industry could make the research effort sustainable. Dissemination is not specified and the educational initiatives not impressive. Interaction and coordination with other DOE labs and wind engaged universities should be formalized and strengthened.
- Presentation provides evidence of strong industry collaboration.
- Good range of partners and collaborators.
- Working with industry and labs (3M, Sandia, etc.).
- While the amount of research completed so far is limited (due to the focus on construction of the Clipper turbine as the biggest issue so far), the research was well presented and the potential for future research seems to be well appreciated.
- Consider connecting with RISO Technical University of Denmark.
- Several published papers.
- New course at University of Minnesota. 150 students so far.

Question 6: Proposed Future Research

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

- Future research goals and plans to ensure long-term use and value of the unit are good.
- Proposed future research appears high quality based on work to date.
- Challenging to make the research from these university/industry consortia projects feel as "relevant and meaningful" as the other good projects we are discussing this week, but this project seems to be well positioned to move ahead.
- This is difficult given the requirement that the consortia link with a turbine supplier. It limits options.

- Future research only presented in general terms. Overlaps with other DOE program activities.
- Good ideas for going forward, but nothing is firm yet.
- Minnesota did a better job of presenting the research progress and relevance than did Illinois.

Strengths and Weaknesses

Project Strengths

- Research turbine not made by GE -- and larger than the 1.5 MW.
- Useful findings that will help with deployment and reducing LCOE.
- Solid cooperation established with industry and good initial research results.
- Completed a difficult construction project.
- PI and project manager.
- Close cooperation with Clipper assures relevance and industry impact.
- O&M cost is increasingly being more and more of an important topic of research and understanding. This unit is equipped with strain gauges that could help shed light on degradation of turbine structures.
- Good future planning, re: sustaining facility in long term.
- Aggressively developing funding sources.
- Modeling strength connected with SNL.
- Membership based access to the consortium is a great idea.
- Producing an enormous amount of data.
- Relationship with Clipper seems ideal.
- Built relationship with OEM so that the facility can be used for research; partnership with OEM is at the core of this being successful but it is also the most complicated aspect.
- Program established wind energy research at University of Minnesota and created many opportunities for collaboration with private companies that are located in close proximity to University.

Project Weaknesses

- Although the testing facility is equipped with sensors, the vision for intended research on the wind turbine is not well explained.
- None apparent.
- The value of research (completed, in progress and planned) is not totally engaging yet. How meaningful is the research agenda?
- Uncertain financial future.
- Activities only draw on other national expertise and R&D activities to a very limited extent.
- Risk that R&D initiatives stimulated by this DOE program could be lost if a long-term funding scheme is not realized. This is a particular concern as the Wind OEMs are facing an uncertain 2013 due to uncertain PTC.
- Sale of Clipper by United Technologies Corporation raises issues of longer-term parts and technology support.

Specific recommendations for additions or deletions to the work scope

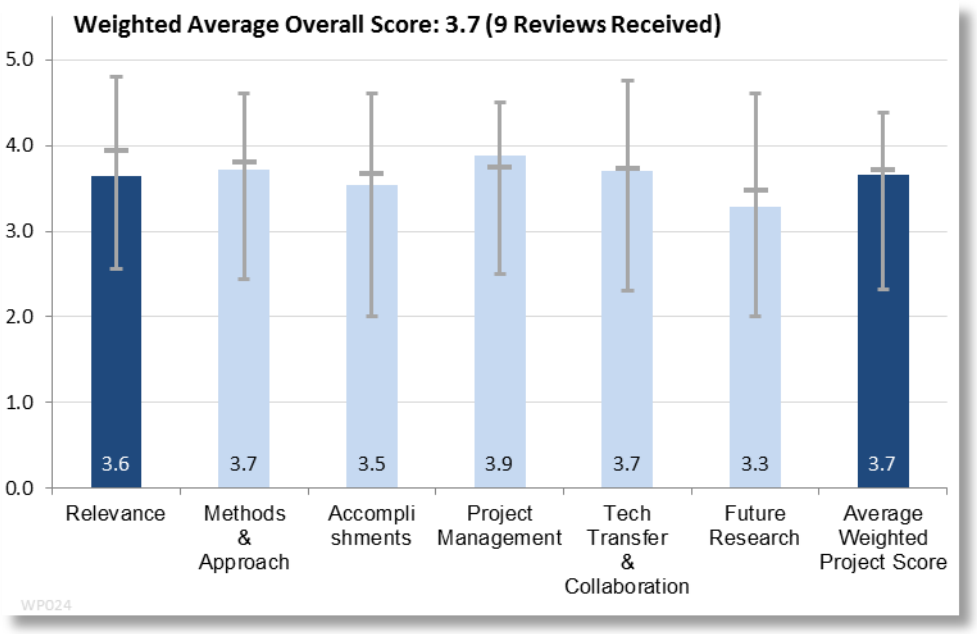
- Plan for long-term O&M should be obligatory of the Consortium and not expected of the DOE.
- Continue to support project with emphasis on interpretation and application of data.
- Develop long term funding plan.
- Now that the first stage of the three university/industry projects are being completed (getting the equipment installed), the projects need to look harder at the research agenda and how further research will be funded.
- Start planning now for future options to sustain program.

- Interaction and coordination with other DOE labs and wind engaged universities should be formalized and strengthened.
- Request donation of spare parts from new owners of Clipper.

WP024: DeepCwind Consortium National Research Program
Dr. Habib Dagher, University of Maine – presented by Anthony Viselli
FY 10 Budget: $1,744,000 DOE $264,000 Cost-Share
FY 11 Budget: $3,717,000 DOE $1,040,000 Cost-Share
Project Duration: Jan 2010 - Dec 2012

Brief Summary of Project

Focusing on the development of floating offshore wind farm technologies for deep water, the primary objectives are to:
1. Partially validate coupled aeroelastic-hydrodynamic models for floating offshore wind turbines.
2. Optimize floating platform designs by integrating more durable, lighter, hybrid composite materials.



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

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

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

- Deep offshore wind facilities are a long-term goal for the wind industry?
- Will help to build acceptance and support for offshore.
- With renewed emphasis on offshore development this program provides valuable input to floating offshore development.
- Directly supports offshore initiative.
- Solidly supports DOE's offshore research objectives and seems to be making good progress.
- Linked to two DOE goals.
- Interaction and coordination with other DOE labs and wind engaged universities should be formalized and strengthened.
- Project complements other university projects with focus on offshore wind.
- This university consortium program benefits from a very focused research effort on floating offshore wind. Floating turbines also happens to be one of DOE strategic technology areas for Offshore Wind. A lot of enthusiasm in Maine.
- This project seems to more appropriately focus on solving long-term offshore implementation issues; filling a gap in current industry knowledge.
- Shouldn't facility be open to more elements of offshore research -- instead of narrowly selecting floating platform applications?
- Significant educational benefits.

- Does this meet DOE objectives in terms of offshore floating structures?

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

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

- Key should be tools and methods that will assist others looking to develop offshore (siting, environmental impacts, permitting etc.).
- The approach is valid by moving from 1:50 scale to 1:8 scale and ultimately to full scale. The data obtained from scaled modeling and actual field data will be helpful in ultimate utilization of offshore floating resource.
- Focus on validating tools for designing and analyzing floating platforms and validating the tools is a good focus given overall DOE Offshore strategy.
- Seems impressive based on what was presented.
- Accomplishing proposed tasks, but tasks seem not very relevant to advancing industry
- Rather broad approach, leading to a 1:8 scale prototype being tested at a site, combined with various site investigations.
- Presentation indicates an interesting set of research initiatives - technologies and test locations.
- Choice of offshore floating structure (patent included) is somewhat too narrow.
- Proper attention paid to environmental impacts.
- Educational program seems to be on target and successful.
- Seven tasks touch critical areas of needed research.
- Detail of tasks lacking.

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

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

- Based on objectives and execution, project appears to be progressing well.
- Not too many details but the published data indicate valuable data for wind wave interaction and impact on tower.
- Completed 1:50 scale tank tests.
- Tough to judge, but supporting the current DOE agenda for offshore.
- Making progress on tasks.
- Early in the project, but good progress.
- A focused effort on floating offshore wind that is leading to a 1/8 demo in early 2013.
- There appears to be significant accomplishments in developing educational and outreach programs using the funding for this grant.
- Good progress in modeling and design of offshore structure and education & Outreach, the other tasks, it's less apparent on accomplishments.
- Identified test sites.
- Next phase should deliver more substantive results.
- Designed 1:8 pilot.
- Not sure of strategy to focus on deep sea floating platforms.

Question 4: Project Management

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

- The big question mark is whether or not the second testing site will be completed on-time and in budget. -- Too many unknowns to say that the project will be completed on time.
- A considerable amount of work is being performed with modest level of funding.
- Based on information provided, very impressive in meeting schedule milestones.
- Good progress but early.
- Project appears to be well managed; on time deliveries and within budget.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- No discussion on consortium members or active engagement with others doing offshore research.
- A multitude of technical and scientific partners were recruited and tremendous involvement with students from high school to college.
- Several publications.
- Seems to show good collaboration - growing relationships for offshore (that are somewhat unique from relationships for land-based wind).
- Large partnerships, dissemination and involvement in IEA task. Industry interest?
- A relatively narrow university consortium.
- Strong indication of technical publications.
- Education aspects good.
- Cooperation with Maritime Research Institute Netherlands and industry.
- Limited collaboration on the project with other researchers or industry.
- Some results published.
- Use of resources in the Netherlands to conduct initial phase of research appears to be a cost-effective use of international resources.
- What about learning from industries well experienced with the marine environment?

Question 6: Proposed Future Research

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

- Proposed research focused on turbine upgrades misses the mark -- the key to offshore success will be the platform. Focus should be on bringing in as many ideas as possible to solve that issue.
- Good proposal for future proposals to continue research.
- Proposed detailed approach for floating platforms design is needed for industry to take over this challenge.
- Good research plan for pilot at two sites, plus materials and controls research.
- Supports current DOE offshore agenda.
- Relevant continuation but industry and lab involvement should be clarified.
- Good ideas for going forward, but nothing is firm yet.
- What do the prototypes indicate?
- Details of how the combined research over the past three years will contribute to a full scale deployment.
- Developing testing methods & design standards for floating offshore wind turbines should be of highest priority. This exercise also requires excellent collaboration.

Strengths and Weaknesses

Project Strengths

- Offshore is a strategic direction taken by the DOE and this is the consortium to address these issues.
- Strong interest from floating wind turbine validation community.
- The project approach is quite valid by successively increasing the scale and getting data from scaled models and comparison to models.
- Systematic research plan for developing and validating tools and designs for floating platforms.
- Impressive work on floating offshore technology.
- New thoughts from involvement of University of Maine, Masters and PhD outcome.
- Strong technology focus: floating platform that are well aligned with DOE priorities.
- Project has put University on the map and generated strong support for offshore wind in state, including Senators.
- The involvement of the research communities and multiple labs is a source of strength.
- Good educational program, even down to the high school level.
- Shows strong potential for industry in taking pilot project to scale, which could have a positive impact on Maine economy and jobs.
- The University was quite successful in motivating students to contribute to floating offshore research.
- Potential to create new industry in Maine.

Project Weaknesses

- Lack of collaboration is really apparent.
- Potential backlash over economics and siting barriers for offshore wind.
- Do not see a plan for utilization of all this material in a full-scale pilot turbine deployment off the coast of Maine.
- Total funding of 14 million is very significant (mostly from ARRA funding and congressionally mandated funding), so this doesn't come cheap by any means. Expectations are similarly higher since this is roughly twice the funding provided to the other university/industry projects.
- Very little new science/technology to contribute to offshore program.
- Can the results be implemented by industry?
- Very focused on University of Maine, the breadth of collaboration could be larger.
- Actual offshore costs are still very difficult to quantify.
- Focus on deep water (rather than shallow) is not well supported by cost evidence.

Specific recommendations for additions or deletions to the work scope

- Focus on methods and tools to provide structure to the floating offshore industry should be the utmost important objective of the consortium. Objective seem rather narrowed towards one specific floating technology and site for monitoring, which limits the benefits to the wind industry.
- Continue to support project and leverage Maine's enthusiasm for offshore wind development to study ways to lower the cost and reduce the deployment barriers.
- Develop funding plan post ARRA funding.
- This is an expensive project, but if offshore is a priority, and then I think they are doing a good job of supporting DOE priorities in a university setting.
- Focus on shallow water.
- Interaction and coordination with other DOE labs and wind engaged universities should be formalized and strengthened.

- It's difficult for me to judge the amount of industry collaboration, but I would hope that more industry relationships can be established and supported.

6.0 Technology Project Evaluations

The goal of the Technology portfolio of projects is to optimize wind plant performance, and the primary metrics of success are to: 1) achieve a land-based LCOE of 4.8 c/kWh by 2020; and 2) certify 40 small wind turbine systems by 2020. Projects in the Technology portfolio conduct fundamental, high-risk research and development (R&D) that is currently out of the scope of industry R&D programs, which are typically more applied, higher technology readiness level (TRL) R&D programs.

The R&D priorities of the Technology portfolio are focused on:

- Complex Wind Plant Aerodynamics and Atmospheric Science
  - Overcoming wind plant underperformance, which can be as high as 20-30%
  - Activities: wind plant field experiments, wind tunnel experiments, and high-fidelity model improvement
- Next Generation Technology Development
  - Developing high-risk, high-reward technologies outside the spectrum of industry R&D
  - Activities: advanced components, advanced controls, integrated systems analysis, & design tools
- Improved Reliability and Performance
  - Improving industry-wide O&M performance and provide world-class testing facilities
  - Activities: industry reliability data collection, industry collaboratives, and test facility development.

Technology activities in the Wind Power Peer Review were organized into the following sessions: characterizing turbine inflow; offshore; manufacturing and materials; design tools and system modeling; reliability; rotor technology; and controls. Figure 6.1 illustrates the funding levels for the Technology projects that were reviewed in the 2012Wind Power Peer Review.

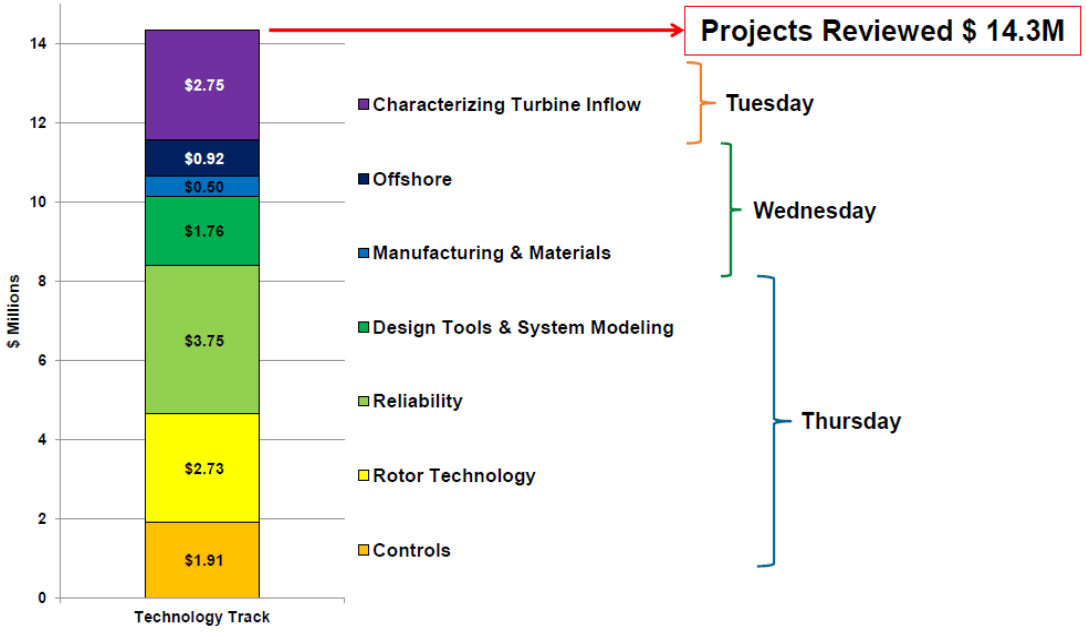


Figure 6.1 Technology Projects Reviewed in the 2012 Wind Power Peer Review

The following table lists all Technology projects reviewed during the 2012 Wind Power Peer Review, including the title, organization, Principal Investigator, FY 2011 budget, peer review session, number of reviewers, average score per metric, weighted average overall score, and relevance score for each project.

Table 6.1 Technology Projects Reviewed in the 2012 Wind Power Peer Review

Project ID	Title	Organization	Principal Investigator	FY 2011 Budget	Peer Review Meeting Session	Number of Reviewers	Methods and Approach (30%)	Technical Accomplis. and Progress (30%)	Project Management (20%)	Research Integration, Collaboration, and Technology Transfer (10%)	Proposed Future Research (10%)	Weighted Average Overall Scores for Projects	Relevance to Wind Industry and Overall DOE Objectives
WP005	Turbine inflow and wake observations with 2-micron LIDAR	LLNL	Jeff Mirocha	$200K	Characterizing Turbine Inflow	5	4.0	3.5	3.3	4.4	3.5	3.7	3.8
WP006	Multiscale Resource Modeling	LLNL	Jeff Mirocha	$200K	Characterizing Turbine Inflow	5	3.6	3.7	3.1	3.4	3.4	3.5	3.4
WP007	Accurate Wind Characterization in Complex Terrain Using the Immersed Boundary Method	LLNL	Jeff Mirocha	$200K	Characterizing Turbine Inflow	5	4.1	4.1	3.1	3.8	3.5	3.8	4.1
WP008	Long Term Observations of Wind Profiles and Turbulence for Model Evaluation	PNNL	Larry Berg	$150K	Characterizing Turbine Inflow	4	3.6	3.5	3.3	3.2	3.2	3.4	3.8
WP009	Wind Turbines In-Situ Particle-Image Velocimetry	LANL	Suhas Pol	$160K	Characterizing Turbine Inflow	5	2.4	2.4	2.9	2.8	2.7	2.6	2.6
WP010	Wake and Array Effects Modeling and Characterization	NREL	Patrick Moriarty	$575K	Characterizing Turbine Inflow	5	4.5	4.2	4.0	4.8	3.8	4.2	4.4
WP011	Stochastic Inflow Simulation, Characterization and Observational Technologies	NREL	Patrick Moriarty	$335K	Characterizing Turbine Inflow	5	3.7	4.1	3.6	3.9	3.6	3.8	3.8
WP012	DOE 1.5 MW Turbine Test / DOE 1.5 MW Instrumentation Upgrade	NREL	Scott Schreck	$950K	Characterizing Turbine Inflow	4	3.8	3.9	4.0	3.9	4.0	3.9	4.1

Project ID	Title	Organization	Principal Investigator	FY 2011 Budget	Peer Review Meeting Session	Number of Reviewers	Methods and Approach (30%)	Technical Accomplis. and Progress (30%)	Project Management (20%)	Research Integration, Collaboration, and Technology Transfer (10%)	Proposed Future Research (10%)	Weighted Average Overall Scores for Projects	Relevance to Wind Industry and Overall DOE Objectives
WP025	New Reference Facility for Offshore Renewable Energy (RFORE)	PNNL	Larry Berg	$139K (FY 12)	Offshore	4	3.5	3.5	3.5	3.5	3.3	3.5	3.5
WP026	Sediment, Transport, Scour and Foundation Impact Analysis	SNL	Jesse Roberts	$100K	Offshore	4	4.1	3.6	4.1	3.9	3.1	3.9	3.6
WP027	Offshore Structural Models and Analysis	NREL	Walter Musial	$595K	Offshore	4	4.3	3.8	4.3	4.0	3.5	4.0	4.3
WP028	Reducing COE with Floating Tension-Leg Platform Technology	Glosten Associates	Charlie Nordstrom	$402K (FY 12)	Offshore	4	3.6	3.4	3.5	3.0	3.3	3.4	4.0
WP029	National Offshore Wind Energy Resource and Design Data Campaign	AWS Truepower	Bruce Bailey	$407K (FY 12)	Offshore	3	4.2	3.5	3.8	3.5	3.3	3.8	3.8
WP030	Advanced Manufacturing Initiative	SNL	Dr. Daniel Laird	$700K (FY 10)	Manufacturing & Materials	4	4.1	3.8	4.0	3.8	3.1	3.9	3.9
WP031	Manufacturing Research	SNL	Joshua Paquette	$500K (FY 10)	Manufacturing & Materials	4	2.6	2.0	2.5	2.3	2.0	2.3	3.1
WP032	Materials Research	SNL	Joshua Paquette	$500K	Manufacturing & Materials	4	3.4	3.8	4.0	3.9	3.4	3.7	4.0
WP033	Advanced Design Tools	NREL	Paul Veers	$1.28M	Design Tools & System Modeling	4	4.1	3.8	4.1	4.4	3.6	4.0	4.6
WP034	Blade Design Tools & System Modeling	SNL	Joshua Paquette	$475K	Design Tools & System Modeling	4	3.6	3.5	3.5	3.1	3.1	3.5	3.9

Project ID	Title	Organization	Principal Investigator	FY 2011 Budget	Peer Review Meeting Session	Number of Reviewers	Methods and Approach (30%)	Technical Accomplis. and Progress (30%)	Project Management (20%)	Research Integration, Collaboration, and Technology Transfer (10%)	Proposed Future Research (10%)	Weighted Average Overall Scores for Projects	Relevance to Wind Industry and Overall DOE Objectives
WP047	Blade Reliability Collaborative	SNL	Joshua Paquette	$800K	Reliability	4	3.5	3.5	3.8	3.5	3.3	3.5	3.8
WP048	Gearbox Reliability Collaborative	NREL	Jonathan Keller	$1.32M	Reliability	4	4.2	4.0	4.3	4.3	3.6	4.1	4.5
WP049	CREW Database and Analysis Program	SNL	Alistair Ogilvie	$1.4M	Reliability	4	3.9	4.0	3.8	3.5	3.8	3.8	3.9
WP050	Condition Monitoring and Data Analysis	NREL	Shawn Sheng	$225K	Reliability	4	4.0	3.5	4.0	4.0	3.6	3.8	4.1
WP056	Blade Testing Methodologies	NREL	Scott Hughes	$680K	Rotor Technology	4	4.6	4.0	4.3	4.6	3.9	4.3	4.2
WP057	Large Offshore Rotor Development	SNL	Daniel Todd Griffith	$250K	Rotor Technology	4	3.3	3.3	3.8	3.8	3.8	3.5	3.3
WP058	Siemens CRADA	NREL	Lee Jay Fingersh	$1.5M	Rotor Technology	4	4.0	4.0	4.0	3.6	3.4	3.9	3.5
WP059	Aerodynamics and Aero-acoustics Research	SNL	Matthew Barone	$600K	Rotor Technology	4	4.0	4.0	3.8	3.8	3.5	3.9	4.2
WP060	Sensor Blades 1 and 2	SNL	Jon White	$200K	Rotor Technology	4	4.3	4.1	3.5	4.1	3.6	4.0	3.9
WP061	Advanced Controls R&D + Controls Partnerships	NREL	Lee Jay Fingersh	$960K	Controls	4	4.1	4.3	4.5	4.5	3.8	4.2	4.1
WP062	Active Aerodynamic Load Control Devices in Blades (SMART)	SNL	Dale Berg	$950K	Controls	4	4.1	3.8	3.8	3.3	3.3	3.7	3.6

Figure 6.2 illustrates the weighted average overall scores and the relevance to wind industry needs and overall DOE objectives scores for all Technology projects that were reviewed in the 2012 Wind Power Peer Review.

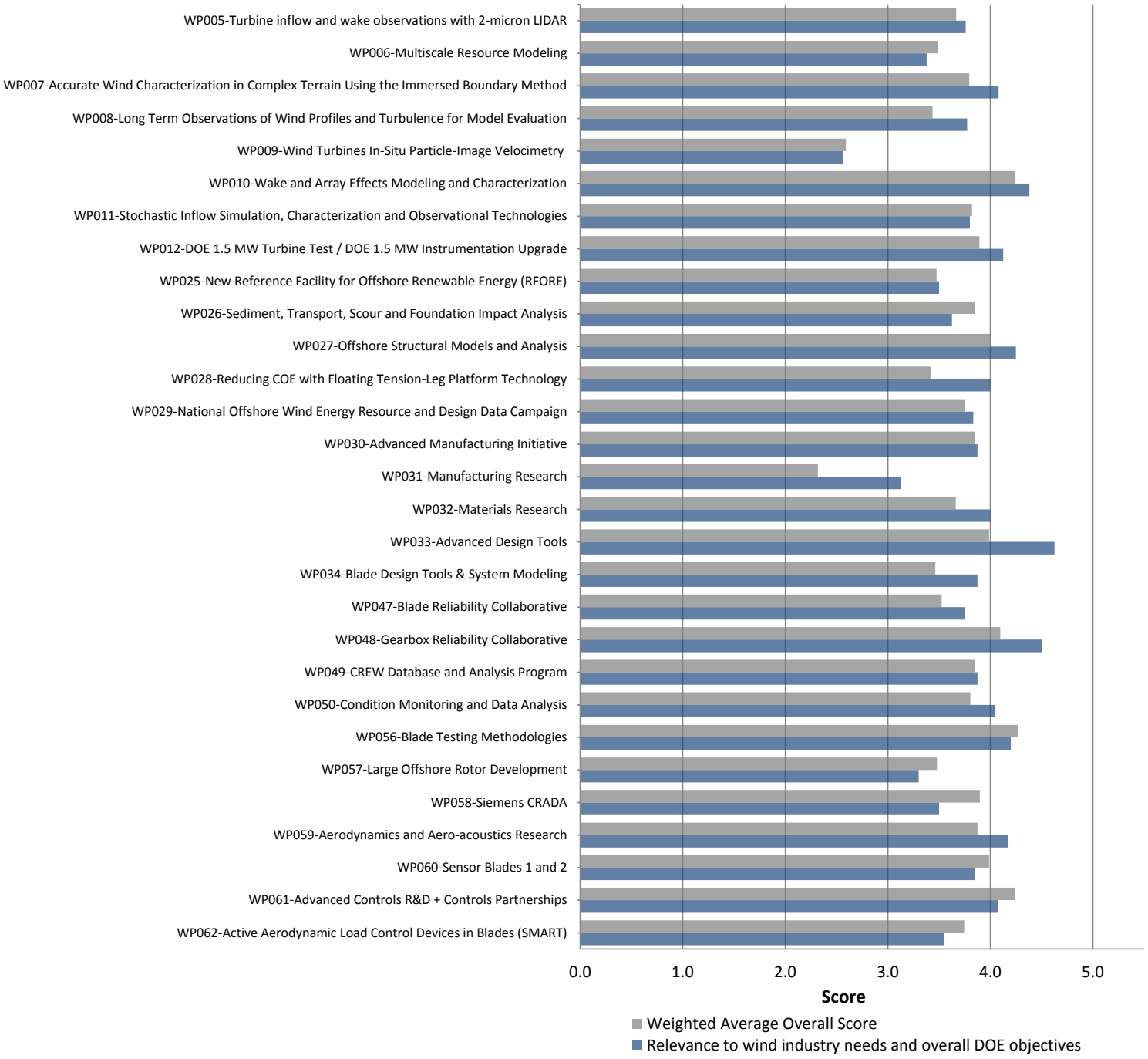
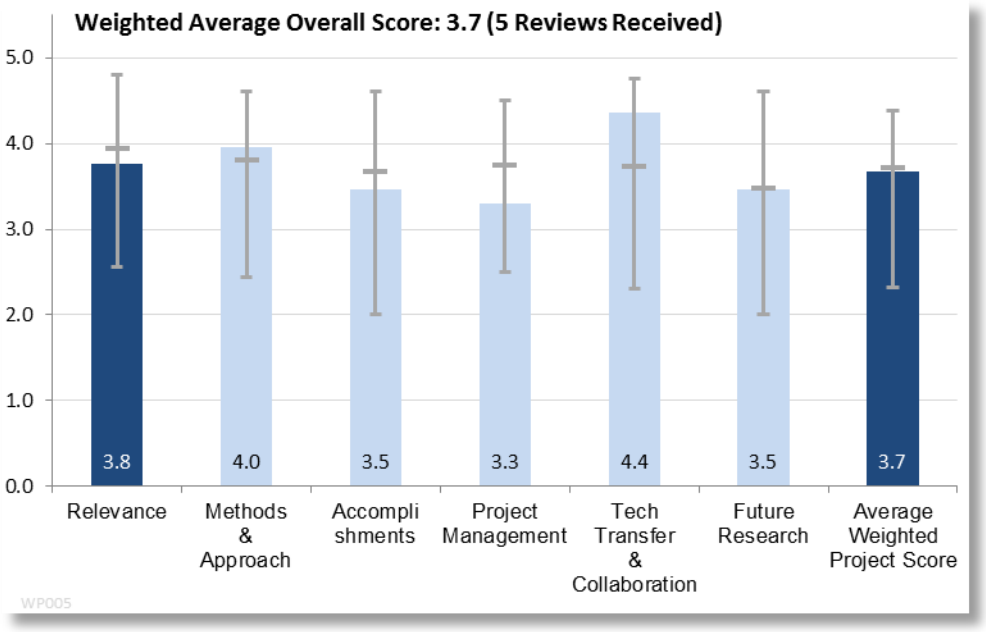


Figure 6.2 Project Scores from Technology Sessions

WP005: Turbine inflow and wake observations with 2-micron LIDAR

Jeff Mirocha, LLNL
FY 10 Budget: $200,000 DOE $0 Cost-Share
FY 11 Budget: $200,000 DOE $0 Cost-Share
Project Duration: Jan 2010 - Dec 2011

Brief Summary of Project



This project will provide a dataset for validation and improvement of wind energy forecasting models and the quantification of wake characteristics of a modern, utility-scale wind turbine. A suite of instrumentation, including an instrumented 135m tower, and the National Oceanic and Atmospheric Administration's (NOAA's) high-resolution Doppler lidar (HRDL), will be sited near the new Siemens 2.3 MW turbine so that both turbine inflow conditions and turbine wake characteristics can be monitored and quantified. The observations will be quality controlled and made publically available. This dataset will further our understanding of both boundary-layer inflow conditions and turbine wakes, helping engineers better understand and design for realistic turbine loads, as well as providing benchmarks for various computational approaches.

The team will also carry out modeling studies based on the observations in LLNL's modified version of the Weather Research and Forecasting (WRF) numerical weather prediction model. These studies will identify the strengths and weaknesses of a widely used contemporary weather model (WRF) in simulating inflow and wake characteristics, and identify areas in need of improvements.

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

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

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

- The focus to provide datasets and tools to better characterize inflow characteristics is right on with what the industry needs.
- Wakes (both turbine-level and plant-level) are a major topic of interest to the industry, so this is very relevant.
- Understanding turbulent inflow and visualization and measurements of wake are important. However, it is not clear how such a short measurement period with low spatial resolution and the adaption of WRF to model wake flows add much to existing models and knowledge. The project is not targeted towards a specific strategic problem.

- Evaluating remote sensing techniques, wakes, understanding WRF are all important.
- The project appears extremely relevant to better understanding the impacts of wake effects on wind farm output.
- WRF for intermediate scale, farm level effects - also a research level code.
- Given limited cost, project appears to be highly cost-effective.
- This is an area where government-funded research can have a significant impact on cost-effectiveness of wind energy.

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

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

- It appears that a clear way to turn the qualitative images into quantitative data is not yet known, but this is R&D.
- Well designed and important topic - much more can be done to be sure.
- The rationale behind developing another wake flow model based on WRF is not clear.
- Study appears to be appropriately designed.
- Inclusion of several meteorological instruments to characterize flow is effective.
- This is really just "starter money" and very limited time on the LIDAR was available, but an intriguing start.
- Integration to WAKEBENCH is an accessible tool for all: good.

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

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

- Project goal means for quantitative data, tools etc., and at this point the project has not provided that; however, there is no reason to think the project will not meet objectives.
- Very impressive for the limited funding involved.
- Images recorded but not much else at this point.
- Even though project has been delayed, data presented during peer review provides evidence of technical accomplishment.

Question 4: Project Management

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

- Project delays related to issues unrelated to the project.
- Fine given the small project size.
- Project delayed.
- Project appears to have been implemented one year late.
- Impressive collaborative effort.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- A great collaborative effort will lead to good results.
- High number of good collaborators.
- Interaction with many parties and measurements can be applied in other projects.
- Identified IEA WAKEBENCH as the method of data dissemination - is this familiar to industry, do most people know how to get to this?
- Numerous articles and presentations.
- Plans to integrate work into the IEA WAKEBECH tool looks to be a great way to disseminate this information and improve modeling efforts.

Question 6: Proposed Future Research

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

- Proposed follow-on work to improve along with eventually collecting such information from real wind farms frames both near-term and longer-term goals of the project.
- Looking at larger plant-level pressure and wake issues, as you plan, would be great.
- Future research of an exploratory nature, not very targeted.
- Very solid evidence of future research planning.

Strengths and Weaknesses

Project Strengths
- Wake modeling is not well understood and this project addresses that.
- Impressive LIDAR from NOAA - 20 seconds per scan.
- Experimental investigations of wakes in demand.
- Very important topic and impressive amount of work for the money.
- WRF may catch more atmospheric phenomena than other engineering tools but it is a research tool for investigation of wakes.
- Advantages of incorporating the modeling with WRF, from which you can get time-series data, for next-generation work on wind farm design and simulation.
- Parties bring new techniques in use.

Project Weaknesses
- Will be a challenge to apply this to wake flow models of wind farms -- quantitative methodology is key.
- Very limited time with the LIDAR was available to the researchers.
- With the resolution of 30 m the lidar system does not capture the detailed wake structure
- Can WRF be used as an engineering tool?
- Three weeks of measurements a short time to catch possible wind states.

Specific recommendations for additions or deletions to the work scope

- Good return on investment.
- More of this type of work is needed and worthwhile.
- It should be analyzed what advantages WRF can bring compared with alternative/faster models

- For this, and other wind modeling programs, the technology transfer etc. is happening at academic conferences --- how will they get this message out to industry?
- Keep a long term view on how all of these types of projects will tie together and lead to tools that can be broadly adopted and economically utilized in the industry. An opportunity for DOE leadership in this area.
- On the whole subject of wind modeling; it would be helpful to industry to have a central site for links to public data coming out of DOE programs in this area. A DOE website could be used for this.

WP006: Multiscale Resource Modeling

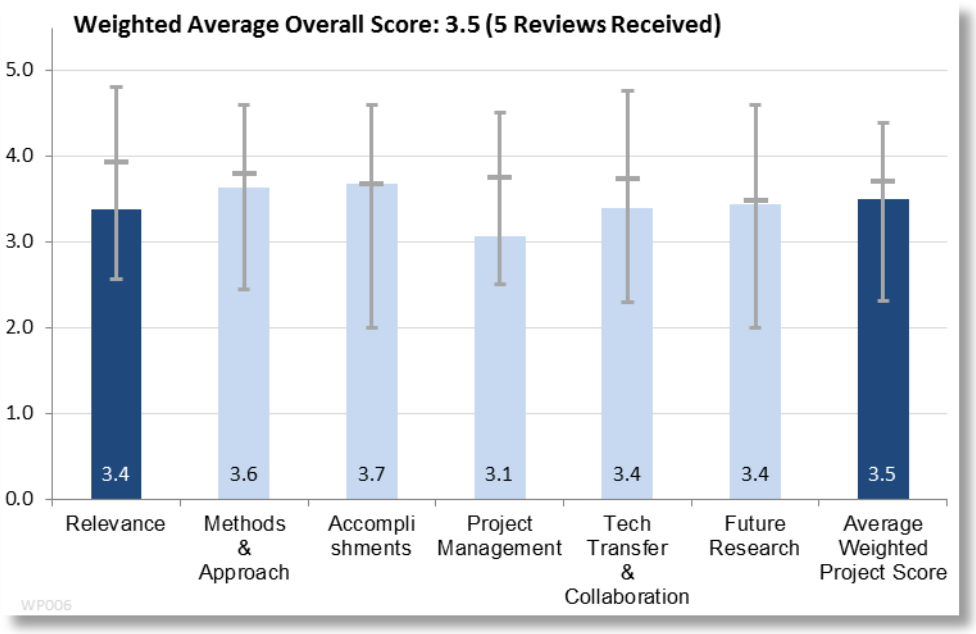
Jeff Mirocha, LLNL

FY 10 Budget: $200,000 DOE $0 Cost-Share

FY 11 Budget: $200,000 DOE $0 Cost-Share

Project Duration: Jan 2010 - Dec 2012

Brief Summary of Project



Turbulence-resolving simulations of the atmospheric boundary layer (ABL) are essential for improved wind forecasting, which will increase farm production and reduce LCOE. However these simulations are challenged by the lack of realistic inflow boundary conditions, and the omission of interactions between turbulence and larger-scale process that influence the flow. This project addresses some of these limitations by developing a methodology for conducting multi-scale flow simulations that can incorporate the effects of all important scales of flow, including changing large-scale weather patterns, regional-scale phenomena, and atmospheric turbulence.

The objective of this research will be a set of tools and guidelines for conducting nested-domain, multiscale simulations using the Weather Research and Forecasting (WRF) Model, an open-source code, freely available and widely used by many operations and research centers, and wind energy forecasting groups. Development of these tools and guidelines within WRF ensures a wide user base and rapid technology transfer. The tools and approaches we develop for multi-scale flow prediction will provide the wind energy industry a much more accurate tool for simulating complicated, turbulent boundary-layer flows in wind park environments. This capability will benefit a spectrum of applications, including site characterization, micrositing of turbines, wind plant operations, and can also provide high-fidelity turbulent inflow conditions to offline turbine-scale computational fluid dynamics codes to further understanding of turbine-airflow interactions.

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

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

This project earned a score of **3.4** for its relevance to wind industry needs and overall DOE objectives.

- This project has value for improving use of the WRF model, which in turn will allow for improvement in wind resource assessment and forecasting etc. However, when this return on investment will occur is not apparent to me.

- Goal is providing guidelines on how to use WRF for multi-scale modeling correctly, avoiding poor practices and errors. This is a very good goal.
- WRF is a very good tool for meso-scale atmospheric modeling. Project is in general an attempt to improve flow modeling on a finer scale, but perspectives and goal not clear.
- This is addressing a very big and important question that will shape the way we approach numerical simulations for wind resource assessment. Many people are going the route of computational fluid dynamics with brute force boundary conditions right now, but this approach is more physically meaningful.
- This is a very interesting technical discussion, but the link to industry needs is not sufficiently identified.
- Difficult to explain to the layperson, as it is "in very deep" into atmospheric modeling details, but I see the value and I'm impressed with the progress.
- Vision is to do the ground breaking work now so that as computing capabilities grow and computing costs come down, these technologies will be ready to be used more extensively in industry.
- Given limited funding, this is very cost-effective research.
- Scored this high since it is important fundamental research within the boundary atmospheric sciences community, which is important for wind power.
- It could be argued that this is fundamental research in meteorology that should be funded elsewhere, but if DOE doesn't do it, I really don't know who would.

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

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

- Good to compare and contrast several models ability to capture reality.
- Impressive on the modeling side, weak when it comes to having real field data to validate, but this is a very difficult area.
- Good work but general and fundamental and only indirectly tied to DOE program objectives.

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

This project was rated **3.7** based on technical accomplishments and progress.

- Models compared quantitatively, large eddy simulation model approaches computed and guidance provided.
- Impressive results in a highly complex area.
- Long way to practical application; interesting but very generic and fundamental research in large eddy simulation flow modeling. Project remedies a limitation of WRF for high resolution use in complex terrain.
- Sounds like they've base-lined the proposed study pretty well so far.
- Project delays have been significant.
- Difficult to determine from presentation how much research progress has been achieved. Results appear to be significant.

Question 4: Project Management

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

- Delay due to understanding models.
- Okay given the small funding and technical hurdles.
- Slight delay.
- Timeline shift is indicative of a research project.

- Case studies delayed to end of project could lead to more set-backs.
- It is not clear why WRF development belongs in the Wind Program and has been split in three separate projects.
- It's difficult to put a time deadline on research, as it requires creativity.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Collaboration with other labs or industry professionals may have improved work's applicability to near-term modeling efforts needed by the wind industry.
- Good team of very good collaborators.
- WRF development seems to be an independent effort, not integrated in the wind energy community. Dissemination focuses on atmospheric science community.
- How do results become accessible to industry in a "friendly" way?
- Several publications indicate effort to communicate with other researchers.
- Information disseminated; however, engagement of actual wind industry appears to be missing.

Question 6: Proposed Future Research

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

- Focus should be incorporating these models into tools used by the wind industry and users of these tools. Proposed work suggests further WRF development, but it's missing the elements that make the work appear useful in the near term.
- They suggest a number of good, but very difficult, tasks for future research.
- Future research focuses on development of numerical methods. Stronger focus on wind energy program objectives. What question is addressed?
- Improving WRF for high resolution / complex terrains with the intent of doing a wind resource assessment is great, as long as there is a vision on how eventually the computational time and costs will allow the technology to be used regularly in industry.

Strengths and Weaknesses

Project Strengths
- Improving understanding of complex, multi-scale flow.
- Very good team tackling some highly technical WRF modeling issues.
- Competent researchers.

Project Weaknesses
- Understanding this project's relevance to the wind industry today is difficult.
- So highly computational. Is this viable for actual use by the wind development community in the practical future?
- Relevance for and involvement of wind energy community not clear.

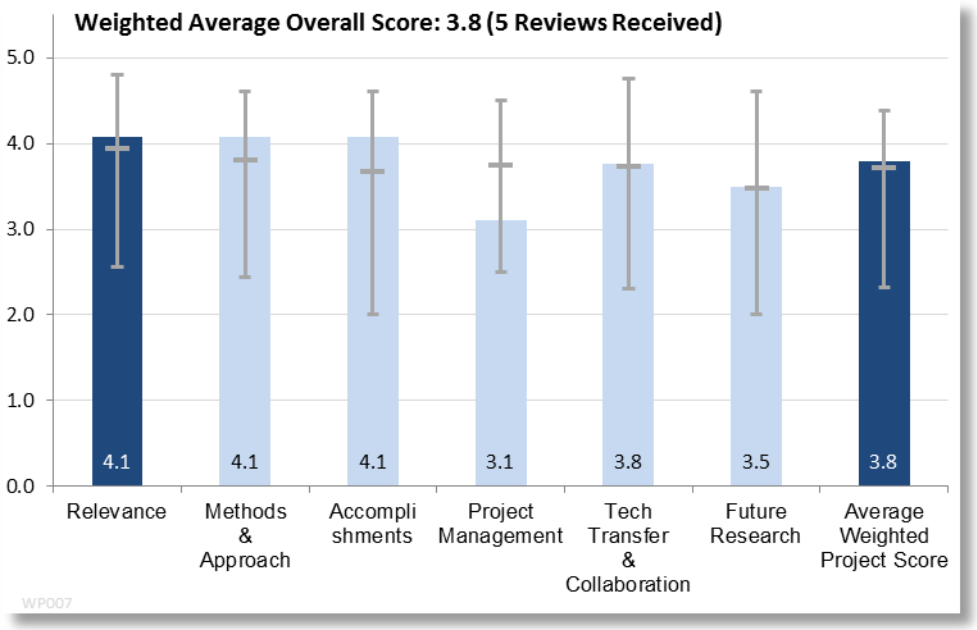
Specific recommendations for additions or deletions to the work scope

- I see value in some level of ongoing support and next steps.

- For this, and other wind modeling programs, the technology transfer etc. is happening at academic conferences --- how will they get this message out to industry?
- Keep a long term view on how all of these type of projects will tie together and lead to tools that can be broadly adopted and economically utilized in the industry. An opportunity for DOE leadership in this area.
- On the whole subject of wind modeling; it would be helpful to industry to have a central site for links to public data coming out of DOE programs in this area. A DOE website could be used for this.

WP007: Accurate Wind Characterization in Complex Terrain Using the Immersed Boundary Method
Katherine Lundquist, LLNL – presented by Jeff Mirocha
FY 10 Budget: $200,000 DOE $0 Cost-Share
FY 11 Budget: $200,000 DOE $0 Cost-Share
Project Duration: Oct 2009 - Sep 2012

Brief Summary of Project



The objectives of this project are to develop numerical tools that will improve the fidelity of atmospheric flow simulations in the presence of complex terrain through improved representations of the terrain. Our tools will advance the industry by addressing the needs for improved wind resource characterization in complex terrain and generating accurate and time-dependent turbine inflow conditions. These tools are developed through modifications to the open-source Weather Research and Forecasting (WRF) model. Using the grid nesting framework in the WRF model in combination with a novel gridding technique, the WRF model can be applied to flow over complex terrain at scales ranging from the mesoscale to the microscale. The final product is a modified version of the WRF model, capable of microscale simulations of atmospheric flow over complex terrain (addressing limitations of the current WRF model).

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

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

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

- The key difference between this project and the other LLNL projects in this area is that the potential improvements to modeling complex terrain are well delivered.
- Points out situations in which complex terrain at high resolution overwhelms the abilities of the standard WRF model grids.
- Important step for using WRF in complex terrain and smaller scales as an alternative.
- This is all really great work, but is so computationally expensive that we may not really be able to use it for day to day business. Important not to neglect though because computers will become cheaper.
- Very cost-effective development of useful research.
- Important, and results are impressive. Some will feel this is an "esoteric" topic, but it is actually quite fundamental to atmospheric modeling and of high interest to "modeling people" in industry.
- How does this approach change the computational requirements compared to standard WRF, if at all?

- Interesting approach to boundary condition issues in complex terrain.

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

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

- Excellent.
- Good and innovative approach by well qualified people.
- If the goal is to adapt WRF, the approach seems to work.
- Interesting approach to increasing usefulness of available modeling tools.

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

This project was rated **4.1** based on technical accomplishments and progress.

- Improvements have been demonstrated.
- Impressive for a small project.
- The approach seems to work.
- Good baseline work done so far.
- Lots of progress given limited funding.
- Validation for use in wind resource modeling is needed.

Question 4: Project Management

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

- Delays due to elements out of control.
- Good work, with some delays.
- Slight delays.
- Limited project delays indicate a need for better project management.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.8** for research integration, collaboration, and technology transfer.

- This work is excellent and would benefit from additional involvement with industry and others working on these issues and those doing modeling of real wind projects.
- Lots of crossover into atmospheric modeling community.
- Collaboration between atmospheric researchers but results are only disseminated in this community. How shall the work be transferred to the wind community?
- Very good - numerous peer-reviewed presentations.
- Offering mentorship is good.

Question 6: Proposed Future Research

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

- Proposed work looks to fully integrate the model.
- Lots of work to be done before this is useful to wind energy in an operational sense, but very intriguing work.
- The future research is still on the development of an alternative generic fine-scale flow modeling tool. While the research in numerical methods is competent, it is not clear that the work belongs in a wind energy program.
- Thoughtful directions for future research.

Strengths and Weaknesses

Project Strengths
- Addresses shortfalls in modeling and provides sound solution.
- Fundamental work that will contribute widely to atmospheric modeling, and therefore to wind energy, but somewhat indirectly and will take more work and time.
- Competent staff but far from practical application.
- Important, modeling intensive work.

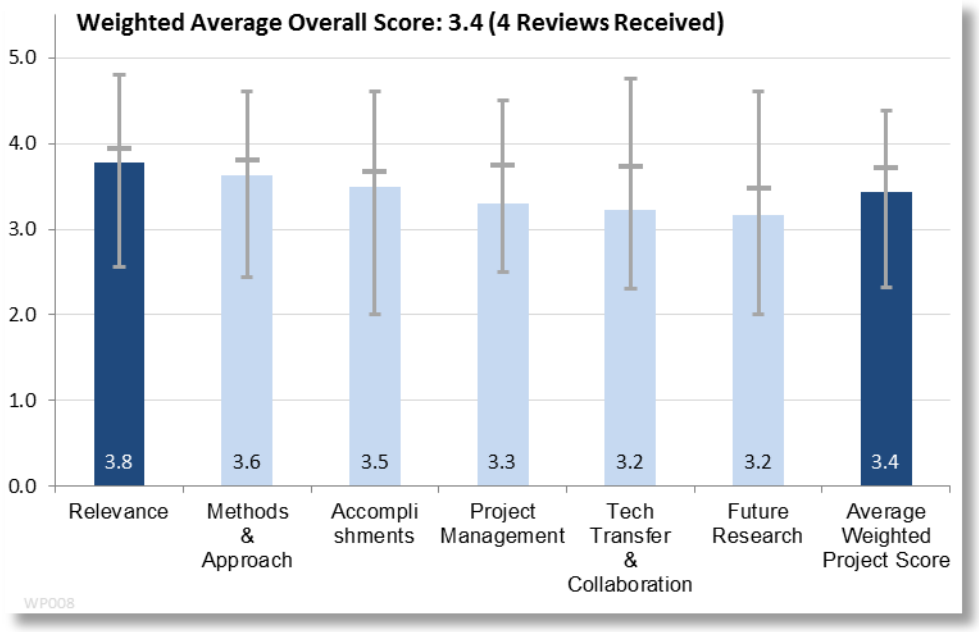
Project Weaknesses
- Disconnect between academic side of things and application.
- Deeply technical and beyond the scope of most wind and energy folks (although people at NCAR and NOAA would love this work).
- Good quality but difficult to see the relevance in a strategic wind energy program.
- How long until computing capabilities increase and computing costs come down so that this type of technology can be widely utilized in the industry? However it is good that DOE has some funding going into this technology area.

Specific recommendations for additions or deletions to the work scope

- The next phase of this work will be of exceptional value.
- Sell the value of this work more widely in the atmospheric sciences community and look for funding and support more widely, as this is more than just a wind energy problem.
- More emphasis on dissemination of results to the wind energy community.
- In addition to the sophisticated papers and journal articles, look at more of a recipe type report that can be used and understood more readily by industry.
- For this, and other wind modeling programs, the technology transfer etc. is happening at academic conferences --- how will they get this message out to industry?
- Keep a long term view on how all of these type of projects will tie together and lead to tools that can be broadly adopted and economically utilized in the industry. An opportunity for DOE leadership in this area.
- On the whole subject of wind modeling; it would be helpful to industry to have a central site for links to public data coming out of DOE programs in this area. A DOE website could be used for this.

WP008: Long Term Observations of Wind Profiles and Turbulence for Model Evaluation
Larry Berg, PNNL
FY 10 Budget: $300,000 DOE $0 Cost-Share
FY 11 Budget: $150,000 DOE $0 Cost-Share
Project Duration: Feb 2010 - Sep 2013

Brief Summary of Project



There are three main objectives: 1) Development of multi-season data sets consisting of mean winds and turbulence in regions of complex and simple terrain, 2) Diagnosis of spatially heterogeneous wind fields in complex terrain, and 3) Completion of a suite of control simulations using a range of boundary-layer parameterizations. The final deliverable of the project will be an integrated set of measurements and simulations for both locations. The primary beneficiaries will be those in the wind power industry interested in developing and/or testing model configurations, or new representations of boundary-layer turbulence that will improve assessment tools and forecasts, helping to advance the industry.

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

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

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

- This project is meant to provide wind shear data sets from ground level to 1kilometer heights, which will be exceedingly useful.
- Long term data for heights corresponding to future large turbine, up to 250 m, strongly needed for model development. However accurate measurements only take up to 60 m.
- High quality research that appears to be designed to provide benefits to the wind industry.

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

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

- Includes interpreting local measurements, radar and WRF simulations, which I think is a good approach to complete the dataset.

- Many element well known, met mast data, WRF but next generation radar new for wind energy wind characterization.
- Good identification of locations with available data and different terrains.

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

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

- Expect a good outcome of this even though project will continue for more than a year before complete. This is based on the fact that the completion date in the slides says Sept 2013, is that correct?
- Next generation radar data studies. It is not clear if data are sufficient in accuracy and resolution to be used for characterization of wind resource of turbulent inflow.
- Presentation indicates thoughtful analysis of available data.
- Work needs to be finalized and made available to industry.

Question 4: Project Management

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

- Delays leave question marks about what can be said in terms of project management meeting goals by the end of the project; however, work completed thus far makes me think that this project will meet its objectives.
- Delay.
- Project timelines have slipped, but not excessively.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- This project aims to provide data packages to be used by the industry, and when that happens, this score is significantly boosted.
- Cooperation with industrial partners. NCAR and NREL would be suitable partners with access to other datasets.
- Need to figure out how the data packages are going to get posted and accessible to all.
- Several peer-reviewed presentations.
- Little collaboration appears to be taking place; however, subcontractors are industry leaders in this kind of work and outcome will likely be successful.
- Technology needs to be finalized and packaged for industry use.

Question 6: Proposed Future Research

This project was rated **3.2** for proposed future research.

- Next steps are to collect more data providing additional data packages.
- While of marginal scientific interest, it is not clear how the future research benefits a strategic wind energy program.

Strengths and Weaknesses

Project Strengths

- Less academic and more application.
- Data packages from several different sites.
- Industry leader's involvement should lead to data packages being relevant immediately.

Project Weaknesses

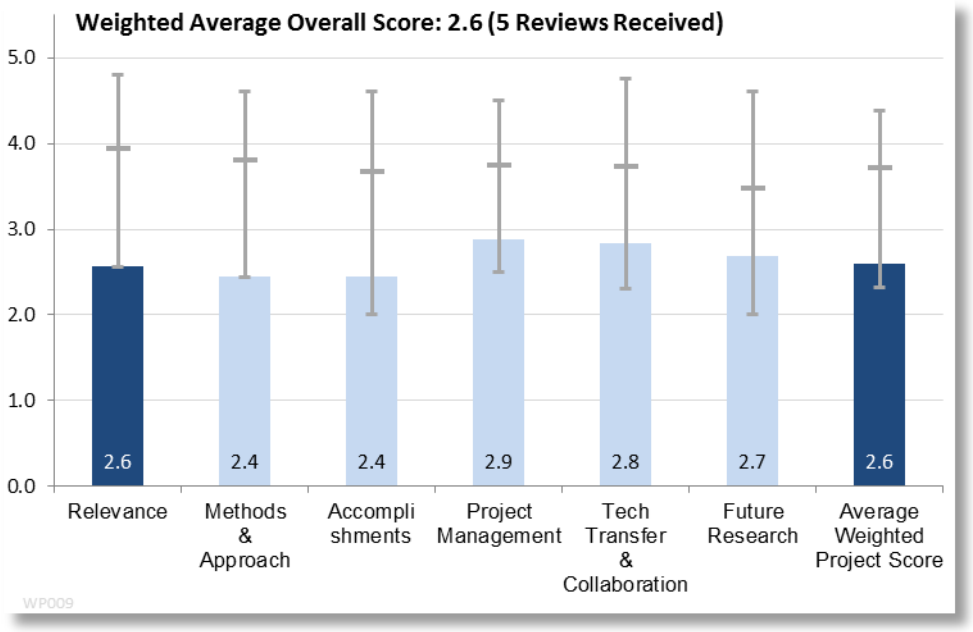
- Collaboration with academic modelers may improve the approach of this project and ensure that academia will value these data packages.
- Compiling high quality data from 60 m masts and low quality data in large heights does not directly benefit the win program objectives.
- Not yet determined where the data packages are going to be posted for public access to the Wind industry.

Specific recommendations for additions or deletions to the work scope

- Good Project.
- For this, and other wind modeling programs, the technology transfer etc. is happening at academic conferences --- how will they get this message out to industry?
- Keep a long term view on how all of these type of projects will tie together and lead to tools that can be broadly adopted and economically utilized in the industry. An opportunity for DOE leadership in this area.
- On the whole subject of wind modeling; it would be helpful to industry to have a central site for links to public data coming out of DOE programs in this area. A DOE website could be used for this.

WP009: Wind Turbines In-Situ Particle-Image Velocimetry
Curtt Ammerman, LANL – presented by Suhas Pol
FY 10 Budget: $126,000 DOE $0 Cost-Share
FY 11 Budget: $160,000 DOE $0 Cost-Share
Project Duration: Oct 2010 - Sep 2012

Brief Summary of Project



We propose to develop and field test an in-situ Particle Image Velocimetry (PIV) instrument capable of detailed blade velocity field measurements in full scale wind turbines. This experiment will lay the foundation for obtaining a comprehensive set of data that will result in an improved understanding of blade loading and load control in a variety of wind conditions. The results from this effort, the first application of PIV for wind turbines exposed to field conditions, will use the velocity field data (from PIV), in conjunction with pressure, blade load and turbine power output measurements, to enable (i) the development of efficient blades, (ii) accurate predictive models for performance, (iii) minimize the cost of energy, and (iv) increased reliability for turbines in general. Thus, this project is designed to directly attack several of the key technology improvement areas, as recognized in the 20 Percent Wind Energy by 2030 report. In addition to wind turbine manufacturers and the research community, this diagnostic would also be useful for wind farm operators to identify optimal locations for turbines in the farm.

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

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

This project earned a score of **2.6** for its relevance to wind industry needs and overall DOE objectives.

- Goal of developing approach and method for PIV measurements would be more appropriate.
- Interesting way to get validation data for flow around blades (as compared with wind tunnel work or other simpler approaches).
- Interesting input to flow modeling efforts if flow around profiles can be studied in situ.
- The value of this for the wind turbine industry is not clear.
- Improvements in analysis of blade turbulence appear to have benefits to industry.
- Can flow around blades provide more information than in-flow and wake-flow measurements?
- Seems to be something of an interesting technology in search of a wind energy problem.
- The need for government funding in this area is not clearly communicated.

- Not clear why this research could not be conducted by turbine blade developers.
- A strong enough case was not made for continuing this research in the field.

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

This project was rated **2.4** on its methods/approach.

- If the approach is to provide datasets of flow around a blade in the field, this project has work to do. It seems much effort has been expended in figuring out instrumentation and they still aren't there yet.
- Very difficult to deploy this to the field, and not clear that field deployment is worth the effort.
- The approach has not yet been demonstrated and first approach for routing laser light has been abandoned.
- Seeding and more specifically lighting techniques - will it work economically on large turbines?
- Changes made due to implementation problems appear to reduce the effectiveness of the research.
- Note that work has been done at Caltech by Professor John Dabiri's group (albeit using a vertical axis wind turbine) on a similar scale turbine. This group used the sun for creating the light sheet, and a snow machine borrowed from a Hollywood studio for seeding. They presented at American Physical Society Division of Fluid Dynamics in 2011.

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

This project was rated **2.4** based on technical accomplishments and progress.

- Outdoor measurements are the critical step, and team is not there. Based on presentation, I question whether project will have successful outcome.
- Tackling difficult deployment challenges with some success, but the usefulness of the results is unclear.
- Equipment developed, not yet applied.
- Limited technical progress exhibited in the presentation.

Question 4: Project Management

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

- As mentioned previously, this project is behind schedule and has not yet figured out fully how to obtain measurements.
- Significant delays.
- Slight delays.
- Timelines appear to have slipped significantly.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Some collaboration with Sandia.
- Limited collaboration?
- Collaboration with SNL, expected use in the SWIFT project.
- Why is this research being conducted by LANL? Are there benefits to isolating this research from other research at Sandia and NREL?
- Collaborative work with the NWTC probably would approve this project immensely.

Question 6: Proposed Future Research

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

- Transfer of methodology would be the most important piece (when the measurement technology is complete).
- Still struggling to make the original scope of project work.
- Visualization of flow around a blade interesting and could complement the instrumentation for SWIFT.

Strengths and Weaknesses

Project Strengths
- Overall objective to take field measurements of flow around a blade could provide datasets used for validation.
- Technically very challenging.
- Visualization of general flow, not just the boundary layer as with tufts.

Project Weaknesses
- Technique for taking these kinds of measurements could be very interesting for wind turbine manufacturers -- the focus of this project is more about data sets.
- This is difficult to deploy to the field, and I'm not sure the effort is justified in terms of benefits.
- Flow 3-dimensional and varies with azimuthal angle and radius. The approach captures the 2D flow field at on radius and azimuthal position.
- Do not see real economic application to large scale wind turbines. A lot of work to get to something useable by industry (if it is possible).
- The lack of collaboration with others, e.g. the NWTC, limits this project.

Specific recommendations for additions or deletions to the work scope

- Do measurements of flow around a blade really provide information that inflow and wake measurements cannot?
- Others may know if these measurements are needed. Otherwise, should reconsider if field deployment of this technology is worth the difficult effort.
- Move the laser sheet and capture different radia at each rotation in order to capture the radius variation, add camera and measure 3D flow.
- Is there a demand for these measurements? Not clear from the presentation.

WP010: Wake and Array Effects Modeling and Characterization

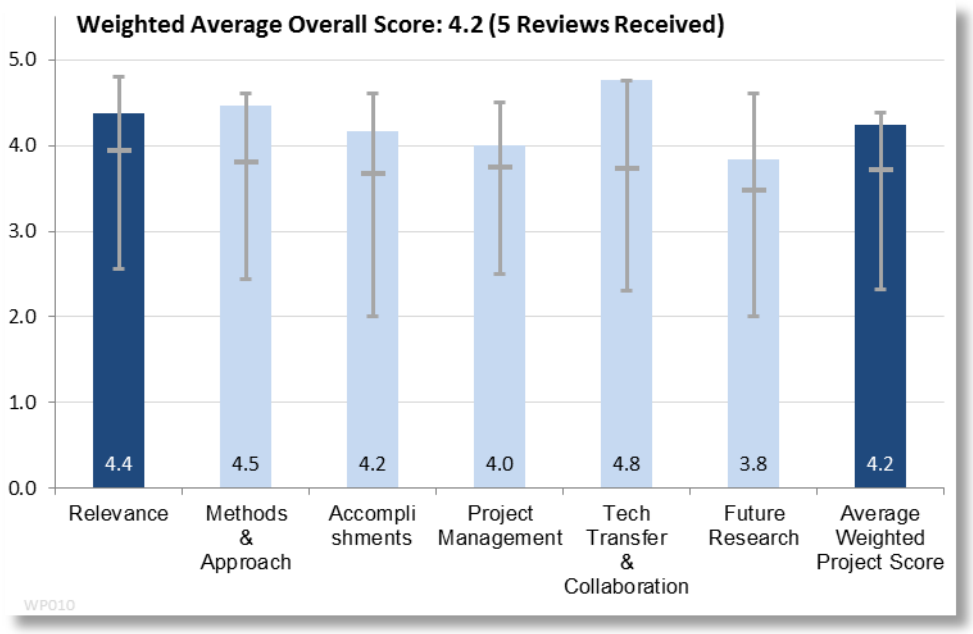
Patrick Moriarty, NREL

FY 10 Budget: $350,000 DOE $0 Cost-Share

FY 11 Budget: $575,000 DOE $321,000 Cost-Share

Project Duration: Oct 2011 - Jun 2012

Brief Summary of Project



This project supports modeling, measurement, and analysis of the inflow environment encompassing wind plants and the aerodynamic impacts those plants have on the atmosphere. The subtask will include studying the range of scales that impact wind plant aerodynamics, from wake effects that affect the interactions of turbines within wind plants to mesoscale impacts that drive the overall wind plant flowfield. Measurement of these different phenomena using remote sensing techniques will also be included to obtain data for model validation. A better understanding of the wind resource and physical interactions within and between wind plants and their wind environment will reduce energy production costs by improving the tools used for wind plant layout design and operation.

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

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

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

- The area of complex flow's relationship to project performance is currently not well understood and is a hot research item.
- Focused on wind plant wake models - an important and timely topic to the industry.
- Understanding and modeling wake effects with respect to loads and performance important. The combination of tools seems powerful.
- Has best line of sight for how to get these models to a scale industry can use (due to computational requirements, which translates to runtime).
- Highly relevant to improving output from wind farms.
- Good that they know they must end up with lower order models for practical use by industry.
- Currently petaflop computing capability required. Also working on how to simplify down to point that industry can utilize.
- Provides string technical analysis in the area of wind farm design.

- Very diverse project that covers modeling plus evaluation of crop effects.

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

This project was rated **4.5** on its methods/approach.

- Combines modeling and field measurements.
- Solid project and work.
- Good, generally accepted approach.
- Appears to be very well designed analysis.
- Assuming SOWFA is intended to also useful as a standalone too (in absence of WRF coupling), has there been work (or will there be work) to advise on how to prescribe site-specific boundary conditions?
- "The effects of stability, terrain, and shear will be analyzed to enable better understanding." Does "terrain" also include forestry? Or is that out of scope?

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

This project was rated **4.2** based on technical accomplishments and progress.

- Great progress.
- Good results so far.
- Good progress, limited validation.
- SOWFA code was publically released in Jan '12 - training session held last month
- Very good technical progress.
- Simulator for offshore wind farm applications, crop wind energy experiment and turbine wake and inflow characterization study work completed.

Question 4: Project Management

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

- Project management appears very successful.
- Good job on schedule and budget.
- Slight delay, interaction with other project essential, coordination not clear.
- Project appears to be well managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.8** for research integration, collaboration, and technology transfer.

- Great collaboration on all three tasks.
- Lots of good collaboration partners, both domestic and international.
- Very large field of collaborators, international framework.
- Mostly academic conferences.
- Excellent collaboration between research and industry participants.
- Tool publicly released.

Question 6: Proposed Future Research

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

- Further simulation tools and better couple observations with simulations: both good, just not stand-out difference from latest iteration of work.
- Work on "full farm" wind farm control is good.
- Relevant but not very detailed. Should be continued as a program effort to develop system engineering tool for wind-terrain-wake-load modeling.

Strengths and Weaknesses

Project Strengths
- Highly collaborative effort producing great and needed results.
- Strong project with a high degree of collaboration across the industry.
- Good combination of modeling and validation.
- Participation in IEA Workbench is a good priority.

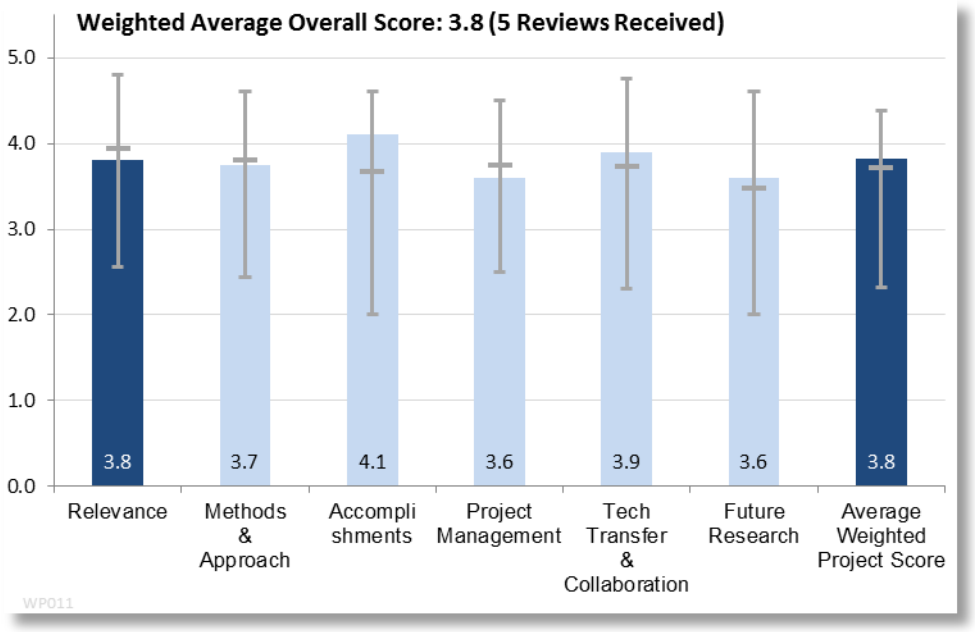
Project Weaknesses
- Opportunity for industry collaboration?

Specific recommendations for additions or deletions to the work scope

- Release and tutoring for the SOWFA ensures that this project has lasting benefit to the industry.
- Stay the course and keep doing it.

WP011: Stochastic Inflow Simulation, Characterization and Observational Technologies
Patrick Moriarty, NREL
FY 10 Budget: $500,000 DOE $0 Cost-Share
FY 11 Budget: $335,000 DOE $0 Cost-Share
Project Duration: Oct 2009 - Jun 2012

Brief Summary of Project



This activity focuses on the characterization of the turbulent properties of turbine inflows and their impact on the resulting turbine structural dynamic response. The results of this work will address inadequacies in current design standards used by industry that may result in design failures. Improved design standards will result in higher reliability in machine design and operation. This project also focuses on examination of remote sensing devices for wind energy applications. Remote sensing devices have not gained widespread acceptance in the industry, but may be an important technology for measuring wind speeds at ever increasing turbine hub heights in remote locations. Unbiased analysis of remote sensing devices and best practices on their use will help these relatively new technologies gain acceptance and also provide understanding of their benefits and limitations when used for wind energy projects.

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

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

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

- Characterization of turbulent wind is a good research area.
- Focused on both turbine inflow (impact of atmospheric stability on loads) and validating remote sensing devices for measuring these issues.
- The project is the conclusion of a long term effort on boundary layer meteorology and an investigation of remote sensing met measurement, just started.
- Best practices on remote sensing would be great.
- A collection of small initiatives to evaluate turbulence issues.
- Very valuable datasets for the industry and researchers.
- Appears to take advantage of other equipment available at the NWTC.
- Program appears to be likely to improve understanding of maintenance issues due to turbulence.

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

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

- Project is bit of a catch-all for flow characterization.
- Solid.
- So far, the project has consisted of reporting a startup effort. Okay but not revolutionary.
- Effective use of existing and new research.

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

This project was rated **4.1** based on technical accomplishments and progress.

- Great progress.
- Good progress that should be publicized even more strongly.
- Interesting technical results presented.
- Kelley was technically very strong, but had a tough time making this work be appreciated. Patrick can do a better job in explaining it.

Question 4: Project Management

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

- Well managed.
- More an ongoing activity with results during the period than a well-defined project.
- Limited discussion of project management - project is more a collection of smaller initiatives that do not require significant project management and coordination.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Engaging remote sensing manufacturers on a technical level (if possible) would be interesting.
- Collaboration between DOE labs (like Sandia and SWIFT test site) still seems a bit strained? But lots of collaboration with other good teams.
- Cooperation with other labs.
- Good level of participation in conferences and peer-reviewed presentations.
- Validation of remote sensing technologies should be a priority.
- Strong collaboration.

Question 6: Proposed Future Research

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

- Atmospheric stability effects on WTG generation is critical.
- Work on stability-specific power curves is important to industry.
- Relevant but not revolutionary.

Strengths and Weaknesses

Project Strengths

- Taking on remote sensing technologies.
- Best practices, and especially the use of LIDAR for IEC power performance standard, are important to keep doing.
- Furthering work in flow characterization.

Project Weaknesses

- Technical benchmark of various remote sensing technologies is needed.
- Being able to model boundary layer phenomena of relevance for wind turbine loads is good, but effort on prediction of such effects at arbitrary site is missing.

Specific recommendations for additions or deletions to the work scope

- Important to keep supporting remote sensing, incorporating remote sensing into standards, and getting acceptance for better flow models that encapsulate atmospheric stability.
- Work with the objective to tie the complex flow fields to specific types of sites should be commenced.

WP012: DOE 1.5 MW Turbine Test / DOE 1.5 MW Instrumentation Upgrade

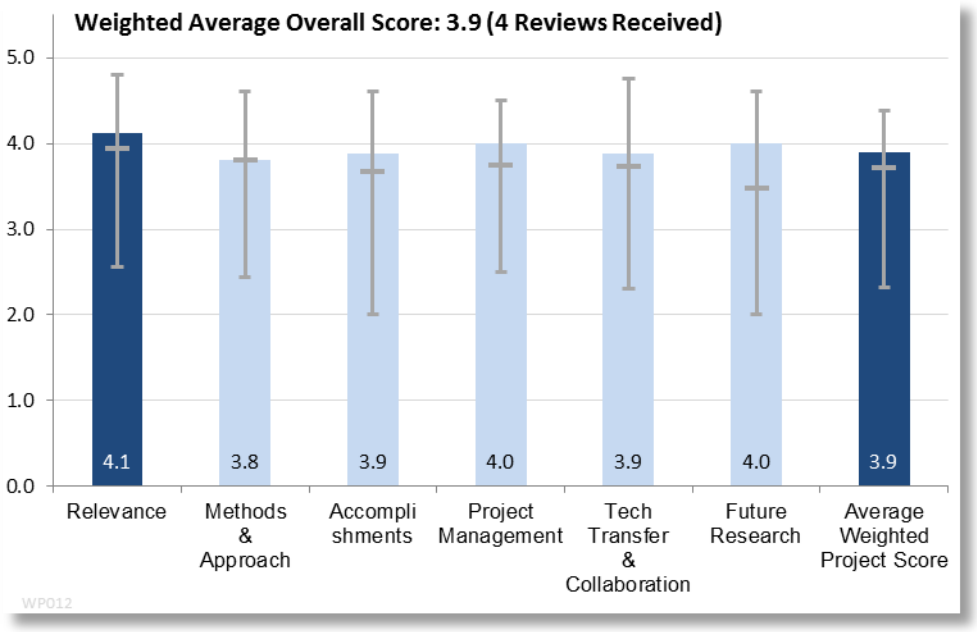
Scott Schreck, NREL

FY 10 Budget: $750,000 DOE $0 Cost-Share

FY 11 Budget: $950,000 DOE $0 Cost-Share

Project Duration: Oct 2009 - Jun 2012

Brief Summary of Project



Thorough understanding, accurate prediction, and reliable validation of atmospheric inflows and turbine response are leading determinants of turbine energy capture and machine component service life. To improve understanding, enable formulation of new models, and to validate model predictions and machine performance, this activity supports instrumentation upgrade and field testing of the DOE 1.5 MW turbine test facility, designed to produce research-grade data sets of wind inflow and turbine aerostructural response for a utility class turbine.

The facility includes the turbine equipped with specialized structural loads, power performance, and power quality instrumentation along with an upwind 135 meter meteorological tower outfitted with state-of-the-art inflow speed and direction sensors. This turbine and meteorological tower are situated at NREL's National Wind Technology Center, where complex terrain features combined with diverse atmospheric phenomena produce a singularly challenging inflow and operating environment.

Experiments carried out in this unique field laboratory facility will serve to acquire data that engineers and scientists in industry, universities, and DOE laboratories can exploit to clarify the complex relationships between turbulent inflow characteristics, turbine energy capture, and fatigue loading. Improved understanding of these interactions will enable formulation of improved inflow and turbine models for machine design, enhancing turbine reliability, energy capture, and profitability.

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

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

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

- Valuable assets leading to great research.
- A very well instrumented industry-standard turbine for studying inflows and turbine responses.
- Having a utility scale wind as research test bench is highly relevant and load data set with adequate information for turbine modeling is very valuable for code validation.

- Good development of data acquisition components required for detailed research of impacts of wind inflows on turbine.
- A significant investment in instrumentation and measurement, so now need to really use it.

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

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

- Executed with precision.
- Good test bed. Need to find more uses for it.
- So far, the project has experimentally documented the turbine. The interaction with GE and IP issues unclear.
- Good combination of sensing equipment and turbine instrumentation to obtained relevant data.
- Good use of characteristics and capabilities of the NWTC site.

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

This project was rated **3.9** based on technical accomplishments and progress.

- Not apparent the extent that the data is currently being used.
- Solid.
- Okay but no revolution.
- Implementation of measurement devices is nearly complete.

Question 4: Project Management

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

- Based on what I could see in the presentation, looks good.
- IP issues and cooperation with GE should have been clarified earlier. Difficult issues and typical response when a turbine is still being manufactured.
- Project has been implemented within original timeline

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Some dissemination of findings.
- Good collaborators, but would like to see an even stronger research collaboration plan on how we can exploit this investment.
- Relevant partnerships and adequate dissemination.
- Good industry and research collaboration.

Question 6: Proposed Future Research

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

- Upgrades improve value of the assets.
- Provides a good baseline for validating models.

- Good plans, data for validation of design tools very important.
- Provides opportunities for future research.
- Proposed future research has a good list. Are there strong drivers for doing certain of those items over others, and who is driving it?

Strengths and Weaknesses

Project Strengths

- These assets have exceptional value for furthering the wind industry efforts.
- Very well instrumented turbine.
- Having access to a utility scale wind turbine as a research platform facilitates the implementation of research results as results become more representative for large new turbines. The turbine may also provide a platform for specific development in cooperation with GE.
- DOE ownership of the turbine is a plus.

Project Weaknesses

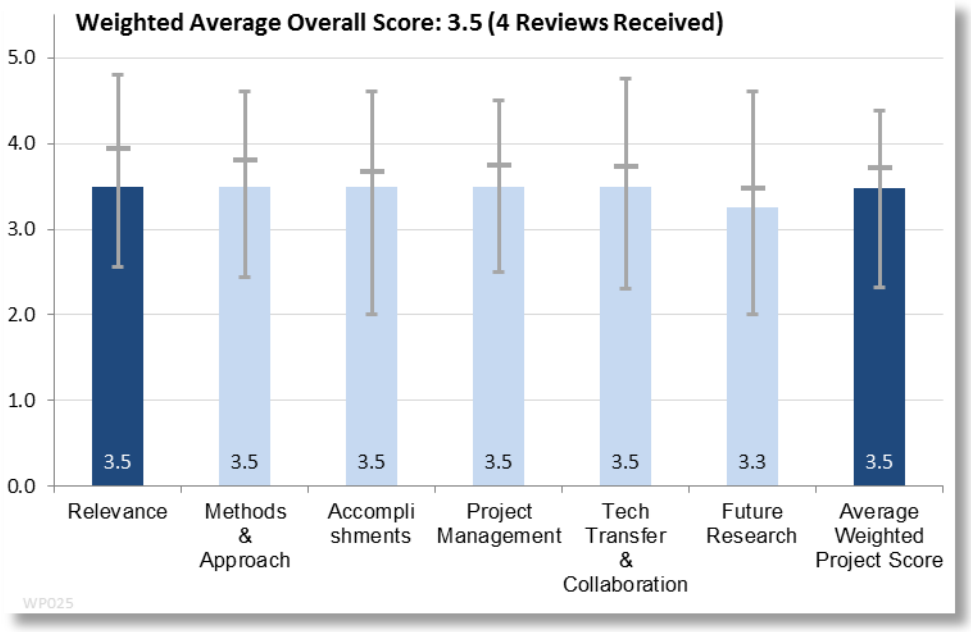
- These assets can contribute to a wide range of research related to many other projects, and that may be the case but it is not readily apparent in the presentation that that is happening.
- Lack of control over turbine IP and control code is a negative, but difficult to avoid with any modern utility-scale turbine.
- Some IP issues have not been dealt with and some turbine characteristics are confidential.

Specific recommendations for additions or deletions to the work scope

- What are the long-term objectives of the assets? The research driving the upgrades? These should be clear.
- Figure out how to leverage this good investment.
- Continue the development of this turbine as a platform for research measurements and establish a clear agreement with GE on access to and publication of turbine characteristics.

WP025: New Reference Facility for Offshore Renewable Energy (RFORE)
William J. Shaw, PNNL – presented by Larry Berg
FY 12 Budget*: $139,000 DOE $0 Cost-Share
Project Duration: Oct 2011 - Sep 2012
**This is a new project that just started in FY 2012*

Brief Summary of Project



PNNL will advance offshore wind facilities by technically supporting the development of a new reference facility for offshore renewable energy (RFORE); the application of high performance computing and climate research to solving complex flow problems in turbine inflow and arrays; providing technical collaboration with appropriate projects on offshore resource characterization; and providing technical support in the completion of a an implementation plan for resource assessment and design conditions for offshore facilities.

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

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

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

- An additional resource assessment to characterize wind resource for offshore and great lake resources.
- Meets offshore objective.
- Meets several program goals.
- Relevant location, project starts in 2012, initial exercises, measurements from 30 to 80 m height expected. Inadequate.
- Primary goals are improved resource characterization and jumpstart offshore.
- There is a need for a reference facility.

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

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

- Data will be valuable for assessment of offshore wind.
- Straightforward investigation of suitability of Chesapeake Light Tower.
- Questions raised about tower height and choice of using the chosen structure.

- Approach straight forward.

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

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

- No data was provided yet except for the fact that the tower does not affect the accuracy of the data.
- Det Norske Veritas (DNV) study of flow distortion.
- Instrumentation recommendations under development.

Question 4: Project Management

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

- Data has not been collected yet. Plans for data acquisition and analysis are to be done.
- Slight delay in RFORE report but generally on schedule.
- Management is okay.
- Good management of subcontracts.
- Has risk assessment been conducted of this particular location? Not sure if it is the best choice.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Provided details of collaboration with experienced organizations in Europe and the DOE.
- Coordinating with key entities, including NOAA, Navy, European Union bodies.
- Working with other agencies.
- A could be expected in such a limited study.

Question 6: Proposed Future Research

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

- Details of future research are quite sketchy. Comparison with existing offshore wind resources for example.
- Full development of the facility.
- Limited information to consider, mostly installing equipment.
- Question on the most relevant location, mast height, instrumentation and data access should be clarified.
- Methods to analyze data and compare with land-based resources and additional parameters required such sea states were not detailed.

Strengths and Weaknesses

Project Strengths

- This can be a useful project to provide detailed resource assessment for offshore and great lake wind resources.
- Clear task and objective.

Project Weaknesses

- More details on data analysis and additional required instrumentation to provide turbine designers with a complete set for proper turbine design and resource assessment.
- Few alternatives if Chesapeake Light Tower is not suitable.

Specific recommendations for additions or deletions to the work scope

- Present detailed plans on future research.
- Complete investigation and proceed if positive recommendation.
- Consider taller tower.
- Question on the most relevant location, mast height, instrumentation and data access should be clarified.
- The height of the mast need to be higher than planned to take into account the large offshore turbines 200m about sea level.
- Evaluate decommissioning costs.

WP026: Sediment, Transport, Scour and Foundation Impact Analysis

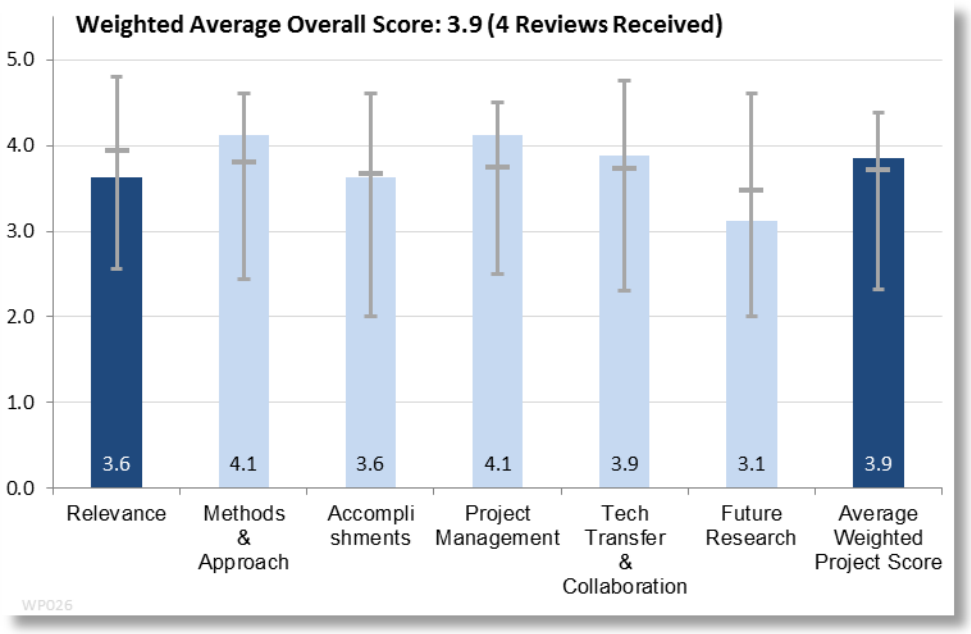
Jesse Roberts, SNL

FY 10 Budget: $0 DOE $0 Cost-Share

FY 11 Budget: $100,000 DOE $0 Cost-Share

Project Duration: May 2011 - Sep 2012

Brief Summary of Project



Interactions of structures and the seafloor are often a primary risk driver for offshore structural projects. The purpose of this work is to reduce lifecycle maintenance costs through intelligent offshore wind (OW) farm array design and reduce time and costs associated with permitting by enabling prediction of site-specific environmental responses to OW farm designs. The objective of this work is to assess wind farm and ecosystem risk potential due to sediment mobilization and scour from seafloor-structure interactions. To achieve this objective, SNL will; (1) perform research to identify and reduce OW farm risk from sediment instability, (2) commercialize the technologies/tools developed by keeping them open source and transferring them to industry through training courses and technical support, and (3) provide guidance that integrates with industry needs. This work will reduce deployment barriers by developing tools (and transferring those tools to industry) to improve our understanding of the interrelationship between ocean and sediment dynamics and commensurate effects on the seabed upon installation of OW turbine arrays.

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

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

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

- Very useful tool if successful in mitigating risk for offshore projects.
- Directly relevant to offshore objective.
- Aligned with three goals.
- Scour and sediment transport important, but only one of many factors that determines foundation costs. Depends on soil, current, wave climate etc. which also governs the foundation design.
- Primary aligned with goal to reduce barriers.

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

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

- Seems to know the tools required to estimate scouring and erosion at foundation as a function of waves, tides and wind.
- Tools development needed in this area. Little useful European Union experience.
- PI has good understanding of scientific issue and strong background in scouring/sediment.
- The approach is good but scope is limited.
- Partnerships with others in DOE and U.S. Navy on simulation waves near shore (SWAN) modeling are good.
- Use of Monterey test site is good.

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

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

- Still too early for actual results but seems to be following the right approach.
- First of kind risk maps developed
- Making good progress.
- Early stage
- Leveraging Water Power Program expertise.

Question 4: Project Management

This project was rated **4.1** on its project management.

- Project is soliciting the right mix of expertise to develop a viable tool for the industry.
- On budget. Leverages Sandia work.
- On schedule.
- Early.
- Good use of other experts in this area.
- On budget.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Good plans for open source data and transfer to industry.
- Partnering with Navy and others.
- Good collaboration with the DOE Water Power group and U.S. Navy.
- Limited but relevant collaboration.
- Public domain tool.

Question 6: Proposed Future Research

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

- Good work on development of maps for the east and west coast. Before this step there should be a step for model validation.
- Propose to map at regional level.
- Moving model to east coast wind areas.
- Mapping conditions makes sense if large scale deployment is underway. Mapping does not replace detailed site investigations for each project.
- Good plan to develop modeling to level that is easily applicable to industry.

Strengths and Weaknesses

Project Strengths
- Use of existing techniques used for the marine industry to apply to OW scouring and erosion.
- Public domain methodology in area where tools needed.
- Principal investigator.
- Collaboration.
- Methodical approach to advancing modeling.

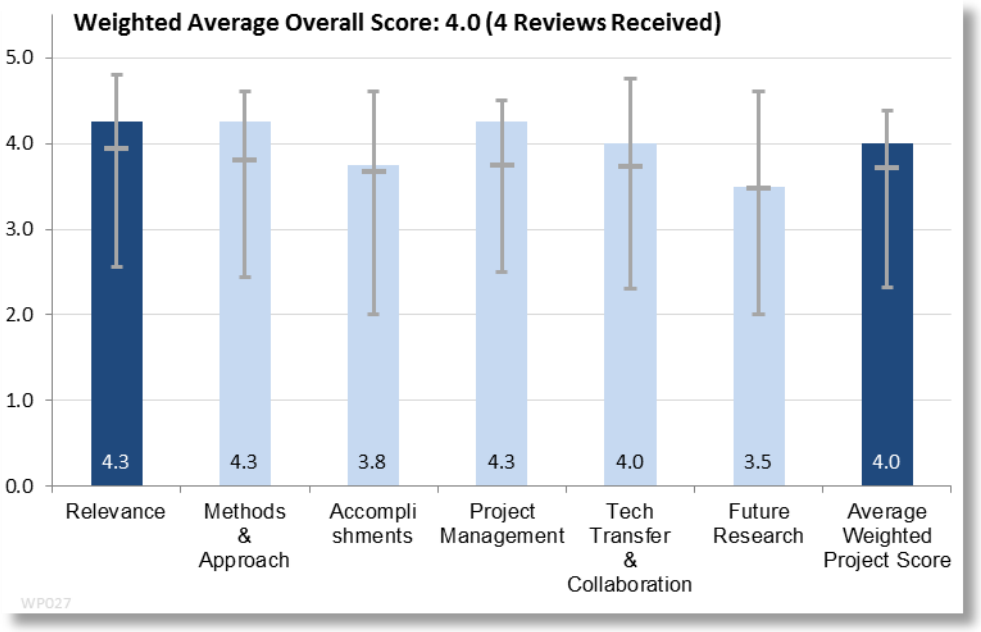
Project Weaknesses
- No reference to model validation on an actual offshore wind project. Why not apply to some projects that have been in operation in Europe for a few years.
- No clear field validation method in near term.
- Limited scope and not essential for decision making.

Specific recommendations for additions or deletions to the work scope

- Valuable work needs to be continued.
- Support next steps.
- Explore mitigation strategies (tower shape, vanes, etc.) from other scouring work that can be integrated into modeling efforts.
- If a mapping exercise is undertaken it should include soil, wave and current condition, which also governs scour.

WP027: Offshore Structural Models and Analysis
Amy Robertson, NREL – presented by Walter Musial
FY 10 Budget: $500,000 DOE $0 Cost-Share
FY 11 Budget: $595,000 DOE $0 Cost-Share
Project Duration: Oct 2010 - May 2012

Brief Summary of Project



The objectives of this subtask are to: 1) Further the development of computational models and computer-aided engineering tools necessary to develop commercial gigawatt-scale deployment of offshore wind turbines in the United States, 2) Verify the tools through code-to-code comparisons, and 3) Interact extensively with the national and international technical offshore wind community to help the United States' advancement of the technology needed for commercial success.

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

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

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

- Extremely valuable tool for offshore turbine designs. Accurate load prediction is a necessity. Use of Fatigue, Aerodynamics, Structures, and Turbulence (FAST) model is a good choice.
- Supports several objectives, LCOE, offshore, deployment and performance optimization.
- This project is supportive of two DOE goals.
- Important work to prepare for offshore development needs validation.
- Development of open source code(s) is key contribution of DOE program.

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

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

- Good strategy to use an existing Hydrodynamic code to link to FAST.
- Expanding capabilities and improving accuracy of tools.
- Well-conceived approach to code development at systems level.
- The modeling is valuable but far exceeds the possibility for experimental validation.

- Clear plan to make incremental improvements to the models and to verify and validate the changes.
- Identified all relevant impacts.
- Research in modeling serves two purposes: open opportunities for innovation by being able to analyze new concepts and support and optimize design. Once industry converges on certain concepts, the modeling can focus, be validated and deal with critical issues. This is not yet possible.

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

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

- Interesting blade flap bending comparison for the different support structures. Can you explain the reason for the differences?
- Modeling enhancements to FAST partially complete (Hydrodyn) including multi-member structures
- Is responsive to industry concerns about certain sub-models.
- Good progress.
- Verification underway.
- Working on code verification.
- Engaging large modeling group for code comparisons.

Question 4: Project Management

This project was rated **4.3** on its project management.

- The project is well planned and starts with code development, comparison of different codes and application to different concepts. The only missing part is actual code verification off an offshore turbine.
- On target to complete modeling by 2013.
- Principal Investigator has good understanding of systems-level integration of sub-components.
- Successful effort, part of a much larger, program-like, effort.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- The list of collaborators is quite impressive.
- Multiple partners and collaborators, including Europe.
- Working closely with large group of key stakeholders.
- Large national and international partnership.
- Publications already made.

Question 6: Proposed Future Research

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

- Continued theoretical validation and using more accurate modeling techniques is worthwhile future work.
- Logical next steps listed in presentation. Including IEA validation task.
- Good understanding of next steps needed in code development.
- Improvement of model systems; research driven, not industry driven. More emphasis on application of models in studies and demonstration as well as validation is recommended.

- Need to emphasize the need to validate the models with actual structural data from an offshore wind research turbine. It seems that there are plans to do that.

Strengths and Weaknesses

Project Strengths

- Very needed tool to compete with offshore bladed program.
- Appears to make good use of NREL modeling capability.
- Partnerships.
- Strong modeling team and strong international research network.
- Very good preliminary results on different foundation concepts.
- Getting international acceptance.
- Open source philosophy is a strong attribute of this program.
- Code development provides asset to industry that they would not likely develop on their own. This is good.

Project Weaknesses

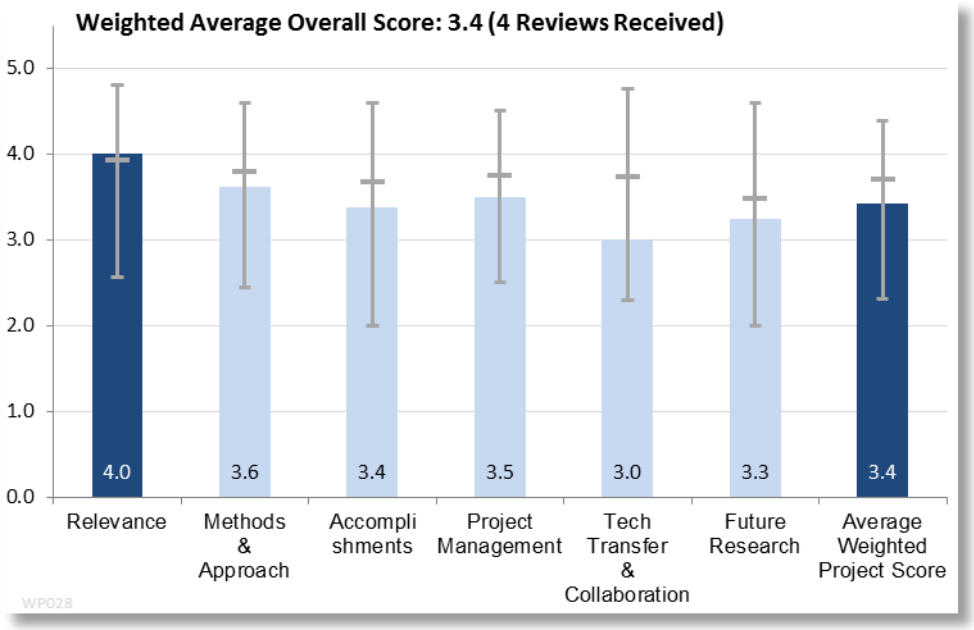
- Need to validate code by actual research offshore turbine.
- Models will need considerable validation to be used in actual design.
- Still research drive. Once actual development projects appear, the modeling may be directed towards understanding and simulating yet undefined critical aspects.

Specific recommendations for additions or deletions to the work scope

- Continue to improve the code and validate it.
- Continue effort but take validation requirements seriously.
- Consider outsourcing user interface and tech support to small business entity. Focus on code development work.
- More emphasis on application of models in studies and demonstration as well as validation is recommended.

WP028: Reducing COE with Floating Tension-Leg Platform Technology
William Hurley, Glosten Associates – presented by Charlie Nordstrom
FY 12 Budget*: $402,000 DOE $100,000 Cost-Share
Project Duration: Sep 2011 - Sep 2013
**This is a new project that just started in FY 2012*

Brief Summary of Project



The purpose of this project is to develop technology that reduces the cost of energy (COE) for offshore wind. We accomplish this COE reduction by developing an integrated, floating wind turbine system, designed for the Gulf of Maine and adaptable to any offshore site where water depths exceed 60 meters.
We will advance floating foundation technology by developing innovative low-cost anchor installation methods, developing new mooring tendon technology, and developing an installation method that reduces turbine installation costs. The final product will be two final designs for integrated offshore floating turbines, suitable for the Gulf of Maine, and also an engineered installation vessel design. The designs will include the results from validation of tendon performance characteristics, and a new anchor installation method for the Gulf of Maine. Most importantly we will deliver a comprehensive Cost of Energy analysis showing how cost is reduced through application of these technology advancements. The U.S. marine and shipbuilding industry will be engaged by providing construction cost estimates and data.

The Glosten Associates will benefit from this project by advancing our PelaStar floating foundation design, the design tools we use, and technology elements critical to reducing the cost of the design. The U.S. energy industry will benefit with the introduction of technology that will enable access to the renewable deep-water wind energy resources at a net cost competitive with energy generated from carbon-based fuels.

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

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

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

- Good approach to give foundation optimization to an experienced marine co. Foundation represents 70 percent of offshore installed cost and provides the largest potential for cost reduction.
- Meets offshore and LCOE objectives.
- Addresses 4 DOE goals.
- Development of a specific innovative, cost optimized, option for floating offshore wind.

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

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

- Optimization of the system seems to be going on the right track 15 percent preliminary.
- Claims to be very practical problem solving organization.
- Difficult to evaluate. Limited information was provided.
- Conceptual design, optimization, design and cost analysis - solid preparation for commercialization and demonstration.
- Are applying their patented technology, which may or may not be successful.

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

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

- Project is too early to have definitive accomplishment.
- Doing tendon testing for fatigue testing which will be inputs into the design.
- PI reports progress, but it is difficult to evaluate with limited information provided.
- Good preparation but early in the project.
- Have improved their in house design optimization tool.
- LCOE projection seems inconsistent with DOE estimates. Needs clarification on assumptions made to get these numbers.
- It's not clear why deep water was target. Shallow water has much better baseline to draw from (Europe).

Question 4: Project Management

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

- The group is going in the right track by finding higher fatigue rope tendons and is performing design tools.
- Project on budget. Two months delay in tendon testing.
- On schedule, on budget.
- PI provides good link to potential offshore component and service providers. This is a much needed link for offshore program.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Samson Rope, TMT Laboratories, Applied Fiber, presented to DOE and in communication with the UK.
- Approach seems to be to work with small team to pursue proprietary design. No publications.
- PI provides good link to potential offshore component and service providers. This is a much needed link for offshore program.
- Industrial partnership, sharing of results possible in a later phase. Use of NREL models.
- Technology transfer is not clear.

Question 6: Proposed Future Research

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

- Developing test facility and an optimization process.
- Glosten will respond to funding opportunity announcement (FOA) for floating demonstration projects.
- On track to close out project per FOA.
- Demonstration and documentation of a solution.

Strengths and Weaknesses

Project Strengths
- Marine Architects have good experience with balance of plant and can achieve cost reductions.
- If successful could be an offshore LCOE breakthrough.
- Industrial involvement.
- Practical approach.

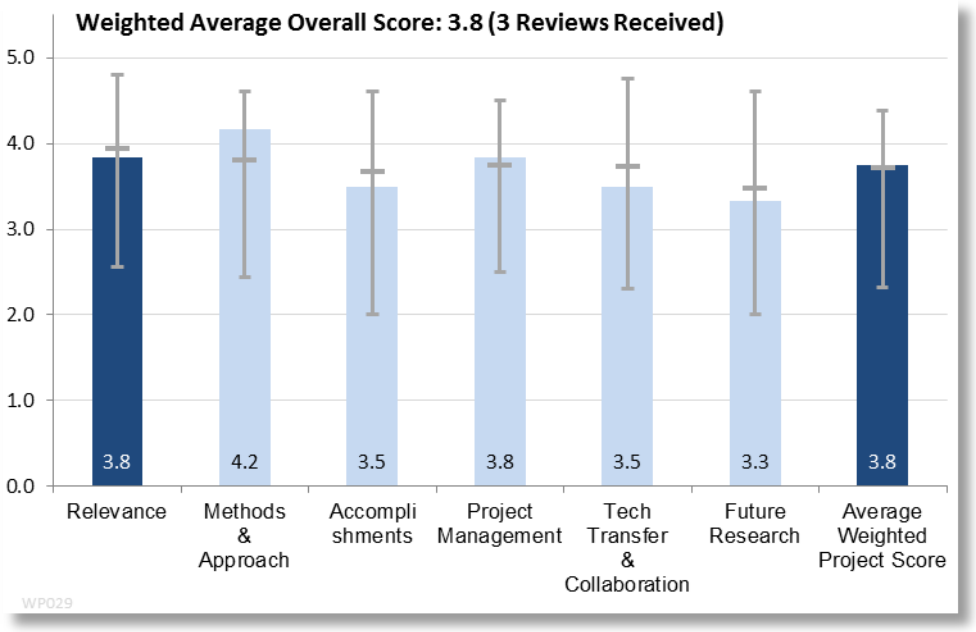
Project Weaknesses
- Seems too optimistic to achieve .1 $/kWh.
- High risk but this may be appropriate for offshore jump-start objective.
- Value, if market does not evolve.

Specific recommendations for additions or deletions to the work scope

- Review their proposal in FOA.

WP029: National Offshore Wind Energy Resource and Design Data Campaign
Bruce Bailey, AWS Truepower
FY 12 Budget*: $407,000 DOE $0 Cost-Share
Project Duration: Sep 2011 - Sep 2014
**This is a new project that just started FY 2012*

Brief Summary of Project



The objective of this project is to supplement and facilitate multi-stakeholder efforts to develop an enhanced, integrated national offshore wind energy data network. The goal is to support DOE's efforts to mitigate or eliminate data-related offshore wind market barriers through a process involving strong public-private collaboration that addresses offshore resource assessment, design condition, and operational industry needs. The results of this effort will provide a comprehensive definition of relevant met-ocean resource assets, needs, accepted modeling approaches, and design standards, together with recommended pathways for meeting industry data and design certification requirements. The beneficiaries of this initiative will include stakeholders involved in any stage of an offshore wind project's lifetime. Target stakeholders include: project developers, regulators and policy makers, turbine and foundation manufacturers, investment and insurance firms, grid operators and utilities, consultancies, academia, and O&M providers.

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

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

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

- Valuable effort to characterize wind resource and provide met-ocean data needed for successful turbine and project development.
- Meets offshore objective and barrier reduction.
- Addresses two DOE goals.

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

This project was rated **4.2** on its methods/approach.

- Valid approach in first collection of existing data from 6 varied resources and identification of missing gaps and development of future data needs.

- Will provide state of the art assessment of definition of met ocean assets, modeling and certification.
- Much needed data campaign.
- Six tasks identified over 3 years; identifying datasets, gap analysis, pending standards, near term measurement strategies, industry outreach plan, long term plan of data and research.

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

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

- Project is new, data sources has been identified.
- Have done inventory of data sources, near term source recommendations, outreach to AWEA and others.

Question 4: Project Management

This project was rated **3.8** on its project management.

- AWS True Power is expected to perform well on this task based on their previous performances on similar tasks.
- Project in ramp up mode. Coordination with NREL and RISO. Draft publication.
- Good management.
- Inventory of resources established.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Collaboration with RISO and NREL and dissemination of data to industry.
- Good partnerships with NREL and RISO.
- Engaging appropriate stakeholders and those with data.

Question 6: Proposed Future Research

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

- Details of data to be collected were not made clear. Met and surface and subsurface data may not be all that is needed to design and certify an offshore wind turbine. Need a list of data to be accumulated.
- Implementation of three year program as approved.
- Not much to base this score on.

Strengths and Weaknesses

Project Strengths
- The plan of collecting existing data sources and filling in the gap to develop a comprehensive of National data set for offshore wind is comprehensible and valuable to industry.
- Contractor has good understanding of land-based data and good relations with NREL, DOE other players.

Project Weaknesses
- Need a list of types of atmospheric, surface and subsurface data needed for resource assessment, turbine design and certification.
- Still starting up.

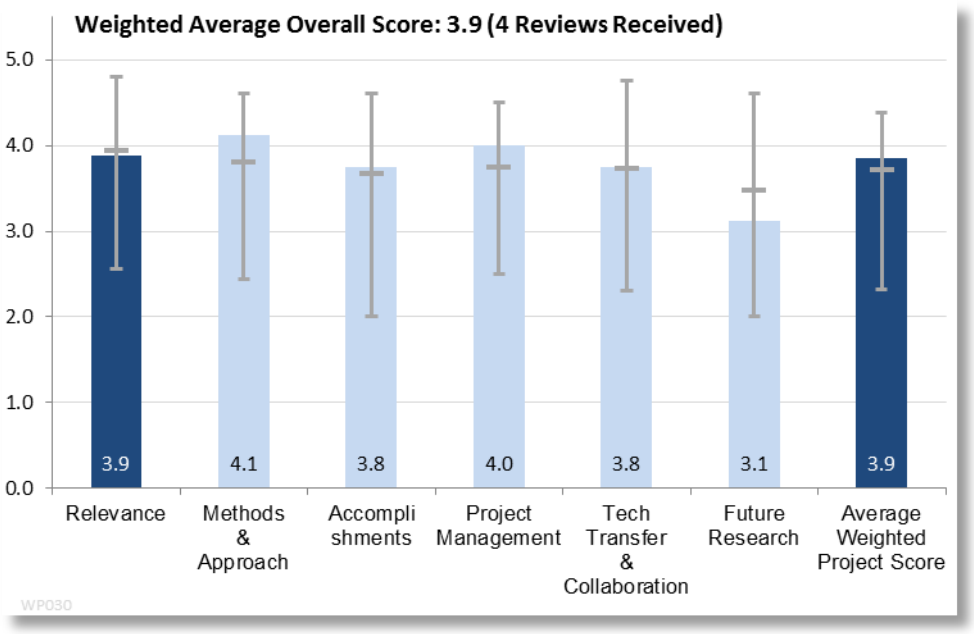
- Will not collect data just identify where it is, so follow up required.

Specific recommendations for additions or deletions to the work scope

- The goal of the program should be a comprehensive national data set that will help industry and engineers design and implement successful offshore projects.
- Proceed with study plan.

WP030: Advanced Manufacturing Initiative
Dr. Daniel Laird, SNL
FY 10 Budget: $700,000 DOE $1,400,000 Cost-Share
FY 11 Budget: $0 DOE $0 Cost-Share
Project Duration: Aug 2009 - Aug 2012

Brief Summary of Project



The Advanced Manufacturing Initiative is a collaborative manufacturing research effort involving DOE/Sandia, TPI Composites, and Office of Energy Independence (OEI)/Iowa State University. The goal of this collaboration is to enable the creation of U.S.-based manufacturing jobs by improving the labor productivity associated with wind turbine blade manufacture. For the U.S. market, this improved labor productivity will allow domestic manufacture of blades to be cost competitive with blades from low cost-of-labor countries.

This increased labor productivity is the goal of the Advanced Manufacturing Initiative. The Advanced Manufacturing Initiative is a three-way research collaboration involving Sandia National Laboratories, TPI Composites, and Iowa State University with the funding being provided equally by U.S. DOE, TPI, and the state of Iowa through its Office of Energy Independence. The project is a three year effort and the goal of this collaboration is to increase labor productivity by 35% over existing state-of-the-art -wind blade manufacturing practices while maintaining or improving part quality. This level of improvement in labor productivity will make domestic manufacture of wind turbine blades competitive with blades imported from low cost-of-labor markets. The success of this research collaboration requires the effective leveraging of the expertise of a national laboratory, a commercial blade manufacturer, and a large university.

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

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

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

- Need to reduce manual labor through automation to encourage U.S. manufacturing of blades rather than reliance on low wage countries.
- Meets LCOE objective and manufacturing and standards objectives.
- Link to two DOE goals.
- More efficient manufacturing can have big effect on COE.

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

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

- The three way steering committee was innovative and made use of lab, industry and university expertise.
- Established a productivity goal and then tried a variety of approaches to reduce critical path items. Used SNL techniques from Federal Aviation Administration work.
- Unique partnership with industry and academia.
- Improvements originates from TPI process but fairly general for dry fabric.

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

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

- 37 % reduction in handling time is quite impressive.
- Found fewer automation opportunities than expected.
- Cycle time goal reached, productivity may be less.
- Have shown how can reduce cycle time over 35%.
- Expect to get at least half of 35% productivity increase.

Question 4: Project Management

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

- The project apparently was well managed since it yielded good results.
- Simple and effective with 3 party steering group.
- Well managed process for selecting projects.
- Mostly on time, once started.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.8** for research integration, collaboration, and technology transfer.

- The University/industry/Lab collaboration is quite effective.
- Good involvement of key industry player (TPI) and local university.
- Small number of partners. Dissemination through Sandia workshops and national conference.
- Cost sharing from TPI and Iowa State.

Question 6: Proposed Future Research

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

- Many tasks were identified as possible future research such as pultruded rods, vacuum turning and automatic layup equipment.
- Apply to offshore blades.
- It is not clear where this project will go.
- Project has considered manufacturing innovation, close to implementation. Manufacturing research for a 100+ m blade may be premature if same approach is used.

- What about carbon spars, and Resin Transfer Modeling?

Strengths and Weaknesses

Project Strengths
- Achieved major reduction in handling time.
- Strong three party team.
- Good partnership and demonstration.
- Significant improvement in cycle time and productivity.

Project Weaknesses
- Not very clear on how achieved and many other ideas that can be utilized in future research.
- Did not look at materials cost reductions and these are 60% of blade costs.

Specific recommendations for additions or deletions to the work scope

- It is important to disseminate results to industry. This has not happened yet.
- Continue to include large land-based blades in follow on research.

WP031: Manufacturing Research

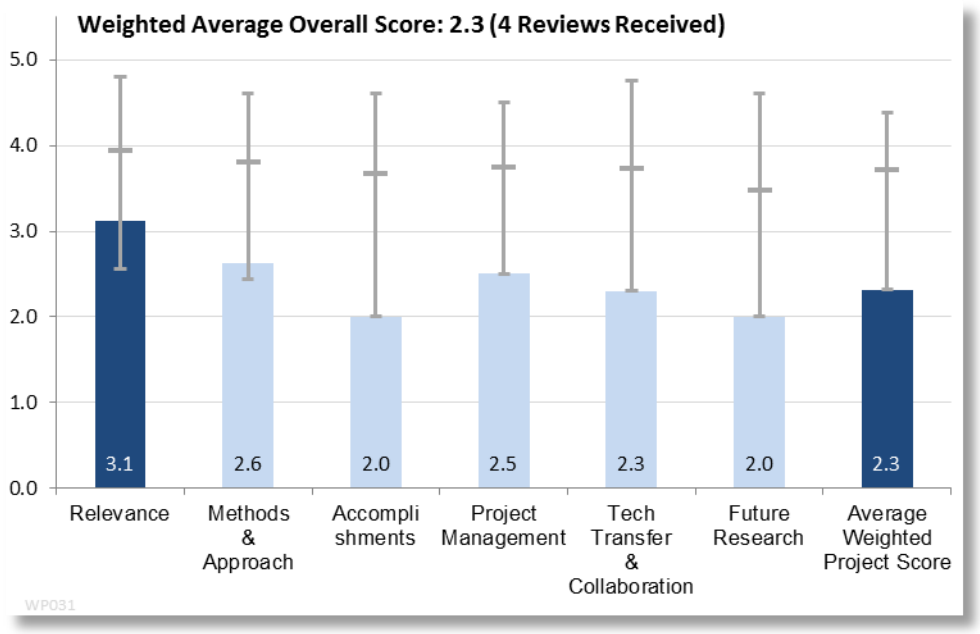
Joshua Paquette, SNL

FY 10 Budget: $500,000 DOE $0 Cost-Share

FY 11 Budget: $0 DOE $0 Cost-Share

Project Duration: Oct 2009 - Apr 2012

Brief Summary of Project



As the wind industry continues to mature and grow the importance of manufacturing and supply chain increases. The DOE/Sandia Manufacturing R&D effort executes the fundamental manufacturing research that supports and enables all manufacturing-oriented projects which are part of the DOE Wind Program and generates the research topics for future manufacturing-oriented projects. The Manufacturing R&D effort is a core capability which supports current manufacturing-oriented projects and will generate the next generation of manufacturing-oriented projects. A new focus on addressing the supply constraints to identify the bottlenecks for the industry is being pursued to meet the industry's rapid growths. By integrating both the manufacturing and the supply chain agenda, the program will focus on developing the necessary agenda to further stimulate U.S. based manufacturing and address the potential shortfalls to meet the 20% by 2030 scenario. Thus, the objective of this project is to perform fundamental manufacturing research and development to support and enable DOE-funded manufacturing projects such as the Advanced Manufacturing Initiative, Sensor Blade 2, Blade Reliability Collaborative, Blade Manufacturer Demonstration Platform, and SMART.

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

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

This project earned a score of **3.1** for its relevance to wind industry needs and overall DOE objectives.

- Could have been valuable. Do not see a very positive outcome of the task.
- Meets LCOE and manufacturing objectives.
- Addresses three goals.
- Project, imbedding sensors during manufacturing, interesting but does not seem critical for meeting DOE objectives.

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

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

- Very limited information on the success of the imbedded sensor approach.
- Approach is to look at placing in situ sensors in blades without hurting reliability.
- Sound approach.

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

This project was rated **2.0** based on technical accomplishments and progress.

- Only said that sensors are feasible but are not durable and strength is an issue.
- Tried a variety of sensor approaches. Found that durability of the sensors a continuing issue.
- This program is making little progress.
- No clear outcomes.
- Little value to industry.

Question 4: Project Management

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

- Not very effective.
- Project was funded $500k in FY2010 and not continued.
- Slight delay, budget spent.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- No reference to collaboration or outside reviewers or partnership with industry.
- Montana State University as collaborator. Several degrees awarded.
- Collaboration weak, Montana University sub-supplier, presentation at workshops and conference.

Question 6: Proposed Future Research

This project was rated **2.0** for proposed future research.

- Not mentioned.
- Research transitioned to more specific improvements rather than general research on imbedding blade sensors.
- Not clear.

Strengths and Weaknesses

Project Strengths
- Did not see major benefit to industry.
- Practical demonstration.

Project Weaknesses

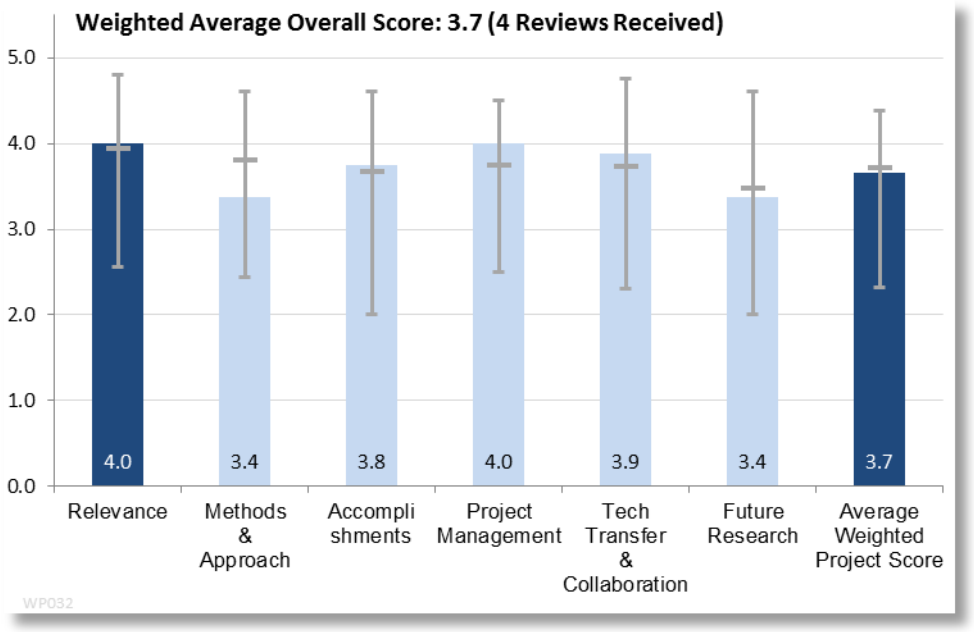
- No useful results sighted.
- Project did not seem to be leading to near term specific improvements.
- No broad direct project collaboration with industry.

Specific recommendations for additions or deletions to the work scope

- The program should reassess the work scope for this project.

WP032: Materials Research
Joshua Paquette, SNL
FY 10 Budget: $500,000 DOE $0 Cost-Share
FY 11 Budget: $500,000 DOE $0 Cost-Share
Project Duration: Oct 2009 - Sep 2012

Brief Summary of Project



The objective of the Materials R&D project is to characterize wind turbine blade materials in terms of their resistance to extreme and fatigue loads. The materials investigated include fibers, fabrics, resins, adhesives, and core materials. Industry collaboration is integral to the project, both in terms of material suppliers as well as blade designers and turbine OEMs. The primary outcome of this research is the yearly publication of the DOE/SNL/Montana State University Composite Materials Database, which is among the largest of its kind in the world. While intended to be used by wind blade designers, the database is also used extensively for code validation by designers from other industries including aerospace and defense.

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

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

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

- Valuable data set for blade designers.
- Potential to reduce LCOE and jumpstart offshore.
- Impacts three DOE goals.
- Recent step in a long going important program with constant interaction with industry.
- Database is of significant value to industry.

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

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

- There are newer high strength materials that are not included such as pultruded rods and carbon.
- Looking for blade materials that have desirable qualities.
- Well-executed program.

- Tests performed inspired by recent R&D development or industry request.
- Data on such materials placed in a public database.
- Database continues to expand in content and test methodology.

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

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

- Test results were published. Newer materials are not included.
- Over 12,000 items in database. Widely used not just by wind industry.
- Valuable database.

Question 4: Project Management

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

- Data published is available to industry.
- On time and meeting all its milestones.
- Good progress at low cost.
- Well executed effort.
- High value to industry.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Montana State is a good partner for this work.
- Montana State plus several industrial partners.
- Strong technology transfer.
- Many industrial partners, dissemination of conferences and workshops.
- Conference presentations and publications.
- Annual Material Data Base updates key.

Question 6: Proposed Future Research

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

- Missing new materials. Lightweight blades are important but no path to achieving this goal.
- Continue database.
- Good plans for continued growth of database to meet needs of industry.
- Continuation of database valuable, proposed developments relevant.
- Multi scale test development.

Strengths and Weaknesses

Project Strengths
- Continue to increase data set for material characterization.
- Builds on materials database since 1989.

- Dissemination through well-established database and with wide industrial collaboration.
- Broad industry use.

Project Weaknesses

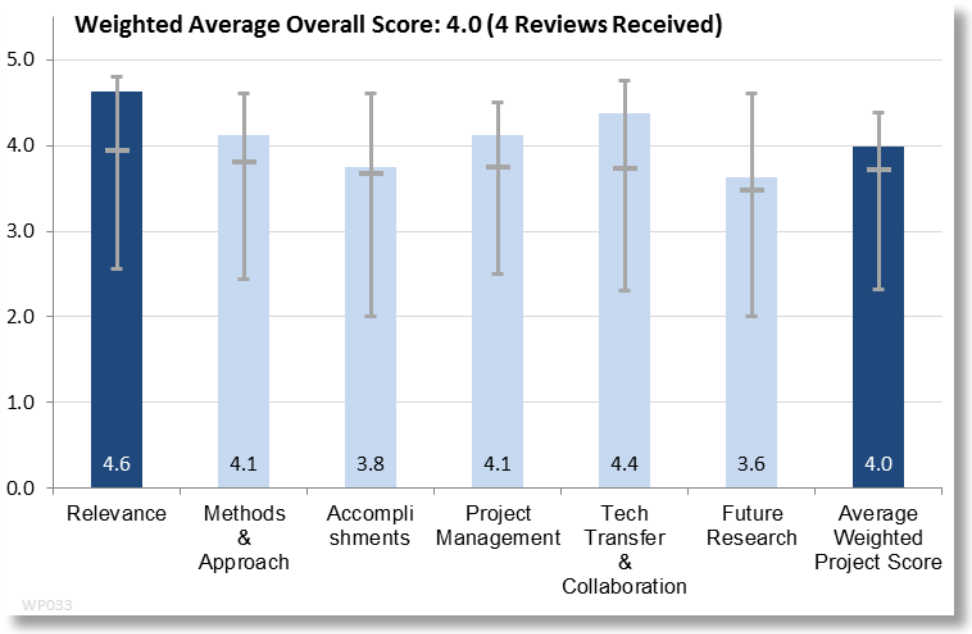
- Need to add more advanced materials that can increase efficiency and reduce weight and enhance reliability.
- Rationale and process for selecting tests a bit vague.

Specific recommendations for additions or deletions to the work scope

- Need to continue the work and expand to include more advanced materials.
- Continue database.
- Continue focus on blade materials.

WP033: Advanced Design Tools
Jason Jonkman, NREL – presented by Paul Veers
FY 10 Budget: $850,000 DOE $0 Cost-Share
FY 11 Budget: $1,280,000 DOE $0 Cost-Share
Project Duration: Mar 2010 - Sep 2012

Brief Summary of Project



The wind industry relies extensively on design tools for wind turbine performance, loads, and stability analyses. Limitations—and consequent inaccuracies—in the tools slow the advancement of wind power. Without accurate tools, it is prohibitively expensive or impossible for the wind industry to develop innovative, optimized, and reliable wind technology. The Program-developed tools have become the industry standard and are used by thousands of U.S. based and international wind turbine designers, manufacturers, consultants, certifiers, researchers, and educators. Overcoming current modeling limitations increases in importance as turbines scale up to larger sizes, incorporate novel architectures and load-control technologies, and are installed on offshore support platforms. This project continues to implement improvements to advanced design tools based on the latest research in support of the wind industry that are required for developing the innovative, lower-risk, and higher-performing turbine technology needed to achieve the COE, reliability, and deployment objectives that are part of the Program's mission.

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

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

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

- Extremely valuable since the industry does not have the time and may be expertise to come up with these accurate design tools.
- Meets LCOE, offshore, manufacturing and operations objectives.
- Code development is very important to wind industry.
- Development and validation of advanced design tools for research, innovation and product development of high value for industry and research, complies well with DOE objectives.
- This program is a key contribution of the DOE program.

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

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

- Well designed in the sense it ties all prediction models from input conditions to output loads. Has there been an optimization loop included or the emphasis is only on accuracy of prediction?
- Builds on NREL extensive modeling capability: improving models, verifying and validating them.
- Systems approach is good.
- The integration of tools and code structure well thought out; more emphasis on validation recommended.

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

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

- The models are progressively getting better and the continued emphasis on improvements will ultimately help the industry progress.
- Upgraded inflow models, electrical drive, structural dynamic models (especially in blade dynamics), and analysis.
- Making good progress in code development.
- Good model development and efficient approach to user interaction.

Question 4: Project Management

This project was rated **4.1** on its project management.

- Continue to improve on the models. For offshore these models need to be more accurate because of the higher variability of the resources.
- NREL experienced management of such efforts.
- PI is very good manager.
- Slight delay but good progress.
- Some increased effort was needed to implement modular methods.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Using a variety of labs, Universities and industry partners.
- Now tacking downloads and getting wide international use.
- Outstanding tech transfer.
- Impressive amount of partners and international collaboration. Interaction with industry could be strengthened by collaboration using the tools for actual design analysis in addition to workshops.
- Well established user base.

Question 6: Proposed Future Research

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

- Improve aero input and introduce controls and structures.
- Good proposed list.

- Well balanced future plans.
- Relevant future research, more emphasis on tool validation and use of tools for design analysis in cooperation with industrial partners recommended.

Strengths and Weaknesses

Project Strengths
- This work is the specialty of National Labs and continued improvement of these models is a necessity.
- NREL a recognized world leader in this modeling.
- Management.
- Strong technical background and well-established set-up.
- Systematic research agenda with new modular approach.
- Open source approach to code development.

Project Weaknesses
- Did not see any plans for validation.
- None apparent.
- Validation.

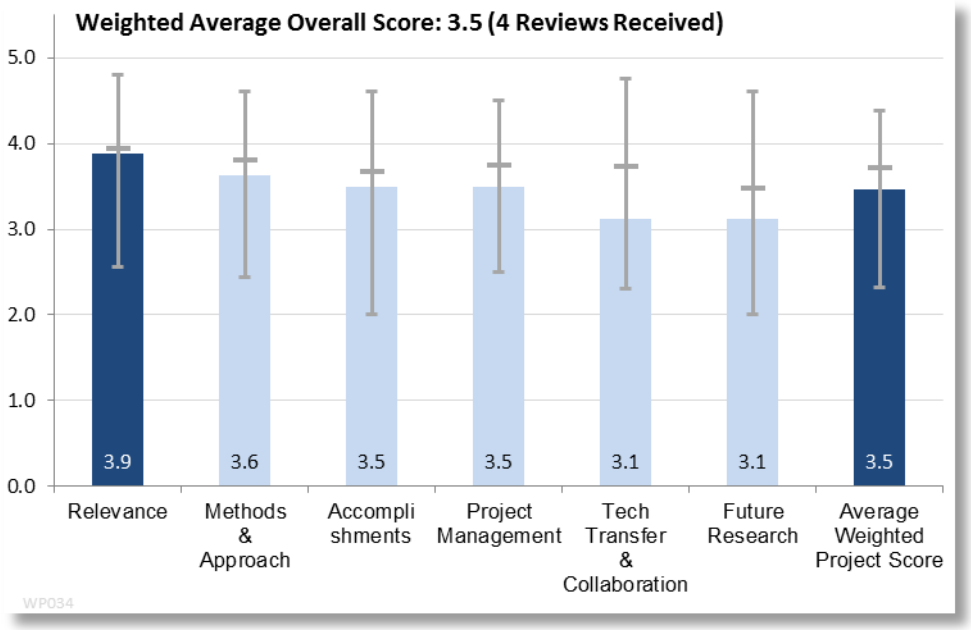
Specific recommendations for additions or deletions to the work scope

- Continue efforts.
- Consider outsourcing user interface and tech support to small business entity. Focus on code development and verification.
- Continue on optimization path.

WP034: Blade Design Tools & System Modeling
Brian Resor, SNL
FY 10 Budget: $600,000 DOE $0 Cost-Share
FY 11 Budget: $475,000 DOE $0 Cost-Share
Project Duration: Jan 2010 - Dec 2012

Brief Summary of Project

The Blade Design Tools & System Modeling project supports both specific internal Sandia projects as well as the wind energy research community and industry, as a whole, by creating and verifying state of the art and efficient wind turbine blade analysis tools and by enabling and verifying specific and efficient state of the art capabilities for full system wind turbine aeroelastic simulations.



The Blade Design Tools & System Modeling effort is a core capability which supports specific FY10-11 Sandia projects including SMART Rotor Simulation and Design, Blade Reliability Collaborative, Sensor Blade 2, Offshore Large Rotor, and Offshore structural health monitoring. Capabilities developed by this project are transferred to the public in order to enable highly effective and efficient analyses by the entire research community.

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

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

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

- NuMAd is a good tool to perform finite element method analysis on blades. Updating is a good idea.
- Meets LCOE and other listed objectives.
- Development of an advanced simulation platform, imbedding new research in the form of a blade sign tool and dissemination through a computer code to researchers and industrial stakeholders is a good idea that serves many purposes.

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

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

- The upgrade is intended to make it more user friendly and can be utilized by the industry more effectively.

- Focus on high fidelity blade design tools while complementing NREL design codes.
- Consider outsourcing user interface and technical support.
- Sound approach that includes the use of a general purpose FE model.

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

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

- No data delivered.
- Upgraded the Numerical Manufacturing and Design (NuMAD) Tool, which is widely used.
- Making good progress.
- Good although not revolutionary accomplishments.

Question 4: Project Management

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

- Not being utilized effectively by the industry.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Need to include more industry participation to ensure that the tool is being utilized.
- Already widely used.
- No formal partnerships or collaboration, dissemination through a tutorial and papers.
- Good publication list.

Question 6: Proposed Future Research

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

- Nonlinear and blade damage among good list of future prospects.
- Sound progression proposed, but for whose benefit other than SNL?

Strengths and Weaknesses

Project Strengths
- It is a system approach to material properties.
- SNL is strong in blade structures and materials and continued development of an advanced simulation platform serves many purposes.

Project Weaknesses
- It is a system approach to blade design and manufacturing process.
- Little collaboration with other research groups and industry. Use of a commercial FE model hampers wide spread use.

Specific recommendations for additions or deletions to the work scope

- Consider optimization loop.
- Establish a much stronger collaboration and involve stakeholders in planning development.

WP047: Blade Reliability Collaborative

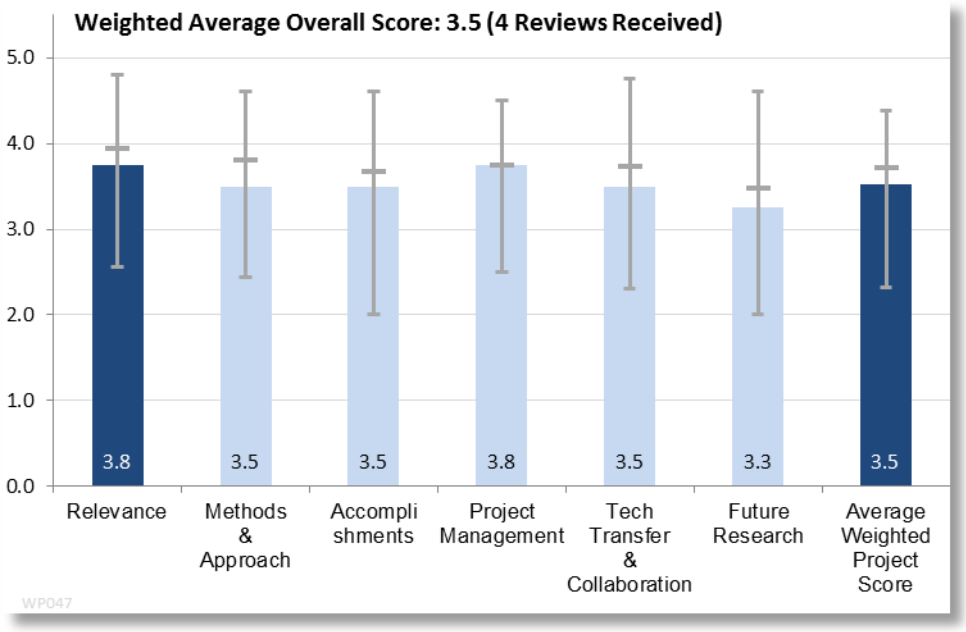
Joshua Paquette, SNL

FY 10 Budget: $800,000 DOE $0 Cost-Share

FY 11 Budget: $800,000 DOE $0 Cost-Share

Project Duration: Jan 2010 - Dec 2012

Brief Summary of Project



Blade reliability issues can have large effects on COE as blade failures can cause extensive down time and lead to expensive repairs. Through a survey of industry experts and other studies, it was found that significant reliability issues existed with wind turbine blades. Among the problems cited were: Wind blades are being delivered to the site in a condition that often requires additional treatment of quality issues before they can be installed and rare installations that required replacement of all the blades after the discovery of a batch problem

The Blade Reliability Collaborative (BRC) was initiated to develop a collaborative framework to address the issues related to the reliability of wind turbine blades as they are delivered to the field and operated for the turbine lifetime. The goal of the collaborative is to improve the reliability of blades delivered to the field so that remediation work before operation can be eliminated and the service lifetimes can achieve the 20 year targets that are expected by wind plant operators and financiers. The project solicits the advice of industry partners for evaluation of manufacturing process through the testing of full-scale blades and the evaluation of inspection techniques. Also, design alternatives that are better able to avoid flaws where possible and are more readily inspected are evaluated in conjunction with other Sandia large blade analysis programs. The results of the collaborative will be communicated publically and international standards bodies will be engaged so that the findings will inform future drafts.

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

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

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

- Collecting data about true sources of blade unreliability, based on interviews with OEMs, blade experts.
- Blade reliability is essential to achieving 20-year life and meeting COE goals.
- Addresses important DOE objectives.
- Good alignment with industry needs in developing data and NDI info available by all.

- DOE role in facilitating collaborative is important -- some challenges in implementation given that members are business competitors.
- Valuable effort on NDI work and the standard panel to be used for inspections.

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

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

- The project is well designed with broad participation from industry and academia.
- Development of industry general tests (i.e., specimens) has value.
- Clear areas of focus for the program.
- Impact standard has value.
- Would have liked to hear more on how dealing with industry with proprietary data - how much has that hindered the program, how much has it not hindered the program.
- Collection of actual blade failure data may not be very informative.

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

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

- Blade defect and damage survey identified common issues.
- It seems that good results have been achieved however the presentation does not point out details of the findings and response of blade manufacturers to these quality issues.
- Would have liked to have seen more on the results.
- Created standardized inspection panels to detect flaws.

Question 4: Project Management

This project was rated **3.8** on its project management.

- Project started late but on schedule to meet milestones on effects of defects research.
- The project is well funded and managed. Better communication of results to manufacturers and industry participants is required.
- Need to give thought to how DOE can add value to an area where industry is likely to be protective of information shared with others.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Need more quantification on the applications of the Effects of Defects findings, plus difficult to get a wind turbine OEM to be forthcoming about flaws or problems they are having with their blades.
- Considerable participation from manufacturers and academia.
- Moderate engagement of other agencies.
- No involvement of universities beyond Montana State University. Program would likely benefit from broadening university involvement.
- Does database have sufficient data to impact designs, or is it more valuable to correcting manufacturing problems?

- Involvement of NDI experts from other industries is good.

Question 6: Proposed Future Research

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

- Proposed work on effects of saltwater/erosion would be valuable to offshore.
- Continue to develop data base. Need to verify NDI efficacy in locating defects before blades are shipped to the site.

Strengths and Weaknesses

Project Strengths
- Working to solve an industry problem.
- Combined a good combination of OEMs, blade manufacturers, labs and University.
- Provides useful information for standards setting.

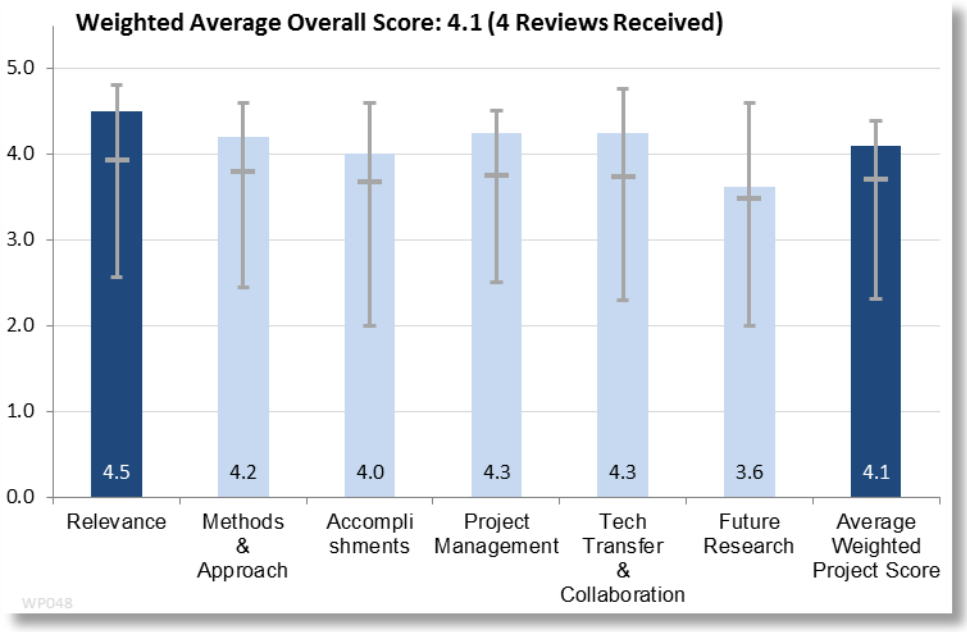
Project Weaknesses
- Reluctance of OEMs to report issues they are having with blade deflects.
- Specific mitigation and NDI methods need to be published and communicated to OEMs to avoid issues after the blades are shipped.
- Possible redundancy with industry research.

Specific recommendations for additions or deletions to the work scope

- Focus on saltwater/offshore applications where industry is not conducting its own research and would be more willing to participate.
- Suggest that cost effective NDI methods are pursued and their efficacy is verified.
- On a program like this with significant industry involvement, suggest the program request each participant fill out this page as a survey. This could provide useful insights to the Program Manager and DOE.

WP048: Gearbox Reliability Collaborative
Jonathan Keller, NREL
FY 10 Budget: $2,500,000 DOE $625,000 Cost-Share
FY 11 Budget: $1,323,000 DOE $330,000 Cost-Share
Project Duration: Jan 2007 - Sep 2012

Brief Summary of Project



The purpose of the Gearbox Reliability Collaborative (GRC) is to determine why wind turbine gearboxes do not always achieve their expected design life through a multi-pronged approach of analysis, field testing, dynamometer testing, and the development and population of a gearbox failure database. Knowledge and data gained from the GRC will enable designers, developers, and manufacturers to improve gearbox designs and testing standards and create more robust modeling tools. This knowledge is already resulting in increased gearbox reliability and an overall reduction in the cost of wind energy.

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

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

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

- Solving a problem with gearbox issues - determining why wind turbine gearboxes do not always achieve their expected design life through multi-pronged approach of analysis, field testing, dynamometer testing, and development and population of gearbox failure data.
- Extremely valuable work. Gearbox is very cost effective compared to direct drive if high reliability is achieved.
- Program is focused on improving area of turbines that have major role in LCOE.
- Overall theme of gearbox reliability is directly beneficial to the industry and the existing wind turbine fleet.
- Relevant to DOE program goals.

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

This project was rated **4.2** on its methods/approach.

- Sound methodology.

- The approach is quite sound. By analyzing an existing gearbox and modifying it to prove the validity of the design change, a clear path forward is established.
- Good balance of modeling and testing.
- Not convinced on the value of doing the gearbox 3 design, build, and test.

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

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

- Provided insights into gearbox issues.
- The project has specific recommendations that will result in a longer life gearbox and more importantly will make its way to gearbox certification standard.
- Detailed best practices identified through this program.

Question 4: Project Management

This project was rated **4.3** on its project management.

- Good use of industry partnerships; clear and effective methodology.
- Project is well managed and results so far are promising.
- Program management is high quality.
- Understands balance of establishing reputable baseline tests (and gearbox) for comparison purposes versus addressing specific industry needs.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Active Collaborative with shared funding and leveraging of DOE partners.
- A very eclectic group of consultants, gearbox manufacturers, and OEMS and lab personnel was formed and major exchange is taking place.

Question 6: Proposed Future Research

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

- White-etching area can be the next major issues in the field. Finding a root cause and a solution is of extreme importance.
- Work on white etch area phenomenon would be very valuable.

Strengths and Weaknesses

Project Strengths

- Solves real problems and provides key insights into gearbox failures. Findings that can be applied to improve reliability of gearboxes.
- The project was able to come up with specific recommendation that was applied to a redesigned gearbox. If proven in dynamometer testing will be extremely valuable.
- Extremely valuable work that could ultimately have a big impact on industry.

Project Weaknesses

- Need to determine how this information will result in clear, definitive recommendations and beneficial changes to standards.
- White-etching area and other bearing problems are still a major contributor to gearbox failures.

Specific recommendations for additions or deletions to the work scope

- Recommend to continuing this program but include more specific proposal in terms of what will be done with results, in terms of dissemination, application and standard setting.
- Concentrate on white-etching area problems.

WP049: CREW Database and Analysis Program

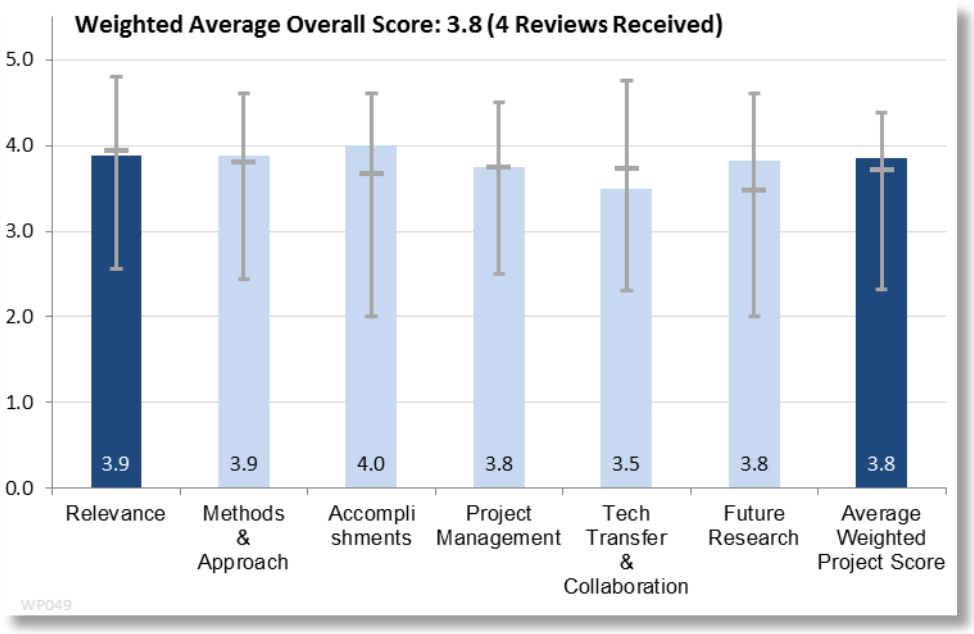
Alistair Ogilvie, SNL

FY 10 Budget: $1,405,000 DOE $0 Cost-Share

FY 11 Budget: $1,405,000 DOE $0 Cost-Share

Project Duration: Jan 2008 - Dec 2012

Brief Summary of Project



The Department of Energy (DOE) published a 2008 report describing a scenario in which wind energy provides 20% of the United States electricity production by the year 2030. In order for wind-generated energy to reach high electrical market penetration, customers must have confidence in fleet operating performance levels. These are judged both by energy delivery and low operating costs. Sandia National Laboratories initiated a Reliability Collaboration and System Analysis activity in support of the DOE's mission to enable continuous reliability improvement of wind turbines in the United States. This program will establish a national reliability database (Continuous Reliability Enhancement for Wind - CREW) containing a sufficiently large sample of wind plants to track and benchmark the operation and maintenance (O&M) experience of the U.S. fleet. The Sandia program will provide ongoing data analysis to drive national investments in reliability enhancement to those components with the greatest payoff. The database will also provide regular public-domain reporting of aggregated fleet reliability data to enable owners and operators of wind plants to benchmark their experience against the fleet. The Sandia program will champion the further maturing of the wind industry by the collection, storage and analysis of O&M data to advance effective reporting to all stakeholders.

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

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

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

- Provides important baseline data to track and improve upon reliability.
- Program gives a snap shot of the performance of the wind fleet.
- Objective is to 1) provide info to DOE and 2) to champion use of data 3) ability to benchmark. Being able to collect proprietary data and integrate/report in a non-proprietary manner is important for the industry. Well done.

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

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

- Good use of partnerships for data collection and Sandia for analysis and reporting.
- A good combination of developers, Lab personnel and utilities and reliability organizations. No OEMs present.
- Very sound approach to developing CREW.
- Approach of collecting data is bringing wind industry up to types of data collected in other technologies such as gas turbines.
- Good use of SNL data security.

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

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

- First publically available analysis of U.S. wind fleet performance.
- The graph with the snap shot of performance of the fleet is very informative. Expected to drill down more on root cause analyses for unavailability.
- A good start with 500+ turbines in the program. A long way to go to get to a meaningful representation of the U.S. fleet.

Question 4: Project Management

This project was rated **3.8** on its project management.

- From the start, this program appears to be designed for long-term sustainability. Good example of how DOE can jump-start a program for the common good that has potential for long-term sustainability.
- Good handling of data, more OEMS need to join.
- Well managed.
- Good use of partners and contractors.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Data can be used to establish best practices.
- Need to publish to OEMs and developers.

Question 6: Proposed Future Research

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

- Continue to fund this program and expansion of the plants participating to take to beta test to commercial level.
- No future research identified. Suggest pursuing root causes of unavailability.
- Valuable work going forward with lots to do

Strengths and Weaknesses

Project Strengths

- Industry led and funded capability.
- Good snap shot representation of the U.S. fleet.
- Same basic technology approach that has been used for years in the gas turbine power plant industry.
- Collection of wind performance, operations and maintenance data of U.S. fleet.
- Project will bring industry up to the level of gas-turbine industry.
- Role of Lab in confidentiality of data.

Project Weaknesses

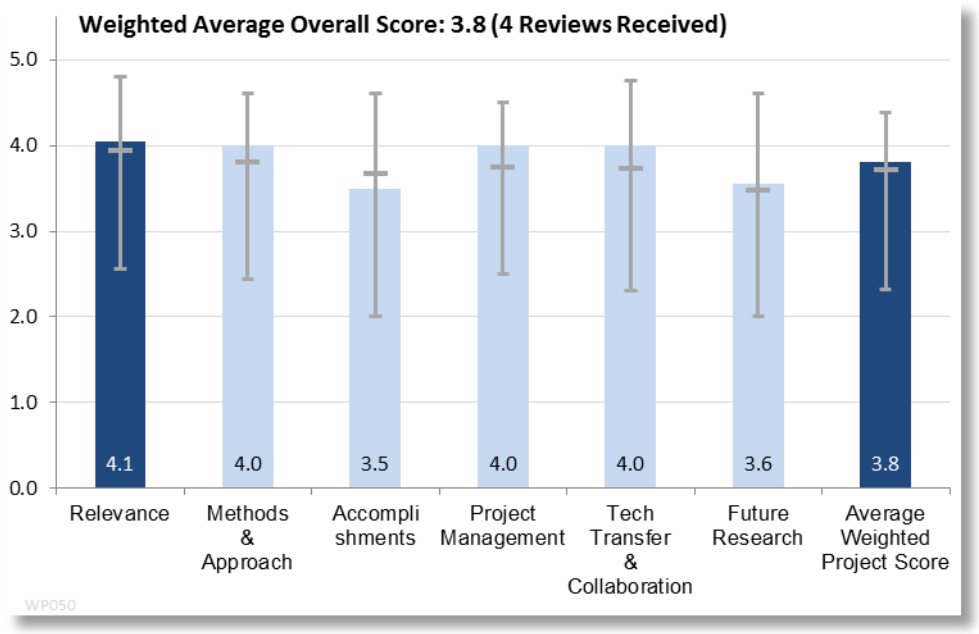
- May be certain areas of the fleet that are not represented in the data, since there are different technologies.
- Need to analyze root cause of unavailability and make industry recommendation.

Specific recommendations for additions or deletions to the work scope

- Continue to fund this program.

WP050: Condition Monitoring and Data Analysis
Shawn Sheng, NREL
FY 10 Budget: $100,000 DOE $200,000 Cost-Share
FY 11 Budget: $225,000 DOE $350,000 Cost-Share
Project Duration: Oct 2009 - Mar 2012

Brief Summary of Project



The project purpose is to help the wind industry improve turbine/plant operation & maintenance (O&M) practices and turbine availability through the investigation and advancement of condition monitoring (CM) and data analysis techniques. As a result, the O&M cost and, subsequently, the cost of energy (COE) for wind power can be further reduced. Utility-scale wind turbines have historically experienced premature component failures, leading to increased downtime and COE. The majority of the downtime is caused by power electronics, gearbox, and generator failures. There is a need for the industry to improve turbine reliability and availability. Taking crane cost into consideration, the immediate focus should be on the drivetrain, i.e. the main bearing, gearbox and generator. Condition monitoring and data analysis techniques can help the industry improve turbine availability through enabling the practices of more cost effective condition-based instead of schedule-based maintenance. As a result, O&M cost, a major piece for both land-based and offshore applications can be further reduced. The project evaluates typical wind turbine condition monitoring techniques, recommends best possible practices, and researches new techniques. The advancements made through this project will benefit the global wind industry at large.

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

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

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

- Helping industry improve turbine availability.
- Improved condition based monitoring system can increase reliability y alerting to a possibility of failure before it happens which saves O&M cost and lost hours.
- Condition monitoring has potential to play major role in LCOE.
- Certainly an important topic to the U.S. Wind Industry given the large 50GW Wind Power footprint. A good program from DOE to get activity going in this area.
- Follows what other more mature power industries have used to improve reliability and lower O&M.

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

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

- Use of GRC data and experience of 31 operators can help propel the project.
- Selected particle analysis as first focus and conducted sound mythology to achieve results.

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

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

- Condition-based maintenance is now emerging as expected feature of newly installed plants.
- Details vibration algorithms, particle count data shared with industry.
- R&D projects are leading to improved operations.

Question 4: Project Management

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

- Considerable cost share from partners in the industry.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- Considerable number of partners and many condition based monitoring system meetings.
- Working closely with instrument makers on equipment and data analysis.

Question 6: Proposed Future Research

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

- Well thought out agenda for future research opportunities, with focus on verification and validation.
- No future research identified.
- Good growth in cost share in 2012 is a good indication that this work is of interest going forward.
- Continue evaluation of different condition monitoring techniques.

Strengths and Weaknesses

Project Strengths

- Public domain nature of this work makes it possible to release data and report to the public. Getting requests for data from graduate students - there is a lot of value to providing data to this population.
- Strong collaboration.
- Sound research approach.
- Organizing workshops and work on evaluating monitoring technologies.
- Extensive collaboration.
- Key findings that wind turbine condition monitoring has potential to improve turbine availability.
- In-kind cost share from project partners; potential for cost-share to grow. Interest in project growing.

Project Weaknesses

- Data are turbine specific, which means that you cannot extrapolate to a broad range of turbines. Field tests will enable this.
- Increase accuracy of condition based monitoring system through continued collaboration with stake holders.
- Due to proprietary nature of much of condition monitoring data, this program is not able to access databases of Carnegie Mellon University data. In light of this, the program is focusing on appropriate activities such as working with the Gearbox Reliability Collaborative program, workshops, and evaluations.

Specific recommendations for additions or deletions to the work scope

- In the future, would like to see some more R&D focus on technologies that could enhance the economic data collection in support of condition monitoring.

WP056: Blade Testing Methodologies

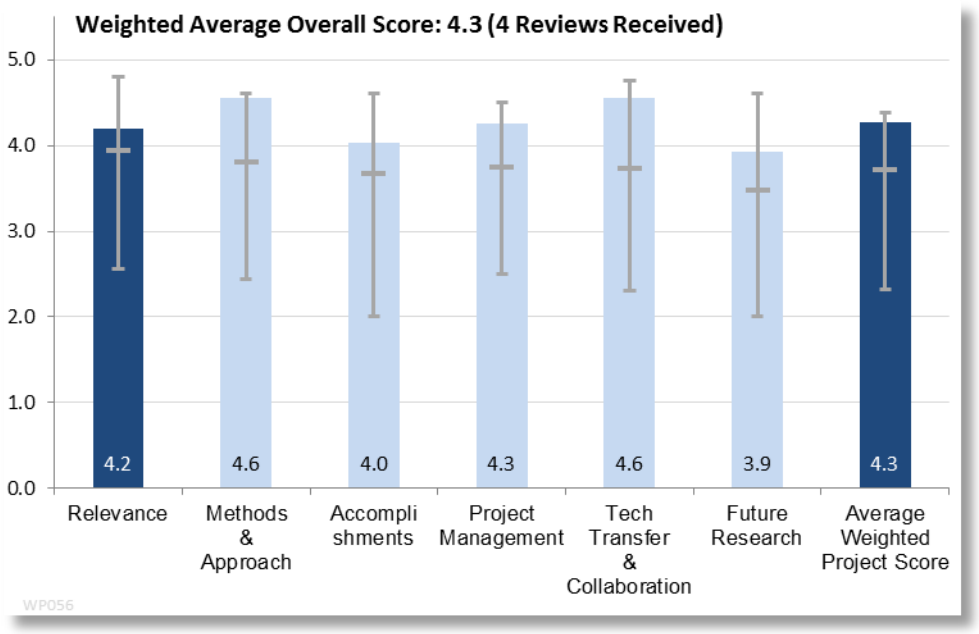
Scott Hughes, NREL

FY 10 Budget: $1,355,000 DOE $0 Cost-Share

FY 11 Budget: $681,000 DOE $0 Cost-Share

Project Duration: Feb 2010 - Sep 2012

Brief Summary of Project



Work in this project is focused on developing advanced test methods for improving blade testing technology. Blade testing is needed to both demonstrate advanced prototypes, and also required to demonstrate conformity to international standards. Current test methods available for testing large wind turbines do not sufficiently represent characteristic in-field loads; additionally existing methods suffer from lengthy timeframes for completing fatigue testing. Current test methods do not sufficiently address blade designs that incorporate advanced aerodynamic and structural features including bend-twist coupling, sweep, and modular structure designs. Wind turbine blades are fatigue tested in the flap-wise and the lead-lag directions. Large blade fatigue tests are conventionally performed independently in flap-wise and lead-lag directions due to limitations in test technology preventing synchronous testing of both flap and lead lag directions. Current methods do not take into account the torsional load effects due to bend-twist and swept blade designs, and do not provide detailed assessment of system boundary conditions including segmented joints and the root connection. Accuracy of current test methods could be improved and the total time to complete the tests could be reduced by performing the flap and edge tests simultaneously at resonant or higher frequencies. Currently, it takes months to conduct the fatigue test for full-scale testing, which presents a time barrier to development and deployment. For very large blades, testing could take a year or longer using existing test methods.

The objective of this work is to develop methods that reduce cost and time of conventional test methods. Advances in test methods can be used to improve the fidelity and accuracy of internationally accepted blade and full-system standards. Improving test methods can lead to better assessment of designs leading which in turn improve reliability. Manufacturers and end-users benefit by employing these test methods with shorter test times, lower testing costs, and improved reliability.

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

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

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

- Blade testing is needed to both demonstrate advance prototypes and also to demonstrate conformity to international standards.
- Important tool for verification of new blade designs and quality control of production blades.
- This type of project is needed to provide continuous improvement to testing methodology.
- Good leverage of NREL blade testing expertise in approaching a testing improvement that will benefit the industry.

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

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

- NREL has had 30 years of experience designing and developing extreme and fatigue load test methods. The new approaches are required for testing longer and softer blades in flap, and twist.
- Demonstrated feedback from test results to test methodology.
- Good partnership with Massachusetts Test Facility.

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

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

- The new methods are being developed and verified. They are developing a dual axis ground and mass actuated system that can be extended to longer blades.

Question 4: Project Management

This project was rated **4.3** on its project management.

- The NREL blade test facility has contributed to multiple blades and is very well managed and up to date on fatigue and static testing plans. They also contributed to the development and commissioning of the MA test facility.
- Some delays, but overall it is well managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- 14 blade tests completed in the past two years. Are there communications with European facilities?
- Well-coordinated with others.

Question 6: Proposed Future Research

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

- Specific proposals for proposed future research - hybrid test systems, effect of defect testing, large-scale health monitoring and sensing, component and system-level test needs assessment, etc.

- What about the development of ground based actuation? Complement NDI methods and tools.

Strengths and Weaknesses

Project Strengths

- Blade testing work is valuable to industry and important to standards setting and improving reliability. Good return on this relatively small budget.
- State of the art NREL/MA facilities, very experienced test teams.

Project Weaknesses

Specific recommendations for additions or deletions to the work scope

- Develop The Knowledge Centre Wind turbine Materials and Constructions (WMC) type actuation and faster tests for long flexible blades.

WP057: Large Offshore Rotor Development

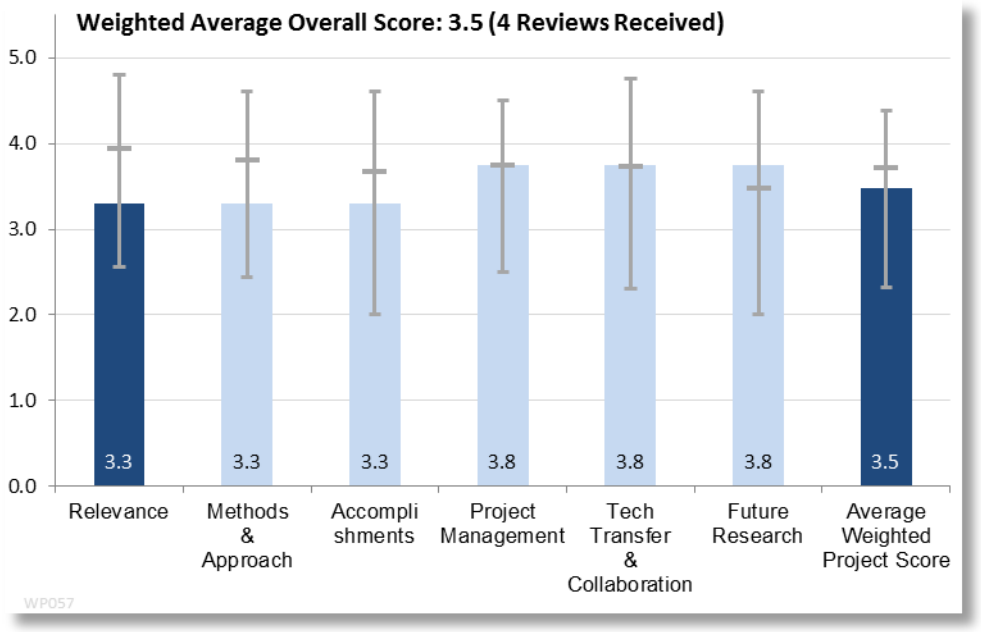
Daniel Todd Griffith, SNL

FY 10 Budget: $94,000 DOE $0 Cost-Share

FY 11 Budget: $250,000 DOE $0 Cost-Share

Project Duration: Oct 2009 - Sep 2012

Brief Summary of Project



Sandia has developed a very large rotor (205-m diameter) for the offshore environment called the Sandia 100-meter All-glass Baseline Wind Turbine Blade, termed as SNL100-00. Both a detailed composite design model (Numerical Manufacturing And Design Tool) and a Fatigue, Aerodynamics, Structures, and Turbulence (FAST) model for the associated 13.2 MW turbine were made publicly available. The blade and turbine models are the largest publicly available models in the world (current state-of-the-art machines have ratings of 5 MW with 60- to 70-meter blades). Together, these models enable quantification of how changes at the blade structure level (i.e. layup or geometry) affect performance and cost at the turbine full system level.

The project goal is to support offshore blade and turbine research by (1) providing large-scale offshore reference models and (2) identifying potential barriers to large rotor technology through analysis. Industry and academic researchers are using these models to evaluate numerous blade and turbine innovations, design and analysis codes, and approaches to improve large rotor technology and reduce the cost of energy of offshore wind energy production. Sandia is also performing a series of design studies to identify technology barriers and solutions.

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

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

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

- Good idea to establish an upper limit and see if technology can catch up and be used as the generic 1.5 land-based or 5 MW NREL offshore machine.
- Has some linkage to offshore and growth in turbines, would place it as a lower priority for DOE.
- Good idea of doing a 100m blade design to see where the design/technology challenges are. It is good to get a design in the public for other researchers, such as at universities.

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

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

- Not much detail on the design of the blade but the approach is good.
- Focused on design without manufacturability and cost considerations.

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

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

- Again no actual data presented on blade design but use of an all glass blade is probably impractical rather at least a carbon spar.
- Integrate more with manufacturing and cost people.

Question 4: Project Management

This project was rated **3.8** on its project management.

- Good management team in place.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.8** for research integration, collaboration, and technology transfer.

- Numerous requests for blade and turbine models. Presenting information at technical conference. Launched project website. A number of publications coming out of work.
- Detailed dissemination plans with access to data on web sites are quite effective.

Question 6: Proposed Future Research

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

- Value in continuing work - depth and breadth of study. Creating a large blade working group. Study and disseminate mitigation of the identified barriers to large, cost effective offshore rotors. Aeroelastic stability codes evaluation, international working group.
- As the blades get longer and more slender aeroelasicity will become an important issue.
- Uncertain of next steps.
- Undergraduate design projects -- engage and encourage future wind engineers.

Strengths and Weaknesses

Project Strengths

- Large blade model is made publicly available to researchers.
- Provide the industry with a baseline blade for large offshore turbines.
- Serves as a baseline for future considerations.
- Getting insight on the design issues for a very large, 100m blade.
- Fills an industry need. Design challenges specific to large blades are being identified.
- Identifies potential roadblocks to large blades.

- Public blade model available to all.
- Industry and academic researchers are using these models to evaluate numerous blade and turbine innovations, design and analysis codes, and approaches to improve rotor technology and reduce cost of energy of offshore wind energy production.
- Model can be used by software companies to demonstrate their products.
- Provides industry with baseline model.
- For the cost, creates value to the industry, especially academia.

Project Weaknesses

- This could be redundant with industry R&D.
- An all glass blade of this size can be too heavy and impractical.
- Practicality of all-glass blade.

Specific recommendations for additions or deletions to the work scope

- Continue project but increase collaboration with academia and industry.
- Consider a carbon spar blade.

WP058: Siemens CRADA

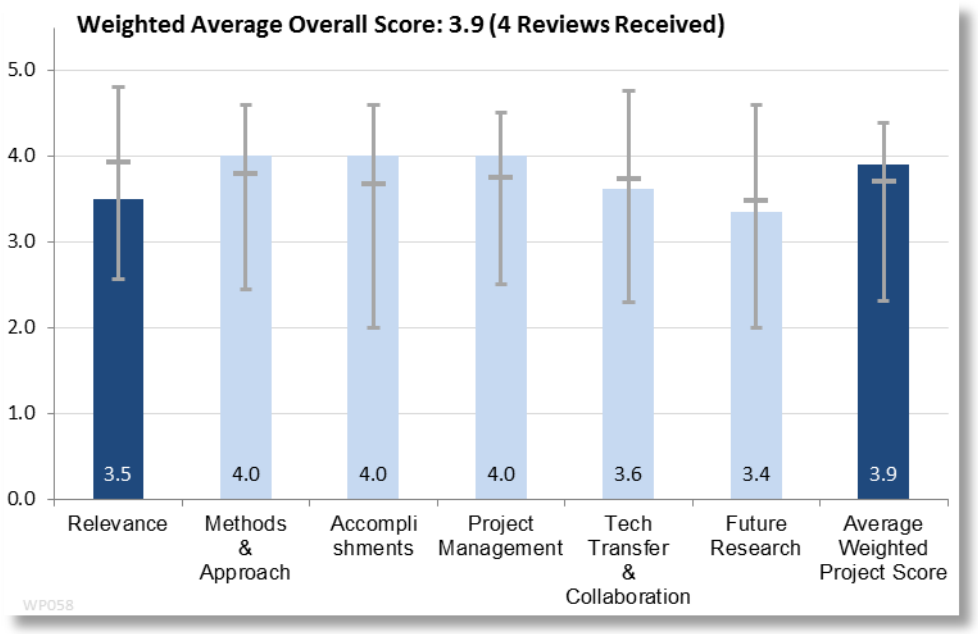
Lee Jay Fingersh, NREL

FY 10 Budget: $1,500,000 DOE $2,000,000 Cost-Share

FY 11 Budget: $1,500,000 DOE $1,500,000 Cost-Share

Project Duration: Jan 2009 - Jan 2013

Brief Summary of Project



The purpose of this project is to investigate the reliability of new methods of wind turbine blade aerodynamic design. These methods have been employed to design the Siemens 2.3MW-101 rotor, a 101m diameter three bladed rotor stretch of their workhorse 2.3MW-93 93 meter machine. The data collected can be used to evaluate and improve the performance of wind turbine aerodynamics and aeroelastic codes, leading to better-designed, more reliable and more cost-effective wind turbines. Additionally, many side projects have been completed and are further planned in the areas of aeroelastics, aeroacoustics, inflow, sensors and advanced blade design.

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

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

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

- Data collected can be used to evaluate and improve the performance of wind turbine aerodynamics and aeroelastic codes, leading to better-designed, more reliable and more cost-effective wind turbines.
- The program can be useful in verification of aero and structural models. The benefits will mostly accrue to Siemens but verification of tools will help the rest of the industry.

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

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

- High density sensors that characterize input wind and blade structural and aero performance are in place. Can be a very good source of data that can be used by NREL to improve aero and structural code performances.

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

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

- Some papers published but the major accomplishment is that Siemens was able to extend the 101 to 107.
- Would have been helpful if major findings were summarized but because it is a Cooperative Research and Development Agreement (CRADA) they may have been limitation on publishing.

Question 4: Project Management

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

- Met milestones.
- Lee is quite experienced in turbine testing and of course Siemens is a strong industry partner.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Some of test methods being used for additional tests.
- Strong cooperation between Industry and NREL, a government Lab.
- 5-year window on data release seems too long for meaningful contributions to others
- Publishing of papers on data analysis. All data becomes publicly available after 5 years.
- Co-share with Siemens.
- Presentations, publications and master's thesis.

Question 6: Proposed Future Research

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

- Developing more efficient rotors can be very useful. I don't know how much of this info will be available to the rest of the industry besides of course research in aeroelasticity and code validation.

Strengths and Weaknesses

Project Strengths

- Unique project.
- Testing and baselining one of the most commercially available machines over the past few years.
- Some of test methods have been used on additional tests.
- Have released some of raw data and lessons learned from data. The data is used in code validation and code development.
- Project is mainly funded by Siemens with relatively small contribution by DOE. Allows public sharing of lessons learned.

Project Weaknesses

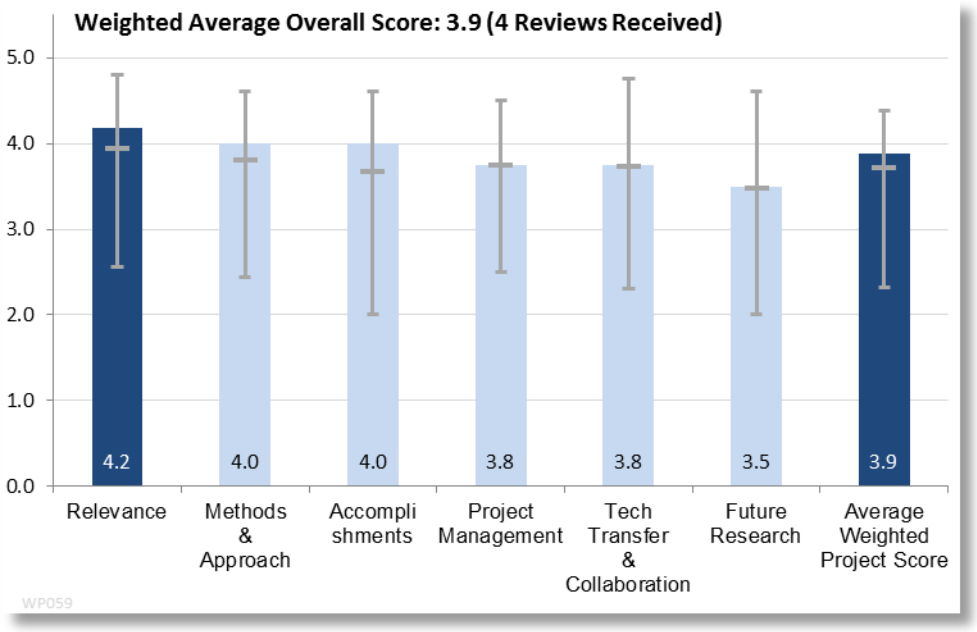
- Turbine data is proprietary and cannot be released for 5 years. In the meantime, publish lessons learned from data.
- Code validation and improved blade aero prediction and improved aeroelastic prediction can be very helpful if communicated to the industry.

Specific recommendations for additions or deletions to the work scope

- Continue to increase NREL experience with utility scale models.

WP059: Aerodynamics and Aero-acoustics Research
Matthew Barone, SNL
FY 10 Budget: $750,000 DOE $0 Cost-Share
FY 11 Budget: $600,000 DOE $0 Cost-Share
Project Duration: Oct 2009 - Sep 2012

Brief Summary of Project



The main purpose of this project is to advance the fundamental understanding of wind turbine aerodynamic performance, loads, and noise in order to enable rotor design solutions that reduce cost-of-energy and reduce deployment barriers. Advanced models of aerodynamic performance are aimed at novel blade designs to increase energy capture, providing fundamental design data for turbine and blade manufacturers to improve their designs. Application of high-performance computing resources to prediction of lifetime aero-elastic loads on wind turbine will reduce uncertainty in turbine design through improved design standards. Aero-acoustic modeling and testing using advanced experimental techniques lays the foundation for quiet blade designs that reduce system COE and/or mitigate deployment barriers.

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

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

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

- Advancing fundamental understanding of wind turbine aerodynamic performance, loads, and noise will enable rotor design solutions that reduce cost of energy and reduce deployment barriers.
- Valuable work if performance enhancement and noise reduction result from this work.
- Basic research that can have immediate feedback to industry.

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

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

- Good use of Sandia's Red Sky supercomputer to simulate wind turbine load predictions spanning entire life of a wind turbine.
- Good combination of expertise. Application of high speed computation can be helpful.

- Very sound science.

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

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

- Did not see any results yet in terms of percentage improvement in performance and noise mitigation and efficacy of different approaches.
- Two-three major contributions on flow separation and blade design to optimize flow.
- In performing the detailed CFD analysis, and in presenting the results, give more attention to what insights the results provide, what innovative ideas (IP) that leads one to come up with. I had the sense that this was focused on analyzing what was seen in existing blades and may not have spent time thinking about innovation.
- During the presentation performance improvement due to fencing was of the order of 2 percent due to better root aero performance.

Question 4: Project Management

This project was rated **3.8** on its project management.

- Good coordination between NREL and Sandia and three major universities.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.8** for research integration, collaboration, and technology transfer.

- Can be used in standards development.
- Mostly University conference papers. Need to communicate to OEMs directly through direct communication.
- Excellent collaboration with others.

Question 6: Proposed Future Research

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

- Need to do a better job communicating with the OEM's and industry.

Strengths and Weaknesses

Project Strengths
- Largely unexplored topic.
- Fundamental detailed CFD analysis that goes into greater detail than most would be able to do on a routine basis.
- Noise work beneficial to industry and removing deployment barriers.
- Good example of where basic research can inform future trends and result in technology improvements.
- Connection to test facilities is important.
- Leveraging supercomputing resources.

Project Weaknesses

- Ability to predict over 96 years based on uncertainly in future weather and climate data.
- Need to establish the performance enhancement and noise reduction associated with that work.
- Need to better extract the important nuggets of learning that industry needs to know about. Digesting a thesis paper to extract the nuggets is not something most in industry would have the time to do.

Specific recommendations for additions or deletions to the work scope

- Continue project but increase efforts to get information out into the community.

WP060: Sensor Blades 1 and 2

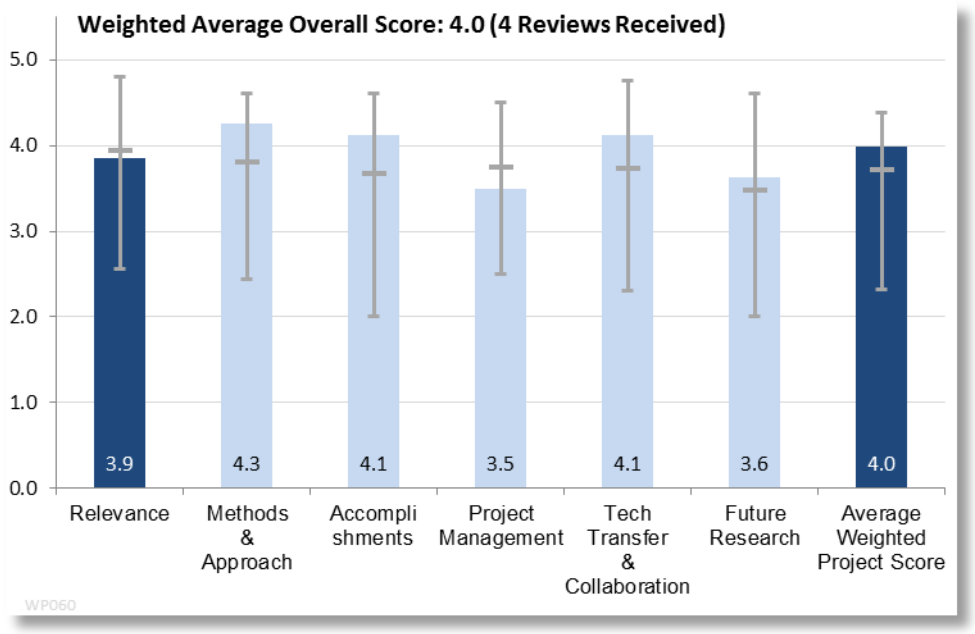
Mark A. Rumsey, SNL – presented by Jon White

FY 10 Budget: $250,000 DOE $0 Cost-Share

FY 11 Budget: $200,000 DOE $0 Cost-Share

Project Duration: Jul 2007 - Sep 2012

Brief Summary of Project



Future wind turbines will utilize additional sensing systems in order to optimize system performance. However, there are several unresolved issues concerning sensing systems, such as sensing technology specification/selection, integration/installation, operation/maintenance and reliability. The purpose of all the Sensor Blade projects was to identify and evaluate innovative and cost-effective sensors and develop data analysis approaches which seek to improve the performance of existing turbines.

These efforts were necessary to develop the sensing foundation to allow breakthrough technologies required in the near future. Internally at SNL, and more specifically, the projects were used to identify, evaluate and gain experience in sensing systems for the SMART Rotor project. The Sensor Blade 1 project was designed to be a highly collaborative effort with numerous teams from commercial companies, universities and other national labs. Each team provided instrumentation and expertise that was targeted for a particular wind application that included structural dynamics, operational dynamics, non-destructive testing and structural health monitoring. The team members were encouraged to publicly share information, their knowledge and expertise. As a result of this particular project, several companies and products were brought into the wind industry, and several new products have been initiated, refined or developed. The Sensor Blade projects have advanced the wind technology expertise at several national labs, universities and commercial companies. These innovations have and will benefit the wind industry.

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

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

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

- Addresses unresolved issues concerning sensing systems such as sensing technology.
- The results of this work can help industry if proven 20 year life sensors can be used major controls and load mitigation techniques can be used.
- Excellent alignment with work and learning of importance to industry.

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

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

- Sensor life is measured during accelerated life cycle testing also tested during actual flight on the turbine.
- PI is well versed and highly knowledgeable of data collection.

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

This project was rated **4.1** based on technical accomplishments and progress.

- Operational measurements improved the accuracy of computational turbine models.
- Improved reliability of accelerometers and estimated reliability of other sensors.
- Excellent learning on how to put sensors on blade and have them last.
- Several new organizations brought into the wind community.
- Great to see a patent coming out of the program.

Question 4: Project Management

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

- Modest project implemented when turbines where available.
- Very well organized project.
- Well managed by knowledgeable people.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Partnerships were key to this project - sensor companies, universities, etc.
- Major contributors from sensor manufacturers, Universities and Lab personnel.
- This is the type of lab-based research that couples lab strengths with industry needs.
- Patent came out of work, as well as dissertation, published paper and conference presentations.

Question 6: Proposed Future Research

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

- Repeat for marine environment, minimum number of sensors that definitely have a 20 year life and interaction with controls.

Strengths and Weaknesses

Project Strengths

- Partnerships.
- Very good project that can contribute to lower the cost of energy.
- Investigators have sound knowledge of methodology needed to collect relevant data.
- Excellent value to the industry and DOE for a modest DOE investment.

- As the result of the projects, several organizations new to the wind industry have developed technology that focuses on applications of key interest to the wind industry.
- The experiment proved that sensor arrays must cover the entire rotor in order to be beneficial for turbine control and damage detection purposes. Reliability of the accelerometer array was improved by 40-100%.

Project Weaknesses

- Increases cost of turbine, although nominally. Developing return on investment.
- Again Sandia need to communicate to industry rather than PhD thesis and papers.
- Reducing cost to install sensors.

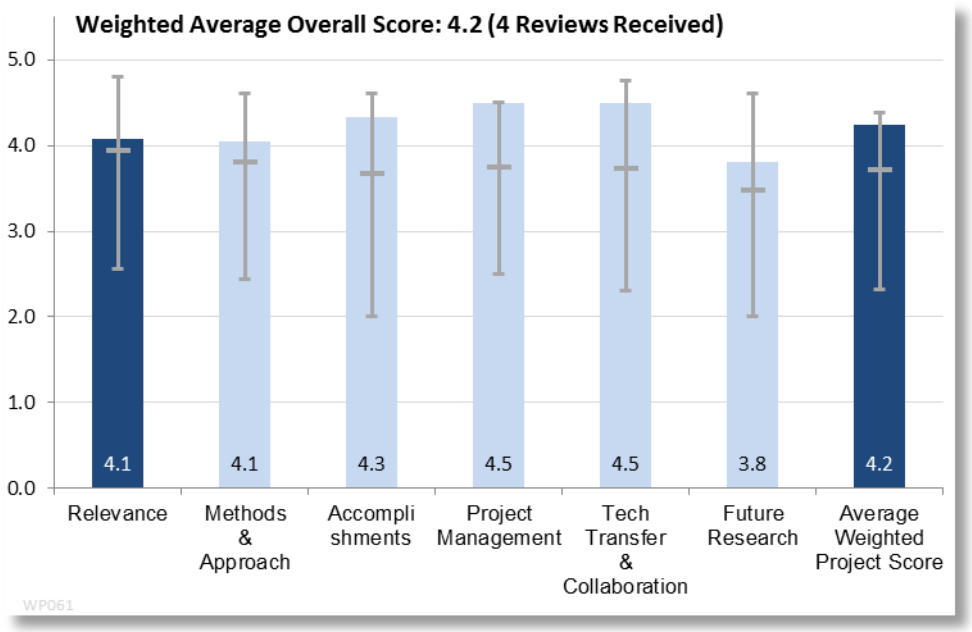
Specific recommendations for additions or deletions to the work scope

No reviewer comments were received for this metric.

WP061: Advanced Controls R&D + Controls Partnerships
Dr. Alan Wright, NREL – presented by Lee Jay Fingersh
FY 10 Budget: $1,360,000 DOE $50,000 Cost-Share
FY 11 Budget: $960,000 DOE $270,000 Cost-Share
Project Duration: Oct 2009 - Sep 2012

Brief Summary of Project

The purpose of the Advanced Controls R&D project is to develop a new generation of wind turbine advanced controls technology that will optimize COE reductions for large on- and offshore turbine systems through increased energy capture, reduced fatigue and extreme loads, and increased turbine reliability. Collaborate with industry partners to accelerate deployment of these controls in their machines.



The Controls Partnership objective is to assess the Catch the Wind (CTW) Vindicator LIDAR (Light Detection and Ranging) for use in wind turbine advanced load-mitigation control applications. The goal is to integrate LIDAR wind-speed data into advanced feed-forward load mitigation control algorithms and demonstrate their performance through field tests on the NREL 3-Bladed Controls Advanced Research Turbine (CART3).

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

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

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

- Believe that controls can have the single largest impact on a turbine.
- Very valuable work. One of the most effective cost of energy reduction strategy is load mitigation. This will have a major impact.
- Clear link to several DOE goals.
- Turbines are complex, non-liner dynamically active structures, subject to complex turbulent winds and waves that drive fatigue and extreme loads and reduce turbine lifetimes. Result: many low-damped low-frequency flexible modes- easily excited by wind and wave inputs.

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

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

- Testing on the Controls Advanced Research Turbine (CART) machine make these algorithms developed very robust and ready for implementation by industry.
- Researchers have conducted a very sound program.

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

This project was rated **4.3** based on technical accomplishments and progress.

- Showed major reduction from independent blade pitch control and multiple input multiple output.

Question 4: Project Management

This project was rated **4.5** on its project management.

- The project is well managed and shows very valuable results with use of expertise from Labs and Universities.
- Well managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Extensive list of partners. Good involvement from industry.
- Very eclectic group of Universities, Labs and OEMs.
- Strong partnership with leaders in field from Europe.
- CARTs are used to vet new controls solutions, stepping stones to commercial machine implantations.
- Involvement with university people is good.
- Good opportunity for technology transfer.
- Data from machines is widely published.

Question 6: Proposed Future Research

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

- Support future research proposals -- continue advanced LIDAR based controls development and field testing, develop controller modules for offshore platform stabilization, develop fault detection and fault tolerant controls, develop extreme event detection and controls, develop new blade mounted actuation and sensing methodologies.
- LIDAR, Feed Forward Controls are very timely in their contribution to load mitigation.

Strengths and Weaknesses

Project Strengths

- First LIDARS installed in the world that are fully integrated with controllers.
- Very good results for use of advanced controls to limit loads on larger diameter utility scale turbines.

- Has potential to lower LCOE and improve performance.
- An important technology area utilizing DOE CART turbines at NREL.
- Feed forward controls.

Project Weaknesses

- Better communications to U.S. industry.

Specific recommendations for additions or deletions to the work scope

- Continue this project.
- This work needs to continue due to its huge impact on load mitigation.

WP062: Active Aerodynamic Load Control Devices in Blades (SMART)

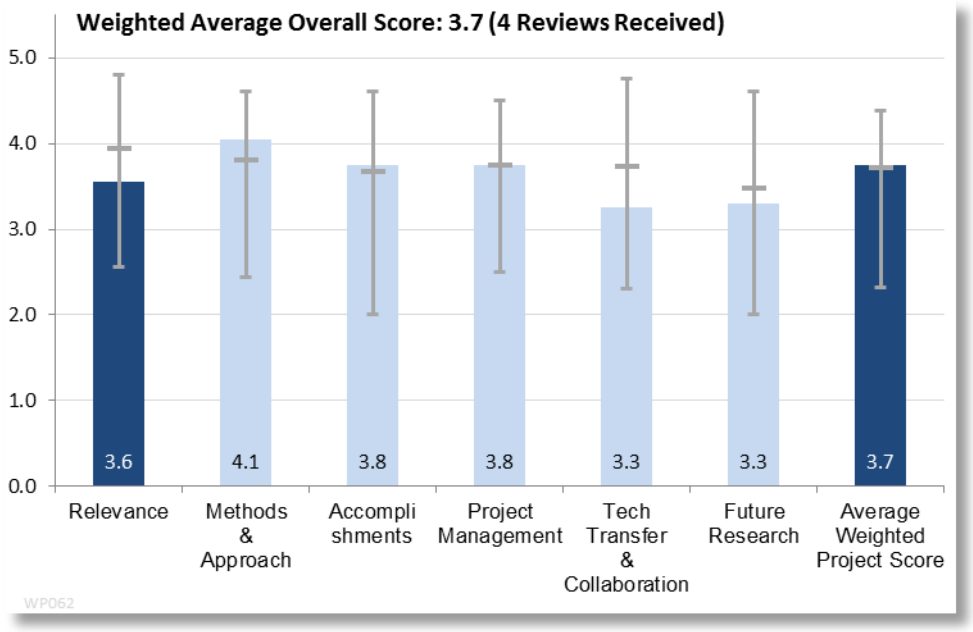
Dale Berg, SNL

FY 10 Budget: $950,000 DOE $0 Cost-Share

FY 11 Budget: $950,000 DOE $0 Cost-Share

Project Duration: Oct 2009 - Sep 2012

Brief Summary of Project



The purpose of this project is to demonstrate active aerodynamic load control (AALC) technology on a research scale turbine and use the test results to improve simulation capabilities and to guide the future direction of active load control research. The major objectives are threefold:

1) Create an AALC testing platform composed of a full set of blades with integrated sensors and AALC devices

2) Work through the entire design-build-test cycle to fully understand the implementation details and requirements necessary to achieve a working AALC system

3) Characterize the full turbine dynamics and active aerodynamic response and then use this test data to evaluate and improve active aerodynamic simulation tools. This project is the follow-on to a number of years of simulation work investigating the potential impact on wind turbine cost of energy when small, fast-acting AALC devices are integrated into the blades of a wind turbine. Success of the project provides feedback on the accuracy of our AALC simulation capabilities. Success of project also "buys down" the risk of industry OEMs performing R&D efforts in AALC.

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

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

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

- Project is follow-on to simulation work investigating the potential impact on wind turbine cost of energy when small, fast-acting AALC devices are integrated into the blades of a wind turbine.
- The objective is to use the flaps to reduce loads in a variable speed fixed pitch machine.
- Could be relevant, but not on near term industry R&D investment plan.

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

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

- Follows design-build-test plan.
- Flying the system on Micon machine is the shortest route to verify the effectiveness of the flaps in controlling loads.
- Investigators have conducted very sound research.

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

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

- Designing and building the world's first full set of blades with working AALC devices.
- The data has not been communicated yet.
- Good progress.

Question 4: Project Management

This project was rated **3.8** on its project management.

- Complex project involving as many as 50 people on the team. Safety was a priority. Experienced some delays as a result.
- Good progress in actually flying the rotor and designing the flaps. Cannot judge progress without any data.
- Investigators conduct sound research and deliver on results.
- Not clear if they are adequately linking the program back to DOE goals.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.3** for research integration, collaboration, and technology transfer.

- No involvement with industry.
- Very weak link back to industry.

Question 6: Proposed Future Research

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

- Collaboration with Romax and University California-Davis. Did not see any modeling results.

Strengths and Weaknesses

Project Strengths
- Success of project also buys down the risk of industry OEMs performing R&D efforts in AALC.
- The concept has merits yet to be proven.

Project Weaknesses
- Unclear project goal and impact.
- No modeling to show potential and no data to judge success of project.

Specific recommendations for additions or deletions to the work scope

- Continue testing and modeling to verify the benefits of the concept.

7.0 Market Acceleration and Deployment Project Evaluations

The priorities (approximately $18.6 million in FY 2012) of the Market Acceleration and Deployment portfolio are focused on the following:

- Grid Integration and Operations
  - Increasing the understanding of planning and operations engineers on how to reliably and cost effectively integrate large amounts of wind energy.
  - Supporting efforts to increase transmission infrastructure (Federal Energy Regulatory Commission Order 1000).
- Barriers/Radar
  - Developing and evaluating software and physical mitigation options to reduce impacts on National Airspace Systems.
- Environmental
  - Substantially increasing the understanding of wildlife issues with the highest GW impact: bats, sage-grouse, and eagles, and enabling the development of cost-effective mitigation measures.
- Education and Outreach
  - Completing the transition from state-based Wind Working Groups to regional approaches to deliver technical assistance and information to decision-makers.
  - Enhancing wind energy educational opportunities to increase public awareness and workforce development.
- Small and Mid-Sized Wind
  - Certifying 40 small wind turbine designs by 2020.

Projects in the Market Acceleration and Deployment portfolio collaborate to solve complex market barriers not addressable by industry alone. Additionally, some of the key Market Acceleration and Deployment activities are focused on wildlife and environment, outreach and education, small and mid-sized wind, radar mitigation and solutions, market research and analysis, forecasting improvement, and grid system planning and operations. Figure 7.1 illustrates the funding levels for the Market Acceleration and Deployment activities that were reviewed in the 2012 Wind Power Peer Review.

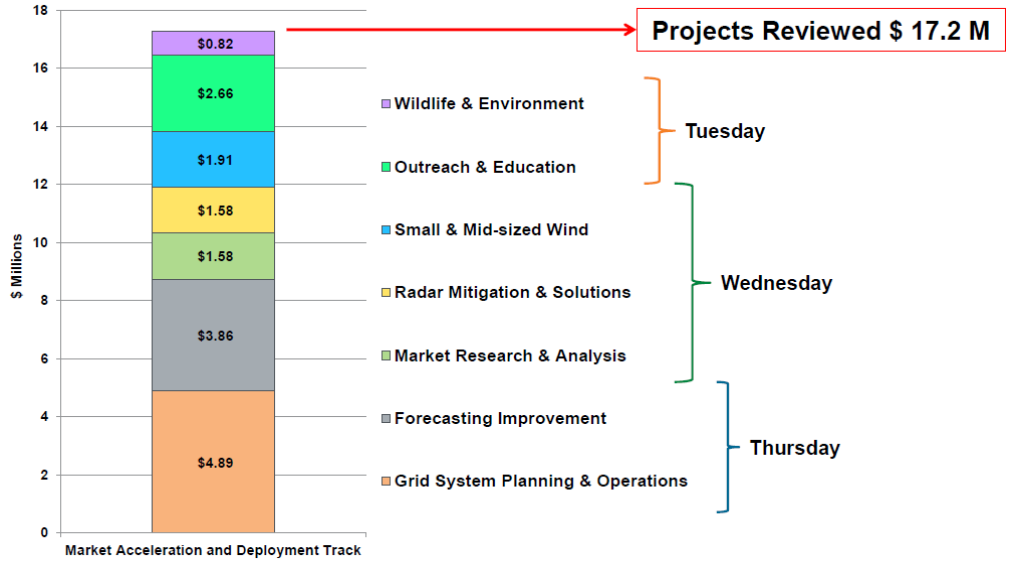


Figure 7.1 Budget for Market Acceleration and Deployment Projects Reviewed in the 2012 Wind Power Peer Review

The following table lists all Market Acceleration and Deployment projects reviewed during the 2012 Wind Power Peer Review, including the title, organization, Principal Investigator, FY 2011 budget, peer review session, number of reviewers, average score per metric, weighted average overall score, and relevance score for each project.

Table 7.1 Market Acceleration and Deployment Projects Reviewed in 2012 Wind Power Peer Review

Project ID	Title	Organization	Principal Investigator	FY 2011 Budget	Peer Review Meeting Session	Number of Reviewers	Methods and Approach (30%)	Technical Accomplis. and Progress (30%)	Project Management (20%)	Research Integration, Collaboration, and Technology Transfer (10%)	Proposed Future Research (10%)	Weighted Average Overall Scores for Projects	Relevance to Wind Industry and Overall DOE Objectives
WP013	Wildlife Impacts	NREL	Karin Sinclair	$820K	Wildlife & Environment	3	3.3	3.0	3.3	4.0	3.7	3.3	4.3
WP014	Wind Energy Development in Critical Wildlife Habitats: Sage Grouse	ANL	Kirk E. LaGory	$150K (FY 10)	Wildlife & Environment	4	3.9	3.6	4.0	3.3	3.4	3.7	3.9
WP015	Market Acceleration and Barrier Reduction - Stakeholder Engagement and Communications	NREL	Ian Baring-Gould	$2.12M	Outreach & Education	4	3.8	4.0	3.9	3.9	3.5	3.8	4.4
WP016	Market Acceleration and Barrier Reduction - Workforce Development	NREL	Ian Baring-Gould	$1.0M	Outreach & Education	4	3.8	3.4	3.9	3.8	3.8	3.7	4.1
WP019	Certifying the Performance of Small Wind Turbines	SWCC	Larry Sherwood	$350K	Small & Mid-sized Wind	4	3.5	3.4	3.8	3.8	3.0	3.5	4.0
WP020	NWTC Small Wind Testing	NREL	Jeroen Van Dam	$440K	Small & Mid-sized Wind	4	3.8	4.0	4.0	4.0	3.4	3.9	3.8
WP021	Regional Test Centers	NREL	Karin Sinclair	$400K	Small & Mid-sized Wind	4	3.4	3.0	3.3	3.4	3.0	3.2	3.8
WP035	Wind Radar Interagency Field Test & Evaluation	MIT-LL/SNL	Franz Busse	$1.5M	Radar Mitigation & Solutions	5	4.4	3.9	4.3	4.3	4.2	4.2	4.8

Market Acceleration and Deployment Project Evaluations

Project ID	Title	Organization	Principal Investigator	FY 2011 Budget	Peer Review Meeting Session	Number of Reviewers	Methods and Approach (30%)	Technical Accomplis. and Progress (30%)	Project Management (20%)	Research Integration, Collaboration, and Technology Transfer (10%)	Proposed Future Research (10%)	Weighted Average Overall Scores for Projects	Relevance to Wind Industry and Overall DOE Objectives
WP036	Wind Technologies Market Report and Other Analyses	LBNL	Ryan Wiser	$500K	Market Research & Analysis	5	4.2	4.6	4.2	4.1	4.0	**4.3**	**4.3**
WP037	Jobs and Economic Development Impacts Modeling	NREL	Suzanne Tegen	$200K	Market Research & Analysis	5	4.0	3.9	4.0	4.4	4.0	**4.0**	**3.8**
WP038	System Levelized Cost of Energy (LCOE) Analysis	NREL	Maureen Hand	$600K	Market Research & Analysis	5	3.8	3.8	4.0	4.0	3.9	**3.9**	**3.8**
WP039	Offshore System Cost Analysis	NREL	Maureen Hand	$184K	Market Research & Analysis	5	3.5	3.4	3.9	3.3	4.2	**3.6**	**3.9**
WP040	Enhancing Short Term Wind Energy Forecasting for Improved Utility Operations	NOAA	James M Wilczak	$575K	Forecasting Improvement	4	4.2	4.0	3.9	4.3	3.4	**4.0**	**4.4**
WP041	Wind Forecasting Improvement Project: Southern Study Region	AWS Truepower, LLC.	Jeffrey Freedman	$2.15M	Forecasting Improvement	4	4.2	3.9	3.7	4.1	4.0	**4.0**	**4.1**
WP042	Wind Forecasting Improvement Project: Northern Study Region	WindLogics	Cathy Finley	$1.24M	Forecasting Improvement	4	3.8	3.7	3.6	4.0	3.2	**3.7**	**4.0**
WP043	Improved Statistical Methods for Wind Power Forecasting	ANL	Audun Botterud	$190K	Forecasting Improvement	5	3.1	3.0	3.2	2.6	2.7	**3.0**	**3.4**
WP044	Improved Forecasting Methods	LLNL	Sonia Wharton	$342K	Forecasting Improvement	5	4.2	4.3	4.3	4.1	3.8	**4.2**	**4.3**
WP045	Developing WindSENSE for Control Room Integration	LLNL	Chandrika Kamath	$575K (FY 10)	Forecasting Improvement	5	3.0	3.0	3.5	3.0	2.9	**3.1**	**2.7**

Market Acceleration and Deployment Project Evaluations

Project ID	Title	Organization	Principal Investigator	FY 2011 Budget	Peer Review Meeting Session	Number of Reviewers	Methods and Approach (30%)	Technical Accomplis. and Progress (30%)	Project Management (20%)	Research Integration, Collaboration, and Technology Transfer (10%)	Proposed Future Research (10%)	Weighted Average Overall Scores for Projects	Relevance to Wind Industry and Overall DOE Objectives
WP046	Resource Modeling and Data Collection	NREL	Debra Lew	$360K	Forecasting Improvement	5	4.4	3.8	4.0	4.0	3.9	**4.1**	**4.7**
WP051	Western Wind and Solar Integration Study Phase II	NREL	Debra Lew	$780K	Grid System Planning & Operations	5	4.6	4.1	4.3	4.6	4.6	**4.4**	**4.6**
WP052	Eastern Renewable Generation Integration Study	NREL	Debra Lew	$670K	Grid System Planning & Operations	5	4.4	3.6	3.6	4.4	3.8	**3.9**	**4.6**
WP053	Concurrent Cooling – Increasing Transmission Capacities With Dynamic Monitoring Systems	INL	Kurt Myers	$300K	Grid System Planning & Operations	5	3.5	3.1	3.8	3.2	3.4	**3.4**	**3.7**
WP054	Wind Plant Collector System Design & Protection	ORNL	Travis Smith	$300K	Grid System Planning & Operations	5	2.6	3.1	3.5	2.8	2.8	**3.0**	**2.6**
WP055	Benefits of Balancing Authorities Cooperation Across the Western Interconnection	PNNL	Nader Samaan	$400K	Grid System Planning & Operations	5	3.3	3.5	2.6	3.3	3.4	**3.2**	**3.3**
WP063	Wind Power Plant Modeling	SNL	Ben Karlson	$300K	Grid System Planning & Operations	5	3.9	4.0	4.0	3.9	3.7	**3.9**	**4.4**
WP064	Generator Modeling	NREL	Eduard Muljadi	$450K	Grid System Planning & Operations	5	3.8	4.0	3.8	4.1	3.8	**3.9**	**4.4**
WP065	Operational Strategies, Modeling and Analysis	NREL	Michael Milligan	$850K	Grid System Planning & Operations	5	4.1	4.2	4.0	4.1	3.8	**4.1**	**4.5**
WP066	Operating Reserves Analysis	NREL	Erik Ela	$580K	Grid System Planning & Operations	5	3.9	3.9	3.7	3.9	3.6	**3.8**	**4.3**

Market Acceleration and Deployment Project Evaluations

Project ID	Title	Organization	Principal Investigator	FY 2011 Budget	Peer Review Meeting Session	Number of Reviewers	Methods and Approach (30%)	Technical Accomplis. and Progress (30%)	Project Management (20%)	Research Integration, Collaboration, and Technology Transfer (10%)	Proposed Future Research (10%)	Weighted Average Overall Scores for Projects	Relevance to Wind Industry and Overall DOE Objectives
WP067	Interconnection Support	NREL	Michael Milligan	$580K	Grid System Planning & Operations	5	4.1	4.2	4.2	4.6	4.6	**4.3**	**4.6**
WP068	Wind Integration Model (WIM)	PNNL	Jeff Dagle	$300K (FY 10)	Grid System Planning & Operations	5	3.4	3.0	3.0	2.5	2.9	**3.1**	**3.5**
WP069	Use of Wind Power Forecasting in Operational Decisions	ANL	Audun Botterud	$100K	Grid System Planning & Operations	5	3.3	3.0	3.1	2.6	2.3	**3.0**	**3.0**
WP070	Active Power Control from Wind Power	NREL	Erik Ela	$670K	Grid System Planning & Operations	5	3.9	4.0	3.6	3.9	4.0	**3.9**	**4.3**

Figure 7.2 illustrates the weighted average overall scores and the relevance to wind industry needs and overall DOE objectives scores for all Market Acceleration and Deployment projects that were reviewed in the 2012 Wind Power Peer Review.

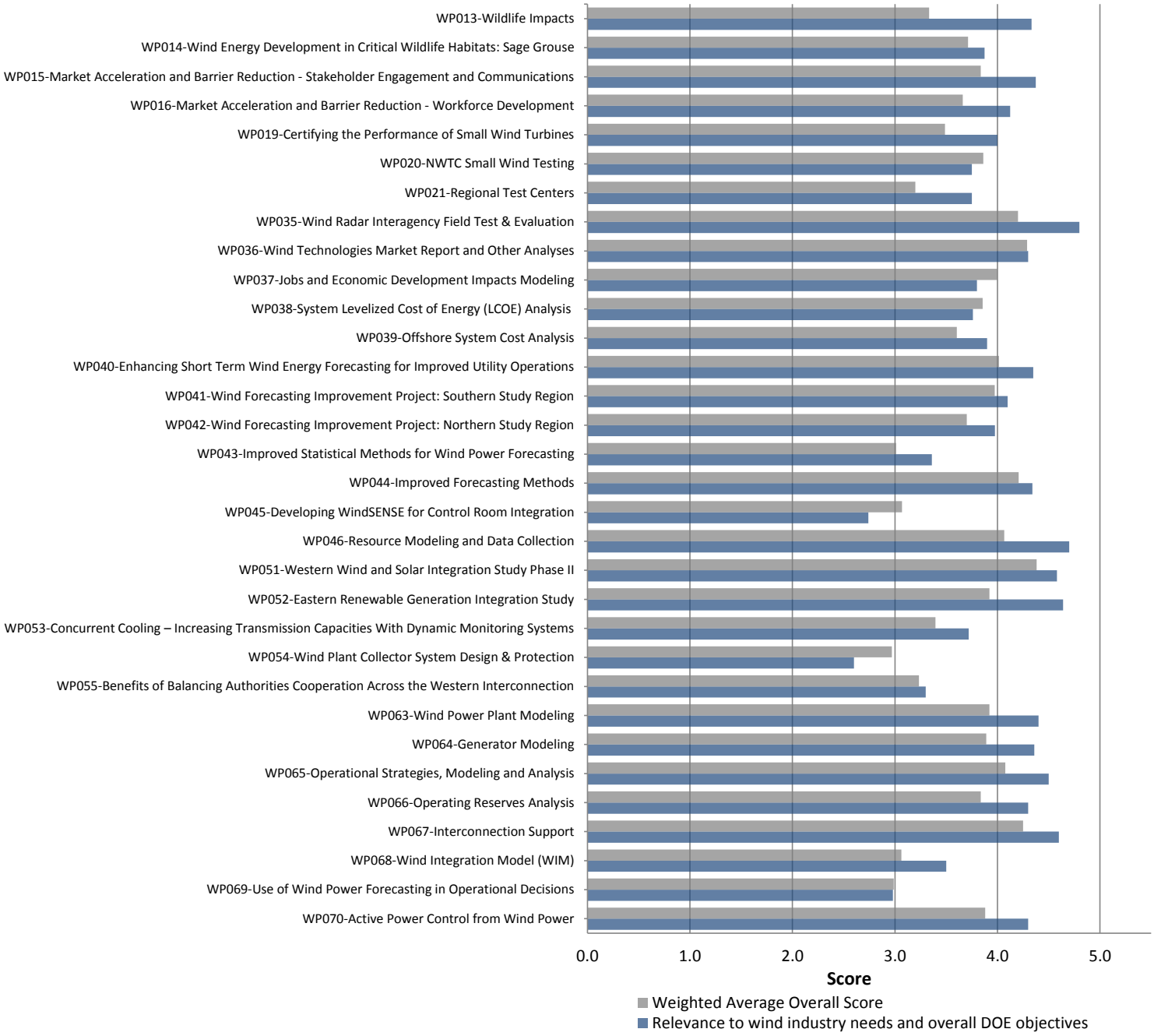
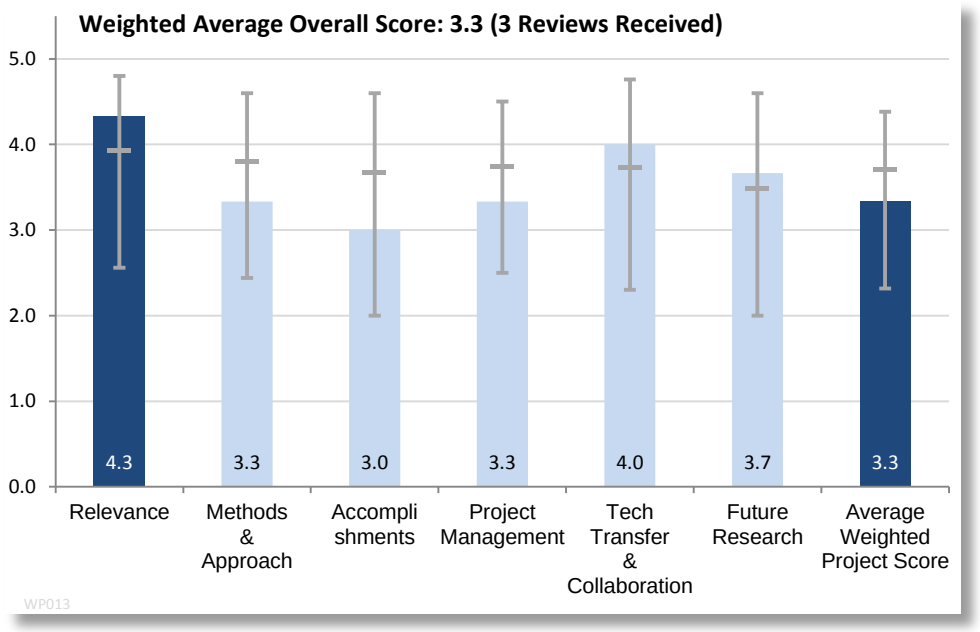


Figure 7.2 Project Scores from Market Acceleration and Deployment Sessions

WP013: Wildlife Impacts
Karin Sinclair, NREL
FY 10 Budget: $405,000 DOE $0 Cost-Share
FY 11 Budget: $820,000 DOE $0 Cost-Share
Project Duration: Jan 2009 - Sep 2012

Brief Summary of Project



The primary objective of this project is to reduce a significant barrier to deployment – uncertainty around potential impacts from wind projects on a range of wildlife species and habitats. By supporting science-based research in multi-stakeholder collaboratives, the resultant findings will be used by industry to design projects that avoid, minimize, and when necessary, mitigate negative impacts to wildlife and their habitats from wind projects across the U.S. The portfolio of science-based research supported by this project will help inform agencies (both federal and state), non-governmental organizations, tribes, and others as decisions are made on permitting requests submitted by developers. These results will also help industry control pre- and post-construction monitoring costs, and their contributions to LCOE, as hypotheses are tested and research conclusions are developed. Research results will provide scientific support for permitting processes where species impacts were previously unclear, allowing deployment to go forward in areas where this barrier previously impeded development.

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

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

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

- Wildlife impacts - real and perceived - affect the cost to industry. This project aligns with program objective of reducing deployment barriers.
- These wildlife issues can be true impediments and being an environmental industry requires that we assess impacts on wildlife scientifically and accurately.
- There is a clear need for sound, scientific research in this area.
- There are big knowledge gaps that make it difficult to determine whether project impacts result in population impacts – knowledge gaps can slow deployment.
- Investigators bring credibility to outcomes.
- Concern over species impact can slow or abandon project. Stakeholders need assurances that impacts are minimal.

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

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

- This is a reactive approach to research. It is filling important research needs but would benefit from a higher-level strategic approach based on priorities, accelerated timelines, and dissemination of information.
- It is not clear to me why some of these wildlife studies do not have a definitive conclusion, such as the BWEC studies and their effectiveness in creating an acoustic barrier.
- It is a peer-reviewed approach.
- Need to define a pro-active approach to addressing future wildlife issues (rather than being reactive to the species of the month).
- Very credible approach to managing quality control on data generated from the program.

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

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

- Developing solutions to species impact, i.e. fatality reduction of bats have resulted from this project.
- Seems to be continuing without a definitive conclusion; this may be the nature of these biological studies.
- There is no clear project schedule or stated goals.
- Reliance on peer-reviews is important but delays the process.

Question 4: Project Management

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

- There are a variety of projects in various stages. Not a clear sense of overall project management.
  - Good collaboration with stakeholders: the National Wind Coordinating Collaborative, the Bat Wind Energy Collaborative, the American Wind Wildlife Institute, and etc.
- This is a well-managed project with good impact for a small budget.
- This is a patchwork system of projects and collaboratives, which are species-specific. It could benefit from additional budget for overall project management, from goal setting to results dissemination.
- The milestones were met.
- The project is within budget.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- Good work has been done on real impacts and mitigation measures, but it has not disseminated to the public. The information available is more focused on the problem than the work being done, i.e. the mitigation solutions.
- NREL has been doing a good job in leading and organizing varied stakeholders.
- The project team is working well with university partners.
- Greater dissemination and promotion of science-based results, particularly to counter the spread of misinformation. The general public is not aware of the research results.

Question 6: Proposed Future Research

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

- Working on a prioritized list of research projects that could benefit the industry in the long term.
- It is an important task and continuing research activities to reach definitive conclusions is encouraged.
- Much of what they have done so far has been reactive. Working on wildlife impacts analysis to allow for a more proactive approach and to prioritize critical species would benefit the project.
- The National Wind Coordinating Committee fact sheet needs to be updated with new information and should be disseminated.
- Proposed future research could be organized more strategically.
- Can we compare wind impacts to other technologies and wildlife impediments?

Strengths and Weaknesses

Project Strengths

- Science-based research, stakeholder approach, and collaborative projects are strengths.
- NREL is organizing stakeholders' research effectively.
- Academic approach to quality control of research findings is beneficial.
- This work is filling a significant need regarding removal of deployment barriers.

Project Weaknesses

- Dissemination and promotion of results could improve.
- Need to arrive at definitive conclusions that will eliminate barriers to implementation of projects in environmentally sensitive areas and publish recent findings as frequently as possible.
- Insufficient funding.

Specific recommendations for additions or deletions to the work scope

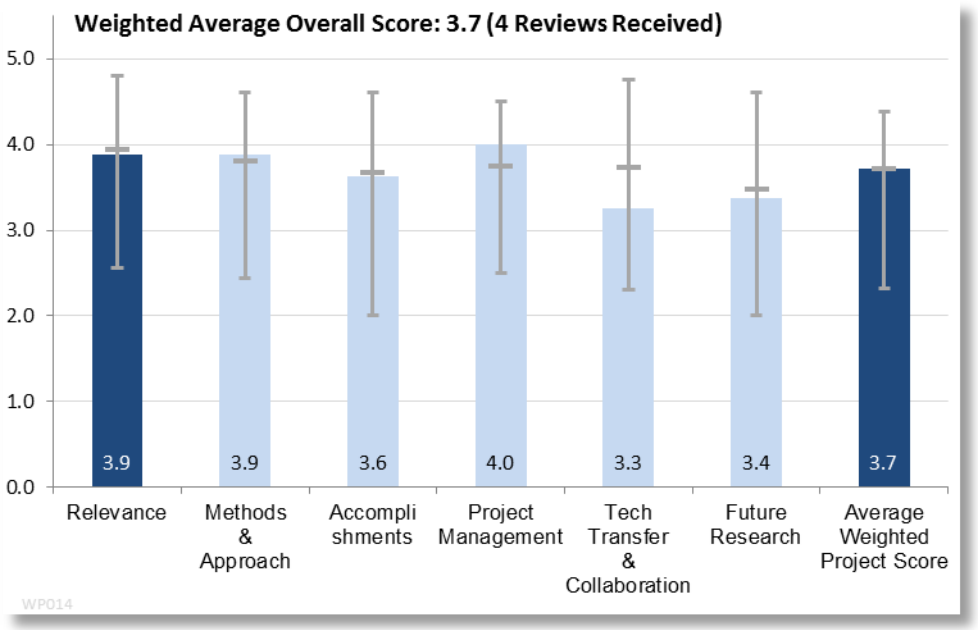
- Devote more resources to project management and strategy.
- Make sure results of the work performed are published, especially successful mitigation techniques and definitive impacts on wildlife.
- Significantly increase funding for the wildlife studies.
- Increase dissemination results and communication around the work that is being done.

WP014: Wind Energy Development in Critical Wildlife Habitats: Sage Grouse

Kirk E. LaGory, ANL

FY 10 Budget: $150,000 DOE $0 Cost-Share
FY 11 Budget: $0 DOE $0 Cost-Share
Project Duration: Jan 2009 - Sep 2012

Brief Summary of Project



The greater sage-grouse (Centrocercus urophasianus) is a candidate for listing under the Endangered Species Act. There is evidence that populations of this species have declined over the last three decades as sagebrush habitats have been converted to other land-use types including agriculture, rangeland, and energy production. Although most energy development has been for oil and gas production, there is growing concern for the effects of any development including wind energy, which is expected to expand as renewable energy systems are promoted at the national and state levels. The project goal was to develop a landscape-based modeling framework that considered the cumulative impacts of prospective wind energy development on populations of critically important wildlife species to facilitate smart development that minimizes ecological impact.

Project objectives for Phase I (FY 10-11) included the following:
(1) Develop a prototype modeling framework for the greater sage-grouse to examine population viability over an extended time frame (e.g., decades or centuries) using realistic starting populations and distributions
(2) Demonstrate the viability of the technical approach
(3) Demonstrate applicability to evaluating the cumulative effects of wind energy development
(4) Identify issues associated with full-scale deployment of the framework.

Objectives for Phase II (FY 12) include:
(1) Validate and update the model by performing sensitivity analysis of key parameters
(2) Update the model with more current data and information from the sage-grouse research community and developers if available
(3) Incorporate seasonal habitat suitability maps being developed by United States Geological Survey .
(4) Obtain feedback regarding the utility and performance of the model from the sage-grouse research community and industry.

By the end of FY 12, the product is expected to be an improved individual-based modeling framework for the greater sage-grouse that can assist DOE, wind energy developers, and permitting authorities in planning for dispersed but extensive development in sage-grouse habitats. Coordination with key stakeholders will occur via webinars and face-to-face meetings as needed.

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

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

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

- The model helps to understand what the most important areas are to mitigate.
- High relevance to the wind area; the results will allow safe development with less impact on sage-grouse.
- Wildlife modeling and sage-grouse in particular is an important deployment issue.
- Provides scientific evidence and modeling to address issues of concern to industry groups.

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

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

- Project scenario approach is a very useful tool for minimizing species impact.
- Good approach. Can we think of direct physical barriers that allow the coexistence of wind the sage-grouse?
- Systematic modeling approach but needs to be continued and have field validation.
- The model development seems solid. Needs some work on improving the accuracy of input sub-models.

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

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

- This is a cost-effective project that is on track to complete this year.
- Model for the habitat and life cycle is complete. Don't see data as to the final results if the model applied.
- Initial model and simulations are encouraging, but it is at small scale and may not be much better than simple aversion model.

Question 4: Project Management

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

- There is good collaboration from various stakeholders. The project needs to disseminate the information and explain the results of research.
- The project achieved reasonable milestones for budget.
- This is well-managed at low cost.
- There is a good return on investment by DOE.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.3** for research integration, collaboration, and technology transfer.

- There is no technology transfer yet. Once the model is working, they will focus on collaborating with industry on how it can be applied.
- I did not see any leading scientific institution that can give guidance to the study. Other stakeholders are included.
- At an early stage but planning to reach out appropriate stakeholders.

- The PI is working with relevant groups.
- Good use of post-doc and others.

Question 6: Proposed Future Research

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

- The model has good potential for wider application.
- Need to verify the model and apply it to larger geographic areas.
- Proposed research is relevant but unfunded.
- The PI has a good sense of weak links in the model and need for improvement. Also has a good sense of future direction for the model.

Strengths and Weaknesses

Project Strengths
- One can use the model for impact assessment but also early in a project to help mitigate impacts.
- Good work in identification that habitat is the most important factor. There is good collaboration with stakeholders.
- Begins work in an important area.
- Model can be used for compensation and determining where that type of mitigation would be most successful.

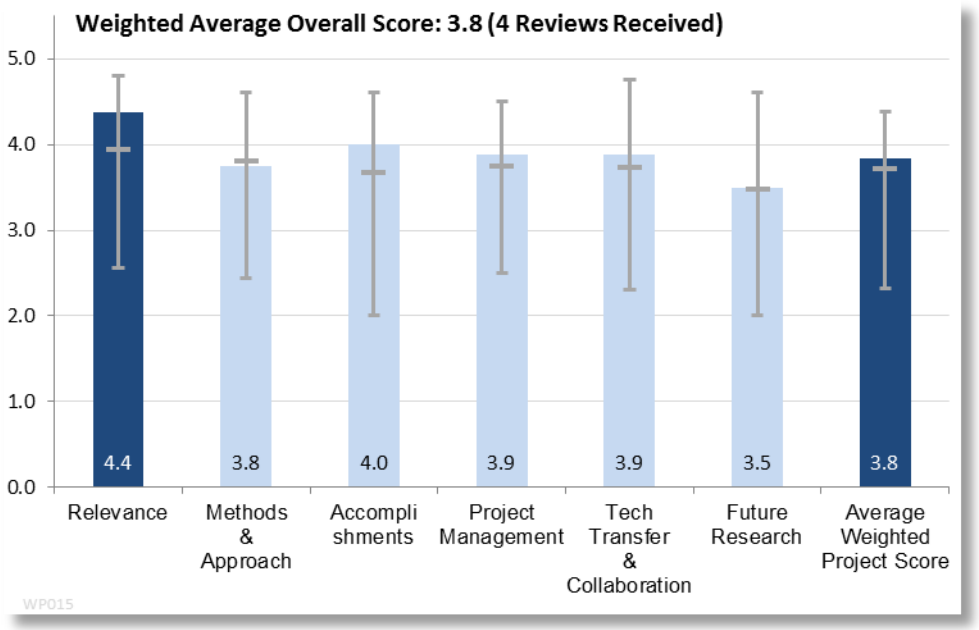
Project Weaknesses
- No field data project currently planned.
- Need to communicate the results of this work, its impact on wind energy development in these areas, and suggest mitigation approaches.
- If not part of a longer term program, this will not be of use in practice (e.g. permit modeling).
- There is a greater need to collaborate and interface with other projects.

Specific recommendations for additions or deletions to the work scope

- Verify the effectiveness of the model and try to develop specific mitigation techniques.
- Need Non-governmental Organization and industry consultant feedback on the value of continuing.
- Investigate the possibility of linking this model with the Landscape Assessment Tool from the American Wind Wildlife Institute.

WP015: Market Acceleration and Barrier Reduction - Stakeholder Engagement and Communications
Ian Baring-Gould, NREL
FY 10 Budget: $2,539,000 DOE $0 Cost-Share
FY 11 Budget: $2,116,000 DOE $0 Cost-Share
Project Duration: Oct. 2009 - Feb 2012

Brief Summary of Project



The Stakeholder Outreach and Engagement activity's principal goal is to have 15 states with at least 1,000 MW by 2018, while working to finalize the 2010 goal of 30 states with at least 100 MW of installed wind capacity, which is expected to be met this calendar year. The key objectives of this work are:

- Disseminating accurate and needed information to critical stakeholders
- Developing and assisting in the operation of a diverse partner network to support the dissemination of knowledge and the replication of deployment and public engagement successes through improved best practice sharing
- Integrating a feedback system to continually evaluate initiative effectiveness and inform positive adjustments to activity and investments
- Providing assistance to federal entities, states, and regional organizations working to expand wind deployment.

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

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

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

- This is an important program with no private sector counterpart at this time.
- This is the only advocacy and information dissemination program in the DOE. It helps increase awareness of wind energy especially in view of the fact that many fossil fuel interest groups are attacking wind and spreading misinformation.
- Has been a direct contributor to the deployment objective. Lack of credible information and training are deployment barriers.
- Stakeholder engagement is critical at this time in wind energy deployment. WPA meets this need.
- The transition to a regional approach is more reflective of energy markets and project development.
- Has been of direct benefit to the developers through JEDI, resource maps, and outreach at the state level.
- Meets goals by providing expert knowledge.

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

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

- Good overall purpose, but there is no sense of what the overall method or strategy is and how it is working to reduce barriers to deployment. What are the metrics?
- The program is well designed and tries to reach out to varied stakeholders. The shift from an emphasis on each state to a regional focus is probably a good approach where the emphasis should be placed on high potential regions and integration.
- State and school focused efforts are well-suited to the state Renewable Portfolio Standard era.
- Good use of web-based content.
- Makes sense to support all of these projects, but need a high-level view of how each of these projects supports the overall objectives.
- Good portfolio of methods to engage stakeholders.

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

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

- Website, wind resource assessments, and JEDI are all critical assets that help with deployment, education, and reducing barriers.
- Program goals very nearly achieved. Awareness of wind energy has increased considerably due to WPA efforts.
- Hard to measure the marketing-type activities but widespread use of tools that the program disseminates (e.g. JEDI) and the impact of schools programs supports the effectiveness.
- Excellent progress. Good outcomes at low cost.

Question 4: Project Management

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

- This feels more like a lot of projects within a program. No real sense of overall project management.
- Most goals achieved on budget. The 2012 budget is 700k and expenditure is above a million. The answer was given it is a carryover money. This year they have level funding so the work will remain at the same level. This is good.
- Has used cost effective tools such as webinars with a good effect. There is high web traffic.
- Very well managed.
- Budget instability hurts the effectiveness.
- Ian deserves credit for running a very well-managed program.
- Unclear what "regional" strategy means. May become more apparent after further information.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- The project reaches out to state energy offices, utilities, and integrated resource planning experts as well as many other stakeholders.
- Industry is using the tools refined and customized by this program.
- Integrates with local stakeholders where appropriate and with the appropriate content.

Question 6: Proposed Future Research

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

- Emphasis on universities and utilities is a great strategy. There are three regional universities that have large programs with the DOE. Informing and continuing to educate the utilities on wind energy and tying up with Integrated Resource Planners is quite valuable since they are the ultimate buyers of wind generated electricity.
- Regional approach may by good, but with no clear budget, guidance has not been fleshed out.
- Unclear of future funding makes it difficult to project future work.

Strengths and Weaknesses

Project Strengths
- Publication of fresh and accurate information.
- WPA has been quite successful in educating the public and energy experts on the benefits of wind energy. It is the only DOE advocacy based on facts vs. the misinformation being disseminated by the fossil fuel lobby.
- Has the best experience in DOE in getting messages relevant to deployment into the hands of stakeholders.
- Leadership is outstanding.
- Development of wind resource information.
- State level resource and jobs impacts are valuable to front line developers (not a substitute for internal studies but good for community and regulator communication).
- Impacts a broad base of stakeholders at a low cost.
- The combination of web-based and face-to-face communication is effective.

Project Weaknesses
- Too many projects and activities - need more strategy, structure and priorities.
- Needs to put more emphasis on universities, utilities, ISOs, and other organizations that have a measurable influence on wind energy regional dissemination.
- No longer term budget commitment. Compared to support for agriculture (Morrill Act), fishing and offshore oil (Sea Grant), and nuclear training the scale is not comparable to prospective benefits.
- Need a better exit plan for when they move out of areas or projects.
- It's always difficult to measure the value of communication activities, but projects can be set up with specific goals and metrics.

Specific recommendations for additions or deletions to the work scope

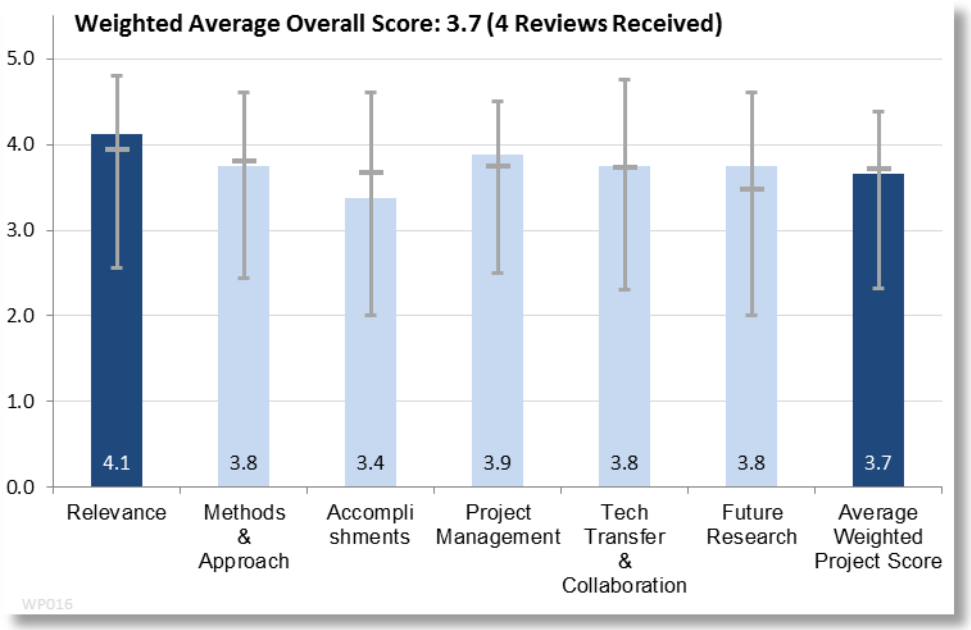
- Identify target audiences.
- Continue and expand the effort until the barriers fall and the wind industry achieves its 20 percent goal.
- Do a zero base budget review compared to deployment and training support for other energy forms.
- Avoid becoming too diluted in your efforts.
- Clarify program goals and measurable objectives.
- Develop a success-oriented theoretical budget to overcome deployment barriers needed, for example 125 GW by 2020.
- Prioritize projects and activities, and align with objectives.

WP016: Market Acceleration and Barrier Reduction - Workforce Development

Ian Baring-Gould, NREL

FY 10 Budget: $625,000 DOE $600,000 Cost-Share
FY 11 Budget: $1,000,000 DOE $700,000 Cost-Share
Project Duration: Dec 2009 - Jan 2012

Brief Summary of Project



The purpose of this project is to enhance the prospects for continued robust wind deployment, workforce development, and education in specific windy states in collaboration with educators, government entities, industry, and other workforce development stakeholders that would enable the development of a vibrant and sustainable wind energy industry in the United States. The primary objective is to ensure there is a robust educational framework for training new entrants into the wind workforce while also implementing activities that directly impact students at the K-12 levels who are interested in Science, Technology, Engineering, and Mathematics (STEM) fields of learning.

Specific targeted outcomes include:

- Identification and development of the resources required to ensure the creation of the talented workforce that will be required to meet the 20% by 2030 vision
- Development of self-sustaining Wind Application Centers established at state universities with strong potential wind development, thus training the next generation of wind application specialists
- A vibrant self-sustaining university-based activity that works to implement small wind energy systems at local K-12 "host" schools, providing an education platform for university, community college, and K-12 students
- The development, implementation, and teacher trainings required to expand wind curricula at all levels
- Increased education and engagement of rural utilities in the implementation of school turbines
- Expand local dialog about wind energy deployment, issues, and benefits through local host schools.

The development of a skilled and trained workforce was one of the principle challenges outlined in the 20% wind report and clearly has impacts on cost of electricity from wind, not only in deployment but also design and system reliability. The endpoint of this project is variable, but in most cases support projects that are targeted to become self-sufficient in the 3-5 year timeframe.

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

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

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

- The Wind for Schools (WFS) program is the heart of activities and the flagship program - designed to engage students and teachers as well as train future works at wind application centers. Develop Centers of Excellence in the states where they should be.
- The program helps prepare future workers for the wind industry. Essential for growth of the industry.
- The need for trained workers is important to address for deployment and lowering LCOE.
- WFS is a well-regarded program with high impact at a low cost.

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

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

- Well designed; relatively low cost/high value program.
- The idea of WFS is very good. I think there should be equal emphasis on community colleges that graduate wind techs and universities that graduate engineers with wind degrees to try to expand their numbers.
- Good focus on the key states, wind academy concept.
- Engages a broad stakeholder group.
- The main issue is ensuring WFS programs continue when DOE funding ends.
- The idea of a Wind Academy is interesting but collaboration with existing universities that have wind programs is essential.

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

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

- Need more clarification on project goals and timelines. It is hard to determine if technical goals have been accomplished.
- Graduating students with just exposure to wind turbines is not enough. The program should also concentrate on helping community colleges and four year engineering colleges and graduate schools to develop curricula and graduate engineers with wind energy degrees at different mechanical, electrical, and etc. specializations.
- Wind for Schools program is a success for the budget scale provided.
- This has impacted a wide range of schools across U.S.A.
- Wind curricula and turbines at schools are good products.
- Engages K-12 and universities. Good decision.

Question 4: Project Management

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

- The resources need to expand to include higher education-level graduates.
- Well run within the budget constraints.
- Very well managed.
- The PI performs well in this program.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.8** for research integration, collaboration, and technology transfer.

- It is not clear if there is any technology transfer or research integration.
- The program has been working closely with K-12 and educational centers. More emphasis needs to be given to graduating students with higher degrees that can feed the growth of the industry.
- The project has developed many tech transfer programs.
- The project team works well with numerous stakeholders.

Question 6: Proposed Future Research

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

- There is a clear articulation of future programs, e.g. university competition, support for K-12, workforce development, round 2 for WFS.
- The future research activities seem to indicate more emphasis on graduating higher degree wind professionals with an emphasis on higher education.
- Wind for Schools and the Wind Workforce plans appear cost effective. There is a good, new focus on manufacturing and accreditation.
- An uncertain budget makes this one difficult.

Strengths and Weaknesses

Project Strengths
- Strong student interest in workforce development.
- Very successful with K-12 and WFS programs as well as interaction with schools in various states.
- Meets real needs with good work products.
- Expects five states to be self-supportive within six months for WFS. The plan is not prescriptive; each has developed its own model for continuing funding.

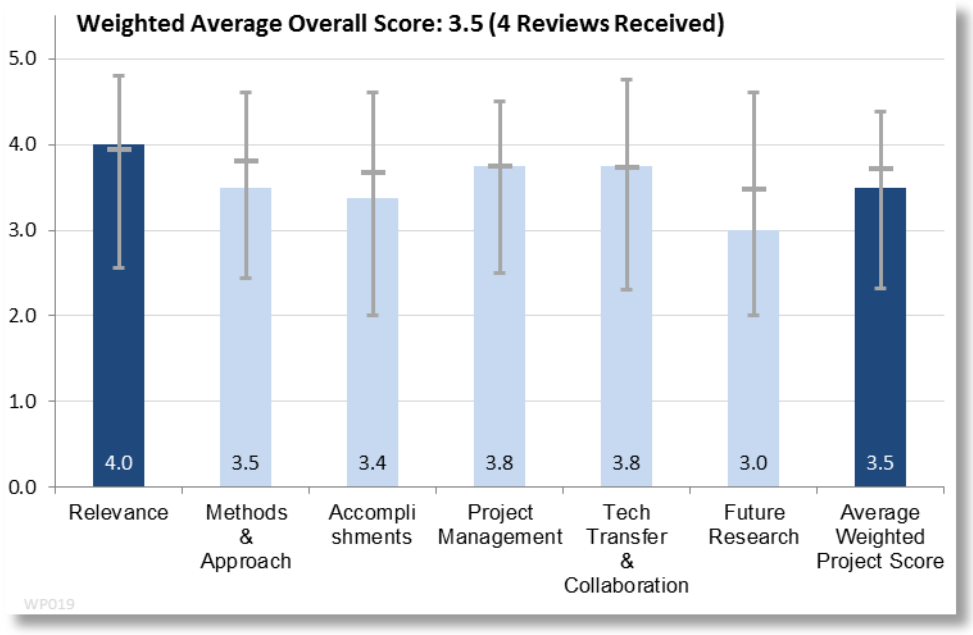
Project Weaknesses
- Need to concentrate also on community colleges and universities with the goal of increasing wind-centered education in community and higher level educational institutions. There should be a target of increasing their existing number by a certain percentage.
- Underfunded and needs clearer objectives consistent with funding.

Specific recommendations for additions or deletions to the work scope

- Provide more support and resources to help the wind application center be self-supporting after five years.
- Suggest developing joint programs with universities that already have great interest in wind and are recipients of R&D programs such as the University of Michigan, University of Minnesota, Illinois Institute of Technology, University of Iowa, and Iowa State University.
- Continue support, but assess what realistic Federal scale is required for the goals (for example the 125 GW by 2020 milestone).
- Consider seeking more leverage by setting roadmap goals and tracking progress instead of just trying to do it at a retail level.

WP019: Certifying the Performance of Small Wind Turbines
Larry Sherwood, SWCC
FY 10 Budget: $300,000 DOE $0 Cost-Share
FY 11 Budget: $350,000 DOE $0 Cost-Share
Project Duration: May 2009 - May 2014

Brief Summary of Project



The Small Wind Certification Council (SWCC), as an independent, accredited certification body, has established a program to certify that small wind turbines meet the performance, durability, and safety requirements of the AWEA Small Wind Turbine Performance and Safety Standard (AWEA Standard 9.1-2009), and advance mainstream acceptance of small wind technology to serve increasing demands for distributed generation. With certification, consumers can compare products and funding agencies and utilities will gain greater confidence that small turbines installed with public assistance have been tested and meet consensus standards, and can provide a cost-effective solution for homes, farms, schools and other end-uses. Certification helps prevent unethical marketing and false claims, thereby ensuring consumer protection and industry credibility.

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

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

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

- Aligns with reducing barriers to deployment, as there's a need for small wind turbine (SWT) standards to protect consumers and allow for comparison of turbines.
- Very valuable to counter some of the unsubstantiated claims made by small wind turbine manufacturers and to encourage high quality information dissemination.
- Has created a viable testing program for small turbines. This helps protect the brand including large turbines.
- SWCC addresses a very important issue (certification) that supports a DOE goal.

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

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

- Good approach to establish independent, accredited certification centers to serve different U.S.A regions.
- Setting up an independent certification body is a critical step.

- The approach to engage manufacturers is good.
- A challenge will be sufficient buy-in at the level that makes this self-supporting.

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

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

- The certification program is ramping up. States are reluctant, but more states are requiring certification.
- Completion of accredited test centers is quite an accomplishment in 2 years. However, the number of turbines certified seems too small compared to the number of manufacturers.
- Adopted a policy framework and launched the certification program.
- Adequate progress.
- The progress was hurt by the industry slow-down.
- The cost may also be an issue for small manufacturers.

Question 4: Project Management

This project was rated **3.8** on its project management.

- Professional and organized approach to the rollout of the new certification program.
- Very good progress to date. Need to increase the number of certified models.
- SWCC a cost effective approach.
- Well managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.8** for research integration, collaboration, and technology transfer.

- The Memorandum of Understanding with UK Certification Bodies avoids manufacturers having to redo the certification processes in the U.S. if certified in the UK; this will lower the cost of certification around the world.
- Communication with accreditation agencies (A2LA) and independent testing centers is impressive. Need to encourage the speed of certification so that consumers can choose their products based on a sound foundation. Communications with the UK small wind program can also be very helpful.
- SWCC came out of a collaborative process.
- Work with NREL and the NREL/DOE funded Regional Test Centers at a high level of collaboration.
- Stakeholder meetings, presentations, and articles were used effectively to communicate how they expect to certify turbines; overall, good emphasis on communication.

Question 6: Proposed Future Research

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

- Exploring an expansion for certification of mid-sized turbines.
- Expanding to mid-sized turbines is a good goal. Try to remove the barriers against a fast response to certification requests.
- Does it make sense to expand to mid-sized turbines when many small turbines are still not certified?
- Needs a business plan to make it self-sufficient in the current economy.
- Should consider a lower-cost protocol, if feasible. The current bar may be too high for entry.

Strengths and Weaknesses

Project Strengths

- Small wind turbines are the public face of the wind energy industry, since many utility scale projects are in rural areas or generally out of the public eye.
- The SWCC has accomplished quite a lot in these past two years with achieving A2LA accreditation and 4 test centers.
- Supports U.S. leadership in small turbines
- Coordination between SWCC, NWTC and regional test centers RTC is good.
- It's important to invest in small wind turbines to build public confidence and acceptance of wind energy in general. In that regard, this project is providing an important benefit.
- Works through an independent SWCC.

Project Weaknesses

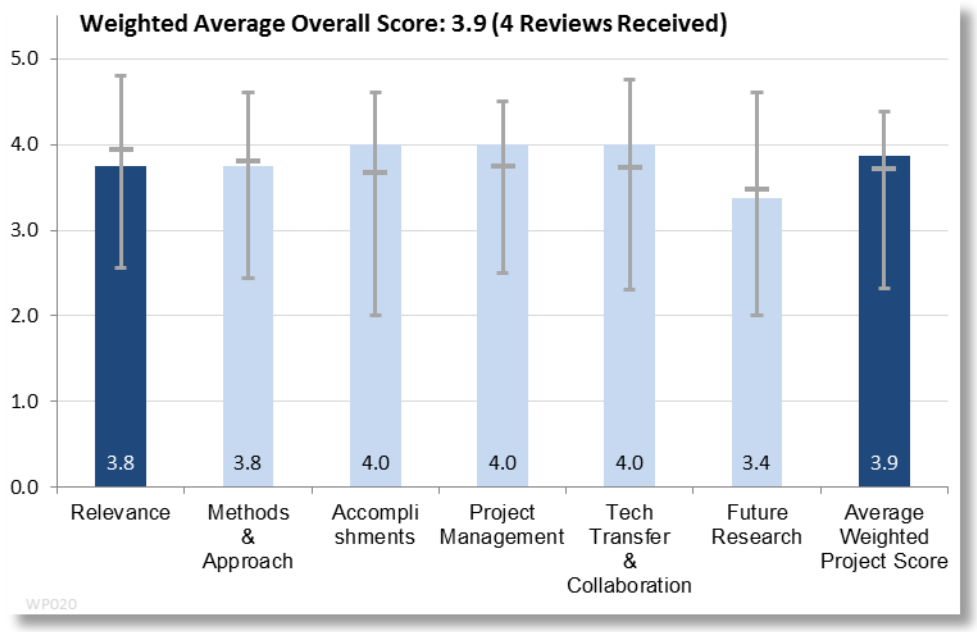
- Takes a long time to go through the process but added information on the website about certifications that are pending helps.
- The number of certified turbines is still quite small. An increase of that number can enhance competition and deliver sound information to market.
- No plan for a handoff to industry on a self-sustaining basis.
- Sustainability in current business climate; SWCC needs growth in user-base.
- There is a lack of specific goals for programs regarding states requirements and the number of turbines certified.
- The program needs to find a way to respond to some of the exaggerated claims made by new entrants to the market. They can give the industry a black eye.
- There is a chicken and the egg problem with getting critical mass of certified turbines and states requiring such certification.
- More specifics on the business plan in terms of costs and revenue projections is needed.
- There is a lower than expected number of customers.

Specific recommendations for additions or deletions to the work scope

- Continue supporting this project for the public benefit aspect, but monitor the costs and return on investment.
- Continue to certify as many turbines as possible to minimize the risks to consumers to maintain the viability of the SWCC. Should have a goal of a certain number of turbines per year until all U.S. and Canadian manufacturers are complete.
- Develop a plan for industry support and funding after the DOE grant ends.

WP020: NWTC Small Wind Testing
Arlinda Huskey, NREL – presented by Jeroen Van Dam
FY 10 Budget: $100,000 DOE $0 Cost-Share
FY 11 Budget: $440,000 DOE $0 Cost-Share
Project Duration: Oct 2007 - Sep 2013

Brief Summary of Project



The objective of this project is to provide accredited IEC testing (power performance, acoustic noise, duration, safety and function and, for three phase machines, power quality) to commercially available small wind turbines. The test reports that are produced by this work can be used to obtain AWEA, BWEA or IEC certification.

In recent years, a lot of newly developed products have come onto the market. It has been difficult for consumers to distinguish the different products. By subjecting turbines to IEC testing, the performance of turbines (such as energy output and noise characteristics) can be well defined and thus compared. By obtaining IEC certification the industry will be able to market wind turbines in the global market place.

Lastly, turbine testing has provided data to further develop small wind turbine testing methods. These methods have been implemented into the IEC standard for small turbine design, power performance testing and acoustic noise testing.

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

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

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

- Aligns with the program objective of reducing barriers to deployment.
- IEC testing is more involved than the previous task and requires more detailed analysis and expertise. This testing can be valuable for the future advances in small wind technology.
- Meets deployment objectives for the sector at a time when consumer confidence is needed.
- Relevant to DOE goals.
- Data is needed to improve consumer confidence in unproven/uncertified small turbines.

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

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

- Selected small wind turbines to test against a suite of IEC testing standards and used that data to improve the standards.
- Four turbine models have been tested and the results were published.
- Builds on NREL proven methods.
- The quality of the staff at NWTC brings significant credibility to the small wind testing facilities.
- Publicly available test reports are good.
- Good integration with RTCs.
- Cost of testing is too high for small turbines, but this may have been apparent in advance.

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

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

- Has completed testing for four models at a cost of $400,000 per turbine. Since the scope is not as high as a utility scale certification, the cost seems high.
- The testing program is in operation.
- This is a high-caliber program.

Question 4: Project Management

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

- Managed to complete the certification testing but at considerable cost.
- Well respected leadership and good support from the NREL staff.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- There is a variety of project partners, subcontractors, and collaborators. Good collaboration with turbine manufacturers.
- A good combination of industry and certification agencies.
- Working closely with industry.
- Good integration with RTCs and others in the small wind industry.
- Good communication and technology transfer.

Question 6: Proposed Future Research

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

- No additional activities were identified.
- Load testing as a future phase is good.

Strengths and Weaknesses

Project Strengths

- Well defined project with clear outcomes and well published results.
- Completed accurate certification testing at NREL for four turbines.
- Meets objectives to support U.S. leadership in the small wind turbine industry.
- Strengthened NREL's role in small wind turbine testing.
- Test reports are publicly available on the website. Consumers now expect test data on turbines.

Project Weaknesses

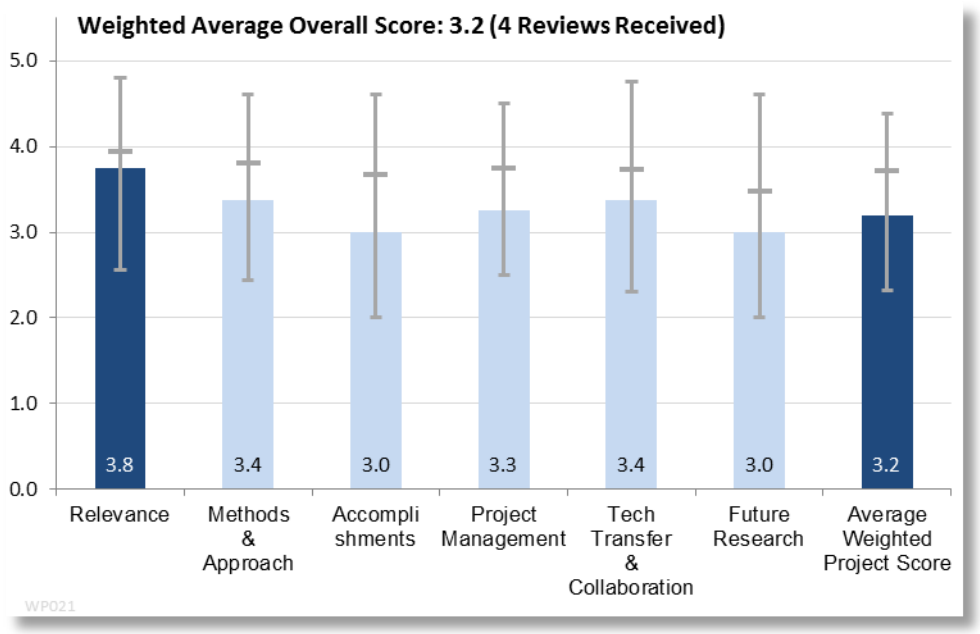
- The time and cost to complete were too high.
- Long term plan is unclear.
- Is this a cost effective role for NREL? The cost was $400,000 per turbine tested.

Specific recommendations for additions or deletions to the work scope

- Need to automate the testing in order to complete it in a reasonable time and at a lower cost.
- Develop a long term plan (note: review the most recent Small Wind Turbine Roadmap - it might meet this requirement).

WP021: Regional Test Centers
Tony Jimenez, NREL – presented by Karin Sinclair
FY 10 Budget: $0 DOE $400,000 Cost-Share
FY 11 Budget: $0 DOE $400,000 Cost-Share
Project Duration: Jan 2009 - Dec 2013

Brief Summary of Project



This project's objective is to maintain consumer confidence in small wind turbine (SWT) technology by providing the information needed for consumers to identify reliable wind turbine models.

The project's goal is to expand small wind turbine testing capability within the United States to allow cost effective performance testing of small wind turbines (rotor swept area < 200 m^2). The endpoint will see multiple (up to four) non-NREL organizations that provide the expertise to conduct SWT certification testing on behalf of the industry.

This project supports the recently developed SWT testing and certification "architecture" developed by the U.S. SWT industry. The beneficiaries of the project include the Regional Test Centers (RTCs) who are our partners in this project. SWT manufacturers will benefit from access to cost effective certification testing. The SWT industry as a whole will benefit as purchasers can more easily identify reliable, cost effective turbines. Over time this should increase the reliability and cost effectiveness of SWTs.

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

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

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

- Meets a need for cost-effective small wind turbine testing and certification to increase consumer confidence in these turbines. Testing is a pre-cursor to certification.
- Helps achieve certification for small wind turbines on a regional scale to protect buyers.
- By providing more cost effective ways of testing small turbines, this project helps deployment objectives.
- Relevant to DOE's small wind objectives.

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

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

- There is a clear technical approach for selecting and establishing the Regional Test Centers.
- It is generally effective to allow for other centers to perform certification testing.
- Seeding regional test centers and then transitioning to self-support a good plan.
- Brought RTCs up to speed. May need to stick with them longer to assure stability and quality control.
- Can industry actually support this level of testing and certification?

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

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

- Centers are in place, and they are starting to produce certification testing.
- Established four RTCs.

Question 4: Project Management

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

- Certification testing should be accelerated to provide coverage for all commercial small wind turbine manufacturers.
- Testing is underway but behind schedule.
- Is cost sharing coming in as budgeted?

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Identified centers and progress is being made on certification.
- The project team sought regional input.

Question 6: Proposed Future Research

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

- No future research was proposed. I suggest developing approaches that can accelerate testing.
- Good list but is it likely to be funded?

Strengths and Weaknesses

Project Strengths
- The idea of creating regional centers for certification testing is a good one.
- This is a good concept as a way to seed regional testing.

Project Weaknesses
- There is a high cost per turbine. It is not clear how this program will continue without DOE funding.
- Need to develop methods to accelerate the certification testing process.

- Is it working?
- There is no requirement for where you get your turbine tested, so if this program is too costly for small wind turbine manufacturers, it is not clear how it will continue.

Specific recommendations for additions or deletions to the work scope

- Let the program continue and see if one or more can become self-sustaining.

WP035: Wind Radar Interagency Field Test & Evaluation

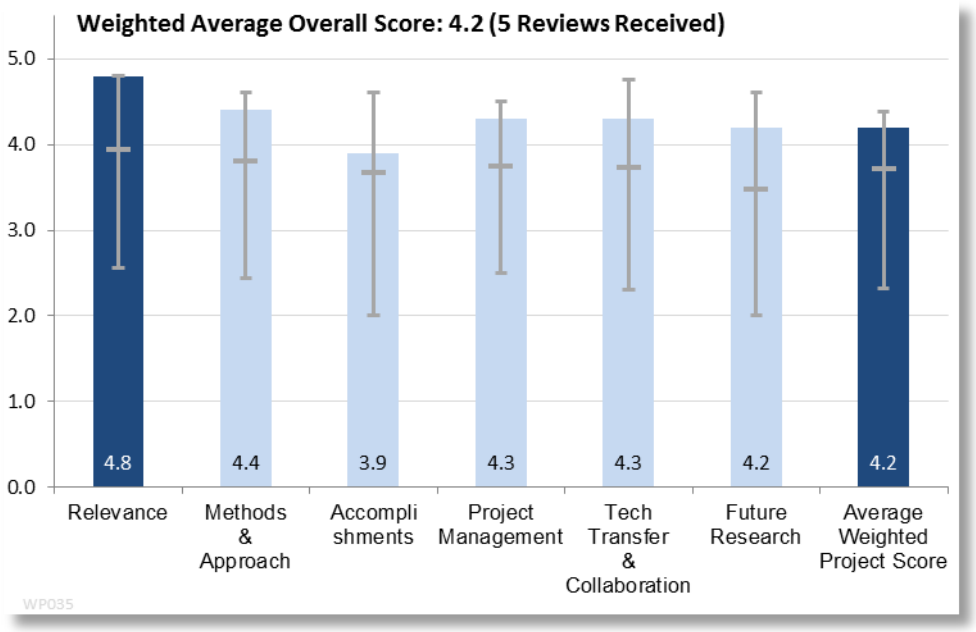
Franz Busse, Massachusetts Institute of Technology-Lincoln Laboratory/Sandia National Laboratories

FY 10 Budget: $0 DOE $0 Cost-Share

FY 11 Budget: $1,500,000 DOE $1,750,000 Cost-Share

Project Duration: Aug 2011 - Aug 2012

Brief Summary of Project



The Interagency Field Test and Evaluation program will characterize the impact of wind farms on existing ground-based air surveillance radars and assess the effectiveness of industry-proposed technical mitigations. The final products will be a series of field reports and operational assessments based on flight campaigns and system analysis. The findings from this effort will guide future Federal Aviation Administration, Department of Defense, and Department of Homeland Security radar upgrades and investments, as well as increase options for DOE and the wind industry in building wind farms in proximity to radars. This will help remove an important barrier to wind turbine deployment. Additionally, data collected from this effort will be extremely useful in developing wind farm planning tools, radar algorithms and technologies, and new wind turbine designs. It will also support turbine and radar modeling/simulation efforts, and NOAA weather radar development.

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

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

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

- This kind of work could open up many gigawatts of cheap wind power.
- Uncertainty about the impact on radar is holding up projects - concern for flight safety (FAA), homeland security (DHS), and homeland defense (DOD). The lack of data is creating a barrier to development.
- Solving this barrier is of critical importance to the wind industry.
- This project looks to be doing a good job in working this important challenge for the wind industry.
- This is an area where DOE involvement can have a significant impact due to the need to coordinate with other government agencies.
- Project appears designed to significantly improve current understanding of radar/turbine issues.
- Presenter provided a realistic approach from current research to implementation of potential mitigation technologies.

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

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

- Three site studies using many methods for abatement will lead to great results.
- Joint project; invited selected mitigations to present for assessing 11 concepts (mitigation technologies).
- Looks like great work.
- Sounds like a sound plan.
- Multiple approaches included in the study appear to be well-designed.
- Characterizing current impact; assessing proposed mitigations; proposed future solutions.

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

This project was rated **3.9** based on technical accomplishments and progress.

- Great progress.
- Preliminary results indicate that we will be able to remove some of the barriers, although there will be some areas where you will never be able to build a wind farm.
- Good so far, but much more to do.
- Good progress.
- Project seems to be making good progress towards useable results. There are limited results available at this time.

Question 4: Project Management

This project was rated **4.3** on its project management.

- On schedule and on budget! The implementation appears to be no easy feat.
- Early phase of project but is on schedule for August 2013 completion and on budget.
- On schedule and on budget.
- Project timelines appear to be met to date. Budget is being maintained.
- Interagency approach is the right strategy because it gets each agency invested in the project and paying attention.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Excellent collaboration with industry providing different approaches.
- Opportunity for greater collaboration with UK.
- Impressive collaboration, but how do we transfer this into practice ASAP?
- Good group of team members.
- Strong collaboration, but limited publications. This may be necessary due to security issues. It will be important to ensure that lessons learned are communicated to industry.
- The project is engaging federal agencies involved.
- Response indicating mutual benefits of this research and UK research was helpful.

Question 6: Proposed Future Research

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

- Moving ahead on additional research, and especially transferring it into practice, is critical.

Strengths and Weaknesses

Project Strengths
- Excellent project bringing together the key players: industry and federal agencies to improve understanding of this critical topic.
- Resulting in a System Analysis Model for Wind-Radar Interference (SAMWRI) is great. This model can be used to simulate other conditions.
- Tackles a very critical industry problem.
- Radar is an important issue for the industry. This program addresses the issues.

Project Weaknesses
- There is a question about how to proceed to make sure it gets used, since this is a big roadblock for industry.
- Even faster deployment and tech transfer would be good.

Specific recommendations for additions or deletions to the work scope

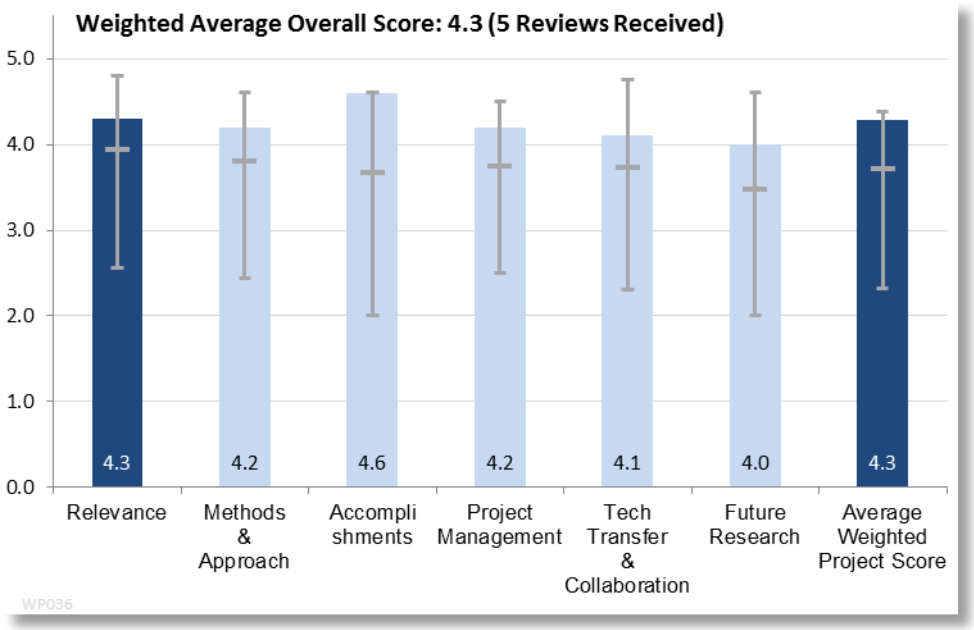
- Great, great project with the potential to unlock thousands of GW of low cost wind development
- Evaluate additional radar types; integrate and do operational evaluation of candidate systems; develop project planning and modeling tools to estimate impact on radars before they start; have the government fund additional mitigation technologies.
- Keep funding this as an important area to remove a roadblock to the industry.

WP036: Wind Technologies Market Report and Other Analyses

Ryan Wiser, LBNL

FY 10 Budget: $593,000 DOE $0 Cost-Share
FY 11 Budget: $500,000 DOE $0 Cost-Share
Project Duration: Jan 2010 - Dec 2012

Brief Summary of Project



LBNL provides data, targeted analysis, and technical assistance to DOE and other key stakeholders for the purpose of informing the DOE Wind Program's R&D planning and investment activities, and to provide stakeholders with unbiased data on, and objective analysis of, the potential benefits, costs, and barriers to wind power in the U.S. Specific objectives of each of our five general project areas are as follows:
A) Annual "Wind Technologies Market Report": Help relevant stakeholders stay current by publishing an annual report that provides a detailed overview of developments in the rapidly changing U.S. wind power market.
B) Spinoff Analyses of Data from Annual "Wind Technologies Market Report": More-thoroughly analyze larger research questions about the cost, performance, and pricing of wind energy by digging deeper into data that are collected for the "Wind Technologies Market Report."
C) Other Market Analysis: Analyze key market-related issues facing the wind industry, including issues related to the impacts, costs, and benefits of wind energy (often based on input from industry and other stakeholders).
D) Public Acceptance: Address critical public acceptance issues with objective analysis in order to inform stakeholders in the siting and permitting process, and thereby address deployment-oriented barriers.
E) Technical Assistance: Berkeley Lab is regularly called upon by state and federal policymakers to provide policy-related technical assistance on a variety of matters relating to the DOE Wind Program's mission. Berkeley Lab is also increasingly called upon to provide other types of technical assistance to wind energy stakeholders.

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

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

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

- Good project giving a "state-of-the-wind-industry" look.
- Rapid industry growth and volatility in that growth complicate the formation and maintenance of a clear, unbiased understanding of wind power's benefits, costs, and etc.
- Huge value for the money with this project.
- Important analysis capability for the DOE and the industry.

- This work is very beneficial to the overall DOE wind analysis effort - analyzing current issues, costs, barriers, and benefits of wind technologies.
- Annual Wind Technologies Market Report is the flagship product of LBNL, with spinoff analysis.
- The LBNL reports are well done and very useful in the industry.
- Very helpful to hear discussion of distinction between the LBNL focus (as discussed here) and the NREL focus.
- Other market analysis and public acceptance for seeking growth in the existing literature base to give stakeholders greater confidence in the results.
- Important documentation of reductions in wind energy costs.

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

This project was rated **4.2** on its methods/approach.

- Retrieving great information from sources where no one else can, or knows to look.
- Understanding Trends in Wind Turbine Prices found that the single largest factor that increased turbine prices was turbine scaling.
- Excellent.
- Grantee appears to have a clearly defined, well-focused approach.
- Wind Project Performance Drivers, FY 10 found that technology performance had improved capacity factors, but these were offset by siting in lower resource areas, masking the performance gains.

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

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

- Outstanding work.
- Found that the Section 1603 Program provided a number of benefits to the Wind Program development.
- Excellent work product and productivity.
- Ongoing completion of relevant reports and studies of wind issues.
- The Impact of Wind Power Projects on Residential Property Values (under Public Acceptance) was completed in 2010 and found no real impact on home value, although more data on homes that are half a mile or closer is needed.
- Determined that wind's LCOE is now lower than in 2002, and that locked in PPA prices from greater than 15 GW of existing wind projects can provide a long-term hedge against natural gas prices.

Question 4: Project Management

This project was rated **4.2** on its project management.

- Valuable work for relatively low cost ($600,000).
- Great value and appears to be well managed.
- Study timelines appear to have been consistently met.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Good collaborative effort and the reports reach just about everyone in the industry.
- This is more synthesis from the body of work by others, but it works very well and I never hear complaints

from others that their work is being interpreted incorrectly, so they are doing it well.
- Good collaboration with researchers and other government agencies.

Question 6: Proposed Future Research

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

- The future work updates current work. This is great.
- Wind Technologies Market Report; additional modeling analysis and ongoing analysis; analytical and survey work surrounding public acceptance of wind; technical assistance to federal and state policymakers.
- Keep doing what you are doing, while staying nimble for emerging questions.

Strengths and Weaknesses

Project Strengths
- Market analysis reaches everyone and used by just about everyone.
- Established flagship report on the wind energy market, with good additional analysis.
- Provides very useful analysis to the industry.
- Reports come across as well done and objective.

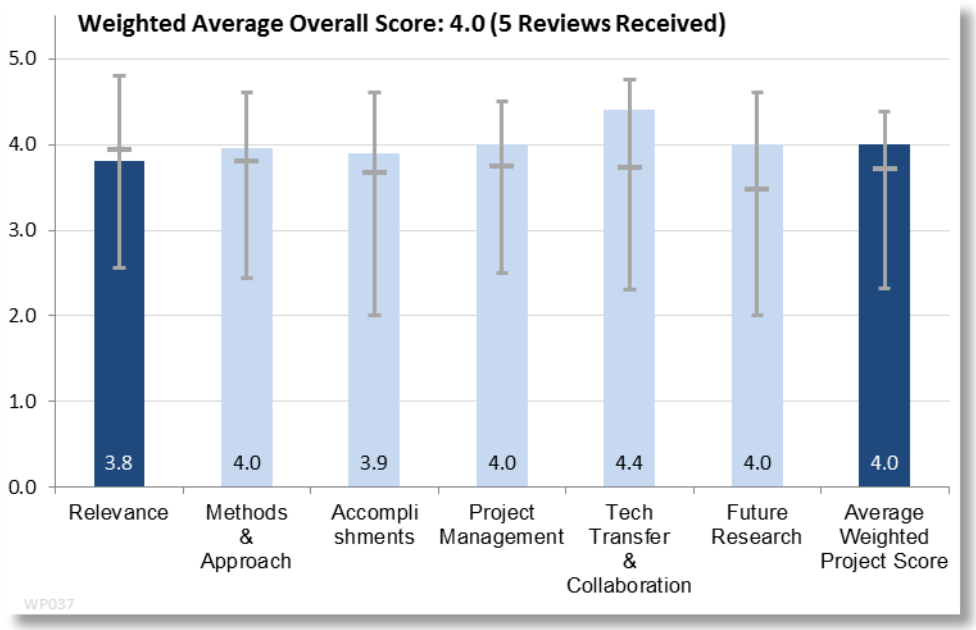
Project Weaknesses
- Communication of findings.
- The future research list could be more specific and geared toward solving a specific problem (i.e., reducing barriers to deployment).

Specific recommendations for additions or deletions to the work scope

- Continue to fund this great work.
- Make an effort to disseminate information through reports and presentations.
- Provides a lot of bang for the buck. Keep it up.
- DOE should consider adding some links on the DOE Wind page to the LBNL reports from this program.
- Generate more specific proposals around public acceptance.
- Expand support of this project.

WP037: Jobs and Economic Development Impacts Modeling
Suzanne Tegen, NREL
FY 10 Budget: $250,000 DOE $0 Cost-Share
FY 11 Budget: $200,000 DOE $50,000 Cost-Share
Project Duration: Oct 2009 - Sep 2011

Brief Summary of Project



State and local decision-makers are keenly interested in the economic development benefits that will accrue from a wind plant in their area, either singularly or compared to other generation options. Regional and Federal decision-makers are interested in jobs and other economic impacts from wind power and potential renewable energy policies. Wind Powering America developed, uses, and maintains the Jobs and Economic Development Impacts (JEDI) model to project these impacts. There is increasing demand for actual data to corroborate these projections. WPA also has an ongoing effort to collect data about real project impacts and maintains a growing database of jobs, taxes, economic development impacts and domestic wind manufacturing. JEDI models are also used to estimate domestic wind workforce, including onsite jobs as well as the manufacturing and supply chain employment. The final product is an easy-to-use input-output model which is available to the public free of charge from our website.

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

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

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

- Narrowed focus in engagement and outreach.
- Helps remove deployment barriers by assessing jobs benefit and economic impacts of wind development.
- Analysis of jobs and local economic benefit is more important than ever. This is important work.
- Very useful and necessary analysis of economic impacts.

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

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

- Focusing on the validation of the model is good.
- Wind model updated twice based on real project information. The wind and solar JEDI models were used in

an analysis of the ARRA 1603 Grant Program.
- Results seem to be well accepted. Ongoing validation is a good idea.
- Not able to give an opinion on the details of the model itself, but the overall methodology appears to be appropriate.

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

This project was rated **3.9** based on technical accomplishments and progress.

- Expansion of the model and dissemination.
- JEDI analysis is used by several public utilities commissions and utility-scale OEMs interested in assessing the economic impacts of new wind projects.
- From what is seen, this work is well focused with good progress.
- Good technical progress on updating and maintaining the model.

Question 4: Project Management

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

- No concerns.
- Project appears to be very well managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- There is close collaboration with folks that intend on using the models.
- The JEDI model is presented and published widely.
- Good job of collaboration and communications.
- Good collaboration with researchers, universities, and with other agencies.

Question 6: Proposed Future Research

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

- Next steps will improve towards a user-friendly web-based tool, likely leading to more users.
- Working on an offshore JEDI and Transmission model as well as Small Wind models.
- Validation effort sounds good.
- Good future research directions - small-scale wind and offshore wind.
- Future research - would like to be able to maintain JEDI models, and to develop web-based interactive JEDI tools, User Guides, and online training.

Strengths and Weaknesses

Project Strengths
- It is the only project of this kind.
- No other easily-accessible tool is available to the public that estimates gross jobs and other economic impacts from power projects.
- Provides important information to the industry.

- Results are important to supporting the case for wind with job impact analysis results.
- Widespread acceptance.
- Free tool.

Project Weaknesses

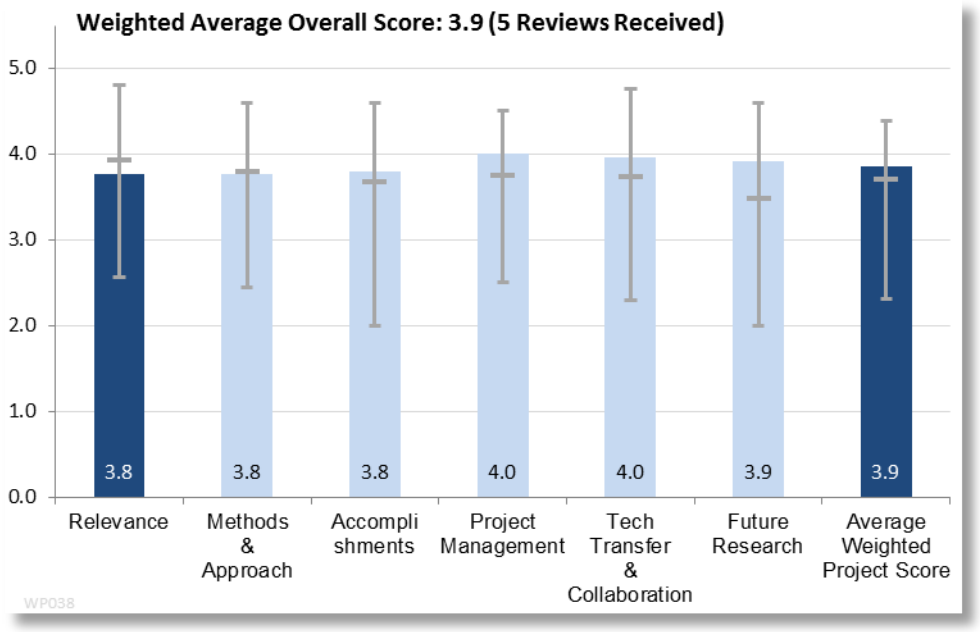
- It’s not clear who uses these models when trying to develop a project, or why people should.

Specific recommendations for additions or deletions to the work scope

- Continue this project.
- Solid results and important work that isn't covered anywhere else.

WP038: System Levelized Cost of Energy (LCOE) Analysis
Maureen Hand, NREL
FY 10 Budget: $800,000 DOE $0 Cost-Share
FY 11 Budget: $600,000 DOE $0 Cost-Share
Project Duration: Nov 2010 - Sep 2012

Brief Summary of Project



NREL conducts technology assessment and market analysis to:
1. Synthesize market data describing the existing wind industry;
2. Identify potential cost reduction opportunities;
3. Evaluate future wind energy generation potential. The objective of this type of analysis is to inform the Wind and Water Power Program (WWPP), as well as external stakeholders, of the potential impact of developing industry trends, R&D investment options, and/or policy implications for the wind industry. This information will advance the industry by identifying highest-impact research and enabling improved decision making processes.

To understand the current cost of wind energy and to project future cost of wind energy scenarios, both market data and techno-economic models are used. Analysis of market data representing wind plant cost and performance provides context for analysis of historical trends. Techno-economic models are used to analyze detailed elements of wind turbine and wind project cost of energy for specific conditions and to project possible cost of energy changes associated with turbine specification changes.

In FY11, activities focused on:

- Review and assessment of methods to estimate LCOE including evaluating market data supporting land-based wind technology cost of energy estimates
- Development of land-based wind technology balance of system predictive model capability, and
- Application of the NREL Wind Turbine Design Cost and Scaling model in combination with other published literature to demonstrate technology evolution corresponding to cost and performance projections used in the DOE 20% Wind Energy by 2030 study.

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

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

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

- Improves understanding of the cost of energy allowing for targeting cost savings.
- Focused on impacting future cost of wind energy.
- Provides important baselines and information for setting program priorities for the larger wind program.
- DOE needs this analysis in assessing and planning which technologies to focus on for reducing LCOE and establishing LCOE targets for the impact of the work it does. I do not believe this is used by industry - correct?
- This work is important in both evaluating potential future costs of wind technologies, and in targeting DOE funding in areas where the most improvement in costs can be achieved.
- I think recent efforts to focus more attention on the cost of individual plant components and allowing analysis of impacts of cost changes on components is worthwhile. However, it will be important to keep in mind the costs and benefits of the additional effort.

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

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

- Relies on old data and literature surveys for the cost of wind.
- Complex to manage all the pieces, but this seems to be a solid model and approach.
- This is ongoing research that appears to be based on sound analysis.

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

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

- Component level costs are good.
- Not clear how this work has contributed to reducing LCOE or removing barriers to deployment. Needs better explanation of how NREL or DOE uses these data.
- Well done.
- This is an ongoing effort; only recent efforts were described. These appear to be worthwhile.
- The chart showing wind class/speed and capacity factors for different technologies is excellent.

Question 4: Project Management

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

- Don't see any issues with project management.
- No concerns based on what I could see here.
- Project appears to be well managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- Involvement with IEA tasks is good to reach a very wide audience.
- Participating in IEA Wind Task 26 the international partnership dedicated to exploring the costs of wind

projects.
- IEA Task 26 collaboration is important and good.
- The effort is well-publicized through organizational reports.
- Are there other data sources/partners to improve estimates?

Question 6: Proposed Future Research

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

- Interesting step to include R&D advancements in lowering the cost of energy.
- Finishing Wind Technology Trends analysis; land-based O&M cost drivers and sensitivity analysis; WindProspector; land-based and offshore Balance of Station (BOS) cost drivers and sensitivity analysis; system advisor model.
- It is difficult for me to fully understand the models that are used for this analysis, but the approach seems to work and provide useful results.
- Additional areas of review were described in the presentation, including integration technology requirements, wildlife impacts, etc. It will be important to review the overall costs of these in order to ensure that their inclusion in the analysis is justified.
- Interesting proposal to work on the system engineering model to understand how the cost of energy can be reduced through technology.

Strengths and Weaknesses

Project Strengths
- Useful information for everyone, especially for policy makers.
- New system model could be used to evaluate the impact on the cost of a technology change, like a new drive change.
- Provides an important foundation for setting priorities in the larger DOE program.
- Helps the DOE establish priorities for R&D and to set goals.

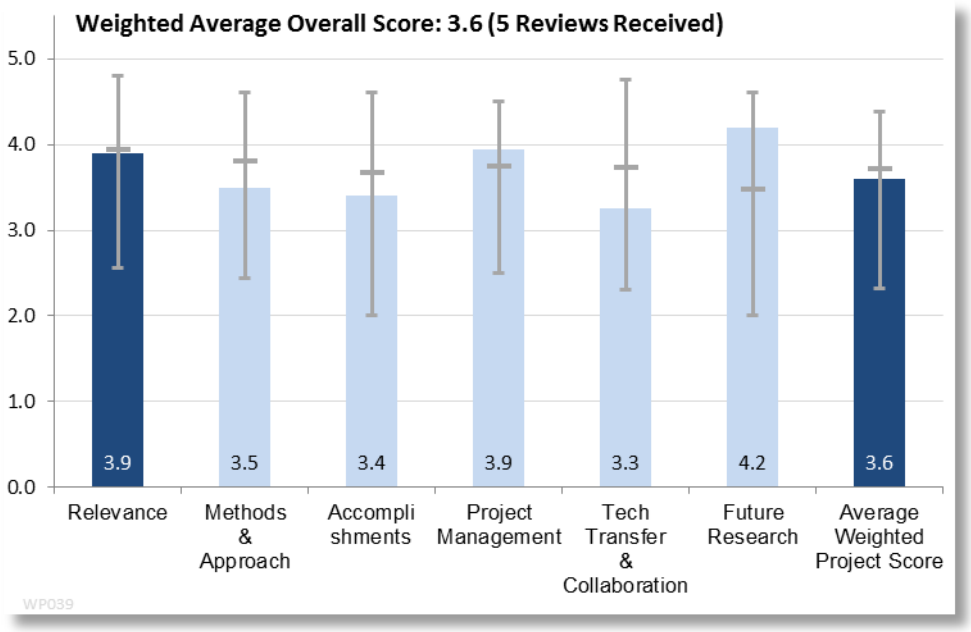
Project Weaknesses
- Technology and cost of wind energy are changing quickly, so any data published by NREL will always be behind "current" pricing and therefore immediately out of date.
- Not always easy to explain the underlying modeling approach to the general public, but perhaps this is unavoidable.
- Very academic and removed from real-world data.
- Not clear that these models are necessary for setting R&D priorities.

Specific recommendations for additions or deletions to the work scope

- Further evaluate the effectiveness of this project.
- Provides a critical foundation for long-term priority setting within the DOE program, so ongoing support and enhancement is important.
- A question could be posed to the program: How does this tie together? LBNL takes a historical look at wind power costs and this group at NREL does modeling to assess the impacts of technology improvements. Who makes projections to senior DOE and Congress on where the LCOE is going over the coming years? This could be important to Congress as they consider policy issues like PTC.

WP039: Offshore System Cost Analysis
Maureen Hand, NREL
FY 10 Budget: $0 DOE $0 Cost-Share
FY 11 Budget: $184,000 DOE $0 Cost-Share
Project Duration: Jan 2011 - Sep 2012

Brief Summary of Project



NREL conducts technology assessment and market analysis to: 1) synthesize market data describing the existing wind industry; 2) identify potential cost reduction opportunities; and 3) evaluate future wind energy generation potential. The objective of this type of analysis is to inform the WWPP, as well as external stakeholders, of the potential impact of developing industry trends, R&D investment options, and/or policy implications for the wind industry. This information will advance the industry by identifying highest-impact research and enabling improved decision making processes.

To understand the current cost of wind energy and to project future cost of wind energy scenarios, both market data and techno-economic models are used. Analysis of market data representing wind plant cost and performance provides context for analysis of historical trends. Techno-economic models are used to analyze detailed elements of wind turbine and wind project cost of energy for specific conditions and to project possible cost of energy changes associated with turbine specification changes.

Due to the great uncertainty associated with offshore wind project cost in the U.S., initial efforts in FY11 were focused on:

- Development of offshore wind project data base to represent market conditions for the U.S. and global industry and estimation of typical U.S. offshore wind project costs.
- Assessment of deployment implications associated with the targets described in the DOE National Offshore Wind Strategy.
- Development of a framework for the economic assessment of floating offshore wind technologies.

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

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

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

- Aligns very well with program goals.

- Need data models and analysis to inform the Wind and Water Power Program for future technical advancements.
- Very relevant but extremely difficult.
- The DOE needs this analysis in assessing and planning which technologies to focus on to reduce the LCOE and establish LCOE targets for the impact of the work it does. I would expect that the results would be of interest to the industry as they influence the offshore political landscape.
- Important to have an understanding of offshore wind costs, as well as, areas in which those costs can be reduced.
- Without a single offshore facility in the U.S., how real can cost analysis be?
- Almost no "real" data to go on here, so it is a tough challenge.
- This project can help make a business case for a chosen offshore strategy.
- The focus on "risk and who accepts that risk" for new work is on target, and that is the "$64,000 question" for offshore wind in North America.

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

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

- Builds on techniques and information from previous land-based work, which has been successful.
- Trying to collect data and create a baseline.
- Methods appear appropriate.
- Develop tools to return the COE of offshore wind.

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

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

- Reports and products clearly have been timely and critical to the DOE planning strategy process.
- The Offshore Wind Deployment Report contains assessments in resource availability and the viability of deployment scenarios but no commercial floating offshore wind projects, so much less data available.
- Still very early.
- Limited technical information provided at this time. Work is still ongoing.

Question 4: Project Management

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

- Some delays to two deliverables, but otherwise I see no issues.
- Focused on data collection so that they can begin to model starting with future estimates based on U.S. developer expectations and the European experience, as well as some Chinese data.
- It is early in a difficult project, but there are no concerns on the project management at this time.
- Project appears to be well-managed and maintaining the original timeline.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.3** for research integration, collaboration, and technology transfer.

- Would collaboration with the European offshore wind industry improve results?
- Working with developers to better understand the costs.

- Too early to tell, but OK for now.
- Good collaboration with researchers and industry.
- Will share data with IEA for the Annual Energy Outlook report, which has its own model and assumptions about learning.
- Final report should provide sufficient technology transfer.

Question 6: Proposed Future Research

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

- Risk reduction does seem like a good area to improve cost.
- Developing methodology for quantifying risk in all elements of offshore wind projects investment in order to identify the most likely areas where risk reduction can reduce the offshore wind cost of energy.
- Agree that it is all about the risk and who bears the risk.
- Expansion to the JEDI model and a review of allocation of project risk appears to be interesting future work.

Strengths and Weaknesses

Project Strengths
- Providing critical information for understanding and planning for a U.S. offshore wind industry.
- Will provide baseline data on cost.
- Insightful in their thoughts about risk; risk, and who bears it, drives the cost in this situation.
- Offers good insight on the cost of risk and the need to mitigate risks to reduce costs.

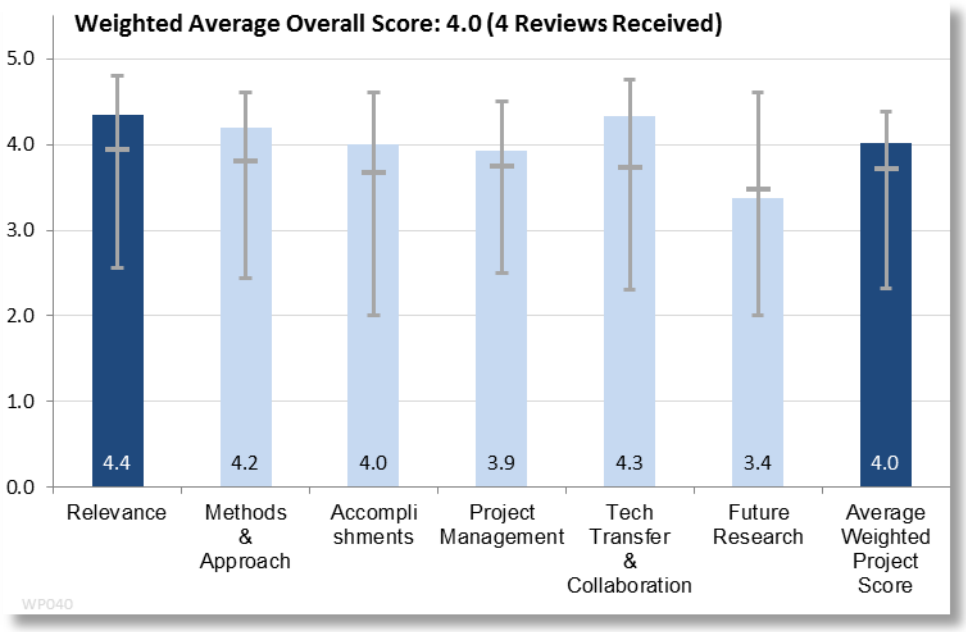
Project Weaknesses
- Providing economic analysis for an industry that has not yet built a project yet. Can the analysis be trusted?
- No installed projects in the U.S. means there is no data for modeling from the U.S.
- No real data; no real market; so it is challenging to analyze.

Specific recommendations for additions or deletions to the work scope

- This is clearly vital analysis providing a business case for DOE direction.
- If you continue to fund offshore, then this is a vital piece of the analysis to be done.

WP040: Enhancing Short Term Wind Energy Forecasting for Improved Utility Operations
James M Wilczak, NOAA
FY 10 Budget: $2,000,000 DOE $0 Cost-Share
FY 11 Budget: $575,000 DOE $410,000 Cost-Share
Project Duration: Jan 2011 - Dec 2012

Brief Summary of Project



The overarching goal of this project is to demonstrate that it is technically possible to materially improve the skill of numerical weather prediction models used to forecast wind energy production. Improved forecasts would allow for more efficient integration of highly variable wind energy onto the electrical grid by enabling utility room operators to more readily balance supply and demand with the lowest cost production, through reduction of unnecessary spinning reserves and periods of wind curtailment. This in turn would reduce barriers to new wind energy development, lower the ultimate cost of wind energy to consumers, and help facilitate the nation's goal of achieving 20% of the nation's energy supply through wind energy by 2030. In addition, this project will inform NOAA and the wind energy industry on the value of deploying new meteorological observing networks, and accentuate the benefits to the wind energy industry of sharing proprietary meteorological observations with NOAA. In summary, the project will 1) highlight a path through which wind energy integration costs can be reduced through improved forecasts, and 2) lead to a new paradigm in which the private sector shares its proprietary meteorological data with NOAA resulting in improved forecasts that benefit not only the wind energy industry but large segments of the economy, government, academia, and the general public.

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

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

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

- Critical project to improving the numerical weather prediction (NWP) models, which are relied upon for most wind power forecasting.
- Good potential for lowering the LCOE, optimizing wind power plant operations, and improving resource characterization.
- Very important priority for reducing the impact of wind energy on system operations.
- Improved modeling effort will allow for more efficient integration of highly variable wind energy onto the electricity grid by enabling utility room operators to more readily balance supply and demand with the lowest cost production, through reduction of unnecessary spinning reserves and periods of wind curtailment.

- Must ensure that consistency with industry efforts is maintained, and based on following the presentations, it appears this is the case.

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

This project was rated **4.2** on its methods/approach.

- Two regions with two different wind resources, using two different industry forecasters leads is great.
- Focused on short term forecasting in regions with high wind resources.
- Technical basis of the project appears sound and well developed.
- Deploying instrumentation to determine the value in additional measurements.

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

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

- Has demonstrated that new observations assimilated into the NWP models can improve forecasts!
- Deployment of instrumentation in the field; development of a real-time observation and a model evaluation website; development of appropriate metrics.
- Good progress on providing technical results.
- This presentation has to be viewed in combination with following two. The combined presentations indicate a thorough review of potential for improvement of existing models.

Question 4: Project Management

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

- Extended the completion date.
- Project appears to be well managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- DOE, Industry, NOAA, labs and universities are all involved. Great.
- Good example of inter-agency collaboration and partnering.
- Along with two sub-projects, this work appears to have significant connection to researchers and to industry representatives.
- Transfer has occurred through presentations already, and final report will come in 2013.

Question 6: Proposed Future Research

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

- Two proposed research areas would be interesting, but will they make marked improvements on the findings of this project from 2011-2012?
- Replication of field data in different regions of the country is logical next step.
- Note that the extra data measurements are research only and will be removed when the study is complete.

Strengths and Weaknesses

Project Strengths

- Looks to improve the NWP modeling using observational data. This is a question that has been discussed for years with many different answers. This project says yes.
- Valuable project with immediate benefits to wind farm optimization.
- Choosing two different resources and two different forecasting providers that lead to the same improved results really leaves less to question on the validity of the results.

Project Weaknesses

- In what ways are the North and South wind resources similar? Would the results work on the west coast or northeast? Offshore?
- Path to realizing the benefits demonstrated by this program are dependent on Congressional funding in a tight fiscal environment.

Specific recommendations for additions or deletions to the work scope

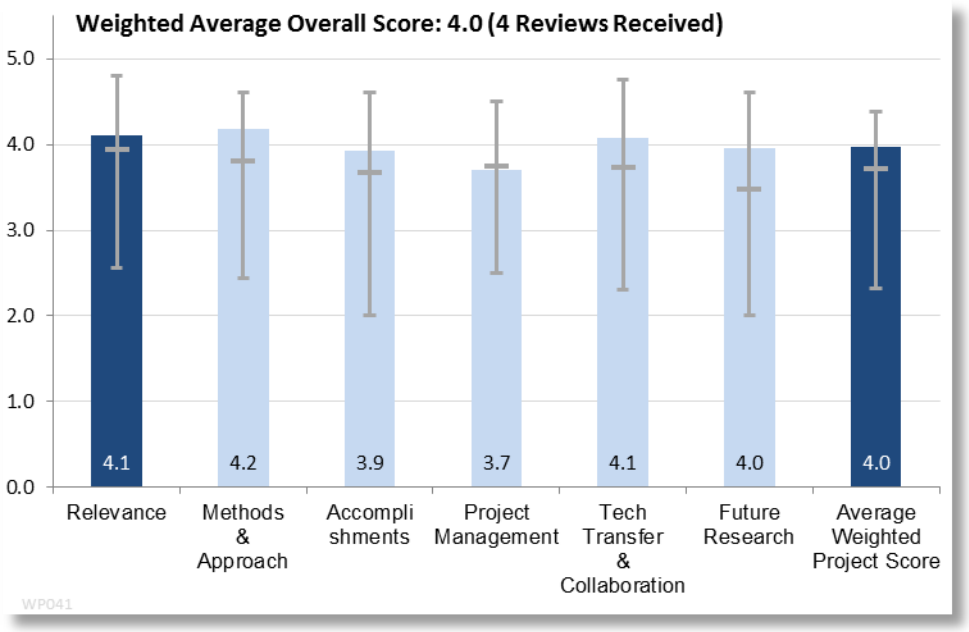
- Excellent exercise. Would be good for the results to address forecasting improvements vs. cost of acquiring the additional observational data.
- Continue to support this project.

WP041: Wind Forecasting Improvement Project: Southern Study Region

Jeffrey Freedman, AWS Truepower, LLC.

FY 10 Budget: $0 DOE $0 Cost-Share
FY 11 Budget: $2,150,000 DOE $1,068,000 Cost-Share
Project Duration: Oct 2010 - Sep 2012

Brief Summary of Project



For the Southern Study Region (encompassing the Electric Reliability Council of Texas [ERCOT] territory in western and central Texas), the project takes a comprehensive approach in meeting the objective of improving zero- to six-hour wind forecasts through the use of additional atmospheric observations combined with model enhancements on wind forecasts at turbine height. A major reason for choosing the ERCOT territory, wholly within the Southern Study Region, is that it contains the largest number of operating wind farms in the U.S., with an aggregate installed wind generating capacity approaching 10,000 MW. The region also contains existing high quality surface-based and remote sensing networks, and is logistically favorable for placement of additional instrumentation. The project field deployment scheme includes a combination of surface and remote sensing platforms as integrated observation sites to ensure the complete capture of the wind profile from the surface through and beyond the top of the atmospheric boundary layer, typically one – three kilometers in this region. This work includes the deployment, management, and decommissioning of all AWS Truepower and partner-contributed instrument platforms.

The forecast/modeling efforts include development and implementation of improved statistical and ensemble-based forecasting approaches and improved data assimilation systems using the observational network available during the project. An enhanced and expanded version of AWS Truepower's operational forecast system is the centerpiece of the modeling efforts. More specifically, a set of wind power production forecasts is being generated each hour for the duration of the forecasting campaign. This 1-hour update frequency is greater than what is used by most Numerical Weather Prediction (NWP) cycles. However, new information is still available from the non-NWP methods and five of the NWP runs (for example, the NOAA High Resolution Rapid Refresh or HRRR) have a one-hour update frequency. Each forecast extends for 12 hours after the time of delivery. Other forecasting efforts are being led by Oklahoma University and Texas Tech University. The resulting forecasts are being evaluated using standard accuracy performance metrics.

The economic benefit of improved forecasts will be quantified using statistical models of power production and cost, dispatch, unit commitment and other relevant parameters. Lastly, a forecast sensitivity analysis will be performed to provide a basis for subsequent research and planning next steps to improve forecast performance in the study area as well as other locations 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 wind industry needs and overall DOE objectives

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

- Focusing on improving the zero to six hour wind power forecasts with more observational data is great.
- Designed to show how additional atmospheric observations lead to improved wind power production forecasts.
- This program, in conjunction with the previous program, is aimed at demonstrating the benefits so that a better case can be made to Congress to fund NOAA to install more sensing capabilities.
- Wind forecasting improvements are important to reducing the costs of integrating wind resources.
- Demonstrates how improved forecasts reduce costs.
- This project appears to be well connected both to research organizations and to the industry.

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

This project was rated **4.2** on its methods/approach.

- Focused on quantitative analysis, improved economics, and performance metrics.
- Chose small municipal airports for testing sites.
- Well-developed methodology.
- Ensemble forecast method will demonstrate those more successful in forecasting.
- Look at the phenomena that cause changes in the wind speed.

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

This project was rated **3.9** based on technical accomplishments and progress.

- Identified ideal locations, measurement needs, and economic benefits.
- Purported significant cost savings from using this forecasting model.
- Technical achievements are not complete at this time, but preliminary results appear beneficial.
- Identified best sites; deployed instrumentation; real-time forecasts; preliminary analysis demonstrates significant cost savings; identifying phenomena responsible for ramp events.

Question 4: Project Management

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

- See no issues. Delays due to contracting delays.
- After initial delays, on target to wrap up at the end of this year, early 2013.
- Timelines have been generally maintained.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Very good team.

- High levels of collaboration between the project, researchers, and industry.
- Preliminary results have been presented.
- Good set of publications.

Question 6: Proposed Future Research

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

- Translating the results of this work into actual improvements of NWP models, national network of observational data, and guidelines for placing measurement technologies is critical.
- A network of remote sensing equipment nationwide to benefit renewable energy.
- Future research listed appears to be interesting and useful.
- Embrace efforts by DOE and NOAA to use the information learned from this project to expand existing network capabilities or deploy new sensor networks in regions already populated by or undergoing expansion.

Strengths and Weaknesses

Project Strengths
- Good approach with incorporating an ensemble forecast, including economic benefits, and demonstrating when and where to use observational data.
- Using instrumentation that can measure phenomena that, otherwise, are not typically measured in wind forecasting.
- Shows the benefits of NOAA getting involved in wind.
- Builds a case for placing sensing equipment upstream of wind projects.

Project Weaknesses
- Are the results transferrable to other wind resources?
- Significant cost savings demonstrated from the project are difficult to verify. Not clear what the actual cost savings would be.
- Path to realizing the benefits demonstrated by this program are dependent on Congressional funding in a tight fiscal environment.

Specific recommendations for additions or deletions to the work scope

- How do these results compare to other approaches for forecasting, such as those that are based on training, based on historical information, or those that forecast primarily based on turbine output, i.e. less emphasis on NWP models?
- Further evaluate and verify cost savings estimates before moving forward with this project.
- What about improvements for the day ahead market?

WP042: Wind Forecasting Improvement Project: Northern Study Region

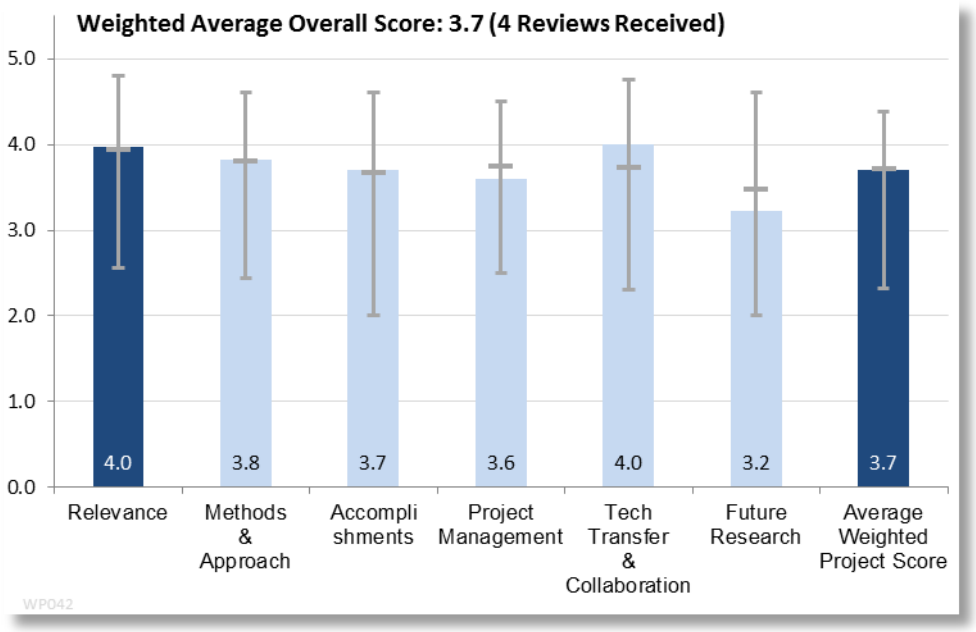
Cathy Finley, WindLogics

FY 10 Budget: $0 DOE $0 Cost-Share

FY 11 Budget: $1,247,000 DOE $1,490,000 Cost-Share

Project Duration: Oct 2010 - Sep 2012

Brief Summary of Project



The Upper Midwest/Northern Plains area was chosen for this study because 1) it is a region of extensive current (and future) wind energy development, 2) the meteorology and forecasting issues in this region are similar to most of the Great Plains where roughly half of all installed wind capacity currently exists making the results applicable to a large portion of current (and future) wind energy supply, and 3) the large penetration of wind in the northern portion of the Midwest Independent System Operator (MISO) area footprint make it an ideal region for quantifying the economic impact of wind energy forecast accuracy on utility operations. In addition to power forecasts made using wind forecasts directly from the models, optimized forecasts are generated for each wind plant by using the real-time plant power data along with weather model forecast data to train a machine learning system to make more accurate site-specific wind power forecasts. A model of the electrical grid system operated by MISO is being developed and will be used along with the suite of wind energy forecasts, plant power production data and new innovative techniques that are being developed to quantify the economic benefits of operating the MISO system with the improved short term wind power forecasts. These techniques include quantifying the cost reductions from reductions of operating reserves, the improvements of more efficient load following and unit commitment, and the economic and reliability benefits from the improvements in forecasts that are tailored at predicting wind ramp events.

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

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

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

- Focusing on improving the zero to six hour wind power forecasts with more observational data is great.
- Aligned with optimizing wind power plant operations and improving resource characterization.
- This appeared to be the weaker of the two sub-projects.
- It will be important for the actual benefits and weaknesses of the revised analysis be appropriately quantified and communicated.

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

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

- Focusing on raw and trained forecasts using the High Resolution Rapid Refresh (HRRR) Numerical Weather Prediction (NWP) model.
- Approach needs to be complemented with a thorough analysis of results. Why are the new methods improving forecasting at some sites and decreasing accuracy at others? Are these results likely to persist under different prevailing weather conditions (different years)?
- Using existing data from wind turbine generators (WTGs) may offer improvements that anyone could implement without introducing additional meteorological assets.

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

This project was rated **3.7** based on technical accomplishments and progress.

- Have shown improvement of high-Resolution Rapid Refresh over Rapid Refresh models, but not the same for all facilities?
- At most of the sites, this is significantly reducing the error by using the new forecasting.
- Results show inconsistent improvements - some locations show improved forecasting, others show reduced. These disparities were not explained in the presentation.
- Limitations evident in this analysis are critically important - wind forecasts methodologies can have specific benefits that are noted spatially or temporally. Limited-time studies that don't explain geographic disparities in the results will likely provide little benefit.

Question 4: Project Management

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

- Delayed completion date.
- Some project timeline slip was indicated.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- Good team.
- Good collaboration and publications.
- Technology transfer through typical venues.

Question 6: Proposed Future Research

This project was rated **3.2** for proposed future research.

- No reviewer comments were received for this metric.

Strengths and Weaknesses

Project Strengths

- Examining benefits/differences of trained and raw forecasts.
- Demonstrated that improvements in forecasting accuracy will clearly contribute to improving the scheduling of wind power in electricity markets and lowering the overall wind integration costs.

Project Weaknesses

- No need for additional observational instruments, e.g. met towers or remote sensing?
- Path to realizing the benefits demonstrated by this program are dependent on Congressional funding in a tight fiscal environment.

Specific recommendations for additions or deletions to the work scope

- What about improvements to the day ahead market?
- At what time-scales will the improvements be most likely within the zero to six hour time frame?

WP043: Improved Statistical Methods for Wind Power Forecasting

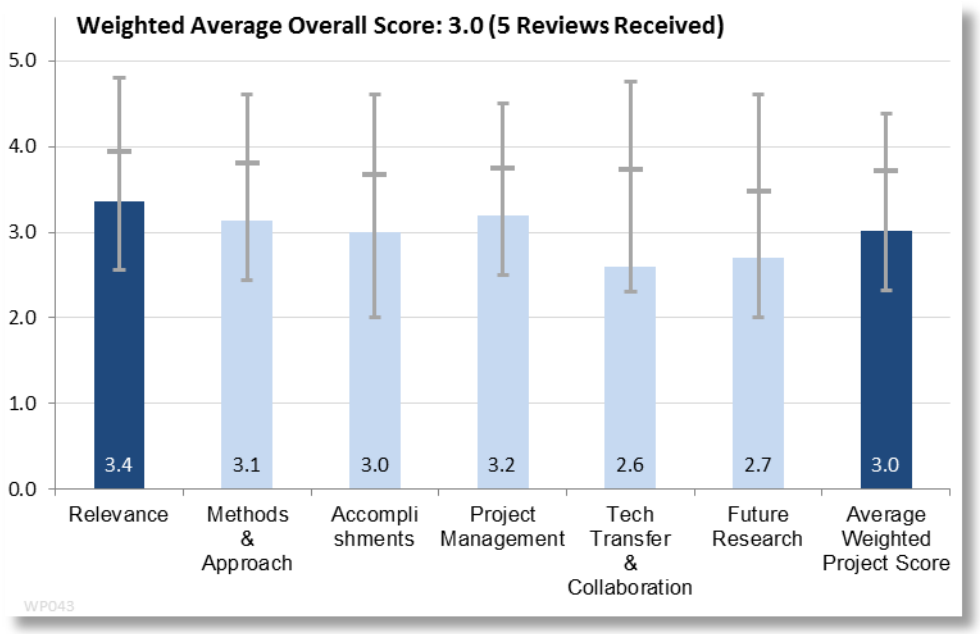
Audun Botterud, ANL

FY 10 Budget: $300,000 DOE $0 Cost-Share

FY 11 Budget: $190,000 DOE $0 Cost-Share

Project Duration: Jan 2010 - Dec 2011

Brief Summary of Project



The high level objective of the project is to improve the state of the art in wind power forecasting. By developing and testing novel statistical forecasting algorithms, the goal is to improve forecast performance, in terms of reduced errors for point forecasts and more accurate probabilistic forecasts.

Wind power forecasting is a key tool to efficiently integrate large shares of wind power into the electric power grid. The algorithms developed in the project contribute to improve the wind power forecasts provided by private forecasting vendors. In turn, improved forecasts lead to lower integration costs and increased viability of wind power plants. Ultimately, this facilitates a more rapid expansion of wind power 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 wind industry needs and overall DOE objectives

This project earned a score of **3.4** for its relevance to wind industry needs and overall DOE objectives.

- Very interesting area for research into improving wind power forecasting accuracy.
- The goal is to improve forecast performance in terms of reduced errors for point forecasts and more accurate probabilistic forecasts.
- It was difficult to understand as presented.
- Improved wind forecasting is good for the DOE and industry, but how the learning of this program gets out to the public and industry is difficult to contemplate.
- Improvements in wind power forecasting are very important to increased integration of wind power. However, the benefits of this specific effort were hard to divine.
- Wind power forecasting is key tool to efficiently integrate large shares of wind power into the electric power grid.
- Paid licensing of DOE-funded research by DOE labs should be questioned.
- Not clear that this effort was at the cutting edge of analysis.
- The licensing may be legal, but it looks very bad in the context of wind power forecasting (NOAA public/private historical agreements, concerns from past NCAR activities, AWEA wind forecasting white

paper, etc.).
- Improvements developed from this research were not presented in a clear manner.

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

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

- Neural network is a buzzword.
- Seems to be based on good principles, but not easy to follow. Look for better ways to explain the core points and values.
- Hard to determine.
- Entropy, really?
- Focus is on training the forecast.
- It is not clear how the approach will lead to improved forecasting results nor how to implement this novel approach.

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

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

- Highly academic results leading to confusion on how this analysis can lead to forecasting improvements. Presenting the information per industry practice would help a lot.
- Most milestones completed.
- Some good deliverables, but I've seen them demonstrated more impressively in Portugal's market context than in the U.S. context. Can we make the value more concrete to people in the U.S.?
- Focus is on running the new routine and giving the results without (apparently) understanding the trends that are being seen.
- What was actually accomplished was hard to determine. Benefits to industry harder so.
- Not clear what project results were and how they benefit the industry.

Question 4: Project Management

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

- Don't see any issues here.
- Difficult to judge.
- Unable to determine.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Project would benefit by including industry forecasting providers on the project team to ensure results can reach a wide audience.
- Highly mathematical and difficult to understand, with benefits also difficult to clearly appreciate.
- Use of research to produce a product for sale to the public appears inconsistent with the goal of technology transfer.
- Collaboration with Portugal, but little within the U.S. mainstream.

Question 6: Proposed Future Research

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

- Proposed research looks useful and a step in the direction of bringing these tools into the operations rooms.
- Feels like statistical methods in search of a problem. Is it clearly tied to real problems? I believe it is, but need to do a better job of explaining the value.
- Not clear where this would go in the future to clearly benefit DOE and the industry.

Strengths and Weaknesses

Project Strengths
- New, different approach towards wind power forecasting.
- Based on a premise that is likely valid (do not assume Gaussian error distribution).

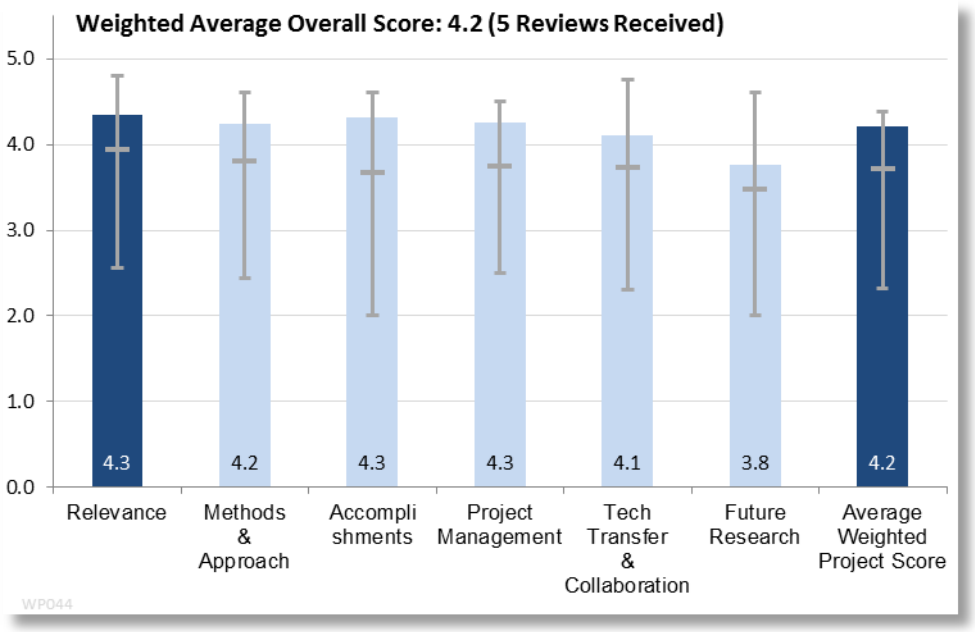
Project Weaknesses
- The approach is different, but so is the presentation of results.
- Unclear on why they are charging to license the software and how a DOE lab can make a license to a private company that is not disclosed.
- Not very easy to understand, and the actual improvement benefits are not clearly presented.
- I do not understand how the benefits of this program benefit the public/industry.
- Unclear where the improvements are occurring.
- Paid licensing of IP from government labs looks bad.

Specific recommendations for additions or deletions to the work scope

- Uncertainty analysis is likely the way of the future, but integrating these approaches into the decision making process in operations and scheduling will require clear and simple processes.
- Further review of this program is recommended.
- Clarify the policy on paid licensing by DOE labs.
- Provide technical writing support for this project so that the benefits can be more clearly explained to others.
- The licensing may be legal and accepted practice in some labs, but it looks very bad in the context of wind power forecasting (NOAA public/private historical agreements, concerns from past NCAR activities, AWEA wind forecasting white paper, etc.).

WP044: Improved Forecasting Methods
Sonia Wharton, LLNL
FY 10 Budget: $350,000 DOE $0 Cost-Share
FY 11 Budget: $342,000 DOE $0 Cost-Share
Project Duration: Jan 2009 - Jan 2012

Brief Summary of Project



Objective 1: Quantify impacts of atmospheric stability on tall turbine power generation at a multi-MW, land-based wind farm by deriving stability parameters applicable to the wind industry by using available, on-site measurements.
Objective 2: Execute and compare models to the wind farm domain, specifically to address the ability of models to forecast large increases or decreases in power production ("ramping" events).
Objective 3: Quantify synergistic effects of atmospheric stability and turbine-induced wakes on downwind power performance at a multi-MW, land-based wind farm to isolate downwind power deficiencies under different weather (e.g., stability) regimes.

Project Purpose: The Tall Turbine resource assessment results help industry reduce the cost of energy by improving the understanding of power, shear and loads (i.e., atmospheric stability), leading to better controls and turbine designs and enhanced energy capture by the rotor. The Tall Turbine forecasting results showed that "user-defined" WRF led to the most accurate forecasts of wind speed, direction and power generation over traditional models (stand-alone WRF). Our forecasting methods were tested for ramping events, i.e., very difficult conditions to traditionally model. Ramping events often lead to large power generation differences across a wind farm. Such forecasting improvements are directly beneficial to wind farms, particularly in areas with highly variable wind conditions. The Tall Turbine wake study results benefit wind farm operators by developing a methodology to quantify wake effects across the farm under different stability regimes. This finding helps wind operators more accurately forecast next-day power across the wind farm by examining next-day weather conditions (full sun = convective stability, cloudy = neutral stability, nighttime = stable).

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

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

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

- Atmospheric stability effects on power production are not well understood and could lead to major shifts in the way forecasting is done. This is important work.

- The Tall Turbine resource assessment results will help the industry reduce the cost of energy by improving the understanding of power and atmospheric stability, leading to better controls and turbine designs and enhanced energy capture.
- Work on stability-specific power curves, and how to model the atmosphere to take such stability into account, is a high priority.
- Looks like a good technology advancement program in the area of wind forecasting.
- Improved wind forecasting provides a significant benefit to reducing wind integration costs.
- Particularly impressed by other presentations from the collaborator Julie Lundquist (CU-Boulder) on this work.
- Wind forecasting represents a part of the integration process that can benefit from increased government-funded research.
- Focus needs to be on underlying meteorological science and availability of weather data sources. There are numerous vendors that provide wind forecasting capabilities to system operators – the DOE needn't be involved in this effort.

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

This project was rated **4.2** on its methods/approach.

- Quantified stability impacts and then validated them using four model approaches.
- Very well done.
- Not sure on the approach to soil moisture that is used, but otherwise impressed.
- Good combination of new research combined with improvement of an existing industry-accepted tool.

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

This project was rated **4.3** based on technical accomplishments and progress.

- Stability impacts on power are significant and predictable.
- Found that atmospheric stability was accurately derived from available wind farm data including Sonic Detection and Ranging (SODAR), and other findings.
- Solid work.
- Interesting results indicated in the presentation.

Question 4: Project Management

This project was rated **4.3** on its project management.

- Finished under budget and added new tasks.
- Looks well done.
- Very well-managed effort.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Findings widely published and presented.
- Impressive team and work.
- Strong collaboration with university research - indicative that this effort is targeted on a part of the forecasting

effort where the DOE can provide significant support.

Question 6: Proposed Future Research

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

- Not applicable? Appears as though the project is concluding, which is fine. My score is based on 2012 work.
- Not sure what's next for this project, other than additional publication.
- I like the work and the future direction.

Strengths and Weaknesses

Project Strengths
- Demonstrating that stability affects power curves is excellent.
- Stability-specific power curves are a current "big deal" in this field, with good reason.

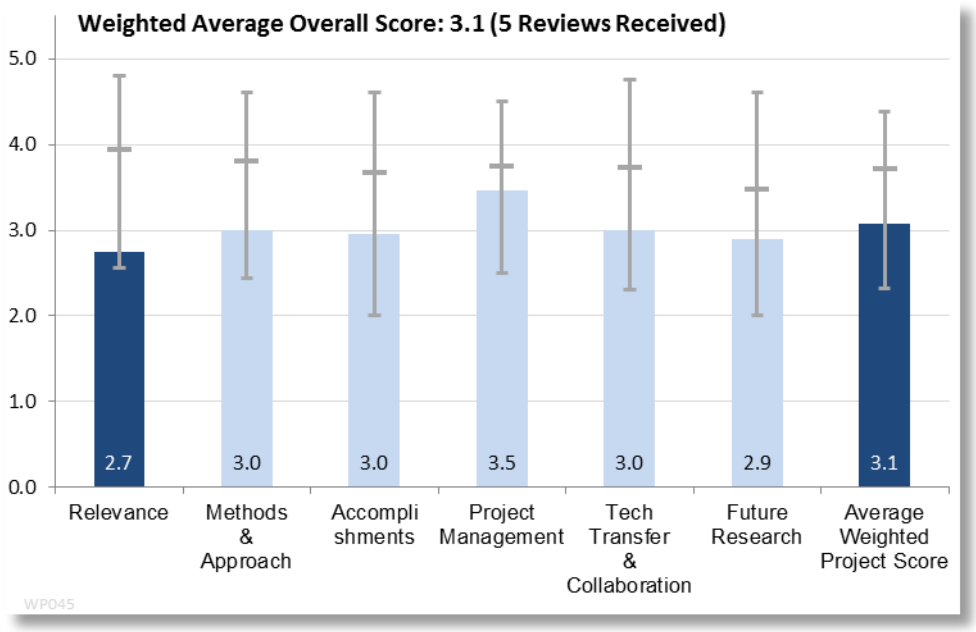
Project Weaknesses
- Not clear to me where the core work is really being done. How much is now at Colorado-Boulder vs. LLNL?

Specific recommendations for additions or deletions to the work scope

- Follow-on work is recommended: could atmospheric stability be quantified and included in publically available information in which wind power forecasting providers draw from?
- I'd like to see work on these topics continue, perhaps at various projects and locations.

WP045: Developing WindSENSE for Control Room Integration
Chandrika Kamath, LLNL
FY 10 Budget: $575,000 DOE $0 Cost-Share
FY 11 Budget: $0 DOE $0 Cost-Share
Project Duration: Dec 2008 - Sep 2012

Brief Summary of Project



We need to understand wind resources better to manage their increased contribution to the grid. Control-room operators schedule wind energy based mainly on the short-term forecasts and the trends of actual generation from previous days. This is a challenge when the forecasts are inaccurate and today's trend does not match yesterday's. The goal of WindSENSE is to provide the control room operators an awareness of the wind conditions and energy forecasts so they can make well-informed scheduling decisions, especially during extreme events such as wind ramps.

WindSENSE supports the Program's mission by enabling an expansion of 'reliable' wind power by addressing barriers to grid integration. By working closely with Bonneville Power Administration (BPA), Southern California Edison (SCE), and California Independent System Operator (CaISO), we are improving their ability to integrate the rapidly increasing wind energy generation into the grid while maintaining its reliability.

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

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

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

- Improving understanding of weather conditions and patterns effects on ramp events and production.
- Identified key weather variables (wind speed, gusts, direction, humidity, temperature) for ramp events.
- I question the general utility of this approach. It may work well in a constrained, special area like the Tehachapi Pass, but little evidence is presented that this data can be integrated into models or be generalized to other locations.
- Appears to be a very narrowly designed program. It is not clear on how the technique tested on this program is providing value.
- It doesn't appear to me that this research will have general applicability.
- I don't believe that a focus on Tehachapi I is warranted; DOE should be looking for subjects that have general applicability across the country.

- I don't know if the DOE needs to be involved in developing tools for control room operators; these entities have capabilities to review and select tools provided by the industry to minimize system costs and maintain reliability.

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

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

- Mined historical data to identify key metrics for specific wind resources.
- Not clear that this has much general value outside of a few special microclimate areas.
- This seems a very small effort - limited data analysis.

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

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

- Showed that the Bonneville Power Administration and SCE have different factors influencing changes in generation.
- How generally useful is this data?
- They've been talking about this project for years, but it is difficult to see that much has changed. What is the recent progress?
- Limited accomplishments were presented for review.

Question 4: Project Management

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

- Under budget and ahead of schedule. Although recently have delayed project waiting for AWS Truepower data.
- Project appears to be adequately managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Collaboration with ISO, industry, and utility leads to great results due to data availability.
- Collaboration has been quite limited.
- Unclear - it does not appear that this work has general applicability, although it has been presented at several conferences.

Question 6: Proposed Future Research

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

- Expansion of WindSENSE to improve accessibility to those creating forecasts.
- Machine learning methods could make sense with this type of data, but assimilating into weather models will probably never work well.

Strengths and Weaknesses

Project Strengths

- Data mining historical data sets shows key variables affecting wind characteristics.
- First historical data mining for forecasting.

Project Weaknesses

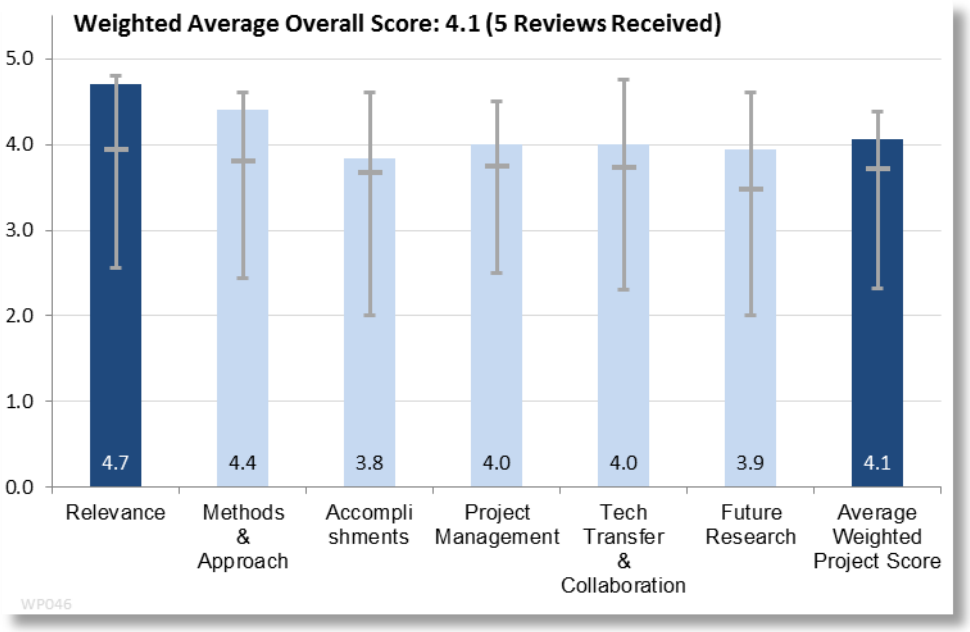
- Are these results applicable everywhere?
- Not clear how this project will be expanded.
- Probably not a general solution - limited widespread utility outside of a few locations.
- I do not see the broad value of this project beyond the specific locations that were studies.
- WindSENSE appears to be a valuable tool, could anyone start using it now?
- Unlikely to be able to assimilate this data into weather models, so utility is limited.

Specific recommendations for additions or deletions to the work scope

- WindSENSE appears to be a valuable tool, could anyone start using it now?
- Further review value and effectiveness of this project.
- Get DOE out of it. Let CEC fund it in California if it has specialized use for SCE and others.

WP046: Resource Modeling and Data Collection
Kirsten Orwig, NREL – presented by Debra Lew
FY 10 Budget: $650,000 DOE $0 Cost-Share
FY 11 Budget: $360,000 DOE $0 Cost-Share
Project Duration: Oct 2009 - Sep 2013

Brief Summary of Project



The needs for wind resource characterization have evolved dramatically over the last several years. Originally, the focus was on high-resolution mapping of resources regionally, nationally, and internationally for locating optimal sites for wind energy development. Today, wind resource characterization covers a broad range of applications including developing and validating modeled inputs for integration studies, wind power forecasting, enhancing metrics for quantifying wind forecast uncertainty, flow characterization and modeling for reducing wind turbine inefficiency and wear and tear, and others. This report focuses on the development and validation of wind datasets for integration studies.

The 2004-2006 mesoscale wind speed and power production data generated for the Western Wind and Solar Integration Study (WWSIS) and the Eastern Wind Integration and Transmission Study (EWITS) were very useful for industry stakeholders beyond the studies themselves. These datasets were developed using what was then the current state of the art in numerical weather prediction (NWP) models. Computational limitations at the time required the model to be periodically restarted and required using numerous overlapping grid domains. The purpose of this work was to validate the original datasets and use the lessons learned to develop a new generation of data.

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

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

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

- Perfecting datasets used for widespread integration studies is absolutely critical.
- Wind planned output from selected sites. Datasets were compared to observations to ensure the variability, capacity factors and forecast errors were realistic.
- This data is critical to wind integration studies, transmission studies and other purposes.
- Wind power modeling data is necessary for regions to conduct wind integration studies.
- Good representation of the application of the project.

- This is an important effort. Improved wind power patterns allow for improvement of a range of systems operations analysis.

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

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

- Erroneous data have been identified and logical means to correct such issues being enacted.
- Appears to be a solid approach, with significant improvements over the prior datasets.
- Technical approach appears to be well-reasoned and sound.

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

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

- Discovered that 2004-2006 data contained periodic false ramps.
- Too early in project to judge this well.
- No technical accomplishments presented – request for proposal for work has been released but no results are available.
- Learning from these and fixing in the next generation of data.

Question 4: Project Management

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

- Identified and addressing issues and errors in original dataset.
- Too soon to tell, but well managed so far. Past work by this group inspires confidence and trust.
- Well managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **4.0** for research integration, collaboration, and technology transfer.

- Entire project hinges on collecting necessary data which requires great collaborative work, this project does that.
- Good discussions and collaboration in preparing request for proposal.
- Good collaboration with industry - this will ensure that the output is useable.

Question 6: Proposed Future Research

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

- Great idea to develop a do-it-yourself variable generation integration study toolkit -- will add standard practices for all to follow.

Strengths and Weaknesses

Project Strengths

- Collecting data from many sources to create large validated datasets that are publicly available.
- Data set is a big leap forward to develop a consistent data set compared to original datasets.
- A consistent, multiyear dataset is needed, and this approach seems sound.
- Wide use of NREL wind data.

Project Weaknesses

- It's impossible to get all data to provide a complete picture so there will always be room for improvement -- subsequent iterations.

Specific recommendations for additions or deletions to the work scope

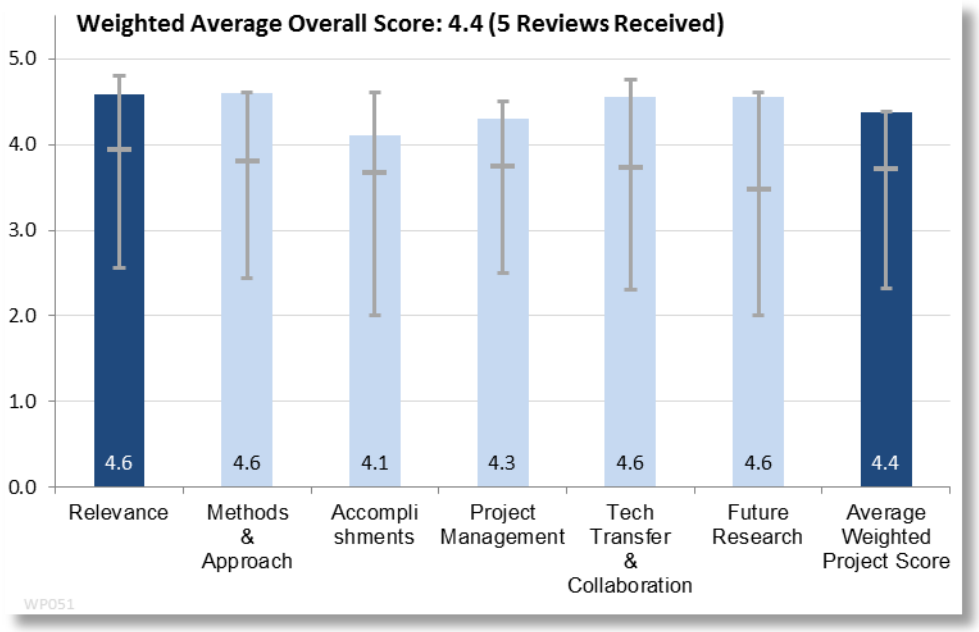
- Key project for integration studies.
- Continue this program and increase collaboration with potential users of database.
- Do it and keep everyone informed.

WP051: Western Wind and Solar Integration Study Phase II

Debra Lew, NREL

FY 10 Budget: $0 DOE $0 Cost-Share
FY 11 Budget: $780,000 DOE $188,000 Cost-Share
Project Duration: Oct 2009 - Sep 2013

Brief Summary of Project



The Western Wind and Solar Integration Study (WWSIS) tackles the issue of wear-and-tear costs and emissions impacts from wind-induced cycling and ramping of fossil generation in Western Electricity Coordinating Council (WECC). High wind penetrations cause conventional generation to cycle on and off and ramp more frequently. Many utilities believe the wear-and-tear costs and emissions impacts from this operation will significantly negate the cost and emissions benefits of wind. In fact, there is analysis that supports that emissions belief that has been widely publicized. WWSIS obtains high fidelity data on wear and tear cost data and impacts and emissions and inputs this new data into a 5-minute production simulation model to determine the impact of wind-induced cycling and ramping of fossil generation. WWSIS will then examine mitigation options (e.g., plant upgrades, modifications to operations/procedures, other infrastructure options) to reduce this impact and run these as sensitivities. WWSIS has 4 scenarios which consider the impact of wind versus solar and increasing wind penetration levels. In 9/2012, a report on the result of these simulations, mitigation options and sensitivities will be completed. FY13 work will consider frequency response in these scenarios. The wind/utility/regulatory community will benefit from WWSIS by putting to rest this question of wear-and-tear and emissions impacts.

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

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

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

- One of the most used and quoted reports in wind integration discussions.
- Valuable grid integration study. Phase I demonstrated feasibility. This stage addressed issues of cycling fossil units.
- Huge return on investment from this work.
- Clarifying myths is necessary to remove (perceived) deployment barriers.
- This is an important effort to understand the systems impacts of increased renewables.
- Meets deployment barrier removal and optimization of output objectives.

- Critical to renewable energy acceptance and deployment in the utility and ISO space.
- Limited focus on emissions rates from existing thermal units.
- Given the potentially limited economic viability of traditional solid-fuel generation technologies, this study provides good information but may have limited long-term applicability.

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

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

- Additional elements of cycling costs and emissions will be well received.
- Examined wear and tear as well as emissions increase issues.
- Very well done.
- Convincing approach.
- Appropriate methodology.
- Acquired needed data from source that has done extensive studies around world.
- Researchers should benchmark this study with operational results over the past 6 months, during which time reduced natural gas prices may have created unit operational scenarios that could inform this study.
- Got EPA emissions data base and estimated incremental emissions data.
- Got higher resolution wind and solar data.
- Generated and analyzed scenarios.
- Used PLEXOS model in house.

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

This project was rated **4.1** based on technical accomplishments and progress.

- Can now run PLEXOS model in house.
- Impressive results in a sensitive (and very important) area.
- Convincing study, impact depends on the dissemination of results to policy makers and broader audience, not yet carried out.
- Currently waiting on PLEXOS model run results.
- Developed and analyzed scenarios.

Question 4: Project Management

This project was rated **4.3** on its project management.

- See no issues here.
- Good that can now run PLEXOS internally.
- Very high return on DOE investment.
- On track.
- Good project management.
- Cost share with Office of Electricity and EERE Solar Program.
- Principal Investigator's abilities to run these studies and communicate the value of the work are outstanding.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Highly collaborative effort to get right.
- Large number of collaborators including key stakeholders.
- Technical Review Committee approach has been very effective in getting the larger system operator community engaged.
- Good national partnerships, international cooperation may make the message more convincing to a broader audience.
- Very good collaboration leveraging industry capabilities and publications.
- What does it take to get more folks involved to contribute additional datasets?
- Good Technical Review Committee.
- Great technology transfer; material reaching wide audience.

Question 6: Proposed Future Research

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

- Wind impacts on frequency response is a critical area to improve understanding as penetration of variable generation increases.
- Want to look at frequency response in FY 2013.
- Proposed research (frequency, transient response, etc.) is critical to head off future concerns/issues from grid operators.
- Proposed research is essential.

Strengths and Weaknesses

Project Strengths
- WECC wide integration study -- Only of its kind.
- Very valuable to have these databases. Very appropriate role for federal government.
- These lines of studies, the Western Wind and Solar Integration Study (WWSIS), are foundational work in supporting wind and solar deployment for the west.
- Now have valuable tool for many investigations, such as wind-gas dialogue started by Wind Energy Foundation.

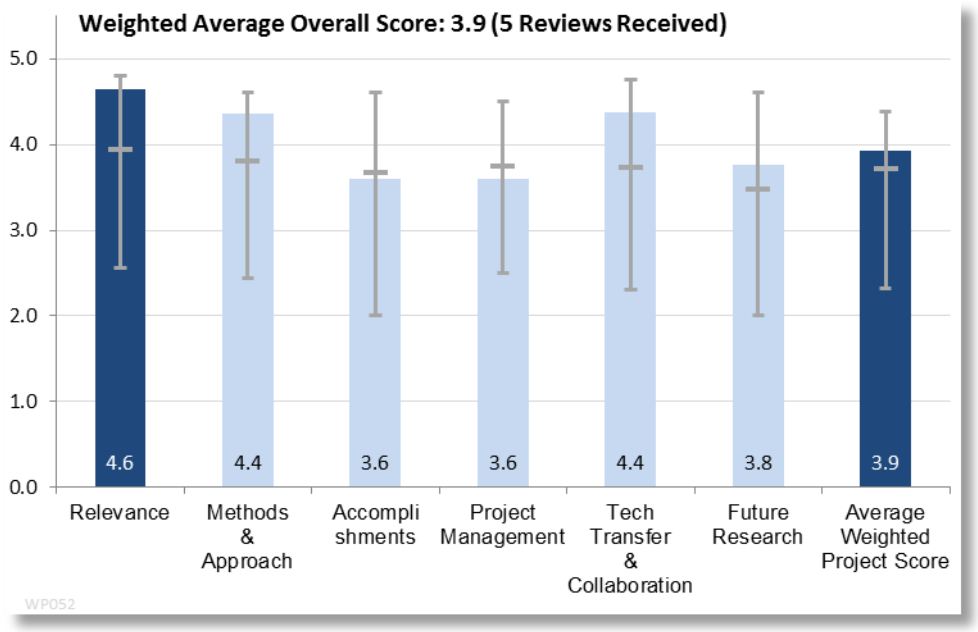
Project Weaknesses
- Does the study reflect intended Utility/ISO developments? E.g. storage.
- Can the message reach and convince the appropriate audience?

Specific recommendations for additions or deletions to the work scope

- Can't say enough about how valuable this study is.
- Expand stakeholder contacts to include gas supply side (producers, pipelines, need for storage).
- Vital work that should be continued and supported.
- Good work, continue to deal with myth and old philosophies for power system operation.
- Include possible methane emissions from gas supply side, formation to burner tip.

WP052: Eastern Renewable Generation Integration Study
Kara Clark, NREL – presented by Debra Lew
FY 10 Budget: $300,000 DOE $0 Cost-Share
FY 11 Budget: $670,000 DOE $0 Cost-Share
Project Duration: Jun 2010 - Dec 2013

Brief Summary of Project



The Eastern Renewable Generation Integration Study (ERGIS) will analyze selected follow-up items identified at the end of the Eastern Wind Integration and Transmission Study (EWITS), including more detailed analysis of reserve requirements, regional impacts and results, mitigation strategies (e.g., demand response), and system robustness via sensitivities (e.g., transmission expansion). The project is focused on identifying the impact of significant renewable penetrations (e.g., 30%) on grid operation. It includes significant new analysis of operating and reserve strategies and ramping requirements via statistical analysis, as well as of the impact of sub hourly scheduling. Results will be summarized for each of the large operating regions to identify regional commonalities and differences. These regional results, rather than interconnection wide, will allow the various regions to develop custom action plans and integration strategies.

ERGIS also places additional emphasis on developing new analytical capabilities by using the PLEXOS software to perform production simulation analyses. Addressing the sub-hourly variability of renewable generation is an on-going stretch for other such analysis tools, which are hourly. By advancing the analytical state of the art, this study will increase the credibility of the results from this and other integration studies.

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

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

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

- Addressed previous criticism from the first iteration.
- Needed follow up from EWITS.
- Very important, and even more challenging for WWSIS Phase 2 due to both political and wind data issues.
- Important for informed decision making.
- Important work to assess impact of renewables integration.
- It seems unfortunate that the wind generation dataset required a significant fix.

- Actual outputs of this study are not clear - appears to be a more fundamental component of the analysis - correcting wind input data and implementing the plexos model for future studies.
- But developing this underlying analytical capability is very important.

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

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

- Are correcting eastern wind data set.
- Good, but there are untested risks with new PLEXOS model of Eastern Interconnect.
- Relevant scenario.
- Methodology appears workable and appropriate.
- Using PLEXOS model in house. This will be first application of eastern data set.
- Three scenarios for 2020. Base case, then two 25% wind 5% solar scenarios.

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

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

- Work in progress. No reason to think won't be highly successful especially that previous criticism has been neutralized.
- Found 12 hour wind data set anomaly and working to fix it.
- Solid work. Doesn't feel as "tight and solid" as WWSIS just yet, but still early in the process.
- Early phase, data problems encountered.
- Limited progress displayed at this time - project still has considerable work left to be done.
- AWS has provided revised data set.

Question 4: Project Management

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

- See no issues here.
- Some delays because of data correction issue and first time using PLEXOS with eastern database.
- Some delays due to technical issues.
- Okay, some delay.
- Slippage on model development - this probably was unavoidable.
- Technical review committee working well although requires time it provides credibility and improves results.
- May require politically astute leadership going forward, but project leadership is experienced and good.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Technical review committee pulling many voices to make sure the effort meets the various needs
- Technical review committee good. Stakeholders involved.
- Great to get all the system operators engaged through the technical review committee process.
- Regional collaboration, plans for dissemination, not yet carried out.
- Good collaboration with market stakeholders and industry.

- Solar an increasing focus in east.

Question 6: Proposed Future Research

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

- Solar is much less understood on the east coast so improving the understanding there will be important.
- Higher solar scenarios and higher coal retirements.
- Future solar work would be a good idea.
- Relevant, but not very specific.

Strengths and Weaknesses

Project Strengths
- As a result of criticism from last iteration, this iteration will be more well received having taken into account the various comments.
- Will provide first PLEXOS capability for East.
- This is very important work and serves to engage the larger utility and ISO communities.
- Independent study.
- Good technical review committee and stakeholder input.

Project Weaknesses
- Problems with wind data base, need to ramp up PLEXOS database.
- Impact?

Specific recommendations for additions or deletions to the work scope

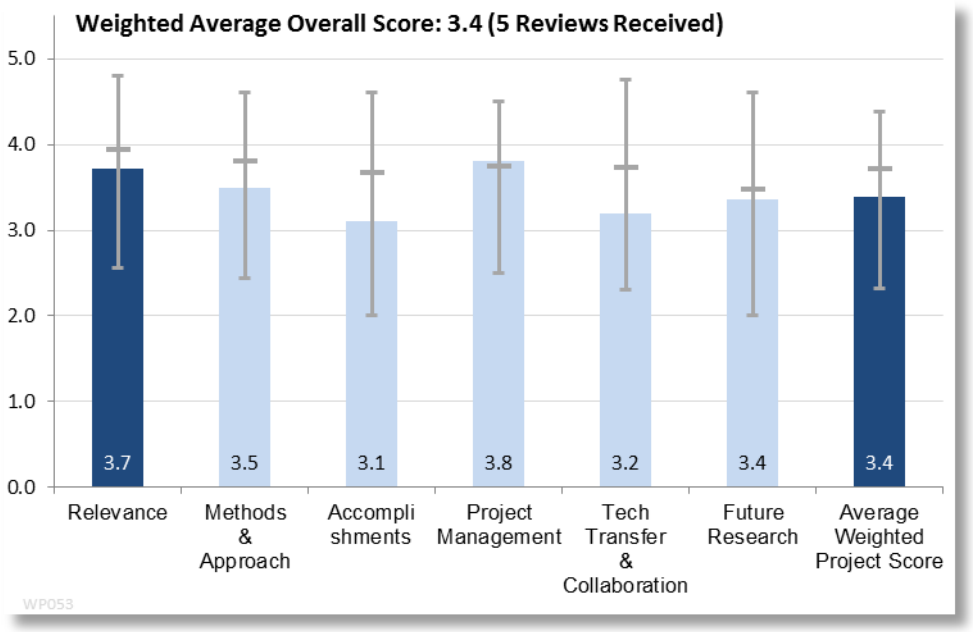
- These are critical to understanding impending issues to increasing penetration of variable generation.
- Keep working to improve, as is a valuable tool.
- Important to continue/expand this work and engage eastern grid operators and market participants.
- Ensure coordination with Eastern Interconnection Planning Collaborative transmission planning.

WP053: Concurrent Cooling – Increasing Transmission Capacities With Dynamic Monitoring Systems

Kurt Myers, INL

FY 10 Budget: $175,000 DOE $100,000 Cost-Share
FY 11 Budget: $300,000 DOE $250,000 Cost-Share
Project Duration: Oct 2011 - Sep 2013

Brief Summary of Project



Idaho National Laboratory (INL) and Idaho Power (IPCo) are working on a project to monitor and model wind and other data parameters along certain electrical transmission corridors. This real-time and historical data is being used for wind, thermal and electrical capacity modeling and validation, and to determine possibilities for dynamic transmission operation. The project is currently implementing a demonstration system that power system operators may use in the future to make decisions about existing transmission conditions and use, and for future transmission planning. The results may also be used to determine if partial upgrades to certain areas/sections of the lines are feasible in order to limit or postpone the need for full line upgrades or new transmission lines in certain cases.

As part of the study, INL and IPCo are implementing a real-time dynamic line rating system along transmission lines using instrumentation mounted on the existing lines and poles. Data includes 3-5 minute averaged wind data, including wind speed, wind direction, ambient air temperature, conductor temperature, and solar radiation. These parameters are being used to better calculate and manage the line ampacity ratings with respect to conductor thermal limits. Preliminary findings show that line ratings can be increased at least 10-30% over significant periods of time in the area of study, and sometimes well over 30% within certain areas and times.

Findings will allow existing lines to be better utilized based upon actual line characteristics and the localized weather and wind conditions rather than being derated to allow for the rare, worst case circumstances that are currently used. Continued analysis of different historical cases to show the effects of concurrent cooling via monitored wind and other data along the selected transmission corridor in Southern Idaho will allow system planners to better regulate power flows and increase emergency ampacity ratings under certain conditions.

Maximizing the existing capabilities of transmission will allow better penetration of renewable resources onto the electrical grid, something that will be internationally recognized and implemented.

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

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

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

- The focus of this work to increase capacity of transmission lines is good.
- Meets deployment barriers, resource and operating objectives.
- Dynamic line rating is a long-standing problem, and actual use is challenging, so mixed feelings on how much impact the work may have.
- Transmission capacity a barrier, increase by monitoring a cost effective way for moderate increase.
- Interesting area of study. Given limited funding requirements this appears to provide a good return of useful information to investment.
- As the sole piece of work looking at transmission issues, I've missed the reason for zeroing in on dynamic line rating.
- Maximizing the use of the existing system has the potential to increase the ability to integrate wind resources.
- One key issue regarding transmission lines is that capacity is reserved statically (on large lines), a study demonstrating benefits for dynamically reserving capacity, or for example selling unused capacity, would be useful.
- Cost-effectiveness discussion during presentation was helpful. The ability to use this as a retrofit technology on existing lines also increases the potential benefit.

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

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

- What about using satellite models?
- Good work plan to use a specific region to investigate dynamic features.
- Is CFD, with the WindSim tool, up to the task of dealing with the full range of wind variability?
- Interesting use of weather stations to define wind impacts on line ratings. Unclear if this is the most cost-effective technology to define any incremental available transmission capacity given ambient conditions.
- Temperature sensors don't tell the same information as wind sensors?
- Does this compete with private sector solutions?
- How important are local wind speed measurements?

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

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

- No results have been presented to indicate that the approach will work.
- Installed data loggers, developing communications systems.
- Significant budget and effort - not sure on the cost/benefit payoff.
- Good progress.
- No results presented at this time.

Question 4: Project Management

This project was rated **3.8** on its project management.

- Milestones are on schedule.
- On schedule. Slight budget increase to enhance scope.

- Difficult to judge. Seems OK given the project design.
- Good - maintaining project timeline.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- It's not apparent to me that other Transmission System Opertors see this as an area of interest for R&D: collaboration with other utilities? Industry?
- Key collaboration established with the Idaho Power Company (utility).
- Some, but seems relatively limited.
- Primarily regional collaboration, some limited international cooperative.
- Good collaboration and cost-sharing.
- Good information dissemination.

Question 6: Proposed Future Research

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

- The proposed research seems like it should have been the first iteration of this work? Benchmarking of measurement technologies should come before implementation of a selected technology in my opinion.
- Additional testing of line measurement technologies and computational methods.
- Quite a list, but priorities are not obvious to me.
- Appears to be significant potential to leverage this current work for future studies.

Strengths and Weaknesses

Project Strengths
- Intends on demonstrating that dynamic line rating should lead to better use of line capacity.
- Good work plan.
- It would be great to get more capacity out of existing transmission lines.
- Large demonstration effect.
- Excellent partner in the Idaho Power Company. Includes cost sharing.

Project Weaknesses
- The lack of collaboration with other Transmission Systems Operators/Utilities.
- Not sure that WindSim is the best approach.
- Only regional participation.

Specific recommendations for additions or deletions to the work scope

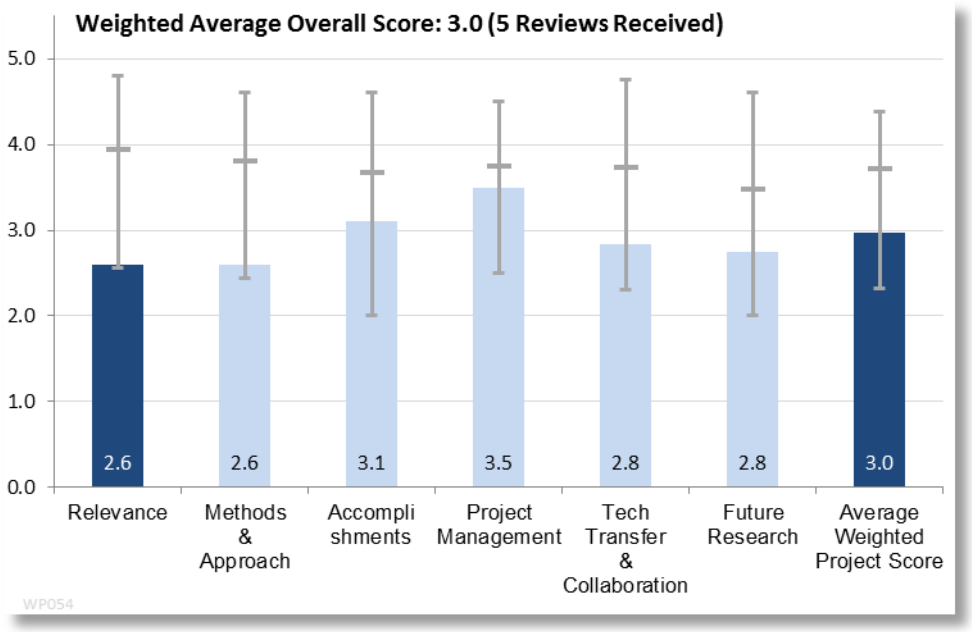
- Better utilization of existing transmission assets should be explored as this project does.
- Complete project and disseminate results widely.
- Mixed feelings. Certainly an important issue that would be great if we can solve the problem, but a more holistic solution with more diverse stakeholder buy-in would be more attractive.
- Continue this work.
- Explore other additional opportunities for increasing use of transmission lines, e.g. dynamically reserving transmission capacity based on need.

WP054: Wind Plant Collector System Design & Protection

Travis Smith, ORNL

FY 10 Budget: $400,000 DOE $0 Cost-Share
FY 11 Budget: $300,000 DOE $0 Cost-Share
Project Duration: Oct 2010 - Sep 2012

Brief Summary of Project



Objectives of this project involves Institute of Electrical and Electronics Engineers (IEEE) support (Power System Relaying Committee & Transmission & Distribution) and Industry Collaboration to address research gaps, utility involvement for understanding interconnection and short circuit characteristics, defining the different types of wind generation and the short circuit characteristics for plant and transmission grid interconnection. Developers, Engineers, Utilities, Wind Turbine & Power System Equipment Manufacturers, and Research organizations will benefit from this research and industry involvement. The endpoint for this project will be a standard for wind plant collector system design and methods for analytically determining the short circuit characteristics for utility and wind plant for use in protection coordination and analysis. Initial planning has been started in the working groups to create this standard. This project advances the industry through dissemination of knowledge and models for proper protective device coordination that provides increased security and reliability of power grid and wind plants. The appropriate protection for short circuit events, grounding system design, insulation coordination, and arc flash hazards is crucial for utility and wind plants.

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

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

This project earned a score of **2.6** for its relevance to wind industry needs and overall DOE objectives.

- Clearly system protection issues are important, but I'm missing the importance and urgency of this work.
- May meet identified barriers but unclear to this reviewer whether this is a frequent problem in the field.
- I like the IEEE involvement, but I'm less sure on the level of impact to the larger system operator and wind operator community.
- Communication and contributions to standards development important.
- This analysis does not appear to be designed to provide significant benefits to the overall DOE effort
- The goals of this project are not clear to me.

- Detailed Electro Magnetic Transients Program-type modeling is necessary to understand the full implications of wind integration, but it requires a significant effort. This study appears to be far too limited to provide benefit.

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

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

- Project missing an element of peer-reviewed validation of models.
- Created Power System Relay Committee whitepaper. Appear to be making good use of IEEE committee system.
- This is probably important "heavy lifting" that is needed and important for the electrical engineering issues around wind deployment.
- Expert contribution to IEEE working groups, miss discussions with wind turbine industry.
- Methodology is unclear and not designed to be vetted by appropriate outside parties.
- What are the methods? Approach?

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

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

- Papers have been published, but what are the results of this work?
- White paper created.
- Progress seems good.
- Very productive.
- Significant effort to disseminate information, but it appears that information is of superficial use.
- IEEE recognition.

Question 4: Project Management

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

- I see no issues here with management, but it’s also unclear to me on how to measure success.
- Met milestones and deliverables.
- Difficult to judge, as I don't know the required effort, but seems okay.
- One person effort.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Working through IEEE committee memberships.
- Important connections/support with IEEE and some universities.
- Cooperation with the Gogte Institute of Technology and within IEEE. No international collaboration or cooperation with turbine industries. Large number of papers.
- Good tech transfer efforts; poor collaboration efforts.
- Reached out to utilities including Southern and American Electric Power.
- Would be great to involve system operators and utilities more broadly.

Question 6: Proposed Future Research

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

- Although the topic is valuable, I do not understand what the scope, approach and methods and products are.
- Developing Test Case for 100 MW wind plant.

Strengths and Weaknesses

Project Strengths
- Using IEEE system.
- Deep in the reality of electrical engineering, so challenging for many people to grasp, but probably important that this is done.

Project Weaknesses
- If this is an important topic, it requires a team including labs, academics, and key players in wind industry.
- Unclear why this needs federal lab involvement.
- Challenging to explain and get non-EE folks engaged.

Specific recommendations for additions or deletions to the work scope

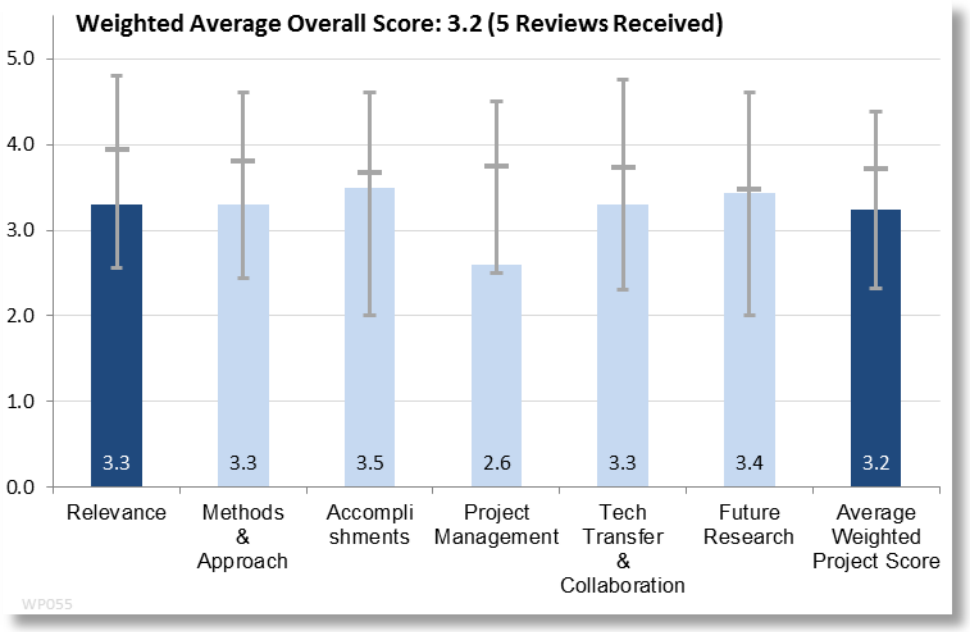
- Clarify rationale for why this is a problem that needs national lab role as opposed to commercial wind park electrical designers.
- To the extent I can judge, my perception is that this is important work and should be supported, but it would be great to have a "larger stakeholder" approach (although the IEEE standards work is also very important and he seems to be doing well there).

WP055: Benefits of Balancing Authorities Cooperation Across the Western Interconnection

Nader Samaan, PNNL

FY 10 Budget: $600,000 DOE $0 Cost-Share
FY 11 Budget: $400,000 DOE $250,000 Cost-Share
Project Duration: Feb 2010 - Sep 2012

Brief Summary of Project



As wind and solar penetration increases in each of the 37 balancing authorities (BAs) in the Western Interconnection, it becomes more challenging and costly for the individual BAs to operate independently from one another due to the difficulty associated with managing variable sources of energy within a given system. Cooperation among BAs can facilitate high-level penetration of variable generation without significant increase in power grid operating cost because the collective impact of variability and uncertainty is accumulated over a large geographic area, across multiple distributed resources, and combined with all other sources of variability and intermittency (including system load). The project objective is to demonstrate the benefits of BAs consolidation through the development and utilization of a detailed model and methodology. The study is working to determine the savings in production cost and reduction in balancing reserve requirements in the Western Electricity Coordinating Council (WECC) system. The effect of transmission congestion on potential benefits is evaluated. In addition, the benefits of intra-hour (10-min) scheduling for the current WECC BAs structure are being assessed. The analysis is being performed for two different scenarios of variable generation penetration: 11% (8% wind & 3% solar) and 33% (24% wind & 9% solar) of WECC projected energy demand in 2020. The study outcomes, which will be published in a final report on October 2012, represent an upper bound of potential benefits and provide the evidence needed to motivate BA cooperation to enable higher levels of renewable penetration.

An Energy Imbalance Market (EIM) represents another form of cooperation between BAs. Currently, different versions of the EIM are under consideration in the WECC system. The capital and annual costs of these markets have been already evaluated, but the benefits remain largely unknown. This project helps to address this problem by building models, methodologies, and providing target values for expected benefits. This is a must-do step before making decisions on multimillion-dollar investments into the EIM. As such, BA cooperation methods will be implemented that will allow the fast growth of wind energy enabling the achievement of DOE goal of 20% wind by 2030.

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

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

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

- This project is interesting on paper but the intended results do not reflect the reality of any expectation of the future of the Western Interconnection.
- Further demonstration of value of balancing authority cooperation would aid achievement of barrier reduction and optimization objectives.
- Important topic, but the approach and results are very unclear and a golden opportunity to advance understanding in WECC may be wasted.
- BA cooperation meets DOE objectives.
- Overall this is an area where the DOE can support the industry through facilitating regional analysis.
- This is a complicated area of study. Availability of existing tools to conduct this type of research is limited.
- Study appears to be targeted at an extremely appropriate area of study. Due to project delays, and poor overall communication of the presentation, it was difficult to determine the value of this research.

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

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

- Three of the four scenarios will produce results that are too unrealistic to be useful -- even as "book ends" (Scenario 4 is relevant).
- Using PROMOD and PLEXOS to analyze coordination benefits. Seeking to establish high end range of potential benefits.
- Generally good. Important to really communicate the key findings in a clear manner.
- Support of WECC variable generation subcommittee with studies.
- Difficult to determine due to poor communication of results.
- Two penetration cases 11% and 33% by 2020.

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

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

- Completed analysis of 11% variable generation penetration. Found 2.4-3.2% benefits ($400-600MM/yr).
- The intent is good. Forcing PLEXOS to 10-minute analysis appears to have been difficult. Clarity around understanding the project could be better.
- Study results show significant advantages of BA cooperation.
- Results were hard to judge given time limitations and poor presentation of results.
- Built model of WECC database that can be used in other studies.

Question 4: Project Management

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

- Significant delays.
- Delays of several months experienced due to data delays, WECC contracting delays, difficulty of building a 10 minute model.
- Complex project, but quite a few delays (probably not under their control).
- Several delays.

- Significant delays across project.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.3** for research integration, collaboration, and technology transfer.

- Decent collaborative effort.
- Working with WECC, NREL. But cooperation apparently not enough to keep on schedule.
- Great to get WECC participants involved and working together on these issues.
- Secured through WECC subcommittee.
- Limited collaboration with other labs.
- Lack of a full and active technical review committee is a serious flaw.

Question 6: Proposed Future Research

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

- Suggested research starting to reflect more realistic scenarios of future BA cooperation.
- Can use tool and models for other scenarios and cooperation methods.
- Important tasks to be done, but not clear that PNNL is the best one to do them.
- Very general description.
- Results must be very clearly communicated and tactfully publicized.

Strengths and Weaknesses

Project Strengths
- Looking to provide a best-case scenario for BA cooperation in sharing regulation services.
- Tools built may be able to strengthen case for BA coordination and cooperation with significant potential savings and penetration increase.
- The work is critical to moving WECC ahead, but must be done right.
- Independent study

Project Weaknesses
- The study does not represent any real expected future state of the Westconnect.
- Project has been behind schedule and unclear how effective the dissemination plan will be.
- Not obvious that PNNL is the best at leading and explaining this work.
- Not having a big enough of an impact.
- Are State policies represented in this analysis?

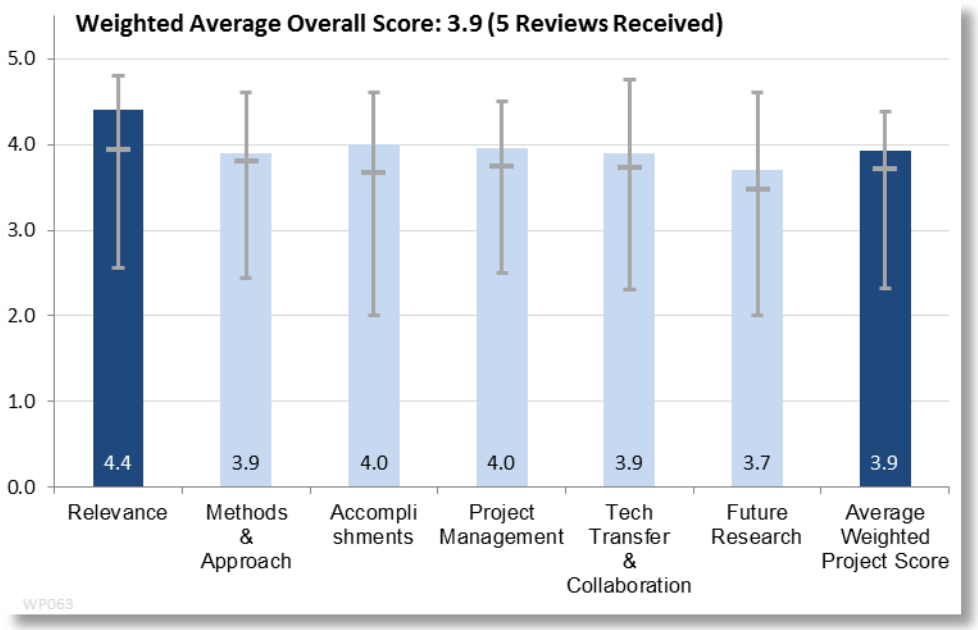
Specific recommendations for additions or deletions to the work scope

- Complete work and if study results are as strong as hoped develop and implement stronger dissemination plan.
- The work is very important, but need to improve the clarity around explaining the results and broadly communicating the value and key findings.
- The clarity and execution is poor, and it feels like a wonderful opportunity is not being exploited to its full potential.

WP063: Wind Power Plant Modeling
Ben Karlson, SNL
FY 10 Budget: $500,000 DOE $0 Cost-Share
FY 11 Budget: $300,000 DOE $0 Cost-Share
Project Duration: Oct 2010 - Sep 2012

Brief Summary of Project

Positive-sequence power flow and dynamic models are routinely used for simulation and planning of power system networks. As more wind power plants interconnect with the electric power system, it becomes increasingly important that they are properly modeled in power system simulations. The development and validation of these planning models for wind power plants continues to be a high priority for the industry.



This work is a continuation on previous years' work to develop adequate power system simulation models for wind power plants and to ensure widespread adoption of models for interconnection and grid planning studies. Models for all four wind turbine generator types exist across multiple platforms but have not been adequately validated in field operation.

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

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

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

- Generic models for WTG's are needed by everyone to complete wind plant studies interaction with the grid.
- Publicly available wind turbine models are needed to facilitate acceptance of wind plants by utility planners. Having same will help achieve deployment and operational objectives.
- Important foundational work for the industry, to support interconnection of wind energy systems.
- Accurate modeling is important for system simulations and planning.
- Critical importance.
- Vital that models are available that accurately represent behavior of wind plants on the system.
- Validation is the next frontier.
- There is an increasing need for market available Electro Magnetic Transients Program type models for wind turbines - future funding opportunity.

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

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

- Validating models using real WTGs.
- Updating first generation models a reliable approach.
- Solid approach.
- Continuous development of models.
- This is a continuing research effort - methods have been appropriate.

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

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

- All four types of WTG have been validated.
- Four first generation models in use.
- Continuous development of models, providing input to national bodies and IEC.
- Good accomplishments - 1st generation generic models complete.

Question 4: Project Management

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

- Some schedule delay.
- All but one milestone met. On budget.
- Well managed and with good collaboration.
- On track.
- Good maintenance of project schedules.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Highly collaborative effort.
- Good slate of partners: WECC, NERC, IEEE committees, NREL and others.
- Good engagement.
- Broad interaction with industry but unclear interface to NREL activities.
- Very good collaboration with industry; availability of models going forward provides benefits to a range of stakeholders.
- Great tech transfer. Models will be available to public.
- Number of papers and presentations presented.

Question 6: Proposed Future Research

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

- Not completely clear that the further research is in addition to this project or recommended new project work.
- Validate and standardize across platforms.

- As noted, ongoing validation with high level of stakeholder engagement and NERC involvement is very important.
- Continued effort, limited description.

Strengths and Weaknesses

Project Strengths
- This work will reach a very wide audience and will be a valuable resource.
- Building on first generation models reduces project risk.
- Important work for wind plant interconnect and system planning.
- Strong ties to WECC, NERC, and IEEE.

Project Weaknesses
- Models are based on steady-state analysis?

Specific recommendations for additions or deletions to the work scope

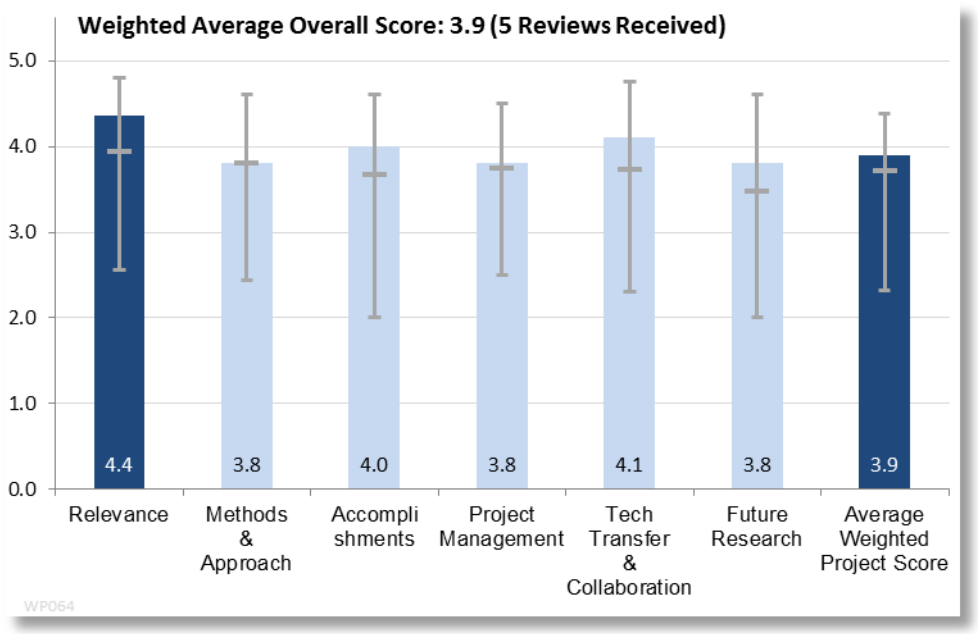
- Continue work.
- Important to continue, with high level of collaboration and engagement.
- Extend the international cooperation.

WP064: Generator Modeling

Eduard Muljadi, NREL

FY 10 Budget: $600,000 DOE $0 Cost-Share
FY 11 Budget: $450,000 DOE $0 Cost-Share
Project Duration: Oct 2009 - Sep 2012

Brief Summary of Project



Objectives:

- Develop generic dynamic models of four different types of wind turbine generators available for public users to allow power system planners, wind developers, researchers perform various studies of power system impact and interaction with wind turbine generator and wind power plant.
- Support the development, revision, improvement, and validation of wind turbine dynamic models in Power System Simulator and Positive Sequence Load Flow, and expand the work on wind turbine generator modeling to other software platforms commonly used by power system engineers.

Who will benefit?

- The availability of public domain computer modules of different types of wind turbines dynamic models for power system analysis will benefit: Utility planners, System Operators, Wind Plant Developers/Operators, Wind Turbine Manufacturers, Researchers, and Universities without the need of Non-Disclosure Agreement among many parties.
- Along with public domain computer modules, we perform several case studies to investigate various aspects of power system dynamics. Reports have been published in the conferences, journals, and the IEEE Transactions.
- With availability of planning tools and valuable references accessible to more peoples, we can overcome the barriers and reach our national goals of wind and renewable energy deployment on a fast track without delay.

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

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

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

- Wind plant facility modeling using generic WTG models completing the picture and usability of these models so that they can be integrated into power systems software and used by appropriate audience.

- Adds to generator models needed to facilitate utility and system planning for wind. Will help achieve deployment and optimization objectives.
- Closely linked to WP063, with both providing important service to the industry.
- Models essential for deployment planning.
- This is work through which DOE funding can provide significant benefit.
- Work needs to be continued - progress has been made, but significant challenges remain, both in developing new models and in existing model validation.
- PSCAD models will be of significant importance in the future.

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

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

- Developing generic models that can be used with a variety of standard planning tools. First generation by WECC funded by CEC.
- Solid and seems to be well thought out.
- Very similar to Sandia effort, use PSCAD.
- Methodology appears appropriate.

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

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

- Models have been created.
- First generation models developed and approved. Equivalence method as well. Ongoing updating effort as OEMs changes products.
- Good work on a subject that is important for electrical engineering issues.
- Good progress and broad cooperation.
- Progress in developing available models has been good.

Question 4: Project Management

This project was rated **3.8** on its project management.

- See no issues here.
- Several milestones substantially late.
- Seems well done.
- Project appears to be well-managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Project has many collaborators including end users.
- Working with WECC, CEC, NREL, and other key groups.
- Good collaboration through IEEE, WECC, Sandia and others.
- Broad national collaboration and dissemination, international collaboration through IEC and IEA.
- Good collaboration through ongoing work activities with industry groups.
- Presented at WECC and IEEE workshops, 20 technical papers.

Question 6: Proposed Future Research

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

- Continuous effort to reach a point when there is a valid model for representing wind facilities interconnected to the power system.
- Keep up with changes in OEMs, regulatory requirements.
- It looks like this work is wrapping up and will be folded into wind power plant modeling efforts.
- Wind power plant modeling important for system modeling and planning. Very ambitious.
- A very strong list of future research avenues.
- Refocus to wind plants rather than single turbines.

Strengths and Weaknesses

Project Strengths

- Building on first generation models.
- Solid work on an important (highly technical) topic.
- Good links into WECC, IEEE and other key bodies.

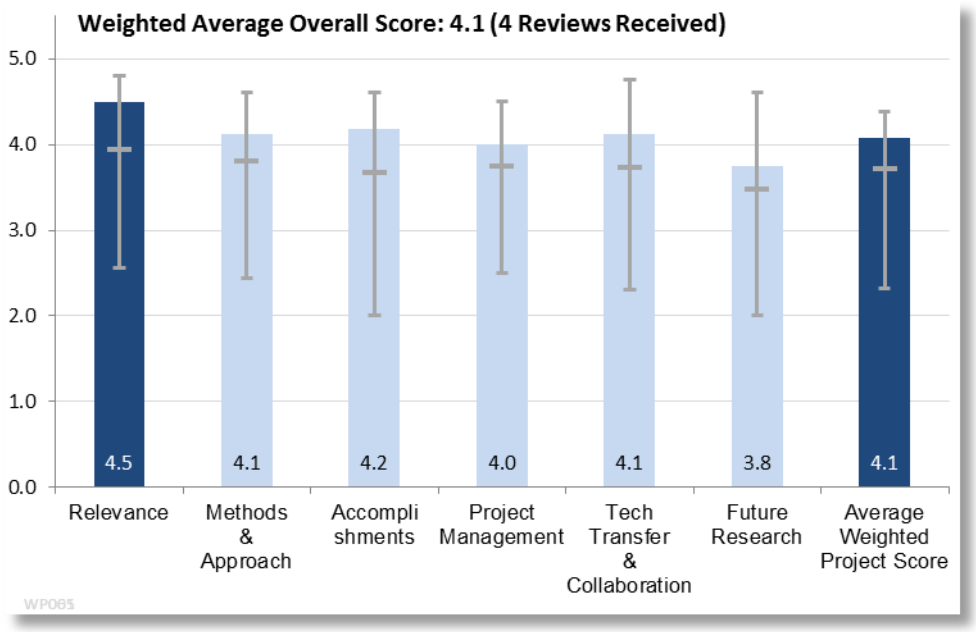
Project Weaknesses

Specific recommendations for additions or deletions to the work scope

- Continue work.
- It looks like the research side of this effort is generally wrapping up and will be folded in to wind power plant modeling efforts.
- Formalize the coordination with Sandia.
- Important to maintain and update the models with changing generator models.

WP065: Operational Strategies, Modeling and Analysis
Michael Milligan, NREL
FY 10 Budget: $1,581,000 DOE $0 Cost-Share
FY 11 Budget: $850,000 DOE $0 Cost-Share
Project Duration: Jan 2010 - Sep 2012

Brief Summary of Project



Operational Strategies:
The objectives of this project are to improve the reliable and economic integration of wind into the power system. This work is broken down into the following topics: (1) develop the framework to analyze operating reserve impacts, so that future work can build on this effort (2) undertake foundational analysis to determine if there are conditions that might make it economic for wind turbines to provide frequency regulation (3) analyze promising mechanisms for balancing-area coordination in the Pacific Northwest, (4) Develop a project scoping document with hydro stakeholders to analyze the potential of hydro power to help with wind integration.

Modeling and Analysis:
The task objectives were to initiate new modeling techniques to answer questions from wind integration studies that couldn't be answered with the current available models. In particular, the task included first initiating the development of a model that simulated multiple power system operations time scales, utilizing a better understanding of variability and uncertainty impacts of wind and deployment of operating reserves. The task also included developing a better understating of the impacts of modeling wind uncertainty using advanced unit commitment models.

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

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

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

- Great subject. Utilities and ISO working on planning studies need results from work like this to better understand reserve requirements of wind power as well as to learn about alternative ways to firm wind power such as market mechanisms.
- Alternative operating strategies could contribute to more optimal operations.
- This has been very important and very influential work.
- DOE has a significant role to play in this area.

- Project includes modeling (FESTIV Model and enhancements).
- A talented and well respected team. Thankfully, their talents and work are now flowing into next-generation projects. This should be supported.
- There is a significant need for tools that allow system operators to evaluate operational strategies to minimize cost of integrating wind.

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

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

- Identifying operating reserve strategies, treat wind as possible source of flexibility, look at other operating structures.
- Viewed as top people in the field - doing very good work, good papers and good communication of results.
- Little detail.
- Appropriate methodology.
- Upgrading FESTIV model.

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

This project was rated **4.2** based on technical accomplishments and progress.

- Great progress.
- Did simulations that led to current project.
- Very solid.
- Completed project, little detail on accomplishments.
- Good progress to date.
- Showed how the Bonneville Power Administration could improve its operations.
- Showed how could use the models for automatic general control impacts, system uncertainty and variability.

Question 4: Project Management

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

- No issues here.
- On schedule. Task ended.
- No concerns.
- Project completed.
- Project appears to be well-managed.
- Subcontract model delayed but now complete.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Good collaborative effort.
- Very good collaborators and influential in the industry.
- Broad national and international collaboration.
- Good representative publications and collaboration with individuals in industry and research.

Question 6: Proposed Future Research

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

- Improve understanding of integration needs for higher penetrations of wind power. This information is relevant now.
- This work task has been largely completed (and well done), but work has flowed into other important new projects.

Strengths and Weaknesses

Project Strengths

- This project addresses one of the critical topics being looked at anywhere there is or will likely be wind facilities.
- Great work, very influential, and has now flowed into other important projects.

Project Weaknesses

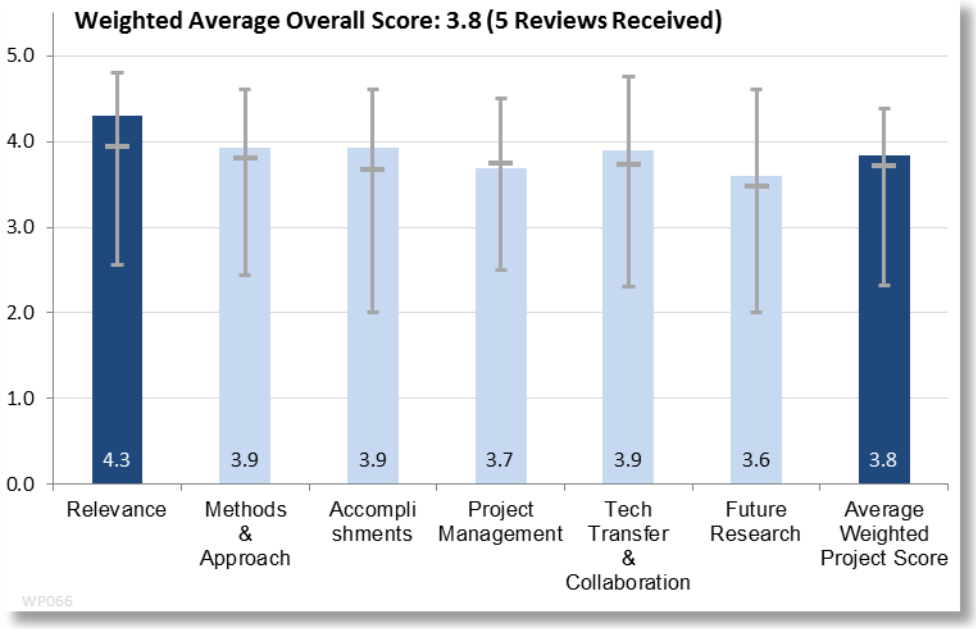
- No reviewer comments were received for this metric.

Specific recommendations for additions or deletions to the work scope

- This group is outstanding - solid work, prolific output, great reports and clear presentations of their results. Find good ways to support them.

WP066: Operating Reserves Analysis
Michael Milligan, NREL – presented by Erik Ela
FY 10 Budget: $0 DOE $0 Cost-Share
FY 11 Budget: $580,000 DOE $0 Cost-Share
Project Duration: Oct 2011 - Sep 2012

Brief Summary of Project



This task was put in place to better understand the needs for system operators to procure and define operating reserves needs on systems with significant wind power penetrations. The issue is a large one that all system operators are grappling with and all are developing very different and sometimes flawed methods. The goal was to collect these methods together with a consistent terminology and use NREL developed models and careful analysis to improve the understanding of operating reserves requirements on power systems.

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

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

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

- This project aims to leverage lessons learned from those already experiencing significant amount of wind resources on their system to inform others of optimal reserve determination strategies; such a task leads to cost savings for those adding wind to their system.
- Continuation of operating reserves modeling projects. Contributes to optimization objective.
- Important work on a critical area of wind integration into systems and markets.
- Continuation of studies WP064 and WP065. Relevant study for system integration.
- DOE has a significant role to play in this area.
- There is a significant need for tools that allow system operators to evaluate operational strategies to minimize cost of integrating wind.

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

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

- As the presenter acknowledged, the challenge of the project is the difference between BA's in BA size, market, regulations etc. which makes the benchmarking actual practices for improving the FESTIV model critical.
- Review current methodologies, enhance FESTIV model, and work with BA or ISO to examine real need for operating reserves.
- Very good analysis and publication of results.
- Approach appears appropriate.

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

This project was rated **3.9** based on technical accomplishments and progress.

- Great reports.
- Report on Operating Reserves and Variable Generation surveyed and catalogued methods and terminology.
- Impressive and well qualified team of researchers - good outputs.
- Progress appears delayed by data availability.
- Model development has been completed.

Question 4: Project Management

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

- Minor issues dealing with NDAs.
  - Challenge was getting high-resolution data from WECC Midwest Independent System Operator.
- No concerns - good value for the results.
- Delay, data confidentiality should have been anticipated.
- Project is maintaining budget and timeline.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Good effort working with ISO and WECC.
- Conference presentations and publications.
- Good publications, presentations, international outreach.
- Broad collaboration through national committees and IEA. Good dissemination.
- Very good effort to publish results and present at industry events.

Question 6: Proposed Future Research

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

- Completely agree with the presenter that optimal reserve determination is a critical topic and should be furthered.
- Need more data to continue.
- Data availability seems to be the key blocker for more work - can this be solved?
- Not detailed, but important area.
- Many avenues for future research.
- How to get utilities/ISOs involved?

Strengths and Weaknesses

Project Strengths

- Knowledge gained from this project (and similar) is pressing the issue on the federal level to highlight that variable generation can be successfully integrated but requires changes to the way business has traditionally been done.
- Addresses issue of great interest.
- Vital topic for optimizing the integration of wind in systems.
- Allows investigation of better strategies.

Project Weaknesses

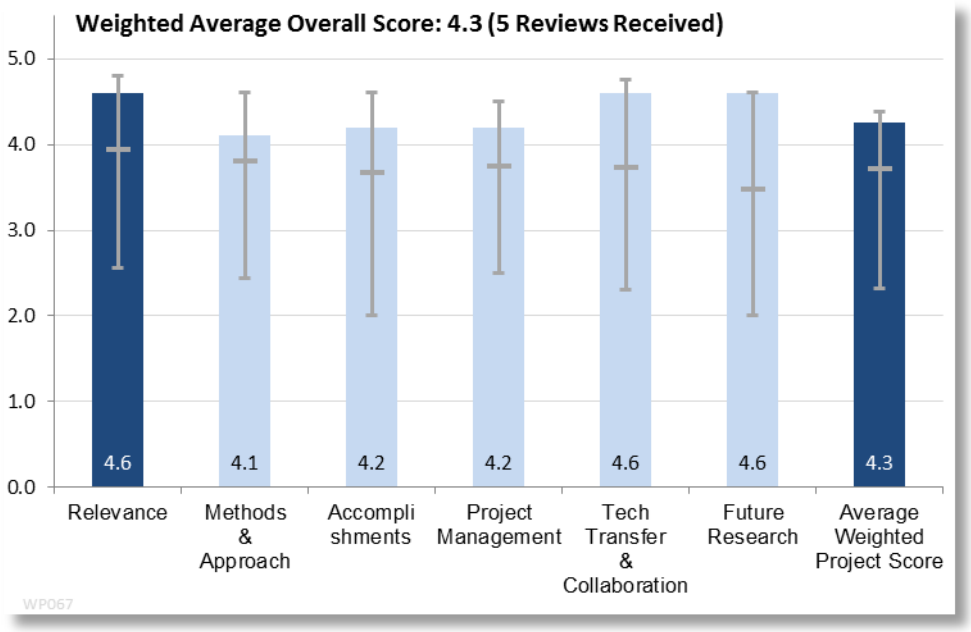
- Is there a way to engage diverse BA's to provide data to this effort?
- Requires access to BA or ISO data.
- Requirement for data from system operators can be a challenge.

Specific recommendations for additions or deletions to the work scope

- Continue to fund.
- Continue to pursue access to data.
- Important work, well done, need to help with data access.
- Seems like the data access issue could be resolved, perhaps with some high-level encouragement from DC.

WP067: Interconnection Support
Michael Milligan, NREL
FY 10 Budget: $500,000 DOE $0 Cost-Share
FY 11 Budget: $580,000 DOE $0 Cost-Share
Project Duration: Jan 2010 - Dec 2010

Brief Summary of Project



The objectives of this project are to provide support to the North American Electric Reliability Corporation (NERC), and the Western Electricity Coordinating Council (WECC). The project also covers U.S. participation in the International Energy Agency (IEA) Task 25, Design and Operation of Power Systems with Large Amounts of Wind Power.

- NERC formed the Integrating Variable Generation Task Force (IVGTF) in 2008. This task force examines potential issues with large-scale penetration of wind and solar generation. Data and results from NREL (and other) projects helped inform the IVGTF, as discussed below.
- WECC formed the Variable Generation Subcommittee in 2009. This group is charged with assembling best practices with respect to integration, and coordinating with the NERC IVGTF.
- IEA Task 25 provides an international exchange of best practices for integrating wind energy, and performing analysis and integration studies.

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

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

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

- This project disseminates all the great work completed in wind integration issues, which is absolutely critical.
- A collection of outreach efforts to get the results out to key audiences, such as NERC and WECC. Contributes to deployment and other objectives.
- This project provides extremely high value for the money - vital outreach, publication and collaboration.
- Support to NERC and WECC on integration.
- This is a communication and coordination effort. Vitally important.
- It is key that the staff involved in this effort in the future be appropriate for the task - as is currently the case.
- NERC coordination is vital.
- DOE is gaining significant leverage by supporting qualified individuals to participate in these industry-wide efforts.

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

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

- Working through NERC's Variable Generation Subcommittee. Multiple task forces set up to follow up.
- Great approach to support wind energy's technical education and acceptance.
- Leading several task forces and participation in IEA task.
- This work is appropriate.
- IEA Task 25 another channel.

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

This project was rated **4.2** based on technical accomplishments and progress.

- Reporting information at expected venues.
- Involvement in NERC and IEA activities. UVIG involvement as well.
- NERC, IEEE, UVIG, IEA - great work.
- Many publications.
- Continuing coordination effort with ongoing results.

Question 4: Project Management

This project was rated **4.2** on its project management.

- Good approach to assure consistent attention to outreach by identifying it as a project.
- No concerns.
- Productive, some delay.
- Appears to be well-managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- This project is all about tech transfer and collaboration. Effort with NERC is especially important.
- This is integral to the project and appears to be done well.
- Outstanding collaboration both domestically and internationally.
- Large partnership group.
- Significant collaboration and coordination with industry and other researchers.

Question 6: Proposed Future Research

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

- Continue to work with NERC, WECC, Utility Variable Integration Group, and the University of East Anglia.
- Continued support is vital to the wind program.
- Important work, to be continued.
- Ongoing participation in these efforts is very likely to provide continued benefits to wind integration efforts.

Strengths and Weaknesses

Project Strengths

- Presenting the great work to appropriate audiences.
- Straightforward but effective approach to disseminating results of critical work.
- This project provides the primary "technical face" of the wind program both domestically and internationally.
- Good access to key entities.
- UVIG has been a huge success in getting utilities and ISOs engaged.
- Gaining substantial credibility.

Project Weaknesses

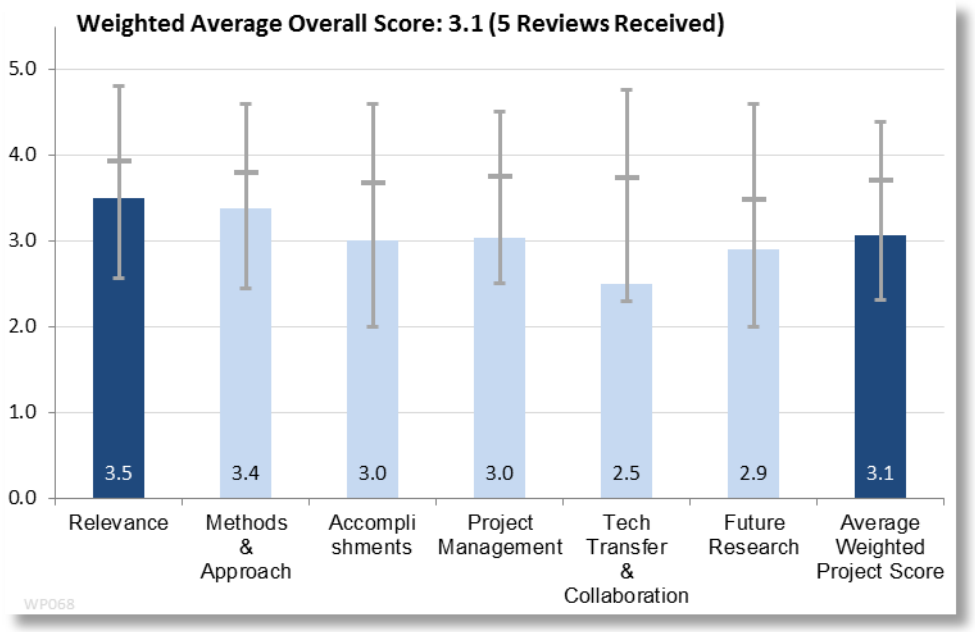
- Resources not sufficient to penetrate at "retail" level (e.g., all 50 state commissions).
- No concerns - strong program.

Specific recommendations for additions or deletions to the work scope

- Continue to fund.
- Continue and enhance if funds available.
- Vital to continue and grow support for these activities.
- Several projects related. Can coordination and management be simplified by combining in one larger program? Integration clearly important, continue.
- Map out scope and budget for a full bore "retail level" campaign as a benchmark for current activities
- Increasing education of PUC staffs and commissioner would be great if it could be funded (a big job). National Association Of Regulatory Utility Commissioners (NARUC) training sessions are a great start.
- Attend NARUC meetings.

WP068: Wind Integration Model (WIM)
Harold Kirkham, PNNL – presented by Jeff Dagle
FY 10 Budget: $300,000 DOE $1,050,000 Cost-Share
FY 11 Budget: $0 DOE $375,000 Cost-Share
Project Duration: Apr 2008 - Dec 2010

Brief Summary of Project



The objective of the project is to provide a way to answer questions about the impact of renewables on power system operation. The way the project will do this is to develop a computer model of power system operation that can be used to do "what if" studies that can lead to the answers sought. In general, the answers will be in terms of economics. For example, the impact of changing the requirement for generation reserves can be assessed by running the same case with different reserve requirements, and calculating the costs, including the cost of not meeting the reserve requirements, not serving some load, or not meeting any performance standards (such as North American Electricity Reliability Council Control Performance Standards). The final product was originally to be a program that was executed on a supercomputer at PNNL. The present product is envisioned as a program that can run either on a workstation or supercomputer. The ultimate users of the software may be the utilities (evaluating reserve strategies) or renewables developers (developing case studies to advance their cause), or wind-model companies (testing improved wind-prediction algorithms). Since many actors in the business could use the program – the utility, the manufacturer, and the forecast provider – the overall benefit will be multifaceted.

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

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

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

- Developing a wind integration model will be useful for planning folks.
- Reference Information Model tool fills a gap in models that will allow more consideration of high renewables integration scenarios. If successful, will contribute to deployment and optimization objectives.
- Sounds good from the slides, but there has been so little outreach and engagement that I'm not sure what to make of it.
- Modeling tool for planning of system with variable generation important for integration of wind energy.
- It is difficult to tell of this study will lead to solid gains; but this is an area in which additional research is required.
- Where is the engagement and validation with multiple system operators that would make this believable?

- There is much in the description that is intriguing and suggestive that the approach an analysis may be beneficial.
- This appears to be high risk, high potential reward analysis.
- Key will be whether staff are capable of meeting the challenge they are addressing.
- This type of project may benefit from breaking the overall modeling effort into smaller quanta of potential improvements.

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

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

- Creating a flexible and fast model to reach a wider audience: good.
- Model development plan is solid.
- Very difficult to tell, given the lack of real data validation and actual industry involvement.
- DOE EERE part of larger effort, comprehensive open source model. Ambitious.
- Approach appears to be appropriate.
- How does the model compare to other similar efforts?
- Target of making suitable for a workstation also good.
- Not clear if model specifications arise from consultation with commercial stakeholders.
- Includes modeling for resources like cascade hydro that other commercial software do not yet model.

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

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

- Open source tool nearing stage where it can be tested by utility planners.
- Lots of time and money already expended, considering that they are just starting validation stages.
- Comprehensive model, not yet applied on real cases.
- Accomplishments appear to be limited at this time.

Question 4: Project Management

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

- Delays in deliverables.
- Some delays and personnel changes.
- Not enough info to tell for sure.
- Seems ok but the DOE EERE is part of larger effort. Project management of this part is difficult to assess.
- Significant slippage in meeting intermediate project deadlines.
- Total effort $2.6M. A sizeable investment.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Tech transfer could have been better.
- AWS TruePower and 3TIER good for wind data.
- This is the most "done in a vacuum" project that I've seen all week. Where is the ISO or utility system operator involvement? No outside review?

- Not much collaboration and dissemination.
- Very limited indications of industry collaboration or work with other researchers.
- Will the model work for any BA?
- Seems to compete with private sector tools, or at least naively trying to outdo them (while working without real world input).

Question 6: Proposed Future Research

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

- The storage and hydro optimization pieces don't work well?
- Studies of real systems good development.

Strengths and Weaknesses

Project Strengths
- Integration model that includes more resources than commercially available software.
- Open source platform will be useful In future will be able to include demand response and storage.
- Ambitious goals to model everything.

Project Weaknesses
- Is the model applicable to all BA's?
- Project delays and personnel changes.
- Totally done in a vacuum with no outside review or input. The PI is gone, and there does not appear to be a clear champion even in PNNL.
- Not yet exposed to utility planners/users.

Specific recommendations for additions or deletions to the work scope

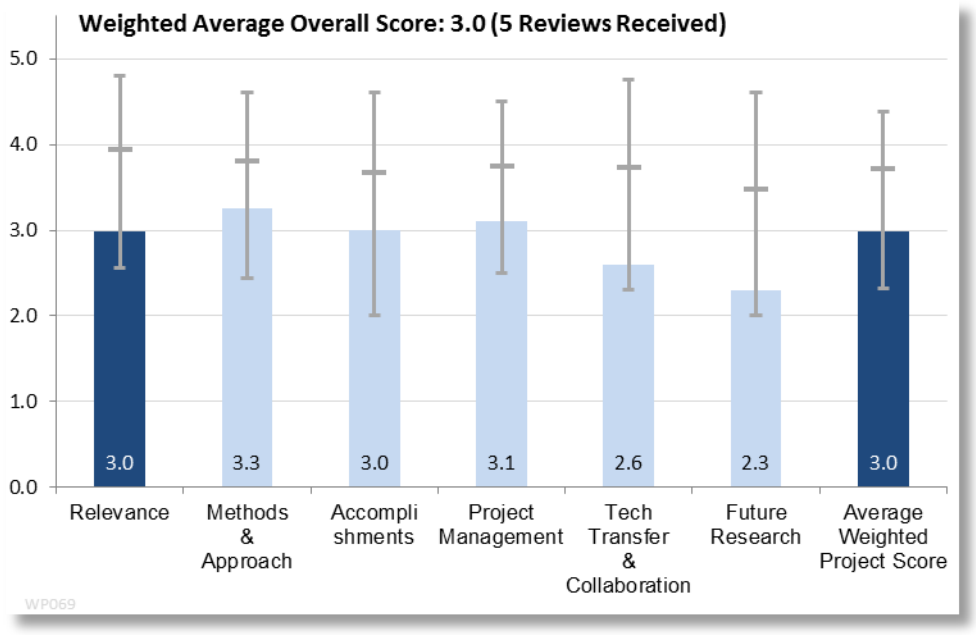
- Widen the national and international partnerships.

WP069: Use of Wind Power Forecasting in Operational Decisions

Audun Botterud, ANL

FY 10 Budget: $475,000 DOE $0 Cost-Share
FY 11 Budget: $100,000 DOE $0 Cost-Share
Project Duration: Apr 2008 - Sep 2012

Brief Summary of Project



The purpose of this project is to develop and test new and improved strategies for how to efficiently operate the power grid under increasing shares of wind power. In particular, we have investigated the use of forecasting to address uncertainty and variability from wind power in operational decisions, from the perspectives of the system operator as well as the wind farm owners.

By developing and testing novel optimization models for scheduling, commitment, and dispatch, the objective is to advance the operational tools and procedures used by grid operators and wind power producers. Furthermore, by conducting case studies and analyses, the project will contribute to better informed decisions about market design within rapidly evolving electricity markets with larger shares of wind energy. Enhanced grid operating strategies will contribute to lower wind integration costs and also improve the profitability of wind power assets. Ultimately, this will facilitate a more rapid expansion of wind power 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 wind industry needs and overall DOE objectives

This project earned a score of **3.0** for its relevance to wind industry needs and overall DOE objectives.

- Great to look at influence of forecasting variability and uncertainty of the resource into the reserve determination process.
- Should advance operational objectives.
- This should be a very good topic (wind trading strategies and market design), but it seems to be represented with negative reinforcements rather than positive reinforcements.
- The model can be used to maximize the income for a wind power producer. Limited contribution to DOE objectives.
- Significant benefits to DOE wind integration efforts from this work are unclear.
- Designed to take uncertainty and variability in wind into better accounting grid strategies.
- We really need good work in market design and trading strategies, but this doesn't appear to meet our needs.

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

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

- Market framework appears specific to Illinois.
- Developing unit commitment model with forecast uncertainty.
- I believe there are nuggets of goodness in here, but something is making them difficult to decipher. I'm not sure if this is based on the overly mathematical style of presenting the results, failing to truly understand the bigger picture, or what - but it just feels that the full potential of this topic is being missed.
- Model has been successfully tested.
- Methodology is not clear. Explanation was difficult to follow.
- Need to ensure results can be transferrable to all.
- The work approach appears to be flawed and further hampered by poor description and explanation.

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

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

- Some interesting results that should be applicable nation-wide.
- Case study of Illinois system. Found more reserves lower total cost. Did not find big improvement in stochastic University California-Davis model.
- Does not feel adequately realistic. Creating an "Illinois market" is misleading and will inevitably lead to misunderstandings.
- Model has been developed tested and reported.
- Accomplishments are not clear. Research appears to have determined an optimal deviation charge for wind developers?
- Case study of wind farm. Bidding strategies.

Question 4: Project Management

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

- See no issues here.
- Project complete with final project report September 2011.
- Difficult to judge.
- Original project scope reached, new developments taken up.
- Not clear.

Question 5: Research Integration, Collaboration, and Technology Transfer

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

- Coordinated with Midwest Independent System Operator and EDP Renewables North America LLC.
- Limited collaboration with other labs, market design experts, etc.
- Modest partnership, dissemination good.
- Limited collaboration.
- Published papers.
- Not clear to what extent this work has undergone peer review to evaluate benefits to industry and technical methodology.

- Little interest evidenced by EDP Renewables North America LLC in commercial use of bidding model.

Question 6: Proposed Future Research

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

- A key research area should be: how to integrate into an actual control or scheduling room. Schedulers must make many decisions each hour, so a tool must be simple.
- Ongoing work on emissions in Illinois system.
- It is not clear that the PI understands the larger picture and how to communicate it in a meaningful way.
- Future research relevant, but other international parties have done similar.
- I don't see that the proposed future research is warranted given concerns expressed here.
- Future research doesn't seem to be sufficiently aligned with initial efforts.

Strengths and Weaknesses

Project Strengths
- Highlights impact of scheduling strategies on cost.
- Attempting to include important uncertainties in University California-Davis and wind farm bidding procedures.

Project Weaknesses
- Applicability to other BA's.
- Focus seems split on two very different problems, with only uncertainty the shared characteristic.
- The research team may be missing the bigger picture.

Specific recommendations for additions or deletions to the work scope

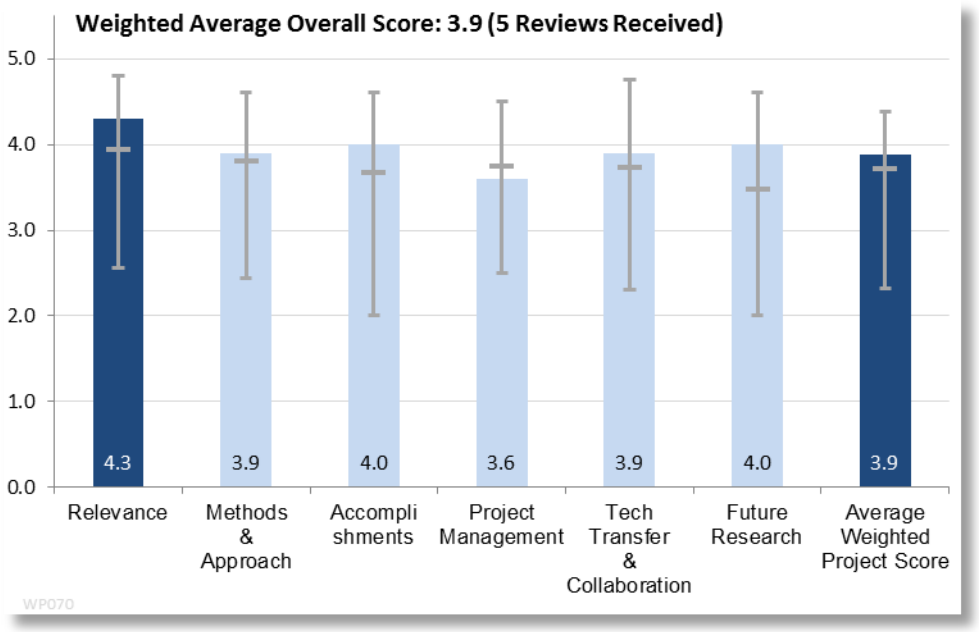
- Making this work exceptional requires developing a tool to be usable.
- Continue only if near term customer interest.
- Market design is a critical need, but this project is not meeting the need. It's important to get more market design expertise involved in the DOE program.
- Expand the partnership.
- The work of NREL (with Mark O'Malley, Erik Ela, Milligan, etc.) shows some better and more realistic potential in this area.
- Market design and operating strategies are vital areas for deploying wind. How can we get a significant, collaborative program going in this space that can engage labs and universities, including people from power systems, market design, economics, etc.? We need this, and it needs to provide clear and understandable results that can guide the Independent System Operators, North American Electric Reliability Corporation and the Federal Energy Regulatory Commission.

WP070: Active Power Control from Wind Power

Erik Ela, NREL

FY 10 Budget: $0 DOE $0 Cost-Share
FY 11 Budget: $670,000 DOE $0 Cost-Share
Project Duration: Sep 2011 - Sep 2012

Brief Summary of Project



The objectives of this project are to identify the benefits of using different forms of active power control (controlling active power for frequency support and energy balancing support) for the electric power industry. The project spans different spectrums of time: from milliseconds to years; spectrums of space: from the interconnection to components of an individual wind turbine; and spectrums of analyses: from economics to dynamics to control systems to structural engineering. The project will evaluate how wind power plants providing active power control to the grid can benefit the power system rather than be a detriment, and how it can earn additional revenue which can increase the adoption throughout the country.

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

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

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

- Very important topic to operators
- Addresses the question of whether wind can actually provide certain grid services. If can show benefits from active power control, will contribute to deployment and optimization barriers.
- Takes on an important question for wind power - active power control.
- Demonstrate benefits from active wind power control, removes myths.
- This study is focused on a key issue in wind integration - should wind developers be required to install grid support capabilities in their turbines.
- It's a chicken and egg issue - wind turbine capabilities do not appear cost-effective now, but they may be in the future, if sufficient wind generation gets developed that wind generation becomes curtailed due to lack of grid control capability on-line.
- Analysis like this is needed because once the turbines are installed, it is very difficult for wind resource owners to make retrofits to increase technological capability.

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

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

- Straightforward approach: steady state base case; dynamic case; response simulation; field test; dissemination.
- Impressive approach that seems solid.
- Good combination of models and tests.
- Approach is not entirely clear but from what is provided appears to be likely to lead to valuable information.

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

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

- Good progress.
- Interim report on progress.
- Impressive progress, including field testing.
- Conference held in January appears to have brought together a broad array of participants.
- Non-Disclosure Agreement with GE for field test a good step.

Question 4: Project Management

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

- See no issues here.
- On schedule and budget.
- Slow start due to uncertainty.
- Project appears well-managed.

Question 5: Research Integration, Collaboration, and Technology Transfer

This project was rated **3.9** for research integration, collaboration, and technology transfer.

- Have enlisted industry support (GE, Siemens).
- Good team including EPRI, universities and turbine OEMs.
- National partnership, good dissemination.
- Good collaboration with industry and research; good technical documentation.
- EPRI key partner. Good choice for utility acceptance.

Question 6: Proposed Future Research

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

- Great proposed research.
- Apply to full wind park. Investigate market design options to monetize value wind can provide.
- Good - would love to see market design work related to this.
- Logical extension, although not very detailed.
- Future research appears to be worthwhile.

Strengths and Weaknesses

Project Strengths

- Frequency response is a very important topic to operators.
- Well defined issue and approach.
- Solid understanding of the problem, with involvement of both researchers and turbine OEMs.
- Good collaborative effort.
- Stepwise progress towards field test and demonstration using commercially available machines.
- Very good use of stakeholder group for information, review and results.

Project Weaknesses

Specific recommendations for additions or deletions to the work scope

- Another critical topic to operators is inertia of variable generation -- even combined cycle and simple cycle natural gas turbines.
- Final report due end of 2012. If well received, consider moving on the full wind park demonstration.
- Impressive project, good team, good progress - take it through all the way to market design and field testing.
- Regarding options and opportunities on turbine and wind farm level, more international collaboration is recommended.

8.0 Program Evaluation

As part of the 2012 Wind Power Peer Review process, reviewers were also asked to perform a quantitative and qualitative analysis of the Wind Program based on the 4 aspects listed below:

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

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

Each criterion was scored as a stand-alone metric. Numerical scores were based on a five-point scale, with qualitative descriptors given for the numerical scoring index (i.e., a score of 1 corresponds to a "Poor" rating, 2 corresponds to a "Fair" rating, 3 corresponds to an "Average" rating, 4 corresponds to a "Good" rating, and 5 corresponds to an "Outstanding" rating). The Figure 8.1 below summarizes the reviewers' overall quantitative evaluation of the program including the average, minimum, and maximum scores per criteria or metric.

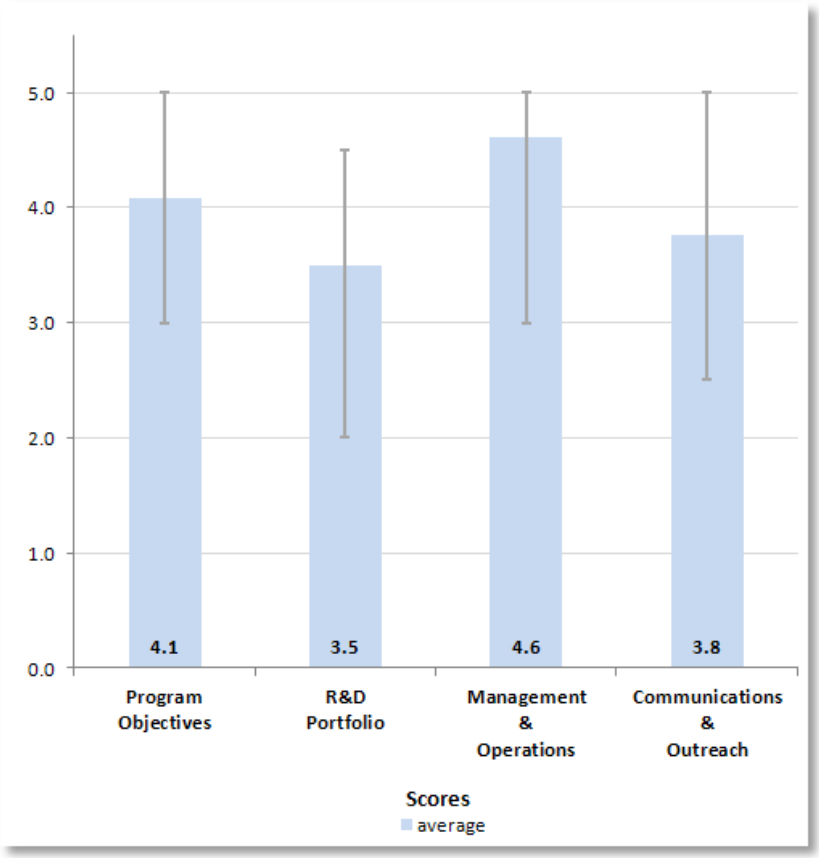


Figure 8.1 Overall Program Scores

Question 1PROGRAM OBJECTIVES: How well do Program objectives align with industry needs and Administration Goals?

- This is a great program that is addressing issues, barriers, and research needs to lowering the levelized cost of energy (LCOE) and deployment of wind.
- There is too much emphasis on offshore when significant barriers to deploying land-based wind power still exist. More resources should be directed toward overcoming siting barriers, communicating the benefits of wind power and progress being made (i.e., lowering the cost, mitigating siting concerns, etc.).
- The wind industry in the U.S. is not doing well due to lack of energy policy, Production Tax Credit (PTC) extension, no Renewable Portfolio Standard (RPS), and low natural gas prices.
- The program objectives do an excellent job of linking the Administration goals with the needs of the industry.
- Program leadership is stronger and more strategic in their view, so good progress with the overall program.
- With the exception of a few projects, the program is well aligned with the Administration goals and industry needs.
- Well thought-out strategic program that addresses important issues for society and industry. The program has been extended to other labs and universities, which gives important opportunities for new ideas, outreach and education of qualified staff to the sector.
- The Department of Energy (DOE) Wind Program leadership should be complimented in how, to the best of their ability, they have kept an appropriate balance between land-based and offshore activities.
- The program objectives are generally hitting the correct targets. Approve of what are perceived to be the change in focus between the grants funded in the past (and being reviewed in this peer review event) and the current focus as expressed in the presentations made by program management.
- Transmission and environmental barriers are critical to accelerating deployment at an acceptable cost. There are many decent wind resources that could be developed with the current technology, but due to lack of transmission and full understanding of environmental impacts and mitigation strategies, these resources are undevelopable at this time.
- Only a few projects had clear exit strategies for either completion, continued DOE funding, or self-sustaining. These program managers should be given more assistance with long-term business planning and strategy.
- The program's emphasis on innovation and technology development and history of support for the U.S. industry is responsible for creation of competitive U.S. manufacturers. The DOE program supported Zond Z-40 and Z750 (first doubly fed induction generator machine in the world) and the 1.5 Enron Wind that formed the basis for GE Wind which improved on the product and sold 15,000 units. Also, the DOE supported Clipper's 2.5 MW which sold 740 units. The program is responsible for the only utility-scale wind turbine manufacturers in the U.S.
- Reducing the LCOE is a key objective that enables and facilitates many others. This should be pursued both for land-based wind as well as offshore wind as presented in the program overview presentations.
- Support for next-generation, long-distance transmission is noticeably lacking. Changing our current system to a workable national transmission system is a very challenging problem, but would have huge national benefits for citizens.
- ARRA funds were well used to advance the program goals.
- The program is encouraged to continue a "wind" focus that addresses offshore and land-based. There is concern that significant funds going to offshore will constrain DOE's ability to address important issues in the land-based space. Land-based offers the largest opportunity for growth of U.S. wind power.
- The significant emphasis on offshore wind programs is premature.
- Integration studies looking at reserve determination, firming resources, system reliability, and forecasting are all topics of great interest to operators and planners. This program does a great job to address many of these issues. A formalized agreement to address these issues with the DOE Solar Program may provide maximum benefit.
- There seems to be some duplication of efforts and expertise spread around the various projects that would

benefit from either a "centers of excellence" approach, cross-teaming, or greater collaboration.

- The DOE EERE support for testing advanced manufacturing certification and standards is enabling to the wind industry.
- Reducing deployment barriers is also extremely important. With the wind industry facing a near term "PTC cliff," and the retention of the manufacturing base in jeopardy, making the best of the next few years to break the back of key deployment barriers such as radar issues, eagle and Endangered Species Act species issues, grid integration and transmission access issues should be able to complement the effort to jumpstart the offshore wind industry at a realistic budget level.
- In creating a U.S.-based offshore industry, the approach of "leap frogging" to floating platforms is a mistake. Even if it works, it is not protectable intellectual property (designs will be easily cloned), and it will therefore fail to lead to significant U.S. manufacturing and export. The challenges of cabling to floating platforms, including reliability and contingency issues for such interconnections, are yet to be taken into account.
- Some program/project managers have a clear focus on how their respective projects link back to LCOE goal. Others are not as linked back to LCOE reduction goal.
- The program could add an objective to maximize the leverage or impact of limited government funding through participation in industry and research collaborations.
- Education and work force development is increasingly becoming more of a priority and is needed. Programs such as the consortium developments will provide a great return on investment in terms of knowledge base of the industry. Furthering relationships and collaboration between academia, industry and federal labs is a great direction of the DOE Wind Program.
- The wildlife work and projects designed to optimize the performance of power plants appeared to have the biggest return on investment and greatest value toward enabling 20%.
- Removing barriers from wind deployment has had a very positive effect in spreading the word about wind energy and counter balancing false negative publicity about wind. These activities including integration, Radar, wild life, better resource characterization, all need to continue.
- By making the 20% by 2030 study the guidepost for the program objectives, the program has built on a strong base. However, much has changed since that study was done, including turbines with significantly improved performance, natural gas prices at historical lows, and deployment issues becoming evident as the industry is the first renewable power source to be deployed at scale in dozens of states.
- DOE also has developed greatly improved tools to evaluate the feasibility, costs and benefits of such scenarios. This reviewer would suggest a fresh look at a clean energy scenario that would include an additional 100 GW of wind in 10 years, or something similar, to provide organizing principles for the program going forward.
- To truly enable 20% wind by 2030, the program should increase funding for wind integration and removing deployment barriers, which are currently underfunded and provide your best return on investment, and stick to demonstrating shallow water offshore wind.
- 13.6 cents/kWh for offshore wind in 2030 is too high to be competitive on the west coast, and likely even on the east coast.
- The balance in the program has shifted considerably towards offshore. A rebalancing towards more innovation in land-based machines to overcome low gas prices and to create robust U.S. industry is still required. Wind is still higher than current prices of natural gas and even if they are at parity the cost of variability needs to be taken into account. The job is not done yet.
- Offshore strategy is driven by the wrong baseline goal, since it only makes financial and business sense if the regional coastal hurdle rate for higher power prices remains in place. Why not spend $180MM on removing the hurdle rate? The current strategy will entrench the hurdle rate and therefore subject many U.S. citizens to 50 years of unnecessarily high power prices.
- Testing, standards, certification projects are on target and doing well. They link back to the goals.
- From a utility perspective, the LCOE of the energy at delivery point is the critical number for selecting resources. This includes transmission, variability, and uncertainty of the resource, market structures.
- DOE needs to support the efforts of the successful university programs to create research centers that can

contribute to the speed of innovations besides industry and national labs may be by joining consortiums of the successful ones.
- In addition to research, the program provides a critical role in educating policymakers and regulator - providing the basis for them to move forward. More support for educating regulators (PUCs) would be beneficial, along with ongoing and growing support to Independent System Operators, Federal Energy Regulatory Commission, North American Electric Reliability Corporation, transmission planners, legislators, and members of Congress.

Question 2 R&D PORTFOLIO: Is the Wind Program investment portfolio appropriately balanced across research areas and recipient organizations to achieve the program's mission & goals?

- Investing more funds in market barriers and then integration studies will first open the door to significantly more wind resources and then also provide the tools and knowledge needed for integrating the resulting higher penetrations of wind generation.
- Focus on "leapfrogging" near-shore offshore developments in favor of floating offshore structures is of high risk. DOE has strategic initiative to jumpstart the offshore wind industry, and at this stage investing in tools and facilities that will allow industry to drive the direction of where the development occurs may provide better result.
- The focus of bringing emerging technologies across the "valley of death" into actual deployment is a good objective, but investing too heavily in any one unproven technology is additional risk. DOE may be most successful by providing a helping hand, but not pre-selecting technologies for success.
- There is too much emphasis on offshore. This is important and interesting work, and some of it is technology agnostic, but the portfolio is not balanced appropriately in terms of enabling 20% which could be accomplished with a greater emphasis on removing the land-based deployment barriers.
- The R&D program at NREL and SNL is very responsive to industry needs and all tasks being pursued are quite relevant to the innovations needed to continue the downward pressure on the COE.
- As mentioned before, the imbalance between land-based and offshore can result in weaker U.S. industry in the most immediate task of having a competitive COE for wind generated electricity that can compete in this new paradigm.
- The program balance is good and covers all critical areas. There is an obvious question about the size of the offshore demonstration projects versus continued work to reduce LCOE and deployment barriers for land-based wind, which will necessarily carry the main burden for GW deployment in the next 10 years. However, program personnel provided comfort that the land-based opportunities are well understood and would not be neglected going forward.
- Programs with a critical mass of expertise are doing well, especially when they embrace a stakeholder process (technical review committee) approach as is done by NREL.
- Labs with a small effort in renewables are struggling, since they lack both a critical mass of expertise to critique their work and they often fail to embrace strong outside and international collaboration. Good research in this field does not get done in a vacuum.
- Programs/projects that are most needed for deployment and reaching 20% (removing barriers and grid integration) are underfunded, and some programs/projects that are unlikely to help you reach the 20% goal are more heavily funded.
- Next steps for American Recovery and Reinvestment Act -funded projects will be a challenge. Some appear to have a good start for the future (blade testing facility, NREL drive train testing facility, Minnesota project). Others may lack a clear future direction and sustainable plan.
- The portfolio has too much emphasis on the offshore goal, and within that portfolio, too much emphasis on deep water.
- Testing and certification portfolio has a good balance of projects to meet goal. Dollars don't always look balanced, but that is understandable given the nature of the work.
- Education and outreach programs support barrier goal at a seemingly low cost.

- Resource characterization portfolio appears to be a well-balanced approach to modeling and field work. Good coordination with labs and universities.
- The Technology portfolio supports several goals, and it has good array of basic-applied projects with different timeline of impact on goals.
- The Program's project portfolio is fairly balanced and overall meets the mission and goals in a convincing way. Not all participants are equally strong and some projects could benefit from stronger coordination and combination into larger projects/programs.
- Great additions made to U.S. testing facilities for Wind between NREL, SNL, MA blade test, and SC drivetrain.
- It appears that DOE Wind work has been spread too broadly across the National Labs. DOE should evaluate situations where a national lab has only one small activity. Where it makes strategic sense, consolidate so there is a critical mass of related work at the National Labs.
- Lessons learned from the 2010 solicitation for 20% Wind where $23 million was spread across 83 projects. This is not an efficient use of resources at DOE, at Labs, and industry. With these small awards, the administrative costs become too large a percentage of the program costs. Strive for larger awards and do not try to cover more topics than the funding can reasonable support.
- Without analysis indicating cost-effectiveness of offshore resources (due to savings in transmission), the significant investment in offshore wind resources appears premature. The land-based industry faces impediments that could significantly limit development (transmission system reliability; adequate transmission capacity; siting issues; economics). Addressing these impediments should be the immediate focus, along with further evaluation of total costs of land-based and offshore development, and funding of new potential technologies.
- More emphasis needs to be placed on analysis of transmission issues: local reliability issues (sub synchronous interactions; behavior of asynchronous machines in areas of low short-circuit ratio); cost-effectiveness of transmission technologies needed to move power over long distances; and cost-effectiveness of local resources versus distant wind resources.
- The program needs less balance across recipient organizations. Focus funding on researchers that have achieved industry excellence in key areas. Also, focus on programs that include significant collaboration with industry and other researchers.
- The program needs to achieve a balance between big thought research (high risk, high reward research) and implementation or impediment issues research.

Question 3 MANAGEMENT & OPERATIONS: Please evaluate the quality of the Wind Program's team, management practices, and operations.

- Fully support the initiative to commission sizable portion of budget through a non-competitive process only to ensure that program strategy and research areas are being met as intended.
- The program management is passionate, knowledgeable, and dedicated to achieving the program's goals and objectives.
- The commitment of the DOE/Labs on their commitment to grow the wind industry and create local U.S. manufacturers that can compete domestically and internationally is appreciated.
- Program management quality and morale seem very high. Previous peer review participants also noted a distinct improvement in these regards since the 2010 review.
- Management at DOE headquarters is improved and impressive. In general, projects appear to be well managed.
- Entire team is outstanding.
- Impressive leadership and engagement
- Significant improvement in DOE Wind leadership, organizational structure, credibility, and having a strategic portfolio.

- Impressed with the management of the wind program. Management staff appears to be highly capable and extremely dedicated.
- Recommend that DOE play a strong role in activities of consortia, and as a result consortia will continue to support key objectives of DOE Wind Program and also broaden relationships with others in wind industry.
- Maybe there should be more emphasis on communicating solid results in these biannual reviews so that the reviewers are not chasing the information that should have been included.
- There is always room for improvement of course. Some areas that deserve continued effort are (1) coordination between the major new test facilities, notably between Clemson and NREL regarding use of the dynamometers facilities, (2) clarification and consolidation of lab roles and their particular areas of excellence, and (3) evaluation of post ARRA funding and performance of the university consortia, which to date have not been of equal quality.
- The level of collaboration/outreach between labs is still problematic. NREL is great, SNL is good, LLNL work that collaborates widely (such as with CU-Boulder and NREL) is good, but ANL and PNNL are not as strong in this area.
- Data generated in funded projects is difficult to access. A small investment in data management will benefit program by engaging more stakeholders.
- Program management staff impressed me with their understanding of the technical details of the programs they managed, an understanding of the management issues associated with the overall grants program, as well as an understanding of the political realities of the government organizations involved in the grant process.
- Really great and friendly staff.
- There should be an emphasis on communicating R&D results directly to industry besides publishing in journals and conference. The industry is under siege and cannot afford to chase this information in widely dispersed resources.
- Wind program has invested in developing modeling tools of value to entire community. Should consider using 3rd party (possibly through small business innovation research) to provide tech support and user interfaces. Entire community would benefit. These are not necessarily core strengths of DOE staff.
- Creating a multi-year strategic plan and seeking industry/public feedback would be a useful in setting priority on work as well as ensuring a complete portfolio.
- Business and research strategies for DOE large test facilities (blade and drivetrain) need to be integrated.
- It is not always clear how some projects are unique from each other or how they are related, or meant to be related.

Question 4 COMMUNICATIONS & OUTREACH: How effective is the Program at engaging with industry, universities, other agencies, international actors, and other stakeholders?

- Highly recommend creating a portal that can be used to present information on all the great work being completed through the program, as well as make available key contacts and resources.
- A DOE Wind Program newsletter (e.g. quarterly) of key developments and accomplishments of funded work may be a great way to disseminate information to a wide audience.
- The Program does an effective job of communicating to most stakeholders, but could improve its communications approach and efforts by focusing on greater dissemination of information (earlier and throughout the research process) and inclusion of a broader group of stakeholders, i.e., community leaders, consumers and other key influencers, in the process.
- The program has the right mix of industry, laboratories, universities and stakeholders.
- The program needs to understand the critical period that the industry is experiencing and continue to directly support innovations and new product development that can compete with natural gas including variability and possible elimination of incentives in the U.S.
- Communications and outreach ranges from excellent in some areas to less than effective in others. In some areas where DOE has been effective in the past, such as Wind Powering America, industry needs have

changed and the new emphasis on regional approaches makes sense. In technical areas, such as standards, modeling, design tools and technical studies, the program has done excellent work that is not always easily accessible. For example, there is no single portal which provides access to the range of work products being developed.

- One example of an area where making the results of program activities available to the key decision makers is essential in grid integration. This is a complex area where individual industry players do not have the depth of capability or credibility to influence outcomes and attitudes. Yet successful deployment will require the education and involvement of state commissions, utilities, regional transmission organization, regional bodies, etc. The program's work in this area is good, but this reviewer would recommend developing a more comprehensive plan that could scale up these efforts on reasonable notice.
- The underlying analytical work conducted by the program is excellent.
- Some labs are doing a great job on outreach and collaboration (NREL in general, LBNL/Wiser, standards work, some SNL projects, and some LLNL work).
- Wind is still at a fragile point, with deployment help needed, so more attention to deployment and barriers is still critical.
- Communication and outreach is mostly excellent, although some projects need improvements. Easy access to results and data could be improved.
- Lots of examples of programs involving multiple entities from National Labs, Universities, and industry. Great examples of the DOE Wind Program seeking to bring together multiple government agencies to address wind siting issues.
- Make the results of DOE funded research, and data collection more readily accessible to industry and others. A conference paper and posting data to various web sites is not "user friendly". Consider a DOE Wind portal that organizes links to all data, reports, etc. Include a brief statement of what was learned, or important from the work.
- The DOE labs need to put more emphasis on communicating their core competencies. This will emphasize benefits provided by labs to industry and general public, and result in increased focus on core competencies at the labs themselves.
- While Wind Powering America may not be the perfect approach, ongoing support of regional education and deployment is still needed.
- Communications and education for policy makers should be much stronger. Educate state regulators and their staffs, state legislators, and federal policy makers of all types to facilitate wind integration and deployment.

Question 5 STRENGTHS: Discuss the aspects of the program that support successful outcomes or that provide an advantage to the program. Factors may be internal or external.

- The program does a great job addressing needs of the industry that really do require federal intervention, such as creating relationships with other federal agencies.
- Impressed by the expansive portfolio of work carried out by the program.
- Emphasis on consortiums and collaboration is an asset.
- Focus on eliminating deployment barriers, including reducing the LCOE.
- The commitment of the program to advancing wind energy goals and strengthening the U.S. industry is valued.
- The experience in DOE/NREL/SNL is outstanding and the areas being pursued in load mitigation, controls, carbon blades, and manufacturing are essential to achieving the competitive edge that wind need in this new environment of lack of political will and cheap gas.
- The utilization of the ARRA money was outstanding and created global centers of excellence in Clemson, Massachusetts, and NREL and the University/Industry consortiums.
- The extent to which the program has taken the themes and findings of the 20% by 2030 wind study and provided significant advances in many areas covered by the report is impressive. Since wind is the first

renewable power source to reach the stage of where it is close to being cost competitive (and already is in certain markets), it is both facing the push back from deployment issues as well as bearing the responsibility to "get it right" and show the path for other technologies following close behind, such as solar. The attention to the vision and the long "to do" list embodied in the 20% Wind report has provided a strong conceptual framework for the program.

- The program leaders, national labs, principal investigators, and projects are in general of very high quality.
- Great attention has been paid by the program managers to defining the appropriate federal role in each area. This provides strong protection against stepping into areas the private sector might play a stronger role in. If anything, this reviewer believes there is an even stronger rationale for a federal role in reducing deployment barriers and educating key decision makers than the program currently supports.
- Many of the deployment barriers either involve federal agency coordination, such as radar and wildlife, or involve regional issues such as grid integration that no private developer could be expected to adequately and credibly address.
- The offshore demonstration projects exemplify technology stretch goals that industry could not do on its own.
- The standards development and open system design tools should hopefully one day be self-sustaining within the industry, but when the industry is subject to repeated policy driven boom bust cycles it is unrealistic to expect industry to maintain such long term analytical functions when they are laying off key development and manufacturing staff.
- The ARRA investment in major test facilities at NWTC, Massachusetts, and Clemson were well done and provide important new national capabilities.
- Programs with strong stakeholder/technical review committee structures are noticeably stronger and more successful.
- Activity and progress on interagency and international collaboration is particularly strong for NREL projects, as it their very effective use of technical review committees and stakeholder groups.
- Good job on grid integration of renewables, international/interagency collaboration, and Wind Powering America-type activities (especially considering the limited funding that these areas receive relative to some other programs).
- Integration of lab strengths with select programs/projects strengthens research projects.
- Integration of work being done at NREL and Massachusetts blade test facilities is a program strength.
- Strategic approach creates focus and invitation of other labs and universities create new opportunities.
- Effectively organized and focused on a broad array of issues that are important to wind power in the U.S. There is not another part of DOE that has to work such a range of issues. In many ways, the DOE Wind Program is pioneering the types of issues other EERE programs will hit when they start seeing serious deployment.
- The DOE Wind Program is taking leadership roles in bridging across to other government agencies on key wind issues such as radar, wildlife, offshore siting, etc.
- The DOE Wind Program leadership has credibility and communicates a clear vision.
- The key program strength is the technical competence and dedication of the program management staff and the technical research staff at the labs.
- Many of the grant-funded activities, especially those that are essentially participation in industry groups, are successful entirely due to the exceptional capabilities of the staff involved.
- Another key strength is the strong connection between the researchers funded by these programs and the overall industry.

Question 6 WEAKNESSES: Discuss the aspects of the program that hinder successful outcomes or that disadvantages the program. Factors may be internal or external.

- The wind industry has experienced great success in recent years; however, that success is leaving the DOE Wind Program with tough choices to make on defining its role moving forward. Straying too far from what

has been successful in the past may lead to poor results.

- Portfolio balance. The programs that appear to have the most potential for reducing deployment barriers receive far less funding support than programs that have a much less evident return on investment, at least for the short-term.
- The wind industry has certainly been hit by policy uncertainty (PTC expiration, eagle rules etc.), heightened competition (natural gas plants and utility preference for solar), and the general economy (fewer PPAs). But while these may have made achieving certain quantitative milestones harder (e.g. deployment at a 16GW per year rate in the mid-20-teens), they have not fundamentally altered the objectives of the program in terms of lowering LCOE and reducing deployment barriers. On the positive side, the advance in land-based turbine technology has kept wind within "portfolio parity" of natural gas if not one to one LCOE equality, and the deployment of nearly 50,000 MW of wind in what are generally very high quality projects have provided a much clearer roadmap of the deployment challenges for the next 100 GW.
- Coordination between participants and the strategic focus with some few projects can be improved.
- The program tried to spread their available funding too far with an average of $280,000 per award. How much can be accomplished for that much spread over the project duration? A high percentage of available funds will go to administrative tasks at the project owner and at DOE.
- In some studies, it appeared that the research funding had been spread too thin. Fewer grant-funded studies with more resources could lead to greater aggregate success.
- Wind energy development requires great relationships with many federal agencies, Department of Energy, Department of Interior, Department of Defense, etc. A better working relationship with the Wind Program and others in federal agencies may improve results, reduce cost, and eliminate some barriers
- Communication: the communications approach is very academic and focused on making information available, as opposed to pushing information out to the public and industry.
- The results of R&D should be communicated directly to U.S. industry.
- Budget constraints do not allow the program to simultaneously jump start the offshore industry and comprehensively resolve all land-based deployment issues at a "retail" level (covering every state commission, county planning dept. etc.) nor should it need to do this. But the projects and experience the program have developed in the past few years, and the design, planning and modeling tools it has developed, can be the basis for a very high leverage action plan at the federal level for advancing the technologies (both land-based and offshore) and addressing the barriers (as it did with radar).
- Transmission is essentially missing from the program and this is a major gap. While some may view large-scale transmission as being outside of the Wind Program's scope, wind is a major catalyst for transmission so this makes no sense. The two should be coupled and wind should logically be involved in transmission issues.
- Choice of deep water (over shallow water) as focus for offshore is a significant risk.
- Studies conducted at labs that were more remote from the core wind programs generally did not appear to be successful or wise investments. Consolidation to labs with core competencies in wind technology studies is warranted.
- Competition among labs versus creating a more coordinating network of centers of excellence reduces Program optimization.
- As noted earlier, continued efforts to clarify lab roles, improve internal coordination, and sort through project winners and losers is always needed.
- Some projects have made great progress, but appear to have lost touch with DOE goals.
- Be aware of studies that do not have broad collaboration with other researchers or industry.
- Lack of ongoing communication to a broader group of stakeholders about the technology breakthroughs and other progress toward reducing deployment barriers coming out of the program weakens Program impact.
- Wildlife issues, such as the Indiana Bat, golden eagle, California condor, sage grouse, whooping crane, lesser prairie chicken and others, could be major show stoppers. There is simply not sufficient funding of the baseline, behavioral and mitigation measures to ensure that large swaths of the best wind areas will not be declared off limit in this decade if they are not addressed. This reviewer has provided a ball park estimate of

$5 million per species to address these issues, which would be a small fraction of the 2013-2017 budget.
- Transmission needs and implications of limited available transmission from the other research cannot be separated. Transmission availability and cost is a key component of the overall evaluation of the benefits of a locational resource such as wind generation.
- Lack of exit strategies and business planning assistance were observed in several projects.
- Program seems too isolated from the Office of Electricity and the issues associated with integrating wind into a diversified electricity portfolio.

Question 7. RECOMMENDATIONS

- Shift additional funds to projects that will remove land-based deployment barriers.
- Continue to innovate and not be satisfied with the status quo. The industry is not yet in a safe place due to the above detailed circumstances.
- Continue the good work to strike a balance between land-based technology and deployment issues and the offshore initiatives.
- Labs should be strategically growing centers of excellence, not spending their time responding to funding opportunity announcements (FOAs) and competing with each other. Encourage focus and stronger, deeper teams rather than inter-lab competition.
- Improve coordination across labs.
- Continue the strategic approach and keep relevant and qualified labs and universities in the program. Initiate work on improving the coordination, dialogue and interaction between labs and universities. The sector is global, and the excellent approach to international cooperation with some labs should be adopted by all participants.
- Suggest establishing a DOE Wind website clearing house that organizes a portal to results from DOE funded work.
- Continue development of excellence in program staff and staff at the labs, but be equally cognizant of programs and staff that are not meeting the needs of the industry and the public.
- Provide more support with regards to exit strategies and long-term business planning for projects that are expected to be self-sustaining after initial DOE funding.
- Increase communications efforts to a broader group of stakeholders, earlier and throughout the life of a project.
- Great collaboration with Office of Electricity and emphasis on overcoming barriers to integrating wind energy into a diversified electricity portfolio.
- Support U.S. wind industry so it can survive this difficult downturn and achieve new competitive products that can compete globally.
- Continue to remove the barriers to full deployment of wind energy so that we can maintain the momentum we achieved in the past decade.
- Support some of the successful university programs that are trying to self-fund research by joining their consortium or include them in some DOE research in which they have proven to excel.
- Update the 20% by 2030 wind study using the new tools available (e.g. from the Western Wind Integration Study and Renewable Energy Futures studies) and with a nearer-term focus (8-10 years) but a broader technology focus.
- Track progress towards the new plan not just in GW and LCOE but in other trackable objectives, such as transmission availability, workforce development, and progress on siting issues.
- Jump-start the research on showstopper wildlife issues (do at least one, say golden eagles, at scale).
- Now is not the time to back off on removing barriers to deployment and grid integration. These efforts should be redoubled.
- Both offshore wind and large-scale transmission are big problems that are important to the country and they should be equally funded by DOE. Currently, it feels like the decision has already been made to solve the

problem with offshore wind. This is premature and we should be spending at least as much on looking at transmission solutions for using high levels of land-based renewables.

- The challenges of shallow water offshore wind are more than ample, and the more meaningful effort would be to emphasize the optimization, deployment and integration of very large amounts of land-based wind energy.
- Engage more university people.
- Improve data sharing with non-lab investigators.
- European experiences and model for joint programming of research, university/lab cooperation and international academic collaboration could provide inspiration for other ways of coordination.
- University Consortiums - R&D at these universities may end or see a significant cut-back if they do not find long term funding. DOE should look at its university research strategy. DOE should look at the landscape of Wind research at universities today and decide how it is going to fund future research. The consortium winners should compete against the other "Wind" universities that were not winners.
- Continue focus on aerodynamic modeling from atmospheric to regional to wind farm to the turbines and blades. A lot of sophisticated analysis research going on. Need leadership in how these diverse activities tie together into something that, in the end, results in tools that can be used by all.
- One often sees European researchers spending time in the U.S. and thereby using U.S. facilities; however it is not very often one sees U.S. researchers spending time at the European Institutes. Why? Should there be a greater emphasis on having National Lab personnel spending research assignments at European Research Institutes?
- Need to ensure that money is not spent in areas where staff is not part of the cutting edge of current research.
- Need to make sure that there is a concerted effort to grow staff capabilities and to maintain excellence in staff capability. Many of the studies described are successful because of the key staff involved. In order to do maintain staff excellence, areas where excellence is not being achieved must be reviewed and adjustments made as necessary.
- Need to continue to align top-down focus on areas of key needs in the wind industry and bottom-up focus of areas where research staff can provide the most benefit. Both need to be flexible to adjust to the other.

9.0 Lessons Learned from the 2012 Wind Power Peer Review Meeting Process

The 2012 Wind Power Peer Review meeting took place on June 19 – 22, 2012 at the Hilton Alexandria Mark Center Hotel in Alexandria, VA. A peer review panel consisting of a total of nine members, including a chairperson, participated in the 2012 peer review process. The purpose of the review was to evaluate DOE-funded projects for their contribution to the mission and goals of the program, to assess progress made against stated objectives, and to assess the program's overall management and performance. Principal Investigators (PI), leading approximately 67 projects, and federal program staff came together to disseminate information, progress, and results. The following is a list of comments and actionable recommendations aimed at improving the process for future peer review meetings:

- Stronger quality control and checks on reviewer conflict of interest are required. Peer review staff should consider reviewing all presentations manually to check for listings of subcontractors, partners, etc. Often panelists are simply not aware of all the involvements their companies have with other entities.
- Consider encouraging PIs to select a singular/most important program objective rather than "selecting all that apply."
- Some panel members would like to receive a thumb drive and a print book of all materials prior to the review. Provide one complete (personalized - i.e. the reviewer's own list of projects) hard copy and thumb drive to each reviewer in advance of meeting instead of having reviewers do the download dance.
- The panel would prefer to hear more about the impacts of the projects and how the accomplishments of the projects are impacting the goals of the program, i.e. lowering the LCOE of wind, and etc. Reporting on a project's results and accomplishments is not the same as communicating its impact.
- Uniformity of presentations led to un-needed information. There should be some allowance for programs to adjust the presentation format in order to concentrate on issues of greatest relevance to each study.
- Presenters should use less jargon and acronyms in their presentations.
- On occasion, some presenters tended to talk faster in an effort to convey more information. However, this actually made it harder for reviewers to capture and process what the presenters were saying.
- Program presentations should have a problem statement section to justify their existence, similar to PI presentations.
- The Panel members would like to receive program presentations at least one week before the peer review meeting as these help put the individual project materials into perspective. They also inform Panel members about the program areas including those projects that individual Panel members may not be assigned to evaluate.
- Develop a project numbering system in advance so that early users of the SharePoint do not have files without the numbers.
- The peer review staff was very efficient and responsive.
- Review panel dinners provided useful planning and discussion sessions for the reviewers (initial dinner was very helpful for introductions, and the pre-wrap-up dinner was particularly useful in organizing general thoughts for discussion with the program).
- Allow three to five minutes between presentation to give Panel members time to complete their worksheets or notes before moving on to the next presentation.
- Remind reviewers about the reimbursement schedule and detailed procedures.

APPENDICES

Appendix A: Acronyms

Appendix B. Project Evaluation Form

Appendix C. Program Evaluation Form

Appendix D. Meeting Agenda

Appendix E. Meeting Attendee List

Appendix A. Acronyms

Abbreviations

Abbreviation	Description
AALC	Active Aerodynamic Load Control
ARRA	American Recovery And Reinvestment Act
AWEA	American Wind Energy Association
BA	Balancing Authority
CART	Controls Advanced Research Turbine
CEC	California Energy Commission
CFD	Computational Fluid Dynamics
COE	Cost Of Energy
CRADA	Cooperative Research And Development Agreement
CREW	Continuous Reliability For Enhancement Of Wind
ERCOT	Electric Reliability Council Of Texas
ERGIS	Eastern Renewable Generation Integration Study
FESTIV	Flexible Energy Scheduling Tool For Integration Of Variable Generation
FOA	Funding Opportunity Announcement
FY	Fiscal Year
GE	General Electric
GRC	Gearbox Reliability Collaborative
GW	Gigawatts
IEA	International Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute Of Electrical And Electronics Engineers
IP	Intellectual Property
ISO	Independent System Operator
ITC	Investment Tax Credit
JEDI	Jobs And Economic Development Impact Model
kW	Kilowatt
kWh	Kilowatt Hour
LCOE	Levelized Cost Of Energy
LIDAR	Light Detection And Ranging
LLC	Limited Liability Company
MA	Massachusetts
MISO	Midwest Independent System Operator
MW	Megawatt
MWh	Megawatt Hour

Abbreviation	Description
NARUC	National Association Of Regulatory Utility Commissioners
NCAR	National Center For Atmospheric Research
NDI	Non-Destructive Inspection
NERC	North American Electric Reliability Corporation
NWP	Numerical Weather Prediction Models
NWTC	National Wind Technology Center At NREL
O&M	Operations & Maintenance
OEM	Original Equipment Manufacturer
OW	Offshore Wind
PI	Principle Investigator
PIV	Particle Image Velocimetry
PLEXOS	PLEXOS is a simulation tool that uses cutting-edge data handling, mathematical programming, and stochastic optimization techniques to provide a robust analytical framework for power market analysis.
PPA	Power Purchase Agreement
PTC	Production Tax Credit
PUC	Public Utilities Commission
R&D	Research And Development
RFI	Request For Information
RFORE	Reference Facility For Offshore Renewable Energy
RISO	Risø Technical University Of Denmark
RTC	Regional Test Centers
RTCs	Regional Test Center(S)
SC	South Carolina
SMART	Structural Mechanical Adaptive Rotor Technology
SMUD	Sacramento Municipal Utility District
SOWFA	Simulator For Offshore Wind Applications
SWCC	Small Wind Certification Center
SWIFT	Scaled Wind Farm Technology (New Facility At SNL)
SWT	Small Wind Turbine
TPI	TPI Composites
TRC	Technical Review Committee
UK	United Kingdom
US	United States Of America
UVIG	Utility Variable Integration Group
VG	Variable Generation
WA	Washington
WECC	Western Electricity Coordinating Council

Abbreviation	Description
WFS	Wind For Schools Program
WPA	Wind Powering America
WRF	Weather Research And Forecasting Model
WTG	Wind Turbine Generator(S)
WWIS	Western Wind Integration Study
WWPP	DOE Wind And Water Power Program
WWSIS	Western Wind And Solar Integration Study
NARUC	National Association Of Regulatory Utility Commissioners

National Laboratories

Abbreviation	Description
ANL	Argonne National Laboratory
INL	Idaho National Laboratory
LANL	Los Alamos National Lab
LBNL	Lawrence Berkeley National Laboratory
LLNL	Lawrence Livermore National Laboratory
NREL	National Renewable Energy Laboratory
ORNL	Oak Ridge National Laboratory
PNL	Pacific Northwest National Laboratory
PNNL	Pacific Northwest National Laboratory
SNL	Sandia National Laboratories

Government Agencies

Abbreviation	Description
DHS	Department of Homeland Security
DOD	Department of Defense
DOE	Department of Energy
EERE	Energy Efficiency and Renewable Energy
EPA	Environmental Protection Agency
GAO	General Accounting Office
NOAA	National Oceanic and Atmospheric Administration
NWS	National Weather Service

Appendix B. Project Evaluation Form Template

The evaluation forms were the only means by which reviewers documented their quantitative and qualitative project evaluations. The panel was asked to rate General and Cross-cutting, Technology, and Market Acceleration and Deployment on the following metrics:

1. **Relevance to Overall DOE Objectives:** the degree to which the project aligns with the objectives and goals of the Wind Power Program and meets the needs of the wind industry at large. (Stand Alone Metric)
2. **Methods/Approach:** the degree to which the project is well designed, technically feasible, and likely to overcome the technical and non-technical barriers. (Weight = 30%)
3. **Technical Accomplishments and Progress:** degree to which the project has delivered results and/or progressed technically compared to the stated project schedule and goals. (Weight = 30%)
4. **Project Management:** the effectiveness of the project's management, including project planning, project execution, and allocation of resources to complete the project within scope, on-time, and within budget. (Weight = 20%)
5. **Research Integration, Collaboration, and Technology Transfer:** the degree to which the project successfully interacts, interfaces, or coordinates with other institutions and projects, and the degree to which projects are disseminating the results of the R&D. (Weight = 10%)
6. **Proposed Future Research (if applicable):** the degree to which the future research proposed is relevant, well-planned, and worthwhile of continued funding. (Weight = 10%)

For project evaluations, numerical scores were based on a five-point scale, with qualitative descriptors given for the numerical scoring index (i.e., a score of 1 corresponds to a "Poor" rating, 2 corresponds to a "Fair" rating, 3 corresponds to a "Average" rating, 4 corresponds to a "Good" rating, and 5 corresponds to an "Outstanding" rating). In addition to the above six criterion, peer reviewers were asked to provide an overall qualitative assessment of the project in a written narrative. Reviewers were asked to comment on overall strengths and weaknesses, and to include recommendations for ways to improve the projects.

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Project Evaluation Form for #N/A

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Agenda

Project ID:		Reviewer:		#N/A
Presenter Name:		Presenter Org:		#N/A
Enter comment in green shaded cells	*Provide specific, concise comments to support your evaluation.*			#N/A
				#N/A

Q1 **Relevance to wind industry needs and overall DOE objectives**

The degree to which the project aligns with objectives and goals of the Wind Power Program and meets the needs of the wind industry at large.

Stand Alone Metric

5 - Outstanding	Project is critical to objectives and goals of the Program and meeting wind industry needs.
4 - Good	Project has valuable impact to Program goals & objectives and meeting wind industry needs.
3 - Average	Project has moderate relevance with objectives and goals of the Program and wind industry needs.
2 - Fair	Project is marginally relevant to the objectives and goals of the Program and wind industry.
1 - Poor	Project has little relevance to Program goals and objectives and wind industry needs.

score

Key Finding	Comments	Comment Category

Q2 **Methods/Approach**

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

Weight 30%

5 - Outstanding	Excellent project design and technically feasible; approach will likely be successful.
4 - Good	Well designed and technically feasible; continue to move forward with this approach.
3 - Average	Generally effective.
2 - Fair	Has significant weaknesses in methods; requires significant improvement.
1 - Poor	Ineffective approach to meet project objectives; new methods should be developed.

score

Key Finding	Comments	Comment Category

Q3 **Technical Accomplishments & Progress**

The degree to which the project has delivered results and/or progressed technically compared to the stated project schedule and goals.

Weight 30%

5 - Outstanding	Excellent accomplishments and progress; little to no monitoring needed for excellent project results.
4 - Good	Good progress; successful outcome is likely.
3 - Average	Adequate accomplishments and progress. Continue monitoring.
2 - Fair	Accomplishments and progress appear behind schedule or short of original goals; extra project monitoring needed to improve outcome.
1 - Poor	Little or no demonstrated progress made. Major course correction needed to achieve success.

score

Key Finding	Comments	Comment Category

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Project ID:		Reviewer:	
Presenter Name:		Presenter Org:	

Enter comment in green shaded cells — *Provide specific, concise comments to support your evaluation.*

Q4 Project Management — Weight 20%

The effectiveness of the project's management, including project planning, project execution, & allocation of resources to complete the project within scope, on-time, and within budget.

5 - Outstanding	Excellent project management demonstrated that should result in well-run, successful project.
4 - Good	Project management appears successful and should result in an in-scope, on-time, within-budget project.
3 - Average	Project management should result in completion of objectives mostly within scope, on-time, and within budget.
2 - Fair	Project management evidence indicates project may have issues with executing within scope, on-time, and/or within budget.
1 - Poor	Poor project management demonstrated. Project likely to have significant overruns in schedule or budget, and may need re-scoping.

score

Key Finding	Comments	Comment Category

Q5 Research Integration, Collaboration, and Technology Transfer — Weight 10%

With industry/universities/other laboratories – the degree to which the project successfully interacts, interfaces, or coordinates with other institutions and projects, and the degree to which projects are disseminating the results of the R&D.

5 - Outstanding	Close coordination with other institutions strenghtens project impact; results well-documented and being communicated to appropriate audiences.
4 - Good	Close, appropriate coordination with other institutions; results reaching appropriate audiences.
3 - Average	Some coordination across institutions; some technology transfer and communications demonstrated.
2 - Fair	Little coordination exists across institutions, to the detriment of the project; weak evidence of technology transfer and/or communications.
1 - Poor	No collabroation or coordination with other institutions significantly weakens the project; no evidence of technology transfer and/or communications.

score

Key Finding	Comments	Comment Category

Q6 Proposed Future Research (if applicable) — Weight 10%

The degree to which the future research proposed is relevant, well-planned, and worthwhile of continued funding.

5 - Outstanding	Proposed future research is critical for Program and industry success, appears well-planned and achievable, and should be prioritized for funding.
4 - Good	Proposed future research aligns well with Program and industry needs, and appears likely to deliver results.
3 - Average	Proposed future research is moderately relevant to Program and industry needs, with moderate likelihood for impact.
2 - Fair	Proposed future research is marginally relevant and may achieve its intended impact.
1 - Poor	Proposed future research is not relevant or does not appear likely to achieve results. Consider de-funding.
NA - Not Applicable	Project is complete, so no future research is proposed.

score

Key Finding	Comments	Comment Category

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Project Evaluation Form for

#N/A

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Project ID:		Reviewer:	
Presenter Name:		Presenter Org:	

Enter comment in green shaded cells *Provide specific, concise comments to support your evaluation.*

Q7	**Project Strengths** Discuss the aspects of the project that support successful outcomes or that provide an advantage to the project. Factors may be internal or external.	
Key Finding	**Comments**	Comment Category

Q8	**Project Weaknesses** Discuss the aspects of the project that hinder successful outcomes or that disadvantage the project. Factors may be internal or external.	
Key Finding	**Comments**	Comment Category

Q9	**Recommendations**	
Key Finding	**Comments**	Comment Category

Appendix C. Program Evaluation Form Template

The evaluation forms were the only means by which reviewers documented their quantitative and qualitative evaluations of the Wind Program. The panel was asked to rate the Wind Program based on the metrics listed below:

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

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

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

2012 U.S. DOE Wind Power Peer Review

Program Evaluation Form

Page 1 of 3

Program Name:		Reviewer:		Agenda
Presenter Name:		Presenter Org:		

Input Cells — *Provide specific, concise comments to support your evaluation.*

Q1 **Program Objectives**

How well do Program objectives align with industry needs and Administration Goals?

- Reduce unsubsidized LCOE (levelized cost-of-energy) to be cost-competitive with fossil fuels;
- Reduce deployment barriers and promote the industry to enable 20% wind by 2030;
- Jumpstart a U.S. offshore wind industry;
- Testing, advanced manufacturing, certifications, and standards;
- Optimized wind power plant operations and production in the power system; and
- Improved resource characterization and understanding of wind phenomena

5 - **Outstanding**	All Program objectives fully support industry needs.	score
4 - **Good**	Most Program objectives fully support industry needs.	
3 - **Average**	Program objectives marginally support industry needs.	
2 - **Fair**	Some Program objectives do not support industry needs.	
1 - **Poor**	Few or none of Program objectives support industry needs; objectives should be re-evaluated and revised.	

Key Finding	Comments

Q2 **R&D Portfolio**

Is the Wind Program investment portfolio appropriately balanced across research areas and recipient organizations to achieve the program's mission & goals?

5 - **Outstanding**	Program investment portfolio is excellent across research areas and organizations to achieve program mission & goals	score
4 - **Good**	Program investment portfolio is fairly balanced across research areas and organizations to meet program mission & goals	
3 - **Average**	Program investment portfolio mix and diversity is adequate	
2 - **Fair**	Program investment portfolio has some weaknesses in balance across research areas and recipients	
1 - **Poor**	Program investment portfolio will not enable program to achieve its mission & goals	

Key Finding	Comments

Q3 **Management & Operations**

Please evaluate the quality of the Wind Program's team, management practices, and operations.

5 - **Outstanding**	Program has excellent leadership, personnel, and program operation practices.	score
4 - **Good**	Program management and operations appears mostly effective.	
3 - **Average**	Program management and operations is adequate.	
2 - **Fair**	Some of the Program team and practices reduce its effectiveness.	
1 - **Poor**	Program team and practices are not effective.	

Key Finding	Comments

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

2012 U.S. DOE Wind Power Peer Review

Project Evaluation Form

Page 2 of 3

Project Name:		**Reviewer:**	
Presenter Name:		**Presenter Org:**	

Input Cells *Provide specific, concise comments to support your evaluation.*

Q4 **Communications & Outreach**

How effective is the Program at engaging with industry, universities, other agencies, international actors, and other stakeholders?

5 - Outstanding	Program is extremely effective in communications, coordination, and outreach with relevant stakeholders.	**score**
4 - Good	Program does a good job with communications, coordination, and outreach to relevant stakeholders.	
3 - Average	Program communications, coordination, and outreach is adequate.	
2 - Fair	Program needs improvement on communications, coordination, and outreach activities.	
1 - Poor	Program's ineffective communications, coordination, and outreach impede its overall success.	

Key Finding	Comments

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy	2012 U.S. DOE Wind Power Peer Review Project Evaluation Form	Page 3 of 3

Project Name:		Reviewer:		
Presenter Name:		Presenter Org:		

Input Cells *Provide specific, concise comments to support your evaluation.*

Q5	Program Strengths Discuss the aspects of the program that support successful outcomes or that provide an advantage to the program. Factors may be internal or external.
Key Finding	**Comments**

Q6	Program Weaknesses Discuss the aspects of the program that hinder successful outcomes or that disadvantage the program. Factors may be internal or external.
Key Finding	**Comments**

Q7	Recommendations
Key Finding	**Comments**

Appendix D. Meeting Agenda

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

2012 Wind Program
Peer Review Agenda
Tuesday, June 19, 2012

Track
Technology

Start	End	Session & Location	Presentation	Presenter
7:30 AM	**8:30 AM**	***Plaza Foyer***	**CONTINENTAL BREAKFAST**	
8:30 AM	8:45 AM	Program Overview *Plaza Ballroom B*	Chairperson Welcome and Introductions to the Panel	Jim Walker, Peer Review Chair
8:45 AM	8:55 AM		Peer Review Instructions for Panelists and Presenters	Jessica Lin-Powers, DOE/NREL
8:55 AM	9:55 AM		PROGRAM INTRODUCTION	Jose Zayas, DOE
9:55 AM	10:05 AM		BREAK	
10:05 AM	10:35 AM	Laboratory Testing Facilities *Plaza Ballroom B*	Testing Facilities at Sandia National Lab	Dr. Jonathan R. White, SNL
10:35 AM	11:15 AM		Testing Facilities at NREL National Wind Testing Center	David Simms, NREL
11:15 AM	11:35 AM	Large Facilities *Plaza Ballroom B*	WP001-5 MW Dynamometer Upgrade	David Simms, NREL
11:35 AM	11:55 AM		WP002-Clemson University Wind Turbine Drivetrain Testing Facility	Jim Tuten, Clemson
11:55 AM	12:15 PM		WP003-Massachusetts Large Blade Testing Facility	Rahul Yarala, MassCEC
12:15 PM	**1:15 PM**	***Plaza Foyer***	**LUNCH**	
1:15 PM	1:30 PM	Program Overview *Plaza Ballroom B*	Portfolio Overview: Turbine Standards Development	Jeroen Van Dam, NREL
1:30 PM	1:50 PM		Portfolio Overview: Market Acceleration & Deployment	Patrick Gilman, DOE
1:50 PM	1:55 PM		Chairperson's Comments for Afternoon sessions	Jim Walker, Peer Review Chair
1:55 PM	2:00 PM		BREAK	
2:00 PM	2:20 PM	Characterizing turbine inflow *Plaza I & II*	WP005-Turbine inflow and wake observations with 2-micron LIDAR	Jeff Mirocha, LLNL
2:20 PM	2:40 PM		WP006-Multiscale Resource Modeling	Jeff Mirocha, LLNL
2:40 PM	3:00 PM		WP007-Accurate Wind Characterization in Complex Terrain Using the Immersed Boundary Method	Jeff Mirocha, LLNL
3:00 PM	3:20 PM		WP008-Long Term Observations of Wind Profiles and Turbulence for Model Evaluation	Larry Berg, PNNL
3:20 PM	3:40 PM		WP009-Wind Turbines In-Situ Particle-Image Velocimetry	Suhas Pol, LANL
3:40 PM	4:00 PM		BREAK	
4:00 PM	4:20 PM	Characterizing turbine inflow *Plaza I & II*	WP010-Wake and Array Effects Modeling and Characterization	Patrick Moriarty, NREL
4:20 PM	4:40 PM		WP011-Stochastic Inflow Simulation, Characterization and Observational Technologies	Patrick Moriarty, NREL
4:40 PM	5:00 PM		WP012-DOE 1.5 MW Turbine Test / DOE 1.5 MW Instrumentation Upgrade	Scott Schreck, NREL

Black = General and Cross Cutting Track Blue = Technology Track Green = Market Acceleration and Deployment Track

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

2012 Wind Program
Peer Review Agenda
Tuesday, June 19, 2012

Track
Market Acceleration and Deployment

Start	End	Session & Location	Presentation	Presenter
7:30 AM	**8:30 AM**	***Plaza Foyer***	**CONTINENTAL BREAKFAST**	
8:30 AM	8:45 AM	Program Overview *Plaza Ballroom B*	Chairperson Welcome and Introductions to the Panel	Jim Walker, Peer Review Chair
8:45 AM	8:55 AM		Peer Review Instructions for Panelists and Presenters	Jessica Lin-Powers, DOE/NREL
8:55 AM	9:55 AM		PROGRAM INTRODUCTION	Jose Zayas, DOE
9:55 AM	10:05 AM		BREAK	
10:05 AM	10:35 AM	Laboratory Testing Facilities *Plaza Ballroom B*	Testing Facilities at Sandia National Lab	Dr. Jonathan R. White, SNL
10:35 AM	11:15 AM		Testing Facilities at NREL National Wind Testing Center	David Simms, NREL
11:15 AM	11:35 AM	Large Facilities *Plaza Ballroom B*	WP001-5 MW Dynamometer Upgrade	David Simms, NREL
11:35 AM	11:55 AM		WP002-Clemson University Wind Turbine Drivetrain Testing Facility	Jim Tuten, Clemson
11:55 AM	12:15 PM		WP003-Massachusetts Large Blade Testing Facility	Rahul Yarala, MassCEC
12:15 PM	**1:15 PM**	***Plaza Foyer***	**LUNCH**	
1:15 PM	1:30 PM	Program Overview *Plaza Ballroom B*	Portfolio Overview: Turbine Standards Development	Jeroen Van Dam, NREL
1:30 PM	1:50 PM		Portfolio Overview: Market Acceleration & Deployment	Patrick Gilman, DOE
1:50 PM	1:55 PM		Chairperson's Comments for Afternoon sessions	Jim Walker, Peer Review Chair
1:55 PM	2:00 PM		BREAK	
2:00 PM	2:30 PM	Wildlife & Environment *Plaza Ballroom B*	WP013-Wildlife Impacts	Karin Sinclair, NREL
2:30 PM	2:45 PM		WP014-Wind Energy Development in Critical Wildlife Habitats: Sage Grouse	Kirk E. LaGory, ANL
2:45 PM	3:15 PM	Outreach & Education *Plaza Ballroom B*	WP015-Market Acceleration and Barrier Reduction - Stakeholder Engagement and Communications	Ian Baring-Gould, NREL
3:15 PM	3:45 PM		WP016-Market Acceleration and Barrier Reduction - Workforce Development	Ian Baring-Gould, NREL
3:45 PM	4:00 PM		BREAK	
4:00 PM	4:10 PM	Small & Mid-sized Wind *Plaza Ballroom B*	NREL Small and Mid-size Wind Overview	Karin Sinclair, NREL
4:10 PM	4:30 PM		WP019-Certifying the Performance of Small Wind Turbines	Larry Sherwood, SWCC
4:30 PM	4:45 PM		WP020-NWTC Small Wind Testing	Jeroen Van Dam, NREL
4:45 PM	5:00 PM		WP021-Regional Test Centers	Karin Sinclair, NREL

Black = General and Cross Cutting Track Blue = Technology Track Green = Market Acceleration and Deployment Track

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

2012 Wind Program
Peer Review Agenda
Wednesday, June 20, 2012

Track: Technology

Start	End	Session & Location	Presentation	Presenter
7:30 AM	**8:30 AM**	***Plaza Foyer***	**CONTINENTAL BREAKFAST**	
8:30 AM	8:45 AM	Program Overview *Plaza Ballroom B*	Comments from the Chair - Day 2	Jim Walker, Peer Review Chair
8:45 AM	9:15 AM		20% by 2030 Projects - Summary Overview	Gary Nowakowski, DOE
9:15 AM	9:45 AM		Portfolio Overview: Offshore Strategy	TBD, DOE
9:45 AM	10:15 AM		Portfolio Overview: International Collaboration & Interagency Activities	Jim Ahlgrimm, DOE
10:15 AM	10:30 AM		BREAK	
10:30 AM	10:50 AM	University Consortia *Plaza Ballroom B*	WP022-University/Industry Consortium: Illinois Institute of Technology	Dr. Mohammad Shahidehpour, Illinois Institute of Technology
10:50 AM	11:10 AM		WP023-University/Industry Consortium: University of Minnesota	Dr. Fotis Sotiropoulos, University of Minnesota
11:10 AM	11:30 AM		WP024-DeepCwind Consortium National Research Program	Anthony Viselli , University of Maine
11:30 AM	12:00 PM	Program Overview *Plaza Ballroom B*	Portfolio Overview: Analysis & Models	Mark Higgins, DOE
12:00 PM	**1:00 PM**	***Plaza Foyer***	**LUNCH**	
1:00 PM	1:20 PM	Offshore *Plaza I & II*	WP025-New Reference Facility for Offshore Renewable Energy (RFORE)	Larry Berg, PNNL
1:20 PM	1:40 PM		WP026-Sediment, Transport, Scour and Foundation Impact Analysis	Jesse Roberts, SNL
1:40 PM	2:10 PM		WP027-Offshore Structural Models and Analysis	Walter Musial, NREL
2:10 PM	2:30 PM		WP028-Reducing COE with Floating Tension-Leg Platform Technology	William Hurley, Glosten Associates
2:30 PM	2:50 PM		WP029-National Offshore Wind Energy Resource and Design Data Campaign	Bruce Bailey, AWS Truepower
2:50 PM	3:00 PM		Extra time for Peer Review Panel Scoring and Comments	
3:00 PM	3:15 PM		BREAK	
3:15 PM	3:35 PM	Manufacturing & Materials *Plaza I & II*	WP030-Advanced Manufacturing Initiative	Dr. Daniel Laird, SNL
3:35 PM	3:55 PM		WP031-Manufacturing Research	Joshua Paquette, SNL
3:55 PM	4:15 PM		WP032-Materials Research	Joshua Paquette, SNL
4:15 PM	4:35 PM	Design Tools & System Modeling *Plaza I & II*	WP033-Advanced Design Tools	Paul Veers, NREL
4:35 PM	4:55 PM		WP034-Blade Design Tools & System Modeling	Brian Resor, SNL
4:55 PM	5:00 PM		Extra time for Peer Review Panel Scoring and Comments	

Black = General and Cross Cutting Track Blue = Technology Track Green = Market Acceleration and Deployment Track

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

2012 Wind Program
Peer Review Agenda
Wednesday, June 20, 2012

Track
Market Acceleration and Deployment

Start	End	Session & Location	Presentation	Presenter
7:30 AM	**8:30 AM**	***Plaza Foyer***	**CONTINENTAL BREAKFAST**	
8:30 AM	8:45 AM	Program Overview *Plaza Ballroom B*	Comments from the Chair - Day 2	Jim Walker, Peer Review Chair
8:45 AM	9:15 AM		20% by 2030 Projects - Summary Overview	Gary Nowakowski, DOE
9:15 AM	9:45 AM		Portfolio Overview: Offshore Strategy	TBD, DOE
9:45 AM	10:15 AM		Portfolio Overview: International Collaboration & Interagency Activities	Jim Ahlgrimm, DOE
10:15 AM	10:30 AM		BREAK	
10:30 AM	10:50 AM	University Consortia *Plaza Ballroom B*	WP022-University/Industry Consortium: Illinois Institute of Technology	Dr. Mohammad Shahidehpour, Illinois Institute of Technology
10:50 AM	11:10 AM		WP023-University/Industry Consortium: University of Minnesota	Dr. Fotis Sotiropoulos, University of Minnesota
11:10 AM	11:30 AM		WP024-DeepCwind Consortium National Research Program	Anthony Viselli , University of Maine
11:30 AM	12:00 PM	Program Overview *Plaza Ballroom B*	Portfolio Overview: Analysis & Models	Mark Higgins, DOE
12:00 PM	**1:00 PM**	***Plaza Foyer***	**LUNCH**	
1:00 PM	1:30 PM	Radar Mitigation & Solutions *Plaza Ballroom B*	WP035-Wind Radar Interagency Field Test & Evaluation	Franz Busse, MIT-LL/SNL
1:30 PM	2:00 PM	Market Research & Analysis *Plaza Ballroom B*	WP036-Wind Technologies Market Report and Other Analyses	Ryan Wiser, LBNL
2:00 PM	2:15 PM		WP037-Jobs and Economic Development Impacts Modeling	Suzanne Tegen, NREL
2:15 PM	2:45 PM		WP038-System Levelized Cost of Energy (LCOE) Analysis	Maureen Hand, NREL
2:45 PM	3:00 PM		WP039-Offshore System Cost Analysis	Maureen Hand, NREL
3:00 PM	3:15 PM		BREAK	
3:15 PM	3:30 PM	Forecasting Improvement *Plaza Ballroom B*	WP040-Enhancing Short Term Wind Energy Forecasting for Improved Utility Operations	James M Wilczak, NOAA
3:30 PM	3:45 PM		WP041-Wind Forecasting Improvement Project: Southern Study Region	Jeffrey Freedman, AWS Truepower, LLC.
3:45 PM	4:00 PM		WP042-Wind Forecasting Improvement Project: Northern Study Region	Cathy Finley, WindLogics
4:00 PM	4:15 PM		WP043-Improved Statistical Methods for Wind Power Forecasting	Audun Botterud, ANL
4:15 PM	4:30 PM		WP044-Improved Forecasting Methods	Sonia Wharton, LLNL
4:30 PM	4:45 PM		WP045-Developing WindSENSE for Control Room Integration	Chandrika Kamath, LLNL
4:45 PM	5:00 PM		WP046-Resource Modeling and Data Collection	Debra Lew, NREL

Black = General and Cross Cutting Track Blue = Technology Track Green = Market Acceleration and Deployment Track

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

2012 Wind Program
Peer Review Agenda
Thursday, June 21, 2012

Track: Technology

Start	End	Session & Location	Presentation	Presenter
7:30 AM	**8:30 AM**	***Plaza Foyer***	**CONTINENTAL BREAKFAST**	
8:30 AM	8:40 AM	Program Overview *Plaza Ballroom B*	Chairperson Remarks - Kick-off Day 3	Jim Walker, Peer Review Chair
8:40 AM	9:00 AM		PROGRAM RECAP	Jose Zayas, DOE
9:00 AM	9:30 AM		Portfolio Overview: Technology Development	Mike Derby, DOE
9:30 AM	10:00 AM		Portfolio Overview: Grid System Planning and Operations	Charlton Clark, DOE
10:00 AM	10:15 AM		BREAK	
10:15 AM	10:40 AM	Reliability *Plaza I & II*	WP047-Blade Reliability Collaborative	Joshua Paquette, SNL
10:40 AM	11:05 AM		WP048-Gearbox Reliability Collaborative	Jonathan Keller, NREL
11:05 AM	11:30 AM		WP049-CREW Database and Analysis Program	Alistair Ogilvie, SNL
11:30 AM	11:55 AM		WP050-Condition Monitoring and Data Analysis	Shawn Sheng, NREL
11:55 AM	12:00 PM		Extra time for Peer Review Panel Scoring and Comments	
12:00 PM	**1:00 PM**	***Plaza Foyer***	**LUNCH**	
1:00 PM	1:25 PM	Rotor Technology *Plaza I & II*	WP056-Blade Testing Methodologies	Scott Hughes, NREL
1:25 PM	1:50 PM		WP057-Large Offshore Rotor Development	Daniel Todd Griffith, SNL
1:50 PM	2:15 PM		WP058-Siemens CRADA	Lee Jay Fingersh, NREL
2:15 PM	2:40 PM		WP059-Aerodynamics and Aero-acoustics Research	Matthew Barone, SNL
2:40 PM	3:05 PM		WP060-Sensor Blades 1 and 2	Jon White, SNL
3:05 PM	3:15 PM		BREAK	
3:15 PM	3:55 PM	Controls *Plaza I & II*	WP061-Advanced Controls R&D + Controls Partnerships	Lee Jay Fingersh, NREL
3:55 PM	4:20 PM		WP062-Active Aerodynamic Load Control Devices in Blades (SMART)	Dale Berg, SNL
4:20 PM	4:30 PM		BREAK	
4:30 PM	4:45 PM	Program Overview *Plaza Ballroom B*	Closing Thoughts - Program Manager	Jose Zayas, DOE
4:45 PM	5:00 PM		Closing Thoughts - Peer Review Chair	Jim Walker, Peer Review Chair

Black = General and Cross Cutting Track Blue = Technology Track Green = Market Acceleration and Deployment Track

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

2012 Wind Program
Peer Review Agenda
Thursday, June 21, 2012

Track: Market Acceleration and Deployment

Start	End	Session & Location	Presentation	Presenter
7:30 AM	**8:30 AM**	***Plaza Foyer***	**CONTINENTAL BREAKFAST**	
8:30 AM	8:40 AM	Program Overview *Plaza Ballroom B*	Chairperson Remarks - Kick-off Day 3	Jim Walker, Peer Review Chair
8:40 AM	9:00 AM		PROGRAM RECAP	Jose Zayas, DOE
9:00 AM	9:30 AM		Portfolio Overview: Technology Development	Mike Derby, DOE
9:30 AM	10:00 AM		Portfolio Overview: Grid System Planning and Operations	Charlton Clark, DOE
10:00 AM	10:15 AM		BREAK	
10:15 AM	10:35 AM	Grid System Planning & Operations *Plaza Ballroom B*	WP051-Western Wind and Solar Integration Study Phase II	Debra Lew, NREL
10:35 AM	10:55 AM		WP052-Eastern Renewable Generation Integration Study	Debra Lew, NREL
10:55 AM	11:15 AM		WP053-Concurrent Cooling – Increasing Transmission Capacities With Dynamic Monitoring Systems	Kurt Myers, INL
11:15 AM	11:35 AM		WP054-Wind Plant Collector System Design & Protection	Travis Smith, ORNL
11:35 AM	11:55 AM		WP055-Benefits of Balancing Authorities Cooperation Across the Western Interconnection	Nader Samaan, PNNL
11:55 AM	12:00 PM		Extra time for Peer Review Panel Scoring and Comments	
12:00 PM	**1:00 PM**	***Plaza Foyer***	**LUNCH**	
1:00 PM	1:20 PM	Grid System Planning & Operations *Plaza Ballroom B*	WP063-Wind Power Plant Modeling	Ben Karlson, SNL
1:20 PM	1:40 PM		WP064-Generator Modeling	Eduard Muljadi, NREL
1:40 PM	2:00 PM		WP065-Operational Strategies, Modeling and Analysis	Michael Milligan, NREL
2:00 PM	2:20 PM		WP066-Operating Reserves Analysis	Erik Ela, NREL
2:20 PM	2:40 PM		WP067-Interconnection Support	Michael Milligan, NREL
2:40 PM	3:00 PM		Extra time for Peer Review Panel Scoring and Comments	
3:00 PM	3:15 PM		BREAK	
3:15 PM	3:35 PM	Grid System Planning & Operations *Plaza Ballroom B*	WP068-Wind Integration Model (WIM)	Jeff Dagle, PNNL
3:35 PM	3:55 PM		WP069-Use of Wind Power Forecasting in Operational Decisions	Audun Botterud, ANL
3:55 PM	4:15 PM		WP070-Active Power Control from Wind Power	Erik Ela, NREL
4:15 PM	4:30 PM		BREAK	
4:30 PM	4:45 PM	Program Overview *Plaza Ballroom B*	Closing Thoughts - Program Manager	Jose Zayas, DOE
4:45 PM	5:00 PM		Closing Thoughts - Peer Review Chair	Jim Walker, Peer Review Chair

Black = General and Cross Cutting Track Blue = Technology Track Green = Market Acceleration and Deployment Track

Appendix E. Meeting Attendee List

Jim Ahlgrimm
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