U.S. DEPARTMENT OF
ENERGY

Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

2022 PROJECT PEER REVIEW

U.S. DEPARTMENT OF ENERGY
WATER ENERGY TECHNOLOGIES OFFICE

Summary Report

July 2022

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Preface

MESSAGE FROM DIRECTOR

Dear Colleague,

On behalf of the U.S. Department of Energy's (DOE) Wind Energy Technologies Office (WETO), I am pleased to present the results of the 2021 WETO Peer Review, which was held virtually August 2–5, 2021. The purpose of the review was to evaluate projects funded by DOE during fiscal years 2019–2020 for their contribution to the mission and goals of the wind office, assess progress against stated objectives, and appraise WETO's overall management and performance.

As an independent, expert evaluation of the office and its body of research, peer reviews are an essential part of developing and evaluating the WETO research portfolio. At the review, principal investigators from DOE's national laboratories as well as academic and industry representatives presented the progress of WETO-funded research projects to 11 independent reviewers.

External subject-matter experts from industry, academia, and federal agencies reviewed and scored the technical, scientific, and business relevance of more than 90% of the projects in our research and development (R&D) portfolio—66 projects with a combined value of more than $560 million, including non-federal cost share. They also evaluated the effectiveness of the office itself in executing its mission and managing the project portfolio. We are grateful to the reviewers for their candid and constructive scoring, comments, and recommendations. The office will use this feedback to assess and revise current and future portfolio decisions.

WETO is committed to developing a portfolio of innovative land-based, offshore, and distributed wind energy technologies for cost-effective domestic power generation. Growing wind energy is an important part of the Biden Administration's goals to diversify and decarbonize the U.S. energy portfolio, create jobs, and provide cost-competitive electricity to all Americans. The 2021 Peer Review results will help WETO evaluate and plan its research portfolio, ensuring effective investment of taxpayer dollars to achieve these goals for the benefit of the nation.

Sincerely,

Jim Ahlgrimm
Acting Director, Wind Energy Technologies Office
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

PEER REVIEW INTRODUCTION

WETO's 2021 Peer Review was held August 2–5 through a virtual conference platform. Over the course of four days, more than 275 people were in attendance, including independent reviewers, principal investigators (PIs), researchers, stakeholders, and WETO staff.

WETO leadership and project managers use the peer review results to help inform programmatic decision making, evaluate existing programs and projects, guide the direction of newly funded projects and the design of future opportunities, and support other budgetary and strategic planning objectives.

This report summarizes the evaluations from the panel of independent reviewers, WETO's response to their observations and recommendations, and other supporting materials, including program objectives, the peer review agenda, and the list of participants.

DOE's Energy Efficiency and Renewable Energy Office (EERE) recognizes the value of objective review and advice from peers as an important tool for enhancing the relevance, effectiveness, and productivity of EERE's projects. As such, EERE requires its applied technology offices to conduct regular peer reviews and to consider the results for strategic planning and program design and management. Under EERE peer review guidance, "Results of Peer Reviews should inform Office planning, including Multi-Year Program Plan development, Lab and Annual Operating Plans Planning, and Funding Opportunity Announcement Planning."

DOE offices generally hold peer reviews every two years. EERE guidelines call for peer reviews to cover projects representing, in aggregate, approximately 80% of a program's project-related funding during the review period.

WETO's previous peer review was held in 2019 and covered activities performed in fiscal years 2017 and 2018. The 2019 WETO Peer Review report is available on the DOE website. The 2021 WETO Peer Review covered periods of performance and budgets spanning fiscal years 2019 and 2020.

In accordance with EERE guidelines, the review evaluated a selection of WETO-funded projects to assess their contribution to the mission and goals of the Office, the progress made against stated objectives, and the overall management and performance of the Office. The peer review was structured to facilitate objective review of the strategy and goals of WETO and the progress and accomplishments of projects funded by the Office in fiscal years (FYs) 2019 and 2020. There was also a strong emphasis on fostering research-focused interactions among DOE's national laboratories, industry, and academic institutions, and facilitating dissemination of information regarding WETO-funded projects.

EVALUATION METRICS

In accordance with EERE peer review guidance, the peer review panelists were asked to submit both quantitative (i.e., numerical scores) and qualitative (i.e., narrative comments) evaluations as part of their review of WETO and its portfolio of research, development, demonstration, and deployment (RDD&D) projects.

The reviewers evaluated the management, performance, and effectiveness of WETO and its project portfolio at three organizational levels: the Office's three program areas ("program-level"); each of the activity areas within the programs ("activity-level"); and each individual project ("project-level").

The evaluation scoring rubric can be found in Table 1-1 below. In addition to providing scores on a scale of 1 ("Unsatisfactory") to 10 ("Superior") for each criterion, the reviewers were asked to delineate the strengths and weaknesses used as the basis for their assessment, and to provide recommendations for the Office to consider.

Table 1-1. Evaluation scoring rubric.

Rating	Score	Scoring Definition
Superior	10	All aspects of the criterion are comprehensively addressed. The project has one or more significant strengths in this area and **no notable weaknesses**. The project materials demonstrate outstanding impact/performance/engagement.
	9	All aspects of the criterion are comprehensively addressed. The project has one or more significant strengths and no more than a few minor weaknesses that are easily correctable, where **the number and/or level of significance of the strengths far outweigh these aspects of the weaknesses**. The project materials demonstrate outstanding impact/performance/engagement.
Good	8	All aspects of the criterion are adequately addressed. The project has one or more strengths and may have a few minor weaknesses that are easily correctable, and **the number and/or level of significance of the strengths far outweigh these aspects of the weaknesses**. Scoring within the "Good" rating depends on the relative degree to which the strengths outweigh the weaknesses. The project materials demonstrate strong impact/performance/engagement.
	7	All aspects of the criterion are adequately addressed. The project has one or more strengths and **may contain several weaknesses that are correctable**. The project materials leave little doubt regarding the project's impact/performance/engagement.
Satisfactory	6	Most aspects of the criterion are adequately addressed. The project has one or more strengths and may have one or more weaknesses. **The number and or level of significance of the strengths slightly outweigh those aspects of the weaknesses**. Scoring within the "Satisfactory" rating depends on the relative degree to which the strengths outweigh the weaknesses. The project materials demonstrate reasonable/moderate impact/performance/engagement.
	5	
Marginal	4	Some aspects of the criterion are not adequately addressed. The project may have one or more strengths and has one or more weaknesses, and **the number and/or level of significance of the weaknesses outweigh those aspects of the strengths**. Scoring within the "Marginal" rating depends on the relative degree to which the weaknesses outweigh the strengths. The project materials demonstrate low/poor impact/performance/engagement.
	3	
Unsatisfactory	2	Most aspects of the criterion are **not** adequately addressed. The project may have strengths but it also has **several significant weaknesses**. The project materials demonstrate no/negligible impact/performance/engagement.
	1	

SCORING OVERVIEW

Graphs summarizing the reviewer scoring at the program levels are provided below.

The average scores for all individual projects are broken down by evaluation metric in Table 1-2. These averages are provided first for WETO projects in aggregate on the top line of the table, followed by the three program tracks at the bottom.

Table 1-2. Average scores for peer-reviewed WETO projects by evaluation metric.

Average Scores for all WETO Project	***8.04***	***8.18***	***8.17***
Average Project Scores by Track	Project Impact	Performance	Stakeholder Engagement and Info Sharing
Technology Research, Development, and Testing	7.53	7.76	7.95
Environmental, Siting, Workforce, and Grid	8.76	8.73	8.38
Analysis & Modeling	8.51	8.7	9.09

All three tracks performed well, with the Environmental, Siting, Workforce, and Grid track scoring the highest of the three at an average weighted score of 8.67. The lowest score in Table 1-2 is 7.53 for the Project Impact metric in the Technology Research, Development, and Testing track.

The following three graphs (Figures 1-1, 1-2, and 1-3) plot the relative scores of each of the projects evaluated within the three program areas, with the Project Impact metric on the X-axis and the Performance metric on the Y-axis. The boxes on the graph represent 1σ and 2σ (1 and 2 standard deviations) from the average of all the scores within that program area. The better a project scored overall, the higher and farther to the right the representative dot for that project is located on the plot. The average score plots shows the average score of the two metrics for each track, with the darker and lighter shaded areas around it indicating 1σ and 2σ from that average, respectively.

The plots illustrate that, in general, the reviewers evaluated the entire portfolio of projects highly in terms of both relevance and performance. Although several projects fell outside of the shaded area that indicates two standard deviations from the average score, those projects remained in the "Average" to "Good" categories of scores. The scores and associated reviewer comments for all projects have been considered by the responsible WETO technical leads to determine why certain projects scored higher or lower than others, as well as what programmatic adjustments could be made to ensure the highest levels of performance for all projects.

Figure 1-1. Average scores for Project Impact and Performance metrics for projects within the Technology Research, Development, and Testing track.

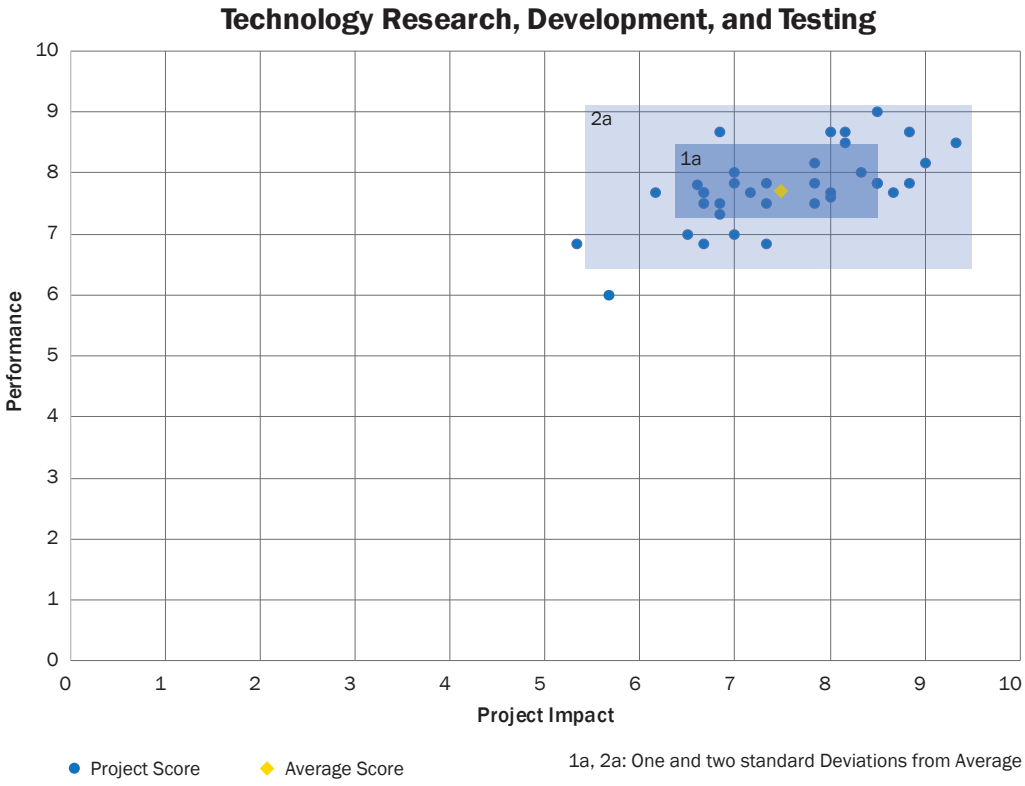


Figure 1-2. Average scores for Project Impact and Performance metrics for projects within the Environmental, Siting, and Workforce, and Grid track.

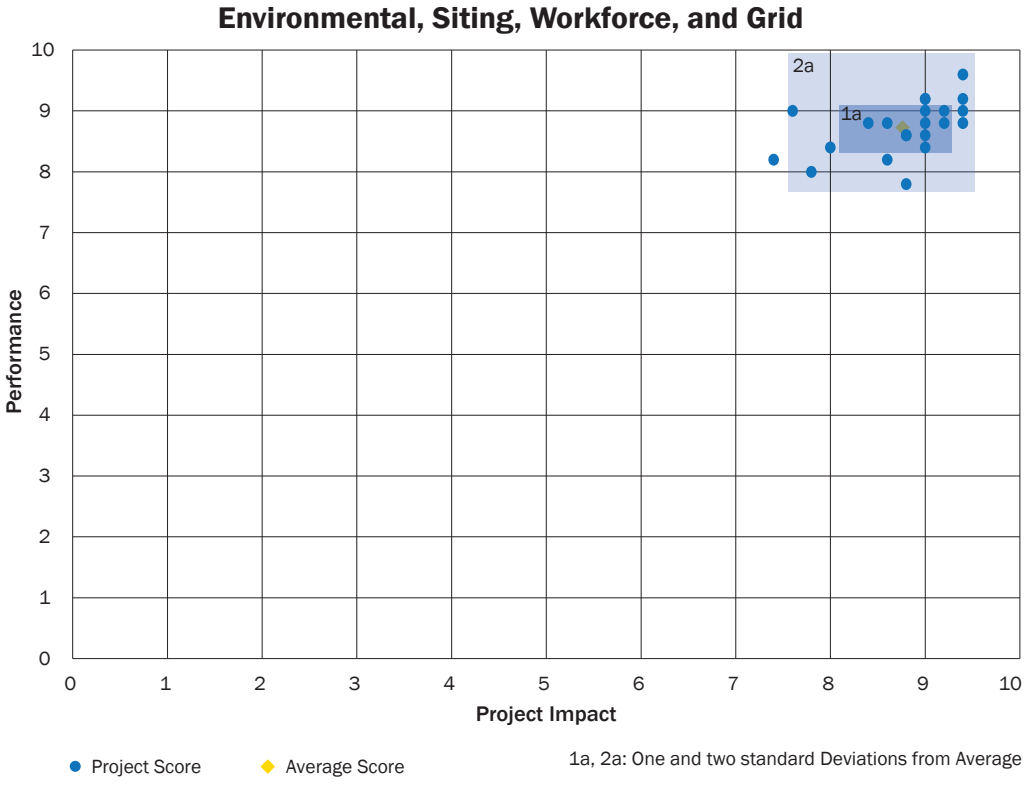


Figure 1-3. Average scores for Project Impact and Performance metrics for projects within the Analysis & Modeling track.

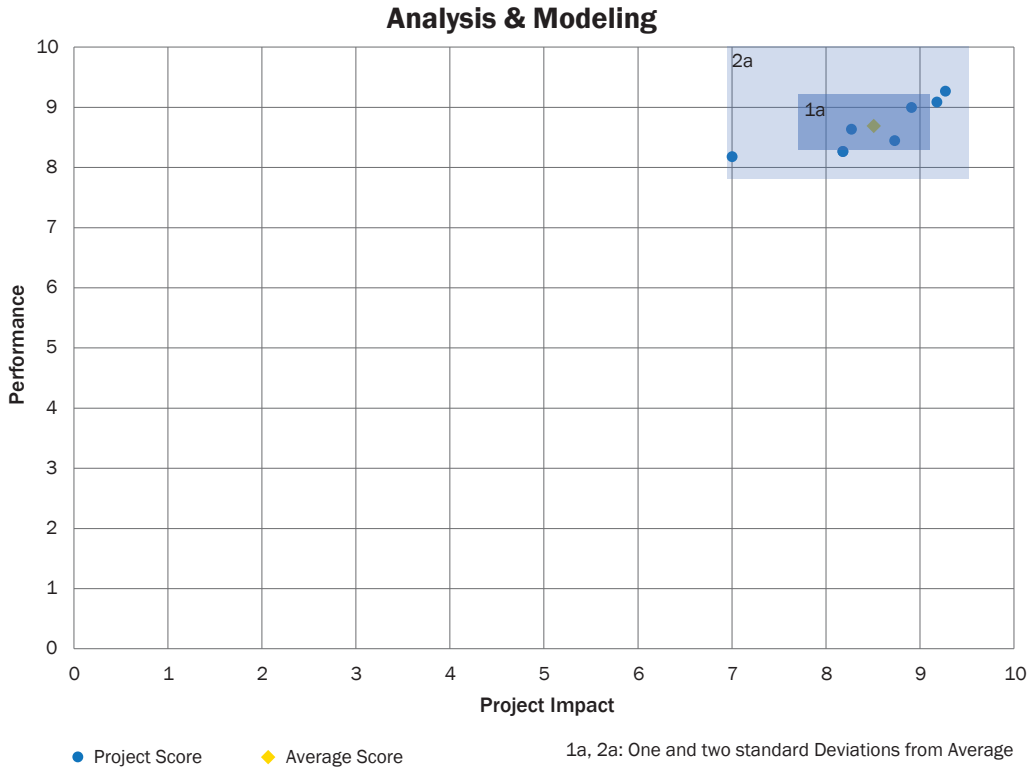
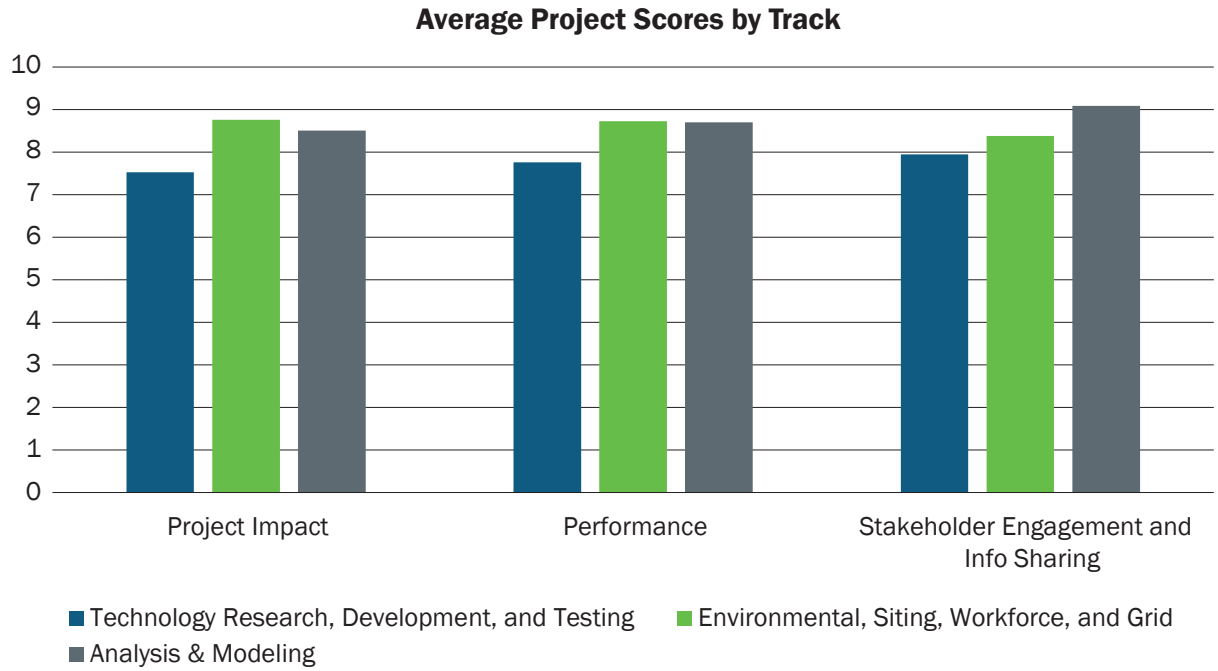


Figure 1-4. This figure summarizes the reviewer scoring for Project Impact, Performance, and Stakeholder Engagement and Info Sharing metrics of all the reviewed projects arranged by the three review tracks within the WETO peer review.



PEER REVIEW PANEL

For the 2021 Peer Review, WETO commissioned a peer review panel comprised of 11 reviewers to conduct the formal peer review. Reviewers were experts from wind energy-related organizations, including industry, academia, trade organizations, and technical and environmental organizations.

WETO screened reviewers to ensure no conflicts of interest existed on reviewed projects. Reviewers recused themselves from projects on which they worked, for which they had relationships with project team members, or for which they had a financial interest in the subject matter.

REVIEWER BIOGRAPHIES

TECHNOLOGY RESEARCH, DEVELOPMENT, AND TESTING REVIEW PANEL

Chair - Christina Aabo is director for R&D at Ørsted. Christina holds a Master of Science in Civil Engineering and started her career in 1998 as an R&D engineer. Later, she led Product Management for global wind turbine manufacturers such as NEG Micon, Vestas, and Suzlon. In 2010 she joined DONG Energy (now Ørsted) to develop strategy for and organization of operations and asset management functions. Since 2012 she has been responsible for R&D in the offshore wind power part of Ørsted, where the focus is on research related to foundations and wind power plants. The Ørsted R&D team is further responsible for all external research and development collaboration with partners in research and innovation platforms, such as the Carbon Trust Offshore Wind Accelerator, and with universities worldwide.

Padma Kasthurirangan is an engineer and President at Buffalo Renewables, a distributed wind and solar photovoltaic (PV) installation firm based in Buffalo, NY, serving the western New York region. She holds a Master of Science degree in Electrical Engineering from the University at Buffalo (SUNY) and is an eligible small wind installer through the New York State Energy Research and Development Authority and North American Board of Certified Energy Practitioners PV installation professional. Padma specializes in development, permitting, interconnection, installation, and maintenance of distributed wind and solar PV projects ranging from 5 kilowatts (kW) to 2.5 megawatts (MW) in NY. Padma also serves on the board of the Distributed Wind Energy Association (DWEA) and is an Institute of Electrical & Electronics Engineers (IEEE) Senior Member. When not battling utilities or climbing towers, she enjoys kickboxing, biking, skydiving, and amateur farming.

Dan Brake co-founded and served as President of the American Renewable Energy Standards and Certification Association (ARESCA). ARESCA is a non-profit organization that supports U.S. renewable standards committees to participate in international standards as well as development of U.S. standards for those committees through the American National Standards Institute (ANSI).

Dan has recently retired from NextEra Energy Resources where he served as Technical Services Director for the Power Generation Division since July 2007. With more than 14,000 MW installed wind and more than 2,000 MW of solar PV, NextEra Energy Resources is the largest owner and operator of renewable power in the United States. Prior to assuming that role, Mr. Brake served as the plant general manager at NextEra Energy Resources' California operations, responsible for operations at the seven Solar Energy Generation Systems solar thermal power plants in the Mojave Desert and the Port of Stockton District Energy Facility power plant in Stockton, CA. Before that, he was director of due diligence for power generation, and prior to that he led the division's combustion turbine engineering. Earlier in his career he held positions of increasing responsibility at various fossil and renewable power plants in the division including the Martin, Manatee, and Sayreville plants. Mr. Brake began his career with NextEra Energy in Powerplant Engineering in June 1990. Mr. Brake holds a bachelor's degree in Aerospace Engineering from the University of Florida. He also holds a Six Sigma Black Belt certification and is a registered professional engineer in the state of Florida.

Mr. Brake is actively involved in Wind Standards through the American Clean Power Association and the International Electrotechnical Commission (IEC). In 2013, Mr. Brake was awarded the IEC 1906 award for his work with TC88 – Wind Turbine Standards and again awarded the IEC 1906 award for his work with IECRE – Wind Turbine Conformity Assessment in 2015. He currently holds ten patents in the renewable power field and is a member of the WindESCo Technical Advisory Board.

Kimberly Mortstock has over fourteen years of experience in wind energy. In her current role as Principal Engineer, she is involved in wind optimizing project performance and using benchmarking to highlight opportunities for improved revenue generation. Ms. Mortstock also evaluates the cost, reliability, and performance of operational assets in support of financial and operational decision-making. In previous roles, she developed wind energy analysis techniques and supported investor due diligence, wind turbine site suitability, and portfolio analyses. Ms. Mortstock has a Bachelor's degree in Aerospace Engineering from the Pennsylvania State University and a Ph.D. in Atmospheric Sciences from the University of Washington.

Silvia Palma-Rojas, Ph.D. leads the Data and Analytics unit at the California Energy Commission's Renewable Energy Division. Her unit oversees the data modernization and analytics efforts at the Division, which supports the state programs in renewable energy and climate change. During 2015–2020, she was a program manager in the Commission's Research Division, leading the research portfolio in wind and solar energy. In that role, she was able to create an offshore wind (OSW) research portfolio and select the first OSW research projects focused on technology innovation funded through the Commission's main research program. She also supported the research portfolio in renewable energy forecasting, bioenergy, and small hydropower. Before joining the California Energy Commission, Dr. Palma-Rojas worked as an economic consultant in international organizations, a life cycle assessment expert in Brazilian Federal Government agencies, and researcher in the Departments of Economics and Engineering at the University of Brasilia, Brazil. Dr. Palma-Rojas holds a Ph.D. in Economics and a Master's degree in Mechanical Engineering, and has 18+ years of experience in energy economics, technology innovation in renewable energy, circular economy, and life cycle assessment.

Scott Larwood is an associate professor of mechanical engineering at the University of the Pacific in Stockton, California. His first wind energy experience was working on the Boeing MOD-2 wind turbine as an intern for PG&E in 1986. His undergraduate years included work on the Cal Poly DaVinci human-powered helicopter. After receiving his degree, he went to work at NASA Ames Research Center, first on space life-sciences payloads, then on full-scale wind tunnel testing. After seven years at NASA, he followed colleagues to Kenetech Windpower. After Kenetech filed for bankruptcy, he moved on to work for the National Renewable Energy Laboratory (NREL). After four years at NREL, he moved to Enron Wind Energy, which was absorbed by General Electric. He later returned to school to obtain his doctorate from UC Davis. He then followed his wife to Stockton (where she works in agricultural research) and started teaching part-time at the University of the Pacific. That job later grew into a tenure-track position, with research in wind energy. His experience spans from component and full-scale testing to computational analysis.

ENVIRONMENTAL, SITING, WORKFORCE, AND GRID REVIEW PANEL

Chair - Dr. Hannele Holttinen is a Partner at Recognis and Operating Agent of the International Energy Agency (IEA) Wind Task 25 (MSc in 1991, PhD in 2004, Helsinki Technical University). She has worked at VTT Technical Research Centre of Finland for more than 25 years in different fields of wind energy research including resource assessment and measurements, production and failure statistics, and offshore and arctic wind power feasibility. Since 2000, her main interest has been the impact of wind and solar on power systems and electricity markets. She has acted as Operating Agent of the IEA international collaboration on power system operation with large amounts

of wind power (IEA WIND Task 25) since 2006. She also chaired the IEA: Implementing Agreement on Wind Energy Executive Committee in 2011–12; was a member of the ETIP Wind platform through EERA co-operation in 2017–18; served in the European Union Wind Energy Platform TPWIND from 2007–2014 leading the Grid integration group and participating in the steering committee; and served in the steering committee of the Nordic TFI programme for wind from 2009–2014. She has also been a Docent at Aalto University since 2014.

Tom Vinson is Vice President of Policy and Regulatory Affairs, at the American Clean Power Association (ACP). In this role, Tom leads the ACP team focused on engaging with regulatory agencies on various issues including wildlife, social license (i.e. non-wildlife siting issues), radar-airspace compatibility, offshore wind, public lands, and tax policy, among others. Tom's team at ACP also leads industry activities focused on project operations, worker health and safety, workforce development, and standards development. Tom is in his thirteenth year advocating on behalf of clean energy industries. Prior to representing clean energy industries, Tom spent more than 10 years working for members of Congress in both the House and Senate.

Dahvi Wilson is Vice President of Public Affairs at Apex Clean Energy. Dahvi leads Apex's public affairs team, a unique department of the core operations team that is focused on preserving and enhancing the company's license to operate in statehouses and communities across the nation. Under Dahvi's leadership, Apex's public affairs team is working to rapidly innovate an approach to engagement that is relationship-based and politically savvy, rooted in a campaign mentality. In her nine years at Apex, Dahvi has built a team from the ground up, led the development and implementation of a new approach to engagement, and overseen a successful effort to increase Apex's influence with key legislators and strategic partners. Prior to joining Apex, Dahvi served in leadership roles with numerous community, government, and nonprofit organizations, specializing in strategic development, community relations, and communications. Dahvi holds a Master of Environmental Management degree from Yale University and a B.A. from Brown University.

Nicholas W. Miller is Principal of HickoryLedge LLC. Nick recently retired as a Senior Technical Director of Energy Consulting at GE Power after nearly 40 years of experience and research on bulk power systems. He has lectured on Wind and Solar Power integration to governments and institutions in more than three dozen countries. He currently provides consulting expertise to a variety of private and public institutions on the grid integration of renewable resources. He holds twenty U.S. patents for wind, solar, and grid technologies; is a fellow at the Institute of Electrical and Electronics Engineers, a NY professional engineer, and a Distinguished Member of the International Council on Large Electrical Systems (CIGRE); has authored over 150 technical papers and articles; and is the recipient of several power industry awards. Nick holds a B.S. and M.Eng., in Electric Power Engineering from Rensselaer Polytechnic Institute, Troy, New York.

Garry George is Director of the Clean Energy Initiative for climate strategy at the National Audubon Society (https://climate.audubon.org). He oversees a team of three to provide resources on clean energy planning, projects, and permitting policies to the Audubon Network of 27 state offices, 465 chapters, and 36 nature centers. He also collaborates with the clean energy industry and agencies on statewide and regional planning, individual utility-scale projects, and federal and state permitting policies for wind, solar, storage, and transmission to provide for rapid deployment of clean energy and the conservation of birds and the places birds need both now and in the future. He is past Chair of the Board of American Wind & Wildlife Institute (www.awwi.org) and now represents Audubon in the Avian Solar Work Group (www.aviansolar.org), the Regional Wildlife Science Entity for offshore wind in the Atlantic, POWER (Pacific Offshore Wind Energy Research Group), and with federal agencies in the Condor/Wind Working Group and Golden Eagle Working Group for Region 8. When not spending time with his eight-year-old grandson, Garry goes birding around the world to add to his world list of over 7,500 species seen out of the 10,000+ species in the world.

Wind Energy Technologies Office Overview

BACKGROUND AND MISSION

American wind energy resources are vast. In 2020, wind energy produced 8.4% of all U.S. electric power. Even so, the nation's wind energy potential is mostly untapped. With continued innovation and deployment, wind energy has the potential to contribute 35–45% of U.S. electricity in less than two decades (EERE's Solar Futures Study). Beyond electricity, wind energy can also contribute to grid reliability and resilience, as well as the generation of clean fuels to help transition the U.S. economy to net-zero emissions in the transportation, buildings, industrial, and agricultural sectors. This would support growth in good-paying jobs and domestic manufacturing across all regions of the country. Progress on these fronts, arising from continued innovation in technology, grid systems integration, and innovative solutions to deployment challenges, can position the United States as a global leader in wind energy at home and abroad.

Meeting the country's goals for a robust economy supported by carbon-free energy will require significant increases in annual installation rates of new wind projects. Expansion of wind projects on land and offshore could create tens of thousands of good-paying jobs in domestic manufacturing throughout the supply chain, deployment, operations, and maintenance. It would revitalize communities throughout the U.S. and along the coastlines, with significant benefits for improved environmental quality, public health, and economic justice for all Americans.

WETO's work is underpinned by competitively awarded investments in related science, modeling, and analytical tools; complemented by cost-shared demonstrations; and carried out in collaboration with industry, academia, DOE national laboratories and facilities, and other research enterprises.

With its continued unique role in federal science-driven research, the Office provides leadership in supporting industry to develop the next generation of wind technology innovations — driving economic benefits for U.S. manufacturers, businesses, and consumers.

Across all its wind energy development objectives, WETO emphasizes three common and overarching themes:

- Reduce the cost of wind energy for all wind applications (offshore, land-based utility-scale, and distributed);
- Enable and facilitate the interconnection and integration of substantial amounts of wind energy into a dynamic and rapidly evolving energy system that is cost-effective, cyber-secure, reliable, and resilient, and includes systems integrated with other energy technologies, and;
- Accelerate the deployment of wind energy through siting and environmental solutions to reduce environmental impacts, minimize timetables for wind energy project development, and facilitate responsible, sustainable, and equitable development and delivery of wind energy resources.

RESEARCH OBJECTIVES

The projects presented at the 2021 Wind Energy Peer Review aligned with one or more R&D objectives for projects awarded within the FY 2019–2020 timeframe, including:

- Reducing costs and improving performance through applied R&D of components or whole technology systems;
- Validating technologies and reducing risks by confirming the performance of technologies, both in controlled laboratory and real-world conditions, and providing benchmarks for performance and durability;
- Reducing market barriers by addressing specific gaps through environmental impacts research and mitigation strategies, siting solutions, workforce development programming, and social science research and community outreach;
- Optimizing energy production through complex aerodynamics R&D, wind plant reliability improvement, and resource characterization;
- Optimizing grid integration through interconnection studies and operational forecasting tool development.

BUDGET OVERVIEW

The 2021 Wind Energy Peer Review evaluated projects that were active in FY 2019 and FY 2020. EERE guidelines call for peer reviews to cover projects representing at least 80% of a program's project-related funding during the review period.

The total WETO funding for projects initiated, active, or completed during these two years was $208 million. This total includes funding appropriated to the Office during those fiscal years, plus carryover funding from prior year appropriations. With funding and in-kind contributions from industry and other project partners included, the total funds applied to WETO-supported projects in FY 2019–FY 2020 exceeded $564 million. The project funding was distributed through three WETO program areas: Technology, Research, Development, & Testing (Tech RD&T); Environmental, Siting, Workforce, and Grid (ESW&G); and Modeling and Analysis (Analysis). Additionally, WETO had funding of just over $16.5 million across the program for Operations and Communications, supporting the execution of the program budget. Reviewers evaluated nearly 90% of WETO's active FY 2019–FY 2020 R&D projects during the 2021 Peer Review. Internal program operations and management and communications were addressed during peer review as part of the office-level assessment.

Table 1-3. Total WETO project funding. 1.4 ORGANIZATION

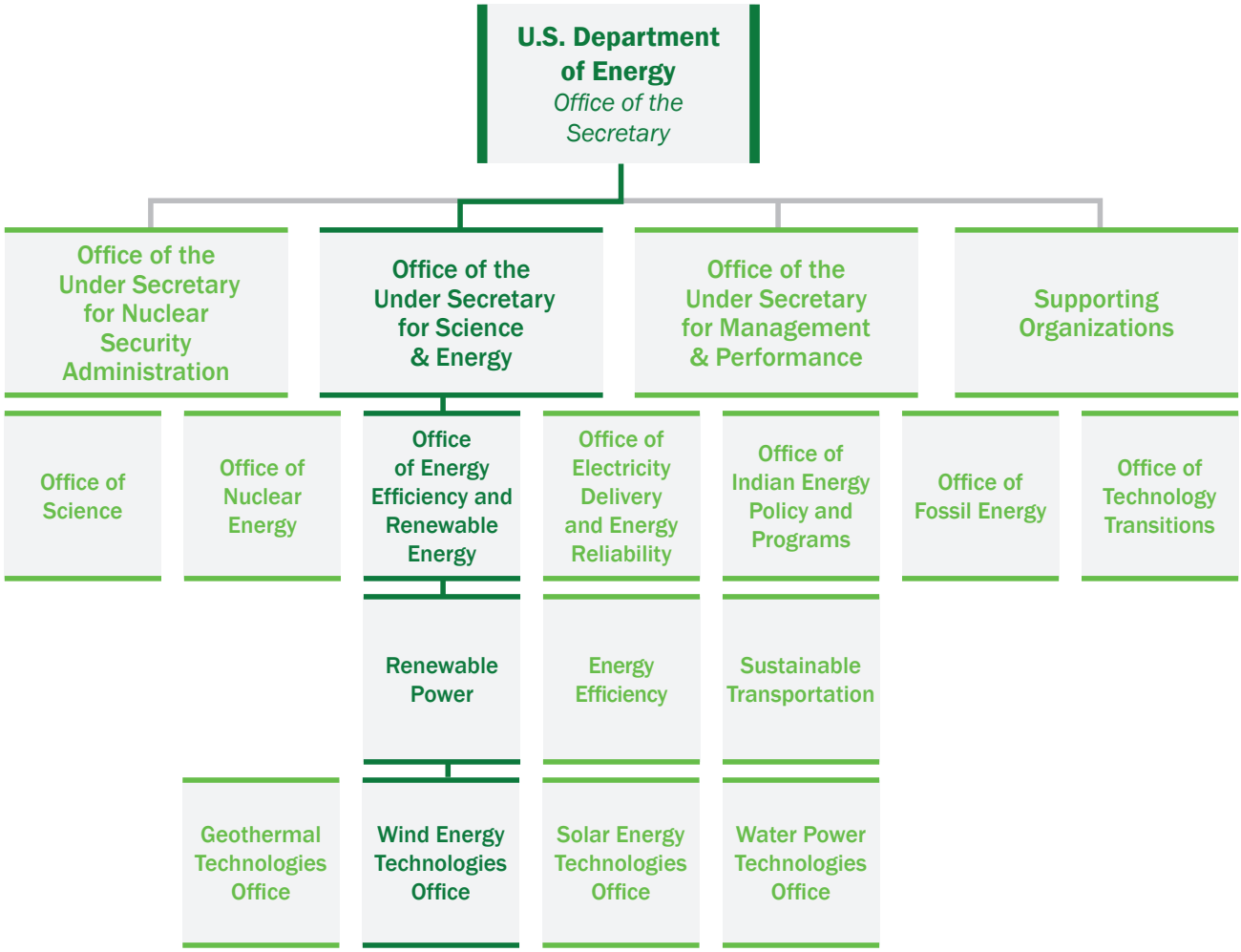
Analysis	$10,805,065	5%
ESW&G	$24,751,134	14%
Operations	$10,216,378	6%
Tech RD&T	$185,851,511	75%

ORGANIZATION

WETO is housed within EERE, under DOE's Office of the Under Secretary for Science and Energy. EERE is made up of three major sectors, each of which has several technology offices, and WETO sits within the Renewable Power sector, which also includes Geothermal, Solar Energy, and Water Power Technologies Offices. Formerly part of the integrated Wind and Water Power Technologies Office, WETO became a stand-alone entity in 2016.

WETO's role is codified through public law and informed by the priorities and guidance of the Administration, Congress, DOE, and EERE; the U.S. Congress makes budget appropriations.

Figure 1-5. DOE organization indicating WETO's position within EERE at the time of the 2021 Peer Review.



Since the 1970s, WETO has evolved to reflect the changing status, needs, and prospects of wind power technology. In the peer review period, the Office's roles included:

- Scientific research
- Technology innovation and evaluation
- Leadership in the wind community
- Formation and management of collaborations
- Facilitation of stakeholder interactions and education
- Outreach to the broader energy community.

The overall aim has always been to develop and enable the installation of cost-competitive and reliable wind power in U.S. electrical grid.

WETO restructured in 2021, transitioning its focus from the two pillars of Technology Development and Market Acceleration & Development to a market segment approach. The activities and projects of the Office now support the development of three market segments: (1) offshore wind, (2) land-based wind, and (3) distributed wind, as well as a fourth category—grid integration—which integrates the energy production of the first three to maintain a reliable, cost-effective, and cyber secure grid infrastructure. Activities and goals within these segments include the following:

- Offshore wind – technology development, siting, and permitting research initiatives needed to reduce costs and support the development of shallow water, fixed-bottom wind energy in the short term and floating offshore wind energy in the longer term
- Land-based wind – technology development, siting, and permitting research initiatives needed to reduce costs and expand access to U.S. land-based wind resources for utility-scale wind energy
- Distributed wind – technology development, siting, and systems integration research initiatives needed to reduce costs, increase compatibility with other distributed energy resources, and expand access for local energy stakeholders
- Grid systems integration – research needed to integrate increasing levels of wind energy into the grid, while maintaining cost effectiveness, reliability, cyber security, and resiliency.

Analysis & Modeling Program

INTRODUCTION AND OVERVIEW

Analysis and modeling create the basic rationale for the strategic direction of the planned activities of the Office and its R&D programs. The Analysis and Modeling program's activities aim to form an integrated information system with developed capabilities to track ongoing and assess emerging trends in wind energy and R&D.

The primary goal of the Analysis and Modeling program is to inform, guide, and enable the planning, execution, and delivery of the Office's research and innovation mission. A related and ancillary goal is to share information with others who may benefit from its availability and, in turn, guide and facilitate the expansion of wind energy in the United States. In order to realize these priorities, analysis and modeling activities include the following:

- Acquire, process, and provide timely and accurate data from best-available sources
- Develop models and tools that represent a full range of wind generation technologies, operations, interactions, and their potential impacts, including those related to systems that interface with the electric grid
- Carry out analyses that provide insight to decision making applicable to DOE's R&D investments, and to policymakers, energy analysts and advocates, industry leaders, and other wind energy stakeholders to drive wind technology evolution and expansion.

Analysis and modeling activities help ensure WETO sets robust goals and makes sound, analytically based decisions to maximize taxpayer return on investment, advance the state of the art in wind energy technoeconomic and scenario analysis, and provide deep insights on wind energy's roles today and in future deep decarbonization scenarios. These activities also help represent siting, technology innovations, and other issues in wind energy supply curves, benchmarking wind plant performance and establishing technology baselines and industry benchmarks.

The mission, research priorities, and objectives are realized through collaboration with national labs, industry partners, and other external stakeholder groups.

EVALUATION SUMMARY

CRITERIA: 1. ARE THE ACTIVITIES AND PROJECTS WITHIN THIS PORTFOLIO ON THE LEADING EDGE OF WORK WITHIN THIS FIELD? IF NOT, PLEASE COMMENT ON WHAT YOU FEEL IS MISSING.

Reviewers said the activities and projects within this portfolio are on the leading edge. Projects, such as those developing the Wind Market Reports for land-based, offshore, and distributed wind energy are on the leading edge of market analysis. In particular, the reviewers thought the big picture, future-focused work that shows how the U.S. power system works in a deeply decarbonized world, both technically and economically, is extremely important. DOE is simply not doing enough on transmission according to the reviewers.

CRITERIA: 2. IS THERE A PERSUASIVE RATIONALE FOR THE BODY OF WORK WITHIN THIS PROGRAM? IF NOT, PLEASE ELABORATE.

This work is essential to achieving the Biden Administration's priorities, supports cross-department work, and informs various agencies. The portfolio helps characterize the big picture of what is going on with wind energy development in the United States, and what opportunities exist to further advance the growth of the industry.

CRITERIA: 3. WITHIN THIS FIELD, ARE THOUGHT LEADERS AWARE OF THE WETO-SUPPORTED WORK? IF NOT, WHO ELSE SHOULD BE ENGAGED?

Reviewers believe that thought leaders are aware of the WETO-supported work in this field. Original Equipment Manufacturers (OEMs) and industry leaders seem well aware. Developers, Authorities Having Jurisdiction (AHJs), and Funding Agencies should be engaged. Reviewers encouraged more diverse project teams, where different sectors (universities or industry) are directly involved in specific activities of the project.

CRITERIA: 4. ARE THERE IMPORTANT TOPIC AREAS THAT ARE UNDERREPRESENTED OR MISSING WITHIN THE PROGRAM? IF SO, PLEASE ELABORATE.

Reviewers indicated that the portfolio is missing the social and equitable aspects of wind energy and should increase emphasis on underrepresented communities. Transmission also appeared to be underrepresented and should receive increased emphasis.

CRITERIA: 5. PLEASE ELABORATE ON ANY NOTABLE PROGRAM PORTFOLIO CONTENT OR DIRECTION STRENGTHS.

Reviewers indicated that in general the market reports and analysis for priority needs strengthen the program and provide usable information to the right stakeholders, and that the Land-Based Wind Market Report (LBWMR) in particular is the "crown jewel" and is "worth its weight in gold." The Lawrence Berkeley National Laboratory (LBNL) benchmarking work is highly praised. There is a strong consensus among reviewers about the strength of the local siting and regulatory work being done within this portfolio and they applaud the push for open source.

CRITERIA: 6. PLEASE ELABORATE ON ANY NOTABLE PROGRAM PORTFOLIO CONTENT OR DIRECTION WEAKNESSES.

Reviewers voiced concerns over whether the investment in distributed wind is worth the effort. There could be greater bi-directional communication with the wind industry. Some of the tools developed benefit the research community but appear to not be useful to industry stakeholders.

CRITERIA: 7. WHAT RECOMMENDATIONS WOULD YOU LIKE TO CONVEY TO THE MANAGER(S) OF THIS PROGRAM?

At every level of review, the program should better clarify how efforts are being prioritized and why work is being done. According to the reviewers, different ways of sharing the data, tools, models, etc. should be explored beyond what is currently being communicated to industry stakeholders. Reviewers indicated that for future peer reviews it would be helpful to see more details on projects' budgets and how funding is spent. DOE should also look for opportunities to engage with industry at all stages of a project, including conceptualization.

PROGRAM RESPONSE

The Analysis and Modeling program is currently well aligned to assist in achieving President Biden's energy and climate goals. Through data collection, analysis, and reporting the program establishes technology baselines and industry benchmarks, tracks and reports on programmatic goals, and retrospectively analyzes the cost and benefits of wind energy. WETO was pleased to hear from reviewers that the data collection and market report efforts provided valuable insights and information. The data collection effort is accompanied by widely used reports and associated data that establish cost and technology trends, help WETO set baselines, and measure progress against them. These are critical for tracking progress towards the Administration's energy goals.

The program is built on constantly-improving, world-class analytical and modeling capabilities. These capabilities position the analysis and modeling program to provide key insights and analysis relevant to deep decarbonization of the electric grid. Deep decarbonization futures scenario analysis directly aligns with the Administration's goals and positions the Analysis and Modeling program to be a key leader in identifying the technical potential of wind energy and the evolution of the U.S. electric grid.

The Analysis and Modeling program has developed many open-source models that are widely used by researchers, academia, and industry. The models can range from simple spreadsheet tools to complex bottoms-up engineering cost models. These tools and models help explore key analyses and allow users to assess potential impacts, costs, and value of wind technologies.

Critical research and activities have been identified to improve and develop upon its world-class modeling capabilities. Models and tools will be updated to better represent energy storage technologies and wind storage hybrids, to better address detail requirements of scaling wind energy and economies of scale pathways, and more accurately model wind siting constraints in support of environmental research efforts.

WETO agrees with reviewers concerning the key weaknesses identified, such as lacking work in the social and equitable impacts of wind energy as well as transmission modeling efforts. WETO's Analysis and Modeling program aims to improve upon these weaknesses by prioritizing their inclusion in the scope of this portfolio and by collaboration with other programs in the Office, such as Grid Integration. Energy and environmental justice will continue to be included in the Analysis and Modeling project scopes, with focus on the spatial distribution of the benefits and burdens of wind energy.

Environmental, Siting, Workforce, and Grid

INTRODUCTION AND OVERVIEW

The Environmental, Siting, Workforce, and Grid (ESWG) subprogram strengthens the body of knowledge necessary to inform key grid integration, regulatory, and siting decisions associated with the deployment of offshore, land-based, and distributed wind energy. The subprogram determines research needs and evaluates technology solutions to address regulatory and siting restrictions for radar interference, wildlife impacts, and community impacts associated with domestic wind energy development, in support of wind turbine cost goals. The subprogram also supports science, technology, engineering, and mathematics (STEM) and workforce programs that support a domestic wind workforce for the 21st century. These subprogram components address market barriers that can prevent the successful siting and development of wind projects in areas where wind is otherwise cost-competitive. As such, this subprogram is critical to enabling wind deployment.

The subprogram invests in R&D to ensure the cost-effective, reliable, cyber secure, and resilient operation of the power grid with increasing levels of wind energy for all wind technology applications. Its wind energy grid integration R&D aims to generate the knowledge that electric grid operators, utilities, regulators, and industry need to develop and deploy novel technologies that support reliable incorporation of wind energy into the power system. This work is conducted as part of coordinated grid modernization efforts across the Department through the national laboratories and the Grid Modernization Initiative (GMI). Additionally, early-stage research can help identify opportunities to address power grid reliability and resilience concerns as increasing amounts of wind energy are added to the grid.

The subprogram collaborates with the Department of Defense (DOD), Department of Homeland Security (DHS), and other agencies on wind turbine radar mitigation to address the impacts of wind development on critical radar missions. The objectives include development of technology solutions to evaluate the impacts of existing and planned wind energy installations on sensitive radar systems; development of mitigation measures to increase the resilience of existing radar systems to wind turbines; and encouraging the development of next-generation radar systems that are resistant to wind turbine radar interference.

The subprogram evaluates the environmental performance of offshore and land-based wind projects, including avian and bat species interactions with wind turbines, and conducts research to inform the development of technical mitigation solutions. Solutions will be developed to reduce wind impacts on wildlife through research on instrumentation, advanced components, and operational strategies. The subprogram's work in this area will inform regulatory and siting processes and facilitate wind industry deployment through the development of technical solutions.

Finally, the subprogram manages STEM [education/workforce] activities, supports the National Wind Turbine Database, conducts research on community impacts, supports development of a robust domestic wind energy workforce, and provides informational resources to ensure decision makers are using the best available science to support wind energy decisions.

EVALUATION SUMMARY

CRITERIA: 1. ARE THE ACTIVITIES AND PROJECTS WITHIN THIS PORTFOLIO ON THE LEADING EDGE OF WORK WITHIN THIS FIELD? IF NOT, PLEASE COMMENT ON WHAT YOU FEEL IS MISSING.

The review team noted ESWG program activities cover a broad spectrum of barriers. Providing mitigation options for each barrier is critical for widespread wind energy deployment. WETO should continue its investments here.

Distributed wind was cited as an area where barrier identification and mitigation investment is needed. Also, further analysis of the project development cost from permitting delays and unclear processes should be evaluated.

CRITERIA: 2. IS THERE A PERSUASIVE RATIONALE FOR THE BODY OF WORK WITHIN THIS PROGRAM? IF NOT, PLEASE ELABORATE.

Reviewers felt the overall aims of the program were laudable and largely appropriate for DOE to be championing. The program needs to constantly package research results, which are often technically nuanced, into messages that can be understood by key, sometimes nontechnical audiences. Having non-biased, third-party analysis of some of these sensitive issues is important to secure buy-in from state and federal regulators. Regulators may view an industry-funded study with some level of suspicion, so DOE investment in this space is very important to improving regulator confidence in the results.

This work needs to help moderate two extremes: the "just go do this" school, which underappreciates how difficult the challenges are, and the "we can't do it, we can't afford it" school, which needs to understand that their worries are overblown and being actively addressed by DOE and the wider industry. DOE is doing okay in this regard but needs to do better.

CRITERIA: 3. WITHIN THIS FIELD, ARE THOUGHT LEADERS AWARE OF THE WETO-SUPPORTED WORK? IF NOT, WHO ELSE SHOULD BE ENGAGED?

Stakeholder engagement through platforms like WINDExchange, wind for schools, etc. is very strong.

Regional Transmission Organizations (RTOs), Independent System Operators (ISOs), and the North American Electricity Reliability Corporation (NERC) are aware of, and sometimes engaged in, WETO-supported work on grid integration. However, engagement is less certain with respect to state and local permitting authorities (such as state fish and wildlife departments); more outreach to state energy agencies would be useful.

CRITERIA: 4. ARE THERE IMPORTANT TOPIC AREAS THAT ARE UNDERREPRESENTED OR MISSING WITHIN THE PROGRAM? IF SO, PLEASE ELABORATE.

Investment in transmission is underwhelming on multiple fronts. The plan for future work (offshore, grid services, grid-forming, hybrid systems) is good but insufficient. DOE, including WETO, needs to have a massive, multifunctional program for every aspect of building new transmission and optimizing existing transmission and rights-of-way. This includes distribution voltage level grid integration. The grid integration work of the big studies (e.g. the North American Renewable Integration Study) must be expanded and given greater granularity.

For environmental and radar interference, there is good coverage of tracking technology development, but the deterrent/mitigation technology work needs greater investment.

CRITERIA: 5. PLEASE ELABORATE ON ANY NOTABLE PROGRAM PORTFOLIO CONTENT OR DIRECTION STRENGTHS.

For the wildlife space, in particular, DOE does a good job soliciting stakeholder input on priorities up front through Requests For Information (RFIs), participation in stakeholder workshops, and the Bats and Wind Energy Cooperative science meeting. For industry, participation in wildlife studies has been valuable. Industry participation in studies at operational wind facilities that have produced more meaningful results has also been an asset.

Grid integration work is strong, capturing a wide array of issues and developing what is needed to reach stranded wind resources. The cyber security work has had an excellent start, and for siting, the tool development and analyses so far are a good start. With the increased deployment ambition of the wind sector, more analyses are needed.

The emphasis on detection and monitoring technology for wildlife, especially for offshore wind, is a critical path forward for sustainable and environmentally sound wind energy and to overcome opposition and curtailment. Without real data, we can't understand the impacts of wind energy on wildlife or put adaptive management into action. This is a direction strength and could be increased in scope.

International collaboration exists in almost all projects – learning from Europe, for example, offshore is encouraged.

CRITERIA: 6. PLEASE ELABORATE ON ANY NOTABLE PROGRAM PORTFOLIO CONTENT OR DIRECTION WEAKNESSES.

As a general theme, research findings need to be proactively distributed and shared with key policymakers and decision-makers. Research dissemination was limited to "putting it on the web" where key stakeholders may not find it even if they search for it themselves. More attention should be given to creating plans for proactively sending this information to those who could use it to inform decision making.

There are opportunities for cross-activity collaboration that might make sense. For example, the cybersecurity projects referenced the fact that several new technologies being developed to help manage wildlife interactions could create new cyber vulnerabilities.

DOE could impose stricter time limits on reviews and potentially identify a neutral expert to serve as an arbiter when disagreements arise between peer reviewers and the research team.

Some research peer reviewers, particularly in the wind-and-wildlife space, may have biases due to their own research, advocacy efforts, or policy positions in the same sphere. The research peer review pool should be broadened. For example, while the wind-and-wildlife research space may be relatively small, technical questions around statistical methodology, study design, and the interpretation of results are more broadly applicable and could potentially be reviewed by those outside this space.

Finally, peer reviews should be limited in scope. Sometimes multi-year, multi-site, multi-objective projects can act as a barrier to industry participation and interest. By the time the research is finished the market and/or technology may have already moved on.

WETO should consider implementation challenges to deploying a given solution (i.e. wind-and-wildlife, radar interference, etc.) when deciding on research projects and potentially incorporate such analysis into the research project scope.

WETO's Grid Integrations activity area does not seem to focus enough on the distribution system. While the transmission system needs work, distribution is critical to providing much needed grid resilience, as the country's distribution system is antiquated and fragmented between co-ops and Investor-Owned Utilities. The regulatory and siting work seems very limited.

CRITERIA: 7. WHAT RECOMMENDATIONS WOULD YOU LIKE TO CONVEY TO THE MANAGER(S) OF THIS PROGRAM?

WETO is encouraged to make sure this program has a balance of early-, mid-, and late-stage research. From the industry's perspective, solutions are needed that have regulator buy-in now. So, industry leans toward WETO investing in field testing wildlife, radar, and other mitigations that can be deployed if the results are compelling.

WETO is pivoting too fast towards offshore wind. While offshore potential is vast, it doesn't mean that the potential of land-based power has been fully tapped.

PROGRAM RESPONSE

Although the reviewers recognized the value, impact, and leadership of the ESWG portfolio, there were specific areas where portfolio activities could be enhanced and made more effective. We appreciate the reviewers' comments in this regard. In some but not all cases the reviewer comments could at least partially be addressed by the availability of more program resources to broaden the scope and accelerate the timing of important ESWG projects.

Increased collaboration and engagement were a theme that the program will make efforts to address. Activity areas need to have research dissemination strategies that are more advanced than just posting on the Office website, for example. Improving the communication of research results will require the creation of stakeholder networks that include industry and government officials, and WETO's active engagement with those networks. Communication is also important during project planning and implementation. WETO has successfully set up industry research groups and should use the groups as models for increased industry engagement.

Achieving the widespread growth of wind energy needed for a clean energy future will require massive investment in transmission infrastructure. The program will continue to execute its grid activities, with the goal of providing technical analysis of the capabilities needed in a power sector with high levels of renewable energy. The most critical capabilities will be developed through lab and industry partnerships and take advantage of sophisticated testing infrastructure at the National Renewable Energy Laboratory's Flatiron campus.

Distributed wind is an important program area, providing a renewable energy option to rural America. Some reviewers felt an increased investment in distributed wind was justified. WETO foresees an ongoing investment in distributed wind and will continue to assess priorities against other wind program research needs.

For environmental research results, the timeliness and objectivity of journal peer reviews was noted as an area for process improvement. The development and dissemination of high-quality, scientifically defensible research is critically important for WETO's environmental research program. While this work often takes time, WETO will explore options for simplifying or streamlining research programs to address and more rapidly disseminate findings related to high priority research areas.

Technology Research, Development, and Testing

INTRODUCTION AND OVERVIEW

The primary objective of the Technology Research, Development and Testing (RD&T) and Resource Characterization (Land-Based, Offshore, Distributed) subprogram is to generate scientific and engineering knowledge that enables industry to reduce the U.S. wind power levelized cost of energy (LCOE) for land, offshore, and distributed wind systems to complement traditional electricity sources for the nation. The subprogram's strategy is to explore concepts and improve modeling and simulation capabilities that enable the wind plant optimization as an integrated system, rather than focusing solely on components. To enable industry to address key cost drivers—capital costs, operation and management (O&M) costs, annual energy production (AEP), and financing rates—and improve the performance and reliability of the wind plant overall, the subprogram invests in a range of parallel and complementary basic and applied R&D activities. These activities inform wind turbine technology innovations, including those that enable higher hub heights, larger rotors, and improved wind plant energy capture. These activities provide the opportunity for significant growth in U.S. wind power and U.S. industry competitiveness through 2030 and beyond.

The subprogram's applied research portfolio, informed through collaborative activities with industry and reinforced by independent peer review, takes an integrated approach to improving wind plant performance. This approach includes early stage R&D focused on complex aerodynamics, advanced component manufacturing, wind plant reliability, resource characterization, controls, sensors, and modeling.

In addition, the subprogram manages wind-specific test facilities that enable validation of R&D results. This validation can ultimately inform industry development and deployment of novel technologies to reduced wind plant LCOE for land and offshore applications. The Atmosphere to Electrons (A2e) initiative—a consortium of scientists from national laboratories, academia, and industry—is a major component of the subprogram, examining the performance of an entire wind plant comprised of an array of turbines. This complete system approach enables the design of low-cost "SMART" (System Management of the Atmospheric Resource by Turbines) wind power plants by improving current predictive capability of wind plant flow and performance. A2e is conducting R&D for next-generation wind plants to reduce wind plant underperformance due to turbine-to-turbine wake interaction (20–30% observed in current operational wind plants). Ultimately, the goal is to develop the modeling, simulation, sensors, and control capabilities that enable industry to improve wind plant reliability over 20–25 year lifetimes and demonstrate a "SMART" wind plant through real-time plant-flow control strategies capable of increased energy capture and mitigating stress loading in both existing and next-generation wind plants, and to lower the integrated plant systems LCOE by 20%.

Other long-term objectives include using and maintaining unique testing facilities to support, validate, and inform research of wind turbine technologies at the component, turbine, and wind plant levels. The subprogram also aims to increase the capability and capacity of existing facilities in support of new research requirements.

The subprogram pursues fundamental scientific research in resource characterization, remote sensor measurement and development, and forecasting. These areas are essential for the development of offshore wind and for the United States to remain competitive in the global market of offshore wind technologies.

Trends toward larger wind turbine blades and the drive for global competitiveness call for exploration of technologically challenging, long-horizon investment in transformative manufacturing technologies. Technology R&D in wind manufacturing explores novel concepts of materials and process applications that can enable the competitiveness of U.S. manufacturers to develop advanced blade designs, improve fabrication techniques, automate processes, and increase reliability while lowering production costs. The goal of the subprogram is to generate knowledge that enables industry to advance U.S. manufacturing competitiveness.

EVALUATION SUMMARY

CRITERIA: 1. ARE THE ACTIVITIES AND PROJECTS WITHIN THIS PORTFOLIO ON THE LEADING EDGE OF WORK WITHIN THIS FIELD? IF NOT, PLEASE COMMENT ON WHAT YOU FEEL IS MISSING.

The reviewers generally felt that the work in this portfolio was on the leading edge. They noted in particular the testing capability and high-performance computing assets DOE provides as examples of activities that would be difficult for private industry to do alone. The A2e work, offshore-specific work, and the materials and manufacturing work was noted as highly valued by the wind industry.

Some reviewers expressed concern that the research in certain areas may be lagging behind industry, and that DOE may be working to develop technology that has already been fielded by industry. These reviewers suggested setting ambitious targets for research, enabling technology that may be up to 30 years in the future. Reviewers were divided on the relative value and emphasis of the distributed wind work. Better support of academic research was suggested as an area that DOE should try to improve.

CRITERIA: 2. IS THERE A PERSUASIVE RATIONALE FOR THE BODY OF WORK WITHIN THIS PROGRAM? IF NOT, PLEASE ELABORATE.

Reviewers expressed support for the program's rationale for its body of work. They noted that the portfolio attempts to improve the performance and reliability of both operating facilities (including individual turbine components and systems) and future facilities, which helps with project economics and policymaker support. They also noted that the portfolio attempts to expand the geographic areas in which wind energy is competitive, which is important to the President's deployment and climate objectives.

The reviewers questioned how DOE balances pursuing higher risk, higher reward research with a need to maintain a diverse portfolio of research projects with near-term, medium-term, and longer-term commercial applicability. A concern was also expressed that investments in distributed wind have not had a proportional impact as compared to the other programs.

CRITERIA: 3. WITHIN THIS FIELD, ARE THOUGHT LEADERS AWARE OF THE WETO-SUPPORTED WORK? IF NOT, WHO ELSE SHOULD BE ENGAGED?

Generally, the reviewers felt that thought leaders at OEMs, developers, owners, operators, technology vendors, and other researchers are aware of WETO-supported work; however, it was expressed that there is an apparent lack of robust engagement with academia. The reviewers suggested the program would benefit from strengthening the relationships with universities.

CRITERIA: 4. ARE THERE IMPORTANT TOPIC AREAS THAT ARE UNDERREPRESENTED OR MISSING WITHIN THE PROGRAM? IF SO, PLEASE ELABORATE.

The reviewers suggested that a few areas of the program may benefit from additional investment, such as floating offshore wind, turbine end-of-life, the circular economy, power electronics, and demonstration projects. There was some concern expressed that the program appears to be pivoting away from land-based wind research. More university research support and engagement to train the next generation of engineers was also recommended.

CRITERIA: 5. PLEASE ELABORATE ON ANY NOTABLE PROGRAM PORTFOLIO CONTENT OR DIRECTION STRENGTHS.

The reviewers felt that the program has a very broad and innovative research portfolio. The portfolio touches most relevant topics within the offshore and onshore wind industry at all scales and most aspects of the wind turbine and project life cycle. In particular, the DOE efforts to gather data in advance of a buildout of offshore wind was noted and reviewers questioned if more are needed and feasible as offshore wind expands to southern Atlantic states and the Gulf of Mexico.

CRITERIA: 6. PLEASE ELABORATE ON ANY NOTABLE PROGRAM PORTFOLIO CONTENT OR DIRECTION WEAKNESSES.

The majority of reviewers did not identify any particular overarching program weakness; however, one reviewer did note that the portfolio was not diverse in a couple of ways. First, a significant proportion of the funding was directed to national laboratories, with a relatively small proportion directed to academia and industry. Second, principal investigators, project teams, and WETO appear to be male-dominated, potentially reducing the benefits of diversity in the workplace and projects. It was also noted that utilities, market operators, and plant operators are not partners or recipients in the atmosphere science models, bringing into question whether the work is providing value to that sector.

CRITERIA: 7. WHAT RECOMMENDATIONS WOULD YOU LIKE TO CONVEY TO THE MANAGER(S) OF THIS PROGRAM?

The reviewers indicated a desire to see more diversity in the entities funded by DOE, and higher Technology Readiness Level (TRL) demonstration projects. The reviewers encouraged the technology development portfolio to be developed with more direct synergy with the environmental and wildlife solutions portfolio.

It was also recommended that the program develop a means to assess the effectiveness of the public funds expended, considering whether projects achieved targeted metrics, whether the technology substantially increased in TRL or was commercialized, and what tangible benefits were realized by the wind sector and ratepayers.

Lastly, the reviewers noted that clear prioritization of the work was necessary. Prioritization would include a strong delineation between what technology development is appropriate for the government to undertake versus industry, or if it needs to be a collaborative effort. Every project should consider this perspective and at every level of review, WETO should provide better clarity on why DOE should be doing that particular work.

PROGRAM RESPONSE

The Wind Program appreciates the Peer Review Panel's assessment that the portfolio is innovative and provides high-value work in addressing research areas that would be difficult for industry to undertake. DOE strives to focus on higher risk, higher reward investments that industry may be unwilling to make on their own. DOE acknowledges the reviewers' observation that there needs to be a balance between near-term, medium-term, and longer-term commercial applicability of the program activities.

The Program recognizes that university activities play only a small role in the current portfolio and is actively working to address this issue. The Program will continue to look for opportunities to further engage academia and universities while balancing the work performed by both the national labs and industry. The Program also acknowledges that more attention to diversity, equity, and inclusion is needed across the portfolio—DOE is aggressively addressing this important issue.

The Program recognizes the need for more demonstration projects, including ones at higher TRLs, and has support from Congress in appropriations language to conduct these activities. However, resource constraints have limited our ability to expand activities in this area. Demonstrations remain a high priority for the Program and will grow as resources permit.

The Program strongly agrees with the review panel that well-defined differentiation of what technology development is appropriate for the government to undertake versus industry is necessary, and the Program endeavors to make this evaluation on every activity DOE supports. The Program also aims to balance the portfolio between land-based and offshore wind research needs while addressing the Administration's priorities and congressional direction.

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