WIND TECHNOLOGY TO MARKET INDUSTRY SURVEY

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This data is being collected to identify:

(1) New and improved research capabilities and tools that would be valuable to the wind industry, and (2) Opportunities for, and barriers to, national laboratory and industry collaboration on technology development and transfer in those high-value areas.

The data you supply will be used to form the cornerstone of a report being developed for the U.S. Department of Energy and national labs to better align the national labs with wind industry technology development needs.

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Office of the Chief Information Officer, Enterprise Policy Development & Implementation Office, IM-22, Paperwork Reduction Project **(enter OMB control number)**, U.S. Department of Energy, 1000 Independence Ave SW, Washington, DC, 20585-1290; and to the Office of Management and Budget (OMB), OIRA, Paperwork Reduction Project **(enter OMB control number)**, Washington, D.C. 20503.

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Submission of this data is voluntary. You can skip questions that you are not comfortable answering, and any responses you do provide will be kept anonymous. Expected involvement is limited to this survey and does not include any future information collection.

Section 1. Technical Capabilities

The first part of this survey lists several technology areas in which the national labs have and/or are developing capabilities and tools to support the continued development and deployment of wind energy. We are interested in your perspectives on how important and useful **new and/or improved capabilities** in each area would be to you and your company.

For each general category of wind energy capabilities and tools shown below, **please indicate whether you are comfortable considering more detailed questions about specific capabilities**. For reference, the specific capabilities within each area encompass land-based, offshore, and distributed wind, and are summarized here. If you choose to review questions in a category, you can still skip any individual question, and you will have the opportunity to identify additional useful capabilities within that area.

	Yes, I will consider these questions	Prefer to skip
Wind power resources and site characterization	●	●
Wind turbine and plant technology advancement	●	●
Wind plant performance and reliability	●	●
Wind electricity delivery and integration	●	●

nrel.gov/wind/technology-to-market-survey-supplemental-information

Wind Technology-to-Market Survey Supplemental Information

The tables below list the four general wind technology areas discussed in this survey and the more specific capabilities and tools within each area that are being developed by the national labs. Questions in Section 1 of the survey focus on these more specific capabilities and tools.

Wind Power Resources and Site Characterization	
Mapping and GIS tools	Data collection and development of GIS data resources that include wind flow conditions, terrain, soil, other environmental conditions (offshore and land-based), built environment, wildlife, etc.
Plant sighting analysis and computational	Investigations of meso- and microscale flow phenomena, wake conditions, acoustics, radar impacts, and other factors that affect plant siting and demonstration of those physics in wind plant siting software tools.
Instrumentation and methodologies for wind resource and environmental characterization data collection	Investigations of the physics and technology associated with wind resource characterization and other environmental factors that affect wind plant development (offshore and land-based).

Wind Turbine and Plant Technology Advancement	
Component technology development	Development of turbine component technology for proving and validating new design concepts.
Lab and field testing	Testing of new and current commercial wind turbine technology both in test facilities and in the field. This can range from materials to full systems, hardware to control and communication systems.
Design verification	Independent assessment of new technology innovation using state-of-the-art wind turbine analysis tools. This includes validation against various design standards for different components.
Advanced manufacturing technology	Development and testing of advanced manufacturing technology for wind turbine components. This may include particular equipment as well as processes.
Computational analysis and support tools for wind turbine and plant design	Development of analysis and design tools for component and wind turbines that incorporate state-of-the-art physics and mathematics. This may include finite-element analysis, aero-elastic analysis, complex fluid dynamics, and other analyses.
Computational analysis and support tools for wind plant performance, control, and	Development of analysis and design tools for wind plant performance, controls and operation that

optimization	incorporate state-of-the-art physics and mathematics. This may include engineering tools validated against high fidelity models and real-world data as well as the direct use of high fidelity simulation capabilities.

Wind Plant Performance and Reliability	
Inspection technologies	Development and assessment of new technologies for inspection and prognostics of wind turbine component health.
Remote monitoring (including structural health monitoring, remote monitoring technologies, etc.)	Development and assessment of remote monitoring equipment and analysis systems for wind turbine component diagnostics and prognostics.
O&M data analytics	Methods for data collection and assessment of wind turbine plant operational parameters informing optimized O&M strategies
Reliability, root cause, and failure analyses	Detailed engineering analysis of wind turbine component failures to better understand failure modes and root causes. This may include laboratory analysis of failed components as well as detailed simulation using engineering and high fidelity models.
Repair methods and technologies	Development and assessment of new repair methods and technologies.

Wind Electricity Delivery and Integration	
Production forecasting	Development, assessment and validation of various techniques for wind plant production forecasting which may include both physics-based and statistical models.
Technology development for improved grid integration (e.g., active power control)	Development, assessment, and validation of technologies that improve grid interaction of the wind plant. An example of this is active power control where the wind plant can provide frequency and voltage support to the grid.
Grid modeling (e.g., grid stability and reliability analysis; power flow analysis; ancillary services)	Modeling tools and assessments of the electric grid system for stability, reliability, and security (physical and cyber) concerns.
Large-scale grid integration studies for planning purposes	Modeling of electric grid system with varying levels of wind penetration for operation (economic dispatch and unit comment) as well as planning (medium-term planning for maintenance and use of other resources as well as long term capacity planning of generation and transmission).

Wind Power Resources and Site Characterization

The next several questions ask for your opinion about the value of new and/or improved capabilities within the general area of **wind power resources and site characterization.** The first question, below, asks about the value to you and your company; the question on the next screen will ask about the importance of DOE or national lab participation in the development of those capabilities.

How important is it for you and your company to have access to new and/or improved capabilities within each of the following areas?

	Very important	Important	Moderately important	Slightly important	Not important	No opinion
Mapping and GIS tools. Data collection and development of geographic information system (GIS) data resources that include meteorological, oceanographic, terrain, soil, and other environmental conditions (offshore and land-based), built environment, wildlife, etc.	●	●	●	●	●	●
Plant siting analysis and computational tools. Investigations of meso- and micro-scale flow phenomena, wake conditions, oceanographic conditions, acoustics, radar impacts, and other factors that affect plant siting; demonstration of those physics in wind plant siting software tools	●	●	●	●	●	●
Instrumentation, methodologies, and data collection for wind resource and environmental characterization. Investigations of the physics and technology associated with wind resource characterization and other environmental factors that affect wind plant development (both offshore and land-based)	●	●	●	●	●	●

Wind Power Resources and Site Characterization

How important is DOE/national lab participation in developing new and/or improved capabilities within each of the areas listed below?

- Critical = Improved capabilities are unlikely to be developed without DOE or national lab support.
- Valuable = DOE or national lab participation will result in better capabilities, available to the industry sooner.
- Useful = Industry is likely to develop the capabilities with or without support. DOE or national lab participation has the potential to reduce the costs or the time required to develop those capabilities.
- Not necessary = Industry either has or will develop the necessary capabilities. DOE or national lab participation is not likely to lead to better capabilities, nor to faster deployment of those capabilities.

	Critical	Valuable	Useful	Not necessary
Anything that was rated "important" or "very important" from the previous question	●	●	●	●
	●	●	●	●
	●	●	●	●

Wind Power Resources and Site Characterization

Finally, if there are capabilities in the area of wind power resources and site characterization that would be even *more* valuable to you or your company than those identified above, please list them in the following table. For each, please indicate how important DOE/national lab participation is to the development of those capabilities.

Additional useful capabilities	**Importance of DOE/national lab participation**
<fill in the blank>	<drop down menu with the 4 options from the previous question: Critical, valuable, useful, not necessary>

Wind Turbine and Plant Technology Advancement

The next several questions ask for your input on the value of new and/or improved capabilities within the general area of **wind turbine and plant technology advancement.** The first question, below, asks about the value to you and your company; the question on the next screen will ask about the importance of DOE or national lab participation in the development of those capabilities.

How important is it for you and your company to have access to new and/or improved capabilities within each of the following areas?

	Very important	Important	Moderately important	Slightly important	Not important	No opinion
Turbine component technology development. Development of turbine component technology for proving and validating new design concepts to enhance performance, reduce costs, or reduce deployment barriers.	●	●	●	●	●	●
Balance of system technology development. Development of transportation, logistics, support structure, installation, and other plant technology for proving and validating new design concepts to enhance performance, reduce costs, or reduce deployment barriers	●	●	●	●	●	●
Lab and field testing. Testing of new and current wind turbine technology both in test facilities and in the field. This can range from materials to full systems, hardware to control and communication systems.	●	●	●	●	●	●
Design verification. Independent assessment of new technology innovation using state-of-the-art wind turbine analysis tools. This includes validation against various design standards for different components.	●	●	●	●	●	●
Advanced manufacturing technology. Development and testing of advanced manufacturing technology for wind turbine components. This may include particular equipment as well as processes.	●	●	●	●	●	●
Computational analysis and support tools for wind turbine design. Development of analysis and design tools for component and wind turbines that incorporate state-of-the-art physics and mathematics. This may include finite-element analysis, aero-elastic analysis, complex fluid dynamics, and other analyses.	●	●	●	●	●	●
Computational analysis and support tools for wind plant performance, control, and optimization. Development of analysis and design tools for wind plant performance, controls and operation that	●	●	●	●	●	●

incorporate state-of-the-art physics and mathematics. This may include engineering tools validated against high fidelity models and real-world data as well as the direct use of high fidelity simulation capabilities.						

Wind Turbine and Plant Technology Advancement

How important is DOE/national lab participation in developing new and/or improved capabilities within each of the areas listed below?

- Critical = Improved capabilities are unlikely to be developed without DOE or national lab support.
- Valuable = DOE or national lab participation will result in better capabilities, available to the industry sooner.
- Useful = Industry is likely to develop the capabilities with or without support. DOE or national lab participation has the potential to reduce the costs or the time required to develop those capabilities.
- Not necessary = Industry either has or will develop the necessary capabilities. DOE or national lab participation is not likely to lead to better capabilities, nor to faster deployment of those capabilities.

	Critical	Valuable	Useful	Not necessary
Anything that was rated "important" or "very important" from the previous question	●	●	●	●
	●	●	●	●

Wind Turbine and Plant Technology Advancement

Finally, if there are capabilities in the area of wind power resources and site characterization that would be even *more* valuable to you or your company than those identified above, please list them in the following table. For each, please indicate how important DOE/national lab participation is to the development of those capabilities.

Additional useful capabilities	**Importance of DOE/national lab participation**
<fill in the blank>	<drop down menu with the 4 options from the previous question: Critical, valuable, useful, not necessary>

Wind Plant Performance and Reliability

The next several questions ask for your input on the value of new and/or improved capabilities within the general area of **wind plant performance and reliability.** The first question, below, asks about the value to you and your company; the question on the next screen will ask about the importance of DOE or national lab participation in the development of those capabilities.

How important is it for you and your company to have access to new and/or improved capabilities within each of the following areas?

	Very important	Important	Moderately important	Slightly important	Not important	No opinion
Inspection technologies. Development and assessment of new technologies for inspection and prognostics of wind turbine blade and component health.	●	●	●	●	●	●
Remote monitoring. Development and assessment of remote monitoring equipment and analysis systems for wind turbine component diagnostics and prognostics.	●	●	●	●	●	●
O&M data analytics. Methods for data collection and assessment of wind turbine plant operational parameters informing optimized O&M strategies.	●	●	●	●	●	●
Reliability, root cause, and failure analyses. Detailed engineering analysis of wind turbine blade and component failures to better understand failure modes and root causes. This may include laboratory analysis of failed components as well as detailed simulation using engineering and high fidelity models.	●	●	●	●	●	●
Repair methods and technologies. Development and assessment of new repair methods and technologies.	●	●	●	●	●	●

Wind Plant Performance and Reliability

How important is DOE/national lab participation in developing new and/or improved capabilities within each of the areas listed below?

- Critical = Improved capabilities are unlikely to be developed without DOE or national lab support.
- Valuable = DOE or national lab participation will result in better capabilities, available to the industry sooner.
- Useful = Industry is likely to develop the capabilities with or without support. DOE or national lab participation has the potential to reduce the costs or the time required to develop those capabilities.
- Not necessary = Industry either has or will develop the necessary capabilities. DOE or national lab participation is not likely to lead to better capabilities, nor to faster deployment of those capabilities.

	Critical	Valuable	Useful	Not necessary
Anything that was rated “Important” or “very important” from the previous question	●	●	●	●
	●	●	●	●

Wind Plant Performance and Reliability

Finally, if there are capabilities in the area of wind power resources and site characterization that would be even *more* valuable to you or your company than those identified above, please list them in the following table. For each, please indicate how important DOE/national lab participation is to the development of those capabilities.

Additional useful capabilities	**Importance of DOE/national lab participation**
<fill in the blank>	<drop down menu with the 4 options from the previous question: Critical, valuable, useful, not necessary>

Wind Electricity Delivery and Integration

The next several questions ask for your input on the value of new and/or improved capabilities within the general area of **wind electricity delivery and integration.** The first question, below, asks about the value to you and your company; the question on the next screen will ask about the importance of DOE or national lab participation in the development of those capabilities.

How important is it for you and your company to have access to new and/or improved capabilities within each of the following areas?

	Very important	Important	Moderately important	Slightly important	Not important	No opinion
Wind and production forecasting. Development, assessment and validation of various techniques for wind and wind plant production forecasting. May include both physics-based and statistical models; uncertainty quantification; decision support tools for wind and plant production and planning for volatility	●	●	●	●	●	●
Technology development for improved grid integration. Development, assessment, and validation of technologies that improve grid interaction of the wind plant.	●	●	●	●	●	●
Grid modeling. Modeling tools and assessments of the electric grid system for stability, reliability, and security (physical and cyber) concerns.	●	●	●	●	●	●
Large-scale grid integration studies for planning purposes. Modeling of electric grid system with varying levels of wind penetration for operation (economic dispatch and unit comment); medium-term planning for maintenance and use of other resources; long term capacity planning of generation and transmission.	●	●	●	●	●	●

Wind Electricity Delivery and Integration

How important is DOE/national lab participation in developing new and/or improved capabilities within each of the areas listed below?

- Critical = Improved capabilities are unlikely to be developed without DOE or national lab support.
- Valuable = DOE or national lab participation will result in better capabilities, available to the industry sooner.
- Useful = Industry is likely to develop the capabilities with or without support. DOE or national lab participation has the potential to reduce the costs or the time required to develop those capabilities.
- Not necessary = Industry either has or will develop the necessary capabilities. DOE or national lab participation is not likely to lead to better capabilities, nor to faster deployment of those capabilities.

	Critical	Valuable	Useful	Not necessary
Anything rated “important” or “very important” from the previous question	●	●	●	●
	●	●	●	●

Wind Electricity Delivery and Integration

Finally, if there are capabilities in the area of wind power resources and site characterization that would be even *more* valuable to you or your company than those identified above, please list them in the following table. For each, please indicate how important DOE/national lab participation is to the development of those capabilities.

Additional useful capabilities	**Importance of DOE/national lab participation**
<fill in the blank>	<drop down menu with the 4 options from the previous question: Critical, valuable, useful, not necessary>

Section 2. Working with the national labs

In this section of the survey, we would like your input on the potential benefits of and barriers to collaborating with the national labs on wind energy technologies.

Each statement below describes a potential benefit of industry and national lab collaboration. **Please indicate your level of agreement or disagreement with each statement.** If you have experienced or anticipate other benefits that could come from collaboration with the labs, there is space to add them below.

Benefit of working with the national labs	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Provides access to useful existing intellectual property and patents owned by the labs.	•	•	•	•	•
Lab technical staff provide exceptional depth of knowledge and research experience that may be critical to project success.	•	•	•	•	•
Provides access to unique Lab and testing facilities that would otherwise be too expensive or not available.	•	•	•	•	•
Presents the opportunity for DOE co-funding of research and work.	•	•	•	•	•
Increases the visibility or credibility of research and development outcomes.	•	•	•	•	•

Additional benefits of collaboration: (you many describe more than one)

Each statement below describes a potential challenge or barrier to industry and national lab collaboration. **Please indicate your level of agreement or disagreement with each statement.** If you have experienced or anticipate other barriers to collaboration with the labs, there is space to add them below.

Barrier to collaboration with national labs	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Contracting processes are too difficult (too slow, unclear, and/or not well communicated).	●	●	●	●	●
Costs of working with the labs are too high.	●	●	●	●	●
Inability of the company to obtain full control of intellectual property developed during collaboration.	●	●	●	●	●
It is not clear what research and funding opportunities and technical capabilities at the labs are available to industry.	●	●	●	●	●
Labs do not have the skill sets or technical capabilities that I /my company need(s).	●	●	●	●	●
Work culture between labs and private industry are too different.	●	●	●	●	●

Additional barriers to collaboration: (you may describe more than one)

Have you or others at your company worked directly with any of the national labs on wind energy related work? If so, how recently? (Please check one)

- We are currently working with one or more of the labs.
- Within the last 5 years (but not currently).
- More than 5 and less than 10 years ago.
- Not within the past 10 years.
- Never worked with the labs (or not to my knowledge).

What types of agreements have you used in your work with the national labs? (Select all that apply)

- Subcontractor to a lab
- Agreement for Commercializing Technology (ACT)
- Cooperative Research and Development Agreement (CRADA)
- Work for Others or Technical Service Agreement (including Strategic Partnership Projects (SPP), Non-Federal Entity (SNFE) Agreements, Funds-In Agreement (FIA)
- DOE Funding Opportunity Announcement (FOA)
- Work conducted under Small Business Innovation Research (SBIR) / Small Business Technology Transfer (STTR), user facility agreements, or the New Mexico Small Business Assistance (SBA) program.
- Commercial Intellectual Property License Agreement
- Collaboratives or joint industry projects conducted under a Memorandum of Understanding (MOU)
- Other (please specify)_____
- I don't know what type of agreement
- Have not worked with the national labs

What, if anything, worked well in establishing and conducting this joint work?

What, if anything, were the significant hurdles to conducting this joint work? What would make it easier for you to collaborate with the national labs in the future?

Finally, we would appreciate knowing a bit about you and your organization. The answers to these questions will be used only to segment the survey responses and will not be made publically available.

Which of the following best describes your organization? (Check all that apply)

- Wind energy equipment manufacturer
- Wind project developer
- Wind plant owner or operator
- Electric utility or system operators
- Service provider to the wind industry
- Wind energy consultancy
- Wind project financier or insurer
- Other (please describe) _____

In what market segment does your company focus? (Check all that apply)

- Utility-scale land-based
- Utility-scale offshore
- Small and distributed

Compared to other companies that do similar work in the wind industry, how large is the market share of your company? (Check one)

- We are the dominant company in the market
- We currently have a large share of the market
- We currently have a moderate share of the market
- We currently have a small market share
- I don't know or prefer not to answer

What are your primary job responsibilities? (Check all that apply)

- Senior / company management
- Principal investigator / Project manager
- Research and Development Technical Staff
- Production or Application Technical Staff
- Financial analyst / Cost specialist
- Business development
- Legal and/or contracting specialist
- Other (please describe) _____

How many years have you been working in the wind industry? [Fill in the blank]