

Wind Plants Operations and Maintenance Research

FINAL

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INTRODUCTION

As wind power plants have grown across the United States, numerous studies have sought to quantify the economic impacts of these facilities on their surrounding communities. As the literature review section below highlights, many of these studies have struggled to develop a clear picture of the economic impact of wind farm operations and maintenance (O&M). Challenges, such as variability in the age of wind plants, capacity and quantity of wind turbines, as well as varying surrounding population concentrations, have hindered researchers' ability to create accurate and granular economic impact models of O&M wind activity. This study seeks to provide a new source of information on the economic and employment impacts of wind plants and their operations and maintenance activities.

Additionally, NREL and BW Research (the Research Team) sought to uncover the role that some of these factors may play in a wind plant's workforce and subsequent impacts on the surrounding community. Do rural wind plants tend to outsource their O&M work more often than wind plants that are relatively close to urban centers? Does geography play a role in the types of workers that employers struggle most to hire? Do contract O&M workers typically live outside the immediate local community? How do these aspects alter economic impact? These questions, among others, are the types of questions that the Research Team sought to answer.

DATA COLLECTION METHODOLOGY

NREL began this project by compiling a list of 46 wind plants across the United States. BW Research identified sixteen wind plants. The original list was clustered based on rated capacity, turbine name plate capacity, age of wind plant, and geographic region. Sample clustering allowed for several additional replacement options (up to four additional plants for selection by sample cluster) should the primary selection decline participation in the interview and survey process. For selection, special consideration was taken to include only one wind plant from each identified geographic cluster (provided by NREL).

From August 12, 2019 to September 27, 2019, the selection of wind plants was contacted via phone and email outreach efforts. If a respondent declined to participate, another wind plant within the same sample cluster was contacted. Each location was called at least ten times (with voicemails) and emailed (if email was available) up to eight times to elicit a response. Representatives from 11 separate wind plants from nine different states across the United States completed the executive interview. After the executive interviews were conducted, each representative was asked to share an online employee survey (programmed in Qualtrics by BW Research) with their employees. Thirty employees from six separate wind plant locations completed the survey.

- Thirty-nine percent (18 of 46) of all wind plants identified by NREL for the project responded to our request for interviews.
- Sixty-one percent of these locations (11 of 18) agreed to the employer phone executive interview, with six sharing the employee survey.
- Five of the wind plant completions were from the finalized list of sixteen, with the remaining six from adjacent sample clusters.

Economic Impact Models

The economic impacts throughout this report are quantified using IMPLAN, an input-output economic model that estimates spending patterns and infrastructure developments throughout a specified region. The cumulative effects of the wind O&M jobs are quantified, and the results are categorized into direct, indirect, and induced effects. Direct effects show the change in the economy associated with the initial job creation (or loss), or how the industry experiences the change. Indirect effects include all the backward linkages, or the supply chain responses as a result of the initial job change. Induced effects capture the additional household spending that results from direct and indirect workers spending their wages. Output is defined as the total value of production, components of which include labor income, intermediate expenditures, tax on production and imports, and other property income. Value added is defined as the difference between total output and cost of intermediate inputs, otherwise known as GDP.¹

For this study, economic impacts are estimated at the county level, unless otherwise noted. This means that numbers and dollar values are reflective of the economic impacts within that county only. Additionally, employee inputs for economic impact modeling were adjusted for the regional presence of workers. For example, workers who lived outside of the local area (at least 15 miles outside the wind farm location) were not included in the economic impact analysis.

LITERATURE REVIEW

Through this review of relevant literature, a few key factors were uncovered that informed and guided our research process.

1. **Operational expenditures have declined in recent years** (a majority of which is operations and maintenance), though a consensus of plant managers have indicated these costs to be higher than originally anticipated.

¹ For more information on economic impacts and direct, indirect, and induced effects, please see Appendix A.

2. **A wind plants geographic proximity to labor and the supply chain plays a substantial role in a wind farm's regional economic impact.**
3. **Jobs and economic activity per MW varied greatly across wind plants—even in studies that examined wind plants within a single state.**
4. **Locally owned wind farms have substantially greater local economic impact than their non-regionally owned counterparts.**

The following four papers highlight prior research that analyzes the construction and operation and maintenance costs and the resulting economic impacts of wind power plants. Reviewing this literature provides valuable background and context in framing and understanding the economic effects of wind farms on surrounding regions.

Assessing wind power operating costs in the United States: Results from a survey of wind industry experts Ryan Wiser, Mark Bolinger, Eric Lantz. 2019

This paper seeks to estimate operational expenditures (OpEx) of US land-based wind power plants. Based on an extensive literature review and an email and phone survey of 16 wind professionals, the article concludes that **OpEx has declined from about \$35/MWh for 1990s wind projects to about \$11/MWh for 2018 projects** (though respondents provided a large range of estimates). The researchers expect a further \$5-8/kW per year reduction by 2040. While the general trend among OpEx has been declining costs, the paper also notes that many managers cited higher-than-anticipated OpEx (in particular O&M) costs. Ultimately, while operational expenditures do not provide direct translations to economic impact, the paper is useful for providing context in framing and analyzing the impacts of variables across wind farms. The researchers note that OpEx varied significantly across wind farms of different ages, turbine capacities, locations, and the presence/absence of manufacturer contractual obligations. Acknowledging the importance of these variables was crucial to conducting this research.

Ex post analysis of economic impacts from wind power development in U.S. counties

Jason P. Brown, John Pender, Ryan Wiser, Eric Lantz, Ben Hoen. 2012

This article describes a county-level economic impact analysis of wind power installations from 2000-2008 across 1,009 Great Plains counties. The authors outline 8 ways in which wind power development can affect local economies: (1) direct employment and income; (2) local goods and services like gravel, concrete, vehicles, fuel, hardware, and consumables; (3) lease payments and displacement of other land uses; (4) shareholder profit if locally owned; (5) property taxes or payment in lieu of taxes; (6) local spending

from additional direct and indirect income; (7) desirability of living in the area; and (8) spillover effects on nearby communities that in turn spend money in local community.

The researchers explain that for absentee-owned plants, previous research estimates 0.1-2.6 local jobs and \$5,000-\$8,000 (2010 dollars) of local economic activity per MW of installed capacity during construction, and 0.1-0.6 jobs and \$5,000-\$18,000 of local economic activity during operations. These numbers are significantly higher for locally owned plants. Brown et al. could not separate the construction and operations phases of wind power development but, by taking into account factors influencing wind turbine location, the analysis shows **an aggregate increase in county-level per-capita income and employment of approximately \$11,000 and 0.5 jobs per MW of wind power capacity across plants of all ownership types.**

State and local economic impacts from wind energy projects: Texas case study

Michael C. Slattery, Eric Lantz, Becky L. Johnson. 2011

Slattery, Lantz, and Johnson utilize NREL's Jobs and Economic Development Impacts (JEDI) model to estimate local (100-mile radius of farm) and state economic impacts of two specific wind power projects in Texas. The researchers state that, despite claims of large positive economic state impacts of wind farms, little effort has been made to quantify impacts at the local level, particularly in rural areas with few supporting industries. This latter consideration is important, as economic impacts will be directly related to the relative availability of local suppliers and workers. Other important factors include preferences of individual contractors, existence of local ownership, and sourcing of large capital items. **The average 100 MW wind plant supports 80-100 construction workers for a year, 6-8 O&M workers annually, \$4,000-\$1,200 /MW in annual local taxes, and \$3,000-\$7,000 / MW in lease payments. The researchers also find that local ownership of wind projects increases jobs by a factor of 100% - 300%.**

Some stated limitations of the modeling include a lack of consideration for spillover effect on areas outside the study area, impacts of neighboring wind farms, and spending of plant profit. Assuming a 4-year construction period and 20-year operations period, the article estimates that the two case-study projects will produce more than \$1.3 million of state economic activity per MW on installed capacity, \$0.52 million/MW of which will occur in the local communities. Local workers would fill an estimated 22% of construction jobs and 64% of O&M jobs.

The authors note that there is a delicate balance of "ruralness" that is optimal for maximizing benefits; some studies find wind farms can create new industries that become a large percentage of the local tax base and contribute to local businesses, while

other studies have found significant economic “leakage” when the small local community cannot provide the services necessary for the farm.

Wind farms in rural areas: How far do community benefits from wind farms represent a local economic development opportunity?

Max Munday, Gill Bristow, Richard Cowell. 2011

This article examines rural development implications of 29 wind farms in rural Wales. Munday, Bristow, and Cowell conducted their research through internet searches, planning documents, semi-structured interviews with industry stakeholders, and a phone survey with seven developers. Wind farms *can* generate moderate local harm through landscape quality reduction and negative tourism impacts, so economic rationale has become an important aspect with every proposed wind farm.

In the short term, large numbers of construction workers bring local spending to the rural communities. However, the article finds that wind farms often fail to improve long-term incomes and jobs in the communities; this is because owners, goods (particular those of higher monetary value), and labor are usually sourced from outside the low-population areas. **The study finds that wind farms’ largest inherent local impacts arrive from operations and maintenance (8,000-10,000 euro/MW/yr) and rent (10,000 euros/turbine), but these account for a small percentage in comparison to construction activity.** Due to a relatively small impact, most wind companies provide community benefits through local donations or other benefits. These benefits can be categorized as the following:

1. ***Conventional economic benefits:*** the use of locally manufactured content and local contractors for construction, operation and maintenance, land rental income to landowners and any royalties, and local business rates and/or taxes.
2. ***Flows of financial benefits to local communities:*** some form of ownership/investment in the project among local people, either as equity or a form of profit share; some form of community fund, with lump sum and/or annual payments.
3. ***Contributions in kind to local assets and facilities:*** to landscape and ecological enhancement measures or to tourism/visitor facilities.
4. ***Provision of other local services:*** educational visits or other educational programs.
5. ***Involvement in the development process:*** various forms of liaison activity.

WIND FARM CASE STUDIES

The following case studies provide summary information on 11 wind power plant locations. Some location-specific information is excluded from these case studies to preserve the anonymity requested by some respondents.

Figure 1. Amazon Wind Farm US East Project Case Study²

Amazon Wind Farm US East Project	
Location:	Perquimans and Pasquotank Counties, North Carolina – Southeast Region
Capacity:	208 MW
Number and Description of Employees:	<ul style="list-style-type: none"> • 19 permanent part- or full-time employees (plant manager, plant administrator, wind farm technicians) • 2 temporary/seasonal employees (including wildlife specialist, environmental and health specialist, etc.)
In Operation Since:	Operational since 2017
Plan Ownership:	Private, national
O&M Workshare:	Mostly in-house, however, suppliers of certain turbine parts provide warranties and subsequent maintenance service until that warranty expires.
Annual Economic Impact in County	
Direct Jobs:	19
Indirect Jobs:	52
Induced Jobs:	19
Value Added:	\$24,757,773
Output:	\$39,330,174
Taxes:	
Federal:	\$1,924,220
State:	\$959,756
Local and County:	\$528,777
Model of Turbines:	104 turbines at 2.0 MW each
Executive Interviewed:	Paul Copleman, Communications Director at Avangrid
Geographic Proximity of Workers:	70% or more of permanent employees live within 15 miles. No temporary workers live within 15 miles.
Regional Involvement:	Estimate \$1.5 million into community (\$640,000 in taxes and \$624,000 in lease payments to 60 landowners). \$18.5 million was spent locally on construction.
Status of Employee Surveys:	Multiple requests, unable to get completed employee surveys

² Impacts are estimated based on a merged region of Perquimans and Pasquotank counties.

Figure 2. Beech Ridge Project Case Study

Beech Ridge Project	
Location:	Greenbrier County, West Virginia – Southeast Region
Capacity:	147.6 MW
Number and Description of Employees:	
In-House	
•	10 permanent full-time and part-time employees (site manager, site administrator, wind farm technicians)
•	2 temporary/seasonal employees (landscaping and aviary studies)
In Operation Since:	Operational since 2010
Plan Ownership:	Private, national
O&M Workshare:	Entirely in-house with exception of some janitorial services.
Annual Economic Impact in County	
Direct Jobs:	10
Indirect Jobs:	20
Induced Jobs:	1
Value Added:	\$3,795,999
Output:	\$10,595,761
Taxes:	
Federal:	\$356,981
State:	\$318,357
Local and County:	\$22,190
Model of Turbines:	67 turbines at 1.5 MW each
Executive Interviewed:	Eric Ritchie, O&M Manager at Invenergy
Geographic Proximity of Workers:	Permanent workers seldom (1%-30% of the time) live within 15 miles. Temporary workers live within 15 miles frequently (31%-69% of the time).
Regional Involvement:	Support local children’s homes and shelters, donations to child sporting associations, company mandated community contributions, Veteran’s day events and donations.
Status of Employee Surveys:	9 completes

Figure 3. El Cabo Project Case Study

El Cabo Project	
Location:	Torrance County, New Mexico – Interior Region
Capacity:	298.2 MW
Number and Description of Employees:	
In-House	
•	17 permanent part- or full-time employees (plant manager, plant administrator, wind farm technicians)
•	2 temporary/seasonal employees (including wildlife specialist, environmental and health specialist, etc.)
In Operation Since:	Operational since 2017
Plan Ownership:	Private, national
O&M Workshare:	Mostly in-house, however, suppliers of certain turbine parts provide warranties and subsequent maintenance service until that warranty expires.
Annual Economic Impact in County	
Direct Jobs:	17
Indirect Jobs:	22
Induced Jobs:	1
Value Added:	\$12,466,900
Output:	\$23,622,296
Taxes:	
Federal:	\$989,125
State:	\$440,326
Local and County:	\$54,718
Model of Turbines:	142 turbines at 2.1 MW each
Executive Interviewed:	Paul Copleman, Communications Director at Avangrid
Geographic Proximity of Workers:	Permanent workers seldom (1% - 30% of the time) live within 15 miles. Temporary workers never live within 15 miles.
Regional Involvement:	Money for community sponsorship. Estimated \$1.5 million to community through leases and PILOT payments. Excess land still used for previous purposes.
Status of Employee Surveys:	Multiple requests, unable to get completed employee surveys

Figure 4. Glenrock Project Case Study

Glenrock Project	
Location:	Converse County, Wyoming – Interior Region
Capacity:	99 MW
Number and Description of Employees:	
In-House	
•	1 permanent full-time employee (Wind operations supervisor).
•	0 temporary/seasonal employees
Contracted	
•	12 full-time operations and service technicians contracted through GE
•	3-5 road crew members, 1-2 janitors (weekly), bi-weekly pest control, bi-annual landscaping
In Operation Since:	Operational since 2009
Plan Ownership:	Private, regional
O&M Workshare:	Most of operations and maintenance work is through contracted workers.
Annual Economic Impact in County	
Direct Jobs:	17
Indirect Jobs:	24
Induced Jobs:	4
Value Added:	\$12,688,212
Output:	\$24,557,688
Taxes:	
Federal:	\$1,026,960
State:	\$244,702
Local and County:	\$457,056
Model of Turbines:	66 turbines at 1.5 MW each
Executive Interviewed:	Casey Collins, Wind Operations Supervisor at PacifiCorp
Geographic Proximity of Workers:	
•	Permanent employee lives within 15 miles.
•	Most contracted service is local (within 15 miles), though landscaping is out-of-state.
Regional Involvement:	Volunteer work with food bank and invest time into community in other ways.
Status of Employee Surveys:	5 completes

Figure 5. BWID10 Project Case Study³

BWID10 Project	
Location:	Interior Region
Capacity:	90-150 MW
Number and Description of Employees:	
In-House	
•	4 part- or full-time employees (site manager, IT technician, maintenance technicians)
•	0 temporary/seasonal employees
Contracted	
•	12 contracted maintenance technicians
In Operation Since:	Operational since 2005-2010
Plan Ownership:	Private, national
O&M Workshare:	In-house workers conduct quality audits and inspections. Contract workers do 100% of repairs.
Annual Economic Impact in County	
Direct Jobs:	16
Indirect Jobs:	76
Induced Jobs:	15
Value Added:	\$19,055,777
Output:	\$51,986,938
Taxes:	
Federal:	\$1,764,865
State:	\$956,296
Local and County:	\$1,288,784
Model of Turbines:	63-75 turbines at 1.5-2.0 MW each
Executive Interviewed:	Site Manager
Geographic Proximity of Workers:	
•	Part- or full-time employees all live within 15 miles.
•	Most contract workers are also local (within 15 miles).
Regional Involvement:	Donate to local schools and sports programs.
Status of Employee Surveys:	3 completes

³ Impacts are estimated based on a merged region of two adjacent counties.

Figure 6. Horse Butte Project Case Study

Horse Butte Project	
Location:	Bonneville County, Idaho – West Region
Capacity:	57.6 MW
Number and Description of Employees:	
In-House	
•	2 permanent part- or full-time worker (Director of Resources and manager)
•	0 temporary/seasonal employees
Contracted	
•	6 contracted employees (1 site manager, 1 O&M manager, and 4 technicians)
In Operation Since:	Operational since 2012
Plan Ownership:	Public, regional
O&M Workshare:	All work is provided by the contract provider, including supervision and quality control.
Annual Economic Impact in County	
Direct Jobs:	8
Indirect Jobs:	26
Induced Jobs:	6
Value Added:	\$4,913,729
Output:	\$11,563,992
Taxes:	
Federal:	\$493,920
State:	\$383,941
Local and County:	\$95,728
Model of Turbines:	32 turbines at 1.8 MW each
Executive Interviewed:	Nate, Director of Resources at Utah Municipal Power Agency
Geographic Proximity of Workers:	
•	Permanent and contracted employees usually (70% of the time or more) live within 15 miles.
Regional Involvement:	No community events.
Status of Employee Surveys:	One complete

Figure 7. BWID6 Project Case Study

BWID6 Project	
Location:	West Region
Capacity:	40-90 MW
Number and Description of Employees:	
In-House	
•	1 permanent employee (site manager)
•	0 temporary/seasonal employees
Contracted	
•	Three maintenance agreements and an environmental agreement
In Operation Since:	Operational since 2010-2015
Plan Ownership:	Private, national
O&M Workshare:	All work done by contracted employees
Annual Economic Impact in County	
Direct Jobs:	4
Indirect Jobs:	11
Induced Jobs:	2
Value Added:	\$1,650,139
Output:	\$4,969,042
Taxes:	
Federal:	\$210,598
State:	\$197,838
Local and County:	\$40,896
Model of Turbines:	23-41 turbines at 2.0-2.5 MW each
Executive Interviewed:	Project Site Manager
Geographic Proximity of Workers:	
•	Half of contracted workers are within 15 miles; half are from outside of county.
Regional Involvement:	Support local educational and community organizations.
Status of Employee Surveys:	Refused to distribute survey to employees

Figure 8. Manzana Winds Project Case Study

Manzana Winds Project	
Location:	Kern County, California – West Region
Capacity:	189 MW
Number and Description of Employees:	
In-House	
•	12 permanent part- or full-time employees (plant manager, plant administrator, wind farm technicians)
•	2 temporary/seasonal employees (including wildlife specialist, environmental and health specialist, etc.)
In Operation Since:	Operational since 2012
Plan Ownership:	Private, national
O&M Workshare:	Mostly in-house, however, suppliers of certain turbine parts provide warranties and subsequent maintenance service until that warranty expires.
Annual Economic Impact in County	
Direct Jobs:	12
Indirect Jobs:	28
Induced Jobs:	8
Value Added:	\$16,447,715
Output:	\$25,739,438
Taxes:	
Federal:	\$1,544,282
State:	\$886,947
Local and County:	\$421,486
Model of Turbines:	126 turbines at 1.5 MW each
Executive Interviewed:	Paul Copleman, Communications Director at Avangrid
Geographic Proximity of Workers:	
•	In-House permanent workers frequently (31% - 69% of the time) live within 15 miles.
•	Temporary workers never live within 15 miles.
Regional Involvement:	Help develop wind farm technician curriculum, donate and sponsor fire department, hospitals, and child sports leagues. Additionally, estimated \$50 million in taxes over the lifetime of project and \$30 million in lease payments.
Status of Employee Surveys:	Multiple requests, unable to get completed employee surveys

Figure 9. BWID7 Project Case Study

BWID7 Project	
Location:	West Region
Capacity:	90-130 MW
Number and Description of Employees:	
In-House	
•	2 permanent part- or full-time employees
•	0 temporary/seasonal employees
Contract	
•	9 contracted employees (technicians and maintenance crew)
In Operation Since:	Operational since 2010-2015
Plan Ownership:	Private, national
O&M Workshare:	All work done by contracted employees.
Annual Economic Impact in County	
Direct Jobs:	11
Indirect Jobs:	35
Induced Jobs:	8
Value Added:	\$6,756,377
Output:	\$15,900,489
Taxes:	
Federal:	\$679,140
State:	\$527,919
Local and County:	\$131,626
Model of Turbines:	52-75 turbines at 2.0-2.5 MW each
Executive Interviewed:	Operations Manager
Geographic Proximity of Workers:	
•	In-House permanent workers usually (70% of the time or more) live within 15 miles.
•	Contract workers usually (70% of the time or more) live within 15 miles.
Regional Involvement:	Have a large budget to support the community, sometimes struggling to find organizations to take donations. They did a walk/run fundraiser to help families with children who have had organ transplants and have donated a truck load of supplies to shelters.
Status of Employee Surveys:	10 completes

Figure 10. Twin Buttes II Project Case Study

Twin Buttes II Project	
Location:	Prowers County, Colorado – Interior Region
Capacity:	63 MW
Number and Description of Employees:	
In-House	
•	11 permanent part- or full-time employees (plant manager, plant administrator, wind farm technicians)
•	2 temporary/seasonal employees (including wildlife specialist, environmental and health specialist, etc.)
In Operation Since:	Operational since 2017
Plan Ownership:	Private, national
O&M Workshare:	Mostly in-house, however, suppliers of certain turbine parts provide warranties and subsequent maintenance service until that warranty expires.
Annual Economic Impact in County	
Direct Jobs:	11
Indirect Jobs:	24
Induced Jobs:	1
Value Added:	\$13,912,388
Output:	\$21,594,389
Taxes:	
Federal:	\$1,135,650
State:	\$365,629
Local and County:	\$49,283
Model of Turbines:	30 turbines at 2.1 MW each
Executive Interviewed:	Paul Copleman, Communications Director at Avangrid
Geographic Proximity of Workers:	
•	In-House permanent workers seldomly (1%-30% of the time) live within 15 miles.
•	Temporary workers never live within 15 miles.
Regional Involvement:	Help develop wind farm technician curriculum, donate and sponsor fire department, hospitals, and child sports leagues. Additionally, an estimated \$0.5 million in taxes and lease payments is injected into the community each year.
Status of Employee Surveys:	Multiple requests, unable to get completed employee surveys

Figure 11. BWID11 Project Case Study⁴

BWID11 Project	
Location:	Interior Region
Capacity:	75-120 MW
Number and Description of Employees:	
In-House	
•	4 part- or full-time employees (site manager, IT technician, maintenance technicians)
•	0 temporary/seasonal workers
Contracted	
•	12 contracted maintenance technicians
In Operation Since:	Operational since 2005-2010
Plan Ownership:	Private, national
O&M Workshare:	In-house workers conduct quality audits and inspections. Contract workers do 100% of repairs.
Annual Economic Impact in County	
Direct Jobs:	16
Indirect Jobs:	76
Induced Jobs:	15
Value Added:	\$19,055,777
Output:	\$51,986,938
Taxes:	
Federal:	\$1,764,865
State:	\$956,296
Local and County:	\$1,288,784
Model of Turbines:	54-80 turbines at 1.5-2.0 MW each
Executive Interviewed:	Site Manager
Geographic Proximity of Workers:	
•	Part- or full-time employees all live within 15 miles.
•	Most contract workers are also local (within 15 miles).
Regional Involvement:	Donate to local schools and sports programs.
Status of Employee Surveys:	2 completes

⁴ Impacts are estimated based on a merged region of two adjacent counties.

OVERALL FINDINGS AND ECONOMIC IMPACT

Employment Extrapolations

The Research Team created a model based on the 11 wind farms interviewed in this study and 11 more from the EIA database that had publicly available O&M employment data to approximate the number of full-time workers required for a given wind farm. This comprehensive sample of 22 wind farms was analyzed by capacity (MW), number of turbines, age, and geographic location. When modelling employment by the previously listed characteristics, number of turbines appeared to be the best estimator of actual full-time, permanent O&M employment.⁵ The derived employment model uses a polynomial equation from the best-fit line on full-time, permanent O&M employment and number of turbines, and explains over 83% of variation in observations.

The Research Team was able to use this model to approximate the number of full-time employees needed for each wind plant in the United States to determine a total number of wind O&M and related employees required across the country. **The results find that the 1,112 active onshore wind plants across the United States require, on average, one full time, permanent O&M related worker for every 7 turbines. This equates to 8,204 full time O&M related workers.**⁶

National Economic Impact

Using the extrapolated employment data from the EIA database of wind farms in the United States, the Research Team estimated the national economic impacts of all wind O&M employment using IMPLAN. Employment impacts were computed at the state level, and the resulting output is an aggregation of these effects across the country. The wind electric power generation in the United States is estimated to support 26,311 jobs indirectly, or through the supply chain of wind electric power generation activities. The 8,204 full time employees that are estimated to be supported by the wind electric power generation industry spend their wages in surrounding communities, the effects of which support 18,876 jobs. This results in 53,391 total jobs supported by US wind farms. The wind electric power generation industry's direct output as a result of our estimated O&M

⁵ In a linear regression model predicting employment by number of turbines, capacity, age, and location, number of turbines is the only statistically significant estimator, with $p < 0.001$.

⁶ The 2019 U.S. Energy and Employment Report (USEER) reports 111,166 total jobs in wind electric power generation, broken out by Utilities, Construction, Manufacturing, Wholesale Trade, Professional Services, and Other Services. Most wind farm O&M workers fall under the Utilities sector, reported as 6,231 jobs, but some O&M workers captured in this report also fall under Professional Services and Other Services, which explains the difference in reported employment in this report and the 2019 USEER. For more information on the 2019 USEER, visit www.usenergyjobs.org.

employment is \$14.96 billion, with \$10.5 billion in direct value added. Wind energy employment also contributes over \$2.1 billion in federal, state, and local tax revenues.

Direct Jobs:	8,204
Indirect Jobs:	26,311
Induced Jobs:	18,876
Value Added:	\$14,695,325,534
Output:	\$22,404,389,511
Taxes:	
Federal:	\$1,267,673,853
State:	\$455,441,277
Local and County:	\$386,404,167

Measuring these impacts by industry reveal a deeper message behind the economic activity of wind O&M. Direct employment only effects the wind electric power generation industry, but indirect and induced effects can be traced throughout the value chain. The industry in the supply chain that is most impacted by wind electric power generation activity is marketing research and all other miscellaneous professional, scientific, and technical services, with over 3,200 jobs supported by wind energy activities nationwide. When wind workers spend their wages in local communities, they support jobs mostly in restaurants, hospitals, real estate, and other retail stores.

Figure 12. Top Five Industries, Indirect Jobs

Industry	Indirect Jobs Supported
Marketing research and all other miscellaneous professional, scientific, and technical services	3,233
Scenic and sightseeing transportation and support activities for transportation	2,262
Employment services	2,246
Full-service restaurants	2,066
Maintenance and repair construction of nonresidential structures	2,013

Figure 13. Top Five Industries, Induced Jobs

Industry	Induced Jobs Supported
Full-service restaurants	983
Limited-service restaurants	950
Hospitals	889
Real estate	865
Retail - General merchandise stores	574

The industry whose output is most impacted indirectly by national wind farm employment is petroleum refineries, likely due to the oil used to maintain the wind

turbine gearboxes, as well as to operate the machinery that aids in repairs and maintenance activities. When wind farm O&M workers spend their wages, they most impact the output of industries like real estate, hospitals, wholesale trade, and restaurants – similar to induced employment impacts.

Figure 14. Top Five Industries, Indirect Output

Industry	Indirect Output
Petroleum refineries	\$490,269,203
Scenic and sightseeing transportation and support activities for transportation	\$361,468,346
Maintenance and repair construction of nonresidential structures	\$338,053,409
Monetary authorities and depository credit intermediation	\$248,916,743
Marketing research and all other miscellaneous professional, scientific, and technical services	\$240,564,126

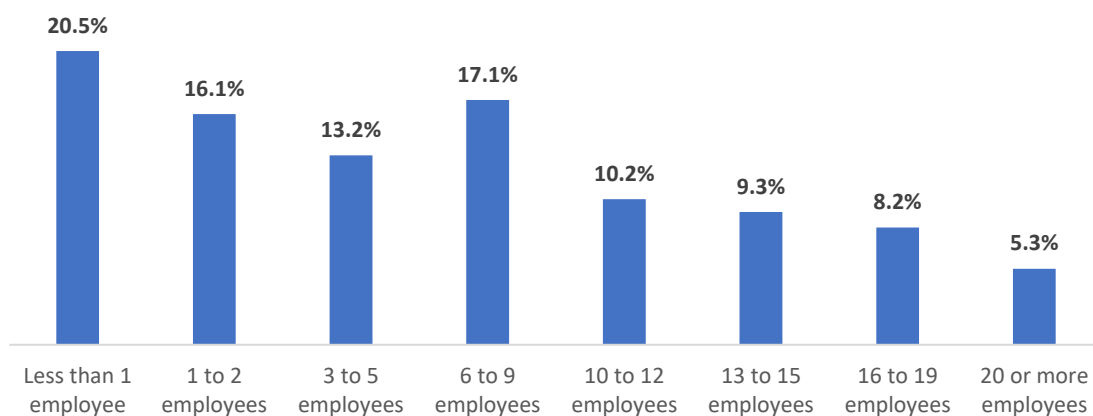
Figure 15. Top Five Industries, Induced Output

Industry	Induced Output
Owner-occupied dwellings	\$320,151,765
Real estate	\$176,758,470
Hospitals	\$149,958,795
Wholesale trade	\$118,831,427
Limited-service restaurants	\$84,028,697

CROSS TABULATION OF FINDINGS

The following section elaborates on the extrapolated national employment data, and summarizes results based on geography, age of plant, and plant capacity to give us a deeper understanding of the O&M workforce. One fifth of all wind farms in the United States employ less than one full-time, permanent O&M worker. More than 36% of wind farms only employ two or fewer O&M employees. This is because nearly one quarter of wind farms in the US only operate with up to five turbines.⁷

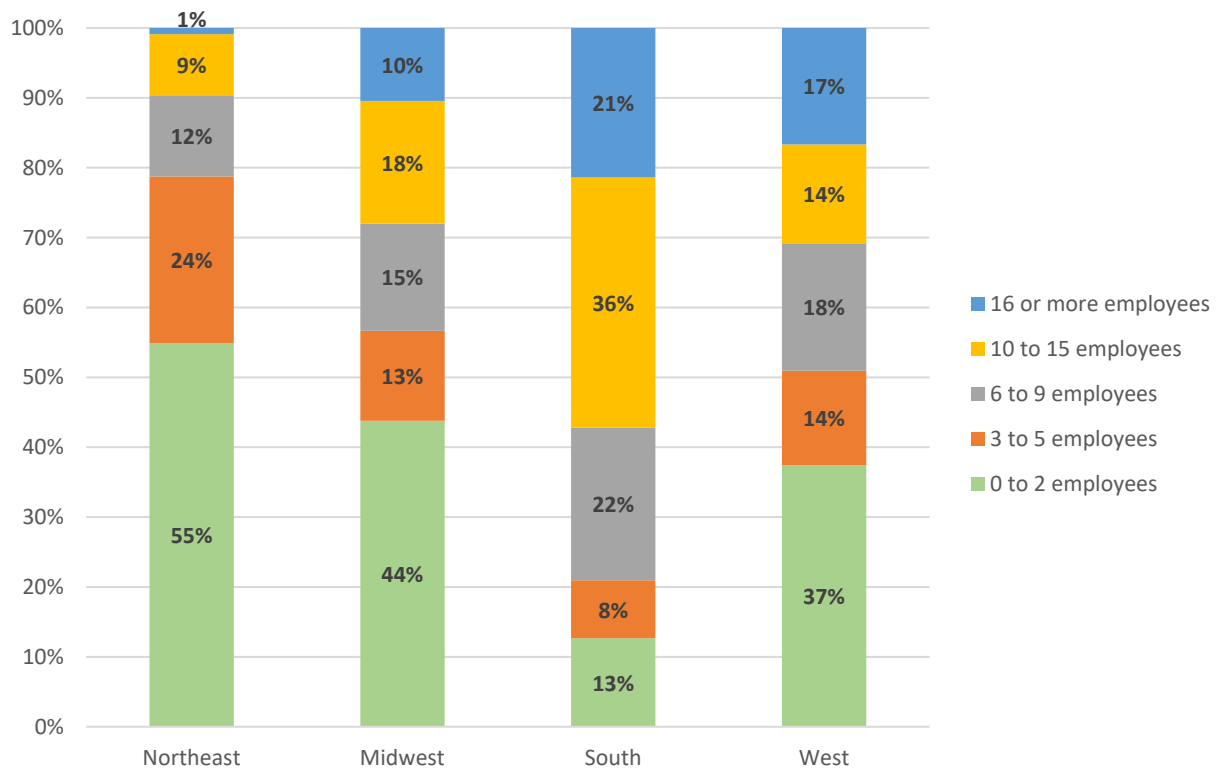
Figure 16. US Wind O&M Employment Estimation Distribution



Geography

An analysis of geographic trends shows us that the majority of wind farms across the Northeast (79%), Midwest (57%), and West (51%) census regions employ five or fewer full-time O&M employees, while just 21% of wind farms in the South region employ five or fewer. Diving deeper into specific census divisions, most (74%) wind farms in the New England division employ two or fewer full-time O&M workers, 53% of which employ less than one full-time O&M worker. This makes sense when considering that 60% of New England wind farms have between one and five turbines and 29% have only one. Wind farms in the West South Central division (containing Arkansas, Louisiana, Oklahoma, and Texas), usually (60%) support 10 or more full-time O&M workers, with 40% of farms employing 13 or more employees, and 9% employing 20 or more employees. Most wind farms in the West South Central division are relatively large, as only 18% of wind farms in the region employ five or fewer full-time O&M employees. 26% of wind farms in the East North Central division (Illinois, Indiana, Michigan, Ohio, and Wisconsin) employ 13 or more employees. The Pacific division (Alaska, California, Hawaii, Oregon, and Washington) is close behind, with one quarter of their wind farms employing 13 or more employees, and with 9% of farms employing 20 or more employees.

⁷ US Energy Information Administration. Form EIA-860, Sept 2019.
<https://www.eia.gov/electricity/data/eia860/>.

Figure 17. Wind Farm Employee Estimations by Census Region⁸

Age of Plant

Older wind farms tend to need more labor to operate. However, this is not because of machinery degrading, it is due to the technological innovations that have made turbines capable of generating more electric power. 99% of all wind farms that began operating before 2000 operate with turbines that generate less than 1000 kW, while only 1% of wind farms that began operations after 2005 operate with turbines of the same capacity. Due to this lack in efficiency, old farms need more turbines. Wind farms that began operations pre-2000 (61%) operate 50 turbines or more significantly more than farms that began operations between 2000 and 2018 (42%). A larger share of turbines to operate demands a larger share of labor to maintain them; old farms (pre-2000) employ 13 or more full-time O&M workers more than twice as much as newer, post-2000 wind farms (42% of old, 21% of new).

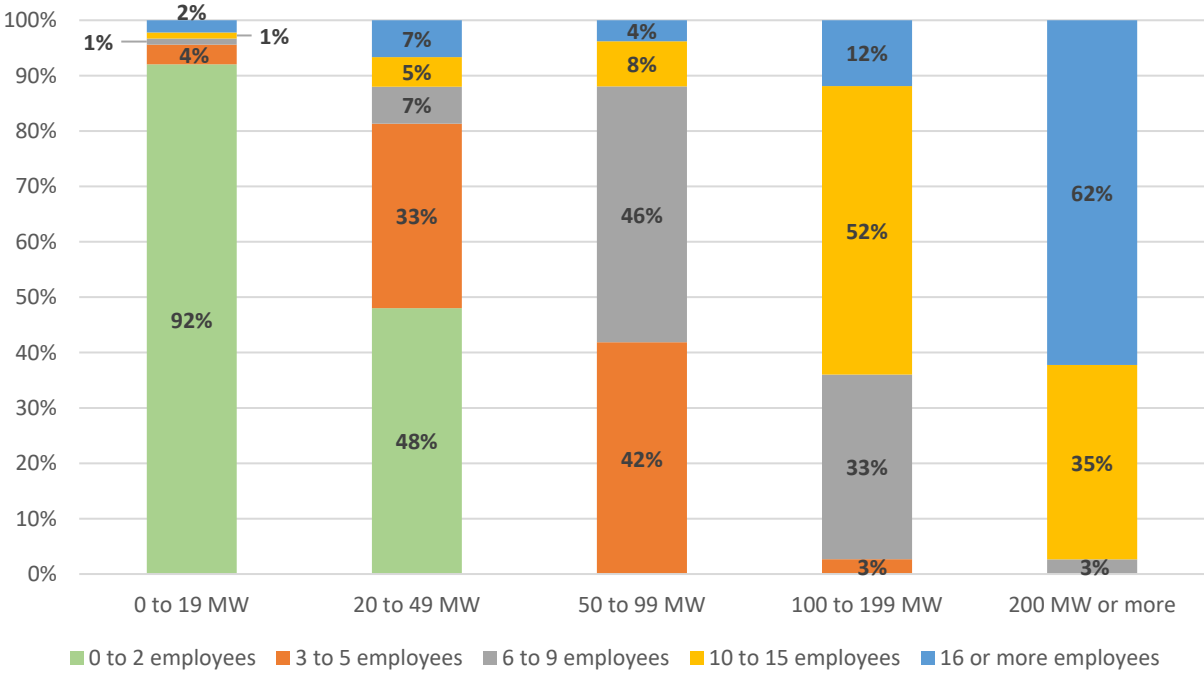
Capacity

As generated capacity of a wind farm increases, full-time, permanent O&M employment increases. This is relatively intuitive, as our extrapolated O&M employment is based on

⁸ Census Region and Census Division Definitions by the US Census Bureau
https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

the number of turbines, and wind farm capacity and number of turbines share a strong positive correlation. As seen in Figure 18, farms included in the EIA database that produce up to 19 MW of energy rarely employ more than two full-time, permanent O&M employees, while farms that produce more than 100 MW are sure to employ at least three full-time, permanent O&M workers and typically employ more than 10.

Figure 18. Employment Estimations by Wind Farm Capacity



WORKFORCE PROFILE OF WIND O&M

This section describes the findings of the employee survey fielded to wind plants after their completion of the employer survey. These responses highlight key aspects of the wind plant O&M workforce, including their education, professional background, and the length and location of their residence. Ultimately, this information highlights that:

- wind plant O&M positions are often long term (5+ years).
- workers have varied wind-specific prior work experience.
- many workers who had formal training received the training near the wind plant.
- many workers resided in the region prior to starting their role at the wind plant.

These findings suggest that wind O&M occupations are often “sticky”, meaning their workers are often already from the region and are not likely to be seeking new opportunities. Similarly, these findings may provide some insight into the findings of Keyser and Tegan, 2019, which discusses the challenges of wind-education training facilities to place graduates in wind-related careers.

Wind Plant Workforce Profile

Thirty employees from six different wind plants responded to our survey. Of these respondents, 70% were wind technicians (also identified as OMS technicians), 13% were operations or managers or assistant managers, 7% were site managers, and two respondents identified as an administrative assistant and a field service documentation engineer.⁹ All respondents were full time employees. The average and median age of respondents was 34. All but one respondent were male. Eighty-three percent of respondents were White, 7% were Hispanic or Latinx, and 3% were Pacific Islander (Table 1).

Table 1. Race and ethnicity of respondents

83.3%	White
6.7%	Hispanic or Latinx
3.3%	Pacific Islander
0.0%	Black or African American
0.0%	Asian
0.0%	American Indian/Alaskan Native
3.3%	Other
3.3%	Don't know/ Refused

⁹ One respondent refused to provide their occupation title.

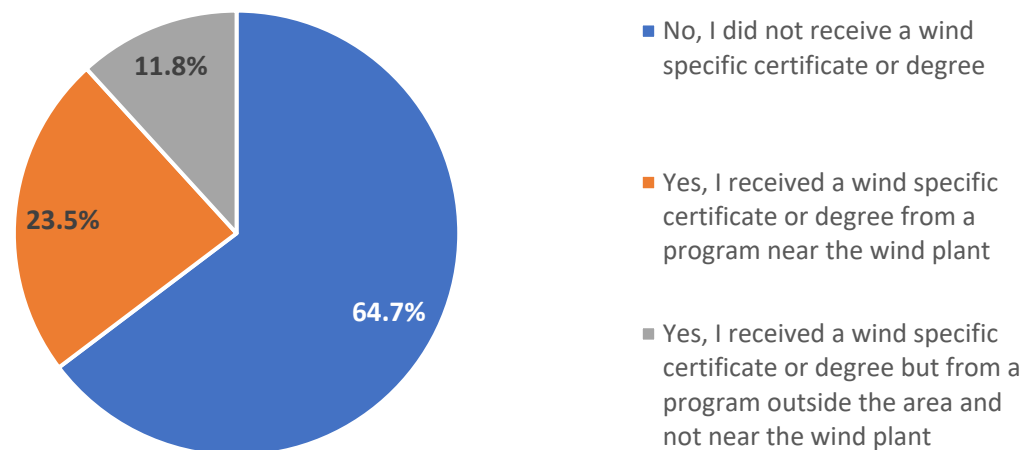
Education

More than two-thirds of respondents have attended some college or received a post high school certificate or Associate degree (Table 2). Occupations of the 13% of respondents that have received a four-year Bachelor's degree include wind technician, O&M Manager, Administrative Assistant, and O&M Supervisor. Most (65%) did not receive a wind-specific certificate or degree. Furthermore, of those who do have a wind-specific education, two-thirds received the education from a program near the wind plant at which they were currently working (Figure 19). These results suggest that few wind plant workers receive wind-specific education, and those that do are typically already within the region. This may suggest that, as Keyser and Tegen 2019 suggest, geography is a substantial factor for the wind workforce.

Table 2. Educational Attainment of Respondents

0.0%	Less than high school
13.3%	High school diploma or GED
30.0%	Some college
43.3%	Post high school certificate or Associate Degree (A.A. or A.S.)
13.3%	Four-year Bachelor's Degree (B.A. or B.S.)
0.0%	Graduate school (M.S., MBA, M.A., Ph.D, M.D., J.D....)

Figure 19. Wind-specific education program and location

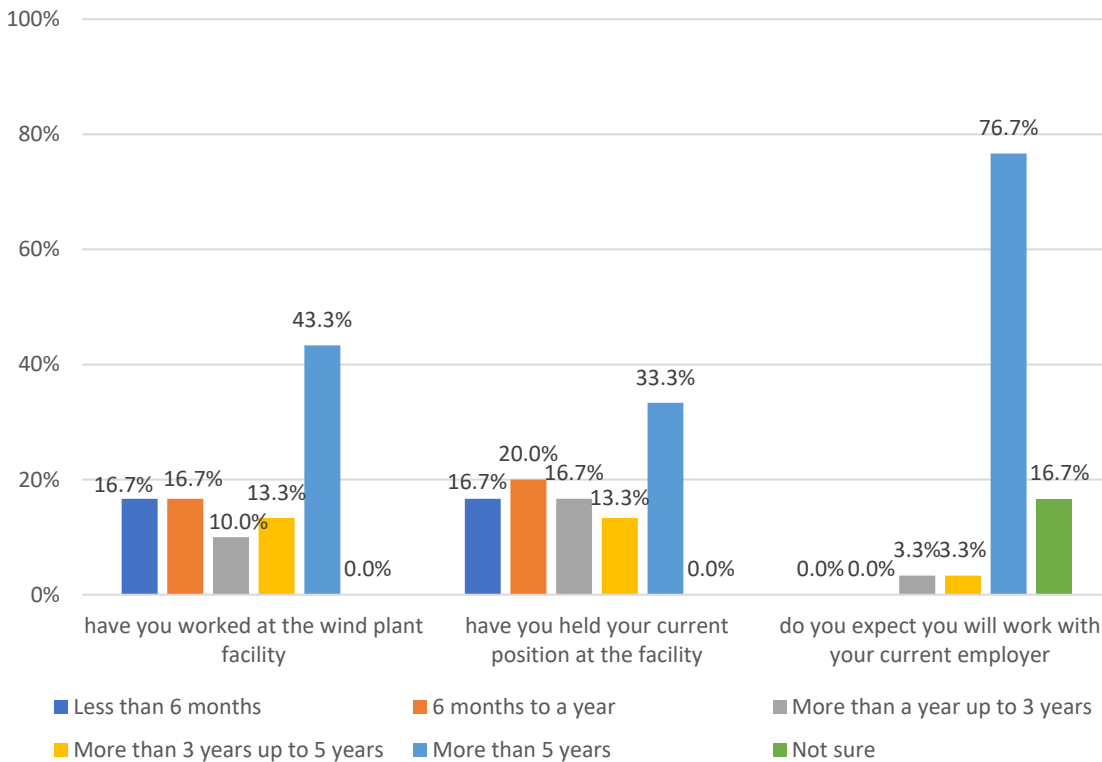


Seniority and Future Expectations

There appears to be relatively little desire for mobility among the wind workforce respondents; 43% of respondents have worked at their wind plant for more than five years, more than three-quarters feel that they will remain at their wind plant for more

than five years, and no respondents feel they will leave within a year. However, there appears to be some possibility for upward mobility; a slightly smaller portion of workers have been in their current role for as long as they have been at their wind facility (Figure 20).

Figure 20. Tenure and Expectations at Wind Plant



Compensation and Benefits

Average annual wages across all occupations is \$63,424. The two most common occupations, wind technicians and O&M Management (including site supervisors, O&M Supervisors, and Assistant Managers), receive an average annual compensation of \$55,137 and \$84,750, respectively.

O&M workers receive relatively high rates of benefits. Nine out of ten respondents receive medical insurance for themselves from their employers, compared to 78% of all employed installation, maintenance, and repair workers across the U.S.¹⁰ About 93% of respondents receive paid time off, compared to nearly 86% of employed installation, maintenance, and repair workers in the United States.¹¹ All respondents reported access

¹⁰ BLS Employee Benefits Survey. Civilian workers, all industries, occupation code 490000. March 2019.

¹¹ Ibid. PTO calculated by averaging percent of those with paid vacation, holidays, and sick leave.

to retirement benefits, which is notably higher than the 67% of U.S. installation, maintenance, and repair employees who receive retirement benefits.¹²

Table 3. Benefits offered to employees

90.0 %	Medical insurance for yourself
76.7%	Medical insurance for your household
96.7%	Dental insurance for yourself
83.3%	Dental insurance for household
100.0%	401k or related retirement account that the employer contributes to
93.3%	Paid time off
10.0%	Other
0.0%	None of the above

Proximity to Wind Plant and Involvement in the Surrounding Community

Most wind plant workers are long-term residents. Eighty percent of respondents own their residence; the remaining 20% rent. About two-thirds of respondents have lived in their current residence for more than five years (Table 4). This number is considerable given that only 43% of workers have worked at their plant for more than five years, suggesting that many workers lived in their residence before they began working at the wind plant. Furthermore, 73% expect to live for 3 or more years in their residence.

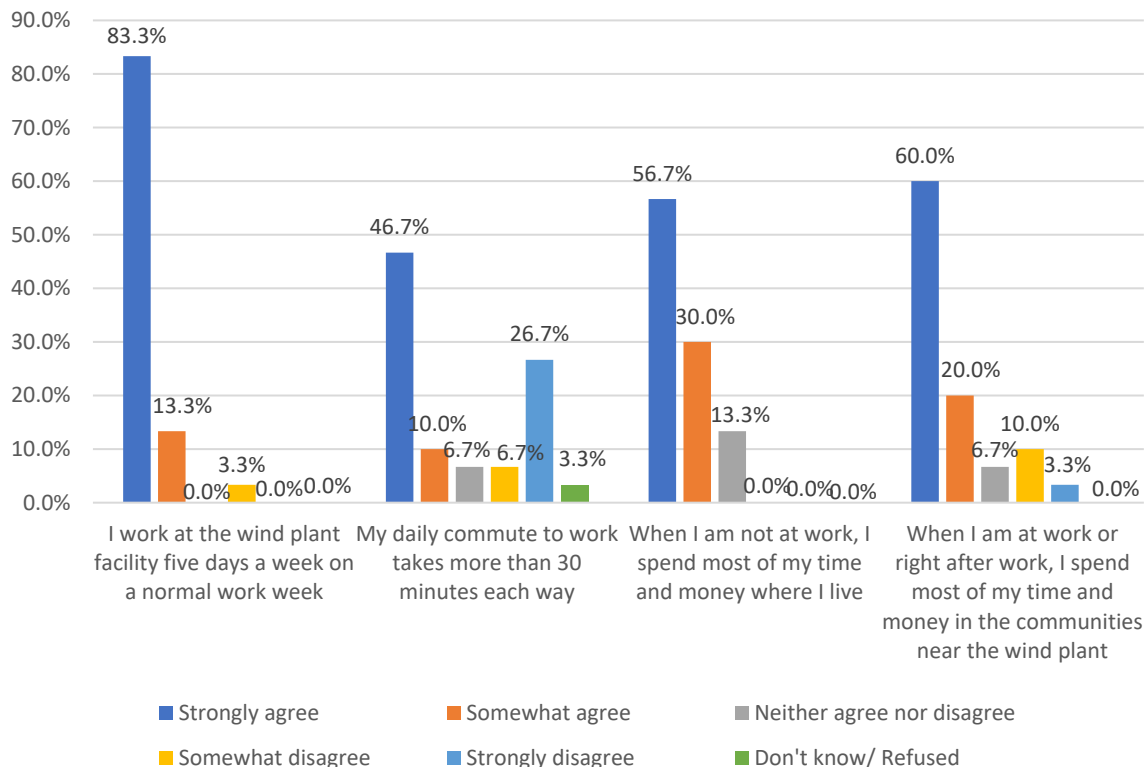
Table 4. Length of current residence

16.7%	Less than 6 months
16.7%	6 months to a year
0.0%	More than a year up to 3 years
3.3%	More than 3 years up to 5 years
63.3%	More than 5 years
0.0%	Not sure

About eight of every ten respondents work at the wind plant facility five days a week during a normal week, and more than half commute less than 30 minutes each way. Additionally, most respondents appear to spend most of their time and money in the communities nearest their current location (Figure 21). Given that a majority of respondents live less than 30 minutes away from the wind plant, it seems likely that these communities are frequently one and the same, meaning most of the wind plant workers' economic activity occurs in that community.

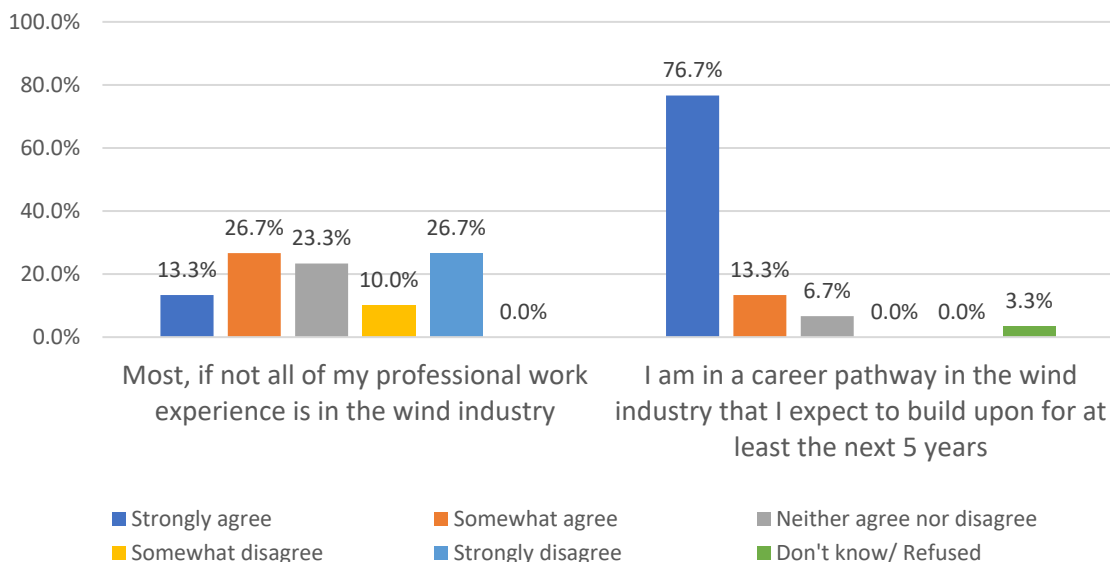
¹² Ibid.

Figure 21. Respondents residences' proximity to wind plant



Many wind O&M workers do not have wind-focused background or professional experience; less than half of respondents had strong or exclusive wind industry backgrounds. Despite these varied backgrounds, most respondents (77%) feel they will remain in the industry for at least the next 5 years (Figure 22).

Figure 22. Education and career pathways



APPENDIX A: ECONOMIC IMPACT MODELING

IMPLAN is an input-output economic modeling software that uses regional and industry-specific models to estimate changes in economic activity such as additional jobs, revenue, and tax generation. These models are based on industry-specific multipliers, which essentially capture the economic effects of a given action. For example, if full-service restaurants have a multiplier of 1.25, this means that for every dollar spent on full-service restaurants, an additional \$0.25 of economic activity is generated locally. Multiplier values are determined through extensive economic research and modeling at various geographic scales.

Direct, Indirect, and Induced Effects

- **Direct effects** show the change in the economy associated with the initial job creation (or loss), or how the industry experiences the change. An example of direct jobs would be the jobs that are a direct result of O&M operations (i.e., a plant manager).
- **Indirect effects** include all the backward linkages or the supply chain responses as a result of the initial job change. An example of an indirect job would be a job in gearbox manufacturing that is created as a result of gearboxes needed for a turbine.
- **Induced effects** refer to household spending and are the result of workers who are responsible for the direct and indirect effects of spending their wages. An example of an induced job would be a new nurse is hired due to increased demand for healthcare from the direct jobs mentioned above.

Output and Value Added

- **Output** is defined as the total value of production, components of which include labor income, intermediate expenditures, tax on production and imports, and other property income.
- **Value added** is defined as the difference between total output and cost of intermediate inputs, otherwise known as GDP.

APPENDIX B: EMPLOYER DISCUSSION GUIDE



NREL – Wind O & M
 August 2019
 Draft 4.0

Executive Interview Discussion Guide Wind O & M – Employer (Locational Representative)

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INTRODUCTION:

We are contacting you as part of an effort by the National Renewable Energy Laboratory (NREL) to quantify the positive economic impacts of wind energy on local {INSERT STATE} communities. The {INSERT WIND PLANT} wind plant has been identified by NREL and BW Research as one of sixteen preferred candidates for case studies. The findings of this research will be published in a report, informing community-level stakeholders about wind plant O&M and the level of economic impacts on nearby communities.

Would you happen to have any time to discuss the operations of {INSERT WIND PLANT} over the next week? We are offering compensation in the form of a **\$50 Amazon Gift Card** for your time.

(If needed): Depending on your input, this discussion could take anywhere from 10 to 20 minutes of your time.

As a follow-up to your interview, we would ask that a short online workforce survey is shared with your employees so that we can gather additional information about commuting times, local spending, etc. Your employees will be compensated with a **\$25 Amazon Gift Card** for their participation. All responses for this case study will remain **CONFIDENTIAL** and will only be shared in the aggregate.

A. Are you willing to share the survey link with your employees?

1. Yes [SKIP TO S1]
2. No [ASK SCREENER B]

ASK SCREENER B IF SCREENER A=2

B. Are you willing to share a list of employee emails for our distribution?

1. Yes [CONTINUE]
2. No [CONTINUE]

Let's go ahead and begin.

.....
....

SHORT PROFILE ON EACH RESPONDENT

- S1. Name of Individual:
- S2. Name of Company:
- S3. Contact information
phone:
Email:
- S4. Date & Time of Interview:
- S5. Firm Size (Employees managed by owning/controlling organization – Based on Secondary Data and Working at or from location FTP)
 - A. Small – 1 to 9
 - B. Medium – 10 to 99
 - C. Large – 100+
- S6. Wind Farm Ownership
 - A. Utility-Owned
 - B. Investor-Owned
 - C. Community-Owned
 - D. Developer-Owned
- S8. How Long has wind farm location been in operation
 - A. 0 to 2 years

- B. 2+ to 5 years
- C. 5+ to 10 years
- D. 10+ to 20 years
- E. 20+ years

S9. Geographic location?

- A. Zip Code
- B. County
- C. State

I. Profile & General Information [FILL OUT IN ADVANCE AS INFORMATION IS AVAILABLE]

Let me begin by asking a few general questions about you and [NAME OF ORGANIZATION]

1. What is your title or position within the firm?

[Record title] _____

2. How long have you been with the organization?

[Record years / months] _____

3. What role do you play at the organization?

4. What location(s) does your firm have for commercial wind farms? (BY ZIP CODE PREFERRED)

II. EMPLOYMENT PROFILE

[REMINDER = PLEASE NOTE THE LOCATION WE WILL BE FOCUSING ON FOR THE REMAINDER OF THE CONVERSATION IS THE WIND FARM AT _____ LOCATION]

The next few questions are about trying to better understand the size and scope of people that work at or provide services at your current wind farm location.

Thinking about anyone that works at your location, let's categorize them into three groups.

Group ONE – are those permanent employees (Full-Time or Part-Time) that work at or from your location and are employed by your organization.

Group TWO – are those temporary, seasonal, or on-call employees (Full-time or part-Time) that are employed by your organization but are not on employed on a permanent basis.

Group THREE – are those people that work at your location but are ultimately employed by a vendor or supplier organization, who provides contracted out services for your organization.

5. Including all full-time and part-time employees, how many **permanent** [IF NEEDED: PERMANENT EMPLOYEES INCLUDE THOSE WORKERS WHO ARE NOT TEMPORARY, SEASONAL OR ON A CONTRACT FOR A LIMITED PERIOD OF TIME – GROUP ONE] employees work at or from your current location?

Record # of employees _____

[IF UNABLE TO PROVIDE NUMBER, OFFER INTERVALS]

- | | |
|---|--------------------|
| 1 | Fewer than 5 |
| 2 | Between 5 and 9 |
| 3 | Between 10 and 24 |
| 4 | Between 25 and 49 |
| 5 | Between 50 and 99 |
| 6 | 100 or more |
| 7 | (DON'T READ) DK/NA |

6. If you currently have [TAKE Q5 #] full-time and part-time **permanent** employees at your current location, how many more or less employees do you expect to have 12 months from now?

- | | |
|---|-----------------------|
| 1 | More [record # _____] |
| 2 | Less [record # _____] |

- 3 (DON'T READ) Same number of employees
- 4 (DON'T READ) Refused

[If amount differs by 10% or more in either direction, ask:]

Just to confirm, you currently have ____ permanent employees and you expect to have ____ (more/less) employees, for a total of ____ employees 12 months from now.

7. Over the last three years, has your company grown, declined or stayed about the same in terms of permanent employment at your location? [If it has grown or declined, ask] By about how many people?

- 1 Grown by ____ total employees
- 2 Stayed the same
- 3 Declined by ____ total employees
- 4 [DON'T READ] DK/NA

8. What are the primary job positions, categories or classifications that your location employs for permanent employment? (IF NEEDED – THIS IS FOR PERMANENT GROUP ONE EMPLOYEES)

9. Thinking of those permanent group one employees, how often do they live within the community of your current location? [IF NEEDED: THIS WOULD BE A ONE-WAY COMMUTE OF MORE THAN 20 MINUTES OR MORE THAN 15 MILES FROM YOUR LOCATION]

- 1. Usually (70% of the time or more)
- 2. Frequently (31% to 69% of the time)
- 3. Seldom (1% to 30% of the time)
- 4. Never
- 5. DK/NA [DON'T READ]

10. How many or what percentage of your permanent or group one employees are union members?

- 1. All (100%)
- 2. Most (99% to 61%)
- 3. About Half (60% to 40%)
- 4. Less than half (39% to 1%)
- 5. None (0%)
- 6. DK/NA [DON'T READ]

Now I would like to ask the same questions about temporary, seasonal, or on-call workers who are working for a limited period of time but are employed by your organization. This would be the group two employees that are employed by your organization but not on a permanent basis.

11. Including all full-time and part-time employees, how many **temporary, seasonal, or on-call workers** [IF NEEDED: THIS IS NON-PERMANENT EMPLOYEES] employees work at or from your current location?

Record # of employees _____

[IF UNABLE TO PROVIDE NUMBER, OFFER INTERVALS]

- | | |
|---|--------------------|
| 1 | Fewer than 5 |
| 2 | Between 5 and 9 |
| 3 | Between 10 and 24 |
| 4 | Between 25 and 49 |
| 5 | Between 50 and 99 |
| 6 | 100 or more |
| 7 | (DON'T READ) DK/NA |

12. If you currently have [TAKE Q8 #] full-time and part-time **temporary, seasonal, or on-call** employees at your current location, how many more or less employees do you expect to have 12 months from now?

- | | |
|---|---------------------------------------|
| 1 | More [record # _____] |
| 2 | Fewer [record # _____] |
| 3 | (DON'T READ) Same number of employees |
| 4 | (DON'T READ) Refused |

[If amount differs by 10% or more in either direction, ask:]

Just to confirm, you currently have _____ permanent employees and you expect to have _____ (more/fewer) employees, for a total of _____ employees 12 months from now.

13. Over the last three years, has your company grown, declined or stayed about the same in terms of temporary, seasonal, or on-call employment at your location? [If it has grown or declined, ask] By about how many people?

- | | |
|---|-----------------------------------|
| 1 | Grown by _____ total employees |
| 2 | Stayed the same |
| 3 | Declined by _____ total employees |
| 4 | [DON'T READ] DK/NA |

14. What are the primary job positions, categories or classifications that your location employs for non-permanent employment? (IF NEEDED – THIS IS FOR TEMPORARY, SEASON OR ON_CALL EMPLOYEES GROUP TWO EMPLOYEES)

15. Thinking of those non-permanent group two employees, how often do they live within the community of your current location? [IF NEEDED: THIS WOULD BE A ONE-WAY COMMUTE OF MORE THAN 20 MINUTES OR MORE THAN 15 MILES FROM YOUR LOCATION]

1. Usually (70% of the time or more)
2. Frequently (31% to 69% of the time)
3. Seldom (1% to 30% of the time)
4. Never
5. DK/NA [DON'T READ]

16. How many or what percentage of your temporary or group two employees are union members?

7. All (100%)
8. Most (99% to 61%)
9. About Half (60% to 40%)
10. Less than half (39% to 1%)
11. None (0%)
12. DK/NA [DON'T READ]

Lastly, I would like to ask about people that work at your location but would not be your employees. GROUP THREE EMPLOYEES

17. Do you have contracts or agreements with other firms, suppliers or vendors to provide cleaning, maintenance, or other work at your location?

1. Yes
2. No
3. (Don't Read) DK/NA

[IF Q17 = 1, ASK Q18 & Q19, OTHERWISE SKIP]

18. Please describe the number of agreements and the type of work that is provided at your location?

19. Generally, describe what percentage or portion of work is done by your locational employees and the service or contract provider for each agreement?

[ASK FOR EACH AGREEMENT IDENTIFIED IN Q18]

1. All of it is provided by the contract provider including supervision and QC (100%)
 2. Most of it is provided by the contract provider (99% - 61%)
 3. About half of it is provided by the contract provider (60% to 40%)
 4. Less than half of it is provided by the contract provider (1% to 39% of the time)
 5. DK/NA [DON'T READ]
-

20. In general, are your vendors and suppliers for this location primarily local – within the County, regional – within the region, Statewide – within the state, national – within the Country, or international - outside the Country? [UP TO 2 RESPONSES PERMITTED]

- 1 Local – County
- 2 Regional – Within Region
- 3 Statewide – Within State
- 4 National – Within the United States
- 5 International – Outside the United States
- 6 (Don't Read) Don't know

III. General Hiring Behavior and Priorities

Next I want to briefly ask your hiring processes and priorities -

21. How do you look for and recruit qualified applicants? [WAIT FOR INITIAL RESPONSE AND THEN PROBE ON]

- a. Online tools (job boards, be specific...)
- b. Person to person networks or referrals
- c. Internal HR tools (recruitment process, evaluation process, ...)
- d. Local Schools (High School or College) and educational/workforce training programs
- e. Other (please specify)

22. Thinking about those positions at your current location *in general*, how much difficulty does your organization have finding qualified applicants who meet the organization's hiring standards?

1. Little to no difficulty
2. Some difficulty
3. Great difficulty
4. (Don't Read) DK/NA

[IF Q20 = 2 OR 3, ASK Q21, OTHERWISE SKIP]

23. Why do you think you have difficulties finding qualified applicants (WAIT FOR RESPONSE AND THEN PROBE ON GEOGRAPHY, Salary Requirements – DO THEY HIRE OUTSIDE OF THE COMMUNITY IS YES WHY)?

24. Please describe any positions, skills or areas of expertise that are particularly difficult to find among job applicants when hiring for the current location?

25. Now I want to ask you about retaining or keeping employees at your current location *in general*, how much difficulty does your organization have retaining productive employees who work at or from your location?

1. Little to no difficulty
2. Some difficulty
3. Great difficulty
4. (Don't Read) DK/NA

[IF Q23 = 2 OR 3, ASK Q24, OTHERWISE SKIP]

26. Why do you think you have difficulties retaining or keeping productive employees (WAIT FOR RESPONSE AND THEN PROBE ON GEOGRAPHY, SKILLS AND TRAINING AND EXPERTISE, Other Industries)?

Lastly, I want to ask about the impact your wind farm location has on the surrounding community.

27. Does your wind farm provide any additional support to the community, such as supporting schools, community events other community or regional contributions?

28. Is there any other information that we should be aware of as we estimate the economic impact your location has on the local, regional and national economy?

29. Do we have your permission to share your name and organization with NREL, who is ultimately using this research to better understand organizations like yours.

- A. Yes, share my name and organization
- B. Only share my organization
- C. No, do not share my name or organization

IF SCREENER B=1 ASK Q30

30. Will you be willing to share a list of employee emails over email?

- 1. Yes [THANK AND END SURVEY]
- 2. No [COLLECT EMAILS OVER THE PHONE]

IF SCREENER A = 1, SHARE EMPLOYEE SURVEY LINK WITH RESPONDENT FOR DISTRIBUTION

COLLECT EMAIL FOR AMAZON GIFT CARD AND TO SHARE SURVEY LINK (IF REQUESTED) – IF WILLING TO SHARE LIST OF EMPLOYEES, SHARE RYOUNG@BWRESEARCH.COM WITH RESPONDENT SO THAT THEY CAN SEND LIST

WE WILL BE WORKING TO COMPLETE A SHORT SURVEY WITH YOUR EMPLOYEES TO BETTER UNDERSTAND THEIR ECONOMIC IMPACT ON THE SURROUNDING REGION

On behalf of NREL thank you very much for your time and expertise in this discussion.

If you have any interest in seeing the findings of this research, please let us know and when it is completed, we will make sure you get a copy.

Thank you for your time!

- A. Name of Respondent _____
- B. Position _____
- C. Date and time of Interview _____
- D. Relevant Contact Information
- Phone: _____
- Email: _____
- E. Organization _____
- F. Segment _____

APPENDIX C: EMPLOYEE SURVEY



NREL Wind EIR Research
Employee Survey - August 2019
Draft 2.0

.....
....

Introduction:

Hello, may I please speak to _____. Hi, my name is _____ and I'm with an independent research firm, BW Research, that is working to better understand the nature of employment in your community.

(If needed): This should only take a few minutes of your time.

(If needed): I assure you that we are an independent research agency and that all of your responses will remain strictly confidential.

(If needed): This is a study about issues of importance in your community – it is a survey only and we are not selling anything.

(If needed): This survey should only take a few minutes of your time.

(If respondent indicates that he/she is a city employee, council member, or elected official, thank him/her for his/her time and end the interview.)

(If the individual mentions the national do not call list, respond according to American Marketing Association guidelines): "Most types of opinion and marketing research studies are exempt under the law that congress recently passed. That law was passed to regulate the activities of the telemarketing industry. This is a legitimate research call. Your opinions count!")

~~~~~

### Screener Questions

SA. Are you currently employed at \_\_\_\_\_ wind plant facility?

- 1 Yes
- 2 No [Thank and terminate]

SB. What is the zip code where you live?

- 1 Note zip codes (THAT ARE WITHIN 15 miles of wind plant facility - WITHIN)
- 2 Note zip codes (THAT ARE OUTSIDE 15 miles of wind plant facility - OUTSIDE)
- 3 Don't know/ refused [Thank and terminate]

SC. What year were you born?

[RECORD YEAR AND CATEGORIZE]

- 1 Less than 18 years old [Thank and terminate]
- 2 18 to 24 years old (Gen Z – Post-Millennial)
- 3 25 to 31 years old (Young Millennial)
- 4 32 to 39 years old (Older Millennial)
- 5 40 to 47 years old (Young Gen X)
- 6 48 to 55 years old (Older Gen X)
- 7 56 to 64 years old (Baby boomer)
- 8 65 years or older (Thank and terminate)
- 9 Don't know/ refused [Thank and terminate]

SD. What is the last grade you completed in school?

- 1 Less than high school
- 2 High school diploma or GED
- 3 Some college
- 4 Post high school certificate or Associate Degree (A.A. or A.S.)
- 5 Four-year Bachelor's Degree (B.A. or B.S.)
- 6 Graduate school (M.S., MBA, M.A., Ph.D, M.D., J.D....)
- 7 (Don't Read) DK/NA [Thank and terminate]

IF SD=4, 5 OR 6 ASK SE OTHERWISE SKIP

SE. Did you get a degree or certificate in a specific wind program?

- 1 No, I did not receive a wind specific certificate or degree
- 2 Yes, I received a wind specific certificate or degree from a program near the wind plant

- 3 Yes, I received a wind specific certificate or degree but from a program outside the area and not near the wind plant

SF. Are you currently employed at \_\_\_\_\_ wind plant facility, on a permanent full-time, permanent part-time, or on a temporary or seasonal basis? (ALLOW MORE THAN ONE RESPONSE)

- 1 Permanent full-time (at least 35 hours a week)
- 2 Permanent part-time (less than 35 hours a week)
- 3 Temporary or seasonal
- 4 Contractor
- 5 None of them [Thank and terminate]
- 6 (Don't Read) DK/NA [Thank and terminate]

.....  
 ....

## I. Introduction – Work Profile

I want to start with a few quick questions about employment.

1. How long have you worked at \_\_\_\_\_ wind plant facility?
  - 1 Less than 6 months
  - 2 6 months to a year
  - 3 More than a year up to 3 years,
  - 4 More than 3 years up to 5 years
  - 5 More than 5 years
  - 6 Not sure (DK/NA)
  
2. How long have you held your current position at the facility?
  - 1 Less than 6 months
  - 2 6 months to a year
  - 3 More than a year up to 3 years,
  - 4 More than 3 years up to 5 years
  - 5 More than 5 years
  - 6 Not sure (DK/NA)
  
3. How long do you expect you will work with your current employer?

- 1 Less than 6 months
- 2 6 months to a year
- 3 More than a year up to 3 years,
- 4 More than 3 years
- 5 Not sure (DK/NA)

4. What is your occupation or positional title?

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5. Which of the following benefits do you receive from working at the \_\_\_\_\_ wind plant facility? (ALLOW MULTIPLE RESPONSE)

- 1 Medical insurance for yourself
- 2 Medical insurance for your household
- 3 Dental insurance for yourself
- 4 Dental insurance for yourself
- 5 401k or related retirement account that the employer contributes to
- 6 Paid time off
- 7 Other (specify \_\_\_\_\_)
- 8 None of the above

## II. COMMUTE AND SPENDING PROFILE

6. How long have you lived in your current community in \_\_\_\_\_ (USE ZIP CODE IN SB)?

- 1 Less than 6 months
- 2 6 months to a year
- 3 More than a year up to 3 years,
- 4 More than 3 years up to 5 years
- 5 More than 5 years
- 6 Not sure (DK/NA)

7. How long do you expect you will live at your current residence (IF NEEDED, IDENTIFY ZIP CODE IN SB)?

- 1 Less than 6 months
- 2 6 months to a year
- 3 More than a year up to 3 years,
- 4 More than 3 years

5 Not sure (DK/NA)

8. Now I'm going to read a list of statements that describe how people spend their time and money within and outside of work. Please indicate whether you generally agree, disagree, or neither agree nor disagree with the following statements.

Here is the (first/next) one: \_\_\_\_\_ Do you generally agree, disagree or neither agree nor disagree with the statement? (GET ANSWER IF AGREE OR DISAGREE ASK:) Would that be strongly (agree/disagree) or somewhat (agree/disagree)?

**RANDOMIZE**

|                                                                                                                        | <u>Strongly<br/>Agree</u> | <u>Somewhat<br/>Agree</u> | <u>Neither<br/>Agree nor<br/>Disagree</u> | <u>Somewhat<br/>Disagree</u> | <u>Strongly<br/>Disagree</u> | <u>(DON'T<br/>READ)<br/>DK/NA</u> |
|------------------------------------------------------------------------------------------------------------------------|---------------------------|---------------------------|-------------------------------------------|------------------------------|------------------------------|-----------------------------------|
| A. I work at the wind plant facility five days a week on a normal work week .....                                      | 1                         | 2                         | 3                                         | 4                            | 5                            | 6                                 |
| B. My daily commute to work takes more than 30 minutes each way.....                                                   | 1                         | 2                         | 3                                         | 4                            | 5                            | 6                                 |
| C. When I am not at work, I spend most of my time and Money where I live.....                                          | 1                         | 2                         | 3                                         | 4                            | 5                            | 6                                 |
| D. Most, if not all of my professional work experience is in the Wind industry.....                                    | 1                         | 2                         | 3                                         | 4                            | 5                            | 6                                 |
| E. When I am at work or right after work, I spend most of my time and money in the communities near the wind plant ... | 1                         | 2                         | 3                                         | 4                            | 5                            | 6                                 |
| F. I am in a career pathway in the wind industry that I expect to build upon For at least the next 5 years .....       | 1                         | 2                         | 3                                         | 4                            | 5                            | 6                                 |

9. What are the primary reasons you live in your current community in \_\_\_\_\_ (USE ZIP CODE IN SB)? (ALLOW MORE THAN ONE RESPONSE)

To wrap things up, I just have a few background questions for statistical purposes only.

A. Do you own or rent the unit in which you live?

- 1 Rent
- 2 Own
- 3 Neither rent nor own
- 4 Don't know/ Refused

B. How many children under 19 years of age live in your household?

- 1 \_\_\_\_\_ (# of children living in the household under 19 years old)
- 2 None



3 Don't know/ Refused

C. Including yourself, how many adults 19 years of age or older live in your household?

1 \_\_\_\_\_ (# of adults living in the household 19 years old or older)  
2 Don't know/ Refused

D. Are there any languages spoken in your home other than English? (If yes, which ones?)

1 Yes (please specify: \_\_\_\_\_)  
2 No  
3 (Don't Read) Refused

E. What ethnic group do you consider yourself a part of or feel closest to? (IF HESITATE, READ):

1 Pacific Islander  
2 Black or African American  
3 Hispanic or Latin(o)a  
4 Asian  
5 White  
6 American Indian/Alaskan Native  
7 Other (Please specify: \_\_\_\_\_)  
8 (Don't Read) DK/NA

F. What is your Gender?

1 Male  
2 Female  
3 Non-Binary

G. What is *your annual or hourly take home pay*?

Annual \$\_\_\_\_\_,000

Hourly \$\_\_\_\_\_

IF NOT COMFORTABLE WITH SPECIFIC AMOUNT PLEASE IDENTIFY CATEGORY THAT FITS YOUR ANNUAL TAKE HOME PAY?

1 Below \$25,000  
2 \$25,000 to \$50,000  
3 \$50,001 to \$75,000  
4 \$75,001 to \$100,000  
5 \$100,001 to \$199,000

- 6 More than \$200,000
- 7 I don't know

H. What was ***your total household income*** before taxes from last year.

- 1 Below \$25,000
- 2 \$25,000 to \$50,000
- 3 \$50,001 to \$75,000
- 4 \$75,001 to \$100,000
- 5 \$100,001 to \$199,000
- 6 More than \$200,000
- 7 I don't know

Those are all of the questions we have for you. Thank you very much for participating!

First Name of Respondent \_\_\_\_\_

Phone \_\_\_\_\_

Date of Interview \_\_\_\_\_

Name of Interviewer \_\_\_\_\_

Time of Interview \_\_\_\_\_

Type of Interview

- 1 Online Employer-invite
- 2 Online email-invite
- 3 Phone