South Carolina Wind Energy Supply Chain Survey and Offshore Wind Economic Impact Study

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KEY FINDINGS

The purpose of this project is to assess the economic impact of the wind energy industry on the state of South Carolina. To do so, we needed to complete two main tasks. The *South Carolina Wind Energy Census* identified South Carolina firms in the wind energy supply chain.

The second task estimated the current and potential economic impact of the wind energy industry on South Carolina. The economic impact analysis has two components: the estimated economic impact of installation and operation of a 1000 MW wind farm off the coast of South Carolina, and the estimated economic impact of the state's existing wind energy supply chain, as identified in the *South Carolina Wind Industry Census.* Key findings are presented below.

South Carolina Wind Energy Census

The 2012 *South Carolina Wind Industry Census* is a survey of manufacturers and service providers in the wind energy supply chain in South Carolina. This survey was designed to obtain information about the composition and characteristics of the wind energy supply chain in South Carolina, and to measure the number of jobs involved.

EMPLOYEES AND JOBS

- Thirty-three firms[1] responding to the *South Carolina Wind Industry Census* reported 1,134 of their employees spend part or all of their time on wind energy related production or service activities. These wind energy employees represent close to 14% of total employment in these 33 firms.
- Employment in wind energy related production or service activities ranged from a single employee at seven firms to 400 employees at one firm. Most firms reported 10 or fewer wind energy employees. The median firm had five employees in wind energy activities.
- South Carolina wind energy employees in management, professional, scientific, and technical jobs made slightly above the state's average annual salaries for these types of jobs. Average earnings reported by survey respondents were $78,308 a year for employees in these jobs. Statewide, salaries range from $62,406 a year for management, scientific, and technical consulting services to $73,005 for architectural and engineering services.

FIRM CHARACTERISTICS

- Engineering Procurement & Construction (19 firms) and Component or Material Supplier (13 firms) were the top two primary firm functions selected by 26 firms. Six respondents identified consulting (including environmental, energy, permitting, and site selection) as their firm's primary function.
- Less than 10% of respondents selected Wind Turbine Original Equipment Manufacturer (one firm), Developer (four firms), or Operations & Management (2 firms) as their firm's primary function.
- Professional, Scientific, and Technical Services (13 firms) and Manufacturing (11 firms, including durable goods wholesalers) and are the two industry sectors most frequently represented by firms in the South Carolina wind energy supply chain.
- Engineering services (6 firms) and other consulting services (6 firms) were the most frequently occurring wind energy specific activity in South Carolina. Eight firms manufactured products used in the wind energy supply chain, such as power cables, seals, bearings, and lubricants, among others.
- All 38 firms reported a market for their products and services in the United States.
- Canada (22 firms), Western Europe (20 firms) and Mexico (19 firms) were the dominant international markets identified by respondent firms.

[1] Thirty-eight firms provided usable responses to the *South Carolina Wind Industry Census*. Five of these firms had no employment in the state, or no wind energy employment in the state, and were excluded from the employment summary data. These firms would be in the state's wind energy supply chain, however, so their answers about other business characteristics were retained.

Business Climate

- About 84% of respondents expected their firms to either increase capital investment above current levels (16 firms) over the next one to five years, or keep it about the same (16 firms).
- Twenty-five of 38 respondents expected their firms to increase employment over current levels in South Carolina, and an additional 11 respondents expected employment levels to remain the same. No respondents expected their firm to decrease employment in the next one to five years.
- Nearly all respondents expected their firms to either add new products or services over the next one to five years (28 firms) or to stay at about the same level (8 firms).
- South Carolina's quality of life (18 firms) and existing firm location(s) in the state (17 firms) were the most frequently selected factors affecting firm location decisions.
- Over one-third of respondents (14 firms) selected a competitive and skilled workforce as an important factor in their firm's decision to locate in South Carolina, followed by supportive state regulations (11 firms).
- Economic development incentives (5 firms) and access to finance (3 firms) were the least frequently identified factors affecting firm location decisions.
- Industry volatility was selected by 27 respondents as a risk facing their company at this time.
- Domestic tax policies and domestic industry competition were the next four most common risks facing respondents, headed up by the risk posed to firms by inconsistent renewable energy targets among states (16 firms).

The Economic Impact of Wind Energy on the State of South Carolina

South Carolina's Wind Energy Supply Chain

- The *South Carolina Wind Industry Census* identified 1,134 direct jobs involved in wind energy related production or service activities in 2012. These direct jobs in the wind energy supply chain are estimated to generate an additional 1,797 jobs statewide through indirect and induced effects for a total employment impact of 2,931 jobs in 2012. South Carolina's existing wind energy supply chain has an estimated jobs multiplier of 2.6.
- South Carolina's existing wind energy supply chain generated an estimated $530 million in total output in the state in 2012, including indirect and induced effects.
- South Carolina's wind energy supply chain generated an estimated annual net fiscal impact of $29 million for state government and $21 million for local governments around the state in 2012.

Proposed 1,000 MW Offshore Wind Farm

Turbine Component Manufacturing. During the wind farm development period between 2016 and 2025, wind turbine components for 1,000 MW of electric power generating capacity will be manufactured for installation in the proposed offshore wind farm. This level of manufacturing activity would generate an *average annual estimated economic impact* on the state of South Carolina as follows:

- ✓ 293 total jobs per year (direct, indirect, and induced),
- ✓ $18.3 million in wages per year,
- ✓ $54.9 million in output per year, and
- ✓ $5.7 million in combined state and local government revenue per year.

Turbine Installation. The economic impact on the state resulting from the installation of 1,000 MW of wind turbine electric generating capacity off

the South Carolina coast takes place beginning in 2016, the year that the first 40 MW of turbines are installed. Over the 10 year wind farm development period, installation activities alone would generate an estimated:

- ✓ 3,329 average annual total jobs per year (direct, indirect, and induced),
- ✓ $163.1 million in wages per year,
- ✓ $270.7 million in output per year, and
- ✓ $51.2 million in combined state and local government revenue per year.

Wind Farm Operations & Maintenance (O&M). The post-construction (2026-2030) average annual economic impact to the state of O&M activities for a 1,000 MW offshore wind is estimated to be:

- ✓ 678 total jobs per year in South Carolina (direct, indirect, and induced),
- ✓ $41.8 million in wages per year,
- ✓ $115.2 million in output per year, and
- ✓ $13.4 million in combined state and local government revenue per year.

Aggregate Economic Impacts. The construction and operation of a 1,000 MW wind farm off the South Carolina coast will have a large economic impact on the state, particularly during the 10 year construction phase.

- ✓ 3,879 total jobs in the average year in South Carolina (direct, indirect, and induced),
- ✓ $1.96 billion in wages over the 10 year period 2016 to 2025,
- ✓ $1.93 billion in disposable income 2016 to 2025,
- ✓ $3.66 billion in output 2016 to 2025, and
- ✓ $616.2 million in combined state and local government revenue 2016 to 2025.

Employment Impacts by Industry Sector. The construction sector is predicted to see the largest impacts during the installation of the wind farm. During the ongoing O&M phase, the largest predicted impact is on professional services. Some sectors with significant employment effects are those associated with induced effects, such as food services and health care.

CONTENTS

List of Tables

List of Figures

Background

The purpose of this project is to assess the economic impact of the wind energy industry on the state of South Carolina. To do so, we completed two main tasks.

First, we surveyed South Carolina firms about wind energy related products and services they provide, in-state employment, and other business characteristics. The **South Carolina Wind Industry Census** was designed to identify existing and potential firms in the wind energy supply chain in South Carolina. Data from survey respondents was also used as employment and industry sector input to the economic impact model of the existing wind energy supply chain on the state.

Second, we estimated the current and potential **economic impact of the wind energy industry** on South Carolina, including impacts on output, employment, wages and salaries, disposable income, and state and local government revenues. Two different economic impact studies estimate the impact of wind energy related production and service provision on the state's economy through the year 2030.

One economic impact study uses data from the South Carolina Wind Industry Census to estimate the current economic impact of the existing wind energy supply chain on the state of South Carolina. The second economic impact study estimates the economic impact of construction and operation of a 1,000 megawatt (MW) offshore wind farm on the state's economy over the years 2016 to 2030.

The Clemson University Restoration Institute (CURI) and Clemson University's Strom Thurmond Institute (STI) conducted this research to measure the number and nature of wind energy jobs in South Carolina and their impact on the state's economy. CURI and STI worked in conjunction with the South Carolina Energy Office (SCEO), a division of the South Carolina Budget and Control Board, which funded this project as part of a larger multiyear grant from the U.S. Department of Energy.

The estimated economic impacts of the existing wind energy supply chain and the construction and operation of a 1,000 MW wind farm off the coast of South Carolina will provide wind energy stakeholders with data useful to advance private and public sector efforts to install utility scale wind energy production off the state's coast. Economic impact estimates and data collected by the South Carolina Wind Industry Census will also help economic developers attract firms in the wind energy supply chain to the state.

Wind Energy Production and the State

Wind energy products and services represent an area of economic opportunity for South Carolina and its people. According to the U.S. Department of Energy (USDOE and USDOI 2011, 5-6) and others (Schwartz et al. 2010), South Carolina possesses excellent offshore wind resources in shallow waters close to its growing coastal demand centers near outstanding port facilities like Charleston and Georgetown.

The January 2012 *South Carolina Resource Study* prepared for the General Assembly's South Carolina Energy Advisory Council conservatively estimates that offshore wind has the potential to generate 3,300 MW in the near future (South Carolina Energy Advisory Council 2012, 1-4).

While South Carolina has no utility-scale offshore wind energy generation capacity at this time, the state already plays an important role in the nation's wind energy supply chain. In South Carolina firms in the wind energy supply chain include a range of products and activities, from the manufacture of components used in wind turbines to engineering services to land and marine freight transportation services.

Firms in the supply chain, such as industry leaders GE Energy (wind turbine manufacturer) and Prysmian (manufacturer of underground and submarine power transmission cables), contribute to the state's economy through purchase of goods and services produced by other firms in the state, payment of taxes to state and local governments, and payment of wages and salaries to their employees.

South Carolina's offshore wind resources, port facilities, rail network, and manufacturing oriented economic development incentives and workforce combine to make the state an attractive location for emergence of a wind energy cluster. IMO and Nexans, two major manufacturers in the wind energy supply chain, have made recent announcements to locate new

facilities in South Carolina. These firms are expected to create an additional 440 new jobs for South Carolina.[2]

Act 318 of 2008

Study of South Carolina's potential for coastal clean energy development has taken place in recent years under the leadership of the South Carolina Energy Office (SCEO), the South Carolina legislature, other state and federal agencies, Clemson and Coastal Carolina Universities, and utility and industry partners. South Carolina Act 318 of 2008 created the Wind Energy Production Farms Feasibility Study Committee, which examined the feasibility of wind energy production in South Carolina.

The committee's 2010 report to the South Carolina legislature included a recommendation that the state adopt a "clean energy portfolio standard with a target of 40-80 MW for generation capacity from offshore wind by 2013, and 1,000 MW by 2018." Additional recommendations were to "develop a leasing framework for offshore coastal ocean activities in state waters," to "establish a Wind Energy Cluster within South Carolina," and to "expand and increase existing renewable energy tax credits to include wind installations," among others (South Carolina General Assembly 2010, 3-5).

The final report contained a total of 18 recommendations, all of which were supportive of the development of offshore wind energy in the state. This project's economic impact analysis of a 1,000 MW wind farm off the South Carolina coast is based on the Wind Energy Production Farms Feasibility Study Committee's recommendation that a wind farm of that size be constructed.

[2] http://www.charlestonbusiness.com/news/33240-wind-turbine-parts-manufacturer-to-employ-190-at-plant-in-dorchester-county; and http://www.postandcourier.com/article/20120614/PC05/120619530

Regulatory Task Force for Coastal Clean Energy

Also in 2008, the SCEO obtained a grant from the U.S. Department of Energy for the purpose of identifying and overcoming existing barriers for coastal clean energy development for wind, wave and tidal energy projects. This grant supported a wind, wave and current study and created the Regulatory Task Force for Coastal Clean Energy, whose mission is to identify regulatory barriers to the development of offshore wind energy production in South Carolina. Project partners included Santee Cooper, Coastal Carolina University, Clemson University, Savannah River National Laboratory and North Carolina State University.

The Regulatory Task Force's recommendations were adopted by the Wind Production Farms Feasibility Study Committee in its 2010 report to the South Carolina legislature. The Regulatory Task Force continues to meet regularly.

This federal grant also supported a coastal spatial mapping project, which was conducted by the South Carolina Department of Natural Resources[3] Finally, this grant supported the wind energy supply chain survey and economic impact studies discussed in this report.

Offshore Renewable Energy State-Federal Task Force

The State of South Carolina has established an Offshore Renewable Energy State-Federal Task Force with the Bureau of Ocean Energy, Management, Regulation, and Enforcement (BOEMRE). With its first meeting held in late March 2012, the focus of this group is to facilitate coordination and consultation among federal, state, local, and tribal governments on renewable energy activities in federal waters off of South Carolina's coast. In addition to appointees made by Governor Nikki Haley, this task force also consists of federal representatives whose agencies have responsibilities associated with renewable energy development on the outer continental shelf, as well as representatives of coastal local governments and tribal interests that could be affected by potential development.

[3] Results of this study including downloadable data can be found at: http://www.dnr.sc.gov/GIS/gisenergy.html

South Carolina Offshore Wind Demonstration Project

University and industry partnerships have advanced wind energy research in South Carolina as well. The Palmetto Wind Project is a partnership between Clemson University's Restoration Institute (CURI), Santee Cooper—South Carolina's state-owned electric and water utility—Coastal Carolina University and SCEO.

In 2009, CURI and its partners obtained a $45 million grant from the U.S. Department of Energy, combined with $53 million in matching funds, to build and operate a large-scale wind turbine drive train testing facility at the former Navy base in North Charleston. The Wind Turbine Drivetrain Test Facility, currently under construction (photos below), is on schedule to begin commercial testing in Fall 2012.

South Carolina Wind Industry Census

The purpose of the South Carolina Wind Industry Census is to understand the composition and characteristics of firms in the wind energy supply chain in South Carolina. Its purpose is also to measure the number of jobs involved in wind energy specific production or service activities. This work establishes a benchmark for the number and type of wind energy jobs in South Carolina, which will help stakeholders in economic and workforce development forecast wind energy business opportunities in the state, identify training needs for businesses and workers, and promote South Carolina to potential employers.

We completed three tasks to obtain such information about the wind energy supply chain in South Carolina.

1. Identify members of the wind energy supply chain with operations in the state.
2. Identify ways of reaching potential, but unknown, members of the supply chain.
3. Develop a set of questions that would enable us to measure the number of wind energy related jobs located in South Carolina, and to identify key characteristics of the firms with those jobs.

Firms in the Wind Energy Supply Chain

We drew on existing industry contacts to compile a list of South Carolina firms known to be in the wind energy supply chain. In Fall 2011, CURI solicited members for an Industrial Advisory Board from key firms and organizations that would be involved in development of large-scale wind energy generation off the South Carolina coast.

The purpose of the Industrial Advisory Board was to provide input on firms to contact for the wind energy supply chain survey, to provide input on the survey instrument, and to ensure that the project team had ready access to top-level technical expertise. The Industrial Advisory Board drew membership from the following organizations:

- Coastal Carolina University, Center for Marine & Wetland Studies
- GE Energy
- Morgan AM&T
- North Carolina Offshore Wind Coalition
- Prysmian
- Santee Cooper
- South Carolina Coastal Conservation League
- South Carolina Department of Commerce

We also solicited potential wind industry contacts in South Carolina from:

- American Wind Energy Association (AWEA)
- Charleston Regional Development Alliance
- CURI Wind Turbine Drivetrain Testing Facility
- GLWN, an international wind energy supply chain advisory group and network of manufacturers
- South Carolina Department of Commerce
- South Carolina Engineering Cluster
- South Carolina Manufacturers Alliance

In January 2012, the project team worked with members of the Industrial Advisory Group to design the survey instrument (Appendix A). The survey was not administered to obtain a random sample of South Carolina manufacturers or engineering firms. Its primary purpose was to solicit responses from South Carolina firms known to serve the wind energy industry. For this reason, survey results cannot be interpreted statistically. The results do, however, provide qualitative data on this sector of the state's economy for industry and government policymaking.

The South Carolina Wind Energy Census was deployed as an online survey using Qualtrics software. The link to the survey was distributed in several waves beginning in February 2012. First, on February 2, 2012, the Director of the South Carolina Engineering Cluster sent out the survey in a mass email to the 200 member organization's contact list, which contained over 4,000 email addresses. On February 8, GSA Business Magazine published

an article on the project, including a link to the survey. These efforts garnered about 12 usable survey responses.

In early March 2012, email was sent to the Industrial Advisory Board, noting that the survey was live and requesting they fill it out for their firm and also forward it to other industry contacts. On March 24, another survey email was sent to contacts identified from other sources listed above. In late April, the South Carolina Manufacturers Alliance sent survey email to 170 of its members. After April 6, 2012, no additional usable survey responses were obtained. In total, 38 usable survey responses were received. Results from the South Carolina Wind Energy Census are discussed below.

Employees and Jobs

The first three questions in the South Carolina Wind Energy Census asked about firm employment in the state, including wind energy related employment and average wage and salary levels.

Employees

Q1. List the total number of employees working for your company at all your locations in South Carolina.

Q2. List how many out of your company's total South Carolina employees spend part or all of their time on wind energy related production or service activities.

Q3. We want to estimate the economic impact of the wind energy supply chain on the economy of South Carolina. To assist this work, please give us some general information about the types of jobs held by your company's South Carolina wind energy employees and their associated average salary or wage levels.

Thirty-three survey respondents reported 8,307 employees at all firm locations in South Carolina, with 1,134 employees, or 13.7% of these firms' total employees, spending part or all of their time on wind energy related production or service activities.[4] The average number of total employees and wind employees was pulled up by three firms with total employment near or above 1,000. Most firms had less than 150 total employees, and 10 or fewer wind employees (Table 1, Figure 1).

Table 1. South Carolina Wind Energy Supply Chain Employees (full time or part time)

No. of Employees	Total	Max	Min	Avg	Median	N
Total SC employees in any job	8,307	4,000	1	252	40	33
In wind energy related jobs	1,134	400	1	34	5	33
In wind energy production jobs	643	320	0	21	0	31
In wind energy professional, technical or management jobs	527	300	0	16	5	32

Survey respondents reported annual salary or hourly wage information for production jobs, which ranged between about $25,000 per year ($12 per hour) to $33,280 per year ($16 per hour). In May 2012, average hourly wages in manufacturing were $16.68 in South Carolina (SC DEW 2012). This comparison could suggest that production jobs in the wind energy supply chain in South Carolina pay slightly below the prevailing hourly wage for manufacturing jobs in the state. However, our data is limited because only seven of 33 firms responded to this survey question. In addition, the South Carolina Wind Industry Census asked specifically for the wages of production workers; wage data by industry sector includes all employees, from entry-level workers to top executives.

South Carolina salaries reported for engineering, scientific, technical, and management jobs associated with wind energy were above the prevailing state level. Twenty-six of 33 respondents provided average annual salary information for these types of jobs, which ranged from $50,000 per year to

[4] Five additional respondents, whose data is included for non-employment questions, had either no identified wind energy employees or no employees in South Carolina at this time.

$125,000 per year (Table 2). In comparison, estimated average annual wages in 2011 for all South Carolina workers in architectural and engineering services[5] were $73,005 ($35.10 an hour).

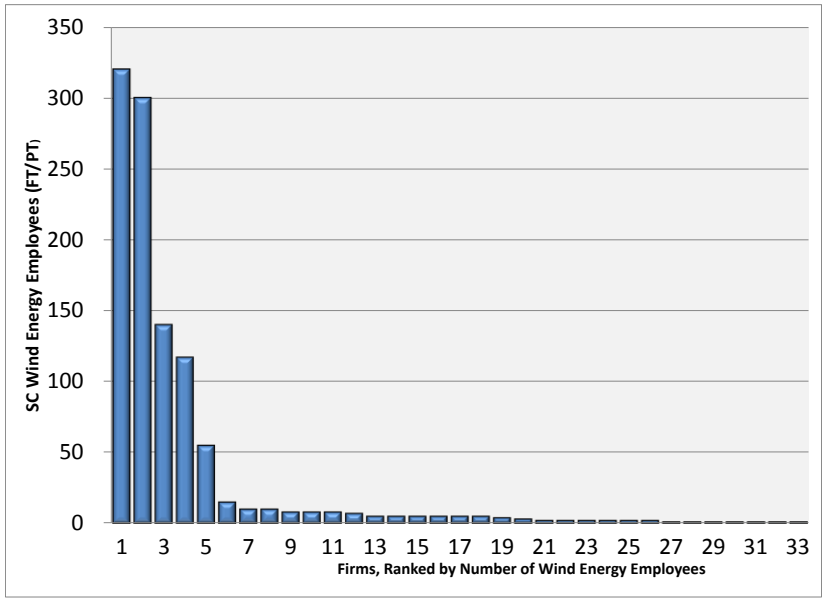

Figure 1. South Carolina wind energy employees by firm (FT/PT)

Average estimated annual wages for management, scientific, and technical consulting services[6] in South Carolina were $62,406 in 2011 ($30.00 an hour). Average and median annual earnings reported by survey respondents for wind energy employees in South Carolina were above these levels, at $78, 308 and $80,000 a year, respectively.

[5] North American Industry Classification System (NAICS) 5413, Architectural and engineering services.

[6] NAICS 5416, Management, scientific, and technical consulting services.

Table 2. Wind Energy Related Job Characteristics

	Max	Min	Avg	Median	N	SC Avg (All Jobs)
Average annual salary: manuf./production*	$32,000	$30,000	$31,000	$31,000	2	$51,132
Average hourly wage: manuf./production*	$16.00	$12.00	$14.50	$15.00	5	$24.58
Average annual salary: professional, technical, management	$125,000	$50,000	$78,308	$80,000	26	$62,406 to $73,005
Average hourly wage: professional, technical, management	$160.00	$22.00	$64.00	$50.00	7	$30.00 to $35.10

*Only seven respondents reported wage or salary data for wind energy production-related jobs.

Firm Characteristics

Thirty-three survey respondents reported a total of 1,134 wind energy related jobs in South Carolina in 2012. Four additional respondents reported no wind energy jobs in South Carolina, but would be members of the wind energy supply chain if they opened or increased their presence in the state. The fifth and final respondent reported no dedicated wind energy jobs, but is already part of the wind energy supply chain when it carries freight for any in-state or out-of-state firms. For these reasons, we included their responses in the summary statistics of non-employment questions in the survey.

Primary Firm Functions in South Carolina

Q5. Select the option(s) that best describes the primary function of your company's South Carolina location(s).

Q12. Please provide your company's North American Industry Classification System (NAICS) or Standard Industrial Classification (SIC) code, if you know it.

The 38 firms responding to the survey cover a range of functions. As expected, some survey respondents selected more than one of the six listed functions for their South Carolina operations. These were Component or Material Supplier, Wind Turbine OEM, Developer, Engineering Procurement & Construction, Operations & Management and Other. This question was intended to capture all firm operations, including but not limited to wind energy related production or service activities.

Engineering Procurement & Construction (13 firms) and Component or Material Supplier (10 firms) were the two most frequently selected functional categories (Figure 2).

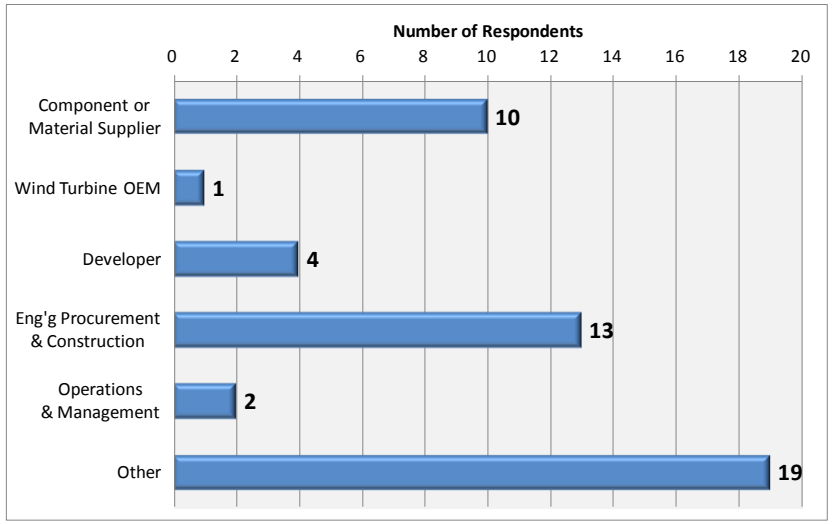

Figure 2. Primary firm functions

Nineteen firms selected the category Other: 14 firms exclusively and five in conjunction with one or more functions. Other firm functions self-identified by survey respondents were:

- Consulting, including permitting, regulatory, and site selection (6 firms)
- Marine or land transportation, including transportation brokerage (4 firms)
- Distribution, sales, and/or marketing (3 firms)
- Computer modeling and/or software (2 firms)
- Products (custom controls and spray coatings) (2 firms)
- Wind turbine testing (1 firm)
- Technical staffing services (1 firm)

Primary NAICS and/or SIC codes were also used to classify firms in the South Carolina wind energy supply chain by their primary activities. Most respondents provided NAICS codes. These codes and missing codes were verified by cross-checking with industry databases.

When viewed by primary industry code, supply chain activities are dominated by professional, scientific and technical services (13 firms), and manufacturing (9 firms) (Table 3).

Table 3. NAICS Codes for Respondent Firms in Supply Chain

NAICS	Description	Respondents
221	Utilities	2
236	Construction of buildings	1
327	Nonmetallic mineral product manufacturing	1
331	Primary metal manufacturing	1
332	Fabricated metal product manufacturing	2
333	Machinery manufacturing	2
335	Electrical equipment, appliance and component manufacturing	2
339	Miscellaneous manufacturing	1
423	Durable goods merchant wholesalers	2
483	Water transportation	1
488	Support activities for transportation	2
531	Real estate	1
541	Professional, scientific and technical services	13
561	Administrative and support services	1

Wind Energy Specific Production and Service Activities

Q8. Select the options(s) that best describe the area(s) of wind manufacturing and/or services your company provides in South Carolina.

This question was used to obtain additional detail about respondent firms' wind energy specific production and service activities in South Carolina. Table 4 shows that South Carolina has a broad distribution in the manufacture of components used for wind turbines and towers.

Among 34 respondent-identified wind energy specific production and service activities, professional services were the most frequently mentioned, with 12 firms providing engineering and/or energy, site selection, or permitting consulting services. Eight firms manufactured other products used in the wind energy supply chain, such as seals, lubricants, and power cables, among others. These results are presented in Table 5.

Table 4. Wind Energy Specific Production and Service Activities (survey categories)

Category	Firms Responding	Category	Firms Responding
Blades	0	Pitch System	1
Gearbox	3	Power Cables	1
Generator	1	Castings	1
Bearing	4	Forgings	0
Power Converter	1	Resins	0
Transformer	1	Reinforcement Cables	1
Tower	0	Subaquatic Cables	1
Turbine/Tower Service & Maint.	3	Other (see list below)	34

Table 5. Wind Energy Specific Production and Service Activities (respondent identified)

Category	Firms Responding	Category	Firms Responding
Engineering services	6	Technical staffing services	1
Consulting, including site selection, regulatory and permitting	6	Land transportation	2
Computer modeling and software	2	Marine transportation	1
Construction management	3	Heavy lift crane services	1
Testing for drivetrains and turbine components	3	Electric power	2
Other products (seals, gaskets, carbon brushes, lubricants, spray coatings, power and fiber optic cables, hydraulics, controls)			8

Markets for Products and Services

Q6. Select your company's market(s). Please select all that apply.

Q7. Provide the percentage of your sales that stay in the United States.

All of the 38 respondents reported a market for their products and services in the United States. Ten firms reported that 100% of their sales remain in the United States and 21 firms reported that 90% or more of their sales were in the United States (Table 6).

Table 6. Percentage of Respondent Sales Remaining in the U.S.

	Max	Min	Avg	Median	N
Percentage of firm sales within US	100% (10 firms)	30% (1 firm)	83%	94%	38

More than half of respondents identified markets in Canada, Western Europe, and Mexico (Figure 3). Eight respondents specified other locations, including the Middle East or Iraq (3), Central America (1), the Caribbean (2), Worldwide (2), and South Carolina (1).

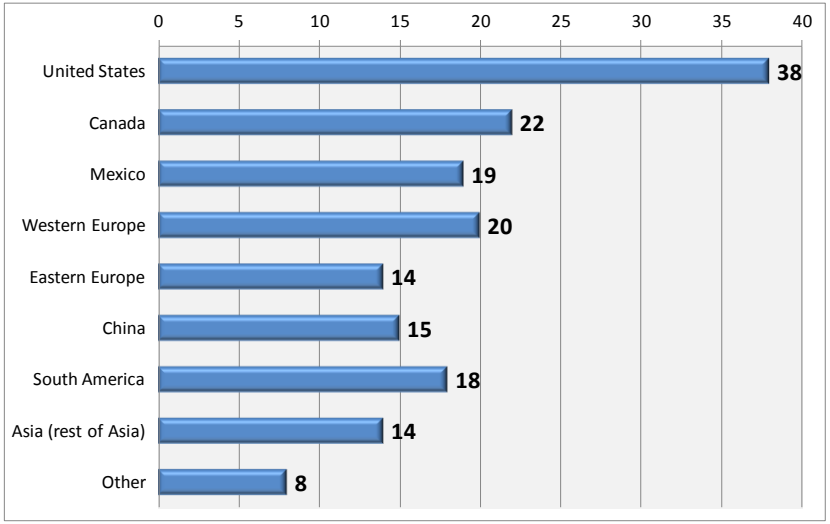

Figure 3. Markets for products and services of firms in SC's wind energy supply chain

Business Climate

The final set of questions in the South Carolina Wind Industry Census was designed to provide us with insight into the business climate in South Carolina for firms with wind energy related production or service activities, such as: What brings firms in this industry to South Carolina? What are firms planning for the future? What issues are of concern to firms operating in the wind energy supply chain? These questions were intended to cover all firm operations, and were not limited to wind energy related activities. All 38 survey respondents answered these questions.

Future Business Plans

Q4. Please give us some general information on your company's future business plans in South Carolina over the next one to five years.

Over three primary areas—capital investment, employment, and products and services—the future South Carolina business plans of respondent firms are highly positive. For capital investment plans, 84% of respondent firms expected to either increase capital investment from current levels or keep it about the same. Only one firm expected to decrease capital investment in South Carolina in the next one to five years. Five respondents did not know their firm's future capital investment plans (Figure 4).

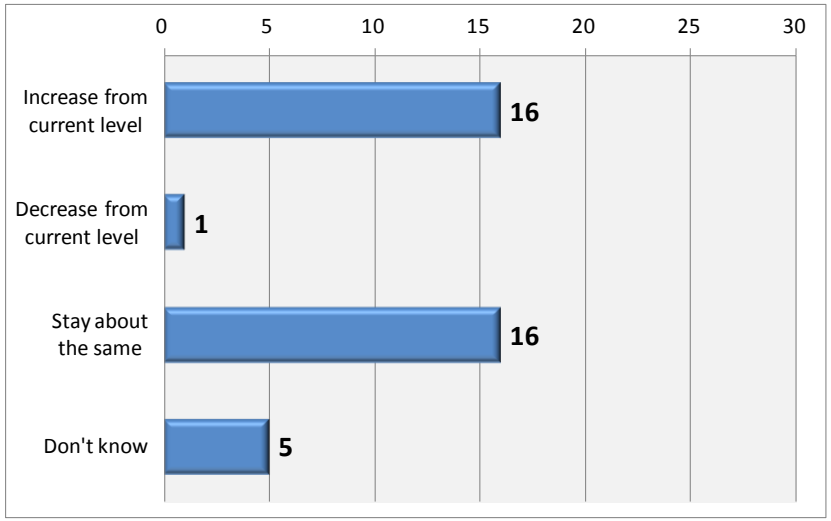

Figure 4. Future business plans for capital investment

Respondents were highly positive about their firms' future plans for employment and business activities in South Carolina. In both areas, 95% of respondents expected their firms to either maintain or increase activity over current levels. Twenty-five of 38 respondents expected their firms to increase employment over the next few years, and an additional 11

respondents expected employment levels in South Carolina to stay about the same. No respondents expected their firm to decrease employment, and two did not know (Figure 5).

Respondents were even more positive about their firms' future plans to increase products and/or services provided over the next one to five years. Twenty-eight respondents expected an increase in this area, and eight respondents expected their firm's level of activity to stay about the same.

No respondents expected their firm would decrease the amount of products or services over the next one to five years, and two did not know (Figure 6).

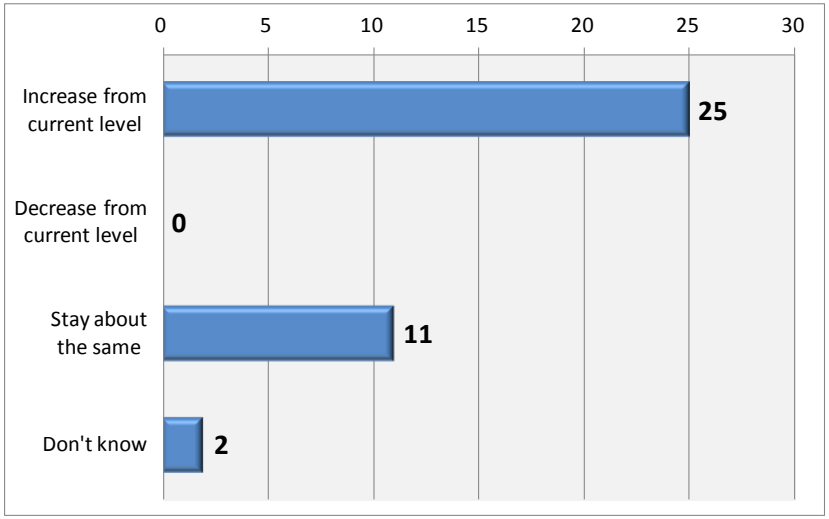

Figure 5. Future business plans for employment

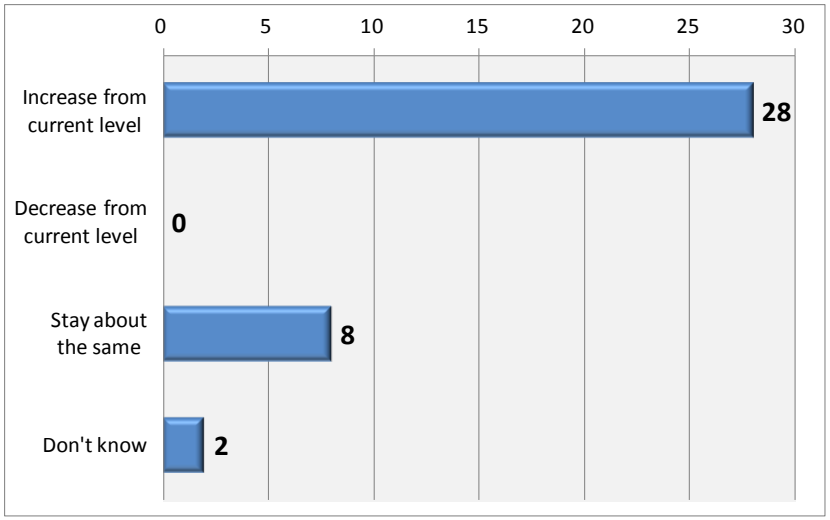

Figure 6. Future business plans for adding new products or services

Firm Location Decisions

Q9. Were the factors listed below important in your company's decision to locate in South Carolina?

This question was designed to provide information about the factors affecting firm location decisions, specifically the decision to locate in South Carolina by firms in the wind energy supply chain.

Quality of life and existing firm location(s) in South Carolina were the most frequently selected choices, with just under half of the 38 respondents selecting each of these two factors (Figure 7). Detailed responses to this question are presented in Appendix B.

Over one-third of respondents indicated that a competitive and skilled workforce was an important factor in their firm's decision to locate in the state, followed by supportive state regulations. Economic development incentives were important to only 5 of 38 respondents. Access to finance

was the least frequently identified location decision factor, perhaps because at a corporate level finance is not particularly location dependent.

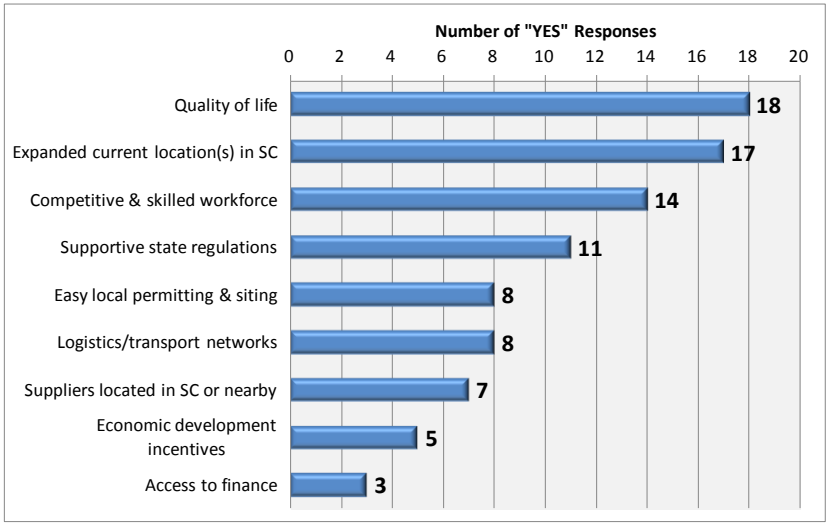

Figure 7. Important factors in firm decisions to locate in SC

Firm Risk Factors

Q10. What are the risks facing your company at this time? (Please select all that apply)

This question was designed to provide input to policymakers about firm perspectives on doing business in the wind energy supply chain, and more generally, on firms doing business in South Carolina. Industry volatility was the most frequently identified risk, with 27 respondents making this selection (Figure 8).

Risks from domestic tax policy and industry competition were the next four most frequently identified risks facing respondents, headed up by the risk posed to firms by inconsistent renewable energy targets among states. Risks from other countries were less frequently cited by respondents than domestic risks. Three other risks were self-identified by survey respondents: market uncertainty, inconsistent federal energy policy targets, and high rates for electric power used in production.

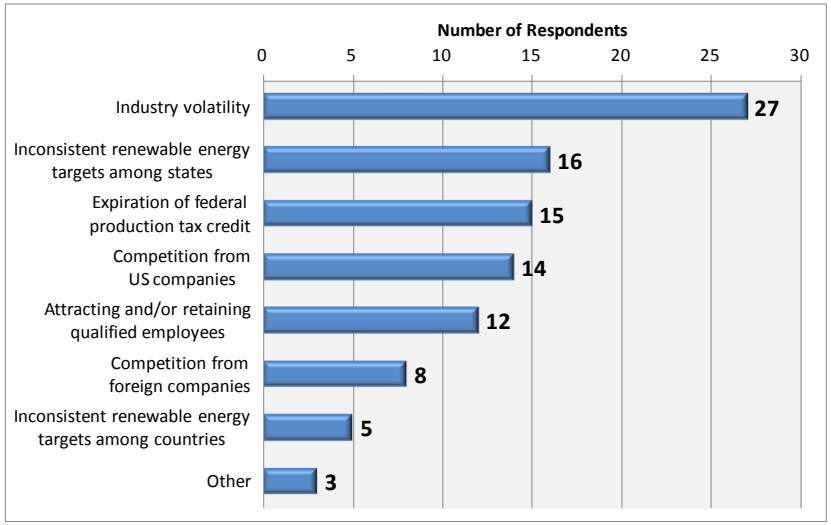

Figure 8. Risks facing firms

Economic Impact Analysis Overview

In the next two sections, we estimate the economic and fiscal impacts of existing and potential wind energy related production and service activities on the state of South Carolina. This section briefly reviews the basic structure of economic impact analyses.

The Input-Output Model

To estimate the economic and fiscal impacts on the state of South Carolina of the existing wind energy supply chain and the construction and operation of a 1,000 MW offshore wind farm, we used the input-output (I/O) function of the Regional Dynamics (REDYN) economic modeling engine.[7] REDYN is currently the largest computer model of the United States economy ever built (currently 7.6 terabytes).

The model utilizes data from government sources, including the Bureau of Labor Statistics (BLS) input-output tables, National Income and Product Accounts (NIPA) published by the Bureau of Economic Analysis (BEA), and the U.S. Census of Governments. Data from the Oak Ridge National Laboratory transportation study are also used to account for the efficacy of interregional trade flows.

The REDYN model forecasts a baseline level of activity within over 800 Standard Occupational Classification (SOC) codes and 703 NAICS industry sectors. It also considers distance-to-market and transportation costs in determining the supply and demand of commodities across geographic regions.

Changes to employment, income, or demand for products or services by either the private or the public sector can be used as input to the model. Based on these inputs, the REDYN model generates a county or multicounty level estimate of the resultant variation from the projected baseline, as well as the effects on every industry.

[7] http://www.redyn.com

Economic Impacts

The REDYN model's estimated economic impacts above the baseline forecast are stated using the following metrics. All REDYN estimates include direct, indirect, and induced effects.

Employment is the number of jobs in the economy that are attributable to the operation and capital expenditures of firms involved in the actual production, construction, and operation and maintenance (O&M) of the wind farm.

Wages are the change in aggregate income from wages and salaries (including fringes) paid by all firms in the state to workers employed in the state. Note that this includes wages paid to non-residents who work in-state and does not include wages paid to South Carolina residents who work outside of the state.

Disposable Income is the aggregated change in household after-tax income. In other words, the amount reported in the tables is the total amount summed for all households. Dividing by the number of households in the state would provide the change in household income. This includes income from wages, dividends, interest and rent.

Output is the dollar value of all goods and services produced in the state in a given year. This is similar to regional gross domestic product (GDP), but is not limited to final goods.

Net state or local government revenue is the revenue to state, county and municipal governments throughout the state from all sources, including taxes, fees and intergovernmental transfers, less expenses.

Direct effects are the workers employed in the actual production, installation, and O&M of the wind farm, their wage income, and the involved firms' actual output.

Indirect effects are the jobs, wages, and output of second- and third-tier suppliers located within South Carolina.

Induced effects are the "ripples" expanding into the broader economy from the direct and indirect effects of spending of wage income by employees of the firm and its suppliers.

Economic Impact Analysis of the South Carolina Wind Energy Supply Chain

In this section we discuss the economic impact of firms in the South Carolina wind energy supply chain on the state for the year 2012. This analysis uses employment and industry sector data from firms responding to the South Carolina Wind Industry Census.

Supply Chain Model Assumptions

Data from the South Carolina Wind Industry Census were used as inputs to an I/O model in order to estimate the economic and fiscal impact of the existing wind energy supply chain in South Carolina. This impact estimate is based solely on the data provided by survey respondents; it is not interpolated to include any South Carolina firms known to be in the wind energy supply chain but who did not respond to the survey. As such, these impact estimates reported are likely conservative.

Inputs to the model consist of the number of South Carolina employees each firm reported who spend part or all of their time working on wind-related projects, along with their total wages or salaries. Employment was categorized by 5-digit NAICS industry sector for modeling purposes. All estimates are presented for the state of South Carolina in 2012 constant dollars.

Supply Chain Model Results

South Carolina's wind energy supply chain made a strong contribution to the state's economy in 2012. Survey respondents reported 1,134 direct jobs in wind energy production or service provision (Table 7). These direct jobs generate a total estimated jobs impact of 2,931 jobs statewide in 2012.

The South Carolina wind energy supply chain's estimated total jobs impact indicates a jobs multiplier of approximately 2.6 for the supply chain. In other words, every job in wind energy in South Carolina generates an estimated additional 1.6 jobs in the state through indirect and induced effects. Firms have the strongest employment impact on the multicounty regions in which they are located. In South Carolina, wind energy employment is located primarily in the Upstate, Midlands, and around Charleston County (Figure 9).

South Carolina's wind energy supply chain contributed an estimated $146.5 million in wages paid to employees in the state in 2012 (including direct, indirect and induced jobs). The supply chain also added $144.4 million in disposable income to the state. This money is spent by individuals and households on goods and services, which helps support other economic activity in South Carolina and provides tax revenues to the state and its local governments.

Table 7.
Estimated Impact of SC's Wind Energy Supply Chain

	2012 ($ in millions)
Employment (direct jobs only)	1,134
Employment (direct, indirect & induced jobs)	2,931
Wage Bill	$146.5
Disposable Income	$144.4
Output	$530.2
Net State Government Revenue	$29.3
Net Local Government Revenue	$21.1

The direct impact on output of the wind energy supply chain—from which indirect and induced impacts are derived—was approximated by the model using the number of direct wind energy jobs in conjunction with historic regional worker productivity statistics for each industry sector represented by the firms responding to the survey.

The estimated fiscal impact of South Carolina's identified wind energy supply chain on state and local government revenues is large and positive. Increased revenue results from increases in income and sales taxes, as well as increased property values resulting from projected increases in commerce. These fiscal impacts are net of the expenses incurred to

governments by economic activity associated with wind-related jobs, including demands placed on infrastructure, public safety, and public education.

In addition to the direct jobs reported in the South Carolina Wind Industry Census, we are aware of approximately 440 additional jobs that have been announced for South Carolina by IMO and Nexans, two firms in the wind energy supply chain that are locating operations in the state. If we apply our estimated wind energy supply chain multiplier of 2.6, these 440 direct jobs will soon mean an additional total jobs impact on the state of approximately 1,144 jobs, including indirect and induced jobs.

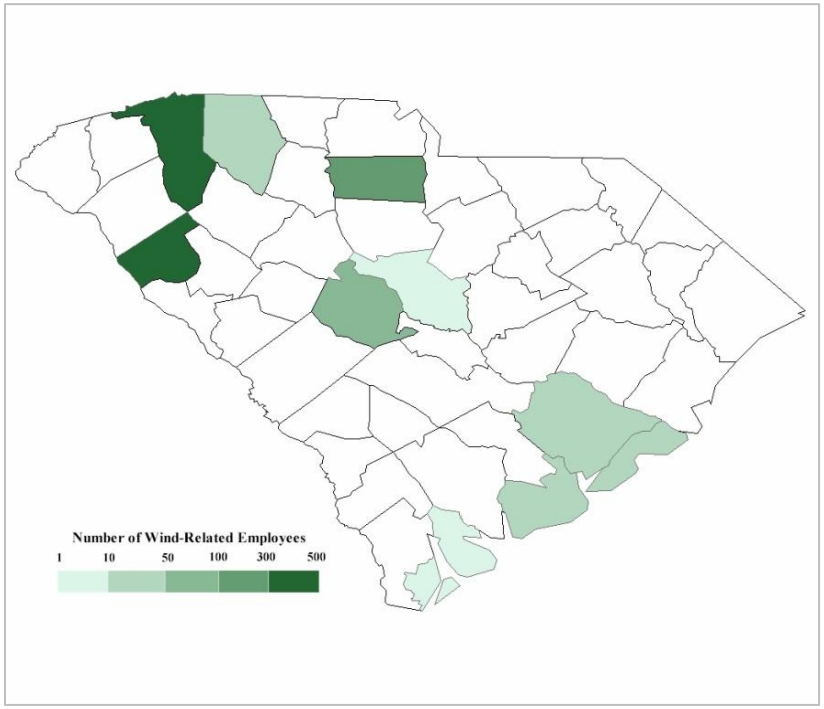

Figure 9. Wind energy related employment in South Carolina, 2012

Economic Impact of a 1,000 MW Offshore Wind Farm

In this section we discuss the estimated economic impact on the state of South Carolina of development and operation of a 1,000 megawatt (MW) wind farm off the South Carolina coast.

Model Assumptions and Data Sources

The model used in this analysis assumes a 40 megawatt (MW) wind farm constructed in 2016 and beginning operation in 2017. Additional capacity is added beginning in 2019, reaching a total of 1,000 MW in 2025. This scale of wind farm and 10 year build-out timeframe is consistent with plans under development by Santee Cooper (a state-owned electric utility) and other partners. Estimated costs associated with this scenario assume:

- offshore wind installation consisting of 3 to 5 MW turbines,
- 25 meter water depth at the site,
- 100 miles between the site and the staging port,
- 50 miles to electrical interconnection on land, and
- less than 30 miles to the servicing port.

Based upon data provided by Santee Cooper, the total component cost of turbines in the modeled offshore wind farm is assumed to be $2.1 million per MW. This figure is based on current industry turbine capital cost estimates of $1.9 million per MW, adjusted for additional costs for marinization and foundation materials.

A schedule for installation of offshore wind energy generation capacity for each year is presented in Table 8, along with the total cost of wind turbine components installed in each year. Costs for operations and maintenance (O&M) are assumed to occur with a one year lag following turbine installation in order to allow for construction time and bringing electric power generating capacity online. The economic impact of spending on O&M is modeled through 2030 in order to capture these impacts for five years following completion of the 1,000 MW wind farm in 2025. All costs and impacts are reported in constant 2012 dollars.

Table 8. Proposed Build-Out Schedule for Offshore Wind Farm

Year	Capacity Installed By Yr. (MW)	Total Installed Capacity (MW)	Component Cost ($ Millions)
2016	40	40	$84.0
2017	0	40	$0.0
2018	0	40	$0.0
2019	150	190	$315.0
2020	150	340	$315.0
2021	150	490	$315.0
2022	150	640	$315.0
2023	150	790	$315.0
2024	150	940	$315.0
2025	60	1,000	$126.0

The economic impact model for the offshore wind farm was constructed as three separate models, which are added to generate the total estimated economic impact of the proposed 1,000 MW offshore wind farm.

Wind Turbine Component Model

The wind turbine component model estimates the impact that production of the individual components of the turbines making up the wind farm would have on the state. Each component's production was assigned to one of twelve NAICS sectors, which are shown in Table 9.

Offshore Wind Farm Installation Model

The offshore wind farm installation model estimates the economic impact of labor and port services, land and marine transportation, and other activities. Cost estimates for each of the activities associated with wind farm installation were derived from the NREL Offshore Jobs and Economic Development Impact (JEDI) model (Hamilton, Lantz and Paidipati 2012) and from data provided by Santee Cooper (NREL and Ocean & Coastal Consulting/COWI Group 2012).

Table 9. NAICS Sectors Used for Turbine Component Model, Including Estimated Share of In-State Production

NAICS Code	Description	Components	Local Share
32551	Paint and Coating Manufacturing	Coating	0%
32619	Other Plastics Product Manufacturing	Blades, Nacelle Cover	10%
32731	Cement Manufacturing	Foundation	77%
33151	Ferrous Metal Foundries	Hub, Isolation Mounts, Support Structure	0%
33231	Plate Work and Fabricated Structural Product Manufacturing	Tower	15%
33299	All Other Fabricated Metal Product Manufacturing	Bearing/Block	15%
33341	Ventilation, Heating, Air-Conditioning, and Commercial Refrigeration Equipment Manufacturing	Cooling System	0%
33361	Engine, Turbine, and Power Transmission Equipment Manufacturing	Gearbox, Mainshaft, Mounting System, Brake/Hydraulics, Coupling, Generator, Switchgear	25%
33451	Navigational, Measuring, Electromedical, and Control Instruments Manufacturing	Control/Safety	0%
33531	Electrical Equipment Manufacturing	Pitch/Bearings, Electronics, Yaw	25%
33592	Communication and Energy Wire and Cable Manufacturing	Cable	10%
33599	All Other Electrical Equipment and Component Manufacturing	Transformer	0%

Total installation cost per MW is estimated to be $2.8 million. The industry sectors associated with these activities are presented in Table 10. The assumed percentage of in-state provision of services of the remaining activities was determined in consultation with industry sources.

Operations and Maintenance Activities Model

The operations and maintenance activities model estimates the impact of ongoing wind farm O&M on the state. This model includes the impact from technician and engineering jobs, water transportation, and a levelized estimate of replacement part costs. (Costs for replacement parts increase over time as turbines age.) The cost of each of these O&M activities was extracted on a per-MW basis from the NREL Offshore JEDI model and from consultation with industry sources.

Total for O&M per installed MW is estimated to be $133,200 per year. The percentage produced in-state for replacement parts was estimated using the same method as in the turbine components model. The assumed percentage of in-state provision of services of the remaining activities was determined in consultation with industry sources.[8] The NAICS sectors for O&M activities are presented in Table 11.

[8] Due to the nature of the types of parts required for maintenance we retained 38% as the local share in the O&M model for NAICS 33361.

Table 10. Industry Sectors for Wind Farm Installation Model
Includes estimated share of in-state production/employment

NAICS Code	Description	Activity	Local Share
23493	Industrial Nonbuilding Structure Construction	Foundation/Substructure Installation (Labor cost)	75%
23493	Industrial Nonbuilding Structure Construction	Turbine Erection/Installation (Labor cost)	50%
55111	Management of Companies and Enterprises	Management (Labor cost)	75%
23499	All Other Heavy Construction	Collector System Installation	25%
23492	Power and Communication Transmission Line Construction	Grid Interconnection	75%
54	Professional Services	Engineering/Legal	50%
48831	Port and Harbor Operations	Ports/ Staging	75%
23499	All Other Heavy Construction	Erection/Installation (equipment services only)	25%
4831	Deep Sea, Coastal, and Great Lakes Water Transportation	Transportation	90%

Table 11. Industry Sectors for O&M Model
Includes estimated share of in-state production/employment

NAICS Code	Description	Activity	Local Share
54133	Engineering Services	Technician	90%
56111	Office Administrative Services	Administration	90%
55111	Management of Companies and Enterprises	Management	75%
483	Water Transportation	Water Transportation	90%
81131	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance	Subcontractors	50%
33361	Engine, Turbine, and Power Transmission Equipment Manufacturing	Replacement Parts	38%
N.A.	Demand by Speculators for Equipment & Software	Facilities & Equipment	90%

Impacts: Turbine Component Manufacturing

Table 12 shows the average annual economic impact on the state resulting from turbine component manufacture of wind energy electric generating capacity for installation off the South Carolina coast. Results are reported in total dollars and dollars per MW of generating capacity installed. Estimates are based on a total turbine component cost of $2.1 million per MW.

Between 2016 and 2025, the wind farm buildout scenario assumes that 1,000 MW of turbine components will be manufactured and purchased for installation in the proposed offshore wind farm. During the wind farm development period between 2016 and 2025, this level of manufacturing activity would generate about 293 jobs per year on average, or about one job per MW of turbine components installed.

Table 12. Average Annual Economic Impact of Turbine Component Manufacture, 2016-2025

	Average Impact Per Yr. ($ in millions)	Average Impact Per MW Per Yr. ($)
Total Jobs (direct, indirect, induced)	293	2.4
Wage Bill	$18.3	$146.4
Disposable Income	$18.0	$144.4
Output	$54.9	$439.2
Net State Revenue	$3.3	$26.8
Net Local Revenue	$2.4	$19.6

For the components assumed to be produced within the state, the estimated output multiplier is 1.6; this means that every dollar of output generates 60 cents worth of additional output of goods and services in the state through indirect and induced effects. Yearly total estimated economic and fiscal impacts on South Carolina of turbine component manufacture based on the proposed offshore wind farm buildout schedule are presented in Appendix C.

In terms of fiscal impact, the economic activity associated with production and import of turbine components generates both revenue (by way of taxes, fees, and other sources) and costs (such as demand on infrastructure). The model estimates that the increase in state and local government revenues both outweigh the increase in government costs associated with turbine manufacture. This model does not assume any financing of industry inducements using of state or local government general revenue funds or through tax increases.

Because these economic impacts are tied to the manufacture of turbine components, they only persist so long as the investment in turbines continues. Once the wind farm is completed and the components are no longer demanded, the economic impacts reported in this portion of the model will cease. The economic impact of the production of replacement parts for wind turbine maintenance on the state of South Carolina are addressed separately in the O&M discussion below.

Impacts: Offshore Wind Farm Installation

While wind turbines are multimillion dollar pieces of equipment, the largest share of costs associated with offshore wind farm development is found in turbine installation. Offshore wind farms are more complicated than land-based wind farms because of their higher foundation engineering design and construction costs, and staging and marine transportation costs, among others.

The economic impact on the state resulting from the installation of 1,000 MW of wind turbine electric generating capacity off the South Carolina coast takes place beginning in 2016, the year that the first 40 MW of turbines are installed. Over the 10 year wind farm development period, installation activities alone would generate an estimated 3,329 jobs per year, on average, or around 11.0 jobs per MW installed (Table 13).

Wind farm turbine installation activities are estimated to generate average annual output valued at $270.7 million a year during the decade. State and local governments would receive about $167,500 in revenues as a result of wind farm development.

The estimated output multiplier is 2.1 for installation activities only. This multiplier means that every dollar spent on installing a wind farm off the coast of South Carolina generates an additional $1.10 of output in the state through indirect and induced effects. Yearly total estimated economic and

fiscal impacts of turbine installation on South Carolina for a 1,000 MW wind farm's full build-out scenario are presented in Appendix C. Over time the model assumes the introduction of new technology and other efficiencies; this results in a very gradual decline in the employment impact over time.

Table 13. Average Annual Economic Impact Offshore Wind Farm Installation, 2016-2025

	Average Impact Per Yr. ($ in millions)	Average Impact Per MW Per Yr. ($)
Total Jobs (direct, indirect, induced)	3,329	26.8
Wage Bill	$163.1	$1,305.3
Disposable Income	$161.0	$1,288.0
Output	$270.7	$2,165.4
Net State Revenue	$29.6	$239.2
Net Local Revenue	$21.6	$174.7

Because these impacts are tied to the installation of turbine components, they only persist as long as the wind farm is under construction. Once the wind farm is completed, the impacts reported in this portion of the model will cease. For example, there are no installation costs (or initial turbine component purchases) assumed after the 10 year construction period.

Impacts: Offshore Wind Farm Operations & Maintenance

Economic and fiscal impact estimates for the O&M phase of the proposed offshore wind farm begin starting in 2017, the year after the installation of the first 40 MW of generating capacity. In this model, new O&M activities are assumed to begin in each year following turbine installation.

As shown in Table 14, over the 10 year construction period between 2016 and 2025, O&M activities associated with the proposed offshore wind farm are estimated to generate 257 jobs per year, on average, or around 0.5 jobs per MW installed. Wind farm O&M activities are estimated to generate average annual output valued at $40.5 million a year during the decade. State and local governments would receive about $9,200 a year in revenues as a result of O&M during the construction period.

Table 14. Average Annual Economic Impact Offshore Wind Farm O&M Activities, 2017-2025

	Average Impact Per Yr. ($ in millions)	Average Impact Per MW Per Yr. ($)
Total Jobs (direct, indirect, induced)	257	0.5
Wage Bill	$14.9	$29.2
Disposable Income	$13.9	$27.2
Output	$40.5	$78.8
Net State Revenue	$2.7	$5.3
Net Local Revenue	$2.0	$3.9

Note: O&M activities begin in 2017.

We also modeled the post-construction impact of O&M activities for a fully operational 1,000 MW offshore wind farm. After the wind turbines are installed, the only economic impact to the state from the wind farm is from ongoing O&M.

At this point, O&M activities are estimated to generate 678 jobs per year, on average, or around 0.7 jobs per MW installed. Wind farm O&M activities are estimated to generate average annual output valued at $115.1 million a year. State and local governments would receive about $13,300 a year in revenues as a result of ongoing O&M after the wind farm is built out (Table 15).

The estimated average annual economic impact from O&M is much higher in the post-construction phase than when productive capacity is ramping up because the number of operating wind turbines increases gradually over the installation period.

The estimated output multiplier for O&M operations is approximately 1.4, that is, every dollar spent on O&M generates an additional 40 cents of output in the state. Because O&M activities continue after completion of

wind farm installation, these economic impacts will persist as long as the wind farm continues to operate.

Table 15. Average Annual Economic Impact of Post-Construction O&M Activities, 2026-2030

	Average Impact Per Yr. ($ in millions)	Average Impact Per MW Per Yr. ($)
Total Jobs (direct, indirect, induced)	678	0.7
Wage Bill	$41.8	$41,800
Disposable Income	$39.0	$39,000
Output	$115.2	$115,100
Net State Revenue	$7.7	$7,700
Net Local Revenue	$5.6	$5,600

Impacts: Total Economic Impact

There are two ways to examine the total economic impact on the state of South Carolina from the construction and operation of a 1,000 MW offshore wind farm.

1. We can calculate the average annual impact of turbine component manufacture, turbine installation, and wind farm O&M, as we did above for each model individually.
2. We can also sum the annual impacts from the three models over the entire construction scenario to determine an aggregate impact over the multiyear period.

Average Annual Total Economic Impact

Table 16 shows the average annual economic impact of the proposed 1,000 MW offshore wind farm over the 10 year construction period between 2016 and 2025. Table 17 shows the average annual economic impact of the wind farm during five years of post-construction O&M from 2026 to 2030. The annual total economic impact of the wind farm is presented in Appendix C.

During the construction period, the largest economic impacts to the state are due to wind turbine installation. For example, close to 86% of average jobs generated by the wind farm and 83% of estimated wages paid for those jobs are associated with the turbine installation phase.

As was discussed earlier, this model assumes that turbine installation involves a high level of in-state participation in many industry sectors. The more employment and goods and services production comes from existing South Carolina sources, the higher the economic impact of the activity on the state.

Table 16. Average Annual Economic Impact of Construction and Operation of 1,000 MW Offshore Wind Farm, 2016 to 2025

	Turbine Components	Turbine Installation	Turbine O&M	Total
Impact per Year ($ in millions)				
Employment	293	3,329	257	3,879
Wage Bill	$18.3	$163.1	$14.9	$196.3
Disposable Income	$18.0	$161.0	$13.9	$192.9
Output	$54.9	$270.7	$40.5	$366.1
Net Govt. Revenue	$5.7	$51.2	$4.7	$61.6
% of Total				
Employment	7.5%	85.8%	6.6%	100.0%
Wage Bill	9.3%	83.1%	7.6%	100.0%
Disposable Income	9.4%	83.4%	7.2%	100.0%
Output	15.0%	73.9%	16.1%	100.0%
Net Govt. Revenue	9.3%	83.1%	7.6%	100.0%
Impact per MW per Year ($)				
Employment	2.4	26.8	0.5	29.6
Wage Bill	$146,400	$1,305,300	$29,200	$1,480,900
Disposable Income	$144,400	$1,288,00	$27,200	$1,459,600
Output	$439,200	$2,165,400	$78,800	$2,683,300
Net Govt. Revenue	$46,400	$413,800	$9,200	$469,400

Table 17. Average Annual Economic Impact of O&M Activities for a Fully Operational 1,000 MW Offshore Wind Farm, 2026 to 2030

	Turbine Components	Turbine Installation	Turbine O&M	Total
Impact per Year ($ in millions)				
Employment	0	0	678	678
Wage Bill	$0	$0	$41.8	$41.8
Disposable Income	$0	$0	$39.0	$39.0
Output	$0	$0	$115.2	$115,2
Net Govt. Revenue	$0	$0	$13.3	$13.3
% of Total				
Employment	0	0	100.0%	100.0%
Wage Bill	$0	$0	100.0%	100.0%
Disposable Income	$0	$0	100.0%	100.0%
Output	$0	$0	100.0%	100.0%
Net Govt. Revenue	$0	$0	100.0%	100.0%
Impact per MW per Year ($)				
Employment	0	0	0.7	0.7
Wage Bill	$0	$0	$41,800	$41,800
Disposable Income	$0	$0	$39,000	$39,000
Output	$0	$0	$115,100	$115,100
Net Govt. Revenue	$0	$0	$13,300	$13,300

Aggregate Total Economic Impact

The construction and operation of a 1,000 MW wind farm off the South Carolina coast will have a large aggregate economic impact on the state, particularly during the construction phase. Estimated jobs are annualized because, unlike dollars in wages or output, some jobs are likely to carry over into succeeding years, thus making it inappropriate to sum them over time.

- 3,879 average total jobs per year in South Carolina (direct, indirect, and induced)
- $1.96 billion in wages paid 2016-2025
- $1.93 billion in disposable income received 2016-2025
- $3.66 billion in output generated 2016-2025
- $616.2 million in combined state and local government revenue generated 2016-2025

Economic impacts associated with the proposed offshore wind farm spike during periods of turbine installation, which requires much more labor than component manufacturing or O&M. Economic impacts drop sharply and level off during years in which O&M is the only activity, as in the years 2017 and 2018, when the proposed 40 MW wind farm is operating and no new capacity is being installed, and starting again in 2026, when the 1,000 MW of generating capacity has been installed.

The single year with the largest economic impact is predicted is 2024. It is the sixth year of a 150 MW per year build-out and 790 MW of installed capacity requires ongoing O&M. The annual total jobs impact resulting from this 10 year construction period is shown in Table 18 and Figure 10.

Table 18. Total Estimated Economic Impact of Construction and Operation of a 1,000 MW Offshore Wind Farm, 2016 to 2025

	Constr. + O&M 2016 to 2025 ($ in millions)	O&M only 2026 to 2030 ($ in millions)	Total Impact 2016 to 2030 ($ in millions)
Employment (avg. ann.)	3,879	678	2,819
Wage Bill	$1,963.3	$209.2	$2,172.5
Disposable Income	$1,929.2	$195.1	$2,124.3
Output	$3,660.8	$575.8	$4,236.5
Net Govt. Revenue	$616.2	$66.8	$683.0

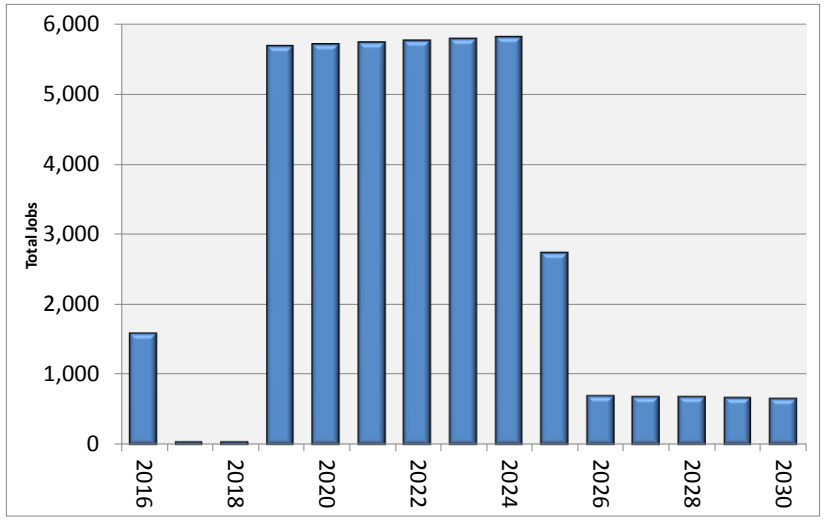

Figure 10. 1,000 MW offshore wind farm, total annual employment impact

Jobs Impacts and Industry Sectors

We looked at estimated jobs by 3-digit NAICS industry sectors to identify sectors that would see the greatest jobs impact from installation of a 1,000 MW wind farm off the coast of South Carolina. This information can provide workforce development officials with information to help them plan for and implement appropriate training and skill development programs to serve the needs of industries involved in wind farm construction.

Industries with the largest jobs impact were ranked by estimated employment for the years 2016-2025, the period in which the wind farm is being developed. They were also ranked for 2026-2030, a strictly O&M phase of the project (Tables 19 and 20).

The five industries with the largest employment impact over the years 2016-2025 are sectors largely directly involved in installation and O&M of the wind farm. The tenth-ranked sector is involved in turbine component manufacturing. The remaining four industry sectors are associated with the increase in ancillary spending by households resulting from the increase in activity (and a predicted associated increase in population due to workers relocating either temporarily or permanently to the state) in the state economy, including food services and medical care.

The seven industry sectors with the largest employment impact during the operational phase are all associated with O&M activities. The remaining three sectors are associated with demand generated by induced effects, including demand for food services, health care, and state and local government services.

Table 19. Top Ten NAICS Sectors by Estimated Total Employment Impact Wind Farm Construction Phase (2016-2025)

Rank	NAICS Code	Description	Average Annual Jobs
1	234	Heavy Construction	1,502
2	488	Support Activities for Transportation	349
3	541	Professional, Scientific, and Technical Services	166
4	551	Management of Companies and Enterprises	148
5	561	Administrative and Support Services	121
6	722	Food Services and Drinking Places	129
7	622	Hospitals	80
8	621	Ambulatory Health Care Services	78
9	813	Religious, Grantmaking, Civic, Professional, and Similar Organizations	69
10	332	Fabricated Metal Product Manufacturing	66

Table 20. Top Ten NAICS Sectors by Estimated Total Employment Impact Wind Farm O&M Phase (2026-2030)

Rank	NAICS Code	Description	Average Annual Jobs
1	541	Professional, Scientific, and Technical Services	102
2	551	Management of Companies and Enterprises	58
3	561	Administrative and Support Services	49
4	483	Water Transportation	49
5	811	Repair and Maintenance	42
6	333	Machinery Manufacturing	36
7	488	Support Activities for Transportation	32
8	722	Food Services and Drinking Places	28
9	621	Ambulatory Health Care Services	16
10	932	State and Local Government	16

Conclusion

While Europe has garnered much experience in offshore wind energy generation, it is a new endeavor in the United States. The opportunity clearly exists for South Carolina to take a leading role in offshore wind energy development, both in terms of wind farm location, supply chain, or both. In this study, we investigated the extent to which the state's existing wind energy supply chain and a 1,000 MW offshore wind farm would impact the state's economy and fiscal situation. These impacts are indeed significant.

In 2012, South Carolina's existing wind energy supply chain provided 1,134 jobs in wind energy manufacturing or service provision activities. These direct jobs generated 1,797 additional jobs in the state economy through indirect and induced effects. The wind energy supply chain contributed $530.2 million in the value of output to the state's economy, and generated $50.4 million in net revenue for state and local governments.

If constructed, a 1,000 MW offshore wind farm would have a much larger economic impact on the state of South Carolina, adding an estimated 3,900 total jobs in the average year (direct, indirect and induced) during the 10 year construction period and 680 jobs in the average year after that for ongoing O&M activities. Between 2016 and 2030, construction and operation of the proposed wind farm would contribute close to $2.2 billion in wages and $4.2 billion in the value of output to the state's economy. State and local governments would receive an estimated $683 million in total.

In order to illustrate the upper bounds of what might be possible, we constructed one final economic impact model assuming that South Carolina had the production and service capabilities to capture 100% of the manufacture, installation, and O&M activities associated with a proposed 1,000 MW offshore wind farm in all related industry sectors.

Under this scenario, the total impact per MW installed per year would be approximately 75 jobs, $3.6 million in disposable income, and $6.6 million in output statewide. The net fiscal impact per MW installed per year would be approximately $665,000 for state government and $486,000 for local governments. For an installation schedule of 100 MW per year, say, the economic impacts associated with component manufacture, turbine installation, and O&M would add 7,500 jobs and hundreds of millions to the state's economy in income and output. Such a state of affairs may be extremely unlikely, but demonstrates the economic potential for South Carolina that exists in offshore wind energy.

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APPENDIX A: SOUTH CAROLINA WIND INDUSTRY CENSUS

Cover Message: South Carolina Wind Industry Census

Clemson University is conducting a census of wind energy component manufacturers, operations and maintenance providers, and other related industries.

- The purpose of this census is to identify manufacturers and service companies currently of the wind industry supply chain in South Carolina.
- The census will provide Clemson University researchers with needed information to assess the impact of the industry on the state's economy.
- The census will also give the state's economic developers a benchmark against which to measure future growth in the industry.

The South Carolina Wind Energy Industry Census is funded by a **U.S. Department of Energy** grant with oversight from the **South Carolina Energy Office.**

We also understand the sensitivity of this request and assure that your participation and information will be kept *confidential*, with results presented in aggregate form. In return for your participation, you will receive an advance copy of the final report.

If you have any questions about the survey, or would like more information, please contact:
Clemson University Restoration Institute
843.554.7226

Please fill out your contact information.

Your Name _____
Company Name _____
Job Title _____
Email Address _____
Mailing Address _____
City _____
State_____
Zip _____

Q1. List the total number of employees working for your company at all your location in South Carolina [TEXT RESPONSE].

Q2. List how many out of your company's total South Carolina employees spend part or all of their time on wind energy related production or service activities [TEXT RESPONSE].

Q3. We want to estimate the economic impact of the wind energy supply chain on the economy of South Carolina. To assist this work, please give us some general information about the types of jobs held in your company's South Carolina wind energy employees and their associated average salary or wage levels.

- Number of production jobs
- Average annual salary for production jobs (if salaried annually)
- Number of professional/technical/management jobs
- Average annual salary for professional/technical/management jobs (if salaried annually)
- Average hourly wage for professional/technical/management jobs (if salaried hourly)

Q4. Please give us some general information on your company's future business plans in South Carolina over the next one to five years.

		Increase from current level	Decrease from current level	Stay about the same	Don't Know
1	Capital Investment				
2	Employment				
3	Add new products/services				

Q5. Select the option(s) that best describes the primary function of your company's South Carolina location(s). (Please select all that apply.)

#	Choices	Response
1	Component or Material Supplier	
2	Wind Turbine OEM	
3	Developer	
4	Engineering Procurement & Construction	
5	Operations & Management	
6	Other	

Q6. Select your company's market(s). Please select all that apply.

#	Choices	Response
1	United States	
2	Canada	
3	Mexico	
4	Western Europe	
5	Eastern Europe	
6	China	
7	South America	
8	Asia (rest of Asia)	
9	Other	

Q7. Provide the percentage of your sales that stay in the United States [TEXT RESPONSE].

Q8. Select the options(s) that best describe the area(s) of wind manufacturing and/or service your company provides in South Carolina.

#	Choices	Response
1	Blades	
2	Gearbox	
3	Generator	
4	Bearings	
5	Power Converter	
6	Transformer	
7	Tower	
8	Pitch System	
9	Power Cables	
10	Castings	
11	Forgings	
12	Resins	
13	Reinforcement Fibers	
14	Subaquatic cables	
15	Other	
16	Turbine/Tower Service & Maintenance Contracts	

Q9. Were the factors listed below important in your company's decision to locate in South Carolina?

#	Choices	Yes	No	Not Applicable/Don't Know
1	Access to finance			
2	Supportive state regulatory structure			
3	Ease of local permitting & sitting			
4	Availability of competitive & skilled workforce			
5	Availability of economic development incentives			
6	Ease of logistics/transportation networks			
7	Expanded current location(s) in SC			
8	Suppliers located in SC or nearby			
9	Quality of life			

Q10. What are the risks facing your company at this time? (Please select all that apply)

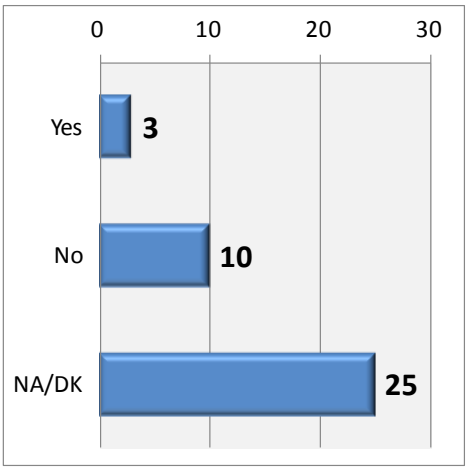
#	Choices	Response
1	Industry volatility	
2	Expiration of federal production tax credit	
3	Inconsistent renewable energy targets among states	
4	Inconsistent renewable energy targets among countries	
5	Attracting and/or retaining qualified employees	
6	Competition from foreign companies	
7	Other	

Q11. To help promote the industry, we wish to compile a comprehensive list of companies in the wind energy supply chain in South Carolina. Please assist us by listing the names of other wind energy related companies that have facilities in South Carolina. [TEXT RESPONSE]

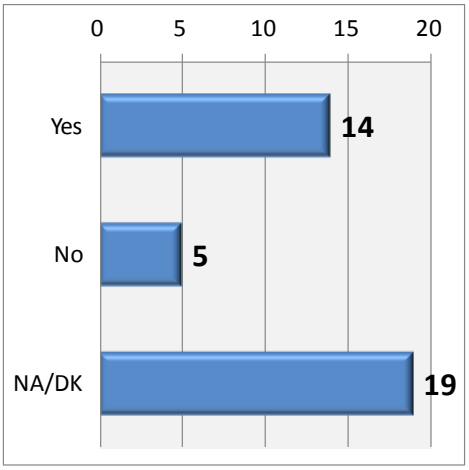
Q12. Please provide your company's North American Industry Classification System (NAICS) or Standard Industrial Classification (SIC) code, if you know it. [TEXT RESPONSE]

NAICS	SIC

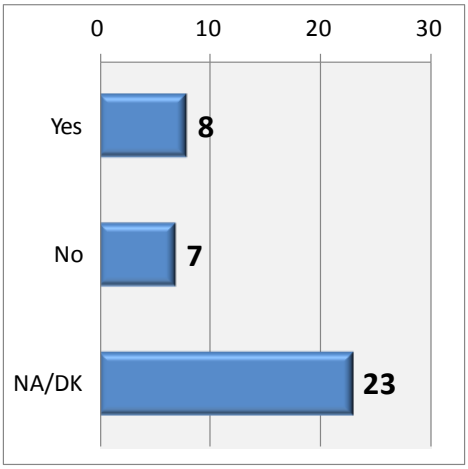
Appendix B: Firm Location Factors Detail



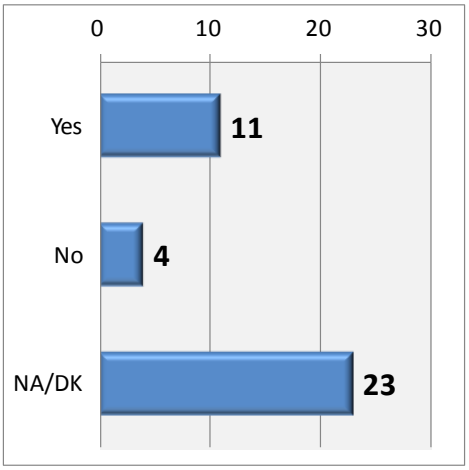
Access to finance



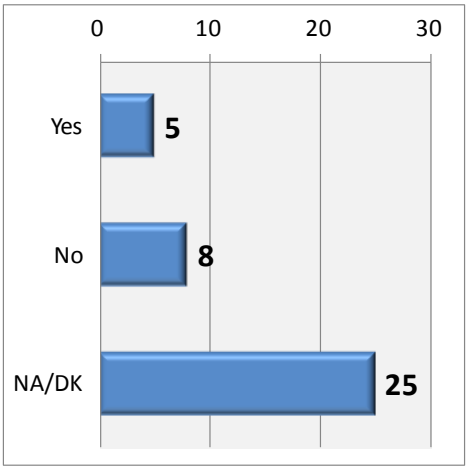
Availability of competitive & skilled workforce



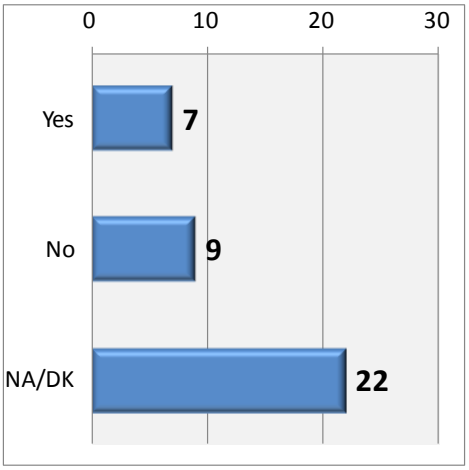
Ease of local permitting & siting



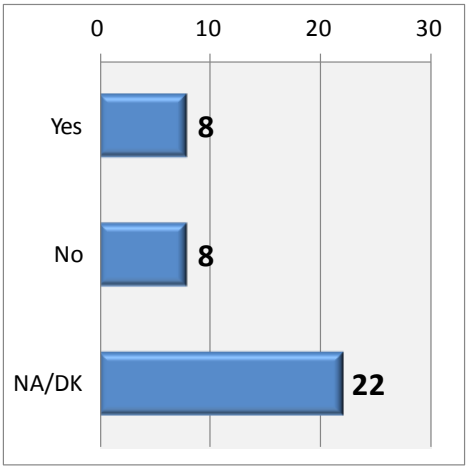
Supportive state regulatory structure



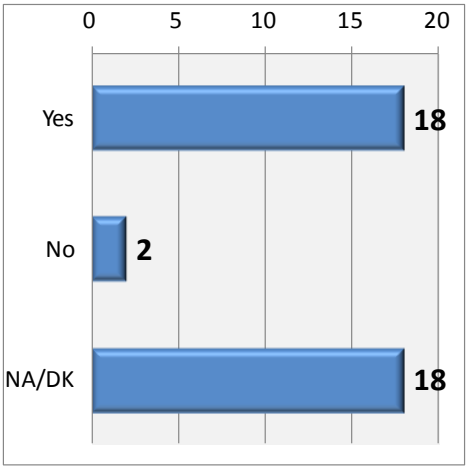
Availability of economic development incentives



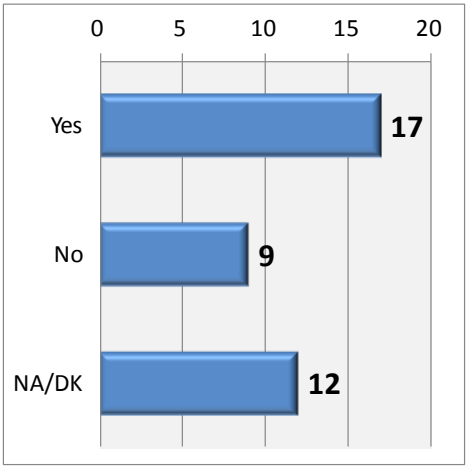
Firm suppliers located in SC or nearby



Ease of logistics and transportation networks



Quality of life



Expanded current location(s) in SC

APPENDIX C: TOTAL 1,000 MW OFFSHORE WIND FARM IMPACT DETAIL

Table C1. Estimated Impact from Turbine Component Manufacture

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030
Employment (total jobs)	129	0	0	457	449	442	435	428	421	166	0
Wage Bill ($1000s)	$7,384	$0	$0	$27,543	$27,496	$27,450	$27,406	$27,363	$27,321	$10,913	$0
Disposable Income ($1000s)	$7,281	$0	$0	$27,167	$27,124	$27,081	$27,040	$26,999	$26,961	$10,769	$0
Output ($1000s)	$21,964	$0	$0	$82,355	$82,351	$82,348	$82,344	$82,341	$82,338	$32,934	$0
Net State Government Rev. ($1000s)	$1,486	$0	$0	$4,905	$4,920	$4,934	$4,947	$4,960	$4,972	$1,993	$0
Net Local Government Rev. ($1000s)	$1,071	$0	$0	$3,598	$3,606	$3,614	$3,621	$3,628	$3,635	$1,456	$0

Table C2. Estimated Impact from Turbine Installation

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030
Employment (total jobs)	1,451	0	0	5,184	5,103	5,025	4,950	4,877	4,807	1,896	0
Wage Bill ($1000s)	$65,559	$0	$0	$245,255	$245,038	$244,816	$244,591	$244,365	$244,140	$97,566	$0
Disposable Income ($1000s)	$64,653	$0	$0	$241,946	$241,756	$241,561	$241,361	$241,160	$240,958	$96,303	$0
Output ($1000s)	$108,170	$0	$0	$405,891	$405,958	$406,019	$406,073	$406,123	$406,166	$162,482	$0
Net State Government Rev. ($1000s)	$13,202	$0	$0	$43,715	$43,885	$44,045	$44,194	$44,334	$44,464	$17,835	$0
Net Local Government Rev. ($1000s)	$9,508	$0	$0	$32,061	$32,162	$32,256	$32,343	$32,425	$32,501	$13,029	$0

Table C3. Estimated Impact from Operations and Maintenance

	2016*	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030
Employment (total jobs)	0	33	32	31	146	257	365	468	569	666	659
Wage Bill ($1000s)	$0	$1,740	$1,732	$1,725	$8,160	$14,546	$20,886	$27,184	$33,443	$39,667	$41,633
Disposable Income ($1000s)	$0	$1,625	$1,618	$1,610	$7,618	$13,577	$19,492	$25,365	$31,202	$37,004	$38,817
Output ($1000s)	$0	$4,630	$4,627	$4,624	$21,952	$39,262	$56,556	$73,835	$91,100	$108,354	$115,078
Net State Government Rev. ($1000s)	$0	$329	$307	$307	$1,461	$2,617	$3,774	$4,932	$6,092	$7,252	$7,733
Net Local Government Rev. ($1000s)	$0	$239	$225	$225	$1,071	$1,917	$2,762	$3,607	$4,453	$5,298	$5,635

*** O&M model lagged one year behind wind farm installation.**

Table C4. Total Estimated Impact

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2030
Employment (total jobs)	1,580	33	32	5,672	5,699	5,724	5,749	5,773	5,797	2,728	659
Wage Bill ($1000s)	$72,943	$1,740	$1,732	$274,523	$280,694	$286,812	$292,883	$298,912	$304,904	$148,146	$41,633
Disposable Income ($1000s)	$71,934	$1,625	$1,618	$270,723	$276,497	$282,218	$287,892	$293,525	$299,120	$144,076	$38,817
Output ($1000s)	$130,135	$4,630	$4,627	$492,870	$510,261	$527,629	$544,973	$562,298	$579,605	$303,770	$115,078
Net State Government Rev. ($1000s)	$14,689	$329	$307	$48,928	$50,267	$51,596	$52,915	$54,226	$55,528	$27,080	$7,733
Net Local Government Rev. ($1000s)	$10,579	$239	$225	$35,884	$36,839	$37,786	$38,727	$39,661	$40,589	$19,783	$5,635