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VINEYARD WIND

Draft Construction and Operations Plan

Volume III Appendices

Vineyard Wind Project

June 3, 2020

Submitted by

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700 Pleasant Street, Suite 510
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Submitted to

Bureau of Ocean Energy Management
45600 Woodland Road
Sterling, Virginia 20166

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Draft Construction and Operations Plan

Volume III Text

Vineyard Wind Project

Submitted to:

BUREAU OF OCEAN ENERGY MANAGEMENT
45600 Woodland Rd
Sterling, VA 20166

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Public Archaeology Laboratory, Inc.
RPS
Saratoga Associates
Swanson Environmental Associates
Wood Thilsted Partners Ltd
WSP

June 3, 2020

1. Supplemental Economic Analysis
2. Proposed Vineyard Wind Offshore Wind Energy Project; Estimated Contribution to Employment and Economic Development

Supplemental Economic Analysis

VINEYARD WIND PROJECT Lease Area OCS-A 0501 North

Submitted to:

BUREAU OF OCEAN ENERGY MANAGEMENT
45600 Woodland Rd
Sterling, VA 20166

Prepared by:

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March 31, 2020

SUPPLEMENTAL ECONOMIC ANALYSIS, MARCH 2020

Summary

Vineyard Wind 1 (the “Project”) is an 800 megawatt (MW) offshore wind project proposed for Lease Area OCS-A 0501. Developing, constructing, operating, and maintaining the Project will bring significant employment and other economic benefits to both Massachusetts and Southeastern Massachusetts (SEMA), and will generate jobs in a diverse range of occupations that represent a wide distribution of skill and educational levels. The Project’s potential to generate substantial and positive economic impact in both Massachusetts and SEMA is supported by a comprehensive analysis conducted by the Public Policy Center at UMass Dartmouth. The resulting report was included as Appendix III-L in the Project’s Construction and Operations Plan (COP), submitted to BOEM in December 2017.

The UMass Dartmouth analysis was based on an 800 MW Project and a maximum Project Envelope design scenario of up to 100 WTGs. In December 2019, Vineyard Wind expanded the Project Envelope to include from 8 to 14 MW WTGs. If selected, a 14 MW WTG could reduce the number of WTGs deployed from a maximum of up to 100 to a potential minimum of 57. A 57 WTG scenario is by no means certain as other Project configurations with higher numbers of WTGs remain under active consideration.

At BOEM’s request, Vineyard Wind has provided the following economic values to reflect the range of employment and other economic benefits associated with the expanded Project Envelope of 57 to 100 WTGs. As this supplemental economic analysis demonstrates, the Project, in any configuration, will deliver substantial economic benefits to Massachusetts and SEMA. The potential range of values for the direct, indirect, induced, and tax revenue impacts of the Project are summarized as follows:

- ◆ The Project will directly support an estimated minimum of 1,100-1,142 full-time equivalent (FTE) job years statewide during the pre-construction, construction, and installation periods and 73-80 FTEs annually during operations and maintenance (O&M), for a total of 2,025 – 2,225 FTE job years. Total O&M job figures are based on a 25-year operational period, but have the potential to be higher as the Project is requesting a 30-year operational period.
- ◆ Spending associated with direct impacts is estimated to generate and support a significant number of additional indirect and induced jobs. Specifically, Vineyard Wind’s direct payroll and non-payroll expenditures are expected to result in 373 – 387 indirect jobs statewide during the pre-construction, construction, and installation periods. Direct and indirect impacts from the Project are projected to induce an additional 898 – 932 jobs during the same period and support an additional 81 – 89 indirect and induced jobs annually during O&M.

- ◆ The new economic activity generated by the Project will also have a substantial positive impact on state and local tax receipts. Specifically, the development, construction, and first year of O&M of Vineyard Wind 1 will generate between \$13.6 – \$14.7 million in state and local tax revenues. This includes an estimated increase in Massachusetts personal income tax payments of \$3.4–\$4.1 million, an increase in sales taxes of \$2.7 – \$3.0 million, and an increase in local property taxes of at least \$5.1 million. Notably, these tax impacts include only one year of O&M expenditures although tax payments will continue annually over the Project’s multi-decade operational life.

This supplemental economic analysis also shows that the range of potential employment and other economic benefits for the expanded Project Envelope is not directly dependent on the number of WTGs for the Project. More specifically, the economic benefits associated with the 57 WTG scenario do not differ materially from the maximum design scenario of up to 100 WTGs assessed in the UMass Dartmouth report. This is due primarily to the fact that a linear relationship does not exist between the number of WTGs and an offshore wind project’s economic benefits. Also relevant is the Project’s federal permitting delay, which has increased Vineyard Wind 1’s development and pre-construction period by two years, thus increasing the FTE job years carried during that phase of the Project by an estimated 100 FTEs per year. This delay not only increases Vineyard Wind’s development and pre-construction jobs, but also the jobs for the numerous consultants working on the project. The federal permitting delay also largely offsets potential changes in both Direct Labor Income and Non-Labor Expenditures during the same period. As a result of the two year delay, the revised economic estimates demonstrate that the 57 WTG scenario would result in a slightly higher number of direct, indirect, and induced jobs than the maximum design scenario assessed in the 2017 UMass Dartmouth report in the pre-construction, construction, and installation phases. While this analysis has not updated the 100 WTG scenario for the continued employment and economic impact during the two-year permitting delay, the estimated 100 FTEs supported by Vineyard Wind during the delay would apply to both scenarios.

Overall, this supplemental economic analysis demonstrates that, regardless of which configuration is selected, the Project will deliver substantial employment and other economic benefits to Massachusetts and SEMA. The range of WTG numbers included within the Project Envelope does not significantly alter the key outputs relating to the employment and economic output impacts of the Project. Moreover, as explained below, the economic values presented herein are conservative and represent the maximum likely range for the expanded Project Envelope based on the potential minimum number of WTGs installed. Finally, as Vineyard Wind 1 would be the first commercial-scale offshore wind project in the US, the Project will play a critical role establishing the offshore wind sector in Massachusetts and help realize the tremendous potential economic benefits of this rapidly emerging industry.

Introduction

In December 2017, Vineyard Wind submitted a COP to BOEM for Vineyard Wind 1, an 800 MW wind energy project consisting of up to 100 WTGs in the northern portion of Lease OCS-A 0501. The Project is expected to bring significant employment and other economic benefits to both Massachusetts and SEMA. The Project also represents an important foundational step in creating a thriving, utility scale, domestic offshore wind industry in the US.

Economic benefits from the Project will occur throughout the preconstruction, construction, O&M, and decommissioning phases and include:

- ◆ The Project has already opened and staffed offices in New Bedford and Boston and has engaged a number of Massachusetts-based professionals to support elements of the design effort, licensing, and permitting.
- ◆ The construction and installation process will make use of existing port facilities, and the Project has already signed a letter of intent to utilize the New Bedford Marine Commerce Terminal. To the extent feasible, construction materials and other supplies, including vessel provisioning and servicing, will be sourced locally.
- ◆ Vineyard Wind also plans to locate the Project's O&M facilities in Vineyard Haven on Martha's Vineyard. The Project will also make local and regional purchases of goods and services throughout the multi-decade O&M period.

The Vineyard Wind 1 COP includes a comprehensive analysis by UMass Dartmouth confirming that the Project would result in substantial and positive economic benefits in both Massachusetts and SEMA. UMass Dartmouth analyzed the potential economic benefits of the Project using IMPLAN (IMPact Analysis for PLANning), which is an input-output database and model that traces a project's purchases of goods, services, and labor through an economic area. The resulting UMass Dartmouth report included the following key outputs relating to the employment and economic output impacts of the Project in Massachusetts and SEMA:

- ◆ Direct, indirect, and induced jobs created;
- ◆ Direct, indirect, and induced labor income and non-payroll expenditures; and
- ◆ Project tax revenues.

Among other things, the report shows that the Project will require workers drawn from a diverse range of occupations that represent a wide distribution of skill and educational levels, ranging from white collar jobs such as environmental scientists and engineers to blue collar jobs such as iron workers, longshoremen, and machine operators. The report also notes that the "steady and well-paying jobs" created by the Project during the O&M period will "have a significant positive impact on Martha's Vineyard economy, which experiences severe seasonal fluctuations in

employment due to its largely tourism dependent economy” and will result in a “positive and stabilizing impact on one of the Commonwealth’s most highly seasonal regional economies beyond that which can be directly captured by this analysis.”

In developing economic estimates for the Project, UMass Dartmouth assessed the employment and other economic benefits and impacts from the installation of 100 WTGs at 8 MW each (the maximum design scenario). In December 2019, Vineyard Wind expanded its Project Envelope to include up to 14 MW WTGs, which if utilized, could reduce the number of WTGs deployed in the original Project Envelope of up to 100 WTGs to a potential minimum of 57 WTGs. A change in the number of WTGs could alter some of the Project’s impacts on Massachusetts employment and economic output, primarily those local activities relating to the staging and installation of the foundations and WTGs during the construction phase, and the O&M of the WTGs during the O&M period.

At BOEM’s request, Vineyard Wind has utilized quantitative and qualitative analysis to provide updated figures for a scenario of 57 WTGs for the Project so the employment and other economic benefits of the expanded Project Envelope can be fully understood. It is by no means certain that the Project will use 14 MW WTGs as Project configurations with higher numbers of WTGs remain under active consideration. The below analysis describes the steps required to update the number of jobs, expenditures, and tax revenues.

Vineyard Wind is providing revised economic values for the following tables included in the Project’s Draft Environmental Impact Statement (DEIS):

- ◆ **Table 3.4.1-2:** Vineyard Wind’s Projected Jobs and Expenditures during Preconstruction, Construction, and Installation (Base Estimate)
- ◆ **Table 3.4.1-3:** Projected Tax Revenues, Development, Construction, and First Year Operations and Maintenance (Base Case)
- ◆ **Table 3.4.1-4:** Jobs and Economic Impact during Operations and Maintenance (Base Case)

The sections that follow are categorized by Direct Impacts, Indirect and Induced Impacts, and Tax Revenues. Each section provides both the range of employment and other economic benefits previously developed for the 100 WTG scenario and an overview of the approach used to estimate the economic benefits for the expanded Project Envelope reflecting the scenario of 57 WTGs for the Project.

Direct Impacts

As described in Section 3 of the UMass Dartmouth report, “direct impacts” are those that “result from expenditures associated with developing, constructing, and operating the wind farm, including money spent on salaries, supplies, and operating expenses.” Vineyard Wind provided UMass with detailed estimates and expenditures for each phase of Vineyard Wind 1. These estimates were based on Vineyard Wind’s extensive experience and knowledge building similar

sized projects in Europe, as well as information Vineyard Wind required supply chain companies to provide when submitting proposals to supply or service the Project. UMass Dartmouth subsequently reviewed Vineyard Wind’s inputs, using its own expertise and data gathered from previous work, interviews with offshore wind industry leaders, site visits to wind projects and ports in Europe, and an extensive literature review.

Adjustments to Direct Impacts

The Project is comprised of 11 different major components (referred to as “packages”) that drive overall economics and potential economic benefits. Of these 11 packages, only three packages—WTG, Foundations, and Operating Expenditures (OPEX)—would be affected by changes to the number of WTGs. What’s more, while these three packages include 21 separate activities, only eight of the 21 activities are related to the number of WTGs.

For the three packages, a conservative (57 WTG) scenario would adjust the direct impact estimates from the 100 WTG scenario in a manner that is proportional to the change in the number of WTGs, however, a linear relationship does not exist between these two factors. Nevertheless, Vineyard Wind employed this approach for the WTG and Foundation packages during the pre-construction, construction, and installation phase of the Project. The conservative nature of this approach is underscored by the fact that some activities have start up, base, or mobilization costs and associated labor costs that would be incurred regardless of the type or number of WTGs. In addition, there are significant counter balancing effects on job creation and economic expenditures that would result from an increase in the size of the Project’s WTGs. For example, the Project may still need just as large a harbor workforce for installation activities over the same period of time, a larger workforce over a shorter period, or fewer workers for a longer period. All else equal, larger components have higher costs per component, which has an offsetting effect on the spending reduction from utilizing fewer components.

For the OPEX package, only two of the 10 activities may change due to the use of larger WTGs in the expanded Project Envelope. Vineyard Wind utilized Project-specific estimates from its internal team of experts to estimate potential changes to these activities. These estimates are derived from extensive experience and knowledge building similar sized projects in Europe, as well as information Vineyard Wind developed during the advanced stages of the WTG procurement and O&M planning processes for the Project.

Importantly, the revised direct impact figures do not account for the fact that the maximum design scenario of up to 100 WTGs included a denser layout than the 1 by 1 nautical mile layout currently being considered by BOEM. This means that despite the potential for fewer WTGs in the expanded Project Envelope, the Project area is not being reduced one for one. This has mitigating effects on those packages and activities potentially impacted by a change in the number of WTGs, in particular, OPEX as well as WTG logistics and commissioning.

For the above reasons, the range of estimates provided for the expanded Project Envelope may overstate the potential changes to direct economic impacts for the 57 WTG scenario.

Indirect and Induced Impacts

The indirect and induced effects of the direct employment and economic output impacts of the Project are derived from industry-, sector, and activity-specific multipliers, which are the basis upon which IMPLAN makes estimations of the potential impacts of economic changes, such as employment, labor income, output, and value added. Given that the type of activities and economic sectors would not change based on the number of WTGs, the same multipliers used in the UMass Dartmouth report are used to estimate the range of indirect and induced impacts for the expanded Project Envelope.

Tax Revenues

UMass Dartmouth generated tax revenue estimates for the Project using IMPLAN and the direct impact estimates provided by Vineyard Wind. Table 1 shows the estimated maximum level of state and local tax revenues projected to be generated by the Project, as estimated by UMass Dartmouth, as well as whether or not a specific category of tax revenue could be affected by the number of WTGs installed. The categories of tax revenues affected include personal income taxes, other personal taxes, and sales taxes, due primarily to the potential for the number of WTGs installed to impact direct labor and non-labor expenditures.

Table 1 Estimated Tax Revenues

| Tax Revenue Category | 100 WTG Estimate (thousands) | Impacted by Number of WTGs? | Expenditure Category |
|------------------------|------------------------------|-----------------------------|----------------------|
| Personal income taxes | \$4,133 | Yes | Labor |
| Other personal taxes | \$547 | Yes | Labor |
| Payroll taxes | \$67 | No | Labor |
| Sales taxes | \$3,019 | Yes | Non-Labor |
| Property taxes | \$5,178 | No | Non-Labor |
| Corporate income taxes | \$1,231 | No | Non-Labor |
| Fees and other taxes | \$500 | No | Non-Labor |
| Total | \$14,674 | | |

Given that the affected tax revenue categories are directly tied to the Project's direct labor and non-labor expenditures, a reasonable approach to estimate potential tax revenues for the expanded Project Envelope is to adjust each impacted category's estimated tax revenues by the percentage change in total labor and non-labor income between the maximum design scenario of up to 100 WTGs and the 57 WTG scenario. Table 3 below provides the calculated adjustment percentage based on the change in direct labor and non-labor expenditures, and the resulting adjusted estimated range for tax revenues generated by the Project.

Note that the revised figures in Table 3 do not account for the fact that the Project will have employed its project management and development teams for two years longer than originally estimated due to federal permitting delays, which will offset potential changes in personal income tax and other personal tax revenues, while increasing payroll tax revenues. As noted above, the federal permitting delay has increased the development and pre-construction period by two years, thus increasing the FTE job years carried during that phase of the Project by an estimated 100 FTEs per year.

Results

This section provides revised estimates for tables included in the Vineyard Wind 1 DEIS that pertain to the Project's estimated economic impacts in the Commonwealth of Massachusetts. These tables have been updated to include the range of expected employment and other economic benefits for the expanded Project Envelope. Tables 2 through 4 included below, respectively, are the revised versions of the following tables from the DEIS:

- ◆ **Table 3.4.1-2:** Vineyard Wind's Projected Jobs and Expenditures during Preconstruction, Construction, and Installation (Base Estimate)
- ◆ **Table 3.4.1-3:** Projected Tax Revenues, Development, Construction, and First Year Operations and Maintenance (Base Case)
- ◆ **Table 3.4.1-4:** Jobs and Economic Impact during Operations and Maintenance (Base Case)

The estimates provided in these tables for the 57 WTG scenario reflect the data and methodology employed by UMass Dartmouth in the December 2017 report and the revised direct impact estimates provided by Vineyard Wind based on the expanded Project Envelope. The estimates provided for the up to 100 WTG scenario are the economic benefit figures previously developed by UMass Dartmouth.

Table 2 (below) shows the Project will directly support an estimated minimum of 1,100-1,142 FTE job years statewide during the pre-construction, construction, and installation period. In SEMA, conservative estimates indicate that the expanded Project Envelope will result in 954 – 1,071 direct jobs, 192 – 215 indirect jobs, and 593 – 666 induced jobs in the same period. These figures reflect the fact that jobs and expenditures during this period are not directly proportional to the number of WTGs installed.

The Project's two-year federal permitting delay has also been taken into account in the employment and economic impact estimates provided for the 57 WTG scenario. While this analysis has not updated the 100 WTG scenario for the continued employment and economic impact during the two-year permitting delay, the ~100 FTEs supported by Vineyard Wind during the delay would apply to both scenarios. As a result, the expanded Project Envelope results in a slightly higher number of direct, indirect, and induced jobs statewide during this period compared to the maximum design scenario assessed in the 2017 UMass Dartmouth report. This delay has

increased Vineyard Wind 1’s development and pre-construction period by two years, thus increasing the FTE job years carried during that phase of the Project by an estimated 100 FTEs per year. This delay not only increases the development and pre- construction jobs for Vineyard Wind, but also for its lead permitting consultant team and associated subconsultants. Almost all these jobs are in the state of Massachusetts.

The federal permitting delay also largely offsets potential changes in both Direct Labor Income and Non- Labor Expenditures during this period. Statewide, the expanded Project Envelope is estimated to generate Direct Labor Income of \$123.6 – \$114.9 million and Direct Expenditures (other than payroll) of \$178.8 – \$177.4 million. Conservative estimates indicate that, in SEMA, the expanded Project Envelope would result in Direct Labor Income of \$81.9 – \$91.5 million and Direct Expenditures (other than payroll) of \$100.3 – \$104.9 million during this period.

Table 2 Revised Vineyard Wind DEIS Table 3.4.1-2: Vineyard Wind’s Projected Jobs and Expenditures during Preconstruction, Construction, and Installation (Base Estimate)

| Scenario | | Massachusetts Statewide | | Southeastern Massachusetts | |
|---|----------|-------------------------|-------------------|----------------------------|-------------------|
| | | 57 WTGs Estimate | 100 WTGs Estimate | 57 WTGs Estimate | 100 WTGs Estimate |
| Jobs (FTE) ^a | Direct | 1,142 | 1,100 | 954 | 1,071 |
| | Indirect | 387 | 373 | 192 | 215 |
| | Induced | 932 | 898 | 593 | 666 |
| Direct Labor Income (thousands) | | \$123,633 | \$114,858 | \$81,927 | \$91,502 |
| Direct Expenditures other than payroll (thousands) ^b | | \$178,821 | \$177,363 | \$100,334 | \$104,850 |

^a One FTE (full-time equivalent) job is the equivalent of one person working full time for 1 year (2,080 hours). Thus, two half-time employees would equal one FTE. Only those jobs that Vineyard Wind would perform in the designated area are included.

^b Amount to be spent procuring materials and services from the suppliers in the designated area to support the development and construction of the wind facility.

Similarly, Table 3 (below) provides the estimated range for Projected Tax Revenues, Development, Construction, and First Year Operations and Maintenance for the expanded Project Envelope. Overall, the Project is estimated to yield \$13.6 – \$14.7 million in new tax revenues in Massachusetts during development, construction, and the first year of O&M. This includes an estimated increase in Massachusetts personal income tax payments of \$3.4 – \$4.1 million, an increase in sales taxes of \$2.7– \$3.0 million, and an increase in local property taxes of at least \$5.1 million. As these figures reflect, tax revenues are more directly related to overall Project expenditures rather than the specific number of WTGs. In particular, estimated payroll taxes, local property taxes, corporate income taxes, and fees and other taxes are the same regardless of the Project configuration. Total tax revenues generated by the Project will be higher than the figures presented herein as they include only one year of O&M while tax payments will continue annually over the Project’s multi-decade operational life.

Table 3 Revised Vineyard Wind DEIS Table 3.4.1-3: Projected Tax Revenues, Development, Construction, and First Year Operations and Maintenance (Base Case)

| Tax Revenue Category | Estimated Revenue (thousands) | |
|----------------------------|-------------------------------|-------------------|
| | 57 WTGs Estimate | 100 WTGs Estimate |
| Personal income taxes | \$3,430 | \$4,133 |
| Other personal taxes | \$454 | \$547 |
| Payroll taxes ^a | \$67 | \$67 |
| Sales taxes | \$2,717 | \$3,019 |
| Property taxes | \$5,178 | \$5,178 |
| Corporate income taxes | \$1,231 | \$1,231 |
| Fees and other taxes | \$500 | \$500 |
| Total | \$13,577 | \$14,674 |

^a Includes both employee and employer paid payroll taxes.

Table 4 (below) provides the revised economic values for the expanded Project Envelope in relation to Jobs and Economic Impact during Operations and Maintenance. The updated economic analysis projects 73 – 80 direct FTEs annually, for a total of 2,025 – 2,225 FTE job years. Direct and indirect impacts from the Project are expected to support an additional 81 – 89 indirect and induced jobs annually during O&M. These figures demonstrate that, employment and other economic benefits in the O&M period are not directly proportional to the number of WTGs. Further, total jobs and economic impacts have the potential to be higher as these estimates are based on a 25-year operational period while the Project is requesting a 30-year operational period.

Table 4 Revised Vineyard Wind DEIS Table 3.4.1-4: Jobs and Economic Impact during Operations and Maintenance (Base Case)

| Scenario | | Massachusetts Statewide | | Southeastern Massachusetts | |
|--|----------------------|-------------------------|-------------------|----------------------------|-------------------|
| | | 57 WTGs Estimate | 100 WTGs Estimate | 57 WTGs Estimate | 100 WTGs Estimate |
| Jobs (FTE) ^a | Direct | 73 | 80 | 73 | 80 |
| | Indirect and Induced | 81 | 89 | 81 | 89 |
| | Total | 154 | 169 | 154 | 169 |
| Annual labor income (thousands) | Direct | \$7,548 | \$8,151 | \$7,512 | \$8,151 |
| | Indirect and Induced | \$5,886 | \$6,356 | \$3,730 | \$4,407 |
| | Total | \$13,434 | \$14,507 | \$11,242 | \$12,198 |
| Annual expenditures (thousands) ^b | Direct | \$4,562 | \$5,215 | \$4,100 | \$4,606 |
| | Indirect and Induced | \$5,423 | \$6,199 | \$4,521 | \$5,079 |
| | Total | \$9,985 | \$11,414 | \$8,621 | \$9,684 |
| Annual added economic value (thousands) ^c | Direct | \$3,485 | \$3,486 | \$2,174 | \$2,388 |
| | Indirect and Induced | \$9,003 | \$9,937 | \$5,889 | \$6,469 |
| | Total | \$12,488 | \$13,783 | \$8,063 | \$8,857 |

^a One FTE job is the equivalent of one person working full time for 1 year (2,080 hours). Thus, two half-time employees would equal one FTE.

^b Amount to be spent procuring materials and services from suppliers in the designated area to support the operations and maintenance of the offshore wind facility, excluding labor costs.

^c Economic value generated by operations and maintenance of the Proposed Action, excluding direct expenditures.

Conclusions

As this updated economic analysis clearly shows, the Project, in any configuration, will deliver substantial economic benefits to Massachusetts and SEMA. The analysis also shows that the expanded Project Envelope does not significantly alter the key outputs relating to the employment and economic impacts of the Project in Massachusetts and SEMA. More specifically, the employment and other economic benefits associated with a 57 WTG scenario do not differ materially from the maximum design scenario of up to 100 WTGs scenario assessed in the UMass Dartmouth report.

The primary reason for this is that the range of potential economic benefits for the expanded Project Envelope is not directly dependent on the number of WTGs. Only three of the Project's 11 packages have the potential to be impacted by a change in the number of WTGs. Of the three packages affected, only eight of the 21 activities are related to the number of WTGs. For specific activities impacted by the number of WTGs, the impact is not directly scalable based on the percentage reduction in WTGs. For the purposes of this updated economic analysis, however, Vineyard Wind conservatively assumed that direct impacts for the WTG and Foundation packages were equivalent to the percentage change in the number of WTGs from the maximum design scenario. This assumption disregards the fact that some activities have start up, base, or mobilization costs and associated labor costs that would be incurred regardless of the type or number of WTGs. What's more, larger components have higher costs per component, which has a moderating effect on the reduction in spending from utilizing fewer components. As such, the estimates provided for the 57 WTG scenario therefore overstate likely potential changes to direct impacts for the expanded Project Envelope.

Further, important developments since the COP for Vineyard Wind 1 was submitted in December 2017 have bolstered the Project's employment and other economic impacts in Massachusetts. Namely, the two-year federal permitting delay has increased the development and pre-construction period by two years, thus increasing the FTE job years carried during that phase of the Project by an estimated 100 FTEs per year. This delay increases the development and pre-construction jobs not only for Vineyard Wind, but also for its lead permitting consultant team and associated subconsultants. Taking this into account, the 57 WTG scenario is estimated to result in a slightly higher number of direct, indirect, and induced jobs than the maximum design scenario assessed in the UMass Dartmouth report in the pre-construction, construction, and installation period.¹

The level of total employment and other economic benefits for the expanded Project Envelope is also likely to be greater than the values presented herein. Projected tax revenues for the expanded Project Envelope, for example, do not account for the fact the Project will have employed

¹ This analysis has not updated the UMass 100 WTG scenario for the continued employment and economic impact during the two-year permitting delay. The ~100 FTEs supported by Vineyard Wind during the delay would also apply to the 100 WTG scenario.

its project management and development team for two years longer than originally estimated due to the federal permitting delay, which will increase personal income taxes, other personal taxes, and payroll taxes revenues. Also, as discussed, the Project is requesting a 30-year operational period which, if granted, would have a positive impact on total jobs, expenditures, and tax revenues during O&M.

Ultimately, the revised economic values presented herein are overly conservative and represent the maximum likely range for the expanded Project Envelope based on the potential minimum number of WTGs installed. Nevertheless, these estimates demonstrate that the expanded Project Envelope does not materially change the expected significant employment and other economic benefits the Project will deliver to both Massachusetts and SEMA. Finally, as Vineyard Wind 1 would be the first commercial-scale offshore wind project in the US, it's also important not to lose sight of the critical role the Project will play in establishing the offshore wind sector in Massachusetts and realizing the tremendous potential economic benefits of this rapidly emerging industry.

Proposed Vineyard Wind Offshore Wind Energy Project

Estimated Contribution to Employment
and Economic Development

800 MW

December 2017



Public Policy Center
UMass Dartmouth

OCS-A
0501



MASS
USA

VINEYARD WIND

Public Policy Center

UMass Dartmouth

Our Mission

The mission of the Public Policy Center (PPC) at UMass Dartmouth is to:

- Inform evidence-based policy making.
- Improve public understanding of critical policy issues.
- Provide educational and research opportunities to our faculty and students.
- Connect the resources of the University of Massachusetts to the communities we serve.

The PPC's primary goal is to inform public policy discussions by providing policy makers with university quality research, technical assistance, and analytical services designed to help make our state, region, and communities better places to live, work, and do business. We do this by leveraging the substantial skills of our students and faculty partners, and enhancing the connections between the University and the communities it serves.

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VINEYARD WIND

Vineyard Wind is hoping to develop the first utility-scale offshore wind energy project off the coast of Massachusetts, generating clean, renewable and cost-competitive energy to power thousands of homes and businesses across the state. The Vineyard Wind parent companies consists of funds managed by Copenhagen Infrastructure Partners (CIP), whose Senior Partners are pioneers with an unparalleled track record in the offshore wind industry, and Avangrid Renewables (AR), the third largest onshore wind developer in the US with operations in more than 20 states, a Lead Market Participant in the ISO-NE market and an affiliate of the Iberdrola Group, the world's largest wind developer with more than 15,000 MW of wind installed.

EXECUTIVE SUMMARY

BACKGROUND

The Public Policy Center (PPC) at UMass Dartmouth conducted this analysis to describe the economic contributions to employment and economic output that the proposed 800 MW Vineyard Wind Offshore Wind Energy Project can be expected to have on the Commonwealth of Massachusetts and the regional economy of Southeastern Massachusetts (SEMA).

This analysis is designed to support the development of a conservative and credible estimate of the economic impact of the Vineyard Wind proposal in response to inquiries contained in the Request for Proposals for Long-Term Contracts for Offshore Wind Energy Projects (RFP) issued by the state's four electric distribution companies in coordination with the Massachusetts Department of Energy Resources (DOER).

Vineyard Wind provided the PPC with detailed job creation estimates and expenditures for each project phase for their proposed 800 MW project. These estimates were based on the Vineyard Wind team's extensive experience and knowledge building similar sized projects in Europe, as well as information Vineyard Wind required supply chain companies to provide when submitting proposals. The PPC thoroughly reviewed the direct job creation and expenditure estimates, applying its expertise informed by data gathered from previous related work, interviews with industry leaders, site visits to European wind farm developments and ports, and an extensive literature review.

MAJOR FINDINGS

A comprehensive analysis of the proprietary project data for the 800 MW OSW development being proposed by Vineyard Wind finds that a substantial and positive economic impact can be expected in both Massachusetts and SEMA (see table below).

Direct FTE Job Years Over the Project Period

| Region | Total Direct FTEs | Pre-Construction & Development | Construction | O&M Annual | O&M Lifetime Job Years | *Total Job-Years |
|----------------------|-------------------|--------------------------------|--------------|------------|------------------------|------------------|
| Massachusetts | | | | | | |
| Base Scenario | 1,180 | 126 | 974 | 80 | 2,000 | 3,180 |
| High Scenario | 1,633 | 126 | 1,426 | 81 | 2,025 | 3,658 |
| SEMA | | | | | | |
| Base Scenario | 1,151 | 119 | 952 | 80 | 2,000 | 3,151 |
| High Scenario | 1,407 | 119 | 1,207 | 81 | 2,025 | 3,432 |

Specifically, in Massachusetts:

- The proposed Vineyard Wind project will support an estimated 3,180 direct FTE job years across all phases over the project period under the Base scenario and 3,658 direct FTE job years in the High scenario. This total includes job years over the entire 25-year Operations phase.

- Under the Base scenario, there are expected to be 1,100 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 80 FTEs annually over 25 years, for a total of 2,000 FTE job years.
- Under the High scenario, there are expected to be 1,552 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 81 FTEs annually over 25 years, for a total of 2,025 FTE job years.
- In terms of the actual number of workers (not FTEs), the project is expected to employ 1,706 workers in the Base scenario and 2,120 workers in the High scenario across all the project phases.

INDIRECT AND INDUCED IMPACTS

The spending associated with direct impacts is estimated to generate and support a significant number of additional indirect and induced jobs in both Massachusetts and SEMA. Specifically, our Base scenario analysis finds that in Massachusetts:

- Vineyard Wind’s direct payroll and non-payroll expenditures are expected to generate an additional 373 indirect jobs in Massachusetts during the Development and Construction phases and support an additional 26 jobs annually during the 25-year Operations period.
- The direct and indirect impacts of the proposed project are expected to induce an additional 898 jobs during the Development and Construction phases and support an additional 63 jobs annually during the 25-year operations period.

In our High Scenario, we find that in Massachusetts:

- Vineyard Wind’s direct payroll and non-payroll expenditures are expected to generate an additional 408 jobs during the Development and Construction phases and support an additional 29 jobs annually during the 25-year Operations period.
- The direct and indirect impacts of the proposed project are expected to induce an additional 1,102 jobs during the Development and Construction phases and support an additional 69 jobs annually during the 25-year operations period.

STATE AND LOCAL TAX IMPACTS

The new economic activity that would result from the development of the proposed 800 MW project will have a substantial and positive impact on state and local tax receipts in Massachusetts and SEMA.

Specifically, we estimate that:

- The amount that will be paid in state and local taxes as a result of the development, construction, and annual operation of the 800 MW Vineyard Wind project is \$14.7 million in the Base scenario and \$17.0 million in the High scenario.
- This includes an estimated increase in Massachusetts personal income tax payments between \$4.1 million and \$4.7 million, an increase in sales taxes between \$5.2 million and \$6.0 million, and an increase in local property taxes between \$3.0 million and \$3.5 million, for the Base and High scenarios respectively.
- Corporate income taxes can be expected to increase by \$1.2 million in the Base scenario and \$1.4 million in the High scenario.

Notably, these tax impacts include only one year of expenditures for the O&M phase, although tax impacts will continue annually over the wind farm’s 25-year lifetime as payroll and non-payroll expenditures are spent to support the wind farm’s operation.

Estimated State and Local Tax Impacts as a Result Of
Vineyard Wind’s Payroll and Non-Payroll Expenditures

| | Base | High |
|-----------------------|--------------|--------------|
| Personal Income taxes | \$4,132,689 | \$4,663,992 |
| Other Personal Taxes | \$546,879 | \$617,186 |
| *Payroll taxes | \$66,770 | \$75,225 |
| Sales taxes | \$3,018,548 | \$3,542,512 |
| Property taxes | \$5,178,301 | \$6,077,159 |
| Corporate taxes | \$1,230,736 | \$1,390,876 |
| Fees & other taxes | \$500,065 | \$586,866 |
| Total | \$14,673,988 | \$16,953,816 |

*Includes both employee and employer paid payroll taxes

Impact of Proposed Community Investments and Host Community Agreements

There are several additional activities proposed by Vineyard Wind that, while not directly related to the Development, Construction, or Operations phases of the proposed project, can be expected to have a positive economic impact on both the Commonwealth and SEMA. The activities include a proposed \$10 million “Offshore Wind Industry Accelerator Fund” and a \$2 million “Windward Workforce” fund that will support the recruitment and training of Massachusetts residents for careers in offshore wind. Vineyard Wind reports that they are also negotiating, or seeking to negotiate, host community agreements with Yarmouth, Barnstable, and possibly other communities and organizations in the project area.

Vineyard Wind Direct Payments

| Payment Description | Amount |
|---|---------|
| Offshore Wind Industry Accelerator Fund | \$10.0m |
| Windward Workforce | \$2.0m |
| Host Community Agreements | \$1.5m |

We estimate that these expenditures will generate a total of 179 jobs, \$14.7 million in total labor income, \$15.1 million in total value added, and \$35.5 million in total output.

Catalyzing High Quality, Year-Round Job Opportunities in a Highly Seasonal Economy

Developing, constructing, operating, and maintaining the proposed 800 MW offshore wind project will require workers drawn from a diverse range of occupations that represent a wide distribution of skill and educational levels, ranging from white collar jobs such as environmental scientists and engineers to blue collar jobs such as iron workers, longshoremen, and machine operators. The workforce needs of the proposed project are well aligned with the education and skill levels of SEMA residents, a region characterized by traditional blue-collar urban areas bordered by more affluent suburbs. Further, the broad occupational needs of the project also provide opportunities for project staff to work their way up the occupational ladder within the emerging OSW industry, whether through continuing education or on-the-job training and acquired experience during the project period.

Notably, these steady and well-paying jobs will have a significant positive impact on Martha's Vineyard economy, which experiences severe seasonal fluctuations in employment due to its largely tourism dependent economy. Adding long-term and high quality year-round employment will significantly increase the number of opportunities for local workers to obtain presently unavailable stable sources of full-time year-round income. This can be expected to have a positive and stabilizing impact on one of the Commonwealth's most highly seasonal regional economies beyond that which can be directly captured by this analysis.

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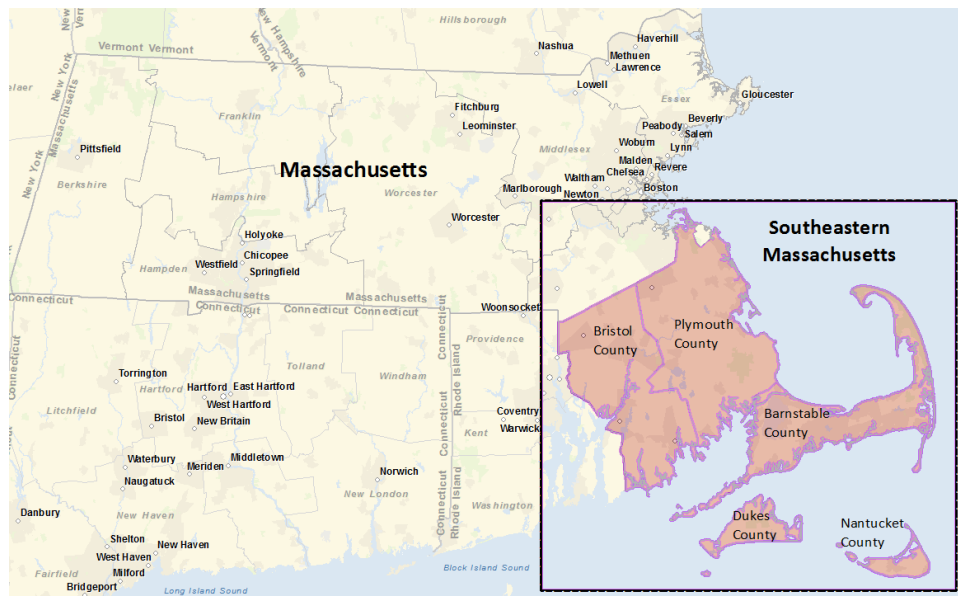
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1 INTRODUCTION

The Public Policy Center (PPC) at UMass Dartmouth conducted this analysis to describe the economic contributions to employment and economic output that the Vineyard Wind Offshore Wind Energy Project can be expected to have on the Commonwealth of Massachusetts and the regional economy of Southeastern Massachusetts (SEMA). SEMA is defined as Barnstable County (Cape Cod), Bristol County, Dukes County (Martha's Vineyard), Nantucket County, and Plymouth County (see Figure 1).

Figure 1
Areas of Analysis



The analysis is designed to support the development of a credible estimate of the economic impact of the Vineyard Wind proposal in response to inquiries contained in the Request for Proposals for Long-Term Contracts for Offshore Wind Energy Projects (RFP) issued by the state's four electric distribution companies in coordination with the Massachusetts Department of Energy Resources (DOER). The genesis of the RFP is Section 83D of the *Green Communities Act*, which aims to promote energy diversity in the Commonwealth by requiring Massachusetts electric distribution companies to "jointly and competitively solicit proposals for clean energy generation and, provided that reasonable proposals have been received, shall enter into cost effective long-term contracts for clean energy generation for an annual amount of electricity equal to approximately 9,450,000 megawatt-hours by December 31, 2022."¹

The *Act Relative to Energy Diversity* was signed into law by Massachusetts Governor Charles Baker in August 2016. Among other things, the Act requires Massachusetts electricity

¹ An Act Relative to Energy Diversity (H. 4568). See <https://malegislature.gov/Laws/SessionLaws/Acts/2016/Chapter188>. Retrieved December 5, 2017.

distribution companies to procure 1,600 megawatts (MW) of cost-effective offshore wind energy by June 2027.² As a consequence, Section 83C, a second provision of the Green Communities Act, was enacted specifically “to ensure that the Distribution Companies enter into cost-effective contracts for Offshore Wind Energy Generation equal to approximately 1,600 MW of aggregate nameplate capacity not later than June 30, 2027.” Accordingly, an RFP under Section 83C was issued by the state’s four electric distribution companies and DOER as “... part of a staggered procurement schedule developed by the Distribution Companies and DOER, in accordance with Section 83C.”³

The RFP solicitation specifies that distribution companies are seeking to procure 400 MW of offshore wind energy generation, and will consider procuring up to approximately 800 MW if the Evaluation Team determines that a larger-scaled proposal is “both superior to other proposals in response to the RFP and is likely to produce significantly more economic net benefits to ratepayers based on the evaluation criteria set forth in this RFP.” The RFP also notes that eligible bidders may also submit alternative proposals with a nameplate capacity of no less than 200 MW.

This report includes an analysis of the employment and economic development impacts of the proposed 800 MW project.

1.1 RFP SECTIONS ADDRESSED IN THIS ANALYSIS

This analysis is designed specifically to support responses to the following five specific components of the *Request For Proposals For Long-Term Contracts For Offshore Wind Energy Projects*:

- Section 14.1 Please provide an estimate of the number of jobs to be created directly during project development, and construction, and during operations, and a general description of the types of jobs created, estimated annual compensation, the employer(s) for such jobs, and the location. Please treat the development, construction, and operation and maintenance periods separately in your response.
- Section 14.2 Please provide the same information as provided in response to question 14.1 above but with respect to jobs that would be indirectly created as a result of the proposed project.
- Section 14.3 Please describe any other economic development impacts (either positive or negative) that could result from the proposed project, such as creating property tax revenues, creating lease revenues to public and private parties, or purchasing capital equipment, materials or services for local businesses. Please provide the location(s) where these economic development benefits are expected to occur.

² See <https://malegislature.gov/Bills/189/House/H4568>. Retrieved December 5, 2017.

³ Request For Proposals For Long-Term Contracts For Offshore Wind Energy Projects. Massachusetts Department of Energy. June 29, 2017.

Section 14.4 Please describe any tracking or reporting mechanisms, such as an annual report(s) of milestones achieved and jobs created, to verify the contributions to employment and economic development identified in 14.1, 14.2 and 14.3.

Section 14.5 To the extent not already specified elsewhere in your response, please address the factors listed in Section 2.2.2.7 and describe any benefits or impacts associated with the proposed project.⁴

This report is organized into four primary sections designed to inform the Vineyard Wind proposal's responses to the aforementioned RFP components:

[Section 4](#) describes the direct job and expenditure requirements to construct the project for two geographic areas: the Commonwealth of Massachusetts and Southeastern Massachusetts. Impacts are reported for Base and High scenarios. The section also reports the types of jobs that will be created and average and aggregate annual compensation by major occupational category.

[Section 5](#) describes the full economic impacts of the project, including the indirect and induced economic impacts of the project on the Commonwealth of Massachusetts and Southeastern Massachusetts. Impacts are reported for Base and High scenarios. The section also reports the types of jobs that will be created as a result of the indirect and induced impacts.

[Section 6](#) provides an estimate of the expected tax revenues that will be generated by payroll and expenditures of the Massachusetts-based employees, contractors, and suppliers, and the employees of those contractors and supplier associated with the Base and High scenarios.

[Section 7](#) describes other anticipated economic development effects such as the impact of Vineyard Wind's proposed Offshore Wind Industry Accelerator Fund, and Host Community Agreements with the towns of Barnstable, Vineyard Haven, and Yarmouth.

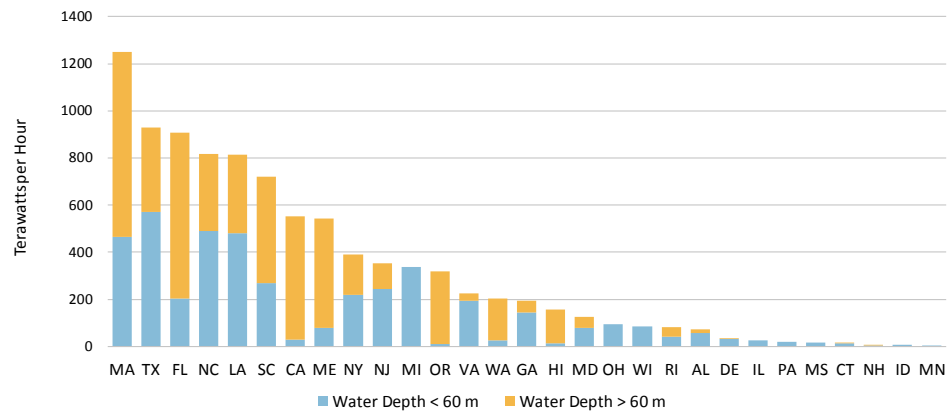
⁴ 2.2.2.7 pertains to a bidder's ability to demonstrate that its proposal can be developed, financed, constructed and technically viable within a commercially reasonable timeframe.

2 THE VINEYARD WIND PROJECT

Massachusetts waters have the largest technical offshore wind potential of any state in the contiguous U.S.⁵ Theoretically, capturing all of Massachusetts' OSW energy could generate over 18 times the state's existing electricity consumption. Figure 2 displays the gross technical offshore wind potential by state and water depth, if all areas could be developed.

Figure 2

Technical Offshore Wind Potential by State and Water Depth (TWh/yr)



Source: National Renewable Energy Laboratory, 2016

Massachusetts waters have the largest technical offshore wind potential of any state in the contiguous U.S.

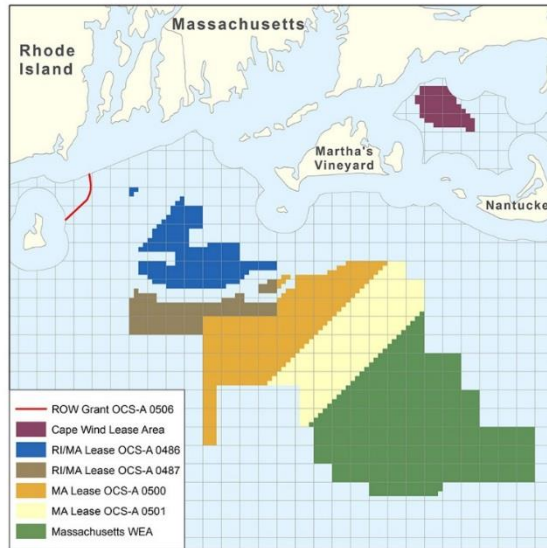
Massachusetts issued its first comprehensive Ocean Management Plan for state waters in 2009, identifying areas appropriate for offshore wind development (see Figure 3).⁶ Then in 2013, the Bureau of Ocean Energy Management (BOEM) held its first competitive offshore commercial wind lease sale, auctioning off 164,750 acres within the “area of mutual interest” defined by Rhode Island and Massachusetts in a Memorandum of Understanding between the two states in 2010.

Two of the lease areas in the Massachusetts Wind Energy Area (WEA) were auctioned off in 2015, with one of those areas being leased by Vineyard Wind (OCS-A 501 in Figure 3). Vineyard Wind is hoping to develop the first utility-scale offshore wind energy project off the coast of Massachusetts.

⁵ Beiter, P., Musial, W., Schwabe, P., Spitsen, P., Stehly, T., & Tian, T. (2017). *2016 Offshore Wind Technologies Market Report*. U.S. Department of Energy Office of Energy Efficiency & Renewable Energy National Renewable Energy Laboratory. NREL publication GO-102017-5031.

⁶ Commonwealth of Massachusetts, Executive Office of Energy and Environmental Affairs, 2015 Massachusetts Ocean Management Plan, Volume 1 Management and Administration (2015), p. 1-1.

Figure 3
Massachusetts Offshore Wind Project Areas



Source: Bureau of Ocean Energy Management

2.1 PROJECT PHASES

The development and construction of the Vineyard Wind project will proceed in phases. Our analysis assesses and reports impacts for each of the three major development phases, Pre-Construction & Development, Construction, and Operations & Maintenance (O&M).

2.1.1 PRE-CONSTRUCTION AND DEVELOPMENT

The Pre-Construction & Development phase covers the activities, such as planning and permitting, that precede the start of wind farm construction. The first step involves identifying and selecting potential sites for an offshore wind project. Important factors that require thorough examination include wind strength and occurrence, the characteristics of the seabed, and the possible environmental impacts. Around the time when the project location has been determined, design of the plant and communication with the grid operator begins. The final step of this phase includes obtaining consent from all necessary bodies, such as local or national governments, and it requires that all permits and contracts are completed, with a clear and reliable source of funding.

2.1.2 CONSTRUCTION

In addition to the installation of the wind turbines, the Construction phase involves the building and installation various onshore and offshore structures, including the onshore and offshore cables, onshore and offshore substations, the O&M facility, and the turbine foundations. Before the turbines can be installed, Vineyard Wind will oversee the construction of the so-called “balance-of-plant,” which includes the onshore and offshore substations, array cables, export cables, and turbine foundations. Once all of these components are in place, the turbine manufacturer will install the wind turbine components.

As much of the installation work as possible is done quayside (shoreside), in a phase known as “pre-assembly,” in order to reduce costs and complexity associated with offshore assembly. The tower, for example, often arrives in pieces and without many of the internal components. When it arrives, it is bolted together and parts such as the elevator and power cables are installed. Finally, all the components are transported to the wind farm where they are installed using specialized installation vessels. When the wind turbine has been completely constructed and all components have been installed, the commissioning phase begins. During this phase, the staff will follow up to ensure compliance with the manufacturer’s requirements and design-phase documentation, inspect all engineering aspects, and test the electrical components. Furthermore, the grid connection for each wind turbine and power generation must be secured. Vineyard Wind proposes to begin in-state (on-shore) construction in late 2019.

*Vineyard Wind
proposes to begin
in-state (on-shore)
construction in
2019.*

2.1.3 OPERATIONS & MAINTENANCE

During the Operations & Maintenance (O&M) phase, the turbines, foundations, cables, and other components are inspected regularly and any necessary repairs or upkeep are performed. Additionally, the environmental impacts of the OSW farm are monitored. During the warrantee period, Vineyard Wind and the turbine manufacturer will jointly maintain the OSW farm. O&M is the longest phase, extending the full life of a wind farm: approximately 25 years. Accordingly, this phase also provides the longest lasting jobs.

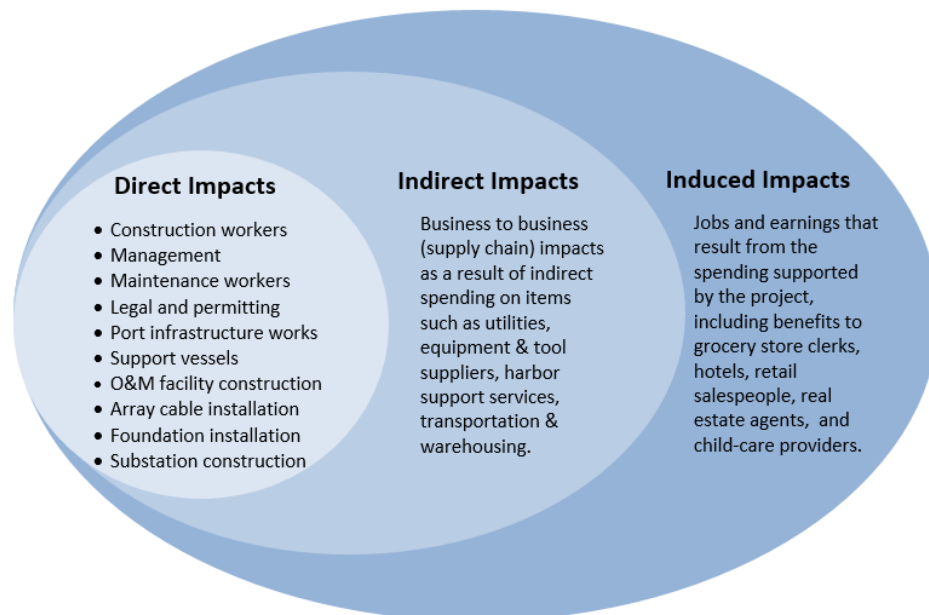
3 METHODOLOGY AND DATA SOURCES

Economic impacts measure how spending associated with an industry flows through an economy. For example, employee wages and purchases made from suppliers circulate through the economy and support additional spending and job creation, that is, the original expenditures and job creation are multiplied. Measuring these ripple effects on the economy provides a fuller picture of the economic contributions an offshore wind farm's construction has on a particular impact area or region. These impacts are expressed as direct impacts, indirect impacts, and induced impacts (see Figure 4).

Measuring the ripple effects on the economy provides a fuller picture of the economic contributions an offshore wind farm's construction creates in a region or impact area.

- **Direct impacts** result from expenditures associated with developing, constructing, and operating the wind farm, including money spent on salaries, supplies, and operating expenses.
- **Indirect impacts** result from the suppliers of the wind farm purchasing goods and services as a result of the direct spending on the project. Because these impacts measure interactions among businesses, they are often referred to as supply-chain impacts.⁷
- **Induced impacts** result from the spending of employees directly involved in the development, construction, and operation of the wind farm, as well as the spending of employees of the wind farm's suppliers within the region. These induced effects are often referred to as consumption-driven impacts.

Figure 4
Examples of Offshore Wind Impacts



⁷ Not including the initial round of spending, which is included in the direct effects.

3.1 DIRECT IMPACTS

Vineyard Wind provided the PPC with detailed job creation estimates and expenditures for each project phase for their proposed 800 MW project. These estimates were based on the Vineyard Wind team's extensive experience and knowledge building similar sized projects in Europe, as well as information Vineyard Wind required supply chain companies to provide when submitting proposals. In other words, the direct job creation estimates were derived primarily from the input of the suppliers who will actually be doing the hiring.

The PPC thoroughly reviewed the direct job creation and expenditure estimates, applying its expertise informed by data gathered from previous related work, interviews with industry leaders, site visits to European wind farm developments and ports, and an extensive literature review.

This analysis reports both the direct number of FTE job years and the number of individual jobs (i.e. workers):

FTE Job Years: Refers to the years of full-time equivalent (FTE) employment created by the wind farm project, including wage and salary employees and self-employed persons. One FTE is the equivalent of one person working full time for 1 year (2,080 hours), thus two half-time employees would equal one FTE. Similarly, a full-time person working five years on the project would equal five FTE job years.⁸

Jobs: The actual number of workers on the project, which includes both full-time and part-time workers who may be on the project for several years, one-year, or less.

3.1.1 LOCAL CONTENT: BASE AND HIGH SCENARIOS

The ability of the Commonwealth's supply chain to support the development of OSW and to support local jobs is one of the largest drivers of job and economic impacts for the project. Accordingly, determining local content is an essential exercise in developing a credible and valid economic impact model. The PPC developed a Base and High scenario based on the expected local content for the project. Only expenditures that will be spent in the geographic areas of analysis (i.e. Massachusetts and SEMA) are included as direct expenditures and only those jobs that are performed in these areas are included as direct jobs. These final payroll and non-payroll expenditures were then used as inputs into the IMPLAN input-output modeling system which was used to estimate the indirect impacts of the proposed project.

⁸ O&M FTEs are calculated for one year only, except where otherwise noted, even though these jobs are expected to exist for the entire 25-year operations phase of the project.

To determine local content, Vineyard Wind provided the PPC with the expected degree of local content for each payroll and non-payroll expenditure, based on their previous development experience and conversations with local suppliers.

Vineyard Wind provided the PPC with the expected degree of local procurement and content for each payroll and non-payroll expenditure, based on their previous development experience, conversations with local suppliers, and project plans.⁹ Local content was defined using a tiered system that assigned payroll and non-payroll expenditures according to the likelihood of the content being local for both the Base and High scenarios (see Table 1). The PPC reviewed and vetted these local content assumptions to ensure that the local content assumptions used in our analysis are both conservative and plausible.

Table 1
Base and High Scenarios

| Tier | Base Scenario | High Scenario |
|--------------------|---------------|---------------|
| Tier 1 Expenditure | Included | Included |
| Tier 2 Expenditure | Included | Included |
| Tier 3 Expenditure | Not Included | Included |
| Tier 4 Expenditure | Not Included | Not Included |

3.1.2 DEVELOPING THE SUPPLY CHAIN THROUGH THE OFFSHORE WIND INDUSTRY ACCELERATOR

As noted above, developing the Commonwealth’s OSW supply chain is essential to maximizing the economic benefits of the OSW projects for Massachusetts and SEMA. Vineyard Wind’s proposed Offshore Wind Industry Accelerator is designed to be an important component in the development of the Commonwealth’s OSW supply chain. The fund will invest up to \$10 million in projects to accelerate the development of the offshore wind supply chain, and related businesses and infrastructure in Massachusetts. Funds could be used to improve Massachusetts port infrastructure available to support of offshore wind activities, support the establishment of offshore wind supply chain manufacturing facilities in Massachusetts, and/or develop technologies to improve the deployment offshore wind components on the U.S. East Coast.

Importantly, the Offshore Wind Accelerator Fund could also be used to improve the capabilities of existing supply chain companies in Massachusetts, who would otherwise be hard pressed under current conditions to justify investments in upgrading their facilities to produce secondary turbine components. To ensure these funds are invested strategically, a steering committee that includes local and regional workforce and economic development professionals from southeastern Massachusetts will be established. Overall, it is anticipated that, if implemented early in the development of Massachusetts’ OSW industry, the Offshore Wind Accelerator Fund’s investments will support job creation and increase the likelihood that the economic impacts of the proposed project(s) are in line with the High scenario results presented in this report.

Vineyard Wind’s proposed \$10 million Offshore Wind Industry Accelerator will be an important component in the development of Massachusetts’ OSW supply chain.

⁹ Vineyard Wind has secured numerous letters of support from Massachusetts supply chain companies.

3.2 INDIRECT IMPACTS

The indirect (supply chain) impacts of the proposed project are specified using IMPLAN (IMpact Analysis for PLANning), which is an input-output database and model that traces a project's purchases of goods, services, and labor through an economic area. The PPC constructed custom IMPLAN models for two geographic areas to conduct the analysis: Massachusetts and Southeastern Massachusetts (SEMA).¹⁰

3.2.1 Inputs to the Model

Payroll Expenditures

The PPC estimated total employee compensation and proprietor income using Vineyard Wind's estimates of direct FTEs, and wage and proprietor income data from the Bureau of Labor Statistics and Economic Modeling Specialists International (EMSI). These data served as the primary inputs to our IMPLAN model as Labor income (both employee compensation and proprietor income). **Notably, the model has been designed to only include those payroll expenditures from jobs that are expected to exist in the two study regions: The Commonwealth of Massachusetts and Southeastern Massachusetts(SEMA).**¹¹

Non-Payroll Expenditures

IMPLAN works by applying a change in demand or production to 1 of 536 industry sectors. However, a mature OSW industry does not exist in the United States and consequently the industry is not a unique sector within the standard North American Industry Classification System (NAICS) or IMPLAN industry sectors. Consequently, the PPC developed a customized IMPLAN model built from the bottom up that assigns detailed direct expenditure data to specific industry IMPLAN codes that map to the OSW industry. More than 100 individual expenditures were mapped to 23 IMPLAN sectors for each scenario examined.¹² **As noted above, the model includes only those expenditures that are expected to occur in the two study regions: Massachusetts and SEMA.**

3.2.2 Project Years and Multiple Models

Purchases of labor and non-labor inputs will occur over multiple years. In order to account for the phases of the project and Vineyard Wind's proposed timeline, several input-output models were constructed, including one for each year in which the expenditures are expected to occur. The results of these individual yearly models were then aggregated to produce the final impact tables.

¹⁰ A more detailed methodology can be found in Appendix A.

¹¹ Southeastern Massachusetts is defined as Barnstable County (Cape Cod), Bristol County, Dukes County (Martha's Vineyard), Nantucket County, and Plymouth County.

¹² The IMPLAN sectors used for the model can be found in Appendix A.

The PPC developed a customized IMPLAN model built from the bottom up that assigns detailed direct expenditure data to specific industry IMPLAN codes that map to the OSW industry.

4 ESTIMATED DIRECT JOBS AND EXPENDITURES ASSOCIATED WITH THE PROPOSED 800 MW PROJECT

This section presents the Massachusetts- and SEMA-based direct jobs and direct payroll and non-payroll expenditures that we estimate will be associated with the Pre-Construction & Development, Construction, and O&M of the 800 MW wind farm over the expected 25-year operating period. Section 4.1 examines the direct FTE job years that will be required to complete the project and when these jobs are expected to come online, while Section 4.2 describes the expected payroll and non-payroll expenditures that will be made in each region.

4.1 SUMMARY OF DIRECT FTE JOB IMPACTS

4.1.1 Massachusetts

- The Vineyard Wind project will support an estimated 3,180 direct FTE job years in Massachusetts across all phases over the project period under the Base scenario and 3,658 direct FTE jobs in Massachusetts in the High scenario (see Table 2).¹³
- Under the Base scenario, there are expected to be 1,100 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 80 FTEs lasting 25 years, for a total of 2,000 FTE job years.
- Under the High scenario, there are expected to be 1,552 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 81 FTEs over 25 years, for of 2,025 FTE job years.
- In terms of the actual number of workers (not FTEs), the project is expected to employ 1,706 workers in the Base scenario and 2,120 workers in the High scenario across all the project phases.

4.1.2 Southeastern Massachusetts

Most of the jobs will be located in Southeastern Massachusetts, since the proposed Vineyard Wind project plan calls for nearly all the project work to be completed in the southeastern portion of the state, including the Cape and Islands (see Table 2).

- The Vineyard Wind project will require an estimated 3,151 direct FTE job years in the SEMA region over the project period under the Base scenario and 3,432 direct FTE jobs years in SEMA in the High scenario.
- Under the Base scenario, there are expected to be 1,071 FTE job years during the Pre-Construction & Development phases. During the O&M phase, there are expected to be 80 FTEs annually over 25 years, for a total of 2,000 FTE job years.

The Vineyard Wind project will support an estimated 3,180 direct FTE job years in Massachusetts across all phases over the project period under the Base scenario and 3,658 direct FTE job years in Massachusetts in the High scenario.

¹³ A portion of these workers will commute to the site from out-of-state. While it is not possible to precisely estimate the number of in-commuters, overall 7.5 percent of people working in Massachusetts in 2015 commuted to work from a location outside the state, while 8.1 percent of people working in SEMA commuted in from another state—primarily Rhode Island (5.9%). (Source: Public Policy Center calculations using U.S. Census LEHD Origin-Destination Employment Statistics).

- Under the High scenario, there are expected to be 1,326 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 81 FTEs annually over 25 years, for a total of 2,025 FTE job years.
- In terms of the actual number of workers (not FTEs), the project is expected to employ 1,671 workers in SEMA in the Base scenario and 1,926 workers in the High scenario across all the project phases.

Table 2
Direct FTE Job Years Over the Project Period

| Region | Total Direct FTEs | Pre- | | | O&M Lifetime Job Years | *Total Job-Years |
|----------------------|-------------------|----------------------------|--------------|------------|------------------------|------------------|
| | | Construction & Development | Construction | O&M Annual | | |
| Massachusetts | | | | | | |
| Base Scenario | 1,180 | 126 | 974 | 80 | 2,000 | 3,180 |
| High Scenario | 1,633 | 126 | 1,426 | 81 | 2,025 | 3,658 |
| SEMA | | | | | | |
| Base Scenario | 1,151 | 119 | 952 | 80 | 2,000 | 3,151 |
| High Scenario | 1,407 | 119 | 1,207 | 81 | 2,025 | 3,432 |

4.1.3 Job Timeline

The direct jobs created by the proposed project will not be distributed evenly during the project’s development. The professional jobs in Pre-Construction & Development will come online first and constitute nearly the entirety of the employment during that phase. Some of these professional planning positions will be filled by people with experience in OSW planning and construction, most likely from Europe, although many of these professionals will need to be based in the Commonwealth, collaborating and contracting scientists and technicians to assist with site assessments and environmental reviews. Development positions will drop off gradually but not entirely as Construction begins. Construction jobs are expected to be filled primarily by local labor,¹⁴ although some supervisory and other technical positions will be filled by experienced Europeans and workers from the Gulf of Mexico. The FTE job years associated with Construction are expected to decline as the turbines come online, when O&M jobs will be the only occupations that remain, of which nearly all will be filled by local workers.

¹⁴ Local jobs are defined as jobs that are done on-site and are not necessarily the same as a job filled by an incumbent local worker. In other words, a worker who moves to the region to work on the project and then moves on when the project is over is considered a local worker for impact assessment purposes.

4.1.4 Job-Years: Development and Construction Versus Operations

While development and construction activities contribute to the greatest number of direct jobs, most of these jobs will not extend beyond the construction phase. Conversely, most O&M jobs will last for the entire 25-year operations period. Consequently, O&M activities actually represent the majority of the project’s total job years. In the case of the Base scenario, O&M will account for an estimated 65 percent of the total job years over the lifetime of the wind farm, while these jobs will account for 57 percent of the total job years in the High scenario (see Figure 5 and Figure 6).

O&M activities represent the majority of the project’s total job years.

Figure 5
 Lifetime Job-Years: Development and Construction Versus O&M
 Base Scenario

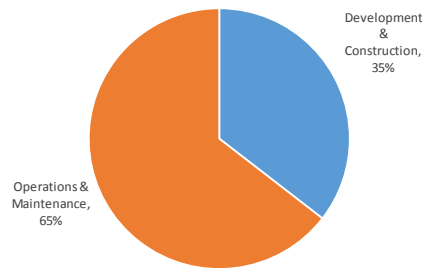
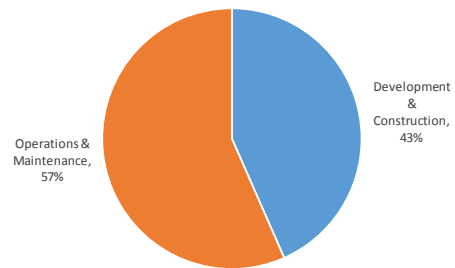
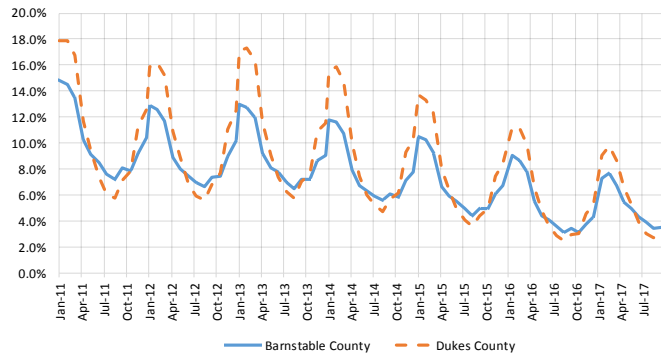


Figure 6
 Lifetime Job-Years: Development and Construction Versus O&M
 High Scenario



These steady and well-paying jobs will have a significant positive impact on the Barnstable County and Martha’s Vineyard economies, which experience severe seasonal fluctuations in employment due to their largely tourism-dependent economies (see Figure 7). Adding long-term and high-quality year-round employment will significantly increase the number of opportunities for local workers to obtain presently unavailable stable sources of full-time year-round income. This can be expected to have a positive and stabilizing impact on one of the Commonwealth’s most highly seasonal regional economies beyond that which can be directly captured by this analysis.

Figure 7
 Unemployment by County, January 2011– October 2017



Source: Local Area Unemployment Statistics (LAUS)

4.2 SUMMARY OF DIRECT EXPENDITURES: ALL PHASES

4.2.1 Compensation and Wages

An estimated \$120.3 million will be spent on payroll in Massachusetts under the Base scenario, and \$152.5 million on payroll in the High scenario.

Massachusetts: An estimated \$120.3 million will be spent on payroll¹⁵ in Massachusetts in the Base scenario (including just the first year of O&M) and \$152.5 million on payroll in the High scenario to support direct project activities. Average wages range from \$85,021 in the Base scenario to \$77,671 in the High scenario (see Table 3).

SEMA: An estimated \$115.9 million will be spent on payroll¹⁵ in Southeastern Massachusetts in the Base scenario (including just the first year of O&M) and \$133.3 million on payroll in the High scenario to support direct project activities. Average wages range from \$83,826 in the Base scenario to \$78,748 in the High scenario (see Table 3).

Table 3
 Average Wages for Base & High Scenarios: All Phases¹⁶

| | Massachusetts | SEMA |
|---------------|---------------|----------|
| Base Scenario | \$85,021 | \$83,826 |
| High Scenario | \$77,671 | \$78,748 |

Offshore wind is a relatively high-wage industry, even for blue-collar workers. In the Base scenario, it is predicted that Massachusetts workers will receive an average compensation, which includes the value of fringe benefits,¹⁷ ranging from \$150,092 in the Pre-Construction & Development phase to \$95,990 in the Construction phase. The long-term O&M jobs offer an average total compensation of \$99,456 (see Table 4).

Table 4
 Average Compensation for Base and High Scenario

| Region | All Phases | Pre-Construction & Development | | |
|----------------------|------------|--------------------------------|----------|----------|
| | | Construction | O&M | |
| Massachusetts | | | | |
| Base Scenario | \$101,985 | \$150,092 | \$95,990 | \$99,456 |
| High Scenario | \$93,363 | \$150,092 | \$88,003 | \$99,748 |
| SEMA | | | | |
| Base Scenario | \$100,663 | \$150,656 | \$94,512 | \$99,456 |
| High Scenario | \$94,715 | \$150,656 | \$88,856 | \$99,748 |

¹⁵ Note that unlike labor income, payroll does not include proprietor income. Therefore, these results should not be compared to the IMPLAN economic impact summaries.

¹⁶ Includes just first year of Operations and Maintenance (O&M). Does not include fringe benefits. Average annual salaries by industry and occupation for each region were obtained from Emsi and derived from a variety of publicly available sources, including the Bureau of Labor Statistics Quarterly Census of Employment and Wages for Q1 of 2017 and Occupational Employment Statistics for 2016.

¹⁷ The benefit amount was calculated by multiplying direct wages for each occupation obtained from the U.S. Bureau of Labor Statistics by employment compensation-to-income ratios available from the U.S. Bureau of Economic Analysis.

4.2.2 Non-Payroll

Excluding the payroll listed in the previous section, Vineyard Wind estimates that it will spend \$177.4 million procuring materials and services from Massachusetts suppliers, of which \$104.8 million will be purchased from SEMA suppliers, to support the development and construction of the wind farm in the Base scenario. In the High scenario, these numbers increase to \$196.3 million and \$107.4 million, respectively (see Figure 8 and Table 5).

These expenditures will support a variety of Massachusetts and SEMA based businesses, from tool suppliers and crane companies to transportation companies and component suppliers. In turn, these expenditures support further job impacts through business to business transactions along the supply chain as well as from the wages that the suppliers' employees spend in the local economy on goods and services such as gas, rent, food, and childcare. These specific indirect and induced impacts are discussed in Section 5.

Vineyard Wind's expenditures will support a variety of Massachusetts- and SEMA- based businesses, from tool suppliers and crane companies to transportation companies and component suppliers.

Figure 8
 Non-Payroll Expenditures From Massachusetts & SEMA Suppliers

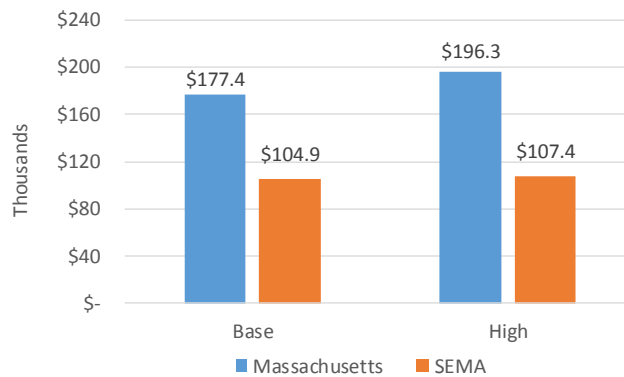


Table 5
 Non-Payroll Expenditures From Massachusetts & SEMA Suppliers, Thousands

| Package | Massachusetts | | SEMA | |
|----------------------------|------------------|------------------|------------------|------------------|
| | Base | High | Base | High |
| Array cables | \$5,085 | \$683 | \$2,784 | \$3,217 |
| Construction Management | \$36,004 | \$11,522 | \$9,374 | \$9,374 |
| Export cable, Offshore | \$4,622 | \$9,035 | \$683 | \$899 |
| Export cable, Onshore | \$11,522 | \$11,522 | \$11,522 | \$11,522 |
| Foundation | \$37,809 | \$37,809 | \$12,992 | \$12,992 |
| O&M Preparations | \$6,229 | \$6,229 | \$4,522 | \$4,522 |
| Permitting | \$12,744 | \$12,744 | \$12,244 | \$12,244 |
| Project Management | \$16,984 | \$16,984 | \$13,498 | \$13,498 |
| Substation, Offshore (ESP) | - | \$1,081 | - | - |
| Substation, Onshore | \$1,601 | \$1,601 | \$1,601 | \$1,601 |
| Wind Turbine Generator | \$36,132 | \$43,557 | \$29,058 | \$29,058 |
| Total | \$177,363 | \$196,338 | \$104,850 | \$107,366 |

4.3 TYPES OF DIRECT JOBS AND AVERAGE ANNUAL COMPENSATION

Developing, constructing, operating, and maintaining the offshore wind will require workers drawn from a diverse range of occupations that represent a wide distribution of skill and educational levels, ranging from white collar jobs such as environmental scientists and engineers to blue collar jobs such as iron workers, longshoremen, and machine operators. The workforce needs of the proposed projects(s) are well aligned with the education and skill levels of Southeastern Massachusetts residents, a region characterized by traditional blue-collar urban areas bordered by more affluent suburbs. The broad occupational needs of the project also provide opportunities for project staff to work their way up the occupational ladder within the emerging OSW industry, whether through continuing education or on-the-job training and acquiring experience during the project period.

The following section provides a brief description of the major types of occupations that are expected during each phase of the proposed project's development.¹⁸

Pre-Construction and Development

White-collar occupations dominate the Pre-Construction and Development phase, which will rely heavily on highly skilled workers drawn from the fields of management, finance, engineering, law, and related scientific, and professional service occupations (see Table 6).

¹⁸ These occupations include most of the major occupations required to develop, construct, and operate the project, but is not inclusive of all occupations.

Table 6
 Expected Occupations, Credentialing Requirements, and Earnings During
 Pre-Construction & Development

| Major Occupations | Credentials | Annual Mean Earnings |
|--|------------------------------------|----------------------|
| Engineering | | |
| Civil Engineers | Master's Degree | \$91,930 |
| Mechanical Engineers | Master's Degree | \$94,500 |
| Electrical Engineers | Master's Degree | \$108,990 |
| Marine Engineers & Naval Architects | Master's Degree | \$98,370 |
| Electrical and Electronic Eng. Techs. | Associate's Degree | \$65,370 |
| Mechanical Engineering Technicians | Associate's Degree | \$56,110 |
| Surveying and Scientific Monitoring | | |
| Environmental Engineers | Bachelor's Degree | \$88,800 |
| Geoscientists | PhD | \$84,310 |
| Natural Sciences Managers | PhD | \$172,000 |
| Zoologists & Wildlife Biologists | PhD | \$83,340 |
| Atmospheric & Space Scientists | PhD | \$103,770 |
| Mechanical Engineering Technicians | Associate's or On-the-Job Training | \$56,110 |
| Geological & Petroleum Technicians | Associate's or On-the-Job Training | \$56,450 |
| Surveying Technicians | Associate's or On-the-Job Training | \$51,680 |
| Finance | | |
| Financial Manager | Master's Degree | \$138,610 |
| Budget Analysts | Bachelor's Degree | \$77,480 |
| Cost Estimators | Bachelor's Degree | \$74,200 |
| Permitting | | |
| Compliance Officers | Bachelor's Degree | \$83,030 |
| Paralegals & Legal Assistants | Associate's or On-the-Job Training | \$55,250 |
| Legal | | |
| Lawyers | J.D. | \$158,760 |
| Paralegals & Legal Assistants | Associate's or On-the-Job Training | \$55,250 |
| PR and Marketing | | |
| Market Research Analysts | Master's Degree | \$79,030 |
| Machine Maint./Port Services | | |
| Bus/Truck Mech. Incl. Diesel | Associate's/Postsecondary Cert. | \$54,880 |
| Ship Engineers | Postsecondary Certificate | \$90,120 |
| Site Managers | | |
| Construction Managers | Bachelor's Degree | \$109,900 |
| Architect/Eng. Managers | Bachelor's Degree | \$145,000 |
| Water Transportation Workers | | |
| Captains/Mates/Pilots | Associate's/Postsecondary Cert. | \$60,480 |
| Sailors & Marine Oilers | Postsecondary Certificate | \$38,670 |
| Ship Engineers | Associate's/Postsecondary Cert. | \$90,120 |

Vineyard Wind; U.S. Bureau of Labor Statistics; PPC calculations.

Construction

Trade workers play a significant role during the construction of the proposed project. Although the construction jobs are short-term, a number of the workers employed during this phase would be well-prepared to transition into long-term roles in the O&M phase, since they have experience working offshore and are familiar with the turbine systems and associated technology being used by the proposed project (see Table 7).

Table 7
Expected Occupations, Credentialing Requirements, and Earnings During the Construction Phase

| Major Occupations | Credentials | Annual Mean Earnings |
|---------------------------------------|------------------------------------|----------------------|
| Project Engineers | | |
| Civil Engineers | Master's Degree | \$91,930 |
| Mechanical Engineers | Master's Degree | \$94,500 |
| Electrical Engineers | Master's Degree | \$108,990 |
| Industrial Health & Safety Engineers | Bachelor's Degree | \$98,310 |
| Marine Engineers & Naval Architects | Bachelor's Degree | \$98,370 |
| Construction Managers | | |
| Construction Managers | Bachelor's Degree | \$109,900 |
| Architectural & Engineering Managers | Bachelor's Degree | \$145,000 |
| Inspectors and QA Managers | Bachelor's Degree | \$62,890 |
| Vessel Managers | Bachelor's Degree | \$82,250 |
| Trans/Storage/Distribution Managers | Associate's or On-the-Job Training | \$105,810 |
| Trade Workers | | |
| Longshoremen/Stevedores | Apprenticeship/Postsecondary Cert. | \$31,400 |
| Iron & Steel Workers & Welders | Apprenticeship/Postsecondary Cert. | \$70,350 |
| Electricians | Apprenticeship/Postsecondary Cert. | \$66,130 |
| Material Moving Machine Operators | Apprenticeship/Postsecondary Cert. | \$27,080 |
| Elevator Installers & Repairers | Apprenticeship/Postsecondary Cert. | \$89,910 |
| Commercial Divers | Apprenticeship/Postsecondary Cert. | \$54,750 |
| HVAC/Refrig. Mechanics & Installers | Apprenticeship/Postsecondary Cert. | \$57,110 |
| Other Construction Technicians | | |
| Scaffolders | High School & On-the-Job Training | \$43,600 |
| Riggers | High School & On-the-Job Training | \$47,680 |
| Painters | High School & On-the-Job Training | \$48,980 |

Vineyard Wind; U.S. Bureau of Labor Statistics; PPC calculations.

Operations & Maintenance

Operations and Maintenance occupations consist primarily of wind technicians, managers, and water transportation workers (see Table 8).

Table 8
Expected Occupations, Credentialing Requirements, and Earnings During
Operations & Maintenance Phase

| Major Occupations | Credentials | Annual Mean Earnings |
|-------------------------------------|-------------------------------|----------------------|
| Site/Plant Managers | | |
| Power Plant Operators | Bachelor's Degree | \$75,820 |
| Trans., Storage, Distr. Mgrs. | Associate's Degree | \$105,810 |
| Project Engineers | | |
| Electrical Engineers | Bachelor's Degree | \$108,990 |
| Mechanical Engineers | Bachelor's Degree | \$94,500 |
| Civil Engineers | Bachelor's Degree | \$91,930 |
| Ind. Health & Safety Engineers | Bachelor's Degree | \$98,310 |
| Water Transportation Workers | | |
| Captains/Mates/Pilots | Assoc. or Postsecondary Cert. | \$60,480 |
| Sailors & Marine Oilers | Postsecondary Certificate | \$38,670 |
| Ship Engineers | Assoc. or Postsecondary Cert. | \$90,120 |
| Wind Technicians | Assoc. or Postsecondary Cert. | \$67,000 |

Vineyard Wind; U.S. Bureau of Labor Statistics; PPC calculations.

5 TOTAL DIRECT, INDIRECT, AND INDUCED IMPACTS

This section expands on the previous section by examining the indirect and induced effects of the proposed 800 MW project on the Massachusetts and SEMA economies for both the Base and High scenarios.

5.1 MASSACHUSETTS

5.1.1 Base Scenario

Indirect Impacts: Vineyard Wind's direct payroll and non-payroll expenditures are expected to generate an additional 373 indirect jobs during the Development and Construction phases and support an additional 26 jobs annually during the 25-year Operations period (see Table 9).¹⁹ In addition:

- These jobs can be expected to generate \$30.3 million in labor income during the Development and Construction phases and \$2.2 million annually during the Operations period.
- The proposed project will also contribute nearly \$44.1 million in added value to the Massachusetts economy during Development and Construction and \$3.0 million annually during Operations.
- These indirect impacts are estimated to support an estimated \$74.0 million in new economic output during the Development and Construction phases and an additional \$5.1 million annually during the Operations period.

Induced Impacts: The direct and indirect impacts of the proposed project are expected to induce an additional 898 jobs during the Development and Construction phases and support an additional 63 jobs annually during the 25-year operations period (see Table 9). In addition:

- These jobs can be expected to generate \$59.3 million in labor income during the Development and Construction phases and \$4.2 million annually during the Operations period.
- The proposed project will also contribute nearly \$98.0 million in added value to the Massachusetts economy during the Development and Construction phases and an estimated \$6.9 million annually during Operations.
- These induced impacts are estimated to support \$156.8 million in new economic output during the Development and Construction phases and an additional \$11.1 million annually during the Operations period.

In the Base scenario, Vineyard Wind's direct payroll and non-payroll expenditures are expected to generate an additional 373 indirect jobs during the Development and Construction phases and support an additional 26 indirect jobs annually during the 25-year Operations period.

¹⁹ IMPLAN does not report jobs as FTEs. Accordingly, the reported jobs for the indirect and induced impacts were converted to FTEs using IMPLAN conversion tables.

Table 9
Impact Summary for Base Scenario: Massachusetts²⁰

The 800 MW project will produce nearly \$79 million in direct value-added impacts for Massachusetts and just under \$170 million in direct output.

| Massachusetts Impact | | | | | |
|--|------------|----------------|----------------|----------------|--|
| 800 MW: Base Scenario | | | | | |
| Pre-Construction & Development Phase (2017 - 2021) | | | | | |
| ImpactType | Employment | LaborIncome | ValueAdded | Output | |
| Direct Effect | 126 | \$ 19,734,093 | \$ 6,615,054 | \$ 12,072,668 | |
| Indirect Effect | 27 | \$ 2,166,711 | \$ 3,172,692 | \$ 5,266,233 | |
| Induced Effect | 121 | \$ 7,965,164 | \$ 13,159,673 | \$ 21,065,940 | |
| Total Effect | 274 | \$ 29,865,968 | \$ 22,947,419 | \$ 38,404,841 | |
| Multiplier | 2.2 | 1.5 | 3.5 | 3.2 | |
| Construction Phase (2020 - 2021) | | | | | |
| ImpactType | Employment | LaborIncome | ValueAdded | Output | |
| Direct Effect | 974 | \$ 95,124,190 | \$ 68,388,963 | \$ 148,485,739 | |
| Indirect Effect | 346 | \$ 28,110,471 | \$ 40,921,371 | \$ 68,758,340 | |
| Induced Effect | 777 | \$ 51,323,683 | \$ 84,800,766 | \$ 135,739,944 | |
| Total Effect | 2,097 | \$ 174,558,345 | \$ 194,111,101 | \$ 352,984,024 | |
| Multiplier | 2.2 | 1.8 | 2.8 | 2.4 | |
| Pre-Construction & Development + Construction Phases (2017 - 2021) | | | | | |
| ImpactType | Employment | LaborIncome | ValueAdded | Output | |
| Direct Effect | 1,100 | \$ 114,858,283 | \$ 75,004,017 | \$ 160,558,408 | |
| Indirect Effect | 373 | \$ 30,277,181 | \$ 44,094,063 | \$ 74,024,573 | |
| Induced Effect | 898 | \$ 59,288,848 | \$ 97,960,439 | \$ 156,805,884 | |
| Total Effect | 2,371 | \$ 204,424,312 | \$ 217,058,520 | \$ 391,388,865 | |
| Multiplier | 2.2 | 1.8 | 2.9 | 2.4 | |
| Note: This table summed from two tables above. | | | | | |
| Operations & Maintenance Phase (Annual) | | | | | |
| ImpactType | Employment | LaborIncome | ValueAdded | Output | |
| Direct Effect | 80 | \$ 8,150,659 | \$ 3,846,393 | \$ 9,060,996 | |
| Indirect Effect | 26 | \$ 2,173,441 | \$ 3,025,898 | \$ 5,073,301 | |
| Induced Effect | 63 | \$ 4,182,822 | \$ 6,911,035 | \$ 11,062,627 | |
| Total Effect | 169 | \$ 14,506,922 | \$ 13,783,326 | \$ 25,196,924 | |
| Multiplier | 2.1 | 1.8 | 3.6 | 2.8 | |

Source: Vineyard Wind, Public Policy Center, IMPLAN
All dollar figures are in 2017 dollars.

²⁰ Note that the Labor Income multiplier in the impact tables for all scenarios and regions are lower than the other multipliers. This is primarily due to the relatively high wages of the OSW industry coupled with the fact that induced labor income is often in relatively lower paying industries such as restaurants, hotels, etc. Thus, in terms of induced impacts, high-wage workers are spending their disposable income in industries that are primarily staffed by lower wage workers. Also, we are not surprised by the output multiplier since OSW is a very CAPEX intensive industry with high output per worker. In any sector with high output per worker, the indirect and induced employment will be high relative to the direct employment. This results in a higher employment multiplier than would be expected in a less CAPEX intensive project. Lastly, the induced effects might seem a bit high in some cases. However, induced impacts are driven by wages, both of workers directly working on the project and supply chain workers. The OSW industry as a whole pays relatively high wages, even for blue-collar workers, so we are not surprised that the induced impacts are high in some cases. This is particularly true in the Development phase, where most of the employees are highly paid white-collar workers.

5.1.2 High Scenario

Indirect Impacts: Vineyard Wind's direct payroll and non-payroll expenditures are expected to generate an additional 408 jobs during the Development and Construction phases and support an additional 29 jobs annually during the 25-year Operations period (see Table 10). In addition:

- These jobs can be expected to generate \$32.0 million in labor income during the Development and Construction phases and \$2.5 million annually during the Operations period.
- The proposed project will also contribute nearly \$46.7 million in added value to the Massachusetts economy during the Development and Construction phases and \$3.5 million annually during Operations.
- These indirect impacts are estimated to support an estimated \$78.4 million in new economic output during the Development and Construction phases and an additional \$5.9 million annually during the Operations period.

Induced Impacts: The direct and indirect impacts of the proposed project are expected to induce an additional 1,102 jobs during the Development and Construction phases and support an additional 69 jobs annually during the 25-year operations period (see Table 10) . In addition:

- These jobs can be expected to generate \$71.4 million in labor income during the Development and Construction phases and \$4.5 million annually during the Operations period.
- The proposed project will also contribute nearly \$118.0 million in added value to the Massachusetts economy during the Development and Construction phases and \$7.5 million annually during Operations.
- These induced impacts are estimated to support an estimated \$188.9 million in new economic output during the Development and Construction phases and just under \$12.0 million annually during the Operations period.

In the High scenario, Vineyard Wind's direct payroll and non-payroll expenditures are expected to generate an additional 408 indirect jobs during the Development and Construction phases and support an additional 29 indirect jobs annually during the 25-year Operations period.

Table 10
 Impact Summary for High Scenario: Massachusetts

Massachusetts Impact
800 MW: High Scenario

Pre-Construction & Development Phase (2017 - 2021)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|------------|----------------------|----------------------|----------------------|
| Direct Effect | 126 | \$ 19,734,093 | \$ 6,615,054 | \$ 12,072,668 |
| Indirect Effect | 27 | \$ 2,166,711 | \$ 3,172,692 | \$ 5,266,233 |
| Induced Effect | 121 | \$ 7,965,164 | \$ 13,159,673 | \$ 21,065,940 |
| Total Effect | 274 | \$ 29,865,968 | \$ 22,947,419 | \$ 38,404,841 |
| Multiplier | 2.2 | 1.5 | 3.5 | 3.2 |

Construction Phase (2020 - 2021)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|--------------|-----------------------|-----------------------|-----------------------|
| Direct Effect | 1,426 | \$ 127,257,320 | \$ 73,458,216 | \$ 162,519,537 |
| Indirect Effect | 381 | \$ 29,880,973 | \$ 43,524,865 | \$ 73,166,167 |
| Induced Effect | 981 | \$ 63,451,608 | \$ 104,837,578 | \$ 167,815,255 |
| Total Effect | 2,788 | \$ 220,589,901 | \$ 221,820,659 | \$ 403,500,959 |
| Multiplier | 2.0 | 1.7 | 3.0 | 2.5 |

Pre-Construction & Development + Construction Phases (2017 - 2021)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|--------------|-----------------------|-----------------------|-----------------------|
| Direct Effect | 1,552 | \$ 146,991,413 | \$ 80,073,270 | \$ 174,592,206 |
| Indirect Effect | 408 | \$ 32,047,683 | \$ 46,697,557 | \$ 78,432,400 |
| Induced Effect | 1,102 | \$ 71,416,772 | \$ 117,997,252 | \$ 188,881,195 |
| Total Effect | 3,062 | \$ 250,455,869 | \$ 244,768,079 | \$ 441,905,801 |
| Multiplier | 2.0 | 1.7 | 3.1 | 2.5 |

Note: This table summed from two tables above.

Operations & Maintenance Phase (Annual)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|------------|----------------------|----------------------|----------------------|
| Direct Effect | 81 | \$ 8,323,572 | \$ 5,675,660 | \$ 12,941,678 |
| Indirect Effect | 29 | \$ 2,507,558 | \$ 3,462,209 | \$ 5,877,503 |
| Induced Effect | 69 | \$ 4,528,856 | \$ 7,482,530 | \$ 11,977,766 |
| Total Effect | 179 | \$ 15,359,986 | \$ 16,620,399 | \$ 30,796,946 |
| Multiplier | 2.2 | 1.8 | 2.9 | 2.4 |

Source: Vineyard Wind, Public Policy Center, IMPLAN
 All dollar figures are in 2017 dollars.

5.1.3 Employment Impacts on Other Industry Sectors

Vineyard Wind’s direct expenditures will be a major source of employment for many different sectors of the economy. Table 11 lists the top fifteen sectors that would be impacted by Vineyard Wind’s direct payroll and non-payroll expenditures for the Base scenario (indirect and induced employment impacts).

Table 11
 Indirect and Induced Employment Impacts in Massachusetts
 Base Scenario

| Industry | FTEs |
|---|------|
| Real estate | 44 |
| Full-service restaurants | 44 |
| Hospitals | 44 |
| Wholesale trade | 36 |
| Insurance agencies, brokerages, and related activities | 32 |
| Limited-service restaurants | 29 |
| Couriers and messengers | 27 |
| Retail - Food and beverage stores | 27 |
| Offices of physicians | 22 |
| Scenic transportation & support activities for transportation | 22 |
| Individual and family services | 22 |
| Junior colleges, colleges, universities, and professional schools | 20 |
| All other food and drinking places | 20 |
| Services to buildings | 20 |
| Employment services | 19 |

Vineyard Wind’s direct expenditures are a major source of employment for many different sectors of the Massachusetts economy.

5.2 SOUTHEASTERN MASSACHUSETTS (SEMA)

5.2.1 Base Scenario

Indirect Impacts: The proposed project can be expected to support an additional 215 indirect jobs in SEMA during the Development and Construction phases and support an additional 24 jobs annually during the 25-year Operations period (see Table 12). In addition:

- These jobs can be expected to generate \$13.0 million in labor income in SEMA during the Development and Construction phases and \$1.3 million annually during the Operations period.
- The proposed project will also contribute just over \$18.8 million in added value to the SEMA economy during the Development and Construction phases and \$1.8 million annually during Operations.
- These indirect impacts are estimated to support an estimated \$34.4 million in new economic output during the Development and Construction phases and \$3.5 million annually during the Operations period.

Induced Impacts: The direct and indirect impacts of the proposed project can be expected to induce an additional 666 jobs in SEMA during the Development and Construction phases and support an additional 54 jobs annually during the 25-year Operations period (see Table 12). In addition:

- These jobs can be expected to generate \$33.6 million in labor income in SEMA during the Development and Construction phases and \$2.7 million annually during the Operations period.
- The proposed project will also contribute just over \$57.6 million in added value to the SEMA economy during the Development and Construction period and \$4.7 million annually during Operations.
- These induced impacts are estimated to support an estimated \$99.1 million in new economic output during the Development and Construction phases and \$8.1 million annually during the Operations period.

In the Base scenario, Vineyard Wind's direct payroll and non-payroll expenditures are expected to generate an additional 215 indirect jobs during the Development and Construction phases and support an additional 24 indirect jobs annually during the 25-year Operations period in Southeastern Massachusetts.

Table 12
 Impact Summary for Base Scenario: Southeastern Massachusetts²¹

SEMA Impact
800 MW: Base Scenario

Pre-Construction & Development Phase (2017 - 2021)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|------------|----------------------|----------------------|----------------------|
| Direct Effect | 119 | \$ 18,831,670 | \$ 4,066,173 | \$ 6,582,305 |
| Indirect Effect | 12 | \$ 651,288 | \$ 1,076,026 | \$ 1,948,293 |
| Induced Effect | 94 | \$ 4,743,626 | \$ 8,133,248 | \$ 13,996,396 |
| Total Effect | 225 | \$ 24,226,585 | \$ 13,275,447 | \$ 22,526,994 |
| Multiplier | 1.9 | 1.3 | 3.3 | 3.4 |

Construction Phase (2020 - 2021)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|--------------|-----------------------|-----------------------|-----------------------|
| Direct Effect | 952 | \$ 91,502,010 | \$ 34,484,017 | \$ 84,681,794 |
| Indirect Effect | 203 | \$ 12,369,705 | \$ 17,766,676 | \$ 32,480,362 |
| Induced Effect | 572 | \$ 28,847,764 | \$ 49,470,450 | \$ 85,120,131 |
| Total Effect | 1,727 | \$ 132,719,478 | \$ 101,721,143 | \$ 202,282,287 |
| Multiplier | 1.8 | 1.5 | 2.9 | 2.4 |

Pre-Construction & Development + Construction Phases (2017 - 2021)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|--------------|-----------------------|-----------------------|-----------------------|
| Direct Effect | 1,071 | \$ 110,333,680 | \$ 38,550,190 | \$ 91,264,099 |
| Indirect Effect | 215 | \$ 13,020,993 | \$ 18,842,702 | \$ 34,428,655 |
| Induced Effect | 666 | \$ 33,591,390 | \$ 57,603,698 | \$ 99,116,527 |
| Total Effect | 1,952 | \$ 156,946,063 | \$ 114,996,590 | \$ 224,809,281 |
| Multiplier | 1.8 | 1.4 | 3.0 | 2.5 |

Note: This table summed from two tables above.

Operations & Maintenance Phase (Annual)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|------------|----------------------|---------------------|----------------------|
| Direct Effect | 80 | \$ 8,150,659 | \$ 2,387,677 | \$ 6,993,237 |
| Indirect Effect | 23 | \$ 1,314,124 | \$ 1,782,662 | \$ 3,483,945 |
| Induced Effect | 54 | \$ 2,733,037 | \$ 4,686,616 | \$ 8,064,228 |
| Total Effect | 157 | \$ 12,197,820 | \$ 8,856,954 | \$ 18,541,410 |
| Multiplier | 2.0 | 1.5 | 3.7 | 2.7 |

Source: Vineyard Wind, Public Policy Center, IMPLAN
 All dollar figures are in 2017 dollars.

²¹ Note that the Labor Income multiplier in the impact tables for all scenarios and regions are lower than the other multipliers. This is primarily due to the relatively high wages of the OSW industry coupled with the fact that induced labor income is often in relatively lower paying industries such as restaurants, hotels, etc. Thus, in terms of induced impacts, high-wage workers are spending their disposable income in industries that are primarily staffed by lower wage workers. Also, we are not surprised by the output multiplier since OSW is a very CAPEX intensive industry with high output per worker. In any sector with high output per worker, the indirect and induced employment will be high relative to the direct employment. This results in a higher employment multiplier than would be expected in a less CAPEX intensive project. Lastly, the induced effects might seem a bit high in some cases. However, induced impacts are driven by wages, both of workers directly working on the project and supply chain workers. The OSW industry as a whole pays relatively high wages, even for blue-collar workers, so we are not surprised that the induced impacts are high in some cases. This is particularly true in the Development phase, where most of the employees are highly paid white-collar workers.

5.2.2 High Scenario

Indirect Impacts: The proposed project can be expected to support an additional 215 indirect jobs in SEMA during the Development and Construction phases and support an additional 24 jobs annually during the 25-year Operations period (see Table 13). In addition:

- These jobs can be expected to generate just over \$13.1 million in labor income in SEMA during the Development and Construction phases and \$1.4 million annually during the Operations period.
- The proposed project will also contribute just over \$18.9 million in added value to the SEMA economy during the Development and Construction phases and \$1.9 million annually during Operations.
- These indirect impacts are estimated to support an estimated \$34.5 million in new economic output during the Development and Construction phases and \$8.4 million annually during the Operations period.

Induced Impacts: The direct and indirect impacts of the proposed project can be expected to induce an additional 745 jobs in SEMA during the Development and Construction phases and support an additional 56 jobs annually during the 25-year operations period (see Table 13). In addition:

- These jobs can be expected to generate \$37.6 million in labor income in SEMA during the Development and Construction phases and \$2.8 million annually during Operations.
- The proposed project will also contribute just over \$64.4 million in added value to the SEMA economy during the Development and Construction phases and \$4.9 million annually during Operations.
- These induced impacts are estimated to support an estimated \$110.8 million in new economic output during the Development and Construction phases and \$8.4 million annually during the Operations period.

In the High scenario, Vineyard Wind's direct payroll and non-payroll expenditures are expected to generate an additional 215 indirect jobs during the Development and Construction phases and support an additional 24 indirect jobs annually during the 25-year Operations period in Southeastern Massachusetts.

Table 13
 Impact Summary High Scenario: Southeastern Massachusetts

SEMA Impact
800 MW: High Scenario

Pre-Construction & Development Phase (2017 - 2021)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|-------------------|----------------------|----------------------|----------------------|
| Direct Effect | 119 | \$ 18,831,670 | \$ 4,066,173 | \$ 6,582,305 |
| Indirect Effect | 12 | \$ 651,288 | \$ 1,076,026 | \$ 1,948,293 |
| Induced Effect | 94 | \$ 4,743,626 | \$ 8,133,248 | \$ 13,996,396 |
| Total Effect | 225 | \$ 24,226,585 | \$ 13,275,447 | \$ 22,526,994 |
| Multiplier | 1.9 | 1.3 | 3.3 | 3.4 |

Construction Phase (2020 - 2021)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|-------------------|-----------------------|-----------------------|-----------------------|
| Direct Effect | 1,207 | \$ 108,832,100 | \$ 34,869,548 | \$ 85,307,078 |
| Indirect Effect | 203 | \$ 12,410,496 | \$ 17,828,014 | \$ 32,589,559 |
| Induced Effect | 651 | \$ 32,815,348 | \$ 56,272,614 | \$ 96,826,593 |
| Total Effect | 2,061 | \$ 154,057,944 | \$ 108,970,176 | \$ 214,723,230 |
| Multiplier | 1.7 | 1.4 | 3.1 | 2.5 |

Pre-Construction & Development + Construction Phases (2017 - 2021)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|-------------------|-----------------------|-----------------------|-----------------------|
| Direct Effect | 1,326 | \$ 127,663,770 | \$ 38,935,721 | \$ 91,889,383 |
| Indirect Effect | 215 | \$ 13,061,785 | \$ 18,904,040 | \$ 34,537,852 |
| Induced Effect | 745 | \$ 37,558,974 | \$ 64,405,862 | \$ 110,822,989 |
| Total Effect | 2,286 | \$ 178,284,529 | \$ 122,245,623 | \$ 237,250,224 |
| Multiplier | 1.7 | 1.4 | 3.1 | 2.6 |

Note: This table summed from two tables above.

Operations & Maintenance Phase (Annual)

| ImpactType | Employment | LaborIncome | ValueAdded | Output |
|---------------------|-------------------|----------------------|---------------------|----------------------|
| Direct Effect | 81 | \$ 8,323,572 | \$ 3,143,876 | \$ 8,723,951 |
| Indirect Effect | 24 | \$ 1,439,385 | \$ 1,951,572 | \$ 3,819,338 |
| Induced Effect | 56 | \$ 2,838,235 | \$ 4,867,009 | \$ 8,374,628 |
| Total Effect | 161 | \$ 12,601,192 | \$ 9,962,457 | \$ 20,917,917 |
| Multiplier | 2.0 | 1.5 | 3.2 | 2.4 |

Source: Vineyard Wind, Public Policy Center, IMPLAN
 All dollar figures are in 2017 dollars.

6 EXPECTED STATE TAX REVENUE GENERATED FROM THE 800 MW VINEYARD WIND PROJECT

Tax revenues include those paid by Vineyard Wind, its employees, and contractors (direct impacts) and taxes generated through the economic activities created in other areas of the economy through indirect and induced impacts. Importantly, many of these taxes, particularly at the state and local levels, directly support affected communities by providing resources to support important local needs including education, public safety, and infrastructure.

Tax impacts were generated using IMPLAN. The IMPLAN model estimates that the amount paid in state and local taxes as a result of the development, construction, and the first year of operations of the 800 MW Vineyard Wind project is \$14.7 million in the Base scenario and \$17.0 million in the High scenario (see Table 14). This includes an estimated increase in Massachusetts personal income tax payments of between \$4.1 million and \$4.7 million, an increase in sales taxes between \$3.0 million and \$3.5 million, and an increase in property taxes between \$5.2 million and \$6.1 million, for the Base and High scenarios respectively. Corporate income taxes can be expected to increase by \$1.2 million in the Base Scenario and \$1.4 million in the High Scenario. Notably, these tax impacts include only one year of expenditures for the O&M phase, although tax impacts will continue annually over the wind farm’s 25 year lifetime as payroll and non-payroll expenditures are spent to support the wind farm’s operation.

The IMPLAN model estimates that the amount paid in state and local taxes as a result of the development, construction, and the first year of O&M of the 800 MW Vineyard Wind project is \$14.7 million in the Base scenario and \$17.0 million in the High scenario.

Table 14
 Estimated State and Local Tax Impacts As a Result Of
 Vineyard Wind’s Payroll and Non-Payroll Expenditures

| | Base | High |
|-----------------------|--------------|--------------|
| Personal Income taxes | \$4,132,689 | \$4,663,992 |
| Other Personal Taxes | \$546,879 | \$617,186 |
| *Payroll taxes | \$66,770 | \$75,225 |
| Sales taxes | \$3,018,548 | \$3,542,512 |
| Property taxes | \$5,178,301 | \$6,077,159 |
| Corporate taxes | \$1,230,736 | \$1,390,876 |
| Fees & other taxes | \$500,065 | \$586,866 |
| Total | \$14,673,988 | \$16,953,816 |

*Includes both employee and employer paid payroll taxes

7 OTHER ECONOMIC DEVELOPMENT IMPACTS

Direct Payment Impacts

There are several additional activities proposed by Vineyard Wind that, while not directly related to the Development, Construction, or Operations phases of the proposed project, can be expected to have a positive economic impact on both the Commonwealth and SEMA. The activities include a proposed \$10 million “Offshore Wind Industry Accelerator Fund” and a \$2 million “Windward Workforce” fund that will support the recruitment and training of Massachusetts residents for careers in offshore wind. Vineyard Wind reports that they are also negotiating, or seeking to negotiate, host community agreements with Yarmouth, Barnstable, and possibly other communities and organizations in the project area. For the purpose of this analysis we have assigned a value of \$13.5 million in total direct payments by way of these sort of agreements.

Table 15
 Vineyard Wind Direct Payments

| Payment Description | Amount |
|---|---------|
| Offshore Wind Industry Accelerator Fund | \$10.0m |
| Windward Workforce | \$2.0m |
| Host Community Agreements | \$1.5m |

There are several additional activities proposed by Vineyard Wind that, while not directly related to the Development, Construction, or O&M phases of the proposed project, can be expected to have a positive economic impact on both the Commonwealth and SEMA.

Given that it is not possible for us to know exactly how these funds will be expended at this point in time, for the purposes of this analysis we have assumed that these funds will circulate in the state and regional economy in much the same way as other the other expenditures made by state and local government. Accordingly, the PPC modeled the total \$13.5 million as a direct impact to state and local government.

The IMPLAN model estimates that these expenditures will generate a total of 179 jobs, \$14.7 million in total labor income, \$15.1 million in total value added, and \$35.5 million in total output (see Table 16). Note that Vineyard Wind estimates it will directly pay \$1.5 million in host community agreements *each year* during the construction and operations phases of the proposed project, so these impacts are likely conservative.

Table 16
 Estimated Economic Impacts Vineyard Wind Direct Payments

| Impact Type | Employment | Labor Income | Value Added | Output |
|-----------------|------------|---------------|---------------|---------------|
| Direct Effect | 53 | \$ 5,989,692 | \$ 2,545,576 | \$ 13,500,000 |
| Indirect Effect | 66 | \$ 5,236,848 | \$ 6,802,407 | \$ 11,745,985 |
| Induced Effect | 59 | \$ 3,466,677 | \$ 5,728,323 | \$ 9,168,688 |
| Total Effect | 179 | \$ 14,693,216 | \$ 15,076,306 | \$ 34,514,672 |

APPENDIX A: METHODOLOGY

The economic impacts of the proposed project are specified using IMPLAN (IMpact Analysis for PLANning), which is an input-output database and model that traces a project's purchases of goods, services, and labor through an economic area. The IMPLAN modeling system utilizes the U.S. Bureau of Economic Analysis' Input-Output Benchmarks with other data to construct quantitative models of trade flow relationships between businesses and between businesses and final consumers. From this data, one can examine the effects of a change in one or several economic activities to predict its effect on a specific state, regional, or local economy (impact analysis).

The Public Policy Center constructed input-output models in IMPLAN for the state of Massachusetts and Southeastern Massachusetts, defined as Barnstable, Bristol, Dukes, Plymouth, and Nantucket Counties. The data inputs used in the model vary depending on the project years(s) they are expended. Model outputs are reported in 2017 dollars. The latest available IMPLAN dataset is for 2016.

Inputs to the Model

Payroll Expenditures

Vineyard Wind provided the PPC with detailed job creation estimates and expenditures for each project phase for their proposed project. These estimates were based on the Vineyard Wind team's extensive experience and knowledge building similar sized projects in Europe, as well as information Vineyard Wind required supply chain companies to provide when submitting proposals. In other words, the direct job creation estimates were derived primarily from the input of the suppliers who will actually be doing the hiring.

The PPC thoroughly reviewed the direct job creation and expenditure estimates, applying its expertise informed by data gathered from previous related work, interviews with industry leaders, site visits to European wind farm developments and ports, and an extensive literature review.

The PPC estimated total employee compensation and proprietor income using Vineyard Wind's estimates of direct FTEs, and wage and proprietor income data from the Bureau of Labor Statistics and Economic Modeling Specialists International (EMSI). These data served as the primary inputs to our IMPLAN model as Labor income (both employee compensation and proprietor income). **Notably, the model has been designed to only include those payroll expenditures from jobs that are expected to exist in the two study regions: The Commonwealth of Massachusetts and Southeastern Massachusetts (SEMA).**

Non-Payroll Expenditures

IMPLAN works by applying a change in demand or production to 1 of 536 industry sectors. It is not possible to estimate the economic impact of Vineyard Wind's operations and capital expenditures simply by changing the output of an aggregated offshore wind industry in the econometric model because a mature offshore wind industry does not exist in the U.S. However, because Vineyard Wind provided the Public Policy Center with detailed information on its payroll and local expenditures, it was possible to use a more precise method for

estimating the organization’s economic impacts. Instead of specifying a change in output for the offshore wind industry, the PPC instead specified a long list of changes in the output of each industry that is a beneficiary of the project’s purchases, which allows IMPLAN to apply the appropriate regional purchase coefficient to each industry.

The table below lists the IMPLAN industry codes used in this analysis. More than 100 individual expenditures were mapped to 27 IMPLAN sectors for each scenario examined. **As noted above, the model includes only those expenditures that are expected to occur in the two study regions: Massachusetts and SEMA.**

Table 17
IMPLAN Sectors Used to Construct the Offshore Wind Model for Massachusetts

| Code | Sector |
|------|---|
| 54 | Construction of new power and communication structures |
| 56 | Construction of new highways and streets |
| 57 | Construction of new commercial structures, including farm structures |
| 58 | Construction of other new nonresidential structures |
| 159 | Petroleum lubricating oil and grease manufacturing |
| 218 | Iron, steel pipe and tube manufacturing from purchased steel |
| 315 | Search, detection, and navigation instruments manufacturing |
| 339 | Other communication and energy wire manufacturing |
| 406 | Retail - Miscellaneous store retailers |
| 407 | Retail - Nonstore retailers |
| 408 | Air transportation |
| 410 | Water transportation |
| 414 | Scenic and sightseeing transportation and support activities for transportation |
| 434 | Nondepository credit intermediation and related activities |
| 437 | Insurance carriers |
| 440 | Real estate |
| 442 | Automotive Rental |
| 452 | Computer systems design services |
| 455 | Environmental and other technical consulting services |
| 457 | Advertising, public relations, and related services |
| 461 | Management of companies and enterprises |
| 499 | Hotels & motels |
| 501 | Full service restaurants |
| 502 | Limited service restaurants |
| 510 | Other federal government enterprises |
| 523 | Other state government enterprises |
| 526 | Other local government enterprises |

Project Years and Multiple Models

Purchases of labor and non-labor inputs will occur over multiple years. In order to account for the phases of the project and Vineyard Wind’s proposed timeline, several input-output models were constructed, including one for each year in which the expenditures are expected to occur. The results of these individual yearly models were then aggregated to produce the final impact tables.

Local Content: Base and High Scenarios

The PPC developed a Base and High scenario based on the expected local content for the project. Only expenditures that will be spent in the geographic areas of analysis (i.e. Massachusetts and SEMA) are included as direct expenditures and only those jobs that are performed in these areas are included as direct jobs. These final payroll and non-payroll expenditures were then used as inputs into the IMPLAN input-output modeling system which was used to estimate the indirect impacts of the proposed project(s).

Vineyard Wind provided the PPC with the expected degree of local procurement and content for each payroll and non-payroll expenditure, based on their previous development experience, conversations with local suppliers, and project plans.²² Local content was defined using a tiered system that assigned payroll and non-payroll expenditures according to the likelihood of the content being local for both the Base and High scenarios (see Table 18). The PPC reviewed and vetted these local content assumptions to ensure that the local content assumptions used in our analysis are both conservative and plausible.

Table 18
Base and High Scenarios

| Tier | Base Scenario | High Scenario |
|--------------------|----------------------|----------------------|
| Tier 1 Expenditure | Included | Included |
| Tier 2 Expenditure | Included | Included |
| Tier 3 Expenditure | Not Included | Included |
| Tier 4 Expenditure | Not Included | Not Included |

Tax Impacts

Tax impacts were estimated using IMPLAN's social accounting matrix, which measures transactions that occur between industry sectors and transactions that occur between government and households and between government and production sectors. In so doing, information on tax transfers is recorded. There are limitations to this approach in estimating tax impacts. IMPLAN's tax impacts are based on what was collected for the year of the data, not tax rates, therefore the tax estimations themselves do not reflect actual collected taxes. Also, the distribution of taxes will be the same regardless of the industries affected. For example, tax impacts in the healthcare industry are treated by IMPLAN the same as they are for auto manufacturing or a university. Lastly, using IMPLAN's tax impacts does not take into account the cost of providing government services, that is, the tax impact only considers the revenue side of the equation.

²² Vineyard Wind has secured numerous letters of support from Massachusetts supply chain companies.

APPENDIX B: DESCRIPTION OF IMPLAN

The indirect and induced economic impacts of the Vineyard Wind project are specified using IMPLAN (Impact Analysis for PLANning), which is an econometric modeling system developed by applied economists at the University of Minnesota and the U.S. Forest Service. The IMPLAN modeling system utilizes the U.S. Bureau of Economic Analysis' Input-Output Benchmarks with other data to construct quantitative models of trade flow relationships between businesses and between businesses and final consumers. From this data, one can examine the effects of a change in one or several economic activities to predict its effect on a specific state, regional, or local economy (impact analysis).

IMPLAN also includes social accounting data (e.g., personal income and gross state product) that makes it possible to measure non-industrial transactions such as the payment of indirect taxes by businesses and households. The IMPLAN data base provides data coverage for the entire United States by county and has the ability to incorporate user-supplied data at each stage of the model building process to ensure that estimates of economic impacts are both up-to-date and specific to an economic impact area. IMPLAN can construct local input-output models in units as small as five-zip code clusters.

IMPLAN's Regional Economic Accounts and the Social Accounting Matrices are used to construct local, county, or state-level multipliers specific to an impact area. Multipliers describe the response of an economy to a change in demand or production. The multipliers allow economic impact analysis to move from a descriptive input-outputs model to a predictive model. Each industry that produces goods or services generates demand for other goods and services and this demand is multiplied through a particular economy until it dissipates through "leakage" to economies outside the specified area. Thus, multipliers calculate the response of the economic impact area to a change in demand or production.

IMPLAN models discern and calculate leakage from local, regional, and state economic areas based on workforce configuration, the inputs required by specific types of businesses, and the availability of both inputs in the economic area. Consequently, economic impacts that accrue to other regions or states as a consequence of a change in demand are not counted as impacts within the economic area. The model accounts for substitution and displacement effects by deflating industry-specific multipliers to levels well below those recommended by the U.S. Bureau of Economic Analysis. In addition, multipliers are applied only to personal disposable income to obtain a more realistic estimate of the multiplier effects from increased demand. The reliability of these estimates has been proven through empirical testing.

A predictive model is constructed by specifying a series of new expenditures in a specific economic area (e.g., new employment or construction), which is then applied to the industry multipliers for that particular region. Based on these calculations, the model estimates final demand, which includes employment, employee compensation (excluding benefits), and point-of-work personal income (including benefits). The initial IMPLAN data details all purchases in a given area, including imported goods and services. Importantly, IMPLAN's Regional Economic Accounts exclude imports to an economic area so the calculation of economic impacts identifies only those impacts specific to the economic impact area. IMPLAN calculates this distinction by applying Regional Purchase Coefficients (RPC) to predict regional

purchases based on an economic area's particular characteristics. The Regional Purchase Coefficient represents the proportion of goods and services that will be purchased regionally under normal circumstances, based on the area's economic characteristics described in terms of actual trade flows within the area.

