

Proposed Vineyard Wind Offshore Wind Energy Project

Estimated Contribution to Employment
and Economic Development

400 MW

December 2017



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VINEYARD WIND

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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.

Report Authors

David R. Borges, MPA, Director of Research & Administration

Michael Goodman, Ph.D., Executive Director

Elise Korejwa, MS, MPP, Senior Research Associate

Michael McCarthy, MPP, Research Associate



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 400 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 400 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 400 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).

Region	Total Direct FTEs	Pre-Construction & Development	Construction	O&M Annual	O&M Lifetime Job-Years	Total Job-Years
Massachusetts						
Base Scenario	761	108	595	58	1,450	2,211
High Scenario	993	108	825	60	1,500	2,493
SEMA						
Base Scenario	733	101	574	58	1,450	2,183
High Scenario	866	101	705	60	1,500	2,366

Specifically, in Massachusetts:

- The proposed Vineyard Wind project will support an estimated 2,211 direct FTE job years across all phases over the project period under the Base scenario and 2,493 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 703 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 58 FTEs annually over 25 years, for a total of 1,450 FTE job years.
- Under the High scenario, there are expected to be 933 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 60 FTEs annually over 25 years, for a total of 1,500 FTE job years.
- In terms of the actual number of workers (not FTEs), the project is expected to employ 919 workers in the Base scenario and 1,134 workers in the High scenario across all the project phases.

INDIRECT AND INDUCED IMPACTS

The spending associated with the 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 210 indirect jobs in Massachusetts during the Development and Construction phases and support an additional 24 jobs annually during the 25-year Operations period.
- The direct and indirect impacts of the proposed project are expected to induce an additional 611 jobs during the Development and Construction phases and support an additional 52 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 254 jobs 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 717 jobs during the Development and Construction phases and support an additional 55 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 400 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 400 MW Vineyard Wind project is \$9.3 million in the Base scenario and \$10.6 million in the High scenario.
- This includes an estimated increase in Massachusetts personal income tax payments between \$2.9 million and \$3.2 million, an increase in sales taxes between \$1.8 million and \$2.1 million, and an increase in local property taxes between \$3.1 million and \$3.6 million, for the Base and High scenarios respectively.
- Corporate income taxes can be expected to increase by \$814,069 in the Base scenario and \$898,269 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	\$2,882,689	\$3,195,425
Other Personal Taxes	\$381,466	\$422,851
*Payroll taxes	\$46,479	\$51,382
Sales taxes	\$1,811,230	\$2,098,069
Property taxes	\$3,107,155	\$3,599,225
Corporate taxes	\$814,069	\$898,269
Fees & other taxes	\$300,055	\$347,574
Total	\$9,343,143	\$10,612,795

*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 400 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 ironworkers, 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.

CONTENTS

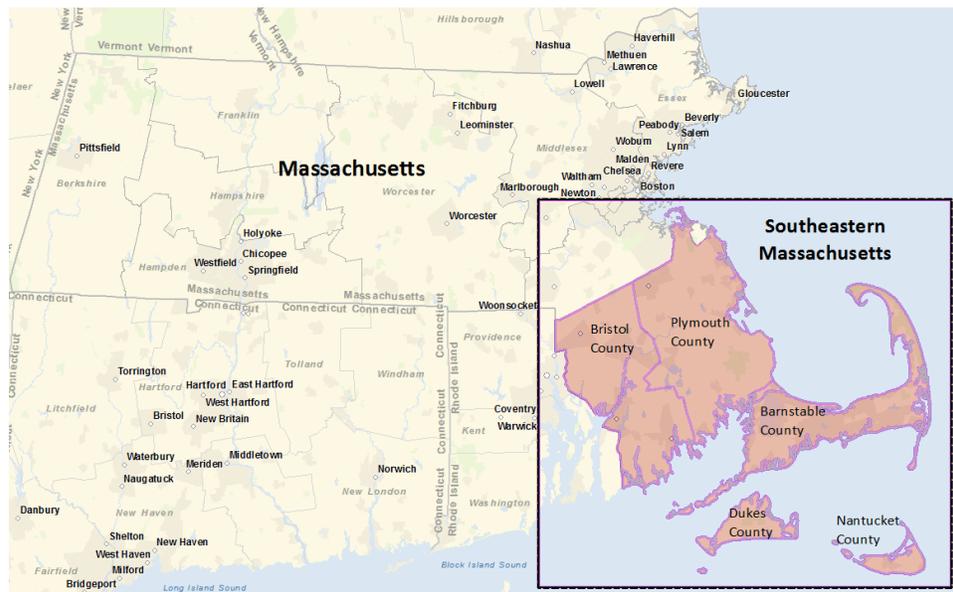
Executive Summary	i
1 Introduction	1
1.1 RFP Sections Addressed In This Analysis	2
2 The Vineyard Wind Project	4
2.1 Project Phases	5
2.1.1 Pre-Construction and Development.....	5
2.1.2 Construction.....	5
2.1.3 Operations & Maintenance	6
3. Methodology and Data Sources.....	7
3.1 Direct Impacts	8
3.1.1 Local Content: Base and High Scenarios	8
3.1.2 Developing the Supply Chain Through the Offshore Wind Industry Accelerator.....	9
3.2 Indirect Impacts.....	10
3.2.1 Inputs to the Model	10
3.2.2 Project Years and Multiple Models.....	10
4 Estimated Direct Jobs And Expenditures Associated with the Proposed 400 MW Project.....	11
4.1 Summary of Direct FTE Job Impacts	11
4.1.1 Massachusetts	11
4.1.2 Southeastern Massachusetts.....	11
4.1.3 Job Timeline	12
4.1.4 Job Years: Development and Construction Versus Operations	13
4.2 Summary of Direct Expenditures: All Phases	14
4.2.1 Compensation and Wages	14
4.2.2 Non-Payroll	15
4.3 Types of Direct Jobs and Average Annual Compensation	16
5 Total Direct, Indirect, and Induced Impacts.....	20
5.1 Massachusetts.....	20
5.2 Southeastern Massachusetts (SEMA)	25
6 Expected State Tax Revenue Generated from the 400 MW Vineyard Wind Project	29
7 Other Economic Development Impacts	30
Appendix A: Methodology	31
Appendix B: Description of IMPLAN	34

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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 400 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.

*Proposed Vineyard Wind 400 MW Offshore Wind Energy Project:
Estimated Contribution To Employment And Economic Development*

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 suppliers 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.

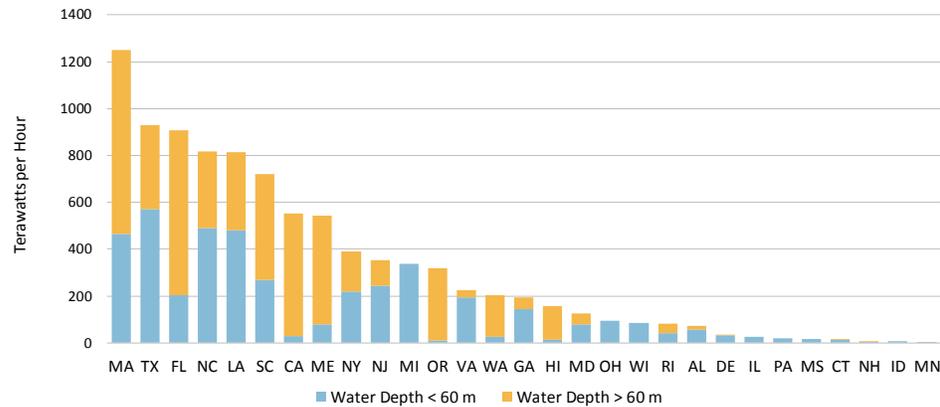
⁴ 2.2.2.7 pertains to a bidder's ability to demonstrate that its proposal can be developed, financed, constructed and technically viable within a commercially reasonable timeframe.

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.

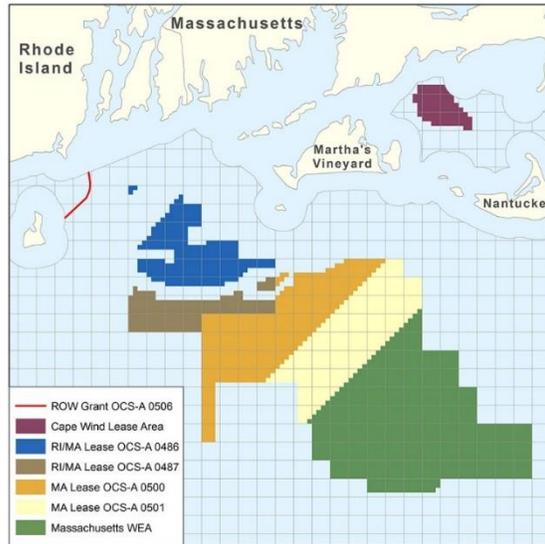
Massachusetts issued its first comprehensive Ocean Management Plan for state waters in 2009, identifying areas appropriate for offshore wind development (see Figure 3).⁶ Then in 2013, the Bureau of Ocean Energy Management (BOEM) held its first competitive offshore commercial wind lease sale, auctioning 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 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.

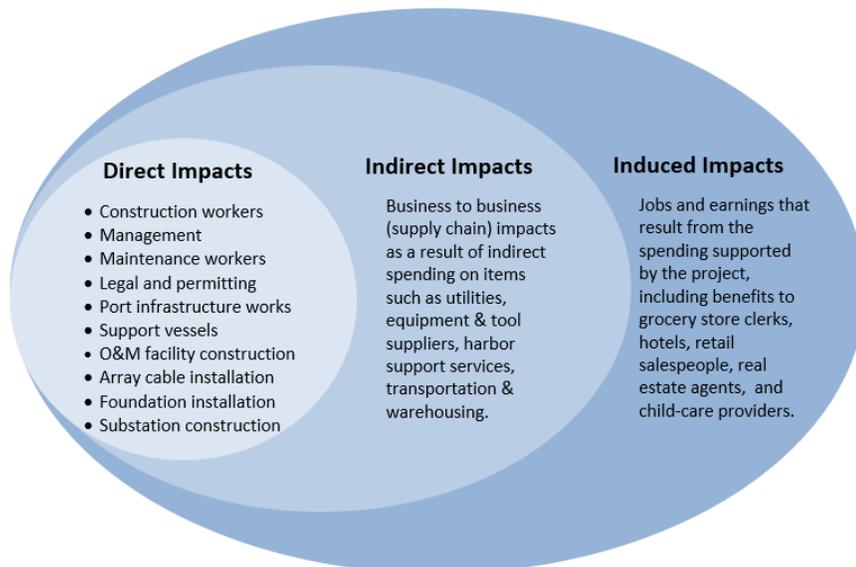
3. METHODOLOGY AND DATA SOURCES

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 400 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 windfarm 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 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 FTE job years, 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 400 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 400 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, and Section 4.2 describes the expected payroll and non-payroll expenditures in each region.

4.1 SUMMARY OF DIRECT FTE JOB IMPACTS

4.1.1 Massachusetts

- The Vineyard Wind project will support an estimated 2,211 direct FTE job years in Massachusetts across all phases over the project period under the Base scenario and 2,493 direct FTE job years in Massachusetts in the High scenario (see Table 2).¹³ This total includes job years over the entire 25-year O&M phase.
- Under the Base scenario, there are expected to be 703 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 58 FTEs annually over 25 years, for a total of 1,450 FTE job years.
- Under the High scenario, there are expected to be 933 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 60 FTEs annually over 25 years, for of 1,500 FTE job years.
- In terms of the actual number of workers (not FTEs), the project is expected to employ 919 workers in the Base scenario and 1,134 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 performed in this region (see Table 2).

- The Vineyard Wind project will require an estimated 2,183 direct FTE job years in the SEMA region over the project period under the Base scenario and 2,366 direct FTE job years in SEMA in the High scenario. This total includes job years over the entire 25-year O&M phase.

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).

The Vineyard Wind project will support an estimated 2,211 direct FTE job years in Massachusetts across all phases over the project period under the Base scenario and 2,493 direct FTE job years in Massachusetts in the High scenario.

*Proposed Vineyard Wind 400 MW Offshore Wind Energy Project:
Estimated Contribution To Employment And Economic Development*

- Under the Base scenario, there are expected to be 675 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 58 FTEs annually over 25 years, for a total of 1,450 FTE job years.
- Under the High scenario, there are expected to be 806 FTE job years during the Development and Construction phases. During the O&M phase, there are expected to be 60 FTEs annually over 25 years, for a total of 1,500 FTE job years.
- In terms of the actual number of workers (not FTEs), the project is expected to employ 883 workers in the Base scenario and 1,020 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-Construction & Development	Construction	O&M Annual	O&M Lifetime Job-Years	Total Job-Years
Massachusetts						
Base Scenario	761	108	595	58	1,450	2,211
High Scenario	993	108	825	60	1,500	2,493
SEMA						
Base Scenario	733	101	574	58	1,450	2,183
High Scenario	866	101	705	60	1,500	2,366

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. Pre-Construction & 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 67 percent of the total job years over the lifetime of the wind farm, while these jobs will account for 62 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 & Construction Versus O&M
Base Scenario

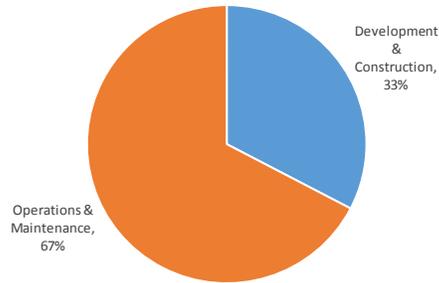
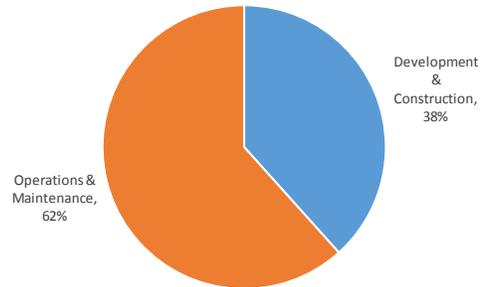
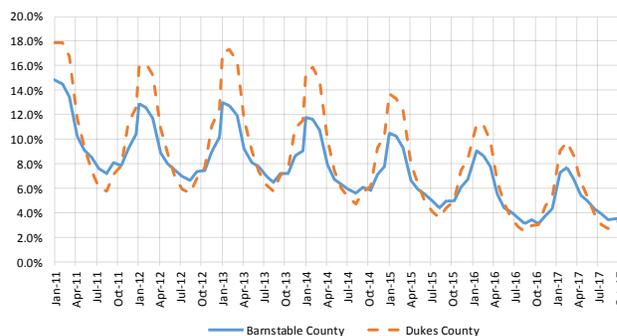


Figure 6
Lifetime Job-Years: Development & Construction Versus O&M
High Scenario



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 \$81.0 million will be spent on payroll in Massachusetts under the Base scenario, and \$97.5 million on payroll in the High scenario.

Massachusetts: An estimated \$81.0 million will be spent on payroll¹⁵ in Massachusetts in the Base scenario (including just the first year of O&M) and \$97.5 million on payroll in the High scenario to support direct project activities. Average wages range from \$88,945 in the Base scenario to \$81,978 in the High scenario (see Table 3).

SEMA: An estimated \$76.6 million will be spent on payroll¹⁵ in Massachusetts in the Base scenario (including just the first year of O&M) and \$85.8 million on payroll in the High scenario to support direct project activities. Average wages range from \$87,218 in the Base scenario to \$82,570 in the High scenario (see Table 3).

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

	Massachusetts	SEMA
Base Scenario	\$88,945	\$87,218
High Scenario	\$81,978	\$82,570

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 \$148,767 in the Pre-Construction & Development phase to \$98,986 in the Construction phase. The long-term O&M jobs offer an average total compensation of \$103,971 (see Table 4).

Table 4
 Average Compensation for Base & High Scenario

Region	All Phases	Pre-Construction & Development	Construction	O&M
Massachusetts				
Base Scenario	\$106,402	\$148,767	\$98,986	\$103,971
High Scenario	\$98,269	\$148,767	\$91,257	\$104,256
SEMA				
Base Scenario	\$104,494	\$149,347	\$96,645	\$103,971
High Scenario	\$99,067	\$149,347	\$91,421	\$104,256

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 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.

Offshore wind is a relatively high-wage industry, even for blue-collar workers.

4.2.2 Non-Payroll

Excluding the payroll listed in the previous section, Vineyard Wind estimates that it will spend \$123.6 million procuring materials and services from Massachusetts suppliers, of which \$75.0 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 \$135.2 million and \$76.4 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

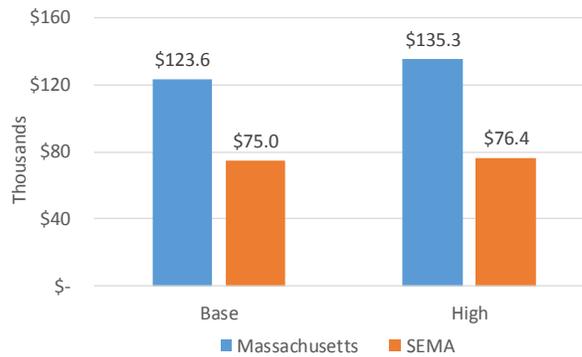


Table 5
Non-Payroll Expenditures From Massachusetts & SEMA Suppliers, Thousands

Package	Massachusetts		SEMA	
	Base	High	Base	High
Array cables	\$2,371	\$3,177	\$1,220	\$1,408
Construction Management	\$23,397	\$23,397	\$5,697	\$5,697
Export cable, Offshore	\$4,622	\$9,035	\$683	\$899
Export cable, Onshore	\$11,522	\$11,522	\$11,522	\$11,522
Foundation	\$25,526	\$25,526	\$8,953	\$8,953
O&M Preparations	\$6,229	\$6,229	\$4,522	\$4,522
Permitting	\$12,744	\$12,744	\$12,244	\$12,244
Project Management	\$12,030	\$12,030	\$9,790	\$9,790
Substation, Offshore (ESP)	-	\$550	-	-
Substation, Onshore	\$1,601	\$1,601	\$1,601	\$1,601
Wind Turbine Generator	\$15,917	\$19,644	\$12,778	\$12,778
Total	\$123,580	\$135,262	\$75,046	\$76,419

4.3 TYPES OF DIRECT JOBS AND AVERAGE ANNUAL COMPENSATION

Developing, constructing, operating, and maintaining the offshore windfarm 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 ironworkers, 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. 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 & Development

White-collar occupations dominate the Pre-Construction & 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.

*Proposed Vineyard Wind 400 MW Offshore Wind Energy Project:
Estimated Contribution To Employment And Economic Development*

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.

*Proposed Vineyard Wind 400 MW Offshore Wind Energy Project:
Estimated Contribution To Employment And Economic Development*

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 for the proposed project (see Table 7).

Table 7
Expected Occupations, Credentialing Requirements, and Earnings During
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

O&M occupations consist primarily of wind technicians, managers, and water transportation workers (see Table 8). These workers would need to live in or around the O&M port, in order to be on call for emergency maintenance and to deploy quickly for routine visits the windfarm.

Table 8
Expected Occupations, Credentialing Requirements, and Earnings During the
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 400 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 210 jobs during the Development and Construction phases and support an additional 24 jobs annually during the 25-year Operations period (see Table 9).¹⁹ In addition:

- These jobs can be expected to generate \$20.2 million in labor income during the Development and Construction periods and \$2.0 million annually during the Operations period.
- The proposed project will also contribute nearly \$29.7 million in added value to the Massachusetts economy during Development and Construction and \$2.8 million annually during Operations.
- These indirect impacts are estimated to support an estimated \$49.9 million in new economic output during the Development and Construction phases and an additional \$4.7 million annually during the Operations period.

Induced Impacts: The direct and indirect impacts of the proposed project are expected to induce an additional 611 jobs during the Development and Construction phases and support an additional 52 jobs annually during the 25-year operations period (see Table 9). In addition:

- These jobs can be expected to generate \$40.3 million in labor income during the Development and Construction periods and \$3.4 million annually during the Operations period.
- The proposed project will also contribute nearly \$66.6 million in added value to the Massachusetts economy during the Development and Construction phases and an estimated \$5.7 million annually during Operations.
- These induced impacts are estimated to support \$106.6 million in new economic output during the Development and Construction phases and an additional \$9.1 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 210 indirect jobs during the Development and Construction phases and support an additional 24 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

Massachusetts Impact
400 MW: Base Scenario

Pre-Construction & Development Phase (2017 - 2021)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	108	\$ 16,769,895	\$ 4,685,158	\$ 9,035,490
Indirect Effect	16	\$ 1,754,906	\$ 2,531,082	\$ 4,229,235
Induced Effect	111	\$ 6,633,308	\$ 10,959,141	\$ 17,543,482
Total Effect	235	\$ 25,158,109	\$ 18,175,381	\$ 30,808,207
Multiplier	2.2	1.5	3.9	3.4

Construction Phase (2020 - 2021)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	595	\$ 60,410,735	\$ 47,004,174	\$ 101,348,919
Indirect Effect	194	\$ 18,517,243	\$ 27,163,245	\$ 45,699,992
Induced Effect	500	\$ 33,671,174	\$ 55,635,090	\$ 89,053,126
Total Effect	1,289	\$ 112,599,152	\$ 129,802,509	\$ 236,102,038
Multiplier	2.2	1.9	2.8	2.3

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

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	703	\$ 77,180,631	\$ 51,689,332	\$ 110,384,409
Indirect Effect	210	\$ 20,272,149	\$ 29,694,327	\$ 49,929,227
Induced Effect	611	\$ 40,304,482	\$ 66,594,232	\$ 106,596,608
Total Effect	1,524	\$ 137,757,261	\$ 147,977,891	\$ 266,910,245
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	58	\$ 6,181,064	\$ 3,291,563	\$ 8,081,246
Indirect Effect	24	\$ 2,043,699	\$ 2,831,251	\$ 4,760,698
Induced Effect	52	\$ 3,439,800	\$ 5,683,411	\$ 9,097,507
Total Effect	134	\$ 11,664,563	\$ 11,806,226	\$ 21,939,451
Multiplier	2.3	1.9	3.6	2.7

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 254 jobs during the Development and Construction phases and support an additional 26 jobs annually during the 25-year Operations period (see Table 10). In addition:

- These jobs can be expected to generate \$21.3 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 \$31.3 million in added value to the Massachusetts economy during the Development and Construction period and \$3.1 million annually during Operations.
- These indirect impacts are estimated to support an estimated \$52.6 million in new economic output during the Pre-Construction and Construction phases and an additional \$5.2 million annually during the Operations period.

Induced Impacts: The direct and indirect impacts of the proposed project are expected to induce an additional 717 jobs during the Development and Construction phases and support an additional 55 jobs annually during the 25-year operations period (see Table 10). In addition:

- These jobs can be expected to generate \$46.6 million in labor income during the development construction period and \$3.6 million annually during the Operations period.
- The proposed project will also contribute nearly \$77.1 million in added value to the Massachusetts economy during the Development and Construction periods and just under \$6.0 million annually during Operations.
- These induced impacts are estimated to support an estimated \$123.4 million in new economic output during the Development and Construction phases and an additional \$9.5 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 254 indirect jobs during the Development and Construction phases and support an additional 26 indirect jobs annually during the 25-year Operations period.

Table 10
 Impact Summary for High Scenario: Massachusetts

Massachusetts Impact
400 MW: High Scenario

Pre-Construction & Development Phase (2017 - 2021)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	108	\$ 16,769,895	\$ 4,685,158	\$ 9,035,490
Indirect Effect	16	\$ 1,754,906	\$ 2,531,082	\$ 4,229,235
Induced Effect	111	\$ 6,633,308	\$ 10,959,141	\$ 17,543,482
Total Effect	235	\$ 25,158,109	\$ 18,175,381	\$ 30,808,207
Multiplier	2.2	1.5	3.9	3.4

Construction Phase (2020 - 2021)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	825	\$ 76,929,087	\$ 50,728,485	\$ 110,396,604
Indirect Effect	238	\$ 19,598,073	\$ 28,761,223	\$ 48,398,557
Induced Effect	606	\$ 40,012,058	\$ 66,111,460	\$ 105,823,260
Total Effect	1,669	\$ 136,539,218	\$ 145,601,168	\$ 264,618,421
Multiplier	2.0	1.8	2.9	2.4

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

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	933	\$ 93,698,983	\$ 55,413,643	\$ 119,432,094
Indirect Effect	254	\$ 21,352,979	\$ 31,292,305	\$ 52,627,792
Induced Effect	717	\$ 46,645,366	\$ 77,070,602	\$ 123,366,742
Total Effect	1,904	\$ 161,697,328	\$ 163,776,550	\$ 295,426,628
Multiplier	2.0	1.7	3.0	2.5

Note: This table summed from two tables above.

Operations & Maintenance Phase (Annual)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	60	\$ 6,353,977	\$ 4,244,406	\$ 10,099,884
Indirect Effect	26	\$ 2,216,516	\$ 3,056,682	\$ 5,176,598
Induced Effect	55	\$ 3,610,695	\$ 5,965,784	\$ 9,549,489
Total Effect	141	\$ 12,181,187	\$ 13,266,872	\$ 24,825,971
Multiplier	2.4	1.9	3.1	2.5

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

5.1.3 Indirect and Induced Employment Impacts

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).

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

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

5.2 SOUTHEASTERN MASSACHUSETTS (SEMA)

5.2.1 Base Scenario

Indirect Impacts: The proposed project can be expected to support an additional 142 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 \$8.6 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 \$12.6 million in added value to the SEMA economy during the Development and Construction phases and \$1.7 million annually during Operations.
- These indirect impacts are estimated to support an estimated \$23.1 million in new economic output during the Development and Construction phases and \$3.4 million annually during the Operations period.

Induced Impacts: The direct and indirect impacts of the proposed project can be expected to induce an additional 447 jobs in SEMA during the Development and Construction phases and support an additional 50 jobs annually during the 25-year Operations period (see Table 12). In addition:

- These jobs can be expected to generate \$22.5 million in labor income in SEMA during the Development and Construction phases and \$2.2 million annually during the Operations period.
- The proposed project will also contribute just over \$38.6 million in added value to the SEMA economy during the Development and Construction period and \$3.8 million annually during Operations.
- These induced impacts are estimated to support an estimated \$66.4 million in new economic output during the Development and Construction phases and \$6.6 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 142 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
400 MW: Base Scenario

Pre-Construction & Development Phase (2017 - 2021)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	101	\$ 15,867,473	\$ 2,955,949	\$ 4,780,026
Indirect Effect	9	\$ 463,867	\$ 763,344	\$ 1,380,948
Induced Effect	79	\$ 3,961,293	\$ 6,791,846	\$ 11,688,055
Total Effect	189	\$ 20,292,634	\$ 10,511,139	\$ 17,849,028
Multiplier	1.9	1.3	3.6	3.7

Construction Phase (2020 - 2021)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	574	\$ 56,835,933	\$ 24,150,758	\$ 58,973,871
Indirect Effect	133	\$ 8,146,444	\$ 11,846,047	\$ 21,763,192
Induced Effect	368	\$ 18,528,077	\$ 31,775,568	\$ 54,670,903
Total Effect	1,075	\$ 83,510,454	\$ 67,772,373	\$ 135,407,966
Multiplier	1.9	1.5	2.8	2.3

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

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	675	\$ 72,703,406	\$ 27,106,707	\$ 63,753,897
Indirect Effect	142	\$ 8,610,311	\$ 12,609,391	\$ 23,144,140
Induced Effect	447	\$ 22,489,370	\$ 38,567,413	\$ 66,358,958
Total Effect	1,264	\$ 103,803,087	\$ 78,283,512	\$ 153,256,995
Multiplier	1.9	1.4	2.9	2.4

Note: This table summed from two tables above.

Operations & Maintenance Phase (Annual)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	58	\$ 6,181,064	\$ 2,032,457	\$ 6,469,783
Indirect Effect	24	\$ 1,273,678	\$ 1,727,374	\$ 3,395,980
Induced Effect	50	\$ 2,241,005	\$ 3,842,641	\$ 6,612,335
Total Effect	132	\$ 9,695,746	\$ 7,602,472	\$ 16,478,098
Multiplier	2.3	1.6	3.7	2.5

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 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 143 indirect jobs in SEMA during the Development and Construction phases and support an additional 23 jobs annually during the 25-year Operations period (see Table 13). In addition:

- These jobs can be expected to generate just over \$8.6 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 \$12.6 million in added value to the SEMA economy during the Development and Construction phases and \$1.7 million annually during Operations.
- These indirect impacts are estimated to support an estimated \$23.2 million in new economic output during the Development and Construction phases and \$3.4 million annually during the Operations period.

Induced Impacts: The direct and indirect impacts of the proposed project can be expected to induce an additional 490 jobs in SEMA during the Development and Construction phases and support an additional 46 jobs annually during the 25-year operations period (see Table 13). In addition:

- These jobs can be expected to generate \$24.6 million in labor income in SEMA during the Development and Construction phases and \$2.2 million annually during Operations.
- The proposed project will also contribute just over \$42.1 million in added value to the SEMA economy during the Development and Construction phases and \$3.8 million annually during Operations.
- These induced impacts are estimated to support an estimated \$72.5 million in new economic output during the Developments and Construction phases and just over \$6.6 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 143 indirect jobs during the Development and Construction phases and support an additional 23 indirect jobs annually during the 25-year Operations period in Southeastern Massachusetts.

Table 13
 Impact Summary High Scenario: Southeastern Massachusetts

SEMA Impact
400 MW: High Scenario

Pre-Construction & Development Phase (2017 - 2021)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	101	\$ 15,867,473	\$ 2,955,949	\$ 4,780,026
Indirect Effect	10	\$ 463,867	\$ 763,344	\$ 1,380,948
Induced Effect	81	\$ 3,963,189	\$ 6,794,752	\$ 11,693,534
Total Effect	192	\$ 20,294,529	\$ 10,514,045	\$ 17,854,508
Multiplier	1.9	1.3	3.6	3.7

Construction Phase (2020 - 2021)

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	705	\$ 65,930,222	\$ 24,390,992	\$ 59,363,502
Indirect Effect	133	\$ 8,171,862	\$ 11,884,268	\$ 21,831,235
Induced Effect	409	\$ 20,618,015	\$ 35,358,747	\$ 60,837,360
Total Effect	1,247	\$ 94,720,099	\$ 71,634,008	\$ 142,032,097
Multiplier	1.8	1.4	2.9	2.4

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

ImpactType	Employment	LaborIncome	ValueAdded	Output
Direct Effect	806	\$ 81,797,695	\$ 27,346,942	\$ 64,143,528
Indirect Effect	143	\$ 8,635,729	\$ 12,647,612	\$ 23,212,183
Induced Effect	490	\$ 24,581,204	\$ 42,153,499	\$ 72,530,894
Total Effect	1,439	\$ 115,014,628	\$ 82,148,053	\$ 159,886,606
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	60	\$ 6,353,977	\$ 2,032,457	\$ 6,469,783
Indirect Effect	23	\$ 1,273,678	\$ 1,727,374	\$ 3,395,980
Induced Effect	46	\$ 2,241,005	\$ 3,842,641	\$ 6,612,335
Total Effect	129	\$ 9,868,659	\$ 7,602,472	\$ 16,478,098
Multiplier	2.2	1.6	3.7	2.5

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

6 EXPECTED STATE TAX REVENUE GENERATED FROM THE 400 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 O&M of the 400 MW Vineyard Wind project is \$9.3 million in the Base scenario and \$10.6 million in the High scenario (see Table 14). This includes an estimated increase in Massachusetts personal income tax payments between \$2.9 million and \$3.2 million, an increase in sales taxes between \$1.8 million and \$2.1 million, and an increase in local property taxes between \$3.1 million and \$3.6 million, for the Base and High scenarios respectively. Corporate income taxes can be expected to increase by \$814,069 in the Base Scenario and \$898,269 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 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 400 MW Vineyard Wind project is \$9.3 million in the Base scenario and \$10.6 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	\$2,882,689	\$3,195,425
Other Personal Taxes	\$381,466	\$422,851
*Payroll taxes	\$46,479	\$51,382
Sales taxes	\$1,811,230	\$2,098,069
Property taxes	\$3,107,155	\$3,599,225
Corporate taxes	\$814,069	\$898,269
Fees & other taxes	\$300,055	\$347,574
Total	\$9,343,143	\$10,612,795

*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 windfarm 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.

