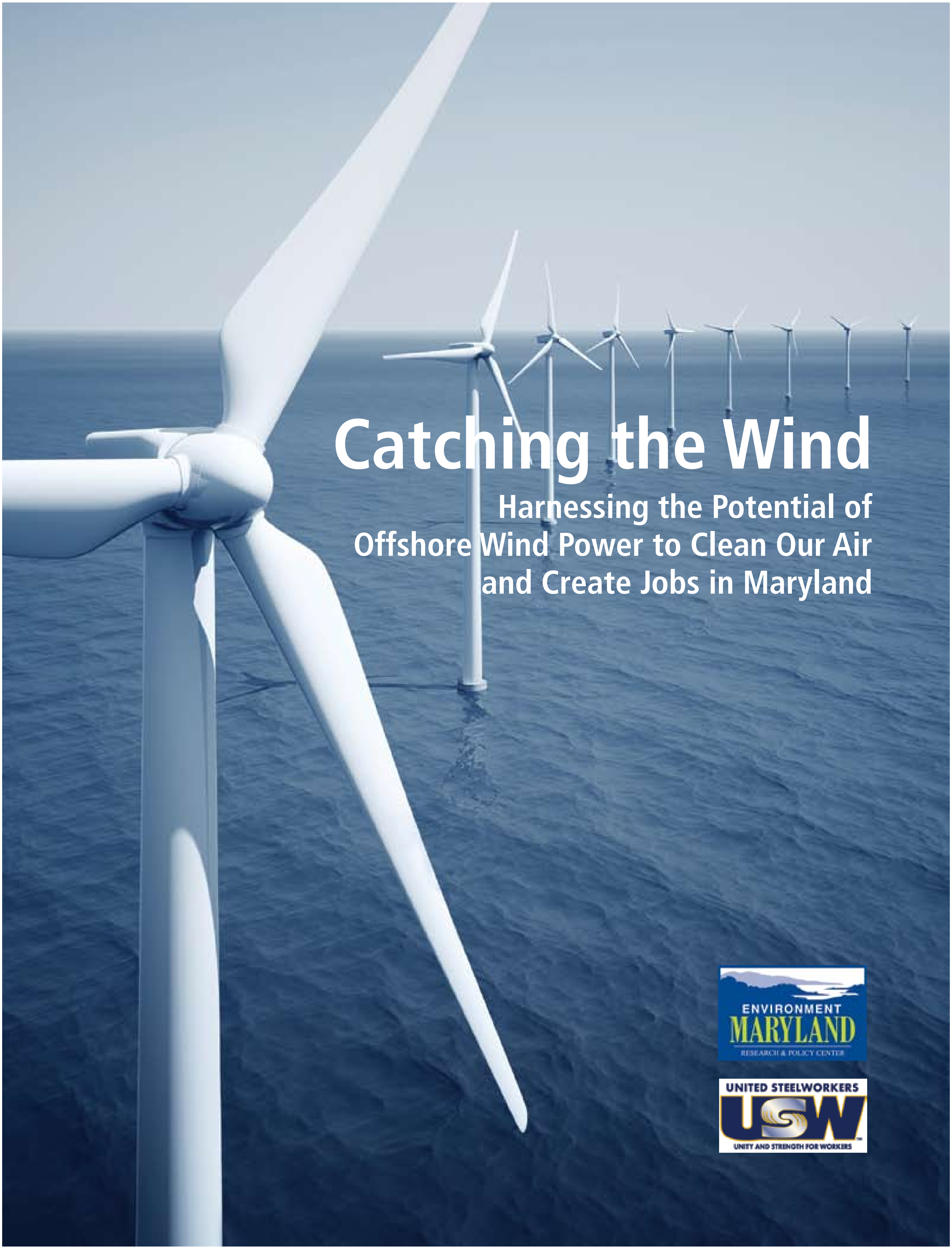

Catching the Wind

Harnessing the Potential of Offshore Wind Power to Clean Our Air and Create Jobs in Maryland

Environment Maryland Research & Policy Center

United Steelworkers USW Unity and Strength for Workers

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The United Steelworkers represents 1.2 million active and retired workers in North America in a wide variety of industries in both the public and private sectors. In Maryland, it is the largest union in the manufacturing sector. USW represents Maryland workers in the steel, cement, paper, energy, chemical and food industries, among others. For more information about the United Steelworkers, please visit www.usw.org.

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Executive Summary

Offshore wind energy presents a tremendous environmental and economic opportunity for Maryland.

Environmentally, Maryland's vast offshore wind resource can reduce our dependence on coal-fired power plants, curb global warming pollution, and help the state meet its renewable energy requirements. Economically, offshore wind development can stabilize electricity prices and has the potential to create thousands of jobs in dozens of fields—helping to sustain existing Maryland firms and encouraging the creation of brand-new industries.

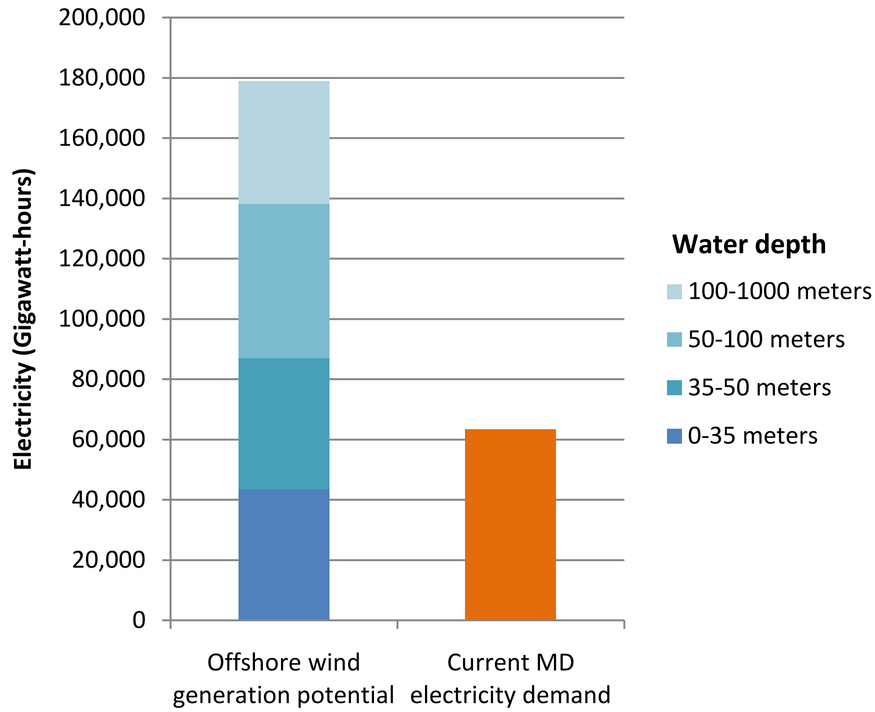
Maryland already has more than 150 businesses—employing more than 7,000 workers—that can participate in the manufacturing of components for offshore wind parks. Another 980 businesses—employing more than 20,000 workers—have the potential to play supporting roles in the construction of offshore wind energy. A commitment to offshore wind development could also result in new businesses setting up shop in Maryland in fields ranging from science and engineering to construction and manufacturing.

To reap the benefits of offshore wind, Maryland should provide certainty for developers of offshore wind parks by ensuring that the power they produce will find a market in the state.

Maryland's dependence on fossil fuels threatens our environment. Electric power plants produce 38 percent of Maryland's emissions of carbon dioxide—the leading global warming pollutant. Power plants are also a major source of nitrogen oxides, a key component of smog, and sulfur dioxide, which forms fine particles in the air, contributing to lung disease and heart attacks.

Maryland is blessed with a tremendous offshore wind resource that can meet a significant share of the state's electricity needs. The wind energy potential in shallow-water areas off Maryland's coast is capable of producing the equivalent of two-thirds of the amount of electricity we use. (See Figure ES-1.) Maryland has even greater potential to generate wind power in deeper offshore waters and can benefit from offshore wind development in the waters of neighboring states.

Figure ES-1. Maryland Offshore Wind Potential Compared with Current Electricity Demand (Source: University of Delaware Center for Carbon-Free Power Integration)



Offshore wind parks require hundreds of workers in dozens of fields and create a wide variety of economic opportunities for Maryland.

Turbines

- Wind turbines represent about half the cost of an offshore wind park. Offshore wind turbines are currently built abroad, but strong and consistent demand for offshore wind power in the Mid-Atlantic could lure turbine manufacturers to the region—as has already occurred with the land-based wind turbine industry in the United States. Maryland already has more than 150 firms, employing at least 7,000 workers, in industries that could participate in the manufacture of components for wind turbines.

Foundations

- The foundations that hold offshore wind turbines to the seabed require large quantities of steel—which could conceivably be manufactured in Maryland and fabricated locally. Foundations for the Cape Wind development in Massachusetts, for example, will require 50,000 tons of steel plate—believed to be the largest steel plate order in the U.S. in a decade—and will be fabricated by a local firm, creating 100 manufacturing jobs in New England.

- Maryland has the potential to produce the steel for offshore wind foundations locally. The Sparrows Point steel mill, for example, could compete for the large steel orders that would result from offshore wind development.

Cables and electrical infrastructure

- Connecting offshore wind parks to the grid will require the efforts of skilled electrical workers, excavators, marine pilots and other workers. Creating a strong, regional demand for submarine cables could lure international cable manufacturers to set up shop in the Mid-Atlantic region. These manufacturers tend to locate in port cities, where cables can be readily loaded onto ships.

- Recent submarine cable projects in New York Harbor and San Francisco Bay involved the hiring of numerous local subcontractors to build on-shore electrical substations and lay cable.

Shipping and logistics

- The construction of offshore wind turbines requires a large amount of activity on land. The Port of Baltimore operates around the clock, is accessible via a deepwater channel, and has ample open space to store and assemble wind turbine components. It is well equipped to compete for business with other Mid-Atlantic ports, given some current methods of transporting and assembling offshore turbines.

- The need to deliver workers and materials to offshore wind installations will also create business for operators of smaller craft operating out of both the Port of Baltimore and other Maryland ports.

Permitting, legal and environmental work

- Offshore wind development has already begun to create opportunities for white collar workers in fields such as project management, finance, law, engineering and earth sciences.

Ongoing operations and maintenance

- Even after construction is complete, skilled maintenance and electrical workers will be required to keep offshore wind parks up and running. The Cape Wind development in Massachusetts, for example, will create approximately 110 permanent jobs in operations and maintenance, which could last for 20 years or more.

Offshore wind development has the potential to create large numbers of new jobs in a variety of industries.

- The state of Maryland estimates that construction of a 500 MW wind park could create 2,000 manufacturing and construction jobs over a five-year period, along with 400 permanent supply and maintenance jobs. Studies conducted by other Atlantic coast states have identified similar job-creation potential.

Maryland already has many firms and workers capable of participating in offshore wind development.

- According to data compiled by the U.S. Census Bureau and previous studies of the wind industry, there are more than 150 Maryland firms, employing more than 7,000 Maryland workers, that are engaged in industries that could participate in the manufacturing of components for offshore wind parks. (See Table ES-1.)

- There are approximately another 980 firms, employing more than 20,000 workers, that are engaged in industries that could provide support for the installation of offshore wind parks. (See Table ES-2.)

To encourage the development of offshore wind power—with its strong environmental and economic benefits for Maryland:

- The state and federal governments

Table ES-1. Employment in Industries with the Potential to Take Part in Wind Turbine Manufacturing

2007 NAICS code	Industry description	Number of employer establishments	Employer sales, shipments, receipts, revenue, or business done ($1,000)	Annual payroll ($1,000)	Number of paid employees
332420	Metal tank (heavy gauge) manufacturing	6	$53,790	$5,712	228
325520	Adhesive manufacturing	7	$286,531	$28,546	471
326150	Urethane and other foam product manufacturing	3	D	D	250-499
326199	All other plastics product manufacturing	58	$797,482	$140,062	3,461
332312	Fabricated structural metal manufacturing	26	$153,426	$36,933	741
333613	Mechanical power transmission equipment manufacturing	3	D	D	250-499
334418	Printed circuit assembly (electronic assembly) manufacturing	8	$31,582	$9,558	163
334513	Industrial process variable instruments	5	D	$15,718	197
334519	Other measuring and controlling device manufacturing	17	D	$24,379	443
335313	Switchgear and switchboard apparatus manufacturing	6	$90,527	$17,962	488
335314	Relay and industrial control manufacturing	8	$19,507	$5,264	100-249
335929	Other communication and energy wire manufacturing	3	D	D	250-499
335999	Miscellaneous electrical equipment manufacturing	6	D	D	100-249
	TOTAL	**156**	**>$1,432,845**	**>$284,134**	**>7,142**

(D= Withheld to avoid disclosing data for individual companies) should set bold goals for offshore wind development in the Atlantic, in order to provide clear leadership and vision regarding the important role of offshore wind in America's energy future and to demonstrate that it is a high priority.

- The U.S. Department of the Interior should improve and streamline current siting regulations for offshore wind projects in federal waters, while maintaining a high level of environmental protection.

- The Maryland Public Service Commission should solicit proposals for a wind park to be built off Maryland's coast. The PSC should then direct utilities to sign long-term power supply contracts with the wind developer with the best proposal.

Table ES-2. Employment in Industries with Potential to Supply Raw Materials or Aid in Installation of Offshore Wind Parks

2007 NAICS code	Industry description	Number of employer establishments	Employer sales, shipments, receipts, revenue, or business done ($1,000)	Annual payroll ($1,000)	Number of paid employees
22112	Electric power transmission, control, and distribution	60	Q	D	5,000-9,999
237130	Power and communication line and related structures construction	128	$481,101	$127,570	2,887
237310	Highway, street, and bridge construction	212	$1,495,639	$319,854	6,862
48311	Deep sea, coastal, and Great Lakes water transportation	22	D	D	250-499
484121	General freight trucking, long-distance, truckload	245	$593,831	$162,536	3,703
4883	Support activities for water transportation	47	D	D	1,000-2,499
213112	Support activities for oil and gas operations	8	D	$4,660	103
336611	Ship building and repairing	22	D	$11,420	263
541620	Environmental consulting services	234	$341,537	$125,269	2,063
331111	Iron and steel mills	3	D	D	1,000-2,499
	TOTAL	981	>$2,912,108	$751,309	>23,131

(D= Withheld to avoid disclosing data for individual companies, Q=Revenue not collected at this level of detail for multi-establishment firms)

- The federal government should use its buying power to facilitate the financing of offshore wind. The government should negotiate a long-term power purchase agreement with an offshore wind developer covering electricity purchases for military installations and other federal facilities.

Introduction

Maryland's environmental health and our economic prosperity are inexorably linked.

Our state's dependence on polluting sources of energy such as electricity from coal-fired power plants jeopardizes the health of our people and contributes to global warming, which is expected to bring a rise in sea level that threatens the treasured ecosystems and coastal communities of the Chesapeake Bay.

At the same time, the increasing demand for solutions to our environmental challenges creates the potential for new economic opportunity—particularly in developing the skills and technologies to harness our vast resources of clean energy.

Nowhere do the environmental and economic benefits of clean energy intersect in Maryland so well as they do in the waters off the state's Atlantic coast. There, strong and reliable winds provide a plentiful resource that Maryland can use to replace fossil fuels.

Offshore wind development also creates the potential for new economic prosperity for Maryland. The construction of offshore wind parks requires skilled labor, raw materials, and expertise—resources that Maryland has in abundance. Harnessing those resources can create employment for thousands of Marylanders—all working toward the noble purpose of breaking our state's dependence on fossil fuels, once and for all.

Maryland and our neighbors in the mid-Atlantic region are latecomers to the development of offshore wind. Over the past two decades, nations such as Denmark have seized the initiative, building large numbers of offshore wind turbines and, in the process, developing the expertise and home-grown manufacturing capability that now make them global leaders in the offshore wind industry.

Now it is our turn. By laying out a pathway toward development of Maryland's offshore wind resources, we can put Maryland on a path toward greater environmental sustainability and economic prosperity.

Energy from Offshore Wind Will Benefit Maryland

Offshore wind is a potentially powerful solution to Maryland's energy problems. Currently, coal-fired power plants pollute Maryland's air and transmission lines are becoming increasingly stressed as they import electricity (often generated from coal) from other states. Offshore wind power can address many of these problems—supplying the state with ample amounts of clean energy, and enabling the state to reach its renewable energy and global warming pollution reduction requirements.

Maryland Is Dependent on Coal-Fired Power Plants

More than half of the electricity generated in Maryland comes from coal—a key source of pollution linked to health problems and global warming. (See Figure 1.) This figure understates Maryland's dependence on coal, since the state imports a large share of its electricity from neighboring states that are highly dependent on coal for electricity generation.

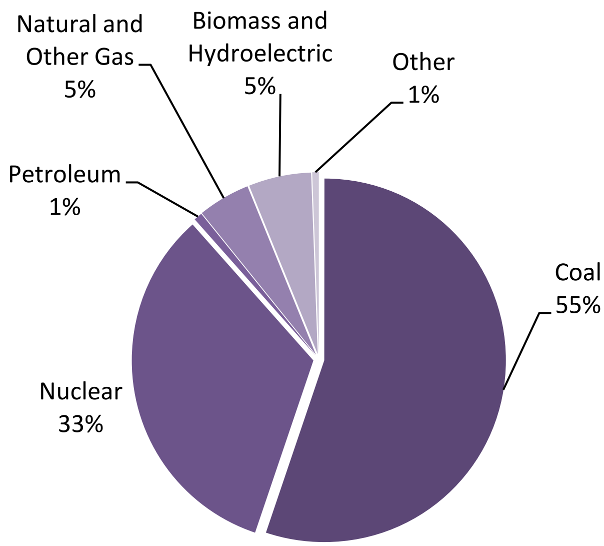
Electricity consumption is the state's leading source of global warming pollution. The use of electric power in Maryland represents 38 percent of the state's total emissions of global warming pollution.[2]

Within the state's borders, coal-fired power plants stand out as the leading contributors to global warming from power generation. Maryland's coal-fired power plants produce 92 percent of carbon dioxide emissions from power generation in Maryland, despite the fact that those plants produce only 55 percent of the power generated in the state.[3]

Coal-fired power plants also contribute to air pollution that threatens the health of Marylanders and our environment, including:

- **Sulfur dioxide** emissions, which form fine soot particles in the atmosphere. When inhaled, these particles become lodged deep in the lungs where they cause a variety of health problems, including asthma, bronchitis, lung cancer and heart attacks.[4] Soot pollution from power plants is responsible for significant harm to public health in Maryland.[5]

Figure 1. Energy Sources for Electricity Generation in Maryland, 2009[1]



- **Emissions of nitrogen dioxide**, one of the primary ingredients in smog. Smog makes lung tissues more sensitive to allergens and less able to ward off infections.[6] It scars airway tissues.[7] Children exposed to smog develop lungs with less flexibility and capacity than normal. During high smog days, otherwise healthy people who exercise can't breathe normally.[8] Over time, smog exposure can lead to asthma, bronchitis, emphysema and other respiratory problems.[9]

Energy Imported from Other States Stresses Maryland's Electrical Grid and Pollutes Regional Air

Utilities satisfy Maryland's electricity demand by purchasing energy from neighboring states. In 2008, Maryland imported roughly one-quarter of its electricity from elsewhere.[10]

All this power must travel many miles over Maryland transmission lines, putting increasing strain on the electrical grid. The U.S. Department of Energy has designated both the Baltimore/Washington metropolitan area and the Delmarva Peninsula as "Critical Congestion Areas," because the transmission lines are extremely overcrowded and nearing inadequacy.[11] If energy demand increases over the coming years, more and more electricity will have to come from outside the state, further stressing the transmission lines.

The imported electricity—largely brought in from states such as West Virginia and Pennsylvania—also comes from coal. Because of this, electricity consumption in Maryland contributes to the release of health-threatening pollutants and global warming pollution produced out of state.

Dependence on power imported from other states and generated by fossil fuels also leaves Maryland vulnerable to the impact of wildly volatile fossil fuel prices. Since the beginning of 2008, the price to Maryland power plants of natural gas has varied by a factor of three, while the price of coal has varied by nearly a factor of two.[12] These variations in fossil fuel prices wind up affecting consumers' utility bills, as do the "congestion charges" incurred by utilities—and passed along to ratepayers—for importing electricity along congested transmission lines.

Offshore wind energy has the potential to address many of Maryland's biggest energy challenges—curbing emissions of pollution that threaten Marylanders' health and the climate, meeting the state's goals for generation of home-grown renewable energy, and alleviating the need for electricity imports from neighboring states.

Offshore Wind Is a Powerful Solution to Maryland's Energy Challenges

Maryland has tremendous potential to generate clean, renewable electricity from the winds blowing off our coast. Taking advantage of Maryland's offshore wind resources can help the state clean up our air, meet our requirements for renewable energy development and reducing global warming pollution, and stabilize electricity prices.

Clean Power

Offshore wind can help clean Maryland's air and improve public health. By displacing dirtier power sources, offshore wind can help prevent emissions of pollutants that form soot and smog, two serious public health threats.

Unlike coal-fired power plants, offshore wind turbines produce no emissions of smog, soot or mercury. Even when the entire life cycle of wind energy is considered—including pollution related to construction of the turbines themselves—emissions are far lower than comparably sized fossil fuel-fired power plants.

Compared to traditional coal- and natural gas-fired power plants, offshore wind power has effectively zero emissions. According to an analysis by Spanish researchers, the energy spent in building an offshore wind park is "paid back" in energy from the wind park in less than six months, and the global warming emissions produced in building a wind park are repaid in less than three months.[13] A similar analysis of a theoretical offshore wind park off the coast of Jacksonville, Florida, estimated that the wind park would produce 96 percent less global warming pollution over its lifespan than a natural gas combined cycle power plant and 98 to 99 percent less global warming pollution than a coal-fired power plant.[14]

Wind power can go a long way in enabling Maryland to meet its renewable energy requirements. Under Maryland's renewable electricity standard, 20 percent of the state's electricity supply must come from renewable sources of energy—including wind, solar, biomass, geothermal, ocean, and low-impact hydroelectric power—by 2022.[15] Offshore wind is one of Maryland's largest renewable energy resources. One large offshore wind park

One large offshore wind park (600 MW) would generate 3 percent of Maryland's electricity, putting Maryland more than a seventh of the way towards the 2022 renewable energy goal.

Maryland and the Atlantic coast have tremendous potential for offshore wind development, following the lead of nations such as the United Kingdom, which have developed strong offshore wind industries. Credit: Siemens

(600 MW) would generate 3 percent of Maryland's electricity, putting Maryland more than a seventh of the way towards the 2022 renewable energy goal.[16]

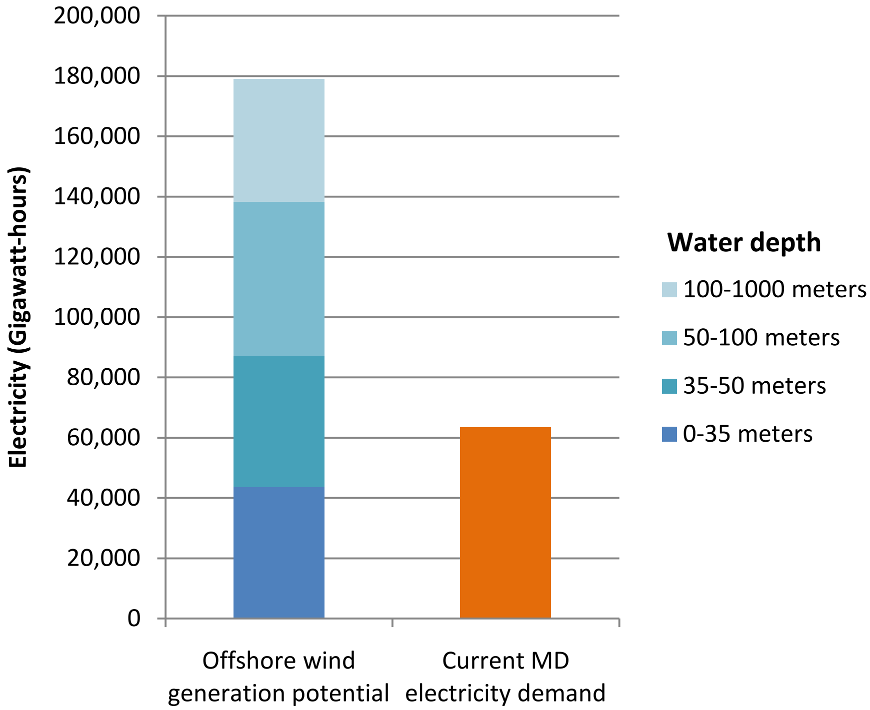
Wind power can also go a long way in enabling Maryland to meet its cap on global warming pollution. In an effort to do our share to limit the severity of global warming, Maryland state leaders have committed to reduce global warming pollution by 25 percent below 2006 levels by 2020.[17] Among the many actions that will be required to meet this target, Maryland must reduce emissions of global warming pollution from existing power plants and shift its electricity system toward sources of energy that do not produce carbon dioxide, such as offshore wind.

Immense Potential

Maryland has tremendous potential to generate clean, renewable electricity from the winds blowing off its coast. Not all of that potential is likely to be realized—competing demands such as the protection of critical ecosystems and wildlife, the preservation of navigational safety, and the continuation of other ocean-based activities will mean that certain areas of Maryland's offshore waters will remain off-limits to wind power. Still, tapping only a portion of Maryland's immense wind energy potential could result in the generation of large amounts of clean, renewable energy.

A 2010 study by researchers at the University of Delaware estimated that the shallow waters (less than 35 meters) off Maryland's coast are capable of hosting 14,600 megawatts of wind power capacity, capable of supplying 43,600 gigawatt-hours of electricity each year—equivalent to roughly two-thirds of the electricity that Maryland consumes in a year. Count-

Figure 2. Maryland Offshore Wind Potential Compared with Current Electricity Demand[20]



ing the potential offshore wind resource in deeper waters, Maryland could host nearly 60,000 megawatts of wind power capacity; enough to generate 179,000 gigawatt-hours of electricity each year.[18] By contrast, Maryland currently consumes roughly 63,300 gigawatt-hours of electricity each year.[19]

There is even greater potential for offshore wind development beyond Maryland waters. The entire Mid-Atlantic Bight (the portion of the continental shelf alongside the Mid-Atlantic coast) is fertile territory for offshore wind development. According to a 2007 study, the offshore wind resources available in areas of the Mid-Atlantic Bight less than 100 meters in depth have the potential to produce as much energy as the electricity currently used in coastal states from Massachusetts to North Carolina—plus an amount equivalent to the oil and natural gas used by the region's motor vehicles, homes and industry.[21] Again, it is unlikely that the United States can or should develop this entire resource, but taking advantage of only a fraction of it could deliver large dividends in weaning the nation from its dependence on fossil fuels.

Offshore wind energy provides the opportunity to repower Maryland's economy with clean energy. Taking advantage of even part of that potential, however, will require the development of new industries in the state and in the region—creating the potential for thousands of new jobs, both in existing companies and in new ones.

Brains, Ships and Steel: What It Will Take to Build Offshore Wind in Maryland

Offshore wind parks are high-tech facilities requiring the use of massive machinery working in often harsh offshore conditions. The task of building an offshore wind park requires the involvement of thousands of workers—often with specialized skills—working at sea, on land, in manufacturing facilities, and in back offices.

The entire string of businesses that are involved in making an offshore wind park a reality is called the **supply chain**. Nations such as Denmark that have been building offshore wind parks for more than a decade have developed a base of expertise and well-developed supporting industries. Maryland and other Mid-Atlantic states have no such experience—but there are hundreds of firms and thousands of workers with the capabilities and skills to take part in an offshore wind economy.

Taking advantage of the economic opportunity presented by offshore wind also makes environmental sense. By sourcing offshore wind components locally—rather than from abroad—we can reduce emissions from transportation, reduce the cost of offshore wind relative to dirty sources of power, and develop turbine designs that are optimized to produce clean energy in the specific conditions of Mid-Atlantic waters.

In this report, we seek to describe the offshore wind supply chain in detail and identify opportunities for Maryland businesses and workers to take part.

A Large-Scale Opportunity

Offshore wind development is such a large-scale opportunity that its magnitude can be difficult to comprehend. The Cape Wind project in Massachusetts—which involves the proposed installation of 130 turbines capable of generating more than 420 MW of electricity—will likely be different in some ways than a new offshore wind park in Maryland, but it nonetheless provides a good example of the scale of the endeavor, and the economic opportunities that result.

Construction of Cape Wind in the form proposed by the developer will require:

- Manufacture and installation of 130 offshore wind turbines, each with hundreds of components.

- Manufacture and installation of a foundation for each of those turbines, requiring the purchase and fabrication of 50,000 tons of steel plate—believed to be the largest steel plate order in the United States in at least the last decade.[22]

- Manufacture and installation of 67 miles of underwater electrical cable at the wind park itself, plus another 50 miles of high-voltage cable to link the wind park to the Massachusetts electrical grid.[23]

- Construction of an offshore electrical substation, as well as connections to the on-shore electrical grid.

- Construction of a new port terminal in New Bedford, Mass., for staging and on-shore assembly of wind turbines. The port project is expected to create 400 person-years of employment over a two-year period.[24]

Assembly and installation of Cape Wind is projected to create 1,700 person-years of employment, along with an additional 110 permanent jobs in operations and maintenance.[25]

The Cape Wind example, however, exposes just the tip of the iceberg for the potential economic impact of offshore wind. First, Maryland is considering a larger offshore wind park—up to 600 MW—than the 420 MW Cape Wind development, and has a great deal of additional offshore wind potential that can be taken advantage of in future years.

Second, because Cape Wind is the first development of its kind in the United States, many key components—including turbines—will be imported from nations with greater experience in offshore wind. As more projects are developed and a sustainable and strong offshore wind industry emerges in the Mid-Atlantic, many of those components are likely to be produced domestically—adding to the job creation impact.

The Ingredients for Offshore Wind

The construction of an offshore wind park is a vast, complex endeavor, involving workers from dozens of industries—everything from basic manufacturing to finance.

In this report, we break down the offshore wind supply chain into six basic categories:[26]

- **Turbines** – Wind turbines are the most visible and technologically complex parts of any offshore wind installation. Each wind turbine contains hundreds of mechanical components, potentially sourced from a variety of vendors.

- **Foundations** – Foundations are the physical structures that affix wind turbines to the seafloor. The production of foundations requires the use of vast amounts of steel, with the large, heavy foundations typically fabricated in close proximity to the offshore wind park.

- **Electrical Infrastructure** – Submarine electrical cables link wind turbines with each other and with the on-shore electric grid. This segment of the supply chain includes cable manufacturing and installation, and the construction of on-shore and off-shore electrical substations and conversion stations.

- **Shipping and Logistics** – Offshore wind turbines are installed in difficult and often harsh marine environments, requiring special facilities and skills. Port operation, shipbuilding, piloting of a variety of vessels, diving, and other forms of maritime work are important contributors to wind park construction.

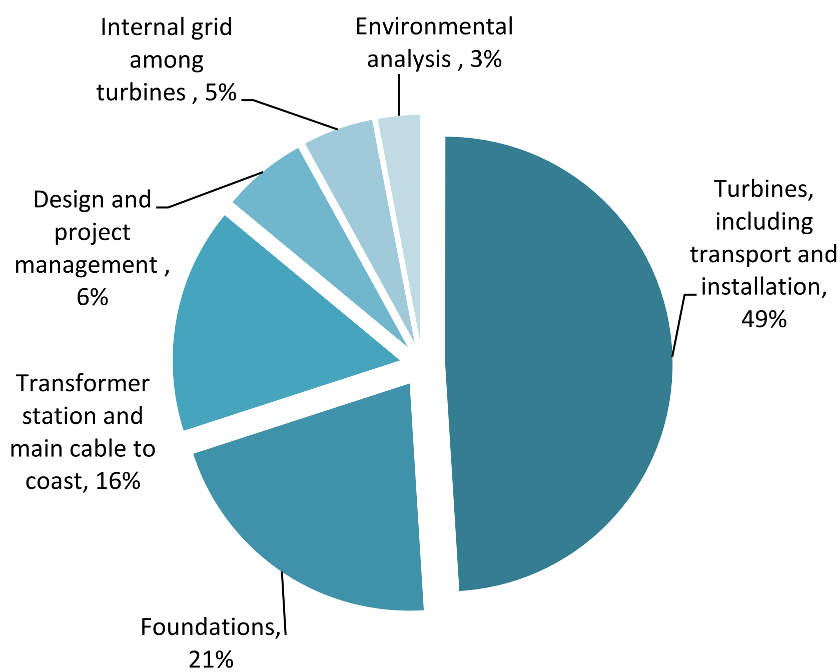
- **Permitting, Legal and Management Work** – The development of a wind park involves a wide variety of white collar labor as well – in finance, law, engineering, science, design and insurance.

- **Ongoing Operations and Maintenance** – After a wind park is completed, workers are needed to operate and maintain the facility.

Each of these segments of the supply chain is an important source of economic activity. Based on experience with offshore wind development in Europe, a recent University of Maryland study estimated that the capital cost of offshore wind parks (not including ongoing maintenance) can be broken down as follows:

- Turbines, including transport and installation: 49%
- Foundations: 21%
- Construction of transformer station and main cable to the coast: 16%
- Design and project management: 6%
- Construction of internal electric grid among turbines: 5%
- Environmental analysis: 3%
- Miscellaneous: less than 1%[27]

Figure 3. Cost Breakdown of a Representative Offshore Wind Park (miscellaneous expenses not shown)[28]



More than half the cost of a wind park, in other words, is spent on goods and services other than the turbine itself—creating economic opportunities in many sectors of Maryland's economy.

Wind Turbines

- Turbine assembly
- Turbine component manufacturing
- Support services

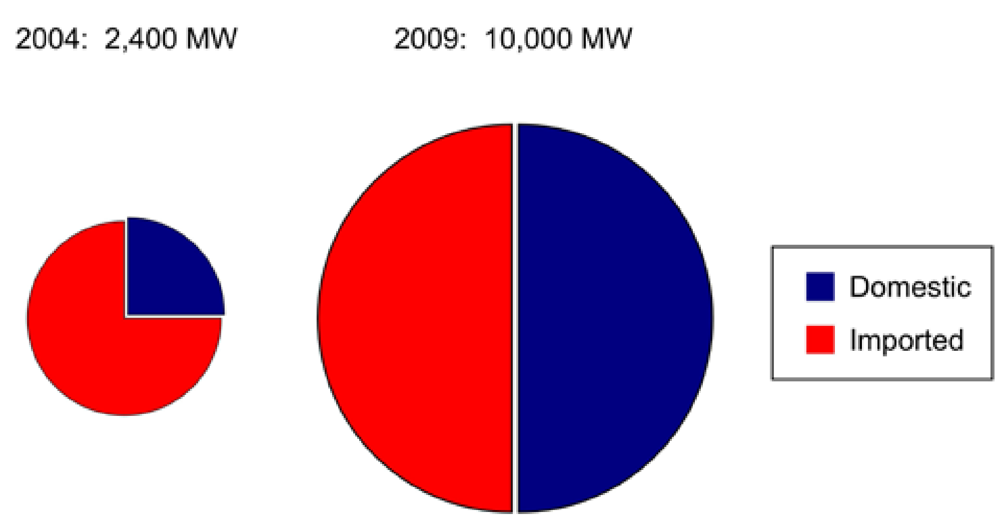
Wind turbines are the most visible and technologically complex parts of any offshore wind installation. Offshore wind turbines are larger—sometimes much larger—than their land-based counterparts, but typically have shared similar designs. That is beginning to change as turbine manufacturers are beginning to design turbines specifically suited to offshore wind energy production.

The growing demand for offshore wind turbines worldwide—and potentially in the Mid-Atlantic—creates the opportunity for the development of offshore wind manufacturing capability in the region. Developing local wind turbine manufacturing capability in Maryland would ensure that the majority of Maryland's investment in offshore wind would return to the state's economy. In addition, regardless of where in the region turbines are built, Maryland firms would have the ability to compete to supply the dozens of components used in those turbines.

A recent report by the United Steelworkers, American Wind Energy Association and Blue-Green Alliance describes the rapid emergence of a domestic on-shore wind energy industry over the past decade. Between the end of 2004 and 2009, the domestic content of U.S. wind turbines doubled from 25 percent to 50 percent, even as the number of turbines installed increased dramatically.[29] (See Figure 4.)

According to the study, the heaviest and most difficult-to-transport portions of the wind turbine—first towers, then blades—were the first to be sourced domestically, followed by the final assembly of the nacelle (the structure that sits atop the tower and contains the turbine's electronics and

Figure 4. Share of Domestic Content (by Value) in U.S.-Installed Wind Turbines[30]



Wind turbine blades are likely to be among the first components of offshore wind farms to be manufactured domestically because of their size and bulk. Above, workers fashion blades for land-based turbines at a factory in Grand Forks, North Dakota. Credit: flickr user Tuey.

controls) and now, increasingly, the manufacture of high-value electrical components for the nacelle.[31]

The offshore wind industry shares much in common with the burgeoning land-based U.S. wind industry, including similar designs for turbines and many components. However, offshore turbines are generally much larger than land-based turbines and require special protection from the harsh marine environment. As a result, the offshore and land-based industries are expected to diverge over time.

The potential economic impact of offshore wind turbine development in Maryland follows much the same pattern as the onshore industry has followed over the past decade. Firms in the state are very likely to compete for the job of building the foundations that root offshore wind turbines to the seabed, and have a chance to compete for the business of assembling wind turbines and manufacturing turbine components.

Rotors (Blades)

The manufacture of turbine rotors—or blades—is likely to be performed near offshore wind installation locations. Like foundations and towers, rotors are long and heavy—one 5-megawatt wind turbine currently in production, for example, has rotor blades that are more than 200 feet long, greater than the length of two basketball courts.[32]

Megawatt-scale turbines require blades that are long, low-density, and sturdy, a requirement best met by fiberglass or composite materials.[33] Blades are manufactured in specialized facilities capable of casting long composite strips.[34]

In Massachusetts, site of the Cape Wind

development, TPI Composites, Inc., a wind turbine blade manufacturer, has established a new rotor testing and manufacturing facility in Fall River, creating approximately 30 jobs. The company's plans include room for potential expansion of the facility in the future.[35] States in the middle of America's onshore wind heartland—the flat, windy Great Plains—have seen blade manufacturing arrive in significant volumes. For example, Siemens, one of the world's largest wind energy companies, was attracted by local demand to construct a rotor factory in Fort Madison, Iowa, that now employs 600 workers.[36]

Maryland's offshore wind resource differs from the resource off the coast of Europe that existing offshore rotor designs are intended to harness.[37] Wind speeds along some portions of the Mid-Atlantic Bight, for example, are lower than those in the North Sea waters for which most offshore wind turbines have been designed. Specially designed blades will be needed if turbines here are to operate as effectively as possible, and the logical place to manufacture them would be near the source of demand in the Mid-Atlantic.

Nacelles

Nacelles are the components of a wind turbine that connect the blades to the tower and contain the machinery through which energy is harnessed and converted to electricity. Nacelles are both large and complex; nacelles for megawatt-scale turbines weigh hundreds of tons; as much as 400 to 430 tons for a 5 MW turbine.[38] Nacelles contain the turbine's gearbox (if needed), drive train, control systems, and generator.

Assembling nacelles out of their component parts requires large amounts of skilled labor. Siemens, for example, has constructed a nacelle assembly plant in Hutchinson, Kansas, capable of producing 650 nacelles each year, which will employ 400 workers at full capacity.[39]

Nacelles are designed to produce large volumes of electricity under massive and variable loads from the turbines they support. The machinery they contain, therefore, is the most complex and high-tech of the wind turbine's components. The gearboxes, drive trains, and generators contained in nacelles are composed of dozens or hundreds of individual components, such as bearings, gears, and electrical components, which transmit the energy captured by turbines and convert it into electricity useable by the grid.

The supply chain for the individual nacelle components has been the last element of the onshore wind industry to migrate to the United States.[40] While large components like blades, foundations, and assembled nacelles are difficult to transport, nacelle internals can be shipped relatively easily, so factories that produce them are likely to develop only once a wind industry has matured to the point of assuring steady demand. The domestic onshore wind industry has begun to reach that threshold, with several factories composing small, high value-added components opening in the U.S. in 2009.[41] Those factories have the potential to multiply the job creation potential of nacelle manufacturing facilities by attracting further manufacturers to the area to supply the internal components.[42]

Foundations

- Steel manufacturing
- Steel fabrication

The steel "monopile" foundations that are used to secure most shallow-water offshore wind turbines to the seabed are large, heavy, and extremely costly and cumbersome to transport. The monopile foundations for one offshore wind park off the coast of Denmark, for example, weigh between 165 and 231 tons each.[43] Maryland foundations are likely to be heavier, weighing as much as 300 tons.[44] Because of their weight and size, the fabrication of offshore wind foundations is very likely to occur near the site of an offshore wind park.

In the case of the Cape Wind development off Massachusetts, a local steel-tank manufacturing firm, Mass Tank, was selected to supply foundations for the 130 wind turbines that make up the development. The firm, which is partnering with a German company, EEW Group, will build a new manufacturing facility for the foundations, adding between 100 and 350 jobs.[45] The company will place what is believed to be the largest steel plate order in the U.S. in at least a decade to secure the 50,000 tons of steel plate needed for the foundations.[46]

Maryland has several firms that, like Mass Tank in Massachusetts, perform steel fabrication work.[47] In addition to primary fabrication work of shaping the large, cylindrical foundations that support the turbines, local steel fabricators will be needed to perform secondary fabrication of the "transition" pieces (the interface between the foundation and the tower) as well as ladders, handrails and other metal pieces.[48]

Perhaps the greatest opportunity presented to Maryland, however, is the potential to supply steel to the growing offshore market throughout the Mid-Atlantic. Three-quarters of the cost of a turbine foundation is for raw materials, largely steel.[49]

Foundations are massive steel structures, weighing hundreds of tons, that root offshore wind turbines to the seafloor. Foundations are typically fabricated locally, given the cost and difficulty of transporting them long distances. Here, an offshore wind turbine in the United Kingdom is affixed to its foundation. Credit: Siemens

The Sparrows Point steel mill in Baltimore has long played an important role in Maryland's economy, dating back to the late 19th century. Once the largest steel mill in the world, the Sparrows Point mill has experienced a succession of setbacks over the last several decades. However, unlike many other U.S. steel mills that have shut down in recent decades, Sparrows Point continues to operate. Sparrows Point could compete for the business of supplying slab steel that could be used to supply a growing offshore wind market along the U.S. Atlantic coast.

Connecting Offshore Wind to the Grid

- Cable manufacturing
- Cable laying
- Directional drilling
- Tug and small vessel piloting
- Diving
- Excavation, landscaping and paving
- Electrical substation construction and line work

Offshore wind turbines generate electricity, but that electricity does no good without the cables, substations, and other infrastructure to feed that electricity into the grid, which can deliver it to Marylanders' homes.

Each offshore wind turbine generates electricity independently—functioning as a small power plant. The first step in delivering electricity from the turbines to Marylanders' homes is to aggregate the power produced by all the turbines in a wind park at an electrical service platform—in essence, a power substation built offshore. From the electrical service platform, power is fed to underwater cables that carry electricity to the onshore grid.

There are two main options for getting electricity from a wind park to the grid. The first option is to connect each wind park directly to the electric grid by running alternating current (AC) transmission cables from the wind park to a substation on land. This is the system proposed to be used for the Cape Wind development in Massachusetts and the NRG Bluewater Wind development off the coast of Delaware. Electricity from the wind turbines is to flow through smaller AC cables to an electrical service platform in the midst of the wind park, where the voltage is increased (or "stepped up") to the voltage used in the underwater transmission line. The electricity then flows through a series of high-voltage wires buried under the seabed and shore to a substation where the electricity is fed into the regional grid.[50]

The other possibility is to create a high-voltage direct current (HVDC) transmission backbone that links offshore wind parks in Maryland with those in other mid-Atlantic states. Instead of each new wind park being responsible for making its own connection to land, the wind parks would instead link to a major transmission line running parallel with the shoreline, which is connected to the land-based transmission grid at a few pre-determined locations.

Construction of an offshore transmission backbone would make the process of establishing each new offshore wind park significantly easier and less expensive, as those parks would merely need to connect to the backbone rather than stringing undersea cable all the way to shore. In addition, such a backbone could utilize HVDC cables, which lose less energy during long-distance transmission than AC networks.

In late 2010, a consortium of investors proposed construction of the Atlantic Wind Connection—an offshore transmission backbone that would run 350 miles off the East coast from Virginia to New Jersey. The $5 billion project would have the potential to support as much as 6,600 MW of offshore wind power in the mid-Atlantic and could be scaled up over time to accommodate additional wind parks.[51]

The Atlantic Wind Connection proposal provides a good idea of the types of labor and skills required to connect offshore wind parks to the electricity grid. Construction of the complete system would require:

- The manufacture and laying of 1,200 miles of copper cable—300 miles for each of two parallel circuits.
- The manufacture and laying of many additional miles of lower-voltage AC cable to connect each wind turbine to the centralized converter platform.
- The construction of 12 offshore converter platforms.
- Construction of seven on-land connection stations.[52]

Regardless of how electricity from wind parks is carried to the shore, construction of offshore transmission lines creates a variety of job opportunities, some of which may be available to Maryland workers.

Cable Manufacturing

There is recent evidence that international cable manufacturers are willing and able to establish manufacturing operations in the United States if there is a consistent and large enough market for their products. In addition, American firms that currently manufacture other types of electrical cable could be persuaded to enter the submarine cable market if sufficient domestic demand were to develop.

There are currently no cable manufacturers in North America capable of manufacturing the submarine high-voltage cables that would be used in an aggressive offshore wind build-out scenario.[53] Leaders of the industry include companies such as Siemens (Germany), ABB (Sweden), Prysmian (Italy), Nexans (France), NKT (Germany), and LS Cable (South Korea).

The Swedish firm ABB, however, recently announced plans to build a manufacturing plant in Huntersville, North Carolina, (outside Charlotte) for land-based high-voltage cable, citing the need for new transmission infrastructure to connect renewable energy installations and to bolster grid reliability.[54] The new cable factory will employ approximately 100 people. The Italian firm Prysmian—which supplied cable for the recent Neptune submarine transmission project between New Jersey and Long Island and the Trans Bay submarine cable project in California—has established an extra-high voltage cable manufacturing facility in Abbeville, South Carolina.[55]

Should a market for submarine cable emerge in the United States—such as would be generated by an aggressive move toward offshore wind power in the Atlantic—these or other suppliers might be induced to build manufacturing capability along the Atlantic Coast. This is particularly true if offshore wind installations continue to expand around the globe, straining existing supplies of high-voltage submarine cables.

Atlantic coast cities would appear to be good prospects for submarine cable manufacturing. Coastal cities have proven to be prime locations for submarine cable manufacturers, as they allow the finished product to be loaded directly onto ships. Many major international cable firms have established manufacturing facilities in port cities—ABB, for example, currently manufactures sub-sea cables at a port facility in Sweden,[56] Nexans at a port facility in Norway,[57] Prysmian at a port facility in Arco Felice, Italy,[58] NSW (a subsidiary of U.S.-based General Cable) at a port city in Germany,[59] and LS Cable at a plant in Donghae, South Korea.[60]

Cable Laying

The laying of transmission cables to offshore wind parks involves work on land, in the coastal transition zone, in shallow waters, and in deeper offshore waters.

On land, cable installation follows typical procedures for the laying of underground cable. Trenches are dug, conduits laid, and manholes installed along the route. Lengths of cable are then pulled through the conduits and spliced together at manhole locations. Finally, the trenches are refilled and repaving or restoration of the surface takes place.[61] On-shore cable laying work for subsea cable connections can be extensive—in the case of the Neptune transmission project between New Jersey and Long Island, cables were laid underground along a 14-mile stretch of Long Island's Wantagh Parkway, requiring labor for trenching, burial of the cable, and restoration of the land following installation.[62]

In the transition zone between land and sea, horizontal directional drilling—a drilling technique often used in the oil and gas industry, as well as in the laying of various types of cable—is used to minimize impacts on shoreline environments. Directional drilling equipment bores holes in the ground through which conduits are inserted. The undersea cable is then fed through the conduit and linked to the underground cable.[63]

Offshore electrical substations, such as the cylindrical structure above, aggregate the electricity generated by the individual wind turbines, where it can be delivered via submarine cables to the shore. Credit: Siemens

The installation of both the underground and transitional sections of the project is well within the expertise of Maryland firms engaged in underground cable installation and directional drilling, including firms engaged in trucking, excavation, landscaping, paving, and electrical contracting.

In the marine environment, the laying of underwater cable is often performed by barges that feed cable into trenches dug by an underwater jetplow. In deeper waters, specialized cable-laying ships might be used. Regardless of the types of vessels used, local labor will be required in the form of tugs, support vessels and divers to help position equipment and rectify problems.

Maryland already has some experience with the economic impact of submarine cable installation. TE SubCom (formerly Tyco Telecommunications) operates a large telecommunications cable facility in Baltimore. The fleet operations center, which covers 20 acres and uses four deepwater berths, employs roughly 100 marine engineers, sailors and other workers.[64] The center serves as one of several depots for the company's global fleet of submarine cable installation ships.

Electrical Service Platform

The electrical service platform for a wind park is, at minimum, an offshore substation where electricity from wind turbines is aggregated and the voltage is "stepped up" for injection into the underwater transmission wires that carry electricity to shore. Electrical service platforms sometimes double as remote maintenance platforms and can include helicopter landing pads, control rooms, emergency and rescue equipment and even temporary lodging.[65]

In the case of the Cape Wind development, the electrical service platform and its supporting structure are to be fabricated on-shore and delivered to the site by barge, where installation would likely occur in a manner similar to the installation of the wind turbine foundation.[66] The platform would contain electrical equipment such as circuit breakers and transformers, as well as a helipad, boat dock, emergency equipment, and temporary living quarters.[67]

Installation of the electric service platform will require the use of barges and cranes for transporting the components of the platform and erecting it at sea, as well as the types of equipment—including pile drivers and jack-up barges—used for securing the offshore wind turbines to the seabed.

On-Shore Converter Stations and Substations

Connecting submarine cables to the grid also requires work on land. An AC connection requires work to connect the offshore transmission line directly to the grid via an electrical substation. Use of a high-voltage DC system requires the construction of an additional facility—a converter station—to convert DC power into the AC power that can be transmitted through the grid.

Construction of converter stations for HVDC systems relies on local labor provided by subcontractors. The California Trans Bay cable project—which involved the laying of a submarine HVDC cable under San Francisco Bay—for example, employed local union electrical workers in the construction of the converter stations, which will require continuing employment beyond their initial operation.[68]Additional local labor was required for pile driving and grading work.[69] Local union labor was also involved in the construction of a converter station at the end of the Neptune cable line in Sayreville, New Jersey.[70]

Much of the work of constructing land-based electrical facilities is typically farmed out to local subcontractors. The land-based electrical work for the Neptune project, for example, required the involvement of 15 subcontractors.[71]

The location of the connections between offshore wind turbines off the Maryland coast and the region's electrical grid have yet to be determined. The Atlantic Wind Connection proposal includes the construction of a converter station at Piney Grove, Maryland, on the Eastern Shore, as well as a second station at Indian River, Delaware, not far from the Maryland border.[72]

Shipping and Logistics

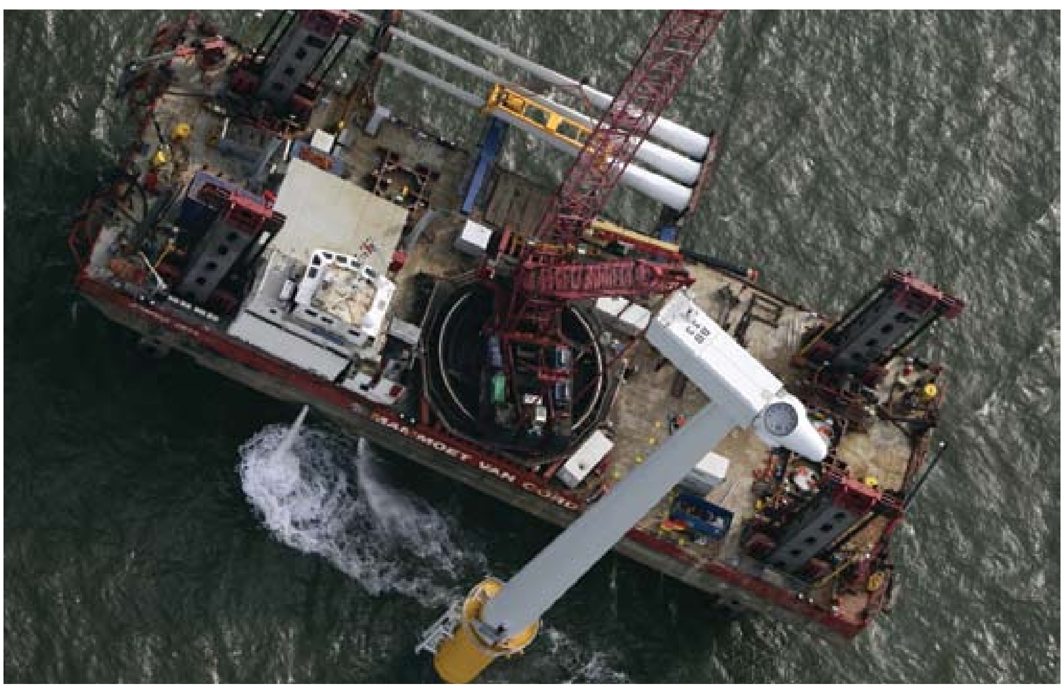
- Shipbuilding
- Port facilities and support services
- Servicing

Maryland's offshore waters hold tremendous wind energy potential. But taking advantage of that potential means harnessing the skills and materials needed to work in a difficult and demanding ocean environment, as well as having the right on-shore facilities to act as a staging ground for offshore activities.

Maryland has an important potential asset when it comes to serving as a shipping and logistics hub for offshore wind development: the Port of Baltimore. But the state—like others in the Mid-Atlantic region—will also need to develop new skills and capabilities to take full advantage of the promise of offshore wind.

Port Facilities

Maryland has a major deepwater port, the Port of Baltimore, which is a potent economic engine for the region. A 2008 study for the state of Maryland estimated that the port sustains roughly 50,000 jobs in the Maryland economy.[73]



Installation of offshore wind turbines requires the use of specialized ships—such as the jack-up barge pictured above—equipped with massive cranes. The three rotors of the wind turbine under construction above can be seen on the far side of the jack-up ship. Credit: Siemens.

Maryland would receive the greatest economic benefit if the Port of Baltimore were to emerge as a major logistics, shipping and manufacturing hub for offshore wind energy in the mid-Atlantic region. A study undertaken for the Port of Wilmington, Delaware, found that basing two turbine installation vessels out of a port would create 250 in-state jobs for the duration of the project.[74] The availability of adequate port facilities is also likely to be a critical factor in decisions made by turbine manufacturers, fabricators of steel turbine foundations, cable manufacturers and other firms about where to locate their facilities to serve the mid-Atlantic market.

The Port of Baltimore has several advantages—and an important potential disadvantage—in competing with nearby ports such as Newport News, Virginia; Wilmington, Delaware; and Paulsboro, New Jersey, for offshore wind.

One advantage is the Port of Baltimore's status as a well-developed deep-water port. The shipping channel in Baltimore Harbor is sufficiently deep to accommodate the large delivery ships, jack-up barges and crane ships that will be needed to deliver and install the turbines and foundations.[75] Baltimore's port is already being improved to host the larger container ships that will reach the Atlantic after Panama Canal improvements are completed in 2014, which should enable it to support the transport and construction ships associated with laying steel monopile foundations.[76]

The Port of Baltimore also appears to have sufficient land area to serve as a staging ground for offshore wind installation. Turbines are massive pieces of machinery, and cannot be shipped whole to the construction site from distant manufacturing facilities.[77] This means that a nearby port is needed as a staging facility, where turbine parts can be offloaded and partially assembled. Ideal ports for wind turbine staging are also located near the site of construction and capable of operating round-the-clock, with access to pier facilities on demand.[78]

One potential disadvantage of the Port of Baltimore is the need for ships to pass under the Chesapeake Bay Bridge, which has a vertical clearance of 186 feet, on the way to the Atlantic Ocean. The height of the bridge may limit the ability of jack-up barges with tall legs, as well as preassembled tower assemblies, to pass between Baltimore Harbor and the Atlantic Ocean.

Support Services

The task of assembling and installing wind turbines may be the most important one in the development of an offshore wind park, but there are many other potential jobs in supporting and facilitating offshore wind installation—with work available both on land and at sea.

Shipping needs for wind park construction begin even before construction starts. Sites need to be scouted and surveyed before foundations or turbines can be sunk into the ground, which means that experts need to visit the site repeatedly during preparations for construction. Once construction starts, workers need transportation to and from the site. The best candidates to provide this transportation, in both cases, are local fishermen and other boat owners.[79] While the Port of Baltimore is likely the only Maryland port with the infrastructure to support turbine installation, smaller Maryland ports, such as those in Cambridge and Ocean City, may be in a position to provide some of these charter boat services.

Ports also serve as a refueling, resupply and maintenance base for ships large and small used in the installation of offshore wind parks. Many existing businesses—as well as new businesses—have the potential to benefit from the increased port activity generated by offshore wind development, including:

- Chandlers, who supply ships with food and nautical equipment.
- Barge and tug operators.
- Fuel suppliers.
- Marine surveyors, who inspect vessels for seaworthiness.
- Shipyards.[80]

Increased port activity resulting from offshore wind development would likely benefit these supporting port businesses as well.

Shipbuilding

The construction of new, purpose-built installation ships for offshore wind development is certain to be located in the United States, but unlikely to be located in Maryland. Shipbuilding represents a potentially large economic opportunity—unlike other aspects of the offshore wind industry, which are global in scope, federal law essentially requires all vessels used to install offshore wind turbines to be U.S.-built vessels, crewed by American sailors.[81] Given the strong global demand for ships capable of installing offshore wind turbines, a growing market for offshore wind would appear to be a gift-wrapped economic opportunity for U.S. shipbuilders.

Turbine installation requires specialized construction vessels with powerful cranes. The task is best performed by ships custom-built for that purpose, but vessels initially built for other offshore construction purposes—particularly the construction of offshore oil and gas drilling platforms—can also perform the task.[82] Few, if any, of these vessels are currently based in Maryland, as the greatest demand for their services is in the Gulf of Mexico. No ships custom-built for offshore wind installation yet exist in American waters, so they will be built in the coming years to supply the emerging market.[83]

Maryland formerly had a major shipyard at Sparrows Point, but new ships have not been built at the facility since 1986.[84] The shipyard may prove useful for vessel repair, but major shipbuilding will likely be carried out by existing shipyards elsewhere.

Permitting, Legal and Management Work

- Project development and management
- Finance and insurance
- Law
- Civil, mechanical, structural and electrical engineering
- Earth sciences

Tapping Maryland's offshore wind energy potential will require massive amounts of blue-collar labor—in basic and high-tech manufacturing, construction trades, marine industries, and support services. But as with any other major infrastructure project in today's economy, offshore wind also creates opportunities in white-collar professions, from finance to engineering.

These white collar tasks can make up a significant share of the cost of an offshore wind park—roughly 12 percent, according to the accounting firm Ernst & Young, based on experience in Europe.[85]

Project Development

The construction of an offshore wind park reflects the efforts of hundreds of people, organized in a complex web of investors, managers, contractors and sub-contractors. At the center of that web is the project developer. Project developers oversee the entire process of constructing an offshore wind park—bringing together the core project team, creating a coordinated strategy for development, and lining up investors.

Project developers typically maintain local offices in areas near proposed wind developments. NRG Bluewater Wind, for example, which is the developer of a proposed wind park off the Delaware coast, has a local office in Berlin, Maryland, which serves Maryland, Virginia and the Carolinas.[86]

Financial Planning and Management

Offshore wind projects are billion dollar-plus endeavors, requiring the amassing of capital from investors, constant vigilance on project costs, and ongoing day-to-day fiscal management.

The early stages of an offshore wind project might entail the securing of high-risk capital to fund the initial studies of wind potential and early outreach efforts to elected officials and potential vendors. Once the basic feasibility of the project has been proven, project developers must raise additional capital from investors. Prior to construction, developers must obtain insurance coverage, evaluate competing bids for service, negotiate power purchasing agreements with utilities, and understand the tax implications of project construction, including the potential benefits of local, state and federal tax subsidies. During construction, financial managers must engage in the day-to-day fiscal management of the project while keeping an eye on project costs. Post construction, the firm (if it retains control of the wind park) must manage continuing operations and maintenance costs and interactions with the electricity marketplace.

Engineers

The construction and operation of offshore wind facilities also creates work for civil, structural and electrical engineers. Electrical engineers are needed to design offshore wind turbines, to plan for integration of offshore wind power into the electric grid and to design systems to integrate offshore wind into the state's electricity network. Civil and structural engineers are needed to assure the integrity of structures built both offshore and on land, as well as to design additions or changes to the land-based infrastructure needed to support offshore wind development—for example, the construction of new roads to port facilities or the construction of larger drydocks for ship construction.

Legal Assistance and Permitting

Offshore wind projects must navigate a complicated thicket of rules, regulations and environmental review processes before construction can begin. As a result, offshore wind developers require the services of law firms with expertise in these areas.

Earth Scientists

Installation of offshore wind parks and transmission infrastructure requires detailed and highly technical understanding of the geology and biology of the marine environment.

Marine geoscientists survey the ocean floor to determine the appropriate locations for wind turbine foundations, transmission lines and other offshore infrastructure. Marine biologists are often called in to consult on offshore wind projects to determine the degree to which new offshore structures or construction activities will disrupt important ecosystems—and to make recommendations for how those impacts might be reduced. Meteorologists are needed to assess the likely wind conditions and other weather conditions that will affect the design and effectiveness of offshore wind generation. Other technical and scientific tasks involved with the planning and construction of offshore wind parks include geographic information system (GIS) mapping, evaluation of avian and bat impacts, and evaluation of potential conflicts with shipping, radar and recreation.

Ongoing Operation and Maintenance

The construction of an offshore wind park takes years of painstaking planning and the coordination of hundreds of workers carrying out a wide variety of tasks. But the job creation opportunities provided by offshore wind development do not end when the wind park is completed. Workers are still needed to operate and maintain the offshore wind park and its associated electrical infrastructure over the 20 or more years that the wind park is in operation.

As noted earlier, the Cape Wind project off Massachusetts is anticipated to create approximately 110 permanent jobs in operations and maintenance.[87]

Maryland's Capacity to Win Offshore Wind Business

The development of Maryland's offshore wind resources has the potential to create jobs throughout the economy—in manufacturing, in transportation, in construction, in electrical services, and in highly skilled positions from finance to engineering—even as it reduces Maryland's dependence on sources of energy that foul our air and contribute to global warming.

Maryland and other Mid-Atlantic states, however, enter the offshore wind race several laps behind competitors in Europe. For more than a decade, firms working off the coasts of Denmark, Great Britain and other nations haven't just been debating the role offshore wind parks can play in their energy systems—they've been building them, gaining priceless real-world expertise in the countless technical tasks needed to bring an offshore wind project to fruition.

If Maryland is to reap the economic—as well as the environmental—advantages of offshore wind, the state will need to work alongside its Mid-Atlantic neighbors to build a truly sustainable offshore wind industry for the region.

Maryland Firms and Workers Are Positioned to Benefit from Offshore Wind Development

Should offshore wind energy take hold in the Mid-Atlantic region, Maryland will be positioned to reap the benefits—both in terms of increased work for existing firms and in the possibility of creating brand new industries.

Existing Maryland Industries and Workers Can Participate in Offshore Wind Development

This report describes the many economic opportunities that can result from offshore wind development. Many Maryland firms already participate in industries that will be in demand by companies seeking to build offshore wind parks.

Over the past decade, several analysts have compiled detailed assessments of the industrial sectors that are engaged in wind turbine construction.[88] Less study has been given to the businesses that provide supporting services for the installation of offshore wind parks, and even less to businesses that could benefit from the creation of "indirect" jobs spurred by offshore wind.

Wind Turbine and Tower Components
According to the U.S. Economic Census and previous studies of the wind turbine manufacturing industry, as of 2007, there were a minimum of 156 Maryland firms

Table 1. Employment in Industries with the Potential to Take Part in Wind Turbine Manufacturing[90]

2007 NAICS code	Industry description	Number of employer establishments	Employer sales, shipments, receipts, revenue, or business done ($1,000)	Annual payroll ($1,000)	Number of paid employees
332420	Metal tank (heavy gauge) manufacturing	6	$53,790	$5,712	228
325520	Adhesive manufacturing	7	$286,531	$28,546	471
326150	Urethane and other foam product manufacturing	3	D	D	250-499
326199	All other plastics product manufacturing	58	$797,482	$140,062	3,461
332312	Fabricated structural metal manufacturing	26	$153,426	$36,933	741
333613	Mechanical power transmission equipment manufacturing	3	D	D	250-499
334418	Printed circuit assembly (electronic assembly) manufacturing	8	$31,582	$9,558	163
334513	Industrial process variable instruments	5	D	$15,718	197
334519	Other measuring and controlling device manufacturing	17	D	$24,379	443
335313	Switchgear and switchboard apparatus manufacturing	6	$90,527	$17,962	488
335314	Relay and industrial control manufacturing	8	$19,507	$5,264	100-249
335929	Other communication and energy wire manufacturing	3	D	D	250-499
335999	Miscellaneous electrical equipment manufacturing	6	D	D	100-249
	TOTAL	**156**	**>$1,432,845**	**>$284,134**	**>7,142**

(D= Withheld to avoid disclosing data for individual companies) that work in industries that could supply wind turbine and foundation components, employing a minimum of 7,142 Maryland workers.[89] (See Table 1.) Not every company within each industry may be equipped to produce wind turbine components, but the list of industries presented provides a broad assessment of the number of existing Maryland firms and workers that could take part in manufacturing components used in offshore wind parks.

Raw Materials and Support Services

As this report makes clear, the economic opportunities provided by offshore wind extend well beyond turbine manufacturing. Maryland has both the potential to provide key raw materials for turbine or foundation manufacture—in the form of steel—as well as many of the support services needed to make an offshore wind park a reality.

Table 2. Employment in Industries with Potential to Supply Raw Materials or Aid in Installation of Offshore Wind Parks[92]

2007 NAICS code	Industry description	Number of employer establishments	Employer sales, shipments, receipts, revenue, or business done ($1,000)	Annual payroll ($1,000)	Number of paid employees
22112	Electric power transmission, control, and distribution	60	Q	D	5,000-9,999
237130	Power and communication line and related structures construction	128	$481,101	$127,570	2,887
237310	Highway, street, and bridge construction	212	$1,495,639	$319,854	6,862
48311	Deep sea, coastal, and Great Lakes water transportation	22	D	D	250-499
484121	General freight trucking, long-distance, truckload	245	$593,831	$162,536	3,703
4883	Support activities for water transportation	47	D	D	1,000-2,499
213112	Support activities for oil and gas operations	8	D	$4,660	103
336611	Ship building and repairing	22	D	$11,420	263
541620	Environmental consulting services	234	$341,537	$125,269	2,063
331111	Iron and steel mills	3	D	D	1,000-2,499
	TOTAL	981	>$2,912,108	$751,309	>23,131

(D= Withheld to avoid disclosing data for individual companies, Q=Revenue not collected at this level of detail for multi-establishment firms)

There has been far less detailed study of the types of industries that have the potential to participate in raw materials production and installation activity. In this report, we have reviewed the 2007 Economic Census to identify a set of industries that might be eligible to participate in these functions.[91] We have purposely left out a set of broad, white-collar employer categories—such as law firms, financial firms, and insurance brokers—for which offshore wind would likely produce only a small amount of business relative to their overall role in Maryland's economy.

This broader definition of the economic opportunities presented by offshore wind suggests that an additional 981 businesses—employing more than 22,000 workers—could participate in some way in the provision of raw materials for offshore wind parks or in their installation.

Indirect and Induced Jobs

Offshore wind development also has the potential to create jobs and economic opportunities in fields with seemingly little connection with wind energy. Vessels installing wind turbines or submarine cables require fuel and supplies; crews building offshore wind turbines require food and often temporary lodging; and maintenance workers require tools. The "indirect" jobs created by these support industries are an important source of employment.

Offshore wind projects also create "induced" jobs—that is, jobs that are not related at all to the project itself, but rather result from the spending of those with direct or indirect employment resulting from the offshore wind project. For example, installation workers might use the money they earn from their work on an offshore wind project to go to the movies or save up for a new car. Increased income tax revenue might result in a local school hiring additional teachers or police officers to improve the community. These additional jobs and economic opportunities are part of the ripple effect of major projects such as offshore wind developments.

Counting indirect and induced employment, the economic development impacts of offshore wind projects can be dramatic. Several Atlantic coast states have conducted economic analyses demonstrating that strong, sustained investment in offshore wind can create significant new opportunities for employment:

- The state of Maryland estimates that construction of a 500 MW wind park would create approximately 2,000 manufacturing and construction jobs over a five-year period, with an additional 400 ongoing supply, operations and maintenance jobs for the lifetime of the plant.[93]

- A study in South Carolina projected that construction of a 480 MW wind park off the state's coast could create more than 1,800 full-time jobs over the two-year period of construction.[94]

- A study in Virginia projected that that state could create more than 9,700 career-length jobs through the steady construction of offshore wind projects, equivalent to 160 MW of offshore wind per year for 20 years.[95]

- Similarly, in Maine, one study projected that the state could create 16,700 career-length jobs by developing 5,000 MW of offshore wind capacity over a 20-year period.[96]

- In the Great Lakes area, a recent Canadian study estimated that the province of Ontario could generate more than 55,000 person-years of employment from construction of 2,000 MW of offshore wind capacity over a 13-year period.[97]

Building a Project or Building an Industry?

As Maryland pursues offshore wind development, one key question will be whether the region endeavors to build offshore wind *projects* or to build an offshore wind *industry*.

A project-based approach to offshore wind would yield significant environmental benefits—offsetting the need for polluting fossil fuel-fired electricity—and also create broad economic opportunity in a wide variety of fields for many businesses and workers. But a single wind park will not be enough to entice entrepreneurs and multinational corporations to create a new turbine manufacturing facility. However, the number of projects moving forward in the region may be approaching the threshold needed for such an investment.

A recent study conducted for the state of Virginia estimated that it would take sustained, annual demand for 100 to 150 offshore turbines—equivalent to roughly 500 to 750 megawatts of wind generating capacity per year—to attract turbine manufacturing to the region.[99] In other words, to have a strong hope of luring manufacturing facilities for turbines—which account for nearly half the cost of an offshore wind park—the Atlantic coast would need to be on a pace to build roughly one large-scale wind park per year.

It is likely that similar levels of demand will be necessary to spark the location of other key wind-related manufacturing industries—from cable manufacturing to shipbuilding—and to catalyze the development of a skilled workforce with experience in offshore wind development. Establishment of a robust offshore wind industry, for example, could make it once again worthwhile to produce plate steel at the Sparrows Point steel mill, something the plant has not had the capacity to do since its plate mill closed in 1997.[100]

Currently, wind parks are in development or being seriously discussed in seven states—North Carolina, Virginia, Maryland, Delaware, New Jersey, Rhode Island, and Massachusetts. By the time all of those wind parks are built, it is a real possibility that some of the first states will be discussing expansions of their wind parks. This could be enough total activity to make a turbine manufacturing facility viable. The United Kingdom, for example, is in the midst of its third round of offshore wind energy development, with the potential for as much as 32,000 megawatts of new wind energy.[101]

Table 3. Summary of Job Creation Estimates from Recent Studies of Offshore Wind Development[98]

Where	How Many Jobs?	Over What Time Period?	For What Kind of Project?
Maryland	2,000 manufacturing and construction jobs; 400 supply and maintenance jobs	five years for manufacturing and construction; lifetime for supply and maintenance	500 MW wind park
South Carolina	1,881 full-time jobs	during two-year construction period	480 MW wind park
Virginia	9,700 - 11,600 career length jobs	20-year period	160 MW of offshore wind per year for 20 years
Maine	16,700 career length jobs	20-year period	5,000 MW of offshore wind
Ontario, Canada	55,000-62,000 person-years of employment	13 years	2,000 MW of offshore wind

The Environmental Case for Building a Local Offshore Wind Industry

In recent years, environmentalists, entrepreneurs and organized labor have touted the job-creating potential of green industries. Luring clean energy entrepreneurs to an area has often been promoted as a way to spark economic activity in the midst of a severe economic downturn.

But in the case of offshore wind, the logic for building a local offshore wind hub goes well beyond job creation. Indeed, developing an offshore wind industry in Maryland and the Mid-Atlantic region has several *environmental* benefits.

First, building wind park components locally and developing a well-trained, experienced local workforce will reduce the cost of future wind park developments—making offshore wind more economically competitive with fossil fuel power plants. A study compiled for the state of Virginia estimates that local sourcing of wind turbines would reduce costs—improving the cost-competitiveness of offshore wind versus fossil fuel-fired generation.[102] Moreover, as local workers gain experience with manufacturing wind turbine components and installing offshore wind parks, their productivity can be expected to increase, again reducing costs.[103]

Second, establishing a local offshore wind hub would enable manufacturers to tailor their turbine designs to the specific conditions of the Mid-Atlantic coast. To date, offshore wind turbines have largely shared design elements with on-shore farms, but the National Renewable Energy Laboratory projects that "offshore turbine designs are likely to increasingly decouple from land-based technology."[104] As long as the offshore wind energy market is dominated by other regions of the world, offshore wind turbine designs are likely to reflect the needs of those markets. The development of a strong domestic market for offshore wind power would enable manufacturers to develop designs that take into account the Mid-Atlantic's wind conditions, installation challenges, and environmental and societal needs.

Third, local manufacturing reduces the emissions created in the transportation of large wind turbine components. A life-cycle analysis of a conceptual wind park off the coast of Jacksonville, Florida, for example, estimated that transporting wind turbine components from Europe would account for more than one-tenth of the total global warming pollution produced in the entire life cycle of the wind park.[105] Producing components locally can reduce this important source of environmental impacts.

Finally, creating a long-term path for offshore wind development will enable the region to make smart investments in infrastructure right from the start. Construction of an offshore wind transmission "backbone," for example, is only worth considering if the region is prepared to build sufficient offshore wind capacity to use it. Similarly, with a strong commitment to offshore wind, state universities, workforce development agencies, and labor unions can begin to develop programs to train Maryland workers to take part in offshore wind development.

Policy Recommendations

To take advantage of the environmental and economic benefits of offshore wind, Maryland and the United States should make a strong commitment to the development of wind energy off the mid-Atlantic coast.

Specifically:

- The state and federal governments should set bold goals for offshore wind development in the Atlantic, in order to provide clear leadership and vision regarding the important role of offshore wind in America's energy future and to demonstrate that it is a high priority.

- The U.S. Department of the Interior should improve and streamline current siting regulations for offshore wind projects in federal waters, while maintaining a high level of environmental protection. In so doing, they must establish careful procedures to make sure that offshore wind parks do not have major impacts on wildlife, shipping channels or military operations, but this can be done while shortening a process that is currently unduly burdensome.

- The Maryland Public Service Commission should solicit proposals for a wind park to be built off of Maryland's coast. The PSC should then direct utilities to sign long-term power supply contracts with the wind developer with the best proposal.

- The federal government should use its buying power to facilitate the financing of offshore wind. The government should negotiate a long term power purchase agreement with an offshore wind developer covering electricity purchases for military installations and other federal facilities.

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