Blue Ribbon Panel on Development of Wind Turbine Facilities in Coastal Waters

INTERIM REPORT

November 2005

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State of New Jersey
BLUE RIBBON PANEL ON DEVELOPMENT OF
WIND TURBINE FACILITIES IN COASTAL WATERS
PO Box 001
TRENTON NJ 08625

RICHARD J. CODEY
Acting Governor

EDWARD J. MCKENNA, JR.
Chair

November 30, 2005

Dear Reader:

I am pleased to present for your consideration the enclosed interim report produced by acting Governor Richard J. Codey's Blue Ribbon Panel on Development of Wind Turbine Facilities in Coastal Waters.

Last December, Governor Codey signed his twelfth Executive Order, creating this Panel and charging it with "identifying and weighing the costs and benefits of developing offshore wind turbine facilities." This interim report represents our progress to date toward meeting the Governor's mandate.

This document is a product of our activities since EO12 was signed. Throughout the spring, a series of public meetings was held in each of New Jersey's four oceanfront counties during which a range of concerns were brought to the Panel's attention. In the months that followed, the Panel researched these issues and prepared this interim report for public comment. This document provides a summary and analysis of the Panel's objective findings. During the next phase of our work, we will seek public input on the content, accuracy, and scope of these findings before deliberations begin on the specific policy recommendations to be included in the final report that will be forwarded to Governor-elect Jon S. Corzine next March.

Accordingly, we welcome your thoughts on this document. I encourage you to submit your comments either by postal mail at the address shown above or through our web site, www.njwindpanel.org. We will soon announce additional public meetings to be held between now and early next year. This information will also be available on our web site.

This interim report is not a finished product as the issues relevant to wind turbines in coastal waters and to New Jersey's energy future are complex. With your input, we hope to expand upon our research before submitting our final report with recommendations next year.

We look forward to hearing from you during the next phase of our work.

Very truly yours,

Edward J. McKenna, Jr.

EXECUTIVE ORDER #12

Acting Governor Richard J. Codey

23 December 2004

WHEREAS, the marine and coastal environment is an important natural resource and the subject of a public trust administered by government for the benefit of all citizens; and

WHEREAS, the marine and coastal environment is also an important economic and recreational resource; and

WHEREAS, the protection of this resource is a primary responsibility of state government; and

WHEREAS, the protection of this resource requires adequate planning and regulation; and

WHEREAS, as part of a much-needed effort to reduce air pollution and other negative consequences of relying too heavily fossil and nuclear fuels, the State of New Jersey has actively encouraged the use of renewable energy including solar and wind power; and

WHEREAS, there has been significant interest in the use of coastal waters for the development of wind turbine facilities; and

WHEREAS, the development of offshore wind turbine facilities has the potential to affect marine, recreational, avian and scenic resources and other offshore and onshore uses; and

WHEREAS, the State is committed to the use and production of electricity through renewable resources and through responsible planning and regulation; and

WHEREAS, the State has the authority to regulate activities occurring in the coastal zone, including its three nautical mile territorial sea, pursuant to the Submerged Lands Act of 1953, 43 U.S.C. 1301 et seq.; Coastal Area Facility Review Act, N.J.S.A. 13:19-1 et seq.; Waterfront Development Act, N.J.S.A. 12:5-3; Wetlands Act of 1970, N.J.S.A. 13:9A-1 et seq.; and State Tidelands law; and

WHEREAS, the State of New Jersey has Federal Consistency review authority pursuant to Section 307 of the Coastal Zone Management Act, 16 U.S.C. 1451 et seq., for activities occurring in its coastal zone and in Federal waters where there is a reasonably foreseeable effect on the uses and resources of New Jersey's coastal zone; and

WHEREAS, prior to the construction of any offshore wind turbine facilities, there is a vital need for the State of New Jersey to identify and weigh the costs and benefits of such development and to determine if building such facilities is appropriate; and

WHEREAS, there is a vital need for the State to develop policies governing the development of offshore wind turbine facilities, if these facilities are found to be appropriate and in the public interest;

NOW, **THEREFORE, I, RICHARD J. CODEY**, Acting Governor of the State of New Jersey, by virtue of the authority vested in me by the Constitution and by the Statutes of this State, do hereby **ORDER AND DIRECT**:

1. There is hereby created a Blue Ribbon Panel on Development of Wind Turbine Facilities in Coastal Waters (hereinafter "Blue Ribbon Panel"), which shall consist of 9 members, including 6 public members appointed by the Governor from among persons representing environmental, academic, tourism and local government interests, and 3 ex officio voting members, the Commissioner of the Department of Environmental Protection, the President of the Board of Public Utilities and the Chief Executive Officer and Secretary of the Commerce and Economic Growth Commission. The ex officio members may appoint a designee to serve on the Panel in their absence.

2. The Governor shall appoint one of the 6 public members to serve as Chair of the Blue Ribbon Panel. The members of the Panel shall serve at the pleasure of the Governor and shall not receive compensation for their service on the Panel.

3. The Blue Ribbon Panel is charged with identifying and weighing the costs and benefits of developing offshore wind turbine facilities, and considering both economic and environmental costs and benefits. The Blue Ribbon Panel shall also consider the need for offshore wind turbines and a comparison to other electric power sources, including fossil, nuclear and renewable fuels as part of the State's long-term electricity needs. The Blue Ribbon Panel shall submit to the Governor, within 15 months, a report providing policy recommendations regarding the appropriateness of developing offshore wind turbine facilities.

4. Prior to the issuance of its report, the Blue Ribbon Panel shall hold at least three public hearings to solicit input from the public and may hold meetings with stakeholders as necessary.

5. The Board of Public Utilities shall not fund, and the DEP shall not approve, the development of wind turbine facilities or supporting infrastructure in coastal waters for 15 months during the deliberations of the Blue Ribbon Panel.

6. The Department of Environmental Protection, the Board of Public Utilities and the Commerce and Economic Growth Commission shall provide staff assistance to the Blue Ribbon Panel. The Panel is authorized to call upon any department, office, division or agency of State government to provide such information, resources or other assistance deemed necessary to discharge its responsibilities under this Order. Each department, office, division and agency of this State is required to cooperate with the Commission and to furnish it with such information and assistance as is necessary to accomplish the purposes of this Order.

7. This Order shall take effect immediately.

GIVEN, under my hand and seal this
23rd day of December
in the Year of Our Lord,
Two Thousand and Four, and
of the Independence of the
United States, the Two
Hundred and Twenty-Ninth.

/s/ Richard J. Codey
Acting Governor

Blue Ribbon Panel

Public Members

Edward J. McKenna, Jr., chair
Mayor; Borough of Red Bank

Timothy P. Dillingham
Executive Director; American Littoral Society

Theodore J. Korth
Special Counsel; New Jersey Audubon Society

Bonnie J. McCay
Professor; Cook College at Rutgers the State University of New Jersey

Scott A. Weiner
Director; Center for Energy, Economic & Environmental Policy at Rutgers the State University of New Jersey

Diane Wieland
Director; Cape May County Department of Tourism

Ex Officio Voting Members

Virginia S. Bauer
CEO & Secretary; Commerce, Economic Growth & Tourism Commission

Bradley M. Campbell
Commissioner; Department of Environmental Protection

Jeanne M. Fox
President; Board of Public Utilities

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Nancy J. Byrne
Daniel Cappello
F. Phyllis Oppenheimer
Cathy Scangarella
Steven Stegman

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Public Comment Instructions

The Blue Ribbon Panel welcomes your comments on this Interim Report.

1) Postal Mail: Blue Ribbon Panel on Development of
Wind Turbine Facilities in Coastal Waters
P.O. Box 001
Trenton, NJ 08625-0001

2) Panel's Web Site: http://www.njwindpanel.org/

When submitting comments, please include your name, hometown, affiliation (e.g., public official, organizations, concerned citizen, etc.), and contact information.

We are particularly interested in comments concerning:

- The content and accuracy of the facts and research presented;
- Areas of investigation that have been overlooked or underrepresented; and
- Areas of investigation that have been included but may be irrelevant to the costs/benefits associated with wind facilities.

BLUE RIBBON PANEL ON DEVELOPMENT OF WIND TURBINE FACILITIES IN COASTAL WATERS

INTERIM REPORT

Introduction

In 1891, Danish scientist Poul la Cour modified the traditional wooden windmill, successfully creating the first utility-scale wind turbine to generate electricity. Sixty years later, a student of la Cour's would become the first to connect a wind turbine to an electrical grid. It was not until the 1970s, however, with the world reeling from a series of shocks to the oil market, that serious innovation of the technology began. The United States created a Federal Wind Energy Program to foster research and development of utility-scale turbines and, in the 1980s, California installed the nation's first large-scale wind farm, consisting of 17,000 turbines. With the subsequent stabilization of oil prices, public funding for research and development of wind energy evaporated and most local and federal government subsidies were retracted, stalling the technology's development in the United States. European governments, however, continued to support their wind energy industries and today, Europe is home to more than 40,000 MW of utility-scale wind-generated capacity, including the world's only offshore wind turbine facilities. European nations have an additional 10,000 MW of off shore wind projects in various planning stages. As of January 2005, the United States had 6,700 MW of utility-scale wind facilities, all of which are land-based.

The recent resurgence of interest in wind energy in the United States has been attributed to several factors. First, a general, international, and scientific consensus of the climate-altering effects of greenhouse gas emissions has renewed interest in development of low- and zero-emission, renewable sources of energy, such as wind. Second, volatility has increased in the markets for energy sources upon which Americans are reliant. Instability in the world's oil-producing regions and a devastating hurricane season have pushed oil prices to record levels, elevating the cost of gasoline and heating oil. Third, and perhaps due in part to the foregoing factors, federal and state clean energy incentives recently have been reestablished. Finally, global demand for energy is projected to increase, while the supply of traditional energy sources—such as fossil fuels—is not. The prospect of energy demand exceeding supply has further motivated the development of alternative energy technologies, including wind turbines. The choice of which resources or approaches supply this demand is critical to New Jersey's economic growth and environmental quality, as well as to the future cost of energy to ratepayers.

In 2003 and 2004, several private corporations announced proposals for utility-scale wind turbine facilities in the federal waters between Sandy Hook and Cape May. These announcements marked the first time such projects had been considered for the waters offshore New Jersey. These proposals came at a time when the State had not yet evaluated or developed policies specific to this new use of its offshore waters.

The Blue Ribbon Panel

Recognizing the need for careful study of wind power, New Jersey's acting Governor Richard J. Codey signed his twelfth executive order (EO12) in December 2004, establishing a 15-month moratorium on the

funding and permitting of offshore wind turbine facilities in the state. EO12 created a Blue Ribbon Panel on Development of Offshore Wind Turbine Facilities, charged with "identifying and weighing the costs and benefits of developing" such facilities and, by March 2006, submitting "a report to the Governor providing policy recommendations regarding the appropriateness of developing offshore wind turbine facilities."

The Blue Ribbon Panel—author of this Interim Report—is composed of nine members: six public members selected for their leadership in the environmental, academic, tourism, and local government communities; the Commissioner of the Department of Environmental Protection; the President of the Board of Public Utilities; and the Chief Executive Officer and Secretary of the Commerce, Economic Growth, and Tourism Commission.

During the spring of 2005, the Panel held four public meetings—one each in Cape May, Atlantic, Ocean, and Monmouth Counties—to receive testimony from elected/appointed officials and members of the public. Throughout this process, the Panel received a wealth of information on a wide range of topics. Subsequent to these hearings, the Panel organized itself into three committees so as to better focus the direction and scope of its research into energy, environment and ocean use issues, and commerce and tourism issues, respectively.

This Interim Report represents the progress to date made toward meeting Governor Codey's mandate. Contained within is a summary and analysis of the Panel's objective findings, which will be subject to public comment before the Panel begins its deliberations on the suitability of offshore wind turbine facilities. The resulting recommendations will be contained in the Panel's final report to Governor-elect Jon S. Corzine next March.

Organization of this Document

The remainder of this chapter contains a summary of issues investigated by the Panel, beginning with energy issues, followed by environmental and ocean resource issues, and concluding with commerce and tourism issues. A wealth of more detailed information may be found in the five appendices attached to this document.

Overview of New Jersey's Electricity and Energy Landscape

New Jersey faces many of the same energy-related challenges that exist at the national level. Of these issues, global climate change is among the most critical. With 127 miles of coastline and many square miles of landmass at or near sea level, New Jersey is particularly vulnerable to the impacts of global climate change and sea level rise.

Moreover, the State faces economic and environmental problems in both demand for and supply of electricity. New Jersey is part of a regional electricity market and regional power grid, Pennsylvania-New Jersey-Maryland (PJM).[1] The state consumes more electricity than it produces and imports the balance from facilities located out-of-state and within the same regional grid. Any increase in New Jersey's demand for electricity not offset by additional in-state generation serving New Jersey or efficiency measures necessarily increases this dependence on out-of-state facilities. Many of these out-of-state facilities use fossil fuels and are upwind of New Jersey, adding to the State's air quality problems; all are beyond the state's regulatory authority to control air pollutants. While New Jersey's Renewable

[1] PJM, or the Pennsylvania-New Jersey-Maryland Interconnection, is the regional power grid serving New Jersey. The region encompasses 51 million people in thirteen states and the District of Columbia.

Portfolio Standards generally allows for the use of out-of-state renewables located within PJM, the State remains concerned about the potential of increasing reliance on polluting sources. Regardless, generation within New Jersey now and in the future will affect the total amount of electricity to be imported.

Supply constraints have been a growing problem in New Jersey as well. Particularly in the southeastern portion of the state, transmission congestion—especially during the peak summer months—frequently has forced the use of more expensive and less environmentally friendly energy sources such as diesel-fueled generators. On several occasions, such congestion has prevented supply from meeting peak demand, resulting in voltage adjustments (brownouts) and, under extreme circumstances, localized blackouts.[2]

These issues have prompted serious consideration of alternative sources of energy and increased energy efficiency efforts in New Jersey. In 1999, the State Legislature adopted a Renewable Portfolio Standard (RPS), requiring energy suppliers to include a minimum percentage of renewable energy in their mix of energy sources. Four years later, the Board of Public Utilities created the Clean Energy Program, charged with administering energy efficiency and renewable energy programs. Today, the Clean Energy Program provides financial incentives to public and private entities for solar, wind, and sustainable biomass systems.

Earlier this year, New Jersey's Board of Public Utilities (NJBPU) adopted the following objectives for New Jersey's Clean Energy Program:

- By 31 December 2008, 6.5 percent of the electricity used by New Jersey residents and businesses will be provided by Class I and Class II renewable energy resources of which at least four percent will come from Class I renewable energy resources;[3]
- By 31 December 2008, install 300 MW of Class I renewable electric generation capacity in New Jersey, of which 90 MW will be derived from photovoltaic technologies; and
- By 31 December 2012, 785,000 megawatt-hours of electricity and 2.0 billion cubic feet of natural gas will be derived from the energy efficiency and renewable energy measures.

In September, NJBPU proposed to increase the RPS to 20 percent by 2020. This revision would require approximately 4,000 to 5,000 MW of Class I and approximately 1,500 MW of solar electric capacity to be constructed and operational by 2020. According to a report presented to Rutgers University as part of Rutgers' evaluation of the Clean Energy Program, New Jersey has a technical potential of approximately 3,255 MW of Class I capacity of which over 2,600 MW can be derived from on shore and offshore wind.[4] The last figure, however, should be noted with some caution. The offshore component assumes that 10 percent of the ocean space beyond three miles offshore, out to a depth of 100 feet, and between Seaside Heights and Cape May is occupied by wind turbines.[5] The feasibility of this assumption will depend in part upon an assessment of the information contained in this report, as well as additional study.

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[2] According to interruption reports filed pursuant to N.J.A.C. 14:3-3.9, there have been three instances of voltage reductions and four localized blackouts during the past five years.

[3] Class I renewable resources include solar technologies, photovoltaic technologies, wind energy, fuel cells, geothermal technologies, wave or tidal action, and methane gas from landfills or a biomass facility, provided that the biomass is cultivated and harvested in a sustainable manner; Class II renewable resources include electric energy produced at a resource recovery facility or hydro power of 30 MW or less.

[4] Navigant Consulting Inc., Sustainable Energy Advantage LLC, and Boreal Renewable Energy Development. "New Jersey Renewable Energy Market Assessment: Final Report to Rutgers University, Center for Energy, Economic and Environmental Policy." 2 August 2004.

[5] These estimates are derived from: Atlantic Renewable Energy Corporation and AWS Scientific. "New Jersey Offshore Wind Energy: Feasibility Study." Prepared for the New Jersey Board of Public Utilities. December 2004, pp. iv-v, (hereafter known as the "Atlantic Renewable Study"); and Navigant, op. cit., pp. 65-66.

Energy efficiency measures can reduce the need for additional generation and transmission resources. Such measures depend on technical and economic potential. *Technical potential* represents the sum of all savings from all measures deemed applicable and technically feasible, while *economic potential* refers to the sum of all measures whose benefits (i.e., avoided energy production and power plant construction) exceed the costs of energy-efficiency and program activities necessary to deliver them. New Jersey's economic potential for energy efficiency measures is substantial. At times of peak demand, energy savings are estimated to exceed 4,000 MW (approximately eight mid-sized power plants). However, these savings would require significant additional investment in energy-efficiency programs. Capturing the entire economic potential through program activity would cost more than $5 billion between 2004 and 2020.[6] Additionally, this would require increasing residential and commercial building energy codes as well as energy efficiency appliance standards. For more details, see Table A.20 in Appendix A.

NJBPU has sought to promote and advance energy efficiency and renewable energy since achieving these objectives can benefit energy consumers, the environment, and the economy. Increasing in-state capacity and reducing dependence on traditional energy sources of limited supply will lower energy costs and thereby benefit energy consumers. Offsetting some of the emissions, discharges, water use and waste generated from fossil fuel and nuclear energy generating plants will benefit the environment. Additionally by helping create new jobs, as well as reducing energy costs, these initiatives will benefit the economy.

Though New Jersey has a robust energy efficiency program, the State's electricity needs continue to grow at roughly 1.4 percent annually. Without this program, New Jersey would experience a 2 percent effective annual energy growth rate. In order to achieve the goal of meeting new growth in energy demand with energy efficiency and renewable energy, the State will have to substantially increase funding and implementation of such projects.

New Jersey currently imports between 15 and 30 percent of its electricity from other states within PJM.[7] This figure has generally followed an upward trend, creating a greater need for new transmission towers to receive out-of-state energy, and resulting in larger economic revenues being sent to other states. In their 2004 State of the Market Report, PJM projected that New Jersey will require over 2,000 MW of additional capacity by 2009 to satisfy its ever-increasing demand for energy.[8] This need is projected to be especially critical in the oceanfront counties that are experiencing above-average growth. In addition, seasonal population growth has further increased summertime peak energy demand.

Existing low- and zero-emission energy sources are not without their drawbacks. Nuclear facilities present safety concerns, among them the long-term storage of radioactive waste; photovoltaic (solar) facilities currently are not economically feasible without significant government subsidies; and sustainable biomass facilities have high fixed and operating costs.

Harnessing energy from the wind presents a host of complicated issues as well. Chief among these issues is the location of New Jersey's available wind resources. In general, wind resources are deemed conditionally viable for commercial-scale energy production at mean speeds of 18 mph or greater. Viable onshore wind locations in New Jersey are limited and almost exclusively near the coast, although a few ridgelines in Hunterdon and Sussex Counties present possible onshore locations. According to the Atlantic Renewable Study, the greatest potential wind resources exist offshore New Jersey.[9] (see Figure

[6] KEMA, Inc., "New Jersey Energy Efficiency and Distributed Generation Market Assessment: Final Report to Rutgers University Center for Energy, Economic and Environmental Policy." August 2004, pp. ES3 and 3-1.

[7] The precise importation figure varies depending on a variety of factors, the largest of which is the operational state of New Jersey's four nuclear facilities.

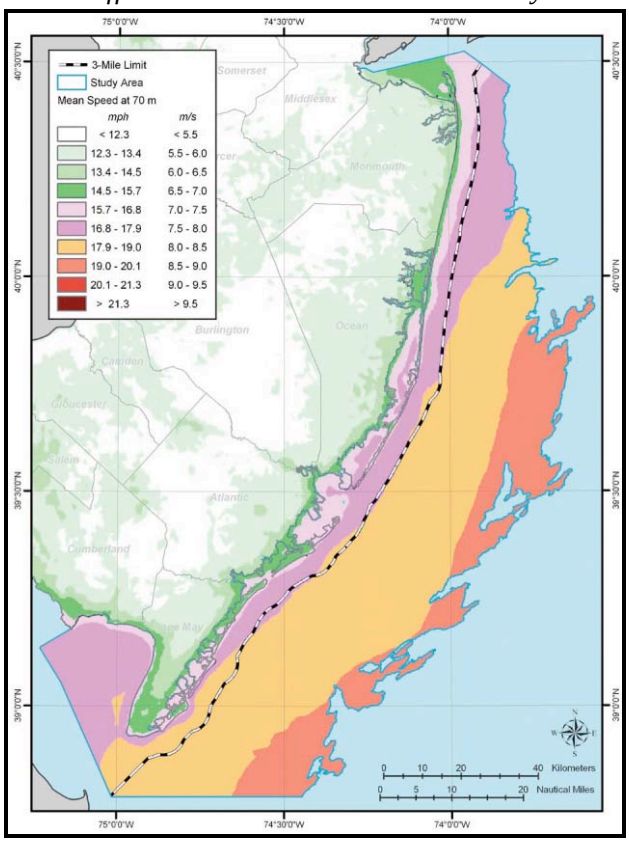
[8] Pennsylvania-Jersey-Maryland Interconnection (PJM). "2004 State of the Market." 8 March 2005.

[9] Atlantic Renewable Study, op. cit., p. 1.

1) Appraising the feasibility and desirability of developing offshore wind resources is complicated by the fact that no offshore wind turbines have been installed in the United States. Much of what is known about these facilities has been culled from research on European installations.

Figure 1

Offshore Wind Potential in New Jersey



Source: Atlantic Renewable Study, p. 46.

New Jersey's energy needs are substantial and growing. Wind power alone cannot reduce the State's dependence on fossil fuels in the short term.[10] Nor can wind provide "base load" power needed to meet every day energy demands.[11] Due to these limitations, wind power alone cannot remedy the current energy-related environmental issues faced by New Jersey and discussed above. Instead, it is possible that wind would help supply a portion of anticipated growth in energy demand and help mitigate future cost of energy to ratepayers, both without contributing additional environmental impacts associated with fossil fuel or nuclear-based generation.

[10] Fossil fuel products generate about 44% of the *electricity* and 76% of *energy* consumed in New Jersey. Energy includes fuels for transportation, which are predominately petroleum products. Nuclear facilities generate 52% of the electricity and 13% of the energy consumed in New Jersey. Source: EIA State Energy Tables. See Appendix A for more detailed information.

[11] "Base load" is generation available on an as needed basis. To ensure the lights stay on, the regional transmission operator must always have a specific amount of capacity available in case someone throws a switch. Wind cannot contribute to the base load because wind is intermittent. Wind can, however, contribute to peak loading.

Overview of Potential Impacts of Offshore Wind Power on the Environment and other Ocean Resources

Offshore wind turbines have the potential to offset a variety of adverse environmental impacts associated with current patterns of electricity production. By their very nature and location, however, such facilities may also introduce direct and indirect impacts upon the ocean environment and upon human uses of coastal resources. Many of the potential environmental benefits associated with offshore wind development, such as emissions reductions, reduced impaired water discharge, and reduced waste generation, can be identified and measured. Given the small scale of currently operating offshore wind farms, however, such benefits likely are small when compared to existing adverse impacts created by electricity production and other contributors to air pollution and global warming. Existing offshore wind facilities occupy a very small portion of the sea floor and ocean space, which may mitigate their direct and indirect impacts upon the marine environment and other coastal resources.

The environmental impacts associated with offshore wind facilities generally fall into two categories: those typical of offshore navigation and construction projects, and those unique to wind turbines for which there is potential for impact on a greater scale and/or for a longer period. There is considerable uncertainty concerning both classes of impacts due to the lack of scientific studies specific to New Jersey.

New Jersey's coastal waters are rich in natural resources and are used extensively by the public. They are habitat for numerous species of finfish and shellfish, sea turtles, marine mammals and birds. Public uses include recreational and commercial fishing, boating, surfing, and divers exploring historic shipwrecks and artificial reefs. These waters also support shipping, telecommunications cables, near-shore barge traffic, commercial and military air traffic routes, and sand-borrow areas for beach nourishment efforts. New Jersey's beaches are the foundation for the State's second-largest economic sector: tourism.

Acting Governor Richard J. Codey's Executive Order directed this Blue Ribbon Panel to study the merits of offshore wind turbine facilities, considering both economic and environmental costs and benefits. Thus, this analysis here begins with an overview of potential environmental benefits and potential adverse impacts to coastal resources. It is supplemented by Appendix D, which contains an evaluation of those resources with respect to three scenarios selected for discussion purposes: no-build (the status-quo); development of 150 megawatts (MW) of zero emission generation or efficiency-based capacity; development of 300 MW of zero emission generation or efficiency-based capacity.[12] A more extensive discussion regarding the environment and coastal resources is contained in Appendix B.

Potential Environmental Benefits

Current patterns of energy production present myriad issues of both global and local concern. Coal-fired power plants are a leading source of anthropogenic mercury deposition in the environment, with consequent bioaccumulation in fish. Once-through (open-loop) cooling systems along coastal tributaries further impact fish populations. Transportation and infrastructure related to coal, oil, and natural gas supplies present risks to the environment, notably from oil spills and the siting of infrastructure in ecologically sensitive areas. Either occurrence can harm terrestrial and/or aquatic wildlife and impact a range of beach uses associated with tourism.

[12] With respect to zero-emissions facilities, these figures represent a capacity that could have been generated at continuous full-power operation. Because of outages, routine maintenance, and other operational inefficiencies, no power generating facility can produce 100 percent of their rated capacity for extended periods. Traditional facilities rarely exceed an 80 percent capacity factor. Wind facilities are estimated to operate at 30-35 percent of their rated capacity.

Electricity production through fossil fuel combustion is the largest stationary-source of carbon dioxide emissions that contribute to global climate change. As a coastal state, New Jersey is particularly vulnerable to these effects. A recent Rutgers study found that anthropogenic sea level rise has doubled in the current century and was about 1mm/year between 1900 and 1995. The study went on to cite global warming as a leading cause.[13] Earlier this month, Princeton University professor Michael Oppenheimer presented a report projecting this trend into the future.[14] Dr. Oppenheimer's research confirmed a pattern of historical sea level rise along New Jersey's coast and estimated an additional rise of 0.3 to 1.1 meters (1.0 to 3.6 feet) between 2005 and 2100.

While only 44 percent of New Jersey's in-state electrical generation comes from fossil fuels, a larger portion of the imported electricity is produced by fossil fuels.[15] In-state nuclear power generation, which currently provides about 52 percent of New Jersey's base-load electricity needs,[16] avoids many of the environmental issues associated with other conventional sources of electricity. These facilities still affect the environment through open loop cooling facilities, transmission and related infrastructure, and the challenge of safely storing nuclear waste for a long period. There is also the added risk, however remote, of catastrophic accidents. Uncertainty regarding the relicensing of Oyster Creek, whose renewal application is pending before the Nuclear Regulatory Commission, presents the prospect that additional generating capacity will be needed in the near term. This possibility would require New Jersey to evaluate and plan for a range of options, including significant investment in conservation and energy efficiency measures and alternative sources of energy, in order to avoid increased reliance on out-of-state plants.

More than one-third of New Jersey's ozone precursors, fine particulate pollution, and mercury deposition originates from upwind, out-of-state power facilities.[17] Compared to in-state generation, New Jersey's importation of electricity requires additional transmission, which could reduce reliability and security and increase congestion in areas of the state experiencing intensive growth. Additional infrastructure can also lead to increased cost of electricity and the loss of wetlands and forest resources, disruption of threatened and endangered species habitat, and visual blight from transmission towers and substations. Importation also increases New Jersey's reliance on pollution-generating facilities that are beyond the State's authority to regulate. These facilities produce pollutants such as nitrogen oxide, sulfur dioxide, and mercury emissions. New Jersey's standards are typically stricter than in neighboring states. These impacts will increase to the extent that growth in New Jersey's electricity demand must be satisfied through additional importation of electricity and/or development of additional generation capacity from fossil fuels.

Wind power generation may offer New Jersey an alternative to construction of additional, conventional generation facilities that would increase emissions of carbon dioxide, sulfur dioxide, nitrogen oxides, mercury, and other combustion byproducts. Offsetting these emissions using wind power would help reduce the energy sector's future contribution to global climate change, the transport and deposition of pollutants into the terrestrial and marine environments, and the public health impacts associated with ground-level ozone, acid rain, and fine particulate pollution. These avoided impacts, quantified in the alternatives analysis found in Appendix D, are relatively small when compared to New Jersey's existing

[13] Stanley, Alissa et al. "Holocene sea-level rise in New Jersey: An Interim Report." 15 September 2004.
[14] Cooper, Matthew J.P., Michael D. Beevers and Michael Oppenheimer. "Future Sea Level Rise and the New Jersey Coast." November 2005.
[15] According to the Energy Information Administration, this figure is closer to 70 percent for surrounding states within PJM.
[16] Source: U.S. Department of Energy. Energy Information Administration (EIA). State Energy Data 2001 Consumption (hereinafter referred to as "EIA State Energy Tables"). EIA State Energy Tables. Note that this figure drops substantially—to 13%—when considering New Jersey's overall energy consumption. For more detailed information, see Appendix A.
[17] New Jersey Department of Environmental Protection. New Jersey Mercury Task Force. "Volume III: Sources of Mercury." January 2002. Chapter 1, p. 13; U.S. Environmental Protection Agency. Mercury Study Report to Congress. "Volume II: An Inventory of Anthropogenic Mercury Emissions in the United States." EPA-452/R-97-004. December 1997, p. 4-27.

sources of pollution. Furthermore, the emissions benefits could also be partially offset by the emissions associated with construction, operation, and maintenance of the turbines, a concern noted by the Minerals Management Service during their review of the Cape Wind Project. Balancing these caveats, however, is the reality that these alternatives would occupy a small portion of New Jersey's ocean space and seafloor.

Potential Impacts to Coastal Resources

Counterbalancing the potential environmental benefits of wind power are the potential adverse impacts to coastal resources that such development may produce. Offshore wind turbine facilities have the potential to affect a broader range of resources and ocean uses when compared to conventional electricity generation. These impacts are not well understood, however, due to a lack of focused scientific investigation to date. Further, there is a significant gap in the science regarding the resources themselves. Basic data and detailed characterizations concerning the abundance and distribution of species of birds, fish, and marine mammals that inhabit and/or transit the coastal waters of New Jersey are scarce. Most existing research is based on terrestrial turbines or European offshore facilities, as no offshore wind turbines have been constructed in the United States. Ongoing studies and scientific literature noted in Appendix B have identified potential impacts and conflicts resulting from the placement and operation of offshore wind turbines. Since the oldest offshore facilities were constructed in the 1990s, data on these impacts are limited. The analysis of impacts presented in this chapter and Appendix B rely upon studies conducted in conjunction with European offshore wind development, information presented in the Atlantic Renewable Study, and studies and modeling exercises completed during the preparation of the Draft Environmental Impact Statement for the proposed Cape Wind project in Nantucket Sound.[18]

Birds

Offshore wind turbines can result in both displacement of birds that avoid areas where turbines are erected and collisions of birds with turbine blades and associated structures. These impacts are believed to be greatest for migratory bird species. Such species tend to move in high concentrations and the physiological demands of migration make them more vulnerable. Collision impacts have been quantified in existing literature from terrestrial and European offshore turbine sites, but such estimates are likely to vary widely depending on site-specific factors. These data should be augmented by additional study that is specific to species commonly found offshore New Jersey. Displacement impacts are less easily quantified, but may also be significant.

Both types of impact may be reduced by physical means (siting turbines away from areas of high ecological significance) or by natural means (species habituation). Certain species have shown an ability to habituate to the presence of wind turbines without significant disruption of their feeding or reproduction patterns. The limited studies to date suggest that habituation varies greatly by species; the likelihood that collision and displacement can be reduced through habituation will depend on the particular species present.

Not surprisingly, mortality rates are likely to be greatest where concentrations of birds are highest. The Delaware Bay shore lies at the heart of the Atlantic flyway, an important migration route for a range of species including numerous species of conservation concern.

[18] Earlier this month the Minerals Management Service, which became the lead federal agency for all offshore wind projects with passage of the Energy Policy Act, announced it would initiate a new environmental review of the Cape Cod wind project. This new environmental impact statement (EIS) will eventually replace the draft EIS issued by the Army Corps of Engineers.

Marine life

Construction and operation of offshore wind turbines could have a number of impacts upon marine life. Marine mammals observed off New Jersey's coast, all of which are protected under federal law, include bottlenose dolphin, harbor porpoise, and North Atlantic right whale. At least five species of sea turtles have been observed off New Jersey's coast seasonally. There are no existing surveys of the distribution of these species, and little research on the possible effects of offshore wind turbines upon these species. Principal impacts to those species include acoustic aggravation from pile driving, vessel mooring and associated operations, disturbances related to maintenance activities, and increased incidence of vessel strikes. An additional concern is interference with migration and feeding due to turbine fields containing multiple structures. Such impacts may affect fish populations as well, but these impacts would be more difficult to quantify. The scale of these impacts may be affected by the size of the wind farm constructed (i.e., number and arrangement of individual turbines), its specific location, as well as cumulative impacts from multiple fields across a range of the affected species.

To the extent that renewable energy sources mitigate the impacts associated with current patterns of electricity production, wind turbine development could have indirect, beneficial effects on fisheries. Noted previously, these beneficial effects include offsetting atmospheric deposition of mercury, a bioaccumulative toxic that limits the amount of fish that can be safely consumed, and offsetting atmospheric deposition of nitrogen oxides, which impair water quality. To the extent that wind turbines create subsurface structure akin to an offshore platform or artificial reef, fish populations may benefit from enhanced habitat.

Water quality and benthic habitat

During the erection of turbines and laying of turbine-to-turbine and turbine field-to-shore electrical cables, benthic habitat would be disrupted. Because turbine support structures would occupy a small amount of the ocean floor, of primary concern is a short-term reduction in water quality, due to a suspension of sediment. Such impacts are reasonably comparable to those associated with other marine construction projects, such as artificial reef building and excavation in sand borrow sites. For turbine field construction, however, the disturbance is likely to extend over a greater geographic area, the extent of which would depend on the size of the wind facility being constructed.

Post-construction, water quality and benthic habitat both would be exposed to risks associated with the storage of motor oil and fuel on maintenance ships and offshore platforms. The draft Environmental Impact Statement for the Cape Wind project indicates the proposed 454 MW wind farm would have an electric service platform with four transformers each with a capacity for 10,000 gallons of cooling oil and 1,000 gallons of diesel fuel.[19] For the alternatives analyzed in Appendix D, the number of transformers and the cumulative capacity for cooling oil and diesel fuel would be proportionately less. Additionally, some types of cable used to conduct electricity are insulated with hazardous materials that may present a risk to water quality should these substances be released to the marine environment.

Commercial fishing

Offshore wind turbine development would impact commercial fishing operations. These impacts could be limited by mandating open access provisions and stringent cable burial protocols that would obviate the need for travel or gear restrictions upon commercial fishing vessels that operate near a turbine field. At 5-6 turbines per square mile, wind farms may still present a veritable obstacle course to commercial

[19] U.S. Department of the Army. Corps of Engineers, New England District. "Cape Wind Project: Draft Environmental Impact Statement." November 2001, revised June 2004, p. 4-21.

fishing vessels seeking to operate in their midst, and may, as a practical matter, render portions of the ocean off-limits to such operations. At nighttime and during periods of restricted visibility, the presence of turbines could create navigational hazards. Commercial fishing operations also may be affected to the extent that wind turbine development has population-level effects on marine life. Beneficial effects to commercial fishing are the same as those listed for marine life resources, including reduced future deposition of bioaccumulative toxics and improvements to overall water quality. Again, the scale of these impacts may be affected by the size of the wind farm constructed, its specific location, and the range of the affected species.

Recreational fishing

The adverse and beneficial effects of wind turbine development upon recreational fishing are generally comparable to those for commercial fishing. A prominent exception is that recreational anglers will have fewer gear limitations that may require avoidance of turbine fields. Furthermore, recreational fishing in proximity to the turbine structures may be enhanced by the reef characteristics associated with the structures, as discussed above. This, however, would be dependent upon access to the waters around and within the field. As is true for commercial fisheries, positive effects of wind power development include those discussed for marine life, and any impact would be relative to the size of the wind facility being constructed.

Navigation

Commercial and recreational navigation could be affected by the presence of offshore turbine fields. Negative effects include additional cost of fuel and time necessary to circumvent turbine structures and an increased risk of collision with those structures. These impacts would be similar in kind to those created by existing exclusion areas, fixed aids to navigation, and other maritime hazards, though on a scale dependent upon the size of the wind facility being constructed.

Wilderness and aesthetic values

Open vistas from beaches and open horizons for coastal boaters are important scenic and wilderness values that could be compromised by wind turbine development. During the day, the structures may be visible from shore and from vessels offshore. At night, turbines may also be visible on the horizon because each would be lit to reduce the collision risk to mariners and aviators. These impacts would vary considerably by location. Furthermore, existing development along New Jersey's coastline may mitigate the aesthetic impact of wind turbines in areas where intensive development has already taken place. The viewshed from Sandy Hook's Gateway National Recreation Area encompasses development in every direction, from dozens of in-water navigation aids to the beachfront amusement parks of Coney Island. Similarly, a nighttime mariner may not consider turbines offshore Atlantic City to be displeasing, especially when compared to casinos that are visible for miles. In contrast, the relatively pristine waters and horizon off Island Beach State Park or Cape May could be considered as having greater aesthetic value.

Though some public opposition to wind farm proposals has focused on the issue of aesthetics, at least one study has found that wind turbines can have aesthetic appeal. A report on terrestrial wind turbines in Vermont noted:

> Surveys conducted in areas where wind facilities are located conclude that people who think of wind developments as clean, renewable sources of electricity see the turbines as positive symbols and so are a more appealing landscape feature than other types of development. For other people they may represent an

> industrial intrusion into a natural landscape and thus have a negative symbolic appearance. The turbines' kinetic aspect (they move with the wind like a flag or mobile) can increase their visual appeal.[20]

In additional to location, the ultimate aesthetic impact of wind turbines would be highly dependent on atmospheric visibility and distance from shore. At distances of 15 or more nautical miles (17 or more statute miles) from shore, turbines may not easily be visible from shore, especially on days of reduced visibility. Nonetheless, in light of the economic data presented below and in Appendix C, the potential for aesthetic impacts on coastal uses deserves especially close attention because of the Jersey Shore's prominent place as a statewide recreational resource and economic engine.

Overview of Potential Impacts of Offshore Wind Power on Tourism and Related Industries

Tourism has been an integral part of New Jersey's economy for more than a century and has grown substantially as an economic and social phenomenon during the past 25 years. In fact, tourism revenues in New Jersey have increased by more than $12 billion in the last ten years alone.[21] To assess the potential socioeconomic impact of offshore wind farms, it is necessary to understand what draws these visitors to the Jersey shore and their role in the local and regional economies. The most current information available on these subjects is introduced here and detailed in Appendix C.

In 2004, tourism and related sales in New Jersey exceeded $32 billion, an amount greater than the state's entire operating budget. In the same year, tourism generated more than 430,000 jobs in New Jersey and was the State's third-largest private sector employer. Together, New Jersey's four oceanfront counties accounted for more than 40 percent of the state's total tourism employment in 2004. Collectively, travelers from within and outside of New Jersey are a major source of revenue to the state's economy, primarily through coastal tourism-related expenditures. Increased revenues generated by visitors to New Jersey mean more jobs for New Jersey workers, a stronger economy, and improved opportunities for tourism related businesses.

New Jersey's coastal region is rich in natural resources and is used extensively by the public. The coastline consists of 127 miles of white, sandy beaches from Sandy Hook to Cape May that are visited by more than 50 million people annually. From the existing body of research, it is clear that the coastline, its resources, and businesses are key attractions enticing tourists to New Jersey's oceanfront counties.

Mentioned earlier, the Jersey Shore is part of the Atlantic Flyway, a multi-continental superhighway for migratory birds that routes a semi-annual migration spectacle drawing many visitors to the region. Eco-tourism is an important component of the New Jersey's tourism industry. In Cape May County alone, eco-tourism has been estimated to generate directly and indirectly $70 million annually.

New Jersey's waters generate more than tourism dollars. The State has five major commercial fishing ports in addition to numerous smaller ports. New Jersey is a leader in shellfish landings from dredge fisheries that include surf clams, ocean quahogs and sea scallops. In 2003, shellfish landings had a cumulative direct and indirect economic impact of $724 million. In 2004, the Cape May-Wildwood port ranked fifth nationally in overall value of commercial fisheries landings. Recreational fisheries provide myriad opportunities for anglers and support several growing industries, including those utilizing New Jersey's burgeoning artificial reef sites. More than one million anglers fish New Jersey's salt waters annually, making more than 6.8 million vessel trips every year.

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[20] State of Vermont Agency of Natural Resources. State Land Wind Power Policy Development. "Aesthetics/Scenic Resource Impacts of Commercial Scale Wind Energy Facilities on State Land." February 2004, p. 31.

[21] Longwoods International. "New Jersey 1994 Travel Year Interim Report." Prepared for New Jersey's Office of Travel & Tourism. March 1994.

To identify the portion of tourism expenditures that is related to the oceanfront, its beaches, waters, and the businesses in their immediate vicinities, this Panel commissioned Rutgers, the State University of New Jersey, to conduct research to provide preliminary analysis regarding the economic effects of changes to beach-based tourism and oceanfront property values.

While a complete analysis must include all four oceanfront counties, this preliminary analysis was specific to Cape May. Of the four oceanfront counties, Cape May is most dependent on shore-based tourism; nearly 60% of all expenditures in the County are attributable to tourism. It is important to note this research did not attempt to predict what impact offshore wind turbine facilities might induce; rather, it illustrates the potential magnitude—positive or negative—of impacts to tourism, whether resulting from wind turbines or some other cause.

Rutgers estimated impacts to tourism on two scales: ±5% and ±10%. Due to the nature of the economic model used, the magnitude of impact is twice as large in the ±10% scenario than in the ±5% scenario. The study found that a 5% impact would result in a gain/loss of 2,382 jobs and $67.4 million of income in Cape May County alone. Not surprisingly, impacts for the entire State were found to be substantially greater. At 5%, New Jersey would gain/lose 3,059 jobs and $97.4 million of income. The last two figures assume no other county in the State absorbs Cape May's gains/losses, which is an extreme economic condition. More than likely, some of these gains/loses would be spread throughout the region as travelers adjust their plans to Cape May from nearby locations in the State and vice versa. The study goes on to conclude it would be more reasonable to assume the State would sustain little or no net economic loss. In other words, the quantified effects are likely to have a localized impact that would be absorbed by the rest of the State. The full text of this study can be found toward the end of Appendix C.

Again, it is important to note this study does not predict the impact of wind turbines on tourism. The study does illustrate, however, what would happen if a ±5% or ±10% impact were assumed. Given the magnitude of these impacts as they are presented, any use of New Jersey's coastal area and offshore waters for turbines must be carefully evaluated to assure such use would not cause undue harm to ocean-based industries.