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The Cost and Economic Impact of New Jersey's Offshore Wind Initiative

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TABLE OF CONTENTS

TABLE OF TABLES

Executive Summary

On August 19, 2010, New Jersey Governor Chris Christie signed the Offshore Wind Economic Development Act (OWED) into law. The law orders the state Board of Public Utilities (BPU) to develop an offshore wind energy certificate program that would support at least 1,100 megawatts (MWs) of generation from qualified offshore wind projects. The law also provides subsidies to potential offshore wind developers.

The law requires a cost-benefit analysis that includes a detailed analysis of the impact of the projects on state economy and state electricity ratepayers.[1] In this report, the Beacon Hill Institute has conducted the analysis of 1,100 MWs of offshore wind power for New Jersey. The findings are as follows.

- The project would produce a net cost of $3.245 billion to New Jersey, within a range of $2.106 billion and $4.137 billion
- New Jersey's electricity prices will increase by 2.1 percent, in 2017, within a range of 0.5 percent and 4.2 percent.
- From 2017 to 2036, the average household ratepayer will pay $431 in higher electricity costs; the average commercial ratepayer will pay an extra $3,054 and the average industrial ratepayer an extra $109,335.

These increased energy prices will hurt New Jersey's households and businesses and will impair the state economy. According to the study by 2017:

- New Jersey will lose an average of 2,219 jobs, within a range of 528 jobs and 4,440 jobs.
- Annual wages will fall by an average of $111 per worker, within a range of $26 per worker and $222 per worker.
- Real disposable income will fall by $330 million, within a range of $79 million and $660 million.
- Net investment will fall by $48 million, within a range of $11 million and $95 million.

The rush to offshore wind power in New Jersey will produce net economic costs, raise electricity costs and dampen economic activity.

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[1] State of New Jersey, Legislature, 2010, *Offshore Wind Economic Development Act,* S2036, 214th Legislature, (June 10, 2010) Sec. 3, (4):22. http://www.njleg.state.nj.us/2010/Bills/S2500/2036_I1.PDF. (accessed April 11, 2011)

Introduction

On August 19, 2010, New Jersey Governor Chris Christie signed the Offshore Wind Economic Development Act (OWED) into law. As implied by its title, the Governor see's the law as a means "to grow and strengthen New Jersey's economy."[2] The law amends the current state renewable portfolio standard (RPS) legislation to include offshore wind power. The law orders the state Board of Public Utilities (BPU) to develop an offshore wind energy certificate program that would require an undefined percentage of electricity sold in New Jersey to be sourced from offshore wind. This percentage would be developed to support at least 1,100 megawatts (MWs) of generation from qualified offshore wind projects, with a goal of 3,000 MWs by 2020.

The law also provides subsidies to potential offshore wind developers. The law includes provisions stating that developers must document that they have "applied for all eligible federal funds and programs available to offset the cost of the project or provide tax advantages."[3] In addition, the law makes available $100 million for tax credits to "qualified wind energy" facilities for 100 percent of their capital investment. The total amount of tax credits may be increased to $1.5 billion pending the approval of additional legislation. The credits require minimum capital investment and employment levels. [4] These new state subsidies will combine with existing current state and federal programs to partially offset the substantial costs of the offshore wind facilities.

The Governor's enthusiasm for the economic benefits of the law is mirrored by others in Trenton. The Department of Environmental Protection (DEP) commissioner Bob Martin says that the law will provide "New Jersey with a major economic boost from jobs that ***surely*** [emphasis added] will be created by this green industry."[5] Senate President Stephen M. Sweeney adds that "not only will this law make New Jersey even more energy independent, it will also bring vital new jobs to the state at a time when we need them the most."[6] Senate Minority Leader Tom Kean Jr. joins the chorus by stating, "we must take this opportunity to

[2] Office of the Governor, "Governor Christie Signs Offshore Wind Economic Development Act to Spur Economic Growth, Encourage Energy as Industry," (August 19, 2010) http://www.state.nj.us/governor/news/news/552010/approved/20100819a.html (accessed April 10, 2011).

[3] State of New Jersey, Legislature, 2010, *Offshore Wind Economic Development Act,* S2036, 22

[4] Ibid, 26-27.

[5] Ibid.

[6] Ibid.

use the emerging new energy economy to create jobs and careers right here in New Jersey and not overseas."[7] However, the zeal with which these political leaders celebrate the new law, marks in great contrast to the reality of offshore wind energy.

Electricity generated by offshore wind resources is much more costly and unreliable than conventional energy sources such as coal and natural gas, and stands little chance of commercial success in a competitive market. In response, producers of renewable energy seek to guarantee a market through legislation similar to the New Jersey law and through the heavy use of federal and state subsidies. But whatever the market offers in terms of renewable energy, it will always be limited. In order to keep the electricity grid in equilibrium, intermittent resources such as wind and solar power need reliable back-up sources. If the wind dies down, or blows too hard (which trips a shutdown mechanism in commercial windmills), another power source must be ramped up instantly.

Not unlike taxes, higher electricity prices produce negative effects on economic activity, since one is paying a higher price for electricity without an increase in the value of that electricity. Prosperity and economic growth are dependent upon access to reliable and competitively-priced energy. Consumers will have limited opportunity to avoid these costs. For low income consumers, these higher electricity prices will force difficult choices between energy and other necessities such as such as clothing and shelter.

The offshore wind facilities also confer benefits in the form of the electricity produced, reduced consumption of fuel and reductions in pollution. The BPU should measure the costs and benefits of each project and approve those projects, if and only if, the benefits outweigh the costs.

Fortunately, the OWED Act calls for “a cost-benefit analysis for the project.” The analysis is required to include a detailed input-output analysis of the impact of the project on state economic variables with emphasis on employment, environmental impacts and effects of subsidies on state electricity ratepayers.[8]

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[7] Ibid.

[8] Ibid, 22.

In this report, the Beacon Hill Institute (BHI) estimates the cost and benefits of OWED legislation and its impact on the state economy. To that end, BHI applied its STAMP® models (State Tax Analysis Modeling Program) to estimate the economic effects of the state offshore wind OWED policy. Since specific offshore wind developers have not submitted detailed applications yet, we use a generic approach the uses cost estimated from the academic literature and findings from similar projects.

The Costs and Benefits

Any project both consumes and saves resources. These are the economic costs and benefits of the project, provided that they are priced appropriately. In the context of wind power projects, the economic costs to New Jersey include the cost of the wind turbines and support structures, installation costs, cost to connect the turbines to the electricity grid, operations and maintenance costs and decommissioning. In addition, offshore wind projects require preconstruction costs for submitting permit applications, project management and feasibility and environmental studies and public relations. There exist a wide variety of cost estimates for offshore wind power.

The Costs

The U.S. Department of Energy's Energy Information Administration (EIA) estimates that electricity from new offshore wind plants that are completed in 2016 will cost 24.32 cents per kilowatt hour (kWh) in 2008 dollars.[9] This figure is in line with the recently approved contract for Cape Wind off the cost of Massachusetts to sell half of its output to the utility national grid for 19.4 cents per kWh in 2016 with an annual increase of 3.5 percent. However, in the absence of federal and state tax credits the base price would increase to 23.5 cents per kWh.[10]

This compares with the average prices at the most recent DPU action which averaged 9.528 cents per KWh for residential and small businesses customer and a range of between 9.256

[9] U.S. Department of Energy, Energy Information Administration, *2016 Levelized Cost of New Generation Resources from the Annual Energy Outlook 2010* (2008/$MWh), http://www.eia.doe.gov/oiaf/aeo/electricity_generation.html (accessed April 10, 2011).

[10] *The Enterprise* Capenews.net "DPU Approves Cape Wind/National Grid Contract," November 26, 2010, http://www.capenews.net/communities/region/news/661 (accessed April 10, 2011)

cents and 12.894 cents per KWh for large commercial and industrial consumers.[11] This is a huge premium over current prices.

There are no exiting offshore wind plants in the United States today that we can use as a basis for our cost estimates. However, several European nations, such as Denmark and Great Britain, have many exiting offshore wind plants that can provide useful cost information for our analysis.

By far, the largest economic cost of the New Jersey Wind projects is the main investment in plant and equipment. We do not have direct information on this, and so, have pieced together estimates of the cost from a variety of sources, as set out in Table 1. We attach weights that reflect our judgment of the applicability of each estimate; and in our simulations, we assume that there is a 90 percent probability that the actual cost is at the level shown here, plus or minus 15 percent.

Based on the figures in Table 1, the total cost of the New Jersey wind projects will be $3,030 per kW of installed capacity (in 2011 dollars). This gives an estimated total cost of $4.601 billion.

Table 1: Total Investment Costs of Recent Offshore Wind Projects in Europe

Project name	In operation	Capacity MW	Investment € million	Investment per MW $ million	Weight (%)
Middelgrunden (DK)	2001	40	47	2.70	4
Horns Rev I (DK)	2002	160	272	2.92	16
Samsø (DK)	2003	23	30	2.19	2
North Hoyle (UK)	2003	60	121	3.38	6
Nysted (DK)	2004	165	248	2.46	17
Scroby Sands (UK)	2004	60	121	3.30	6
Kentich Flats (UK)	2005	90	159	2.82	9
Burbo Bank (UK)	2007	90	181	3.05	9
Lillgrunden (S)	2007	110	197	2.72	11
Robin Rigg (UK)	2008	180	492	4.05	18

[11] New Jersey Board of Public Utilities, "New Jersey Board of Public Utilities Approves Electricity Auction Results," February 9, 2011, http://www.state.nj.us/bpu/newsroom/news/pdf/20110209.pdf (accessed April 4, 2011).

The total investment costs listed in Table 2 encompass several components, including the cost of the turbines themselves, interconnecting the turbines and connecting them to the electricity grid, design, environmental studies and project management. All of these components of offshore wind projects contribute to a portion of the total investment costs. Two offshore wind projects in Denmark provide a breakout of the component costs relative to the overall costs. Table 2 shows the details.

In addition, we assume that the projects will have a useful life of 20 years and that at the end of the project it will cost $592,290 (in 2011 prices) to dismantle each of the towers, within a range of $80,000 (Long Island) and $670,000 (EIA). This number is based on an estimate of the cost of decommissioning in the UK, which put the cost at £275,000 per wind turbine generator (ODA 2007). However, data on decommissioning is unknown, since no offshore wind projects have been decommissioned yet.

Table 2: Share of Component Investment Costs for Offshore Wind Projects in Denmark

Cost Component	Share (per cent)
Turbines ex works, including transport and erection	49
Foundation	21
Transformer station and main cable to coast	16
Internal grid between turbines	5
Design and project management	6
Environmental analysis	3
Total	100

The operating and maintenance costs of wind plants are relatively low, when compared to plants that require fossil fuels, but they are by no means negligible. We assume that these costs are most likely to be equivalent to $59,700 per megawatt (1.8 cents per kilowatt hour) of installed capacity per year initially (in 2011 prices), but could be as low as $43,100 per megawatt, or 1.3 cents per kilowatt hour (Long Island) and could go as high as $76,300 per megawatt, 2.4 cents per kilowatt hour (EIA). We assume that, initially, two thirds of the operating and maintenance costs would consist of fixed costs, including operating a lift boat.[12] Over time the equipment is expected to degrade slowly, by 0.33 percent annually for the blades and 0.5 percent annually for the drive train. This would be corrected by major

[12] G.J.W Van Bussel,. and Chr. Schöntag. Undated. *Operation and Maintenance Aspects of Large Offshore Windfarms.*

rehabilitations of the drive train (every seven years) and the blades (every 10 years). Our assumptions imply that operating and maintenance costs would be about $65.68 million in 2017, the first full year of project operation and a time when the equipment would still be under warranty.

In addition to the cost of the project itself, there are costs related to the integration of wind power into the regional electricity grid. Since wind power is relatively unpredictable, other units must be available to provide power at very short notice ("regulation"), over a period of 10 minutes to several hours ("load following"), and over a period of several days ("load commitment"). This imposes fuel and operating costs on other operators to create reliability to accommodate wind power. Parsons et al. (2003) report integration costs of 0.21 cents/kWh; we apply a triangular distribution, with a peak of 0.21 cents/kWh (in 2011 prices) and a range of 0.11 to 0.32 cents/kWh. This is well below the figure of 0.74 cents/kWh that has been estimated as the grid integration cost in the UK that would result if a fifth of all electricity there were generated by wind power.

The Benefits

Set against these costs are the benefits, including the value of fuel saved, the reduction in spending on building generating capacity elsewhere, the health and other benefits of lower emissions, and greater energy independence.

Avoided Costs of Electricity

The first benefit of offshore wind projects is that they would reduce the need to generate electricity by other means. The main saving would be the ensuing reduction in fossil fuel use and capital expenditures.

To measure the amount of fossil fuel saved one must begin by determining how much electricity the projects would supply to the regional power grid. OWED calls for the installation of "at least" 1,100 MWs of headline capacity. However, as noted above, there are significant periods when wind plants do not produce electricity, which reduces the headline capacity to a lower rated capacity.

EIA estimates a capacity factor of 34 percent for both onshore and offshore wind.[13] In theory offshore wind should have a higher capacity factor than onshore wind, due to higher and more consistent wind speeds. However, the British Department of Energy and Climate Change reports a capacity factor of 33.7 percent, which confirms the EIA figure of 34 percent.[14] Moreover, using wind speed data from a 2004 feasibility study for New Jersey offshore wind, we calculate a capacity factor of 32.16 percent. We assume that in the first full year of operation, the wind plants are expected to deliver 3.276 million MWh of electricity to the grid, based on 1,100 MW of installed headline capacity.

The next step is to determine how much fossil fuel would be saved. Electricity from the wind projects would be fed into the mid Atlantic power grid. Since it is non-dispatchable, the grid would first take electricity from wind farms before turning to generating facilities that are further up the "bid stack" (i.e. have offered to supply electricity at non-zero prices). In moving up the bid stack, the grid operators, who run the regional grid, continue to add producers until demand is satisfied. The bid price of the last producer brought on line will then be the price paid to all producers by all purchasers. It follows that electricity from the wind farm will displace the "marginal" producers — in practice mainly those using coal, but also suppliers that use natural gas and oil.

We have assumed that the wind-generated electricity will displace fossil fuel, but not other renewable and nuclear energy. Nuclear energy provides base load generation and the state RPS mandates call for larger percentages of electricity to come from renewable sources. According to the 2010 State of the Market Report for PJM, the regional grid operator for the mid Atlantic area including New Jersey, the marginal electricity generation is as shown in Table 3, with a strong emphasis on coal (68 percent of the total) and natural gas (24 percent). The EIA projects no major planned retirements of natural gas or coal plants for the mid Atlantic area through 2035. At the margin, we believe that wind power will mainly displace coal and natural gas, and so we allocate fuel savings accordingly.[15]

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[13] U.S. Department of Energy, Energy Information Administration, *2016 Levelized Cost of New Generation Resources from the Annual Energy Outlook 2011*

[14] Department of Energy and Climate Change, United Kingdom, *Energy Trends* http://www.decc.gov.uk/en/content/cms/statistics/publications/trends/trends.aspx (accessed March 10, 2011).

[15] Monitoring Analytics, *2010 State of the Market Report for PJM* (March 10, 2011) 47 (http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2010/2010-som-pjm-volume2-sec2.pdf, (accessed March 2011).

Table 3: Fuel Mix for Marginal Generation, Mid Atlantic, 2009 (%)

Coal	68
Oil/Diesel	4
Natural gas	24
Renewable energy	4

Wind power is relatively unreliable, which is why it assumed that dispatchable backup generating capacity, roughly equivalent to the capacity of the wind power, is still needed, in case there is a time when the wind does not blow.

However, simulation evidence from wind farms elsewhere in the United States suggests that electricity systems typically need to maintain additional reserve capacity (spinning and non-spinning) of at most 20 percent of the rated capacity of the wind turbines, and possibly far less (Milligan 2001). This is because there is typically enough variability in the entire system to take up the slack when the turbines are becalmed.

In the case of the New Jersey projects there is another consideration: peak electricity demand in the region is in the summer, yet this is the time when the wind blows least. The capacity utilization of the wind turbines is estimated at 26.8 percent in July and 25.6 percent in August, compared to an annual average rate of 34 percent. This limits the amount of capacity that could be removed from the system when wind comes on stream. We assume that when the projects are operating, one could avoid building gas-powered plants to the extent of 26.2 percent of the rated capacity (this is the average capacity for July and August).

We project electricity prices – sourced from coal, residual fuel, and natural gas – through 2037 using an ARIMA (Auto Regressive, Integrated Moving Average) model. The appendix includes the details of the model and prices.

The savings from conventional sources of electricity will occur over the coming two decades; we compute the present value of the savings, as of 2011, by applying a (nominal) discount rate of 10 percent, which results in the total savings of $1,713 million listed in Table 1. By dividing this present value by the volume of electricity produced we obtain a measure of the "levelized cost" of fuel saved, which here comes to 2.6 cents/kWh of electricity produced by the wind projects.

Lower Emissions

When wind power reduces fossil fuel use, it also indirectly contributes to cleaner air through lower emissions of sulfur oxides (SO_x), nitrogen oxides (NO_x) and carbon dioxide (CO_2). The reduced emissions of CO_2 are believed to reduce the greenhouse effect and thereby moderate the effects of global warming, although the strength of these effects is a matter of considerable debate.

The main benefit of lower emissions of SO_x, NO_x and CO_2 is a reduction in human mortality and morbidity. It is not easy to put a dollar value on these effects, and so estimates vary widely. We use the numbers reported by Muller et al. and value CO_2 using the most recent futures auctions from the Regional Greenhouse Gas Initiative (RGGI) for New Jersey, or $2.04 per tonne of CO_2.[16]

However, coal is the largest marginal producer for the mid-Atlantic region, according to the market report for the PMJ. In this case, it is unclear that the use of renewable energy resources, especially wind, significantly reduces GHG emissions. Due to their intermittency, wind requires significant backup power sources that are cycled up and down to accommodate the variability in their production. As a result, a recent study found that wind power could actually increase pollution and greenhouse gas emissions when coal represents a large portion of the marginal electricity produced for New Jersey.[17] Thus the case for the heavy use of wind to generate "cleaner" electricity is undermined in terms of replacing coal.

Therefore, we assume that the resources used as the marginal producer will only reduce emissions for the portion of the marginal production from natural gas and oil and not from coal. Table 4 displays the calculations.

[16] Nicholas Z Muller and Robert Mendelsohn, 2009, "Efficient Pollution Regulation: Getting the Prices Right." *American Economic Review*, 99(5): 1714–39

[17] See "How Less Became More: Wind, Power and Unintended Consequences in the Colorado Energy Market," Bentek Energy, LLC. (Evergreen Colorado: May 2010).

Table 4: Emissions avoided due to Offshore Wind in New Jersey, 2017

	Emissions	Value of avoided emissions 2017 to 2037	
Gases	tonnes	$ per tonne	Total ($, million)
SO_2	5,740	970	1.253
NO_x	9,406	250	0.546
CO_2	8,376,403	2.04	4.043
Total			5.841

Note: All figures are in 2011 dollars unless otherwise noted. A tonne is a metric ton.
Sources: Muller, Nicholas Z., and Robert Mendelsohn. 2009. "Efficient Pollution Regulation: Getting the Prices Right." *American Economic Review*, 99(5): 1714–39, for the valuation per tonne.

The net result is that the present value of the reduction in emissions attributable to the New Jersey project would be $5.841 million annually, or about 0.2 cents/kWh. These numbers may seem modest, but they reflect the presumption that the wind power would mainly displace coal, which would need to be cycled and negate any emissions savings from the wind projects.

Benefit: Energy Independence

By using wind power, less oil would be used in the United States. Currently, 55 percent of the petroleum used in the country is imported, a figure that is expected to rise in the coming decades. This dependence on foreign oil has been blamed for some of the costs that the U.S. has incurred in the Middle East, particularly the Gulf War of 1991. However, petroleum represents only 0.5 percent (and declining) of current electricity production in New Jersey, and 4 percent of the marginal production in 2009. The vast majority of both electricity generation and marginal production are sourced from coal and natural gas, which are sourced within the United States. Therefore, we assign a zero value to energy independence for the New Jersey offshore wind program.

Adding together the benefits of fuel saved, avoided investment and emissions reduced, we get a total equivalent to 2.6 cents/kWh. The present value of the benefits is $1.548 billion, which is our measure of the benefit of the output of the wind projects.

The Net Cost- Benefit

Table 5 displays the results of our cost benefit analysis outlined above. The projects would produce a net cost of $3.245 billion dollars, which equals 4.2 cents per kWh. Using alternative estimates of the costs and benefits, the projects would produce a net cost of $2.106 billion to $4.137 billion for New Jersey. Based on these results, pursuing offshore wind project in New Jersey wastes scarce resources.

Table 5: Economic Costs and Benefits of the New Jersey Wind Project, (2011 $)

	Net Present Value		Cents/kWh
	Base	Range	
Benefits	*($ millions)*		
Avoided Cost of Electricity	1,548	1,494 - 1,932	2.4
Emissions reduced	6	3 – 10	0.2
Costs			
Project (site, investment, grid integration, operations and & maintenance, project management)	4,793	3,603 – 6,069	7.0
Benefits – Costs	(3,245)	(2,106) – (4,137)	(4.2)
Note: Totals may not add exactly, due to rounding errors.			

The Economic Impact

The economic impact of the offshore wind derives from the higher cost of the electricity produced and the investment and employment needed to build and maintain them. The higher cost of electricity for New Jersey's households and businesses will have a negative impact on the economy, similar to the current surge in gasoline prices. The projects will require substantial quantities of capital and labor for construction, operation and maintenance and ultimately the demolition of the turbines. The net economic impact sums the two opposing economic effects.

Electricity Rates

We estimate that the wind projects owners will need to receive an average electricity rate of 18.96 cents per kWh over the life of the project to be economically viable before federal and tax credits and subsidies. This figure is close to the Cape Wind contracted price of 19.4 cents per kWh. Once we factor in the federal and state tax credits and subsidies, our calculated electricity rate falls to 16.6 cents per kWh. This rate represents a premium of 5.73 cents per kWh, or 53 percent, over our forecasted average real retail electricity rate of 10.81 cents per kilowatt hour for 2017. However, since the projects will only produce 4 percent of New Jersey's electricity sales, we estimate that the projects will increase electricity prices by 2.1 percent in 2017. Using alternative cost estimates and assumptions, we estimate that offshore wind project could increase electricity prices in New Jersey between 0.5 percent and 4.2 percent in 2017. The appendix contains the details of our calculations and assumptions.

Table 6 shows how the OWED Act will affect the annual electricity bills of households and businesses in New Jersey. In 2017, the offshore projects will cost families on average $26, commercial businesses on average of $187 per year and industrial businesses $6,684. Between 2017 and 2036, the average household ratepayer will pay $431 in higher electricity costs; the average commercial ratepayer will spend an extra $3,054 and the average industrial ratepayer an extra $109,335.

Table 6: Effects of the OWED Act on Electricity Ratepayers (2011 $)

Cost in 2017	**Base**	**Range**
Electricity Price Increase (cents per kWh)	0.23	0.05 – 0.45
Percentage Increase	2.1	0.5 – 4.2
Residential Ratepayer	26	6 – 53
Commercial Ratepayer	187	44 – 374
Industrial Ratepayer	6,684	1,590 – 13,373
Total over period (2017-2036)		
Residential Ratepayer	431	9 – 987
Commercial Ratepayer	3,054	65 – 6,981
Industrial Ratepayer	109,335	2,329 – 249,880

One could justify the higher electricity costs if the environmental benefits, in terms of reduced emissions, outweighed the costs. As outlined above, it is unclear that the use of renewable energy resources, especially wind, significantly reduces emissions.

The Economic Impact

Our economic impact is based on the offshore projects totaling 1,100 MWs of headline electricity production rating as outline in the OWED Act that will come into service in 2017. Table 7 displays the results.

Table 7: The Economic Impact of the OWED Act on New Jersey (2011 $)

Economic Indicator	Base	Range
Net Employment (jobs)	(2,219)	(528) –(4,440)
Gross Wage Rates ($ per worker)	(111)	(26) – (222)
Investment ($ m)	(48)	(11) – (95)
Real Disposable Income ($ m)	(330)	(79) – (660)

The offshore wind electricity production and its mandated sale to New Jerseys ratepayers will reduce economic output in New Jersey. The state's ratepayers will face higher electricity prices which will increase the cost of living and doing business in the state. By 2017, New Jersey will employ 2,219 fewer workers than without the policy, within a range of 528 and 4,440 jobs lost. The decrease in labor demand — as seen in the job losses — will cause gross wages to fall. In 2020, New Jersey will see annual wages drop by $111 per worker, within a range of $26 and $222 per worker.

The job losses and price increases will reduce real incomes as firms, households and governments are forced to allocate more resources to purchase electricity and less to purchase other items. In 2017, annual real disposable income will fall by $330 million, within a range of $79 million and $660 million.

In 2017, net investment will fall by $48 million, within a range of $11 million and $95 million. The relatively moderate investment losses will be offset by the large investments required to build the offshore wind power plants, transmission lines and reconfigurations to the electricity grid. However, these investments are not as productive as the ones based on conventional energy because the renewable mandate works its way through the production methods less efficiently. A good analogy would be applying a mandate to telecommunications. The renewable mandate portion of the OWED Act is akin to requiring that a percent of all internet access to comprise of dial-up service over plain telephone service lines. Business would indeed be good for dial-up modem manufacturers and Internet Service Providers would need to retrofit their networks; but this investment would not increase productivity in the economy.

Conclusion

The rush by many states to impose renewable energy mandates is flawed. The policies promote certain forms of renewable energy — costly ones — at the expense of other, more affordable and dependable sources. New Jersey is no different.

The OWED Act was enacted with great promise of economic development and job creation for New Jersey. "Pass the law and they will come," to paraphrase the famous remark from the film Field of Dreams, is the prevailing attitude toward green energy. However, this dream faces some realities. With the exception of General Electric, the largest, and presumably the most productive wind turbine manufacturers are not located in New Jersey or even United States. If wind developers choose to purchase products from Vesta of Denmark or Siemens of Germany, how much will these projects boost investment and employment in New Jersey?

The OWED law mandates that a certain percentage of all electricity sales come from renewable sources, including offshore wind. However, offshore wind is more expensive than conventional energy and will drive up the costs of electricity for New Jersey's households and businesses. The higher electricity costs put the state's competitiveness at risk resulting in New Jersey seeing slower growth in the future, and falling behind current competitor states.

The law does require cost-benefit and economic analysis to be performed on all offshore wind projects before receiving approval. The evidence presented in this report shows that the costs exceed the benefits and the economic impacts are decidedly negative. The New Jersey DPU should carefully review the cost-benefit and economic impact analysis presented by potential wind developers. To ensure the project truly provides net benefits to the citizens and ratepayers of New Jersey, any such analysis should be subject to a peer review process.

Appendix

The Cost Benefit Assumptions

Table 8 lists the cost assumptions for New Jersey offshore wind projects. We used the weighted average and standard deviation ($3.03, $0.59 million respectively) of the total investment costs contained in Table 1 above. Using Crystal Ball forecasting software we applied a lognormal distribution to the weighted average and standard deviation and used a $2.0 location, the minimum value from Table 2. The lognormal distribution was used to account for the high potential not only for overruns in building at sea, but also to account for the very slight possibility of a catastrophic event, such as a hurricane, that could drive costs to extreme values. We ran 10,000 simulations to estimate 10 percent and 90 percent percentile values, or the $2.44 million and $3.82 million under low and high in Table 8. We then applied the percentages listed in Table 2 to the total investment values in order to estimate the underlying costs.

The process was repeated for operations and maintenance, decommissioning and grid integration costs, using normal distribution for operations and maintenance and decommissioning costs and a triangular distribution costs for grid integration.

Table 8: Cost Assumptions for Offshore Wind Projects per MW ($, millions)

	Low	Base	High
Total investment	2.44	3.03	3.82
Wind turbine	1.19	1.48	1.87
Installation	0.90	1.12	1.41
Interconnection	0.12	0.15	0.19
Environmental, regulatory, and permitting studies	0.07	0.09	0.11
Project management	0.15	0.18	0.23
Grid integration	0.001	0.002	0.003
Operation and maintenance (per year)	0.04	0.06	0.08
Decommissioning	0.08	0.59	0.67

Table 9 provides our estimates of average real retail electricity prices and sales in New Jersey for 2017 to 2037 using an ARIMA (Autoregressive, Integrated, Moving Average) model. For each series, we estimated a regression equation that extrapolates from historical data to predict the future. For each series (price and sales) we used the EIA forecast for the mid Atlantic region as an independent variable.

In estimating the regressions, we paid particular attention to the structure of the errors, in order to pick up the effects of seasonal, quarterly and monthly variations in tax collections. This was done by estimating the equations with autoregressive (AR) and moving average (MA) components. The number and nature of AR and MA lags was determined initially by examining the autocorrelation and partial correlation coefficients in the correlogram, and fine-tuned after examining the structure of the equation residuals.

Table 9: BHI Forecast of Retail Electricity Prices and Sales for New Jersey

Year	Average Retail Price (cents per kWh, 2011)			Annual Retail Sales (MWhs)
	Base	Low	High	
2017	10.81	10.35	13.39	83,459
2018	11.01	10.73	13.86	84,319
2019	10.87	10.71	13.81	85,180
2020	11.10	10.96	14.17	86,040
2021	11.42	10.98	14.16	86,900
2022	11.46	11.12	14.41	87,760
2023	11.64	11.15	14.49	88,620
2024	11.73	11.32	14.65	89,480
2025	11.64	11.38	14.76	90,340
2026	11.73	11.51	14.90	91,201
2027	11.86	11.57	14.97	92,061
2028	12.00	11.70	15.16	92,921
2029	12.41	11.75	15.23	93,781
2030	12.45	11.92	15.34	94,641
2031	12.68	11.98	15.49	95,501
2032	12.86	12.09	15.59	96,361
2033	13.01	12.16	15.69	97,221
2034	13.20	12.29	15.83	98,082
2035	13.25	12.33	15.97	98,942
2036	13.25	12.39	16.07	99,802
2037	13.25	12.52	16.22	100,662

Emissions

For the emissions calculations, we used the range of cost estimates for each type of emission listed in Table 10 (Mueller et al, 2009).

Table 10: Marginal Cost of Emissions

Gases	$ per metric ton		
	Base	Low	High
SO_2	970	550	1,300
NO_X	250	180	370
CO_2	2	1	4

Next, we estimated the emissions and generation by fuel type through 2037. We used EIA historic data for New Jersey and use the linear TREND function in EXCEL to forecast the electricity generation for each fuel type though 2037. The function Returns values along a linear trend by fitting a straight line - using least squares - to an arrays known y's (electricity generation by fuel) and known x's (year). Returns the y-values along that line for the array of new x's specified. Table 11 displays the results.

Table 11: Generation by Fuel Type (MWhs)

Year	Coal	Oil	Gas
2017	13,591,109	347,748	19,530,748
2018	13,771,084	342,418	19,742,517
2019	13,936,112	340,680	20,021,307
2020	14,284,537	336,547	20,239,961
2021	14,544,148	334,011	20,467,466
2022	14,806,425	330,411	20,970,872
2023	15,059,926	327,520	21,028,425
2024	15,344,227	324,156	21,135,129
2025	15,765,277	321,108	21,102,219
2026	16,115,965	317,849	20,998,284
2027	16,374,479	314,731	21,155,869
2028	16,438,636	311,519	21,552,771
2029	16,685,351	308,369	21,836,678
2030	16,955,938	305,178	22,085,977
2031	17,235,147	302,014	22,298,573
2032	17,520,550	298,832	22,491,348
2033	17,805,489	295,663	22,662,874
2034	18,081,025	292,485	22,825,674
2035	18,353,280	289,312	22,996,081
2036	18,624,110	286,136	23,161,588
2037	18,904,081	282,963	23,328,457

We used the same process to forecast the emissions produced for each fuel type except for oil.

For oil we used the TEND function to forecast the first year, and then held this level for the remainder to the period. Since electricity generation by oil has fallen in recent years due to the rising price, the TREND function would have produced zero emissions from oil relatively quickly. We believe this is unlikely to happen, and that as oil prices moderate over the period, electricity production from oil will level off and emissions will follow. Table 12 shows the results.

Table 12 Electric Power Industry Emissions Estimates by Fuel (Thousand Metric Tons)

	SO_2		NO_X			CO_2		
Year	coal	oil	coal	oil	gas	coal	Oil	gas
2017	49.22	0.65	14.10	1.00	3.38	11,053	153	9,051
2018	48.95	0.65	10.13	1.00	3.14	11,292	153	9,038
2019	48.69	0.65	9.51	1.00	0.70	11,456	153	9,081
2020	48.42	0.65	9.37	1.00	0.70	11,583	153	9,101
2021	48.15	0.65	9.01	1.00	0.70	11,431	153	9,114
2022	47.89	0.65	8.95	1.00	0.50	11,489	153	9,310
2023	47.62	0.65	8.76	1.00	0.50	11,584	153	9,273
2024	47.35	0.65	8.63	1.00	0.50	11,678	153	9,296
2025	47.08	0.65	8.91	1.00	0.50	11,737	153	9,193
2026	46.82	0.65	8.74	1.00	0.50	11,807	153	9,065
2027	46.55	0.65	8.17	1.00	0.50	11,891	153	9,020
2028	46.28	0.65	7.18	1.00	0.50	11,967	153	9,054
2029	46.01	0.65	6.61	1.00	0.50	12,024	153	9,104
2030	45.75	0.65	6.05	1.00	0.50	12,060	153	9,138
2031	45.48	0.65	5.50	1.00	0.50	12,114	153	9,156
2032	45.21	0.65	4.97	1.00	0.50	12,187	153	9,165
2033	44.95	0.65	4.49	1.00	0.50	12,280	153	9,165
2034	44.68	0.65	4.06	1.00	0.50	12,345	153	9,162
2035	44.41	0.65	3.72	1.00	0.50	12,406	153	9,164
2036	44.14	0.65	3.47	1.00	0.50	12,468	153	9,163
2037	43.88	0.65	3.36	1.00	0.50	12,532	153	9,157

Finally, we divided the electricity generation by fuel types by the emissions by fuel type to calculate our estimate of per metric ton of emissions for each MWh of electricity produced by each fuel type. Next, we multiplied the total annual MWhs of production from the offshore wind projects by the percentage of marginal production represented each fuel, by the emissions per MWh and by the cost estimate contained in Table 10. For example, for the cost of NOX that will not be produced by natural gas in 2017 due to offshore wind, we made the following calculation: 3,276,240 (MWhs of offshore Wind) X 24 percent (gas supplies the marginal electricity production) X $250 (per metric ton) X .00178 (metric tons of NOX emissions per MWh) = $34,057.

Ratepayer Effects

To calculate the effect of 1,100 MW offshore wind projects on electricity ratepayers, we used EIA data on the average monthly electricity consumption by type of customer: residential, commercial and industrial.[18] The monthly figures were multiplied by 12 to compute an annual figure. We inflated the 2008 figures for each year using the average annual increase in electricity sales over the entire period, or 0.97 percent per year.[19]

We calculated an annual per-kWh increase in electricity cost by dividing the total cost increase – calculated in the section above ─ by the total electricity sales for each year. We multiplied the per-kWh increase in electricity costs by the annual kWh consumption for each type of ratepayer for each year. For example, we expect the average residential ratepayer to consume 11,687 kWhs of electricity in 2017 and we expect the project to raise electricity costs by 0.2259 cents per kWh in the same year in our average cost case. Therefore, we expect residential ratepayers to pay an additional $26.40 in 2017.

Modeling the Policy Using STAMP

We simulated these changes in the STAMP model as a percentage price increase on electricity to measure the dynamic effects on the state economy. The model provides estimates of the proposals' impact on employment, wages and income. Each estimate represents the change that would take place in the indicated variable against a "baseline" assumption of the value that variable for a specified year in the absence of the offshore wind policy.

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[18] U.S. Department of Energy, Energy Information Administration, "Average electricity consumption per residence in MT in 2008," (January 2010) http://www.eia.doe.gov/cneaf/electricity/esr/table5.html, The 2008 consumption figures were inflated to 2010 using the increase in electricity demand from the EIA of 0.89 percent compound annual growth rate.

[19] U.S. Department of Energy, Energy Information Administration, *Annual Energy Outlook 2010*, "Table 8: Electricity Supply, Disposition, Prices, and Emissions," http://www.eia.doe.gov/oiaf/aeo/aeoref_tab.html. (accessed December 22, 2010).

Because the law requires New Jersey households and firms to use more expensive offshore wind power than they otherwise would have under a baseline scenario, the cost of goods and services will increase. These costs would typically manifest through higher utility bills for all sectors of the economy. Standard economic theory shows that a price increase of a good or service leads to a decrease in overall consumption, and consequently a decrease in the production of that good or service. As producer output falls, the decrease in production results in a lower demand for capital and labor.

BHI utilized its STAMP (State Tax Analysis Modeling Program) model to identify the economic effects and understand how they operate through a state's economy. STAMP is a five-year dynamic CGE (computable general equilibrium) model that has been programmed to simulate changes in taxes, costs (general and sector-specific) and other economic inputs. As such, it provides a mathematical description of the economic relationships among producers, households, governments and the rest of the world. It is general in the sense that it takes all the important markets, such as the capital and labor markets, and flows into account. It is an equilibrium model because it assumes that demand equals supply in every market (goods and services, labor and capital). This equilibrium is achieved by allowing prices to adjust within the model. It is computable because it can be used to generate numeric solutions to concrete policy and tax changes.[20]

In order to estimate the economic effects of offshore wind we used a compilation of six STAMP models to garner the average effects across various state economies: New York, North Carolina, Washington, Kansas, Indiana and Pennsylvania. These models represent a wide variety in terms of geographic dispersion (northeast, southeast, midwest, the plains and west) economic structure (industrial, high-tech, service and agricultural) and electricity sector makeup.

Using these three different utility price increases – 1 percent, 4.5 percent and 5.25 percent – we simulated each of the six STAMP models to determine what outcome these utility price increases would have on each of the six state's economy. We then averaged the percent

[20] For a clear introduction to CGE tax models, see John B. Shoven and John Whalley, "Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey," *Journal of Economic Literature* 22 (September, 1984): 1008. Shoven and Whalley have also written a useful book on the practice of CGE modeling entitled Applying General Equilibrium (Cambridge: Cambridge University Press, 1992).

changes together to determine what the average effect of the three utility increases. Table 13 displays these elasticities, which were then applied to the calculated percent change in electricity costs for the state of Ohio discussed above.

Table 13: Elasticities for the Economic Variables

Economic Variable	Elasticity
Employment	-0.022
Gross wage rates	-0.063
Investment	-0.018
Disposable Income	-0.022

We applied the elasticities to percentage increase in electricity price and then applied the result to New Jersey economic variables to determine the effect of the electricity price increases. These variables were gathered from the Bureau of Economic Analysis Regional and National Economic Accounts as well as the Bureau of Labor Statistics Current Employment Statistics.[21]

[21] See the following: Bureau of Economic Analysis, "National Economic Accounts," http://www.bea.gov/national/; Regional Economic Accounts, http://www.bea.gov/regional/index.htm. See also Bureau of Labor Statistics, "Current Employment Statistics ," http://www.bls.gov/ces/.

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