The Potential Economic Impact of an Off-Shore Wind Farm to the State of South Carolina

By

Roger J. Flynn[1] and Robert T. Carey[2]

[1] Doctoral Student in Policy Studies and Research Assistant, Strom Thurmond Institute of Government and Public Affairs

[2] Doctoral Student in Policy Studies and Research Associate, Strom Thurmond Institute of Government and Public Affairs

February 2007

THE STROM THURMOND INSTITUTE

CLEMSON UNIVERSITY SOUTH CAROLINA 1889

Executive Summary

Over the last two decades the demand for renewable energy has increased and in response the wind energy industry has grown by more than 30% annually. Recently, offshore wind power has emerged as a "new frontier" in wind energy, with more than 20,000 megawatts of new generating capacity planned for the waters off Northern Europe alone.[1] By the end of 2007, some projections suggest that the offshore renewable energy market may be worth as much as $12 billion.[2]

However, economic benefits are not the only reason for developing an offshore wind farm. If a 120 turbine wind farm with a maximum generation capacity of 480 MW were constructed off the coast of South Carolina it could provide enough energy to power more than 600,000 homes.[3] It would also prevent more than 1 million tons of greenhouse gases from being released into the air each year by conventional coal fired plants.

With the U.S. Census Bureau estimating that the combined population of FL, GA, SC and NC will increase by over 18 million by 2030, off-shore wind energy can help South Carolina and other Southeastern coastal states meet a growing demand for electricity in a clean and sustainable way while providing significant economic development to both the coastal and inland regions of the state. Wind energy would allow for energy production for regional consumers without greenhouse gas emission or consumption of exhaustible energy sources. Based on this analysis, there would be a number of beneficial economic and fiscal impacts to the State of South Carolina resulting from the manufacture, installation and operation of a 480 MW find farm (120 four megawatt wind turbine generators) off the coast of South Carolina.

Manufacturing and Installation Impacts over Two-Year Period

During the two-year construction phase the equivalent of up to 1,881 fulltime jobs will be created by direct, indirect and induced effects. Annual state economic output is predicted to increase by as much as $287 million, and annual disposable income is expected to increase by up to $93 million in the state. The fiscal effects resulting from the construction of an off-shore wind farm is predicted to be an increase in state income tax revenues of up to $2.8 million and an additional $190,000 in corporate income tax revenues over the two year period.

Operation Phase Impacts

During the operational phase of the project which begins in year three, predicted economic and fiscal impacts will result from the employment of workers to operate and maintain the power generation equipment, as well as from revenue generated by tourism of the off-shore wind farm. The analysis predicts that employment will permanently increase by the equivalent of up to 155 fulltime jobs over the currently predicted baseline. Annual state output is expected to increase by up to $15 million and disposable income by up to $7 million per year above baseline. Predicted fiscal impacts are an increase in state personal income tax revenues of up to $200,000 and corporate income tax revenues of up to $14,000 in each year. In addition, state could potential provide a revenue neutral production tax credit of up to $.84 cents per MWh.

---

[1] U.K. Department of Trade and Industry, Future Offshore: A Strategic Framework for the Offshore Wind Industry 15 (2002), available at http://www.dti.gov.uk/energy/leg and reg/consents/future offshore/FutureOffshore.pdf..

[2] Douglas-Westwood Ltd., The World Offshore Renewables Report: 2002 - 2007 2.2, 4.5.3 (2002) available at http://www.dti.gov.uk/energy/renewables/publications/pdfs/offshorereport.pdf; see also World Offshore Renewables Market Worth 8 Billion, at http://www.e4engineering.com/item.asp?ch=e4 home&type=News&id=46951.

Purpose of Study

Wind is an inexhaustible source of power. It allows for the production of electricity without the use of expensive and environmental damaging fossil fuels. It generates electricity without the emission of greenhouse gasses and it can create vast economic opportunities in not only local communities but state wide as well. The purpose of this analysis is to estimate the economic and fiscal impacts that would accrue to South Carolina during the manufacturing and installation phase and the operational phase of a 480 MW find farm (120 four megawatt wind turbine generators) off the coast of South Carolina.

The wind farm could be constructed far enough off shore thereby preventing interference with coastal vistas. The further away from land the wind farm is placed, the better wind resources will be. South Carolina's off shore region carries the advantage of relatively shallow water for some distance from shore. According to the University of Delaware Graduate College of Marine Studies, mounts for wind turbines can be constructed in waters as deep as 20 to 30 meters. Charts indicate that water depth off of the South Carolina coast is less than 18 meters within twenty miles of shore.[4] This provides ample space to take advantage of stronger winds further off shore than would be available to many Atlantic Coast states.

Employment

Developing South Carolina's off-shore wind energy potential will create jobs in component manufacturing, turbine installation, facility operation and maintenance, and in a variety of other areas which indirectly support these activities. Manufacturing requires skilled laborers who design and build the towers, rotor blades, generators, hubs, substation interconnects, and assorted electronic controls which make up a wind turbine power generating platform. Installation typically involves local construction firms that will help boost local economies. The operation and maintenance needs of a wind farm will create several permanent and high-quality local jobs.

Manufacturing

A majority of work involved in the construction of an off-shore wind farm goes into manufacturing the components, which include rotor blades, structural towers, hubs, gearboxes, generators, pylons and electronic controls, of an off-shore wind turbine generator. At this time, most of the manufacturing of specialized components will happen out-of-state, at least in the near term. Many of the world's major turbine manufacturers are based in Europe, and the U.S.-based industry is mostly in California. However, General Electric does have a presence within the state and is capable of developing and manufacturing off-shore wind turbine generators. The construction of a large off-shore wind farm off the coast of South Carolina could help attract renewable energy manufacturers into the state.

The creation of a Southeast wind energy market could bring additional manufacturing capability to the state and to the Southeast in general. For example, in Montana some current contracts for wind energy include offers to open wind-turbine manufacturing facilities in the state.[5] Denmark-based wind turbine manufacturer Vestas considered establishing its American headquarters just outside of Boulder, Colorado. Vestas originally cited Colorado's central location to the Midwest renewable

---

[4] University of Delaware Graduate College of Marine Studies. "US Atlantic Water Depth Map." University of Delaware, 2005, available at http://www.ocean.udel.edu/windpower/ResourceMap/index-depth.html

[5] Madsen, T., Bonin, S., and Barker, M. "Wind Energy: Powering Economic Development for Colorado." Colorado Public Research Foundation, November, 2003.

energy market as the major reason for consideration and encouraged the state to further develop and market its renewable energy resources.[6] According to Vestas, the facility would have employed at least 600 workers; however the firm eventually decided to locate its facility in Portland, Oregon. Although Vestas officials did not provide any justification for their decision, some possibilities could be Portland's access to port facilities, the economic incentive package offered by the city of Portland, support by state and local officials for the federal wind energy production tax credit, interest in wind development by local utilities, and because several large wind energy projects are currently being planned along the border between Washington and Oregon.[7]

In Greenville, South Carolina, General Electric's plant has 80 employees engaged in the manufacturing of wind turbine generators. These jobs were created in 2005 after GE ran out of space at its wind turbine plant in Pensacola, Florida. In 2005, GE also shifted its turbine business headquarters to Greenville from Schenectady, New York. Since then it has added 200 engineering jobs, bringing the total design and testing work force to around 1,000.[8]

Based on these facts, three models were created, each based on different assumptions as to the amount of in-state manufacturing of the various components that make up a wind turbine generator. Model I assumes that 10% or $50 million will be spent within the state to manufacture some components for the wind turbines. Model II assumes that 30% or $150 million will be spent in the state to manufacture several components of the wind turbine generator and that the assembly of the generators will occur within the state of South Carolina. However, Model III assumes that 100% or $500 million will be spent within the state to manufacture and assemble the wind turbine generators. If South Carolina and other southern states were to provide economic incentives in the form of tax credits and subsidies for renewable energy development, there is always the possibility that renewable energy manufactures would locate more of their facilities in the Southeast.

Installation

It is estimated that an off-shore wind farm requires up to 75 workers on site during construction. These workers assemble turbines, erect towers, construct pylons, and lay cable. The estimated time for construction for this project is 24 months. For land based wind farms, The Electric Power Research Institute estimates that every megawatt of wind energy capacity installed creates 0.5 year-long local installation jobs.[9] However, their estimates assume a 12 month installation phase and it includes workers used to construct roads and other structures that would not be needed for an off-shore wind farm.

Operation and Maintenance

Off-shore wind farms require a well trained staff to operate and routinely service the turbines throughout their 30-year lifetimes. These needs create long-term, full-time employment close to the port facility that would service the wind farm. The Electric Power Research Institute estimates that every 6.9 MW of capacity requires one full-time employee to operate, monitor, and service a land

---

[6] Lyne, J. "Denmark's Vestas Blowing Into Portland, Ore., Bringing 1200 Jobs," The Site Selection Online Insider, 29 April 2002, available at www.conway.com.

[7] Madsen, T., Bonin, S., and Barker, M. "Wind Energy: Powering Economic Development for Colorado." Colorado Public Research Foundation, November, 2003

[8] Duplesse, Jim. "GE's Greenville Plant Shifts Attention to Producing Wind Turbines as Demand for Other Products Ebbs." *The State*, (November 26, 2005).

[9] Simons, G. and Peterson, T. Electric Power Research Institute, "California Renewable Technology Market and Benefits Assessment," Report #1001193, November 2001.

based wind farm.[10] Since this analysis is based on a 480 MW off-shore wind farm, using the estimates from the Electric Power Research Institute would equate to 70 new jobs. The Cape Wind Project being developed off of Cape Cod, Massachusetts estimated that it would require 50 fulltime employees to operate and maintain that off-shore wind farm.[11] Since there is some variation in the estimated number of employees required to operate and maintain the off-shore wind farm, we ran three models with Model I assuming 50, Model II assuming 65 and Model III assuming 75 jobs for operation and maintenance.

Tourism

The construction and operation of an off-shore wind farm will probably not increase overall tourism in the state, however individual tourist sectors should benefit. Several reports have shown that wind farms across the globe have received significant interest from tourists. From Manitoba, Canada to Palm Springs, California, where 12,000 tourists visit each year, wind farms have seen the number of visitors requesting tours climb. A study done by MORI found that nearly 80% of those visiting Argyil, Scotland would be interested in visiting the local wind farm if tours were offered. In Denmark, one study found that tourism in areas near wind farms had increased by 25% after completion of the projects.[12] Although much of the debate has focused on presumed negative impacts of wind farms to tourism, there is evidence that positive impacts to the tourist industry are possible.

The model assumes that after construction is completed 5,000 tourists would visit the off-shore wind farm annually. The cost of the tourist activity was limited to the expected increase in demand for sightseeing by way of motorized water transportation. All other impacts to the coastal tourism industry would be negligible since we are assuming that the primary reason for visiting coastal South Carolina would not be the off-shore wind farm. It was assumed that the average cost of a sightseeing trip to the wind farm would be $100 per visitor or $500,000 annually.

Indirect Employment

The economic impact of building power plants extends well beyond the direct jobs created in building and installing the equipment. Each dollar invested creates impacts that ripple outwards throughout the local economy. For example, workers at a manufacturing plant need raw materials and equipment. Their work in assembling turbines supports jobs in equipment manufacturing and component supply. Contractors at a construction site need concrete and heavy equipment, and their work supports additional jobs supplying these needs. In addition, all of these new workers require housing, food and other necessities that will be purchased locally.

Model

In order to provide a more accurate picture of the potential impact of an off-shore wind farm to the state of South Carolina, three models were developed. Model I was developed to show the bottom range of the potential economic impact to the state. This model assumes that a vast majority of the individual components that make up a wind turbine generator would be built outside of the United States. Model II was developed to show the midrange economic impact to the state where

---

[10] Simons, G. and Peterson, T. Electric Power Research Institute, "California Renewable Technology Market and Benefits Assessment," Report #1001193

[11] Global Insight. "Economic Impact Analysis of the Cape Wind Off-Shore Renewable Energy Project," April 2, 2003.

[12] Golubcow, Molly. "Tourism That Blows." *Atlantic City Weekly* (August 9, 2006); "Manitoba's First Wind Farm a Tourism Hotspot." (July 24, 2006): www.mb.gov.ca.

collaboration occurs between an overseas manufacturer and a manufacturer located within the state of South Carolina. However, Model III was developed to show the potential economic impact when the wind turbine generators where entirely manufactured and assembled in the state of South Carolina. Another possible scenario is that since the state of South Carolina only has control of the first three miles of ocean floor, it might be more feasible to build a shallow water wind farm using 240, 1.8 megawatt WTG's rather than 120, 4 megawatt WTG's. This would exempt developers from seeking approval from federal agencies. Another benefit to a shallow wind farm would be that the General Electric facility in Greenville already produces 1.8 megawatt turbines and would only have to expand and modify its production capacity rather than completely retool its facility or build a new one. Since twice the number of 1.8 megawatt WTG's would be required to produce a comparable amount of energy, Model III assumes the same total cost of construction as the other models since per unit construction cost would be less in shallow water. The chart below shows the input values used in the model.

Inputs for Economic Impact Model for Offshore Wind Energy Development in South Carolina

Model I - Low	**INPUT**	**SECTOR**
TOURISM	$500,000 for Years 3 - 30	Scenic and Sightseeing Transportation, Water
CONSTRUCTION		
BASE	$75M for Year 1 and 2	Cement and Concrete Product Manufacturing
TURBINE	$25M for Year 2 and 2	Power and Turbine Equipment Manufacturing
ASSEMBLY	75 Jobs for Years 1 and 2	Industrial Non-building Structure Construction
MAINTANENCE	50 Jobs for Year 2-30	Commercial and Industrial Machinery Equipment Repair & Maint.
	$300K for replacement parts for Year 3-30	
Model II - Intermediate	**INPUT**	**SECTOR**
TOURISM	$500,000 for Years 3 - 30	Scenic and Sightseeing Transportation, Water
CONSTRUCTION		
BASE	$75M for Year 1 and 2	Cement and Concrete Product Manufacturing
TURBINE	$75M for Year 1 and 2	Power and Turbine Equipment Manufacturing
ASSEMBLY	75 Jobs for Years 1 and 2	Industrial Non-building Structure Construction
MAINTANENCE	65 Jobs for Year 2-30	Commercial and Industrial Machinery Equipment Repair & Maint.
	$900K for replacement parts for Year 3-30	
Model III - High	**INPUT**	**SECTOR**
TOURISM	$500,000 for Years 3 - 30	Scenic and Sightseeing Transportation, Water
CONSTRUCTION		
BASE	$75M for Year 1 and 2	Cement and Concrete Product Manufacturing
TURBINE	$225M for Year 1 and 2	Power and Turbine Equipment Manufacturing
ASSEMBLY	75 Jobs for Year 1 and 2	Industrial Non-building Structure Construction
MAINTANENCE	80 Jobs for Year 2-30	Commercial and Industrial Machinery Equipment Repair & Maint.
	$3M for replacement parts for Year 3-30	

Background

In 2004, a comprehensive review of off-shore wind farm costs found that the average cost per MW was roughly $2.3 million.[13] Therefore, based on costs estimates from 2004, a 480 MW wind farm is estimated to cost $1.1 billion. However, since the cost of wind energy has been steadily declining, the total cost of the project used for the purpose of this study way $700 million. Estimates suggest that the manufacturing and installation phase would take 24 months to complete. Both the installation phase and the maintenance and parts operations will be conducted out of a support facility located near

[13] "Development of Offshore Wind Energy In Europe." The Netherlands Ministry of Economic Affairs, (2004). Found at: http://www.senternovem.nl/mmfiles/137702_EU%20policy%20workshop%20Offshore%20Wind%20background%20document%5B1%5D_tcm24-121340.pdf.

a port in South Carolina. Based on other studies, we estimated that 3 maintenance teams would operate on a daily basis, with each team comprised of 9 maintenance personnel and 2 crew members. With the other various operational jobs that would be required, there would be a total of 50 full time employees.[14]

Economic Impacts During Manufacturing and Installation

The direct economic impacts to the state of South Carolina during the manufacturing and installation phase would consist of the hiring of workers and the purchase of non-labor goods and services. At this point it is difficult to determine exactly how many of the specialized components of the wind turbine generators would be purchased outside of the state. Other non-labor goods and services such as concrete, steel, and marine services more then likely would be purchased within the state of South Carolina. The temporary increase in economic activity within the state during the manufacturing and installation phase would be the sum of:

- direct economic impacts – hiring of workers and purchases of non-labor goods and services

- indirect effects – the additional demands for inputs from the industries that sell non-labor goods and services directly to the project

- induced effects – the increases in employment, income, and demand for other goods and services that would be generated by the expenditure of disposable income of the newly hired workers

The size of the temporary increase in economic activity in the state during the manufacturing and installation phase and during the operations phase would depend upon the proportion of direct expenditures that take place within the state. Once installation of the off-shore wind farm ends and the operations phase begins, the associated direct, indirect and induced economic effects would be permanent changes to the economy of South Carolina.

There will be two types of activities during the 24-month manufacture and installation phase:

- Manufacture of the blades and other wind turbine generator components in South Carolina before being transported to the project site. Studies have shown that a vast majority, nearly 80%, of the labor inputs required during the manufacturing and installation phase will be needed for manufacturing of the wind turbine generators.

- Installation of the wind turbine generators at the project site includes the installation of the undersea monopile foundations that will support the wind turbine generators; the on-site assembly of the wind turbine generators; the construction of the electric service platform; and installation of the offshore and onshore components of the transmission line that transport the electric power to the region's existing electric transmission and distribution system. About 20% of the labor inputs required during the manufacture and installation phase will be needed for installation activities.

[14] Global Insight. "Economic Impact Analysis of the Cape Wind Off-Shore Renewable Energy Project," April 2, 2003. The study that Global Insight performed for Cap Wind Associates is similar to the one conducted in this report. The total cost of the 130 turbine wind farm located off the coast of Cap Cod was estimated to be $700 million.

To estimate the temporary increase in economic activity during the manufacturing and installation phase, we used the REDYN input/output (I/O) model for South Carolina. This model was chosen because it enables the direct expenditures for labor and non-labor inputs to be allocated into specific economic sectors (NAICS codes). The appropriate final demand NAICS code sectors were identified for the purchases of the non-labor goods and services. The REDYN model produces multipliers for the total statewide increases in employment, output and income. The I/O model was used to determine the appropriate multiplier impacts at the state level.

The following impact assessment addresses both the manufacturing activities conducted onshore and the installation activities that will occur offshore during the first two (2) years of the project:

- Between 944 and 1,773 full-time jobs would be created in SC, with the range of the increase varying based on the value of non-labor purchases of goods and services made within SC.

- Total annual output in SC will increase by between $114 million and $287 million.

- Total annual disposable income will increase by between $42 million and $93 million. On a per-capita basis, disposable income will increase by approximately $10 to $21 per year.[15] This gain in income will generate an annual increase in SC personal income tax revenues of between $1.4 million and $2.8 million.

- Annual corporate income taxes would increase by between $8,000 and $14,000. However, general government revenue during the manufacturing and installation phase could range between $ 10.3 million and $20.9 million.

Employment Impact of an Off-shore Wind Farm to South Carolina

	Manufacturing and Installation		Operation and Tourism	
	Jobs	Annual Payroll Value	Jobs	Annual Payroll Value
Model I	939	$43 Million	99	$4 Million
Model II	1152	$55 Million	126	$5 Million
Model III	1789	$89 Million	159	$7 Million

Economic Impacts During Operation

Once the off-shore wind farm begins operation, it is estimated that between 50 and 75 new, permanent high paying jobs would be required. To maintain the off-shore wind farm, estimates show that up to $3 million annually would have to be spent for replacement parts, pylon repair and eventual overhauls of wind turbine generators that fail.[16] In addition to the employment of operations and

[15] Based upon U.S. Census Bureau population projections.
[16] "Development of Offshore Wind Energy In Europe." The Netherlands Ministry of Economic Affairs, (2004). Found at: http://www.senternovem.nl/mmfiles/137702_EU%20policy%20workshop%20Offshore%20Wind%20background%20

maintenance employees, local tourism should also experience a positive economic impact. The combination of the direct, indirect and induced effects as described above would generate the following permanent increases to the economy of South Carolina:

- Annual permanent increases, starting after completion of installation, of between 98 and 148 jobs, between $8.5 million and $13 million in output, and between $4 million and $6.1 million in labor income.

- The annual impact caused by tourism alone is estimated to be an increase in disposable income of $575,000, an increase in output of $980,000 and the creation of 10 new jobs.

- The annual increase in South Carolina personal income tax revenues would be between $120,000 and $181,000, while the rise in corporate income tax revenues would be between $8,000 and $13,000.

Total Economic and Fiscal Impact of an Off-shore Wind Farm to South Carolina

	Manufacturing and Installation			Operation and Tourism		
	Output (GSP)	Invididual Income Tax	Corporate Income Tax	Output (GSP)	Individual Income Tax	Corporate Income Tax
Model I	$236 M	$2.7 M	$181,000	$302 M	$4.2 M	$288,000
Model II	$320 M	$3.4 M	$229,000	$395 M	$5.4 M	$369,000
Model III	$567 M	$5.4 M	$369,000	$520 M	$6.9 M	$468,000

As the chart above demonstrates, in all three models the operation and tourism phase has a significantly larger fiscal impact then the manufacturing and installation phase. Only in Model III is the output during the manufacturing and installation phase greater than the output from the operation and tourism phase of the project. Given the estimated minimum that the state would receive in the form of state income tax and state sales tax revenue, spending at least $17.9 million to encourage the development of an off-shore wind farm would not be unjustifiable. However, if the majority of the wind turbine generators were built within the state of South Carolina, estimates suggests that state expenditures could increase to a minimum of $31.9 million. Based on this data, the state of South Carolina could offer a production tax credit of up to $.84 cents per MWh. However, revenue neutrality does not take into account the health and environmental benefits gained by the construction of an off-shore wind farm, therefore a larger production tax credit should be considered. The chart below shows the total potential federal and state tax credit that could be offered to a developer to construct an off-shore wind farm.

Potential State Tax Credit for the Development of an Off-shore Wind Farm

	Yearly Output	Average Yearly State Tax Revenue	Potential State Production Tax Credit	State Prduction Tax Credit	Federal Prouction Tax Credit ($19 mWh)	Total Potential Tax Credit
Model I	1261 GW	$596,667	$0.47	$17,900,000	$239,590,000	$257,490,000
Model II	1261 GW	$760,000	$0.60	$22,800,000	$239,590,000	$262,390,000
Model III	1261 GW	$1,063,333	$0.84	$31,900,000	$239,590,000	$271,490,000

document%5B1%5D_tcm24-121340.pdf.