CREATING THE CLEAN ENERGY ECONOMY

Analysis of the Offshore Wind Energy Industry

INTERNATIONAL
ECONOMIC DEVELOPMENT
COUNCIL

The Power of Knowledge and Leadership

Creating the Clean Energy Economy

Analysis of the Offshore Wind Energy Industry

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Acknowledgements

IEDC is grateful to the Rockefeller Brothers Fund for its generous support of this research project.

Special thanks Lauren Avioli, Emily Brown, and Patrick McHugh for research support, and Mishka Parkins, who provided technical assistance for the creative design of the report.

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Rockefeller Brothers Fund

This report was made possible by a grant from the Rockefeller Brothers Fund.

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INTRODUCTION TO OFFSHORE WIND ENERGY

Offshore wind power offers an inexhaustible energy source and, in the U.S., is located close to major population centers where demand for energy is highest. To date, this market has been insufficiently tapped. The U.S. has yet to produce a single megawatt (MW) of energy from an offshore wind source. The success of the domestic onshore wind industry foreshadows some of the potential of offshore wind.

This chapter hopes to spur action that will unlock this potential. The first section discusses the benefits of offshore wind energy in detail as well as hurdles to market development. The final section proposes tactics that can help overcome these hurdles.

The Importance of Offshore Wind Energy to Economic Development

There is evidence that offshore wind energy will create new jobs and economic investment. Offshore wind generates more jobs per megawatt than onshore wind and other fossil fuels due to the labor associated with manufacturing, operating, and servicing the wind farms. As the European Wind Energy Association (EWEA) states, the offshore wind industry has an "additional employment effect" due to the higher cost of installing, operating, and maintaining offshore wind turbines than land-based ones.[1]

It is also likely that offshore wind job creation will come at a time and to those places where it is particularly needed. As the U.S. Department of Energy (DOE) indicates, many of the jobs for the new offshore industry will potentially be located in economically depressed ports and shipyards. These locations will serve as fabrication and staging areas for manufacture, installation, and

1 European Wind Energy Association. (2009, January). Wind at Work: Wind energy and job creation in the EU, p. 22. Retrieved from: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/Wind_at_work_FINAL.pdf

maintenance of offshore wind turbines.[2] These areas can particularly stand to gain jobs in a new offshore wind industry, since they have experienced a double blow from the downturn in manufacturing and the recent recession.

Summary of Hurdles and Solutions

The development of offshore wind energy is not without significant hurdles. Hurdles can be grouped under four categories. Supply-side hurdles are related to the high capital, operating, and financing costs of offshore wind projects. This creates a demand-side hurdle in which high costs are passed on to the purchaser of the offshore wind energy, thereby reducing demand. In addition, there are regulatory and policy hurdles due to the lengthy and complicated permitting process for offshore wind projects. Larger political hurdles surround the future of energy policy and government subsidies in the midst of economic recovery.

Yet, these hurdles can be tackled over time through a coordinated strategy and action by multiple stakeholders. Section 3 of this report discusses in detail the strategies that economic developers can pursue to engage these stakeholders and kick start the offshore wind energy market. The table below presents a brief summary of the primary hurdles to offshore wind energy and their potential solutions.

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[2] U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*, Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf.

Hurdles to Development and Solutions			
Supply-side	**Demand-side**	**Regulatory and policy**	**Political**
1) Invest in turbine R&D (such as incubator) 2) Assist in regional grid planning 3) Identify synergies with existing industries (i.e. oil and marine-based) 4) Create stimulus for ship-building 5) Support financing streams for investors 6) Identify/retool existing businesses in supply chain 7) Provide workforce training with local partners 8) Attract FDI and forge foreign partnerships	1) Support "carve-outs" for offshore wind 2) Structure incentives in RPS 3) Provide production incentives (i.e. ITC) 4) Establish government procurement program	1) Streamline the approval process 2) Improve coordinated review 3) Support tax credit programs	1) Align communication strategies 2) Use proactive growth strategies in a recession 3) Engage and respond to opposition stakeholders 4) Public education to garner understanding and support for offshore wind

JOB CREATION POTENTIAL OF OFFSHORE WIND ENERGY

Table 1 summarizes some of the most widely referenced projections for job growth in the offshore wind industry in Europe and the United States through 2020 and/or through 2030. No doubt, job projection numbers vary and are always being updated. Therefore a primary purpose of Table 1 is to show the range of projections by industry expert, thereby establishing a barometer for the employment potential of the industry and a benchmark for analysis.

Table 1: Economic Development and Job Creation Projections in Europe and the United States

Place	Source	# of Jobs	Capacity	Jobs/ MW	By Year
Europe	EWEA 2009	215,637	300GW	7	2030
Europe	EWEA 2011	169,500	40GW	42	2020
Europe	EWEA 2011	300,000	150GW	20	2030
United Kingdom	Institute for Public Policy Research 2009	70,000	32GW	22	2020
United Kingdom	renewableUK 2011	45,000	18GW	25	2020
United Kingdom	Carbon Trust 2008	40,000-70,000	29GW	14-24	2020
United Kingdom	SQW Energy 2008, Institute for Public Policy Research 2009	23,000	N/A	N/A	2020
Germany – North Coast	Various secondary sources	30,000	12GW	25	2030
USA	Department of Energy 2011	43,000	54GW	8	2030
USA – Atlantic Coast	Department of Energy 2012	1,500-7,500	200 MW/yr - 1GW/yr	N/A	2020
USA – Mid-Atlantic Region	IHS Inc./Atlantic Wind Connection	17,000	7 GW	N/A	2026
Lake Erie, Ohio	LEEDCO/Nortech 2010	8,000	5GW	16	2030
Maine Deepwater Plan	The University of Maine 2011	7,000-15,000	5GW	14	2030

Sources: [3,4,5,6,7,8,9,10,11,12,13,14,15,16,17]

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[3] European Wind Energy Association. (2009, January). *Wind at Work: Wind energy and job creation in the EU*. Retrieved from: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/Wind_at_work_FINAL.pdf

Job Projections by Classification

Job creation studies utilize different methods of measurement for jobs and disaggregate jobs into different categories and classifications. The most common measurements and classifications that will be discussed below are as follows:

- Direct/indirect,
- Permanent/temporary,
- Jobs/job-years, and
- Sector/occupation.

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[4] European Wind Energy Association (2011). *Wind in our Sails*. Retrieved from European Wind Energy Association website: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/23420_Offshore_report_web.pdf

[5] Ibid.

[6] Bird, Jenny. (2009) *Green Jobs: Prospects for Creating Jobs From Offshore Wind in the UK. Institute for Public Policy Research*. Retrieved from: http://www.ippr.org/images/media/files/publication/2011/05/green_jobs_1686.pdf

[7] Willow, Christopher & Valpy, Bruce. (2011 June). *Offshore Wind: Forecasts of future costs and benefits*, p. 8. Retrieved from RenewableUK website: http://www.bwea.com/pdf/publications/Offshore_report.pdf

[8] Carbon Trust (2008). *Offshore wind power: big challenge, big opportunity*. London: Carbon Trust.

[9] SQW Energy (2008). *Today's investment-tomorrows asset: skills and employment in the Wind, Wave and Tidal Sectors*. Report to the British Wind Energy Association. Retrieved from: http://www.bwea.com/pdf/publications/BWEA%20Skills%20Report%20FINAL%2016oct.pdf

[10] German Delegate . (2011, January). Ocean Energy: Germany. *Ocean Energy Systems: An IEA Technology Initiative*. Retrieved from: http://www.ocean-energy-systems.org/country-info/germany/

[11] "Germany OKs Huge Offshore Wind Farms." (2009, September 21). Bloomberg Businessweek. Retrieved from: http://www.businessweek.com/globalbiz/content/sep2009/gb20090921_980817.htm

[12] AFP. (2009, September 16). "Germany paves way to offshore wind farms." Retrieved from: http://www.google.com/hostednews/afp/article/ALeqM5hq9p69qXzm9itlHk81grGxnV_Kfw

[13] .S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*. (NREL/TP-500-40745). Retrieved from: www.**nrel**.gov/**wind**/pdfs/40745.pdf.

[14] Hamilton, B., Lantz, E. & Paidipati, J. (2012). *Offshore Wind Jobs and Economic Development Potential*. National Renewable Energy Laboratory. Retrieved from http://usoffshorewind.org/wp-content/uploads/2012/05/USOWC-Offshore-JEDI-Webinar.pdf

[15] IHS Inc. (2012, February). *Assessment of the Economic Benefits of Offshore Wind in the Mid-Atlantic* [Powerpoint]. Atlantic Grid Development. Retrieved from http://www.atlanticwindconnection.com/ferc/Oct2012/IHS_Study_AWC_EI_Review_MidAtlantic.pdf

[16] Elston, Susan et al. (2011, February 23). *Offshore Wind Feasibility Study*, p. I-3-I-5. University of Maine and James W. Sewall Company. Retrieved from: http://www.deepcwind.org/offshorewindreport

[17] Kleinmhenz, Jack and Smith, Russ. (2010, July). *The Potential Economic Impacts in Ohio Associated with the Emergence of a Lake Erie Offshore Wind Industry*. Retrieved from Nortech website: http://www.nortech.org/images/stories/_pdf/LEEDCo_Economic_Impact_Study_FINAL.pdf.

Direct and Indirect Jobs

It is not always clear if projections of jobs include direct and indirect jobs and how indirect jobs are measured. The most widely referenced job study (and the one on which U.S. projections are based) is the 2009 EWEA job projection, which includes direct and indirect jobs.[18] In that report, 151,000 jobs are projected for the offshore wind industry in Europe by 2020 and 215,000 by 2030.

However, the 2009 EWEA report only gives a breakdown for the share of indirect and direct jobs for the wind industry at-large, inclusive of offshore and onshore both in 2007. Of the 151,300 wind industry jobs in 2007, 108,600 jobs (72%) are direct and 42,700 jobs (28%) are indirect. If it is assumed that the direct-indirect jobs breakdown is similar for offshore wind as for the entire wind industry, applying the 28% share to the 215,000 jobs projected for Europe by 2030 yields 154,000 direct jobs and 61,000 indirect jobs in offshore wind. The indirect jobs all come from manufacturing and installation in the EWEA study referenced above and not from installation, O&M, or other areas.

One could also apply this percentage to job projections in the U.S. However, this extrapolation is subject to differences between offshore and land-based job demands as well as between Europe and the U.S. Still, the bottom line is that the U.S. job projection figures, being based on the European projection from EWEA, may very well include a share of indirect jobs (though this is not discussed explicitly in the study)

Permanent and Temporary Jobs

The job projections in Table 1 are assumed to be permanent jobs. For example, the 43,000 jobs projected for the U.S. offshore wind industry by 2030 is explicitly defined as a measure of permanent jobs. This job projection was based on the EWEA 2009 study, so it is assumed that likewise the figures for Europe are for permanent jobs.

In the cases where projections are for permanent jobs, there might be an undercount of employment effects. There could be additional temporary job creation for construction and other

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[18] European Wind Energy Association. (2009, January). *Wind at Work: Wind energy and job creation in the EU.* Retrieved from: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/Wind_at_work_FINAL.pdf

short-term jobs. In fact, the ratio of temporary construction jobs to permanent jobs may be high. For example, the economic impact study for Cape Wind projects 1,000 jobs during construction and permanent employment of about 50 people at the Cape Cod-based headquarters to operate and maintain the wind farm. However, it does not say what the build-out period is for construction. The study conducted for the Lake Erie project north of Cleveland Ohio projects job creation over the whole time period from 2012 through 2030, and it shows a peak at 2027. The maximum jobs throughout the duration of the time period are in construction, however, indicating that construction jobs extend well beyond initial installation.

Jobs and Job Years

It is also important to note whether or not the figures being quoted refer to jobs or "job years." The unit of "job year" refers to one year in one job, so the estimate of 10 job years could mean 10 one-year positions, 5 two-year positions, or 1 ten-year job position. The metric of "job-year" is becoming more and more widely used when analyzing job projections for future projects. It was used by the White House in preparing projections for employment that would result from the 2009 ARRA stimulus bill. The effect can be to give the impression of a larger number of permanent jobs being created than is the actual case. For Table 1, it is assumed that all the job projections are for jobs and not job-years.[19] However, there are some projections for job-years as well. For example, the U.S. Department of Energy projects 43,000 permanent jobs, or more than 1.1 million job-years, associated with meeting its goal of 54 GW of offshore wind production.[20]

Jobs by Sector and Skill

Table 2 shows the findings of a study by Carbon Trust for offshore wind job creation in the United Kingdom. This includes a breakdown of jobs by company type, where employment is listed in number of jobs and in percentage of total jobs. The high projection of 70,000 jobs for the UK by 2020 is the figure most commonly cited by supporters of the offshore industry. This figure assumes a "proactive manufacturing strategy" that retains or attracts a large share of turbine and turbine-component manufacturing in the UK and also transfers a large share of jobs from the oil and gas industry.

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[19] http://www.whitehouse.gov/administration/eop/cea/Estimate-of-Job-Creation/
[20] Ibid, p. 7.

Installation and operating and maintenance (O&M) ranks as the second highest source of jobs in the low projection. O&M includes indirect jobs related to the installation and construction of turbines, foundations substations, and electrical grid connections. The offshore industry has a greater supply of jobs required for installation, operation and maintenance than the onshore wind industry due to the technology and infrastructure associated with operations based in the water.

Manufacturing jobs account for a higher share of employment in onshore wind than for offshore wind, because O&M for offshore is generally more expensive. In the high scenario, the highest share of jobs comes from Installation and O&M, which surpasses services. This indicates that variability in the offshore industry, in terms of employment as well as costs, comes from Installation and O&M. The study done for the project in the Great Lakes north of Cleveland also produced similar results.

Table 2: Job Creation by Company Type. Breakdown of Offshore Jobs in the United Kingdom by 2020 by Category

Company Type	Low Projection		High Projection	
R&D, engineering and design	3,000	8%	4,000	6%
Turbine and component manufacturing	7,000	18%	15,000	21%
Installation and Operations and Maintenance (O&M)	8,000	20%	29,000	41%
Services	22,000	55%	22,000	31%
Total	**40,000**		**70,000**	

Source: Carbon Trust[21]

There are multiple job profiles and occupations associated with each type of company. Table 3 provides a list of representative job profiles based on company type for both the onshore and offshore wind industries. The list is by no means exhaustive, but does provide a point of reference for the skills needed.

Europe has experienced a shortage of high-skill workers in the offshore wind industry, such as engineers and project managers. One of the main bottlenecks in Europe is the shortage of adequate vessels to service offshore wind farms, and with multiple wind farms scheduled to go on-line in the short term, this will become more of a problem. The problem is compounded in the

[21] Carbon Trust (2008). *Offshore wind power: big challenge, big opportunity. P. 74*. London: Carbon Trust.

U.S., where even the available ships that service Europe may be ineligible to service U.S. wind farms since they do not comply with the Jones Act (see case study on "Shipbuilding and the Jones Act"). As a result, there is a major shortage of vessels in the U.S.

Table 3: Representative Company Types and Job Profiles of Offshore Wind Industry

Company Type	Field of Activity	Skilled	Semi-Skilled	Un-skilled	Representative Job Profiles
Planning and Development	Management	X			Economists, Engineers, Lawyers, Meteorologists Project managers
Design and Manufacturing	Wind Turbine and Turbine component producers	X	X		Engineers, Health and Safety Experts Iron Workers, Metal Workers, Millwrights,
Construction and Installation	Building the Wind Farm	X	X	X	Electricians, Engineers, Health and Safety Experts, Iron workers, Marine Operators, Painters, Pile drivers
Operations and Maintenance and Repair	Regular Inspection, Operations and Repair	X	X	X	Crane operators, Electricians, Iron workers, Longshoremen, Marine Operators, Painters
Technical, Financial and Legal Expertise	Diverse Specialized Professional Activities	X			Engineers, Lawyers, Meteorologists, Policy Experts, Programmers, Support Staff
Ship Building and Retrofitting	Specialized, Jones-Compliant Vessels for Installation/Repair	X	X	X	Engineers, Maritime Operators, Ship Building Construction Trades, Support Staff

Source: [22,23]

[22] European Wind Energy Association. (2009, January). *Wind at Work: Wind energy and job creation in the EU.* Retrieved from: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/Wind_at_work_FINAL.pdf
[23] Gerard Dhooge, President, Maritime Trade Council, (personal communication, December 6, 2011)

U.S. Projections in Detail

The U.S. Department of Energy estimates that in addition to the 43,000 permanent O&M jobs, the target 54 GW of offshore wind production would require more than 1.1 million job-years to manufacture and install the turbines.[24] Reaching the target is also expected to generate an estimated $200 billion in new economic activity.[25] This calculation is based on a factor of more than 20 jobs for each MW of new offshore wind, as extrapolated from a EWEA 2009 report.[26] However, it should be noted that EWEA has revised its projection for MW, total jobs and jobs per MW by 2030 in its more recent 2011 publication, which could affect U.S. estimates updated in the future.

Some individual projects in the U.S. have conducted studies providing job projections. Lake Erie Energy Development Corporation (LEEDCo) is undertaking the development of a 5,000 MW wind farm in the waters north of Cleveland, Ohio. The stakeholders believe it could be a strong generator of jobs, partially due to the existing port infrastructure and supply chain capacities from the area's onshore wind industry. By the time the wind farm is online, they project that 8,000 jobs will have been created. In Maine, the Deepwater Offshore Wind Plan is projected to generate 7,000 to 15,000 jobs.

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[24] Ibid, p. 7.

[25] U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*, p. 7. Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf on July 20, 2011.

[26] Ibid

THE STATE OF THE U.S. OFFSHORE WIND MARKET

Current Market Development: Delayed Takeoff

The offshore wind industry in the United States is in the developmental stages. Projects are not yet "in the water" (under construction) nor are they "on-line" (producing energy output). Some date the emergence of the U.S. industry to November 15, 2001, when Cape Wind Associates filed its first permit application for an offshore wind project off the coast of Cape Cod, Massachusetts. In October 2010, Cape Wind received its lease from the federal government—another important milestone in the development of the industry. As of mid 2013, Cape Wind is currently in the project financing phase, with construction slated to begin at the end of the year.

But the process of development has continued to be frustrating for wind-farm developers, economic developers, clean energy advocates, and a host of stakeholders in the industry. While offshore wind generates energy in Europe and China, it has yet to be generated off U.S. coastal waters, despite a growing demand for clean energy, a strong supply of wind resources, and a line of projects in the pipeline. Development has been hampered by high capital costs, permitting, financing, policy, and the inability to find buyers for the energy, which is priced high above fossil fuels and other clean energies. Perhaps the most urgent hurdle is procurement, as there is a noted disconnect between the lease-sale process and the market process. Still, stakeholders remain vested in various attempts to create and stabilize conditions for takeoff. If the domestic land-based industry is any example, the U.S. has the potential to lead the world in offshore wind as well.

Based on examples from Europe and assessments of opportunity in the U.S., the offshore wind industry has the potential to bring in substantial jobs and investment. [27], [28], [29], [30] It is projected to

[27] U.S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*. (NREL/TP-500-40745). Retrieved from www.nrel.gov/wind/pdfs/40745.pdf on July 20, 2011
[28] Pollin, Robert, Heintz, James and Heidi Garrett-Peltier. (2009, June). *The Economic Benefits of Investing in Clean Energy: How the Economic stimulus program and new legislation can boost U.S. economic growth and investment*. Retrieved from Political Economy Research Institute website: http://www.peri.umass.edu/fileadmin/pdf/other_publication_types/green_economics/economic_benefits/economic_benefits.PDF

create more jobs than onshore wind per unit of energy production, due to the higher costs of manufacturing and maintaining a wind farm in a marine environment. Further, in the long term, offshore wind represents an even more productive and constant clean energy source. Winds from off the coast blow more strongly and steady than land-based winds. The following sections examine the offshore wind market in more detail.

Factors Influencing the Growth of U.S. Market

Demand-Side Factors: Economic, Security, and Environmental

Despite a lack of offshore wind power currently online, the federal government has an ambitious goal. Under President George W. Bush, the Department of Energy set a "20% Wind Energy by 2030" goal in July 2008.[31] President Obama has reiterated this goal.[32] The Department of Energy's *20% Wind Energy by 2030* report provided a scenario under which the U.S. would generate 20% of its electricity from wind with offshore wind contributing 54 GW (54,000 MW).[33] In order to meet this goal for offshore wind, the Department of Energy has detailed an "OSWInD" strategy for offshore wind. The strategy calls for an interim deployment of 10GW of capacity by 2020 at a cost of energy of $0.10/kWh en route to meeting the total production goal of 54GW by 2030 at a cost of $0.07kWh.[34]

Offshore wind farms could provide a significant energy source to meet the energy demands of population centers up and down the Atlantic seaboard. The U.S. Energy Information Administration (EIA) projected electricity consumption to grow at a rate of 1.1%.[35] Most domestic

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29 Kleinhenz & Associates. (2010, July). *The Potential Economic Impacts in Ohio Associated with the Emergence of a Lake Erie Offshore Wind Industry*. Retrieved from: http://www.nortech.org/images/stories/_pdf/LEEDCo_Economic_Impact_Study_FINAL.pdf.

30 European Wind Energy Association (2007, December). *Delivering Offshore Wind Power in Europe*. Retrieved from: http://www.ewea.org/fileadmin/ewea_documents/images/publications/offshore_report/ewea-offshore_report.pdf.

31 U.S. Department of Energy, National Renewable Energy Laboratory. (2008, July) *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply*. (NREL/TP-500-41869). Retrieved from: http://www.nrel.gov/docs/fy08osti/41869.pdf.

32 White House Office of the Press Secretary. (2011, January 25). *Remarks by the President in 2011 State of the Union Address*. Retrieved from White House website: www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address/

33 U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States,* Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf.

34 Ibid, p. iii.

35 US Offshore Wind Collaborative. (2009, October). *U.S. Offshore Wind Energy: A Path Forward*. Retrieved from: http://www.usowc.org/

energy consumption occurs in the 26 states that have high coastal winds, including the dense region of the Northeast.[36]

Clean energy sources, including offshore wind, are oftentimes more expensive per energy unit than fossil fuels. Fluctuating commodity prices, supply chain inefficiencies, and a trend toward larger and larger turbines are currently pushing up offshore wind costs in places like Europe. Utilities and the consumers that they serve demand cheap energy sources and oppose increases to their utility bills. As a result, states have found they must play a role in the market and mandate that utilities produce a percentage of their energy from clean energy sources through the introduction of renewable production standards (RPS). Offshore wind is an attractive alternative particularly for regions like the Northeast. The Northeast does not have as plentiful a supply of solar energy as other regions of the country, and it also may face obstacles to land-based wind development, such as a lack of open land for new transmission lines.

However, RPS's may not be sufficient to develop offshore wind due to the high costs of development.[37] States are exploring added incentives targeted at offshore wind such as "carve-outs" and RPS multipliers (see discussion in Policy Tools section.)

Supply-Side Factors: Ample but Constrained

The U.S. absence from the offshore wind market is striking considering that in 2008 and 2009, it was the top worldwide producer of onshore wind energy (losing the top spot to China in 2010.)[38] By the end of 2010, the U.S. onshore wind industry had reached 40,181 MW of total installed capacity with projects located in 38 states.[39] The U.S. onshore wind industry has a far-reaching supply of businesses and workers, including 400 manufacturing facilities employing about 20,000

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[36] U.S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*, p. 2. (NREL/TP-500-40745). Retrieved from www.nrel.gov/wind/pdfs/40745.pdf on July 20, 2011

[37] Inwood, S. (2011, June). *Program on Technology Innovation: Integrated Generation Technology Options,* pp. I-11, Retrieved from Electric Power Research Institute website: http://rfflibrary.wordpress.com/2011/07/30/program-on-technology-innovation-integrated-generation-technology-options/.

[38] Asmus, Peter. (2011, June 1). Which State Will Lead With First Installed Offshore Wind Project in the U.S.? *Pike Research Blog Articles*: Retrieved from http://www.pikeresearch.com/blog/articles/which-state-will-lead-with-first-installed-offshore-wind-project-in-the-u-s.

[39] AWEA. (2011). *AWEA U.S. Wind Industry Annual Market Report*. Forward.

workers.[40, 41] Additionally, about 50 percent of the content for turbines installed on U.S. soil is from domestic suppliers, though some sources have indicated that this percentage has declined.[42]

The strong position of the U.S. in the onshore wind market should help with development of the offshore wind industry. One advantage is that the industries share many of the same businesses in their supply chains. This is particularly true for the Great Lakes and Gulf Coast regions, where the land-based industry is especially strong. However, developing wind farms for the marine environment requires specialized skills, technology, and equipment. Retooling and retraining is necessary, and these will be discussed in the Domestic Manufacturing section of this report.

Two of the most important obstacles to offshore development are permitting and obtaining a purchaser for the energy. These two obstacles are related to other hurdles hindering development, including financing and opposition by stakeholders. It is estimated that it now takes an average of seven to ten years for a project to be permitted.[43] There are multiple agencies with different and sometimes overlapping jurisdictions conducting the permitting. The first project to initiate the permitting process was the Cape Wind project, which submitted its first application in November, 2001 and was awarded a lease by the Department of Interior in October 2010.[44]

Beyond permitting, the additional challenge is finding purchasers for the wattage. This is emerging as the more intractable barrier to the domestic offshore wind industry. Energy produced by offshore wind farms is currently priced higher than energy from land-based wind farms. Offshore wind is also priced higher than other fossil fuels, including coal, oil, and natural gas, which are used to produce the majority of electricity in the U.S. Table 4 shows estimates from the Electric Power Research Institute (EPRI) for the levelized cost of energy in 2015 for various energy sources. The levelized cost of energy is the annual cost of recovering the total capital costs plus

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[40] Ibid, p. 36.
[41] Ibid.
[42] Ibid, Forward.
[43] U.S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*. (NREL/TP-500-40745). Retrieved from www.nrel.gov/wind/pdfs/40745.pdf.
[44] U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*, p. 17. Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf

recurring costs such as operations, maintenance and royalty payments divided by the annual expected output.[45]

Table 4: Levelized Cost of Energy, $/KWh (in constant Dec. 2010 $)

Coal(1)	$.054-$.073
Natural Gas	$.049-$.079
Nuclear	$.076-$.087
Wind: Onshore	$.075-$.138
Wind: Offshore	$.130-$.159
Solar: Concentrating Solar Thermal (CST)	$.151-$.195
Solar: Photovoltaic (PV)	$.242-$.455

Source: Electric Power Research Institute (EPRI)[46]

As aforementioned, the federal government's National Offshore Wind Strategy aims to produce offshore energy at a substantially lower price of 7 cents/kWh in 2030. The interim scenario is to produce at a cost of 10 cents/kWh by 2020.[47]

Domestic Manufacturing and Production Potential

Domestic Wind Resources

The good news is that there is significant energy-generating potential from offshore wind in the United States due to the length of the U.S. coastline and the quality of the wind resource. In general, offshore winds blow more strongly and uniformly than onshore winds. U.S. offshore winds are projected to produce a total energy generation of up to 30 percent more than U.S. onshore winds.[48, 49] The total gross wind resource from U.S. offshore wind energy is projected at more than

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[45] Reeves, Ari, 2003, July). *Wind Energy for Electric Power: A REPP Issue Brief*. Retrieved from Renewable Energy Policy Project website: http://www.repp.org/articles/static/1/binaries/wind%20issue%20brief_FINAL.pdf

[46] Inwood, S. (2011, June). *Program on Technology Innovation: Integrated Generation Technology Options*, pp. I-11, Retrieved from Electric Power Research Institute website: http://rfflibrary.wordpress.com/2011/07/30/program-on-technology-innovation-integrated-generation-technology-options/

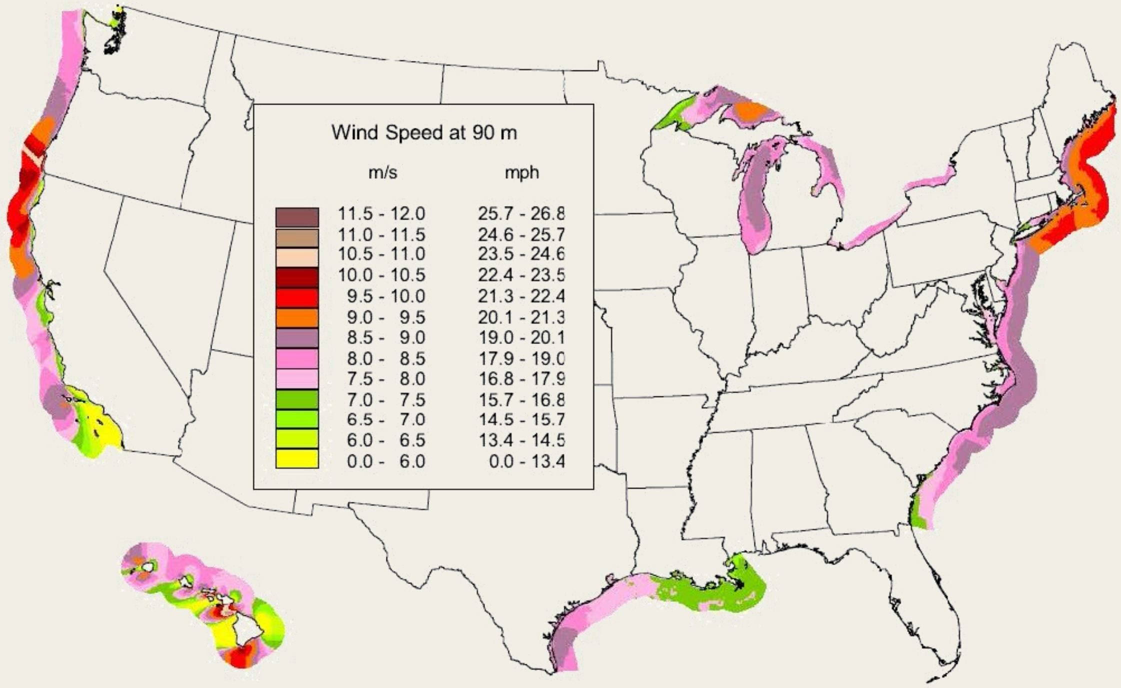
[47] U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*, p. iii. Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf on July 20

[48] U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*, Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf.

4,000 MW or roughly four times the current generating capacity carried on the U.S. electric grid. These estimates place the U.S. reserve behind Asia and Europe in capacity. However, research indicates that if the U.S. unlocks capacity through reforms in the permitting process and improvements in vessel, transmission, and port infrastructure, then capacity could double to 6,180 MW.[50]

Figure 1 shows a map of national offshore resources, displaying national offshore wind speeds at 90m above the surface. The map shows that the highest wind speeds—the areas generating the most power—are in the Northeast and along the west coast.

Figure 1: US Offshore Wind Estimates at 90m Height



Source: [51] [52]

[49] Luis Cerezo and Clarence Lyons, Electric Power Research Institute, (personal communication, August 12, 2011)
[50] Asmus, Peter. (2011, June 1). Which State Will Lead With First Installed Offshore Wind Project in the U.S.? *Pike Research Blog Articles*: Retrieved from http://www.pikeresearch.com/blog/articles/which-state-will-lead-with-first-installed-offshore-wind-project-in-the-u-s.
[51] U.S. Department of Energy, National Renewable Energy Laboratory, Schwartz, M.; Heimiller, D.; Haymes, S.; Musial, W. (2010, April). *Assessment of Offshore Wind Energy Resources for the United States*. (NREL/TP-500-45889.) Golden, CO: NREL.

Most of the offshore projects being proposed are in the Northeast and Mid-Atlantic regions, where winds are strongest, wind energy supply is plentiful, and the population demand is high. The Gulf of Mexico and Great Lakes have significant capacity and so do other coastal regions such as the Pacific Northwest. Table 5 displays a chart of capacity by region and depth.

With the exception of the "South Atlantic Bight," (from North Carolina to the east coast of Florida), virtually all coastal regions of the U.S. have significant wind energy capacity of over 500 MW. However, the regions differ in terms of the depth of the water supply where the wind is generated. This has important implications for short-term development of offshore wind farms. In the Mid-Atlantic and the Gulf of Mexico, the greatest supply of wind power is in relatively shallower waters between zero and 30 meters deep. So far, virtually all market-tested projects worldwide have been in relatively shallow waters less than 30 meters deep. New England and the Great Lakes also have significant wind resources at shallower depths, though there is an even greater source of wind energy at 60 meters and deeper.

Table 5: Wind Capacity by Depth

Region	GW			
	0-30	30-60	>60	Total
New England	100.2	136.2	250.4	486.8
Mid Atlantic	298.1	179.1	92.5	569.7
S. Atlantic Bight	134.1	48.8	7.7	190.6
California	4.4	10.5	573	587.9
Pacific Northwest	15.1	21.3	305.3	341.7
Great Lakes	176.7	106.4	459.4	742.5
Gulf of Mexico	340.3	120.1	133.3	593.7
Hawaii	2.3	5.5	629.6	637.4
Total	1071.2	627.9	2451.2	**4150.3**

Source: [53]

[52] Schwartz, M.; Haymes, S.; Musial, W. (April 2010). Assessment of Offshore Wind Energy Resources for the Untied States. (NREL/TP-500-45889.) Golden, CO: NREL.
[53] U.S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers.* (NREL/TP-500-40745). Retrieved from www.**nrel**.gov/**wind**/pdfs/40745.pdf.

One drawback is that technology for building installations at greater depths is only recently starting to become commercially available. Thus, while states like California and Hawaii may have significant capacity at 60 meters and deeper, the offshore wind supply there is not likely to be captured soon due to technological limitations. However, the U.S. is still devoting resources to researching deep water or "next generation" technologies such as floating turbines. Wind captured further offshore is stronger and can provide a more plentiful energy supply and eventual economies of scale. The main active demonstration project involving floating turbines is being proposed off the coast of Maine by Statoil. Statoil is a pioneer in floating turbine technology; its Norwegian parent company built the world's first large scale floating wind turbine project off the coast of Norway.

Projects in the Pipeline

Table 6 is a list of projects that have achieved important milestones in permitting as of mid-2011. It is perceived that the permitting process for projects in state waters—usually three nautical miles (3 n.m.) or less from the coastline—takes less time than the permitting process for federal waters. Indeed, as Table 6 shows, many projects which have been permitted are in state waters. Some are demonstration projects with small energy output. In federal waters, demonstration projects are often paired with large-scale utility projects proposed by the same developer. Other projects, specifically in Texas, are utility-scale since the state's waters extend nine nautical miles from the coastline.

Table 6: Offshore Projects in U.S. That Have Achieved Permitting Milestones

State	Developer	Project Name	Location	Distance from Shore	Planned Capacity	Permitting Status
DE	NRG Bluewater Wind	Mid-Atlantic Wind Park	Offshore from Rehoboth Beach	13.21 miles	300-450 MW	Lease granted
MA	Cape Wind Associates	Cape Wind	Nantucket Sound	5.2 miles	468 MW	Complete
NJ	NRG Bluewater Wind		Offshore from Atlantic Beach	15.6 miles	348 MW	Met Tower Lease
NJ	Deepwater Wind LLC ,Garden State Offshore Energy		Offshore from Avalon	20 miles	345 MW	Interim Lease
NJ	Fishermen's Energy, LLC	Atlantic City WindFarm	Offshore from Atlantic City	2.8 miles	24 MW	Fully permitted
NJ	Fishermen's Energy, LLC	Offshore New Jersey Windfarm	Offshore from Brigantine	16 miles	350 MW	Interim Lease
NY	To be determined	Long Island – New York City Offshore Wind Project	Offshore from Rockaway Peninsula	14 miles	350 MW	In process
TX	Coastal Point Energy (formerly W.E.S.T.)		Offshore from Galveston	8.5 miles	300MW	State Lease
	Baronyx	Rio Grande Project (North and South)	Off Cameron County in Gulf of Mexico	10 statute miles		State Lease
	Baronyx	Mustang Island Project	Off Nueces County in Gulf of Mexico	10 statute miles		State Lease
VA	Seawind Renewable	Seawind-Virginia	Offshore from Virginia Beach	25 miles	480 MW	In process

Sources: [54].

[54] AWEA Annual Report, Retrieved from http://www.baryonyxcorp.com/ on August 15, 2011

Most of the proposed projects that are now looking for buyers will enter into a contract with a utility to purchase the power that is produced. This contract is a power purchase agreement (PPA) that guarantees a market for a period of usually fifteen to twenty years. Table 7 represents those projects which have obtained purchasers for offshore wind power for at least part of the output from the wind farm.

Table 7: Offshore Wind Projects that have Secured PPAs

State	Developer	Project Name	Location	Distance from Shore	Planned Capacity	Power Purchase Agreement (PPA)
MA	Cape Wind Associates	Cape Wind	Nantucket Sound	5.2 miles	468 MW	National Grid for 77.5%
RI	Deep Water Wind, LLC	Block Island Wind Farm	Offshore from Block Island	Just under 3 miles	30 MW	National Grid for 100%

In addition to the above two projects, there was a third PPA that was secured but cancelled in December 2011. In fact, it was the first PPA in North America for an offshore wind farm. NRG Bluewater Wind had entered into a PPA with Delmarva Power for a project off the coast of Rehoboth Beach, Delaware. However, after NRG was unable to find an investment partner, they halted development of the project and cancelled the PPA. Since then, NRG has acquired the lease while searching for another buyer.

Other projects are currently negotiating PPAs. In the case of New Jersey, under the Offshore Wind Development Act of 2010, qualified offshore wind developers will not enter directly into agreements with buyers through Purchase Power Agreements (PPAs) but will be awarded Offshore Wind Renewable Energy Certificates (ORECs), which will then be bought by purchasers of energy statewide. Those purchasers will be required to buy a designated amount of ORECS or make a cash-equivalent purchase. The program will work similarly to New Jersey's Solar Renewable Energy Certificate (SREC) program.

Retooling Opportunities in Manufacturing

There are various industries that are candidates for retooling, including: onshore wind, shipbuilding, maritime and port-based industries, oil, and gas.

Onshore-Offshore Retooling

The most obvious kind of retooling, which *prima facie* seems the easiest, is retooling onshore manufacturers and supply chain businesses to service the offshore industry. However, there are substantial differences in production. The main component markets of the turbine are: foundations, towers, nacelles, blades, power cable systems, marine installation, operations and maintenance, and vessel construction.[55] While many of these components are similar across land-based and offshore turbines, the marine climate does lend itself to some important design differences. For instance:

- Most offshore installations use larger turbine designs.
- Corrosion protection is needed with outside surface protection against environmental contaminants such as salt.
- Foundation design for offshore wind development requires larger multi-pile foundations for towers as well as floating structures and towers.

These products offer new opportunities for existing manufacturers of turbines and foundations to innovate or for new entrants to the field. The general trend has been a focus on scaling current technology to accommodate the larger sizes needed for greater depths and stronger winds.[56] However, some expertise will be outside the scope of land-based technology. In some cases, investments to adapt a facility to produce for the offshore market may be prohibitively expensive. As a result, the land-based supply chain may have the capacity to produce some components for the land-based industry, but eventually experts predict there will also be some "decoupling." A "decoupling" implies that a supply chain dedicated to production of offshore technology and products may emerge. The move for more radical and "next-generation" redesign would likely involve the activities of a new, specialized offshore supply chain.

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[55] Kleinhenz & Associates. (2010, July). *The Potential Economic Impacts in Ohio Associated with the Emergence of a Lake Erie Offshore Wind Industry*. Retrieved from: http://www.nortech.org/images/stories/_pdf/LEEDCo_Economic_Impact_Study_FINAL.pdf.

[56] US Offshore Wind Collaborative. (2009, October). *U.S. Offshore Wind Energy: A Path Forward*. Retrieved from: http://www.usowc.org/

Ship Building Industry

There is also potential in the shipbuilding industry for the manufacturing of specialized offshore wind vessels. There are several factors precipitating demand for domestic production of these ships. Currently, there are virtually no such ships in the U.S., since the offshore wind industry is not yet on-line, and the supply servicing offshore wind farms in Europe and Asia is being utilized at full capacity. Additionally, it would be very expensive to charter a boat from Europe to service U.S. installations. Finally, based on the interpretation of the Jones Act, which has been in existence since 1920, foreign vessels may not be allowed to service wind farms in U.S. waters. With offshore wind vessels costing an estimated $260 million and taking about two years to build, manufacturing of these ships could be a boon to the U.S. shipbuilding industry and result in the retention or creation of a significant number of jobs.[57, 58] However, the industry will need incentives and financing mechanisms that help developers mitigate the risk associated with such a large investment.

[57] Trabish, Herman. (2010, December 30). The Emerging Opportunity in Offshore Wind Vessels. *Greentechmedia*. Retrieved from: http://www.greentechmedia.com/articles/read/the-emerging-opportunity-in-offshore-wind-vessels/
[58] Fichaux, Nicholas & Wilkes, Justin. (2009). *Oceans of Opportunity: Harnessing Europe's largest domestic resource*, p. 55. Retrieved from European Wind Energy Association website: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/Offshore_Report_2009.pdf

Ship Building Industry and the Jones Act

The Jones Act restricts the transportation of merchandise between points in the U.S. to U.S. built-vessels. These ships must fly the flag of the U.S. and be owned and crewed by U.S. citizens. If indeed the Jones Act is judged to apply to the huge seagoing vessels needed to erect and maintain offshore wind turbines, then there are a few important implications. In the short term, there would be a shortage/absence of specialized vessels to service offshore wind farms in the U.S. The best candidates would be ships used to service the oil and gas industries that are located in the Gulf of Mexico.

In the longer term, this could be a boon for the U.S. ship building industry. The European experience indicates that specialized wind system installation vessels, rather than adapted oil and gas vessels, are required for cost-effective, high volume installation. Such vessels are major undertakings, as they must support 100 to 200 ton towers and cranes, are estimated to cost $150 million to $250 million per ship, and take about two years to construct. Another possibility is that foreign companies already building these ships—including South Korea's Daewoo Shipbuilding and Marine Engineering and Samsung Heavy Industries, Poland's Crist Shipyard, and Germany's Sietas shipyard—set up a domestic shipbuilding capacity in the U.S. so that their ships could comply with the Jones Act.

Precedents are still being established. It is possible that further legal interpretation could allow foreign ships. In May 2010, regulators indicated that a stationary foreign vessel could be used in U.S. waters to install a meteorological tower, which would be necessary for offshore wind farms. But for reasons including the Jones Act, as well as the high cost of leasing foreign ships and the lack of availability, the U.S. ship-building industry could stand to benefit.

Maritime and Port-Based Industry/Oil and Gas Industry

Ports will serve as future staging areas for offshore wind farms, and the businesses that currently support ports will have to gain skills and capacity related to the new industry. An existing port infrastructure is needed for the large specialized ships that service offshore wind farms. A strong local supply chain of businesses is also crucial. The Gulf of Mexico is one area that has both a strong port-based industry and an existing supply chain that operates in deep water due to its experience in oil and gas.

Other Manufacturing and Industries

In addition to the industries mentioned above, there may be opportunities in offshore wind for welders, metal workers, semiconductor companies, machinists, and construction workers. Various state supply chain studies (often based on similar ones focused on onshore wind) have identified businesses by NAICS code.

Opportunities in Foreign Direct Investment

Just as foreign onshore wind companies such as Gamesa, Siemens, and Mitsubishi have invested in U.S. facilities, foreign manufacturers with offshore facilities could confer economic benefits to the U.S. as well. However, so far foreign companies are not moving major manufacturing facilities to the U.S. as they are waiting for U.S. offshore wind farms to start construction, become operational, and start producing a steady stream of energy.

Most current U.S. offshore developments are already importing components or have their sights set on importing turbines and major components from foreign companies. Energy Management, Inc., the company developing the Cape Wind project in Cape Cod, has indicated it will buy its turbines from Siemens.[59] The Deepwater Wind project off the coast of Rhode Island is interested in the most state-of-the-art and largest turbine on the market: the 6MW turbine being manufactured by Repower Systems, Nordex, Alstom, and Siemens. All of these are foreign companies.[60] Indeed, in its report for the Massachusetts Clean Energy Center, Tetra Tech EC, Inc.

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[59] George Sterzinger, personal communication, July 25, 2011.
[60] Franco, Mark del. (2011, Summer). "The 6MW Offshore Turbine Sets Sail for North America." *Offshore Wind. A Supplement to Wind Power*. P. 10.

concludes that "most, if not all, turbine components pieces for the planned offshore wind farms would be manufactured and shipped from European facilities."[61]

However, foreign companies have also begun to partner with U.S. companies. The Spanish company Gamesa partnered with Northrop Grumman's shipbuilding operations to launch the Offshore Wind Technology Center in Chesapeake, Virginia and develop the next generation of wind technology suitable for offshore conditions.[62]

Opportunities in Export Development

Development for the export market provides economic returns for U.S. businesses. Not only will it produce revenue and jobs, but it will also help the domestic industry develop expertise. When the offshore industry takes off in the U.S., these businesses will be ready to serve that market.

There is some export potential in the works, specifically in research and development. Within the U.S., General Electric has developed a 4.0 MW turbine for the offshore wind market. As of October 2010, GE had 35.7 MW installed offshore in Sweden and Ireland and was testing 38.5MW in Norway.[63] In addition, Clipper Wind has developed, but has not yet deployed, its Brittania 10.0 MW turbine.[64] Because offshore wind development is still a nascent field, there is room for the U.S. to compete and become a technology and manufacturing leader (see text box below.)

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http://issuu.com/zackinpublications/docs/osf2010_online?mode=embed&layout=http%3A%2F%2Fskin.issuu.com%2Fv%2Flight%2Flayout.xml&showFlipBtn=true.

[61] Tetra Tech EC, Inc. (February 2010). *Port and Infrastructure Analysis for Offshore Wind Energy Development, p. 6.* Retrieved from Massachusetts Clean Energy Center website: http://www.masscec.com/index.cfm/pk/download/id/11693/pid/11151.

[62] Franco, Mark del. (2011, Summer). State Addresses Offshore Issues. *Offshore Wind. A Supplement to Wind Power.* pp. 3-4. Retrieved from http://issuu.com/zackinpublications/docs/osf2010_online?mode=embed&layout=http%3A%2F%2Fskin.issuu.com%2Fv%2Flight%2Flayout.xml&showFlipBtn=true

[63] AWEA. (October). Presentation at the AWEA.

[64] AWS Truewind. (2010, September). New York's Offshore Wind Energy Development Potential in the Great Lakes: Feasibility Study." Retrieved from: http://www.awstruepower.com/wpcontent/media/2010/09/NYSERDA_AWST_NYGreatLakesFS.pdf. On August 1, 2011.

U.S. Companies Powering Wind in Asia and Europe

If not manufacturing or servicing the U.S. offshore industry, U.S. firms can develop products for the foreign market, just as American Semiconductor and Principle Power are making products for China and Europe. American Superconductor has a strong foothold in the overseas offshore wind-farm market. Its superconducting technology is leading it into the market of superconducting wind turbines, which it has commercially licensed for the overseas market in Europe and China. The company hopes that U.S. wind farms will one day be a customer. Meanwhile, Principle Power's technology will be deployed in Portugal.

Overall European demand is high. In Europe, there is a projected need for 30 GW over the next five years, which would require 10,000 turbine structures by 2020 to meet demand forecasts. The current manufacturing industry does not have the this fabrication capacity, which presents export opportunities for U.S. manufacturers.

Comparative and Competitive Advantages of the Industry within the U.S.

Of the approximately 20 projects in the pipeline, the majority of proposed offshore wind farms have been located in the North Atlantic and Mid-Atlantic regions of the Atlantic Outer Continental Shelf (OCS), the Great Lakes region, and the Gulf of Mexico.[65] Within the OCS, some of the earliest projects have been in the North Atlantic, including the Cape Wind Massachusetts project that was the first to receive a federal permit. But the Mid-Atlantic states of Maryland, Delaware, Virginia, and North Carolina are also developing projects and are a target area of federal support.

Meanwhile, the Great Lakes region and Texas have their own comparative advantages, including being in state water jurisdiction. Table 8 outlines a few of the main regional advantages of the North Atlantic, Mid-Atlantic, Great Lakes, and Gulf Coast.

[65] The DOE divides the OCS into the following areas: North Atlantic (Maine, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey); Mid-Atlantic (Delaware, Maryland, Virginia, North Carolina); South Atlantic (South Carolina, Georgia, Florida) and Straits of Florida (Florida).

Table 8: Regional Advantages

Region	Strong Demand	Early/ Demo Projects	State Water Jurisdiction	Land-Based Wind Synergy	Port/Oil and Gas Synergy	Weather
North Atlantic	X	X				X
Mid-Atlantic	X	X				X
Great Lakes	X		X	X	X	
Gulf Coast			X	X	X	

North Atlantic – High Demand Centers

This region includes Massachusetts, Maine, and Rhode Island. These states have several distinct advantages.

Strong wind supply

Maine has some of the strongest winds on the Atlantic coast. The winds along the coast follow the pattern of being strongest in the north and weaker further south, which explains the absence of offshore wind farm development among states in the southern U.S.

Demand

The North Atlantic is the most densely populated area in the U.S. and also has some of the highest electricity rates. Many of the states in the Northeast depend heavily on heating oil to heat the homes, which results in particularly high heating bills.

Research and Development (R&D)

There is extensive R&D being done in these areas. The Advanced Structures and Composite Center (AEWC) in Maine is the major R&D center in the country for deep water/“next generation” technology. The Massachusetts testing facility will allow domestic turbine component companies to develop their technology for the offshore industry.

Early Projects

In 2010, the Cape Wind Project received the first lease to build a wind farm in the Nantucket Sound (see case study in Appendix 2). It is almost a decade in development and could become the first wind farm off the coast of U.S. waters. It has made the most progress toward achieving regulatory approval, but the project is still trying to get a major utility to buy the balance of the project's power. The utility National Grid has entered into a PPA for one-half the supply, and the State of Massachusetts has entered into a PPA for 27.5% of the rest.

Demonstration Projects

In Rhode Island and New Jersey, developers are proposing demonstration projects. Demonstration projects have the advantage of potentially developing faster since they can go through state permitting channels and do not require such a large investment outlay.

Disadvantages

The North Atlantic region also suffers from some disadvantages. With a relatively longer history of proposed offshore wind development, opposition to this has also developed and grown over time. In Massachusetts, the Alliance to Protect Nantucket Sound was formed in 2011 with the mission of the long-term preservation of Nantucket Sound. The group comprises a vast diversity of stakeholders including U.S. Senators, state representatives, towns and counties on the Sound, fishing groups, environmental groups, and other interests. The opposition of the late Senator Edward Kennedy to the project was a major thorn in the side of developers and proponents. In New Jersey, the Beacon Group recently released a highly publicized report claiming that the State's Offshore Wind Development Act would pass on the project's high cost to residential and commercial electricity consumers and would result in a net loss of revenue and jobs for the state of New Jersey.[66]

Waters in the far northeast experience some icy conditions, but this is not enough to significantly affect design and conditions for wind turbines, according to the Department of Energy. Likewise,

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[66] Tuerck, David, Bachman, Paul, & Murphy, Ryan. (2011, June). *The Cost and Economic Impact of New Jersey's Offshore Wind Initiative*. Retrieved from Beacon Hill Institute website: http://www.beaconhill.org/BHIStudies/NJ-Wind-2011/NJWindReport2011-06.pdf.

there is some risk of extreme weather conditions from "nor'easter" storms, but this also should not significantly affect wind farm development.[67]

Mid-Atlantic – The Next New Frontier?

This region includes New Jersey, Delaware, Maryland, and Virginia. Despite the highest profile offshore project being the Cape Wind project in Massachusetts, various Mid-Atlantic states are competing to have the first offshore energy project on-line. These states have advantages including the following.

Federal Focus

Public sector investment has been strongest in the Mid-Atlantic. In 2009, the Department of Interior issued its first five leases for offshore development: four in New Jersey and one in Delaware. These five "interim leases" allowed companies to begin preliminary site research by erecting meteorological towers to measure things like wind and wave speed and direction. Additionally, the federal government (DOE) is beginning its new initiative to streamline the leasing process in New Jersey, Delaware, Maryland, and Virginia. As a first step, it has completed a draft environmental assessment for the wind energy areas (WEAs) in these states.[68]

Demand

There is strong demand for indigenous sources of energy in the Mid-Atlantic. Virginia, for example, is the second largest importer of electricity after California.[69]

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[67] U.S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*, p. 56. (NREL/TP-500-40745). Retrieved from www.nrel.gov/wind/pdfs/40745.pdf.

[68] U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Office of Offshore Alternative Energy Programs. (2011, July). "Commercial Wind Lease Issuance and Site Characterization Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia. Draft Environmental Assessment." Retrieved from http://www.boemre.gov/offshore/RenewableEnergy/PDFs/MidAtlanticWEAs_DraftEA.pdf on July 15, 2011.

[69] Franco, Mark del. (2011, Summer). State Addresses Offshore Issues. *Offshore Wind. A Supplement to Wind Power.* Pp. 3-4. Retrieved from: *http://issuu.com/zackinpublications/docs/osf2010_online?mode=embed&layout=http%3A%2F%2Fskin.issuu.com%2Fv%2Flight%2Flayout.xml&showFlipBtn=true on July 27, 2011*.

Disadvantages

The Mid-Atlantic contains waters that are located in or near the tropical waters coming from the Gulf of Mexico, which often lead to hurricane threats up and down the coast. As a result, survival conditions for turbines in the Mid-Atlantic and in the Gulf states (including Florida, Texas, and Louisiana) will be affected.[70] This is a threat not faced by wind farms in Europe.

Great Lakes – Where the Turbines Blow Inland

This region includes New York, Michigan, and Ohio and is differentiated from other coastal areas in the U.S. because its wind power generates from a freshwater supply. There are several advantages of the region.

Gentler Water Conditions

The Great Lakes comparative advantages include wave loads that are roughly a third of those in rougher ocean climates. This provides for better construction conditions and potentially different weatherization requirements for equipment going in the water.[71]

State Permits

The U.S. Army Corps of Engineers has prime federal jurisdiction over permitting offshore wind energy in Great Lakes. There is a memorandum of understanding between the Army Corps and several states to coordinate review of these projects.

Domestic Supply Chain Proximity

Unlike the ACS areas, the Great Lakes region is near an already developed supply chain of businesses for the onshore wind industry. For example, the Ohio Department of Development has identified more than 500 existing businesses in the wind supply chain, with the largest clusters

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[70] U.S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*, p. 57. (NREL/TP-500-40745). Retrieved from www.nrel.gov/wind/pdfs/40745.pdf.

[71] Franco, Mark del. (2011, Summer). Capacity Meets Commerce in Lake Erie Wind Project. *Offshore Wind. A Supplement to Wind Power*, P. 10. Retrieved from: *http://issuu.com/zackinpublications/docs/osf2010_online?mode=embed&layout=http%3A%2F%2Fskin.issuu.com%2Fv%2Flight%2Flayout.xml&showFlipBtn=true*

around Cleveland, Cincinnati, Dayton, Toledo, and Columbus.[72] The Great Lakes region is home to a manufacturing base that has drastically downsized in the past few decades and is hoping some of its former capacities in automotive manufacturing and machine tooling might be adapted to offshore wind.

Port/Infrastructure Capacity

In addition to having businesses that supply the industry, the Great Lakes region also has experience with, and infrastructure developed to, ship turbine components.

Disadvantages

Disadvantages of this region include the relatively weak strength of winds that will lead to a lower energy output. Another concern for offshore development is that shipping lanes in the Great Lakes are too narrow for the passage of some of the oversized vessels that transport the large turbines for offshore wind farms. Finally, the icy conditions in the Great Lakes can serve as a threat to production at the wind farms and necessitates the construction of properly weatherized equipment.[73]

Gulf Coast/Texas - Oil and Onshore Wind Energy Synergies

The Gulf Coast has several advantages, including the following.

Synergy with Oil and Gas Industry

The supply chain that services the oil fields of the Gulf of Mexico may be able to adapt and service the offshore wind industry. Texas's oil industry confers the state a unique expertise in deep water technology, including foundations and platforms associated with drilling for oil off the coast. This expertise may be transferrable to deepwater offshore wind farm operations. More generally, Texas has an advantage in its port infrastructure and marine industries. It has an established industry dedicated to offshore engineering, construction, and fabrication for large

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[72] Ohio Department of Development. Retrieved from http://development.ohio.gov/wind/ManufacturingSupplyChain.htm/
[73] U.S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*, p. 57-58. (NREL/TP-500-40745). Retrieved from www.**nrel**.gov/**wind**/pdfs/40745.pdf.

ships and platforms as well as a harbor system with readiness for portside staging and fabrication. The development of an offshore wind industry could also come at a welcome time for the local economy if the oil exploration industry begins to downsize, as some expect, vacating resources in infrastructure, businesses, and the workforce.

Synergy with Land-Based Wind Industry

Like the Great Lakes region, Texas has a synergy with a strong land-based wind industry. Texas leads the nation in installed production for land-based wind. It is the first state to have surpassed the 10,000 MW mark, with 10,085 MW of installed capacity at the end of 2010.[74] It gets roughly 8% of its power supply from wind.[75] Texas is home to a large number of wind-related manufacturing facilities that service these wind farms and could potentially produce parts for the off-wind industry.

Utility Structure

Texas has also developed an innovative transmission system for onshore wind. [76] It has one utility (ERCOT) that services the majority (75%) of the state, and it currently incorporates a substantial amount of land-based wind into its grid. ERCOT invested substantially in its ability to absorb wind energy from the wind-rich regions of west Texas and the inland coastal regions and transmit this power to the grid. The cost of this investment was spread out across the consumer base. Additionally, while wind farms have to pay for the cost of their connection to the utility grid, they do not have to the pay the cost for any upgrade in the transmission system to accommodate the energy load. This covers costs in one important area for wind farm developers.

State Water Jurisdiction

Texas has jurisdiction over waters extending nine nautical miles off its coast, compared to other states that have jurisdiction only within three miles from the coast (such as the Eastern seaboard.)[77] This gives them an advantage in developing projects at a greater depth that are not subject to

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74 American Wind Energy Association. (2011). *AWEA U.S. Wind Industry Annual Market Report*, p.2.
75 http://www.nytimes.com/2011/02/11/us/11ttwind.html
76 American Wind Energy Association. (2011). *AWEA U.S. Wind Industry Annual Market Report*, p.10.
77 Asmus, Peter. (2011, June 1). Which State Will Lead With First Installed Offshore Wind Project in the U.S.? *Pike Research Blog Articles*: Retrieved from http://www.pikeresearch.com/blog/articles/which-state-will-lead-with-first-installed-offshore-wind-project-in-the-u-s.

the federal permitting process. The two projects currently furthest along in development by Baronyx and by Coastal Point Energy are both in state waters. However, there are concerns from the Corpus Christi Naval Air Station that the turbines could interfere with radar systems, and environmental groups are asking for an environmental assessment to determine, among other factors, how the wind farms might affect populations of migratory birds, fish, and the rare breed of ridley sea turtles.[78]

Disadvantages

This region also presents several hurdles. Wind turbines located off the coast of Texas are situated in a region of the Gulf of Mexico that is highly susceptible to hurricanes. This necessitates the weatherization of turbines and platforms to mitigate damaging effects and, more generally, places them at risk for damage in the event of inclement weather. Additionally, there is competition from clean energy sources from land-based wind as well as solar energy, and natural gas is plentiful in the region.

Major Stakeholders and Partnerships

Market development of offshore wind will require greater cooperation among regional players and private, public, and nonprofit stakeholders. Partnerships are especially crucial from a regulatory standpoint. In the case of Cape May, for example, 17 regulatory agencies were involved. Partnerships may also be crucial for purposes of creating scale in order to produce a better energy product and at a better cost. The major players in the offshore industry include multiple federal agencies, state governments, developers, utilities, industry trade and research organizations, universities, and other stakeholders. Table 9 below summarizes major players.

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[78] Mahoney, Melissa. (2011, August 8). "Offshore wind Texas-style: fast and big. *smartplanet*. Retrieved from: http://www.smartplanet.com/blog/intelligent-energy/offshore-wind-texas-style-fast-and-big/8080

Table 9: Major Players

Stakeholders	Description
Government	Various federal and state agencies, Canada
Developers	Regional and National developers, Foreign Partners
Utilities	Wholesalers, Retailers, Local, Statewide (ERCOT)
Research & Development	Universities, Labs/ Testing and Technology Center
Industry and Businesses	OEMs, Domestic Supply Chain, FDI, Trade Organizations
Workforce Stakeholders	Labor Unions, Universities, Community Colleges, Workforce Training Programs
Opposition/Concerned Stakeholders	Marine Animal Population, Residents-Visual Effects, Property Holders, Noise, Tourism, Marine Safety – Fisherman and Boaters
Economic Developers	Regional, state, county, and city economic development organizations, chambers of commerce and other business support agencies, and other economic development organizations
Missing Stakeholders	Investors, Buyers

Local/State Government

Federal Government

The Energy Policy Act of 2005 designated the Department of Interior (DOI) as the lead permitting agency for offshore wind development in federal waters, which generally begin three nautical miles from shore and extend outward to 200 nautical miles. States have jurisdiction over permitting if it takes place within state waters. While state waters usually extend three miles from the shoreline, Texas has jurisdiction over waters nine nautical miles from its coast. Within the DOI, the Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE), formerly known as the Minerals Management Service (MMS), is the federal agency responsible for overseeing the safe and environmentally responsible development of energy and mineral resources on the Outer Continental Shelf.

Various federal statute and agencies play a role in offshore development, and they have the mandate and authority to review and/or approve aspects of offshore wind projects. These agencies include the:

- Department of Interior Bureau of Ocean Management, Regulation and Enforcement (BOEMRE),
- Environmental Protection Agency (EPA),
- Fish and Wildlife Service (FWS),
- National Park Service (NPS),
- National Oceanic and Atmospheric Administration (NOAA),
- National Marine Fisheries Service (NMFS),
- Federal Aviation Administration (FAA),
- Department of Defense (DOD), U.S. Coast Guard (USCG),
- Army Corps of Engineers, and
- Federal Energy Regulatory Commission (FERC).[79]

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[79] Ibid.

The application and review process for offshore wind is more extensive than for land-based wind projects, which are often on private land instead of in federal waters. The process for onshore wind projects has also developed through ten years of learning and improving. Yet, the process for offshore wind is also improving. For example, the review of the application for the Cape Wind development included the active participation of 17 federal and state agencies.[80] As a result, in 2010, the DOI and DOE entered into a Memorandum of Understanding (MOU) to collaborate and bring together the resources and expertise of both agencies to develop commercial-scale offshore wind and water energy projects on the U.S. Outer Continental Shelf.

Regional Governmental Partnerships

The Bureau of Ocean Energy Management is working closely with coastal states to establish task forces on offshore energy development.[81] These states include Washington, Oregon, California, Hawaii, New Jersey, Delaware, Maine, New York, Rhode Island, Florida, Maryland, North Carolina, South Carolina, Georgia, Massachusetts, and Virginia.

In June 2001, U.S. Secretary of the Department of the Interior Secretary Ken Salazar signed a MOU with the governors of 10 East Coast states to establish an Atlantic Offshore Wind Energy Consortium to promote the efficient, orderly, and responsible development of wind resources on the Outer Continental Shelf.[82] However, no progress was made on the MOU, and the initiative is no longer functional.

DOE has indicated the need to undertake collaborative studies with utilities to model offshore wind energy and potential for integration. Enhanced grid interconnection is needed to make the costs of the offshore wind industry viable.[83] Many of the electric grid projects currently being proposed cross state boundaries, and cooperation among the states is mandatory in these cases.

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[80] Gordon, James S. (2011, June 1). Statement as prepared for delivery of James S. Gordon, President, Cape Wind Association, LLC before the U.S. House Committee on Natural Resources.
[81] Bureau of Ocean Energy Management. *State* Activities. Retrieved from http://www.boem.gov/Renewable-Energy-Program/State-Activities/Index.aspx
[82] U.S. Department of the Interior. (2010, June 8). *Salazar Signs Agreement with 10 East Coast Governors to Establish Atlantic Offshore Wind Energy Consortium, Announces New Atlantic Offshore Renewable Energy Office*. Retrieved from Department of Interior website: http://www.doi.gov/news/pressreleases/Salazar-Signs-Agreement-with-10-East-Coast-Governors-to-Establish-Atlantic-Offshore-Wind-Energy-Consortium.cfm.
[83] Hart, Christopher Dr. (2010, October 5). Creating an Offshore Wind Industry in the United States: A National Vision and Call to Action. *U.S. Department of Energy*. Presentation at AWEA North American Offshore Wind 2010 Conference & Exhibition, Atlantic City, New Jersey.

For example, the Atlantic Wind Connection project (which counts Google among its investors) is designed to join together up to 12 offshore wind projects stretching 350 miles from northern New Jersey to southern Virginia and creating a "superhighway" of underwater cables. The principle is that states should not just compete but should collaborate. In fact, the viability of the industry may be dependent on large projects that stretch across multiple states and achieve economies of scale to bring down the cost of offshore wind energy.

State and Local Government

In addition to the federal agencies above, states conduct their own regulatory review related to environment, marine animal, shipwreck, and other policies. State governments also have a role in ensuring the leasing and development process for each project is open to competitive bidding. Additionally, states are involved in providing support and incentives for research, business development, and conducting various impact studies. One of the most aggressive states is New Jersey, which offers a program of $100 million in prospective tax breaks to domestic businesses in the offshore wind industry. Massachusetts and New York State Energy Research and Development Authority also have outstanding program portfolios for offshore wind.

As discussed above, the role of the state is greater if the project is within state waters. When projects are in federal waters, states still have multiple roles to play, including: providing leases, rights-of-way, and other land-use approvals required to site and connect grids for projects.

Developers – A Diverse Set of Prospective Market Suppliers

Developers may be private companies or consortiums of companies. They may be focused on one local project or developing offshore wind in multiple regions. They may represent environmental, economic, and/or group interests. Often times, developers form for the purpose of one development. For example, in Ohio, the Lake Erie Economic Development Corporation (LEEDCo) is a consortium of local companies that are working together to develop a demonstration project that they hope will produce the first offshore wind energy in the U.S. LEEDCo has tapped Great Lakes Ohio Wind (GLOW), a project management firm, to design, finance, and build the project off the coast of Cleveland.[84]

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[84] Ibid.

NRG Bluewater Wind, LLC has positioned itself as a developer for offshore wind in multiple states and is developing offshore wind energy projects in Delaware, Maryland, New Jersey, and New York. However, the NRG Bluewater Wind project halted development of its Delaware project, citing the inability to find an investment partner.[85, 86]

In New Jersey, Fishermen's Energy, LLC is developing two projects off the coast of Atlantic City. The developer is a consortium formed by principals of east coast fishing companies. Traditionally, fishermen have often opposed offshore wind farms, viewing them as a competing use of coastal waters that might threaten productive fishing grounds and seafood industries. In this case, fishermen have come together to develop offshore energy using their knowledge of marine resources in such a way that they can be stewards of sustainable marine resources. They believe they are removing one of the main forces of opposition and capturing the opportunity that wind has to offer instead of viewing it as a threat.[87]

Utilities – The Essential Role of Market Buyers

Utilities are another crucial player whose participation is necessary for the development of the offshore wind industry. Utilities who agree to buy energy output from wind farms are buying more expensive energy than they would from natural fossil fuel sources and other alternative sources like land-based wind sources. There is natural reluctance to buy offshore energy and pass this cost onto customers. Utilities cannot afford to lose their customer base, especially large industrial customers. The fear is that high energy costs may be one factor that drives businesses to move.

In addition to the higher cost, utilities are entering the unknown. There are concerns about the ability of offshore wind to produce a steady flow of energy due to the volatility of wind, which would necessitate the use of a fossil fuel source to compensate for times when wind energy output is low. There are also concerns about connectivity with the existing electrical grid. Utilities are buying a product that has been untested in the U.S. market based on a technology that is relatively new. They are concerned about not just the cost but the dependability of the product.

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[85] About NRG BlueWater. Retrieved from NRG BlueWater website: http://www.bluewaterwind.com/aboutbww.htm
[86] Power Engineering. (2011, December 28). NRG Bluewater Wind terminates offshore PPA. *Power Engineering*. Retrieved from: http://www.power-eng.com/articles/2011/12/nrg_offshore.html.
[87] *About Fishermen Energy*. Retrieved from Firshermen Energy web site: http://www.fishermensenergy.com/about-welcome.html

Research and Development – R&D Partnerships

Various universities have important research centers that partner with industry and government. The University of Maine hosts the Advanced Structures and Composite Center (AEWC) and is building a 37,000 square foot Offshore Wind Laboratory focusing on next generation technology. The University of Maine is a founding member of the DeepCWind Consortium, which is committed to advancing deepwater technology.

The Great Lakes, Northeast, Mid-Atlantic, and Gulf Coast all have R&D actively taking place at universities and research centers. In Michigan, Michigan State University, Grand Valley State University, and the University of Michigan have all been involved in research and development of the industry. The University of Rhode Island Partnership for Energy and a Center of Excellence for Research on Offshore Renewable Energy were founded in 2008. The University of North Carolina-Chapel Hill received stimulus funds for offshore research, while North Carolina State University received a DOE grant for a wind power study. The University of Delaware is undertaking numerous projects with support and partnership from DOE and the state. In the Gulf Coast region, the University of Houston, Texas Tech University, and Texas State Technical College have all been active in research and advancement of the industry.

Some research universities, aided by the federal government, are starting to provide education in offshore wind. The University of Massachusetts Wind Energy Center won a $253,000 grant from DOE's 20% Wind by 2030 program to develop a graduate-level course in Offshore Wind Energy Systems Engineering.[88]

Industry and Industry Partnerships

These include original equipment manufacturers (OEMs) such as General Electric and Clipper Wind, foreign companies such as Siemens and Gamesa, and businesses along the offshore wind supply chain. Supply chain businesses include turbine manufacturers, cable suppliers, vessel operators, marine installation companies, resource assessment and geotechnical and geophysical firms, environmental and permitting consultants, and law firms. These organizations often work

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[88] Morton, Laura Smith. (2010, October 7). Collaborations as Industry Drivers: U.S. Department of Energy Initiatives. *U.S. Department of Energy*. Presentation at AWEA North American Offshore Wind 2010 Conference & Exhibition, Atlantic City, New Jersey.

closely with local, state, and federal governments to gain support for research and development, regulatory and permitting assistance, and economic development.

Advocacy Organizations

Industry and business are some of the principal partners in advocacy organizations for the industry. These groups represent domestic businesses in the existing supply chain, including those that have been working in land-based wind, businesses exploring the next generation of technology, and foreign businesses looking to invest in the U.S. offshore wind market. Advocacy organizations include those listed below.

Offshore WindDC

The Offshore Wind Development Coalition (OffshoreWindDC) is the main trade organization serving businesses in the offshore wind energy industry. OffshoreWindDC advocates for federal policy initiatives promoting offshore wind farms, including loan guarantees and a production and investment tax credit. OffshoreWindDC was founded in 2010 by seven offshore wind developers along with its affiliate the American Wind Energy Association (AWEA). The organization also represents supply chain businesses, including: turbine manufacturers, cable suppliers, vessel operators, marine installation companies, resource assessment and geotechnical firms, environmental and permitting consultants, and law firms. The organization includes international members such as the Irish offshore wind developer Mainstream Renewable Power, which recently became a member of the Board of Directors and has expressed an interest in developing a major wind farm in New Jersey.[89]

The US Offshore Wind Collaborative

USOWC launched in 2009 with a mission of addressing the technical, environmental, economic and regulatory issues necessary to catalyze the sustainable development of offshore wind energy in the U.S. USOWC is an interdisciplinary, non-profit organization representing a diverse group of offshore wind energy stakeholders. Located in Cambridge, Massachusetts, it provides a forum for information-sharing, problem-solving, and capacity-building among government, industry, academia, energy, and environment advocates. It received startup funding from the

[89] Jim Lanard, President, OffshoreWindDC, President (personal Communication, August 3, 2011)

Massachusetts Clean Energy Center (MCEC), along with program funding from the Energy Foundation.

The DeepCWindConsortium

DeepCWindConsortium is a group committed to advancing deepwater offshore wind technology. The University of Maine is its founding member, and it is comprised of representatives from the public and private sector committed to research, commercialization and development of offshore wind farm technology and installations.

The Great Lakes Wind Collaborative

GLWC is a multi-sector coalition of stakeholders in the wind energy industry working to facilitate the sustainable development of wind power in the Great Lakes region, including Canada and the U.S. It was formed in 2007, and there are currently about 450 members from the eight U.S. states (Minnesota, Wisconsin, Illinois, Indiana, Michigan, Ohio, Pennsylvania, and New York) and two Canadian provinces (Ontario and Quebec) that border the Great Lakes. The GLWC's Offshore Wind Workgroup's top priorities are to establish a regional voice and to improve federal-state coordination and communication for Great Lakes offshore wind permitting and policy. Specific agenda items include completing a Great Lakes Ports Survey, conducting public perception studies, and developing offshore wind best practices.

Offshore Wind Accelerator Project

OWAP is led by the Clean Energy States Alliance (CESA) with support from private foundations. CESA is a nonprofit coalition of state and municipal clean energy programs formed in 2002 to facilitate state and federal partnerships to advance clean energy technologies. OWAP's primary function is to serve as an information portal on offshore development priorities by producing reports, polls, and other resources on top challenges and issues like project siting, power procurement, and offshore wind supply chains.

Workforce Stakeholders

These are stakeholders that represent, train, and educate the workforce, including: labor unions, universities, and community colleges. It is important for developers to engage unions from the beginning, as a largely unionized workforce may carry out the construction and installation phrase (perhaps less so in the South) as well as much of the work during the operations and maintenance phase. Working with the unions, developers can gain better cost projections for contractors, including: longshoreman, electricians, elevator operators, piledrivers, and a whole host of trades. Fostering the relationship at the beginning means smoother negotiations and work progress as the project gets underway. Additionally, as the developers of Cape Wind found, the unions were active and crucial partners in lobbying at the state house and at the U.S. Congress for the project. For unions, the project was high stakes, with the promise of providing thousands of jobs for a hard-hit region and sector. The unions may be able to draw on relationships and connections that the developers may not have in order to help move a project along.

Training is a very important part of workforce readiness. Investors, foreign and domestic, will be looking to see to what extent the workforce is skilled to install and operate the wind farms. Using the land-based wind industry as a model, community colleges and universities can be enlisted to offer specialized training. Additionally, unions have training academies that can offer specialized skills. Partners should work together to coordinate the curriculum with the needs of the project and the industry.

Opposition and Concerned Stakeholders

Stakeholders who anticipate they may be adversely affected by offshore development also need to be engaged in the process from an early stage so as not to produce an unexpected and intractable roadblock further down the line. Representative interests include:

- The marine animal population, where concerns over local populations of birds, bats, sea turtles, and other marine life are required to understand the potential risks and mitigate possible adverse effects;
- Local residents and those along the shoreline where the view may be obstructed by the turbines;
- Local property holders who are concerned their real estate loses value due to view, noise, and other effects of the wind farm;
- Fishermen who are concerned that fishing reserves might be lost;
- Recreational boaters and shippers concerned about shipping lanes being disturbed;

- Historical preservationists who are concerned about undiscovered or unpreserved shipwrecks, and;
- Native Americans whose view for ceremonial prayer might be obstructed.

Economic Developers

Economic developers bring a wealth of experience in helping new industries get off the ground and can apply tools and expertise to help the offshore wind industry overcome hurdles and achieve take-off. Economic developers can play a proactive role supporting the development of the supply chain, workforce and infrastructure. Additionally, they can help inform policymakers on conditions and incentives in the regulatory and policy environment that will help foster sound and sustainable growth. Economic developers are actively involved in regional planning, helping to synchronize local industries and supply chains, supporting research and development institutions and partnerships, and coordinating policy and communication on offshore wind. The Hurdles and Solutions follow-up report discusses the role of economic developers in detail.

Missing Stakeholders - Investors and Purchasers

Financial players and purchasers are two of the primary players that are missing in the marketplace and are thus inhibiting the development of offshore wind projects. Financial players include investors and lenders, and purchasers of energy include utilities that will enter into PPAs with projects. Some projects such as Cape Wind are ready to start construction but have not sold adequate energy to guarantee a funding stream that enables the project to be financially viable. Cape Wind has sold only two-thirds of its 468 MW wind capacity. Since the marginal cost of wind is zero, it is absolutely crucial that it sell a large portion of its MW to achieve profitability.

Investors/Funding

The persistent lack of available financing for clean energy projects has been taken up by Congress, but action is stalled due to budget deficit reduction measures. The current environment for investment is wrought with risk and there are minimal government resources in this area. Creative solutions are needed to finance this high risk industry, which has the potential for high rewards in the long term.

Recognizing the dearth of green investment, the Energy Committee passed a measure to create a Clean Energy Deployment Administration (CEDA) in 2009 on a bipartisan basis, but the

Committee has now indicated that the cost of the program would need to be offset by spending reductions elsewhere in the federal budget .[90] The idea was that CEDA would reuse its funding over time to back private lending for clean energy projects, instead of only offering one-time payments in the form of grants or tax credits as previous programs have done.

Purchasers

It is a difficult sell to entice utilities to buy offshore wind energy that is priced higher than other clean energy sources and perhaps two to three times as high as some fossil fuels. Renewable performance standards are now existent in over 30 states, but they do not specify that a certain amount must be set aside or carved out for offshore wind (with the exception of New Jersey, although the offshore wind is not on-line yet so the requirement is not yet active).[91] The continual question is how costs can be brought down so that utilities can justify to their customers the pass-through of the premium for the offshore wind source. A mixture of capital cost reduction and technology enhancement, policy mandate, government procurement, and good will on the part of the utilities will be needed.

Policy Tools

Stakeholders in the offshore wind industry point to important financial tools that have spurred growth of other clean energy industries like land-based wind. The two most often cited policies are the Internal Revenue Service's investment tax credit and the Department of Energy's loan guarantee program.

One important note, however, is that neither of these programs has actually benefitted offshore wind because they apply to products that are in service or will be within a very short timeline. Given the current conservative fiscal climate and the likely expiration of some stimulus programs, it is now almost certain these programs will not benefit offshore wind unless they are renewed.

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[90] United States Senate Committee on Energy and Natural Resources. *Murkowski: Clean Energy Deployment Administration Needs Offsets*. Retrieved from: http://energy.senate.gov/public/index.cfm?FuseAction=PressReleases.Detail&PressRelease_Id=77e3a383-e3b8-48c8-972b-22ecd32cfa8f

[91] Inwood, S. (2011, June). *Program on Technology Innovation: Integrated Generation Technology Options,* pp. I-11, Retrieved from Electric Power Research Institute website: http://rfflibrary.wordpress.com/2011/07/30/program-on-technology-innovation-integrated-generation-technology-options/.

Stakeholders believe these kinds of programs and incentives in some form are necessary at the federal level to help incentivize investors and developers as well as reduce risk. These programs need to be reliable in order to make the financing models work.

Tax credits

The principle financing incentive from the federal government for the wind industry has been the Renewable Electricity Investment Tax Credit (ITC) program offered by the Internal Revenue Service (IRS). Starting in 2009 with the American Recovery and Reinvestment Act (ARRA), wind project developers can choose to receive a 30% ITC as an alternative to the production tax credit. However, the ITC is set to expire at the end of 2013 unless it is renewed. Or, as another popular incentive, they can take what is essentially cash up front: Treasury grants in lieu of 30% tax credits, designed to promote the growth of clean energy. The Treasury grants program, also known as the Sec. 1603 program, is set to expire at the end of 2011. [92] [93]

The American Wind Energy Association (AWEA) credited Sec. 1603 with enabling construction of 10,000 megawatts of new land-based wind capacity in 2009, which was 6,000 more MW than would have been installed without the program.[94]

Loan guarantees

The Department of Energy's loan guarantee program was created by the Energy Act of 2005 with the goal of helping companies commercialize new technology. The loan guarantee program guarantees the debt of privately owned clean energy developers and manufacturing companies, thereby ensuring that, if they cannot pay the balance on a loan, the government will. This is crucial for companies in early stages of technology commercialization where the product is not proven and financing would be unlikely or at a prohibitively high rate without a government guarantee.

The ARRA stimulus bill appropriated $6 billion for loan guarantees for projects in clean energy including wind energy. Several projects, including Cape Wind, are under consideration for a loan

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[92] Production Tax Credit for Renewable Energy. Retrieved from Concerned Scientists website: http://www.ucsusa.org/clean_energy/solutions/big_picture_solutions/production-tax-credit-for.html

[93] American Wind Energy Association. *Federal Policy*. Retrieved from: http://www.awea.org/issues/federal_policy/index.cfm Accessed 7/28/11. On July 28, 2011.

[94] Tax Credit For Offshore Wind Facing Another Uphill Battle. (2011, March 31). *Offshorewindwire*. Retrieved from http://offshorewindwire.com/2011/03/31/tax-credits-facing-uphill-battle/

guarantee program.[95] While the loan guarantee program has been an important source of support for clean energy industries like land-based wind, it has yet to provide one conditional commitment or close one loan for an offshore project as of April 2013.[96]

National Clean Energy Policy/Target

Clean energy targets are a major policy tool employed worldwide and increasingly in the U.S. to help foster the development of clean energy. The targets may or may not be binding. As of 2010, more than 85 countries had some form of an energy target.

The federal government has an ambitious goal. The Department of Energy's *20% Wind Energy by 2030* report produced under President George W. Bush provided a scenario in which the U.S. would generate 20% of its electricity from wind with offshore wind contributing 54GW.[97, 98] President Obama called for 80% of the nation's electricity to be generated by clean energy sources, including offshore wind.[99] President Obama's Goals for Offshore Renewable Energy include achieving 10 GW of wind capacity in the OCS and Great Lakes by 2020.[100]

Renewable Energy Standards

A renewable electricity standard (RES), also known as a renewable portfolio standard (RPS), is a policy that sets hard targets for clean energy. Today, 28 states and the District of Columbia have renewable electricity standards and seven states have renewable energy goals.

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[95] Szaniszlo, M. (2013, April 5). Mass. delegation pushes for Energy Dept. loan for Cape Wind. Boston Herald. Retrieved from http://bostonherald.com/business/technology/technology_news/2013/04/mass_delegation_pushes_for_energy_dept_loan_for_cape

[96] Edward Righter, DOE, Loan Guarantee Program (personal communication, August 9, 2011)

[97] U.S. Department of Energy, National Renewable Energy Laboratory. (2008, July) *20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply*. (NREL/TP-500-41869). Retrieved from: http://www.nrel.gov/docs/fy08osti/41869.pdf.

[98] U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*, Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf.

[99] White House Office of the Press Secretary. (2011, January 25). *Remarks by the President in 2011 State of the Union Address*. Retrieved from White House website: www.whitehouse.gov/the-press-office/2011/01/25/remarks-president-state-union-address/

[100] Department of Interior, The Bureau of Ocean Energy Management, Regulation and Enforcement. "The Bureau of Ocean Energy Management, Regulation and Enforcement, Fact Sheet: Renewable Energy on the Outer Continental Shelf" Retrieved from: http://www.boemre.gov/offshore/RenewableEnergy/PDFs/BOEMREAlternativeEnergyfactsheet.pdf

With an RES in place, the utility buys some of its energy from the clean energy source. This cost is then passed onto consumers, which effectively constitutes a tax on the consumers in that state or region that receive service from the utility. The effective tax on utility customers is argued as a reasonable policy tool, because clean energy is a public good and because the tax is necessary to help jump start the industry. The tax presumably decreases as the industry technology becomes more developed and economies of scale are achieved.

There is a threat that consumers may contest this in court, if not via the democratic process through protests and votes, which could result in the mandate being overturned.[101] In Rhode Island, the State Supreme Court just upheld the Constitutionality of the PPA between Deepwater and National Grid in the face of opposition. In Europe, nations often set electricity rates, so they do not have the problem of consumer opposition since consumers are charged uniformly throughout the country. As a result, there is some demand among economic and environmental interests for a national renewable energy standard.

R&D Investment

Public Investment – An Uncertain Future

In December 2012, DOE announced R&D awards of $168 million total for offshore wind demonstration.[102] The awards fund seven projects in Maine, New Jersey, Ohio, Oregon, Texas, and Virginia. This round of funding represents the first phase of a six-year initiative that seeks to expedite commercial offshore development in state and federal waters by 2017. Award recipients include Baryonyx Corporation (Austin, Texas), Fishermen's Atlantic City Windfarm (New Jersey), Lake Erie Development Corporation (Cleveland, Ohio), Principle Power (Seattle, Washington), Statoil North America (Stamford, Connecticut), the University of Maine, and Dominion Virginia Power (Richmond, Virginia).

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[101] George Sterzinger, Executive Director, Renewable Energy Policy Project, (personal communication, July 25, 2011)
[102] U.S. Department of Energy. (2012,December 12). DOE Wind Program Selects Seven Projects to Demonstrate Next-Generation Offshore Wind Technologies. Retrieved from http://www1.eere.energy.gov/wind/news_detail.html?news_id=18842

The DOE allocated $90 million to offshore wind research and test facilities through ARRA and FY 2009 and FY 2010 appropriated funds.[103] The following represent main areas where the research and development money was allocated.

- Wind technology testing centers
- Next generation technology
- Reducing market barriers

The majority of the dollars allocated were for major investments in technology development, including wind technology testing centers at Clemson University, the Massachusetts Clean Energy Center, and the University of Maine, as well as investment in next generation technology at the University of Maine. There were also several studies and plans funded for specific projects and regions to reduce market barriers. See Appendix I for more detail on these DOE funded programs.

The DOE also unveiled awards of $43 million in funding to 41 new offshore wind power projects. The awards announced on September 11, 2011 ranged from approximately $200,000 to $4 million. The grants were for technology development and for removing market barriers. The highest awards of about $4 million each were for innovative offshore wind turbine development and went to Alstom Power in Richmond, Virginia, Sandia National Laboratories in Albuquerque, New Mexico, Siemens Energy, Inc. in Orlando, Florida and Zimitar, Inc. in San Francisco, California.[104] Given the current drive toward deficit reduction, it is uncertain at what level the federal government will make such investments in offshore wind technology moving ahead.

Private Investment – Testing the Waters

In terms of clean energy, wind is the most popular renewable source for investors. Fifty percent, or about $17 billion, in U.S. investment in clean energy in 2010 was directed to the wind sector. However, offshore and onshore wind are conflated in this figure, so the amount of offshore investment is unknown. It is safe to say that onshore wind captures the lion's share of the

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103 U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*, p. iii, Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf.

104 U.S. Department of Energy. Secretary Chu Unveils 41 New Offshore Wind Power R&D Projects. Retrieved from: http://energy.gov/articles/secretary-chu-unveils-41-new-offshore-wind-power-rd-projects

investment, while offshore wind captures a small amount that is subject to the risk assessments of investors, the overall drag in the economy, and other factors.

Globally, investment in wind energy leads all other forms of clean energy, followed by solar energy, which did have a faster growth rate in 2010. Wind level investments increased globally by 34 percent in 2010, while solar investments increased 59%.[105] Analysts say offshore wind comprises a growing segment of the wind sector though precise levels of investment are not available, largely because much investment is early-stage venture capital where the dollar amount is not disclosed.[106]

Investment in the U.S. offshore wind sector is coming from the following sources.

In-house R&D—Existing U.S. land-based turbine manufacturing companies are investing in-house in the development of products for the offshore market.

Foreign Investment—Foreign companies are investing independently or in partnership with U.S. companies.

Venture capital (VC)—Investors are providing significant cash outlays for early stage development energy companies and securing an equity stake in those companies.

In-House R&D – Major OEMs Developing for Foreign Market

There are some visible fruits of research and development taking place at existing companies with substantial market share in the land-based wind turbine market.[107] General Electric has developed a 4.0 model in Europe, and Clipper is developing an even larger 10.0 turbine.[108]

Venture Capital – Critical for Industry Takeoff

There is a tradition of strong U.S. venture capital investments in clean energy relative to other countries, and it is hoped VC will fuel the offshore wind industry as well. When it comes to clean

105 Ibid.

106 The Pew Charitable Trusts. (2010 Edition). *Who's Winning the Clean Energy Race? G-20 Investment Powering Forward*. P. 46. Retrieved from http://www.pewtrusts.org/our_work_report_detail.aspx?id=57969 on July 15, 2011.

107 George Sterzinger, (personal communication, July 25, 2011)

108 Lucas, Martin and Stergoulis,Evan. (2011, October). A legal perspective on making offshore wind bankable – some experiences from the European Offshore Wind Market. Presented Presentation at the AWEA Offshore Windpower Conference and Exhibition, Baltimore, Maryland.

energy, the U.S. venture capital market is a crucial source of finance. The U.S. accounted for 73% of total venture capital investment in clean energy among all G-20 countries in 2010.[109]

However, the long delay and relatively barren output thus far from investment in the offshore wind industry, the sluggish economy and the uncertainty of the regulatory environment, as well as the presence of incentives are all limiting factors on VC outlays for the offshore wind industry. Additionally, Pew reports that investors are hesitant to commit money because the United States' commitments to clean energy have a "lack of clarity" and there is an "uncertainty surrounding continuation of key financial incentives."[110]

There is also a strong tradition in the U.S. of political support for fossil fuel industries due to powerful lobbies in coal, natural gas, and other energy industries. Because these resources are concentrated in different parts of the U.S., energy policy has often developed according to regional energy interests, thereby hindering development of a national energy policy and introducing the possibility of multiple veto points into the process for any particular clean energy initiative. Confronting this hurdle, among others, is the goal of the next section of this report.

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[109] The Pew Charitable Trusts. (2010 Edition). *Who's Winning the Clean Energy Race? G-20 Investment Powering Forward*, p. 46. Retrieved from http://www.pewtrusts.org/our_work_report_detail.aspx?id=57969 on July 15, 2011.
[110] Ibid.

HURDLES AND SOLUTIONS: OFFSHORE WIND ENERGY MARKET

The U.S. offshore wind industry has encountered numerous hurdles in the past decade. While many projects are in the pipeline, none have been built. Projects have faced various hurdles, including high capital costs, difficulty finding buyers in the marketplace and a complicated and drawn-out permitting and regulatory framework. Given that the U.S. is one of the world's leaders in land-based wind, the delay in getting even one offshore wind farm on-line is confounding to many.

Economic developers bring a wealth of experience in helping new industries get off the ground and can apply tools and expertise to help the offshore wind industry overcome hurdles and achieve take-off. Economic developers can play a proactive role supporting the development of the supply chain, workforce and infrastructure. Additionally, they can help inform policymakers on conditions and incentives in the regulatory and policy environment that will help foster sound and sustainable growth.

The goal of this chapter is to identify and discuss the main hurdles facing the offshore wind industry. Additionally, the chapter identifies potential economic development strategies to help overcome these hurdles as well as providing examples of initiatives that have been implemented. Hurdles can be summarized into the following categories:

Supply-side Hurdles - Supply-side hurdles relate to high capital, operating and financing costs that make it difficult to get wind farms up and operational.

Demand-side Hurdles – Demand-side hurdles relate to securing purchasers for the offshore wind energy, which is often priced higher than fossil fuels and other renewable energy sources.

Regulations and policy hurdles –The complex and long regulatory and permitting process has delayed projects for years. The industry also faces an uncertain environment for new and existing policies that help promote the industry.

Political hurdles - Many believe the U.S. is hindered compared to other countries because it lacks a unified national energy policy that includes binding commitments for renewable energy. At the local or project level, there are challenges from opposition stakeholders representing property, economic, energy and other interests.

Offshore Wind Energy: Hurdles to Development			
Supply-side	**Demand-side**	**Regulatory and policy**	**Political**
• Invest in turbine R&D (such as incubator) • Assist in regional grid planning • Identify synergies with existing industries (i.e. oil and marine-based) • Create stimulus for ship-building • Support financing streams for investors • Identify/retool existing businesses in supply chain • Provide workforce training with local partners • Attract FDI and forge foreign partnerships	• Support "carve-outs" for offshore wind • Structure incentives in RPS • Provide production incentives (i.e. ITC) • Establish government procurement program	• Streamline the approval process • Improve coordinated review • Support tax credit programs	• Align communication strategies • Use proactive growth strategies in a recession • Engage and respond to opposition stakeholders • Public education to garner understanding and support for offshore wind

Supply Side Issues – How to Overcome High Costs

Offshore wind technology is more expensive than fossil fuel sources and some renewable energy sources. Capital costs and operating costs are high. This can be a disincentive to investors worried about the viability of supporting the industry. Financing costs can add significantly to the project's budget and play a "make or break" role.

Offshore wind farms incur high costs due to the lack of experience in the industry as well as high costs associated with building and operating installations that meet the demands of the marine environment. A fully installed offshore wind farm comes at a cost of about $4,600/kW, which comes close to being twice the cost of a land-based wind farm, which costs about $2,400/kW.[111]

Ultimately, proponents believe the long-term efficiency gains from offshore wind are undeniable and will more than compensate for short-term investments. Offshore wind velocity is stronger and steadier than onshore wind, enabling offshore turbines to operate at a higher capacity. Offshore wind also corresponds more with peak hour electricity usage for coastal cities. Thus, the strongest winds deliver energy supply at periods of high demand, which leads to more competitive pricing for offshore wind energy.[112] Once captured, the cost of the wind energy is free – that is to say, it is inexhaustible and there are no marginal costs per additional unity of energy. In the short term, however, costs may actually increase until the industry develops the next generation of higher-capacity, more efficient wind farms.

The major components of cost for an offshore wind farm include:

- Capital costs (turbine, electrical infrastructure, support structure, logistics and installation)
- Operating and maintenance costs (O&M costs)
- Financing costs
- Project development and permitting costs

Capital costs and O&M costs are projected to increase in the short term due to aggressive development, learning costs associated with a new industry and other factors. In order to achieve long-term efficiency gains and reduce costs, technology, scale and skill all need to be further

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[111] Wood, Elisa. (2010, March 22). Offshore Awakening: US Investment Flows to Offshore Wind. *RenewableEnergyWorld.com*. Retrieved from http://www.renewableenergyworld.com/rea/news/article/2010/03/offshore-awakening

[112] U.S. Department of Energy & U.S. Department of the Interior, Beaudry-Losique, Jacques et al. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States, p. 7*. Retrieved from: http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf

developed and enhanced. This will require strategies and initiatives including research and development, supply chain development, workforce development and regional planning.

Hurdle

Capital costs for offshore wind farms are higher than for onshore wind farms.

The offshore industry is in a "steep development phase"; capital costs for offshore wind farms have been on the rise as wind farms generate higher capacities of energy and operate in waters that are deeper and further from shore. According to one study from the United Kingdom, offshore wind farm capital costs more than doubled from 2005 to 2010.[113] For the currently proposed projects off the U.S. Atlantic coast and in the Great Lakes, the cost of offshore wind is more than the originally projected range of 13 to 16 cents and closer to 20 to 30 cents. Additionally, in some places, onshore wind is being sold much cheaper than 7 to 14 cents, with some estimates for between 4 and 6 cents in states like Texas.[114]

Major capital costs components are:

- Electrical Infrastructure/Transmission Systems
- Turbines
- Support Structure (Foundations)

Electrical infrastructure and turbines both comprise about 40 percent of project costs. This differs from the cost structure for the land-based wind industry, where turbines are by far the highest capital cost component and transmission costs are relatively lower.

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[113] Willow, Christopher & Valpy, Bruce. (2011 June). *Offshore Wind: Forecasts of future costs and benefits*, p. 8. Retrieved from RenewableUK website: http://www.bwea.com/pdf/publications/Offshore_report.pdf
[114] 15. Kim K Zuhlke, Little Blue Ridge LLC, (personal communication, August 22, 2011)

ED Strategies

Invest in R&D and regional planning

Process and product innovations in offshore turbines can result in significant cost savings. In addition, regional planning can help adapt products for a larger scale, resulting in a savings in per unit capital costs.

Hurdle

Electrical Infrastructure and Transmission Systems – Super Grids

Offshore wind projects face high capital costs associated with infrastructure – specifically the high-voltage electrical cables on the ocean floor that connect the offshore farm to the electrical grid. For projects in 2011, the cost of the electrical system was estimated to account for about 40 percent of total capital expenditures for wind farms in the United Kingdom.[115] Costs of transmission are mediated by several forces, including distance from wind farm to the grid, the conditions of the ocean floor, and upgrades to the transmission system to accommodate increased loads. Because of heavy transmission costs, it is important to anchor wind farms near substations on the existing land-based grid. The best candidates are substations that both have the capacity to support the additional load from the offshore farm and are located a minimal distance away.

Another large cost variable is related to the kind of cable used. So far, the industry standard for wind farms constructed close to the shore is alternative current (AC) export cables. However, for proposed wind farms in Europe and the United States that are greater than 80 kilometers from the grid, high voltage direct current (HVDC) systems are now favored. Currently, there is a shortage of HVDC cable. This is one of the two major bottlenecks to the development of the offshore industry, in addition to the shortage of vessels.[116]

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[115] Willow, Christopher & Valpy, Bruce. (2011 June). *Offshore Wind: Forecasts of future costs and benefits*, p. 5. Retrieved from RenewableUK website: http://www.bwea.com/pdf/publications/Offshore_report.pdf

[116] European Wind Energy Association (2011). *Wind in our Sails*. Retrieved from European Wind Energy Association website: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/23420_Offshore_report_web.pdf

One of the main problems associated with offshore wind is its variability – the energy generates depends on the time of day and season of year. Ultimately, grids will need to service multiple wind farms in order to achieve economies of scale as well as an efficient energy delivery system that can mitigate wind's natural volatility.

ED Strategies

Regional grid planning

A regional grid draws energy from a source of wind at any given time and location on the grid and circulates it to provide a more stable energy supply. Economic developers should promote regional strategies to reduce grid costs.

Example Initiative - Europe's Super Grid - Europe is developing a supergrid, or a series of undersea grid connections that will allow energy to be produced on a regional rather than national scale. The grid would connect cables off the Atlantic coast of UK, France, Denmark, Netherlands, Germany, Ireland, Belgium, Norway, Sweden and possibly Spain and Portugal. More than 100GW of offshore wind projects are at some stage of development in Europe, and they are candidates for integration into the grid. In December 2010, ministers signed the Northsea countries Offshore Grid Initiative Memorandum of Understanding, which is the latest step in the program. The project also hopes to capture synergies with other sources of marine energy – including harnessing wave energy into the grid. [ii]

Example Initiative – Atlantic Grid Holdings - Atlantic Grid LLC has proposed a direct current subsea transmission system, which would transport power from winds 12-15 miles off the U.S. eastern seaboard to cities in New York, New Jersey, Delaware, Maryland and Virginia. The transmission lines would accommodate 7,000 MW of wind energy. The project is being reviewed by DOI as of mid-2012.[i]

Example Initiative - Atlantic Wind Connection Project – The Trans-Elect Development Company has announced a $5 billion project for a transmission line up and down the Atlantic coast. The underwater cable infrastructure will serve as a "backbone" that is expected to have a final capacity of as much as 7,000 MW. It will connect Virginia to northern New Jersey and potentially New York City. The first of five phases is expected to be constructed by 2016, connecting Northern New Jersey with southern Delaware with a 2,000 MW capacity. [iii]

Hurdle

Turbines – Working on the "Next Generation"

Capital costs are rising with the development of larger, higher-capacity turbines built to capture more energy and operate further from the shoreline. Along with the grid system, turbines are the highest capital cost, accounting for about 40 percent of total costs. This is projected to rise from 40 percent to 44 percent by 2022.[117] Turbine size has grown from an average of 0.5 MW in the 1990's to an average of 3 MW from 2000 to 2010. From 2015 to 2030, they are projected to average in size to be between 5 and 6 MW.[118] It is projected that the cost of the turbines will increase in the medium term but will level out or decrease in the long term.

ED Strategies

Greater Turbine Efficiency

Economic developers can encourage turbine R&D by U.S. companies as well as initiate plans to site domestic manufacturing of these turbines and their components.

Example Initiative - General Electric is developing turbines that have higher capacity and efficiency. The LEEDCo wind farm project north of Cleveland will employ 54 MW turbines. Each weighs 225 tons and spins three 176-foot blades that are longer and lighter than the average turbine blade. The turbine operates without many of the moving parts (i.e., gearbox, starter brushes and coils), reducing maintenance, and also draws no power from the electric grid to achieve its momentum, increasing efficiency.[119]

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[117] Willow, Christopher & Valpy, Bruce. (2011 June). *Offshore Wind: Forecasts of future costs and benefits*, p. 5. Retrieved from RenewableUK website: http://www.bwea.com/pdf/publications/Offshore_report.pdf

[118] Reuter, Guido. (2010, October). Realizing local economic benefits from offshore wind projects. Supply *Chain America, Siemens Wind Power*. Presentation at AWEA North American Offshore Wind 2010 Conference & Exhibition, Atlantic City, New Jersey.

Research and development can also be done into the production of offshore turbines that incorporate wave (hydrokinetic), tidal and ocean current energy systems. This will result in still more energy potentially being captured by a wind farm installation.[119]

Hurdle

Support Structure/Foundations – Adapting to Deeper Waters

Offshore facilities must bear not only the costs of turbines, but foundations, towers, transmission and installation related to a complex design system. These must harness wind energy while bearing up under storms, waves and tides. Foundations cost about 19 percent of total capital expenditures in 2011, and this is projected to rise in the future, by one measure to 22 percent by 2022.[120] Costs rise as foundations must accommodate deeper water conditions. By one measure, each meter of tower height is an additional $2,000.[121]

The majority of foundations currently used are cylindrical, steel monopoles, but these structures are unable to provide resistance to larger loads from stronger waves further offshore. As a result, there are likely to be increased R&D and capital costs involved in the transition to the next generation of foundations. Many currently proposed projects in deeper waters will require other designs such as space-frames, tripile and concrete gravity-based foundations. In the longer term, for waters in even greater depths (i.e. >90m), floating turbine designs may also be used. This will incur higher capital expenditures, at least until they are fully transitioned into the market.

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119 Cerezon, Luis and Rosinski, Stan (2011, July). *Wind Power: Issues and Opportunities for Advancing Technology, Expanding Renewable Generation and Reducing Emissions,* p. 9, Electric Power Research Institute.
120 Ibid, p. 5.
121 Wood, Elisa. (2010, March 22). "Offshore Awakening: US Investment Flows to Offshore Wind. " *RenewableEnergyWorld.com*. Retrieved from http://www.renewableenergyworld.com/rea/news/article/2010/03/offshore-awakening on July 15, 2011.

ED Strategies

Synergies with Existing Industries

Just as in the case of turbines, economic developers can help the U.S. be in the forefront of developing technology for foundations. The oil industry, which employs platforms and foundations for deep sea drilling operations, may be one source of synergy in R&D.

Example Initiative – Maine's Advanced Turbine Development – Currently, various research and development is occurring at the AEWC Advanced Structure and Composites Center housed at the University of Maine. The Center is invested in the "next generation" of turbines, which service depths of up to 60 or 90 meters. The DOE is supporting a multi-year research program focused on the development and testing of floating offshore wind energy platforms. The University of Maine was also selected by DOE in 2009 to lead a 35 member university-industry consortium focused on R&D for deepwater development.[122]

Hurdle

Logistics and Installation – Developing and Adapting Port Infrastructure

Ports and terminals must be developed along the U.S. coastline that are able to efficiently and safely service offshore operations. Currently, few are in a position to do this. Logistics and installation account for about 23 percent of total capital expenditures in 2011, though unlike turbines and foundations, this component may actually see effective cost controls in the near future. By one estimate, it could reduce to 18 percent of total capital costs by 2022.[122] However, given that the U.S. industry is in its infancy and there are no staging ports serving wind farms, it seems possible this component could be higher for U.S. offshore wind farms.

[122] Willow, Christopher & Valpy, Bruce. (2011 June). *Offshore Wind: Forecasts of future costs and benefits*, p. 5. Retrieved from RenewableUK website: http://www.bwea.com/pdf/publications/Offshore_report.pdf

Ports and terminals servicing offshore wind farms have some unique requirements. While a traditional port handles cargo with a focus on containers, an offshore wind port handles cargo and also large bulky objects, pre-assembly (staging) materials, manufacturing, testing while additionally serving as a transit point for the crew travelling to and from the wind farm. It might be considered partly a port, partly a shipyard and partly an operations headquarters.[123]

ED Strategies

Synergies with Oil and Marine-Based Industries

Confronting this hurdle means adapting ports that are already good candidates with potential to serve the offshore industry as well as developing new ports. Some ports in the U.S., especially in the Gulf of Mexico, are already well-positioned in terms of land area, infrastructure and skilled personnel as a result of serving as a staging area for the oil and gas industries and its large tankers. Outside the Gulf region, ports may have to undergo more upgrades to allow them to accommodate oversized vessels.

It is necessary to identify sites that already meet some base criteria, such as adequate quayside length. An offshore port must have a sufficient land area equipped with cranes and lifting appliances to offload components including wind blades and outload them to installation vessels. It is also optimal that this port be of a sufficient size – and in a central location – to service multiple wind farm projects.

Example Initiative – Paulsboro, New Jersey Port - The Paulsboro, New Jersey port has been identified as possessing the requisite features to accommodate offshore wind: deep water, the ability to accommodate large barges and shipping vessels, central location in New Jersey as well as direct access to the entire Atlantic region. With the hope that the port can become a hub for the state and region, the state's Offshore Wind Act is providing up to $100 million in tax credits to companies that set up wind energy facilities at the port. Other waterfront sites such as Perth Amboy, New Jersey are also positioning themselves to benefit from state incentives.[124]

[123] Nerland, Christian. (2011, October). Onshore Infrastructure for Offshore Wind Development. *Det Norske Veritas*. Presentation at the AWEA Offshore Windpower Conference and Exhibition, Baltimore, Maryland.

Hurdle

Operating and Maintenance Costs - Marine Challenges and the Jones Act Wildcard

Offshore wind farms incur high costs for operating and maintenance (O&M). This is primarily due to inexperience in the industry, complicated access to installations and the extra demands of the marine environment. In addition, legal restrictions in the Jones Act are a wildcard in the cost equation. The largest shares of O&M expenses are:

- Condition Monitoring
- General Maintenance
- Health and Safety Inspections
- Environmental Impact Monitoring
- Personnel (i.e. Engineers and Technicians)
- Vessel Charter Costs
- Building Rentals
- Port Berthing Fees

In the short-term, these costs are projected to rise while the industry develops, but they may decline once expertise is established and economies of scale are realized. Operating costs may go down as a function of increasing turbine size; it costs less to maintain fewer, larger turbines.[124]

Hurdle

Financing Costs – "Make or Break"

One O&M cost likely to differ substantially for U.S. developers in comparison to European wind farms is the cost of vessels for installation and maintenance. Mark Rodgers, spokesman for the Cape Wind project in Massachusetts, said in September 2011 that "the biggest single challenge

[124] Willow, Christopher & Valpy, Bruce. (2011 June). *Offshore Wind: Forecasts of future costs and benefits*, p. 7. Retrieved from RenewableUK website: http://www.bwea.com/pdf/publications/Offshore_report.pdf

for the industry is installation vessels."[125] The shortage of ships has been identified as the main bottleneck in Europe, and the Jones Act only compounds the problem for the U.S. Offshore wind farms require "Jones Act Qualified" vessels that are U.S. owned. Currently there are none. As a result, there will be significant costs in the short term related to finding ships that can service new offshore farms. There are two principle short-term solutions: 1) leasing oil and gas boats that are adapted for offshore purposes from the Gulf (as is the plan for Cape Wind), or 2) employing a combination of U.S. and European vessels (as was the plan for NRG Bluewater Wind in Delaware). In the second scenario, NRG Bluewater plans to technically abide by Jones Act regulations by having those U.S. vessels take components out to the European vessels, who will then install them.

ED Strategies

Shipbuilding Stimulus

There needs to be a short-term plan to deal with the shortage of vessels either by leasing foreign vessels and/or adapting oil and gas vessels from the Gulf. There also needs to be a long-term strategy in place that may involve incentivizing the shipbuilding industry to begin production. The investment is hefty – the estimated cost of each ship is 200 million Euro/260 US dollars.[126] Government can take measures that support the risk related to the investment involved in building vessels.

Financing can ultimately make or break a project. Financing and discount rates are uncertain, depending on a variety of factors: the regulatory environment, capital and operational costs in a new industry and government support for the industry. The cost of capital for a project can vary between 4 percent and 20 percent based on risk allocation. A project with government ownership or a government loan guarantee is likely to be at the lower end of the spectrum compared to a

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[125] Wickless, Andy. Navigant Energy. (11 October, 2011) . "American Opportunities in the Offshore Wind Energy Supply Chain." Presented at the AWEA Offshore WindPower 2011 conference. Baltimore, Maryland.

[126] Fichaux, Nicholas & Wilkes, Justin. (2009). *Oceans of Opportunity: Harnessing Europe's largest domestic resource*, p. 55. Retrieved from European Wind Energy Association website: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/Offshore_Report_2009.pdf

leveraged project, or a project that is all equity.[127] The project capital cost can also vary incredibly based on discount rate.

ED Strategies

Support various financing streams

Economic developers should support the continuation of reliable tax benefit, loan guarantee and other programs (especially the ITC) that give investors some protection from risk and help drive down discount rates.[128] Other ways to financially assist the industry in its infancy include identifying or creating a dedicated funding mechanism. The persistent lack of financing for clean energy projects has been taken up by Congress, such as through the proposed creation of a Clean Energy Deployment Administration to back private lending. However, this has been stalled due to budget deficit reduction measures and looks unlikely to come to fruition.[129]

Hurdle

Identifying and Retooling Existing Businesses in Supply Chain

ED Strategies

Supply Chain Identification

Economic developers can support efforts to identify existing businesses in the supply chain that will manufacture products and provide services to the industry. Existing businesses will come from the land-based wind industry as well as manufacturing and marine-based industries. Existing businesses will need to retool or adapt their manufacturing for the offshore industry and in some

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127 Levitt, Andrew, Kepmton, Willet & Firestone, Jeremy. (2010, October 7). "Cost of Energy for Offshore Wind in the United States. *University of Delaware and NREL*. Presentation at AWEA North American Offshore Wind 2010 Conference & Exhibition, Atlantic City, New Jersey.
128 Ibid.
129 United States Senate Committee on Energy and Natural Resources. (2011, May 3). Murkowski: Clean Energy Deployment Administration Needs Offsets. (Press Release). Retrieved from http://energy.senate.gov/public/index.cfm?FuseAction=PressReleases.Detail&PressRelease_Id=77e3a383-e3b8-48c8-972b-22ecd32cfa8f

cases (i.e. for Midwestern suppliers), figure out distribution channels to service offshore wind farms. Because many offshore components are oversized and thus have high transport costs, the trend of "decoupling" which has been observed internationally is expected to continue. While many of the products developed for offshore wind were from suppliers to the land-based industry, there is emerging an increasingly specialized, dedicated supply chain for the offshore wind industry.[130]

Hurdle

New Businesses May Lack Financing and Lack U.S. Market

The U.S. has traditionally led the world in innovation in new industries and can do so in the offshore industry as well. The industry is currently in a steep development phase, and new specialized firms are just starting up worldwide to meet the different design and operating requirements for offshore wind farms. The U.S. is not necessarily far behind if it enters at this stage in the innovation curve.

ED Strategies

Offshore Wind Incubator

Support innovation for dedicated supply chains for the offshore industry. Given the large existing market abroad and the potential domestic market, the time is already ripe for increased innovation in offshore wind.

Example Initiative - Carbon Trust Offshore Wind Accelerator - In the United Kingdom, a team of international and British wind farm developers, energy companies, state owned utilities and other partners collaborated in a 40 million pound project with the goal of reducing the cost of offshore wind by 10 percent. The Carbon Trust Offshore Wind Accelerator would accelerate the development of new innovations in the industry. The group is funding research into four key areas: foundations, access, electrical systems and array design.[131,132]

[130] Wickless, Andy. (11 October, 2011) . American Opportunities in the Offshore Wind Energy Supply Chain. *Navigant Energy*. Presentation at the AWEA Offshore Windpower Conference and Exhibition, Baltimore, Maryland.

Until the domestic market develops, new businesses can find ample opportunities for revenue in the foreign market. There is a projected need for 30 GW of offshore wind production in Europe in the next five years. This will require 10,000 turbine structures and all the component parts and technology by 2020.

Develop Products for Export Market

Some companies have arisen to serve the global markets: American Semiconductor and Principle Power are developing and commercializing technology for the offshore foreign market.

Hurdle

Lack of skilled workforce

The U.S. lacks a skilled workforce to operate wind farms in the marine environment. In order to obtain financing, U.S. projects will need experienced offshore wind crews to work on the wind farms. There will be a shortage of such workers, and at the onset, Europeans who have the expertise will likely be employed. However, Europe is even facing a shortage of skilled workers for the growing offshore wind industry. In particular, project managers, operations and maintenance technicians and electrical engineers are among the jobs in short supply.[131][132]

ED Strategies

Workforce Training with Local Educational Partners

The industry will need to develop local education programs, some of which have been already proposed by developers working with community colleges.

Workforce Training Abroad

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[131] Fichaux, Nicholas & Wilkes, Justin. (2009). *Oceans of Opportunity: Harnessing Europe's largest domestic resource*, p. 62. Retrieved from European Wind Energy Association website: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/Offshore_Report_2009.pdf

[132] European Wind Energy Association. (2009, January). *Wind at Work: Wind energy and job creation in the EU*. Retrieved from: http://www.ewea.org/fileadmin/ewea_documents/documents/publications/Wind_at_work_FINAL.pdf

U.S. companies should be encouraged to grow in the offshore market abroad. By placing facilities or personnel there, they not only tap into the market, but they train workers who can later service U.S. offshore wind farms.

Work With Unions

Developers should work with unions and enlist them as partners in advance of and at the start of a project. Many trades, including the electricians and seafarers, have an infrastructure of training academies for their union workers.

Hurdle

Lenders are risk averse, restricting the supply of financing

In order to get the industry off the ground in a high-cost, high-risk environment, public and private sources of financing are key. In addition to the government, private angel investors are crucial. For example, Google just invested a large amount in the Atlantic Coast grid project. Another important financing source is foreign investment from established companies who may set up operations alone or in partnership with an American company.

ED Strategies

Support Government Programs that Mitigate Risk

Lenders need security in order to release the funds to the developers. For this reason, government policies including loan guarantees are crucial to helping the industry get off the ground.

Hurdle

Difficulty in attracting foreign investment to the U.S. offshore industry

Foreign investment is an important element to growth of the offshore industry, especially in the short term. Foreign companies have already created hundreds of jobs in the U.S. land-based wind industry. Many foreign companies are already fully operational in Europe and need only transplant their offshore technologies and business plan here. In time, the U.S. will also have home-grown expertise.

While many foreign companies are staying on the sidelines until wind farms are actually operational, some are starting to eye the U.S. market in advance of its take off. In attempts to attract foreign investors, a similar set of factors that applied to companies in the land-based industry applies. Siemens indicated their decision to "localize" or bring a facility to the U.S. was motivated by factors including:

- Significant and predictable incentives schemes
- Clear and consistent local content requirements
- A developed local supply chain
- Clear and fast approval processes
- Clarity on responsibility for grid connections
- Financing availability
- Local community support and local infrastructure.[133]

ED Strategies

Attract FDI and Forge US-Foreign partnerships

Economic developers should focus on efforts to attract FDI from the offshore wind industry, especially foreign companies that might partner with U.S. companies. One example is Gamesa, who is collaborating with Northrup Grundman on a project in Chesapeake, Virginia.

Demand Side Issues – Finding or "Making" the Market

Currently, offshore wind energy is higher than the price of fossil fuels as well as some renewable sources. Competition against land-based wind energy and solar energy can limit the demand for offshore wind and in turn discourage investment. Thus, offshore wind faces challenges to finding a purchaser.

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[133] Reuter, Guido. (2010, October). Realizing local economic benefits from offshore wind projects. Supply *Chain America, Siemens Wind Power*. Presentation at AWEA North American Offshore Wind 2010 Conference & Exhibition, Atlantic City, New Jersey.

Hurdle

The Renewable Energy SubMarket – Competing Against Land-Based Wind and Solar Energy

Price differentials vary from market to market. In New England, there is generally limited onshore wind, and solar energy is more expensive than in sundrenched markets such as the Southwest. New England also has the highest fossil fuel energy prices in the country and is one of most dense and populous markets for electricity. For this reason, it is believed that offshore wind can fare well there, especially in the long term after prices start to benefit from experience and sale in the industry.

In some energy-rich places, offshore wind may have a harder time competing because of the presence of cheaper renewable energy as well as fossil fuel. Markets in the Midwest such as the Great Lakes region are home to a strong land-based wind supply. Likewise, Texas has both onshore wind and natural gas sources that are indigenous and plentiful. In these places, offshore wind will have to compete at an even lower price point in the energy market.

ED Strategies

Set-aside/Carve-out

Until offshore energy can better compete with other renewable energies, renewable standards need to have a "carve-out" or set-aside. These are an additional requirement for a portion of the total renewable energy to come from a specific source such as offshore energy. So far, only New Jersey has a carve-out for offshore wind in its renewable production standard.

Hurdle

The Challenges of Finding Buyers and Securing Purchase Power Agreements (PPAs)

In order to obtain financing, developers need long-term purchase agreements that provide the guarantee of cash flow for 15 to 25 years. Purchase power agreements (PPAs) are the current mechanism for this guarantee. However, utilities and energy purchasers are assuming a higher degree of risk when they enter into a PPA for offshore energy. As a result, only a few have been established

Successful PPAs have required some sort of outside support, either state policy that: 1) helps the utilities financially bear the burden of the higher cost, and/or 2) spread it out over a larger population of electric consumers. Successful PPAs also require building partnerships with utilities to align economic development goals.

ED Strategies

Incentive-based PPAs

PPAs could be structured to allow utilities to defray or spread higher costs of renewable energy over a wider service area.

- **Example Initiative – Renewable Energy Credit Incentive** - In the case of the PPA between Bluewater Wind Delaware LLC and Delmarva Power & Light Co., a key factor was the utility's receipt of a 350 percent credit toward meeting Delaware's renewable portfolio standard and a legislative requirement that costs arising from the PPA be distributed evenly through all of Delmarva's customer base.
- **Example Initiative – Cost Sharing** - In New Jersey's renewable certificate program, utilities and energy purchasers are mandated to buy renewable energy credits, and the costs are spread throughout the state beyond the area of the utility that is proximate to the wind farm.
- **Example Initiative – Equity -** The U.S. Offshore Wind Collaborative (USOWC) suggests that utilities entering into PPAs might seek equity in an offshore wind project in order to prevent any losses incurred from showing up as liabilities on the books.[1] However, this is not likely to be financially feasible without changes to PUC regulations.

Finally, another strategy is encouraging utilities to adjust their cost comparison to consider other factors. For example, it may make sense for utilities to hedge against potential increases in the price of fossil fuels by investing a share of their energy purchase in offshore wind – thus diversifying their portfolio.

Many projects are unable to find a buyer for their energy. This has led many to call for "market-making" mechanisms that involve a stronger role for government. These mechanisms include direct subsidy, government procurement or a national standard for renewable energy.

> **Hurdle**
>
> *A lack of market making mechanisms*

ED Strategies

Funding Assistance for Energy Production
Some say that the government should directly subsidize the offshore wind industry, at least in parity with subsidies for the oil and gas industry. The investment tax credit (ITC) can help achieve some support by providing a tax credit for investment expenditures.

Government Procurement
This involves the government boosting demand for the market as a direct consumer of offshore energy through a procurement program. This may provide a short-term fix until the product develops to the scale that it is viable on the private market.

The Regulatory and Policy Environment

Government plays a crucial role in determining if and when the offshore wind industry gets off the ground. They are active as regulators and as well as stimulators for the industry.

> **Hurdle**
> *The Permitting Process – Coordination and Streamlining Initiatives*

The permitting process is characterized by multiple agencies at different levels of government, often with overlapping jurisdictions. Over 15 federal statutes and 10 agencies have mandate and authority to review and/or approve aspects of offshore wind projects. These agencies have concerns including environmental and cultural resources, historic preservation sites, protected areas such as marine sanctuaries and wildlife refuges, and competing uses such as for ship navigation, commercial fishing and Department of Defense Training[134]. As a result, the typical timeline for projects to get permitted has been seven to ten years.[135] The process for getting permits approved to build offshore wind farms in federal waters is cited by many as the principle source of delay for the projects in the pipeline. As a recent Department of Energy report reflects, the offshore wind industry is facing a new and untested permitting process for a nascent industry in which there is no "institutional knowledge about offshore wind energy facilities."[136] Thus, while permitting for land-based wind facilities can take between one and two years, offshore wind farm projects are in suspension for years.

ED Strategies

Streamline approval process

Economic developers should advocate shortening the timeline for permitting new projects and simplify the process to reduce overlap and multiplicity of actors.

- **Example Initiative - Smart from the Start -** In order to respond to these bottlenecks and help the offshore wind industry, the federal government is trying to streamline its own regulatory process. The Smart from the Start initiative could shorten the permitting timeline for projects by more than half[137]. This initiative is attempting to directly address issues related to energy resource planning, sitting and permitting as well as complementary infrastructure needs. Under Smart from the Start, the Department of the Interior aims to: 1) Streamline the approval

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134 U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*. Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf

135 U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*, p. 17. Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf.

136 U.S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*, p. 10-12. (NREL/TP-500-40745). Retrieved from www.**nrel**.gov/**wind**/pdfs/40745.pdf

137 U.S. Department of Energy. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*, p. 17. Retrieved from http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf on July 20, 2011.

process and implement a comprehensive and expedited leasing framework; 2) implement a leasing framework by identifying wind energy areas (WEAs) on the Atlantic Outer Continental Shelf and conducting environmental reviews; and, 3) moving forward separately to process applications to build offshore transmission lines.[138]

To date, DOE is identifying Wind Energy Areas (WEA's) deemed as potential lease areas and has conducted a draft regional environmental assessment on WEAs in the first four target states of New Jersey, Delaware, Maryland and Virginia.

Improve Coordinated Review

Economic developers should support measures to coordinate project review processes by state and federal actors as another important way of shortening the length of the project timeline. Indeed, this will be necessary as projects cross state lines (such as proposed underwater infrastructure projects.)

Hurdle

Policy Incentives – Crucial Stimulus Tools for Offshore Wind

Key programs that have helped other industries grow are under threat of being suspended or terminated. The principle federal financing incentive for the land-based wind industry has been the PTC. With ARRA, wind project developers can alternatively choose to receive a 30 percent ITC, which will be more critical for offshore wind at this early stage. Another popular incentive is the Section 1603 program, which provides cash up front or grants in lieu of 30 percent tax credits.[139,140]

The reliability and the continuity of the investment tax credit are crucial to the wind industry – as the example of the onshore wind industry shows. The American Wind Energy Association credited

[138] Ibid, p. 13.
[139139] Union of Concerned Scientists. (2011). *Production Tax Credit for Renewable Energy*. Retrieved from http://www.ucsusa.org/clean_energy/solutions/big_picture_solutions/production-tax-credit-for.html
[140] American Wind Energy Association. (2011). *Federal Policy*. Retrieved from http://www.awea.org/issues/federal_policy/index.cfm

Sec. 1603 with enabling construction of 10,000 MW of new land-based wind capacity in 2009 — 6,000 more MW than would have been installed without the program.[141] However, the PTC was allowed to expire in 1999, 2001 and 2003 – and this was correlated with 2000, 2002 and 2004 being the only years since 1999 that there has been an annual drop in new onshore wind installations.[142,143] The production tax credit is again set to expire in 2012.

The short life span and uncertain renewals of the tax credit program are incompatible with the development timeline of offshore wind and other renewable energy projects. With the production tax credit set to expire in 2012, it cannot be calculated into cost projections for purposes of applying for financing.[144]

ED Strategies

Support Tax Credit Programs

Economic developers should advocate for long-term extension of key tax programs.

- **Example Initiative – Long Term PTC** – In 2011, Senator Tom Carpenter (D-DE) and Senator Olympia Snowe (R-ME) proposed a bill to extend the investment tax credit to allow for a longer lead time in development. Once awarded a tax credit, companies have five years to install an offshore wind facility. Tax credits are only offered for the first 3,000 MW of offshore wind facilities or an estimated 600 wind turbines. This legislation is designed to get the industry off the ground.[145,146]

141 Offshorewindwire.com. Tax Credit For Offshore Wind Facing Another Uphill Battle. (2011, March 31). *Offshoerwindwire.com*. Retrieved from http://offshorewindwire.com/2011/03/31/tax-credits-facing-uphill-battle/
142 Reuter, Guido. (2010, October). Realizing local economic benefits from offshore wind projects. Supply *Chain America, Siemens Wind Power*. Presentation at AWEA North American Offshore Wind 2010 Conference & Exhibition, Atlantic City, New Jersey.
143 Jim Lanard, President, OffshoreWindDC, President (personal Communication, August 3, 2011)
144 Statement of James S. Gordon, President Cape Wind Associates, LLC before the U.S. House Committee on Natural Resources. (2011, June 1).
145 Offshorewindwire.com. (2011, July 7). Afternoon Roundup: Senators Carper and Snowe Introduce Offshore Wind Tax Credit Bill. *Offshorewindwire.com*. Retrieved from http://offshorewindwire.com/2011/07/21/afternoon-roundup-senators-carper-and-snowe-introduce-investment-tax-credit-legislation-for-offshore-wind/
146 Tom Carpenter. U.S. Senator for Delaware. (2011, July 21). Sens. Carper, Snowe Introduce Bill to Encourage Offshore Wind Energy Production. (Press Release). Retrieved from http://carper.senate.gov/public/index.cfm/pressreleases?ID=fdef0fd4-8302-488e-aae6-4caf97975ba1

Political Hurdles

There are political hurdles at the national and project level. The lack of a national policy for offshore wind hinders the development of the industry and puts it at a comparative disadvantage to countries in Europe as well as China. The interests that preclude development of a national policy are expressed at the local level by opposition stakeholders in various projects.

Hurdle

National Energy Policy/Politics – an Uncertain Mandate for Offshore Wind

Many stakeholders believe that the U.S. is hindered compared to other countries because it lacks a unified national energy policy that includes not just goals but binding commitments. Although the United States has embraced aspirational targets, including a goal to produce 20 percent of its electricity from wind with offshore wind contributing 54 GW (54,000 MW),[147] its commitment to renewable energy has lagged behind many other Western countries. In 2007, the U.S. signed the Kyoto Protocol to reduce greenhouse gases, but since then it has neither ratified nor withdrawn from the Treaty, so it has effectively been non-binding.

Many countries in Europe demonstrate a stronger commitment to renewable energy evidenced by being signatories to Kyoto and enacting policies such as feed-in-tariffs and national portfolio standards. As a result, as of February 2011, there were 39 offshore projects online generating in excess of 2,000 MW of capacity in Europe.[148]

The U.S. lacks a cohesive national energy in part because it is driven by regional interests. While some regions have strong, established interests in fossil fuels, other regions are moving ahead to develop renewable energy. Indeed, many U.S. communities, states and regions have initiated policies toward greenhouse gas reduction. In 2006, California passed a law to reduce state

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[147] U.S. Department of Energy & U.S. Department of the Interior, Beaudry-Losique, Jacques et al. (2011, February). *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States*. Retrieved from: http://www1.eere.energy.gov/windandhydro/pdfs/national_offshore_wind_strategy.pdf

[148] U.S. Department of Energy, National Renewable Energy Laboratory. Musial, Walter, NREL and Bonnie Ram, Energetics. (2010, September). *Large-Scale Offshore Wind Power in the United States: Assessment of Opportunities and Barriers*. (NREL/TP-500-40745). Retrieved from www.nrel.gov/wind/pdfs/40745.pdf

greenhouse-gas emissions by 25 percent by 2020, putting them in line with Kyoto targets. More than 400 cities also adopted similar targets. Additionally, 29 states and the District of Columbia have a RPS program. In 2007, eight Northeastern US states created the Regional Greenhouse Gas Initiative (RGGI), a state level emissions capping and trading program.

However, while individual initiatives may help bolster the industry, they create an incentive structure that can pit states and regions against one another. As long as communities and states have different standards, companies may make locational decisions based on criteria including cost of compliance with requirements for renewable energy usage.

ED Strategies

Align communication messages

Communicate a national goal that effectively conveys the importance of offshore wind for present and future national security, environmental and economic benefits. In the United States, advocates for offshore energy employ one or some combination of three main areas of argument[149]:

1. **Energy Supply/Independence** – Offshore wind creates another domestic supply of energy, lessening the need for foreign oil and dependence on countries that produce it. According to NREL, reliance on foreign energy "has significant implications for the national security situation, transferring wealth to several despotic regimes and leaving our economy vulnerable to the decisions of these governments."[150] The development of indigenous offshore energy could help mitigate this.
2. **Environment** – Offshore wind provides a clean, inexhaustible energy source, reducing the harmful impact of greenhouse gases.
3. **Economy** – Offshore wind will create green jobs – jobs in manufacturing, services and technology, some of which will accrue to sectors and regions that have been hard hit by the loss of manufacturing. It will provide an antidote to slowing economic trends.

All three of these arguments are employed by supporters of the industry. Yet, it is often the case that for political reasons, each of these arguments has been emphasized at different times – dependent on whether the country faces a national security challenge, is supportive of policies for a clean environment or is facing tough economic times. For example, since the recent depression

[149] Ibid, p. 10-12
[150] Ibid, p. 12.

and amidst the slow recovery, the economic or "green job" argument has been recently employed with some frequency. But even that can be vulnerable. For example, studies can show that offshore wind energy may be expensive in the short term resulting in the need for someone – i.e. government, residential and industrial utility customers - to pick up the cost until the industry can achieve efficiencies.[151]

Hurdle

The current economic slowdown can damper public investment

Shoring up support for investing in a new industry is difficult given the current economic slowdown. The economic context cannot be ignored: the U.S. is in the greatest economic slowdown since the Great Depression. Given federal and state budget shortfalls, it follows that policy-makers are often more focused on the short-term bottom line and less receptive to calls for investment in new industries.

ED Strategies

Proactive Growth Strategies in a Recession

Use recession as a chance to spotlight structural problems in the U.S. economy that demand the need for new industries to produce jobs that have been lost and won't come back. The recession provides an impetus for the U.S. to rally behind renewable energy industries partially by touting their potential to create green jobs during a time of high unemployment (among other environmental and national security benefits.) The job benefit will pay off even more in the long-term as the industry develops.

While there has been recent support for stimulus funding for renewable energy industries, it is uncertain funding at this level will continue given demands for deficit reduction. Active educating about the need for offshore wind will be necessary.

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[151] Tuerck, David, Bachman, Paul, & Murphy, Ryan. (2011, June). The Cost and Economic Impact of New Jersey's Offshore Wind Initiative. Retrieved from Beacon Hill Institute website: http://www.beaconhill.org/BHIStudies/NJ-Wind-2011/NJWindReport2011-06.pdf.

Hurdle

Opposition stakeholders can delay and derail a project

Opposition stakeholders include those who oppose an offshore project on any one or several of the following grounds:

- Competing Fossil Fuel Interests
- Land Owners/Visual Effects
- Marine Life/ Animal Population (i.e. native marine animals, bats, birds)
- Visual Effects
- Property Holders
- Noise
- Tourism
- Marine Safety – Fisherman and Boaters
- Native Americans – sacred ground
- Industry/Taxpayers

Two examples of opposition to offshore wind are the BlueWater Wind and Cape Wind projects in Delaware and Massachusetts. In a survey of 1,000 residents near the projects, opponents were most concerned with fishing and recreational boating safety, followed by marine life/environment followed third by aesthetics.[152]

The best known and most well-funded example of opposition to an offshore wind project is the case of Cape Wind. The project was opposed by the well-funded Alliance to Protect Nantucket Sound, led by members of the business community from the fossil fuel industry and wealthy landowners on Nantucket Sound. At one point, the Chair of the Alliance was William Koch, who donated $1.5 million of his own funds to oppose the project. Koch has a house on Nantucket

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[152] Firestone, Jeremy, Lilley, Meredith Blaydes & Kempton, Willet. (2010, Oct 6). Mapping Public Perceptions and Preferences Through Space and Time. *Center for Power-free Carbon Integration*, *University of Delaware*. Presentation at AWEA North American Offshore Wind 2010 Conference & Exhibition, Atlantic City, New Jersey.

Sound and a business background in the energy industry.[153] The Alliance launched over ten appeals to federal and state courts to block passage of the project.[154] Another well-placed opponent of the project was Senator Edward (Ted) Kennedy who had a family history and property on the Sound.

Opposition can be directed at developers as well as the state in response to aggressive initiatives. In New Jersey, the Offshore Wind Development Act that Governor Chris Christie signed into law in 2010 generated pushback. A report by the Beacon Hill Institute concluded that the policies would result in a high cost to the state's residential and commercial consumers of electricity and a net loss of revenue and jobs to the state of New Jersey.

Additionally, offshore wind opponents may take their battles to court. In Rhode Island, the offshore wind farm off Block Island being developed by Deepwater Grid faced a state Supreme Court review over the legality of the PPA the developer signed with National Grid. Industrial energy consumers and NGOs such as the Ocean State Policy Research Institute said the PPA would increase energy costs, ultimately hurting residents, companies and costing the state jobs. Companies claimed they could see a threefold rate hike under the PPA. In July 2011, the Rhode Island Supreme Court decided not to overrule the state Public Utility Commission and to let the PPA stand on the grounds that Rhode Island residents would experience environmental and economic benefits.[155,156]

More generally, the offshore wind industry could be affected by cases that are brought against state programs such as the RPS. Law suits attacking RPS programs are pending in Colorado, Massachusetts, New Jersey and New York. They are based on the Commerce Clause or Article 1, section 8, clause 3 of the Constitution that has been interpreted to strike down laws that impede interstate commerce. Since RPS requires that utilities purchase a certain percent of renewable

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153 Doyle, Tim (2006, September 21). Koch's New Fight. *Fortune*. Retrieved from: http://www.forbes.com/2006/09/21/koch-gordon-nantucket-biz_cz_td_06rich400_0921nantucket.html
154 Statement of James S. Gordon, President Cape Wind Associates, LLC before the U.S. House committee on Natural Resources. (2011, June 1).
155 Tiernan, Erin. (2011, May 12). Industrial Companies Challenge Block Island's Off Shore Wind Farm. *Narragansettpatch*. Retrieved from http://narragansett.patch.com/articles/industrial-companies-challenge-block-islands-offshore-wind-farm
156 Renewbl.com. (2011, July 5) Deepwater Wind's PPA for Block Island wind farm approved. *Renewbl.com*. Retrieved from http://www.renewbl.com/2011/07/05/deepwater-winds-ppa-for-block-island-wind-farm-approved.html

energy from instate providers, these law suits are claiming the RPS programs are unconstitutional.[157]

ED Strategies

Economic developers should help identify opposition stakeholders and be ready to respond to areas of potential challenge to the offshore project. Engage opposition stakeholders from the beginning and at all stages of the development and review process.

Hydroelectricity: Parallels to the Offshore Wind Industry

The hydroelectric industry faced many of the same hurdles as the offshore wind industry does today. Hydroelectric plants are expensive to construct. The typical hydroelectric plant requires $52.7 to $71.3 million of startup capital.[158] However, once operational, they are cheaper to maintain than traditional energy technologies such as fossil-fuel steam, nuclear steam, and gas turbines.[159] Hydroelectric plants also face regulatory and permitting difficulties. The process for licensing and relicensing dams can be lengthy and expensive, taking from three to seven years and involving as many as 13 federal agencies.[160] Political hurdles are also an issue. Hydropower projects often run into the NIMBY (Not-In-My-Backyard) attitude raised by locals who fear the environmental impacts of a dam as well as accidents stemming from poor engineering.

Although these issues have not been completely resolved, the hydroelectric industry boomed over the latter half of the 20th century. Figure 2 outlines historical U.S. energy generation from traditional and renewable energy sources, including conventional hydropower.[161] Although hydropower generation has reached a plateau in recent decades, it is the most popular form of renewable energy generation today.

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[157] Cavanaugh, Michael and Humes, Stephen J. (October, 2011) . Constitutional Challenges to Renewable Energy – Threats and Opportunities for Offshore Wind. *Holland & Knight* . Presentation at the AWEA Offshore Windpower Conference and Exhibition, Baltimore, Maryland.

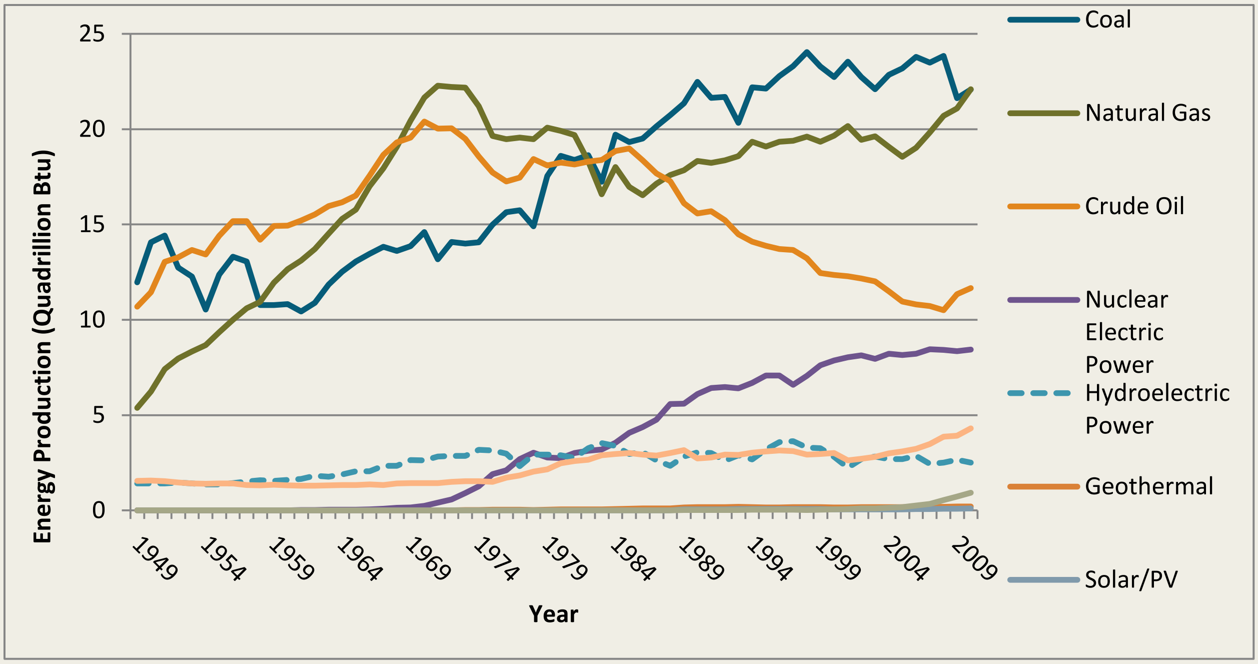
[158] Idaho National Laboratory. (2005, July 18). Hydropower Plant Costs and Production Expenses. Retrieved from http://hydropower.inel.gov/hydrofacts/plant_costs.shtml

[159] Ibid.

[160] The National Energy Education Development (NEED) Project. (2011). Hydropower. Retrieved from http://www.need.org/needpdf/infobook_activities/SecInfo/HydroS.pdf

[161] Conventional hydropower (i.e. a dam and turbine system) is the most popular hydropower technology in the U.S.

Figure 2: U.S. Energy Generation



Source: [162]

Brief Early History

Hydropower has been used since ancient Greek farmers used water wheels to grind wheat into flour. Hydroelectric power harnesses the movement of water to push turbines that produce electricity. The first hydroelectric plant developed in the U.S. for major generation was built at Niagara Falls in 1879. Other notable projects include the Grand Coulee Dam in Washington (the largest hydroelectric plant in the U.S.) and the Hoover Dam on the border of Nevada and Arizona. Hydropower plants have played an important role in the nation's history. The construction of the Hoover Dam during the Great Depression employed a total of over 20,000 workers.[163] During World War II, power plant units could be installed at existing dams to quickly meet the nation's increased demand for energy.

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[162] U.S. Energy Information Administration. (2011, October 19). Annual Energy Review [Data file]. Retrieved from http://www.eia.gov/totalenergy/data/annual/showtext.cfm?t=ptb0102

[163] National Hydropower Association. (2012). History of Hydro. Retrieved from http://hydro.org/tech-and-policy/history-of-hydro/

The U.S. Army Corps of Engineers is the U.S.'s largest owner and operator of hydroelectric plants, managing about a third of the nation's hydroelectric output.[164] Congress also authorized the Department of the Interior's Bureau of Reclamation to construct hydroelectric plants, especially in the resource-rich western U.S. The federally-established Tennessee Valley Authority also manages a significant number of plants along the Tennessee River. These plants are self-powering, and excess power is sold to rural electric power co-ops, public utility districts, municipalities, state and federal agencies, and (at lowest priority) private utilities. Hydroelectric plants have become crucial to the local manufacturing and farming operations that rely on them for energy and irrigation. Today, the Bureau and the Corps of Engineers are focused on modernizing existing facilities to increase efficiency and reliability.

Although hydroelectric plants face significant hurdles, their benefits outweigh their costs. The evolution of the hydroelectric industry includes some solutions that can be applied to the offshore wind industry as well.

Hurdle
Hydroelectric plants require a high upfront investment.

ED Strategies

Increased R&D to raise lifetime of plants

The business model for hydroelectric plants has largely prevailed because of low operational costs and the long lifetime of plants. Hydroelectric plants on average cost $2,000 per kWh of capacity to build, but they cost less than one cent per kWh to operate and maintain.[165] Further, many plants constructed 50 to 100 years ago are still operational today.[166] The long lifetime of plants can be credited to their sustainable design. The design of hydroelectric plants today is

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[164] U.S. Army Corps of Engineers. (2012). Hydropower. Retrieved from http://operations.sam.usace.army.mil/Hydropower/

[165] Idaho National Laboratory. (2005, July 18). Hydropower Plant Costs and Production Expenses. Retrieved from http://hydropower.inel.gov/hydrofacts/plant_costs.shtml

[166] International Energy Agency. (2010). Renewable Energy Essentials: Hydropower. Retrieved from http://www.iea.org/papers/2010/Hydropower_Essentials.pdf

generally standardized, with many of the drastic changes happening before World War II.[167] Increasing federal regulation during this time required private developers to cooperate with new safety standards as well as federal plans for hydropower development.[168] In the 1920's, the Army Corps of Engineers began doing hydropower design work as well. As hydropower became more of a federal priority, private and public engineering alike started to converge.

Modernizing hydroelectric plants is a federal priority today. The 2009 Recovery Act awarded $30.6 million in funding to modernize seven hydropower facilities.[169] The Department of Energy's Water Power Program works actively with federal laboratories across the nation to support ongoing research in water power technologies.[170] In a similar vein, the market for offshore wind will be more feasible as turbines increase in size and thus generate greater efficiencies. Although large turbines represent a higher upfront investment, increasing the quality and durability of these turbines will help justify the cost.

Cost sharing among public and private sectors

Although the federal government played an integral part in financing the nation's largest hydroelectric plants, other partners provided significant funding as well. The National Water Commission estimates funding streams in the first half of the 20th century. Up to 1968, federal financing for hydropower totals to $9.3 billion, state and local governments contributed $3.2 billion, and the private sector pitched in $6.2 billion (in 1972 dollars).[171] As federal budgets have tightened in recent years, public-private investment in hydropower projects has become more common. In Utah, the Central Utah Project (a federally-funded water supply initiative) partnered

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167 U.S. Department of the Interior – Bureau of Reclamation. (2009, August 12). The History of Hydropower Development in the United States. Retrieved from http://www.usbr.gov/power/edu/history.html

168 Billington, D., Jackson, D. & Melosi, M. (2005). The History of Large Federal Dams: Planning, Design and Construction. *U.S. Department of the Interior – Bureau of Reclamation*. Retrieved from http://www.cr.nps.gov/history/online_books/dams/federal_dams.pdf

169 National Hydropower Association. (2012). Modernizing Hydropower. Retrieved from http://hydro.org/tech-and-policy/developing-hydro/modernizing/

170 U.S. Department of Energy – Energy Efficiency and Renewable Energy. (2011, December 8). Water Power Program. Retrieved from http://www1.eere.energy.gov/water/index.html

171 Eisel, L. & Wheeler, R. (1980). Financing Water Resources Development. *Federal Reserve of Kansas City*. Retrieved from http://www.kc.frb.org/Publicat/sympos/1979/s79eisel.pdf

with a private utility to develop hydropower.[172] The government will profit by selling leases to the site, while the private utility gains from selling the energy generated.

- Past hydropower projects point to a blueprint for negotiating cost sharing between various partners. These can also apply to the offshore wind sector:[173]
- Timing of contribution (up front or reimbursement)
- Interest rate on reimbursable balance and the number of interest-free years
- Length of repayment period
- Value and terms of transfer accounts
- Value of contributions in kind

Hurdle

Hydroelectric plants involve a complex permitting and regulatory process.

ED Strategies

Established primary regulatory agency early on

Hydroelectric plants can raise environmental concerns since they may impact water resources, fish and wildlife. These complicate the permitting process. Before 1920, hydropower developers needed a special act of Congress to move forward with plans involving federal lands.[174] Permits were given away on a "first come, first serve" basis and were impacted by each state's Congressional representation. When World War I hit, demand for electricity skyrocketed, and supply had to be expanded quickly. Congress established the Federal Power Commission to regulate non-federal hydropower projects that would affect federal lands or interstate commerce. The FPC underwent a number of transitions over the years, and was reorganized into the Federal Energy Regulatory Commission after the 1970's energy crisis. The FERC now regulates 56 percent of hydroelectric projects in the U.S. The remaining projects were built by the federal

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[172] DeBruin, L. (2011, May 11). U.S. seeking private funds to build Utah hydropower. *Bloomberg BusinessWeek*. Retrieved from http://www.businessweek.com/ap/financialnews/D9N584400.htm

[173] Eisel, L. & Wheeler, R. (1980). Financing Water Resources Development. *Federal Reserve of Kansas City*. Retrieved from http://www.kc.frb.org/Publicat/sympos/1979/s79eisel.pdf

[174] Finnegan, D. & Warning, K. (2011). Hydropower. *Center for Culture, History and Environment*. University of Wisconsin-Madison. Retrieved from http://che.nelson.wisc.edu/cool_stuff/energy/hydro.shtml#history

government and are supervised by the agency that built them (i.e. Bureau of Reclamation, Army Corps of Engineers or the Tennessee Valley Authority).[175]

Today, private hydropower developers still undergo a lengthy permitting process and must interface with a variety of stakeholders: the FERC, federal and state agencies, local governments, tribes, non-governmental agencies as well as the general public. The National Hydropower Association suggests key steps to expedite hydropower development. This includes streamlining licensing for minimal impact projects and for the Army Corps and Bureau of Reclamation to conduct an internal review of possible development sites in order to attract more private investment.[176] Offshore wind permitting faces a lack of knowledge and leadership on the federal level. While these issues may not be solved overnight, the evolution of the hydropower permitting process demonstrates a step by step approach to consolidating regulatory hoops.

Hurdle

Hydroelectric plants often face political hurdles due to environmental and social concerns.

Solutions

Launched marketing campaign to emphasize cautionary measures

The environmental impact of hydroelectric plants varies on a case-by-case basis.[177] At their worst, hydroelectric plants can impact the population and migration of fish by altering water levels or by catching fish in turbine blades. For example, hydropower facilities along the Columbia River in Washington are thought to have contributed to the decline of the local salmon population.[178] Some

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175 Federal Energy Regulatory Commission. (2011, November 18). Use and Regulation of a Renewable Resource. Retrieved from http://www.ferc.gov/industries/hydropower/gen-info/regulation/use.asp

176 National Hydropower Association. (2012). More Efficient Regulatory Process for Hydro. Retrieved from http://hydro.org/tech-and-policy/policy-priorities/more-efficient-regulatory-process/

177 Environmental Protection Agency. (2007, December 28). Hydroelectricity. Retrieved from http://www.epa.gov/cleanenergy/energy-and-you/affect/hydro.html

178 Brower, M. (2002, October 26). Environmental Impacts of Renewable Energy Technologies. *Union of Concerned Scientists*. Retrieved from http://www.ucsusa.org/clean_energy/our-energy-choices/renewable-energy/environmental-impacts-of.html

plants have installed technology to mitigate such impacts: "fish ladders" that help transport fish over dams, screens that protect fish from turbine blades, and even underwater lights that help night-migrating fish swim around turbine blades.[179] Marketing these cautionary measures will help alleviate the concerns raised by conservationists. For example, the National Hydropower Association (NHA) issues "Outstanding Stewards of America's Waters" awards each year for hydropower electricity projects that make exceptional efforts to protect river ecosystems. The winners are profiled on NHA's website with details of the specific environmental challenge at the project site, the technology or method used to tackle it, and the resulting benefits to the wildlife and ecosystem. As more innovative and cost-effective measures are developed to protect wildlife, marketing these technologies will help dispel outdated misconceptions about hydropower's environmental impacts.

Figure 3: Fish ladder at the Ice Harbor Dam in Washington. Source: EERE

Emphasize impacts of hydropower relative to other energy technologies

While some hydroelectric facilities do have real environmental impacts, it is important to emphasize the "bigger picture" of these impacts relative to those of other technologies. Increasing concerns about greenhouse gas emissions have made renewable energy generation indispensable. Hydroelectric plants do not emit carbon dioxide or sulfur dioxide like coal, oil or natural gas plants do, and they do not risk radioactive contamination like do nuclear power plants.[180] Further, the environmental impacts of hydropower facilities must not be confused with the byproducts of other human activities. For example, irrigation, timber, mining, home construction and the activities of other local industries can also impact the river system.[181] The exact roles of these various activities in the ecosystem are difficult to ascertain in isolation, and the environmental impact of hydropower is still a subject of debate among scientists. Attempts to minimize these possible impacts must take into account other local activities as well.

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[179] Ibid.
[180] Baird, S. (n.d.) Hydro-Electric Power. *Ohio State University – Physics Department*. Retrieved from http://www.physics.ohio-state.edu/~kagan/phy367/P367_articles/HydroElectric/hydroelectric.html
[181] Foundation for Water & Energy Education. (2012). Overview of Hydropower in the Northwest. Retrieved from http://fwee.org/education/the-nature-of-water-power/overview-of-hydropower-in-the-northwest/

Like hydropower, several offshore wind projects have faced significant opposition from local interest groups concerned about safety, environmental impacts and aesthetics. Champions of offshore wind can point to the environmental precautions built into the design of wind turbines and also emphasize the relative advantages of wind energy with respect to fossil fuel technologies.

APPENDIX

WIND TECHNOLOGY TESTING CENTERS

Clemson University - The DOE provided $45 million in funds, which was matched by $53 million in local funds, toward the large wind turbine drivetrain test facility at the Clemson University Restoration Institute University in 2009. Drive trains takes energy generated by a turbine's blades and increase the rotational speed to drive the electrical generator, similar to a car transmission.[182]

Massachusetts Clean Energy Center - The DOE awarded $24.7 million in funding from the American Recovery and Reinvestment Act (ARRA) to accelerate development of the Massachusetts Clean Energy Center's (MassCEC) Wind Technology Testing Center Charlestown, Massachusetts in May 2009. The center had previously received a $2 million federal NREL grant in 2007 towards its development. The Center will be the first commercial large blade test facility in the nation, testing blades up to 90 meters in length– including offshore blades – with the goal of expediting their deployment to the marketplace. [183] The WTTC is uniquely positioned on an existing deep water port and near interstate highways, allowing blades to be shipped in by water or with shorter blades shipped by road if required.[184] In May 2011, the facility opened its doors. The American company Clipper Windpower was the first business to utilize the Massachusetts Clean Energy Center's new WTTC.

The University of Houston - The DOE awarded the University of Houston $2 million in capital funds in 2007, as well as technical and operational assistance, for a new facility to test large blades suitable for large turbines. The University of Houston has completed an agreement

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182 http://www.clemson.edu/media-relations/article.php?article_id=2432. Accessed August 22, 2011.
183 Ibid.
184 http://www.masscec.com/index.cfm/page/Governor-Patrick-Celebrates-Opening-of-Nation's-First-Large-Scale-Wind-Blade-Testing-Facility/cdid/12142/pid/3001

with the DOE to design, construct and operate a wind turbine blade testing facility at Ingleside, Texas which would have the capacity to test blades at least 70 meters in length.[185,186]

Next Generation Technology/ University of Maine - The Department of Energy has also contributed substantial R&D funds to develop deepwater "next generation" technology for floating turbans in water depths of 60 meters and more. Such technology is on the cutting edge globally. Maine received $112.4 million in federal stimulus funds to build the 37,000 square foot Wind Laboratory[187] known as the AEWC Advanced Structures and Composite Center, housed at The University of Maine, to develop such technology. Maine also approved a bond measure in June 2010 to provide $11 million in state funds for deepwater wind research.[188]

Cape Wind Case Study

The Cape Wind project was the first to submit an application for a federal permit to build a wind farm in 2001, was the first to win a federal lease in 2010 and now is the only utility-sized project with a purchase power agreement (PPA) contracting a large share of its energy supply to a utility. Cape Wind stands to provide 468 MW of wind energy to the Cape Cod, Massachusetts region, one-half of which has been contracted to National Grid. After a process full of many twists and turns, Cape Wind appears on track to be the first wind farm in federal water.

Cape Wind's regulatory review process involved the participation of 17 federal and state agencies.[189] Midway through the process in 2005, the lead regulatory agency switched from the Army Corps of Engineers to the Department of Interior, and Cape Wind had to virtually begin the permitting process anew. Yet while Cape Wind might have faced headaches navigating through all that, it was the political opposition at the local and national level that almost grounded the project.

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185 "University of Houston wind-power testing site approved for design." Retrieved from http://www.tkvw.com/researchuh/news2.htm on August 15, 2011.
186 (2008, June 6). NREL Launches Major Wind Projects with DOE, Partners. Retrieved from http://www.nrel.gov/features/20080601_new_wind_projects.html on August 15, 2011.
187 US Offshore Wind Collaborative. (2010, August). "State Offshore Wind Initiatives/Proposed Projects." Retrieved from http://www.usowc.org/pdfs/State_Initiatives_8_3_10.pdf. on July 26, 2011.
188 Ibid.
189 Statement of James S. Gordon, President Cape Wind Associates, LLC before the U.S. House committee on Natural Resources. (2011, June 1).

Many of New England's rich and powerful own land on Cape Cod. In many ways it is less a surprise that there was significant opposition to the project than that Cape Wind Associates has been able to overcome it. During the last ten years, the developer of the project Jim Gordon invested significant time and effort to overcome well-funded and high-placed political opposition. Gordon's group Cape Wind Associates forged alliances with environmental groups, unions and other interests, working vigorously at the local and national scale to keep the Cape Wind project alive.

The project was opposed by many who have homes or strong ties to Cape Cod and the Nantucket Sound. The project could be seen in the distance from the shoreline and by those sailing in the Sound. Some exhorted the Cape as a "National Treasure," an original waterway of the Pilgrims. Others called the natural environment of Cape Wind a "sanctuary" that should not be disturbed. (It does not have official sanctuary status). Many of these criticisms existed prior to the environmental review for effects on the wildlife.[190]

The Alliance to Protect Nantucket Sound, also known as Save Our Sound, was the group at the forefront of the opposition. Its tactics included organizing signatures and buying print advertising and video infomercials which at one point featured Walter Cronkite who lived on the nearby Martha's Vineyard and sailed his boat in Nantucket Sound. Cronkite later changed his position and asked the organization to stop using his image. William Koch has been Co-Chair or member of the board of The Alliance to Protect Nantucket Sound since 2005. He has contributed $1.5 million of his own money, much of which was made in the energy industry.[191] Over the course of the project, the Alliance launched over ten appeals to the federal or state courts to block passage of the project.[192]

Court cases have been launched by other parties such as the Wampanoag Tribe of Gay Head that filed suit in July, 2011 on the grounds that the wind farm would potentially damage

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[190] Williams, Wendy and Whitcomb, Robert. (2007). Cape Wind: Money, Celebrity, Class, Politics and the Battle for Our Energy Future. New York, New York: BBS Public Affairs.
[191] Doyle, Tim (2006, September 21). Koch's New Fight. *Fortune*. Retrieved from: http://www.forbes.com/2006/09/21/koch-gordon-nantucket-biz_cz_td_06rich400_0921nantucket.html
[192] Statement of James S. Gordon, President Cape Wind Associates, LLC before the U.S. House committee on Natural Resources. (2011, June 1).

archaeological sites on the ocean floor and would obstruct the view of the rising sun, affecting ceremonial worship.[193]

Many high-profile politicians from both the Democrat and Republican parties opposed the project. Senator Edward (Ted) Kennedy who had a family history and property on the Sound was a strong though usually low-profile opponent, as was his nephew Robert Kennedy, Jr. who spoke up more loudly. Governor Mitt Romney was also an opponent of the Sound. Other politicians outside of New England including U.S. Alaska Senator Ted Stevens and Virginia Senator John Warner were also opposed to Cape Wind.[194]

One of the fiercest battles that Jim Gordon fought was to defeat a 2005 U.S. Senate amendment that would have effectively shut down Cape Wind, allowing the Governor of an adjacent state to Cape Wind to veto the project. Jim Gordon worked the halls of Congress together with environmental, union and other groups who were able to gain the support of key politicians from both sides including to ultimately kill the amendment.

In order to stop this legislation, Jim Wind was joined by many partners who worked the halls of Congress including Greenpeace and the Maritime Trade Council, a group representing 17 unions in New England including the International Brotherhood of Electricians.[195] The relationship forged with the unions was invaluable to the project on several levels: having the unions as partners lessens the chance of labor disputes down the line and helps budgeting for labor costs be more realistic and the unions are well-connected, experienced and influential lobbying partners.

Now Cape Wind stands poised as a survivor, ready to develop its wind farm with federal lease in hand with the major hurdle being the sale of the remaining half of its energy. National Grid's contract to purchase 234 MW of energy from Cape Wind makes Cape Wind the only project to have sold a current PPA commitment for a utility-scale amount of energy. The developer has

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[193] Wood, Elisa. (2010, March 22). "Offshore Awakening: US Investment Flows to Offshore Wind. " *RenewableEnergyWorld.com*. Retrieved from http://www.renewableenergyworld.com/rea/news/article/2010/03/offshore-awakening on July 15, 2011.
[194] Williams, Wendy and Whitcomb, Robert. (2007). Cape Wind: Money, Celebrity, Class, Politics and the Battle for Our Energy Future. New York, New York: BBS Public Affairs.
[195] Cape Wind Associates. (2003, April 24). Fishermen, maritime, and labor organizations endorse Cape Wind project. Press release from Cape Wind Associates. Retrieved from: http://www.capewind.org/modules.php?op=modload&name=News&file=article&sid=1

indicated it will buy turbines from Siemens that will be positioned 6 to 10 miles from shore. The 468 MW generated by Cape Wind is projected to meet approximately 75 percent of the annual electricity needs of Cape Cod and the Islands of Martha's Vineyard and Nantucket[196].

The region where Cape Wind is situated has a need for new sources of energy due to aging power plants, a situation which has been recognized by ISO New England, Inc., the operator of electricity for a four-state New England region including Massachusetts. [197,198] As a result, the case for clean wind has become more compelling. Proponents make the case that the price for offshore wind compares more favorably to other energy sources when the "all-in" cost of fossil fuels includes installation and maintenance of a new plant.

Residents understand the need for new energy. The region has been home to near energy crises during particularly cold spells where the natural gas system was practically at capacity and almost shut down. While there has been high-profile and well-funded opposition, among residents in Cape Code and Massachusetts there has generally been majority support for the project.[199]

The project is also expected to generate jobs for the local economy and the growth or expansion of businesses. A job study done for Cape Wind Associates by the firm Global Insight found that in its initial stage, Cape Wind would generate more than 1,000 construction jobs, 50 O&M jobs and additional spinoff jobs.[200,201]

Finally, the project aims to open up a new frontier in renewable energy. With its "first in the water" splash, Cape Wind will accomplish initiation of the offshore wind industry in the United States and lead to the success of other projects in the pipeline.

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196 George Sterzinger, personal communication, July 25, 2011.
197 Lindsay, Jay. (2011, October 6). Report: New England power grid facing challenges. Bloomberg Business Week: The Associated Press. Retrieved from: http://www.businessweek.com/ap/financialnews/D9Q738RG2.html
198 ISO New England Inc. (2011, October 21). *2011 Regional System Plan*. ISO New England. Retrieved from: http://www.iso-ne.com/trans/rsp/index.html
199 Williams, Wendy and Whitcomb, Robert. (2007). Cape Wind: Money, Celebrity, Class, Politics and the Battle for Our Energy Future. New York, New York: BBS Public Affairs.
200 Global Insight. (2003, April 2). *Economic Impact Analysis of the Cape Wind Offshore Renewable Project*. Retrieved from: http://www.capewind.org/downloads/Economic_Impact.pdf
201 Cape Wind Associates. (2011, November 3). Cape Wind & Massachusetts: *Creating Jobs and Providing Clean Power to Massachusetts*. Cape Wind Associates. Retrieved from: http://www.capewind.org/downloads/CapeWind&Massachusetts2.pdf