NROC White Paper: Overview of the Energy Sector in the Northeastern United States

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1. Background

This white paper provides an overview of the energy sector in the northeastern region of the United States (the coastal waters from Maine to Connecticut). It describes the current status of the sector as well as key issues and trends that are relevant to energy, including existing conditions for generation, transmission, natural gas, LNG and oil and gas development and the potential issues associated with future energy development. The paper was commissioned by the Northeast Regional Ocean Council (NROC) to support NROC efforts to reach out and engage with stakeholders in the energy sector. The paper's intent is to serve as a starting place for discussions between NROC and sector leaders and participants on key issues and challenges facing the sector, recognizing that the content of the white paper will likely be refined based on these discussions.

This draft paper was prepared by ESS Group, Inc. with input from NROC members and staff. It is based on an analysis of key publications and reports on the sector; it has also been informed by interviews and a web-based survey involving 25 energy sector leaders conducted by NROC staff during summer 2012, as well as feedback provided by sector representatives at a series of working sessions in Boston in December 2012.

2. Introduction

The white paper is organized into the following sections:

1. Background
2. Introduction
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2.1 Overview of Energy Market Sector

It is helpful to understand the general composition of the energy sector when considering the components that involve offshore and ocean planning. This sector is composed of several discrete functions further described below. These include generation, which produces the most important ultimate energy end product desired by users – electricity. Associated with the generation function is the technology and fuel used to produce the electricity. The transmission and distribution function or interconnecting infrastructure such as electric or gas lines provides the mechanism to deliver the electricity to users or the fuel to the electricity producer. Additionally, there are other energy sources that are not necessarily tied to electricity production but are also important markets including natural gas, liquefied natural gas (LNG) and exploration for oil and gas production that may have implications for ocean planning efforts.

2.1.1 Electric Generation

The electricity market in New England can be generally thought of as a system of electricity producers and electricity deliverers that transport the product to the end users. The delivery side of the equation can be further divided into transmission providers that transport power in bulk and can be either merchant entities or regulated utilities more commonly referred to as transmission organizations or TOs. The final link in the system are the distribution entities that take electricity from delivery points along the bulk system and reduce the voltage from transmission levels (typically 115kV or higher) to lower voltages compatible with end user requirements. The distribution companies are the regulated local utilities.

Electricity suppliers produce their product in a variety of ways using varying fuel sources. The make up of these sources for New England capacity (i.e. the installed equipment or megawatts) in 2011 and energy (i.e. the electricity delivered by fuel type or megawatt-hours) in 2010 was as follows:

Generation by Fuel Type	2011 New England Electric Capacity	2010 New England Electric Energy
Natural Gas	43%	46%
Oil	22%	0.4%
Nuclear	15%	30%
Coal	8%	11%
Hydro	4%	6%
Pumped Storage	5%	1%
Renewables (wind, solar, landfill gas, biomass)	3%	6%

Source: Regional Profile Update 2011 – ISO New England, Inc.

Electricity is also supplied to New England via transmission line ties to New York, New Brunswick and Quebec.

There has been an increasing dependence on generation fueled by natural gas over time as can be seen in the Table. Gas fired generation now accounts for almost 50% of the present capacity and energy. This is due to a number of factors including retirements of aging nuclear units and older fossil fuel power plants. Retirement of fossil units may be due to age or to increasing cost driven by environmental requirements including tightening of air emission standards and recently due to the low price of natural gas.

In an effort to incorporate more renewable resources, five of the six New England states adopted Renewable Portfolio Standards that specify certain percentages of electricity provided to end users by utilities or competitive suppliers must come from renewable sources or those entities must provide alternative compliance payments.

Additionally as described further below, the New England Governors signed a Resolution in July 2012 directing New England States Committee on Electricity (NESCOE) to implement a work plan to execute the coordinated competitive regional procurement of renewable power with a goal of issuing a solicitation for procurement by the end of 2013.

This renewable energy will come from a variety of on land and offshore sources. There is a potential for a significant portion of this renewable energy to come from new generation sources in the offshore or near shore, predominantly from wind and some hydrokinetic projects. Various estimates have been made of this wind resource which range from a DOE estimate of over 200GW off of New England (<60 meter water depth within 50 nautical miles) (DOE, A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States, Feb 2011), to estimates used in the Independent System Operator-New England (ISO-NE) Wind Integration study which modeled several scenarios ranging from 6 to 10 GW of future offshore capacity (ISO Background-New England Integration Study, ISO-NE, Inc. December 15, 2010).

2.1.2 Transmission

New England Bulk System

The generating capacity in New England is approximately 32,000 megawatts (32 gigawatts), which is supplied by over 350 generators. To transmit this power to the users, there are over 8,000 miles of high voltage transmission lines in New England and 13 interconnections to electricity systems in New York and Canada. In order for this system to operate properly, a Regional Transmission Organization (RTO) known as ISO-NE, has overall responsibility. ISO NE is an independent, not-for-profit corporation that has no financial interest or ties to any company doing business in the region's wholesale electricity marketplace. (http://www.iso-ne.com/nwsiss/grid_mkts/key_facts/index.html)

ISO-NE Role

ISO-NE is a regional transmission organization (RTO), serving Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. As the RTO, ISO-NE is responsible for transmission planning and sets requirements for participants regarding reliability standards, pooled transmission facility cost review and notice of intent to change facilities. ISO-NE meets the electricity demands of the region's economy and people by fulfilling three primary responsibilities:

- Minute-to-minute reliable operation of New England's bulk electric power system, providing centrally dispatched generation and flow of electricity across the region's interstate high-voltage transmission lines to end users.
- Development, oversight and fair administration of New England's wholesale electricity marketplace, through which bulk electric power has been bought, sold and traded since 1999. These competitive markets provide positive economic and environmental outcomes for consumers and improve the ability of the power system to meet ever-increasing demand efficiently.
- Management of comprehensive bulk electric power system and wholesale markets' planning processes to address New England's electricity needs into the future.

2.1.3 Natural Gas and LNG

In addition to providing fuel for electric generation, natural gas is also an important energy resource for industrial use and for commercial and residential heating and cooling. Natural gas is supplied to New England through interstate pipelines and local distribution companies, as there is little to no production of natural gas in New England. Gas supplies are augmented through liquefied natural gas (LNG) storage assets that either take deliveries via tanker transport or through liquefaction of pipeline gas during low demand periods for later vaporization and release back to the pipeline system on high demand days. There are also two offshore LNG vaporization facilities located offshore Massachusetts where tanker vessels tie up to vaporize their LNG for transport via a subsea pipeline to the shore side pipeline system.

2.1.4 Offshore Oil & Gas Exploration

While there is a potential to develop offshore locations for the exploration of oil and/or natural gas supplies, there has been little movement in this direction due to political and environmental concerns. The Bureau of Offshore Energy Management (BOEM) did not include the North Atlantic region, which includes federal waters in the Gulf of Maine and off southern New England, in its current five-year Outer Continental Shelf (OCS) Leasing Program, which is in effect until August 2017. Therefore, exploration is not anticipated in the near term. Additionally, there is a joint Canadian-provincial moratorium on exploration activities in the Georges Bank area in effect until 2015.

3. Status of the Energy Sector

The current status of the offshore energy sector including wind, transmission, hydrokinetic, natural gas, LNG and offshore oil and gas explorations are briefly described below.

3.1 Offshore Wind

Several individual federal, state and local permits that are involved with an offshore wind project whether on the Outer Continental Shelf (OCS) or within state waters. It is this complex permitting process that often invokes requests for streamlining, better coordination and some overall certainty to the process, as can be seen in comments from the stakeholder interviews. Given the scope of this paper it is not possible to discuss each permit process. Therefore we have described the overriding federal authority for OCS projects and discuss some of the regional policy that focuses on renewable development which will control and/or effect offshore wind energy development.

The overriding regulatory authority on the Federal level derives from the Energy Policy Act of 2005 (EPAct) which authorized the Minerals Management Service (MMS)[1] to issue leases, easements, and Rights-of-Way on the Outer Continental Shelf (OCS) for the development of commercial wind energy projects.[2] The EPAct was intended to eliminate the uncertainty concerning jurisdiction over renewable energy development on the OCS. Section 388 of the EPAct established the Department of the Interior (who delegated the authority to the Bureau of Ocean Energy Management (BOEM)), as the lead agency, in consultation with other agencies, for granting leases, easements, and Rights-of-Way on the OCS. It did so, however, without clarifying the roles and responsibilities of all of the other agencies responsible for various aspects of permitting, consultation, and oversight.

In July 2008, BOEM issued proposed regulations for granting competitive and non-competitive commercial leases, limited leases, Rights-of-Way and Rights-of-Use and easements on the OCS and on April 22, 2009, BOEM released its final regulations codified at 30 CFR Part 285[3] and generally referred to as "the Final Rule." The Final Rule provides an implementation framework for OCS renewable energy development.

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[1] On May 19, 2010, Department of the Interior Secretary Ken Salazar published Secretary Order No. 3299 establishing the Bureau of Ocean Energy Management, the Bureau of Safety and Environmental Enforcement, and the Office of Natural Resources Revenue. The Bureau of Ocean Energy Management (BOEM) assumed the duties of the Minerals Management Service concerning the issuance of leases, easements, and Rights-of-Way on the Outer Continental Shelf (OCS) for the development of commercial wind energy projects.

[2] Until Congress enacted the EPAct in 2005, no one federal statute governed the development of renewable energy facilities on the Outer Continental Shelf. During the development of the Cape Wind Project, the U.S. Army Corps of Engineers (USACE) asserted jurisdiction under the authority of Section 10 of the Rivers and Harbors Act of 1899, as amended by the Outer Continental Shelf Lands Act.

[3] The final regulations apply to a range of renewable energy sources in addition to wind, including wave, tidal, and ocean current.

The Final Rule establishes two lease categories: Limited leases that authorize technology testing, research, and site assessment activities and Commercial leases that authorize development, construction, and operation of a renewable energy facility and to sell and deliver power on a commercial scale.

On November 23, 2010, Secretary of the Interior Ken Salazar announced the 'Smart from the Start' wind energy initiative for the Atlantic Outer Continental Shelf to facilitate siting, leasing and construction of new projects. Under this initiative priority, Wind Energy Areas (WEAs) for potential development were identified though a process that involved local, state, and federal partners.

BOEM has issued Requests for Interest in Commercial Leases or Calls for Information and Nominations in several of the Wind Energy Areas notably in Virginia, New Jersey, Delaware, and Massachusetts, Maryland and the Rhode Island / Massachusetts area of mutual interest. The only commercial leases offered as of this writing were for Cape Wind and the recent issuance to NRG Bluewater off of Delaware. BOEM is also advancing Environmental Assessments to allow the leasing of blocks and site assessment activities in the WEAs. For the WEA offshore Rhode Island and Massachusetts, BOEM completed an environmental assessment for leasing and data gathering activities in the fall of 2012 and in December announced the availability of a proposed Sale Notice for Commercial Leasing for Wind Power. For the WEA offshore Massachusetts, a draft environmental assessment was issued in October 2012. Additionally, Statoil submitted an unsolicited request for a commercial lease for windpower to BOEM, and in the fall of 2012 BOEM issued a Determination of No Competitive Interest for the proposed lease area Published a Notice of Intent to prepare an Environmental Impact Statement for the proposal.

At the State level, the New England Governors' Conference (NEGC) prepared a report entitled Renewable Energy Blueprint in September of 2009 that identified up to 10,000 MW of potential capacity from on and off-shore wind energy projects and noted that developing less than this amount would allow New England to meet its renewable energy goals. As a follow on action, NEGC unanimously passed a resolution (hereafter referred to as "the Resolution"), on July 30, 2012, that charges the New England States Committee on Electricity (NESCOE) to "implement a work plan and any regulatory proceedings or procedures as are necessary or appropriate to execute the coordinated competitive regional procurement of renewable power, with the goal of issuing a solicitation for procurement by the end of December 2013". NESCOE is a not for profit organization representing the collective interests of the six New England States on regional electricity matters.

The draft work plan was issued on August 10, 2012, which includes: 1) identification of those steps necessary toward one or more regulatory proceedings in which each state's regulatory authorities could consider whether to approve long-term contract(s) for renewable resources; 2) rough estimates of timeframes associated with steps (Activities) in the procurement and contracting process; and 3) identification of open issues, including some that require advance discussion and resolution. The final work plan was issued on November 21, 2012 and sets a goal of the end of December 2013 to issue a solicitation for procurement.

The resolution by the six New England Governors to solicit a regional procurement for renewable energy is a valuable step forward in the development of renewable energy in New England. However, it should be recognized that the Resolution targets regional renewable energy and does not specifically target offshore renewable energy. As a result, without incentives and or specific capacity targets for offshore energy projects, this solicitation for regional renewable energy may be biased toward on land projects because of the comparatively lower cost.

3.2 Transmission/Interconnection

Transmission facilities can be of two general types in the offshore; those associated with offshore energy projects and those that are providing point to point services using an offshore route. For offshore wind energy facilities that will be sited relatively distant from shore, two transmission system configurations could develop. Offshore facilities could be individually connected to onshore substation or they could be connected to a trunk line (or backbone) that provides common access for multiple facilities to multiple tie in points on the land based transmission system, commonly referred to as a networked system.

The backbone or networked system is generally considered to be the preferred option from a project development perspective because it relieves individual project developers from the need to site projects in consideration of proximity to appropriate landfall locations, which could otherwise restrict the size and distribution of wind energy projects along the Atlantic OCS. Additionally, removing landfall siting issues could simplify the permitting process by limiting state and local community involvement for the transmission interconnection for OCS projects. State and local communities would still have an opportunity to be involved in the review of the wind farm through the BOEM process including the State Coastal Zone Management review. Finally, sharing of a transmission system by a number of projects could provide "cost sharing" opportunities for offshore developers, which is expected to lower the development costs for individual projects.

An example of this type of project is the Atlantic Wind Connection (AWC), a submarine High Voltage Direct Current (HVDC) backbone transmission cable Project being developed by an independent transmission company Trans-Elect and sponsored by Good Energies, Google, and Marubeni Corporation. According to the AWC Website, the Project will be designed to connect up to 7,000 MW of offshore wind and will be scalable to support additional offshore wind energy capacity as the industry expands. The backbone system will be comprised of offshore power hubs connected via sub-sea cables to the land-based transmission system. According to some experts, this project would not be viable if it did not also offer trunk transmission capability from the Carolinas to the Northeast. It has been suggested that a Long Island Sound Connection could link the wind deployments south of Massachusetts with Rhode Island, Connecticut, and Long Island.

Other transmission that may be developed in the near shore and offshore are projects to improve reliability and capacity on local systems or projects designed to move bulk power from point to point that may be best served by routes using the offshore. An example of this later project was a proposal to construct a point to point submarine HVDC circuit from Maine to Boston which would move large blocks of renewable resource such as wind power from remote areas where it is produced to an area of high demand where it would be consumed.

3.3 Marine Hydrokinetic Resources

Marine Hydrokinetic (MHK) energy resources can produce electric energy where wave, tidal, or ocean currents are of adequate energy density. MHK resources in New England have less energy potential than wind but are significant because they are more predictable and having higher utilization rates, providing flexibility to grid operators. Wave technology can be employed in many places but is best along open ocean-facing coastline or, because winds drive wave action, with wind deployments. Tidal energy presently is limited by the need for high water velocity (>1.5 m/s maximum) and sufficient depths to avoid impacts to shipping and other boating activity. This restricts the locations where these project may be economically developed. These new technologies are not as advanced as wind with few in commercial development and most in the stage of developing prototype or pilot test projects to help advance the overall technology. The current regulatory scheme for offshore hydrokinetic development, as recognized by a Memorandum of Understanding between the Department of the Interior's BOEM and Federal Energy Regulatory Commission (FERC) established BOEM with jurisdiction to issue leases on the OCS for MHK projects, and FERC[4] has jurisdiction to issue licenses for these same projects. BOEM/FERC recently issued revised Guidelines on Regulation of Marine and Hydrokinetic Energy Projects on the OCS (version 2 July 19, 2012). http://www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics/pdf/mms080309.pdf

FERC determined that experimental deployment of projects testing new hydropower technology may, in certain limited circumstances, be possible without a license under Part I of the Federal Power Act (FERC, 2008). Expedited license[5] application processing under the Commission's existing regulations is possible for "pilot projects" and in February, 2012 FERC issued the only Pilot Project License in New England to date to Ocean Renewable Power Company (ORPC) for a proposed 300 kW tidal project in Cobscook Bay, Maine (ORPC, 2012). The project will create a multi-device array of advanced design cross-flow turbine generator units (TGU) mounted on the seafloor to capture energy from the flow at both ebb and flood tides.

Prior to issuing the License to ORPC, FERC reviewed the environmental impacts of the Project, in cooperation with the Department of Energy, in accordance with the National Environmental Policy Act (NEPA). FERC and DOE prepared an Environmental Assessment for the Project and issued a Finding of No Significant Impact in January, 2012. In order to minimize the impacts associated with the Project, ORPC proposed a number of conditions including (FERC, 2012):

- Acoustic Monitoring, Benthic and Biofouling Monitoring, Fisheries and Marine Life Interaction Monitoring, Hydraulic Monitoring, Marine Mammal Monitoring and Bird Monitoring Plan.
- Measures to protect aesthetic values of the project area, and
- Various operation and maintenance plans.[6]

In a recent development that provides some encouragement to the offshore energy industry in general and the MHK sector specifically, in April, 2012 the Maine Public Utilities Commission (PUC) approved the basic terms of a Power Purchase Agreement (PPA for ORPC's Maine Tidal Energy Project which begins with the previously mentioned Cobscook Bay Project. On January 1, 2013, ORPC entered into a financial contract with Bangor Hydro Electric Co for the energy output of its underwater tidal power generation devices. Pricing was set at 21.5 cents per kilowatt-hour for the tide-generated electricity in the first year; with an annual 2% per year escalator up to about 31.3 cents per kWh in the final contract year. A challenge will be to be competitive with other

[4] Under the Federal Power Act, the Commission is authorized to issue licenses for construction, operation, and maintenance of hydropower projects. Original licenses can be issued for a term of up to 50 years. Appropriate pilot projects may have short license terms of five years in length in keeping with the early stage of the technology, expected small size of the projects, required safeguards, and the experimental nature of the efforts.

[5] In addition to a short license term, Commission staff also envisions licenses for pilot projects having (1) an emphasis on post-license monitoring; (2) a license condition requiring project modification, shutdown, or removal in the event that monitoring reveals an unacceptable level of risk to the public or environmental harm; and (3) a license condition requiring project removal and site restoration before license expiration if a new license is not obtained. Otherwise, a license for a hydrokinetic pilot project, like any hydropower project license, will authorize construction, operation, and maintenance of the project, including generation of power and transmission into the national electric grid under the conditions of the license.

[6] Project Operations and Monitoring Plan, Project Inspection and Maintenance Plan, Project and Public Safety Plan, Navigation Safety Plan. and Emergency Shutdown Plan.

technologies as ORPC moves to the commercial stage. Power from the project began flowing to the grid in September 2012.

FERC has also issued seven preliminary permits for MHK projects in New England (1-MA, 6-ME) (FERC, 2012a). Unlike the Pilot License, a preliminary permit is only issued for up to three years and these permits do not authorize construction. Rather, they provide developers with priority to study a project at the specified site for the duration of the permit, which is otherwise known as "guaranteed first-to-file status."

An example outside of New England is the Verdant Power project in New York. Verdant received a Pilot License for the Roosevelt Island Tidal Energy (RITE) Project on January 23, 2012. The Project is sited in the East Channel of the East River of New York City. According to the website (www.verdantpower.com) the RITE Project will be comprised of up to 30 commercial class tidal turbines, with a generating capacity of as much as 1 MW. As with ORPC, FERC issued a Finding of No Significant Impact for the RITE Project prior to issuing the License (Maritime-Executive.com, 2012).

3.4 Natural Gas and LNG

Natural gas is a fossil fuel that is utilized in New England for a variety of reasons including electric generation, residential uses such as heating, hot water and cooking and commercial and industrial purposes. New England has virtually no production capacity for natural gas and therefore it must be delivered to end users via a series of pipelines which get their source supply from interstate pipelines, offshore pipeline or LNG deliver points.

An example of gas facilities in the offshore marine environment is the "Hubline" located in Massachusetts Bay stretching approximately 29 miles from Beverly, Massachusetts to Weymouth, Massachusetts (Hubline Pipeline Project, 2007).

Liquefied Natural Gas (LNG) is produced by super cooling natural gas to -160˚C such that the gas becomes a liquid and reducing its total volume by a factor of 600 to one which allows it to be economically stored and transported over long distances. Once the liquid reaches its destination it is vaporized and distributed.

Two LNG deepwater ports that vaporize LNG for introduction into the pipeline have been constructed offshore of Massachusetts. Northeast Gateway Deepwater LNG Port is located approximately 13 miles offshore and delivers gas to the Hubline system via a 16 mile long submarine pipeline. The Neptune terminal is located approximately 10 miles offshore of Gloucester, MA and delivers gas to the Hubline system via a 13 mile long submarine pipeline.

Though several years old now, the Islander East project is an example of some of the difficulties that gas pipelines can encounter in the offshore. The project application was denied by the State of Connecticut, which determined the proposed pipeline was in violation of several State Water Quality Standards ("WQS") and the Anti-Degradation Implementation Policy (Islander East Decision, 2004). Different routing may have resulted in different results as intimated by CTDEP who stated in their decision, "As Department staff have stated on several occasions, we are not opposed to the construction of a natural gas pipeline across Long Island Sound. We recognize that a reliable and robust system of natural gas supply for this region serves the public interest in both New York and Connecticut; however, we believe there are other pipeline routes that would avoid the impacts to sensitive near shore areas posed by the present application." (Islander East Decision, 2004):

3.5 Offshore Oil & Gas Exploration

As described earlier, there has been little movement regarding exploration of oil and/or natural gas supplies, due to political and environmental concerns. BOEM published the *Draft Proposed Outer Continental Shelf (OCS) Oil and Gas Leasing Program 2010–2015* in 2009 which included four proposed program areas; North-Atlantic, Mid-Atlantic, South Atlantic, and the Straits of Florida. However, in the final published plan titled, *Proposed Outer Continental Shelf Oil & Gas Leasing Program 2012-2017*, all four Atlantic Coast areas were excluded from consideration for a number of reasons including: limited understanding of the oil and gas resource potential; complex issues relating to potentially conflicting uses, including those of the Department of Defense; lack of infrastructure necessary to support oil and gas exploration and development; and state opposition. (BOEM, 2011).

To move the leasing program forward and to develop the available up to date survey data on the Atlantic OCS, BOEM prepared a Draft Programmatic Environmental Impact Statement (PEIS) to evaluate potential environmental effects of multiple Geological and Geophysical (G&G) activities on the Mid and South Atlantic Planning Areas of the OCS. Public comment ended in July 2012. The main issues associated with the required G&G activities included interference with operations under any lease, right-of-way, easement, impacts to aquatic resources and/or the marine, coastal, or human environment, pollution concerns or unreasonable interference with other uses.

The final drafts of the PEIS are scheduled to be published by December of 2012. This environmental assessment is expected to last approximately 5 years and upon completion the Atlantic planning areas may be considered for leasing.

4. Issues Facing the Sector

New England offshore energy projects can generally be divided into three categories: fossil fuel transportation (e.g. LNG deepwater ports and gas pipelines), electric transmission (e.g. submarine cables), and renewable energy generation (wind and hydrokinetics). Similarly, the lifecycle of an offshore energy project can generally be separated into four phases: pre-construction, construction, operation, and decommissioning. Gas and oil offshore exploration is not a near term consideration for reasons described earlier. The following table presents a summary of the potential areas where issues can arise for offshore projects.

Resource Category	Resource Type
Physical Resources	Air Quality
	Geology
	Physical Oceanography
	Water Quality
Biological Resources	Avian and Bat Resources
	Coastal and Benthic Habitats
	Finfish, Shellfish, & Essential Fish Habitat
	Marine Mammals
	Sea Turtles
	Coastal Wetland Habitats & Ecosystems
Socioeconomic Resources	Aesthetic & Visual Impacts
	Military Areas & Aviation
	Commercial & Recreational Fishing Activity
	Cultural Resources

Resource Category	Resource Type
	Demographics & Employment
	Environmental Justice
	Land Use & Coastal Infrastructure
	Navigation & Vessel Traffic
	Recreational Resources & Tourism

A comprehensive analysis of the impacts associated with each type of offshore energy project and each lifecycle phase is outside the scope of this white paper. However, a description of some of the similarities and differences between the types of offshore energy with regard to environmental issues/impacts is helpful in understanding the sector and offshore implications. In addition to environmental concerns, two other main issues associated with the offshore energy sector are the supply chain and economic concerns.

4.1 Submarine Cables, Gas Pipelines and LNG Deepwater Ports

Submarine cables and gas pipelines are both linear facilities that may be constructed in the near shore or offshore and intersect coastal areas at one or more locations. Deepwater LNG ports are typically buoys that are connected to the gas pipeline where transport vessels tie up and connect to the buoy to vaporize LNG into the gas pipeline. In most cases, cables and pipelines are buried below the seabed during installation in order to minimize the potential for damage from interaction with anchors or ground fishing activities. Submarine cables are often installed using a hydraulic jetting device, which allows for direct burial to a target depth below the seabed, and is considered to be the industry standard for low impact installation technique. Pipelines on the other hand are often installed within a pre-excavated trench, that is typically created using a mechanical plow and then back-filled to provide proper burial.

Detailed routing studies are typically conducted during the pre-construction phase of a project to avoid sensitive areas (e.g. essential fish habitat and highly utilized fishing grounds) along with substrates types and obstructions that present hazards for cable installation.

With respect to offshore electric transmission, one of the most significant issues to the development of a networked backbone transmission system is the "chicken and egg" dilemma over which comes first: the energy facilities or the transmission system (Analysis Group, 2009). For example, developers of an offshore project are likely to have difficulty financing a proposed generating facility that requires a third party interconnection system in order to sell its power if the system does not exist yet. Conversely, it will be difficult to finance a proposed merchant transmission system based on anticipated use by offshore facilities until there are facilities to actually use the transmission network. The offshore transmission system may provide benefits to the transmission grid by helping relieve congestion even in the absence of the wind turbines, which might help in resolving this question to some extent.

Another significant uncertainty, though not necessarily a barrier to development of an offshore transmission system, is how the transmission system will be owned / financed. There are two primary options for the ownership/investment approach in New England (Analysis, 2009): Investor-Owned Utility (e.g. National Grid) and Private Merchant (e.g. Cross-Sound Cable Company, LLC). Under the investor-owned utility option, the transmission system would be developed by a traditional transmission company under a traditional cost-based investment structure, with the transmission rates established by regulators. The Private Merchant approach would be developed, owned, and operated by a non-utility independent transmission entity, with all of the costs paid for directly by the beneficiaries of the Project.

A third approach to funding a transmission project is through a public authority or similar entity. Under the Public Authority approach, the offshore transmission system could be developed by a state agency (e.g. New York Power Authority) that would have responsibility to plan, build, fund, and otherwise provide transmission access to the offshore wind resources of the state. There are presently no Public Authorities like NYPA in New England.

Environmental impacts associated with submarine cable and pipeline construction are generally temporary and localized and are generally dictated by the width of the trench, length of the route, and depth of burial. For example, the 115 kV transmission cable associated with the Cape Wind Energy project will be installed using a hydraulic jetting device in an area approximately four to six feet wide at the seabed and eight feet deep (CWA, 2011) over a distance of approximately 12.5 miles. In addition to temporary impacts to benthic habitat, construction activities also can temporarily affect water quality through the introduction of suspended sediments into the water column and air quality by the presence of installation vessels.

Impacts associated with operation of submarine cables and pipelines are generally negligible due to the passive nature of these facilities. EMF has been noted as a potential concern for electric cables because some fish use electric field sensing in finding food. Also there are potential conflicts with fishing gear and cables. Offshore terminal operations would also raise concerns about navigation, air emissions, and marine mammal interaction. Decommissioning activities essentially involve the identical techniques and timescales described above for installation. Consequently, the impacts associated with decommissioning are similarly temporary and localized.

Some of the issues/environmental impacts associated with LNG terminals include dredging, vessel and plant emissions, noise, degradation to other natural and scenic resources, and catastrophic explosion (LNG Plant Siting, 2012). Due to the potential ramifications many state and local governments have opposed the construction of any new LNG terminals. For instance, in Maine several onshore proposals including Harpswell, Hope Island, Cousins Island, Sears Island, and Pleasant Point have either been rejected or withdrawn (NE Fish Mgmt Council, 2005). There has also been a view expressed by some that there is little need for new facilities because New England is already well supplied by land-based natural gas pipelines (Natural Gas, 2007). Offshore terminal construction would also raise concerns about navigation, fishing interference, air emissions, hydrostatic water discharge, and marine mammal interaction.

Issues involved with offshore pipeline development include: underwater acoustics produced during survey studies and construction, ecological impacts, archeological impacts, navigational hazards, air emissions, water quality and social-economic effects (Offshore Pipeline Environmental Statement, 2011). The Islander East Pipeline Project is an example of the issues that can arise in the near shore and offshore for gas pipelines. The project was a proposed 45 mile submarine natural gas pipeline from New Haven, CT across Long Island Sound to a terminus in Suffolk County, Long Island, NY, which, as described earlier was denied based at least in part on water quality and route selection issues.

4.2 Renewable Energy Generation

In New England, offshore renewable energy generation comes in two forms: wind energy and hydrokinetic energy. Both project types involve submarine cables, and therefore the discussion above regarding impacts from linear projects is applicable. In addition to the cabling, offshore renewable generation projects involve foundation structures and turbines that rotate either in the water column or in air. The foundation structures associated with wind turbines are typically larger in diameter and penetrate deeper into the seabed. For example, the monopiles for the Cape Wind Project are anticipated to be 4.5 to 6 meters in diameter and will be driven to approximately 26 meters below the seabed (CWA, 2011). In contrast, the hydrokinetic turbine to be installed for the Cobscook Tidal Energy Project will be installed on a bottom mounted frame approximately 100 feet long and anchored by 10 piles, each with a 1 meter diameter (FERC, 2011).

In order to help reduce the cost of offshore wind development to help make it more competitive with land based generation it will become necessary to move further offshore and to improve the technology. A significant issue related to development of large offshore wind generation projects are the constraints associated with moving from the relatively shallow near shore waters to deep water areas on the OCS. The wind sites further offshore typically have higher and more reliable sustained wind speeds and thus higher and more consistent energy production. Technological advancement of offshore wind turbines, foundation designs and other improvements in the feasibility to build utility scale projects will be important in furthering offshore development in these deep water areas. These advancements should help reduce the capital cost of offshore projects in order to make these projects competitive with onshore wind and other renewable and conventional technologies. To date, all commercial-scale installations in Europe have been shallow water with the first transition zone (30-60 meters) installations just beginning and floating primarily in the prototype/pilot stage. Cape Wind is the only shallow water deployment envisioned for New England with the areas south of Massachusetts all transition zone and plans in Maine for floating.

Currently Siemens and Vestas 2.3 to 3.6 megawatt turbines are the most widely used in the largest of European wind farms. These units generally have a 107-112 meter (351-367 ft.) rotor diameter and a hub height of about 80 meters (262 ft.) above mean sea level. New models are being developed by suppliers such as Alston, Siemens, Areva, and Vestas and Repower that range from 5 to 7 MW. The Vestas 7 MW turbine profile is a 164-meter rotor diameter with a combined nacelle and hub weight in excess of 350 tons necessitating significant advancements in foundations and tower design. The increase in the unit capability will help achieve economic efficiencies and reduce the overall footprint over a similar capacity project using the smaller capacity turbines.

Various foundation types are being explored in addition to the typical monopiles currently being used in shallow waters (typically <30 meters) as concerns exist regarding the ability of monopiles to support the total height of the tower and weight of the nacelle and blades of the larger turbines under development. Other foundation types such as gravity, jacketed, twisted jacket and tripod/tri-pile are being considered for deeper waters and for the larger turbines being developed. Floating foundations are being explored particularly for very deep water locations. Some of these foundations, such as the Windfloat allow the entire WTG to be constructed onshore and then the structure is towed out to seas where the foundation is guyed to the ocean floor and the electrical connection is made. Many floating systems utilize active and static ballast systems in a single or series of pylons that sit below the waters surface to offset the wind turbine. SWAY, another design, is a single floating tower that extends far below the water surface with ballast at the lower end. This is anchored to the ocean floor and the rotor is situated downwind of the tower (opposite of conventional turbine systems) to allow the rotor plane to remain perfectly aligned with the wind as the tower tilts up to 8 degrees. Statoil is also developing a Hywind floating technology and has proposed it as a test project in the Gulf of Maine. Statoil submitted an unsolicited commercial lease for its Hywind project in the fall of 2011, for a 12MW floating offshore wind turbine demonstration project in water off of Maine. Statoil NA's short-term objective is to construct the Hywind Maine project to demonstrate the commercial potential of the existing floating offshore

Hywind technology, while responding to a corresponding Request for Proposal issued by the Maine Public Utilities Commission.

The USDOE is supporting the development of advanced offshore wind turbine projects and selected two proposals in Maine (from Statoil and a consortium led by the University of Maine) to develop prototype demonstration projects that challenges developers to efficiently design and build a project that can compete in the energy market without the need of federal subsidies. A total of 180 million dollars in grants are being offered to help explore technology advancement in two areas. Awards were announced in early 2013.

Construction impacts from generation projects are generally the same as for submarine cable and pipeline projects in so far as impacts are in general localized and temporary. However, the time scale involved with installation of an offshore generation facility is typically longer than a submarine cable or pipeline (weeks to months rather than days to weeks). In addition to the impacts described above for cables and pipelines, the installation of foundation structures associated with generation facilities is typically accomplished using techniques that produce acoustic impacts. These acoustic impacts are often mitigated through passive and active monitoring for sensitive receptors (e.g. marine mammals and sea turtles) and other standard best practices that are designed to minimize acoustic impacts to protected species.

Unlike cables and pipelines, renewable generation facilities are dynamic systems and the movement of rotors may impact local biologic resources. In the case of hydrokinetic installations, detailed assessments are made of local aquatic species during the permitting process.

Acoustic studies investigating the impacts on marine species due to seismic surveying, pile driving, vibrations, and vessel traffic has been of recent concern and BOEM has been participating and conducting workshops and conferences related to sound. BOEM ongoing fish related studies include: Biological Effects Studies - Fish and Fish Habitat, and Environmental Survey and Monitoring Studies. Studies scheduled to start in 2012 include: Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments, Socioeconomic Impact of OCS Wind Development on Fishing, and Atlantic Offshore Wind Development: Public Attitudes, Values, and Implications for Recreation and Tourism. Additionally, there are two events planned for 2012 which include: BOEM Fish Acoustics Workshop, and Atlantic Wind Workshop.

In 2010 BOEM requested information on Commercial Leasing for Wind Power on the Outer Continental Shelf OCS Offshore Massachusetts which provided insight on the fisheries related issues including: potential impact to fisheries and fish habitats, electromagnetic fields effects on fish, economic benefits and mitigation for affected communities, access to fishing grounds, and wind farm construction effects on fish populations.

Similarly, offshore wind energy project developers are often required to conduct extensive bird and bat monitoring program pre- and post-construction in order to evaluate impacts and there are concerns over navigational and recreational water uses conflicts during construction and operation.

Although offshore energy development results in some unavoidable environmental impact, the impacts assessed for several projects to date have been found to be minimal and not of a significant nature as stated in the FONSI for Cape Wind and for the Mid-Atlantic WEA EA. However, impacts can be highly project and site specific. Standard best practices implemented during construction and operation are necessary to minimize those impacts. Effective routing and siting of transmission and generation facilities to avoid sensitive areas to the maximum extent practicable is a critical step in the pre-construction development process. As marine spatial data becomes more readily available, project development will benefit from additional regional and site specific data which may help to further minimize environmental impact for offshore energy projects in New England.

4.3 Supply Chain

A potential concern for the long term robust development of an offshore energy industry and the ancillary economic benefits is a lack of supply chain elements in reasonable proximity to project locations. Some advances have been made but significant development is needed. Conversely, until there is a pipeline of projects, significant investment is unlikely to occur. In 2010 the Department of Energy (DOE) funded a study on wind supply chain bottlenecks which identified constraints in manufacturing, transportation/shipping, equipment, and transmission.

In a report prepared by DOE entitled *A National Offshore Wind Strategy: Creating an Offshore Wind Energy Industry in the United States,* supply chain development is cited as a necessary component to establishing wind energy in the US .DOE also supports the utilization of supply chains through their Industrial Technologies Program which promotes DOE "energy-saving tools" to conserve energy and limit carbon footprints. DOE further promotes the use of supply chains through technical workshops such as the DOE's Offshore Wind Strategy workshop hosted in October 2011 as part of their Wind and Water Power Program.

The Northeast Wind Supply Chain Manufacturing Workshop was held on September 4th, 2012 in Portland, ME to discuss some of these issues.

Ports are very much tied to the supply side of the equation and various studies have been advanced to help identify issues that may arise at ports. On May 11, 2011 the United States Coast Guard posted a notice of study to the public titled, *Port Access Route Study: The Atlantic Coast From Maine to Florida.* The purpose of the study is to evaluate current routes, determine the need for modifications to current routing, and explore options for new routes to provide safe access to and from U.S. Ports. Additionally, the study examined "*existing shipping routes and waterway uses, and, to the extent practicable, reconciling the paramount right of navigation within designated port access routes with other reasonable waterway uses such as the leasing of outer continental shelf blocks for the construction and operation of offshore renewable energy facilities*" (Coast Guard Port-Access Route Study, 2011). Some of the concerns raised are:

- Navigational hazards
- Strains on the current vessel routing systems, such as increasing traffic density associated with future growth.
- Modifications that may be needed to existing vessel routes to address hazards and improve traffic efficiency
- Impacts, both positive and negative, that may result from changes to existing routing or new routing

The public comment period ended January 31, 2012 and an interim report was published in July 2012. A shipping data modeling and analysis phase is underway and anticipated to extend through 2013 and into 2014.

A second port access route study by the Coast Guard provides recommendations for avoidance of right whales in New England waters through areas to be avoided by vessels or revised traffic separation schemes. (Second Port Access Route Study, Coast Guard 2007)

Massachusetts Clean Energy Center (MCEC) issued a study in February of 2010 that examined ports in Massachusetts to determine their ability to support the staging for commercial scale offshore wind farm development. The study identified potential ports that met certain identified criteria and estimated economic development (*Port and Infrastructure Analysis, February 2011)*. The study concluded no port facilities in Massachusetts are currently ready to provide staging, installation, and operations and maintenance support to a commercial scale offshore wind farm development project in the region. However, Dry Dock #4 at the Port of Boston and the South Terminal at the Port of New Bedford were cited as potential prospects to attract offshore wind developers if investment in port upgrades is made. The improvements needed at the Port of Boston include improved highway access, education and training centers, political climate and community acceptance, and regulatory compliance. The improvements needed at the Port of New Bedford include improved railway access, education and training centers, and regulatory compliance. The recent signing by the Governor of a state law allowing a critical swap of City and State properties has allowed the New Bedford's South Terminal project to continue to advance by allowing the project to comply with federal environmental permitting and industry requirements.

4.4 Economics

Several central themes arise in the discussion of economics and development in the offshore. They tend to focus on steps to reduce the cost of the projects mainly through technology improvement and/or subsidized early development incentives such as the production tax credit (PTC), long term Power Purchase Agreements to allow financing and attaining a critical mass or pipeline to allow supply chains to locate close to projects and thereby reduce costs.

4.5 Stakeholder Input

As described earlier, interviews were conducted with a number of stakeholders to solicit their views on offshore energy development. Some of the specific points made in these interviews are listed below.

- Permitting/regulatory process: Uncertainty in the permitting process and the currently experienced long timeframes can make offshore projects overly risky for developers.

- Financial: It is difficult to sell the output from the offshore renewable projects given current costs and the competing generation sources that are currently at lower rates given circumstances such as low gas prices and a propensity of purchaser to look only at the price per kWhr and none of the ancillary benefits. Long-term extension of production and investment tax credits or sustained DOE loan guarantees are needed to help advance the current fledgling industry and to provide some certainty for long term pricing.

- Costs: This coupled with lowering the cost of installing and operating offshore wind energy is seen as a key priority. High costs are driven by: technology, deployment of infrastructure, need for supply chain to support the industry, cost of capital. Equipment costs are about a third of the project cost. Bringing vessels and manufacturing to the region could help drive down costs. Also, advances in technology will help drive production unit cost down. Supply chains can play an important role here and once there are a significant number of projects underway, companies that manufacture turbines and other components will be more inclined to locate proximate to projects, which would reduce costs.

- Contracts: In order to finance projects, a long-term contracting system needs to be available at a state and regional scale be it through "off take" agreements, feed in tariffs or

Power Purchase Agreement (PPA) to buy the electricity. Developers are currently trying to get leases for projects without a way to sell the energy. Long-term (20 year) contracts are preferred but the only entities in a position to do this are utilities, which might not be willing to take on too much risk and therefore will only sign on for limited capacity.

- Natural gas: Marcellus Shale gas and advances in gas recovery techniques have resulted in large supply with resultant lowering of prices. As a result, there is little new LNG importing occurring right now and probably not for the foreseeable future.

- Gas pipelines: New offshore pipelines are probably not going to be proposed in any large amounts but as with electric transmission, there may be opportunities to bring natural gas from Labrador and Newfoundland to New England via a coastal waters pipeline. Pipelines may be proposed to bring Marcellus shale gas into New England.

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