Offshore Wind Energy: Considerations for Georgia

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Georgia Coastal Research Council

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Offshore Wind Energy: Considerations for Georgia

This document provides background about offshore wind energy, with a specific focus on its potential development in Georgia coastal waters. Part I is an introduction to the use of offshore wind as a renewable energy source; Part II provides an overview of the components of a wind installation; Part III discusses factors that are considered in siting a wind facility; Part IV describes the environmental considerations associated with such a project; Part V describes planning tools and ongoing offshore wind energy initiatives, along with some concluding notes.

I. Introduction

In 1991, Denmark installed a wind turbine off the southern coast of Fyn, becoming the first nation to generate electricity from offshore wind. By 2008, eight European nations had installed 26 offshore wind projects in the North and the Baltic Seas with a combined capacity of more than 1200 megawatts (MW) (USDOE 2008). By 2010, the offshore combined capacity in the EU had increased to approximately 2,000 MW (USDOE NREL 2010). To date, the world's largest approved offshore wind development is the London Array Project (UK), which is designed to generate enough electricity to power 480,000 homes annually[1] starting in 2013. The project will have 175 wind turbines, and will cover an offshore area of 100 square kilometers (km^2).

According to the U.S. Department of Interior (DOI) the United States "leads the world in installed, land-based wind energy capacity, yet has no offshore wind generating capacity to date, despite the fact that offshore Atlantic winds contain an estimated 1,000 gigawatts of energy" [2]. The U.S. Department of Energy has developed a scenario by which a combination of onshore and offshore wind could provide approximately 20% of America's electrical energy by 2030 (USDOE 2008). Under this scenario, offshore wind could potentially provide "54 gigawatts of installed electric capacity to the grid" (Schwartz 2010).

In October 2010, the U.S. Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE, formerly known as the Minerals Management Service) and Cape Wind Inc[3] signed the nation's first lease for an offshore wind development in federal waters, the Cape Wind Project (CWP)[4]. The area included in the 33-year lease is comprised of approximately 46 square miles on the Outer Continental Shelf in Nantucket Sound offshore from Massachusetts. Cape Wind's "Construction and Operations Plan", approved in April 2011, calls for 130 wind turbines expected to produce (from average winds) up to 420 MW of power. This is projected to be

[1]The London Array website http://www.londonarray.com/the-project/
[2]U.S. Department of Interior website:
http://www.doi.gov/news/pressreleases/loader.cfm?csModule=security/getfile&PageID=73317
[3] Cape Wind Project website: http://www.capewind.org/
[4] U.S. DOI Cape Wind information website http://www.boemre.gov/offshore/renewableenergy/CapeWind.htm

enough electricity to supply up to three quarters of the electrical needs for Cape Cod and nearby islands[5], making it one of the largest wind energy installations in the world.

BOEMRE launched the "Smart from the Start" Initiative in November 2010 to help "fast-track" applications for offshore wind development[6]. As part of that initiative, BOEMRE has been forming federal-state Task Forces[7] to facilitate intergovernmental communications regarding Outer Continental Shelf renewable energy activities. To date, nine of the thirteen states along the Atlantic coast have active task forces: Delaware, New Jersey, Maryland, Rhode Island, Maine, Massachusetts, Virginia, North Carolina and New York. In addition, Secretary Salazar and the governors of ten East Coast states[8] signed a Memorandum of Understanding that formally establishes an Atlantic Governors Offshore Wind Energy Consortium to promote a coordinated approach for offshore wind resources.

A recent Department of Energy report estimated that Georgia' offshore wind resources could provide approximately 6% of the energy generated by the state (USDOE NREL 2010). In 2005, Georgia Institute of Technology's Strategic Energy Institute and the Atlanta-based Southern Company (a utility corporation) undertook an initial study regarding the technical and economic feasibility of locating an offshore wind farm in Georgia's coastal waters. The report, "Southern Winds" (GIT et al. 2007), identified a primary potential area for a wind installation off the southeast coast of Tybee Island. Although the array's precise placement has not yet been determined, the Tybee site is between 6.8 and 10.2 miles from shore (see Figure 9 for photo-simulations). As of this writing, the Southern Company has applied for BOEMRE permits to install two meteorological towers for additional data collection to assess wind energy potential at the Tybee Island site, but no lease has yet been granted.

Offshore wind and other potential renewable energy sources will be increasingly important in the coming years. In this paper we provide some basic background about offshore wind energy, and review the factors that will likely be relevant in its potential development in Georgia coastal waters. Although this report is specifically focused on offshore wind, there are several other types of renewable offshore energy resources and technologies being developed. A brief overview of these is provided below (Box 1).

[5] Cape Wind Project website: http://www.capewind.org/article24.htm
[6] "Smart from the Start" press release, DOI website: http://www.doi.gov/news/pressreleases/Salazar-Launches-Smart-from-the-Start-Initiative-to-Speed-Offshore-Wind-Energy-Development-off-the-Atlantic-Coast.cfm
[7] BOEMRE Task Force updates: http://www.boemre.gov/offshore/renewableenergy/stateactivities.htm
[8] BOEMRE Atlantic Consortium MOU: http://www.boemre.gov/ooc/PDFs/AtlanticConsortiumMOU.pdf

Box 1: Additional Offshore Renewable Energy Sources
In addition to offshore wind, several other potential offshore renewable energy sources are being considered, globally. These are briefly described below.

Ocean Thermal Energy – The ocean's surface water holds significant heat, generated by the sun. If the temperature difference between the surface waters and the cooler sub-surface waters is at least 36°F (20°C) this gradient can drive a conversion technology to produce electric power[9].

Salinity Gradient Energy – This technology utilizes the osmotic pressure differences between salt and fresh water often found in coastal regions.[10]

Wave Energy – Waves produce mechanical energy; devices can be installed nearshore, offshore or far offshore and extract energy directly from either surface motion or from below the surface where wave pressures fluctuate.[11]

Tidal Energy – The ebb and flow of vast amounts of water during the twice-daily marine tidal cycles generates energy that can be harnessed and converted into electricity. [12]

Marine Biomass Energy – Heating or fermentation of algae, seaweeds or other marine biomass can be used to create biofuel. This would involve creating onshore or offshore farms, which could be located on unused existing offshore platforms[13].

Offshore Solar Energy – Two main categories of technologies are being considered, both requiring very large areas of offshore surface collection of solar energy, with accompanying permanent structures.[14]

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[9] NREL Ocean Thermal Energy webpage: http://www.nrel.gov/otec/achievements.html
[10] *Renewable Energy Source Info* website: http://renewable-energy-source.info/renewable-energy-sources/ocean/salinity-gradient-power/
[11] NREL Wave energy webpage: http://ocsenergy.anl.gov/guide/wave/index.cfm
[12] "Ocean Energy Technology Development". NREL powerpoint: http://www.nrel.gov/docs/gen/fy07/40461.pdf
[13] NREL webpage: http://ocsenergy.anl.gov/documents/fpeis/Alt_Energy_FPEIS_Chapter6.pdf
[14] NREL Offshore Solar energy webpage: http://ocsenergy.anl.gov/guide/solar/index.cfm

II. Components of an Offshore Wind Energy Installation

A. Turbines

Wind power is generated when winds blow through a turbine, converting the kinetic energy to electricity. Wind turbines are arranged in arrays that take advantage of the measured prevailing wind conditions at the site. Turbine spacing is usually chosen to minimize aggregate power losses, turbulence within the array, and the cost of cabling between turbines. Most offshore turbines are now between 3.0 and 5.0 MW (compared to land-based turbines which range from 1.5 MW to 3.0 MW); new designs are in the 5.0 to 10.0 MW range (Bedard 2010). Turbines on the market today have a projected life span of approximately 20 years, though wear and tear from the marine environment may result in a shorter lifespan.

The major components of a wind turbine are a rotor, or set of blades, which convert the wind's energy into rotational shaft energy; a nacelle (enclosure) containing a drive train, usually including a gearbox, and a generator; a tower, to support the rotor and drive train; and electronic equipment such as controls, electrical cables, ground support equipment, and interconnection equipment (Figure 1). Tower height will vary depending on the situation, but in the case of Cape Wind Project the center of the blades will be 258 feet above the water (with a rotor diameter of 365 feet). Depending on wind speed, the blades of the wind turbine will move at 8 to 16 revolutions per minute (RPM), or approximately one complete rotation each four to eight seconds.

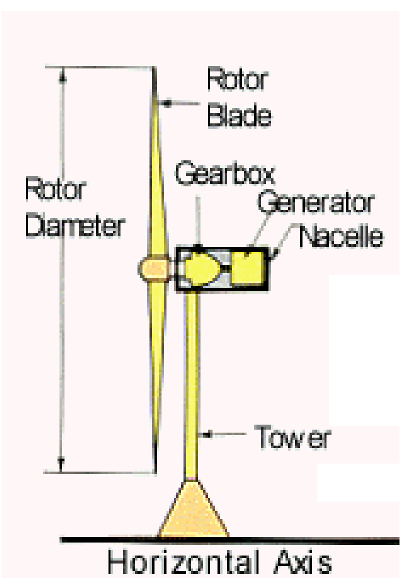

Figure 1. Basic components of a wind turbine (AWEA)[15].

[15] American Wind Energy Association website: http://archive.awea.org/faq/wwt_basics.html

Offshore turbines vary in design depending in large part upon the depth of the ocean at installation site (Figure 2). Currently, most turbines are on pilings sunk into the sea bottom at water depths of 15 to 85 feet, but new designs are extending the technology into deeper waters. For the majority of operational offshore wind farms to date, turbines have been installed on monopile foundations—large, thick-walled steel tubes (up to 2.4 inches thick and 20 feet in diameter) —driven into the seabed sediment. These monopile foundations require massive hammers to drive them into the seabed and special crane vessels for lifting the turbine and tower into place. Less commonly used is a larger gravity-based foundation design, which is a pre-cast concrete structure (with ballast added) that is assembled onshore and transported to the installation site. It is lowered into a pre-dredged pit shaped to fit the bottom of the foundation. A layer of gravel is then put in place over the foundation. This design relies on gravity and water column pressure to maintain its position. These are sometimes used as an alternative to avoid the need for a large pile-driving hammer or to accommodate areas where piles cannot be reasonably installed. Floating turbines offer another design option currently undergoing intensive research and development, with a study installation being tested in Norway's deeper offshore waters[16].

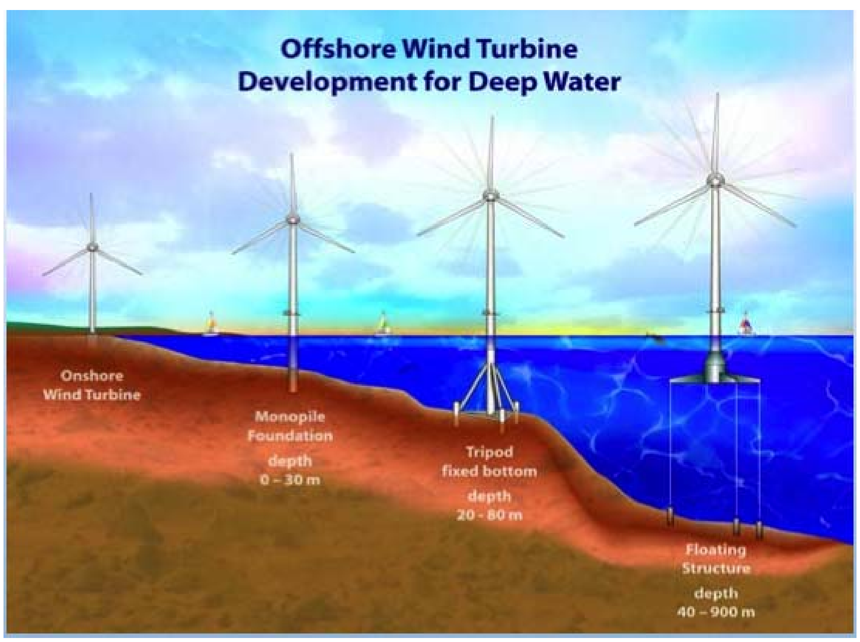

Figure 2. Comparative Turbine Installation Designs (Musial 2005[17]).

[16] "Hywind"- offshore floating turbine installation study by Statoil, southwest of Norway http://www.statoil.com/en/technologyinnovation/newenergy/renewablepowerproduction/onshore/pages/karmoy.aspx

[17] Wind Powering America Workshop 2005 website: http://www.windpoweringamerica.gov/pdfs/workshops/2005_summit/musial.pdf

B. Electrical Service Platform

The wind farm has a power distribution grid system that begins by connecting the outputs of the individual turbines at an electric service platform (ESP), or offshore substation. ESPs house transformers and associated generators and machinery, providing a common electrical interconnection for all the turbines in the array. At the ESP, the voltage is stepped up (i.e. voltage output is made greater than voltage input, through use of a power converter), generally to about 138 kilovolts (kV). The power is then transmitted through a number of high-voltage subsea cables to shore, where an inter-connection point sends the power to the grid (Figure 3). Once onshore, the voltage may need to be increased again. For small arrays of just a few turbines that are closer to shore, the distribution grid can extend to the shore for direct connection to a substation and grid system, eliminating the need for an ESP.

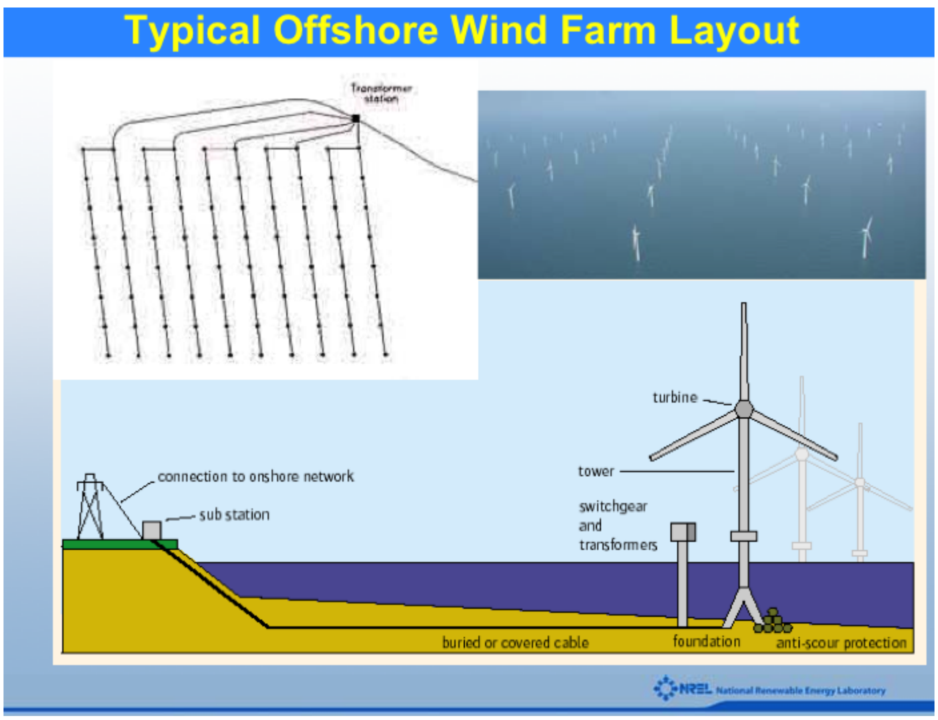

Figure 3. Generic layout of an offshore wind farm. Note that in this case the ESP is labeled as a "transformer station" (Musial 2005[18]).

When ESP's are installed, they also provide a central service facility for the wind farm, and can include helicopter landing pads, a control room with supervisory control and data acquisition monitoring stations, a hoist crane, a rescue boat, a communication station, firefighting equipment, emergency diesel backup generators, and staff and service facilities, including emergency temporary living quarters for maintenance workers (Bedard 2010).

[18] Ibid footnote #11.

C. Cabling

Undersea cables connect the wind turbines and transmit electricity to shore. Cables can be buried, but they may also lie on the sea floor surface. The specific design of the cabling system will depend on a number of factors, including the size and scale of the wind farm, its distance from shore, and the characteristics of existing onshore transmission facilities. Best practices for cabling are still evolving in this relatively new industry, but below we describe the planned transmission system for the Cape Wind Project (CWP), as described in both the "Construction and Operations Plan" (U.S. DOI BOEMRE 2011) and the Executive Summary of the Final Environmental Impact Statement, which were documents mandated by the federal permitting process. However, the scale of possible offshore installations in Georgia and/or the southeastern region may differ significantly from CWP's (one of the largest in the world) and therefore the installation methods and specifications in Georgia's case may vary.

The Cape Wind ESP facility will be located approximately 12.5 miles from the shore of Cape Cod. It will serve as the common interconnection point for the wind generators via an inner-array of 33-kV cables, and then transmit electricity via two to four parallel sets of submarine 115-kV alternating current (AC) cables. The voltage of the AC cables was chosen to match the voltage of existing onshore transmission lines, which is similar to how most offshore installations have been configured to-date. However, it is also possible to use high voltage direct current (HVDC) cables, which require conversion technology to integrate the offshore energy form with the larger grid. It should be noted that BOEMRE recently received an unsolicited application (Frank 2011) for an offshore wind development using HVDC cabling system for the Mid-Atlantic region[19].

1. Hydro-plowing - In the case of the Cape Wind Project, both the inner-array and offshore transmission cables will be buried at a depth of 6 feet via a process known as "hydro-plowing". Hydro-plowing uses high-powered jets operating from a stationary barge, which serve to create a continuous trench in which the cable is laid (Figure 4). The hydro-plow "…is typically fitted with hydraulic pressure nozzles that create a direct downward and backward "swept flow" force inside the trench. This provides a down and back flow of re-suspended sediments within the trench, thereby "fluidizing" the in situ sediment column as it progresses along the predetermined submarine cable route such that the submarine cable settles into the trench under its own weight to the planned depth of burial… it is the installation methodology that has been adopted as the preferred technique by state and federal regulatory agencies based on review of past precedent-setting projects." (U.S. DOI BOEMRE 2008). The cables are then buried as the sediment re-settles around them. The CWP offshore transmission cables will be co-installed with two fiber optic cables to facilitate operational telecommunications between the offshore generating facilities and the mainland.

[19] Atlantic Wind Development transmission project: http://atlanticwindconnection.com/uncategorized/aws-intro/

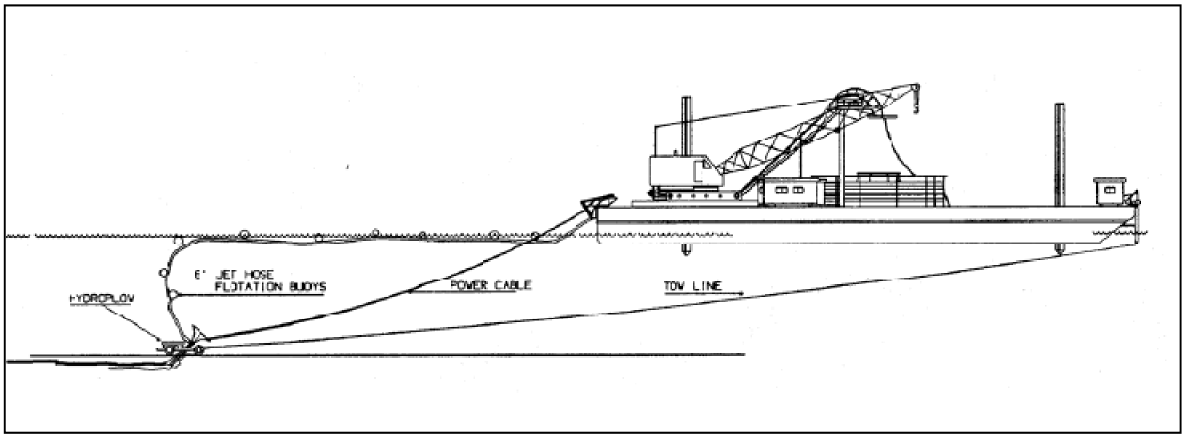

Figure 4- Side view of Hydro-Plow (National Grid 2006)[20].

2. Horizontal Directional Drilling. - In the case of the Cape Wind Project, horizontal directional drilling (HDD) will be used to install underground cables for the final connection to land, as this reduces impacts to the overlying sediment in comparison to the use of a hydro-plow. With HDD, vertical boreholes are drilled and then curved to allow cables to be drawn through horizontally, underneath the surface. HDD was used at the landfall terminal of a cable that was recently installed to connect Nantucket with Cape Cod. (Figure 5) and is also commonly used for activities associated with the oil and gas industries.

Figure 5. Example of a Horizontal Directional Drill rig for a small Nantucket Island undersea electrical transmission cable installation (not from offshore wind*)* (National Grid 2006).[21]

[20] National Grid presentation at the 2006 International Code Council (ICC) meeting, St. Petersburg FL. http://www.pesicc.org/iccwebsite/subcommittees/subcom_c/C11/Presentations/Fall2006/C-11-Campilii-Nantucket-Submarine-Cable.pdf

The HDD and final landfall transition connection process is paraphrased here from CWP's licensing application (USDOI BOEMRE 2008): The plan is to drill holes 200 feet deep from two upland transition vaults, and then lay horizontal 18-inch conduit pipes, which will serve as an outer protection layer for the cabling system. A temporary seawall (also called a cofferdam) will be constructed a hundred feet seaward of the landfall location in order to help contain material associated with dredging and hydro-plow operations. The cofferdam will be approximately 65 feet wide and 45 feet long. Sediment behind the cofferdam will be excavated to expose the seaward end of the HDD borehole. Upon completion of the installation, this sediment will be replaced (Figure 6).

The drilling process requires lubrication and produces drill cuttings (e.g. mud and substrate, with occasional drill bit metal shavings), which are transported to the surface for recycling. This involves the creation of a pit lined with a slurry mixture of fresh water (95%) and bentonite[22] (5%). A re-circulation system will recycle the fluids and contain and process drilling returns for offsite disposal to minimize excess fluids disposal in order to prevent any from reaching the marine or tidal waters. After the outer pipe pieces are installed, smaller conduits will be installed inside of those, to house the cable system from the undersea section. "Pulling" cables will be installed for use in drawing the undersea cables through (either from landfall end or from seaward side, depending on conditions to be determined on site) and a bentonite medium will be used to fill the void between the cable conduits and the 18-inch pipe.

[21] National Grid presentation at the 2006 International Code Council (ICC) meeting, St. Petersburg FL. http://www.pesicc.org/iccwebsite/subcommittees/subcom_c/C11/Presentations/Fall2006/C-11-Campilii-Nantucket-Submarine-Cable.pdf)

[22] Bentonite is a form of highly absorbent clay of volcanic ash sediment origin. It is used extensively in trenching and boring procedures, as it converts readily between a gel and a liquid state and can provide support in water-saturated soils.

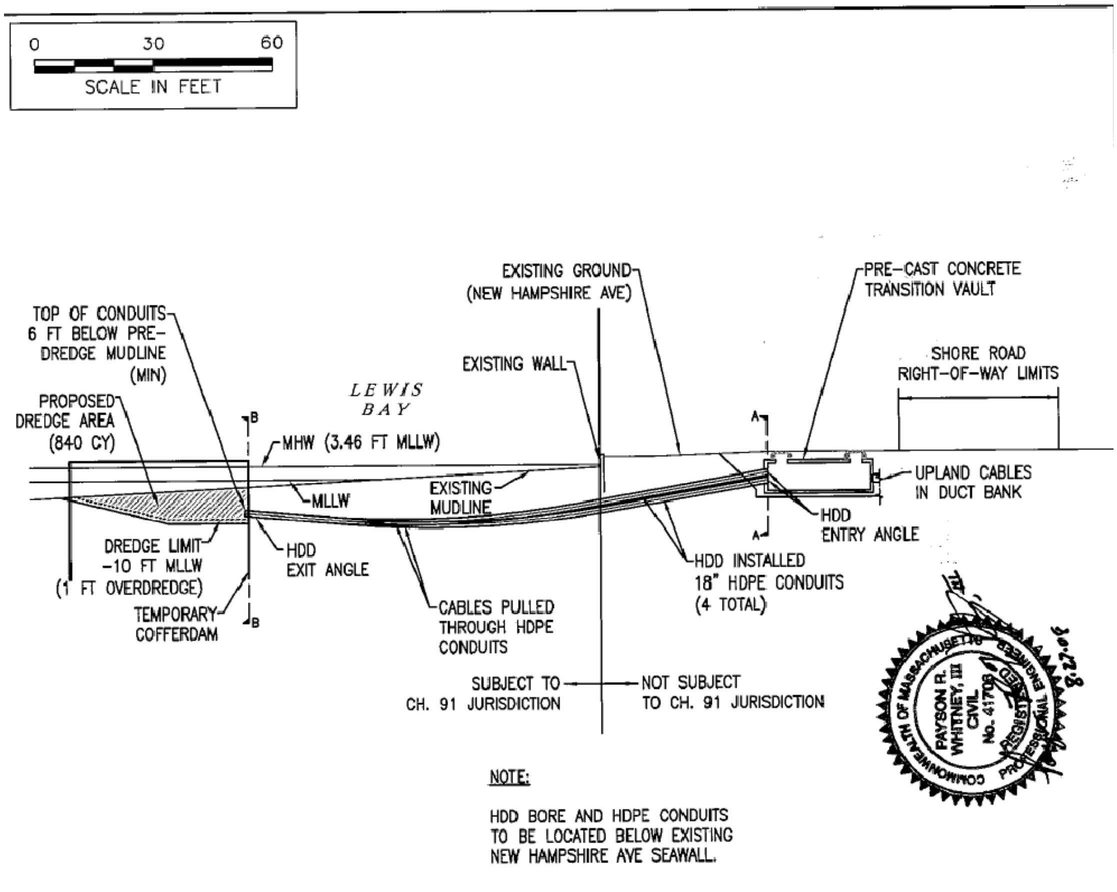

Figure 6. Profile -Proposed Landfall Conditions, Cape Wind Project (U.S. DOI BOEMRE 2008) [23].

At the Cape Wind Project's landfall end, a backhoe or other conventional excavation tool will construct a vault (about 8 feet wide x 35 feet long) and a manhole (or other chamber to contain the transition splice section of the cabling system) for each of the two larger conduits. The manholes will be 38 inches wide, 10 feet deep, each containing a set of 6-inch diameter PVC conduits, which will house and connect the emerging cables to the onshore substation infrastructure at the "ductbank" (an electrical piping system to protect and route wiring or cabling). In order to connect into the larger transmission system, underground cabling will run alongside existing roads to a switching station operated by the electric company. In most cases that cable will be buried using standard underground cable techniques, followed by repaving of the roads[24]. Standard stormwater erosion and sedimentation controls will be installed, inspected and maintained throughout construction operations.

[23] "M.G.L. Chapter 91 Waterways License Application "Submarine Cable electric Transmission Facility Lewis Bay and Nantucket Sound" Attachment A, Sheet 9 of 11. http://www.capewind.org/CW_Ch91_Application.pdf
[24] Cape Wind Project website article: http://capewind.org/article20.htm

III. Offshore Wind Farm Design: Technical Considerations

The technical viability of an effective offshore wind farm is predicated upon the existence of the appropriate conditions. These include the availability of adequate reliable wind; turbine and equipment designs that can perform well in spite of disruptive climate, weather and wave events; appropriate water depth for currently available components; and geological conditions that facilitate installation of architecturally sound pilings and effective cabling systems, among others. The connection to the land transmission system must also be considered. In this section, we present these considerations in more detail, focusing the discussion on issues and potential impacts for the Georgia coastal area in particular. The Georgia-specific information that is presented in this section is largely drawn from the report of the Southern Winds Project (GIT et al. 2007). Other sources are cited as they occur.

A. Wind Energy Potential

Wind turbines are ideally sited where the wind energy potential is greatest. Variables to be considered include wind power density, direction and consistency.

1. Wind Power Density is the standard metric for assigning wind Class Category. The wind power density, measured in watts per square meter (W/m^2), assesses wind speed at varying heights above the surface (wind speed generally increases with height above ground) and therefore indicates how much energy may be available at the site for conversion by a wind turbine (Table 1).

Wind Power Class	Wind Power Density (W/m2)	Speed (mph)
1	< 200	<12.5
2	200-300	12.5-14.3
3	300-400	14.3-15.7
4	400-500	15.7-16.8
5	500-600	16.8-17.9
6	600-700	17.9-19.7
7	700-800	>19.7

Table 1. Wind Power Density at a height of 164 feet (~50 m) (from "NREL-Battelle Wind Energy Resource Atlas" as cited in Alternative Energy Dictionary)[25].

[25] Dictionary of Alternative Energy and Sustainable Living: http://www.daviddarling.info/encyclopedia/W/AE_wind_power_density.html

After studying data from several U.S. Navy and other offshore data stations, a research team from Georgia Institute of Technology's Strategic Energy Institute (SEI) concluded that one particular U.S. Navy platform (R2), located approximately 37 miles offshore from Tybee Island in water of approximately 88 feet depth (Stewart et al. 2006). had a "Class 4" wind regime (GIT et al. 2007). The team decided that this site merited further investigation, and Southern Company submitted an application (lease not yet granted) for the installation of a meteorological tower to collect additional site-specific data. By comparison, the winds available at the Cape Wind offshore site are primarily Class 6 winds, as is the case in many offshore areas of Europe.

***2. Wind Geographical Consistency and Directions* –** Other considerations for harnessing offshore wind energy include seasonal variation in both wind speed and direction. According to the SEI study, the strongest average wind velocities off coastal Georgia (>18 mph, [8+ meters/second]) are associated with the winter months December through March, and with the peak tropical storm season, September (18.5 mph [8.30 m/s]). Summer months have the lowest average wind speeds, with the minimum average calculated for August (13.1 mph [5.88 m/s]). The data indicated that winds are the strongest from the northeast and northwest, with secondary effects from the south by southwest. The most prevalent wind direction is from the south (GIT et al. 2007).

B. Ocean Conditions

1. Storm Events - Current offshore wind technology requires that wind facilities be sheltered from extreme ocean wave action and storms (Kalo et al. 2009). Consequently, occurrences of tropical storms, hurricanes and nor'easters as well as lesser seasonal storm activity in coastal Georgia require that careful assessment be conducted regarding risk to infrastructure as well as reliability of deliverable power for electricity. In addition, lightning strikes during storms, often severe over Georgia's coastal waters could potentially damage offshore wind turbines and associated equipment. This situation would require accessing the turbines to detect, assess and repair any lightning damage. Effective lightning protection components created for offshore turbines have become more reliable and available, and should be part of the final design.

2. Water Depth - It is generally advised that siting of turbines should occur in water that is less than 20 meters deep (approximately 65 feet), usually because water depth impacts construction costs. According to Kalo et al. (2009), "Of the approximately 1,470 MW of wind energy produced from projects offshore in Europe, most of these turbines have been constructed in waters that are less than 20 meters deep". The offshore area that runs from Cape Hatteras NC to the tip of Florida is known as the South Atlantic Bight. The outer continental shelf in this area widens in Georgia's waters due to the westward curve of Georgia's coastline, forming a shallow area of a little less than 3,100 square miles that is of appropriate depth (< 65 ft) for a potential wind farm. The distance from shoreline at the N. Tybee Beach lighthouse to various points east-southeast along the 60 ft. depth contour ranges from approximately 20 miles to 32 miles offshore[26].

***3. Wave Characteristics* -** Turbine pilings are subject to wave loads (Fritz 2011, pers. comm.), so wind generation equipment specifications must be appropriate for the wave characteristics of the area's water. The SEI team cites data that lists significant wave height of 4 ft.[27] and a maximum wave height of 20.6 ft. at locations within the Tybee site area (GIT et al. 2007).

***4. Substrate* -** The geological characteristics of a potential offshore wind farm location can influence specific siting choices for a number of safety and design needs. The towers that hold the turbines must be sunk to a sufficient depth for stability during extreme storm conditions. Shifting sands, the presence of sand-filled channels and submerged barrier islands can all affect drilling and the ability of the turbines to be anchored into place. Also, the undersea transmission cables must be buried deep enough to prevent damage by any marine activities, including ships weighing anchor, fishermen dragging gear, etc. Therefore, the substrate must allow for sufficiently deep drilling. The SEI project team identified the Tybee Island location as more suitable than an alternate site (east of Jekyll Island) because of slightly better winds and "preferable substrate conditions on the ocean floor" (GIT et al. 2007).

C. Landfall Siting

Unlike oil and gas extraction, where ideally 100% of the resource remains in the pipeline, wind energy must be either delivered to the grid as soon as possible or stored safely and efficiently. As such, onshore transmission infrastructure presents a significant planning and design challenge. Leker (2009) states that transmission bottlenecks and onshore storage and grid connections to infrastructure may represent the largest restrictions of capacity for offshore wind. In 2010, the State of Virginia commissioned Dominion Virginia Power to conduct an in-depth study (still underway) of the potential interconnection options for multiple offshore wind facilities to the larger transmission grid. A recent report to the North Carolina legislature about offshore wind energy potential in North Carolina also recommended that a detailed study of potential bottlenecks, grid connection challenges and storage issues be addressed by a high-level transmission study to be conducted by objective third parties prior to any development of offshore wind energy farms (UNC 2009).

In Georgia, the Southern Winds Project evaluated potential landfall sites as the first step in identifying locations for an offshore wind farm. Team members evaluated the coastal Georgia Power substations according to distance from landfall (substations farther than six miles inland

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[26] Calculated using "Bathymetry (Meters)" kzm file of SAFMC-NOAA map, available in Google Earth at: http://ocean.floridamarine.org/efh_coral/ims/Description_Layers.htm

[27] "Significant wave height" is the average wave height (trough to crest) of the one-third largest waves: http://en.wikipedia.org/wiki/Significant_wave_height

were not considered), geographic characteristics, and substation configuration (GIT et al. 2007). Figure 7 shows the general locations of the evaluated substations. The team recommended substations at Tybee Island and Jekyll Island as potential sites for transmission interconnection, and identified the Tybee site as a primary location for further evaluation not only for its potential connection to the grid, but also because it had better proximity to maintenance and industrial resources and less visual impact from shore. Although substations sometimes require additions or upgrades, the team has not yet evaluated whether either the Tybee or Jekyll substations would need any additions, upgrades, etc. (Philpot 2011, pers. comm.)

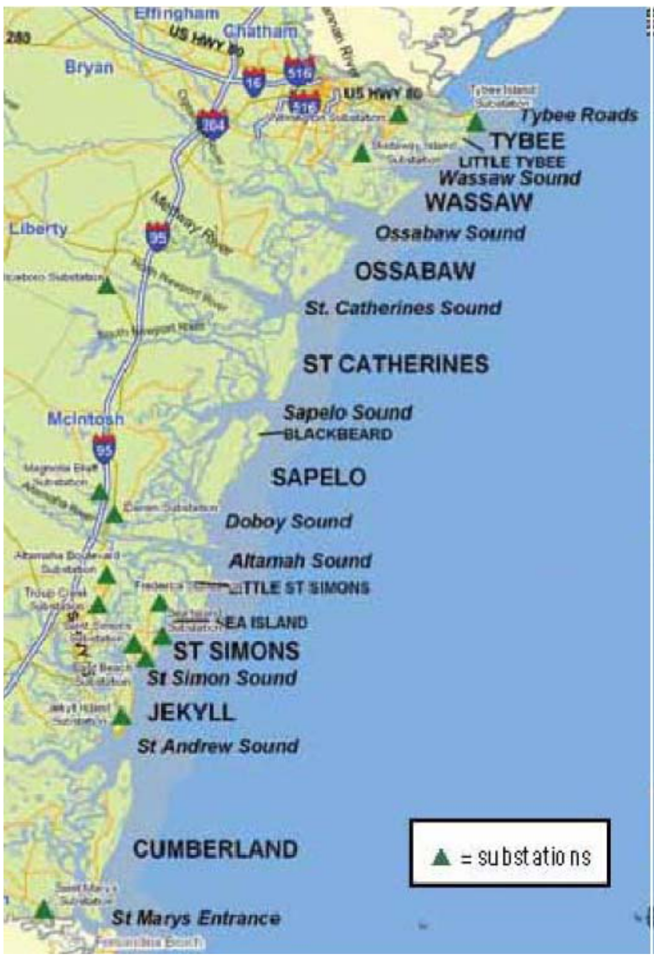

Figure 7. Map of general locations of coastal Georgia substations considered by the Southern Company for offshore wind transmission (GIT et al. 2007).

IV. Offshore Wind Farm Design: Environmental Considerations

The design process for an offshore wind farm must address environmental concerns, keeping in mind that each stage of development (Box 2) can have multiple and in some cases cumulative potential impacts. Moreover, the effects of a given wind farm will depend on its specific design characteristics. In this section we consider the various components of a wind farm and review the primary environmental considerations that have been reported for each one, with a focus on wildlife and habitat. While we provide some information about a few mitigation options, we encourage the reader to consult other sources for more detailed information (see Appendix B).

Box 2: The basic stages of an offshore wind energy facility:

<u>Pre-installation</u> – Planning, design, permitting, preliminary assembly of components onshore.

<u>Construction</u> - Installation of offshore array, undersea cabling, onshore connection components, etc.

<u>Operations and Maintenance</u> - Active transmission of offshore wind energy.

<u>Decommissioning</u> – Removal of some, or all, offshore components when the installation is rendered inoperable.

A. Rotors

1. Collisions - Sea birds can be harmed by wind turbines, although their risk depends on both their chance of encountering a turbine as well as their vulnerability if they do have a collision, and both of these factors depend on behavior. Collision rates appear to be highest for those species that pass through a wind farm on a regular basis, are long-lived (usually with a correspondingly low annual reproductive output), and are large (usually with a correspondingly low maneuverability) (Wilson et al 2010). Large birds such as raptors (e.g. osprey) tend to drift on wind currents and practice contour flying close to the surface, so a sudden updraft may force the bird into the rotor swept area[28]. However, some species of wading birds and gulls may also be at risk due to their daily movement between inland roosting and coastal foraging and breeding sites.

[28] See Madders and Whitfield's study (2006) of upland raptor collisions at onshore wind installations, cited in Drewitt and Langston's literature review (2006) about impacts on birds.

The number of diurnal and nocturnal migrant birds that move through offshore areas varies with species, migration intensity, season, and the weather. In Georgia, the nearshore bird groups that are mostly commonly seen within 12 miles of the coast -especially in winter- and use the near shore environment in large numbers include lesser scaup, loons, gannets, mergansers, and scoters (Keyes 2011, pers. comm.). There are insufficient numbers of studies to ascertain whether true pelagic species occur in Georgia coastal waters in the currently proposed sites, but due to the Outer Continental Shelf and Gulfstream currents being so far off shore, their densities are not expected to be as high as in other states where those oceanographic features are closer to shore (Keyes 2011, pers. comm.).

Some species of bats also make migrations over open sea and coastal areas. The few existing offshore studies of bats indicate there are fundamental differences in their responses to wind farm installations in comparison to birds. Bats will actively investigate wind turbines, a behavior that has not been demonstrated in birds. There are numerous possible explanations for this difference, including the fact that migrating bats may be attracted to the turbine structures, perhaps for food (insects) and potential roosting sites (possibly due to heat produced by turbines), often resulting in collision deaths. It is also possible that their echolocation abilities fail due to electromagnetic field disorientation, or that they are attracted to audible and or ultrasonic sound produced by turbines (Long et al. 2010b). It may be that bats experience decompression injuries or fatalities caused by the decrease in air pressure associated with moving turbine blades, which can damage their air-containing structures (Baerwald et al. 2008). It is possible that some species (e.g. eastern red bats) may migrate along the Georgia coast (Kunz 2011, pers. comm.) but this has not been studied.

Mitigation: The arrangement of towers in a wind farm can help to reduce the potential for collisions with both bats and birds. According to Drewitt and Langston (2006), two such strategies include siting turbines close together to minimize the footprint of the wind farm, and grouping turbines to provide corridors aligned with main flight trajectories. Another strategy, examined in an onshore study by Arnett et al. (2010) found that increasing turbine cut-in speeds (the minimum wind speed at which turbines will generate power) resulted in nightly reductions in bat mortality, ranging from 44% to 93%, with marginal annual power loss (< 1% of total annual output).

Another possible mitigation strategy to reduce collisions involves the visibility of the rotors. Rotors are generally colored yellow, white or gray to reduce their impact in viewshed, but painting them in darker colors (or with contrasting patterns) offers the potential to reduce collisions (McIsaac 2001 as cited in Drewitt and Langston 2006). On a related topic, Long et al. (2010a) suggested that some collisions occur because ultraviolet and infrared components of paint color, invisible to humans, attract an abundance of insects, transforming the turbine area into an attractive foraging site for certain bird species, which may lead to increased collisions. This area of research holds potential value for reducing future collisions.

2. Displacement – The presence of a wind farm may also result in additional effects on birds and bats due to displacement from foraging habitat (reviewed in Wilson et al 2010)) and barrier effects for birds that are avoiding the area. These types of effects can potentially affect an animal's energy budget and result in lower growth rates and decreases in breeding productivity.

Cumulative effects on a species population may also occur if multiple wind farms create a "chain" along a flyway corridor of a given population (Wilson et al. 2010). In studies conducted in Denmark, scientists have found that the proportion of potential habitat affected relative to all available areas outside the wind farms "is relatively small and therefore of little biological consequence" for most bird species that have been studied. However, the cumulative impacts of multiple wind farms may constitute a significant effect in the future (DONG Energy et. al. 2006). In a current research project funded by BOEMRE, scientists are using solar-powered, remotely operated acoustic microphones and thermal imaging cameras along the US east coast to monitor migrating birds, many of which are thought to island-hop[29]. This may be important for Georgia, given the numerous barrier islands along our coast.

3. Noise - Noise and vibrations from turbine operation may potentially cause disturbance to birds and bats as well as animals in the water (e.g. fish and cetaceans). While currently the greater concern with respect to noise is associated with the installation of the towers (considered below), operational noise effects have not yet been adequately assessed (Thomsen at al 2006). One of the few studies available measured underwater turbine noise at Denmark's Horn Rev in the North Sea (the largest offshore operational wind farm to-date) and found it to be dependent upon rotation speed (Betke 2006). Additional study of underwater noise impacts on organisms is needed.

B. Towers

1. Pile-driving

a. ***Noise*** - Pile-driving activities during the installation of the tower foundations create noise pollution and vibrations, as do seismic surveys, which occur during the pre-construction stage. This can potentially impact fish and other pelagic organisms such as marine mammals. BOEMRE includes this topic in a list of "ongoing" studies associated with renewable offshore energy[30]. At a wind farm installation in Ireland, scientists report that pile-driving sounds can be detected at ranges of up to 70 kilometers (km) (43.5 miles). In the same study, comparison of the measured data with noise exposure criteria indicated that behavioral disturbance might have

[29] Offshore Wind Wire website http://offshorewindwire.com/2010/12/28/roundup-bird-monitoring-guides-development/

[30] BOEMRE Ongoing Studies Listing: http://www.boemre.gov/eppd/PDF/EPPDStudies/CharacterizationPotentialImpacts.pdf

occurred up to a distance of 50 km (31 miles) for bottlenose dolphins (Bailey et al. 2010). Other types of fish may avoid the area or experience other types of behavioral impacts from noise. Madsen et al. (2006) recommended that studies of the effects of 30 to 200-hertz (Hz)[31] tones on representative species with sensitive low-frequency hearing (e.g. shallow-water baleen whales like North Atlantic right whales) would be valuable.

b. Physical disturbance - Drilling into the seabed to install turbines increases local water turbidity (i.e. the amount of suspended solids). These solids will be transported by water movement and may therefore mobilize any contaminants within the sediments (Gill 2005). An altered sediment structure in the surrounding area may in turn affect the biological community (e.g. opportunistic species may out-compete less sediment-tolerant species) (Wilson et al. 2010). Drilling can also result in the release of drill cuttings, which are fine-grained material that have the potential to remain in suspension before settling out.

The installation of the towers by pile drivers will disturb the acoustic environment. For example, changes in pressure resulting from piling activities can be fatal to fin-fish, as it can cause their gas swim bladders to inflate inappropriately (Fay and Popper 1999, as cited in Thomsen et al. 2006). An additional potential risk is that high concentrations of suspended sediment may disperse and affect echolocation signals, thus disorientating animals. This is particularly important for cetaceans, because they are highly dependent upon vocal and auditory communication. The greatest concern in this regard for Georgia would be during the migration and calving season of the federally protected, endangered North Atlantic right whale (November to April), when calves may become separated from their mothers, posing a serious risk to their survival[32]. In 2001 the total population of the species was estimated to be only about 300 individuals, so reducing mortality threats from human activities is a top priority in the federally mandated Recovery Plan for the species.[33] The National Marine Fisheries Service is currently in the midst of re-evaluating critical habitat for North Atlantic right whales, with a proposed revision anticipated by the end of 2011[34].

2. Alterations in water, sediment and air movement- Once they are installed, the turbine structures will affect the flow of water in the surrounding area. The alteration of the sediment structure and flow patterns around the foundations and towers can result in "scour" (loss or

[31] Hertz = cycles per second (SI unit)
[32]NOAA-NMFS information brochure about N. Right Whales: http://sero.nmfs.noaa.gov/pr/pdf/Calving%20Season02.pdf
[33] NOAA-NMFS. "Recovery Plan for North Atlantic Right Whale, revised 2005". http://www.nmfs.noaa.gov/pr/pdfs/recovery/whale_right_northatlantic.pdf
[34] NOAA- NMFS. 2010. Federal Register Vol.75, No. 193. pp. 61690-61691 FR Document No: 2010-25214. http://www.gpo.gov/fdsys/pkg/FR-2010-10-06/html/2010-25214.htm

removal of substrate material from around the base of the turbine tower), which has the potential to directly impact the adjacent habitats (Wilson et al. 2010). Increased turbulence may produce a coarser substratum, which then becomes inhabited by coarse-sediment organisms, whereas any pockets of fine sediments created by the local conditions would attract mud-tolerant organisms. Researchers at Old Dominion University are currently developing a model that will evaluate changes in circulation at offshore wind arrays, and the potential impacts on vertical transport of nutrients as well as larvae and sediment accumulation, due to reduced flow and turbulence (Kamel and Klinck, submitted). The presence of turbines can create turbulent wakes in the atmosphere as well, potentially affecting wind patterns at downwind locations[35].

Mitigation - Scour protection is a mitigation tool that attempts to prevent scour and may even create potential habitat. Wilson et al. cite an example in the UK of scour occurring on less than 0.15% of total wind farm area if scour protection is used. However, the type of material installed is important: for example, a study by Wilson and Elliott (2009) showed that when boulder and gravel protection were used, there was a habitat gain, whereas synthetic fronds that were meant to mimic sea-grass resulted in habitat loss. In the CWP process, a group of consultants (including the U.S. Army Corps of Engineers) concluded that no significant scour would occur at that site[36]. However, wave action and currents will differ at each offshore wind farm location.

3. ***Provision of underwater structure –*** Towers provide potential substrate for attached organisms, thereby acting as artificial reefs, which is often considered as desirable. However, it is unclear whether they provide a favorable habitat for native fisheries. Studies conducted at Horn Rev and Nystad, Denmark are inconclusive regarding habitat creation for native communities (Hvidt, et. al. 2006[37]). One study of the initial fouling community associated with underwater wind power structures found that both the attached and mobile organisms were different than those found associated with adjacent natural hard substrates (Wilhelmesson and Mann 2008). If the changes in the fouling community in turn result in changes in the local fish community, it is possible that alteration could extend further into the food web. There is a need for the study of long-term interactions between fish and offshore turbine structures. The role of underwater structures as artificial reefs must also be considered in the context of other alterations of the environment outlined here.

[35] Earth System Research Laboratory, NOAA study of offshore wind flow using Lidar (Powerpoint) http://www.esrl.noaa.gov/research/events/seas/Mar2011/SEAS_March2011_Pichugina.pdf

[36] U.S. COE report for Cape Wind Project: http://www.nae.usace.army.mil/projects/ma/ccwf/app4a.pdf

[37] Offshore Wind Farms & the Environment, Conference November 27-29, 2006. "Hydroacoustic Monitoring of Fish Communities around Offshore Wind Farms Horn Rev and Nysted Offshore Wind Farms 2004-2005" (Powerpoint) http://193.88.185.141/Graphics/Energiforsyning/Vedvarende_energi/Vind/havvindmoeller/demonstrationsprogram_miljoprogram/final%20results/Hydroacoustic%20monitoring%20Bettina%20Jensen.pdf

C. Undersea Cables

1. Installation **–**The hydro-plow used to install cabling will disrupt benthic habitat along the cable trench. As noted above, the HDD technique is less disruptive at the sediment surface, which is the reason HDD is used closer to shore, where there are generally more benthic organisms and where any disruption of the surface, or at shoreline interface is undesirable. Installing cable will also generate noise, and hence could cause problems similar to those associated with tower installation, as described above. However, this process is probably quieter than pile driving and should not be as disruptive.

2. Electromagnetic fields **-** Electromagnetic fields (EMF) arise from buried electrical cables. It should be noted that electric and magnetic fields are distinct: electric fields are measured in volts, and are "created by differences in voltage: the higher the voltage, the stronger will be the resultant field." Electric fields exist even when there is no current flowing. Magnetic fields are "created when electric current flows: the greater the current, the stronger the magnetic field." Magnetic fields are measured as the magnetic flux density, which is reported in "gauss"[38].
In an undersea context, the intensity of the induced EMF depends on many design factors such as type and magnitude of current, conductor core geometry, insulation type, nature of the seabed, depth of the cable if buried, etc.

Some marine organisms, for example elasmobranchs (e.g. sharks and rays) rely on electromagnetism for such important behaviors as navigation, communication and feeding. Possible ecological effects of EMF may include poor hunting performance or failure to complete migrations if fish have to migrate over these cables. Spiny lobsters, which are found in Georgia's offshore waters, are known to be magneto-sensitive. Not much is known about this topic, but the area where EMF strength is at or above the lower sensitivity limit measured in the laboratory could extend hundreds of meters from a cable for more sensitive species (Gill et al. 2009).

Mitigation - Burying insulated cables to reduce EMF strength is a common mitigation technique. This also helps to prevent entanglement, which is a potential problem for marine mammals (and trawling equipment).

D. Land-based Infrastructure

1. ***Electromagnetic Fields*** **–** Potential effects of the electromagnetic field generated by power transmission lines are also a consideration onshore. An evaluation of the potential electrical field resulting from the Cape Wind installation concluded, "the electric fields created by the existing overhead power facilities will continue to exist at present levels. That is because electrical field strength is a function of power line voltage and the operating voltages of those overhead lines will not be changed by addition of the Cape Wind facilities. Also, as with the submarine cables,

[38] World Health Organization. "What is EMF?" http://www.who.int/peh-emf/about/WhatisEMF/en/

the electric field of the proposed 115 kV underground cables will be contained by each cable's grounded metallic shield." (USDOI BOEMRE 2008).

The low frequency magnetic fields associated with power transmission are perhaps of greater concern. The World Health Organization (WHO) reports that magnetic fields can "induce circulating currents within the human body. …The strength of these currents depends on the intensity of the outside magnetic field. If sufficiently large, these currents could cause stimulation of nerves and muscles or affect other biological processes…"[39]. However, "To date, no adverse health effects from low level, long-term exposure to radiofrequency or power frequency fields have been confirmed...". For the Cape Wind Project, the consultant evaluation concluded that magnetic field strengths under both existing and estimated future conditions would be "well within standards that apply in other states and the Massachusetts guideline applied by the Energy Facility Siting Board." (E/PRO-USCOE, 2004).

Due to the global increase in the number and diversity of EMF sources, the WHO launched the International "Electromagnetic Field Project" in 1996 to collect results of studies on the human health effects of EMFs from scientists and key international and national agencies. "Exposures to higher levels that might be harmful are restricted by national and international guidelines. The current debate is centred on whether long-term low level exposure can evoke biological responses and influence people's well being." [40]. Standards and detailed information can be found at the WHO website.

E. Other Considerations

1. Marine Vessel Traffic - There can be considerable marine vessel traffic associated with all stages of wind farm development. During installation, activities associated with tower construction and laying the undersea cables require boats, barges and sometimes helicopters to transport farm components and machinery. Vessels usually conduct maintenance tasks during the operations stage, and decommissioning is considered to be installation in reverse, with similar use of vessels to remove components. In addition to the potential for vessel and machinery fuel spill, increased boat traffic means there is a higher risk of collisions with other boats, or with marine mammals and sea turtles. Of particular concern is the North Atlantic right whale, which bear their calves in warm southern waters off Georgia and Florida, mostly between December and March or April. It is estimated that over a third of the right whale deaths between 1970 and 2007[41] were due to ship collisions. Increased boat traffic may also be an important disturbance factor for waterfowl, though it is not known whether this results in permanent displacement.

[39] World Health Organization "What are electromagnetic fields? Summary of Health Effects" http://www.who.int/peh-emf/about/WhatisEMF/en/index1.html
[40] Ibid.
[41] Right Whale Listening Network http://www.listenforwhales.org/Page.aspx?pid=439

Mitigation –Biologists and federal endangered species protection regulations should be consulted to ensure that activities associated with a wind project do not occur during times when whales and other marine mammals are likely to be in the area. The Woods Hole Oceanographic Institute and Cornell University are developing whale detection buoys to help vessels avoid collisions with whales. Researchers are testing the devices in waters off Massachusetts, Georgia and Florida[42], which are critical areas for North Atlantic right whale calving and feeding during their migrations.

2. Waste disposal - Oil-based substances, fuel, lubricants and additional hazardous materials are used for a variety of purposes during each phase of a wind project. Sources include vessels operated during any of these stages as well as fuel and other hazardous materials used to operate installed turbines, generators and other offshore technology. Scenarios of dispersal impacts and plans to address a spill for the CWP were required by Massachusetts State law and are included in BOEMRE documentation (Applied Science Associates 2006). Marine debris is another important consideration; increased activities often result in more debris, which can range from ship rubbish (much of it non-biodegradable) to lost cables, sunken vessels or parts, etc.

Mitigation - Requiring adequate disposal facilities for hazardous materials and marine debris on vessels, offshore structures, and at related onshore sites has been shown to facilitate prevention, as well as the removal and safe disposal of ocean debris.

3. Visual Aesthetics - The visual impacts of offshore wind farms primarily result from the presence of the wind turbines, which can be seen from both offshore (e.g. while boating or flying) and onshore (while viewing from shoreline). The Southern Company generated photo-simulations showing what the wind installation might look like at different distances from Tybee Island (Figure 9).

4. Reduced access - Activities associated with offshore wind farms can disturb or otherwise impact (e.g. reduce access to) offshore underwater archaeological sites, historic event sites, native sacred areas, ship or airplane wrecks, etc. In addition, onshore access to beaches and public spaces may be reduced if existing substations are enlarged or new ones are built.

5. Impact on navigation and marine safety **–** Location and spacing of structures may very well alter the movement of maritime vessels. Also, sonar or electromagnetic fields may cause interference with communications or navigational systems.

Mitigation – A report by a senior marine transportation specialist in the U.S. Coast Guard (Detweiler 2011) outlines some mitigation steps to be considered during the planning stages of

[42] Cornell University Right whale Projects website: http://www.birds.cornell.edu/brp/update-items/right-whale-projects

an offshore wind farm, including risk assessment, navigational marking, technological improvements and limiting access to routes.

Figure 9. Photo-simulation of potential offshore wind farm location southeast of Tybee Island. Top: 6.8 miles offshore, Bottom: 10.2 miles. [43] (GIT et al. 2007).

[43] See “Southern Winds” report for additional photo-simulations of potential sites off Tybee and Jekyll Islands. http://www.southerncompany.com/planetpower/pdfs/WindReport.pdf

V. Planning for Offshore Wind Energy Development

The Cape Wind Project permitting process took approximately ten years to complete. Although it is beyond the scope of this document to review these requirements, numerous Federal and State regulations must be met before an offshore wind development facility can be built (Appendix A). However, planning for offshore wind should be undertaken in the context of increasing competition for multiple uses of coastal and ocean resources. This section begins with the national ocean policy context and then describes some of the offshore wind initiatives at the Federal, Regional and State levels, intended to assist stakeholders with proactive planning for offshore renewable energy development. We conclude with some overview comments.

A. National Ocean Policy Context

The US National Ocean Policy (June 2010)[44] specifies that planning be conducted at a regional level to "enable a more integrated, comprehensive, ecosystem-based, flexible, and proactive approach to planning and managing sustainable multiple uses across sectors and improve the conservation of the ocean, our coasts, and the Great Lakes." An example of the type of coastal management tool that can be useful for this is Coastal and Marine Spatial Planning (CMSP), which works with stakeholders to balance the uses and protections of coastal and offshore ocean resources for both current and future needs. To this end, the National Ocean Council hosted a workshop in June 2011 that involved high-level representatives from each of the Regional Ocean Partnerships[45], including the Governors' South Atlantic Alliance[46] (SAA). The SAA includes North Carolina, South Carolina, Georgia and Florida and has been endorsed by each of the state's Governors. The purpose of the workshop was to "bring together Federal, state, tribal, and regional representatives to develop an understanding of the CMSP process, begin to build a community of future CMSP practitioners, and consider next steps for regional implementation."[47]

The Coastal and Marine Spatial Planning process involves integrating information about natural and cultural resources, including marine sanctuaries, key marshlands, reefs, essential fish habitat, the location of commercial and recreational fishing grounds, endangered species migration areas routes (and for North Atlantic right whales, the calving area), shipwrecks and other marine cultural resources, military and commercial flight paths, shipping lanes, contaminated sites, etc. Stakeholders utilize this information to make management decisions to reduce conflicts and plan for shared marine resources. This approach has direct applications in the siting of offshore wind facilities. In May 2011, Rhode Island Sea Grant hosted a highly successful training workshop focused on applying CMSP "as a tool to site offshore renewable energy and other future uses,

[44] National Ocean Policy Executive Order: http://www.whitehouse.gov/files/documents/2010stewardship-eo.pdf
[45] http://www.coastalstates.org/wp-content/uploads/2011/03/ROP-2012.pdf
[46] Governors' South Atlantic Alliance website: http://www.southatlanticalliance.org/
[47] NOC "National Coastal And Marine Spatial Planning Workshop" website: http://www.whitehouse.gov/administration/eop/oceans/cmsp-workshop

including the protection of its natural resources." [48] In a letter to BOEMRE regarding Mid-Atlantic Wind offshore energy development, The Nature Conservancy suggested that "utilizing CMSP principles will reduce conflicts, increase certainty for industry and regulators, and, in the end, create a process that is both more efficient and effective, with better outcomes for energy production, conservation and diverse ocean stakeholders." and offered assistance in that process (TNC 2011).

Coastal resource planning should incorporate baseline ecological studies, which can help reduce time and cost associated with impact assessments. The "New Jersey Ocean/Wind Power Ecological Baseline Study" [49] gathered offshore data on marine mammals, sea turtles, avian and fish species over a two-year time period to provide an initial dataset of species use of particular areas offshore of New Jersey (Geo-Marine, Inc. 2010). The data rank areas for environmental sensitivity by species type and provides points indicating where species were actually sighted. Recently, a BOEMRE scientist (Woehr 2011. pers. comm.) recommended the New Jersey study as the best model to-date for baseline study in advance of U.S. offshore wind development. Also, The Nature Conservancy referenced this study extensively in their letter to BOEMRE quoted above, re: the Mid-Atlantic Wind proposal.

In 2009, representatives from the Georgia Department of Natural Resources - Coastal Resources Division, Gray's Reef National Marine Sanctuary and other Georgia stakeholders joined other representatives from southeastern coastal states for the *South Atlantic Workshop on Marine Spatial Planning* hosted by The Nature Conservancy in Charleston South Carolina (TNC 2009). As planning efforts in the southeast region continue, a comprehensive baseline study would be very useful for evaluating potential offshore wind proposals. As a step towards that, the same consultants who authored the New Jersey study recently completed an initial assessment of wind siting issues in offshore areas in Georgia, South Carolina and North Carolina, based upon a suite of factors, including geological, environmental, and economic considerations (Geo-Marine 2011). Their report includes maps of wind speed, transportation corridors, and the location of essential fish habitat, artificial reefs and other potential obstructions, as well as the distribution of marine mammals, birds, and sea turtles within the area, all of which is valuable baseline information.

A potential offshore wind farm in Georgia should also be evaluated in the context of other activities on the Georgia coast, including the activities of ports, fishing, and other industries, as well as tourism, recreational and traditional uses. One potential way to facilitate this would be through the efforts of the SAA, which is just getting underway in its efforts to assist the SE states with offshore planning. As the southeast's Regional Ocean Partnership, SAA is in place to help

[48] Rhode Island Sea Grant CMSP Workshop 2011 http://seagrant.gso.uri.edu/coast/msp_training.html
[49] State of NJ Dept. of Environmental Protection website: http://www.nj.gov/dep/dsr/ocean-wind/report.htm

highlight the region's priority coastal and ocean issues, including involvement in the CMSP process.

B. Offshore Wind Planning Initiatives

There are numerous activities occurring at all levels of government that are relevant to offshore wind energy development. As mentioned in the Introduction, Smart from the Start is a BOEMRE initiative intended to facilitate a more efficient application and permitting process for offshore wind energy. BOEMRE has designated four areas along the Outer Continental Shelf of the Mid-Atlantic coast to be on the “fast track” for regulatory approval (Delaware (122 square nautical miles), Maryland (207), New Jersey (417), and Virginia (165)) [50]. They also recently (2011) issued a revised rule intended to “make the noncompetitive leasing process for commercial renewable energy development on the U.S. Outer Continental Shelf more streamlined and efficient”, eliminating the current requirement for a second round of requests for interest when only one entity responds to a BOEMRE leasing process[51].

As also mentioned in the Introduction, the Atlantic Governors Offshore Wind Energy Consortium was created in 2010 when ten Atlantic State Governors (including North Carolina but not South Carolina or Georgia) signed a Memorandum of Understanding to “promote the efficient, orderly, and responsible development of wind resources on the Outer Continental Shelf.” [52] The Consortium has a regional renewable energy office located in Virginia intended to “coordinate and appropriately expedite the development of wind, solar and other renewable energy resources on the Atlantic Outer Continental Shelf.” [53]

Regional activities recently undertaken in the southeast include the “Southeastern Ocean-based Renewable Energy Infrastructure Project”[54], which is funded by the U.S. Department of Energy and facilitated by the Southern Alliance for Clean Energy[55]. The Georgia Environmental Finance Authority is the administrating authority for this regional collaboration. This team is evaluating the infrastructure required to develop gigawatt-scale ocean renewable energy resources in the southeast region. The project has issued three separate Requests for Proposals to 1) identify potential offshore wind development zones off North Carolina and South Carolina, 2) estimate electric generation time-series data from the identified potential offshore wind development areas and 3) analyze transmission needs of gigawatt-scale offshore wind development in the southeast.

[50] BOEMRE Press release: http://www.doi.gov/news/pressreleases/Salazar-Launches-Smart-from-the-Start-Initiative-to-Speed-Offshore-Wind-Energy-Development-off-the-Atlantic-Coast.cfm
[51] BOEMRE Press release: http://www.doi.gov/news/pressreleases/Salazar-Bromwich-Announce-Elimination-of Redundant-Step-for-Offshore-Renewable-Energy-Leasing.cfm
[52]Atlantic Governors Offshore Wind Energy Consortium: http://www.boemre.gov/ooc/PDFs/AtlanticConsortiumMOU.pdf
[53] Ibid
[54] Southeastern Offshore Wind Energy Project website: https://sites.google.com/site/sobreip/
[55] Southern Alliance for Clean Energy website http://www.cleanenergy.org/

BOEMRE is in the process of setting up joint task forces in individual states to foster communication and cooperation between BOEMRE and each State's responsible agencies. North Carolina's Task Force[56] is already established and has met, while South Carolina is currently in the process of forming theirs[57]. One product of these task forces will be the creation of Wind Energy Area (WEA) designations (NC's are shown at this website[58]). These designations will be useful for planning, as they already take into account information on military exclusion zones, "low potential foundation area" zones (where the seabed is not appropriate for foundation installations), and essential fish and bird habitat.

Numerous initiatives arising from the states are underway to evaluate the region's potential for offshore wind energy development. In 2008, the North Carolina legislature commissioned a report from the University of North Carolina to study the feasibility and potential for offshore wind energy production in the state (UNC 2009). In May 2011, North Carolina legislators proposed one of the most ambitious pieces of offshore wind legislation in the U.S. to date [59] ("Offshore Wind Jobs and Economic Development", NCSB 747[60]). Significant features of this legislation include a target to install offshore wind energy capacity of 5,000 megawatts by 2030. State utilities would be required to have long-term contracts for 2,500 megawatts of offshore wind capacity to be built over a period of seven to ten years and there would be mechanisms established so that winning bids would ensure major economic benefits accrue to the state of North Carolina.

South Carolina's *Palmetto Wind* Project is a collaborative initiative involving Clemson University's Restoration Institute, Santee Cooper (a state-owned electric and water utility), Coastal Carolina University and the South Carolina Energy Office. Studies are underway regarding potential offshore wind energy generation in South Carolina[61]. In October 2010, this consortium[62] held its first public forum, as part of a series by the Southern Alliance for Clean Energy.

In 2005 the Georgia Wind Working Group [63] was formed, creating a partnership between the Southern Alliance for Clean Energy, Georgia Institute of Technology's Strategic Energy Institute, and the Georgia Environmental Finance Authority. The group's membership includes

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[56] BOEMRE Task Forces updates link:
http://www.boemre.gov/offshore/RenewableEnergy/StateActivitiesProjects.htm
[57] Georgia's may be the next Task Force formed.
[58] NC Task Force, draft Wind Energy Areas Map
http://www.boemre.gov/offshore/RenewableEnergy/PDFs/stateactivities/NC/NCOffshoreWindEnergy.pdf
[59] Offshore Wind Wire website: http://offshorewindwire.com/2011/05/05/analysis-nc-bill-econ-growth/
[60] General Assembly of NC. http://www.ncga.state.nc.us/Sessions/2011/Bills/Senate/HTML/S747v1.html
[61] Palmetto Winds Information found at: http://www.clemson.edu/restoration/focus_areas/renewable_energy/wind/
[62] Charleston Post and Courier 2010 article:
http://www.crda.org/news/local_news/santee_cooper_finds__significant_electric_power__in_s_c__s_offshore_winds-1502
[63] Georgia Wind Working Group website: http://www.gawwg.org/

representatives from utility companies, wind developers, government agencies, universities, and other interested stakeholders. In 2011 the focus of the group will be “educating the public on offshore and onshore wind energy in Georgia” with plans to host a total of six public forums and community leader meetings.

C. Concluding Notes

We conclude this document by listing some of the topics that emerged during the writing and researching of this report as important overall considerations to be incorporated into the planning and evaluation of an offshore wind energy project.

***1. Cumulative impacts* –** Each stage of a wind development, from exploration to decommissioning, has its own set of considerations, particularly with respect to the environment. It is important to understand and plan for these at each individual stage, but also for the project as a whole, so that the cumulative impacts of all parts and stages of a project are considered.

There may also be trade-offs. For example, acute effects from a one-time disturbance associated with burying cable during installation may need to be weighed against the potential for chronic effects from electromagnetic fields generated by cable that is lying on the surface. All of these factors need to be evaluated in a coordinated manner.

***2. Indirect effects* –**There may be both short and long term indirect effects of a wind installation. These include potential changes in population dynamics of coastal ecosystems as a result of alterations in food availability, competition, predation, reproduction and recruitment (Gill 2005). These and other indirect impacts should be considered during a coordinated planning process.

***3. Timing* –** Several of the reports we reviewed pointed out the importance of timing in the planning of a wind development, especially in relation to wildlife impacts. For example, installation or decommissioning activities should be avoided during the North Atlantic right whale migration and calving season (November-April).

4. Monitoring - Monitoring creates a body of reliable data for future projects to utilize. In a recent detailed response addressing their environmental concerns to BOEMRE ‘s “Notice of Intent to Prepare an Environmental Assessment for Mid-Atlantic Wind Energy Areas”[64]. The Nature Conservancy recommended that post-installation, long-term environmental monitoring be required as part of the leasing and permitting process (TNC 2011).

***5. Mitigation* –** To the extent possible, mitigation techniques aimed at minimizing impacts to wildlife should be employed during all stages of an offshore wind development. This report

[64] Federal Register Vol.76, No. 27. 2011 http://www.gpo.gov/fdsys/pkg/FR-2011-02-09/html/2011-2774.htm

touches on some of these, but others should be identified and included. Mass Audubon has actively promoted the importance of including mitigation in offshore wind development,[65] especially regarding impacts of collision and disruption of important avian habitat. Their website[66] posts several documents with specifics that would be very useful for outlining a mitigation and monitoring plan. Additionally, adopting an adaptive management strategy allows for building on "Best Management Practices" as data regarding impacts is collected and analyzed, and mitigation strategies tested. Ideally, "no ecologically significant threat" should be the goal; this differs from no threat at all, but takes into consideration the ecological functions of the systems at stake.

6. Context - Despite some of the potential concerns associated with offshore wind energy development, it is important to remember that all forms of energy have associated trade-offs. Wilson's review of the potential effects of wind concludes, "…while not environmentally benign, the environmental impacts are minor and can be mitigated through good siting practices. In addition, it suggests that there are opportunities for environmental benefits through habitat creation and conservation protection areas." (Wilson et al. 2010). Similarly, after nearly a decade of research and review (during which time they worked with Cape Wind and BOEMRE to improve their mitigation and monitoring approaches, especially regarding avian behavior) Mass Audubon became a supporter of the project. They took this position because they viewed the Cape Wind Project (i.e. renewable energy) as preferable to fossil fuel-based energy alternatives.

As human demand for energy increases, there is increasing interest in all offshore energy sectors, including not only renewable energy sources such as wind, waves, and currents (see Box 1) but also fossil fuels such as oil and gas. Comprehensive assessments that evaluate these projects from a long-term, cumulative perspective are a critical component in planning for offshore energy development.

[65] Mass Audubon Letter about CWP: http://www.massaudubon.org/PDF/advocacy/MASFEIRComments.pdf
[66] Mass Audubon website: http://www.massaudubon.org/news/index.php?id=317&type=news

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Appendix A
Permitting and Regulatory - Offshore Wind Energy

This is a partial list of Acts, Code Sections, Programs and other mechanisms related to Permitting and Regulation of offshore wind energy. Please consult the relevant agencies for more complete advisement.

Federal
National Energy Policy Act (NEPA) - Environmental Impacts Statement(s)
Outer Continental Shelf Lands Act (OSCLA)
Coastal Zone Management Act (CZMA)
Rivers and Harbors Act (RHA)
Clean Water Act (CWA)
Clean Air Act (CAA)
Endangered Species Act (ESA)
Marine Mammal Protection Act (MMPA)
National Historic Preservation Act (NHPA
Submerged Lands Act (SLA)

Federal Agencies (partial list)
Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE)
Environmental Protection Agency (EPA)
Federal Energy Regulatory Commission (FERC)
U.S. Fish and Wildlife Service (USFWS)
NOAA National Marine Fisheries Service (NMFS)
Department of Defense (DOD)
U.S. Army Corps of Engineers (USCOE)

State of Georgia
Shore Protection Act
Coastal Marshlands Protection Act
Georgia Erosion and Sedimentation Act
Georgia Natural Areas Act
Protection of Tidewaters Act
Groundwater Use Act
Georgia Oil and Gas Deep Drilling Act
Georgia Hazardous Waste Management Act
Georgia Water Quality Control Act
Georgia Air Quality Act
State of Georgia (continued)

Georgia Boating Safety Act
Georgia Coastal Management Act
Endangered Wildlife Act
Georgia Solid Waste Comprehensive Management Act
Georgia Underground Storage Act
Georgia Safe Drinking Water Act
Right of Passage Act
Mountain and River Corridor Protection Act
Georgia Scenic Rivers Act
Historic Areas Code
Submerged Cultural Resources Code
Heritage Trust Program
Special Management Areas Program
Revocable License Program, Waterbottom Lease, Easements Programs
Federal Consistency Sections
401 Water Quality Certification
Note: Georgia's Coastal Management Program outlines an Energy Facilitating Planning process and other relevant processes, including public involvement.

State Agencies and Commissions (partial list)
Georgia Department of Natural Resources, Coastal Resources Division (GA DNR CRD)
Georgia Department of Natural Resources, Environmental Protection Division (GA DNR EPD)
Georgia Department of Natural Resources, Wildlife Resources Division (GA DNR WRD)
Georgia Public Services Commission (GA PSC)
Georgia State Properties Commission (GA PSC)
Georgia Environmental Finance Authority (GEFA)
Georgia Ports Authority (GPA)

Appendix B
Additional Resources

Below are links to websites with additional information about offshore wind energy.

Wind energy in Europe

European Environment Agency- From website: Their mandate is to "help the Community and EU member countries make informed decisions about improving the environment, integrating environmental considerations into economic policies and moving towards sustainability, and to coordinate the European environment information and observation network". Their website has information about the EU-wide approach to renewable energy, including offshore wind. http://www.eea.europa.eu/articles/renewable-energy-2000-to-2010

There is also a link at this site to a Technical Report, *Europe's onshore and offshore wind energy potential*. European Union Environment Agency. 2009. # 06/2009 http://www.eea.europa.eu/publications/europes-onshore-and-offshore-wind-energy-potential

United States offshore wind energy

Wind Powering America- (sponsored by the U.S. federal government). From website: "is a nationwide initiative designed to educate, engage, and enable critical stakeholders to make informed decisions about how wind energy contributes to the U.S. electricity supply. State-by-state breakdowns of wind resource potential, success stories, installed wind capacity, news, events, and other resources are updated regularly." http://www.windpoweringamerica.gov/

U.S. Offshore Wind Collaborative- From website: "The U.S. Offshore Wind Collaborative (USOWC) is an interdisciplinary, non-profit organization created to help the United States harness its vast offshore wind resources."
http://www.usowc.org/

Offshore Wind Wire- From website: "provides breaking news and intelligent analysis for the US offshore wind industry". They publish a timely daily *Morning Roundup*, weekly analyses, interviews and some original reporting. http://offshorewindwire.com/

This website also has a Southeastern news section: http://offshorewindwire.com/category/south/

Southeastern offshore wind

Southern Alliance for Clean Energy- From website: "promotes responsible energy choices that create global warming solutions and ensure clean, safe and healthy communities throughout the Southeast." http://www.cleanenergy.org/. This website links to a recent report, as mentioned in the text, "Siting Analysis for Potential Near Term Offshore Wind Development: Georgia, South

Carolina and North Carolina. Phase 2 of Southeast Ocean-based Renewable Energy Infrastructure Project" (Geo-Marine 2011), which presents "uniform regionally-focused dataset that is being used to identify potential offshore wind energy development study blocks specifically for the next phases of the project. … This analysis is not meant to be comprehensive and should not be used in lieu of more specific resource studies, but it provides a good synthesis of available baseline data for initial planning purposes."
http://www.gcrc.uga.edu/SARRP/Documents/Phase2ASitingAnalysis_FinalReport.pdf

Strategic Energy Institute, Georgia Institute of Technology- From website: "The Strategic Energy Institute (SEI) represents Georgia Tech's commitment to serve as a national resource for energy information dissemination and to play a leadership role in the transition to a more sustainable energy economy." http://www.energy.gatech.edu/index.php

Georgia Wind Working Group- From website: "The Georgia Wind Working Group promotes the responsible development and use of wind energy by facilitating stakeholder collaborations, assisting with resource assessments, and enhancing public understanding of the benefits and impacts of wind energy. The Georgia Wind Working Group is working to advance wind activities throughout the state by providing general public education and technical outreach, targeted stakeholder outreach, hosting wind workshops, developing state specific literature, and providing presentations at key events."
http://www.gawwg.org

Cape Wind Project

Cape Wind Project – General information. From website "Cape Wind is proposing America's first offshore wind farm on Horseshoe Shoal in Nantucket Sound. Miles from the nearest shore, 130 wind turbines will gracefully harness the wind to produce up to 420 megawatts of clean, renewable energy"*:* http://www.capewind.org/

BOEMRE Final Environmental Impact Statement - "Cape Wind Energy Project Final Environmental Impact Statement."
http://www.boemre.gov/offshore/AlternativeEnergy/PDFs/FEIS/Cape%20Wind%20Energy%20Project%20FEIS.pdf

Environmental Impacts and Mitigation

American Wind Wildlife Institute- From website: Their mission is: *To facilitate timely and responsible development of wind energy, while protecting wildlife and wildlife habitat….*(whose) purpose is to help lay the scientific groundwork and best practices for wind farm siting and operations, through targeted initiatives: wind-wildlife research, landscape assessment, mitigation, and education." http://www.awwi.org/

AWWI commissioned *Enabling Progress*, prepared by Solano Partners, Inc. The report provides a review of current wildlife related mitigation practices employed in the United States and how those practices might relate to future wind energy development. The report also discusses where opportunities exist for developing a mitigation framework tailored to wind energy development." http://www.awwi.org/initiatives/mitigation.aspx

Association of Fish and Wildlife Agencies – This is a working group of resource managers developing guidelines for wind energy development, on land and offshore. http://jjcdev.com/~fishwild/?section=wind_energy_priority

Rhode Island Ocean Special Area Management Plan (Ocean SAMP) - European Fisheries & Offshore Wind Farms Expert Advice & Guidance Final Report. 2010. From website: "University of Rhode Island (URI) Coastal Resources Center/RI Sea Grant staff and researchers have compiled available information to assess the effects (positive, negative, or neutral) of offshore wind farms on fish and fish habitat; fishermen and fisheries activities; and marine mammals for the fisheries and marine mammal chapters of the Rhode Island Ocean Special Area Management Plan (Ocean SAMP). Much of the basis of the assessment has come from the science activity within Europe that has begun to establish a knowledge base on assessing the effects of offshore wind farms on the coastal environment." http://web2.uconn.edu/seagrantnybight/documents/Energy%20Docs/Gill%20Thomsen%20Ocean%20SAMP%20Final%20report.pdf

Collaborative Offshore Windfarm Research Into the Environment (COWRIE). From website: A United Kingdom nonprofit established "to advance and improve understanding and knowledge of the potential environmental impacts of offshore windfarm development in UK waters. COWRIE Ltd is governed by a Board of Directors drawn from The Crown Estate, the Department for Energy and Climate Change (DECC), and the British Wind Energy Association (BWEA). It is chaired by an independent member. " By using the search term "mitigation" one locates several commissioned studies which address impacts in UK waters. http://www.offshorewind.co.uk/Pages/COWRIE/COWRIE_Explained/

National Ocean Policy Context

U.S. National Ocean Council: Provides information about our National Ocean Policy, including role of Coastal and Marine Spatial planning. http://www.whitehouse.gov/administration/eop/oceans

National Oceanic and Atmospheric Administration - Coastal and Marine Spatial Planning information. From website: "The Ocean Policy Task Force defines coastal and marine spatial planning as a comprehensive, adaptive, integrated, ecosystem-based, and transparent spatial planning process, based on sound science, for analyzing current and anticipated uses of ocean, coastal, and Great Lakes areas. Coastal and marine spatial planning identifies areas most suitable for various types or classes of activities in order to reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives." http://www.cmsp.noaa.gov/

NOAA's website also has a page of regional CMSP activities, including links to those underway in Southeast. http://www.cmsp.noaa.gov/activities/index.html

Commonwealth of Massachusetts. 2009. *Massachusetts Ocean Management Plan*. The Massachusetts Oceans Act of 2008 directed the Secretary of the Executive Office of Energy and Environmental Affairs to develop a comprehensive management plan to serve as the basis for the protection and sustainable use of ocean and coastal waters. This Plan contains a significant section on offshore renewable energy, and is notable for being at the forefront of comprehensive marine resource state planning as well as for the process that produced it. "This process has documented, through the best available science and compelling personal testimony, the critical importance of our marine ecosystem, and reinforced our responsibility to manage human uses in a framework of strong environmental protection." http://www.mass.gov/?pageID=eoeeaterminal&L=3&L0=Home&L1=Ocean+%26+Coastal+Management&L2=Massachusetts+Ocean+Plan&sid=Eoeea&b=terminalcontent&f=eea_oceans_mop&csid=Eoeea

Offshore wind siting

Wind Powering America- (sponsored by the federal government-see previous description). The website provides high-resolution wind maps and estimates of the total offshore wind potential that would be possible from development of the available wind offshore areas. The offshore wind resource maps can be used as a guide to identify regions for commercial wind development.
http://www.windpoweringamerica.gov/windmaps/offshore.asp

This website also has a link to the National Renewable Energy Laboratory's report: *Assessment of Offshore Wind Energy Resources for the United States*. 2010. Technical Report NREL/TP-500-45889. This report presents oceanographic data and jurisdictional information collected from many historical and current sources.
http://www.windpoweringamerica.gov/pdfs/offshore/offshore_wind_resource_assessment.pdf

Regulatory

National Sea Grant Law Center. "Offshore Renewable Energy Regulatory Primer". Showalter, S. and T. Bowling. 2009. "This regulatory primer is designed to serve as an introduction to the major federal laws and regulations governing renewable energy development offshore and coastal state authority under those laws. The primer also discusses local concerns about offshore renewable energy projects and marine spatial planning, a possible emerging solution, to provide a backdrop to controversy surrounding these types of projects." MASGP 09-020 18 pages.
http://www.usowc.org/pdfs/offshoreguide.pdf