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American Meteorological Society 96th Annual Meeting
7th Conference on Weather, Climate, and the New Energy Economy
January 10 – 14, 2016

A Climate Benefits Analysis as a Result of Development of Federal Offshore Wind Energy Leases

ABSTRACT

Scholars, scientists and many policymakers would agree that climate change is a genuine threat to the earth. Further, they would agree that anthropogenic greenhouse gas emissions are the main contributor to climate change. The energy sector, through the burning of coal, natural gas, and oil for electricity and heat is the largest single source of global greenhouse gas emissions contributing 25% of 2010 global greenhouse gas emissions[1]. As the United States embarks on a new frontier of clean energy alternatives, the Department of the Interior's Bureau of Ocean Energy Management (BOEM) has the responsibility of leasing public lands for renewable energy development in the ocean environment. BOEM's mission is to promote energy independence, environmental protection and economic development through responsible, science-based management of offshore renewable energy. BOEM grants leases, easements, and rights-of-way for safe and environmentally responsible renewable energy development activities on the outer continental shelf (OCS). The renewable energy program of BOEM anticipates future development on the OCS from three general sources: offshore wind energy, ocean wave energy, and current energy.

The Cape Wind Energy Project Final Environmental Impact Statement (2009) found that operation of the 1,600 GW of power that the Cape Wind Energy Facility will produce would result in the potential to provide benefits in terms of lowering emissions of greenhouse gases and ozone precursors attributed to power production in the New England area[2]. Total CO_2 emissions from fossil fuel combustion in 2004 were 190.8 million tons in the New England area, of that, electric power generation contributed 24 percent to the total. The Cape Wind Energy Facility will be a 130-turbine commercial wind energy project. Analysis shows that the potential reduction in the growth of CO_2 emissions due to the operation of the facility would be about one percent of the 2009 total projected increase of 84 tons per year in New England from 2005 to 2014.

BOEM has issued nine commercial wind energy leases to date (Figure 1.):

- Cape Wind Associates, LLC, for an area offshore Massachusetts (2010)
- Bluewater Wind Delaware, LLC, for an area offshore Delaware (2012)
- Deepwater Wind New England, LLC, for two leases offshore Rhode Island/Massachusetts (2013)
- Virginia Electric and Power Company (dba Dominion Virginia Power), for one lease offshore Virginia (2013)
- US Wind Inc., for two leases offshore Maryland (2014)

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[1] http://www.epa.gov/climatechange/ghgemissions/global.html
[2] http://www.boem.gov/Renewable-Energy-Program/Studies/FEIS/Section5-0EnvironmentalandSocioeconomicConsequences.aspx

- RES America Developments, Inc., for one lease offshore Massachusetts (2015)
- Offshore MW, LLC, for one lease offshore Massachusetts (2015)

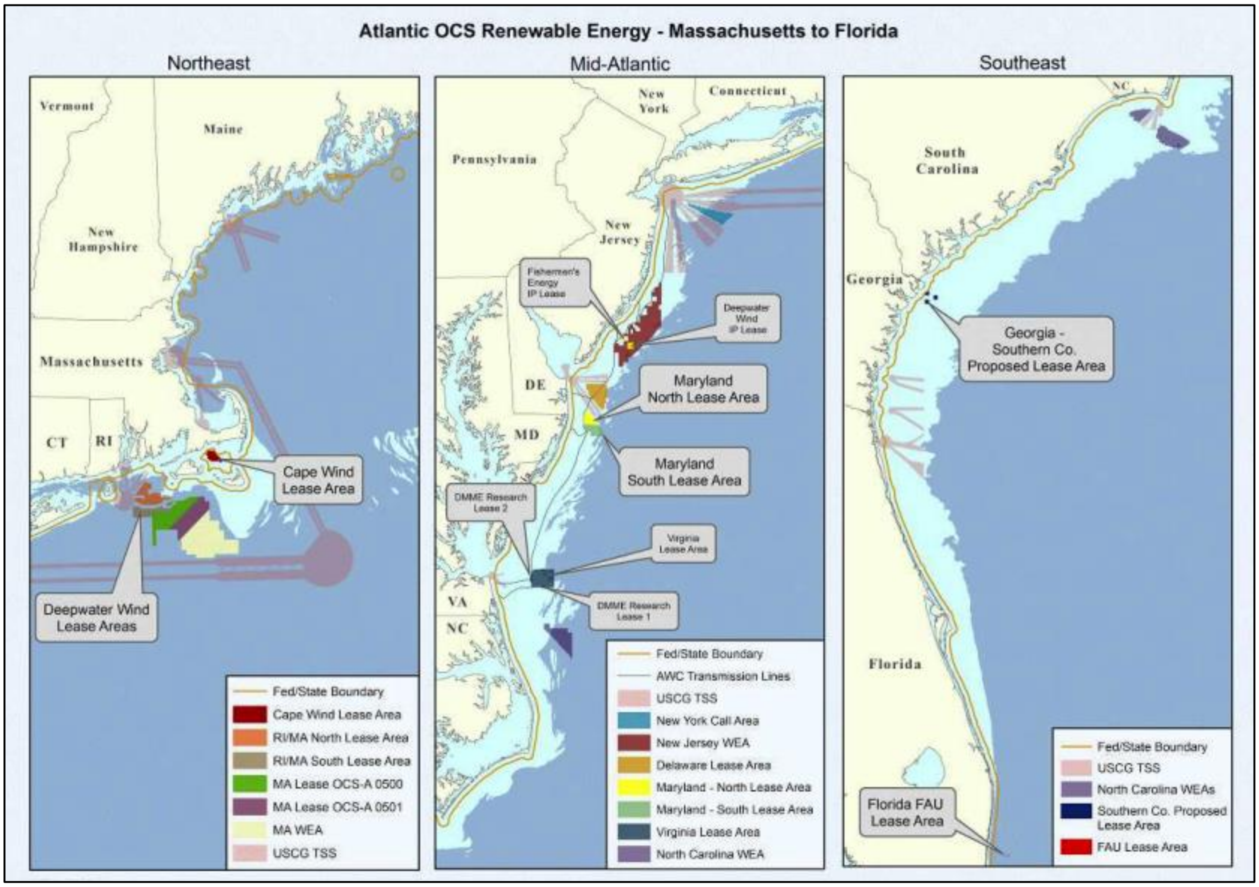

Figure 1. All currently leased areas in the Atlantic Outercontinental Shelf as of January 2016.

BOEM has also issued two research leases to advance wind and marine hydrokinetic technologies:

- Virginia Offshore Wind Technology Advancement Project (VOWTAP) (2015)
    - 2 turbines approximately 24 miles offshore Virginia Beach will help inform future commercial activities offshore VA and the Mid-Atlantic
    - Dominion Virginia Power is the designated operator
- Florida Atlantic University (2014)
    - Located approximately 10 to 12 nautical miles offshore Fort Lauderdale, FL
    - Marine hydrokinetic technology testing offshore Florida to evaluate the use of submerged ocean current turbine prototypes powered by the Florida current

The following report outlines the methodology used to conduct a benefits analysis for the climate based upon the development of the eight remaining commercially leased federal offshore wind energy areas and the resulting conclusions[3].

INTRODUCTION

According to draft guidance from the Council on Environmental Quality (CEQ) (79 FR 247 (December 24, 2014)), federal agencies should consider the following when addressing climate change in Environmental Assessments and Environmental Impact Statements: (1) the potential effects of a proposed action on climate change as indicated by its GHG emissions; and (2) the implications of climate change for the environmental effects of a proposed action. Furthermore, agencies should also take into account both the short- and long-term effects and benefits based on what the agency determines is the life of a project and the duration of the generation of emissions. While the CEQ guidance is implied to pertain to negative impacts to climate change, it is still applicable to a benefits analysis.

METHODOLOGY of ANALYSIS

Step 1. Quantify historical/current Electricity Usage.

1. Historical/current electricity usage/output in region of proposed action if available. The U.S. Energy Information Administration's[4] website provides energy production information, as well as GHG emissions by state.
2. Rate of increase in usage/output in region of proposed action over time.
3. If available, the projected usage/output of electricity if business continues as usual in region of proposed action.

Step 2. Quantify historical/current Greenhouse Gas emissions.

1. For the purposes of this exercise, GHGs can be represented by Carbon Dioxide (CO_2).
2. Historical/current emissions of GHGs due to energy production in region of proposed action if available. The U.S. Energy Information Administration's website provides energy production information, as well as GHG emissions by lbs/MWh by state.
3. Rate of increase in emissions in region of proposed action over time.
4. If available, the projected output of GHGs if business continues as usual in region of proposed action.

Step 3. Analysis of the Proposed Action.

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[3] The first commercial lease for Cape Wind Associates, LLC offshore Massachusetts' climate benefits analysis can be found here: http://www.boem.gov/Renewable-Energy-Program/Studies/FEIS/Section5-0EnvironmentalandSocioeconomicConsequences.aspx

[4] http://www.eia.gov/electricity/state/

1. Calculate proposed project electricity production/output annually[5].

(Proposed action facility production size in MW) * 8760 h/yr * (Capacity Factor) = Energy Produced in MWh/yr

Step 4. Conduct the Climate Benefits Analysis[6]

1. Compare projected electricity output with business as usual.
2. What is the reduction in GHG (CO_2) emissions?
3. Will the proposed action replace some or all of fossil fuel energy source needs presently or in the future?

CLIMATE BENEFITS ANALYSIS

Assumptions

The lease sales were only for site characterization and assessment. With that in mind, according to the Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore New Jersey, Delaware, Maryland, and Virginia Final Assessment, it is expected that there would be 14 – 40 wind turbines per outer continental shelf (OCS) lease block. For the purposes of this analysis, it is assumed that there would be 25 turbines per OCS block, each wind turbine has a maximum output capacity of 3.6 MW (industry dominant Siemens turbine), and the facility's operational capacity factor is 40%[7]. Standard environmental operating conditions for the WTGs include wind speeds between 6.7 mph and 56 mph (3 m/s and 25 m/s), and air temperatures between 14°F and 104°F (-10°C and +40°C)[8]. It is also assumed that these sites will be fully operational in 2030, therefore the benefits analysis is based on forecasts of current activity to that date.

CO_2 Emissions From Fossil Fuel Combustion – Million Metric Tons CO_2 ($MMTCO_2$)

State	Sector	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Delaware		17.69	17.53	17.52	18.90	18.29	17.63	18.27	16.98	16.26	16.48	16.69	16.02
	Electric Power	7.49	7.75	6.76	7.51	7.12	6.65	6.58	5.69	5.36	4.98	5.20	5.09
Maryland		70.57	69.39	67.45	69.72	70.88	70.44	72.59	72.78	75.53	78.20	77.84	78.54
	Electric Power	26.10	25.71	24.96	27.23	28.01	27.09	27.59	27.61	30.30	31.37	30.50	29.84
Massachusetts		83.04	81.84	83.83	81.09	81.33	78.68	79.32	85.37	83.19	80.81	82.00	81.81
	Electric Power	25.09	25.74	24.26	21.85	22.19	21.29	20.72	25.98	26.42	23.65	21.81	21.62
Rhode Island		8.91	10.80	13.05	10.86	12.84	12.10	13.52	13.62	13.86	13.20	11.75	12.30
	Electric Power	0.66	1.35	2.16	1.99	2.12	1.98	3.44	3.36	3.28	2.97	2.66	3.21
Virginia		94.99	96.02	97.31	101.46	100.30	102.68	107.34	109.87	111.04	113.12	121.83	119.68
	Electric Power	23.05	25.05	26.64	31.18	29.09	30.33	33.04	34.33	36.13	37.70	42.23	41.70

State	Sector	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Slope	Forecast 20
Delaware		15.89	16.55	16.54	17.34	16.18	17.06	16.15	11.89	11.93	13.02	13.96	13.91		
	Electric Power	5.04	5.78	5.89	6.29	5.62	6.56	6.14	3.78	4.17	3.80	4.53	4.02	-0.1325	1.96506
Maryland		78.53	81.24	82.64	84.30	77.44	77.82	74.11	70.89	69.53	64.92	60.41	61.70		
	Electric Power	30.21	31.09	30.32	31.59	28.89	29.68	27.42	23.93	24.51	21.66	18.72	17.08	-0.2085	21.1998
Massachusetts		82.73	84.17	82.56	84.07	76.26	79.65	76.67	70.30	71.87	68.21	61.93	68.56		
	Electric Power	22.52	24.62	23.36	24.09	21.24	23.27	19.81	17.27	17.99	14.20	12.04	12.52	-0.4129	9.62847
Rhode Island		11.73	11.53	10.96	11.21	10.53	11.08	10.69	11.26	11.03	11.07	10.56	10.42		
	Electric Power	2.93	2.29	1.96	2.39	2.33	2.81	2.88	3.01	3.08	3.47	3.32	2.56	0.05417	4.13628
Virginia		118.20	122.42	126.37	128.19	121.79	127.01	115.96	105.16	108.13	99.19	97.34	106.90		
	Electric Power	40.78	40.42	40.11	40.91	36.46	40.98	35.77	30.76	33.69	28.06	24.84	30.40	0.2068	39.7955

Figure 2. Emission estimates are based on energy consumption data from EIA's State Energy Consumption, Price, and Expenditure Estimates (SEDS) released Summer 2015. Available online at: http://www.eia.gov/state/seds/seds-data-complete.cfm?sid=US#CompleteDataFile

[5] Note: This calculation assumes full time operation of the facility, if there are known cutoff times or if the annual hours of downtime are known, do consider that in this calculation.

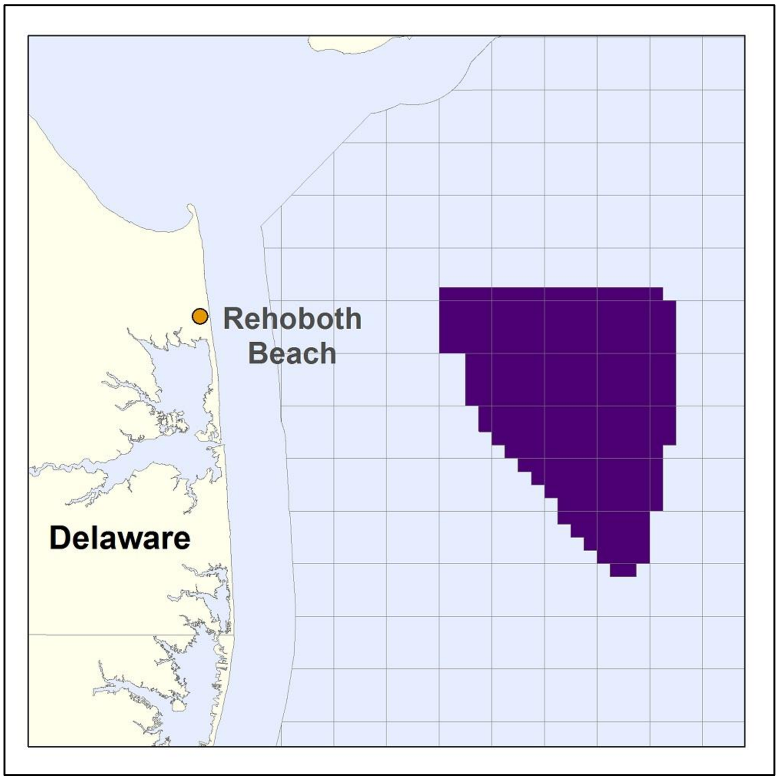
[6] Note: The climate benefit is determined by the total reduction in GHG emissions and/or replacement of future fossil fuel energy sources.

[7] http://energynumbers.info/capacity-factors-at-danish-offshore-wind-farms

[8] http://www.boem.gov/VOWTAP-RAP/

Proposed Wind Energy Facility Based Analysis

Bluewater Wind Delaware, LLC, Delaware (2012)

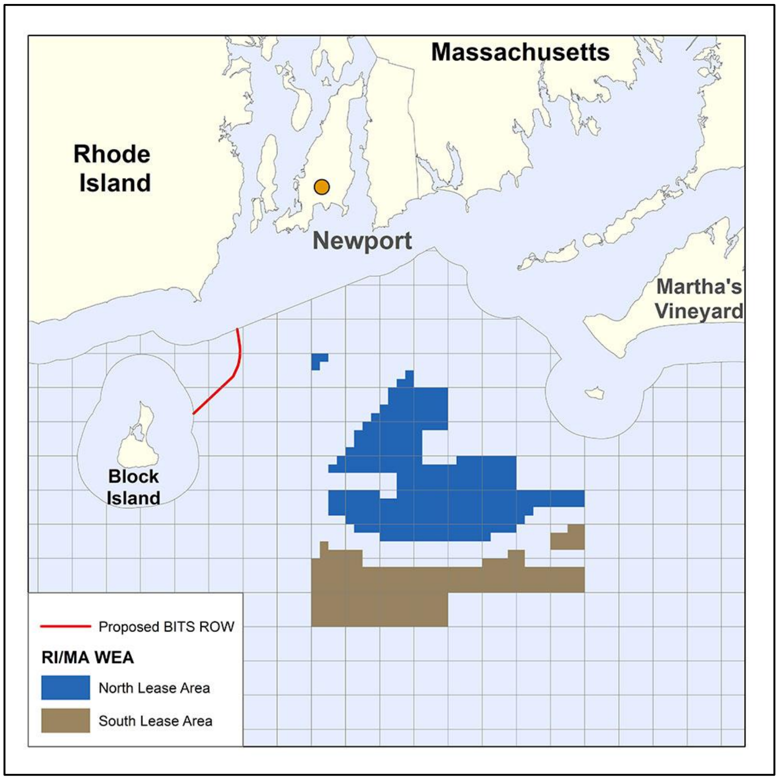


In 2013 Delaware produced 7,760,861 MWh of electricity. Electric power carbon dioxide emissions were 4.02 million metric tons (MMT). Emissions of CO_2 from fossil fuel combustion in Delaware have decreased by 13% over the period between 1990 and 2013. Based on the current trend, CO_2 emissions in 2030 are forecasted to be 1.97 MMT.

16 OCS Blocks
Project Annual Energy Production =
16 OCS Blocks * 25 WTGs * 3.6 MW = 1,440 MW
(1,440 MW * 8,760 h/yr) * .40 = 12,614,400 MWh/yr * .40 = 5,045,760 MWh/yr

The difference in Bluewater Wind's annual energy production and Delaware's 2013 production, results in a 65% reduction of fossil-fueled power; and in turn only 0.69 MMT of CO_2 emissions in the year 2030 in the state from electric power production when compared to business as usual.

Deepwater Wind New England, LLC, Rhode Island/Massachusetts I (North) (2013)



In 2013 Rhode Island produced 6,246,807 MWh and Massachusetts produced 32,885,021 MWh of electricity. Electric power carbon dioxide emissions were 2.56 million metric tons in Rhode Island and 12.52 million metric tons in Massachusetts. Emissions of CO_2 from fossil fuel combustion in Rhode Island have increased by 5% and in Massachusetts have decreased by 40% over the period between 1990 and 2013. Based on the current trend, CO_2 emissions in 2030 are forecasted to be 4.14 MMT in Rhode Island and 9.63 MMT in Massachusetts for a total of 13.77 MMT.

16 OCS Blocks
Project Annual Energy Production: 5,045,760 MWh/yr

The difference in Deepwater Wind's annual energy production and Rhode Island's and Massachusetts' 2013 production, results in a 13% reduction of fossil-fueled power and in turn only 10.6 MMT of forecasted 2030 CO_2 emissions from electric power production when compared to business as usual.

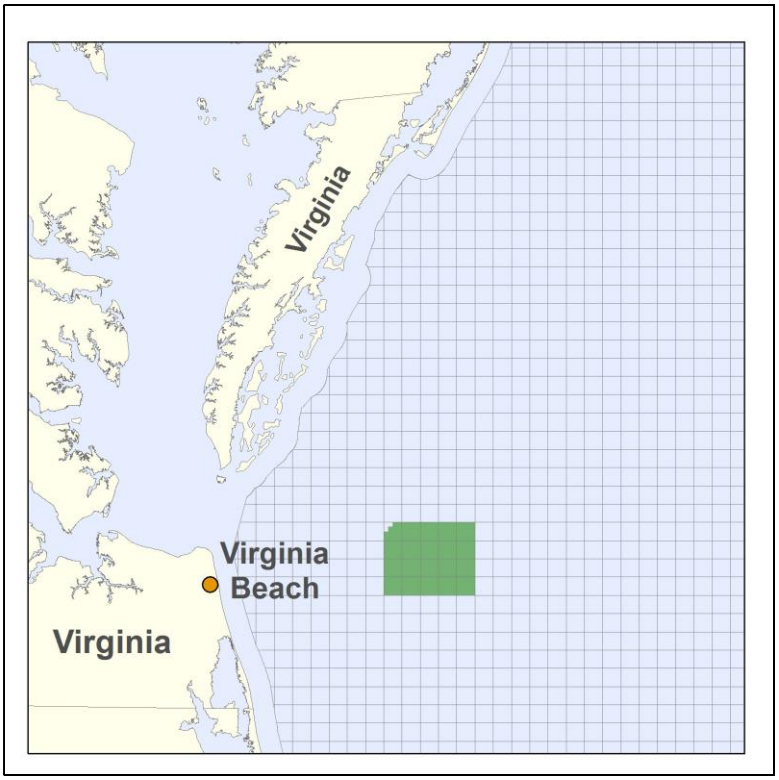
Deepwater Wind New England, LLC, Rhode Island/Massachusetts II (South) (2013)

In 2013 Rhode Island produced 6,246,807 MWh and Massachusetts produced 32,885,021 MWh of electricity. Electric power carbon dioxide emissions were 2.56 million metric tons in Rhode Island and 12.52 million metric tons in Massachusetts. Emissions of CO_2 from fossil fuel combustion in Rhode Island have increased by 5% and in Massachusetts have decreased by 40% over the period between 1990 and 2013. Based on the current trend, CO_2 emissions in 2030 are forecasted to be 4.14 MMT in Rhode Island and 9.63 MMT in Massachusetts for a total of 13.77 MMT.

11 OCS Blocks
Project Annual Energy Production: 3,468,960 MWh/yr

The difference in Deepwater Wind's annual energy production and Rhode Island's and Massachusetts' 2013 production, results in a 9% reduction of fossil-fueled power and in turn only 12.53 MMT of forecasted 2030 CO_2 emissions from electric power production when compared to business as usual.

Virginia Electric and Power Company (dba Dominion Virginia Power) (2013)

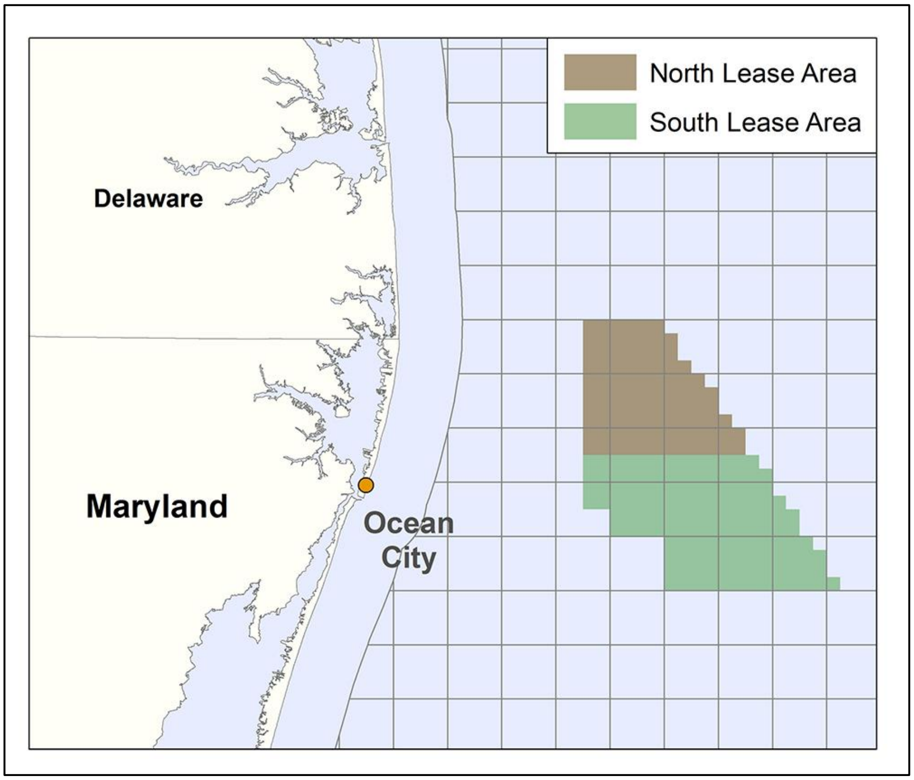


In 2013 Virginia produced 76,896,565 MWh of electricity. Electric power carbon dioxide emissions were 30.4 MMT Emissions of CO_2 from fossil fuel combustion in Virginia have increased by 21% over the period between 1990 and 2013. Based on the current trend, CO_2 emissions in 2030 are forecasted to be 39.8 MMT.

19 OCS Blocks
Project Annual Energy Production: 5,991,840 MWh/yr

The difference in Dominion Virginia Power's annual energy production and Virginia's 2013 production, results in an 8% reduction of fossil-fueled power and in turn only 36.62 MMT of forecasted 2030 CO_2 emissions from electric power production when compared to business as usual.

US Wind Inc., Maryland I (North) (2014)



In 2013 Maryland produced 35,850,812 MWh in electricity. Electric power carbon dioxide emissions were 17.08 million metric tons. Emissions of CO_2 from fossil fuel combustion in Maryland have decreased by 21% over the period between 1990 and 2013. Based on the current trend, CO_2 emissions in 2030 are forecasted to be 21.2 MMT.

5 OCS Blocks
Project Annual Energy Production: 1,576,800 MWh/yr

The difference in US Wind's annual energy production and Maryland's 2013 production, results in a 4% reduction of fossil-fueled power and in turn only 20.35 MMT of forecasted 2030 CO_2 emissions from electric power production when compared to business as usual.

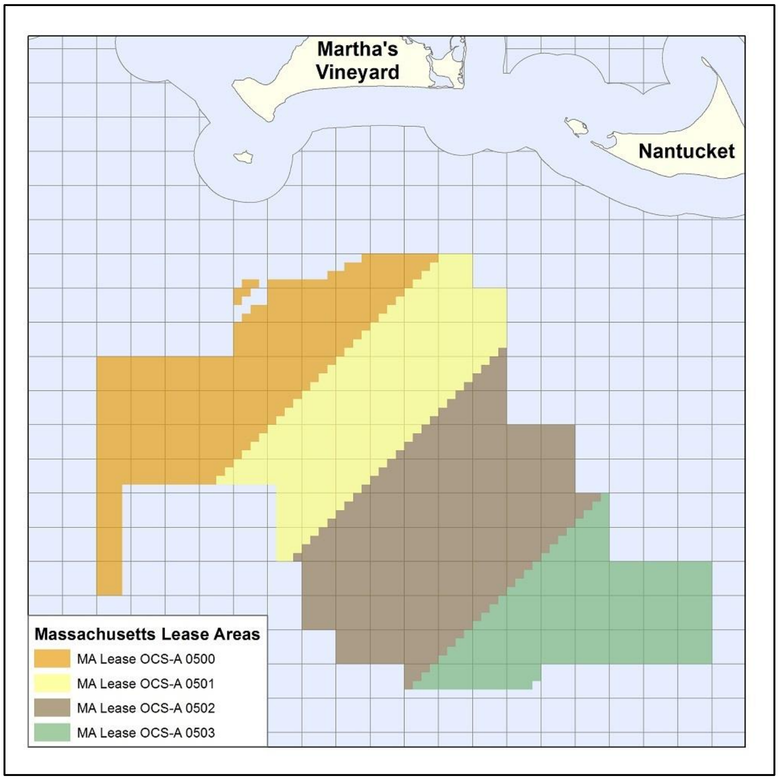
US Wind Inc., Maryland II (South) (2014)

In 2013 Maryland produced 35,850,812 MWh in electricity. Electric power carbon dioxide emissions were 17.08 million metric tons. Emissions of CO_2 from fossil fuel combustion in Maryland have decreased by 21% over the period between 1990 and 2013. Based on the current trend, CO_2 emissions in 2030 are forecasted to be 21.2 MMT.

8 OCS Blocks
Project Annual Energy Production: 2,522,880 MWh/yr

The difference in US Wind's annual energy production and Maryland's 2013 production, results in a 7% reduction of fossil-fueled power and in turn only 19.72 MMT of forecasted 2030 CO_2 emissions from electric power production when compared to business as usual.

RES America Developments, Inc., Massachusetts (OCS-A 0500) (2015)



In 2013 Massachusetts produced 32,885,021 MWh of electricity. Electric power carbon dioxide emissions were 12.52 MMT. Emissions of CO_2 from fossil fuel combustion in Massachusetts have decreased by 41% over the period between 1990 and 2013. Based on the current trend, CO_2 emissions in 2030 are forecasted to be 9.63 MMT.

32 OCS Blocks
Project Annual Energy Production: 10,091,520 MWh/yr

The difference in RES America Developments' annual energy production and Massachusetts' 2013 production, results in a 31% reduction of fossil-fueled power and in turn only 6.64 MMT of forecasted 2030 CO_2 emissions from electric power production when compared to business as usual.

Offshore MW, LLC, Massachusetts (OCS-A 0501) (2015)

In 2013 Massachusetts produced 32,885,021 MWh of electricity. Electric power carbon dioxide emissions were 12.52 MMT. Emissions of CO_2 from fossil fuel combustion in Massachusetts have decreased by 41% over the period between 1990 and 2013. Based on the current trend, CO_2 emissions in 2030 are forecasted to be 9.63 MMT.

28 OCS Blocks
Project Annual Energy Production: 8,830,080 MWh/yr

The difference in Offshore MW's annual energy production and Massachusetts' 2013 production, results in a 27% reduction of fossil-fueled power and in turn only 7.03 MMT of forecasted 2030 CO_2 emissions from electric power production when compared to business as usual.

CONCLUSION

The difference in the total proposed offshore wind energy facilities' power production of 42,573,600 MWh annually and all of the states' 2013 total power production of 300,392,748 MWh results in a 14% reduction in fossil-fueled power. Therefore the 130.97 MMT of forecasted 2030 CO_2 emissions from electric power production if business were to continue as usual would be reduced to 112.63 MMT. As offshore wind energy expands there is potential to not only benefit the climate locally or regionally, but also worldwide.

Future steps in this analysis include considering CO_2 emissions due to construction, operation and maintenance, and decommissioning activities. Also the inclusion of additional fossil-fueled electric power sources or the shutdown of those already in operation in the aforementioned states would provide a complete picture of the climate impacts and benefits.

About the Author:
Prior to launching the McCoy Environmental Group, Inc. Angel McCoy was a meteorologist at the U.S. Department of the Interior's Bureau of Ocean Energy Management Office of Renewable Energy Programs where she implemented the National Environmental Policy Act (NEPA) and ensured environmental compliance specifically with respect to Air Quality in Offshore Renewable Energy.