

# SEA POWER

## North Carolina's Offshore and Nearshore Wind Resource Coincidence with Electrical Demand Load



### Findings

North Carolina's offshore and nearshore wind resources are positively correlated with utility demand during the peak-demand energy months of July and August.

As electrical demand increases in the summer afternoons, offshore and nearshore wind resources generally increase.

Offshore and nearshore wind farms may be able to offset more expensive peaking power stations by providing valuable peak power.

Offshore and nearshore wind capacity factors are highest during the winter months of December, January and February.

## Offshore and nearshore wind resources can provide energy at high-demand peak periods.

Electric utilities in the southeast usually experience high-demand peak electrical demand during the summertime. To supply power at peak demand, utilities may rely on more expensive power plants, like combustion natural gas turbines. However, a natural phenomenon in coastal and offshore areas may help supplant these higher cost peaking power plants. The Sea Breeze Effect occurs when cool ocean air rushes inland where warmer air is rising; this effect is prominent on hot summer afternoons when utility load demands are high.

North Carolina's offshore wind resources would be able to provide high value, and high demand energy when it is needed the most: hot summer afternoons. Based on this research, North Carolina's Sea Breeze Effect is positively correlated with Duke Energy's hourly electrical demand during summertime. Therefore, offshore wind energy resources have good coincidence with electrical demand load.

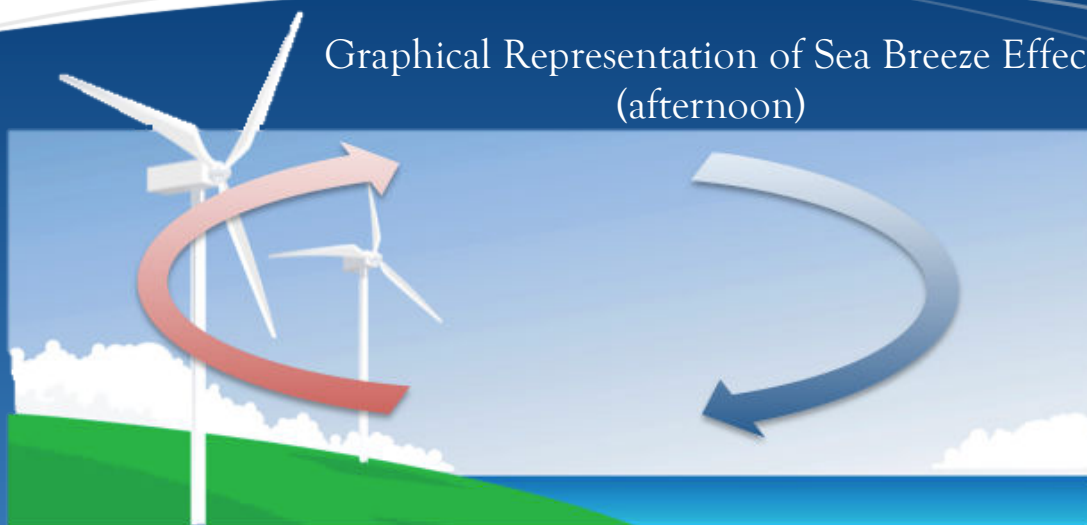
## Wind energy has rarely been viewed as a peaking generation resource.

Wind energy is playing a more predominant role in electricity generation around the world and especially in the United States. Despite the surge in wind energy development, common misconceptions about this resource still remain. One of these misconceptions is that the wind does not blow (and thus, cannot create electricity) when electric power utilities require that electricity the most. To the contrary, wind farms in nearshore and offshore areas are likely to have exceptional coincidence with electrical demand load; especially with electric utilities in the southeast due to the Sea Breeze Effect. The Sea Breeze Effect is the process whereby winds move inward from the ocean to the land, and back again, due to temperature differences between the landmass and ocean. To test this premise, electrical generation data from three theoretical offshore wind farms off North Carolina's coast were compared against an hourly demand load profile of a major electric utility in North Carolina.

## The Sea Breeze Effect puts a different spin on that point of view.

The Sea Breeze Effect occurs in coastal areas. As the ocean and landmasses warm and cool in a cyclical fashion throughout the days and nights, the two bodies lose and gain heat at different rates. Water radiates and absorbs heat from the sun at a slower rate than land. During hot summer afternoons, as the land heats up at a faster rate than the ocean, the hot air mass above the land rises creating a vacuum. That vacuum is then filled by the cooler air mass above the ocean. From the shore, an observer should feel a sea breeze coming from the ocean in the late afternoons on hot summer days. This effect can occur at anytime of year. During the winter, for example, an opposite sea breeze can be felt early in the mornings when the colder land air mass is rushing over the shore to fill the void left by the warmer ocean air rising.<sup>1</sup> If nearshore or offshore wind farms can capture sea breezes, those wind farms will be well positioned to supply the real-time needs of a utility.

### Graphical Representation of Sea Breeze Effect (afternoon)



Temperature differences between a landmass and a body of water drive the Sea Breeze Effect. Landmasses heat up quicker than bodies of water. As the landmass air warms, it begins to rise. With the rising air, a vacuum is created and the relatively cooler air over a body of water (which is heavier and closer to ground level) begins to fill the vacuum – creating a summer afternoon's breeze offshore and nearshore.

## Peak-Power is High Value Power.

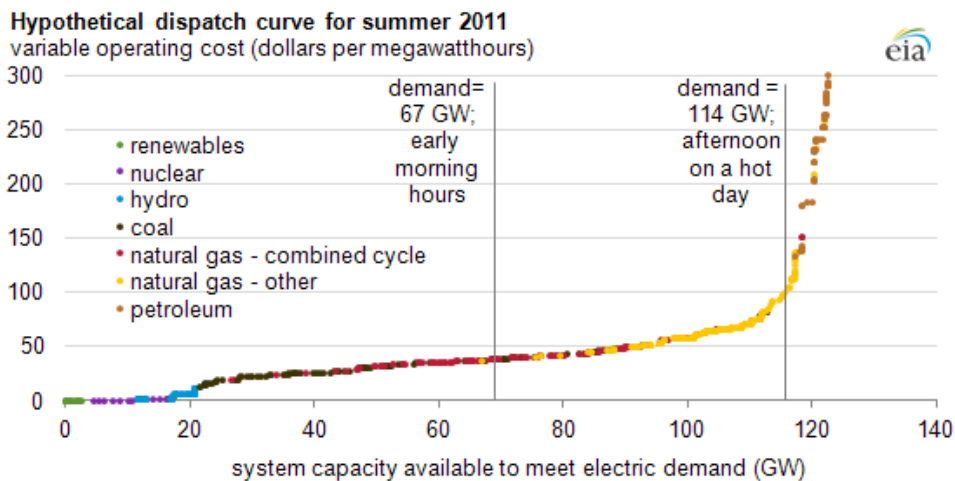
Peaking generation power plants are used minimally, but are required to quickly generate electricity and rapidly ramp up to meet the required electrical load. Peaking generation power plants can use diesel, petroleum, or more commonly, natural gas as a fuel source.<sup>5</sup> The power plant's minimal use, rapid and inefficient response as well as the use of fuels that are subject to price volatility make peaking generation an expensive generation resource. Nevertheless, peaking generation provides vital electrical resources when utilities need it most to prevent brownouts and blackouts. As such, utilities will pay more for peaking generation to ensure electrical reliability.

If offshore wind farms are capable of supplying peak power, utilities would not have to rely on more expensive peaking generation units.

## Sea Breeze Effect Occurs Offshore and Nearshore.

In 2007, an American offshore wind development firm published a report on offshore wind energy's capability of matching a utility's summer demand.<sup>2</sup> The Cape Wind project off the coast of Massachusetts has a tower constructed several miles offshore that collects wind speed data. The data show that if that project were constructed, the electricity it would produce would coincide with summertime peak electrical generating demand. Cape Wind provides anecdotal evidence for the Sea Breeze Effect's implications for offshore wind development.

Similar evidence suggests the Sea Breeze Effect also occurs in nearshore areas. In 2011, on a hot afternoon in Texas, numerous natural gas power plants and at least one coal-fired power plant suddenly went offline due to excessive heat.<sup>3</sup> Newly built coastal wind farms provided power when the Texas grid manager needed the electricity most due in part to the sea breeze effect, helping to prevent a brownout or blackout.<sup>4</sup> Therefore, the Sea Breeze Effect is not only a phenomenon for offshore, but also nearshore areas.



Note: The dispatch curve above is for a hypothetical collection of generators and does not represent an actual electric power system or model results. The capacity mix (of available generators) differs across the country; for example, the Pacific Northwest has significant hydroelectric capacity, and the Northeast has low levels of coal capacity. This dispatch curve does not show all costs associated with electric generation, such as capital costs

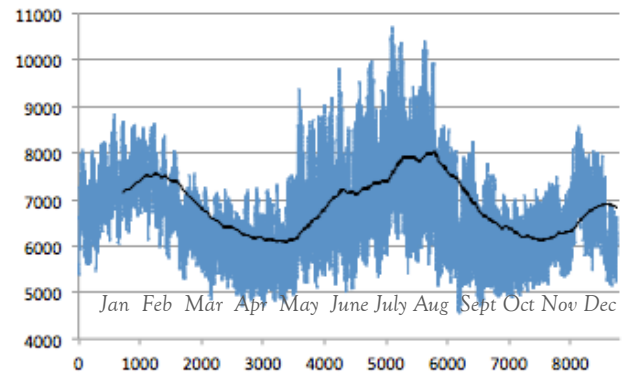
## North Carolina's Power Demands are Highest in the Summer.

Duke Energy is the largest electric utility in the country.<sup>7</sup> The hour-by-hour electrical demand load profile of Duke Energy Carolinas LLC is available through the Federal Energy Regulatory Commission Form 714 for 2006-2008. However, hourly generation cost (system lambda) data are only available for the year 2006.<sup>8</sup>

Duke Energy's electrical demand tends to peak in the summer months from June to early September (represented approximately by hours 4,000 – 6,000). During the wintertime, peak electrical demand also occurs from December to February (represented approximately by hours 8,000-8,760 and hours 0-1,000), albeit at a lesser scale relative to the summer months. Of the top 10% of electrical demand hours, the vast majority of them occur in June, July and August (see Chart 3).

Another way to determine the importance of electrical generation is to evaluate at the cost of electricity at a particular hour. The higher the electrical cost, presumably the more important electrical generation becomes at that particular time. One way to determine these costs is by evaluating a utility's cost to generate the next megawatt-hour (MWh) of electricity, also called the "system lambda".<sup>9</sup> For Duke Energy, the 2006 top 10% of system lambda costs ranged from about \$47 per MWh to about \$241 per MWh. A high occurrence of the top 10% system lambda costs in 2006 occurred in June, July and August (see Chart 4). However, April had the highest occurrences of those top costs, and the top costs (in the \$230+ per MWh range) occurred in November. The variability of these top system lambda costs is potentially due to the availability of only a single year of data.

**Chart 2: Duke Energy Carolinas Power Annual Electrical Demand 2006-2008 Average (MW, by hour)**



Source: Duke Energy, FERC Form 714.

Rolling average indicated by black line.

Hour 0 = 12AM, January 1

**Chart 3: Top 10% Hourly Demand Load Occurrences (Average 2006-2008)**

|           |     |
|-----------|-----|
| January   | 34  |
| February  | 53  |
| May       | 29  |
| June      | 142 |
| July      | 247 |
| August    | 332 |
| September | 28  |
| December  | 11  |

Source: Duke Energy, FERC Form 714.

**Chart 4: Top 10% System Lambda Cost Occurrences (2006)**

|           |     |
|-----------|-----|
| January   | 28  |
| March     | 107 |
| April     | 205 |
| May       | 107 |
| June      | 156 |
| July      | 137 |
| August    | 102 |
| September | 14  |
| October   | 5   |
| November  | 11  |
| December  | 4   |

Source: Duke Energy, FERC Form 714.

## North Carolina's Sea Breeze Effect is Strongest in the Summer.

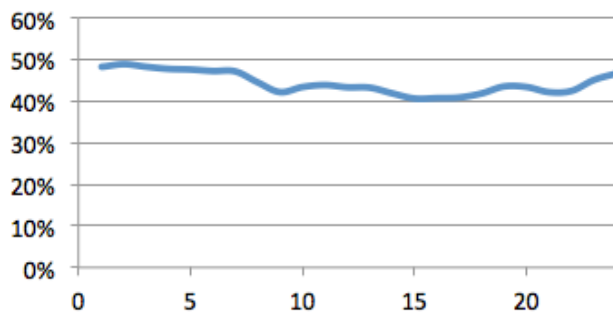
A report completed in 2011 by AWS Truepower estimated offshore wind energy output for three potential offshore wind farms off North Carolina's coast.<sup>10</sup> For each of the three potential wind farms, 10-minute scale wind speed data files were created based on historical data from January 1, 1999 to December 31, 2008. For the purposes of this Sea Breeze Effect report, the data files were aggregated from 2006-2008 (to match data available from Duke Energy) and narrowed down to the wintertime and summertime periods to evaluate wind energy's output during peak demand periods.

As can be seen by Chart 5, the Sea Breeze Effect during the summer months is most pronounced in the afternoon (especially around 5PM or 6PM). However, a similar effect is seen earlier in the day during the summertime peaking around 9AM or 10AM in July and August. Wintertime capacity factors tend to peak in the night; however, capacity factors are generally higher than summertime and also tend to vary less.

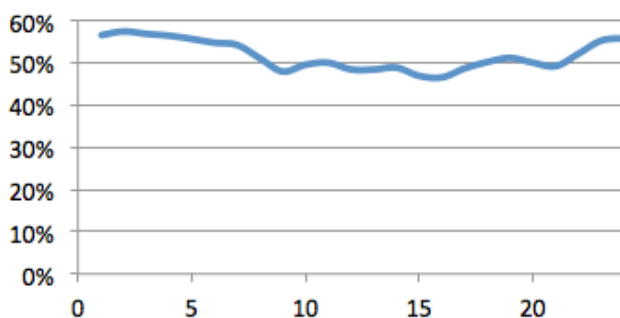
**Chart 5: Seasonal Offshore Wind Energy Output by Hour**

### North Carolina Wintertime Output

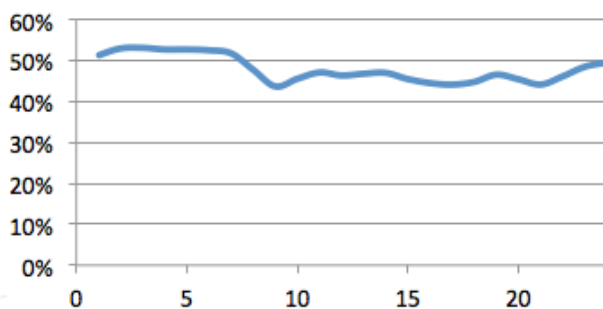
#### December Capacity Factors



#### January Capacity Factors

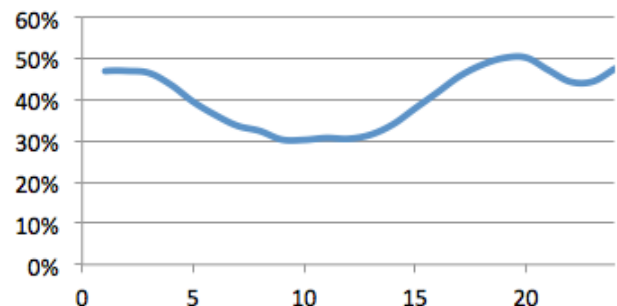


#### February Capacity Factors

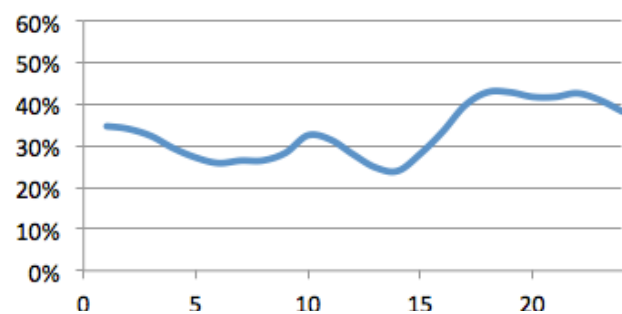


### North Carolina Summertime Output

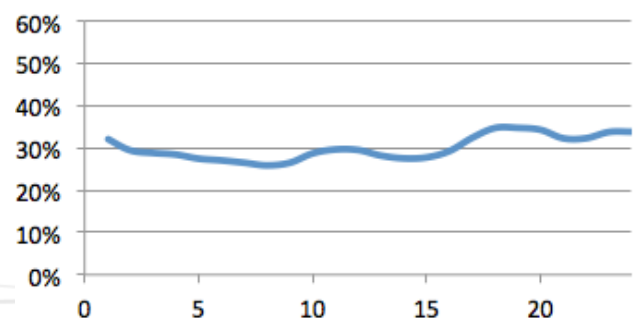
#### June Capacity Factors



#### July Capacity Factors



#### August Capacity Factors





## North Carolina's Sea Breeze Effect Matches Peak Demand.

Offshore wind peak generation generally occurs in the late afternoon during the summertime. Two sea breeze effects are noticeable from North Carolina's offshore wind resource; a small one in the morning peaking around 10AM and a larger one in the late afternoon peaking around 5PM or 6PM in July and August. North Carolina's offshore wind resource is readily available during Duke Energy's top 10% load hours (top 876 hours in a year). During Duke Energy's average top 10% load hours from 2006-2008, the average capacity factor for modeled offshore wind resources was approximately 36%. Modeled offshore wind resources match Duke Energy's top 10% system lambda hourly costs (top 876 hours in a year) better than top load hours. During Duke Energy's top 10% system lambda hourly costs in 2006, the average capacity factor for North Carolina's offshore wind resources was approximately 42%. The most peak load hours and many peak system costs occur in the months of June, July and August.

Wintertime offshore wind energy generation resources are generally more abundant than the summertime resources. However, due to the strong focus on system peak loads and system lambda costs, wintertime offshore wind resources are potentially less valuable to Duke Energy. Nevertheless, wintertime offshore wind resources obtain higher capacity factors and fluctuate less than the summertime resources.

August tends to be the month with the highest peak loads, the highest number of peak load hours and a high number of top system lambda costs. As such, August is a particularly important month for offshore wind resources to correlate to electrical demand. On an annual basis, North Carolina's offshore wind energy resources have a moderately negative correlation\* (-0.51), typically meaning that as electrical demand increases, offshore wind output decreases and vice versa. However, during the month of August, North Carolina offshore wind resource shows a moderately positive correlation with electrical demand (0.50), meaning as demand increases or decreases, offshore wind tends to follow those trends. A moderately positive correlation also occurs in July (0.48). Offshore wind resources during the winter months have a moderately to strongly negative correlation with electrical demand load to a greater degree than the annual correlation. However, daylight (6AM-7PM) correlation is positive for both summertime and wintertime seasons.

### By the Numbers

# 36%

Average Capacity Factor during  
Top 10% Load Hours  
(2006-2008)

# 42%

Average Capacity Factor during  
Top 10% System Lambda Hourly  
Costs (2006)

# 42%

Average Annual Capacity Factor  
(2006-2008)

# +0.50

August Offshore Wind Positively  
Correlated with Electric Demand

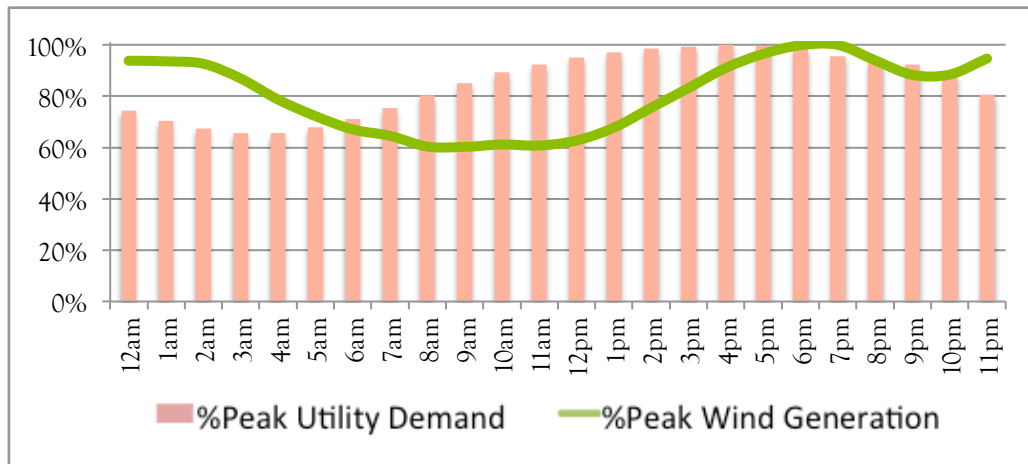
**Chart 6: Offshore Wind  
Correlation with Electric Demand**

|                 | Correlation |          |
|-----------------|-------------|----------|
|                 | 24-hr       | Daylight |
| <b>June</b>     | 0.08        | 0.59     |
| <b>July</b>     | 0.48        | 0.54     |
| <b>August</b>   | 0.50        | 0.68     |
| <b>December</b> | -0.80       | 0.03     |
| <b>January</b>  | -0.81       | 0.07     |
| <b>February</b> | -0.81       | 0.18     |
| <b>Annual</b>   | -0.51       | 0.24     |

\*Correlation identifies a statistical relationship between two variables. A +1 correlation shows a perfect relationship, a -1 correlation shows a perfectly opposed relationship and a 0 correlation shows no relationship.

**Chart 7: Hourly offshore wind output (percentage of peak generation) and hourly Duke Energy demand load curve (percentage of peak load) by month (2006-2008)**

June



40%

Avg. Capacity Factor

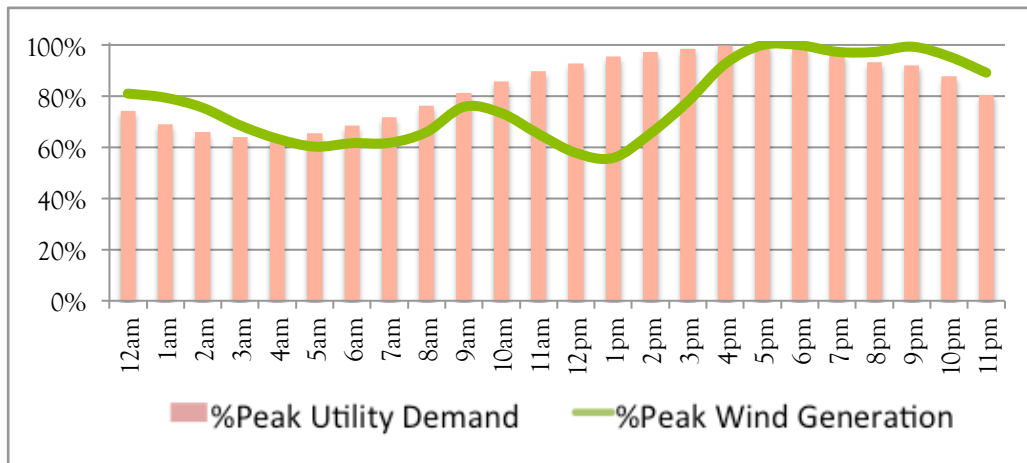
0.40

Hourly Correlation

0.59

Daylight Correlation  
(6AM-7PM)

July



33%

Avg. Capacity Factor

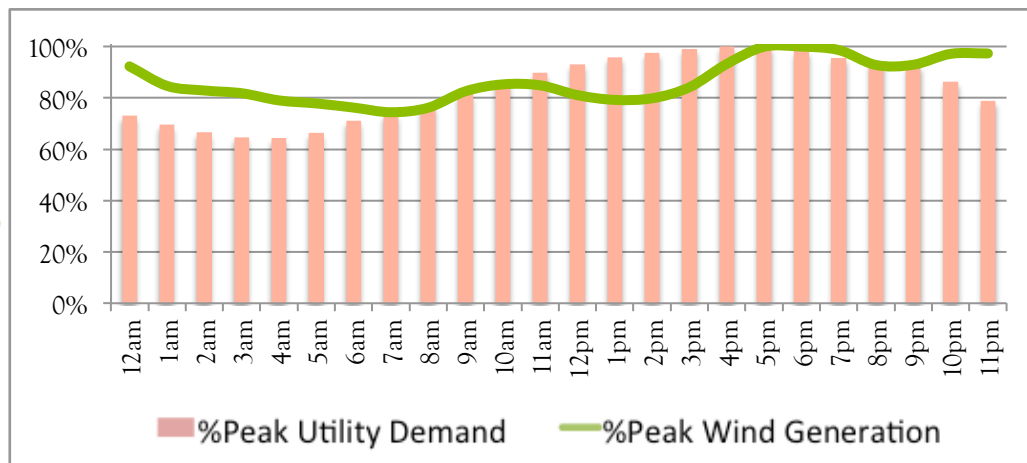
0.33

Hourly Correlation

0.54

Daylight Correlation  
(6AM-7PM)

August



30%

Avg. Capacity Factor

0.30

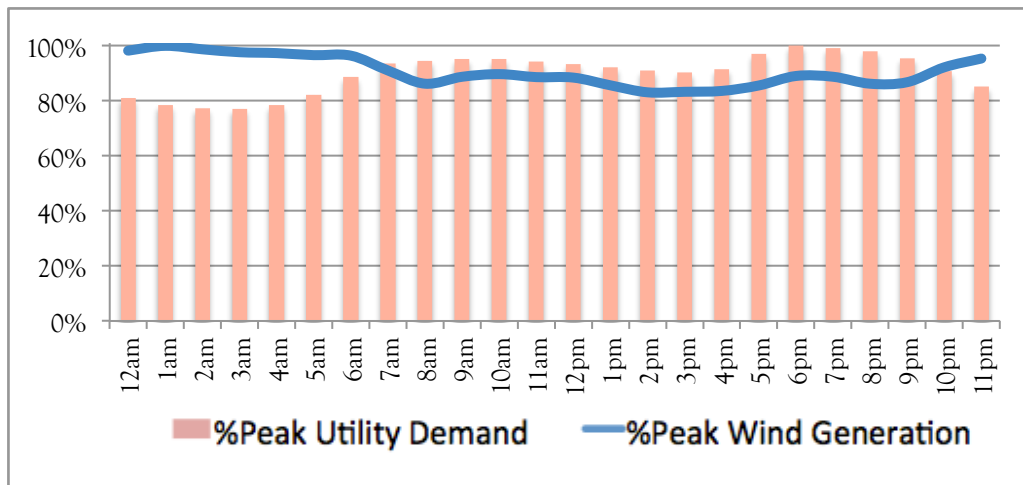
Hourly Correlation

0.68

Daylight Correlation  
(6AM-7PM)

**Chart 8: Hourly offshore wind output (percentage of peak generation) and hourly Duke Energy demand load curve (percentage of peak load) by month (2006-2008)**

December



44%

Avg. Capacity Factor

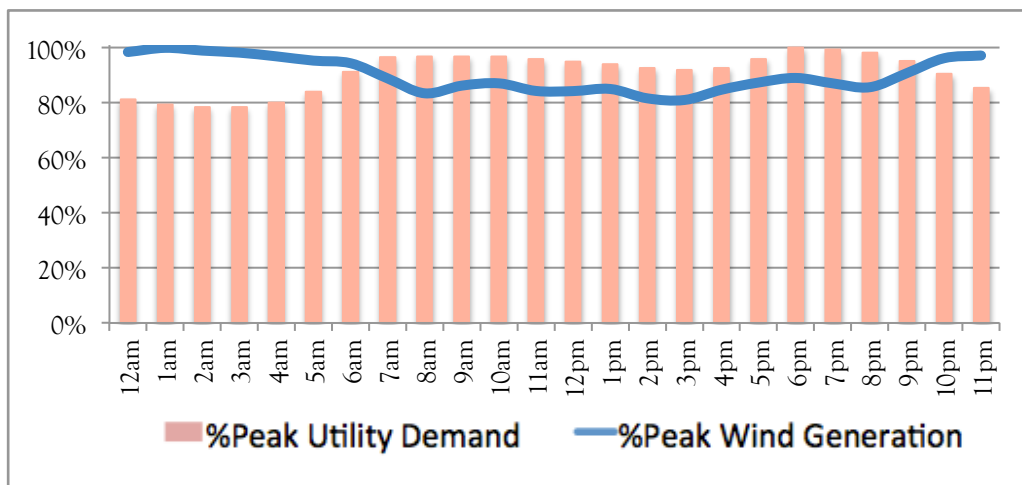
-0.80

Hourly Correlation

0.03

Daylight Correlation  
(6AM-7PM)

January



52%

Avg. Capacity Factor

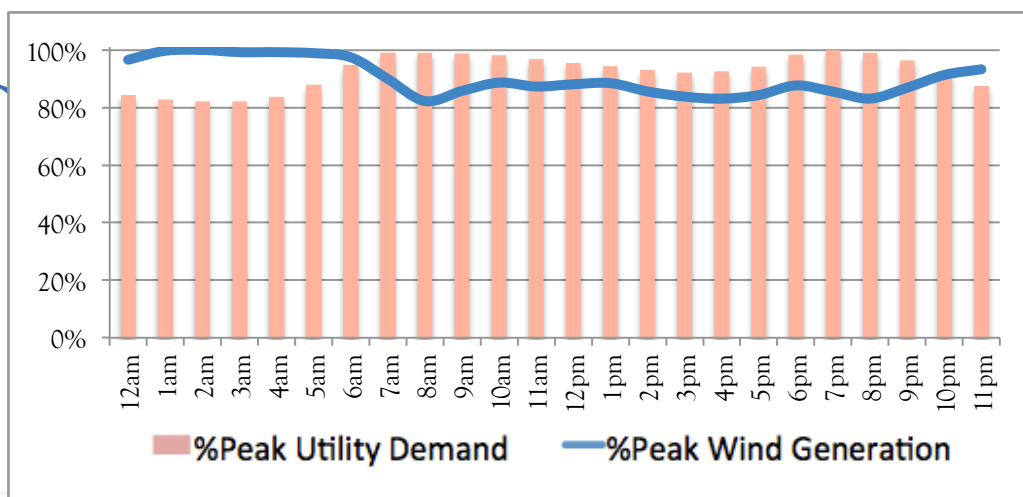
-0.81

Hourly Correlation

0.07

Daylight Correlation  
(6AM-7PM)

February



48%

Avg. Capacity Factor

-0.81

Hourly Correlation

0.18

Daylight Correlation  
(6AM-7PM)



## Conclusions

Currently, no offshore wind farms have been built off the United States. Bureaucratic red tape and hesitation to adopt new technology has thus far hampered this multi-billion dollar opportunity here. Abroad and especially in Europe offshore wind farms have been operational for over two decades. As the United States waits to develop this opportunity, it is becoming increasingly clear that offshore and nearshore wind farms can benefit from a unique natural phenomenon that occurs along coastlines. The Sea Breeze Effect occurs in coastal areas offshore and nearshore where a temperature differential between the land and sea causes a change in the wind. This phenomenon warrants a different evaluation of the value of offshore and nearshore wind farm development.

Offshore wind resources tend to be available when load demands are high. Georgia's electricity demands tend to peak in the summertime. During summertime, the state's offshore winds are positively correlated with Georgia Power's hourly electrical demand. Electricity demand tends to be higher during daylight hours when people are most active. Between the hours of 6AM and 7PM (inclusive), correlation between offshore wind resources and utility demand tend to be moderately positive during the summertime but strongly positive during the wintertime.

Offshore and nearshore wind energy would provide high value power. One common misconception is that wind energy should be compared against base load electric generation (e.g., coal or nuclear power); however, this research shows offshore wind and nearshore wind resources act more like peaking generation resources. Traditional peaking power plants, like natural gas combustion turbines, are usually a utility's highest cost power resource and are readily called upon during high load demands in the hot summer afternoons. Like solar power, offshore and nearshore wind resources naturally provide peak power generation during the summertime afternoons. These findings highlight the beneficial value of offshore and nearshore wind resources.

## Methodology

Hourly demand loads for Duke Energy Carolinas LLC were collected from the Federal Energy Regulatory Commission Form 714, Part 3, Schedule 2, Respondent ID 157, EIA Code 5416. Hourly loads for 2006, 2007 and 2008 were averaged together on an hourly, and monthly basis.<sup>11</sup> February 29<sup>th</sup>, 2008 was removed from the dataset as it was the only leap year day.

Wind output data were provided by AWS Truepower in association with development of the report, *Building an Infrastructure for Ocean Based Renewable Energy in the Southeast U.S.: Phase 2B Southeast Mesoscale Study*, April 4, 2011.<sup>12</sup> According to AWS Truepower,

“Using a mesoscale numerical weather prediction model at 20 km resolution, AWST modeled 10 years of wind resource at locations most suitable for offshore wind farm development identified in a previous phase of the project. Model wind speeds were validated by measurements from offshore moored stations in the region. Gross and net power output was calculated for each wind farm location, taking into account losses and turbine availability associated with typical offshore wind farms. Capacity factors were calculated for each site using 8 MW/km the maximum carrying capacity of each wind farm development area. Capacity factors were found to be consistent to those in previous offshore wind studies. Monthly average gross and net capacity factors.”

Wind output data were provided on a ten-minute scale from 1999-2008. Gross power output for Study Block 2, 2 and 3 (study blocks closest to North Carolina) were aggregated on an hourly, and monthly basis for 2006, 2007 and 2008. Total potential capacity for the three blocks added together is 3,149 megawatts. Data were made available in Greenwich Mean Time (GMT) and were subsequently altered to Eastern Standard Time (GMT-5) or Eastern Daylight Time (GMT-4) depending on the season. February 29<sup>th</sup>, 2008 was removed from the datasets.

### Establishing Percentage of Peak Generation and Peak Demand

In order to better compare utility demand to offshore wind generation, hourly demand load data and wind output data were converted in percentages.

Percentage of Peak Generation = Wind Hourly Capacity Factor / Wind Hourly Highest Capacity Factor

Percentage of Peak Demand = Hourly Demand / Highest Hourly Demand

Offshore wind generation was converted into hourly capacity factors (output divided by total potential capacity). The highest achieved average capacity factors for each evaluated month (January, February, June, July, August and December) was noted as peak generation. For each month, the average hourly capacity factors were divided by the peak generation (that month's highest average capacity factor) to create a percentage of peak generation. For utility demand load, the average hourly output (in megawatts) was plotted for each evaluated month. The highest achieved average hourly output was noted as peak demand. For each month, the average hourly outputs were divided by the peak demand. Pearson correlation coefficient tests were run on the percentage of peak generation and percentage of peak demand datasets to establish correlation and direction.

**Summertime Datasets for Wind Generation and Power Demand (2006-2008, average)**

| <u>June</u> |                      |                       | <u>July</u> |                      |                       | <u>August</u> |                      |                       |
|-------------|----------------------|-----------------------|-------------|----------------------|-----------------------|---------------|----------------------|-----------------------|
| Time        | Wind Generation (MW) | Duke Energy Load (MW) | Time        | Wind Generation (MW) | Duke Energy Load (MW) | Time          | Wind Generation (MW) | Duke Energy Load (MW) |
| 12am        | 1482.6               | 6256.5                | 12am        | 1094.4               | 6668.8                | 12am          | 1009.8               | 6902.7                |
| 1am         | 1477.8               | 5917.0                | 1am         | 1071.4               | 6195.8                | 1am           | 925.7                | 6572.1                |
| 2am         | 1462.9               | 5669.7                | 2am         | 1018.5               | 5918.8                | 2am           | 906.2                | 6291.3                |
| 3am         | 1371.9               | 5531.6                | 3am         | 925.5                | 5743.1                | 3am           | 894.6                | 6116.6                |
| 4am         | 1242.5               | 5515.1                | 4am         | 854.9                | 5705.3                | 4am           | 863.9                | 6080.4                |
| 5am         | 1141.1               | 5707.4                | 5am         | 813.1                | 5865.0                | 5am           | 851.0                | 6274.0                |
| 6am         | 1058.7               | 5986.2                | 6am         | 831.6                | 6145.8                | 6am           | 833.3                | 6715.0                |
| 7am         | 1019.7               | 6344.5                | 7am         | 832.9                | 6428.1                | 7am           | 813.6                | 6961.4                |
| 8am         | 953.2                | 6754.8                | 8am         | 890.4                | 6844.6                | 8am           | 832.8                | 7288.0                |
| 9am         | 951.4                | 7149.8                | 9am         | 1023.3               | 7282.6                | 9am           | 902.9                | 7709.5                |
| 10am        | 966.1                | 7514.0                | 10am        | 990.5                | 7701.5                | 10am          | 932.2                | 8135.0                |
| 11am        | 959.8                | 7773.4                | 11am        | 880.0                | 8042.4                | 11am          | 928.2                | 8485.4                |
| 12pm        | 991.1                | 7996.1                | 12pm        | 780.0                | 8329.0                | 12pm          | 886.4                | 8803.5                |
| 1pm         | 1069.7               | 8177.2                | 1pm         | 753.9                | 8562.3                | 1pm           | 866.2                | 9063.8                |
| 2pm         | 1192.3               | 8284.0                | 2pm         | 882.6                | 8720.2                | 2pm           | 872.9                | 9228.6                |
| 3pm         | 1313.6               | 8358.3                | 3pm         | 1050.8               | 8844.3                | 3pm           | 919.8                | 9355.0                |
| 4pm         | 1437.3               | 8415.3                | 4pm         | 1249.8               | 8957.5                | 4pm           | 1019.1               | 9450.5                |
| 5pm         | 1523.7               | 8386.9                | 5pm         | 1349.2               | 8969.0                | 5pm           | 1092.3               | 9436.4                |
| 6pm         | 1576.8               | 8263.6                | 6pm         | 1348.6               | 8853.5                | 6pm           | 1093.1               | 9291.6                |
| 7pm         | 1579.2               | 8047.5                | 7pm         | 1313.6               | 8622.0                | 7pm           | 1078.5               | 9029.3                |
| 8pm         | 1484.1               | 7841.6                | 8pm         | 1312.8               | 8366.9                | 8pm           | 1014.7               | 8876.5                |
| 9pm         | 1394.6               | 7765.1                | 9pm         | 1340.8               | 8262.6                | 9pm           | 1015.7               | 8748.7                |
| 10pm        | 1396.7               | 7420.2                | 10pm        | 1289.1               | 7862.0                | 10pm          | 1062.2               | 8150.5                |
| 11pm        | 1495.3               | 6788.9                | 11pm        | 1203.3               | 7229.1                | 11pm          | 1063.9               | 7456.4                |

**Wintertime Datasets for Wind Generation and Power Demand (2006-2008, average)**

| <u>January</u> |                      |                       | <u>February</u> |                      |                       | <u>December</u> |                      |                       |
|----------------|----------------------|-----------------------|-----------------|----------------------|-----------------------|-----------------|----------------------|-----------------------|
| Time           | Wind Generation (MW) | Duke Energy Load (MW) | Time            | Wind Generation (MW) | Duke Energy Load (MW) | Time            | Wind Generation (MW) | Duke Energy Load (MW) |
| 12am           | 1778.0               | 6397.3                | 12am            | 1615.1               | 6819.5                | 12am            | 1512.4               | 6143.2                |
| 1am            | 1806.5               | 6246.1                | 1am             | 1665.6               | 6688.8                | 1am             | 1537.9               | 5957.2                |
| 2am            | 1788.5               | 6181.4                | 2am             | 1670.3               | 6635.7                | 2am             | 1518.5               | 5866.2                |
| 3am            | 1775.1               | 6179.1                | 3am             | 1657.7               | 6643.3                | 3am             | 1502.3               | 5850.9                |
| 4am            | 1750.7               | 6295.6                | 4am             | 1657.7               | 6768.2                | 4am             | 1497.4               | 5946.5                |
| 5am            | 1722.7               | 6620.0                | 5am             | 1651.7               | 7100.3                | 5am             | 1485.9               | 6231.9                |
| 6am            | 1705.5               | 7191.1                | 6am             | 1628.0               | 7659.5                | 6am             | 1483.2               | 6720.5                |
| 7am            | 1605.9               | 7604.6                | 7am             | 1501.9               | 7999.4                | 7am             | 1400.4               | 7104.3                |
| 8am            | 1508.0               | 7630.3                | 8am             | 1373.9               | 8006.6                | 8am             | 1326.4               | 7172.7                |
| 9am            | 1558.4               | 7621.7                | 9am             | 1432.7               | 7983.3                | 9am             | 1365.0               | 7217.6                |
| 10am           | 1573.4               | 7617.0                | 10am            | 1481.0               | 7932.3                | 10am            | 1379.9               | 7219.8                |
| 11am           | 1523.5               | 7545.5                | 11am            | 1458.1               | 7823.8                | 11am            | 1363.1               | 7149.0                |
| 12pm           | 1522.5               | 7472.1                | 12pm            | 1471.4               | 7726.7                | 12pm            | 1360.4               | 7077.2                |
| 1pm            | 1536.6               | 7393.5                | 1pm             | 1477.7               | 7621.7                | 1pm             | 1317.2               | 6993.2                |
| 2pm            | 1475.0               | 7293.2                | 2pm             | 1429.6               | 7511.5                | 2pm             | 1278.1               | 6898.8                |
| 3pm            | 1464.1               | 7237.6                | 3pm             | 1399.5               | 7441.9                | 3pm             | 1281.1               | 6850.8                |
| 4pm            | 1531.4               | 7301.0                | 4pm             | 1387.8               | 7475.9                | 4pm             | 1285.9               | 6942.5                |
| 5pm            | 1578.8               | 7557.2                | 5pm             | 1408.7               | 7607.8                | 5pm             | 1316.4               | 7364.7                |
| 6pm            | 1609.0               | 7869.4                | 6pm             | 1464.3               | 7957.9                | 6pm             | 1369.5               | 7585.0                |
| 7pm            | 1573.5               | 7824.3                | 7pm             | 1428.6               | 8083.4                | 7pm             | 1365.2               | 7513.8                |
| 8pm            | 1548.0               | 7724.1                | 8pm             | 1388.4               | 8002.8                | 8pm             | 1326.2               | 7437.4                |
| 9pm            | 1640.6               | 7494.2                | 9pm             | 1451.3               | 7791.8                | 9pm             | 1334.9               | 7248.3                |
| 10pm           | 1738.3               | 7119.5                | 10pm            | 1525.3               | 7439.9                | 10pm            | 1418.0               | 6883.1                |
| 11pm           | 1756.2               | 6716.5                | 11pm            | 1558.3               | 7067.1                | 11pm            | 1467.0               | 6456.6                |

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The Southern Alliance for Clean Energy has been a leading voice for energy policy to protect the quality of life and treasured places in the Southeast since 1985. Our dedicated and diverse staff is poised to tackle our region's energy challenges and harness the economic opportunities presented by clean renewable energy. SACE advocates for federal, state and local climate policy solutions, energy efficiency programs and policies, and renewable energy such as solar, wind, and sustainable bioenergy. We promote clean fuels and vehicles, oppose nuclear and coal-fired power plant expansion, and encourage the retirement of old, dirty inefficient coal-fired power plants in our region.

For over 25 years, SACE has worked as a strong defender of the environment, challenging the status quo and working to minimize the impact of the energy sector on our region's communities, natural resources and economies. We are committed to ensuring that communities throughout the Southeast never have to choose between a healthy environment and a stable economy.



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