ECONOMIC AND ENVIRONMENTAL PERFORMANCE OF POTENTIAL NORTHEAST OFFSHORE WIND ENERGY RESOURCES

FINAL REPORT – APPENDICES

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Appendix A. Northeast Wind Maps

Figure MIT-OWC.A.1: Locations of the 17 NOAA stations selected for analysis

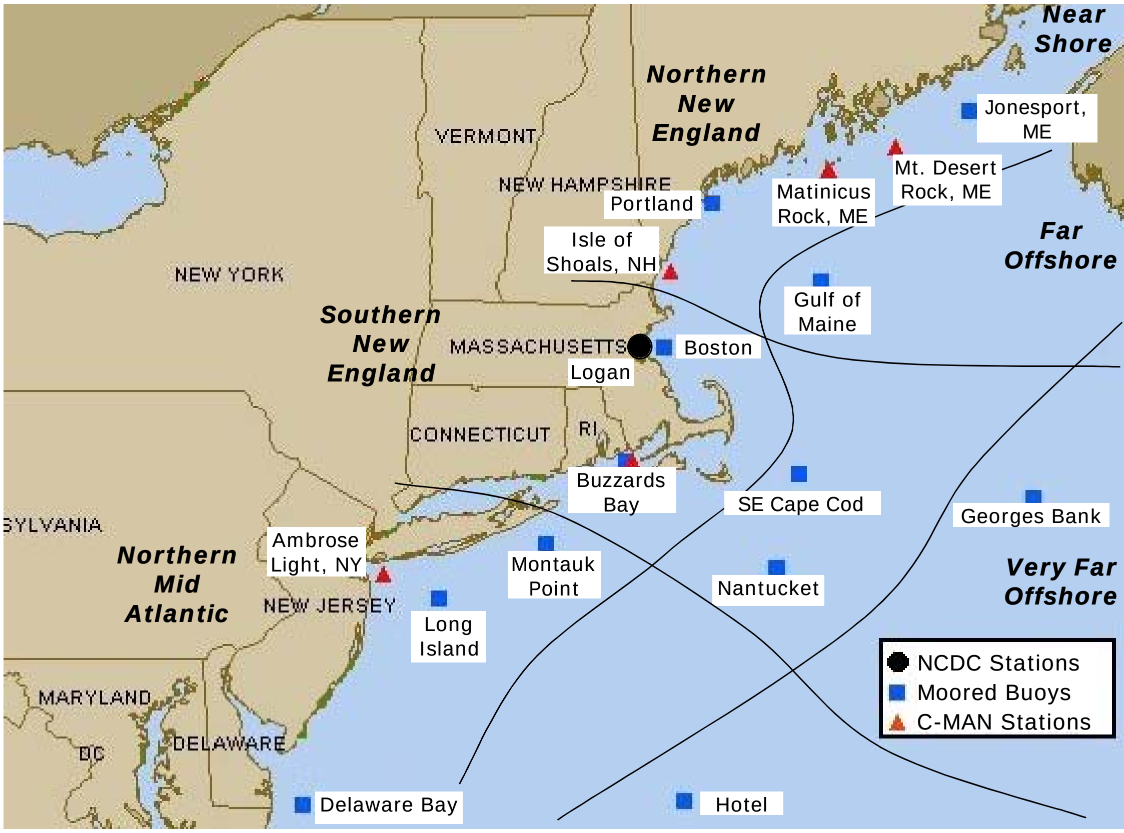


Figure MIT-OWC.A.2: Station Locations – Distance from Shore

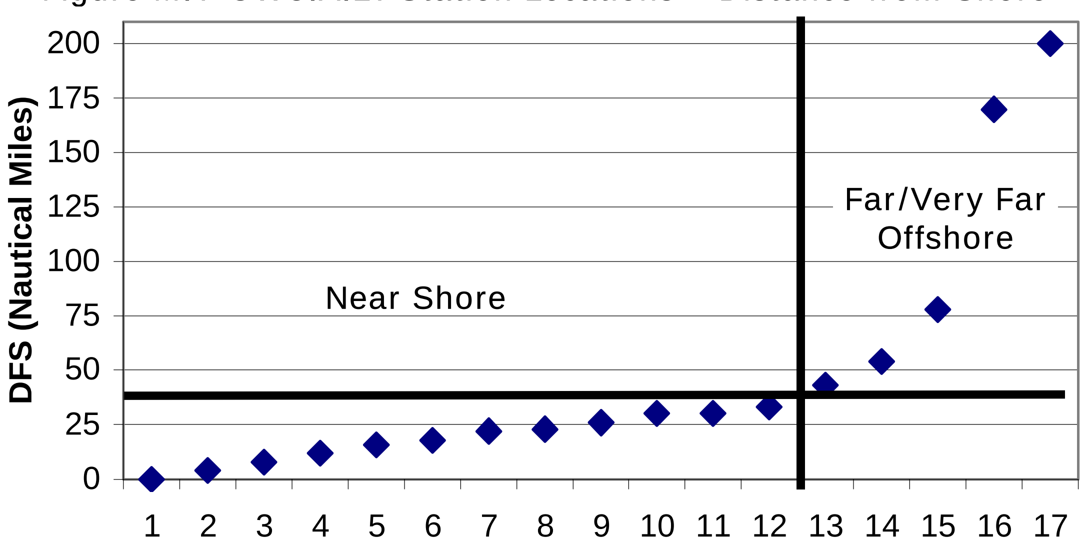
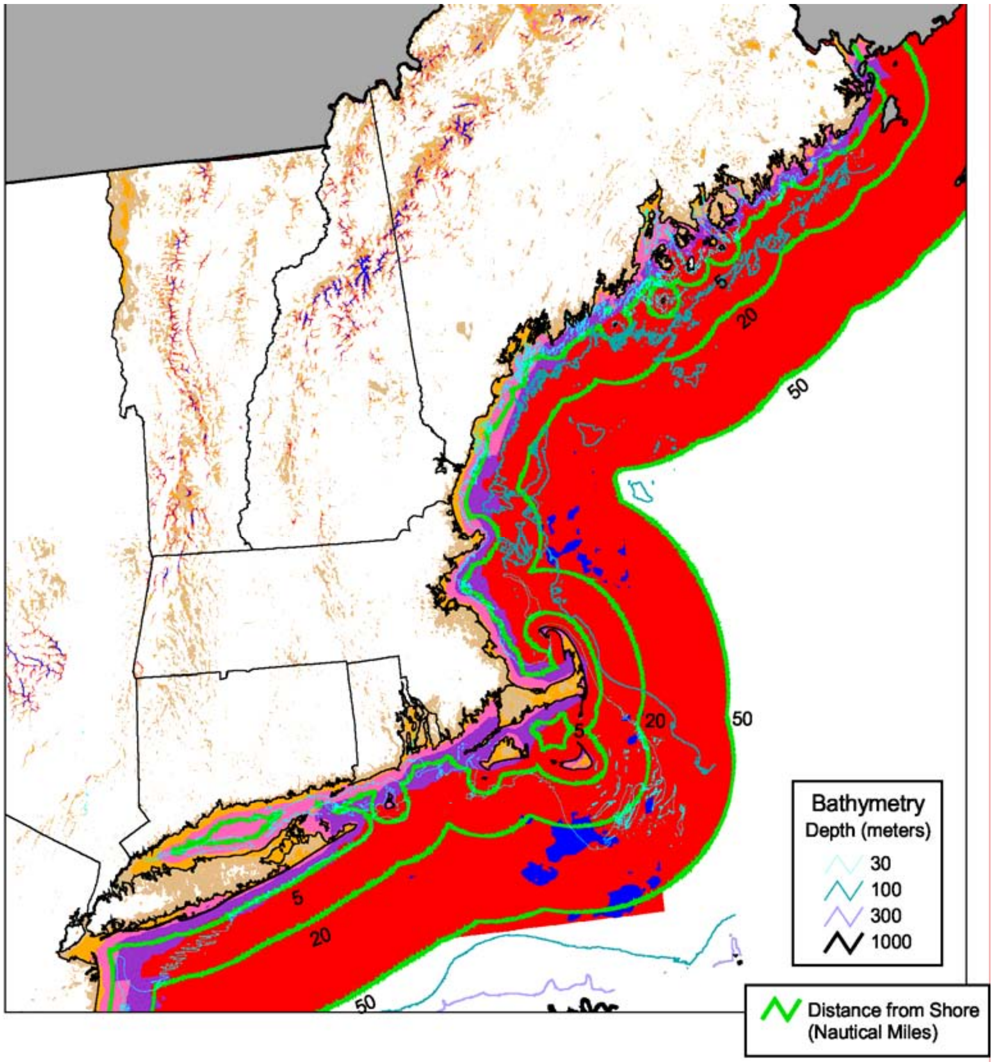


Figure MIT-OWC.A.3: New England Offshore Resource



Source: Musial, W. “Overview: Potential for Offshore Wind Energy in the Northeast.”
Offshore Wind Energy Collaborative Workshop. February 10-11, 2005.
http://www.mtpc.org/renewableenergy/Owec_pdfs/OWEC- Musial.pdf

Figure MIT-OWC.A.4: Wind Power Classification

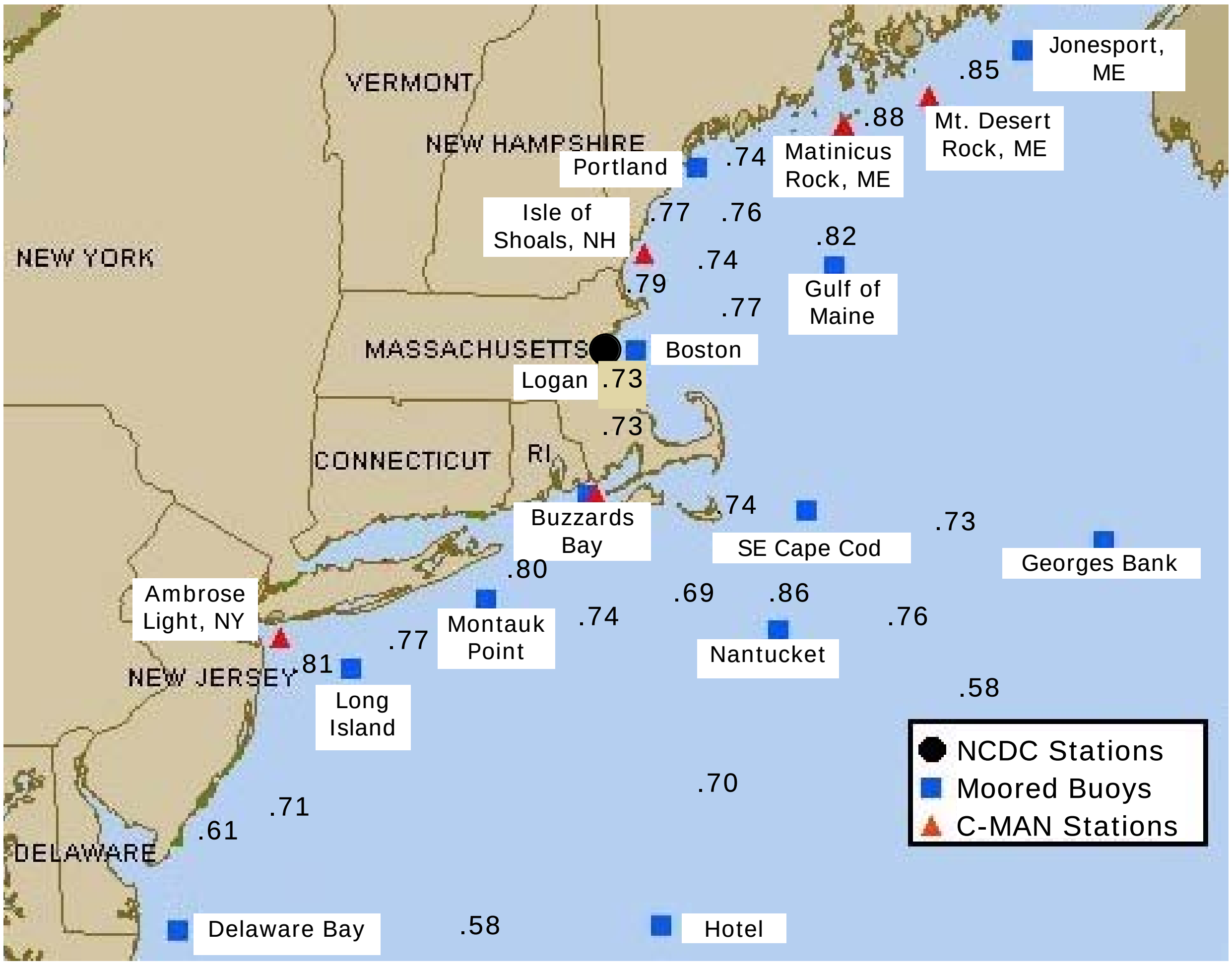
Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	> 800	> 8.8	> 19.7

[a] Wind speeds are based on a Weibull k value of 2.0

As can be seen below, some pairs of sites have better correlated windspeeds than others.

Figure MIT-OWC.A.5: Correlation of Windspeed Between Neighboring NOAA Stations



Note: Correlations based on 2003-2004 raw data. Small gaps (1-2 hours) in the data have been filled in by interpolation.

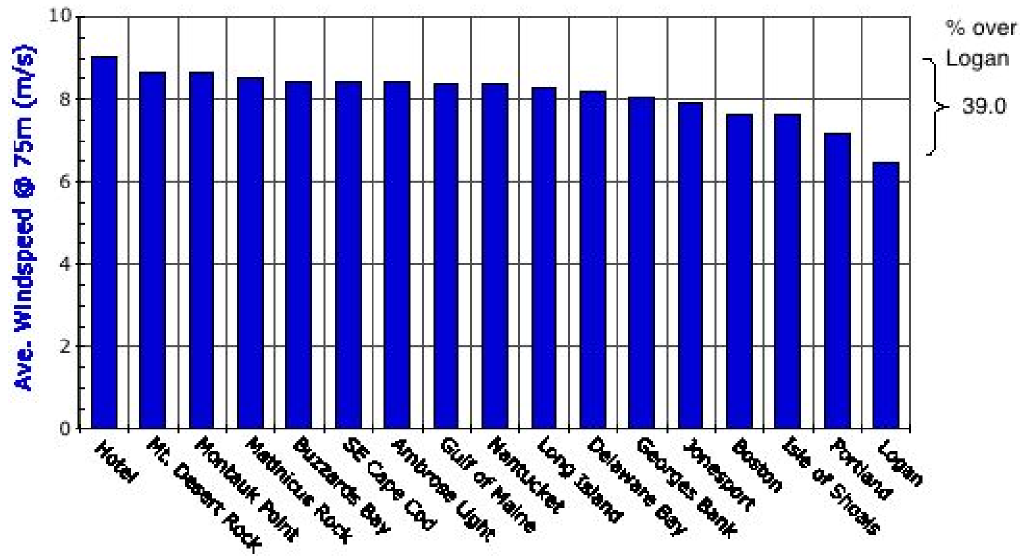
The above figure shows the correlations (r) of windspeeds for 25 pairs of NOAA stations. As would be expected, the closer a station's neighbor, the higher the correlation. Correlations of winter windspeeds are similar to the annual values while summer windspeeds are less correlated (r values are 10-40% lower). Windspeed correlations may change by up to 20% year-to-year.

Appendix B. Graphs of all Data Sites (not in Results section)

Long-Term Averages

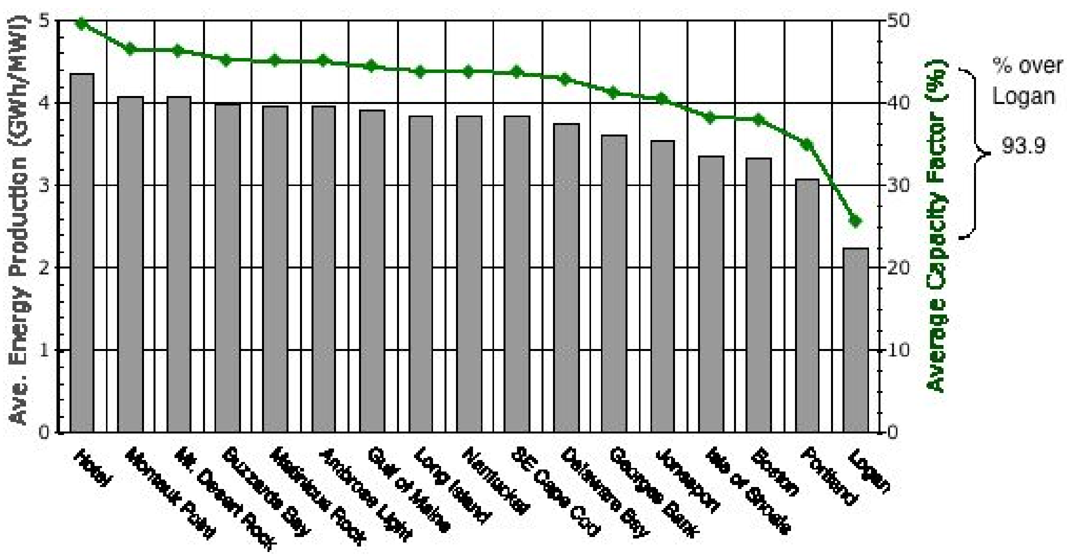
These graphs show results averaged over all available years for each of the data sites. The columns are sorted in order of decreasing average values. The first graph below shows long-term average windspeed at the 17 data sites.

Figure MIT-OWC.B.1: Average Windspeed at 75m



One can see that the very far offshore data sites (Hotel), and some of the near shore sites (Mt. Desert Rock), have quite a bit more wind than the onshore site (Logan).

Figure MIT-OWC.B.2: Average Generation and Capacity Factor



The moderate differences in windspeed across sites are magnified into greater differences in generation and capacity factor.

The following graphs show calculated annual revenue. Because NE power markets and prices have changed dramatically over the last 10 years, 2004 data were used for these displays.

Figure MIT-OWC.B.3: 2004 Revenue

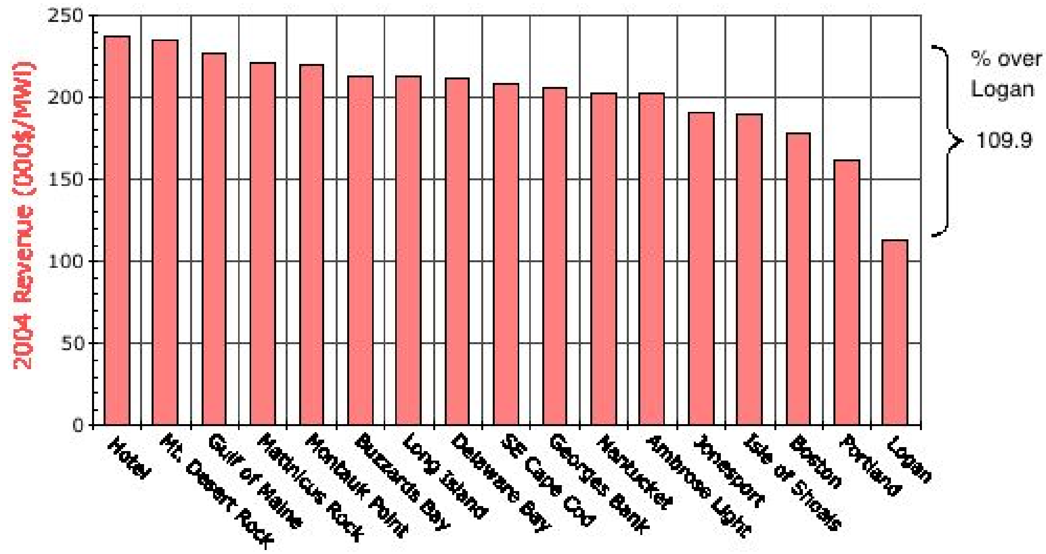
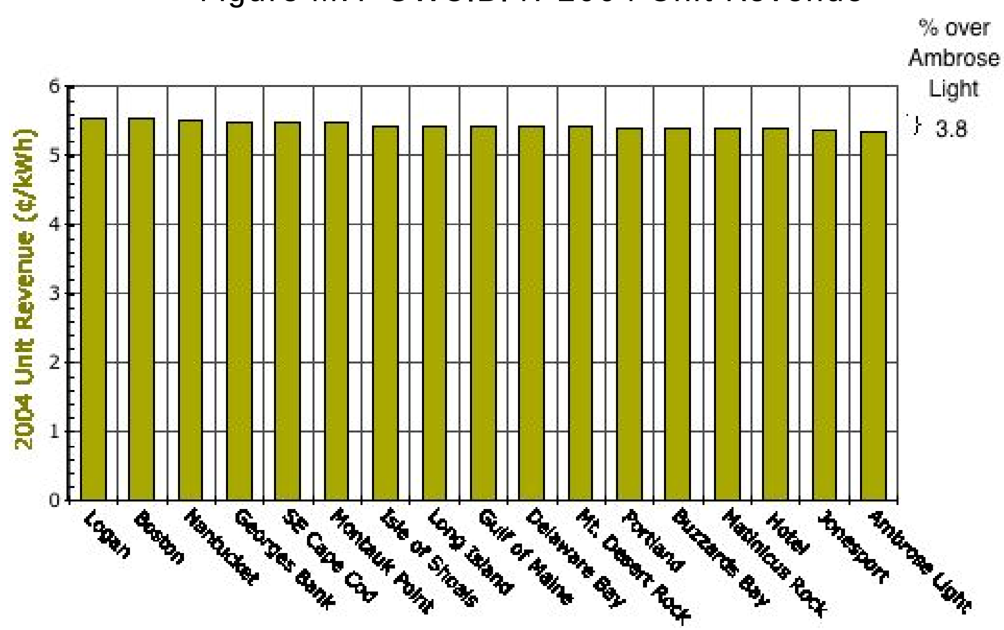


Figure MIT-OWC.B.4: 2004 Unit Revenue

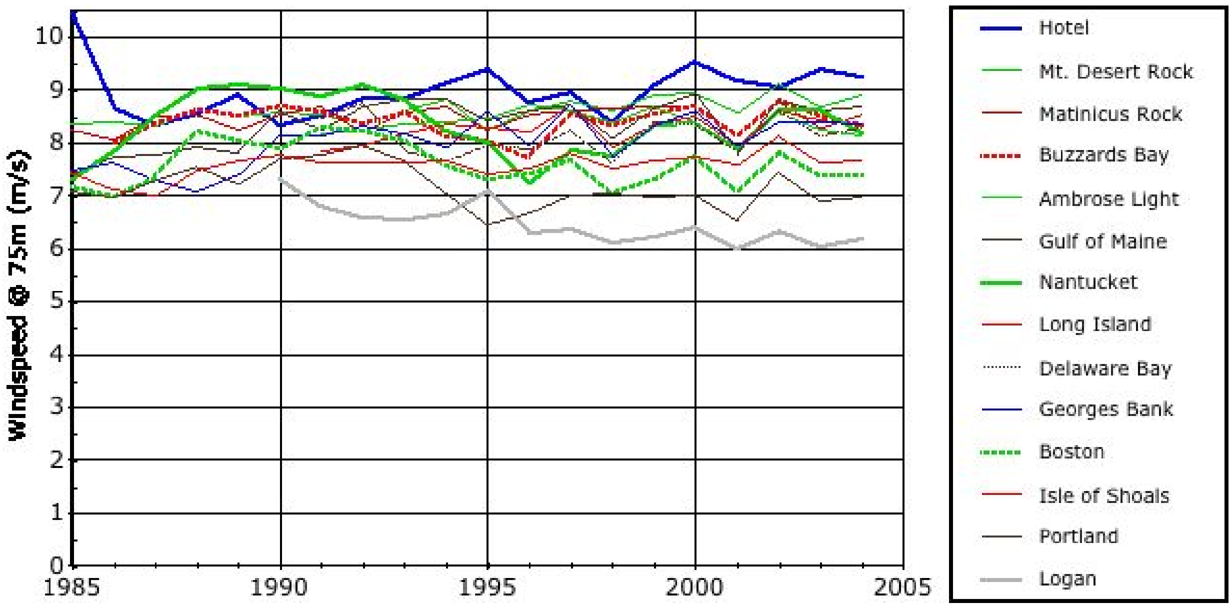


While total generation and revenue vary considerably from site to site, unit revenue on a per kWh basis is similar across all sites. This is due to the equalizing effect of dividing total revenue by total generation

Annual Results for all Data Sites[1]

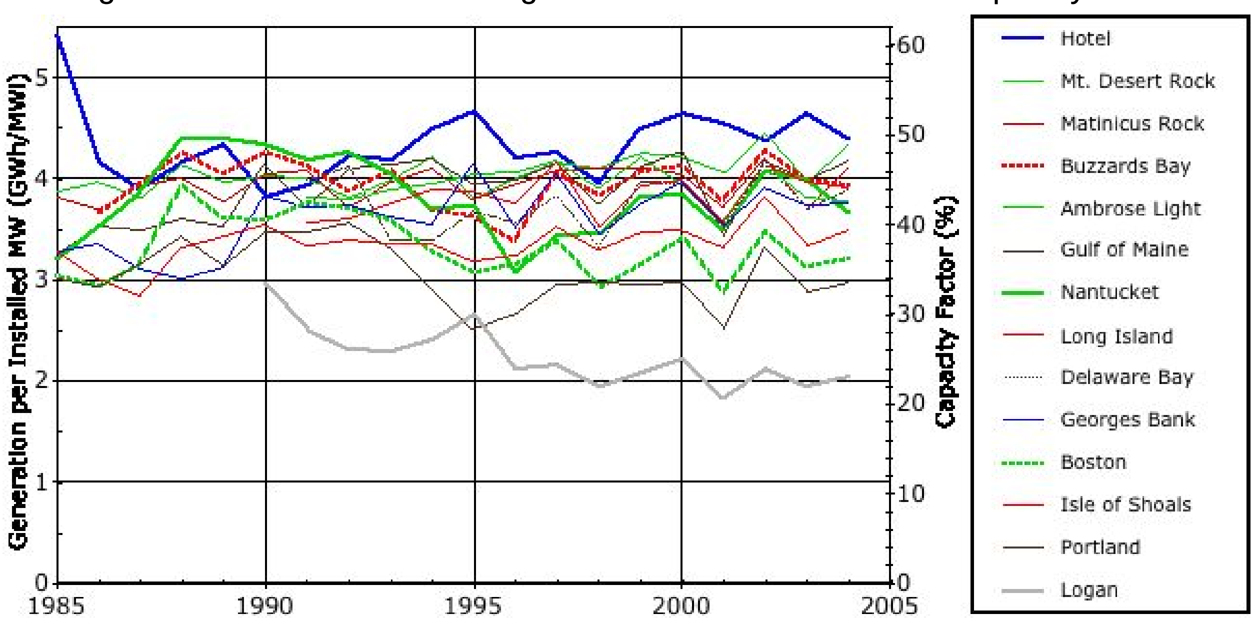
The following graphs show annual results for the 14 data sites with long-term data.

Figure MIT-OWC.B.5: Average Annual Windspeed at 75m



The far/very far offshore data sites have some of the highest average annual windspeeds, but there are years when near shore winds are stronger on average.

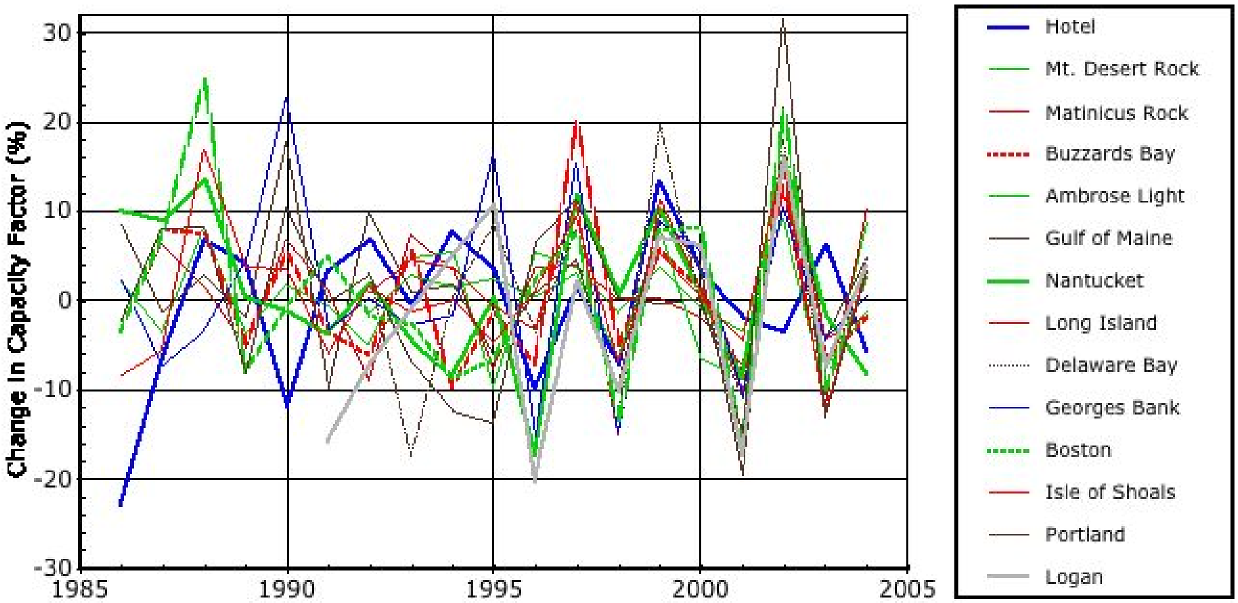
Figure MIT-OWC.B.6: Average Annual Generation and Capacity Factor



[1] Only 14 data sites are plotted in these graphs because the three data sites Jonesport, SE Cape Cod, and Montauk Point only have several years of data and are excluded here.

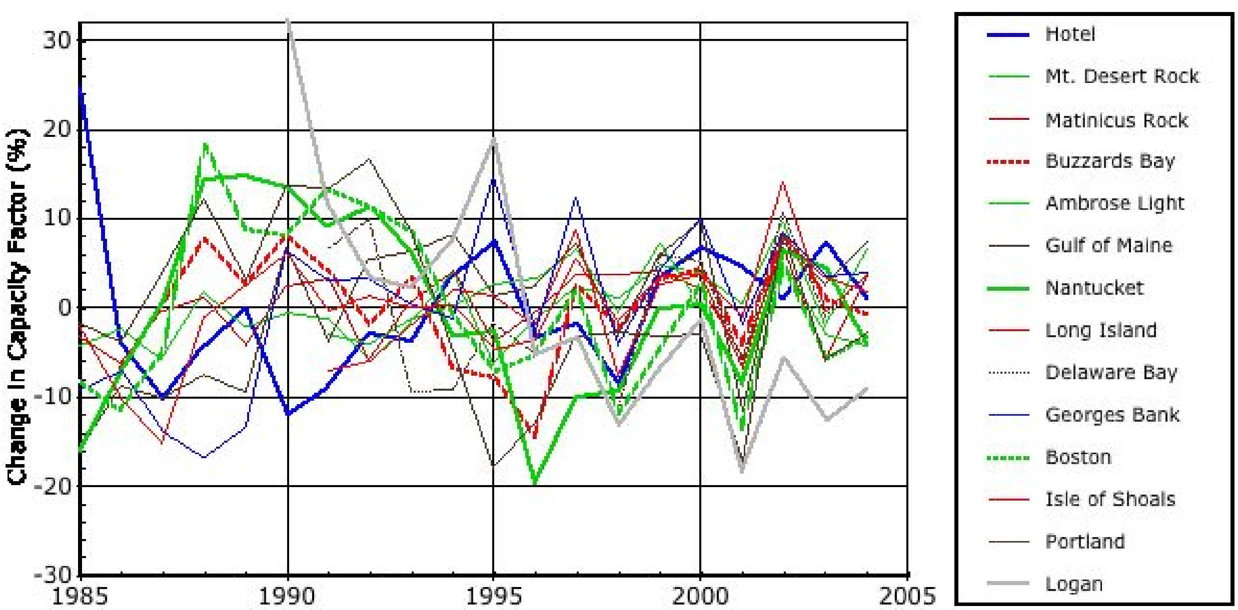
Generation and capacity factor are high offshore, but may vary considerably year to year. The following graphs show annual changes in capacity factor.

Figure MIT-OWC.B.7: Capacity Factor Changes – Year-to-Year



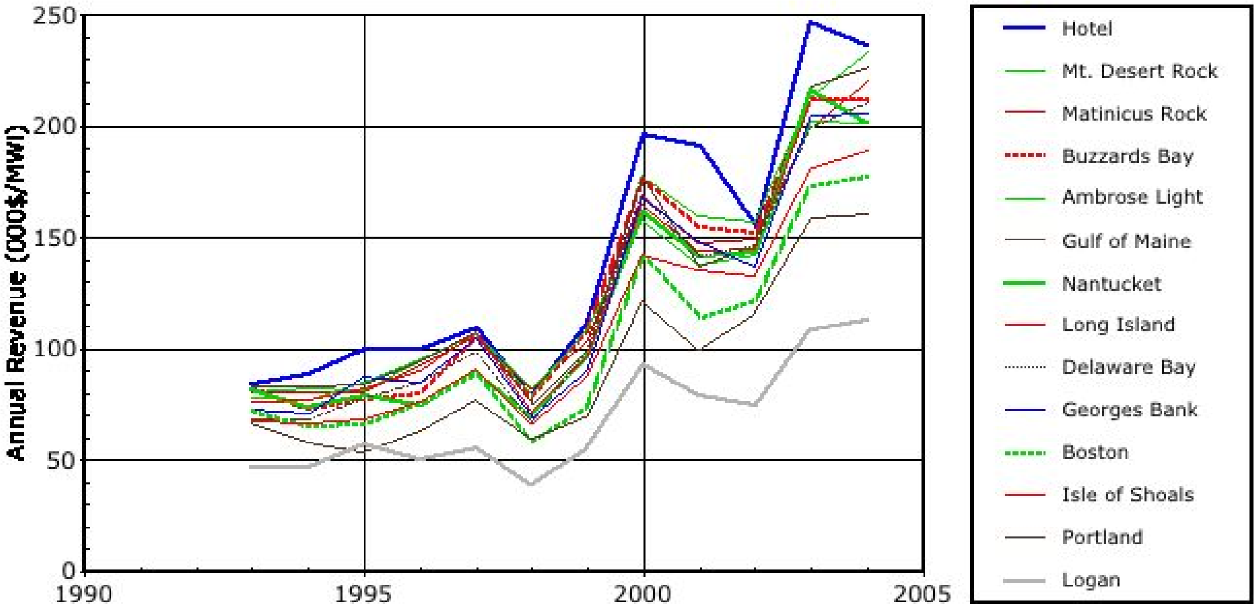
Changes of +/- 10% in capacity factor year-to-year are common among all offshore data sites.

Figure MIT-OWC.B.8: Capacity Factor Changes – From Average



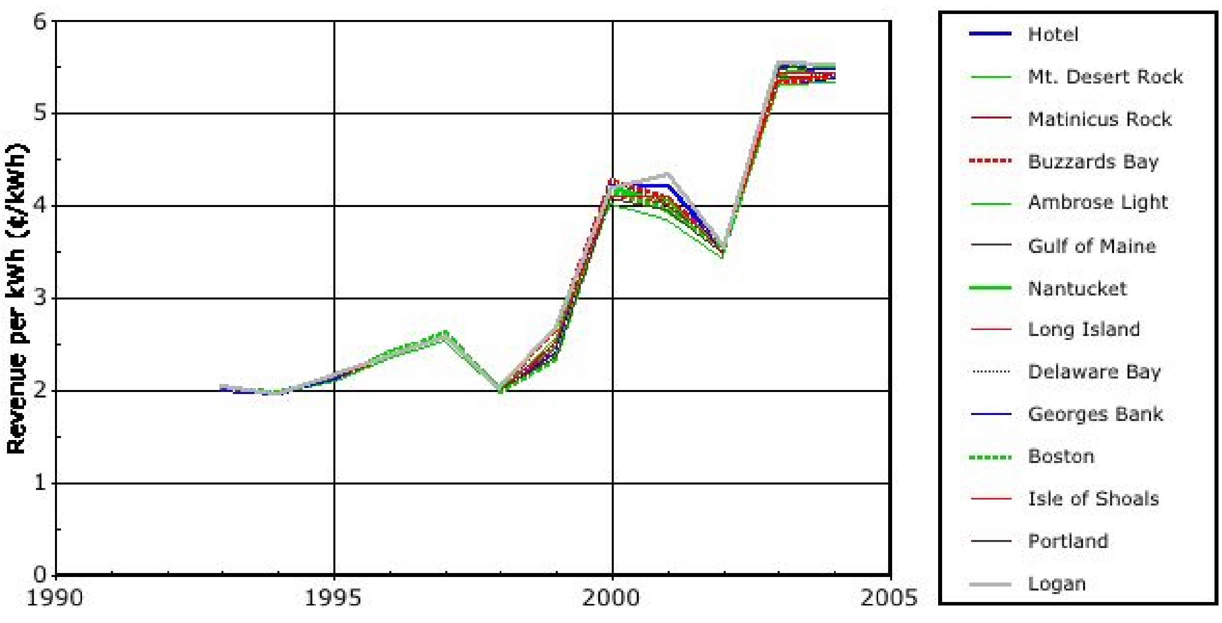
The above graphs shows that changes of +/- 10% in capacity factor from long-term averages are common among all offshore data sites.

Figure MIT-OWC.B.9: Annual Revenue



Annual revenue across data sites follows closely with annual generation. Revenue values over time track closely with trends in average power prices.

Figure MIT-OWC.B.10: Unit Revenue

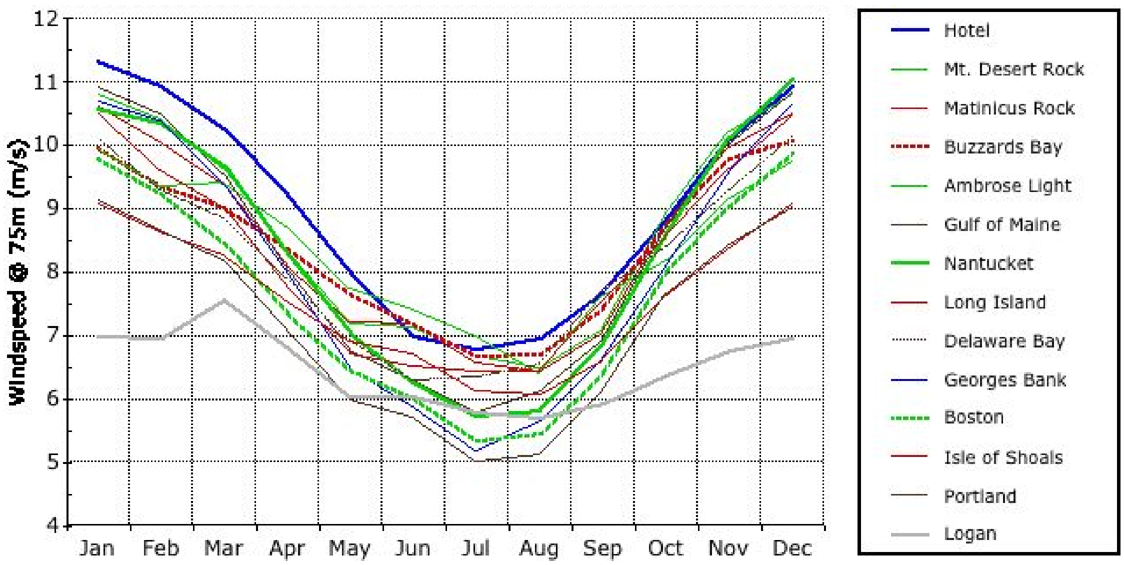


The above graph shows, again, that while total generation and revenue vary considerably from site to site, unit revenue on a per kWh basis is similar across all sites. This is due to the equalizing effect of dividing total revenue by total generation.

Seasonal and Time-of-Day Profiles

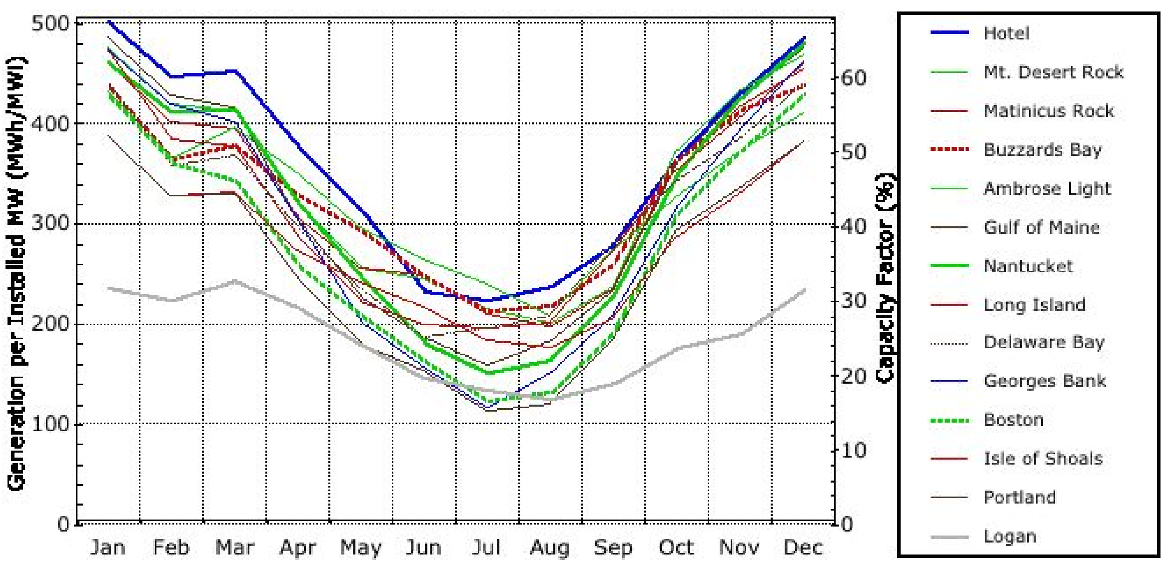
The following graphs show long-term average monthly values for the 14 data sites with long-term data.

Figure MIT-OWC.B.11: Average Monthly Windspeed



It is evident that offshore winds are much stronger in winter than in summer.

Figure MIT-OWC.B.12: Average Monthly Generation and Capacity Factor



The strong winter offshore winds bring much potential generation and high capacity factors.

The following graphs are surface plots that show estimated generation for 2004 for each of the 17 sites, by month and hour of day. The graphs are colored such that warm colors, like red and yellow, show periods of high energy production while cool colors, like blue and green, show periods of low energy production. They are ordered from left to right, from lowest to highest long-term average windspeed.

Figure MIT-OWC.B.13: Generation Surface Plots for 2004