Offshore wind power resource in the Virginia Coastal Ocean

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Virginia Coastal Ocean

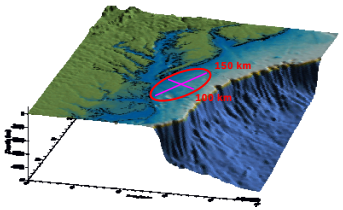


Figure 1.- Bathymetry of Virginia Coastal Ocean. Mean depth in the continental shelf area is 30 m

Methodology

Wind data from selected stations was obtained from the National Data Buoy Center (NDBC). The four stations selected were: the buoy located at 64 nm off Virginia Beach (buoy 44014), the Chesapeake Light Tower (CHLV2), the Chesapeake Bay Bridge Tunnel (CHBBT), and, station DUCN7 - Duck Pier, North Carolina (Fig. 2). The hourly averaged data was available for 17 year period (1990 to 2006), except for the CHBBT (1992 – 2006). The data was adjusted from the measurement height to the standard height of **50 m**.

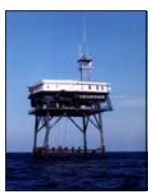
The Wind Energy and Power (Pwr) per unit area (A) is called the Wind Power Density (WPD) and has units of watts/m^2.

$$\mathbf{WPD = Pwr / A = \tfrac{1}{2} * \rho_a * W^3}$$

where $\boldsymbol{\rho_a}$ is the air density (1.225 kg/m^3) and **W** is the wind speed in m/s.

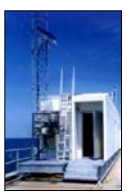
For each station the annual, monthly and hourly average was calculated. Additionally the hourly average was determined for the four seasons: winter (Dec, Jan, Feb), spring (Mar, Apr, May), summer (Jun, Jul, Aug), and fall (Sep, Oct, Nov).

Buoy 44014 - Located at 64 nm East of Virginia Beach. Is a NOAA 3 meter discus buoy anchored on 47.5 m water depth. The anemometer height is 5 m above sea level.



Chesapeake Light Tower stands 13 miles offshore in the Atlantic Ocean off Virginia Beach. The anemometer height is 43 m above sea level.

Chesapeake Bay Bridge Tunnel meteorological station, located on the first island, at the mouth of the Chesapeake bay. The anemometer height is 13.0 m above sea level



DUCN7 - Duck Pier, NC. The anemometer height is 20 m above sea level.

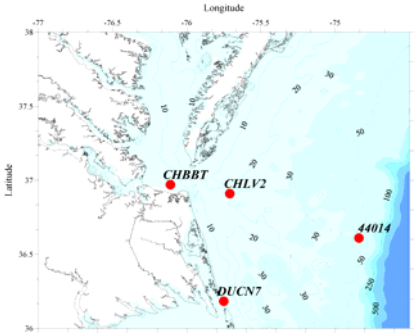


Figure 2.- Location of wind data stations

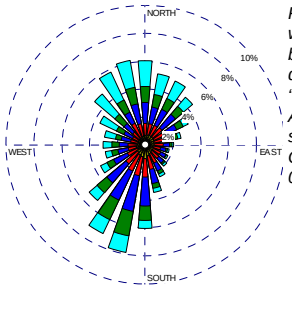


Figure 3.- 50 m wind rose at the buoy 44014. Wind direction is "blowing to". Average wind speed is 7.7 m/s. Calms frequency 0.78%

The wind rose (Fig. 3) shows that during the 17 years of data analyzed, the predominant wind direction in the area is along the coast from N -NNW and from SSW with a frequency of 63% of the time with wind over 6 m/s. The long term average for buoy 44014 was 7.1 m/s and calms are present only 0.78% of the time.

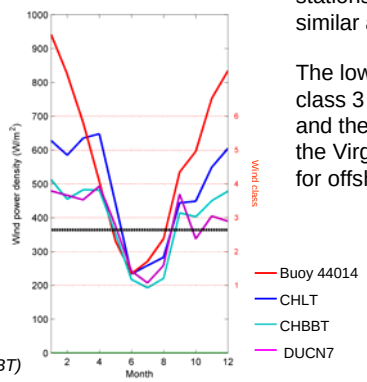


Figure 4. Wind power density (W/m^2) annual average for the Buoy 44014, Chesapeake Light Tower (CHLT), Chesapeake Bay Bridge Tunnel (CHBBT) and Duck Pier, NC (DUCK) stations.

Virginia has Unique Advantages for Offshore Wind Energy Development

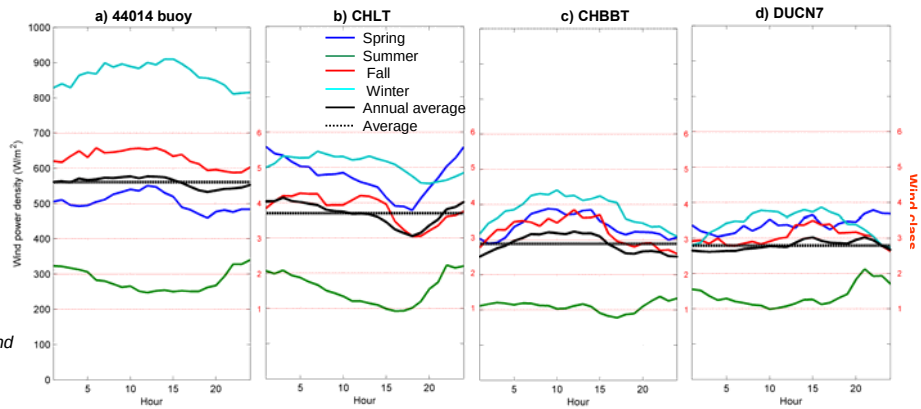


Figure 5. Wind power density (W/m^2) by time of day for a) Buoy 44014, b) Chesapeake Light Tower (CHLT), c) Chesapeake Bay Bridge Tunnel (CHBBT) and DUCK pier, NC (DUCN7) stations by seasons and annual average. Time of day is in GMT time (-4).

Figures 4 and 5 show that the average wind energy density decreases from the ocean to the coast with a maximum in winter and a minimum in summer. At the buoy 44014 and CBBT the highest wind speeds occur at midday and the lowest at night. The opposite pattern is observed during winter in the same stations and at the CHLT. The amplitude of the diurnal pattern is similar all year at all the stations.

The low frequency of calms, the high frequency of wind class 3 and above, the low impact of hurricanes and the shallow of the coastal ocean, make the Virginia coastal ocean a unique place for offshore wind energy development.