ARC
RENEWABLE
ENERGY LLC

WIND STUDY

for

The Town of Long Branch

at

Ocean Place Promenade
Long Branch NJ
(North 40.304, West 73.992)

conducted
March 9th 2010 – May 4th 2010

Overview

Long Branch, Monmouth County, New Jersey, is nine miles southeast of Middletown, New Jersey, thirty miles south of New York City, latitude 40.304N, longitude 73.992W with a standard elevation of 20 feet.

July is typically the warmest month and January the coolest with most precipitation expected in August. With 1116 incidents recorded in the last sixty years, Long Branch gets an average of 19 major storms a year, where wind speeds can exceed 50 miles per hour, typically over the course of several days. This is much higher than most New Jersey towns, as are the average wind speeds recorded throughout the year. In fact, located in the crook of the North Eastern Seaboard, Long Branch is in one of the windiest locations in the United States according to the Government's NREL, the National Renewable Energy Laboratory (see appended map).

These consistently high winds are caused by a combination of geographical and topographical features, and of course, proximity to one of the Earth's largest bodies of water; the Atlantic Ocean. Long Branch receives masses of land-warmed air, traveling east across the country (Westerlies) on the Gulf Stream, warmer moist air brought up the coast directly from the Gulf, cooler air traveling west from the transatlantic (Easterlies and Nor'easterlies), and air traveling northwest from the much warmer equatorial region of the ocean (Northeasterly Trade Winds). Most land areas are typically in the corridor of one or possibly two main bodies of moving air. Long Branch falls in the cyclonic mix of many. Added to this the tumultuous hurricane induced winds and subsequent eddies that buffet and barrage the coast throughout the hurricane season, and the result is, windy.

Test Procedure

To take a snap shot of the wind speeds at the given location, a digital anemometer was placed in the vicinity of the proposed wind turbine. Its purpose was to measure raw data using horizontal rotations stored on permanent memory firmware. An algorithm converts the rotational counts per second into wind speed in miles per hour, once the firmware is docked with its compliant software.

The anemometer does not act like a wind turbine, it merely collects data that we can use as a guide to discern the feasibility of installing a wind turbine. Wind speed is not the only important factor in making this decision, however.

A wind turbine would be permanently installed at the optimal height and position to compensate for immediate surroundings, obstacles, buildings and the general environs. The anemometer, however, without the luxury of a permanent mounting bracket, was placed in the most logical place to avoid damage. Consequently the anemometer results recorded will be significantly less than those of a turbine.

Also note that the anemometers are, by design, lightweight and therefore have negligible momentum. They do not continue to spin after gusts. The wind turbine, because of its mass and very low friction, will continue to spin long after gusts have prevailed.

The anemometers are also designed to measure wind speed in one direction only. Crosswinds, eddy currents and buffeting will all inhibit the rotation of the anemometer and therefore prevent accurate recording. This is also true of standard vertical sail wind turbines which is why they are unsuitable for areas of 'unstable' wind conditions. They work best when strong winds are evident from one direction. The horizontal sail wind turbine, however, is specifically designed to capture, utilize, and indeed optimize, wind and gusts from multiple directions. Consequently, we anticipate much greater average wind speeds recorded at the hub of the wind turbine than those demonstrated by the anemometer results, especially given the volatility of wind behavior in Long Branch.

The anemometers are small, lightweight and catch very little air and are used as a gauge only for comparison purposes to help ascertain what prevailing conditions exist at the survey site.

The raw data from the anemometer test results is appended.

Survey Location Overview

The location is very well suited for the installation of a wind turbine. With a couple of thousand miles of ocean to the east, Gulf Stream concentration overhead, masses of land-warmed air from the west and warm moist air from the southeast, all culminating on the eastern seaboard, Long Branch is guaranteed regular wind energy in every season, all year around.

Test results were taken at the beginning of the summer, probably one of the least windy times of the year, and from those results we can discern a much higher than average speed of both wind and gusts.

Counter intuitively the wind direction, which was presumed to be predominately easterly during the early summer, seemed to emanate from multiple headings; something we would expect in the autumnal and winter months. This could be as a result of concentric currents caused by the topography of the region and the spiraling effect of all the noted bodies of air converging at this location, as discussed, or more specifically the buildings and features immediately surrounding the anemometer.

It is important to note that this phenomenon would retard the spin of the anemometer and minimize the recorded results. The wind turbine, however, will make full use of this phenomenon being designed to capture wind from multiple directions at once.

Obviously average wind speed varies by season, and indeed by month, with greater wind speeds expected in the spring and fall. Air density is higher in the colder months, but despite lower average speeds, cold winds can produce very high energy output as there are more molecules of air per cubic meter than warmer air, so more mass to drive a turbine. While air density is lower in the summer, air pressures vary greatly, because of stark temperature differences, causing air to move to cooler areas and inducing both very high air volume and very high wind speeds. Long Branch is highly susceptible to the effect of Atlantic storms, so we would expect high winds during the hurricane season, but realistically, we would expect every season on the New Jersey Coast to be a reliable source of wind energy.

It is common to experience, in any given location, periods of high wind, low wind and no wind. Obviously when there is insufficient wind to drive the sails of the turbine, no electricity can be produced. If the sails aren't spinning fast enough, the energy produced will be offset against overcoming inertia, friction and lost to the inverter. There is a threshold, therefore, that a turbine must meet to actually produce positive results. With conventional turbines, this could require very large wind speeds. With the utilitarian design of the horizontal sail turbine, however, this threshold is only 4mph.

Conversely, when wind speeds are too high, conventional turbines become ineffective, spinning too fast to efficiently convert kinetic energy to electrical. The horizontal sailed turbine does not suffer this constraint, however, as it is geared specifically to utilize such forces. In fact, in a 90mph wind, you can clearly see the sails turning significantly slower, the additional kinetic energy being converted to potential energy and 'stored' in the gearing system for conversion to electrical energy.

Designed to optimize buffeting, eddy currents and multidirectional winds, unlike anemometers and vertical axis turbines, which are slowed by such forces, the results we expect from a turbine at this location will be much greater than those recorded below. However, even based on these figures, without optimization or factoring in the turbine's design and final positioning, we can discern that this location in Long Branch will be an excellent site for a horizontal sail turbine.

Actual Results Recorded From Survey

The raw data from the survey is appended, but the averages drawn from the data are recorded in the following table. Note that these are anemometer recordings, and as explained herein, we would expect much higher results from the turbine itself.

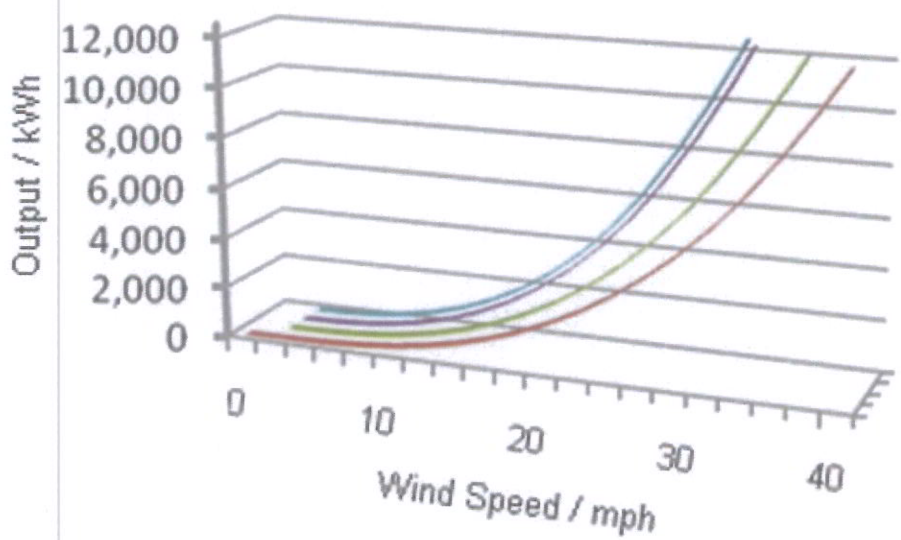
We did not factor recorded gust values when calculating the overall average value, as there is no available data to compare anemometer gust speed results with actual turbine output. The high level of gusts at this location will, however, greatly increase the approximate results cited here for review.

Maximum values are recorded below for reference only, and are not used in calculations.

Long Branch Comfort Station, NJ March 9th to May 4th 2010 Wind Study Results

Wind Speed Average (Unit 1) / mph	8.52
Max Wind Speed (Unit 1) / mph	56.05
Time Spent Above 4mph Threshold	79%
Wind Direction	varied

Graph Demonstrating Average Output at Varying Wind Speeds



As can be seen from the graph the turbine output increases exponentially with wind speed. Location is therefore extremely important, as small increases in wind speed make large increases in output. The final position will be best suited in terms of wind direction, and to optimize roof effect.

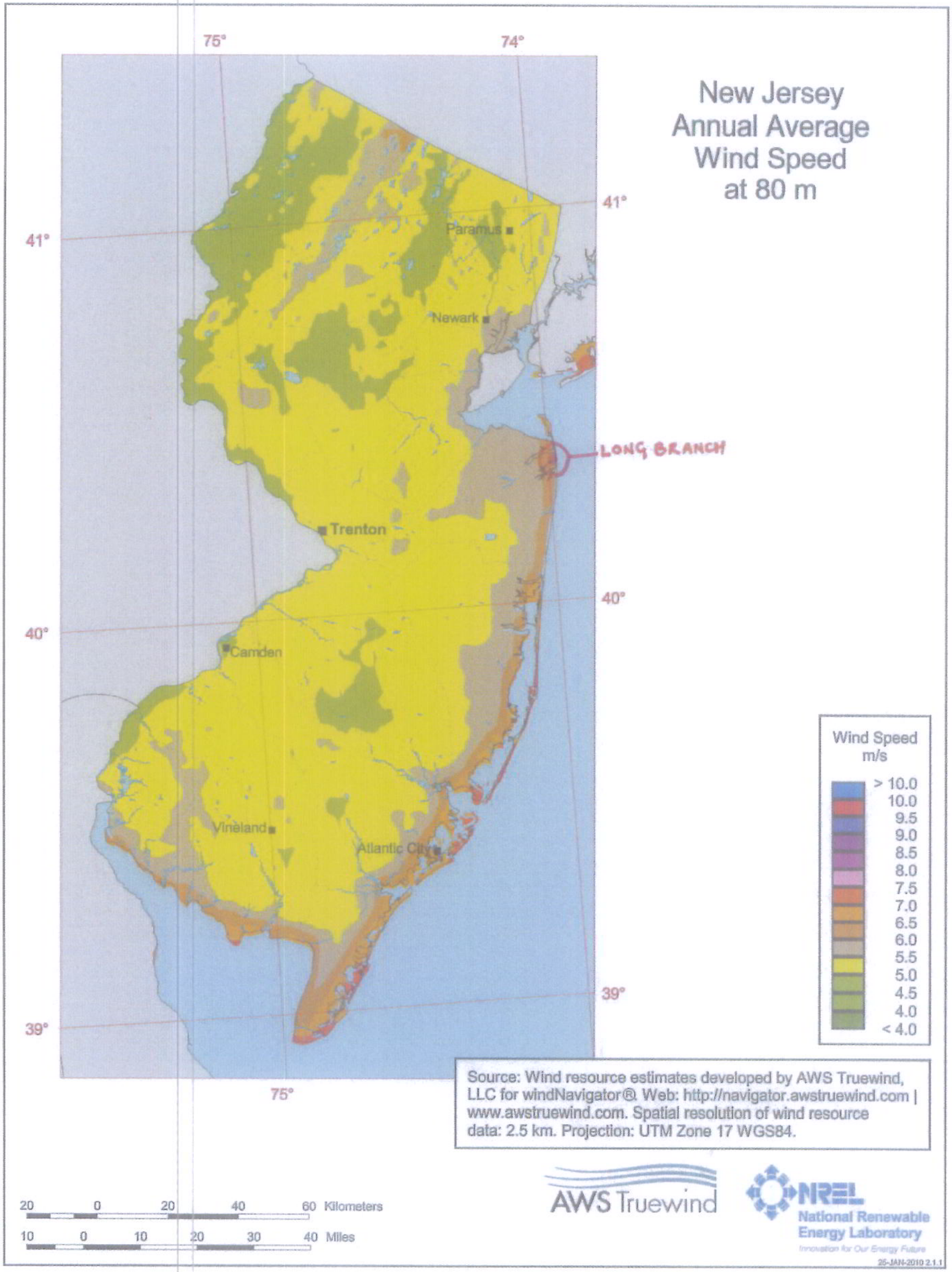
The results demonstrate that Long Branch has above average wind speeds, and also of great significance, consistently high winds. Even a small turbine at this location will generate energy 80% of the time. While there are obvious long term financial rewards to generating electricity independently, the environmental benefits speak for themselves.

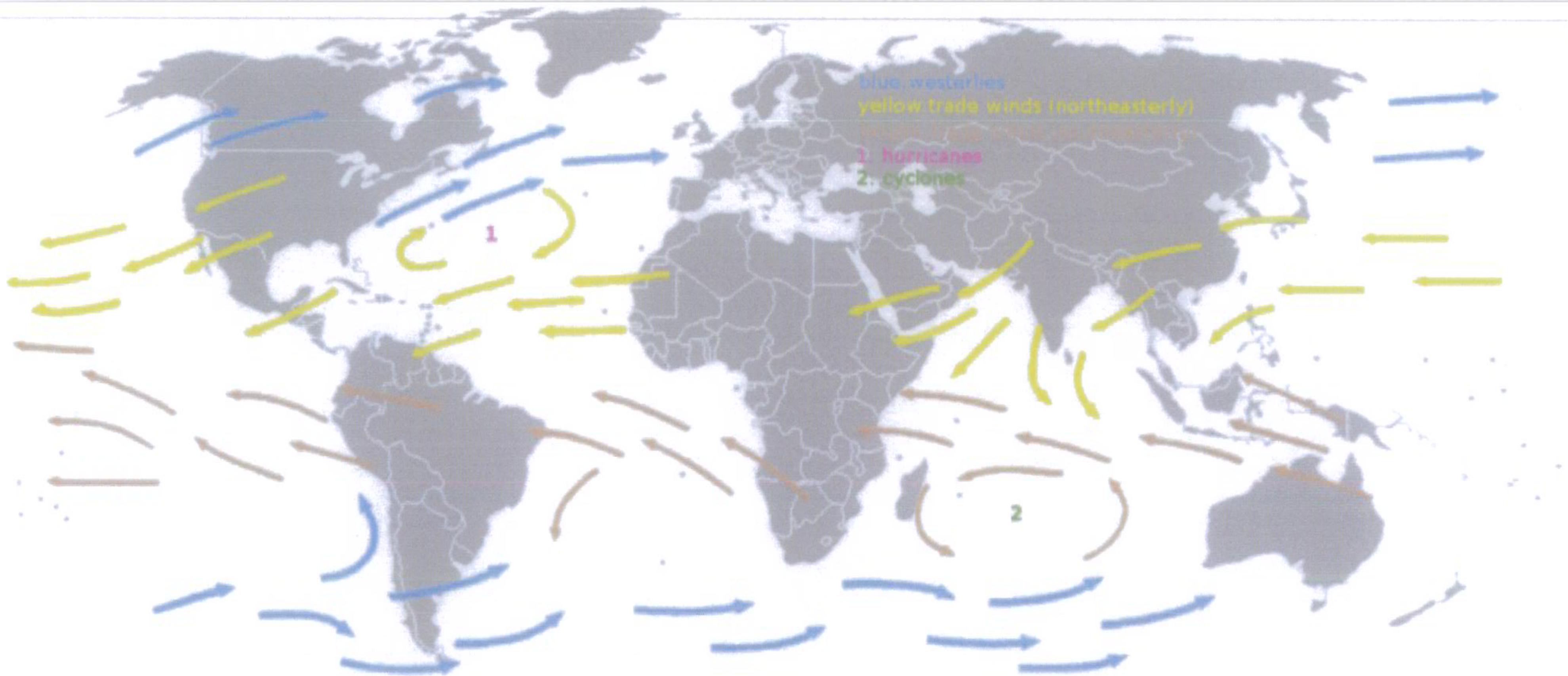
Date & Time	Wind Speed / mph
3/9/2010 0:04	3.8051219
3/9/2010 0:09	4.278283
3/9/2010 0:14	4.0006196
3/9/2010 0:19	2.3686388
3/9/2010 0:24	2.238307
3/9/2010 0:29	3.5954577
3/9/2010 0:34	2.54997

--- TRUNCATED ---

5/4/2010 18:24	5.5079352
5/4/2010 18:29	5.4031031
5/4/2010 18:34	6.0802618
5/4/2010 18:39	7.1625824
5/4/2010 18:44	6.4514241
5/4/2010 18:49	6.0519288
5/4/2010 18:54	6.1595942
5/4/2010 18:59	4.5871127
5/4/2010 19:04	3.9807865
5/4/2010 19:09	3.3546272
5/4/2010 19:14	4.4737807
5/4/2010 19:19	2.7086348
5/4/2010 19:24	3.8504547
5/4/2010 19:29	2.6718019
5/4/2010 19:34	2.6604687
5/4/2010 19:39	2.4111383
5/4/2010 19:44	2.1108085
5/4/2010 19:49	1.7169798
5/4/2010 19:54	3.9184539
5/4/2010 19:59	5.2727713
5/4/2010 20:04	3.9496202
5/4/2010 20:09	4.2187837
5/4/2010 20:14	4.6352788
5/4/2010 20:19	2.691635
5/4/2010 20:24	4.8279432
5/4/2010 20:29	3.9836198
5/4/2010 20:34	4.023286
5/4/2010 20:39	2.7256346
5/4/2010 20:44	1.558315
5/4/2010 20:49	0.6431591
5/4/2010 20:54	0.3428293
5/4/2010 20:59	0.5581601
5/4/2010 21:04	0.0594993
5/4/2010 21:09	0.0056666

Average Wind Speed	**8.52**
Maximum Recorded	**56.05**
Time Spent Above Threshol	**79%**


New Jersey
Annual Average
Wind Speed
at 80 m
75°
74°
41°
40°
39°
Paramus
Newark
LONG BRANCH
Trenton
Camden
Vineland
Atlantic City
Wind Speed
m/s
> 10.0
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
< 4.0
Source: Wind resource estimates developed by AWS Truewind, LLC for windNavigator®. Web: http://navigator.awstruewind.com | www.awstruewind.com. Spatial resolution of wind resource data: 2.5 km. Projection: UTM Zone 17 WGS84.
20 0 20 40 60 Kilometers
10 0 10 20 30 40 Miles
AWS Truewind
NREL
National Renewable Energy Laboratory
Innovation for Our Energy Future
25-JAN-2010 2.1.1


blue westerlies
yellow trade winds (northeasterly)
1. hurricanes
2. cyclones
1
2