

Low Wind Speed Case Study

Puerto Rico Wind Farm Projects

With high energy costs and a need for diversified electricity sources, Puerto Rico has started to invest in wind energy. Puerto Rico contains two large-scale wind farms (totaling over 120 megawatts) and small-scale single turbines along the coasts.

Santa Isabel Wind Farm

Finca de Viento Santa Isabel (Santa Isabel), Puerto Rico's first and currently largest wind farm, began operation in late 2012. **The wind farm is composed of 44 wind turbines (each 2.3 megawatts), with a total capacity of 101.2 megawatts.**

Punta de Lima Wind Farm

Punta de Lima Wind Farm began operation in April 2013. **The wind farm is composed of 13 Vestas 1.8 megawatt turbines, adding up to a total capacity of 23.4 megawatts.**

Both wind farms are successful and provide electricity for the island. The success of these wind farms is contrary to data that is publicly available via wind speed maps, which underestimate the onsite wind speeds. This case study compares estimated wind speeds from the National Renewable Energy Lab's (NREL) only publicly available wind speed map for Puerto Rico (a 50-meter wind speed map) with available information about the two wind farms.

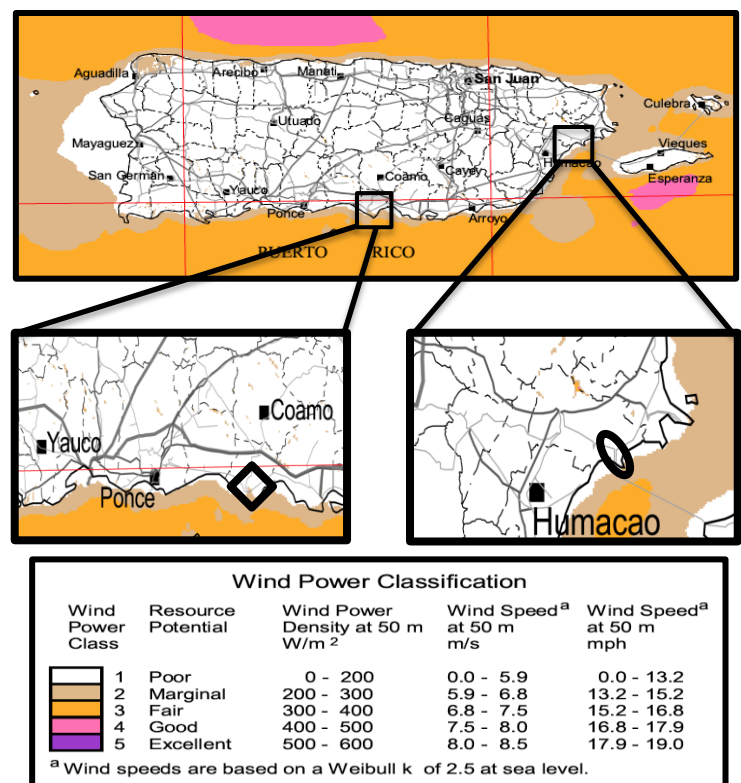
In 2007, NREL published maps showing average annual wind speeds for Puerto Rico. The images on the right (**Figure 1**) are adapted from NREL's 50-meter map for Puerto Rico. The Santa Isabel wind farm, along the Southern coast, is represented by the black diamond. The Punta de Lima wind farm is located along the eastern coast of Puerto Rico in Naguabo and is represented by the black oval.

Based on actual data from wind farm developers in Puerto Rico, average annual wind speeds for the two wind farms are approximately 6-6.5 meters per second (m/s); however, the NREL map would suggest these sites are undevelopable.



Credit: Pattern Energy (Finca de Viento Santa Isabel Wind Project, Puerto Rico)

Figure 1. Puerto Rico and the Virgin Islands 50-Meter Wind Resource Map



Source: National Renewable Energy Lab 2007

How important is the height of wind speed measurements?

A significant cause of the NREL map inaccuracy is the height at which the wind speeds were estimated. The NREL map focuses on wind speeds at 50-meter heights. Both wind projects have turbines with a hub height of 80 meters, making the NREL map an inaccurate portrayal of wind energy capability in Puerto Rico.

Low Wind Speed Case Study

Puerto Rico Wind Energy Projects

This NREL map portrayal of the sites in **Figure 1** would likely make the site unfeasible for wind energy development. Yet, sources from the two wind farms indicate that Puerto Rico has a better wind resource than the wind speed map predicted.

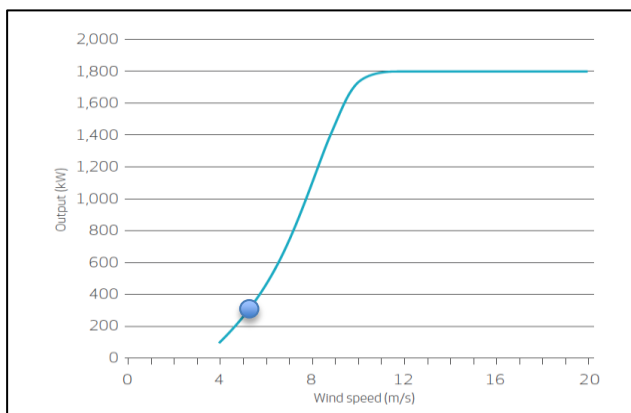
Santa Isabel Wind Farm

Pattern Energy, the developer of Santa Isabel, performed studies before the wind farm was constructed to try to identify Puerto Rico's wind resource potential. **The Santa Isabel site has been reported to have an average wind speed of 6.5 m/s.** This is substantially better than the 0.0-5.9 m/s estimated by the NREL 50-meter wind speed map.

Punta de Lima Wind Farm

According to the developer, Gestamp Wind, "this wind farm will generate 52 GWh per year..." Each turbine is rated for a maximum output of 1.8 megawatts per hour, indicating the wind farm achieves a 25% capacity factor. Therefore, each wind turbine's average hourly output is approximately 450 kilowatts (25% of 1.8 megawatts). Wind turbine manufacturers provide estimates of energy output based on various wind speeds in a graph known as a power curve. Based on the Vestas V100-1.8 power curve, the **Punta de Lima Wind Farm site may achieve 6 m/s average wind speeds (see Figure 2).**

Figure 2. Vestas V100-1.8 Power Curve



Source: Vestas V100-1.8 Brochure

U.S. Virgin Islands Wind Resource: A Comparison

There is currently little public information available regarding Puerto Rico's wind resource. Yet, NREL recently published a report that extensively evaluated wind energy potential in the U.S. Virgin Islands—a potentially comparable location to Puerto Rico. The report recognized St. Thomas, St. Johns, and the Bovoni peninsula as **"prime candidate[s] for utility-scale wind generation."** Some areas in the U.S. Virgin Islands may contain average wind speeds in the 7-7.5 m/s range – significantly higher than estimated by the 50-meter NREL maps in Puerto Rico.

Conclusions

The NREL resource assessment maps are often used to initially assess a site for wind farm development. However, these maps alone are not adequate for determining wind farm success and underestimate wind speeds throughout Puerto Rico. The Puerto Rico wind farms achieve a greater energy output than can be estimated by the NREL resource assessment map. Other areas that could be characterized as "low wind speed," according to the resource assessment maps, may have similar pockets of good wind speed that may be ideal for consideration of wind power development, especially as newer wind turbine technology achieves greater efficiency.

Sources

Del Franco, Marl (February 2014) "Pattern Primes Puerto Rico for Utility-Scale Wind," *North American Windpower*.

Gestamp Wind Farms (2014) "Punta Lima," Gestamp Wind.

National Renewable Energy Laboratory (2007). Puerto Rico. Annual Average Wind Speed at 50 meters.

National Renewable Energy Laboratory (2012). "Wind Power Opportunities in St. Thomas, USVI: A Site-Specific Evaluation and Analysis."

Pattern Energy Projects (2014) "Santa Isabel," Pattern Energy.

Vestas V100-1.8 Brochure.