To: Tulane University Climate Committee

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Date: March 3, 2010

Re: Wind Energy as an option to meet Tulane's Carbon Neutrality Goals

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Purpose

This report recommends that *should Tulane University choose* to invest in wind energy, the Honeywell rooftop wind turbines will help meet its goal of carbon neutrality. However, in order to achieve this goal, Tulane would take a Net Present Value loss of $9,031.16 for each turbine because each turbine cost the University approximately $9,000 up front with annual maintenance costs of $250. The resulting carbon reduction for each Honeywell turbine will be 0.995 Metric Tons of CO_2 per year.

Wind Energy

Wind is caused by the uneven heating of the Earth's surface as it rotates in front of the sun. As long as there is sun and the Earth is rotating, there will be wind. In other words, wind is a renewable resource. This kinetic energy from the wind can be harnessed by wind turbines, which convert the energy to mechanical or electric energy.

A wind turbine system normally includes: a rotor (blades), an enclosure containing the drive train, a tower to support the rotor and drive train, and some electrical equipment including cables and controls. As a general rule of thumb, the longer the blades of the turbine, the more electricity the system is capable of producing. These blades are usually made of fiberglass-reinforced polyester.[i]

Wind energy is an appealing way to produce electricity that is virtually emissions free. Wind energy has no air or water emissions and does not deplete natural resources during operation. In fact, the only emissions will take place during the design and manufacturing process, but these emissions can be recovered within a few months of wind generation. If wind energy could provide 20% of the United States' electricity needs, it could displace one-third of the emissions from coal-fired power plants. While 20% seems daunting, this goal is a reasonable and achievable given the current technology .[ii]

Types of Wind Energy Turbines

Two types of wind energy turbines were considered: horizontal-axis turbines and vertical-axis turbines. Below, we discuss the advantages and disadvantages of each technology. We focused our analysis on one cutting-edge type of each of these turbines, Honeywell (horizontal axis) and WePOWER (vertical axis).

Horizontal-axis turbines are the most traditional approach to harnessing wind's energy. A classic horizontal-axis turbine looks like an airplane propeller mounted on top of a large pole. Vertical-axis turbines look more like an egg-beater placed on top of a large pole (see Exhibit 1).

Honeywell turbines are a new design of horizontal-axis turbines. At just six feet in diameter and 170 pounds, they are significantly smaller than classic horizontal-axis wind turbines. Honeywell turbines are designed to start generating electricity at 2 mph while high resistance traditional horizontal-axis turbines begin at 7 mph.[iii] The average wind speed at 80 meters near Tulane's Uptown Campus in New Orleans of 5.14 m/s (approximately 11.5 mph), which deems the lower speed starting ability is a crucial feature.

The Honeywell turbine is equipped with an anemometer that detects wind speed and direction. The unit will turn in the direction of the wind in order spin most efficiently.[iv] Also, at approximately 42 mph winds, the Honeywell turbine turns perpendicular to the blowing winds and essentially shuts down to minimize the impact from extremely high speeds. This feature will help protect the turbine from damage from high speed winds during hurricane season. For perspective, a tropical storm becomes a hurricane at 74 mph.[v]

A Honeywell turbine needs only to be 5 feet above a roofline. For this reason and due to their power producing abilities, the *Honeywell* units are best equipped for residential use. The units are only sold in one size: 2.8kW. An average size residential roof can hold three Honeywell turbines. [vi]

The Honeywell turbine system is one of the less expensive wind energy option available. The manufacturer suggests a retail price for the unit of $5,995. In addition to the purchase price, Tulane must factor in an additional estimated $3,000 installation cost for each unit. However, the unit is virtually maintenance free and will only be subject to an annual $250 inspection fee. The units are covered by a 5-warranty and are designed to last 20 years. [vii]

Vertical-axis wind turbines are shaped like an egg beater, and the vertical cage spins to create electricity. This design allows the turbines to capture wind from any direction at all times. This design separates the vertical design from horizontal which has to turn to face the wind as it changes direction.

Vertical-axis turbines require greater capital investment, but are capable of creating significantly more electricity than the Honeywell turbines. For this analysis, we examined WePOWER's Falcon series of vertical-axis wind turbines. The Falcon series ranges from energy production levels of 600W to 12kW. All of these models begin spinning at 6 mph and function up to maximum wind speeds of 111 mph. In extremely high winds, the systems have electronic overspeed protection. [viii]

The biggest drawback to the WePOWER systems is their initial capital investment. The 5.5kW turbine sells for approximately $30,000. In addition, the turbine must sit on top of a pole, which must be designed by an engineer. The installation process will run an additional $9,000 to $10,000. The smallest pole for a vertical axis turbine is 18 feet. Like the Honeywell model, after the initial investment the costs of maintenance are virtually zero excluding the yearly inspection fee of $250. The WePOWER turbines are engineered to last 20 years and have a 5-year warranty.

Wind Resources in New Orleans

Wind resource evaluation is a critical element in projecting turbine performance at a given site. The energy available in a wind stream is proportional to the cube of its speed, which means that doubling the wind speed increases the available energy by a factor of eight. In general, annual average wind speeds of 5 meters per second (11 miles per hour) are required for grid-connected applications. Annual average wind speeds of 3 to 4 m/s (7-9 mph) may be adequate for non-connected electrical and mechanical applications such as battery charging and water pumping[ix]. Wind in New Orleans has a yearly average of 5.14 m/s which corresponds to a wind power class between 2 and 3[x]. The Honeywell turbine literature offers a detailed calculation of power produced[xi].

Other Considerations

Wind energy will allow Tulane to take advantage of tax incentives offered at both the state and federal level. Louisiana offers a tax credit of 50% of the investment in wind power for households and corporations. Additionally, the US Government offers an additional 30% tax credit. For the purpose of comparison, we included the analysis with and without the tax credits.

Community Impact

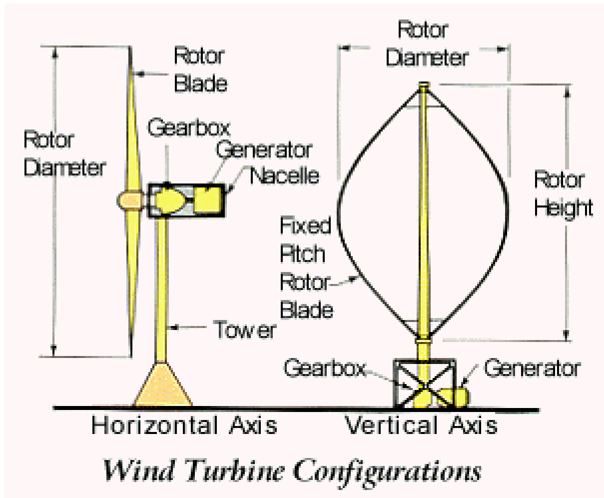
Wind turbines on Tulane's property will have the benefit of reducing carbon emissions, but Tulane should consider other potential impacts on the community. First, wind turbines may have an adverse effect on avian life. While occasionally a bird may collide with a turbine, less than one percent of human-caused bird fatalities are caused by wind turbines. A second concern is noise. Due to improved engineering, however, this concern has largely been eliminated by increasing the thickness of the blades trailing edges and making the machines "upwind" (wind hits blades before the tower). [xii] The final concern is the visual aesthetic of the turbines. Neighbors to the project could be annoyed by a turbine that spoils the view they previously enjoyed. This concern can be mitigated by careful turbine model selection coupled with an agreeable location. Tulane should consider all potential real estate locations, particularly those atop tall buildings. The turbines will be harder to see, and will likely receive higher wind speeds.

Recommendation

As shown in our findings, each Honeywell Turbine will cost a total of $9000 up front ($6,000 capital, $3,000 installation) and reduce 0.995 Metric Tons of CO_2 per year with a minimal annual maintenance costs of $250 for inspections. Using the current federal discount rate of 0.75%, the net present value of installing a turbine is -$9,031.16. Given this cost, we recommend that Tulane explore other sources of renewable energy in order to meet their climate goals.

Exhibit 1

Horizontal vs. Vertical Axis Turbines



"Wind Energy Basics." *American Wind Energy Association.* 2 March 2010. http://www.awea.org/faq/wwt_basics.html

[i] "Wind Energy Basics." *American Wind Energy Association.* 2 March 2010. http://www.awea.org/faq/wwt_basics.html

[ii] "Wind Energy and The Environment." *American Wind Energy Association.* 2 March 2010. http://www.awea.org/faq/wwt_environment.html

[iii] "Introducing the Honeywell Wind Turbine from EarthTronics." *EarthTronics*. 2 March 2010. http://www.earthtronics.com/honeywell.aspx

[iv] Redding, Matthew. Phone Interview. 11 February 2010.

[v] "Saffir System Hurricane Scale". *NOAA*. 2 March 2010. http://www.nhc.noaa.gov/HAW2/english/basics/saffir_simpson.shtml

[vi] Redding, Matthew. Phone Interview. 11 February 2010.

[vii] Ibid.

[viii] "Falcon Series: Vertical Axis Wind Turbines." WePOWER. 2 March 2010. http://wepower.us/products

[ix] "Basic Principles of Wind Resource Evaluation." American Wind Energy Association. 2 March 2010. http://www.awea.org/faq/basicwr.html

[x] Redding, Matthew. Phone Interview. 11 February 2010.

[xi] http://www.earthtronics.com/pdf/Energy-Generation-Information-5.pdf

[xii] Ibid.