Sustainability is a Breeze with Wind Energy!

April 23, 2017, Emma Beck, Emma Martin, Anna Belle Harada, Rosie Xu
Mount Holyoke College, Phys/Envst 104

Our current myopic reliance on fossil fuels has poisoned the planet with Carbon Dioxide. Humanity has reached a point where making dramatic changes is a literal matter of life or death. The Earth cannot sustain our lifestyles without the use of renewable energy. Although solar energy is commonly viewed as the most viable renewable energy option for homeowners and commercial buildings, wind is a plentiful resource that has been widely overlooked and that can supplement solar energy.

Whereas fossil fuels are not only a depreciating investment that requires continued labor resources while polluting the air and damaging the landscape, wind turbines function without maintenance and can be installed wherever there is ample space and Class 3 winds, or wind that has an average annual speed of 14.3 to 15.7 mph at 50m[1]. A 2015 study by the U.S. Department of Energy found that wind could provide 20% of U.S. electricity by 2030 and 35% by 2050 if implemented properly[2]. AH Wind energy will be a significant force in the responsible energy system of the future.

Where does wind fit into Mount Holyoke college's plan for a sustainable future? Wind provides energy during the winter when MHC solar panels cannot access enough strong light. This saves on battery costs because solar energy does not need to be stored for the winter while wind energy is generated spontaneously. Wind turbines can also be placed on flat, vacant rooftops that are not compatible with solar panels.

Wind Energy for Mount Holyoke College

The annual MHC power usage is ~ 45 million kWh/year, with 15 million kWh/year going toward electricity and 30 million kWh/year for heating. Total yearly energy cost is between $2-3 million. Can MHC produce 30 million kWh/year on campus, completely "off-grid" using only solar and wind energy? The answer is **YES** and here's how. EM

- ➔ The Pika Energy 'home' wind turbine is 3.0 meters in diameter and requires a swept area of 7.1 square meters.[3] Pika turbines must be installed 9 meters above trees and other structures within a 90 meter radius EM
- ➔ Monthly output of the home wind turbine is 202 kWh at 5 meters/second EM
- ➔ Is a horizontal axis turbine with an upwind rotor, free yaw with blades of glass reinforced polymer and a top weight of 42 kg EM
- ➔ Tested to operate for 20 years without maintenance, with a 5 year warranty EM
- ➔ Third party testing of the turbine calculated noise of turbine at 38.3 dB, which is quieter than most refrigerators. Pika Turbines also do not pose a significant threat to birds due to the small diameter of their blades EM (image[4]) EB

Where can we put Pika Turbines on MHC campus?

There is one flat, clear space of land owned by MHC behind the equestrian center that is completely unused and that would be an ideal locations for MHC wind turbines[5]. It measures approximately 300 by 300 meters. EM

- ➔ Each turbine requires 7.1 square meters and cannot be within a 90 meter radius of trees and other structures We can fit **~2,057 Pika home wind turbines** across the location. EM
- ➔ We can also fit **~400 Pika turbines** on the flat roofs of several MHC buildings that are not compatible with solar panels. EM
  - Estimates include: **30 turbines** on Kendade, Mary Lyon, Rockefeller, and Skinner Hall, **40 turbines** on the Art Building, Prospect, Torry, Ham/MacGregor Hall, and **50 turbines** on Buckland Hall. EB
- ➔ We need **~5,000 wind turbines** to supply a third of the $30 million MHC energy demand
- ➔ This many turbines would cost ~$25 million EM

---

[1] Center for Sustainable Systems, University of Michigan. 2016. "Wind Energy Factsheet." Pub. No. CSS07-09.

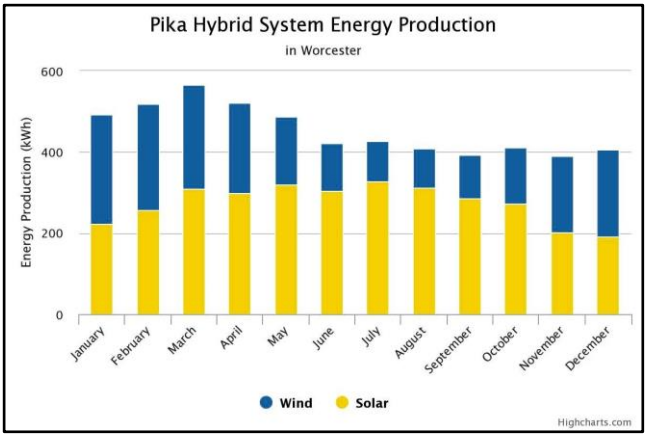
[2] Center for Sustainable Systems, University of Michigan. 2016. "Wind Energy Factsheet." Pub. No. CSS07-09.

[3] Pika energy, 2017. "System Features", "Technical Specifications."

[4] https://www.solar-electric.com/pika-energy-guyed-tower-100-feet.html

[5] DigitalGlobe, MassGIS, Commonwealth of Massachusetts EQEA, Geological Survey, USDA Farm Service Agency, Map data. 2017. "Google Maps/Google Earth."

- ➔ However, wind turbines could save $50 million of the $150 million required to produce 3 million kWh per month **from batteries** EM



The graphic shows the monthly potential for Worchester MA, about 1.5 hours from MHC, made using Pika's tools to assess a region's wind capability[6] EM. It indicates that the use of solar energy could supplement the inconsistently of wind turbines, as solar panels reach peak energy output during the months that average wind speeds are lower, or during the months of April through December. A combination of solar panels and wind turbines allows for MHC to generate consistent grid-free energy all year long. EM

Turbines in Action

There are two types of general small-scale turbines. Horizontal and Vertical, both with 50% efficiency

- ➔ Horizontal Axis Wind Turbine (HAWT) must be on a tall tower, measuring at least 100 ft and produce 1.7 kW. It has small blades with low noise. EB
- ➔ The Vertical Axis Wind Turbine (VAWT) has a better aesthetic and low noise. It can also be mounted on a building which is convenient, but has a lower power at 100 W. EB

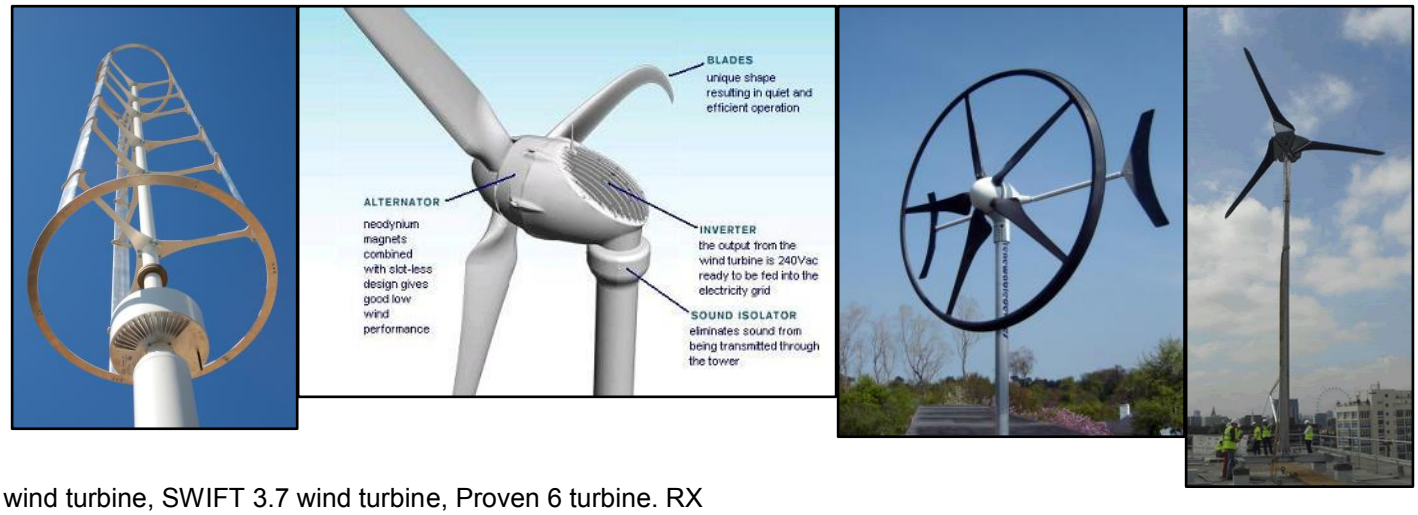
The reasons we choose small scale turbines instead of large scale turbines

- ➔ They are quieter and less disruptive to the aesthetics of Mount Holyoke campus. RX

There are 5 common variations of small scale wind turbines to choose from, all of which have different shapes, benefits and drawbacks. The following turbines are all on top of the Museum of Science (MOS) in Boston, and the information is what the companies have provided[7] EB

- ➔ Windspire Energy creates *Windspire* turbines are 10 meters tall, and produce 1.2 kW of energy at 11 meters per second. AH
- ➔ Southwest Windpower creates *Skystream 3.7* wind turbines which are 3.7 meters in diameter and produce 2.4 kW of energy at 13 meters per second. AH
- ➔ Proven Energy produces the *Proven 6* turbine, measuring 5.5 meters in diameter. It produces 6kW of energy at 12 meters per second. It produces the most of MOS energy, but does not work as well in high winds AH
- ➔ Cascade Engineering sells *Swift*, which is 2.1 meters in diameter and produces 1kW at 11 meters per second. AH

Since small-scale wind turbines are still relatively new to the market, there is no universal standard to compare



turbine functionality. AH (from left) Windspire turbine, Skystream 3.7 wind turbine, SWIFT 3.7 wind turbine, Proven 6 turbine. RX

[6] Highcharts.com. Pika Energy. April 17, 2017

[7] (http://legacy.mos.org/energized/museum-wind.php