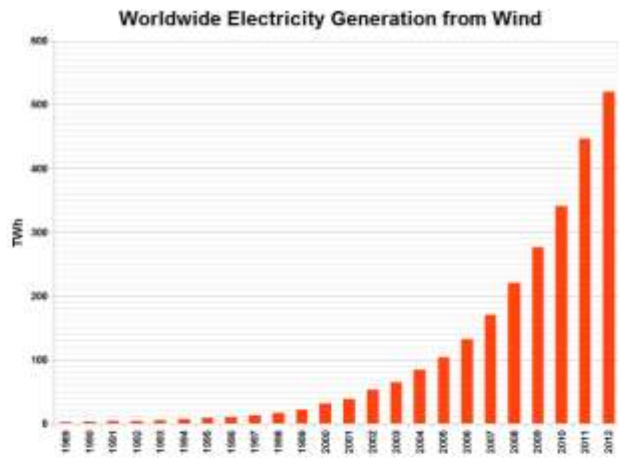
Name: ______________________________ Class: _________________________ Date: ____________

The Answer, My Friend, is

Blowing in the Wind

If you need help, please visit www.tinyurl.com/BITWhelp to see a helpful instructional video.

About 85% of the world's electricity is produced by dirty, polluting sources. It's impossible, they say, to power the world without burning fossil fuels. In order to grow the economy, you need energy. And in order to provide energy, you need coal, oil, and natural gas. But I submit that it is possible, that we could power the world with the sun and the wind and the oceans and perhaps even the stars. Scientists are on the brink of being able to produce solar panels made from common metals, like iron. The use of wind power has grown exponentially in the past 20 years. Tidal power and wave power provide two new, potentially-untapped sources of energy. And Lockheed Martin is said to be on a path toward harnessing fusion, like that of the sun, and using it to make pollution-free electricity. Imagine fitting an entire industrial-sized fusion power plant on the back of a tractor-trailer. That day might be here sooner than you think. But not without some hard work first.



Wind energy is one example of kinetic energy (matter in motion). And as such, it can be measured using the kinetic energy formula below:

$$E = \frac{1}{2}mv^2$$

However, the mass of air as it blows past a windmill is not easily measured. Imagine one second's worth of air, blowing at 7 m/s, as it passes through a 1 meter by 1 meter tunnel. That column of air would have a mass of "area × wind velocity × density." And typical air has a density of about 1.225 kg/m^3. So in the that case, the mass of the air would equal $1 \times 7 \times 1.225$, or about 8.6 kilograms. Thus we can substitute Avd into the equation for *m*, and rewrite the kinetic energy formula for windmills:

$$E = \frac{1}{2}Adv^3$$

1. The average wind speed in Marshfield is about 3 m/s at ground level. A top of the line General Electric Turbine has a diameter of 103 meters. How much energy would pass through the turbine each second? **Your answer will be in watts (W).*

2. How many 12W light bulbs could the turbine power at once?

3. But that's assuming the windmill was able to extract 100% of the wind's energy. Unfortunately, that's not the case. Wind turbines are only able to extract about 45% of the wind's energy. So how many 12W light bulbs could the turbine *really* power?

4. According to the EIA, a typical resident of Massachusetts is using an average 858 watts of electricity at any moment. Given that there are 25,000 people who live in Marshfield, what is the town's typical demand for electricity?

5. How many General Electric Turbines would the town need to meet this demand?

6. But, if the wind turbines were more intelligently placed (in specific, windy spots around Marshfield, using windmill tower heights of 70 m), how many turbines would the town need?