# Electric Wind Shock

New Mexico
Supercomputing Challenge
Final Report
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## Executive Summary

This project is about finding a wind turbine that will provide energy to Santa Fe County when there's a power outage. We've found that we need 212 Wind turbines to power all of the homes in Santa Fe County. We have found two different types of wind turbines that will work for the climate and terrain. This will produce energy in a green way, which will also prevent pollution and other problems. We plan on solving this problem by demonstrating it in an application that will show the energy produced from each turbine.

## Introduction

Now that we know how many windmills we will need to power Santa Fe County, we need to figure out if there is a certain type of windmill better for Santa Fe county.

Electricity is our lives, we use it for everything: keeping food fresh, getting to school, security purposes, and so much more! Wind is a clean alternative energy source that can stop the blackouts in Santa Fe County. We want to learn what kind of windmill is better for Santa Fe County. Most importantly, we want to find a wind turbine that will fulfill our needs in a power outage.

Our plan of action is to visit a wind farm. We will be researching the many different kinds of wind turbines, and using that information to see which is best for Santa Fe County. We will find out what type of windmill is the most efficient in Santa Fe County.

## Problem

Can we successfully create a program that will show the exact amount of energy produced by both wind turbines? Finding which wind turbine will be the most cost efficient in the long run.

Our program will demonstrate which turbine will produce more electricity can be generated by 212 wind turbine. We used XCode to simulate our project.

## Background

What Is the Wind?

Wind is a mixture of cold and hot air. Air is in constant motion. It is affected by changes in pressure and temperature. When one area heats up more than another area that it is next to, the difference in pressure creates wind. Wind is a rotation cycle of cool air and warm air. Edgewood is very windy. It gets very little precipitation.

How Can wind be measured?

Wind is measured by its speed and direction. An anemometer is the tool used to measure wind speed. An anemometer works by using rotating cups to measure wind speed. When the wind catches the cups it causes them to spin and the amount of times the cups rotate completely around is the wind speed measured in rpms (revolutions per minute). The wind direction is measured with weather vanes. It is important to know the direction of the wind because then the wind turbine has an area to turn towards. After a year of measuring the wind it can be correlated to a reference point to calculate the mean of the wind. This information is needed to find the best area to create a wind turbine farm that will be the most efficient. Wind turbines should be placed according to where the wind is blowing the most for the majority of the year.

The exact way to know wind speed is to use a meter. Here's a quick guide:

Regular Box Fan on HI (3) Setting:

| Distance | Wind Speed (m/s) |
|---|---|
| 1 Foot | 4—5 |
| 2 Feet | 2.5—3.5 |
| 3 Feet | 1.5—2 |

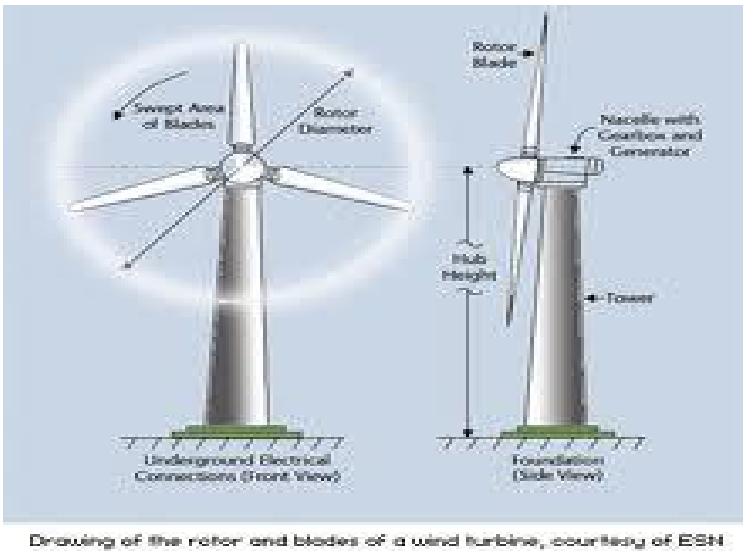
Regular Box Fan on MED (2) Setting:

| Distance | Wind Speed (m/s) |
|---|---|
| 1 Foot | 3—3.5 |
| 2 Feet | 2—2.5 |
| 3 Feet | 1—2 |

Figure 1 Wind Speed Determination

## Wind Turbine

A wind turbine transforms the kinetic energy of the wind into electrical energy. Wind turbines are made up of a foundation (where the wind turbine sits on the ground), a tower (the part where the rotor sits on), and a rotor (how the wind turbine moves to locate the wind), see figure 1. The foundation prevents the turbine from falling over. The tower holds up the rotor. The rotor includes the blades and the hub, which holds them in position as they turn. Most wind turbines have three blades. The length of the blades can be more than 44 metres.



Drawing of the rotor and blades of a wind turbine, courtesy of ESN

Figure 2 Diagram of a Wind Turbine http://blog.cafefoundation.org/?attachment_id=2742

Wind turbines don't create greenhouse emission during its operation. It takes

just three to six months to make up for the energy needed to make that wind turbine. During a windmills lifetime it makes up eighty to one hundred times the amount of energy used during its production. Wind energy has the lowest life cycle emissions of all energy making technology. Wind energy doesn't let out any toxic substances such as Mercury and air pollutants like smog-creating nitrogen oxides, acid rain-forming sulphur dioxide and particulate deposits. These pollutants can trigger cancer, heart disease, asthma and other respiratory diseases, and can acidify terrestrial and aquatic ecosystems, and can also corrode buildings. Wind energy doesn't create any radioactive waste or water pollution.

How is Electricity Transported?

When a gadget is turned on, power is right away transmitted from a power plant to the appliance. Even though this seems to happen immediately there is a certain sequence of events that takes place to make sure the needed electricity is delivered. Electricity travels long distances to reach the place where it is needed. The sites where electricity is generated are often in less populated areas where there is a lot of cheap fuel resources. During the transportation process, part of the electricity is lost. To reduce the amount of electricity lost a transformer will convert the electricity from low to high voltage. This is the more efficient way to transport large amounts of electricity. Transmission lines then transport large supplies of power from generating sites to locations closer to peoples homes. At these locations, other station transformers convert the high voltage electricity to lower voltage for distribution. Distribution lines carry low voltage electricity to communities who then access it through the power outlets in homes and offices(see figure 2). The distribution network

has more power lines than the transmission network.  This is because transmission lines can carry a large amount of power that will then require many distribution lines to take to the people.

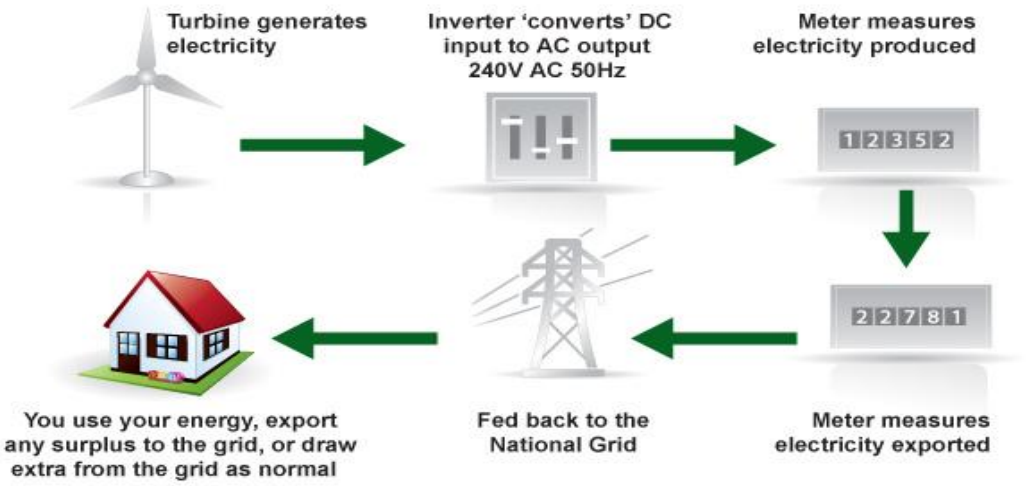



Figure 3 Wind Generating Diagram http://www.rotaryrenewables.co.uk/wind-turbines-for-home

## Vertical Wind Turbine

_____This turbine is cheap but when it breaks down it is very costly. It breaks down quite often. They have a main motor that is placed vertically. The reason for this design so it doesn't have to face the wind. They produce large parts cyclic stress on the turbine's motor. This type could be mounted to your roof top. Instead of their rotor being at the top they are at the bottom close to the ground. These turbines are not very popular due to them breaking down a lot.

## Horizontal Wind Turbine

_____Horizontal wind turbines are very expensive but they hardly breakdown. This kind of turbine is the kind you see a lot they are very popular. When you think of a turbine this is the kind most people think of. They have the main rotor and the and the

generator at the top and they have to face the wind. This type spins like a clock. In order to fix it if it gets damaged but it hardly does get damaged, they send someone up to fix it. It is cheaper to send someone up to fix it than to take that piece off and bring it down and fix it on the floor. This turbine is able to be in stronger winds. The blades move perpendicular to the wind.

## Methods and Materials

For our programming we used XCode which is programmed in Objective C. We wanted to simulate how much electricity two different types of windmills can produce. We did this by finding a formula on converting wind energy by the size of the blade, the wind speed, and the air density (These are the important factors when converting wind energy into the amount of energy produced).

This is just a sample of what the code looks like:

```
{
    [super viewDidLoad];
    // Do any additional setup after loading the view, typically from a nib.

    NSTimer *timer = [NSTimer timerWithTimeInterval:.01 target:self selector:
        @selector(Timr) userInfo:Nil repeats:YES];
    Wind1.text = [NSString stringWithFormat:@"%d",WindSpeed1];  Undeclared selector 'Timr' 2
        WindEnergy1 = 5000;

    WindProduced1.text = [NSString stringWithFormat:@"%d", WindSpeed1 * 56];
}

- (void)didReceiveMemoryWarning
{
    [super didReceiveMemoryWarning];
    // Dispose of any resources that can be recreated.
}

-(void)timr{
    Wind1.text = [NSString stringWithFormat: @"%d",WindEnergy1];
    Wind2.text = [NSString stringWithFormat: @"%d",WindSpeed2];
    Wind3.text = [NSString stringWithFormat: @"%d",WindSpeed3];
    Wind4.text = [NSString stringWithFormat: @"%d",WindSpeed4];

    //Blade Length = 52m
    //Wind Speed = 12m/sec
    //Air density = 1.23 kg/m^3
    //Power Coefficient Cp = 0.4



}

-(IBAction)Count1:(UISlider *)sender{
     WindSpeed1 = WindSlider1.value;
    Wind1.text = [NSString stringWithFormat: @"%d",WindSpeed1];
    WindProduced1.text = [NSString stringWithFormat:@"%d", WindSpeed1 * 56];
}

-(IBAction)Count2:(UISlider *)sender{
     WindSpeed2 = WindSlider2.value;
    Wind2.text = [NSString stringWithFormat: @"%d", (int)sender.value];
}
-(IBAction)Count3:(UISlider *)sender{
     WindSpeed3 = WindSlider3.value;
    Wind3.text = [NSString stringWithFormat: @"%d",(int)sender.value];
}
-(IBAction)Count4:(UISlider *)sender {
    WindSpeed4 = WindSlider4.value;
    Wind4.text = [NSString stringWithFormat: @"%d",(int)sender.value];

}
```

The equation we used is:

$$P_{avail} = \frac{1}{2}\rho A v^3 C_p$$

Where:

$$\begin{aligned} \text{Blade length, } l &= 52 \text{ m} \\ \text{Wind speed, } v &= 12 \text{ m/sec} \\ \text{Air density, } \rho &= 1.23 \text{ kg/m}^3 \\ \text{Power Coefficient, } C_p &= 0.4 \end{aligned}$$

In our program we made individual integers for each of the variables stated above. We can then manipulate those integers to give us the results according to the different type of windmill. We provided sliders inside of the program so the person using the program can manipulate the speed of the wind. We did the background work that changes the wind speed into the amount of energy produced. We can then collect the information and see which windmill is more efficient.

## Results

We will need the horizontal wind turbines to generate electricity for our town and we successfully created a computer model to simulate the two different wind turbine types to be our energy source. However after doing research we found that vertical wind turbines breaks down a lot and have more problems than the horizontal turbine. We also found that the vertical wind turbines are not as reliable because they can't stand high wind velocity as the horizontal wind turbines (high wind is likely to happen where we live). The horizontal wind turbine cost, based on the amount of wind turbines and the power stations, would total to about $323,000,000. We don't know the exact cost the vertical wind turbines would be, but they are usually cheaper to build than the

horizontal wind turbines, although they are more expensive to maintain. Although the vertical wind turbines are a bit cheaper, we think it would be a better investment to buy the horizontal wind turbines, because they are more durable, and they can withstand our climate better.

## Discussion

We have studied windmills because we have many power outages and we want that to change. Horizontal wind turbines turn to the direction of the wind. We have traveled to a wind turbine farm in New Mexico to study windmills and have gone on field trips to learn about different types of turbines. One other energy source we have researched is solar energy. It is environmentally friendly. Individual people currently use solar energy to provide electricity for their home. With wind turbines you have to convert the energy before it goes to your home.

## Conclusion

Our solution for finding the best turbine for Santa Fe county is to use the horizontal turbine. It is more efficient and does not break down often. We have learned that wind turbines are a big energy alternative for the world. The horizontal turbine will better suit our needs and not have issues we have to worry about. Wind turbines capture the winds power and immediately it is converted to electricity. Wind energy is very useful because its eco-friendly. We have also learned that windmills are very expensive to install and repair at the commercial level, which is what would be needed to power an entire county.

## Future Plans

In the future we plan on finding the technology to store energy. Denmark is currently trying to create this kind of technology. When Denmark creates this technology we are going to evolve in our project. Denmark is creating the biggest wind turbine ever created. This wind turbine is going to be three times the size of the windmill that we saw. We are looking into adding solar panels to our project. They take up more space but they are more cost efficient.

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