

# STEMSEL Intermediate Project 8: Wind Power

## Problem

We want to create an electricity generator that does not produce any greenhouse gasses.

## Background

We all use electricity every day for all sorts of different purposes, but did you ever stop to think what electricity is made of, and where it comes from? You can find out in the following video:

<http://www.youtube.com/watch?v=uoQelu7XRjk>

The word electricity actually derives from the word *electron*. If you have already learned about atoms, you may have heard of electrons before. Atoms are the very small particles that make up the world around us, and they are made up of three even smaller particles. The positive *protons* and the neutral *neutrons* are clumped in the middle of the atom and make up the nucleus. The negative electrons orbit around the nucleus.

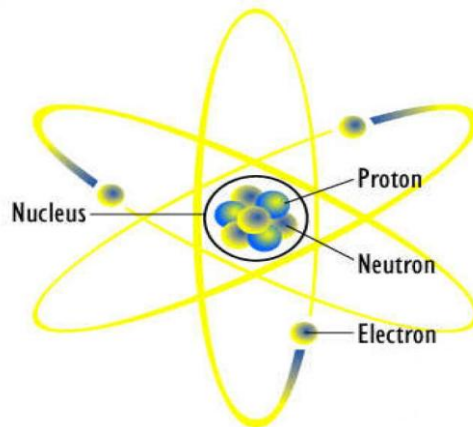


Figure 1: an atom

In certain types of materials, the electrons are only loosely attached to their atoms, and if given a little nudge can move from one atom to another. These materials are called *conductors*, and it is those loosely bound electrons that allow them to conduct electric current. The moving electrons are what we call electricity, and voltage is how we measure the strength of the push.

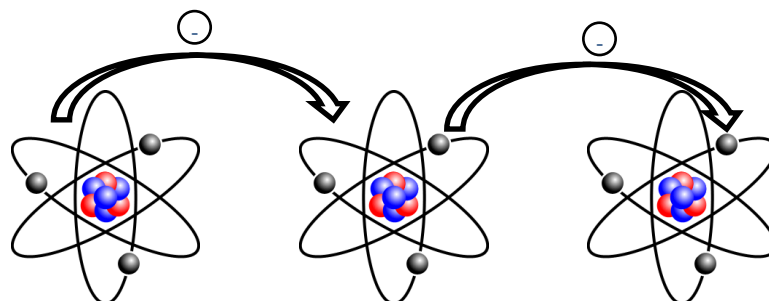


Figure 2: Electrons jumping from atom to atom

So, how can we give these electrons the push they need to become electricity? While there are several ways, one of the most commonly used methods is to pass a magnet close to a metal wire.

The magnetic field generated by the magnet is able to give the electrons the energy they need to flow from one atom to the next, but only while the magnet is passing by. In this way, the kinetic (movement) energy of the magnet is turned into electrical energy.

In order to continually pass the magnet past the wire, it can be attached to a shaft which is then rotated at high speed. Can you think of something in your kit that rotates at high speed?



The DC motor in your kit normally uses this same principle in reverse to turn electrical energy into movement energy and spin around. For this project, we want to use the fan on the motor to make electricity. Large fan-like objects called wind turbines are used in some areas as an environmentally friendly source of electricity. Since wind turbines only use the wind, they do not burn fossil fuels and therefore do not produce any greenhouse gases, making them better for the environment than other types of electricity generators. You can find out about wind turbines here.

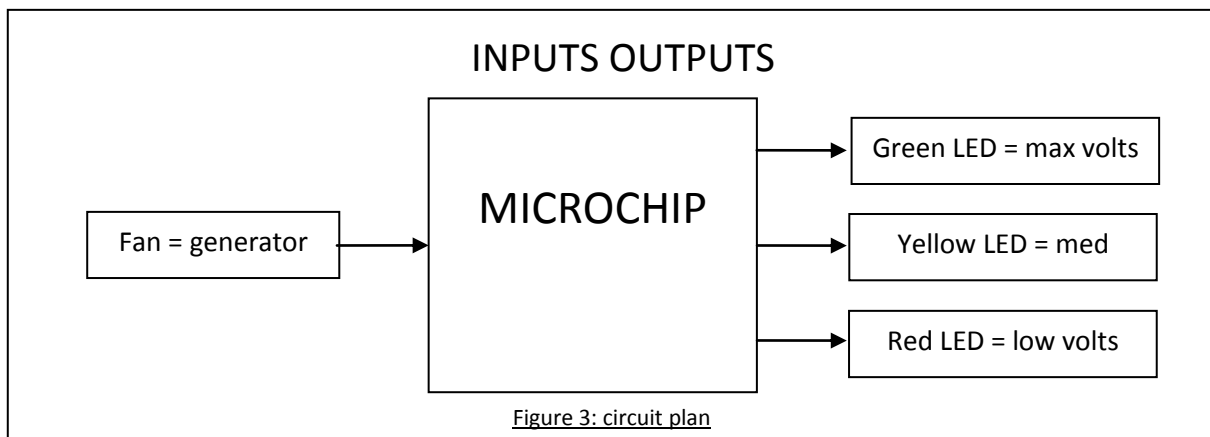
<http://www.youtube.com/watch?v=sLXZkn2W-lk&feature=related>

### **Ideas**

How should we connect the fan to the STEMSEL controller board? Will the electricity be an input or an output? How can we display how much electricity is being produced?

### **Plan**

We will use the fan to generate the voltage and hence electricity. However, we will need to use this as an input to the microchip. We will not be able to display the exact voltage, but we can use several LEDs to display several voltage levels.



So if the voltage is above the first threshold one LED will be on, two LEDs will be on if it's above the second threshold, and all three LEDs will be on if the voltage rises above the third threshold.

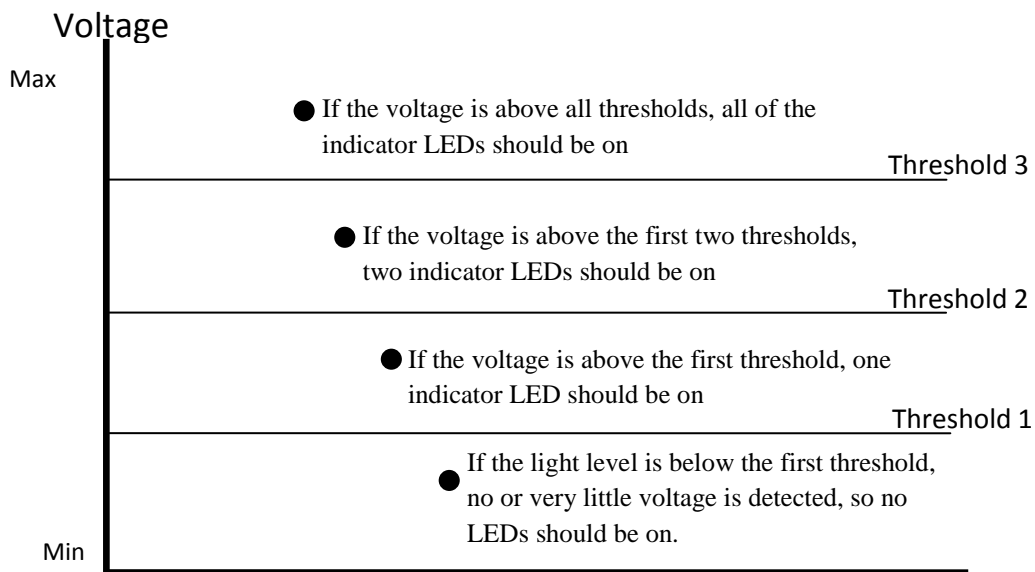


Figure 4: threshold graph

## Design

The first step is to design our electricity making and measuring device. Open ezCircuitDesigner and start a new STEMSEL project, then add the components we specified in the plan. You can just use the LED icons for the LEDs, but since we are using the fan as an input instead of an output, you will need to add it as an analogue input on pin C7 by first clicking the Input button, then ensuring that Analog Input is selected in the Circuit window.

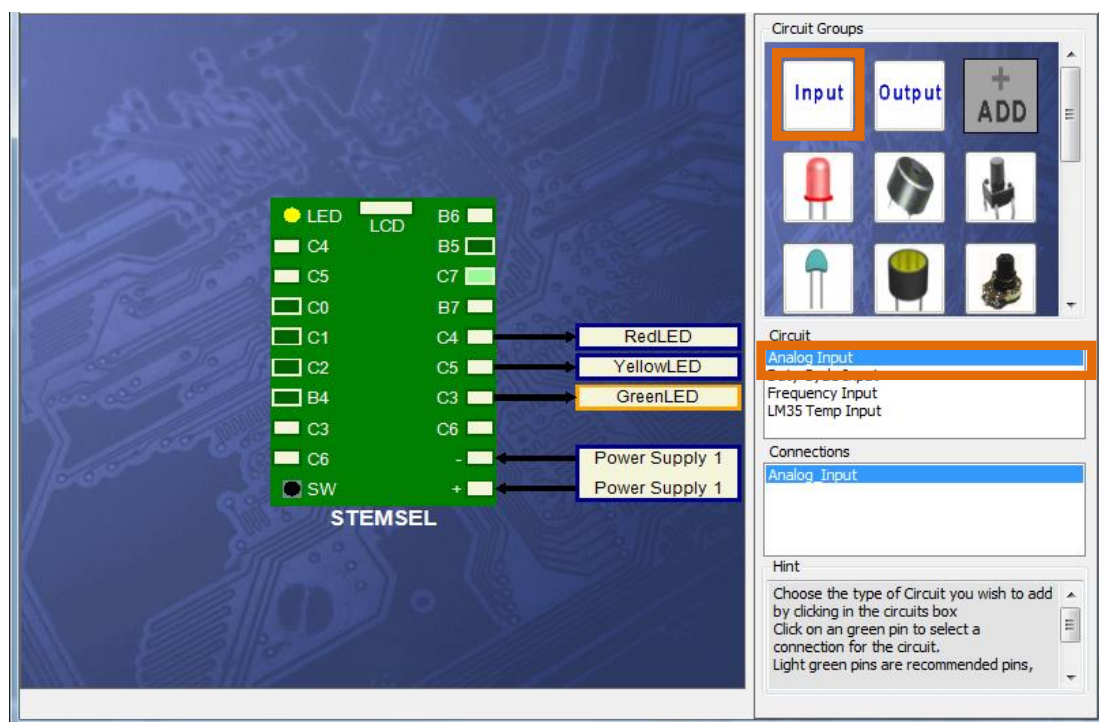


Figure 5: adding the fan input

The completed design should look like this:

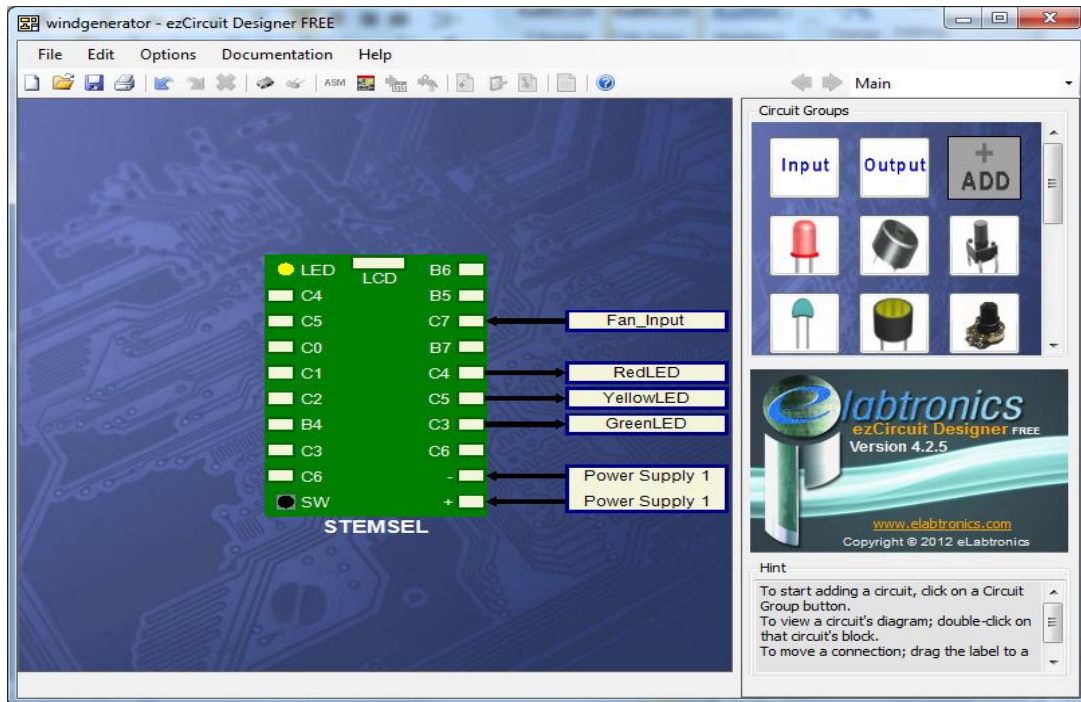


Figure 6: completed circuit diagram

### **Build the circuit**

Now you need to assemble the circuit using your kit. Put all of the black wires into the negative (-) pin, and the white wires from each component as follows:

White wires:

Green LED into pin C3

Yellow LED into pin C5

Red LED into pin C4

First fan wire into pin C7

Second fan wire into negative (-) pin

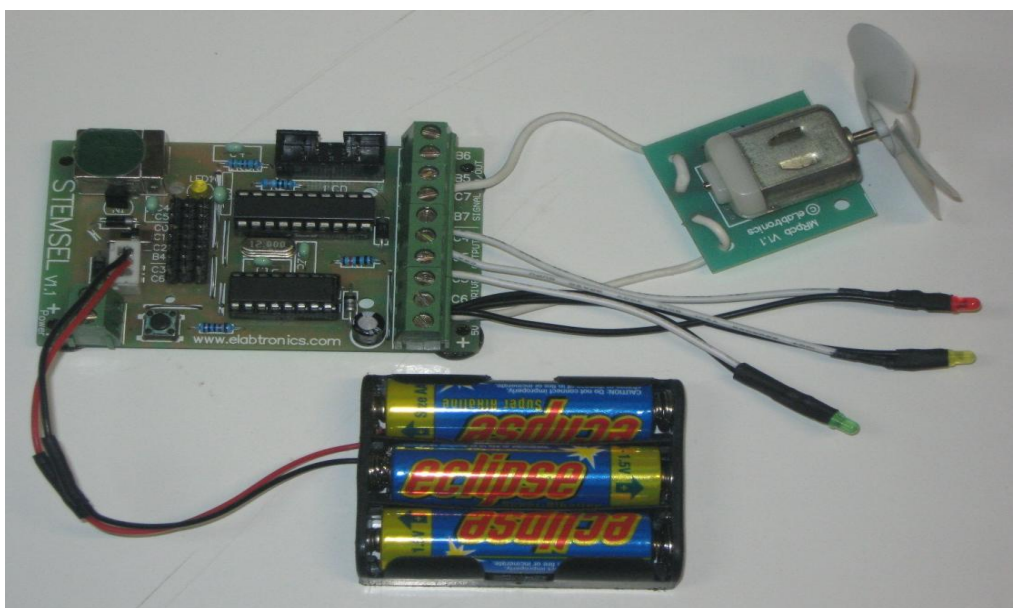


Figure 7: circuit



## Programming

Once you have assembled the circuit, send the design to Corechart by clicking the “Send to Corechart” button, then click the “Send Program To Chip” button to program the chip with the LED test program. Once you have verified that the LEDs are working correctly, delete the test routines so we can start writing our program.

1. The first step is to read in the voltage being generated from the fan using an **Analog\_In** icon, which can be found by clicking the **Inputs** button. Double click the new AnalogIn icon to open the properties box, and select FanInput as the INPUT PIN, then save it as FanVolts. Click OK.
2. Next, we will compare the fan voltage with some threshold values that we set, and turn on the LEDs as the voltage passes these points, like we set out in the plan. Click the **Numbers** button, and select the **Compare** option from the Icon Properties list, then place the new icon after the AnalogIn.
3. Since our fan doesn't create much voltage, we will need to set a low threshold value. Double click the new Compare icon to open the properties window, then select FanVolts in the COMPARE box, type 0.1V in the WITH box, and check both the above and Below checkboxes. Click the OK button
4. Use OnOffPin icons to turn on the red LED if the voltage is above our threshold, and turn it off again if it falls below our threshold.
5. We now want to test the program to make sure it is working as we expect. Add a GOTO START icon at the end of the program, then send the program to chip.

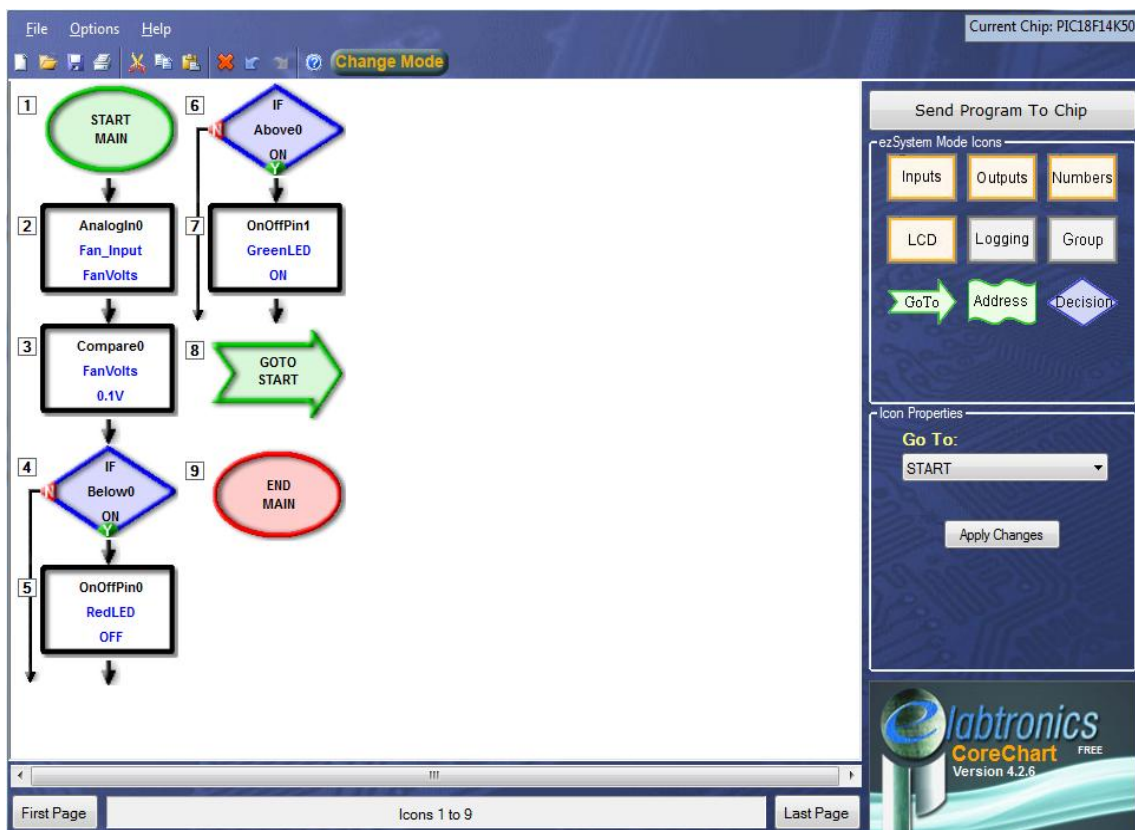


Figure 8: first threshold completed

6. Now blow on the fan and try to get the red LED to turn on. The fan should spin and turn on the red LED to show that electricity is being generated. When the fan stops, the LED turns off. If not, try using your finger to spin the fan in the opposite direction. You may need to swap the wires on the fan.
7. Now we want to turn on the yellow and green LEDs in a similar way, but using higher threshold values to indicate that the fan is spinning faster and generating more electricity. Start by adding the Compare, using 0.3V as the threshold value, then add the two OnOffPin icons to turn the yellow LED on if the voltage is above 0.3V, and off again if the voltage is below 0.3V.
8. Test the program again to ensure that it works correctly. You should notice that the red LED turns on first, than the yellow LED turns on if you blow harder.
9. Finally, we will use the green LED to indicate the highest level of electricity. This time we want to add a Compare icon with a threshold value of 0.5V to turn the green LED on or off. The finished program should look like this:

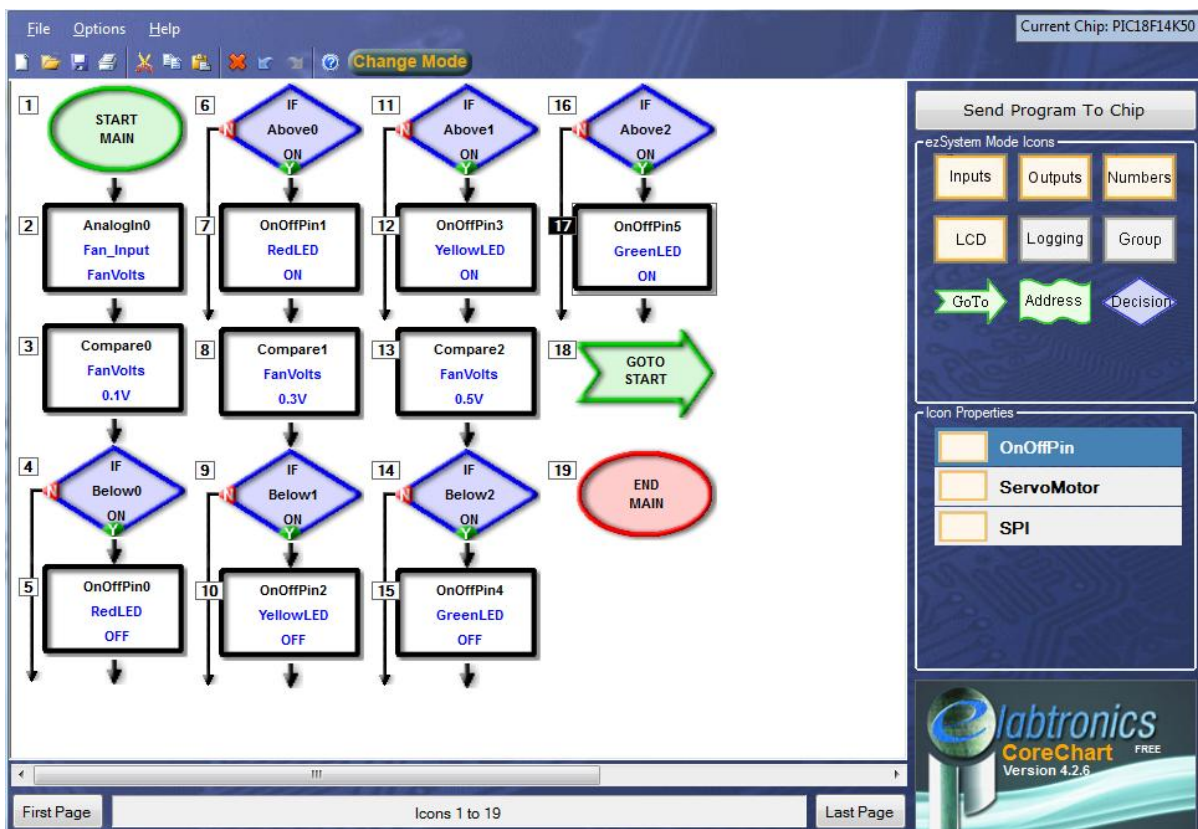


Figure 9: completed program

10. You may need to blow really hard to get the green LED to turn on. If you find that you can't turn it on, lower the threshold values for the yellow and green LEDs to 0.2V and 0.3V by changing them in the compare icons. You may even want to increase the thresholds to see just how much voltage you can make with just your breath!

### **Bonus questions!**

What happens if you use your finger to turn the fan in the opposite direction? Do any of the LEDs turn on?

No matter how fast the fan turns, none of the LEDs will turn on if it spins backwards. This is because when the fan spins backwards, the electricity flows the other way and the microchip can't detect it.

We found that the faster the fan turn, the more electricity it generated. What other factors affect the amount of electricity made by wind turbines?

To find out, follow this link:

<http://environment.nationalgeographic.com.au/environment/global-warming/wind-power-interactive/>

### **Summary**

By using a magnetic field to interact with the conductive wire, the fan is able to turn one form of energy into another, either movement energy into electricity, or electrical energy into movement. During this project we found that the harder we blew on the fan, the faster it span around and the more electricity was made, shown by all three LEDs turning on. Wind turbines work in the same way to create electricity without producing greenhouse gases.