

# Kidwind Mini Wind Farm

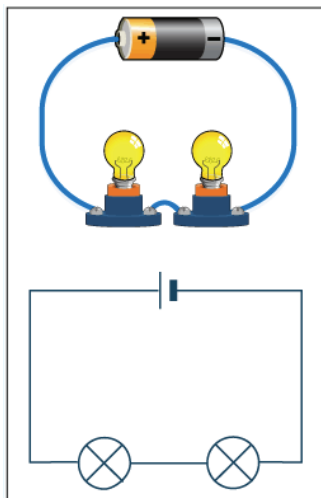


www.theage.com.au

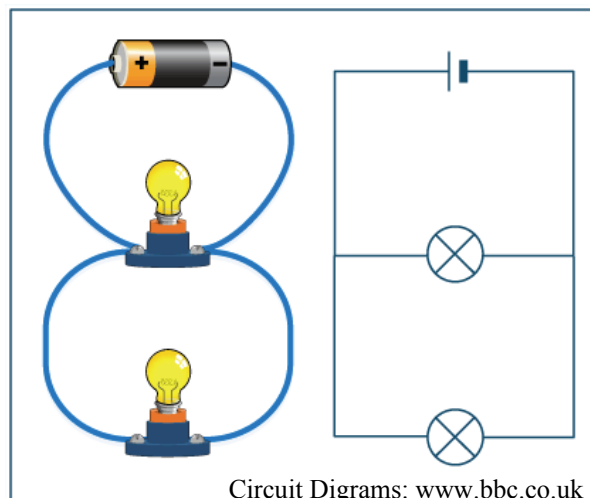
A **wind farm** is a collection of wind turbines in the same location. This may also be called a “wind power plant,” because many wind turbines working together can produce a lot of electricity—just like coal or nuclear power plants. Wind turbines are often grouped together in wind farms because this is the most economical way to create electricity from the wind. In other words, wind farms give us the most power for our buck! Electricity from wind farms is one of the most affordable sources of electricity today, and may soon be the cheapest form as technology advances and fossil fuels become less abundant.

You can build your own wind farm works using KidWind PVC Wind Turbines or using a few WindLab Jrs!

When you connect your various components together (wind turbines, load, meter, etc.), you are making an *electrical circuit*. There are two ways of connecting components in a circuit: **series** and **parallel**. A circuit wired in **series** has components connected end to end, like a chain. The electrons must travel a single path through all of the various parts of the circuit. A circuit wired in **parallel** provides a different path for current to travel through each of the components. In parallel, each component has a separate loop.



**Series** circuit



Circuit Diagrams: [www.bbc.co.uk](http://www.bbc.co.uk)

**Parallel** circuit

## How to Connect Multiple Wind Turbines

When you connect multiple wind turbines together, you are making a mini wind farm! You can choose to wire your turbines in series or in parallel. Before you build a wind farm, you will need to hook up the wires correctly - and to do that you need to find the polarity of each wire coming from your turbine.

### **Finding Polarity:**

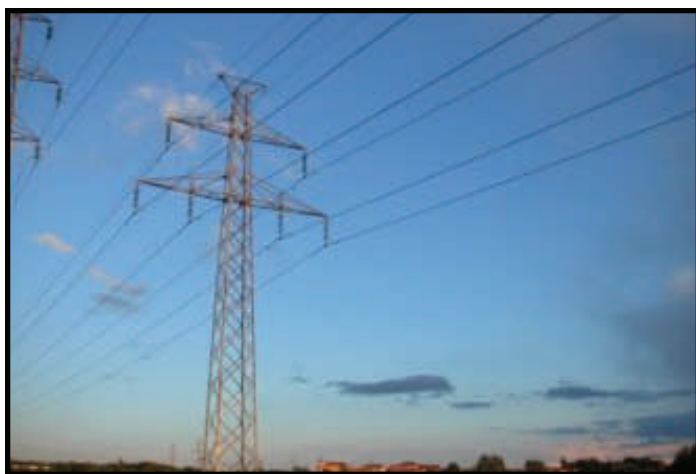
To correctly connect two or more turbines in a circuit, you will need to find the polarity of the wires coming from your wind turbine. Finding the polarity means figuring out which wire is positive (+) and which is negative (-).

Connect your wind turbine to a multimeter. Make sure that the multimeter leads are in the correct ports, as shown in the picture (black to the left, red in the middle). Place the turbine in front of a fan, and get a voltage reading. If your voltage is a positive number, the wind turbine wire connected to the **RED** multimeter lead is *positive* (+). If your voltage reading is negative, the wind turbine wire connected to the RED multimeter lead is *negative* (-). Once you have established which wire is positive and which is negative, it is a good idea to mark them with some tape so you remember.



The polarity of the wires is determined by the direction your blades are spinning. By changing the direction of spin you will change the polarity of your wires.

### **Connecting Turbines:**



Now it is time to choose whether you will wire the turbines in series or in parallel.

If you are connecting the turbines in series, connect the wires of the turbines from positive to negative, making one continuous loop through the circuit.

If you are connecting the turbines in parallel, connect each positive wind turbine wire individually to the red lead from the multimeter. Connect each

negative wind turbine wire individually to the black lead from the multimeter.

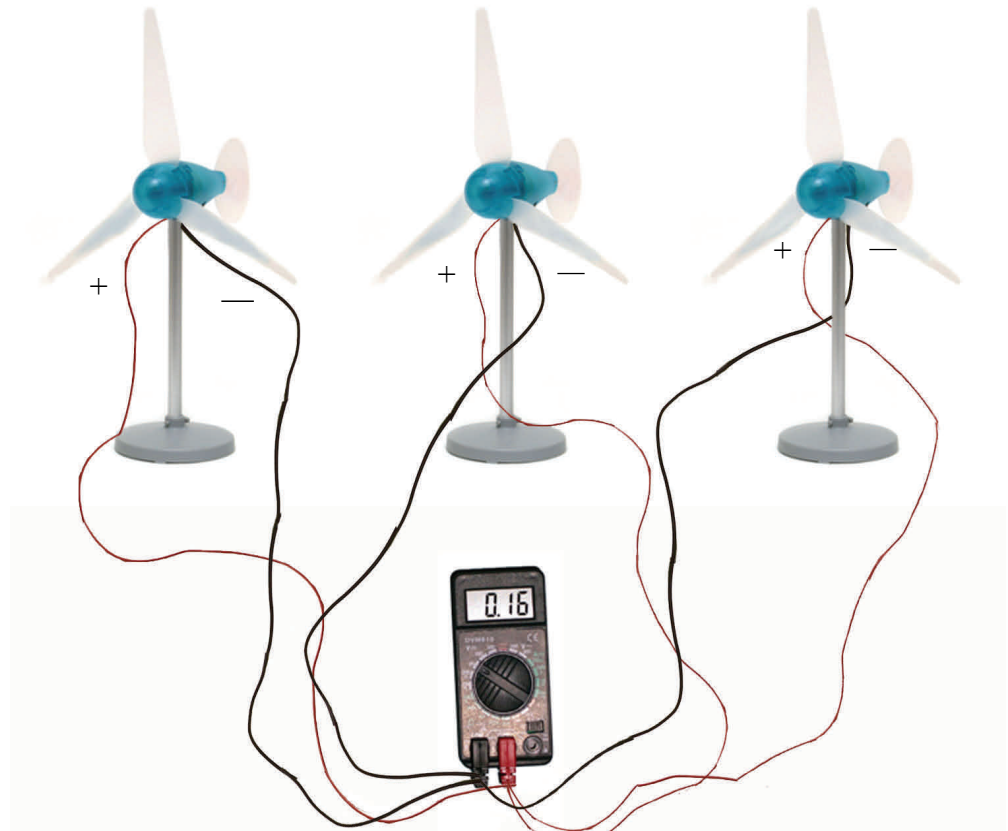
The wires you use to connect your mini wind farm to various loads act just like the high voltage transmission lines that bring the electricity of real wind farms to our homes and schools!

## Three WindLab Jr's in a **parallel** circuit

In the **parallel** circuit, all the negative wires from the turbines go separately to the negative (black) side of the meter and/or the load. All of the positive wires go separately to the positive lead of the meter or load.

You can see that the current from each turbine is able to travel a separate path through the circuit.

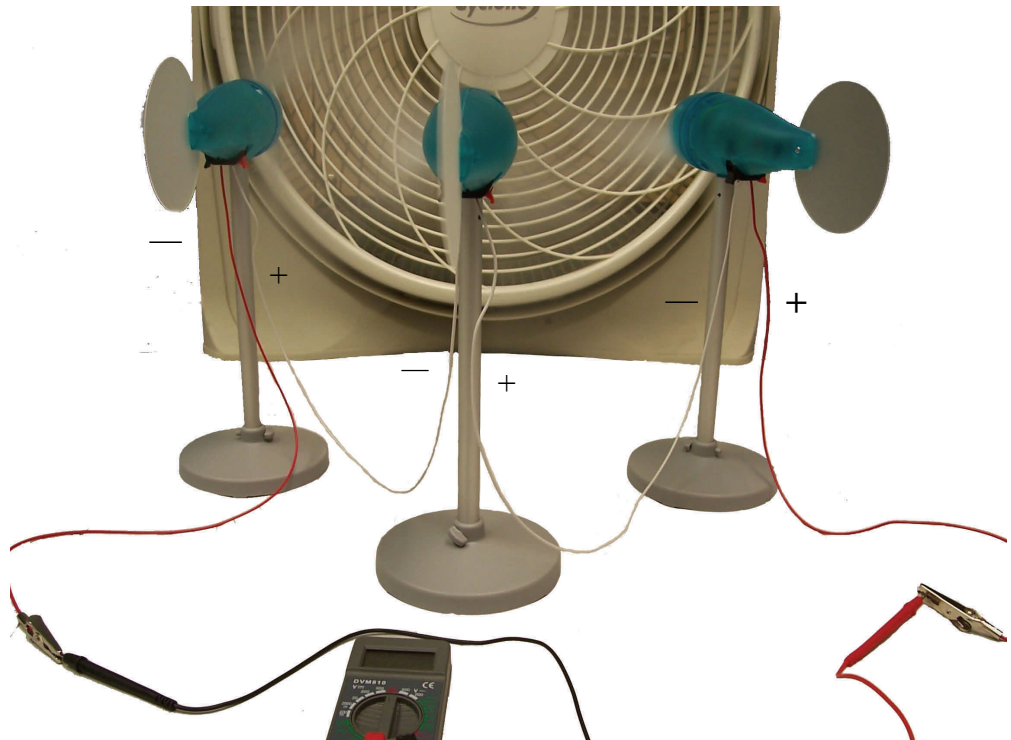
Each turbine in parallel will increase the current, but not voltage.



## Three WindLab Jr's connected in **series**

In a **series** circuit, there is only one pathway for the current to travel. The leads are connected negative to positive to negative to positive and so on.

With your meter measuring voltage, you will see that each turbine in series will increase the voltage. If you measure current through the circuit, you will see it is unchanged.



For help on electricity and circuits, check out:

[http://www.bbc.co.uk/schools/ks3bitesize/science/physics/electricity\\_1.shtml](http://www.bbc.co.uk/schools/ks3bitesize/science/physics/electricity_1.shtml)

# The Power of Wind Farms

Recall the Power in the Wind equation:

$$P = 1/2 \rho (\pi r^2) V^3$$

**P = Power in the Wind (watts)**  
 **$\rho$  = Density of the Air (kg/m<sup>3</sup>)**  
**r = Radius of your swept area (m<sup>2</sup>)**  
**V = Wind Velocity (m/s)**  
 **$\pi$  = 3.14**

What are we changing in this equation when we add more wind turbines and create a wind farm? The density of the air will not change, and adding more turbines will not change the wind velocity either. But you definitely are changing the radius of your swept area (**r**).

Assuming your blades are all the same size, having three wind turbines as opposed to just one will effectively triple your swept area! Of course, due to resistance and losses, we cannot expect to get exactly 3 times the power. What are some of the causes of inefficiency and losses that reduce your total power?

If you use a multimeter to record voltage and current as you add wind turbines to your wind farm, you will find some interesting results.

When you have multiple turbines wired in **series**, the voltage will increase with each additional turbine, but the current will stay the same!

If you wire the turbines in **parallel**, the current will increase with each additional turbine, but the voltage will not change!

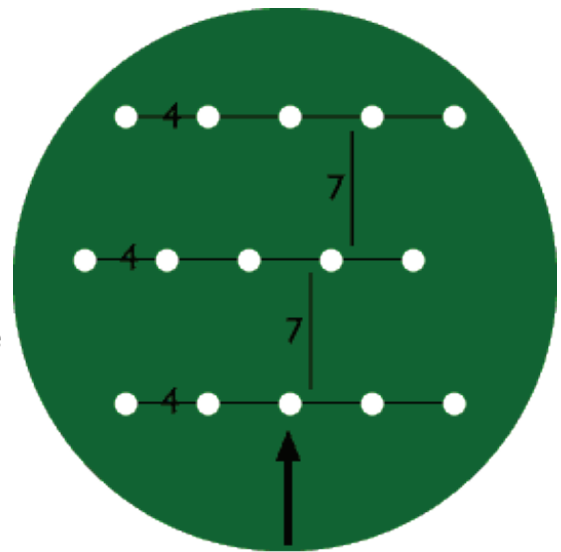
$$\text{Power (Watts)} = I \text{ (current)} \times V \text{ (voltage)}$$

Three turbines in parallel will produce the same Power as the same three turbines wired in series. If you put three turbines in series, you will basically triple the voltage with the same current. Three turbines in parallel will effectively triple the current with the same voltage.

## The Wind Park Effect:

If multiple wind turbines are placed too close to one another, the efficiency of the turbines will be reduced. Each wind turbine extracts some energy from the wind, so directly downwind of a turbine winds will be slower and more turbulent. For this reason, wind turbines in a wind farm are typically placed 3-5 rotor diameters apart perpendicular to the prevailing wind and 5-10 rotor diameters apart parallel to the prevailing wind. Energy loss due to the "Wind Park Effect" may be 2-5%.

What effect do you find when you move the turbines around in your miniature wind farm? Try placing a few turbines very close together, or right behind each other. Do you notice a reduction in the efficiency of your wind farm?



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Wind Farm Layout to minimize "Wind Park Effect" (www.windpower.org)