

# Making model wind turbines

In this workshop we work together in teams to design and test model wind turbines. By changing aspects of the blades we can tune them for more power. Trying lots of different designs, some good, some bad; is part of the engineering process.

## ***Classroom discussion***

### **How do scientists and engineers come up with working designs?**

- Working in teams,
- Coming up with ideas and testing them out,
- If an idea doesn't work then try and understand why, then have another go,
- Come up with a theory and try to disprove it,
- Keep going until the design criteria is met (in this case, the most power from the wind tunnel).

### **Why are wind turbines good for the environment?**

- We are running out of fossil fuels, so we need alternatives.
- There is a lot of wind around the UK, especially on the coast and over the sea.

However, the argument is not that clear! Wind turbines have an “embodied carbon footprint”; this is the amount of carbon released by constructing and installing a turbine. The wind turbine needs to “pay the carbon debt back”, before it becomes carbon neutral and then carbon negative.

### **What shapes worked best for our blades?**

Usually, the bigger the blade the better, because then each blade will catch more wind and be pushed harder.

Think about air resistance and parachutes. We want a big parachute so it catches more air and slows us down more (more drag). The bigger the blades, the more wind we catch, the faster the blades spin. The faster the blades spin, the more power we get out.

The angle is also important. We could have a wide blade but angled directly into the wind, which would not catch the wind at all.

### **Why do big wind turbines have such thin blades?**

From my research, it's to do with 2 factors:

1. Blades like the ones that work well in our tunnel (lots and large) would be huge on a 100m wind turbine. So they'd be too heavy to support. We can't make things that big, stiff and light with our current materials.
2. Our blades have mainly worked with drag, like a parachute. However the big wind turbine's blades work more like an aeroplane's wings. They create lift when the wind

blows over them and this is what moves them.

### **What other uses do we have for wind tunnels?**

- Testing the shapes of cars, rockets and planes.
- Olympic ski jumpers use them to train in!
- Indoor sky diving!

See if you can find some other uses on the internet, and look for some videos of wind tunnels in action with smoke, for example: <http://www.youtube.com/watch?v=RgUtFm93Jfo>

### **How could the wind tunnel be better?**

- It could give the readings of wind as a real number (in meters per second), then we could use this to see how the wind tunnel compares to real wind.
- It could make faster, more powerful wind. Then we could test the blades to see how they would stand up in extreme weather.

If you come up with other ideas, please let me know! [matt@learning-to-learn.org.uk](mailto:matt@learning-to-learn.org.uk).

### ***Further activities***

#### **Maths problem: carbon footprint of a 15kW wind turbine.**

A small (in the scale of things) turbine can generate 15kW (our best scores in the wind tunnel are about 120mW, which is about 125,000 times smaller!)

The 15kW turbine has an estimated embodied carbon footprint of 30 tonnes. If electricity is normally produced by burning coal, then generating 1kWh electricity from wind will save 1kg of CO<sub>2</sub>.

Q1: If a turbine like this can generate 25kW each year, how long does it take to become carbon neutral?

Q2: If the turbine has a life of 20 years, what is the total carbon saving?

#### **Answers**

A1: 14.4 months to become carbon neutral.

A2: 470 tonnes.

These numbers are very approximate, and are only useful for estimating and getting a general understanding of the scale of carbon footprints. At this moment, the average UK citizen is responsible for the emissions of 13 tonnes of CO<sub>2</sub> per year.

## ***How to fit this into the curriculum***

	KS3
<b>Science</b>	<ul style="list-style-type: none"><li>• Human activity and natural processes can lead to changes in the environment.</li><li>• Critically analysing and evaluating evidence from observations and experiments.</li><li>• Recognise the importance of sustainability in scientific and technological developments</li></ul>
<b>Maths</b>	<ul style="list-style-type: none"><li>• Applying suitable mathematics accurately within the classroom and beyond.</li><li>• Consider the assumptions made and the appropriateness and accuracy of results and conclusions</li></ul>
<b>ICT</b>	<ul style="list-style-type: none"><li>• Exploring and using new ICT tools as they become available.</li></ul>
<b>Art and Design</b>	<ul style="list-style-type: none"><li>• Exploring and experimenting with ideas, materials, tools and techniques.</li><li>• Taking risks and learning from mistakes.</li><li>• Investigating, analysing, designing, making, reflecting and evaluating effectively.</li></ul>

## ***How the machine works***

I learnt how to make machines like this by studying computers and electronics. Then I started making them and learning from my mistakes. The wind tunnel took six weeks to build, including a lot of mistakes! You can see photos of its construction here:

<http://www.flickr.com/photos/matthewvenn/sets/72157624187262310/with/4666282699/>

## ***Further information***

- Carbon footprint information from a book called "How bad are bananas?":  
[http://www.amazon.co.uk/How-Bad-Are-Bananas-everything/dp/1846688914/ref=sr\\_1\\_1?ie=UTF8&qid=1296215788&sr=8-1](http://www.amazon.co.uk/How-Bad-Are-Bananas-everything/dp/1846688914/ref=sr_1_1?ie=UTF8&qid=1296215788&sr=8-1)

## ***Other projects***

- Growing snowflakes; an interactive exhibit <http://learning-to-learn.org.uk/blog/2010/11/02/science-of-snow-interactive-exhibit/>
- Build recycled moodlamps - <http://learning-to-learn.org.uk/blog/2009/06/17/make-a-recycled-moodlamp-workshop/>
- Make a solar powered disco ball - <http://www.instructables.com/id/Solar-rainbow-discoball/>