

Lesson 3	Number and Pitch of Blades on a Wind Turbine		
Level	Key Stage 3	Time required	1 hour
National Curriculum Links			
Science, PSHE, Maths (view scheme of work for full details of links)			
Aims			
<ul style="list-style-type: none"> Students will understand how the number and pitch of the blades affects the wind turbine's output 			
Resources required			
Pen, record sheet (one per group), Wind Turbine Kit, electric fan, safety goggles			
Web search keywords			
Wind turbine blades, number of blades on a wind turbine, blade angle on wind turbines			

Task

The students are asked to experiment with different blade arrangements and different numbers of blades.

They enter on the record sheet the number of blades, the approximate angle of the blade to the wind, and the voltage output.

Ask the students to set up the Wind Turbine Kit according to the instructions and connect the motor module to it. Set up an electric fan (ideally 15" diameter) as described in the activity sheets.

Instructions are included with the Wind Turbine Kit. These can be downloaded in PDF format from: http://www.ecostyle.co.uk/products/wind_turbine_kit/wind_turbine_kit_activity_sheets_v2.15.pdf

Once the fan is in position, do not move it or the Wind Turbine Kit. Ensure the fan is always used on the highest (fastest) setting. It is important to keep all these settings constant in order to achieve meaningful results.

Explain the task to the students and show them how the rotor blades fit into the rotor hub. They can experiment with different numbers of rotor blades. The possible combinations are 2, 3 or 6 equally-spaced rotor blades. Fitting other numbers or un-equally-spaced rotor blade combinations will unbalance the wind turbine and should be avoided.

What is the angle of pitch?

With the turbine hub facing directly into the fan, the angle of pitch is 0° when the blade is flat, face to the wind. When the blade is twisted through 90° so it is pointing back towards the gears, this position has a pitch of 90° . All positions between these extremes are described by their individual pitch angles.

For your information

An angle of approximately 30° will give the highest voltage output. The wind turbine rotors will not turn when the blades are angled at 0° or 90° , but it is important for the students to experience this and understand why.

Risk assessment

Ensure the rotor blades are pushed firmly into the rotor hub. If the rotor blade spokes become loose, squashing the spoke slightly with pliers will achieve a tighter fit. Safety goggles should be worn by students operating the equipment and by those in the surrounding area.

Plenary

The students should come to the conclusion that on the Wind Turbine Kit a combination of 6 blades and a blade angle of approximately 5° gives the highest voltage output.

- How many blades do commercial turbines have?
- Why do the children think 3 blades have been accepted on large commercial wind turbines?

Most wind turbines have 3 blades because an even number of blades may put stress and cause wear to the wind turbine. There are complex considerations regarding the turning of a turbine head when the two-bladed rotor is horizontal as opposed to being vertical.

Turbine blades are expensive to manufacture, so it is economical for wind turbine designs to use as few blades as possible.

With more blades as a blade moves round, it travels less distance before the countering dirty wind caused by the blade ahead of it. As the blade rotates it disturbs the wind, creating 'dirty wind'.

There are applications where high speed is not required but high torque is, e.g. pumping water. The wind-powered water pumps have many blades and turn slowly.

KS3 Lesson Plan

Record Sheet

	Number of blades	Blade angle to wind	Voltmeter reading
Configuration 1	2	5°	
Configuration 2	2	45°	
Configuration 3	2	85°	
Configuration 4	3	5°	
Configuration 5	3	45°	
Configuration 6	3	85°	
Configuration 7	6	5°	
Configuration 8	6	45°	
Configuration 9	6	85°	