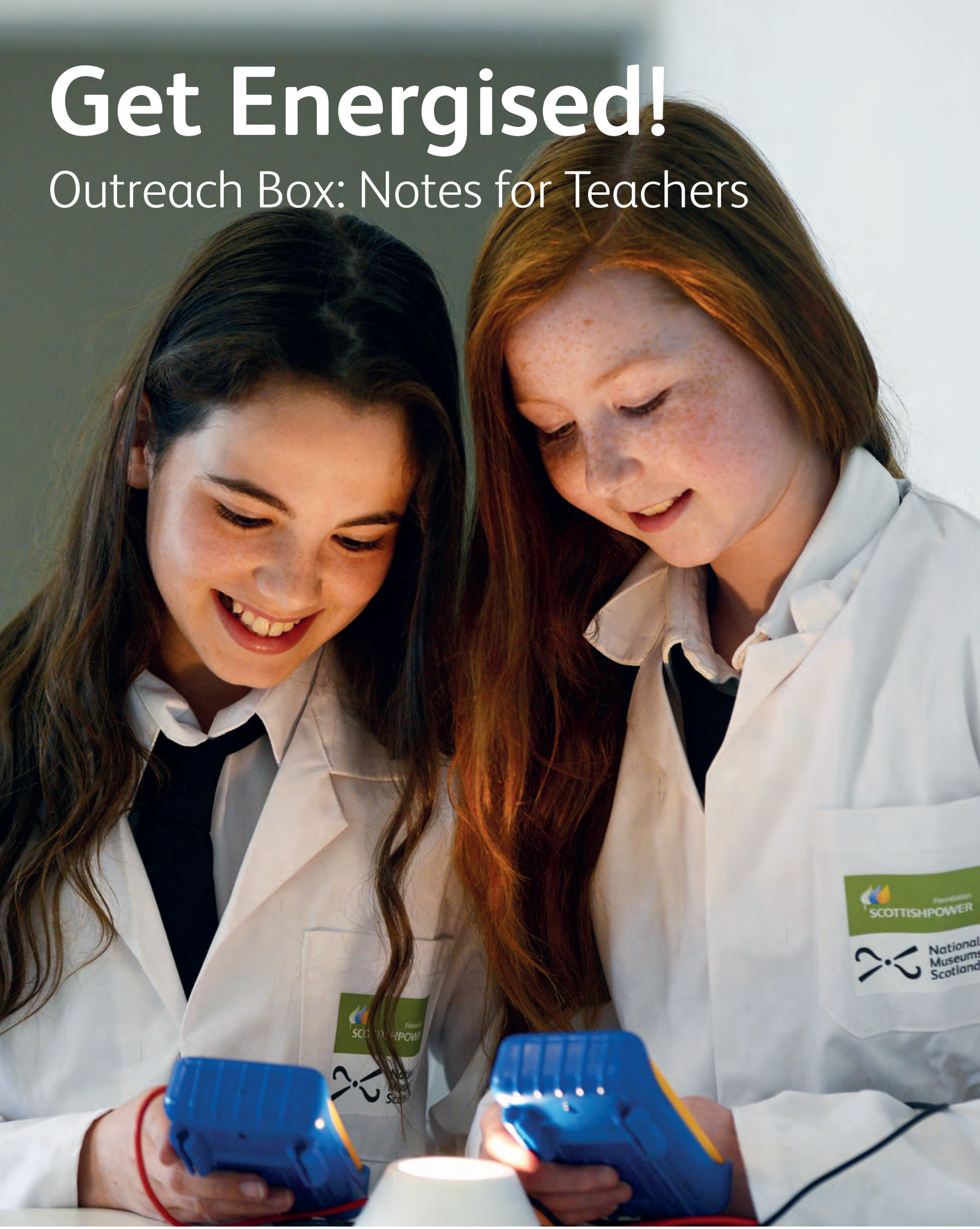
Get Energised!

Outreach Box: Notes for Teachers



National Museums Scotland

Foundation SCOTTISHPOWER

In partnership with

ASC Aberdeen Science Centre

IOP Institute of Physics In Scotland

Get Energised!

National Museums Scotland

Notes for Teachers

This guide provides some starter activities using the equipment supplied in the Get Energised outreach box. These are suitable for use for pupils in BGE or those taking National 4 or 5 physics qualifications.

Contents

For more information about our free Get Energised sessions, visit **www.nms.ac.uk/GetEnergised**

You can also contact us on **schools@nms.ac.uk**

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Aberdeen Science Centre Charity Number: SC014922

Get Energised! Outreach Box Inventory

What's in the resource?

This resource contains 10 full kits equally divided across two crates.

A Turbine hub and generator motor x 10
B Pack of 6 Turbine blades, 2 gears and 1 alan key x 10 packs
C Tower x 10
D Voltmeter x 10
E LED module, Motor module and Piezo module buzzer x 10

Please tick off each object on the list when your session is finished. Once the form is complete please sign at the bottom. Your feedback is important to us and helps us to continually improve and offer outreach learning resources. *Please complete this form to let us know how you used the resource.*

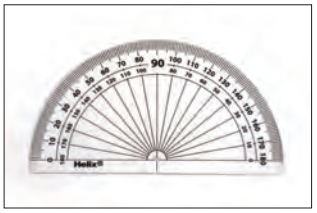
Turbine hub and generator motor x 10 ☐

LED module, Motor module and Piezo module buzzer x 10 ☐

Pack of 6 Turbine blades, 2 gears and 1 alan key x 10 packs ☐

Electrical tape x 10 ☐

Tower x 10 ☐



Protractors x 10 ☐

Voltmeter x 10 ☐

Get Energised! Notes for Teachers x 2 ☐

School name		Date	
No of pupils		No of Teachers	
Teachers signature			
Comments			

Overview

Get Energised is a programme for schools run by National Museums Scotland.
This pack should be used alongside Get Energised resources which provide background information on renewable energy in Scotland. All of these can be accessed online **www.nms.ac.uk/getenergised**

These starter activities can be used in whole or in part when covering renewable energy or electricity generation in class or in a STEM club. There are different activities aimed at BGE, National 4 and National 5. It is hoped that whilst the equipment is in school you can use it as much as possible.

Title	Aimed at:	Summary
Activity A1	BGE	Pupils are asked to design an experiment to find a way of increasing the electricity output of a wind turbine.
Activity A2	BGE	Pupils investigate the wind farm nearest to the school and find out more about its operation and impact on the area.
Activities B1 & B2	Nat 4/5	Pupils maximise the output of the wind turbine by finding the optimum combination of number and angle of blades before turning their attention to blade design.

Curriculum links

Activity A: suitable for BGE

- Science: Planet Earth – Energy sources and sustainability
  - SCN 3-04b: by investigating renewable energy sources and taking part in practical activities to harness them, I can discuss their benefits and potential problems.
  - SCN 4-04a: By contributing to an investigation on different ways of meeting society's energy needs, I can express an informed view on the risks and benefits of different energy sources, including those produced from plants.
- Science: Forces, Electricity and Waves – Forces
  - SCN 3-07a: By contributing to investigations of energy loss due to friction, I can suggest ways of improving the efficiency of moving systems.

Activities B1 & B2: suitable for Nat 4/5

- Nat 4: Electricity and energy – Generation of electricity.
- Nat 5: Electricity and energy – Conservation of energy.

Logistics

The equipment needed to run the activities is included within the box (unless stated). Fans must be provided by the school. The timings are suggested as a guide only, please feel free to adapt them to suit. A set of slides is provided for use as a guide along with worksheets to be handed to each pupil.

Activity A1: Investigating wind turbines

This activity aims to give pupils a chance to investigate a renewable energy source in a practical session. Through this they will gain an understanding of how a wind turbine works and encourages them to think about the factors that affect the electricity output.

Each group will need a set of equipment. The following items are supplied:

- analogue voltmeter*
- pack of six blades and connectors
- pupil worksheets
- nacelle (top section with gearing)
- tower (including desk clamp).

The school should aim to provide one fan to be shared between two groups. If this is not possible then groups should be allocated equal amounts of testing time using the fans available.

Part 1	Using the slides and notes provided, describe how a turbine works and where they are normally found. The notes can be found within the "notes" section in the PowerPoint file.	10 minutes
	Following instructions in the worksheets provided, pupils should set up the wind turbines, take their first measurements and record their results.	10 minutes
	In their groups, they should discuss ways in which to increase the output of the wind turbine. Potential suggestions include: increasing the wind supplied to the turbine (this would mean thinking about where it is sited, so where is wind speed at its greatest?), changing the number of blades or changing the angle of blades. After 5 minutes choose some groups to report back and collate a list of suggestions.	5 minutes
Part 2	Ask the groups to choose whether they will investigate changing the number of blades or the angle of blades. Groups should choose ONE of these to vary. For example, if they choose to vary the angle they should use the same number of blades for each measurement. If they choose to vary the number of blades, the measurements should all be taken with the blades at the same angle. If there are a limited number of fans available for testing, perhaps pair up groups to carry out the same experiment. The measurement taking can be shared between the two.	5 minutes
	Pupils will design an experiment, carry it out and collate their results.	20 minutes
	Once results have been collected, encourage groups to summarise what they have found and report back.	5 minutes

Based on this starter activity, further experiments and investigations can be designed. This could be followed up with the "In Your Area" Activity A2 which prompts investigation into local wind farms and their outputs.

*Please note that when setting up the equipment the analogue voltmeter is a dual scale. It runs either from -1 to 3V if the left hand and central terminal are used or from -5 to 15V if the right hand and left hand terminals are used.

Activity A2: In your area (optional)

This can be set either as a research exercise for homework or completed during class time. Pupils should report back on what they have found.

The activity encourages them to investigate the wind power in their local area.

To investigate more about the effects of the wind on wind farm sites, pupils can play this wind farm builder game: **http://www.nms.ac.uk/explore/games/build-a-wind-farm/**

Activity B1: Investigating electricity output

Pupils will design and undertake an experiment to find out the number and angle of blades that give the highest electricity output.

Each group will need a set of equipment. The following items are supplied:

- analogue voltmeter*
- pack of six blades and connectors
- pupil worksheets
- nacelle (top section with gearing)
- tower (including desk clamp)
- a protractor

The school should aim to provide one fan to be shared between two groups. If this is not possible then groups should be allocated equal amounts of testing time using the fans available

Part 1	Using the slides and notes provided, describe how a turbine works and where they are normally found. The notes can be found within the "notes" section in the PowerPoint file.	5 minutes
	Pupils should set up the wind turbine with all six blades connected and make a record of the electricity produced. Next pupils should design an experiment to test what combination of number and angle of blades gives the highest output. This could mean testing all of the combinations they can think of, or choosing a sample of numbers of blades and angles to see what gives the most electricity.	5 minutes
	Ask groups to feedback about the experiment they have designed. Use points that arise to get them to consider the robustness of their approach. For example, have they thought about how to ensure they have the same wind speed from their source throughout the testing?	10 minutes
Part 2	Based on the class discussion, groups should update their experimental design before going on to collect results. Note that there is the option for the class to design one experiment where the different groups test different combinations due to the limited time available. It is encouraged that at least two groups measure each possible setting.	20 minutes
	Each group in turn should report back on the combination of number of blades and blade angles that give the highest output. It is highly likely that there will be a variation in results. Allow time to discuss why these results vary. This could be a result of: differing fan positions, inaccurate angle measurements, lack of time to test all combinations. Keep a note of the final results as these will be needed if running activity B2.	10 minutes

Activity B2 builds on this session.

*Please note that when setting up the equipment the analogue voltmeter is a dual scale. It runs either from -1 to 3V if the left hand and central terminal are used or from -5 to 15V if the right hand and left hand terminals are used.

Activity B2: Wind turbine blade design

Using the results from B1 as a starting point, pupils now work on designing a blade that will further increase the electricity output. In between activities B1 and B2 pupils could research wind turbine blade shapes. To allow more time for making and testing blades, they could also come to class prepared with some sketches for potential blades.

Each group will need a set of equipment. The following items are supplied:

- analogue voltmeter*
- pack of six blades and connectors
- electrical tape and a protractor
- nacelle (top section with gearing)
- tower (including desk clamp)
- pupil worksheets

The school should aim to provide one fan to be shared between two groups. If this is not possible then groups should be allocated equal amounts of testing time using the fans available.

Part 1	Using the slides and notes provided, summarise the learning points from the previous activity. Groups should use one of the combinations of number and angle of blades identified in Activity B2. The notes can be found within the "notes" section in the PowerPoint file.	5 minutes
	Pupils are asked to sketch what a turbine blade looks like.	5 minutes
	Show pupils the materials available for adapting their turbine blades. They should discuss how they want to change the existing blade and decide what material to use. They should show you a sketch of their initial design before they are given the materials.	10 minutes
Part 2	Pupils design, make and test their designs. They can amend and re-test their designs as many times as possible in the time available.	20 minutes
	Set a deadline by which each group will report their highest output. Go around the groups and discuss the differences in design and look for patterns. What design produced the highest output? Were they able to improve each time they changed their design?	10 minutes

Groups can be given time beyond this lesson to work on their designs, it is up to you how much time to give them.

*Please note that when setting up the equipment the analogue voltmeter is a dual scale. It runs either from -1 to 3V if the left hand and central terminal are used or from -5 to 15V if the right hand and left hand terminals are used.

Connecting with the National Museum of Scotland

The National Museum of Scotland have a range of items relating to wind power, these can be viewed here:

http://www.nms.ac.uk/explore/collection-search-results/?item_id=634302

http://www.nms.ac.uk/explore/collection-search-results/?item_id=642004

http://www.nms.ac.uk/explore/collection-search-results/?item_id=712413

An online game to build a wind farm is also available:

http://www.nms.ac.uk/explore/games/build-a-wind-farm/

Reporting back to NMS and sharing your work

We are keen to find out about the work being done in schools using this outreach box. If you can, please share examples of what your pupils have been doing. This can include photographs, copies of completed worksheets and drawings of designs. You can return these to use using the reporting form on the final page.

When returning examples of work we would appreciate your feedback on using this resource. If you have any comments, please email us at **schools@nms.ac.uk** when sending in examples of work.

Activity A1: Investigating Wind Turbines

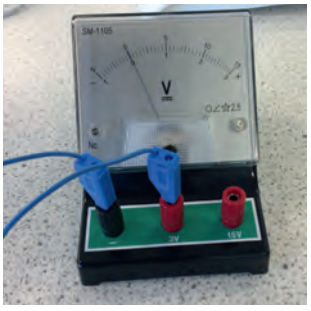
As part of this activity you will be investigating how a wind turbine works and how to maximise its output.

Team members:

Part 1

1. Set up the wind turbine using all six blades on the turbine with the edge of the blades flat against the black disc, as shown in the pictures.

2. Connect the wind turbine to the voltmeter.



3. Turn on the fan and measure the amount of electricity produced. Ensure the blades are set up as they are shown in the picture. Make a record of this in the box below:

4. In your team, use the space below to write down the ways in which you can get more electricity from the wind turbine:

5. Share your ideas with the rest of the class.

Part 2

1. Focussing on changes you can make to the turbine itself, choose one way of generating more electricity from the list you drew up as a class. Which way have you chosen?

2. Design an experiment to test your idea. Write down a description of your experiment below:

3. Carry out the experiment and record the electricity produced at each stage. Summarise your results in a table in the space below.

4. What conclusions can you draw about how to generate more electricity from the turbine based on your results? Is there anything else you observed when carrying out the measurements?

5. Share your conclusions with the rest of the class. Did anyone else draw similar conclusions?

6. Are there other areas you could continue to investigate?

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Activity A2: Renewable energy in your area

- There are more than eighty wind farms across Scotland, all with varying numbers of wind turbines.
- The design of wind turbines are fairly similar: each has a tall tower, a housing on top containing the electricity generator and three long blades.
- However, there are different designs of blades available and the height of the tower will change too.

- A wind turbine uses energy from the wind to generate electricity.
  As the air passes over the blades the force produced causes the blades to turn.
- This drives an electricity generator inside the housing of the wind turbine.
- The electricity produced is then fed into the National Grid and distributed for use.
- In order to produce as much electricity as possible, wind farms need to be on sites with a high average wind speed.

Q1. As with any type of electricity generation, there are risks and benefits. Write down two examples for wind farms.

Risks	Benefits

Q2. You are now going to find out more about the wind farm that is closest to your school. Complete the following table:

Name of wind farm	
Distance from the school	
Number of turbines	
Type of turbines installed	
Estimated output of the wind farm	
Height of turbines	
Length of blades	

Q3. Describe the site of the wind farm. For example, is it a flat open area, is it on a hillside?

Q4. Using data from the BERR wind model map for the UK, find out the average wind speed for the site of your nearest wind farm (you will need a postcode): http://www.rensmart.com/Weather/BERR

Height	Wind speed (ms^{-1})
10m	
25m	
45m	

Q5. If you have been able to identify the type of wind turbine used, what guidance can you find about wind speed?

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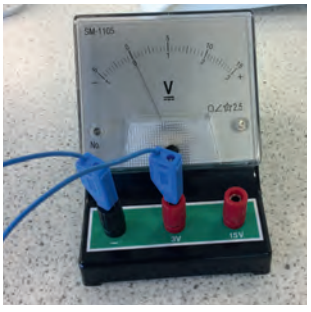
Activity B1: Investigating Electricity Output

In this activity you are investigating the combination of number of blades and blade angles that gives the highest electricity output.

Part 1

1. Set up the wind turbine using all six blades on the turbine with the edge of the blades flat against the black disc, as shown in the pictures.

2. Connect the wind turbine to the voltmeter.



3. Turn on the fan and measure the amount of electricity produced. Ensure the blades are set up as they are shown in the picture. Make a record of this in the box below:

4. Design an experiment to test the combinations of blades and angles of blade. Write down a description of your experiment below:

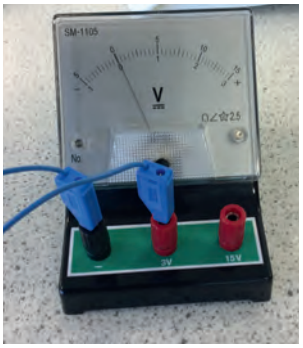
5. Share your experiment design with the class.

Part 2

1. Based on the class discussion, update your experimental description:

2. Prepare a table to collect results.

3. Connect the wind turbine to the voltmeter and begin collecting results. Record them in your table.



4. Once you have collected all of your results, review them and highlight the combination that provides the highest output. Report these back to the class and discuss.

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Activity B2: Wind turbine blade design

In this activity you are using the results gained in Activity B1 to form a starting point for investigating blade design to try and increase electricity output of the wind turbine further.

Part 1

1. **The blades that are provided in the wind turbine kit are straight and thin pieces of plastic. Think about the shape of the blades you have seen on wind turbines, write down a description of that shape.**

2. **Your teacher has provided you with some different materials you can use to change the shape of the blades provided. This means you will be adding to the white blades instead of making a new blade from scratch. In your group discuss how you would like to change the blade shape and decide what material to use.**

3. **Make a sketch on a blank piece of paper showing how you would like to change the shape blades. Share this with your teacher.**

Part 2

1. **You can now begin to make changes to the blades provided. It is important that you test your design to see what effects your changes have on the output. Make a table to record your results.**

2. **Once you have tested your blades you can amend the design and re-test. This can be done several times but will depend on the time available.**

3. **When asked by your teacher report back on the highest reading achieved. Show your design to the rest of the class.**