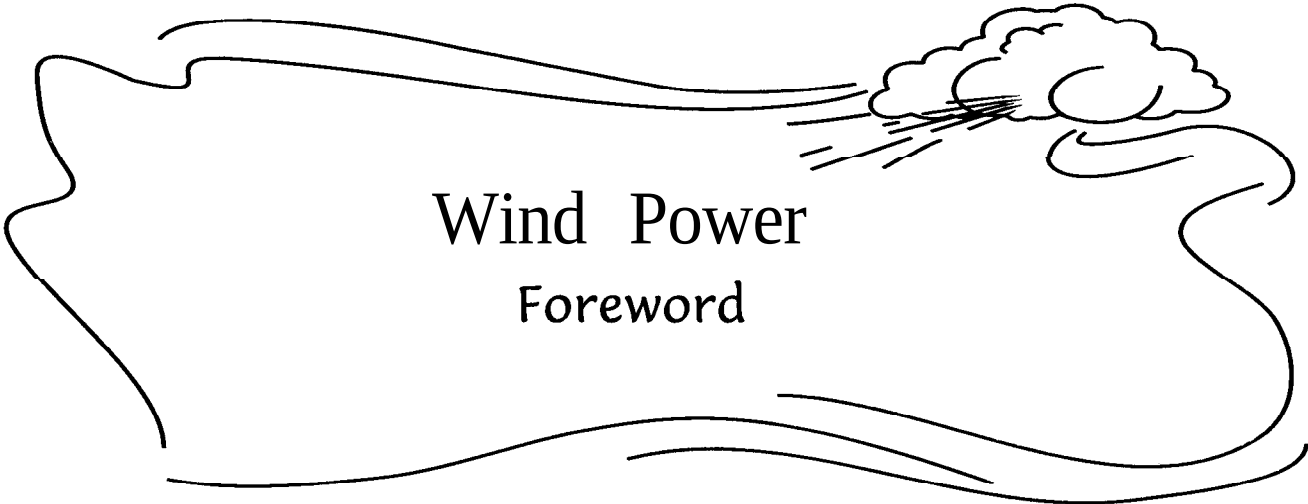


WIND POWER

Key Stage 2



Peter Cryer



Wind Power

Foreword

Clean energy production for the future must be a key priority for any country. No longer can we continue to destroy the environment and inflict on the future inhabitants of the Earth a legacy of unsolved problems. It is down to each one of us to take responsibility for our actions and bring about positive solutions for the future.

As part of the UK's policy the British Government has set targets to reduce the levels of harmful emissions produced. As a renewable energy, Wind power energy is one way to produce electricity without the direct production of any harmful emissions. Wind farms have been constructed throughout the country as part of the UK's policy to develop clean energy production.

Everyone at Border Wind is fully dedicated to work to improve the environment. Over the years we have worked throughout the world advising on and installing appropriate energy supply sources. At present we are fully committed to develop electricity from the wind. We developed our first wind farm at Blyth Harbour in 1991. This first project now supplies enough clean electricity for on average, 1500 households. As a Company we are committed to contributing to the community. We have hosted many visits to our wind farms and talks have been given at schools and other organisations about Blyth Harbour and wind energy in general. We became aware of a need for more teaching material on our area of work. This pack is the result of much work carried out by educationalists and Border Wind. We hope that it will prove of use to schools and contribute to the need for knowledge required to solve our future problems.

David Still

Acknowledgments

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supported by:

Northumberland Education Business Partnership
North Tyneside Education Business Partnership
PowerGen Renewables Limited
Port of Blyth
Border Wind Limited

This booklet is one of three produced for different Key Stages with Border Wind. The booklets were produced following teacher placements at Blyth Harbour Wind Farm, Northumberland.

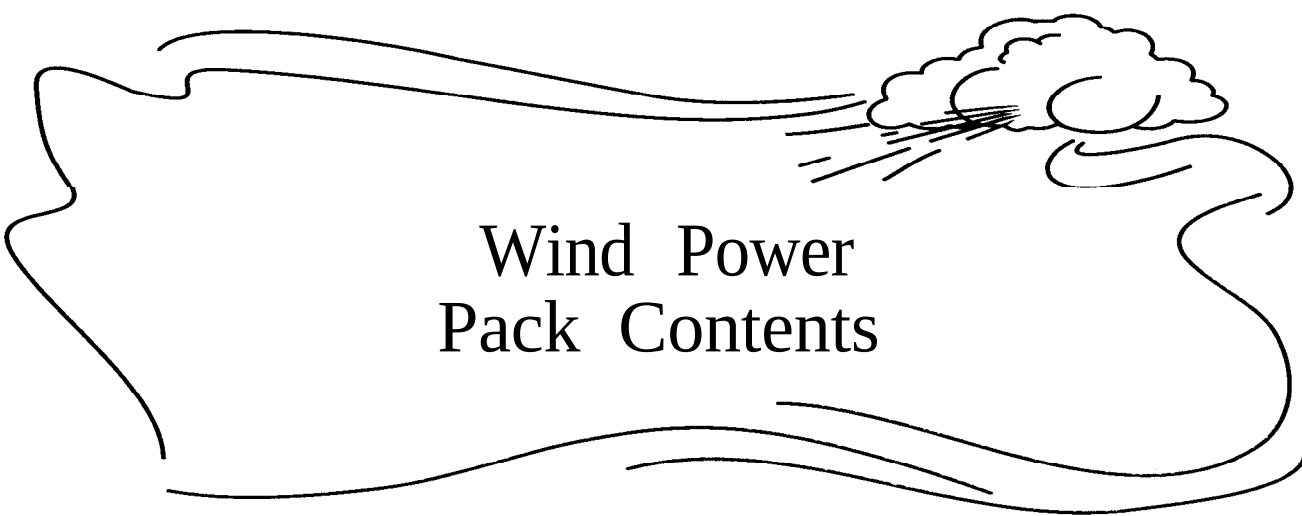
Each booklet investigates Wind Power as an alternative source of Energy and provides information and contacts for teachers to support them in the teaching of Wind Power within the curriculum.

This booklet includes several activities which can be used as an introduction to Wind Power. Each activity can be used within the classroom and is not dependent on a visit to a Wind Farm. The activities consist of a teacher briefing sheet which describes how to organise and run the activity and at least one pupil activity sheet which can be photocopied and distributed to the pupils.

These activities are purely suggestions and can be modified and developed to suit each teacher's curriculum needs. All the activities can be linked directly to the National Curriculum at the appropriate key stage and the booklet includes a National Curriculum reference grid which suggests how to link the activities to the programmes of study.



BORDER Wind



Wind Power Pack Contents

Information Sheet

- 1: Introduction
- 2: Wind Power
- 3: Border Wind Limited
- 4: Wind Turbines
- 5: Wind Turbine - Diagram
- 6: Types of Wind Turbines - Diagram

National Curriculum

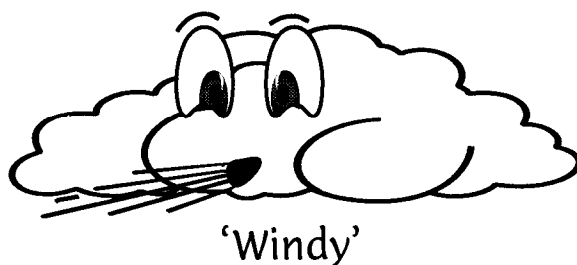
- 1: Reference Grid
- 2: Topic Web

Activity: comprises Teacher Briefing Sheet(s) and Pupil Sheet(s)

- | | |
|-----------------------------------|------------------------------|
| 1a: For and Against | 1b: Referendum on Wind Power |
| 2a: Is it Just the Wind? | 2b: Catching the Wind |
| 3a: Map Work | 3b: Find the Best Site |
| 4a: The Wind | 4b: Strong Structures |
| 5: The Tower of Strength Proposal | |
| 6: Shrinking Turbines | |

Additional Resources

- Wind Energy Poster
- Windy Badges
- Windy Bookmarks
- Stand up Windy!
- The Beaufort Scale
- Wind Vocabulary
- Useful Contacts
- Useful Books
- Useful Videos
- Other Useful Information Sources



Introduction

People particularly in 'western developed countries', have come to need, use and expect to have a continuous supply of electricity. Many areas of the 'developing world' either have a very limited supply of electricity or none at all. It gives power, light and heat in cities, towns and villages all over the world. The process by which electricity is produced is called 'electro-magnetic induction', i.e. a magnet rotating very quickly inside a coil (known as a generator). The magnets are turned by turbines which are made to rotate using the force of the wind, water or steam.

Most power stations have vast steam turbines which work by burning fossil fuels (coal, oil or gas) to heat the water, with some using nuclear fission. The burning of fossil fuels does however cause damage to the environment - acid rain, global warming and the green house effect being the terms most commonly used. Acid rain leads to the pollution of lakes and rivers and can cause severe damage to trees as well as buildings. The greenhouse effect is contributed to by some of the gasses produced in the burning process. This leads to the gradual warming of the earth's atmosphere. Research is ongoing to try and evaluate exactly what impact this will have on our weather, sea currents, crops and agricultural practices and water supplies amongst others. Nuclear power stations produce the steam to drive the turbines using the energy stored in uranium. The most severe side effect of this process is the production of radioactive waste which is extremely dangerous and needs to be stored for centuries before it becomes safe to dispose. Suggestions have been made linking nuclear power stations to clusters of leukaemia (a progressive blood disease) in people who either work or live in the vicinity of these (particularly children). Another factor which needs to be considered in our current energy production is the expected lifetime of known stocks of coal, oil and gas. A number of estimates have been made, some for example indicating that identified stocks of coal will run out in the next 200-300 years.

It is the cumulation of all these factors which has led to the development of alternative, cleaner ways of producing electricity. Possible alternatives use the elements and other natural, free and renewable sources such as hydro-electric, tidal, solar and wind power. This pack focuses on wind power. Wind is a renewable energy source which is safe, cheap (the costs of generation are now very similar to those of fossil fuels - once external costs of environmental pollution are considered wind power becomes more competitive) and free of pollution. There are however some disadvantages associated with wind power: wind strength varies from place to place, from season to season as well as throughout the day. If wind speed drops below a certain level it is not powerful enough to turn the turbines to generate electricity. This is mitigated by the countryside location of windfarms. The visual impact of wind turbines (now up to 60m high at the tip of the blade) has been argued by some as being a form of 'visual' pollution. Careful siting and design aims to minimise sensitive visual impact. The impact on wildlife, particularly birds if the turbines are sited in their migratory flight path has to be carefully assessed. Other issues which are addressed by wind power developments include noise pollution and any electromagnetic interference that may occur (i.e. any effects on TV and radio communications).

Wind Power

In the search for sources of energy people have long harnessed the sustainable forces of nature. For centuries water (also known as hydro power) and wind power have been used for milling and grinding, the most obvious and long standing use of wind power being to power sailing ships. Hydro power has also been used for decades to generate electricity.

The technology to use wind to generate electricity has been available for many years. This is now most importantly being joined by the political will to use and develop wind power. When the wind blows and generates electricity, less burning of fossil fuels is required at power stations. When the wind drops and if more electricity is required, conventional power stations resume their higher rate of burning and generating -just as they would if more loads were switched on, for example at half time when the world cup is broadcast on television. The present National Grid system which collects and distributes all our electricity would be able to accommodate renewable energies supplying up to 20% of Britain's electricity requirements.

Wind power's good fortune is, however a result of the environment's bad fortune. Wind technology is now seen as worth developing because the fossil fuel technologies, upon which we have traditionally relied for our electricity are creating problems we are only beginning to understand and quantify.

Polluting emissions from the burning of coal, oil and gas are causing climate change, acid rain and a host of other problems. At the Earth Summit in Rio in 1992 the world's leaders signed an agreement to take action towards stopping climate change and improving air quality. This is one reason for the blossoming of wind farms. Both in the UK and overseas.

Wind turbines produce energy with no polluting emissions. They can be installed in a green field and will sit happily with grazing sheep and cattle or with crop planting and harvesting. They produce no harmful solids, liquids or gases, no fuel needs to be transported to them nor does any hazardous or toxic waste product need to be taken away for disposal. At the end of their useful life they can be taken down and the steel and other components will be recycled because of their high scrap value.

Compared with other commercial methods of electricity generation, wind turbines sparkle with cleanliness, are sustainable and safe. The wind blows and turns the blades. The turning motion goes through a gear box, is geared up to a faster turning motion and into a generator where it produces electricity which feeds into the National Grid.

For many people a wind farm is a symbol of hope for a cleaner, safer, more sustainable future. With enough vision and political will, we will eventually have wind turbines out at sea and so begin to harness the power of the sea itself. Electricity production from wind technology will never have the tragic consequences summed up in such words as Aberfan, Chernobyl, Exxon Valdez, Piper Alpha, Brent Spar and Milford Haven. Every time we switch on the light, turn on the computer, or put clothes into the washing machine we should consider the environmental consequences of having such a dependable source of power. With wind power what you see is what you get - a small visual impact, not a large invisible hazard.

Border Wind Limited



Border Wind is a wind farm development company which believes in actively working towards a sustainable future. The company consists of three engineers, a financial expert and a planning organiser. Together they deal with all aspects of wind farming; finding potential sites, working out the optimal number and layout for the wind turbines, making planning applications, designing and managing the construction of the wind farm and operating and maintaining it. Border Wind is involved with three working wind farms in England and has more planned throughout Britain.

The personnel of Border Wind have been working together for over ten years on renewable energy projects. These include:

- **Great Eppleton Wind Farm:** Due to be commissioned February 1997. Located South of Sunderland, the four 750kW wind turbines will produce, on average, enough electricity for 1700 homes
- **Blyth Harbour Wind Farm:** Commissioned January 1993. Nine 300kW wind turbines are built on a pier in the harbour north of Newcastle upon Tyne. They generate enough electricity to supply 1500 homes throughout the year. When all the turbines are generating at full output they can supply electricity for 6000 homes.
- **Caton Moor Wind Farm:** Commissioned December 1994. Ten 300kW wind turbines near Lancaster produce enough power for 2000 homes annually or 6700 at peak output.
- **Four Burrows Wind Farm:** near Truro in Cornwall is a fifteen turbine site commissioned in March 1995.
- **Foula:** A wind-hydro-diesel system with pumped storage to serve the fifty strong community on this most westerly of the Shetland Isles.
- **Spain:** Project Zephyr - the design, installation and commissioning of a wind-solar power supply with battery storage for mountain-top telecommunications system.
- **Egypt:** Trouble shooting on a wind-solar electric pumping system supplying water to crops in a desert development centre.

Border Wind constantly receive requests for information from students and from school groups. As a result of the interest shown in wind energy the company approached Northumberland County Council with the idea of producing a resource which could be used in schools around the country. The project has grown and grown. This document is a result of collaboration between many organisations. We thank all of them for their interest in wind energy.

Finally, Border Wind does have an ulterior motive in helping to provide this workbook. We all hope that with the help of the teachers who use this book, today's schoolchildren will be tomorrow's people of vision who promote the use of renewable energy as an important contribution to a better environment for all.

Feb. 1997

Anabel Gammidge, Bill Grainger, David Still, Donna Heeps, Norman Rogers, Sandra Painter

Wind Turbines

As for other machinery, wind turbines operate in different ways depending on the model used. The primary difference lies in whether the wind turbine is regulated by the pitching of the blades, or simply by changes in wind speed.

For the purposes of this pack, we shall be describing a pitch controlled wind turbine which is the type of wind turbine installed at the Blyth Harbour Wind Farm north of Newcastle.

The blades are mounted onto a rotor at the front of the nacelle. The nacelle is the structure at the top of the tower which contains the gearbox, generator and hydraulic components.

The rotational speed is kept constant during generation and controlled by varying the pitch angle of the blades. The gearbox increases the rotational speed and the generator produces 3 phase power AC.

Cables carry the power and control signals to the base of the tower, where the wind turbine control computer is located. This computer controls the turbine and sends and receives information from the central computer over a radio modem link. The turbines can be stopped, started and reset remotely by modem. Any faults automatically set into motion the computer's shut down system and warnings are sent to the control stations - on site or remote.

Below the computer compartment is a transformer which converts the electricity to 11,000V AC or 33,000V AC and feeds into a high voltage cable which links each wind turbine to the switch gear building. This then feeds into the National Grid.

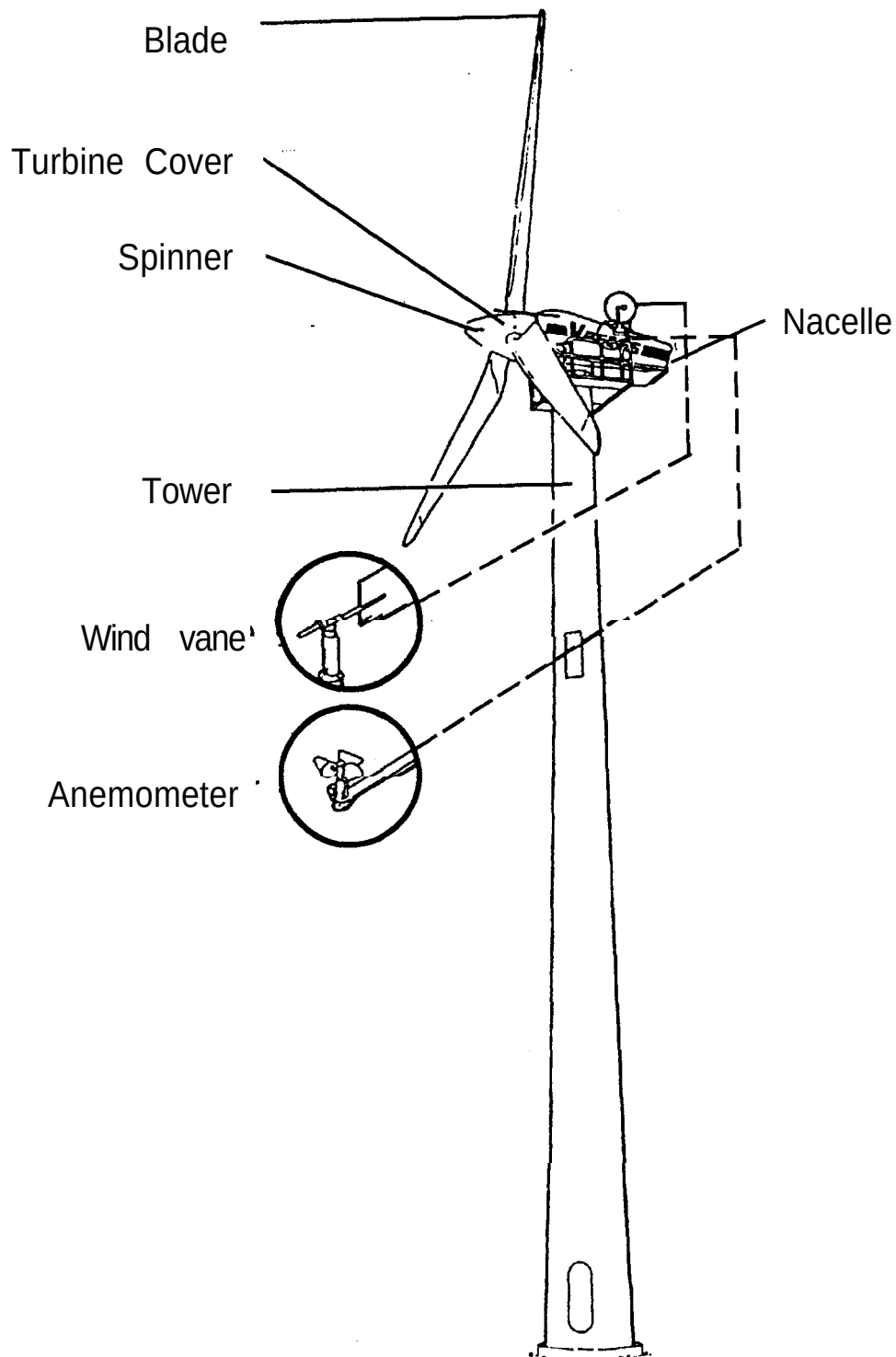
The wind regime will vary across the site of a wind farm. The turbine blades will not all rotate at the same speed - each turbine will produce the maximum energy for its siting.

How do wind turbines generate the electricity?

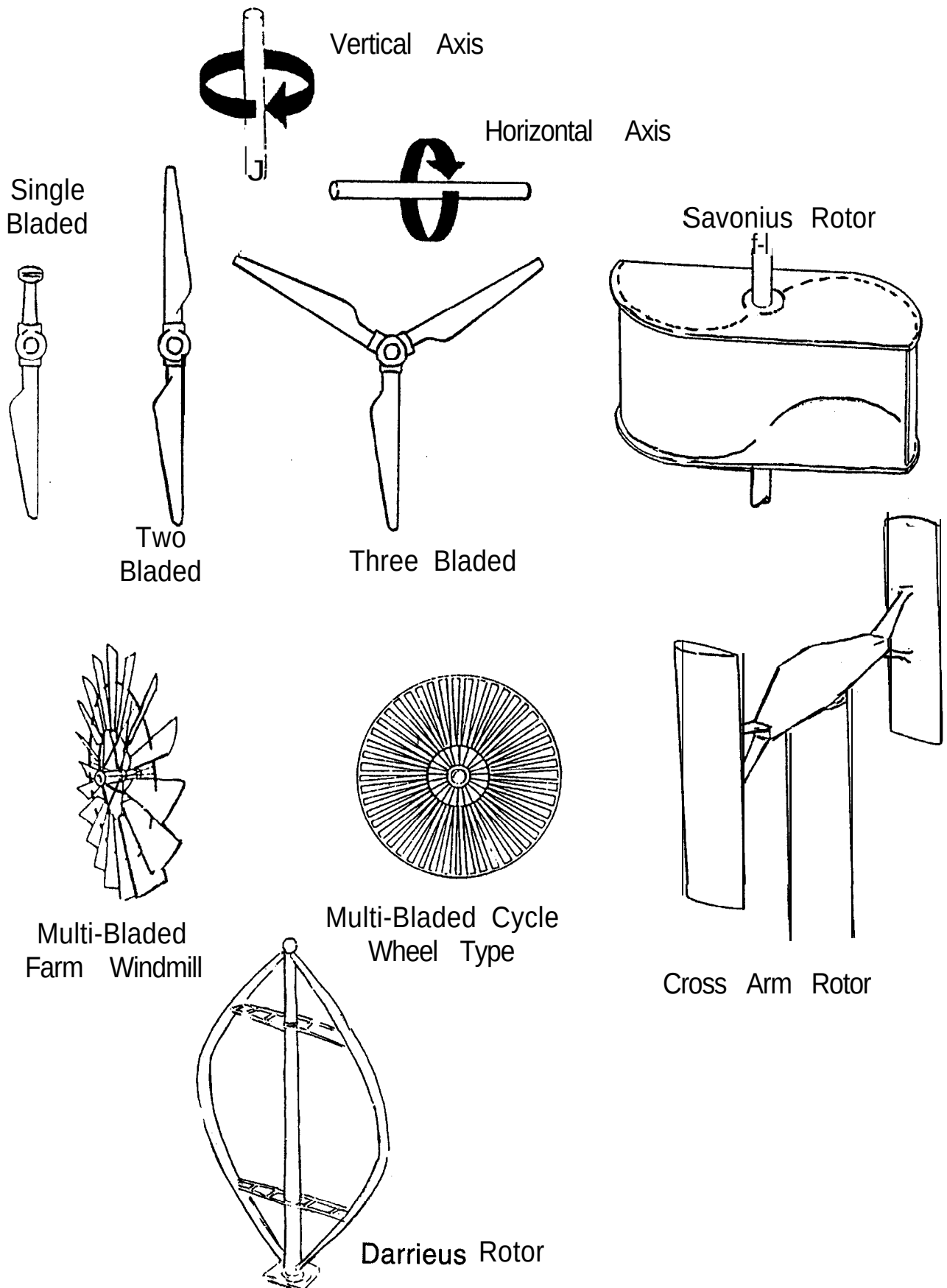
Wind turbines which are used to generate electricity are called aerogenerators. These usually have two or three aerodynamic blades which when 'pitched' (angled) against the wind, can rotate faster than the actual windspeed, giving a tremendous turning force or 'torque'. The turbine is connected to a gearbox which greatly increases the speed of rotation to the generator making it fast enough to generate electricity.

A rudder at the rear of the aerogenerator ensures the blade end always faces the wind, and most use either a computer controlled disk brake or air brake system to ensure the blades don't rotate above a safe speed in strong winds. Computer systems on many aerogenerators can also adjust the angle of the blades to gain optimum performance from changing wind speeds, or to put the blades in line with the direction of the wind to prevent rotation during gales (which would be dangerous) or when the rotors have to be stationary for maintenance work, etc.

A Wind Turbine - Diagram

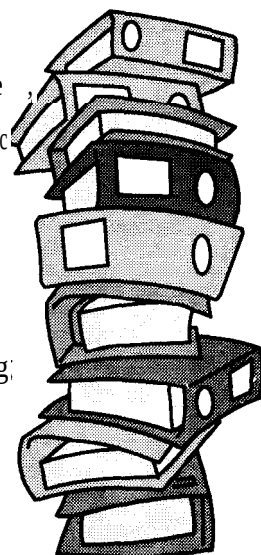


Types of Wind Turbines - Diagram



Reference Grid

Activity:	Subjects:
1a For and Against	English: Speaking and listening Drama History: Shape, Using and Applying Mathematics
1 b Referendum on Wind Power	English: Drama Maths: Using and applying mathematics, handling data IT Information Technology, using hardware & software
2a Is it Just the Wind?	Science: Experimental and investigative physical processes, electricity Technology: Making, evaluating
2b Catching the Wind	Science: Experimental and investigative physical processes, forces and motion Technology: Designing skills Maths: Using and applying mathematics, Shape
3a Map Work	Geography: Skills, place, thematic study History: Britain since 1930, Local History
3b Find the Best Site	Geography: Skills Maths: Using and applying mathematics, data IT: Communicating and handling information
4a The Wind	Music: Performing and composing
4b Strong Structures	Science: Experimental and investigative Maths: Shape, space and measures Technology: Designing and making skills
5 The Tower of Strength Proposal	English: Speaking and listening Technology: Designing and making
6 Shrinking Turbines	Art: Knowledge and understanding Technology: Designing and making



Topic Web Wind Energy

Language:

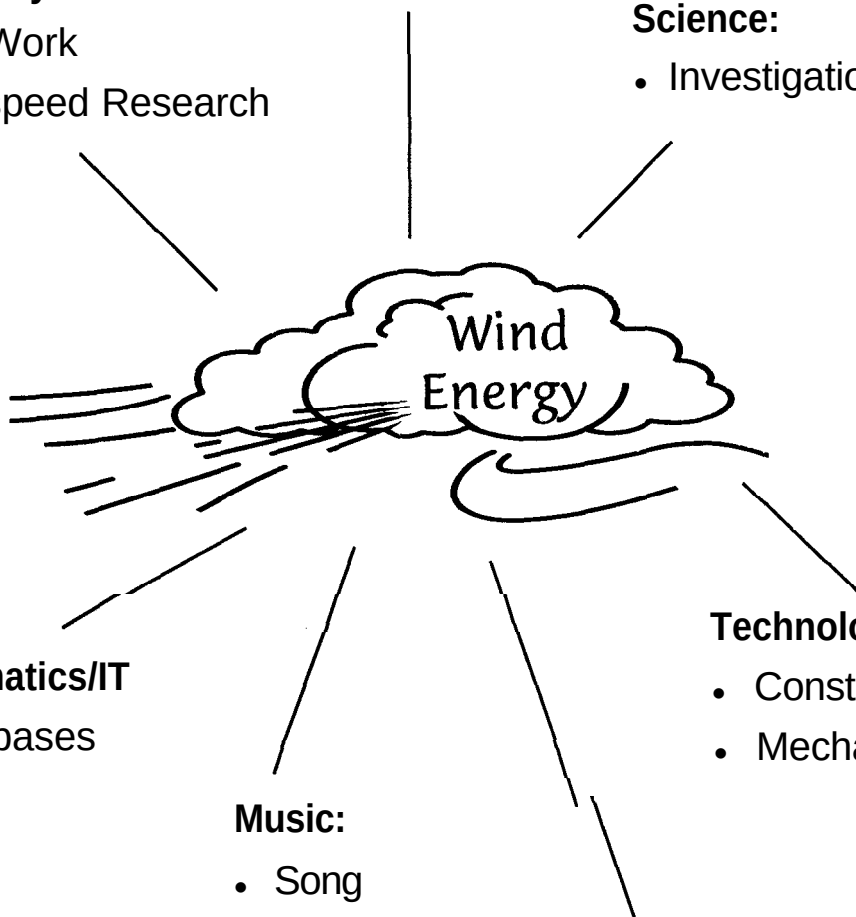
- Debate
- Referendum

Geography:

- Map Work
- Windspeed Research

Science:

- Investigation of Blades



Mathematics/IT

- Databases

Technology:

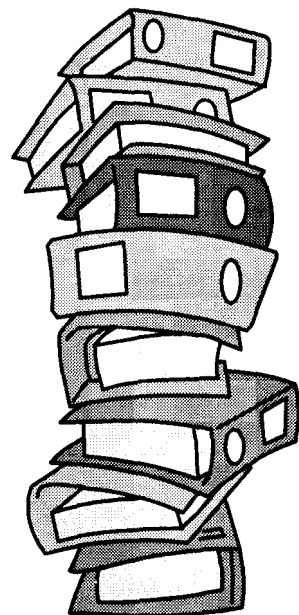
- Constructing Blade
- Mechanism

Music:

- Song

PE:

- Movement



For And Against

No. of pupils: Whole class or large group.

Resources: Pupil sheet 1, scissors and glue.

Aim:

To consider and discuss a range of views both for and against the construction of a wind farm.

Objectives:

1. To know about some of the opposing viewpoints when considering wind energy as a potential source of electricity generation.
2. To practice working cooperatively and collaboratively with their peers.

Method:

1. Give the pupils a copy of the press cuttings (Pupil sheet 1). In groups, the children can sort into two categories - 'for' and 'against'. Do this by cutting and sticking the different opinions into the appropriate columns.
2. Divide the class into large groups and decide which group will be 'for' the wind farms and the other 'against'. Prepare views to present to the other group in a debate situation. The press cuttings (and other books on the topic) will help the children to formulate their arguments.
3. Debate and vote.

Extension Activities:

- The role play situation could be approached from a slightly different angle. The children could be given specific roles to play, eg. representative from the following:

a) Wind Company	b) Local Residents Association
c) The Council	d) The Wildlife Trust
e) The Harbour Commission	f) The Electricity Board
f) Others	
- From the results of the debate the children could write a newspaper report for the rest of the school giving a balanced account of the arguments that were raised by their class.

For And Against

Press Cuttings

Cut out each viewpoint and decide if it is 'for' or 'against' the building of a wind farm. Stick it into the appropriate column on the table below.

FOR	AGAINST

"The wind farm would be an eyesore ".

"The wind is unreliable therefore other forms of electricity are needed".

"Wind energy is a renewable source ".

"Wind energy is non polluting to the environment ".

"The wind power would save burning oil, coal or gas therefore help reduce acid rain and the greenhouse effect".

"Wind turbines cause noise pollution".

"The wind farm will effect the birds ".

"Research shows that not many birds have been killed by wind turbines, unless they are sited in a migratory path ".

"The windmills look a lot better than a huge coal fired power station".

"The windmills will destroy the view ".

"To produce the same amount of electricity as a power station you would need a lot of wind turbines, covering a vast area of land".



Referendum on Wind Power

No. of pupils: Initially in small groups.

Resources: Pupil sheet 2, any sources of information on generating electricity - books, videos (see lists supplied with this pack), newspaper articles; computer for word processing and database compilation.

Aim:

To research all the methods of electricity generation in order to initiate a referendum on building a wind generator in their locality.

Objectives:

1. To know about all the various energy forms used to generate electricity.
2. To become more aware of the problems involved in selling wind power to the general public.
3. To become aware of the concept of a referendum.

Method:

1. The children, in small groups, research all the various methods of generating electricity - each group focusing on one particular method.
2. Each group presents its findings to the class and the whole class debates the arising issues, jointly deciding which aspects are essential for inclusion in an information sheet which will be circulated, along with a voting form, to parent(s)/guardian(s) and other classes (ages permitting) within the school so that they can vote on whether they would be in favour of a wind generator being erected in their locality.
3. Each group takes a turn with the IT facility to add the details of their particular section to the information sheet. As well as the information sheet, a questionnaire-come-voting-form must also be prepared for distribution with the information sheet - Pupil sheet 2 is only an example of a form, as the pupils may wish to suggest their own format after their research.
4. The children circulate the information sheets and voting forms to all necessary participants, and if necessary, make presentations to other classes to help them understand the information if required.
5. Voting forms collected, votes counted, results compiled in a database and displayed on the classroom wall as a bar chart or pie chart.
6. Discussion of the results, including key questions:
 - Were the results as they had expected? If not, why?
 - Do they now think they could sell the idea of wind power to the general public?
7. Pupils write to '**Border Wind**' telling them of their research, referendum and ensuing results.

Referendum on Wind Power

After considering the information provided on Wind Power, would you agree to have a Wind Generator erected near you home. Please tick:

If:	Yes	No
a) Your electricity would cost less than at present		
b) Your electricity would cost the same as at present		
c) Your electricity would cost more than at present		

Is it Just the Wind?

No. of pupils: Pairs or small groups

Resources: Pupil sheet 3, hairdryer, test hub, dowelling, coroflute, bead, cane, knitting needle.

Aim:

The children to be provided the opportunity to understand how wind turbine blades turn when the wind blows over them.

Objectives:

1. The children to make a working rotor blade mechanism.
2. The children to know that it is the pitch (angle) of the wind turbine blades which causes the turning motion when the wind blows over them.

Method:

1. Introduce the children to Pupil sheet 3 and explain the activity.
2. The children make a rotor blade mechanism as per the pupil sheet diagrams.
3. Set the blades for 'test 1' ie in line with the wind source, answer question 1, carry out test 1, and then answer the observation questions 2 and 3.
4. Carry out test 2.
5. Carry out test 3.

To assess if the children have grasped the concept of the pitch of the blades causing the rotation in conjunction with the wind, ask them if they can make it so that the blades will turn the opposite way.

OR

Ask them why they think a real wind turbine's blades are brought in line with the wind when it is required to stop rotating for maintenance work etc.

NOTE:

This activity may be a vital precursor to the 'Catching the Wind' investigation (Activity 2b).

Is it Just the Wind?

Investigation: What makes wind turbine blades rotate?

For each of the three tests on the wind turbine blades answer question 1. before doing the test. Try answering the other questions after observing what happened during the test.

Q1. What do you think will happen when the wind blows over these blades?

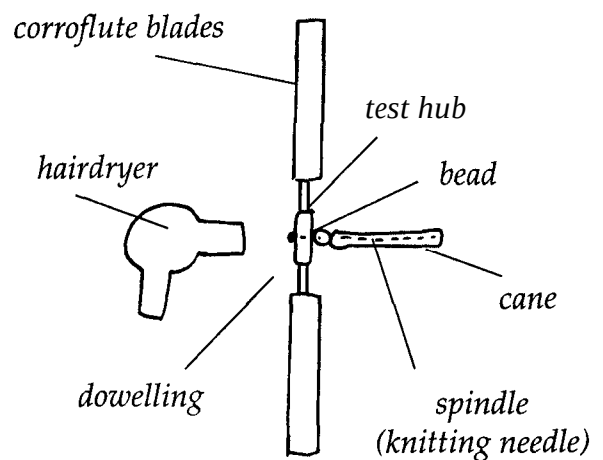
Now try the test.

Q2. What did happen?

Q3. Why do you think this occurred?

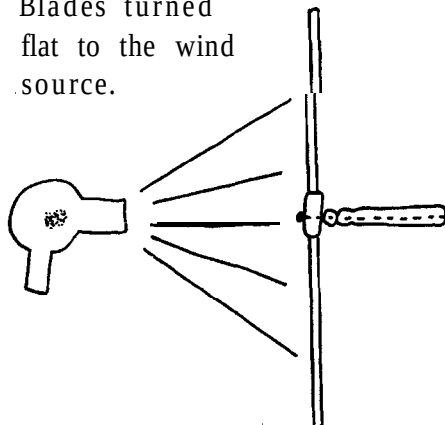
Test 1 -

Blades in line with the wind source



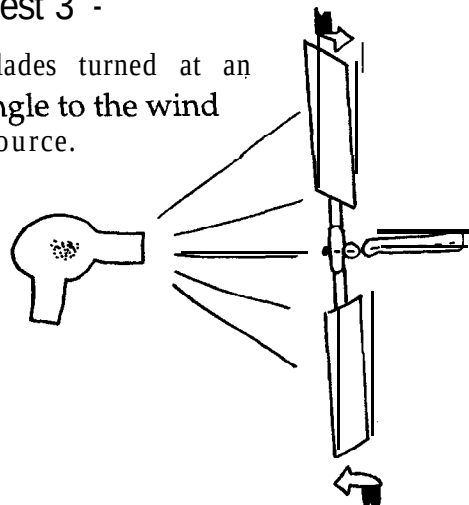
Test 2 -

Blades turned flat to the wind source.



Test 3 -

Blades turned at an angle to the wind source.



Catching the Wind

No. of pupils: Small group.

Resources: Pupil sheet 4, test tube, dowelling, spindle (knitting needle), junior hacksaw, timing device, selection of materials, eg card; corruglute, paper, plastic, etc.

Aim:

To investigate efficiency of blades.

Objectives:

1. To make children aware that changing a variable will effect the efficiency of the rotation of the blades.
2. To develop an understanding of the concept of a fair test.

Method:

1. Assemble a blade mechanism ensuring it rotates with a wind source (if Activity 2a, 'Is it just the Wind?', has been done then the children will already have a blade mechanism).
2. Introduce Pupil Sheet 4.
 - Possible variables could include size, shape, position angle, number and any other suggested by the pupils.
 - Recording methods could be statements, tables, bar charts etc.
 - Make children aware that they must count the number of rotations over a given time - to facilitate counting it would be useful to be able to identify one specific blade, e.g. by making it a different colour or marking it in some other way.

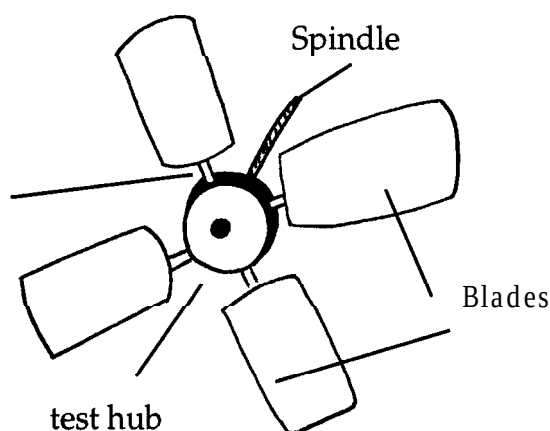
Extension Activities

- Photocopy the Beaufort scale and record wind speeds over a period of time.
- Look at how boats are steered by a rudder.
- Look at feathering of oars in rowing.
- Compare wind turbine blades with aircraft wings.

Catching the Wind

Can you make this
wind turbine,
remember not to
waste resources.

dowelling



Test your turbine and discuss the variable with your group.
Select which variable you would like to change and complete these
statements. Put your name(s) at the bottom of the page.

The variable we are interested in is.....

We will change this variable by

We will need this equipment

We will keep safe by

We expect

..... to happen as a result.

Write about what actually happened and what you found out.

Name(s)

Map Work

No. of pupils: Small group.

Resources: Pupil sheet 5 (map of Blyth Harbour) and Pupil sheet 6 (aerial photograph of Blyth Harbour).

Aim:

The children to be able to recognise on a map features from an aerial photograph.

Objectives:

1. To recognise the landscape features in the area of the wind farm.
2. To be able to compare the photograph with the map.
3. To be able to use a map key.

Method:

Identify the following on the map and number them:

- | | |
|--------------------------|--------------------------|
| 1. <i>wind turbine</i> | 2. <i>alumina depot</i> |
| 3. <i>North Sea</i> | 4. <i>gas works</i> |
| 5. <i>East Pier</i> | 6. <i>South Beach</i> |
| 7. <i>lighthouses</i> | 8. <i>Blyth Harbour</i> |
| 9. <i>West Pier</i> | 20. <i>River Blyth</i> |
| 11. <i>housing</i> | 12. <i>South Harbour</i> |
| 13. <i>power station</i> | 14. <i>jetties</i> |
| 15. <i>Ridley Park</i> | 16. <i>warehouses</i> |

Locate these features on the aerial photograph.

Discussion points:

- Why is there a port at Blyth?
- Why are the turbines on the pier?
- What connections are there between different features?

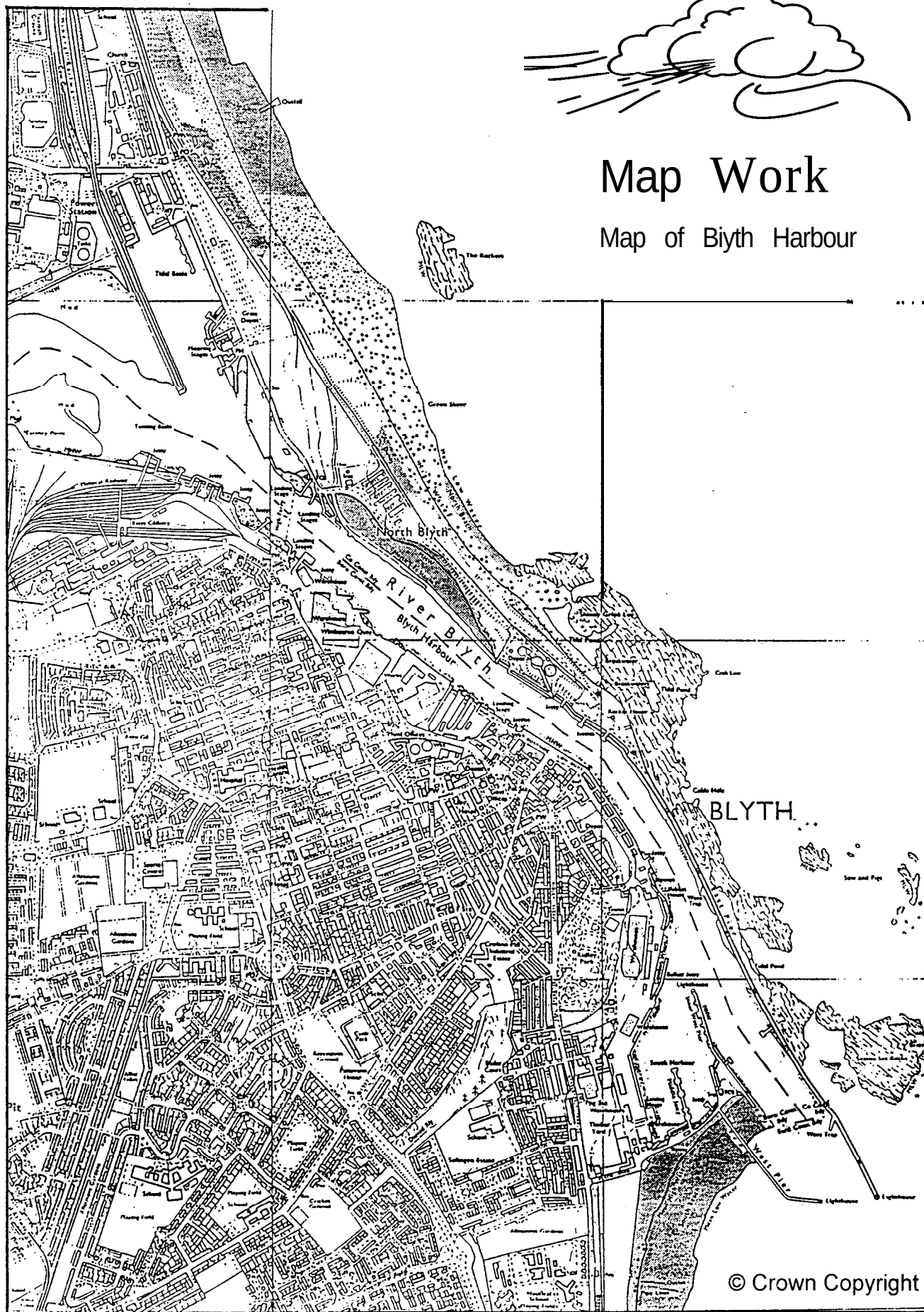
Extension Activity:

Find the area on different maps and compare.



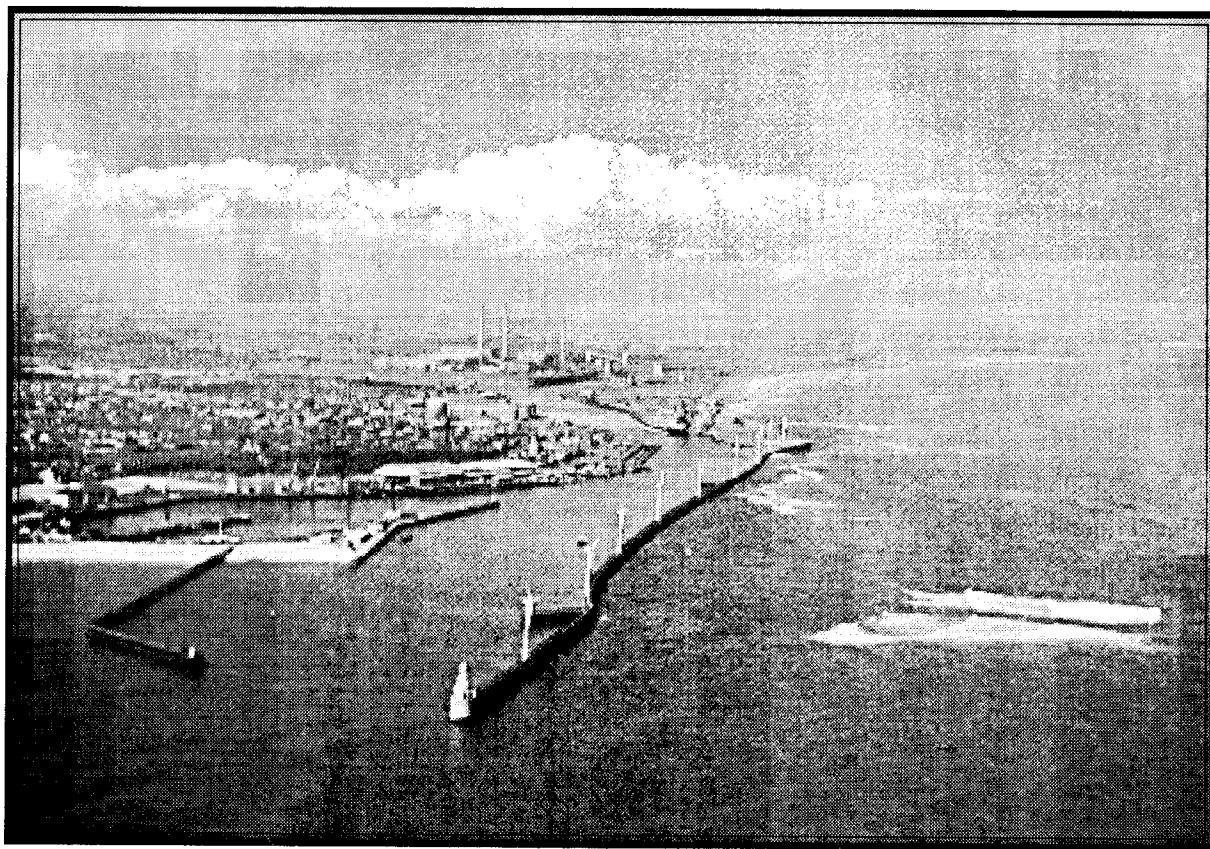
Map Work

Map of Blyth Harbour



Map Work

Aerial photograph of Blyth Harbour.



Can you find these places on the photo?

- | | | |
|-------------------|------------------|-------------------|
| 1. wind turbine | 2. alumina depot | 3. North Sea |
| 4. gas works | 5. East Pier | 6. South Beach |
| 7. lighthouses | 8. Blyth Harbour | 9. West Pier |
| 10. River Blyth | 11. housing | 12. South Harbour |
| 13. power station | 14. jetties | 15. Ridley Park |
| 16. warehouses | | |

Find the Best Site

No. of pupils: Small group.

Resources: Pupil sheet 7, plan/map of school grounds, wind speed measuring instrument (use the blade mechanism from the "Catching the Wind" activity, after formulating a table as to how many times it rotates in the various winds).

Aim:

To find the ideal location in the school grounds for siting a wind turbine - the siting is of crucial importance when constructing a wind farm as twice the amount of wind produces eight times the amount of electricity.

Objectives:

1. To appreciate that some sites are more suitable than others.
2. To develop a fair test for locating the most suitable site.

Method:

1. Draw a plan of the school and grounds.
Or use an Ordnance Survey or architectural map/plan if available.
2. Have a class discussion to decide on a number of places within the school ground which may be possible sites for constructing a wind turbine and mark them on the map.

Divide the map by applying a 3 x 3 grid to it and regarding a point within each of the subsequent squares as a suitable site for a wind generator.
3. Use a wind speed measuring instrument (anemometer), each group of children test and record the wind speed in each of the potential locations over a period of time, formulating the results into a database and deciding on an appropriate method of presenting them. (If wished, the rotor blade mechanisms from activity 2b 'Catching the Wind' can be used as an anemometer, with the children counting the number of rotations in a set time).
4. Draw up conclusions within each group and compare with the other groups.



Find the Best Site

In a small group, measure wind speed in each area of the plan at different times and record the results on the grid below.
Write your names, at the bottom of the page, in the space provided.

3			
2			
1			

Which site do you think would be the best?

What are the reasons for your choice?

.....

Name(s)



The Wind (to the tune of 'Dem bones')

No. of pupils: Whole class - children doing a variety of musical activities.

Resources: Pupil sheet 8 (song sheet), empty plastic bottles (to blow into for wind sounds) suitable instruments for wind sounds, eg. tambourines, bass xylophone (for ostinato part).

Aim:

To help children learn 'through music' - reinforcing, in a fun way, as many aspects as possible of generating electricity by wind power.

Optional Extensions:

The song can be developed in a variety of ways to suit the available time and/or children's musical capabilities:

- The children can do actions as per the word sheet.
- The chorus can build up using equal groups - group 1 singing the first line, then group 2 joining in for the second line, with group 3 joining on the third line, and finally the whole class singing the fourth line.
- During each verse a group could keep the chorus going at a quieter volume.
- At appropriate places, eg. each time the wind is mentioned (especially the chorus), some children could imitate the noise of the wind by blowing into the empty plastic bottles, shaking tambourines, or employing verbal sounds.
- An ostinato part can be included with either untuned percussion instruments repeating the basic rhythm pattern of the tune, or tuned percussion playing a part arranged by the teacher (or both).

Activity 4a: Teacher Briefing Sheet 8

The Wind (to the tune of 'Dem bones')

CHORUS: The wind, the wind, the strong wind,
the wind, the wind, the strong wind,
the wind, the wind, the strong wind,
it turns the turbines 'round.

SONG

Verse 1:

Now the wind it turns the rotor blades,
and the blades are connected to the gearbox,
and the gearbox speeds up the turning,
all from the power of the wind.

CHORUS

Verse 2:

Now the gearbox is connected to the generator,
and the generator makes the electric power,
and the electric power travels through the cables,
that go to the national grid.

CHORUS

Verse 3:

Now the cables are supported by pylons,
as they bring the electric to the houses,
and the houses are connected to the appliances,
giving all the power they need.

CHORUS

Verse 4:

When in your houses what does it do?
Plug into the sockets and switch on too.
It'll work your telly or boil the kettle for you.
Now that's the power of the wind.

CHORUS

Verse 5:

Producing this 'lectric hasn't damaged the world,
no sulphur filled clouds have been unfurled,
no radio activity in the air.
The others don't compare.

CHORUS X2

SUGGESTED ACTIVITIES (children in a line)

Child turns arm as per rotor.

*2 children, 1 with slow turning arm
- the other fast.*

*Child forms a circle with arms as
per a coil and another rotates an
arm inside the circle as per a
magnet.*

Child standing as pylons.

Make roof shape with arms.

Eg. Child ironing.

Roof shape with arms again

Actions of plugging in etc.

Switch on TV and drink tea.

Thumbs-up sign.

Hold up skull and crossbones sign.

Act as dying.

Thumbs-down sign.

The Wind

(sung to the tune of 'Dem bones')

CHORUS: The wind, the wind, the strong wind,
the wind, the wind, the strong wind,
the wind, the wind, the strong wind,
it turns the turbines 'round.



- 1 Now the wind it turns the rotor blades,
 and the blades are connected to the gearbox,
 and the gearbox speeds up the turning,
 all from the power of the wind...
 CHORUS
- 2 Now the gearbox is connected to the generator,
 and the generator makes the electric power,
 and the electric power travels through the cables,
 that go to the national grid...
 CHORUS
- 3 Now the cables are supported by pylons,
 as they bring the electric to the houses,
 and the houses are connected to the appliances,
 giving all the power they need...
 CHORUS
- 4 When in your houses what does it do?
 Plug into the sockets and switch on too.
 It'll work your telly or boil the kettle for you.
 Now that's the power of the wind...
 CHORUS
- 5 Producing this 'lectric hasn't damaged the world,
 no sulphur filled clouds have been unfurled,
 no radio activity in the air.
 The others don't compare...
 CHORUS X2

Strong Structures

No. of pupils: Small groups.

Resources: Pupil sheet 9, card, weights, supports, weight holders.

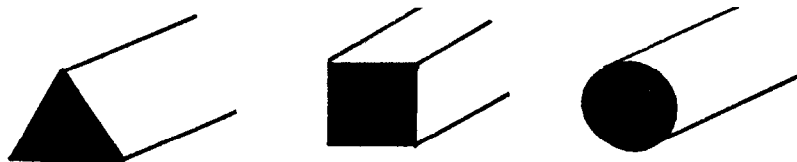
Aim:

This activity investigates the strength of cross sectional shapes and how the shape of a structure can influence its strength.

Method:

1. Ask each group to measure carefully and cut strips of paper approximately 30cm long and 15cm wide.
2. Support one piece of paper at each end using the weight holders, books, or bricks. Suspend a weight holder from it and add different weights until it buckles (weights can be made prior to the activity using plastic balls or cubes).
3. Ask the pupils to design different structures using the other strips of paper altering the cross section each time.

eg.



4. Photocopy Pupil sheet 9 and distribute to each pupil.
5. Ask the pupils to complete and record their results on the chart.

Extension Activities:

- Investigate different structures and strengths ie. chimneys, scaffolding, flagpoles, chair legs, oil rigs.
- Does the structure weaken if you cut shapes out of the paper?
- Does the direction of air on the shape affect its performance?

Strong Structures

Draw and label a diagram of your test.

Record the activity in the spaces provided:

Name of cross section	Draw the cross section	Weight supported	What happened
1. Square			
2. Triangle			
3. Circle			
4. Hexagon			
5.			

Which structure supported the heaviest weight? ..a....*

Write about what you did and what you found out.



The Tower of Strength Proposal

No. of pupils: Whole class divided into 'teams'.

Resources: 18cm diameter paper plates, variety of papers, sellotape, brass splayed pins, hairdrier and stand, placement, variety sized cereal packets or household matches, 1/2 kilo weights, scissors, pencils, alarm clock.

Aim:

Each group constructs a tower which supports a weighted nacelle.

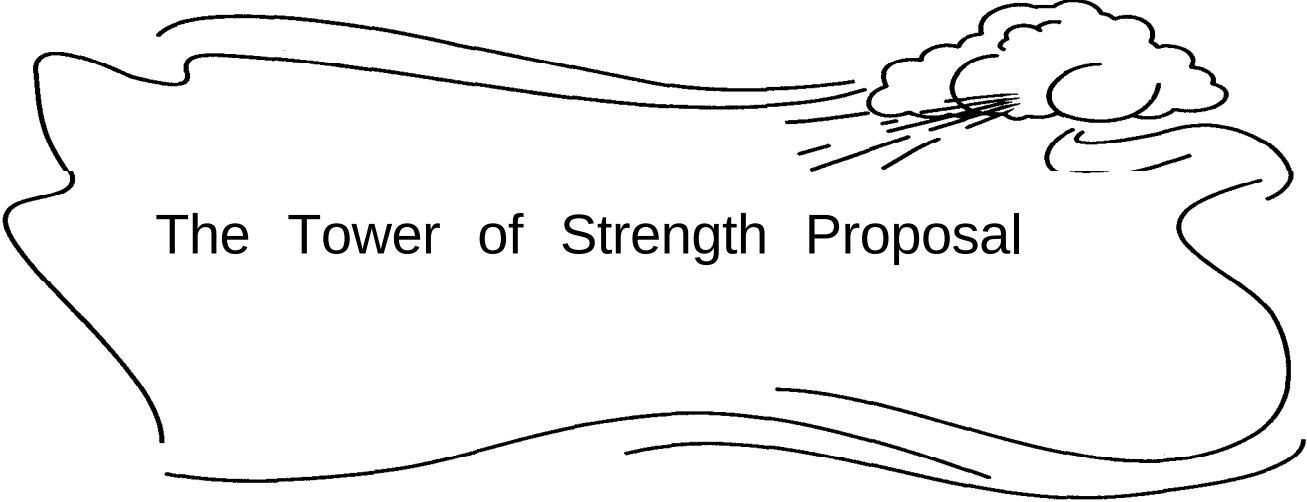
Objectives:

This activity develops problem solving, communication and team building skills. It tests each team's ability to build a strong tower which can support a nacelle of equal weight and withstand a constant wind force.

1. Divide the class into groups of 5. Photocopy and distribute Pupil sheet 10 and 11 to each team.
2. Allow 20 minutes for teams to select jobs, design a logo name and design the tower.
3. Use one table as a 'store' and display a range of papers for sale. Price them according to quality and availability eg. newspaper £10 per sheet, recycled £15, white photocopy paper £25.
4. Set the alarm clock for 45 minutes and open the store, when the alarm goes off the store must close and teams must stop.
5. Test each team's design by standing their turbine on a place mat which is 1 metre from the hairdrier.
6. Discuss and evaluate each design feature and how they could be improved.

Extension Activities:

- Invite an engineer to evaluate designs.
- Vary the distance of the hairdrier and test again.
- Put an axle through the rotor and the box to protrude beyond the box, attach string with a small weight to it.
- See if the turning rotor can lift the weight.
- Investigate the possibilities of using the designs for developing countries.



The Tower of Strength Proposal

The Company:

You are a small construction and engineering company.

Decide on a name and a 'logo' for your company

As a group you must negotiate a job role within your company:

- | | |
|------------------------------------|---|
| Construction Engineer: | <i>you supervise the design of the wind turbine.</i> |
| Materials Buyer/Accountant: | <i>you decide upon cost and purchase materials from the store. Remember you want to achieve greatest strength for the least cost. You work with the engineer to build the turbine.</i> |
| Quality Control Manager: | <i>you must check the quality of everyone's work including your own. You should make sure that everyone has thought about each others role eg. engineer wants most expensive paper, accountant cheaper variety.</i> |
| Production Controller: | <i>you must note the reasons for decisions and make a poster selling the turbine.</i> |

Task:

Your company has been asked to put forward a proposal to build a wind turbine tower for a new wind farm.

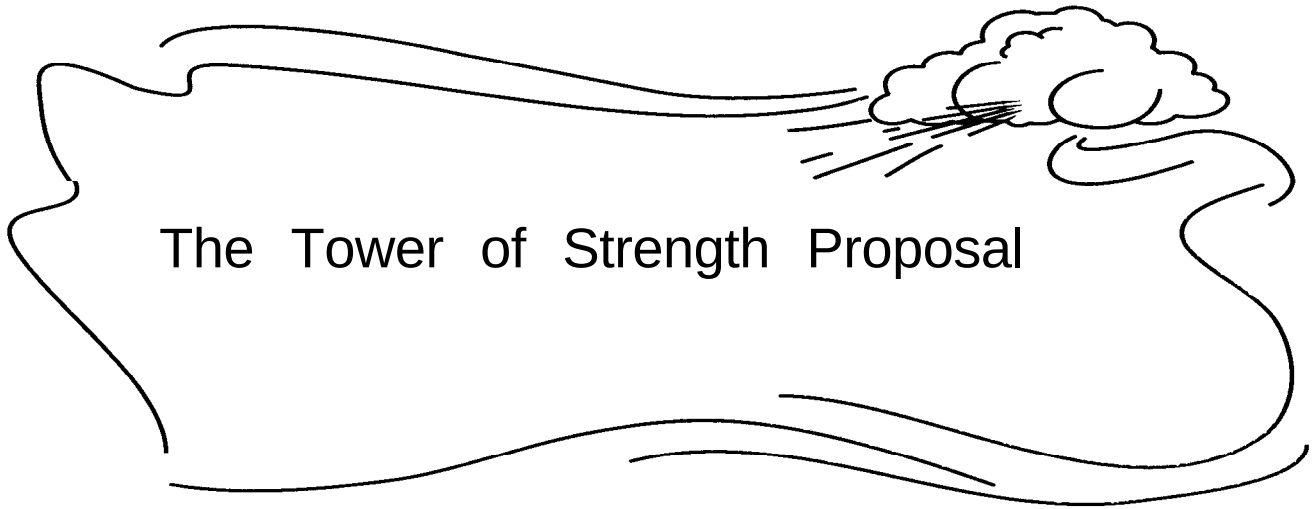
You must build a Nacelle (see Pupil sheet 11 for instructions) and construct a tower strong enough to support the Nacelle. The tower must stand 50 cm from the ground. It must be strong enough to withstand a constant wind force.

You must purchase the paper materials from the store and record your costs on the balance sheet.

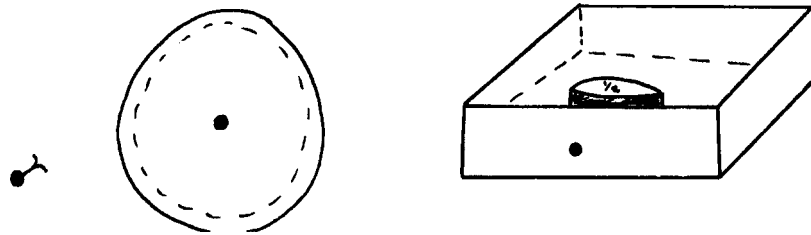
Your design must be ready for demonstration when the alarm rings after 45 minutes.

Designs will be judged on strength, cost and attractiveness.

Activity 5: Pupil Sheet 11



Attach the plate to the box using the splayed pin.



You may attach the nacelle to your tower using 30 cm of sellotape.

Balance Sheet

Company Name:

Type of material	No. of pieces	Cost per sheet	Total
Grand total			

Shrinking Turbines

No. of pupils: Individuals.

Resources: Pictures of wind farms, poles, paper, pencils.

Aim:

To introduce the children to the principles of perspectives with a focus on a row of wind turbines, for example Blyth Harbour Wind Farm.

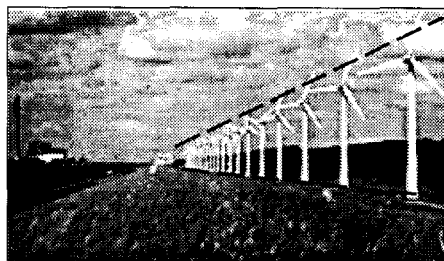
Objectives:

The children to produce a picture using the principles of perspective.

Method:

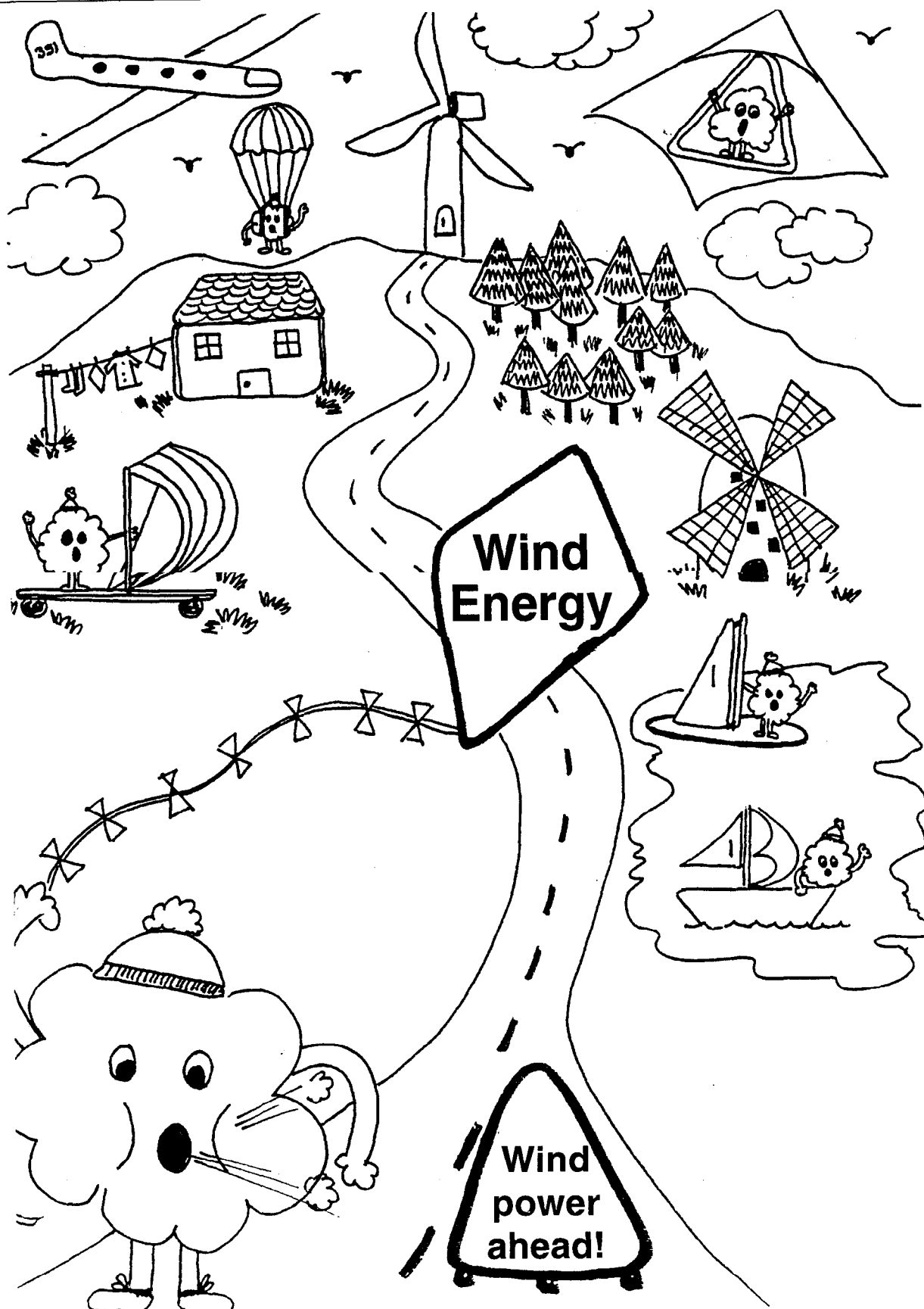
1. If the class has the opportunity to visit a wind farm, draw their attention to the apparent visual differences in size between the wind turbines ie. the further away they are the smaller they appear. How can this be when each turbine is the same size? This can also be seen on the picture below or any other pictures of wind farms.
2. At school. Choose 4 children who are the same size or 4 poles of equal length. On the school field or a large area position the children or poles out at equal intervals. Ask the rest of the class to observe. Ask them the following questions:
 - Who looks the tallest?
 - Who looks the smallest?
 - What other things look smaller when they are further away? (eg. lampposts, boats at sea, streets of houses etc).
3. Ask the children to draw a row of wind turbines in perspective. To help them it may be useful to draw guidelines for them, as shown below.

To assess if the children have grasped the concept of perspective, look to see if they have drawn larger turbines in the foreground and smaller ones in the background.

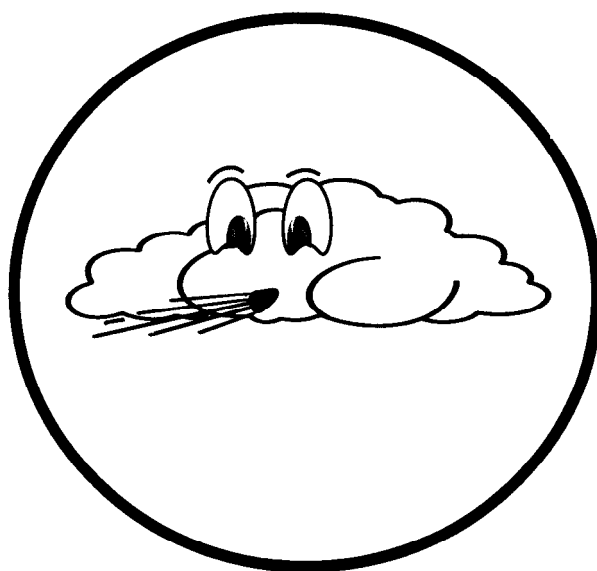
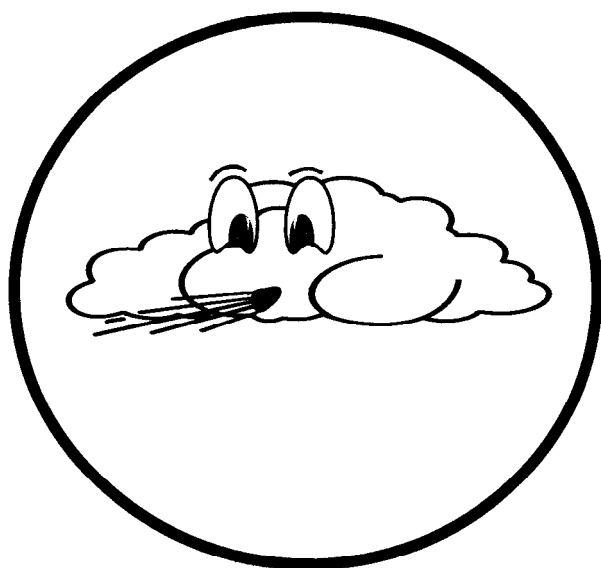
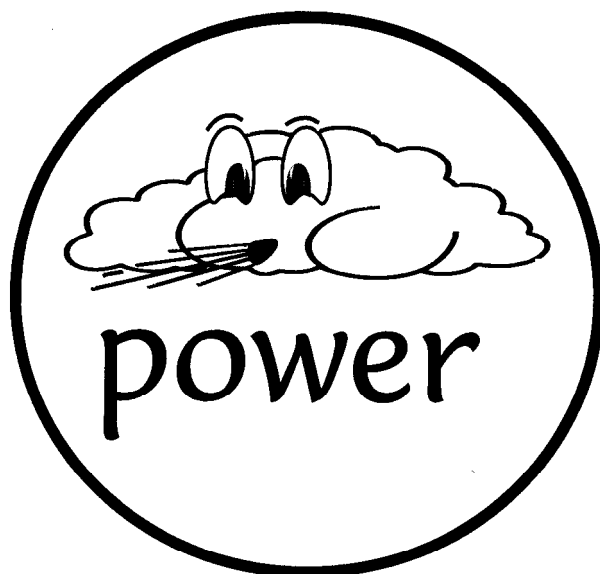


guidelines

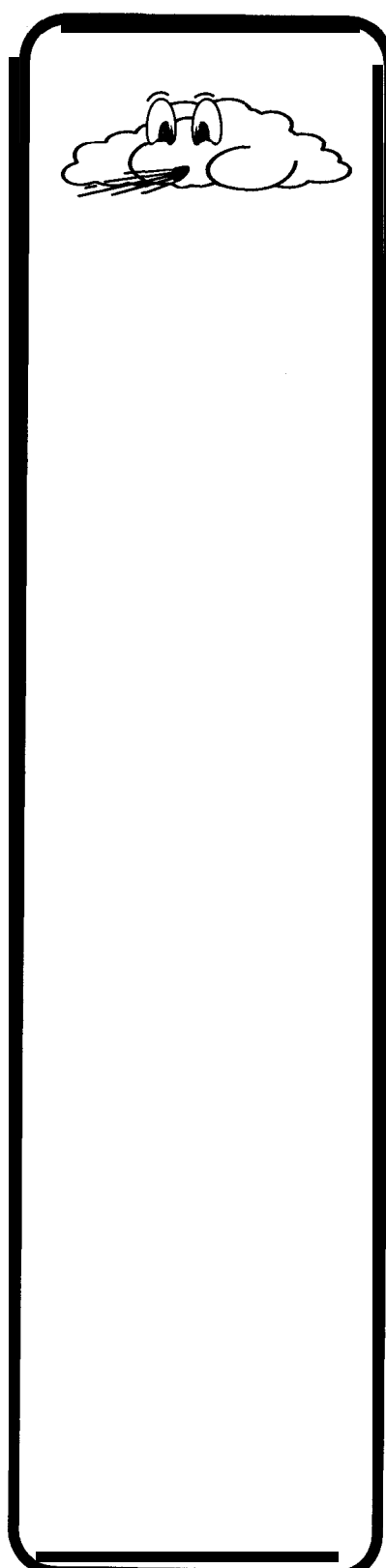
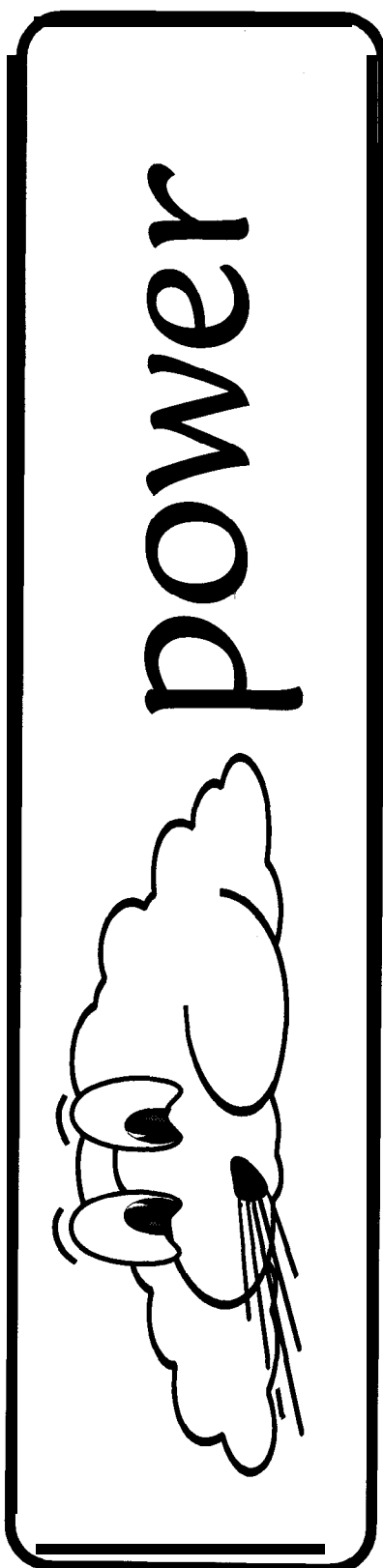
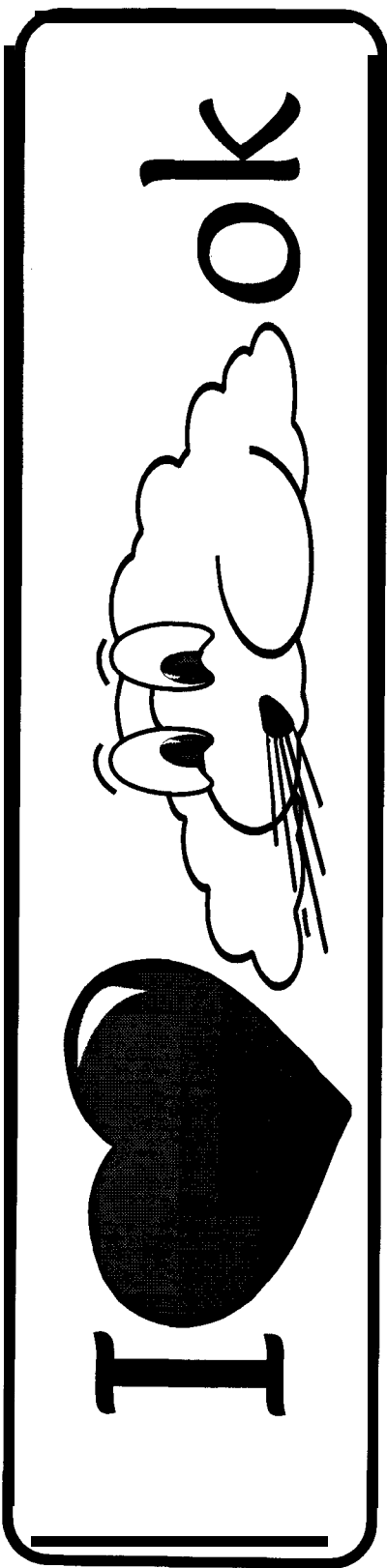
Wind Energy Poster



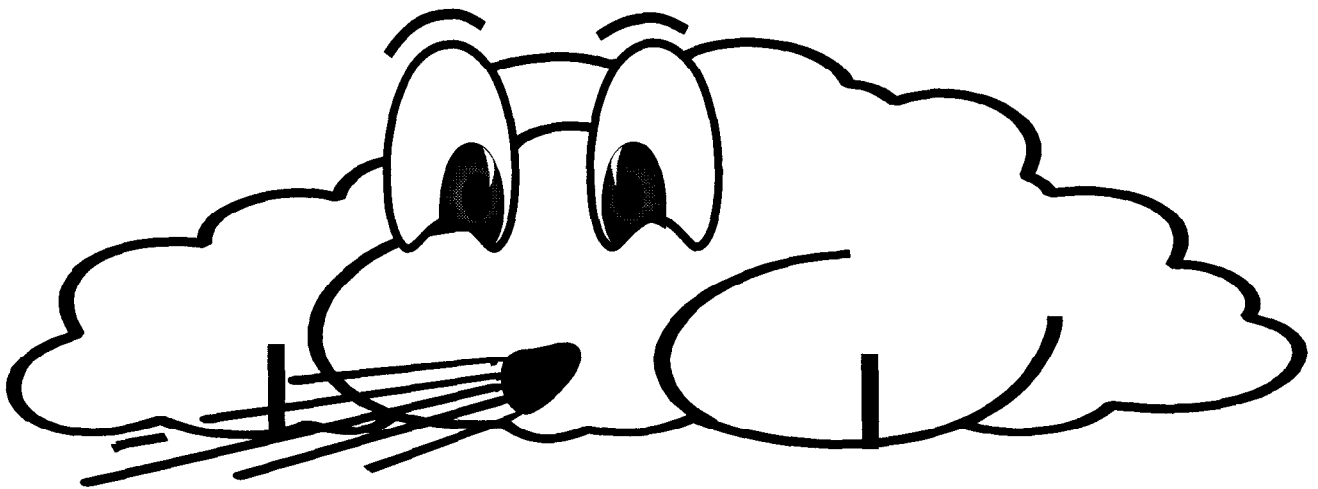
'Windy' Badges



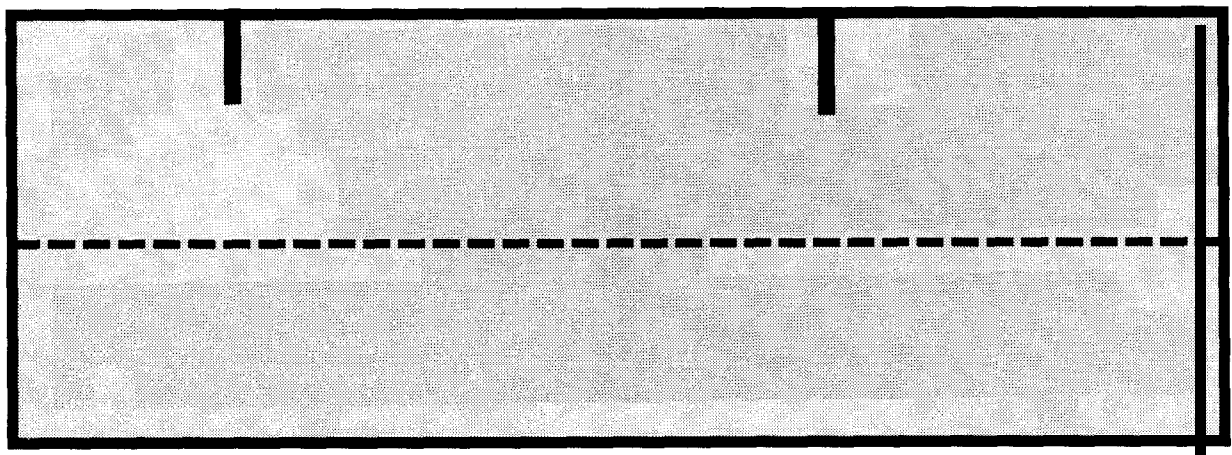
Windy Bookmarks



Stand up Windy!



Stand base.



The Beaufort Scale

0 Calm



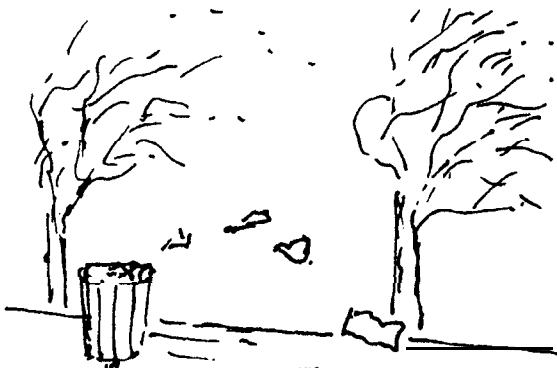
Air is still. Smoke rises vertically.

2 Light Breeze



Leaves rustle. Wind felt on face.

4 Moderate Breeze



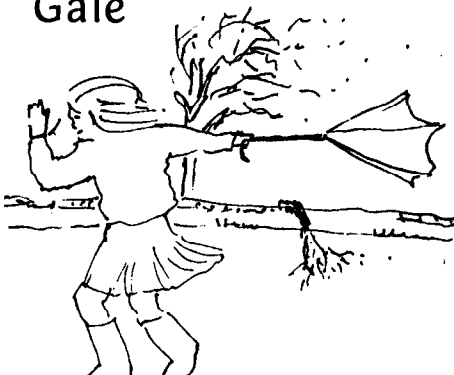
Litter blows about.
Small branches move.

6 Strong Breeze



Large branches move.
Wires whistle.

8 Gale



Walking is difficult.
Twigs break off trees.

10 Storm



Trees blow over.
Damage to buildings.

Additional Resources

Wind Vocabulary

ANEMOMETER	a device for measuring wind speed.
BLADES	the 'sails' which turn at the top of the wind turbine.
ELECTRICITY	charged particles which flow producing heat, light etc.
ENERGY	production of motion, heat, light etc.
ENVIRONMENTAL STATEMENT	a document giving details of how a local environment or site will change as a result of a development.
GENERATOR	a machine which produces electricity.
KILOWATT	a watt is a unit of power named after Scottish inventor James Watt. A kilowatt is 1000 watts. 1000 watts produced for one hour is a kilowatt hour or one unit of electricity.
MEGAWATT (MW)	1 MW equals 1000 KW.
NACELLE	the box like compartment at the top of the tower.
NATIONAL GRID	the country's system of power lines for distributing electricity.
NFFO - SRO - NIO	Non-Fossil Fuels Obligation, (England and Wales), Scottish Renewables Obligation, Northern Ireland Obligation - an obligation placed upon regional electricity suppliers to buy a percentage of their electricity from renewable sources.
PHOTOMONTAGE	a photograph with images of wind turbines grafted on the positions in which it is intended they will be erected.
PITCH CONTROLLED	the way the blades angle themselves in and out of the wind to control their speed.
POWER	the rate of production of energy.
RADCOMS	radio communications - television, radio, radio telephone and microwave links.
TOWER	the conical or cylindrical steel structure which supports the nacelle and blades at the required height from the ground.
UNIT	a kilowatt hour of electricity, the pricing blocks in which electricity is measured for billing. One unit costs between 7.21p and 7.67p (domestic consumption).
VISUAL IMPACT	the effect something has upon the eye when viewed in its environment.
WIND ENERGY	the energy in the wind.
WIND FARM	a group of wind turbines which produce electricity to feed into the National Grid.
WIND POWER	the power of the wind.
WIND RESOURCE	the amount of useable energy in the wind at a given site.
WIND TURBINE	a machine for generating energy from the wind (the name for a modern windmill).
WIND VANE	the 'rudder' at the back of the nacelle which detects the wind direction.
YAW	to turn the nacelle in or out of the wind (responding to information from the wind vane).
ZVI	zones of visual influence - the areas around a development, such as a wind farm, from which it is possible to see some or all of a wind farm, usually represented by an overlay which fits a

Useful Contacts

BLYTH HARBOUR WIND FARM COMPANY LIMITED
The Old Pilots House, Import Dock
Blyth, Northumberland
NE24 3PA
Tel: 01670 540601

BORDER WIND LIMITED
Haugh Lane Industrial Estate
Hexham, Northumberland
NE46 3PU
Tel: 01434 601224 Fax: 01434 601200
Internet: <http://www.bordwind.demon.co.uk>

BRITISH WIND ENERGY ASSOCIATION
26 Spring Street
London
W2 1JA
Tel: 01714027102 and 01714027107
Internet: <http://www.bwea.com>

CENTRE FOR ALTERNATIVE TECHNOLOGY
Machynlleth
Powys
SY20 9AZ
Tel: 01654 702400 Fax: 01654 702792
Internet: <http://www.foe.co.uk/cat>

WIND & SUN
The Howe
Warlington, Oxford
OX9 5EX
Tel: 01491 613859 and 01491614164

RENEWABLE ENERGY ENQUIRY BUREAU
Energy Technology Support Unit
Building 156
Harwell Laboratory
Oxfordshire
OX11 0RA
Tel: 01235 433302 Fax: 01235 432923

WIND ENERGY GROUP
Taywood House
345 Ruislip Rd.
Southall, Middlesex
UB1 2QX
Tel: 0181575 9428 and 0181575 8318

Useful Videos

Energy: Turn to the Wind

Zig Zag. Coach Lane Library TP.621.45 ZIG

This video includes a short observation quiz on household appliances which use electrical energy. It includes some good ideas on making windmills. It also has some interesting footage for a coal-fired power station and how much coal has to be burned to generate electricity,

Energy: Future Generation.

Technology Programme: Design and Technology No 3 Coach Lane Library TP.600 TEC.

Compares the use of energy sources in Britain and Sweden. Really focuses on the environmental issues related to generating electricity - the pollution and the greenhouse effect. Has some good footage on the effects in Sweden of acid rain caused by burning fossil fuels in Britain. Highlights the debate on nuclear energy and tells about the referendum in which the Swedish people voted to discontinue all nuclear generation because of the dangers.

Energy: Questions of Energy.

Technology Programme: Design and Technology no 6 Coach Lane Library TP.600TEC.

Tries to explain the issues surrounding energy in a simple way for children, although it may still be too advanced for primary school children. Good footage on smoke rising from fossil fuel power stations in Britain. Highlights global warming. Gives comparative timescale (in minutes and seconds) of the effect man has had on the world since starting to generate electricity, and how soon things must change if we are not to destroy the environment.

Energy: An Alternative View.

Technology Programme: Design & Technology No 10 Coach Lane Library TP.600 TEC

Made at the 'Centre for Alternative Energy' in Wales where the whole community depends solely on alternative sources of energy and therefore includes excellent information about all the alternative 'renewable' sources of energy, with a great deal of information on various types of wind generators and rotors. Also some excellent information on energy conservation.

Other Useful Information Sources

BEAUFORT WIND SCALE

Fun with Science

Brenda Walpole, Pub. Kingfisher. **p79**

Be an Expert Weather Forecaster

B Taylor-Cork, pub. Gloucester Press. **p18/19**

Time and Place (Geography 1: Teachers Handbook)

P Harrison and S Harrison, pub. Simon and Schuster. **p40**

(Also includes a 'Wind Rose' for recording measurements - **p42**)

WIND SONGS

'The Windmill' Flying A Round by D Gadsby and B Harrop. No **54**
'Little Wind' pub. A and C Black

'Weather Song' Tinder-Box by S Barratt and S Hodge. No 41
'Who has seen the wind' No 44 pub. A and C Black

'Wind in Summer' Assemblies Round the Year by B Birch, pub. Ward Lock.
p94

DANCE AND MOVEMENT

'Flying Like the Wind' Bright Ideas, Dance and Movement by K Harrison, J Lay
Ton, M Morris, pub Scholastic. p **18/19**

POEMS

'Mad March Wind' Bright Ideas Seasonal Activities by Janet Eyre, pub
Scholastic. **p13**

'The Wind' A Puffin Quartet of Poets. **p91**

'The North Wind Doth Blow' A Puffin Book of Verse, compiled by E Graham. **p28**