Wind Farms

Teacher Support Materials

Black Law Interactive PDF on CD-ROM

SCOTTISHPOWER
RENEWABLES

Supporting A Curriculum for Excellence Levels 2 and 3 (5-14 Levels D-F) in:

Science
- Sustainability
- Climate and Earth Science
- Energy Transfer and Sources
- Topical Science

Social Studies (People, Place and Environment
Technologies

Developed by Ruth Ruthven of Innovative Learning Projects for ScottishPower Renewables

THE QUEEN'S AWARDS FOR ENTERPRISE: SUSTAINABLE DEVELOPMENT 2006

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User Guide

How to Navigate This Resource

On the contents page click on any section name to take you to that section. When within any section click anywhere on the page to take you to the next page, hold down your shift key and click anywhere on the page to go to the previous page. At the end of any section click on the 'Return to Contents' button to go back to the contents page.

How to Print This Resource

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How to Search This Resource

Exit full screen mode, then go to Edit Menu and click on Find or Search.

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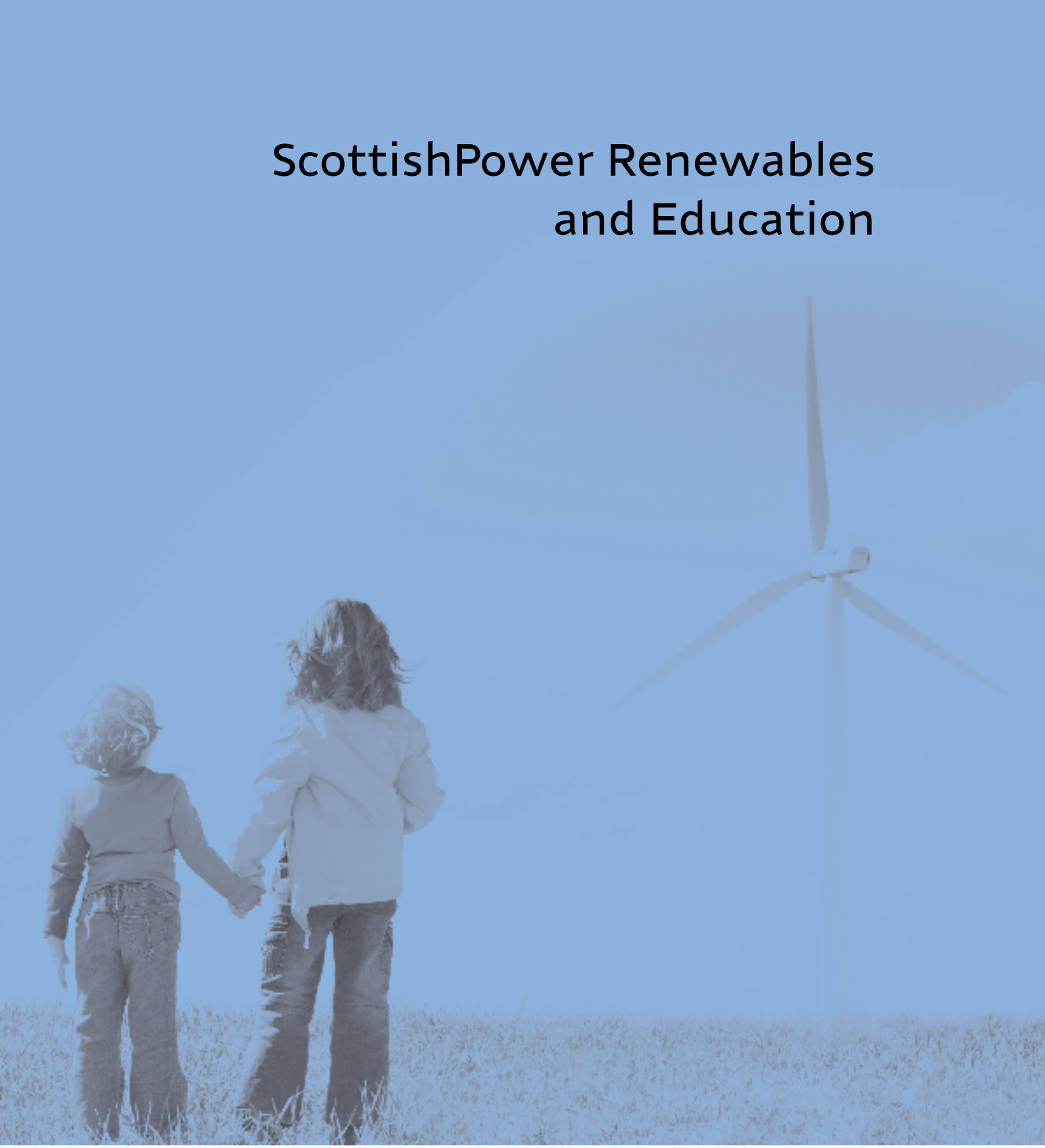
ScottishPower Renewables and Education



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ScottishPower Renewables and Education

The education of young people is a significant factor for ScottishPower Renewables to consider in its development of renewable sources of power.

Keith Anderson

"The major objective in developing new renewable energy sources like Black Law wind farm is to provide the energy required by society without increasing the rate of climate change. This puts us at the forefront of moves to meet our current needs without undermining the needs of future generations.

So we think it is important that our children can understand why we are building new wind farms and shaping the local landscape where they will grow up.

By providing young people with an experience relating to wind farms, it is our aim to allow pupils to draw their own conclusions about energy provision and its effects on our environment. Developing an education pack that helps teachers by supporting the curriculum is a fundamental part of this process. To this end, the experience of Ruth Ruthven of Innovative Learning Projects was absolutely essential and I would like to thank her for her dedication and hard work.

I would also like to thank our teacher focus group of South Lanarkshire primary and secondary teachers, and Careers Scotland who organised their placement with us, for their invaluable input to this project.

I hope that you will find this pack of use in helping to explore this high profile subject in a way which informs and excites children."

Keith Anderson,
Director, ScottishPower Renewables

Our Thanks

Our grateful thanks to Adrienne Dickson (Crawforddyke PS), Elizabeth Galloway (Biggar HS), Karen Hutchison (Forth PS), Emma Jackson (Carluke PS), Alistair Proctor (Lanark Grammar School), John Shearer (Carluke HS) and Jennifer Millar (Careers Scotland).

ScottishPower Renewables is grateful to the team at Paligap who contributed so much to the clarity and usability of this pack.

Glasgow Science Centre provided some of the materials which are used in this pack.

Introduction to Black Law Wind Farm

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Introduction to Black Law Wind Farm

The environmental challenges facing our planet are enormous, and there is a great need to reduce emissions of greenhouse gases radically in order to prevent global warming / climate change.

Developing a wind power resource is key to this aim.

Black Law wind farm, near Forth in South Lanarkshire, is the UK's largest built wind project to date.

The £90 million wind farm delivers an output of 124MW from 54 turbines - enough clean, green energy to power 69,000 homes!

The project is located on the site of an abandoned opencast mine which was completely restored to wet grasslands by ScottishPower Renewables during the wind farm construction programme.

Black Law has taken this badly scarred site and vastly improved it, reversing the damage done by the opencast mining. As well as improving the landscape, this has benefited a range of wildlife, notably breeding waders and farmland birds.

The wind farm also incorporates an extensive habitat management project, covering over 14 square kilometres (equivalent to approximately two thousand football pitches), the largest such project ever undertaken by any UK wind developer.

ScottishPower Renewables has worked closely with environmental bodies including RSPB, Scottish Natural Heritage, local councils and the landowners to create suitable habitats to encourage valued species such as long-eared owls, black grouse, farmland birds and water-vole.

The local communities of Climpy and Forth played an essential role in the development of the project, providing valuable information to allow the project to be designed in the most appropriate manner.

These communities are also benefiting directly with the creation of a Trust Fund, providing annual funds to promote local projects of an environmental, educational or charitable nature.

Electrical Safety

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Electrical Safety

Electricity can be Dangerous

Our top priority is to protect employees, contractors and members of the public from harm. The following two pages provide some vital safety messages.

A Straight Path

If a source of electricity is connected to the ground, the electricity will flow to the ground. The easiest way for it to get to the ground is through water or metal as these are the best conductors.

Since our bodies are made mostly of water, we are good conductors of electricity.

If you touch a live wire and the ground at the same time, electricity can flow through you and kill you or seriously injure you.

Watch Out for Water

Since water is an excellent conductor of electricity, you can be killed or seriously injured if you are touching water that touches electricity.

Electricity can travel through the water and through you to the ground. This is why it is important to make sure your hands are dry and you are not standing in water when touching anything electrical. Keep electrical appliances away from water (like the sink, shower or bath).

Respect!

Electricity should be treated with care because it can be dangerous if not handled properly. Please use these safety tips as reminders for both yourselves and your pupils:

In the Home

- Never use an electrical appliance while in the bath or shower.
- Keep electrical cords and wires away from heat and water.
- Never touch any electrical appliance while your hands are wet.
- Be sure to unplug appliances before cleaning them.
- Don't plug too many appliances into one socket. This may cause a fire hazard.
- Switch off electrical appliances when not in use. Don't leave them on standby. Energy is wasted when they are left on and switching them off acts as a precaution against fire too.
- Don't put anything except plugs into electric sockets - no fingers or toys.
- Ask parents to put in plastic guards in sockets if there are small children in your home.
- Don't pull on the cables to unplug appliances. Hold on to the plug itself to remove it.
- Tell an adult if you see a frayed cable or loose wires.

Electrical Safety

- Never touch broken plugs or loose / worn wires.
- Tidy cables out of the way - someone could trip and hurt themselves.

Playing Outside

- Don't climb or play near power lines. You can be electrocuted even if you don't touch an electrical wire. High voltage electricity can jump gaps!
- Don't climb trees that are close to power lines.
- Don't fly kites or model airplanes near power lines.
- Don't go fishing near power lines.
- Stay away from power equipment boxes / substations etc. or anything marked **DANGER**, **HIGH VOLTAGE** or **KEEP OUT**.
- Never play near or in a substation. You could be killed.
- Never attempt to rescue toys from substations. You could be killed.

Working Outside

- Use circuit breakers on lawnmowers / strimmers etc. to prevent electrocution should wires be cut accidentally.

Further Help with Electrical Safety

"Be Safe with ScottishPower" is a highly effective electrical safety initiative provided to primary school children aged between 5 and 11 years by ScottishPower Energy Networks.

Professionally qualified teachers, wearing ScottishPower uniforms and hard hats present fun and engaging interactive lessons that deliver potent messages on the theme of electricity safety in the home and the wider environment. In addition to the classroom lessons, each school is provided with a resource pack containing educational games, technical information, leaflets, and lesson plans which support the Scottish curriculum and the national curricula for England and Wales.

Our dedicated children's safety website at www.ollieandsparky.co.uk further supports the lessons and provides schools with a valuable resource for future lessons, reinforcing the points made during the *"Be Safe with ScottishPower"* lessons.

Written evaluations provided by the schools following the lessons are highly encouraging and indicate a satisfaction level of over 99%.

The *"Be Safe with ScottishPower"* schools programme and the website are available at **no cost** to schools, for further information please contact us at ensafety@spenenergynetworks.com

About the Teacher Support Materials

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About the Teacher Support Materials

The Teacher Support Materials provide easy-to-implement activities for pupils studying Science, Social Studies and Technologies within A Curriculum for Excellence at the 2nd and 3rd Levels (5-14 Science, Social Subjects and Technology Levels D-F).

Key Topics within the Pack

The key topics covered within the pack are:

- Science: Planet Earth: Sustainability
- Science: Planet Earth: Climate and Earth Science
- Science: Planet Earth: Energy Transfer
- Science: Planet Earth: Energy Sources
- Science: Topical Science
- Technologies
- Social Studies: People, Place and Environment

How to Use this Pack

Each of the lesson suggestions may stand alone, or alternatively can be used as part of a wider study.

We don't expect you to carry out every activity, but the ones that are important to put the wind farm DVD in context for your pupils are marked with the smiley face symbol at the top of this box.

The DVD

The DVD provides images of Black Law wind farm, information on why Black Law was chosen as a good wind farm site, how the wind farm was built, and how it is operated. It can be used by itself or to support lessons in this pack.

Categories to explore within the DVD are:

- Introduction To Black Law Wind Farm
- Why Build Wind Farms?
- Choosing A Wind Farm Site
- Building A Wind Farm
- How Wind Turbines Work
- Controlling Wind Turbines
- Working with Wind Farm Communities
- SCADA Game Instructions
- DVD Extras - Habitat Management Plan
- DVD Extras - Power from The Sea: Wave Power
- DVD Extras - Power from The Sea: Tidal Power

What does the 'Smiley' symbol mean?

We don't expect you to carry out every activity, but the ones that are important to put the wind farm DVD in context for your pupils are marked with a ☺ in the top of this box. We highly recommend you cover these.

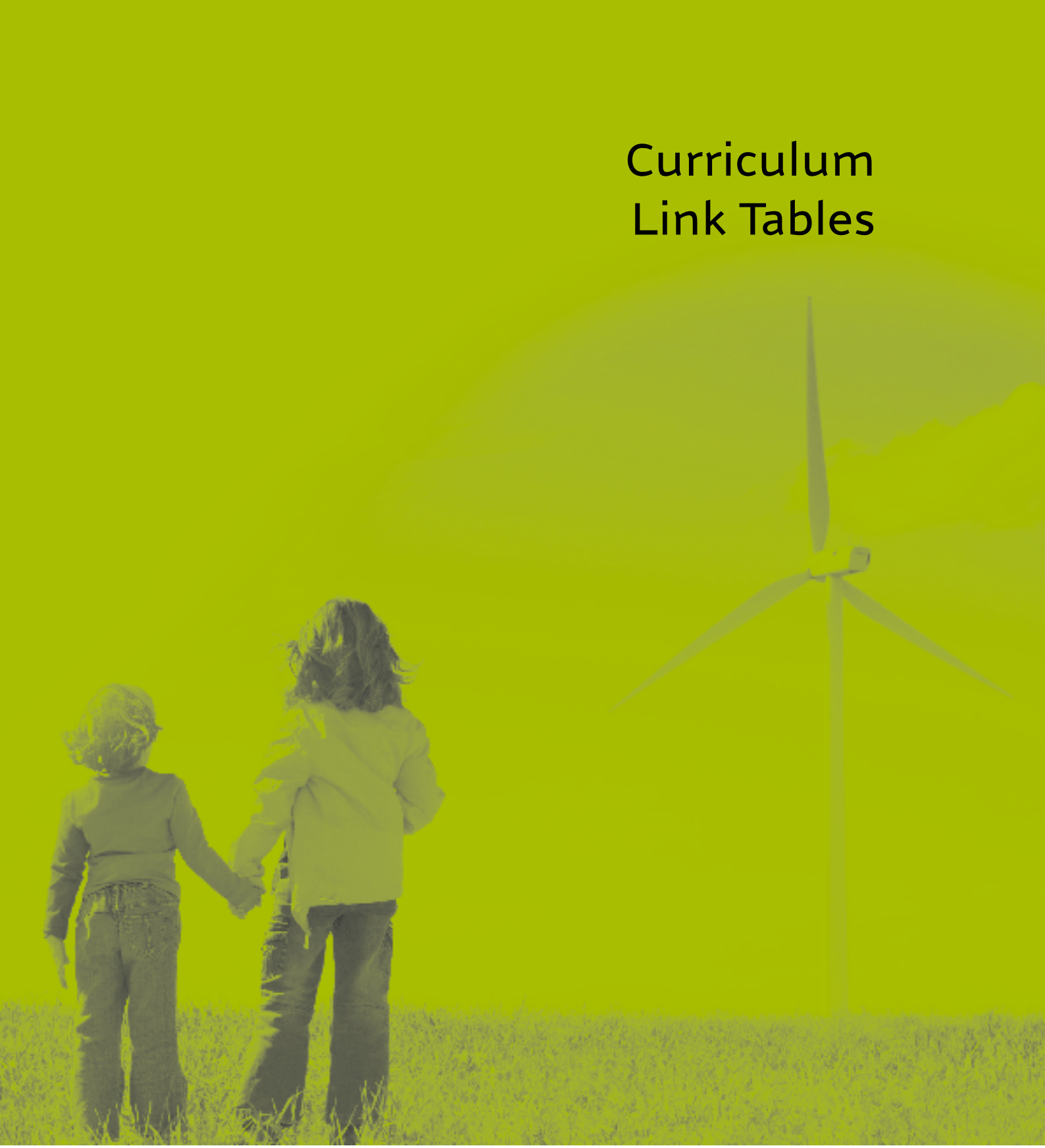
Using the Background Information Pages

We know how demanding it is to teach all manner of subjects and topics, and this is why we have designed the pack to allow you to become 'the instant expert' before teaching the lessons we have provided. Please see pages 40-47 for all the background information you will require to do this!

Using the Lesson Suggestions

Lesson suggestions provide the information required to teach the lesson - learning outcomes, resource lists, and of course discussion ideas and practical activities too! We hope that you and your pupils enjoy all aspects of the Black Law wind farm pack.
For more information got to: www.scottishpowerrenewables.com

Curriculum Link Tables



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Curriculum for Excellence Links

Successful Learners	Developing enthusiasm and motivation for learning within the unique context of a wind farm, and through this: • Be open to new thinking and ideas about renewable energy sources • Use wind farm technology for learning • Make reasoned evaluations about both renewable and non-renewable energy sources and their impact on the world • Develop communication skills through activities presented
Confident Individuals	Developing secure values and beliefs by being able to: • Develop and communicate their own views with regard to energy issues • Make informed decisions based on real experiences within the wind farm context • Achieve success within the related activities undertaken
Responsible Citizens	Developing commitment to participating responsibly in the political and economic development of the environment: • Making informed choices and decisions about energy use and energy sources • Evaluating environmental, scientific and technological issues relating to renewable and non-renewable energy sources
Effective Contributors	• Developing communication skills within the context of the energy issue • Applying critical thinking with regard to the energy issue

Principle

Principle	**The Pack and DVD include:**
Challenge and Enjoyment	Examples of challenging, enjoyable learning activities: • Investigating causes of the wind, investigating wind speed, wind direction and turbine strength through active experimentation • Investigating pros and cons of renewable and non-renewable energy sources through debate and games • Developing creative writing around the renewable energy theme
Breadth	A range of broad learning experiences such as: • Discussion • Debate • Experimentation • Writing • Model Making • Problem Solving
Progression	Activities covering a range of learning outcomes across ACfE Levels 2 and 3. See Experiences and Outcomes section for details. These materials should be adapted to specific pupil needs by teachers to build upon prior knowledge and extend learning.
Depth	Advancing levels of understanding of science and technology gained from working within a 'real life' business context.
Personalisation and Choice	Activities within the pack and DVD designed to allow a flexible learning approach.
Coherence	In depth, logically presented coverage of Wind Farm technology. Topics coherently covered for both pupils and teachers are: • Energy / energy use / transfer of energy • Investigating causes of the wind • Investigating how electricity is generated • Investigating pros and cons of different types of electricity production • Reasons for building wind farms • Choosing sites for wind farms • How wind farms are built • How wind turbines operate • How wind turbines are controlled • Working with communities
Relevance	A learning resource relevant to today's society and its need to develop renewable energy resources for the future. A resource relevant to the Experiences and Outcomes of ACfE, which reflect the ever changing and developing world in which we live.

Experiences and Outcomes

The Wind Farms Pack and DVD address the ACfE experiences and outcomes in the following areas:

Science

	Second Level	Third Level
Planet Earth: Sustainability	I can research a major environmental or sustainability issue of national or global importance and report my findings.	-
Planet Earth: Climate and Earth Science	From a variety of resources, I can inform others on some of the causes of climate change and its possible impact on people's lives.	-
Planet Earth: Energy Transfer	I can demonstrate and describe energy transfers in everyday situations.	-
Planet Earth: Energy Sources	I can discuss why it is important to me and to the future of the world that alternatives to fossil fuels are developed. I can research ways to use energy resources more efficiently.	I can summarise arguments and express an informed opinion on the use of renewable and non-renewable energy resources. -
Topical Science	Through research and discussion I have an appreciation of the contribution that individuals are making to scientific discovery and invention and the impact this has made on society. I can report and comment on a scientific news item to develop my awareness of topical science.	I have collaborated with others to find and present information on how scientists in Scotland have been and are involved in innovative research and development leading to practical applications. -

Technologies

	Second Level	Third Level
Technologies	Having analysed how my lifestyle can impact on the environment and Earth's resources, I can make suggestions about how to live in a more sustainable way. I can investigate the use and development of renewable and sustainable energy to gain an awareness of their growing importance in Scotland or beyond. I can gain an understanding of structures and mechanisms, which demonstrate strengthening, energy transfer and movement. -	Throughout my learning, I can carefully consider the selection and use of resources to demonstrate my knowledge and understanding of the importance of sustainable development. - - I am developing critical thinking skills to help me evaluate my own or others' products or services.
Technologies ICT Skills	Throughout my learning, I can use search facilities of electronic sources to access and retrieve information, recognising the importance this has in my place of learning at home and in the workplace. I explore and experiment with the features and functions of computer technology and I can use what I learn to support and enhance my learning in different contexts.	I experience a sense of achievement and enrichment when applying my ICT skills in different learning contexts across the curriculum. -

Social Studies

	Second Level	Third Level
People, Place and Environment	I can discuss the environmental impact of human activity and suggest ways in which we can live in a more environmentally responsible way. Within a real or imaginary scenario, I can consider the advantages and disadvantages of a proposed land use development and discuss the impact this may have on the community. I can explain how the physical environment influences the ways in which people use land.	Having investigated an environmental issue, I can put forward arguments about the possible consequences for my life and others and make informed suggestions about ways to manage the impact. - -

5-14 Curriculum Link Tables

The content of the Black Law wind farm resource pack meets the 5-14 National Guidelines in the following areas:

Knowledge and Understanding

5-14 Science : Earth and Space			
	Attainment Targets:		
Strand	**Level D**	**Level E**	**Level F**
Changing Materials	• Describe the effects of burning fossil fuels.	-	-

5-14 Science : Energy and Forces			
	Attainment Targets:		
Strand	**Level D**	**Level E**	**Level F**
Conversion and Transfer of Energy	• Give some examples of energy conversions involved in the generation of electricity. • Describe how electrical energy is distributed to our homes.	• Explain the differences between renewable and non renewable energy resources.	-

5-14 Social Subjects : People and Place			
	Attainment Targets:		
Strand	**Level D**	**Level E**	**Level F**
Human-Physical Interactions	• For a selected land use change or industrial process, describe possible effects, good and bad, on the landscape / environment.	• For an economic development describe the main social and environmental impact on the local area.	• For a large development describe and explain the main issues and conflicts and how these can be resolved.

5-14 Technology			
	Attainment Targets:		
Strand	**Level D**	**Level E**	**Level F**
Needs and How They are Met	• Describe how technological activity can affect the needs of people and the environment.	• Explain how technological activity can affect the needs of people and the environment.	• Explain how different perceptions of needs and lifestyle can result in conflict that might be caused or resolved by technological activity.

Developing Informed Attitudes and Citizenship			
	In Science	**In Social Subjects**	**In Technology**
Commitment to Learning	Appreciate the impact of, and think about solutions to environmental issues.	Appreciate and develop an understanding of the environment and their place within it.	Appreciate the impact of technology on society.
Social and Environmental Responsibility	Appreciate the need for conservation and the sustainable use of the Earth's natural resources.	Recognise their role as young citizens, aware of the need for conservation of the environment.	Appreciate the contribution that technological activity can have on the environment and being prepared to make informed choices.

Core Skills	Developed by activities such as:
Communication	• Discussing issues and information from a variety of sources.
Numeracy	• Working with information from charts, tables and graphs.
Problem Solving	• Analysing situations and developing appropriate strategies for solutions.
Using ICT	• Interpreting data in graphical form.
Working with Others	• Working with peers in groups collaboratively in a variety of tasks.

Initial Lesson Suggestions

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Initial Lesson Suggestions

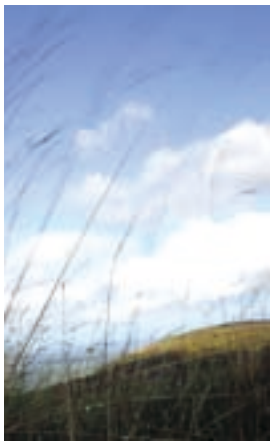
Below you will find a number of lesson suggestions you may wish to carry out BEFORE you look at the DVD with your pupils.

Of course we do not expect you to do them all - the choice is yours.

However, we do recommend you carry out those that are marked with a ☺ as they will greatly enhance your pupil's understanding of the Black Law wind farm DVD.

Background Information Required for Teachers	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
Learning Outcomes	Pupils will understand that: **Energy** • Energy is the ability to do 'work'. • Energy comes in different forms - electrical, heat, light, sound, chemical, kinetic etc. • We use electrical energy to help us with a variety of tasks e.g. heating, lighting etc. **Electricity Generation** • Electrical energy is generated at power stations. • Power stations use a range of energy sources to generate electricity. • Energy sources can be divided into renewable and non-renewable sources. • Renewable sources of energy can be replaced and are clean sources of energy e.g. water, solar, wind. • Non-renewable sources cannot be replaced and can cause pollution, which in turn causes global warming e.g. coal, oil and gas. • Everyone needs to work together to save energy to prevent global warming. **The Wind** • In some cases, wind is caused by the action of the sun heating the land and sea at different rates. • Wind turbines harness the winds' energy.
Resources Required	• The Black Law Wind Farm DVD as detailed in activities. • Pupil Worksheets as detailed in each activity. • A range of small electrical items - radio, hand mixer, lamp etc. (For - **Energy and Electrical Energy Use Discussion** and **Converting Electrical Energy Activity**). • Picture books showing renewable / non-renewable sources of energy e.g. wind turbines, water power, solar power, coal power stations, nuclear power stations (Use for **Energy and Electrical Energy Use Discussion**). • Access to domestic electricity meter (For - **How Much Electricity Do We Use? Activity**). • Paper and coloured pens or pencils (For - **Saving Electricity Activity**). • **Where The Wind Comes From: Experiment 1 - Land and Sea** - 2 identical anglepoise lamps with identical bulbs. - 2 identical plastic trays - one filled with 2cm of dry sand at room temperature, one filled with 2cm of water at room temperature. - 2 identical thermometers. • **Where The Wind Comes From: Experiment 2 - Rise and Fall** - a tiny amount of talcum powder. - table lamp with bulb (remove the shade for better viewing! Care Required - Lamp gets hot!). • **Where The Wind Comes From: Experiment 3 - Make the Wind** - access to 2 adjoining rooms (one small to allow for quick heating). - a small electric fan heater. - a candle. - matches. • A balloon (For - **Think About the Wind Activity**) • The website www.windpower.org/en/kids/index.htm which introduces pupils to Miller, a quirky cartoon character, who shows us and tells us nearly everything we need to know about wind turbines and their work. Pitched appropriately for the P6-S2 age range, turbine power is illustrated through simple explanations, animated graphics, games and real photographs. Definitely worth a look!

Background Information Required for Teachers	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
Discussion: **Energy and Electrical Energy Use**	• Discuss with pupils what they know the term 'energy' to mean. If they are described as being energetic what does this mean? How do they get the energy they need to carry out tasks? (from the chemical energy food gives us). Ascertain that energy gives us the ability to do work. • Discuss with pupils that in the past mechanical energy was used to do 'work' for people e.g. to grind corn, to lift things etc. and that nowadays electrical energy is in huge demand to do this 'work' for us. • Ask pupils if they can name some sources of electrical energy e.g. coal, gas, nuclear, water, wind. • Introduce the terms renewable and non-renewable forms of energy and discuss their meanings.  • Introduce the term fossil fuels and discuss the meaning in relation to pollution and global warming? In comparison, do pupils know what green energy/clean energy means? Discuss these terms in relation to renewable energy sources? View the DVD – Why Build Wind Farms? section and discuss. You may wish to show pupils pictures in books to help also. (e.g. wind turbines, fossil fuel plants etc.). • Can pupils group the energy sources they named above into each category? • Do pupils know that global measures have been put in place to cut pollution and prevent global warming. Discuss why a world-wide approach is required and discuss the implications of the Kyoto agreement. • Discuss how electrical energy, once it has been generated, can be converted into other forms of energy e.g. heat, light, sound, mechanical. How many forms of energy can pupils think of? • Can your pupils think of a household item that produces each type of energy from electricity? You may wish to have some items handy to illustrate this to your pupils.
Activity: **All Change**	• Carry out **Worksheet 1 - Converting Electrical Energy**. • This relates directly to the above discussion and encourages pupils to think about electrical usage and energy conversions in the home e.g. electrical to heat, light, sound energy etc. • You may wish to have some simple household appliances and items handy to show to your pupils.
Activity: **Blankety Blank**	• Carry out the cloze procedure sheet, **Worksheet 2 - Energy and How We Use It**. • Again this relates directly to the above discussion and covers key vocabulary pupils should become familiar with in relation to energy sources.
Discussion / Activity: **Save, Save, Save**	• Ask pupils to provide suggestions for a range of tasks that require electricity. Field answers. • Discuss with pupils that today we use vast amounts of electricity. Because of this, we are encouraged to save electricity at all times. Do pupils know why this is the case? • Ask pupils how they can save electricity in the home and at school? What difference will this make to the bills? What difference will this make to the planet? • You may wish to tell pupils of the slogan *'Do a Little, Change a Lot'* and discuss its significance in terms of the national and global bigger picture.  • Carry out **Worksheet 3 - Why Do We Need Electricity?** This relates directly to the above discussion and encourages pupils to identify tasks requiring electricity, how they would do the tasks instead if they had no electricity, and some simple ways of saving electricity (thus cutting down on global warming).

Background Information Required for Teachers	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
Activity: **Meter Monitors**	• When studying the topic of electricity, the amount of electricity we use should always be brought to the forefront. Pupils should always be encouraged to understand the reasons for saving energy both in terms of the bigger picture (global warming from fossil fuel-related pollution), and in terms of the localised picture (saving money in the home on bills!). • Discuss the above with pupils before carrying out **Worksheet 4 - How Much Electricity Do We Use?** • This worksheet provides further focus upon electricity use and involves monitoring the electricity meter in our home / school and calculating approximate costs for the amount used. • In order to carry out this meter-monitoring activity, pupils should be carefully warned about the dangers of playing with electricity and adult supervision of the activity is highly recommended. 
Activity: **Etch-a-Sketch**	• Ask pupils to design a poster or sticker to encourage other pupils and teachers in school to save electricity e.g. to be situated by light switches, TV standby buttons etc. • Pupils should come up with a catchy slogan to match their artwork. Again, you may wish to stress the significance of the slogan *'Do a Little, Change a Lot'* or the 3 R's - Reduce, Reuse, Recycle (of which reduce is significant for this activity i.e. reducing the amount of electricity we use).
Experiments: **What a Wind!**	• In order to make the most of the Black Law wind farm DVD, it is important to gain an understanding of how the wind is actually 'made'. **Experiment 1 - Land and Sea** • Using the appropriate section of the Background Information for Teachers section, explain to pupils that the land heats up quicker than the sea in some cases. • This can be illustrated by standing identical anglepoise lamps with identical bulbs (switched off at this stage) at identical heights, above 2 identical plastic trays - one filled with 2cm of sand at room temperature, one filled with 2cm of water at room temperature. (If possible, set the trays up the night before. This will allow all resources to be at the same starting temperature when the experiment starts).  • The next day, measure the temperature of the sand and water before starting the experiment. Remember to wait until a reading has been established before removing the thermometer from the sand and water. Remember also, not to have the lamps switched on whilst taking the reading (the heat from the lamp could affect the reading!). • Switch on both lamps. • After 2-3 hours the bulbs will have heated the 'land' and 'sea'. Measure the temperature of each material by putting a thermometer in each. Which has heated up faster? The sand (land) or the water (sea). You may wish to use **Worksheet 5 - Science Experiment Fair Test Sheet** to log your method and results. **Experiment 2 - Rise and Fall** • Once your pupils have understood the above concept, in order for them to gain an understanding of hot air from the land rising, put a tiny amount of talcum powder on top of an unlit table lamp bulb (remove the shade for better viewing!). • Next switch the lamp on so that the bulb lights. What do the pupils notice about the powder? (It is rising as the air heats up, and falling as it cools down.) 

Background Information Required for Teachers	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
Experiments: (cont) **What a Wind!**	**Experiment 3 - Make the Wind** • Next, to enable pupils to understand how the wind actually blows, they need to understand that warm air over the land rises. When the warm air rises, it makes room for the cold air, which then moves into the warm space on the land. You may wish to enlarge the diagrams on **Sheet 6 - How the wind Works** for pupils to see. - You can illustrate this by firstly heating a small room with a quick-action electric fan heater (ensure that your heater will not set anything on fire in the room and do not leave it on too long for this reason!). When the room is heated, switch off the heater and take your pupils, a candle and a match to the door. The room you are standing in will be cooler than the one that has been heated up. Keeping the room door closed to conserve the heat, show pupils the unwavering flame of the candle. - At this point reinforce the theory of creating a wind (as above) to ensure pupils know what they are looking for when the experiment begins, then open the door and allow the air to settle. - After the air has settled, hold the candle at the top of the door and look at what happens to the flame (it should blow / point in the direction of the cooler room you are standing in). A wind is created at the top of the doorway when the warm air enters the cold room and rises. When the warm, light air rises, it makes room for the cold air, which then floats into the warm room at the bottom of the doorway. - Now hold the candle at the bottom of the door and look at what happens to the flame (it should blow / point in the direction of warmer room). Warm air is light and rises. When the warm, light air rises, it makes room for the cold air, which then floats into the warm room at the bottom of the doorway.  • Explain to pupils that wind is a renewable power source. Recap on what this term means. (i.e. generating power from the wind leaves no dangerous waste products behind. Best of all, its supply is unlimited.) • Pupils can find out more about where the wind comes from by looking at the following web link: - www.windpower.org/en/kids/choose/wind/index.htm - Then clicking on Where Does Wind Come From? - Then clicking on Wind and the Troposphere. - Then clicking on Warm Air Floats Towards the Poles.
Discussion / Activity: **Turbine Teasers**	• Use the diagram in **Sheet 7 - A Wind Turbine**, and **Worksheet 8 - How a Turbine Works**, to discuss and explore the basics of how electricity is generated using wind power. This sheet examines a range of components within the turbine. This is covered in greater detail in the DVD - see section entitled How Wind Turbines Work. • Worksheet 8 contains key vocabulary your pupils may hear in the DVD. • Pupils can find out more about the components inside the nacelle (the pod at the top of the turbine) by looking at the web link below. This link provides simple explanations and illustrations of each component. Pupils are also given the opportunity to see an actual photographs of each of the real items: - www.windpower.org/en/kids/choose/nacelle/index.htm - Then click on each component in the given list in turn. - Then click on See a Real Photo (where applicable). 
Discussion / Activity: **Breezing Along**	• Carry out **Worksheet 9 - Thinking About the Wind**. • This activity encourages pupils to think about the wind and wind power in general terms, both today and in the past (e.g. signs of the wind, use of wind in the past, benefits and challenges of using wind power). This worksheet provides a springboard for the Black Law wind farm DVD. 

Follow On Lesson Suggestions

SCOTTISHPOWER RENEWABLES

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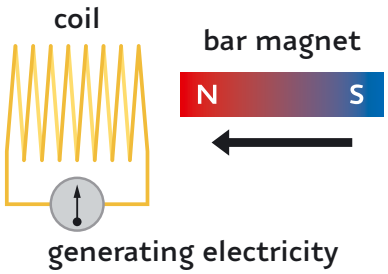
Follow On Lesson Suggestions

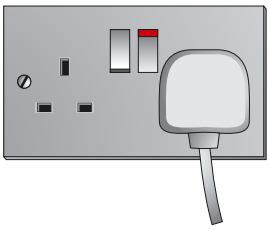
Below you will find a number of lesson suggestions you may wish to carry out AFTER viewing the Black Law wind farm DVD.

Again, we do not expect you to do them all - you decide!

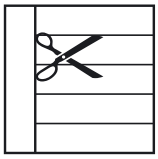
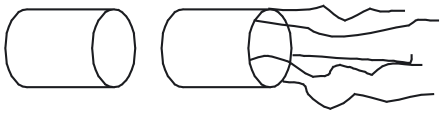
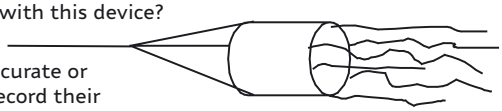
However, we do recommend you carry out those that are marked with a ☺ as these lessons will cement pupils' learning from both initial activities and the wind farm DVD.

Background Information Required	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
for Teachers **Learning Outcomes**	Pupils will understand that: **Electricity Generation** • Electrical energy is generated at power stations. • Power stations use a range of energy sources to generate electricity. • Energy sources can be divided into renewable and non-renewable sources. Each source has its own benefits and challenges. • All power stations use a method of turning a magnet in a coil of wire to generate electricity. • The method of turning the magnet in a coil of wire can vary depending on the energy source used. • Coal power stations heat water to make steam to do this. • Wind farms use the turning of the turbine blades to do this. **Supply and Demand** • Demand for electricity fluctuates throughout the days, months and years for a variety of reasons. • A combination of different types of power stations must meet this demand. **The Wind** • Anemometers are used to measure wind speed. Wind socks can show this too. • The Beaufort Scale is used to describe wind speed. • Weather vanes are used to measure wind direction. Wind socks can do this too. **Wind Turbines** • Turbines are built in places where the wind is powerful. • They must be strong enough to withstand a huge wind pressure from strong winds.
Resources Required	• The Black Law wind farm DVD as detailed in each activity • Pupil Worksheets as detailed in each activity. • Permanent bar magnet, 200cm of Copper wire, insulated with bare ends, galvanometer / ammeter. (For **Discussion / Activity - Order Order! Wind Farms**) • Two old electricity bills from the same household with electric heating - one from summer, one from winter. (For **Discussion - How Electricity Comes into our Homes / Demand for Electricity**). • A pin, a square piece of thick paper (about 25cm x 25cm), a sharp pencil with a rubber on top, scissors, a windy day! (For - **Make a Windmill Activity**). • 1 sheet of printer paper, 1 piece of tissue paper 28cm x 28cm or a piece of plastic bag 28cm x 28cm, glue, sticky tape, scissors, paper punch, 1 paper clip, ruler, 1.2m very thick, strong thread, a pole (1-2m high), a compass, a windy day! (For - **Make a Wind Sock Activity**). • A metre stick, printer paper, sticky tape, plasticine, paperclips, pebbles, small rocks, weights, hairdrier (For - **Build a Turbine Tower Activity**). • Paper and pencils (For - **Poetry Activities and Write to Us Activity**). • Paper, coloured pens or pencils, dice, counters, card, sticky tape etc. (For - **Environmental Issues Board Game**). • Paper and pencils, the internet and information books (For - **Energy Source Stories Activity**). • Scissors and glue sticks (For - **Energy Source Stories Activity**). • The website www.windpower.org/en/kids/index.htm which introduces pupils to Miller, a quirky cartoon character, who shows us and tells us nearly everything we need to know about wind turbines and their work. Pitched appropriately for the P6-S2 age range, turbine power is illustrated through simple explanations, animated graphics, games and real photographs. Definitely worth a look!

Background Information Required	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
for Teachers **Discussion / Activity:** **Order, Order!** **Wind Farms**	• Having explored the Black Law wind farm DVD, discuss how electrcity is generated using magnets and coils of wire within the nacelles of wind turbines. Get pupils to make their own generators to further aid their understanding of this concept. Use this website for full instructions www.practicalphysics.org/go/Experiment_338.html. You can view an illustration of a generator at work generating electricity in the DVD too. (See DVD - How Wind Turbines Work section)  • You may wish to revisit **Sheet 7 - A Wind Turbine**, and **Worksheet 8 - How a Turbine Works** detailing the component parts within the turbines, as a reminder. • Explain that a rotating magnet inside a coil of wire creates electricity within the generator and that whatever the type of power station, be it coal, oil, gas, nuclear, wind, water - the key in generating electricity is making the magnet spin in the wire coil. For example: - in a wind power station, the blades spin a generator which contains a magnet and a wire coil and this makes electricity. - in a coal power station, coal is used to heat water to make steam. The steam turns a turbine (a wheel) and this in turn spins a generator containing a magnet and a wire coil. - in a nuclear power station the heat generated in the nuclear reactors is used to heat water. This steam turns a turbine and this in turn spins a generator containing a magnet and a wire coil... and so on. • Give out **Worksheet 10 - From a Wind Power Station to our Homes**, and explain to pupils that they should correctly order the statements on the sheet to match the process of electricity generation using the winds' energy. • You may wish pupils to cut the statements out and order them to make this a little easier. Similarly, you may wish to insert one or two of the numbers to make it a little simpler for younger or less able pupils.
Discussion / Activity: **Order, Order!** **Coal Power Station**	• As a comparison to the above activity on wind power, give out **Worksheet 11 - From a Coal Power Station to our Homes** and explain to pupils that the principle of spinning a magnet in a wire coil applies to generating electricity using coal also, just as it does in wind power electricity generation. (Coal is used to heat water to make steam. The steam turns a turbine (a wheel) and this in turn spins a generator containing a magnet and a wire coil.)  • Explain to pupils that they should correctly order the muddled statements on the sheet to match the process of electricity generation using energy from coal. • You may wish pupils to cut the statements out and order them to make this a little easier. Similarly, you may wish to insert one or two of the numbers to make it a little simpler for younger or less able pupils.

Background Information Required	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
for Teachers **Discussion:** **Supply and Demand**	• Discuss with pupils what happens when they switch on a lamp (the light comes on). Discuss how the lamp is powered when a plug is plugged into a socket and the switch is switched on (electricity flows from the mains, through the house wires and into the plug wires of the lamp to power it). • How do pupils think the electricity comes into our homes? Discuss and work backwards from switch and socket, to the system of connecting wires inside the walls, in turn connected to the meter, in turn is connected to the mains. • If possible find the school electricity meter and explain to pupils how it works. You may wish to refer back to **Worksheet 4** in the **Initial Activities Section** (where pupils take daily readings to investigate electricity consumption).  • How do pupils think the electricity comes into our homes? (a system of underground wires connected to substations linked by over ground wires on pylons to power stations). • Explain the term the national grid to pupils and that electricity generated from all types of power station goes into a system of power lines called the national grid, to meet the country's needs. • Can pupils think of times during the day, months or years when demand for electricity would be either very high (meal times when lots of electrical appliances are used for cooking; advert breaks when everyone puts the kettle on; during big football matches like the world cup final, in the winter when people use their electric heating) or very low (during the night when everyone is asleep; in the summer when people's electric heating is off).  • Perhaps a pupil with electric heating at home, with his / her parent's permission, could bring in two old electricity bills (from the same house) to allow comparison of electricity use in the winter months and the summer months.
 **Discussion:** **Jumblies**	• Carry out **Worksheet 12 - Electricity Comes into Our Homes**. • This relates directly to the above discussion and encourages pupils to think about the 'pathway' of electricity from the national grid to our homes. • Explain to pupils that they should correctly order the jumbled statements on the sheet to match the 'pathway' of electricity from the national grid to our homes. • You may wish pupils to cut the statements out and order them to make this a little easier. Similarly, you may wish to insert one or two of the numbers to make it a little simpler for younger or less able pupils.

Background Information Required	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
for Teachers **Activity:** **Make a Windmill**	 • Here's how you can make a simple windmill, which will go some way to giving you an idea of how a wind turbine catches the wind. (See Resources section for all you need to make it.) • Cut out a 25cm x 25cm square of thick paper and draw a line diagonally from each corner to the opposite corner. • Mark the middle of the square where the two lines cross and punch a small hole through it with a sharp pencil. • Next, cut along each line stopping about 3cm from the hole in the middle of the square. • Take a pin and make a tiny hole in the top left corner of each of the four flaps. (No two holes should be next to each other.) • Pick up a flap at a corner with a hole in it, and pull it over towards the middle hole. Repeat this for the other flaps matching the holes carefully with the hole in the middle of the square. • When all four flaps are in place, carefully lift the paper without letting the flaps unfold. Lay the pencil flat on a table and carefully push the point of the pin into the side of the rubber on the pencil. • The windmill is now finished and ready to be tested outside. • Pupils should discover that it spins best when the wind hits the middle of it and, like the turbines at Black Law, it must be pointed into the wind in order to spin. (Refer to DVD - Controlling Wind Turbines section for details)

Background Information Required	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
for Teachers **Activity:** **Make a Wind Sock**	See Resources section for all you need to make it. • Although anemometers are found on the top of wind turbines, and their data sent to the control room to show wind speed, they are tricky to make and acquiring data from home made ones can be challenging! • However, instead you can use a wind sock to find out the direction the wind comes from and you can see how strong the wind is blowing by how high the wind sock blows in the wind. Although not as accurate as an anemometer, this will encourage pupils to think about the relationship between wind speed and wind direction with reference to the turbines they saw on the DVD. • Firstly, roll an A4 sheet of printer paper width ways into a cylinder and tape both short ends together securely. • Next lay the tissue paper square (or plastic bag square if you want your wind sock to be slightly more waterproof!) on a table and draw a line 3cm from one edge.  • On the side opposite edge of the paper to the line, make 2cm wide cuts up to the line to make strips. Do not cut the strips off! (You should have about 14 strips cut at the end of this part.) • Make the tissue paper into a cylinder shape to fit over the printer paper cylinder by about 2cms only. It should fit the printer paper shape snugly. Secure this with sticky tape.  • Using the paper punch, punch 3 holes evenly around the edge of the printer paper cylinder (on the edge that does not have the tissue paper attached to it). • Knot 3 x 25cm threads at each hole and then tie all three loose ends together. Attach these to one end of a paper clip, and use the remainder of the thread to attach to the other end of the paper clip. • Tie the wind sock to the top of a pole and push the pole firmly into the ground. • Using the wind sock and a compass you can now work out the wind direction. (Remember to note the direction the wind is coming from, not the direction it is blowing the wind sock to!) You can also see how much wind there is (wind speed), by looking at how high the wind lifts the wind sock. Encourage pupils to think about how they could use the wind sock to record wind direction and wind speed. How many times a day will they measure direction and speed? What problems might they encounter with this device? (A wind sock moves quite erratically.)  Are their measurements going to be accurate or simply a rough gauge? How will they record their results?
Activity: **Log It**	• Wind conditions vary a lot. Make the wind sock (as detailed above) and move it to different parts of the school and find places where the wind is very turbulent and places where the wind is steady. • The wind farm is controlled by a complex computer system called SCADA. (Refer to DVD for details - Controlling Wind Turbines section). Just like the SCADA system collects data in the control room of the wind farm, your pupils could collect wind direction data for a week. • Using the Beaufort Scale chart on the worksheet, they could also record wind speed. • Pupils should use **Worksheet 13 - Wind Conditions**, to do this.
Activity: **Make an Anemometer**	• Anemometers are found on the top of wind turbines, and their data sent to the control room to record wind speed.  • They are a little tricky to make and acquiring data from home made ones can be challenging! However if you wish to have a go please see these web links for details and resources: www.ciese.org/curriculum/weatherproj2/en/docs/anemometer.shtml www.energyquest.ca.gov/projects/anemometer.html www.ezonemag.net/wind/worksheets/make_an_anemometer.pdf

Background Information Required	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
for Teachers **Activity:** **Make a Wind Vane**	• Wind Vanes are found on the top of wind turbines, and their data sent to the control room to record wind direction. • These are a little tricky to make. However if you wish to have a go please see these web link for details and resources: • www.ciese.org/curriculum/weatherproj2/en/docs/windvane.shtml www.galaxy.net/~k12/weather/makevane.shtml 
Experiment / Activity: **A Tower of Strength**	• The turbine towers on the turbines at Black Law Wind Farm are around 70m high. • The tower has to be very strong to resist the vast amount of pressure put upon it by the wind blowing on the rotor. (See DVD - Building a Wind Farm section for details). • Use a metre stick with pupils to carry out this quick experiment. Pupils can carry out this activity in pairs. Get pupil 1 to hold the metre stick at the bottom in one hand, with arm outstretched. • Get pupil 2 to press on the metre stick just above their hand. Can pupil 1 keep it in a vertical position? • Now ask pupil 2 to press on the top end of metre stick. Ask pupil 1 how holding it feels now? (It should be much harder to control the pole.)  • Explain to pupils that the rotor of a wind turbine pushes very hard at the tower when the wind is strong. Ask how pupils think the tower can stand such a large force? • Explain to pupils that they are now going to build a turbine tower (the tower part only) in small groups. • See Resources section for all your need to make the towers. • Explain to pupils that they are to build a turbine tower of height 1 metre from the given materials. Provide a time limit. Also provide anchoring instructions. This will ensure all pupils use the same method of anchoring their tower and will ensure they use the same amount of anchoring materials - thus a fair test. Once their tower is complete, a hairdrier on full power will be used to see if the towers will blow down or stand tall. • After all towers are made, carry out the test ensuring it is fairly implemented e.g. the drier is on same power for each, the air is blown at the same part of the tower etc. • Whose tower stood tall? Whose blew down? Discuss reasons and discuss how real turbine towers are firmly and deeply embedded in steel reinforced concrete foundations to stop the towers blowing down with the pressure of the wind on the rotor. • Pupils can find out more about wind turbine towers (and other aspects about building wind farms) by looking at the DVD - Building a Wind Farm section, and the following web link: - www.windpower.org/en/kids/choose/tower/index.htm - Then click on The Height of the Tower. - Then click on What Tower Designs are There? - Then click on Manufacturing Towers. • View the DVD - Building a Wind Farm section - to examine how the foundations for wind turbines are made, (and to examine other aspects about building wind farms), and/or click on the following link www.windpower.org/en/kids/choose/assemble/index.htm • View the DVD - Building a Wind Farm section - to examine how a turbine is erected (and to examine other aspects about building wind farms), and/or click on the following link www.windpower.org/en/kids/choose/assemble/erect.htm

Background Information Required for Teachers	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
Discussion: **It's a Blow Out - Windy Sites for Turbines**	 • Tell pupils that they are going to think about the best sites for wind turbines in order that 'the best of the wind' is harnessed, just as the developers at the Black Law site would have done. View the DVD - Choosing a Wind Farm Site section - to explore the detail of this area of work. • Ask pupils which types of places they think the wind is the strongest and ask them to provide reasons for this. (It may be helpful for them to think about the location of the turbines at Black Law and other wind farm sites they have seen, and also to think about strong winds when they have been out walking.) • After you have fielded answers, explain to pupils that the wind is strongest at the top of a hill because it speeds up there as it moves. This happens because at the top of a hill the wind is not compressed and the same volume of air has to pass through a narrower gap (between the ground and the sky). When this happens, it has to move much faster to do this - thus creating a windy site! • That is why the ideal site for a wind turbine is at the top of a hill. NB - Not all hills are suitable as wind turbine sites. A good hill for wind turbines should slope gently to the top. • Pupils can investigate the principles of windy sites by looking at the following web link: - www.windpower.org/en/kids/choose/siting/index.htm - Then clicking on Hill Effect. - Next clicking on Steep Slopes. • On the next windy day, get pupils to find the windiest places in the school grounds. Why do they think these places are windier than others? NB - Ensure pupils are aware that windy places can also occur on flat ground if the wind is being funnelled through man-made channels or 'valleys'.
Discussion / Activity: **Game On**	• Although wind farms have relatively little impact on the environment compared to fossil fuel power plants, there is some concern over the noise produced by the rotor blades, the visual impact, and dangers to wildlife/displacement of wildlife. View the DVD- Introduction to Why Build Wind Farms? / Choosing a Wind Farm Site / Working With Wind Farm Communities sections - to explore how ScottishPower Renewables overcame some of these concerns. • Discuss these issues with your pupil and ascertain their viewpoints - you may wish to organise a more formal debate with older pupils.  • Next encourage them in groups of 2-3 to design a board game to support the debate in a balanced way e.g. a snakes and ladders game would work well - go up the ladder when you work with the RSPB to protect the site or support nesting birds; go down the snake when plans are knocked back as local people are concerned about it spoiling the landscape etc. • A card game may also work well... but the possibilities are endless! • After pupils have designed their game, they should explain it to another group and teach them how to play!
Activity: **Poetry Time 1 - Acrostic Poem**	• View the wind farm DVD (or elements within it) to give your class ideas to inspire a poem. • Next write the word **WIND FARM** down the left hand side of a piece of paper. • 5 Choose a short statement to describe an aspect of a wind farm, by starting each new sentence with the given letter and hey presto - you have written what is known as an acrostic poem e.g. - **W**hat do I see? - **I**n front of me - **N**othing but turbines - **D**ancing in the wind - **F**ollowing the breeze - **A** sleepy circle - **R**otating slowly - **M**aking no sound. • You could also use the words **TURBINE**, **WIND**, **TOWER**, **ENERGY**, **RENEWABLE**... etc.

Background Information Required	Please refer to the Background Information for Teachers section to provide you with the relevant background information required to teach the following activities.
for Teachers **Activity:** **Poetry Time 2 -** **Haiku Poem**	• A Haiku is a type of Japanese poem. The poem is written in 3 simple lines: - Line 1 - 5 syllables. - Line 2 - 7 syllables. - Line 3 - 5 syllables. • View the wind farm DVD (or elements within it) to give your class ideas to inspire a poem. • 5 Haikus are easy to write, so encourage your pupils to write a wind-related Haiku to creatively express their feelings about an aspect of a wind farm that interests them. • Give pupils the theme, **TURBINES** for example, and encourage them to write a short poem in this form e.g. Turbines. Circling in the wind (5 syllables). Like stirred coffee in a cup (7 syllables). Hypnotising me (5 syllables). • Other themes could be **WIND FARM**, **WIND**, **TOWER**, **NACELLE**, **BLADES**, **GENERATOR**. • Have fun!
Activity: **Energy Source Stories Cut and Stick**	• Encourage pupils to use the internet and information books to carry out research on the variety of energy sources used to generate our electricity. Discuss with pupils. • Alternatively, use the **Teacher Answer Sheet** on page 36 as information for a class discussion on this subject. Highlight advantages and disadvantages of each energy source in electricity generation, and explain that no source is a perfect solution to our needs. • After discussion, give pupils a copy of **Worksheet 14** and **Worksheet 14A** and explain that the **Energy Source Stories** on the sheet have missing pieces. Explain that the missing pieces can be found on **Worksheet 14A**. • Tell pupils that it is their job to cut out each of the missing pieces and glue them in place to complete the stories. • Once complete, discuss findings as a class, with particular reference to the advantages and disadvantages of each power source.
Activity: **Write to Us!**	• If your pupils have enjoyed the work they have carried out relating to Black Law wind farm, we would be delighted to receive their letters telling us about their favourite aspects. • The address to write to is: Wind Development Team ScottishPower Renewables Spean Street Glasgow G44 4BE • We look forward to hearing from you! 

Related Worksheets

SCOTTISHPOWER RENEWABLES

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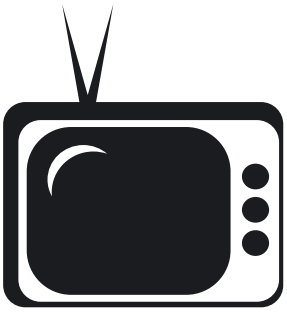
Worksheet 1 - Converting Electrical Energy

NAME_____

- **The electrical energy we generate from power stations of all types, comes to our houses.**
- **It can be changed into different forms of energy.**
- **These energy changes are happening around us all the time.**
- **Tick the boxes to show the energies involved when using each of the electrical items below. (You can tick more than one box!)**
- **Lastly, add two of your own in the blanks at the foot of the page.**



Item	Sound Energy	Heat Energy	Light Energy	Mechanical Energy
Radio				
TV				
Washing Machine				
Hair Drier				
Kettle				
Microwave Oven				
Toaster				
Lamp				
Electric Cooker				
Food Mixer				
Computer				
Iron				
Fan Heater				

Worksheet 2 - Energy and How we Use It

NAME_____

Use the word bank in the box at the bottom of this sheet to complete the passage.

Energy is the ability to do __ __ __ __ . It comes in many different __ __ __ __ __ . These are heat, light, mechanical, electrical, chemical, kinetic (movement) and nuclear energy. We use energy in everything we do - from jumping to watching TV.

The energy sources we use every day are divided into two main groups:

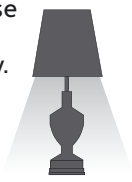
- __ __ __ __ __ __ __ __ __ energy sources (made from resources 'Mother Nature' will replace, like wind, water and sunshine. These are also called 'clean energy' or 'green power' because they don't pollute the air or the water.)

- Non-renewable energy sources (the problem is that these can't be replaced - once we use them up, they're gone forever. They also cause pollution.) Both of the above can be used to produce __ __ __ __ __ __ __ __ __ __ __ .

Most of our electrical energy comes from burning non-renewable energy sources, which include the __ __ __ __ __ __ fuels oil, natural gas and coal. They are called fossil fuels because they were formed over __ __ __ __ __ __ __ __ __ of years by the action of heat from the Earth's core and __ __ __ __ __ __ __ __ from rock and soil on the remains (or fossils) of dead plants and animals.

Another non-renewable energy source is the metal called __ __ __ __ __ __ __ , whose

atoms we split to create electricity. This is called __ __ __ __ __ __ __ energy.



People have learned how to __ __ __ __ __ __ , or convert, energy from one form to another so that they can do work more easily e.g. the energy from the __ __ __ __ can heat our homes by generating electricity or the energy from coal can light our homes.

We use all these energy sources to __ __ __ __ __ __ __ __ the electricity we need for our homes, work, schools and factories.

uranium	**Renewable**	**forms**	**fossil**	**nuclear**	**pressure**
electricity	**change**	**work**	**generate**	**millions**	**wind**

Worksheet 3 - Why Do we Need Electricity?

NAME_____

- **Make a list of 10 things you do that use electricity to help you with the task.**
- **Next make a list of what you would use / do without using electricity.**

	I use electricity to do these things		Without electricity I would have to...
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	

Why is it important to save electricity? Write one reason here.

_____

_____

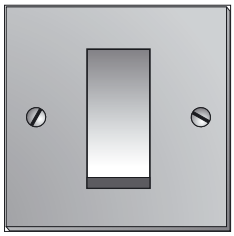
Do you need all the electricity you use? Make a list of 5 ways you could save electricity in your house or school.

	Ways to save electricity
1	
2	
3	
4	
5	

Worksheet 4 -
How Much Electricity Do we Use?

NAME_____

Electrical power lines come into your house or school through an electricity meter. The power company uses these meters to measure how much electricity has been used.



The meter measures the electricity in units called kilowatt-hours (kWh). One kilowatt-hour is equal to 1,000 watts of electricity used for a period of 1 hour.

- **At home WITH THE PERMISSION OF AN ADULT, or in school with your teacher, find your electricity meter and take readings over a week. The adult with you will show you which part of the meter to read.**
- **On Monday simply note the reading on the meter. This is the number of units used since the meter was installed. Write down this number.**
- **To find out how much electricity was used on Monday, subtract the reading on Monday from the reading on Tuesday, to find out how much electricity was used on Tuesday, subtract the reading on Tuesday from the reading on Wednesday and so on...**
- **Do this at around the same time every day and record your readings below. You may wish to graph your results.**
- **Remember electricity can kill, never play with electricity!**

Day	Time	Reading (kWh)	Number of Units used	Cost per unit on average	Space for working out cost
Monday					
Tuesday					
Wednesday					
Thursday					
Friday					
Saturday					
Sunday					
			Total No of Units	Total Cost	

THINK!

- **From your calculation above, multiply the total cost by 52 weeks to get a rough idea how much the bill would be for a year. Write the cost below.**

_____

- **Why would this figure not be accurate? Write your reason below.**

_____

Worksheet 5 - Fair Test Science Sheet

NAME_____

What do we want to find out?

What will we do?

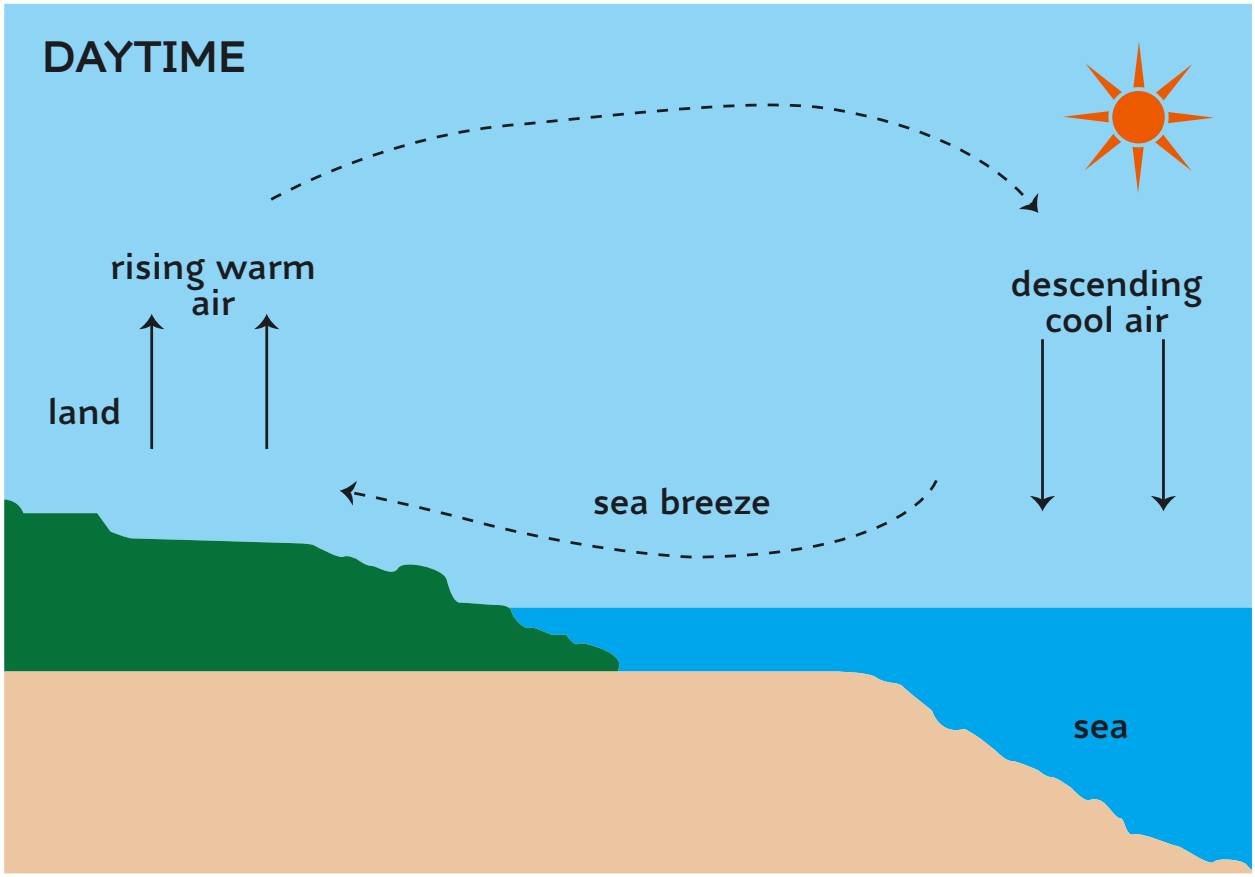
What will we need to use?	
Write a list	**Draw**

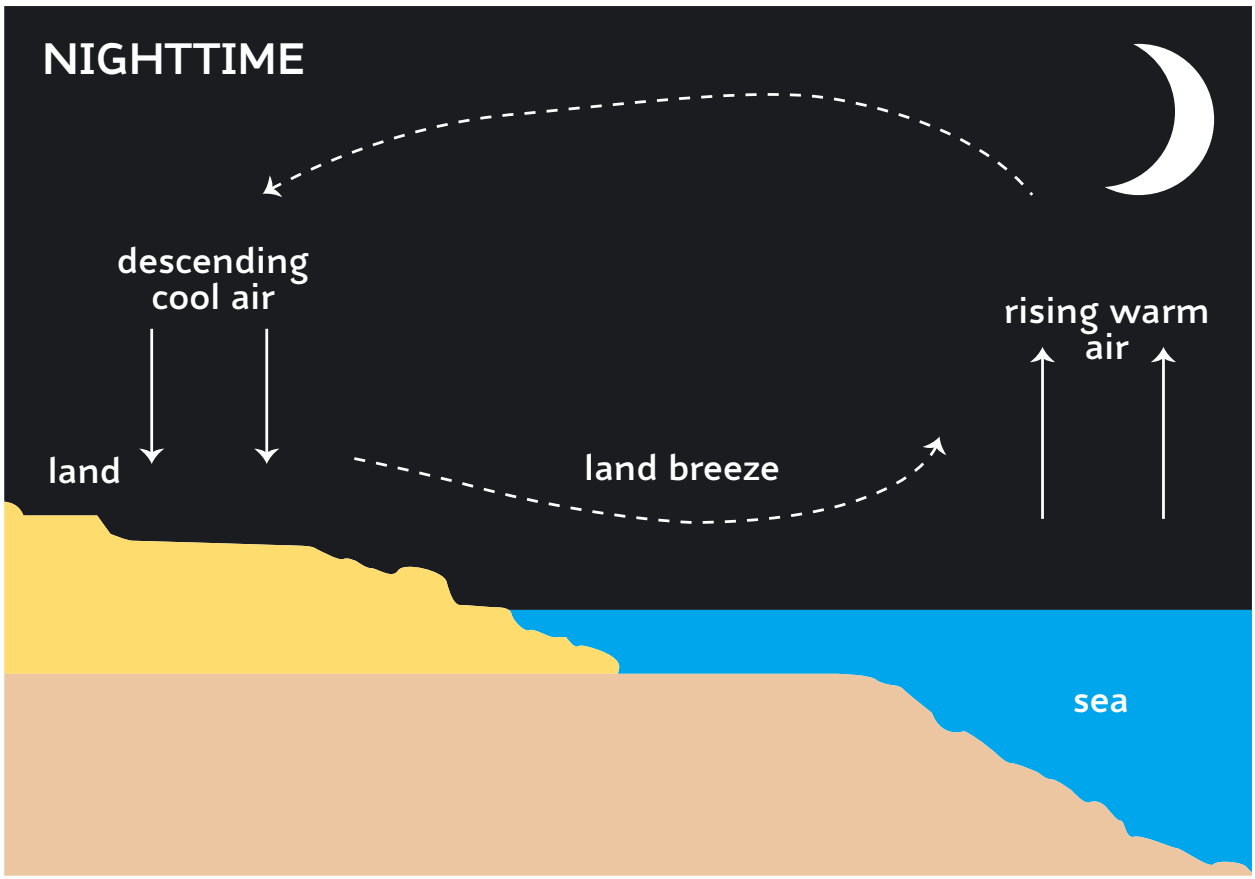
How will we make it a fair test? (What do we need to keep the same?)

What were our results? What did we notice?

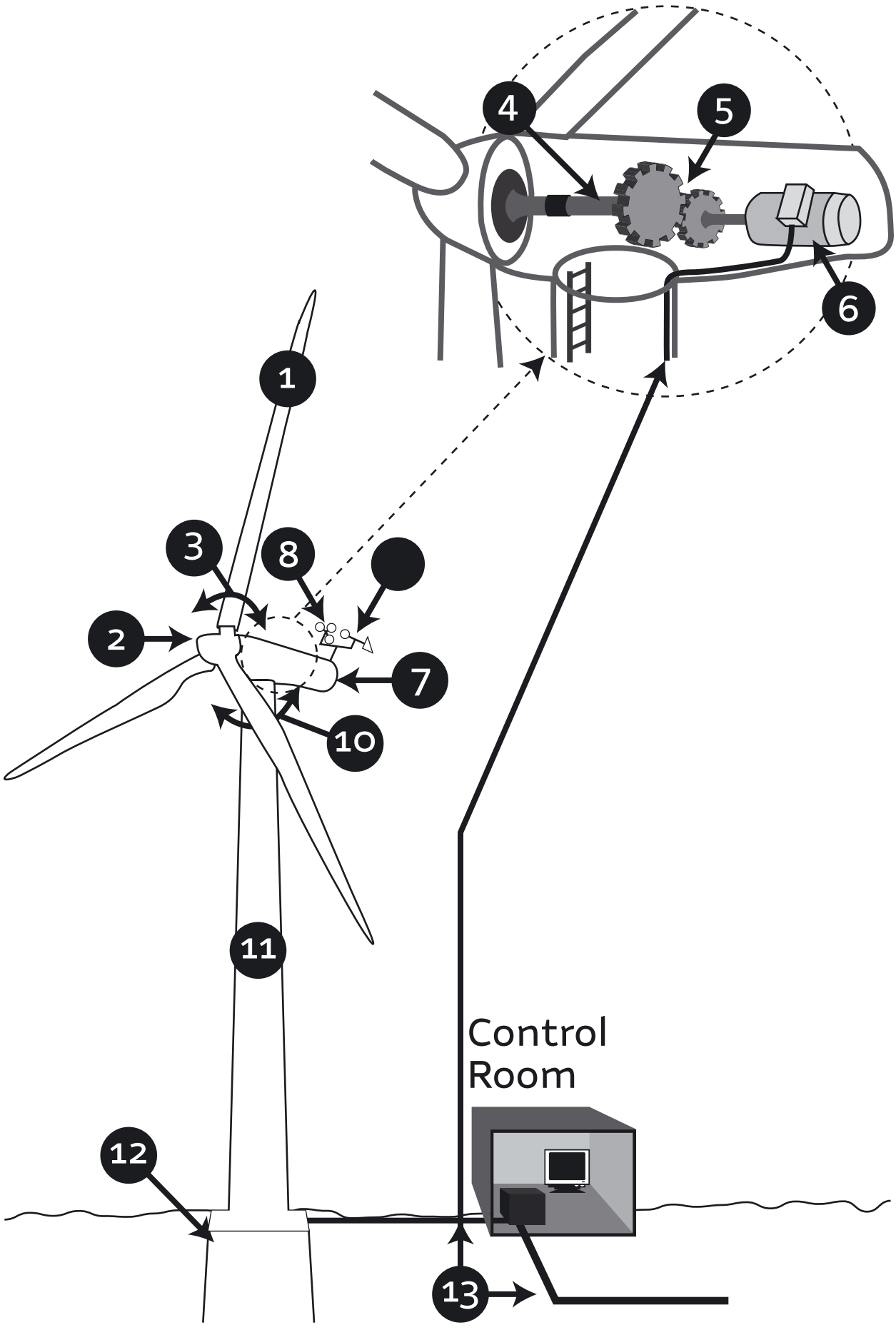
What do our results tell us? What did we discover?

Sheet 6 - How the Wind Works





Sheet 7 - The Wind Turbine



Worksheet 8 - How a Turbine Works

NAME_____

- **You need a copy of Worksheet 7 (The Wind Turbine) for this activity.**
- **Study the Wind Turbine on Worksheet 7 carefully and view the 'How a Wind Turbine Works' section on the DVD.**
- **Now see if you can match the description of each part to the matching word below.**

No	Description of Part	Name of Part
1	This 'catches' the wind. There are 3 of these. If one was laid on its side it would be nearly as tall as a man!	_ _ _ _ _
2	The three number 1's are joined to this. This part moves round and round.	_ _ _ _ _
3	This word describes the way each blade twists to match the way the wind is blowing.	_ _ _ _ _
4	This connects the rotor to the gearbox.	_ _ _ _ _
5	The shaft is joined to this set of cogs. Together they change the speed of the wind turbines' blades.	_ _ _ _ _ _ _
6	Inside this machine, a magnet is spun inside a coil of wire to generate electricity.	_ _ _ _ _ _ _ _ _
7	This is a pod that contains all of the workings of the turbine. It is big enough to hold 3 men standing up!	_ _ _ _ _ _ _
8	This measures the wind speed. It sends this information to computers in the control room.	_ _ _ _ _ _ _ _ _ _
9	This measures the wind direction. It sends this information to computers in the control room.	_ _ _ _ _ _ _ _
10	This describes the way the nacelle and blades turn to get the best from the wind. This word means 'turn'.	_ _ _
11	The large, tall structure the turbine sits on is called this.	_ _ _ _ _
12	Number 11's are embedded in concrete ones.	_ _ _ _ _ _ _ _ _ _ _
13	Wires are bound together to form these. They carry the electricity generated from the turbine.	_ _ _ _ _ _

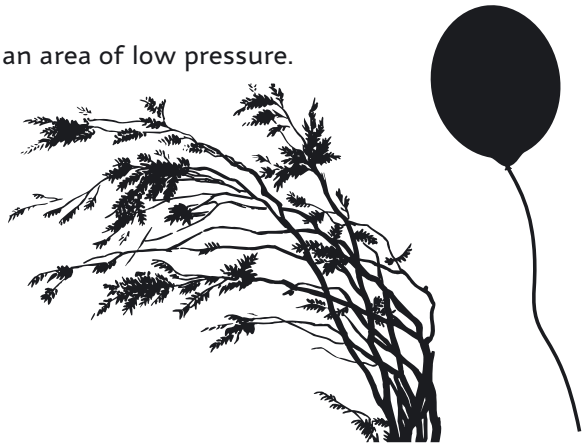
cables nacelle wind vane tower shaft rotor blade
pitch generator gear box anemometer foundations yaw

Worksheet 9 - Thinking About the Wind

NAME_____

Make the Wind Blow

- The wind blows from an area of high pressure to an area of low pressure.
- Blow up a balloon and hold the opening closed.
- The air is in an area of high pressure.
- Now release the air by letting go of the opening.
- A wind rushes out to an area of low pressure.
- You have made the wind blow!

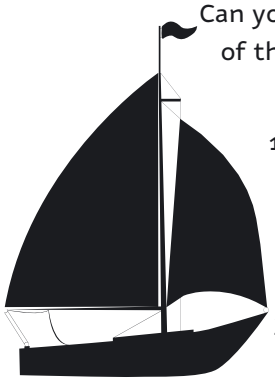


We cannot see the wind but we can see its effects.

Write down 4 signs that the wind is there.

1 _____ 2 _____

3_____ 4 _____



Can you think of 3 ways in which people have harnessed the power of the wind in the past to help them in their everyday lives?

1 _____

2 _____

3 _____

Nowadays wind farms are being built to capture wind power and turn it into electricity.

Can you think of 2 benefits of generating electricity this way instead of generating electricity using fossil-fuelled power.

1 _____

2 _____

Can you think of 3 possible challenges companies will have in generating power using the wind?

1 _____

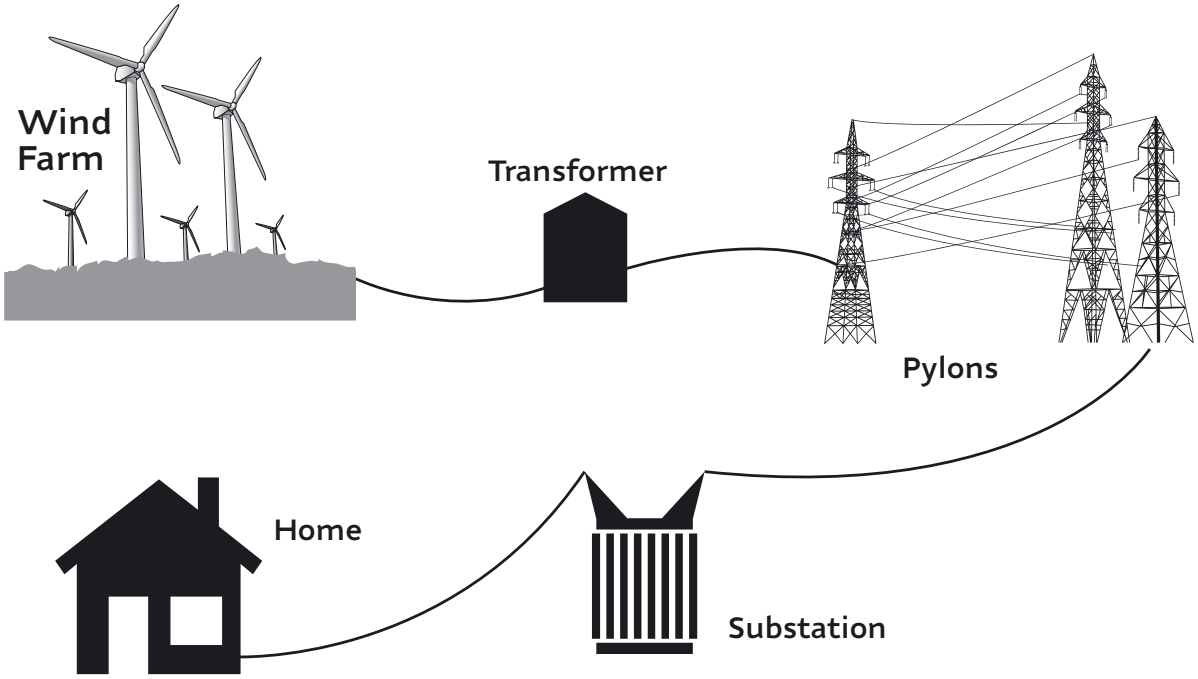
2 _____

3_____

Worksheet 10 -
From a Wind Power Station to our Homes

NAME_____

- **Sort out the process of electricity generation from the wind farm to our homes. Use the diagram to help.**
- **Number the sentences from 1 to 10 in the correct order. The first one has been done for you.**

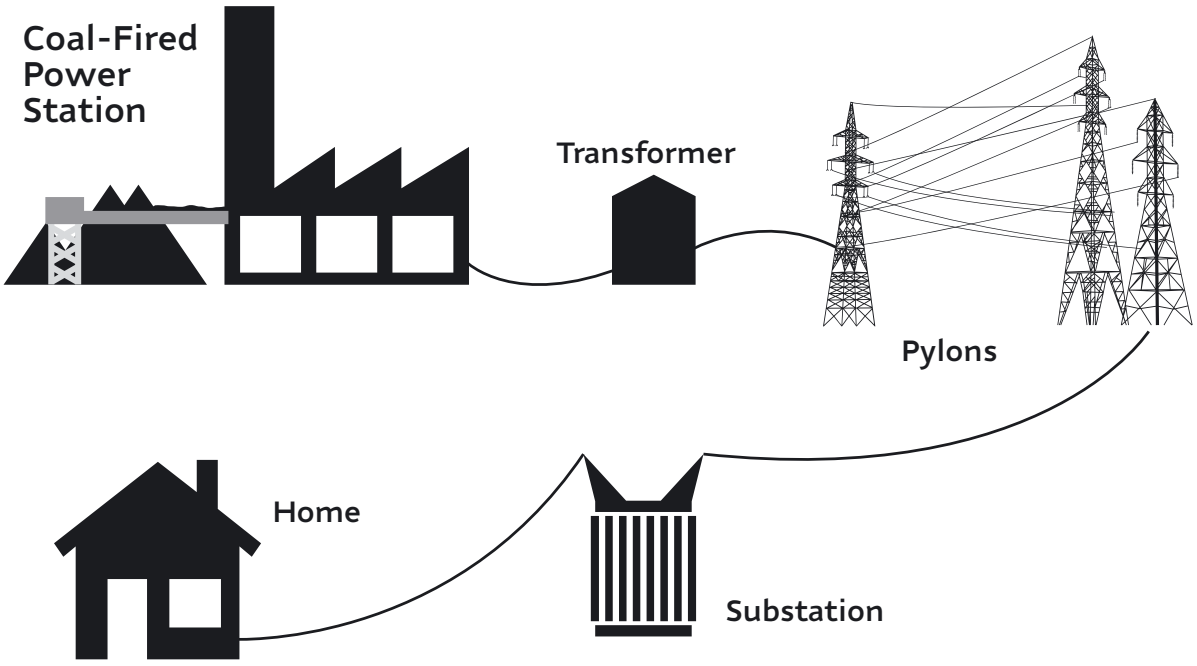


	The blades spin a generator.
	This power station is called a wind farm. It generates electricity by using the energy from the wind.
	Pylons carry the wires with the high voltage electricity across the countryside to substations.
	The thick wires carry electricity to a transformer. It changes low voltage electricity from power stations to high voltage electricity. This flows better over long distances.
	The electricity flows away from the wind farm along thick wires.
	Lastly, wires carry the electricity from the substation to our homes, offices and factories.
1	Firstly, electricity needs to be generated for people to use. This is done at power stations.
	Inside the generator, a magnet is spun inside a coil of wire to generate electricity.
	In substations, the high voltage electricity is changed back to low voltage electricity.
	The wind spins the wind turbines' blades.

Worksheet 11 -
From a Coal Power Station to our Homes

NAME_____

- **Sort out the process of electricity generation from power station to our homes. Use the diagrams to help.**
- **Number the sentences from 1 to 10 in the correct order. The first one has been done for you.**

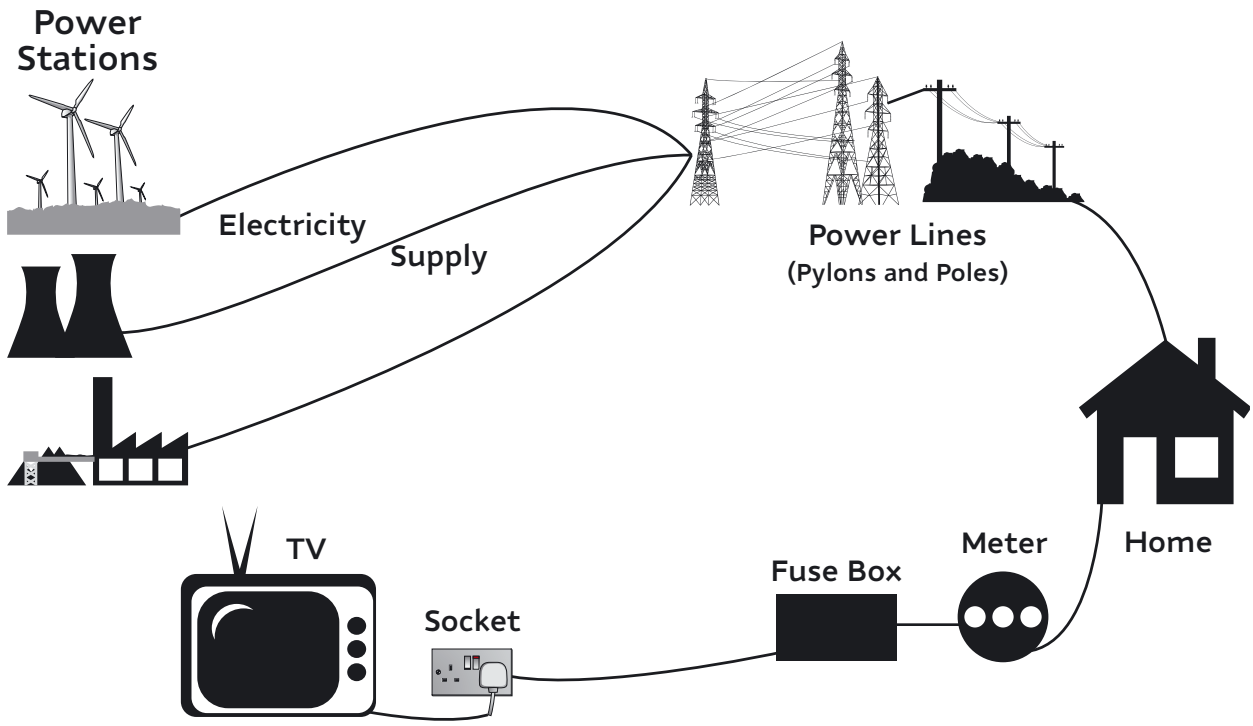


	Pylons carry the wires with the high voltage electricity across the countryside to substations.
	This coal power station generates electricity by burning coal. This heats water to produce steam.
	The thick wires carry electricity to a transformer. It changes low voltage electricity from power stations to high voltage electricity. This flows better over long distances.
	The turbine uses the flowing steam to spin a generator.
	The electricity flows away from the power station along thick wires.
	Lastly, wires carry the electricity from the substation to our homes, offices and factories.
	Inside the generator, a magnet is spun inside a coil of wire to generate electricity.
	The steam passes through pipes to turn a special engine called a turbine.
	In substations, the high voltage electricity is changed back to low voltage electricity.
1	Firstly, electricity needs to be generated for people to use. This is done at power stations.

Worksheet 12 -
Electricity Comes into our Homes

NAME_____

- **Use the diagram to help you understand how electricity comes into our homes**
- **Number the sentences from 1 to 7 in the correct order. The first one has been done for you.**



	All of these power stations work together to generate and supply the electricity the country wants.
	The electricity supply the country wants goes into a system of power lines called the national grid.
	Finally the sockets in our houses are wired to the mains supply to allow us to use electrical items such as lamps, washing machines, cookers, computers and TVs.
	We get the electricity we want from the national grid from the 'mains electricity supply' which comes into our homes.
	In our homes a meter measures the amount of electricity we use. Our electricity bills are calculated using the amount of electricity displayed on the meter.
	Next the mains electricity supply passes through fuses. Fuses help prevent electrical accidents in our houses.
1	Coal and nuclear power stations make most of the energy we want. Wind farms and other types of power station add the extra energy we want.

Worksheet 13 - Wind Conditions

NAME_____

LOCATION OF WIND SOCK OR WEATHER VANE

_____

	Monday	Tuesday	Wednesday	Thursday	Friday
Wind Direction					
Wind Speed (enter a Beaufort Number)					

- **The Beaufort scale is a measure used mainly for wind speed. The scale was created by the British naval commander Sir Francis Beaufort around 1806.**
- **Use the information on the chart (below) to enter a Beaufort Number into your chart (above) to match wind speed on each day.**

Beaufort number	Wind speed. Miles per Hour (MPH)	Description	Sea conditions	Land conditions
0	Less than 1	Calm.	Flat.	Calm.
1	1-3	Light air.	Ripples without crests.	Wind motion visible in smoke.
2	4-7	Light breeze.	Small wavelets.	Leaves rustle.
3	8-12	Gentle breeze.	Large wavelets.	Smaller twigs in constant motion. *Wind Farms start generating.*
4	13-18	Moderate breeze.	Small waves.	Small branches begin to move.
5	19-24	Fresh breeze.	Moderate longer waves.	Smaller trees sway.
6	25-31	Strong breeze.	Large waves with foam crests.	Large branches in motion. *Wind Farms at maximum power.*
7	32-38	Near gale.	Sea heaps up and foam begins to streak.	Whole trees in motion.
8	39-46	Gale.	Moderately high waves with breaking crests.	Twigs broken from trees.
9	47-54	Severe gale.	High waves with dense foam.	Light structural damage.
10	55-63	Storm.	Very high waves. The sea surface is white.	Trees uprooted. Considerable structural damage. *Wind Farms shut down.*
11	64-72	Violent storm.	Exceptionally high waves.	Widespread structural damage.
12	73-82	Hurricane.	Sea completely white with driving spray.	Massive and widespread damage to structure.

Worksheet 14 - Energy Source Stories

NAME_____

Complete the Energy Source Stories by cutting out the pieces on sheet 14A and sticking them in the correct place on this sheet.

Energy Source	Electricity is generated when...	Advantages	Disadvantages	Renewable?
?	Burning coal, oil or gas releases the stored energy of the sun	Currently plentiful. Burns well.	?	?
Solar Power 	?	It's always available Little harm to the environment Can be used to top up the amount of electricity we use Can be used to power lots of different things e.g. cars	?	YES 
Geothermal Power 	?	It's always available Little harm to the environment Can be used to top up amount of electricity we use	Low amount of energy produced Not available in many places around the world	?
?	The energy in running water is used	It's always available Little harm to the environment High amount of energy produced Can be used throughout the world	?	YES 
Biomass Power 	Materials made from animals and plants are burned and released as heat	?	Power stations can be small due to fuel supply limitations. May drive up food prices.	YES 
?	Splitting atoms (tiny particles) which causes a heat reaction	Very little fuel is needed. Fuel is produced in several countries. No climate change gases produced.	?	NO 
Wind Power 	?	It's always available Little harm to the environment Can be used to top up the amount of electricity we use	?	?

Worksheet 14A -
Cut Outs For Energy Source Stories

Cut out the pieces on this sheet, and stick them in the correct place on Sheet 14.

ENERGY SOURCES

Hydroelectric Power

Nuclear Power

Fossil Fuels

ELECTRICITY IS GENERATED WHEN...

Heat energy from inside the Earth is captured

The long blades on wind turbines catch the wind and spin

The spinning movement is converted to electricity by a generator

Special solar panels convert the sun's energy

ADVANTAGES

It's always available

Cuts down on animal and plant waste

Burning it can produce other fuels

Helps the farming industry

DISADVANTAGES

A finite resource so they will run out and take millions of years to replenish.

Gasses given off may pollute or contribute to climate change if untreated or not stored.

Needs lots of fast running water

Can cause problems for fish and river-life

It's not windy all the time

Lots of wind turbines needed to produce useful amounts of electricity

Turbines need to be built in windy places

Low amount of energy produced

Large number of panels needed to produce useful amounts of electricity

Only areas of the world with lots of sunlight work well

Nuclear waste highly poisonous for decades.

Control and treatment of waste can be dangerous.

RENEWABLE?

YES

YES

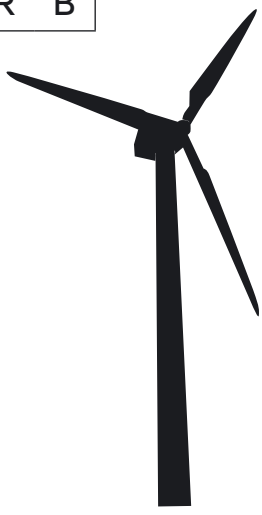
NO

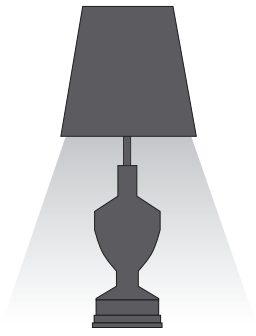
Worksheet 15 -
Black Law Wind Farm Word Search

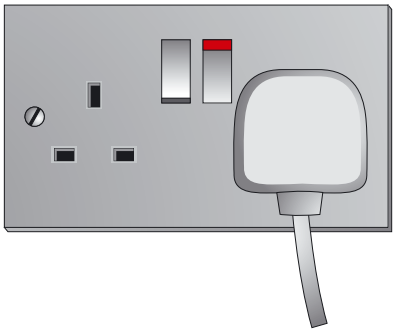
NAME_____

R	D	G	G	W	N	C	G	O	F	N	O	E	W	N
W	E	O	E	K	N	O	A	E	A	V	L	N	I	E
V	E	W	I	M	Q	U	I	E	A	E	J	T	N	E
O	P	A	O	A	F	K	L	T	C	R	H	D	D	L
E	S	X	W	T	J	C	S	T	C	Q	S	P	O	B
N	N	Y	T	I	C	I	R	T	C	E	L	E	S	A
O	A	I	G	V	O	O	B	U	T	X	R	R	S	W
J	E	C	O	K	M	K	L	T	Z	Z	E	I	Q	E
R	U	H	E	A	W	S	A	U	J	M	Y	X	D	N
W	N	Y	G	L	U	K	D	R	O	T	O	R	X	E
Y	A	N	F	P	L	P	E	T	Q	A	R	R	H	R
W	E	T	P	T	Y	E	S	T	U	R	B	I	N	E
T	J	L	W	J	H	U	Y	G	R	E	N	E	A	K
P	Y	L	I	I	C	M	A	C	N	M	K	W	V	D
Z	X	O	R	S	Y	G	X	R	F	I	E	T	R	B

BLADES **CLEAN**
CUSTOMERS **DIRECTION**
ELECTRICITY **ELECTROMAGNET**
ENERGY **GEARS**
NACELLE **RENEWABLE**
ROTOR **SPEED**
SUPPLY **TOWER**
TURBINE **WIND** **YAW**







Answers

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Answers

WORKSHEET 1

Item	Sound Energy	Heat Energy	Light Energy	Mechanical Energy
Radio	✓	✓ (produced also)	✓ (on any lights /LED's)	
TV	✓	✓ (produced also)	✓	
Washing Machine	✓ (produced also)	✓	✓ (produced also)	✓
Hair Drier	✓ (produced also)	✓		✓
Kettle	✓ (produced also)	✓	✓ (produced also)	
Microwave Oven	✓	✓	✓	✓
Toaster	✓ (produced also)	✓	✓ (produced also) (elements glow red)	(the energy from the pop up action was stored in the spring when you provided the energy to push it down)
Iron	✓ (produced also)	✓	✓	
Lamp		✓ (produced also)	✓	
Electric Cooker	✓ (produced also)	✓	✓	
Food Mixer	✓ (produced also)	✓ (produced also)		✓
Computer	✓	✓ (produced also)	✓	✓
Fan Heater	✓ (produced also)	✓	✓ (produced also)	✓

WORKSHEET 2

work, forms, power, Renewable, electricity, fossil, millions, pressure, uranium, nuclear, change, wind, generate.

WORKSHEET 4

Reason that electricity calculation will not be accurate is summer and winter variations in amount of electricity used, especially if household has electric heating.

WORKSHEET 8

1 blade; 2 rotor; 3 pitch; 4 shaft; 5 gear box; 6 generator; 7 nacelle; 8 anemometer; 9 wind vane; 10 yaw; 11 tower; 12 foundations; 13 cables

WORKSHEET 9

4 signs that the wind is there: trees sway, flags move, leaves are blown about, our hair moves when it blows, smoke blows etc.
3 ways in which people have harnessed the power of the wind in the past to help them in their everyday lives: in sailing boats, to grind grain into flour (windmills), drying clothes, pump water (windmills)
2 benefits of generating electricity from wind power: no emissions, the wind is free
3 challenges companies have in generating power using the wind: the wind does not blow all the time, the wind fluctuates, finding places windy enough for turbines can be a challenge (they can often be remote and inaccessible), people can object to the visual impact / sound of turbines.

WORKSHEET 10

Correct order from top to bottom of this sheet is 4, 2, 8, 7, 6, 10, 1, 5, 9, 3

WORKSHEET 11

Correct order from top to bottom of this sheet is: 8, 2, 7, 4, 6, 10, 5, 3, 9, 1

WORKSHEET 12

Correct order from top to bottom of this sheet is: 2, 3, 7, 4, 5, 6, 1

Answers

WORKSHEET 14

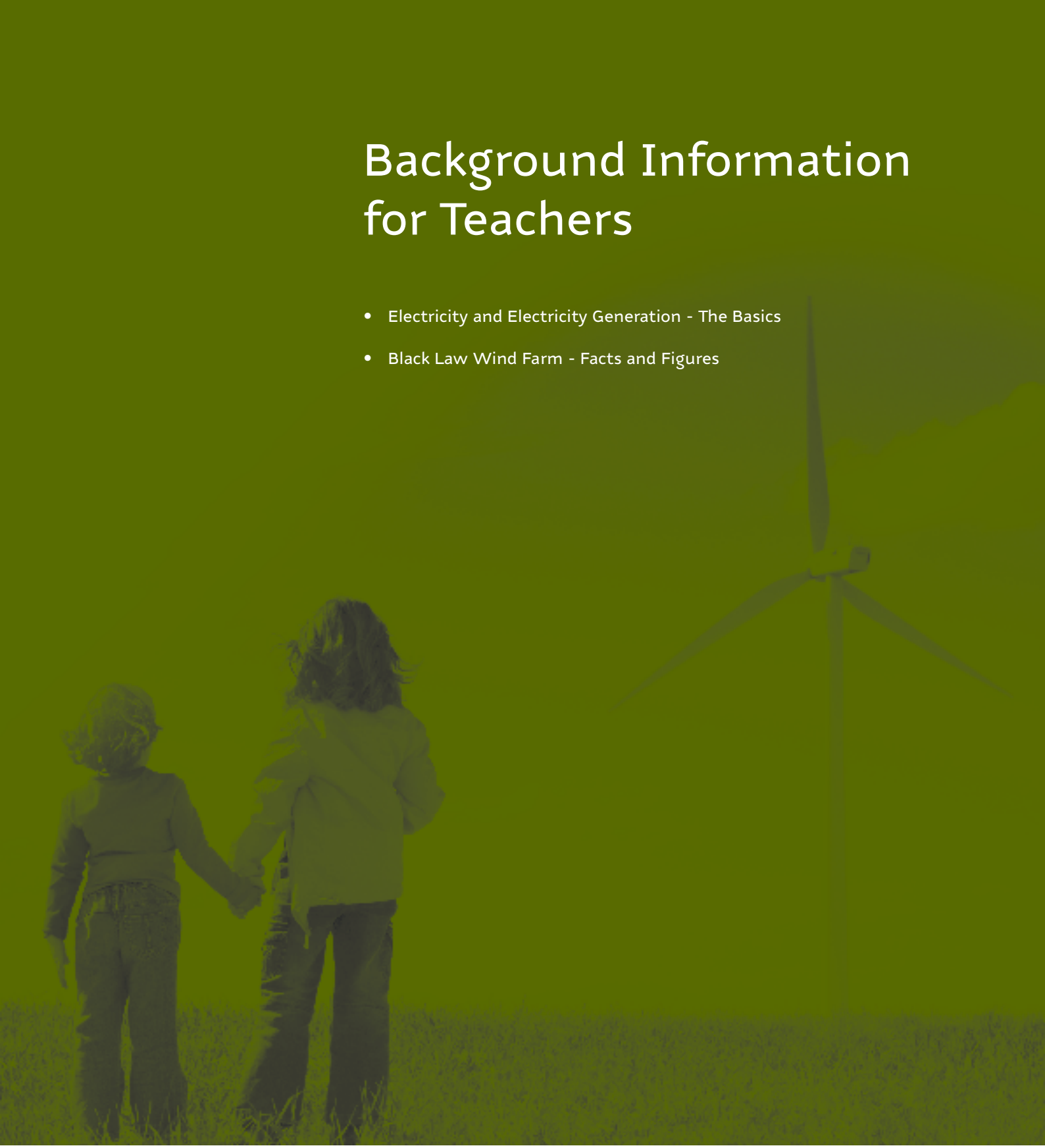
Energy Source	Electricity is generated when...	Advantages	Disadvantages	Renewable?
Fossil Fuels	Burning coal, oil or gas releases the stored energy of the sun.	Currently plentiful. Burns well.	A finite resource so they will run out and take millions of years to replenish. Gases given off may pollute or contribute to climate change if untreated or not stored.	NO
Solar Power	Special solar panels convert the sun's energy.	It's always available. Little harm to the environment. Can be used to top up the amount of electricity we use. Can be used to power lots of different things e.g. cars.	Low amount of energy produced. Large number of panels needed to produce useful amounts of electricity. Only areas of the world with lots of sunlight work well.	YES
Geothermal Power	Heat energy from inside the Earth is captured.	It's always available. Little harm to the environment. Can be used to top up amount of electricity we use.	Low amount of energy produced. Not available in many places around the world.	YES
Hydroelectric Power	The energy in running water is used.	It's always available. Little harm to the environment. High amount of energy produced. Can be used throughout the world.	Needs lots of fast running water. Can cause problems for fish and river-life.	YES
Biomass Power	Materials made from animals and plants are burned and released as heat.	It's always available. Cuts down on animal and plant waste. Burning it can produce other fuels. Helps the farming industry.	Power stations can be small due to fuel supply limitations. May drive up food prices.	YES
Nuclear Power	Splitting atoms (tiny particles) which causes a heat reaction.	Very little fuel is needed. Fuel is produced in several countries. No climate change gases produced.	Nuclear waste highly poisonous for decades. Control and treatment of waste can be dangerous.	NO
Wind Power	The long blades on wind turbines catch the wind and spin. The spinning movement is converted to electricity by a generator.	It's always available. Little harm to the environment. Can be used to top up the amount of electricity we use.	It's not windy all the time. Lots of wind turbines needed to produce useful amounts of electricity. Turbines need to be built in windy places.	YES

WORKSHEET 15

R	D	+	+	+	N	+	G	+	+	N	+	E	W	+
+	E	+	+	+	+	O	+	E	A	+	L	+	I	+
+	E	W	+	+	+	+	I	E	A	E	+	+	N	E
+	P	+	O	+	+	+	L	T	C	R	+	+	D	L
+	S	+	+	T	+	C	+	T	C	+	S	+	+	B
N	+	Y	T	I	C	I	R	T	C	E	L	E	S	A
+	A	+	+	+	+	O	B	+	+	+	R	R	+	W
+	+	C	+	+	M	+	L	+	+	+	E	I	+	E
+	+	+	E	A	+	S	A	+	+	M	+	+	D	N
+	+	Y	G	L	U	+	D	R	O	T	O	R	+	E
+	A	N	+	P	L	+	E	T	+	+	+	+	+	R
W	E	+	P	+	+	E	S	T	U	R	B	I	N	E
T	+	L	+	+	+	U	Y	G	R	E	N	E	+	+
+	Y	+	+	+	C	+	+	+	+	+	+	+	+	+
+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Background Information for Teachers

- Electricity and Electricity Generation - The Basics
- Black Law Wind Farm - Facts and Figures



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Background Information for Teachers

Electricity and Electricity Generation - The Basics

To understand electricity, we have to understand a bit about the atoms that everything is made of. So here goes...

Atoms - A Perfect Balance

Atoms are very tiny, but are made up of even tinier particles. In the nucleus in the middle of the atom there are particles called protons. Orbiting around the nucleus are other particles called electrons.

Protons and electrons are different - a proton has a positive electric charge and an electron has a negative electric charge.

The negative electric charge of an electron can balance or cancel out the positive charge of a proton.

Atoms usually contain as many electrons as they do protons, so they usually have no overall electric charge. We say they are electrically neutral or uncharged.

Electric Charge - It's Ever So Pushy

One thing to note about electric charge is that charged objects push each other around.

Two positively charged objects will push each other away.
Two negatively charged objects will push each other away.
A positively charged object and a negatively charged object will attract each other.

Electric charges behave a bit like the poles of magnets. Similar charges repel each other and opposite charges attract each other.

Making Electricity Flow - The Big Three

When charges flow from one place to another, we say that an electric current is flowing.

The 3 things needed for electric current to flow are:

- The charged particles must be free to move.
- There must be something trying to push the charged particles along.
- There must be somewhere for the charged particles to go.

Conductors - Move Along Please...

In a metal some electrons escape from the atoms and are free to move around inside the metal.

Because electrons are electrically charged, this means that an electric current can flow inside the metal, so it becomes an electrical conductor.

Background Information for Teachers

Electricity and Electricity Generation - The Basics

Moving Electrons Along - The Big Push

Although the electrons are free to move, they won't move unless something pushes them. But exactly what pushes them? Batteries and electric generators are devices for pushing electrons along.

In the case of wind turbines, electric generators push the electrons along.

Electric Circuits - Round and Round...

One way to give electrons somewhere to go is to have a complete electrical circuit. Electrons can travel around and around the circuit, like cars on a racetrack. When a wind farm is up and running its power is generated into the national grid. When we plug things into it, it is effectively a big electric circuit covering the country.

Insulators - Saying No to the Flow

In some materials, like glass, plastic and wood, the electrons aren't free to move. Batteries and generators can't push the electrons along to make an electric current.

These materials are called insulators. Insulators are very useful because they stop electricity flowing where we don't want it to go.

You can see ceramic insulators on overhead electricity lines. They are used to isolate the pylon from the live electric wires. This could be fatal for people and livestock etc that may come into contact with them.

Earths - The Shocking Truth

Some electrical appliances have metal parts you can touch. If something went wrong inside and these parts became connected to the live mains wire, you could get an electric shock if you touched them.

To stop this happening exposed metal parts are earthed - they are connected by a wire to a metal rod in the ground. If the metal parts accidentally connect to a live mains wire, the electricity will then flow away to earth rather than through the person who touched it! The wind turbine tower structure is earthed to prevent such things happening.

Fuses - What a Blow Out

Sometimes a fault in an appliance can cause a very large electric current to flow through the appliance. This can heat up the appliance and start a fire.

Inside a plug is a fuse, which contains a thin wire through which all the electric current flows. If the current gets too big the wire gets hot enough to melt, and automatically breaks the circuit.

When a fuse blows, it needs to be replaced once the fault has been fixed. Devices called circuit breakers do the same job as fuses and can be reset easily once they've done their job. In our houses the fuses in the fuse box do this job.

Background Information for Teachers

Electricity and Electricity Generation - The Basics

Measurement of electricity - Watts it All About?

The 3 words used most to measure electricity are volts, amps and watts.

- The volt (V) is a measure of the strength of the push behind the electricity. Mains electricity is at 230 volts, car batteries produce 12 volts, an AA battery produces 1.5 volts.
- The amp (A) is a measure of the amount of electricity that is flowing. Fuses are labelled to show the maximum current that will flow through them before they blow. Common fuses are 3, 5 and 13 Amp.
- The power of an appliance is the rate at which it uses electricity. Power is measured in watts (W). A kettle will have a power of about 2500 watts, one ring of an electric cooker is about 1000 watts and traditional light bulbs are most commonly 40, 60 or 100 watts. The more powerful an appliance is, the bigger the current that has to flow through it.

James Watt, 1736-1819

However the productive capacity of electrical generators operated by utility companies is often measured in megawatts (MW). This is a unit for measuring power equal to one million watts! Each turbine at Black Law wind farm is capable of producing 2.3MW and the whole wind farm is capable of producing 124MW.

The national grid - Electricity Everywhere

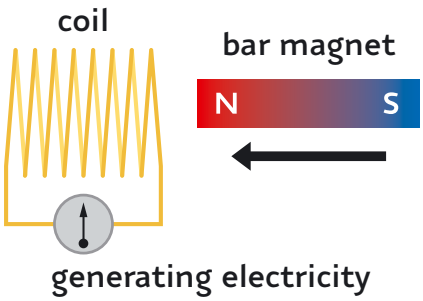
The national grid is the electric power transmission network in Great Britain. It connects power stations and large substations that generate electricity. The 'grid', as its known, makes sure that electricity generated anywhere in Great Britain can be used to satisfy demand.

The mains power we get from the national grid is generated by spinning large coils of wire between magnets. This generates electricity (see section below). The coils are turned using energy from wind (in the case of Black Law wind farm), coal, oil, gas, water or by using nuclear power.

Magnetism and Electricity - A Great Relationship

Electricity and magnetism are not the same, but are very close relations - you can make a magnet using electricity and you can make electricity using a magnet.

For example, if you coil a wire around an iron rod and pass an electric current through the wire, the rod will become a magnet.



Depending on what the rod is made of, it will stop being a magnet when the current is switched off. This is called an electromagnet.

If a magnet is moving near a coil of wire it causes an electric current to flow inside the coil. An electric current will also flow if you keep the magnet still and move the coil instead.

Background Information for Teachers

Electricity and Electricity Generation - The Basics

Energy - Work, Work, Work!

Energy is the ability or capability to do work or to produce change.

Forms of energy include electricity, heat, light, sound, chemical and kinetic (movement) energy.

Most of the energy we use is obtained by burning fossil fuels. Our need for energy (e.g. in our use of cars, electricity, etc) is creating a huge impact on the world around us due to the harmful gases produced by burning these fossil fuels.

Fossil Fuels - Back to the Future

Coal, oil and gas are known as fossil fuels and have been produced over millions of years as plants and animals have died and rotted and have been compressed in layers.

Burning fossil fuels produces huge amounts of carbon dioxide. These are released into the environment and are known as greenhouse gases.

The Greenhouse Effect / Global Warming / Climate Change - What's it All About?

The greenhouse effect is the rise in temperature of the Earth. While this is a natural process, it is being increased, mainly because the main gas produced by burning fossil fuels (carbon dioxide) traps energy from the sun and warms our planet. This is also known as global warming or climate change.

We know the climate is changing because since 1860, millions of individual thermometer measurements have been taken all over the world. These show that the surface air temperature has risen by 0.6 degrees Celsius since the beginning of the 20th Century with about 0.4 degrees Celsius rise occurring since the 1970's!

We need to reduce emissions of these gases, by being more energy efficient and using other sources of energy to reduce the impact of climate change.

Climate change is caused by both natural and human causes.

The Earth's climate varies naturally due to:

- conditions created by the oceans and the atmosphere.
- changes in the Earth's orbit.
- variations in the energy received from the Sun.
- volcanic eruptions.

but the main human influence on the Earth's climate is due to emissions of greenhouse gases e.g. carbon dioxide and methane.

At present, about 6.5 billion tonnes of carbon dioxide is emitted globally into the atmosphere each year, mostly through burning coal, oil and gas for energy.

Background Information for Teachers

Electricity and Electricity Generation - The Basics

Increasing concentrations of greenhouse gases in the atmosphere over the last 200 years have trapped more energy in the lower atmosphere, in turn changing the global climate. (However it is not just as straightforward as this - other pollutants from human activity e.g. sulphur dioxide cool the climate.)

Carbon dioxide is active in the atmosphere for about 100 years. This means that it will take several decades to reduce global emissions to make any change for the better.

Working Together - Action Stations

To tackle the causes of climate change everyone needs to work together to take global action by reducing emissions of greenhouse gases.

The Kyoto Protocol is an agreement made under the United Nations Framework Convention on Climate Change (UNFCCC). Countries that consented to this protocol committed to reduce their emissions of carbon dioxide and five other greenhouse gases.

The UK is committed to meeting the Kyoto target to reduce greenhouse gas emissions by 12.5% by 2008-2012.

The Wind - Where Does it Come From?

The wind blows because the sun heats up the Earth. When the sun's rays hit the Earth the surface of the Earth is heated and so is the air above it.

But the sun does not heat the Earth evenly. It heats it more at the equator than at the North and South poles, and it heats up the land more easily than it heats up the sea.

Where the Earth is heated strongly, the air warms and rises. More air flows in (as a wind) to replace the air that has risen. So the sun causes the wind to blow!

Wind Power - Clean and Green

Wind is a renewable energy source. This means that it is easily replaced by 'Mother Nature', unlike an energy source such as coal, which takes millions of years to form.

Wind is a 'clean energy' source because it doesn't pollute the air.

Today wind energy is used to produce electricity at wind farms. Turbines harness the wind to generate electricity.

Background Information for Teachers

Black Law Wind Farm - Facts and Figures

- There are 54 turbines on site.
- Each turbine can produce up to 2.3MW of electrical power.
- The whole wind farm is capable of producing 124MW of electrical power.
- In comparison, Longannet, a coal-fired power station, is capable of producing 2400MW of electricity.
- The turbines at Black Law are capable of providing enough electricity to power 69,000 homes.
- Towers are either 60m or 70m high.
- Inside the tower there is a lift to take staff to the top.
- Three men can stand in the pod (nacelle) at the top.
- Each blade is 40m long and 3m wide.
- The generator inside each turbine produces electricity at a voltage of 690V.
- The turbines were built in Denmark and brought to Grangemouth by boat. They were then transported by low-loader truck to Black Law.
- In very high winds (Force 10) the turbines automatically shut down to prevent damage.
- They are operated by a control system called SCADA. It logs various data including wind speed, wind direction, yaw angle (direction the turbine is pointing), pitch of blades and electricity outputs.
- The SCADA system can average the data from the turbines for each day, hour and minute.
- Black Law wind farm cost over £90 million to build.