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For Primary Schools and Teachers of S1/S2 courses

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The answer, my friend?

Ten years ago, our Primary Newsletter (8) was concerned with what causes the air surrounding our planet to move and produce what we call wind. As well as discussing how people had harnessed wind in the past to provide mechanical work, it also referred briefly to the potential power of the wind. Indeed the amount of energy in the wind, if it could be fully turned into usable energy, is about three times the current (sorry!) Earth's annual electrical energy usage.

Since then we have seen increasing interest in all forms of renewable energy and, as technology has moved on, more of our electricity can, and is, being generated by the wind. In Scotland this is still only about 3% of our energy needs. There is considerable debate, however, which questions whether wind generation is more than just technically feasible. Whilst it cannot be denied that "clean" electricity is possible, many other factors and opinions should be considered. Groups of wind generators (wind farms - Figure 1) can affect the look and tranquillity of a landscape as well as disturbing wildlife both during their construction and when operational, spinning round at a rate of knots. Cross-curricular debate in the Social Subjects and Science components of Environmental Studies at Level E could look at the advantages and disadvantages of setting up a wind farm in the vicinity of the school. There is often useful material in the media to aid such discussions. In this issue we also look at another form of renewable energy and the design of solar cookers.

Blades and wind turbines

Just like the windmills of old, wind turbines use blades to turn the movement (kinetic) energy of the wind into a more practical form. However, rather than using it to grind corn or pump water for irrigation we are more interested nowadays in generating electricity. As wind flows over the curve-shaped (aerofoil) blades it causes lift (similar to the effect on aeroplane wings - in this case the movement is sideways rather than upwards) causing them to turn. Blades are connected to a central drive shaft, which turns an electric generator to produce electrical energy. This energy can be stored in batteries for use in low-voltage systems or exported back to the companies who supply 'mains' electricity and form what is known as the National Grid.

As some schools have had a wind turbine installed, there are a number of aspects of their operation that you can investigate in the form of relatively simple class activities.

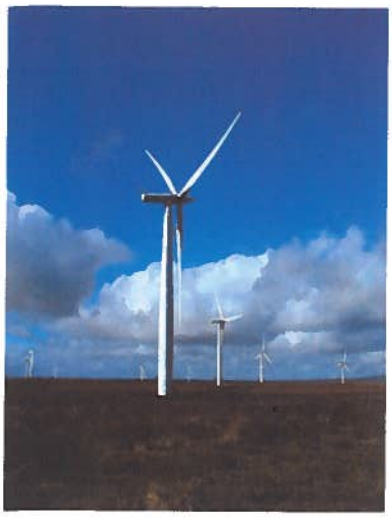


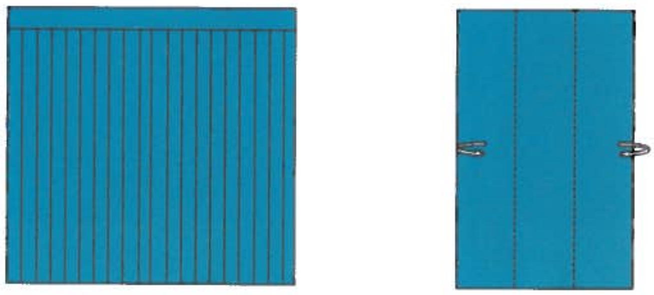
Figure 1 - Causeymire Wind Farm site at Dale Moss near Spittal, Thurso, Caithness.

Each turbine (there are 24 in all) is capable of generating 2.3 megawatts (MW) of electricity, enough to power over 1,200 homes each. They were constructed in Denmark and shipped to Scotland. The wind turbines are 60 metres in height to the hub and the blades are 40m in length. Big!

Class activities

You need to find the direction of the prevailing wind and where will you get the strongest, most constant and reliable winds. This can be tested by using a simple windsock. You may have seen these at the end of airport runways and are used by air-traffic controllers and pilots to gauge the strength and direction of the wind.

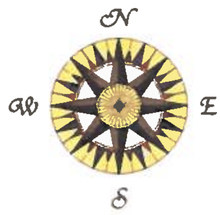
Making a simple windsock - You will require an A4 sheet of paper as well as a sheet of tissue paper or thin plastic (from a carrier bag) measuring about 30 x 30 cm.



Figures 2 & 3 - The 30 x 30 sheet (above left) should be marked out in 1 cm strips and cut with scissors up to the 1 cm line drawn horizontally. This forms the streamer tail of the wind sock. Fold the A4 sheet in three (above right) and Sellotape together. Coil this into a tube and stick together. This forms the body of the windsock. Wrap the top end of the streamer tail around the tube and stick together. The final windsock should look like Figure 4.

Figure 4 - Final construction of windsock

Finding the direction of the wind



Pupils can use a compass to find North and can then mark out a compass rose (opposite) on the ground. When they stand in the centre with their windsock they will be able work out in which direction the wind is blowing (Fig.5).

A word of caution! Winds are named after the direction from which they have come, therefore, if the windsock is blowing over the East marking on the ground the wind is in fact blowing from the West – the West wind doth blow!

Figure 5 - Windsock tied to fixed position and blowing in wind

Strength of the wind or windspeed

Challenge your children to investigate how the windsock behaves as the wind strength changes. Get them to devise ways of recording the height reached by the windsock or the angle the string makes with the fixed position. The strength of the wind is measured by the weather forecasters on a measurement called the Beaufort Scale. This was devised by Admiral Sir Francis Beaufort (1774-1857) who developed the scale in 1805 to help sailors estimate the wind strength by making simple observations. The scale goes from Force 0 (a calm day) through Force 6 (strong breeze) and right up to Force 12 (hurricane). Each level on the scale remarks on everyday observations e.g. of trees, branches, twigs and leaves.

Mini kites – an alternative to windsocks

Instead of using windsocks, the children can acquire similar information by making and flying kites (Fig.6). They are very simple to make and will fly in fairly light winds. The finished size is smaller than a sheet of A4 paper.

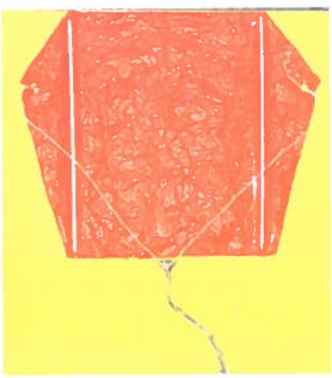


Figure 6 - Students need only tissue paper or thin plastic (from a carrier bag), two straws, Sellotape and string.

School wind turbines

Two years ago, (May 2004) five Fife Primary schools each had a rooftop wind turbine device installed as part of a pilot study jointly funded by the Scottish Executive, Renewable Devices, Scottish Power and Fife Council. It was projected that each turbine could generate up to 4000kW hours of green electricity per year, saving up to 1720kg carbon dioxide.

The pilot study was launched at Collydean Primary in Glenrothes. Recently, we decided to go and find out how the turbine was performing.

The school janitor, Mr Bob Gold, is an enthusiastic advocate of the wind turbine and provided us with a wealth of information (technical and non-technical!). He is also willing to spread the word to any other interested parties.

The wind turbine (Fig.7) is about two metres across with five angled blades to catch the wind. Two tail fins ensure that the turbine is constantly being directed to face the wind. There is an integral safety device to ensure that if the wind is too strong the turbine will stop automatically.

Figure 7 - School turbine installed at Collydean Primary

The direct current produced by the turbine is conveyed to the school switch room where an inverter changes it to alternating current suitable for sending to the National Grid. It can produce up to 1.5 Kw per hour, (currently worth about 9p), and all electricity produced by the turbine is offset against the school electricity bill. A meter (Fig.8) shows the amount of power the turbine has produced and the rate at which it is currently working.

Because this was the first turbine to be installed there were some teething problems but these have now been overcome, and on the bright and breezy day of our visit the turbine was working perfectly and making very little noise.

We visited a Primary Six class who were very aware of the importance of being able to produce "green" electricity from their turbine. Typical comments included - "it is eco-friendly", "it shows we care about the environment", "we are not using up energy resources", "the meter shows how much we have made".

Figure 8 - Display showing kWhr generated

Each term, Mr Gold has one class read the meter regularly and construct graphs to show how the amount of power produced varies over time. He suggested that it would be useful if an LCD display could be installed at the entrance to the school to provide constant monitoring of the wind turbine's performance, wind speed and the energy produced. Mr Gold reported that parties from other schools come to visit the turbine and find out about its potential.

We would be interested to hear from other schools that have had similar devices installed. Our sources suggest that the installation of wind turbines has not always been such a positive experience. Indeed, complaints from neighbours about noise has resulted in at least one school having to turn off its turbine at night and in other cases less power than anticipated has been produced.

Model wind turbine

To engage the interest of the children and demonstrate that a wind turbine can generate useful electrical power, you can easily set up a simple model. This will show that the power of the wind turning a propeller can generate enough electricity to light an LED (light emitting diode).

All that is required (Fig.9) is a solar motor, a propeller, a two-way terminal block, an LED---AND A STIFF BREEZE! (We can supply all components {except the wind!} separately or as a kit - £2.50 including p&p).

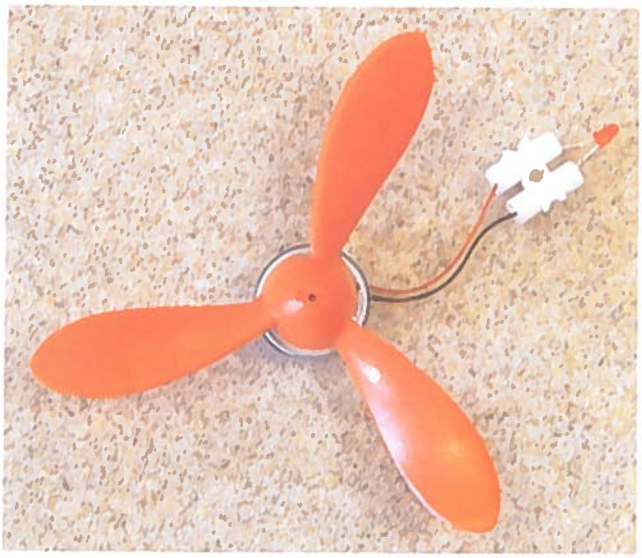


Figure 9 - Model turbine (propellor, terminal block & red LED)

Connecting the LED for this purpose, where the solar motor is acting as a generator, contrary to normal practice you must connect the long leg of the LED to the black lead.

As your pupils become more aware of opportunities for producing electricity by alternative means they will be able to find examples in their local area. Apart from solar powered calculators, some road side warning signs (often "SLOW DOWN" outside schools) are powered by solar cells, ornamental lights in gardens have solar cells which charge a battery during the day to provide light at night and some small fountains for garden are operated by solar powered cells. Other applications which use solar power include parking meters (well in Edinburgh at least), bus shelter lights, remote emergency telephones, lighthouses (Fig.10) and navigation buoys.

Figure 10 - Lighthouse on Brough of Birsay, Orkney Islands Solar panels useful even this far North!

Let's get cooking!

Energy from the sun can be used in many ways to save the Earth's finite fuel resources. In some areas, cooking is done over wood fires which, apart from the pollution caused by the smoke, results in trees around villages being cut down and not replaced. However, solar-powered devices can be used to cook food or sterilise water. The light from the sun is reflected from a shiny dish to a central point (focus). Any object placed at this point will get very hot, very quickly. (BEWARE PLACING FINGERS ANYWHERE NEAR THE FOCUS). Where else can you see dishes shaped like this?

The story of the village of Bysanivaripalle in the Indian region of Andra Pradesh provides a "shining"(!) example of how changes in traditional cooking practices can make a huge difference to both carbon dioxide emissions and the local environment. This village of 36 families has been provided with 26 solar cookers by an Austrian charitable organisation. The cookers are used to fry chips, roast peanuts, bake cakes and biscuits as well as cooking more traditional foods. Using the cookers means the village is saving 72 tonnes of firewood, (equivalent to almost 6000 kg of LPG) and cutting carbon dioxide emissions by 104 tonnes a year. If this type of enterprise was extended on a large scale it would make a huge difference to global emissions.

DIY solar cooker

You can make an effective substitute for a commercial solar cooker using a cardboard magazine file and some aluminium foil. Fig.11 shows a commercial solar cooker and Figs. 12 & 13 show the DIY version.

Figure 11 - Commercial solar cooker © CCAT@humboldt.edu

Figures 12 & 13 - DIY solar cooker (front and rear) made from aluminium foil and a cardboard library box.

AVOID STARING AT SOLAR COOKERS - HARMFUL TO THE EYES

Heating water & cooking with solar power

In the Figs. 12 & 14 you can see small black film cans in place in the solar cookers. These were filled with water and the temperature measured regularly. This was done inside with the cookers set up on a window sill, and although the sky was somewhat hazy and the sun was passing through double glazed windows, we still achieved a noticeable rise in temperature (Fig.15)

To illustrate the cooking potential of the cooker we passed a nail through an apple and attached it to the cooker - 90 min. cooking time at *Sun Mark 5*! (Fig.17). As this was done inside, in Scotland, in May, it is obvious that the temperatures achievable in the cooker

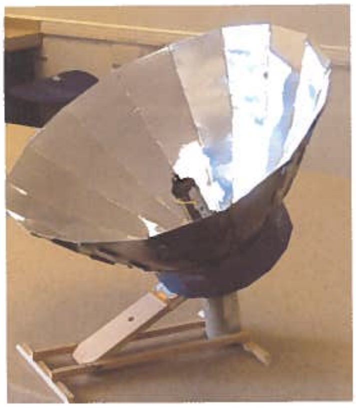


Figure 14 - Solar cooker and film canister filled with water

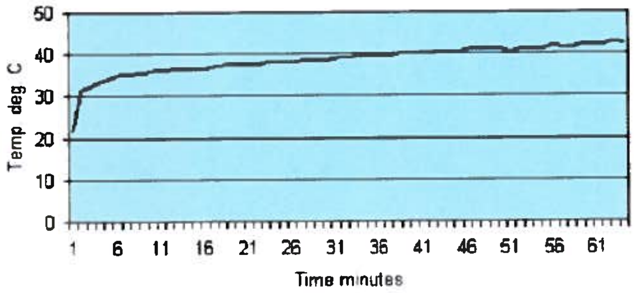


Figure 15 - Library box cooker even heats water to over 40 deg.C

Figures 16 & 17 - Solar cooker cooks apple in 90 minutes.

Equipment Offers

Item	Description	Price
593	Miniature motor, 1.5V to 3V, 2mm dia. shaft	**30p**
614	Miniature motor, 3V to 6V, 2mm dia. shaft. Both motors above can be used for project work but they run at fairly high speeds, some gearing will be required. See worm/gear, item 811	**45p**
621	Miniature motor, 1.5V to 3V, now with 8 tooth pinion. The open body of this motor makes it ideal for showing how such a motor is constructed	**25p**
811	Worm and gear, 34 to 1 speed reduction	**35p**
817	Axles 3 mm dia., nickel plated, round ends, push fit on SSERC plastic wheels, gears and pulleys: 70 mm long, per pack of 4	**50p**
818	As above but 95 mm long, pack of 4	**50p**
819	As above but 12 mm long, pack of 4	**50p**
800	Pack of 100 wheels, 39 mm diameter, assorted colours, 3 mm axle hole	**£5.25**
820	Worms to fit 2 mm electric motor shaft, pack of 5	**£1.00**
821	Reducers 3 mm to 2 mm enables gears, pulleys and wheels, to be fitted to motor shaft, per 5	**25p**
867	Reducers, 4 mm to 2 mm, as above, per 5	**25p**
868	Reducers, 4 mm to 3 mm, as above, per 5	**25p**
723	Microswitch miniature, lever operated	**40p**
822	Plastic toggle switch, low voltage	**40p**
688	Crocodile clips, red, miniature, insulated	**5p**
759	As above, but black	**5p**
788	Crocodile leads, assorted colours, insulated croc. clips at ends,36 cm long. Pack of 10	**£1.35**
835	2 x AA Cell ('battery') holder	**15p**
845	2 x C Cell ('battery') holder	**20p**
729	Battery connector, PP3 type, snap-on press-stud, suitable for Items 835 and 845	**5p**

Item	Description	Price
789	MES (miniature Edison screw) bulbs 3.5 V	**10p**
691	MES battenholders for above	**20p**
866	Lens end lamps, 1.2 V MES. Ideal for use where a narrow, concentrated beam of light is needed. Bargain pack of 100	**£3.50**
508	LED (light emitting diode) 3 mm, red, per 10	**50p**
761	LED 3 mm, yellow, per 10	**60p**
762	LED 3 mm green, per 10	**60p**
790	3V buzzer (works with solar cell see Item 838)	**55p**
838	Solar cell, 100 x 60 mm, max 3.75 V per cell	**£2.10**
839	Solar motor, body 25 dia.12 mm long with shaft 2 mm dia 6 mm long	**£1.70**
840	Solar pack: one of each solar cell, solar motor propeller (801), and 3 V buzzer - with notes	**£3.75**
836	Motor mounts, plastic, push-fit with self adhesive base pad for SSERC motors 593 & 614, 10pk	**£2.35**
801	Propeller, 3 blade, to fit 2 mm shaft. Blade 62 mm long	**35p**
794	Cotton reels (for making buggies, rubber powered tanks etc.) pack of 20	**£1.25**
796	Pack of 20 pulleys, 5 of each of 10, 20, 30 and 40 mm diameters.	**£3.50**
802	Pack of 10 pulleys, 12 mm diameter.	**£1.50**
837	Ring magnet, 40 mm o.d., 22 mm i.d.	**35p**
815	Ceramic square magnet, 19 x 19 x 5 mm	**15p**
823	Ceramic magnets, poles at ends, 10 x 6 x 22 mm	**12p**
861	Bimetallic strip, 10 cm length	**30p**
882	Quartz clock movement , dimensions 56x53x17 mm, with wall hanging bracket, Suitable for dial thickness up to 10 mm. Includes plastic hands suitable for dial diameter to 200 mm. Requires an AA battery. See CD Clocks, Newsletter 18	**£1.75**

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