Sustainable Energy as part of a Curriculum for Sustainable Development

We live in a country in which around three quarters of our electrical energy is generated by fossil fuel combustion and another fifth from nuclear power. This system is based on the premise of limitless cheap energy – our accepted standard of living has huge implications in terms of energy consumption.
The current generation of school pupils are likely to see a huge shift in their lifetime, not only in the resourcing of energy, but also in its availability: our attitude towards energy will be radically changed.

Curriculum Development

Education for Sustainable Development (ESD) is an extremely broad, wide ranging aspect of the school curriculum which should be fundamental to everything we do. What is the point of education, if not to prepare young people for the future, and particularly when so many aspects of our current society are not sustainable?

It is important that in adopting ESD principles, schools do not shy away from the moral imperative. Children need to make value judgements about what should and shouldn't be happening in society, and what needs changing. At the same time there are technical issues and arguments with which they should be conversant.

In my own curriculum area, Science, I feel strongly that pupils should be forming considered views on issues such as nuclear waste and acid rain, but on a pragmatic as well as a morally sound basis.

A wind farm.

What's this got to do with Education for Sustainable Development?

Skills

- co-operative working
- critical thinking
- reasoned debate; the ability to argue effectively
- problem solving
- informed decision-making
- creativity – an ability to envision alternatives
- research and data handling.

Knowledge and understanding

- how natural processes work
- how the processes of decision-making work and how to take part in them
- how pupils' own lives and actions connect with the lives and actions of others – locally, nationally and globally
- what is involved in different methods of providing for human needs and wants (raw materials, energy, human input, environmental impact).

Values and attitudes

- empathy and awareness of the points of view of others
- a commitment to social justice and equity
- a desire for active participation
- an understanding of the place of individual and collective rights and responsibilities
- a belief that, working with others, people can make a difference
- a belief in a positive future.

"It is not too difficult for a teenager to decide that solar power is preferable to burning fossil fuels, but if they go away thinking the petrol engine on a Ford Fiesta can be replaced by a solar panel on the roof and an electric motor under the bonnet, we have failed them."

Teacher

Making a start

We were concerned that our Energy work for Key Stages 3 (12-14 year olds) & 4 (15-16 year olds) should start with the immediate and concrete, run through a scientific analysis and end with a challenge to improve the future situation. Our modules of work would form part of the mainstream curriculum work for all pupils, and needed to be stimulating and challenging but not overly 'worthy'.

Key Stage 3 (12-14s) Science Module

At the Roseland Community School, we are currently redesigning our module on Energy to reflect changes in the National Curriculum which will take effect in September 2000. As well as the more conventional curricular issues, literacy, numeracy and ICT are also impinging upon what is taught in Science.

In re-writing the module, we wanted to incorporate a 'good practice' approach to curriculum development, and specifically to:

a) start from familiar contexts and work towards a broader perspective
b) give pupils concrete examples to enable them to develop their understanding
c) make the work relevant and practical.

We were keen to involve outside agencies and worked with Community Energy Plus, a local energy efficiency organisation run by the District Council. By comparing their materials with the text of the National Curriculum, we identified the 'shortfall' and arrived at an overall scheme, set out below.

Energy Module for Year 8 (13 year olds)

ONE

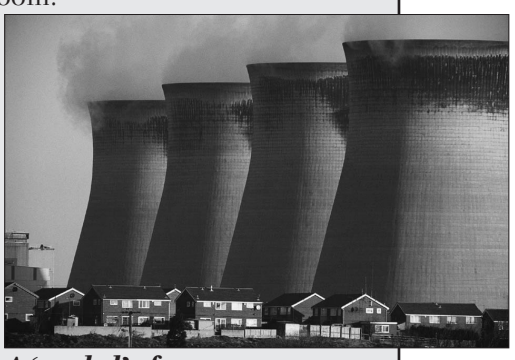
PREPARATION

- **Energy sources**: circus of fuels, such as fossil fuels, food, etc.
- **Energy changers**: circus of transducers, such as clockwork toy, torch, etc.
- **Energy storers**: circus of potential energy holders, such as coal, bow and pile driver.
- Concepts of conservation and dissipation of energy.
- Conduct survey of energy use in classroom.

Key questions

- Where does energy come from?
- How does energy change its form?
- How can we store energy?
- How do we conserve or waste energy?
- How do we use energy at school?
- How do we use energy at home?
- Are we using it appropriately?

Photodisc



A 'symbol' of energy use.

ESD focus

To elicit pupils' attitudes towards energy and to foster the idea that energy is a valuable commodity. Pupils should be tracking energy changes AND commenting on them: for example, filament light bulbs lose some 90% of the energy supplied as heat, so they are economically unsound for the household but also damage the environment. Pupils should be able to see that power stations also pollute the environment and waste energy through heat loss.

HOMEWORK: COMPLETE A HOME SURVEY FORM

Using the context of the pupil's own home has the added bonus of almost inevitably involving the parents. Community Energy Plus supplied every home with a free low energy light bulb and a bar of 'fair trade' chocolate in return for each completed survey!

Key questions

- How is the house heated?
- How is the water heated?
- How is excessive heat loss prevented?
- What measures are in place to stop warmth from escaping?
- How much of the boundary is external wall?

ESD focus

To encourage pupils to be proud of the way their family conserves energy, and also to realise the potential for improvement.

TWO

ANALYSING HOME SURVEYS

- Looking at energy efficiency in the pupil's home, through carbon dioxide emissions and energy saving devices.
- The cost of energy saving (eg draft exclusion pays for itself very quickly; double glazing is less cost effective unless windows already need replacing).

Key questions

- What conclusions can we draw from the data?
- What are the environmental effects of our energy consumption?
- Does everyone use the same amount of energy?
- Do we need to consume as much?
- Are there energy saving devices which can help us?
- Does it cost more to use less?

ESD focus

To develop the idea that a family leaves an environmental footprint (or impact). Carbon dioxide emissions are important because they emphasise individual contributions to a global problem. Pupils need to see beyond the argument that energy efficient appliances cost less to run and move towards an understanding that they also cost the environment less.

The average 3 bedroom house uses about 2,400 kWh of energy in one year. Different energy sources produce different amouts of carbon dioxide.

Energy source	*kg of carbon dioxide produced for each kWh of energy used*
electricity	*0.59*
solid fuel	*0.34*
fuel oil	*0.29*
natural gas	*0.21*

- Half the energy in the average house is used for heating, a quarter for hot water and a quarter for lighting and appliances. Ask pupils to calculate:
  a) how much energy of each type they use at home
  b) how much carbon dioxide they have released in a year
  c) what the average daily rate of carbon dioxide production would be.

  (This exercise could also be carried out using the figures from home energy bills.)

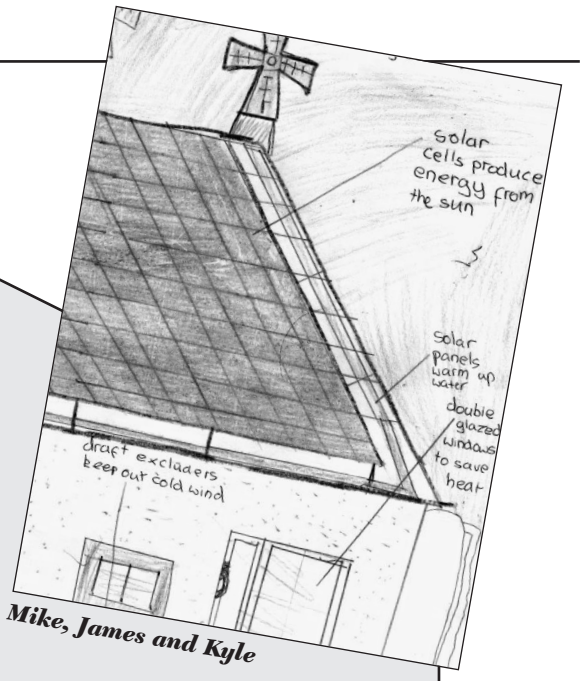
- Use party balloons to illustrate the amount of carbon dioxide produced: Weigh an empty balloon.

  Weigh a fully inflated balloon.

  Calculate the weight gain (this tells you the amount of gas in the balloon).

  Ask pupils to divide their figure for daily carbon dioxide emmissions by the weight gain in the balloon – this will tell them how many balloon-fulls of carbon dioxide their household produces in a day.

- You can illustrate carbon dioxide emmissions for various appliances in the same way, eg a 3kW electric fire turned on for the length of a one-hour lesson will have used 3kWh of electricity, or 3 x 590g of carbon dioxide = 1770g. That's a lot of balloons!



Mike, James and Kyle

THREE

ENERGY IN YOUR HOME

- Measurement of energy.
- Transfer methods.
- Burning of fuel.
- Insulation methods.

Key questions

- What different fuels can we use to heat our homes?
- In what different ways can heat be transferred in a home?
- Are some ways more fuel efficient than others?

ESD focus

To provide pupils with a basic understanding of how heat is transferred, and which transfers can usefully be reduced, to use energy more responsibly.

FOUR

MAKING THE MOST OF OUR RESOURCES

- Various energy sources and associated pollution.
- Renewable and non-renewable sources.

Key questions

- What is the cost of turning on a light bulb? (ie what are the environmental implications of different fuels – their supply, the impact of their extraction, their use and the pollution caused?)
- Do the decisions we make affect energy resources at national and international levels?
- Do the decisions made at national and international levels affect how we use energy?
- What fuels will/should we be using in 25 years time?

ESD focus

Fuels are evaluated not only for their convenience or cost-effectiveness, but also their environmental impact. The question 'What fuels will we be using in 25 years time?' is a powerful one because it elicits aspirations – many of which will have an energy cost.

FIVE

CONTROLLING YOUR ENVIRONMENT

- Use a computer to monitor, record and display data.
- Monitor the movement of heat, in a model house and in the school building.

This can be a powerful tool, as pupils are concerned less with the mechanics of taking temperature readings and plotting graphs, and more with observing changes as they occur.

Key questions

- Where is the heat flowing to?
- How can this be prevented?

ESD focus

Pupils can be cast as 'Waste Energy Troubleshooters' – finding problems and suggesting remedies. This should include improvements to existing buildings, and designs for new ones.

SIX

DESIGN AN ECO–HOME

- Making recommendations about energy efficiency.
- Taking your recommendations home.

Key questions

- What fuel sources would an 'energy efficient' home use?
- What methods of heat transfer would it use?
- How would it conserve energy?
- What materials would it be made of?
- Where would it be situated?
- What means of transport would the inhabitants use?

ESD focus

Draw together the elements of the module and challenge pupils to use their new knowledge and understanding in suggesting ways to refit existing homes and design new ones to use energy responsibly. Painting a picture of a 'sustainable house' is not only about the size of windows, but also the situation: is it in a town? does it need a car? or two? where do the inhabitants work/shop/play?

One student, challenged to draw an energy efficient house, drew an entirely conventional house apart from four windmills sticking out of the roof. Another wanted to use waves in the bath tub to generate electricity.

The Energy Efficiency Office will have processed the home survey forms by this time, giving pupils' parents or guardians recommendations for their own homes. The home design project can form the basis for a school display.

Key Stage 4 (15-16 year olds)

Roseland Community School, like many secondary schools, uses the NEAB Double Award Modular Science course. The module on energy comprises one-twelfth of the course and normally lasts for 25 to 30 hours.

The structure is as follows:

HOW IS HEAT ENERGY TRANSFERRED AND HOW CAN WE REDUCE HEAT TRANSFER?

Introduction: Heat transfer & insulation

Pupils consider how our society's quality of life is reliant upon limitless cheap energy, and contrast this with the developing world. They revisit and refine ideas about heat transfer in the home, comparing where it needs to work well (eg cooking) with where it shouldn't work well (eg space heating). A practical investigation involves testing cardboard model houses with varying amounts of insulation. Case studies include the design of a solar water heater and of cold satchels for delivering vaccines in rural China.

ESD focus

Consider the world distribution of energy and the effect of energy availability upon issues such as health care and levels of development. The design of the cold satchel is not only an exercise in appropriate technology, but also in equity.

WHY ARE ELECTRICAL APPLIANCES USEFUL AND WHAT DOES IT COST TO USE THEM?

Measuring and costing energy consumption

Pupils consider how much electrical energy is used by various appliances and the importance of seeing energy consumption as a factor in making a choice.

ESD focus

To reinforce the notion of each person's 'environmental footprint'. Pupils should consider, for example, not only what a house does for its occupants, but also what it does to the environment.

David Lawson/WWF-UK

CFC recycling at the Coventry Waste Reduction Unit.

HOW EFFICIENT ARE THE APPLIANCES WE USE?

Measuring wastage and calculating efficiency

This section enables pupils to quantify energy efficiency and to appreciate how wasteful some processes are. Pupils investigate the best way of heating a small quantity of water. The class decides what 'best way' might mean, and assess gas and electricity in terms of speed, safety, efficiency and cost. Gas is cheaper and quicker, but more wasteful – this raises questions about the basis for selecting fuels.

ESD focus

To challenge the assumption that fuel choice is purely a matter of personal preference. The impact of using certain fuels upon, say, carbon dioxide emissions can be underlined.

HOW SHOULD WE GENERATE THE ELECTRICITY WE NEED?

Fossil fuels, nuclear fuels and alternative energy sources. Financial and environmental costs

Pupils consider the environmental cost of different ways of generating electricity and the implications of demanding cheap energy at any time. Renewable sources are considered in detail, leading to a case study of a family (with a teenager) living without mains electricity, then to a role play and debate about the plans for a tidal barrage. Energy provision in Sri Lanka is considered and finally there is a debate on energy provision in the year 2020.

ESD focus

To examine the notion that everyone has a right to unlimited cheap energy, and debate issues such as the rationing of energy.

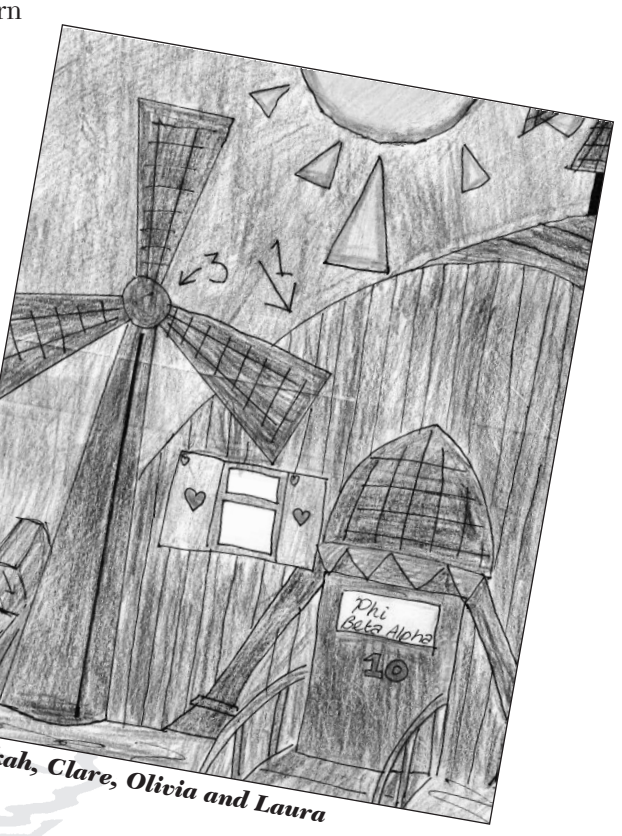
Pupil responses

The Key Stage 3 module (12-14s) is popular with pupils.
The 'energy changer toys' are good fun; they can try out practical experiments; they like talking about their own homes and can see the point of conserving energy.

It is easier to sell energy conservation on financial rather than environmental grounds. Switching to low energy light bulbs cuts electricity bills, but also reduces carbon dioxide emissions (although this cuts less ice at home). This is where the real value of good education comes in: saving money is important, but reducing the release of greenhouse gases is important as well. Where the lessons have worked well, this point seems to have come across effectively.

The balance between economy and ecology is tricky and teachers are sometimes tempted to emphasise the former to make the activities seem immediately relevant. Energy efficiency materials will often stress the money saving angle. In our experience, it is best to keep a global perspective on the issue right from the start, so pupils see clearly that the responsible use of energy is part of good global citizenship. For example, domestic energy usage should be contrasted with third world homes, and transport issues shouldn't be restricted to a Western European view.

The Key Stage 4 module (15-16s) is popular with pupils and staff, not least because there are fewer formulae to learn and fewer theoretical concepts to grasp.



Rebekah, Clare, Olivia and Laura

Further information and resources

The Centre for Alternative Technology (CAT) at Machynlleth in Mid Wales is invaluable for its publications, displays and expertise. When the CAT was founded, nearly 30 years ago, their vision for the future of energy resources was a long way from the mainstream approach. In the intervening period many people have come nearer to their way of thinking. At the start of the CMAS project our Science staff attended a three-day INSET course there, which influenced much of what we went on to develop. Material is available on-line at www.cat.org.uk.

Community Energy Plus is our local energy efficiency charity, and such groups are well worth hunting out. They have access to resources, an overview of the situation and expertise that can be very useful. The Yellow Pages will list local offices and the Department of Trade & Industry website (www.dti.gov.uk) may help with information on a wider scale.

Shell Education Service have a team who visit schools and run practical workshops. Many of their publications feature alternative energy and most are aimed at Key Stages 1 & 2 (5-7 and 8-11 year olds).

Several of our Key Stage 3 (12-14s) experiments were based on the education pack '**Home Energy Conservation, Schools Project: for KS2 and KS3**' produced by the Centre for Sustainable Energy in Bristol. Details are available from Community Energy Plus: telephone 01326 316496, fax 01326 317297.

Our Key Stage 4 (15-16s) work has drawn on Longman's '**Pathways through Science**' materials on Energy Resources. These seem to be out of print, but you may be lucky enough to track them down.

USEFUL WEBSITES

ORGANISATION	WEB SITE
Centre for Sustainable Energy Site under construction, but worth watching in the future. Intends to draw together examples of good practice.	***www.cse.org.uk***
Energy Quest Lots of ideas and resources to download, from The California Energy Commission.	***www.energy.ca.gov/education***
Midlands Energy Efficiency Consortium Information on domestic insulation and energy conservation. Lots of useful links.	***www.savenergy.org***
National Energy Foundation General awareness raising on energy related issues. Ideas about teaching materials.	***www.natenergy.org.uk/educat.html***

Background

This case study is one of a series published by WWF-UK. Each one describes aspects of work undertaken by schools across the UK, whilst involved in WWF professional, curriculum and institutional development programmes.

In England and Wales, support was originally provided through the Curriculum Management Award Scheme, which aimed to stimulate good Education for Sustainable Development policy and practice, demonstrating ways to integrate ESD within the curriculum whilst working towards a whole school policy. This is one way in which WWF helps develop ideas for new teaching and learning approaches - equipping educators and students for thinking about and acting in ways supporting the goals of sustainable development.

For details of current curriculum development programmes, contact the Education division at the address shown opposite.

Acknowledgements

Written by Ed Walsh from the Roseland Community School, Cornwall.

Published by WWF-UK, Panda House, Weyside Park, Godalming, Surrey GU7 1XR.