PUPIL
RESEARCHER
INITIATIVE

Light action

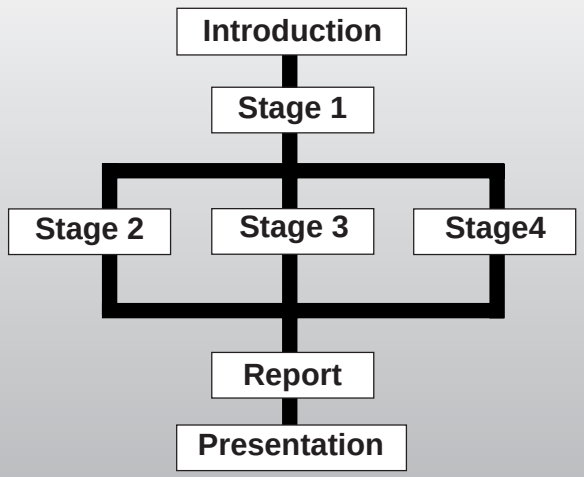
Pupil Research Brief

Teachers' Notes

Syllabus Coverage *Subject Knowledge and Understanding*

- the amount of energy transferred from the mains is measured in kilowatt-hours, called Units
- energy transferred (kWh) = power (kW) x time (h)
- the cost of the energy can be calculated using total cost = number of Units x cost per Unit
- whenever energy is transferred to where it is wanted and in the form it is wanted (usefully transferred) the rest is transferred in some non-useful way and so is wasted.
- the fraction of the energy supplied to a device which is usefully transferred is called the efficiency of the device
- when supplied with appropriate information you should be able to evaluate methods of reducing wasteful transfers of energy

Route through the Brief



Introduction

Since 1993 the Schools and Homes Energy Education Project (SHEEP) has been conducting research into ways that schools can make informed decisions for sustainable energy use. SHEEP has designed and trialing energy management and curriculum activities in a number of schools.

The aim of this work is to demonstrate the need for energy savings and what can be achieved by a school committed to energy efficiency. One important aspect of this is to show how knowledge and understanding about achieving energy efficiency can be built into the school curriculum. It is also important for pupils to understand the link between energy, the economy and the environment.

This Brief is based on lighting surveys. It will provide

- information about how energy for lighting is currently used in the school
- suggestions about where to concentrate energy and money saving efforts
- a baseline against which progress can be measured using data to set targets for reducing future energy consumption.

Lighting is the major user of electricity in schools - it accounts for 50% of electricity use and 23% of total energy costs in a typical school. Each Unit of electricity used costs nearly four Units of energy to produce, because some energy is lost burning oil, gas, coal, etc. during the generation of electricity. For this reason savings on lighting are worthwhile.

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The results of an energy survey (see **Figures 1** and **2)** conducted in 1996 by the Resources Research Unit of Sheffield Hallam University for SHEEP's Pilot School F, is evidence to show that this school would benefit from electricity saving measures.

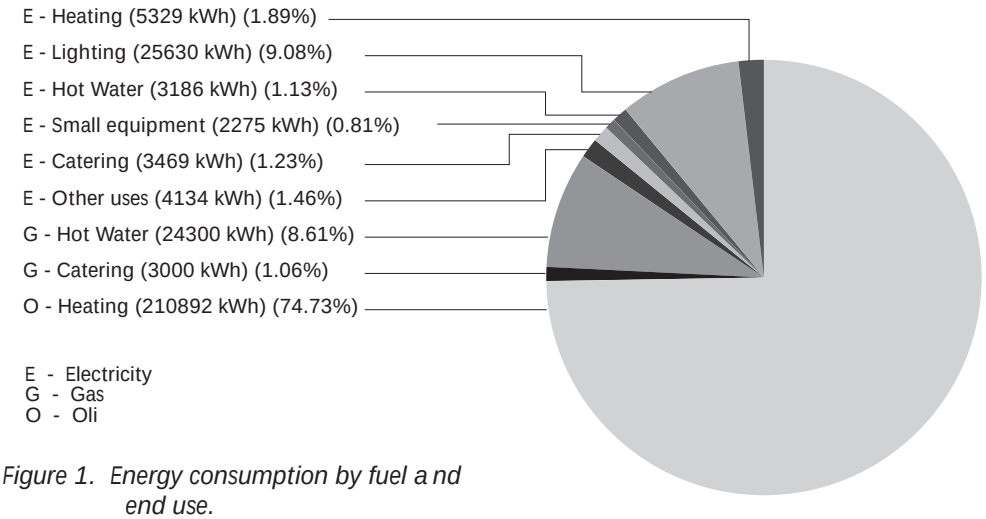

Figure 1. Energy consumption by fuel a nd end use.

As shown in these pie charts, oil heating represents 74.73% of energy used, compared to 15.6% for electricity (figure 1). Since fuel oil is much cheaper than electricity, the cost of heating is less than half (38.13%) of the total energy expenditure. Comparing this to the 55.57% for electricity in School F (figure 2) gives good reason why it pays to tackle electrical lighting first in cutting fuel bills.

The outcome of this research has shown that good energy management will allow schools to save money and energy while maintaining a comfortable and safe environment -especially when schools are allowed to participate at their own level and to reap rewards commensurate with their efforts.

For example, in 1995/96 Pilot School B (Holt House Infant School) saved £552 on its electricity/lighting costs alone. For 1996/97 it is estimated £606 will be the saving, as a result of additional energy efficiency bulbs being installed.

Experimental and investigative skills

- planning experimental procedures
- obtaining evidence
- analysing evidence and drawing conclusions
- evaluating evidence

Prior knowledge

Pupils should have covered a wide range of topics related to energy and the environment in order to appreciate the implications of this work. These topics include electricity generation; ;renewable energy resources (the Sun, wind, tidal, photo-voltaic) and non-renewable resources (fossil fuels: coal, oil and gas); nuclear fuels; biomass (energy stored in decaying organic matter); products of the combustion of fossil fuels; the carbon cycle; the greenhouse effect; global warming and global climatic change; using and buying electricity;
efficiency of energy transfer.

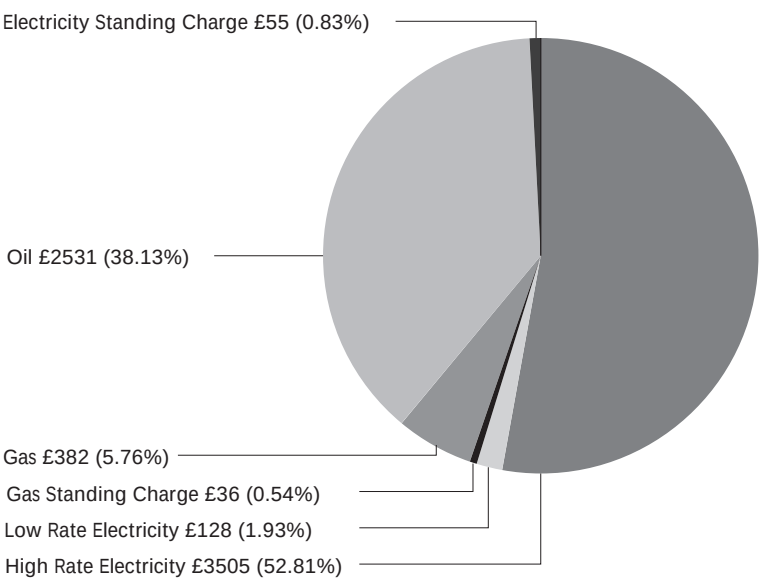

Figure 2. Fuel costs

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Teachers' Notes continued

Running the Brief

Pupil grouping

Pupils could work in a number of groupings during this Brief. Suggestions are:

Initial briefing	-	whole class
Carrying out surveys	-	pairs or small groups. The class should be divided up into three groups for Sections 2, 3 and 4. Each group tackles only one section. These three groups should be sub-divided into pairs or small groups
Writing reports	-	pairs or small groups
Making presentation	-	whole class

Timing

Following the above suggested groupings to divide the the survey work across three groups, the survey and report writing should take about four hours. Time spent in preparing and making the presentation to the school governors will vary. Report writing could be set as a homework task.

Activities and Investigation details

Pupils should be issued with the **Study Guide**, which provides them with a summary of what they should produce as they work through the Brief. It can also be used as a checklist so that they can monitor their own progress.

Each group should be given copies of the **Introduction**, **Useful Information**, **Sample Data sheet** and the **Stage 1 Task sheet**. This last sheet outlines the survey to be undertaken and provides information on how to work out electricity costs. The Sample Data Sheet gives an example of how to fill in the results table, and it includes a blank table for their use. The sample data sheet includes a suggested spreadsheet format. If pupils cannot work out the formulae for the spreadsheet cells, they could be provided with this information to contruct their own spreadsheet, or be provided with a ready made spreasheet to fill in the data themselves. The spreadsheet formulae are given at the end of these Teachers' Notes.

The remaining task sheets can be used by the separate groups, or by the whole class, if time permits.

The **Stage 2 Task Sheet** gives details on how to carry out a survey of rooms to identify the tasks carried out in them, to measure the light levels in the rooms and to estimate the amount of time spent on these tasks. The light levels should be compared with the CIBSE (Chartered Institute of Building Services Engineers) recommended levels. Professional lighting surveys measure the light levels both at night ,when there would be little or no natural light, as well as during the day. The night time level is used to set the minimum lighting level for the room. It is up to teachers whether or not they follow this practice.

The **Stage 3 Task Sheet** contains instructions on surveying the windows and switches and estimating the amount of natural light that is available in different parts of the rooms. They also have to note what lamps are controlled by each switch.

The **Stage 4 Task Sheet** requires pupils to find out the types of lamp used in the rooms surveyed, the number of lamps and their power ratings. They also need to estimate the amount of money saved by replacing the lamps with low energy bulbs.

In addition to the task sheets there are 4 briefing papers and an instruction sheet headed **Report Writing.** This sheet provides guidelines on how to compile a written report for the school governors to consider, and it also includes other ways in which the work they have done can be presented.

Briefing Paper 1 outlines the history of the invention of the incandescent light bulb.

Briefing Paper 2 explains how fluorescent light bulbs work.

Briefing Paper 3 gives a detailed explanation of the savings that can be made by replacing filament bulbs with compact fluorescent lamps (CFLs).

Briefing Paper 4 is a report on a project carried out at a school in Sheffield. This showed just how much money the school could save by changing over to CFLs.

The first two briefing papers are optional background information sheets, but the other two are intended to be used in conjunction with the Stage 4 Task Sheet.

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Technical details

Light intensity meters are required for measuring light levels in classrooms. The light Sensor Meter produced by Philip Harris is very suitable for this purpose.

Safety Issues

PLEASE NOTE: It is also important that you prepare your own risk assessments for practical work in this Brief in the usual way.

Surveying rooms: pupils are required to measure rooms and windows. Care is needed to ensure that any step-ladders used are secure and held firm, and that they are only used under supervision.

Mains electricity: pupils should never unscrew light fittings to find out their power ratings. They should never touch any lamps that are lit. It is advisable that teachers ascertain the power ratings of the lamps in the rooms to be surveyed in advance of the lesson.

Assessment issues for *Experimental and Investigative Science* (National Curriculum for England and Wales)

P	Planning	O	Obtaining evidence
A	Analysing evidence	E	Evaluating evidence

This Brief contains one main investigation, divided into a number of sections, or stages. The aim of the investigation is to carry out a survey of the lighting used in part of the school. Pupils will also be looking at ways to reduce energy costs by changing one or more factors such as type of lamp (bulb or tube) used, or by changing behaviour. The methods outlined in the Brief are based on those used by professional energy consultants to carry out their work. This means that the methods are fairly prescriptive, although pupils do have to make a number of decisions based on their own ideas and school circumstances. This is likely to restrict the achievement in **Skill Areas P** and **O**,and teachers may decide not to assess these skills as a consequence. There should be scope for pupils to reach high levels in **Skill Areas A** and **E.**

Assessment issues for *Experimental and Investigative Science* (Northern Ireland Curriculum)

P	Planning	O	Obtaining evidence
I	Interpreting and Evaluating		

See notes for England and Wales. There should be scope for pupils to reach high levels in **Skill Area I.**

Scottish syllabus coverage

Standard Grade Physics - *Energy Matters*

Further pupil research opportunities

Pupils could use books, videos, CD-Roms and the Internet to find out more about global warming and then produce a report on how we could take steps to reduce it.

Pupils could devise an advertising campaign to promote energy efficiency in the home, possibly using the Brief *Green Light* in Pack 1 as a starting point.

Note: the topics of energy saving and pollution are also tackled in several other Briefs, notably *Green Heating, Out of Site, Out of Mind, A Burning Problem* and *Ozone Conference.*

Pupils couldvisit the Schools and Homes Energy Education Project (SHEEP) Web site at

http://www.solis.co.uk/sheep/

Spreadsheet formulae for the Sample Data Sheet

These formulae are based on the numbering of the spreadsheet cells in the Sample Data Sheet.

B3 enter number of days in school year (i.e. when the school is open, and lighting used)
B5 enter area of room in square metres
B7 enter number of lamps (bulbs or tubes) in room
B8 enter power rating of lamps (or average if several size lamps in use)
B9 enter B8*B7/1000
B10 enter average number of hours that lamps are used each day
B11 enter B9*B10
B12 enter cost per kilowatt hour according to your local charge
B13 enter B11*B12/100
B14 enter B13*B3
B15 enter B11*B3*0.72