PUPIL
RESEARCHER
INITIATIVE

Light Action

Setting the Scene

You will carry out a survey of how lighting is used in your school to find out how both energy and money can be saved. You will produce a report of your findings which you may be required to present to the governors, head teacher and other interested individuals.

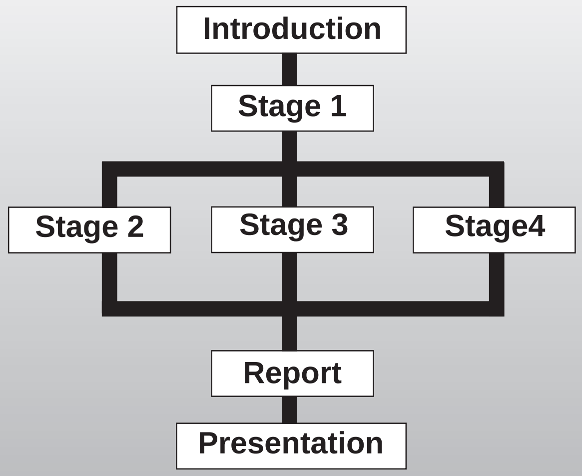
Pupil Research Brief

Study Guide

Syllabus Targets *Science you will learn about in this Brief*

- ❐ 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



Outcome Checklist

You will produce a report on how your school could save energy and money by using lighting more efficiently. You may also present this report to the school governors, headteachers and other interested individuals. You should make sure you produce the following items as you work through the Brief.

Stage 1 Task Sheet

- ❐ spread sheet for performing calculations
- ❐ record or completed spreadsheet or Sample Data Sheet results table

Stage 2 Task Sheet

- ❐ spreadsheet for performing calculations
- ❐ record of completed spreadsheet
- ❐ notes and comments from your research for final report

Stage 3 Task Sheet

- ❐ labelled drawing of selected room
- ❐ notes and comments from your research for final report

Stage 3 Task Sheet

- ❐ notes and comments from your research for final report
- ❐ brief notes from Briefing Papers 3 and 4 on how energy savings can be made

FInal Report (and Presentation)

- ❐ report based on the sections outlined in the Report Writing and Presentation sheet

overview

This sheet explains the background to your research project. There are a number of other sheets which you have to use in carrying out the work. You will be carrying out work which could help your school to save money on energy bills. You will be looking at how lighting is used in your school, and how actions you take could lead to improvements in energy efficiency. You will write a report on your research, making recommendations for saving energy and money.

why do we need to carry out this research?

As a nation we waste an enormous amount of energy, at home, at school, at work, in our leisure time and when travelling. We leave lights and heating on and doors and windows open unnecessarily. We don’t always insulate our homes, schools and workplaces adequately, we sit in traffic jams with the engine running and we often use our cars when we could easily walk or use public transport. We don’t recycle waste nearly enough. This could also save a lot of energy.

Inefficient use of energy is very costly, wasteful of the world’s energy resources, and it also contributes to the pollution of the environment. Global warming, destruction of the ozone layer, pollution of our countryside, lakes, rivers and seas, and damage to ourselves and other living creatures, could all be reduced if we made greater efforts to be more energy efficient.

Engineering researchers are looking at ways to design buildings to make them more efficient in the way that electricity is used to provide lighting, and in making more use of daylight. Existing buildings were not always designed with this sort of energy efficiency in mind, but there are still ways we can help to reduce the amount of electricity used.

The research you are going to carry out can help your school to be more energy efficient. Although you may only concentrate on energy savings from efficiency in the design and use of lighting in one particular area of your school, you will be contributing to the energy saving process. At the same time you will be making recommendations to the school on how to save money!

before you start

It would be helpful for you in doing your research to know:

- ❏ about the history of the filament light bulb; read **Briefing Paper 1**, *Unsung inventors of the light bulb*
- ❏ about how fluorescent lamps work; read **Briefing Paper 2**, *Fluorescent lamps*
- ❏ that light is required in buildings for the following purposes
  - for carrying out tasks (reading, writing, using equipment)
  - to create a pleasant environment
  - for display lighting e.g. corridor displays, galleries, etc.
  - to make the environment safe, both inside and outside buildings
- ❏ that in order to make sure a room is pleasantly lit the following factors should be taken into account
  - brightness of work surfaces
  - enough light on walls and ceilings
  - enough contrast between light and shadow
  - avoidance of harshness
  - glare control
  - colour rendering (i.e light looking 'natural' or 'unnatural')
- ❏ that there are two types of lamp (or bulb) in common use today; the tungsten or filament lamp and the fluorescent lamp (or tube). A third type, the *low energy* fluorescent lamp (or tube) is also becoming more common. The CFL, or *Compact Fluorescent Lamp* is an example of a low energy fluorescent lamp
- ❏ that lamps are given power ratings such as 10W (watt), 60W, 100W etc. A 100W rating tells you that the lamp transfers 100J (joule) of energy each second from the mains supply
- ❏ that electricity is a particular sort of energy. A useful measure of how much electricity is being used is the kilowatt hour (1kWh is equivalent to the power of 1kW transferring energy for 1 hour)
- ❏ in an ordinary light bulb most of the transferred energy is given to heating the environment rather than lighting it
- ❏ that the rate of light emission from a lamp is measured in lumens
- ❏ that an ordinary tungsten filament light bulb gives about 20 lumens per watt. The output for various sorts of fluorescent lamps is about 40 to 100 lumens per watt.

introduction

The research survey has several stages. This page describes **Stage 1**, which should be completed by all groups. **Stages 2**, **3** and **4** can be divided up between groups, so that you do Stage 1 and 2, or Stage 1 and 3, or Stage 1 and 4. If there is enough time, all groups could complete all 4 stages. You will then write a report to the school governors outlining your research and making recommendations for improving energy efficiency from lighting.

doing the research

Use a copy of the results table (on the *Sample Data Sheet*) to record your data for Stage 1.

- ❏ Decide which rooms you will investigate.
- ❏ Measure the floor area of the room(s).
- ❏ Count the number of lamps in the room and their individual power ratings or wattages. It may not be possible to see what wattage the lamps are, if there is a diffuser (cover) on the fitting. If this is so, your teacher may already have found this information out. If not, you may have to ask the school caretaker to tell you the wattage. **Never attempt to remove the diffuser yourself.**
- ❏ Interview users of the room or area and record an estimate of how often lights are left on each day.
- ❏ Work out estimated costs of lighting per day. To work this out find out:
  - the total wattage in kilowatts(kW) [1kW = 1000W]
  - the total time used in hours(h) each day
  - the number of units or kilowatt hours of electricity used per day (kW x h)
  - the cost of one unit (6.95p, data from Yorkshire Electricity, May 1996)
  - the total running cost of the units used per school day.

  running cost = power (kilowatts) x time (hours) x cost (per unit price)

- ❏ Work out the estimated CO_2 produced
  - the generation of 1kWh of electricity is estimated to produce an average of 0.72kg of CO_2.

Construct a spreadsheet to perform the calculations. The teacher has the formulae for the cells of the spreadsheet if you can't work them out yourselves.

sample data

	A	B	C	D
1	**Lighting Survey**	**Holt House School**		
2				
3	No. of days in school per year	191	191	
4	name of room	classroom 1	classroom 2	**savings**
5	floor area of room (m2)	66	66	
6	type of lamp eg filament, CFL	filament	CFL	
7	no. of individual lamps	9	9	
8	individual lamp wattage	150	23	
9	watts/1000 = kW (all lamps)	1.35	0.21	
10	average hours use per day	5.7	5.7	
11	electricity used (kWh)	7.69	1.18	
12	unit cost (p)	6.95	6.95	
13	cost per day (£)	0.53	0.08	0.45
14	cost per school year (£)	102.08	15.66	**86.42**
15	CO2 produced (kg per year)	1057.53	168.25	**889.28**

results table

	A	B	C	D
1	**Lighting Survey**			
2				
3	No. of days in school per year			
4	name of room			**savings**
5	floor area of room			
6	type of lamp eg filament, CFL			
7	no. of individual lamps			
8	individual lamp wattage			
9	watts/1000 = kW (all lamps)			
10	average hours use per day			
11	electricity used (kWh)			
12	unit cost (p)			
13	cost per day (£)			
14	cost per school year (£)			
15	CO2 produced (kg per year)			

choosing lighting levels according to room use

Choosing the right lighting level according to the type of activity going on in the room can greatly influence the amount of electricity used. More often than not, school laboratories have a higher light level than is needed for the use they are put to at any particular time. For example, there are a variety of tasks carried out in a science lab. Each task requires a different light level. However, the design of the lighting layout, the switching controls and light usage often do not take this into account. Usually all the lights are turned on fully, regardless of the task.

The CIBSE (Chartered Institute of Building Services Engineers) recommendations specify the lighting levels for different rooms or areas of buildings, e.g:

- classroom or office 300 lux
- blackboard use 500 lux
- gymnasium 500 lux
- swimming pool 300 lux
- laboratory 500-900 lux
- stairs 150 lux
- outdoor entrance 30 lux
- entrance hall 150 lux.

Lighting levels are measured in a unit called the *lux.*

1 lux is produced when 1 lumen falls on $1m^2$

Lighting levels for certain tasks are:

- discussion work 150 lux
- reading 300 lux
- blackboard work 500 lux
- practical work 900 lux

However, architects and lighting engineers often set lighting above these recommended levels. This means we could be using more electricity than is really needed.

doing the research

Fill in a copy of the table below after answering the points listed below it. You could set up a spreadsheet to perform the calculations, for example:

Room	Task	Time	Light level measured in room (lux)	CIBSE Level	Difference
Science Lab 1A	reading	1 hour	900	300	600
	experimenting	1 hour	900	900	-

- ❑ Decide which room(s) you will investigate (see Stage 1 survey).
- ❑ Identify the tasks carried out in the room (such as writing, reading, talking, experimenting) and the CIBSE lighting requirements.
- ❑ Estimate and record the time spent on each task.
- ❑ Measure the light level in the rooms you survey - if available, datalogging equipment could be used to collect this data.
- ❑ State the CIBSE level required for the task and compare with your measured light level. Record the difference.
- ❑ Predict how much energy and money could be saved if it were possible to use the appropriate CIBSE light level in a room or area for the task being undertaken. For example, in the table above, if a reading activity is going on in a lab then only 300 lux is required, rather than the 900 lux needed for practical work.

reporting

Use the results of this stage of the investigation and your notes and comments to help you write your report.

switching controls and using natural light

Using natural light where possible reduces the need for turning lights on, thus reducing the amount of electricity used. The position of lights in a room, the positioning of windows, and the flexibility to be able to turn lights off in parts of rooms well served by natural light, are also important.

In modern buildings we take it for granted that all rooms, corridors and other areas will be brightly lit. However, this can often lead to a lot of wasted energy. Bad design also results in waste. For example, some light fittings may be in the wrong place. It may not be possible to switch lights off which are near windows without also switching off lights linked to the same switch in the parts of a room where natural light does not reach so well. This could mean that all the lights are on all the time. It would have been so much better if the lights near the window were linked to one switch, and the lights in the part of the room away from the window were linked to another switch. The window lights could be switched off during daylight, cutting down on the amount of electricity used. Careless use by individuals (who turn lights on in a bright room, or don’t turn lights off when a room is empty) also leads to waste and extra expense.

Windows are important for several reasons. As well as providing natural light during daylight hours, they permit passive heating from solar radiation, allow us to see in or out, and provide natural ventilation when open.

How much light and heat gets into a room through the window depends on the size and position of the window. For example, south-facing windows receive direct sunlight, but with the risk of glare. North-facing windows may not receive enough light. High level windows permit greater light penetration into the back of the room than low level ones of the same size.

doing the research

- ❑ Draw lighting plans showing the position of lights and windows in the room(s) selected for investigating in Stage 1.
- ❑ Note how many switches there are, and which lights each switch controls. Put this information onto your plan.
- ❑ Check whether the light fittings have a switch starter visible on the metal housing for the tube (known as the ballast). A switch starter is not the wall switch. It is a small cylindrical device usually found on the side of the ballast. The presence of a switch starter means that the ballast can be fitted with a low energy fluorescent tube.
- ❑ State whether or not it is possible to switch off those lights nearest the windows without having to switch off other lights in the room.
- ❑ Record how much of the wall space the windows occupy (eg. 25% or 15% etc.). How does the light level in the room vary at different times of day or in different weather conditions? What range of tasks could be carried out at the different light levels?
- ❑ Estimate whether the amount of natural light available is the same throughout the room?
- ❑ Is there anything blocking the sunlight from coming into the room?
- ❑ Note down your results and comment on the effectiveness of switching and the use of natural light. What improvements could be made.

reporting

Use the results of this stage of the investigation and your notes to help you write your report.

using low energy lamps

Fluorescent lamps use less energy than filament lamps to produce the same amount of light. Using fluorescent lamps can therefore reduce electricity costs. **Not all fluorescent lamps are the same**. A school which already has fluorescent strip-lighting in its rooms could save energy and money by using T8 (26mm diameter) low energy tubes in place of old T12s (38mm diameter) tubes, hence saving approximately 10%. However the fitting must have a switch starter, (see sheet LA.09.

doing the research

Read through Briefing paper 3: *Energy Savings - Who Benefits?* and Briefing Paper 4, the *Holt House School Case Study.* You should also compare data in classroom 1 and classroom 2 found on the Sample Data Sheet.

In the rooms you have selected, find out what type of bulbs or lamps are used. Count the lamps and note the power ratings or wattages (you may already have this data from Stage 1). If the school does not already use them, find out the wattage of low energy lamps that could be suitable for the room(s) you are surveying. Calculate the cost (or create a spreadsheet to work out the cost) of using these lamps per day compared to existing lamps. This can be done by comparing the wattage of the lamps now used and their more energy efficient replacements. Energy efficient lamps usually cost more than the ones they replace, but they use less energy, and therefore cost less to run. Work out the time it would take to get back your investment in the low energy lamps. Where and when is it sensible to change to using this type of lighting? What are the factors to consider?

reporting

Note your results and comment on the effectiveness of the types of lamps used and if savings could be made.

Use the results of this stage of the investigation and your notes to help you write your report.

‘Unsung inventors of the light bulb’

Inventions and discoveries are usually the result of team work, rather than the work of an individual, although one person’s name is often associated with the new idea. The team will also make use of ideas from other scientists and engineers working in different laboratories and workshops, possibly in different parts of the world, or at different times. The invention of the electric light bulb is usually associated with one man, Thomas Alva Edison, an American inventor born in the 19th century. Without the work of other people, both in his team and outside it, he could not have produced his invention. In fact, the first carbon filament electric lamp, was invented by Joseph Swann in 1848, although it was Edison, who, in October 1879, invented the first *practical* filament electric lamp. Edison did not work alone, but with Charles Batchelor, his principal inventor-associate, Francis R. Upton, Ludwig K. Bohm and a small workforce of about two dozen men that staffed the Menlo Park Laboratory. On the 21st October, 1879 the lamp maintained its glow for more than 40 hours. On 31st December, 1879 they gave a public demonstration of an electric lighting system for streets and buildings at the laboratory in Menlo Park, New Jersey, USA.

However, the era of electric lighting could not have begun without the invention of the carbon filament by an African American, Lewis Howard Latimer. It was this invention which allowed the electric lamp to be developed on a commercial scale.

Joseph Wilson Swann's experiments in England with carbon sticks aided Edison's team to invent the electric lamp. Edison also needed to use a Sprengel (vacuum) pump to draw air out of the light bulbs, so that the filament did not oxidise and burn out when it got hot and glowed.

In 1883 Edison and Swann joined forces as the Edison-Swann United Electric Lighting Company Ltd using Edison's patented ideas. Many improvements in filament light bulbs have occurred since the first was developed. For example, in 1910, Dr. William D. Coolidge invented a process to draw tungsten wire that resulted in a stronger filament and lamps that were more efficient. Further developments in 1913 led Dr. Irving Langmuir to produce a 1000-watt lamp filled with an inert or noble gas. This lamp was twice as efficient as older lamps.

fluorescent lamps

Fluorescence is defined as *the property of a material to become self-luminous when acted upon by radiant energy, such as ultraviolet or X-rays*. This definition pinpoints the two essential elements required in a fluorescent lamp: a source of radiant energy and a material that will fluoresce.

The light of a fluorescent lamp comes from **phosphors** (substances containing phosphorus and which emit light when they receive certain types of energy). Many natural and synthetic materials exhibit fluorescence. In fluorescent lamps, the inner surface of the lamp is coated, usually with a mixture of phosphors, which fluoresce. The phosphors absorb ultraviolet radiation from a very low-pressure mercury discharge and transform it into visible radiation. The selection of the phosphors and additives, called activators, determines the characteristics of the emitted radiation, e.g. ultraviolet, coloured light, or various shades of white light. The phosphor mix makes possible a wide range of colour appearance and colour rendering.

When a high a.c. voltage is put between the heated electrodes of a fluorescent lamp containing mercury vapour at low pressure, electrons are accelerated back and forth in the tube. These collide with the mercury vapour atoms and cause these electrons to move from lower to higher energy levels. They do not stay there for long and, as these move from the higher to lower energy levels, energy is released in the form of blue-green and ultraviolet radiation. When the radiation strikes the phosphors in the tube wall other colours of visible light are emitted, depending on the type of phosphors. The mixture of colours then provides the overall colour, that we see.

fluorescent lamps

Fluorescent lamps have a light output 5 to 10 times higher than that of a filament lamp of the same wattage. This is why they make more efficient use of energy for electric lighting. They also have a longer life than filament lamps.

However, every manufactured object has an energy cost. To consider the true energy savings of fluorescent lamps (normal or low energy) over filament lamps, this cost of energy used in their manufacture must be taken into account. This additional energy cost of course contributes to the higher cost of fluorescent lamps compared to filament lamps.

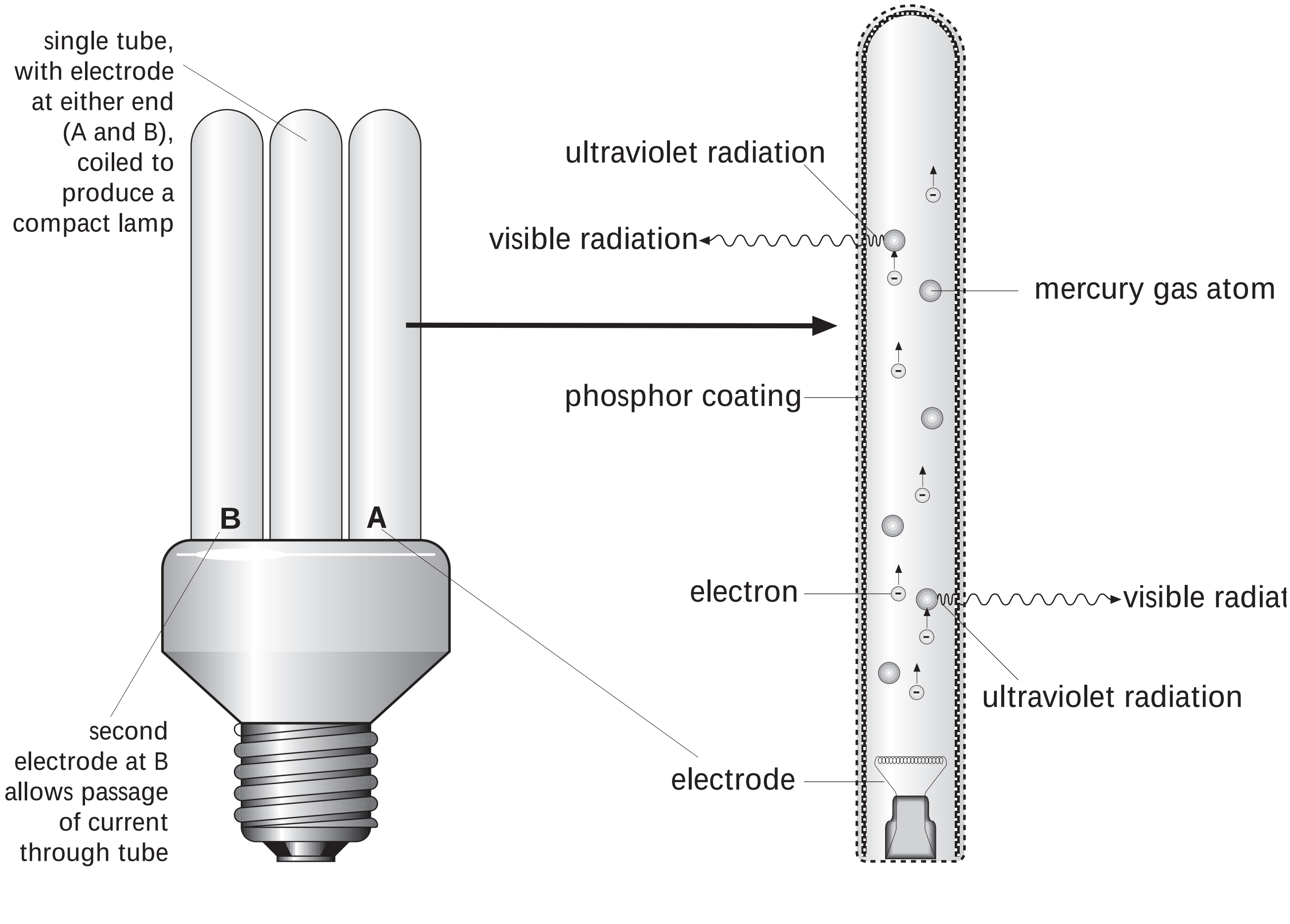


Figure 1. How a fluorescent lamp works

There is a further issue with fluorescent lamps, and that is what to do with them when they are spent. Fluorescent lamps contain phosphorus and mercury and some contain cadmium, (the composition depends on which country the lamp was made in). These are very toxic substances. So, when the lamps come to the end of their useful life, they need to be disposed of according to UK Government and EC regulations, and not dumped in bins or landfill sites.

energy savings - who benefits?

Adapted from *Lighting costs cut by over 60%* by Intermediate Technology, and *Shedding light on savings* by Maurice Craft

Low energy light bulbs have come a long way since they were first available. The bulbs are based on fluorescent tube technology but are now compact, and several designs are available. The main manufacturers of low energy light bulbs in the U.K. are *Philips*, *Mazda*, *Slyvania* and *Osram.*

We need to look at two things to calculate what they really save:

- ❑ the cost of the bulbs themselves, and
- ❑ the saving on electricity.

Let's look first at the cost of the bulbs. A 20W low energy bulb can cost £12. This gives the same amount of light as a 100W ordinary filament bulb.

A low energy bulb can burn for 8000 hours before replacement is necessary but a normal bulb lasts approximately 1000 hours.

If we are cautious and say a low energy bulb does only 6000 hours - which is what the manufacturers estimate - then we would have to replace six filament bulbs during the low energy bulb's lifetime at say 40p each x 6 = £2.40.

So a low energy bulb is around £9.60 more expensive than the equivalent six filament bulbs. So how do we save?

If you have a 100W normal bulb on for say 10 hours it will cost 6.95p and for 1000 hours it will cost £6.95, (based on the cost of electricity in the Yorkshire area, 1996 - find out the cost in your area).

If you have a 20W low energy bulb on for 10 hours it will cost 1.39p and for 1000 hours it will cost £1.39

So, in 1000 hours of operation the electricity saved by using a low energy bulb is £5.56. There are 8760 hours in a year but the average number of hours of operation is around 2000 hours per bulb. So the average saving per bulb is £11.12 per year. If a low energy bulb lasts 6000 hours, then it should last about three years. Over these three years the saving per bulb is therefore 3 x £11.12, that is £33.36. The cost of the low energy bulb also has to be taken into account, so £9.60 must be deducted from this saving. This gives a total saving over the three years of £23.76. To arrive at your own saving in a year you need to look at those lights you use most often and how many hours throughout the year you burn them. However, the use of lights in different households varies tremendously so you really need to make your own calculations if you want to know how much you will save.

making savings

The simple message is you will save sooner or later. Environmentally, if every UK household replaced just one well-used light bulb with a low energy bulb, the output of one large power station would be saved.

Low energy bulbs seem to fit in most light fittings but not all, e.g. they will not fit into spotlight fittings. Although if you are considering decoration or home improvements this may be the time to consider replacing spotlights with a fitting which can take low energy bulbs. There may also be interference between the bulb and the shade. Do not use low energy bulbs with dimmer switches or electronic switches (eg timers) as the electronics will affect the starting and cause the light to flash on and off.

low energy tubes

Another revolution is also happening with the fluorescent tubes we have known for many years. Those who are alert will notice that the tube diameter is getting smaller. Sometimes these smaller diameter tubes are called low energy tubes. Tube replacement in this area is a little more complicated because fluorescent lamp efficiency diminishes with age by up to 10% after one year and by up to 20% after three years. We can be paying for energy that is not converted into useful light.

Therefore, there is a critical point in the tube's life when it is worth replacing it. This will increase light levels and reduce wasted energy. In commercial premises a planned maintenance and condition survey will show this optimum time of replacement. If we replace a T12 40W tube with a T8 low energy 36W lamp we will save 4 watts per tube per hour. This means 35,040 watts (35kW) per year 24 hours use per day for 365 days per year.

In money terms 35kW at say 7p per kW equals a total of £2.45 per annum per tube. (The cost per kW would need to be checked against your own tariff). If we replace tubes before they become noticeably inefficient, ie. within 3 years, then further savings of between 10 - 20% can be made. In addition switch starters for fluorescent tubes, can be replaced by high frequency or ultra high frequency starters (or switching gear) and in this case the savings outlined below can be achieved.

A 40watt x 4ft tube unit will save some 10.5% if you replace the starter. A 65 watt x 5ft tube will save 19.5% and a 75watt x 6ft tube will save approximately 13%. So it is not only worth looking at replacing your tubes more frequently, and using the low energy one, but also replacing the starter. Waiting until either fails could be a false economy.

SHEEP

Since April, 1993 the Schools and Homes Energy Efficiency Project (SHEEP) has been piloting energy education and energy management activities in South Yorkshire. Holt House Infant School, Sheffield, is one of the pilot schools. After the replacement of 150W/200W tungsten filament lamps in all the classrooms with compact fluorescent units, during 1995, a 51% (£521) saving in electricity was achieved, with a 56% (£606) predicted saving for 1996.

Holt House School

Holt House Infant School consists of two main building forms: a single storey, flat roofed section, mainly housing the classrooms, and a two storey, flat roofed section, housing the school hall, catering facilities and offices. These are connected at the main entrance.

In July, 1993 an energy survey was completed by the Resources Research Unit of Sheffield Hallam University. A detailed breakdown of annual energy consumption for the school was obtained from the survey data. This enabled further work to be based on a sound knowledge of the building’s energy use. For example, the space heating and catering accounted for about half and a quarter, respectively, of the total energy consumption. These services, along with water heating, were provided by natural gas. The remaining energy demand was supplied by electricity, of which the majority was used for lighting.

Following this, SHEEP carried out a lighting survey and an 'action-audit', designed by an engineering student on an industrial placement, and produced classroom activities to support the energy and light surveys. The surveys and activities were then used in other local schools.

The findings by the Resources Research Unit, SHEEP and the children were presented to the headteacher, caretaker and governors. It was agreed to monitor electricity consumption in a class with 9 Philips 23W low energy compact fluorescent lamps and another with a mixture of 9 150/200W tungsten filament bulbs. Campbell Adams & Associates Ltd provided the monitoring equipment. CIBSE classroom lux levels were maintained throughout the trial period.

On receiving the results of the electricity consumption (i.e tungsten filament bulbs used 7.98kW x 5.7h= 45.486 kWh; low energy lamps used 1.5.kw x 5.7h = 8.55 kWh), an accurate forecast of predicted savings and payback period was established. The results predicted an estimated savings of £530 per year with a payback period of 181 'school year' days.

In January 1995 as a result of the estimated savings the school changed all classrooms over to low-energy lamps. In April, 1995 when the electricity bill arrived it confirmed the predicted £500 plus savings. Gwyn Gadd, the headteacher, commented: "Schools have to learn about effective building management now that many are managing their own funds. The reduction of energy usage in lighting is a key area where we can reduce costs".

writing your report

You are going to write a report to the school governors and other interested individuals or groups about how your school could save money by using electricity for lighting more efficiently. You may also be able to use your report to make a presentation to them.

The report needs to have the following sections (the teacher may divide you into groups to write one section per group):

- ❑ an **introduction** - this needs to explain the problems which can be caused by using too much electricity (in the school, and in the environment generally)
- ❑ **setting the scene** - this could describe how the school uses electricity now, what its electricity bills are, what type of lighting is used - use your results to Stage1 of the research to help you
- ❑ **results** and **conclusions** to Stages 2, 3 and 4 of the research
- ❑ an **action plan** for how the school can cut down on its electricity bills, including how long it would take for the costs of any suggestions to be met by the school's lower energy costs
- ❑ a **summary of your recommendations**, including how efforts to cut down on electricity use could help the environment.

There are a variety of ways your work can be presented such as:

presenting your work

- ❑ a **verbal presentation** to the headteacher, local business people, councillors, teachers, governors and other students
- ❑ an **exhibition of your work** - this could include posters and/or models showing redesigned lighting systems for the areas of the school you surveyed
- ❑ a **press release** outlining your findings
- ❑ a **video report** (*note:* this will need to planned before you start the research so that you can record the work as it happens)
- ❑ a **role play**, to include: headteacher, a representative of the local electricity company, an environmentalist, a parent, a pupil, etc.
- ❑ a **written report** to the headteacher, governors and others, outlining your findings and making recommendations for future action to save energy and money.