A Simple Guide to Conducting a

SCHOOL ENERGY AUDIT

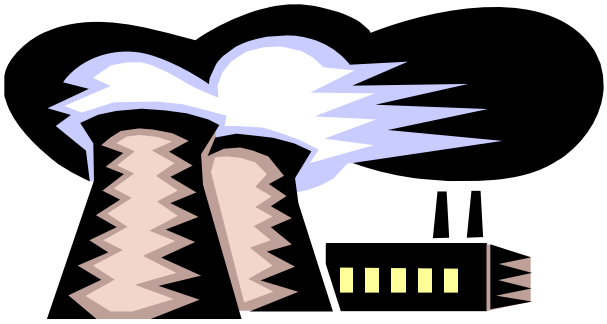
An energy audit tells us how much, where and why energy is used in your school

This unit is designed for stages 2 to 6.

Table of Contents:

Why do an Energy Audit?

➢ Environmental Impacts



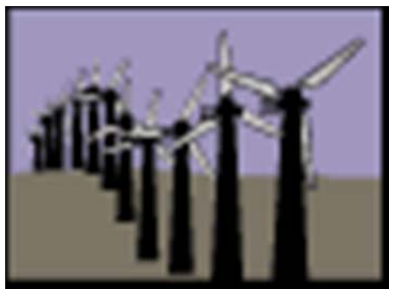
The use of energy from the burning of fossil fuels results in more of the gases (mostly carbon dioxide) that cause global warming, rising sea levels and ocean acidification.

(1 kWh of electricity from burning coal results in about 1 kg of Carbon Dioxide (CO_2). Burning 1 MJ of gas results in about 0.07 kilogram (kg) of Carbon Dioxide (CO_2)

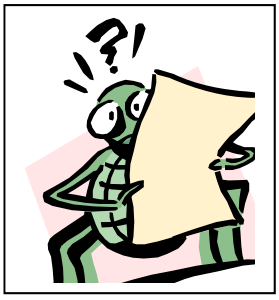
- Most of the energy used in schools comes from electricity and gas.
- In 2004 this resulted in the production of 243,238 tonnes of CO_2.
- The recent installation of air conditioning units in schools has resulted in an additional 20,000 tonnes of greenhouse gas annually.
- The cost of energy is increasing

➢ Benefits of reducing Energy Consumption

- Saves money
- Reduces greenhouse gas emissions
- Conserves the earth's non renewable energy reserves



How to do an Energy Audit



Three simple procedures:

1. ***Get the School's Energy Bills*** – Describe past energy use from information provided in the school's electricity and gas bills.
2. ***Analyse Energy Use Using an Audit or Webgraphs***
3. ***Conduct an Energy Survey*** – Survey the school community about energy use.

1 Analyse the school's electricity bills

- Obtain a copy of your school's electricity bills for the past 12 months. Find the **Average Daily Use (kWh)**, **Greenhouse Gas Emissions** (tonnes) and **Total Cost** ($)

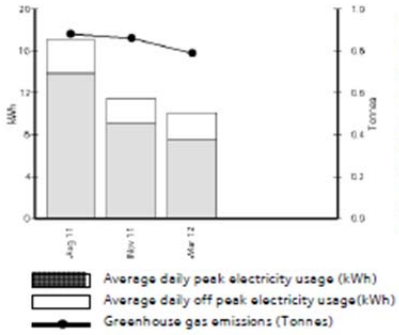
Your overall picture.

Usage

Average usage per day
10.12kWh

Same time last year
n/a

Average cost per day
$2.73



Greenhouse gas emissions

Total for this bill:
0.79 tonnes
from 884.81542kWh

For information on how to reduce your greenhouse gas emissions, visit www.climatechange.gov.au

Put your business to the test at www.agl.com.au/energychallenger

Your account in detail.

Supply address	RUMBALARA ENVIRO EDU CTR Donnison Street GOSFORD NSW 2250
NMI	41023479214
Supply period	30 Nov 2011 to 1 Mar 2012
Plan	Advantage 12%

Reading type		Actual read
Tariff description		General Supply TOU Multi Site
Meter no.	**Days billed**	**Usage kWh**
2712	93	524.318
2712	93	175.273
2712	93	241.702

Usage	Charge
Old Rate Prorate 30 Nov 2011 to 31 Dec 2011 32 days	
Green Energy 273.015 kWh @ $0.00375	$1.02
New Rate Prorate 1 Jan 2012 to 1 Mar 2012 61 days	
Green Energy 668.278 kWh @ $0.003249	$2.17
Unchanged Rate 30 Nov 2011 to 1 Mar 2012 93 days	
Peak 175.273 kWh @ $0.4010	$70.28
Off Peak 241.702 kWh @ $0.0940	$22.72
Shoulder 524.318 kWh @ $0.1700	$89.13
Supply Charge	$66.96

Green energy is an option to purchase electricity from non greenhouse emitting sources. The 100% green energy component of this $253 bill cost an extra $3.19. Unfortunately the resultant reduction in Greenhouse emissions is not recorded on the accounts.

Electricity Costs (previous 12 months)

Time Period			Cost ($) (include all charges)	Greenhouse Gas Emissions (tonnes)	Average Daily Usage (kWh)*
from	to	days			
Total Days			**Total Cost**	**Total Greenhouse**	**Average Cost**

*Note that the average daily use on the account includes school holidays and weekends. Divide the total greenhouse gas emissions by the number of people at the school.

Gas Audit

Billing Period (which months?)	Number of Days	Megajoules (MJ)	Cost ($)	Average Cost /Day*

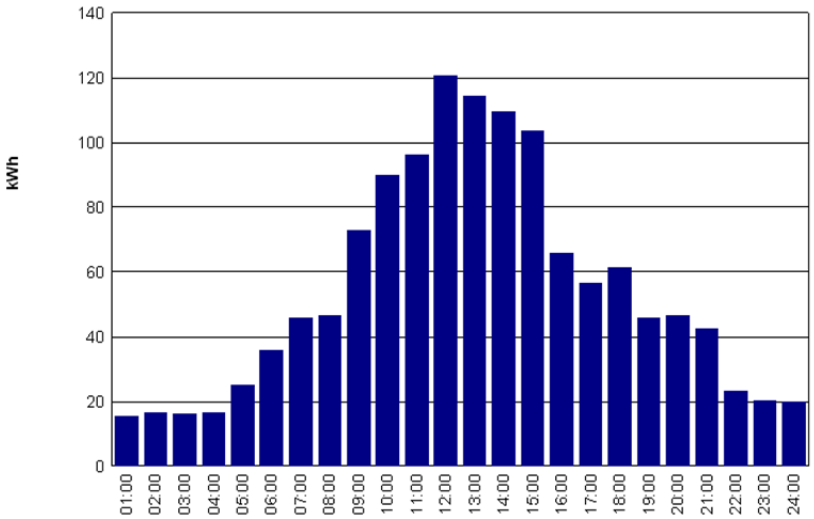
** 1MJ of gas produces about 0.07 kilograms of CO_2*

2 Analyse how our school uses energy

The three biggest energy users in a typical school are:

- **Heating and cooling (35%)**
- **Lights (25%)**
- **Computers and related office equipment (10%)**

Webgraphs enable easy analysis of the school's energy consumption over various time scales from months to hours. In the example opposite the 18kWh consumption all night might guide students to an investigation of power consumption when the school is empty eg turning off the instantaneous hot water heaters overnight and compare to the next days graph. The graphs can also monitor the output of solar cells.
www.webgraphs.com.au
Using webgraphs in schools



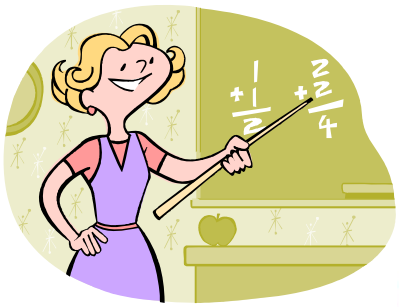
Although a time consuming procedure, an audit of all the energy using equipment in the school can reveal where most energy is being used. The Energy Calculator (below) provides estimates of the wattage for various items and automatically calculates energy consumption based on number of items and hours in use. Estimating the hours in use for thermostat controlled devices is problematic but can be achieved with a power meter (available for loan from Rumbalara EEC). The calculator can be downloaded from the NSW DEC intranet – Asset Management Directorate website. https://detwww.det.nsw.edu.au/assetmanagement/assets/media/energy_audit_cost_calculator.xls

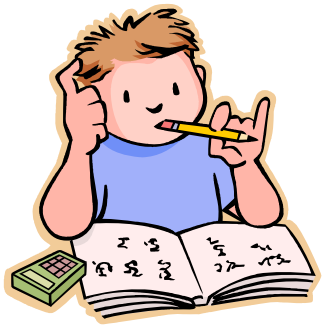
Example:

Electricity Audit Calculator

Column A	Column B	Column C	Column D	Column E	Column F	Column G	Column H	Column I	Column J	Column K	Column L	Column M
Equipment	Number of items	Average Wattage (w)	Hours in use per day	Number of days in use per year	kWh used per day	kWh used per year	Average Wattage on stand-by (w)	Hours on stand-by per day	Number of days on stand-by during a year	kWh left on stand-by per day	kWh left on stand-by per year	Total kg CO2 per year for this item
Air conditioner, Split system	20	7000	3	120	420	50400	35	21	365	15	5366	59558
Desktop Computer & Monitor	70	305	4	200	85	17080	35	20	365	49	17885	37343
DVD Player	5	25	3	200	0	75	20	21	365	2	767	899
Fans	55	100	5.5	120	30	3630						3877
Fax Machine	1	700	3	200	2	420	10	21	365	0	77	530
Freezer	2	320	4	365	3	934						998
Hot Water System, Electric	1	4500	24	365	108	39420						42101
Refrigerator	9	320	24	365	69	25229						26944
Lights, Internal	600	48	7	200	202	40320						43062
Lights, External	20	71	8	365	11	4146						4428
Microwave Oven	2	1200	1	200	2	480	5	23	365	0	84	602
O/H Projector	23	150	1	200	3	690						737
Photocopier	3	1250	4	200	15	3000	35	20	365	2	767	4023
Printer	12	850	3	200	31	6120	15	21	365	4	1380	8010
TV	6	80	1.5	200	1	144	15	22.5	365	2	739	943
Vacuum Cleaner	2	600	3	200	4	720						769
Video Recorder	6	45	2	200	1	108	25	22	365	3	1205	1402
Total					**987**	**192917**				**77**	**28267**	**236225**

3 School Survey



Surveying the school and the school community will assist in finding where energy savings can be made through changes to appliances, attitudes, and practices.

Appendix 1 contains prepared interview sheets focussing on Thermal Comfort, Lighting and Plug-in Appliances. You may ask other questions as well. Students should work in teams eg a thermal team will have a recorder / interviewer and 'scientist' who measures temperature. The Lighting and Appliances team will have a recorder / interviewer and 'scientist' who measures light and power. There should be enough teams to sample a large range of buildings and staff eg classrooms, canteen, office, staffroom, principal, teachers, office staff, cleaners etc).

Each team will need to be briefed on good and bad energy practices (see checklist on next page). They will also need to be briefed on the use of equipment. Note that students need special instruction and supervision when using Power meters as appliances have to be plugged into them.

- **Equipment** can be borrowed from Rumbalara EEC
- Thermometers (thermal' survey).
- Light meters (lighting survey)
- Power meters (plug-in appliances survey) Power-Mate & Power-Mate Light

http://www.power-mate.com.au/pdfs/PML%20Operators%20Manual%20R1-8.pdf
http://www.power-mate.com.au/pdfs/PM10-15_User_Manual.pdf

Required Lighting Level for Secondary Schools
In accordance with Schools Facilities Standards - ver 1.14 - 01/03/2008

Activity	*Recommended Light (Lux)*
Corridors, passage ways, storerooms	*80*
Libraries, laboratories, classrooms, kitchens, administration, canteen, toilet,	*160*
Visual arts/performance workshop	*240*

If a reading is 50 lux above the standard, the room can be considered over illuminated and wasting energy. The room should be within 20 lux of the standard.

Analyse the survey responses and include a summary of your findings in the Energy Plan ppt on the slide 'Energy Survey Results'.

Survey Recording Sheet: Thermal Comfort

Room/Location: **Interviewee:**

1.	Inside Temperature and humidity Outside temperature and humidity	
2.	Is the air conditioner or heater on?	
3.	Are windows or doors open or closed?	
4.	Are ceiling fans on or off?	
5.	What is the current temperature setting on the air conditioner/ heater thermostat?	
6.	How do you ensure that air conditioner / heaters are not left on when the room is vacated for lengthy periods eg lunch, sport?	
7.	Are blinds/curtains used to assist temperature control in the room?	
8.	Are air conditioner filters cleaned regularly	
9.	Is the ceiling insulated?	
10.	Are roof ventilators installed? On or off?	
11.	Is room difficult to keep at a comfortable temperature in winter or summer?	
12.	Is there any shading of the room in summer eg external awnings, window blinds, trees	
13.	Is the building heated by adjacent hard surfaces eg bitumen, concrete,	
14.	Can you suggest ways to reduce the energy used to maintain thermal comfort in this room or in other parts of the school?	

Survey Recording Sheet: Lighting

Location: **Interviewee:**

1.	How do you ensure that lights are turned off when the room is vacated?	
2.	Are energy efficient light sources being used?	
3.	Are the light lenses clean?	
4.	What are the room lighting levels. *Measure with a light meter*:	Room lighting ranged from: _____ lux to _____ lux. Blinds were up / down
5.	Can you suggest ways to reduce the schools light energy use?	

Plug-in Appliances

1.	What mode are computers in when not in use? eg standby, turned off, screen saver etc	Computer power consumption: In use _____ Standby _____
2.	Do the school photocopiers, printers and fax have an Energy Saver mode and is it being used?	
3.	What other appliances get left on when they can be switched off or put on a timer? eg instant boiling water heaters, appliances in the canteen, Smartboards, Connected Classrooms The power consumption of appliances can be checked using power meters (on loan from Rumbalara EEC)	

4 School Energy Management Checklist

The checklist can assist in summarising the survey information and may also identify other questions that need to be asked about energy management in the school

	Air conditioners are thermostatically controlled to between 26^0C – 28^0C in summer and 18^0C – 20^0C in winter
	Timers are used to ensure that air con systems are turned off outside operating hours
	Blinds, windows and fans are used to maintain thermal comfort before using air conditioners.
	External window awnings are used to provide winter sun and summer shade
	Landscaping is used to provide winter sun, summer shade and non-reflective surfaces
	Roof turbo vents are open in winter and closed in summer
	Buildings are well insulated.
	Air con systems are regularly serviced to achieve maximum working efficiency
	Lighting is adequate but not excessive
	Energy efficient lights (compact fluorescent or LED's) are used wherever possible
	Lighting lens covers are kept clean.
	Systems are in place to ensure that lights are not left on unnecessarily
	The school produces green energy from solar panels and or wind turbines
	The school has opted to purchase green energy
	Systems are in place to ensure that computers and other plug-in energy appliances are turned off, put into standby or energy saving mode at appropriate times
	Timers are used on plug in appliances
	Electric kettles are used instead of instant hot water heaters
	Instant hot water heaters are turned off outside school hours
	Electrical appliances have a 5 or 6 star energy rating
	Refrigerators and freezers are properly serviced to maintain operating efficiency.
	People are encouraged to travel to and from school in the most energy efficient way.
	A procurement policy ensures that embedded energy in goods and services is not wasted
	The school has solar thermal water heaters
	The school recognises the value of planting trees to absorb carbon dioxide*

Compare your electricity use with that of similar sized schools. The table below shows the average electricity use per student per year in 2010 from https://detwww.det.nsw.edu.au/procurement/products/electricity/index.htm

School classification	P1	P2	P3	P4	P5	P6	S8	S9	C
2010 NSW Av.kWhr/student/yr	225	249	262	305	431	897	387	490	481

Growing Trees to Absorb Carbon Dioxide

Through photosynthesis, trees absorb CO_2 from the atmosphere and convert it into structural materials like cellulose. About half a trees mass is the carbon in these structural chemicals that make the woody roots, branches and leaves. This natural process is part of the *carbon cycle* and is known as bio-*sequestration*. In most ecosystems, the majority of the carbon is stored belowground, either as roots and decaying biomass or as organic carbon in the soil. The carbon is released back into the atmosphere when the wood decomposes or is burnt.

With a tree carbon calculator you can make a simple measurement of trees in your school, and be given an estimate of just how much carbon they store. Measurements in successive years can be used to find out how much carbon was absorbed (Individual trees would need to be identified). The CO_2 absorbed by trees in the school can be subtracted from the CO_2 produced by the schools energy consumption ie it is a **carbon offset**. Download the tree carbon calculator at: http://www.rumbalara-e.schools.nsw.edu.au/resources/climate-change-energy

Trees can also improve the biodiversity of the school grounds.

Carbon Stored in Trees		date:
Tree Identification eg label or code	Tree girth (cm) at 1.3 m	Carbon Dioxide equivalent (Kgs)

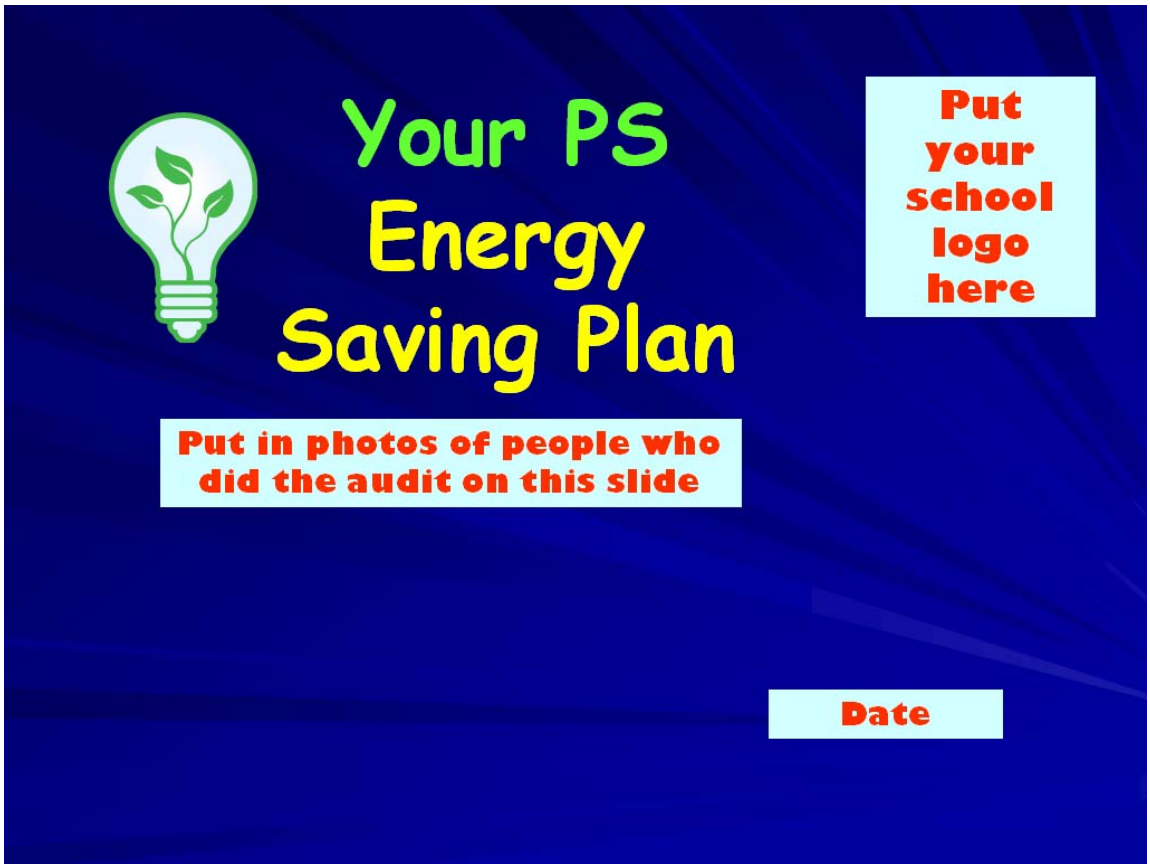
5 The Energy Plan

A simple powerpoint planning template is available from Rumbalara EEC to assist in the preparation of your plan. Discuss / brainstorm the results of the audit as you work through the slideshow to complete your school energy plan and set targets.

This template can be used to create your own school energy saving plan. Download from http://www.rumbalara-e.schools.nsw.edu.au/documents/230888/231169/energy_action_plan_1323141477575.ppt

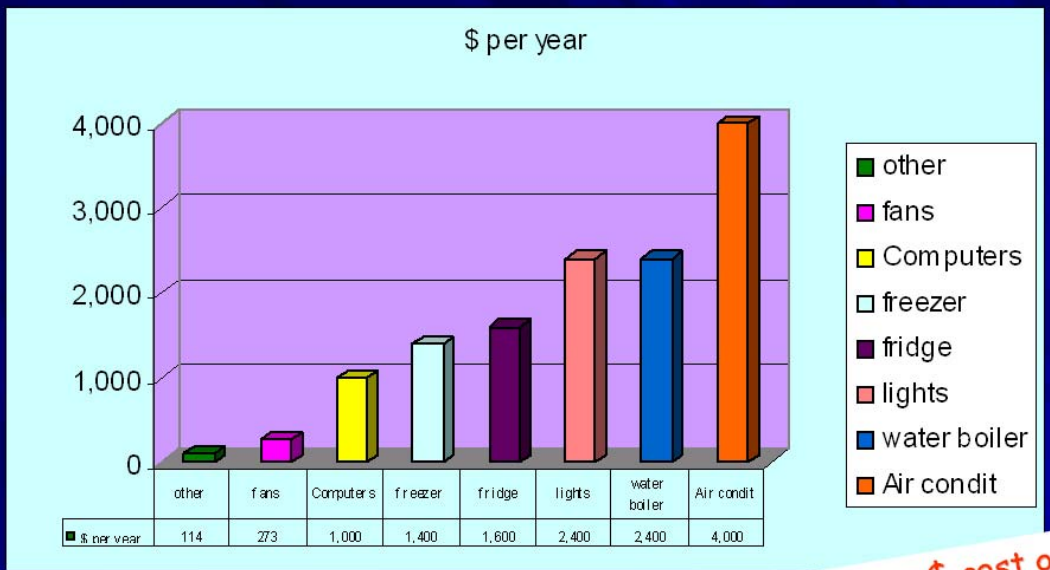
Why a Powerpoint Plan?

1. It is accessible. A class or classes of students can participate in its development through a data projector or Smartboard.
2. It is an action learning tool. Students use the templates to guide them through a process of summarising information from audits, analysis of that information to identify problems and the use of brainstorming and research to come up with agreed solutions.
3. It is empowering. Students developing the project have a sense of ownership and responsibility for the implementation of the plan
4. It is attractive. The slides allow creative use of colour and images that enable the plan to be presented as an engaging document to the whole school community.
5. It is a flexible format. It can be easily adapted to the changing needs of the school. Students in successive years can learn from and build on what has been achieved by students in the past.



In the last 12 months
our school's electricity use
produced
44.4 tonnes of Greenhouse Gas
(or 0.2 tonnes for each person at the school)
and cost **$5013**
(at $ per kWHr)

Include any other energy sources at your school eg natural gas



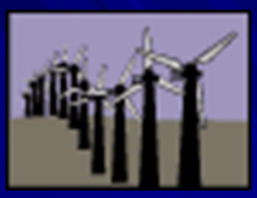
A graph generated from the energy audit calculator can show $ cost or CO_2 production. This one shows that air conditioners were the biggest users of electricity in the school

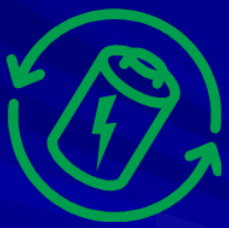
Energy Survey Results

 Thermal Energy	
 Light Energy	
 Computers and Appliances	

Energy Saving Ideas

- Set air con thermostats to the lowest comfortable temperature in winter and the highest in summer and dress for the season. A one degree change can reduce greenhouse emissions by 20%
- Insulate ceilings and walls where possible
- Encourage student energy monitors to check that lights are not left on unnecessarily.
- Clean fluorescent tubes and covers and remove tubes in situations where there is excessive lighting
- Replace incandescent globes with compact fluorescent lamps
- Replace older style 40 watt fluorescent tubes (40mm diameter) with thinner (26mm) 36 watt tubes
- Install movement sensors and lighting controls to avoid leaving lights on continually
- Activate "Energy Saving" features on appliances such as computers, photocopiers, printers.
- Instant Boiling Water Units are big energy users. Install timers to ensure they are turned off at the end of the day and during holiday periods.

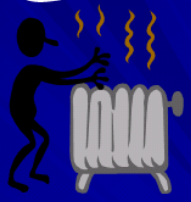




Our Energy Action Plan

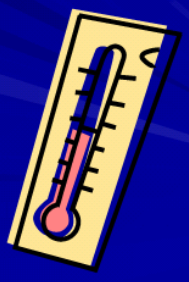
Problems

- In some rooms there are more lights on than needed
- Heaters are left on longer than required
- Computers are left on all day
- Air conditioners are left on all day and sometimes while doors and windows are open



Solutions

- Remove fluorescent tubes where they are not needed
- Keep a thermometer in the room to monitor temperature. Turn off heaters at a designated temperature – eg when everyone is comfortable with a jumper on (not so hot that everyone has to be in short sleeves)
- Only turn computers on when they are needed. Always turn the monitor off
- Educate the school community about the efficient use of air conditioners



OUR ANNUAL TARGET:

REDUCE ENERGY USE FROM FOSSIL FUELS TO 0.16 TONNES OF GREENHOUSE GASES PER PERSON

That's 35.2 tonnes in the next 12 months

- a saving of 9.2 tonnes of greenhouse emissions!

Information and Resources

A. HEATING AND COOLING

Avoid using heaters/cooling systems

- Encourage students to dress for the climate and then heat and cool only the areas that are necessary.
- Set the thermostat at the lowest comfortable temperature in winter (20°C) and the highest in summer (25°C) and dress for the season. A change of one degree can reduce heating and cooling greenhouse gas emissions by 10-20 per cent.
- Minimise the use of electric fan heaters.

Switch off

- Turn off gas heaters and boiler pilot lights over summer and on holidays.
- Turn off fans when leaving the room- even if only for a few minutes.

Building management

- Insulate ceilings and walls when possible. This reduces heat flow by around 80%.
- Seal off exhaust fans and science room fume cupboards when not in use to reduce hidden leaks.
- Rooms with large glass areas can lose heat in winter and increase heat and glare in summer. Cover parts of the windows with insulation panels (notice boards), or blinds. Experiment to see what allows more light in - covering the top of the windows or the bottom.
- Reduce hot and cold draughts through doors by weather stripping, hanging plastic strips across doorways.
- In rooms with high ceilings, use ceiling fans on low settings to recirculate warm air from the ceiling in winter.

B. LIGHTING

Switch off

- Encourage classes to nominate monitors to turn lights off at recess, lunch and at the end of the day.
- Encourage staff and students to switch off lights that are not in use by placing reminder stickers onto switches.

Remove unnecessary lights

- Take out unnecessary fluorescent tubes, especially where there are more than 2 lights in a fitting or next to windows.
- Replace incandescent globes with compact fluorescent lamps or perhaps LEDs..

Maintain lights

- Lights perform more efficiently when they are cleaned regularly.
- Ensure faulty lights replaced promptly.
- Replace older style 40 watt fluorescent tubes (40mm diameter) with thinner (26mm) 36 watt tubes.

Install lighting controls

- Install movement sensors and lighting controls, such as timers in security and other areas to avoid leaving lights on continually.

C. EQUIPMENT

Office Equipment

Reduce greenhouse gas emissions from computers, photocopiers, printers and faxes. This type of equipment usually has energy efficiency modes built in. Sometimes these may not be activated.

To work out how to activate energy saving modes on equipment go to the website of the NSW Sustainable Energy Development Authority (SEDA) at www.seda.nsw.gov.au. Once there, go to the 'Business' section and look for the 'Energy Star' Program. You can use the Energy Star Cost and Environmental Calculator to work out how much energy can be saved or follow the directions to enable the energy saving devices on your equipment.

Boiling Water Units

These units are usually left on for 24 hours /day 365 days of the year producing between 2-3000 kg's of greenhouse gas per year. Halve this by simply putting a timer at the power point that switches it off at the end of each school day and on again in the morning. It may be possible to use an electric kettle instead of the boiling water unit. Also switch it off during the holiday periods.

D. CARBON OFFSETS

The carbon dioxide you produce through the use of energy from coal fired power stations can be offset by removing and storing carbon dioxide. Plants have evolved an ingenious way of doing this called photosynthesis where sunlight energy is used to turn Carbon Dioxide into carbon compounds. Some of these compounds eg cellulose are used in building the plant as it grows and are therefore locked away until the plant is eaten, decomposes or burns. At this point the carbon compounds in the tree are turned back into carbon dioxide and the cycle is complete. The amount of carbon stored in a tree can be calculated simply from a measure of the girth of the tree and putting this information into an automatic calculator that can be found online at tree carbon calculator or (google 'tree carbon calculator')

Green Power

Australia is the highest per capita emitter of greenhouse gases in the world. Only a mere 8% of Australia's electricity is generated from renewable energy – clean, non-polluting energy.

Over 50% of Australia's greenhouse gasses come from electricity generated by burning coal, making electricity the biggest single contributor to Australia's greenhouse emissions.

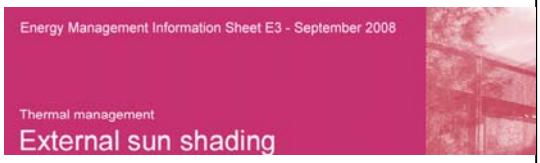
By switching to GreenPower you are investing in the renewable energy sector – helping it to compete with coal on price, and stimulating the development of renewable energy in Australia. www.greenpower.gov.au

DEC – Asset Management Fact Sheets

as at 1st March 2009

Solar Panel Selection and installation
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/is4_sopowerselect.pdf

Internal Window Shading - blinds
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/tm_em2_blinds.pdf



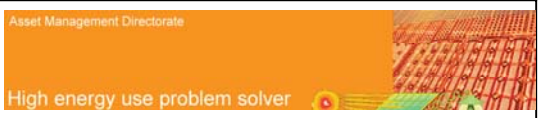
External Sun Shading
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/tm_em3_external_sun_shading.pdf

Roof Space Insulation
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/tm_em4_insulation.pdf

Night Flushing
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/tm_em5nightflushing.pdf

Roof ventilators
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/tm_em6roofventilators_ge.pdf

Lighting
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/lighting242.pdf



High Energy use problem solver
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Landscaping for climate management
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/energyuseflowchartv2.pdf

Solar Panel Feasibility
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/solarproforma.pdf

Selecting an appropriate cooling system
https://detwww.det.nsw.edu.au/assetmanagement/assets/media/reducing_greenhouse_gas_emissions.pdf

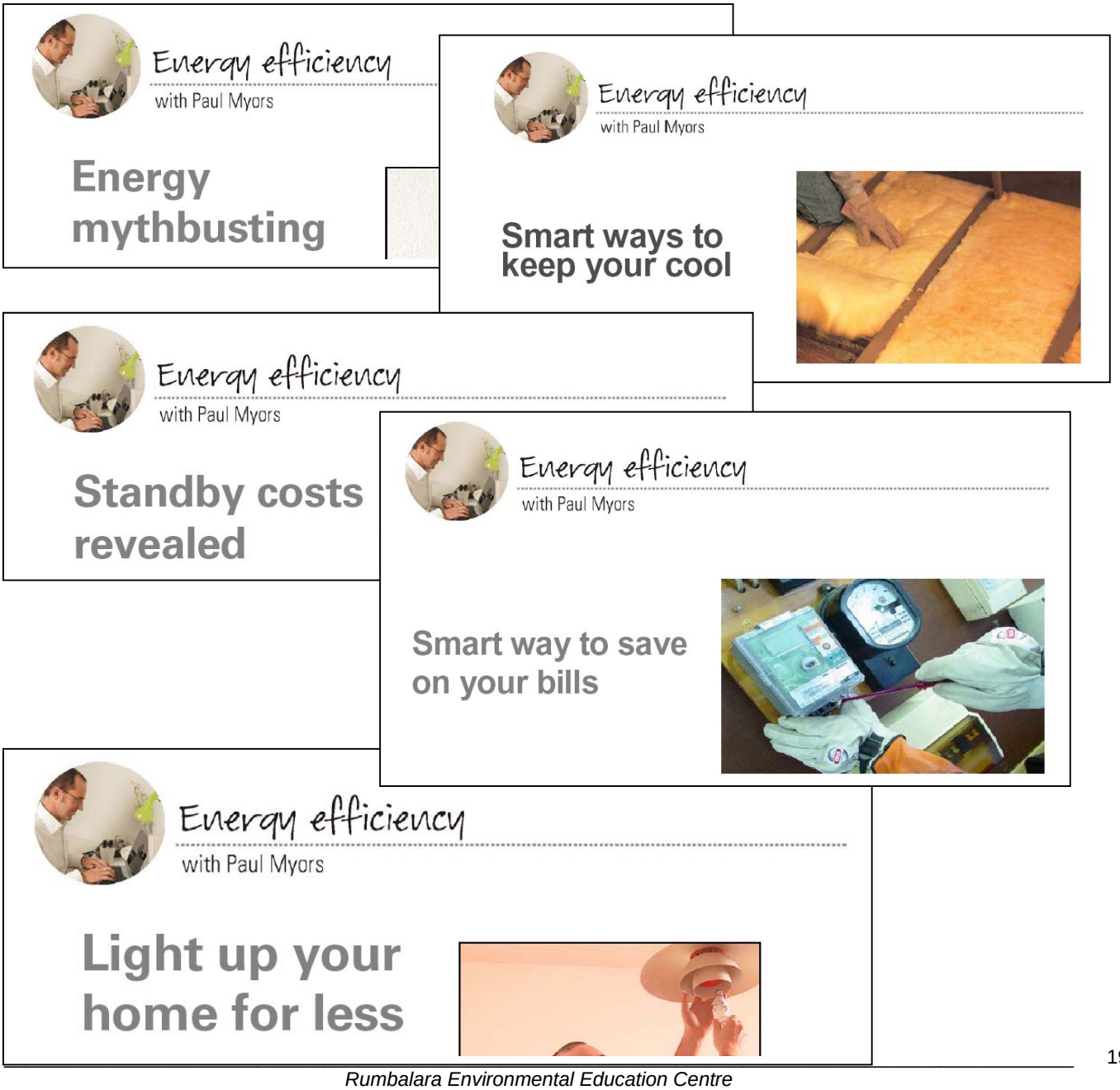
DEC – Asset Management Fact Sheets (continued)

What Targets should be aimed for? Water & Energy.
https://detwww.det.nsw.edu.au/assetmanagement/envisust/solar2.htm

Thermal Performance of buildings
https://detwww.det.nsw.edu.au/assetmanagement/envisust/passive/btg01.htm

Energy Australia Fact Sheets

http://www.energysave.energyaustralia.com.au/articles/all



Syllabus Links

ACTIVITIES	OUTCOMES	STAGE
Discuss various ways electricity is produced and the effects of energy use on the environment. Research the causes of global warming and the predicted changes Discuss ways to reduce energy use in the school.	Science	
Assess past energy usage in the school - look at past electricity and gas bills. Calculate the amount of greenhouse gases produced by the school.	Science Maths	
Analyse data. Graph energy usage over a one year period. Which months have the highest energy use?	Science Maths	
Survey the school community to ascertain knowledge and attitudes to energy use	HSIE	
Develop a School Energy Management Plan	HSIE, Science, Maths	
Communicate Plan to the school Community	English HSIE Creative Arts	
Implement Energy Plan	School Community	

Air conditioners are big users of energy

Some simple things you can do to save energy when using an air conditioner:

- Close doors and windows whenever heaters or air conditioners are running to keep winter heat in, and summer heat out.

- Set the thermostat at the lowest comfortable temperature in winter (eg 17°C) and the highest in summer (eg 27°C) and dress for the season. A change of one degree can reduce heating and cooling greenhouse gas emissions by 10-20 per cent. (Remember the humidity indoors will be low, so it will feel cooler). The temperature should be checked after the air conditioner has been operating for 30 minutes.

- If the machine has adjustable louvres, adjust them towards the ceiling when cooling, and towards the floor when heating (as cool air falls, hot air rises).

- Follow the manufacturer's instructions for filter cleaning.

- Ensure heaters and air conditioners are switched off when not required. Timers can be installed and programmed to automatically switch them off towards the end of the school day.

- Install air conditioner (or outdoor unit of a split system) on the shady side of the building (or shade the air conditioner itself making sure the air flow around it isn't obstructed)

- Turn off gas heaters and boiler pilot lights over summer and on holidays.

- Avoid direct sun through windows in summer. External shading is more effective than internal blinds for keeping the heat out. Plant trees to provide summer shading of classroom.

- Ceiling insulation can reduce heating and cooling costs by up to 30%.

- Ceiling fans use much less energy than air conditioners.

- Minimise the use of electric heaters such as bar radiators, oil column heaters or fan heaters. Gas heaters or reverse cycle air conditioners are more efficient.

LINKS:

http://www.curriculumsupport.education.nsw.gov.au/env_ed/teaching/focus/energy.htm
https://detwww.det.nsw.edu.au/procurement/products/electricity/index.htm
http://www.curriculumsupport.education.nsw.gov.au/env_ed/teaching/focus/transport.htm