Energy Saving Kit for Schools

A manual for school energy saving and greenhouse gas reduction project leaders

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Introduction

Energy saving –
what's in it for your school?

By using this Energy Saving Kit your school can reduce its energy consumption and greenhouse gas production by up to 30% each year. This could mean savings of hundreds, and in some cases, thousands of dollars for your school that can be used to fund other school programs and equipment. Plus, your school community can feel proud that it has reduced its impact on the environment.

A considerable amount of the energy presently used can be saved, with big environmental and financial benefits for individual schools. Greenhouse gases, mostly carbon dioxide, could be reduced by up to 20,000 tonnes each year. The lessons learned in saving energy can bring spin-off savings and environmental benefits at home and even workplaces in years to come.

The following are some examples of how your school may spend its savings:

Further energy reduction equipment:

Installation of electric timers, light sensors and/or solar panels.

Purchase of energy efficient appliances. For example – compact fluorescent lamps, off peak hot water system and/or solar hot water systems.

Curriculum development:

New curriculum materials. For example – class sets of books and audiovisual resources.

Others:

Purchase of computers, printers and software. Improvements to your school grounds.

What this Kit is about

The Kit is a practical resource designed to be used by the School's Energy Management Team. As a result of working through the **Actions** outlined, the Team will develop a School Energy Management Policy, assess their school's current energy consumption, develop a strategy for implementing the policy and present the results to the School Administration. By itself, this manual is not enough to guarantee energy savings. Enthusiasm, support and involvement of the school community is essential.

How to use this Kit and the associated DVD

The Kit consists of 9 **Actions**, each targeting a specific aspect of energy management. Much can be achieved by concentrating on one or two of the **Actions**. However, it is best to work through the package in a step-by-step manner to develop a coordinated strategy that will provide lasting results and continuous improvement.

The DVD component of the package is in two parts:

(Part 1) a motivational video presentation that introduces the importance of energy saving; and
(Part 2) a practical guide designed for use with the **Actions** in this manual.

The DVD is available from Western Power, telephone 9326 6012 or e-mail energyeducation@westernpower.com.au

General Advice:

Appoint an Energy Management Coordinator and assemble your Project Team.

Seek administrative, teacher and School Administration support for implementing an energy management policy.

Develop an Energy Management Policy.

Try to focus on solutions and results early in the process to maintain motivation. This is best achieved by completing an Energy Audit and determining your current energy consumption patterns. A baseline can then be created from which to work and enable you to measure whether your energy policy goals are being achieved.

Skim read the early Actions to gain an overall understanding.

Each Project Team should have a clearly defined, easily achievable role.

Different Teams may specialise in certain areas of energy use.

Each year, one major area of energy use should be targeted.

Remember that energy saving technologies are evolving rapidly. Ongoing reviews will provide opportunities to introduce energy saving technologies that may not have been economical or practical earlier.

Action checklist

Use this sheet to record actions in progress or completed.

Action No.	Sheet Number	Student/ Group	Date Started	Date Completed
1	1 2 3			
2	1 2 3 4			
3	5 6 7 8 9			
4	10			
5	11.1 11.2 11.3 12 13			
6	14 15			
7	16			
8	17			
9	18			

The benefits

General benefits can include:

Financial savings.

Environmental improvement.

Improved comfort and amenities.

Learning new skills.

Development of new relationships within and beyond the school.

Setting up a practical model of teaching by example.

Experience in practical problem solving.

Form part of the school curriculum.

Potential to apply the experiences outside the school.

Opportunities to learn about new energy-related technologies.

Recognition that saving energy does not have a negative impact on working and studying conditions.

Recognition that the use of electricity generated from fossil fuels is connected to greenhouse gas production and global warming.

Foster school pride in improved environmental performance.

Flow on effects to the wider community.

Access to additional funding.

Administrative benefits can include:

Proper recording of energy use and costs through the establishment of an energy database that allows for collection, monitoring and reporting of all data concerning energy consumption, energy costs, energy savings and key performance indicators.

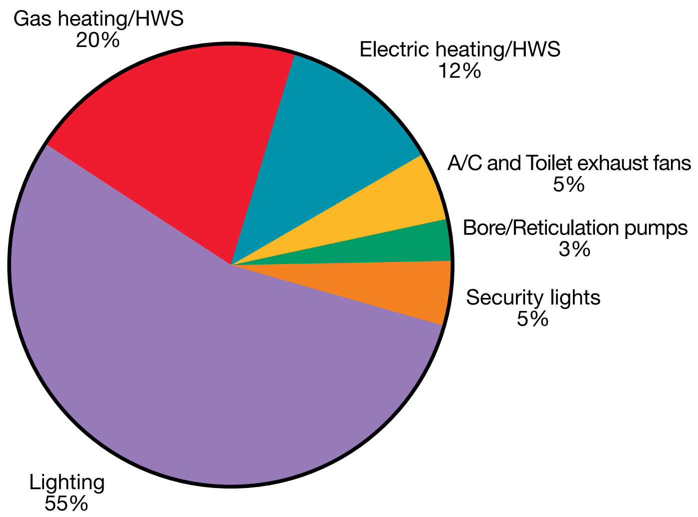
Auditing of school equipment, its use and its whereabouts.

Generating additional funds for school programs.

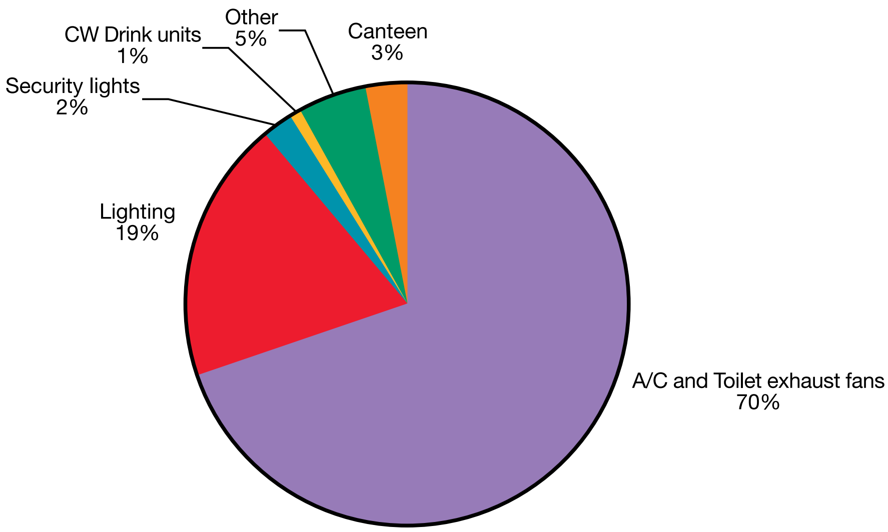
Additional funding opportunities for energy conservation or greenhouse gas reduction initiatives may be identified.

How energy is used in typical schools

South West of Western Australia



North West of Western Australia



Examples of savings

The following examples are from detailed Energy Audits of metropolitan and country schools.

School 1

Discovered that they could save $3,600 annually and reduce their CO_2 emissions by 34 tonnes per year by:

- Purchasing a more efficient pump for the school swimming pool and reviewing the operating times for the filtration system.
- Installing occupation sensors into the classroom lighting system and reducing the number of lights in areas where lighting was excessive.

School 2

Found that they could reduce their greenhouse gas emissions by nearly 14 tonnes and save $2,600 annually by:

- Installing occupancy sensors in the classrooms and staff rooms.
- Reducing the lighting in the library and enabling the power management system on all Energy Star compliant computing and office equipment.

School 3

Found that they could reduce their greenhouse gas emissions by about 12 tonnes and save up to $5,000 annually by:

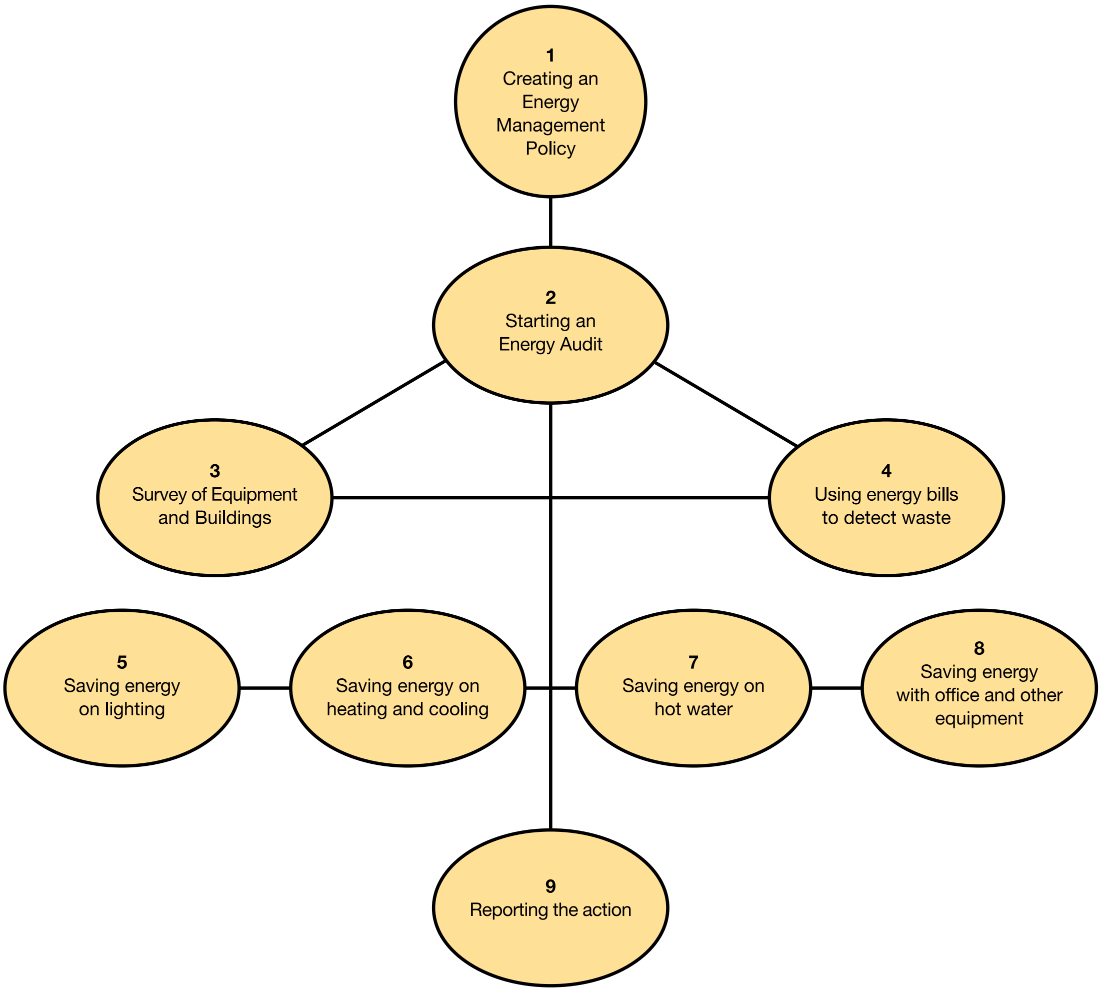
- Switching from electricity tariff L1 to R1.
- Installing occupancy sensors in the classrooms and staff rooms.
- Reducing lighting in the library and enabling the power management system on all Energy Star compliant computers and office equipment.
- Running the kiln in the art classroom on a timer.

School 4

Found that they could reduce greenhouse gas emissions by 20 tonnes and make an estimated saving of $7,000 annually by:

- Installing occupancy sensors in the classrooms and library.
- Enabling the power management system on all Energy Star compliant computers and office equipment.
- Installing pneumatic timer switches in storerooms and toilets.

Structure of the kit



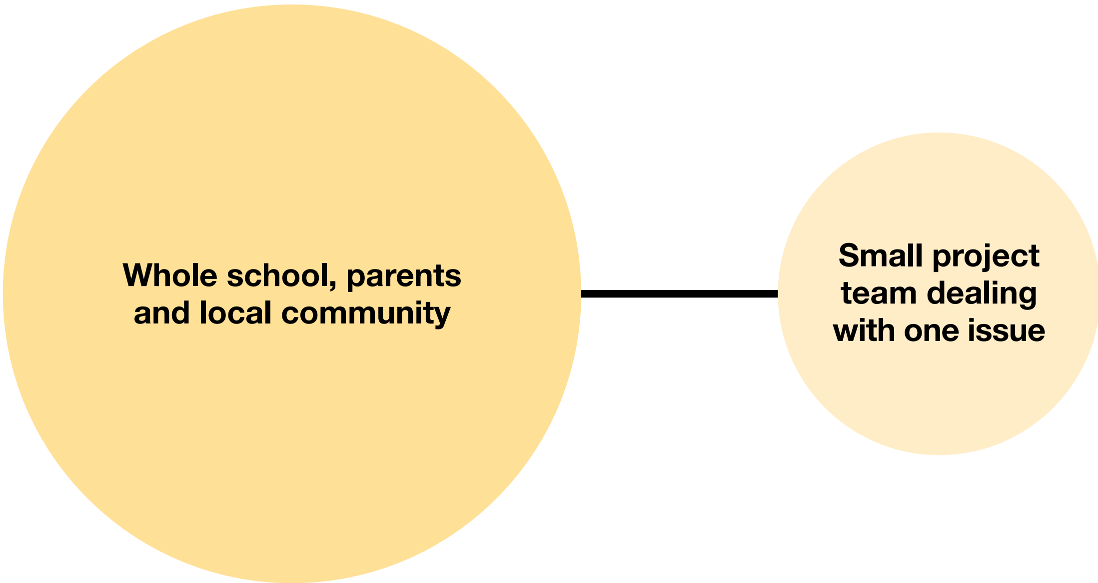
Action 1 discusses and provides a framework for the development of an Energy Management Policy. The policy establishes the school's greenhouse gas reduction and energy conservation commitments, the goals to be achieved and the time frame for their achievement. It also defines the accountabilities of the participants in the Project Team from the Principal through to the Team members.

Actions 2, 3 and 4 provide basic skills for completing an Energy Audit of the school. This will reveal how, when and where energy is used and will provide indicators as to where energy can be saved.

Actions 5, 6, 7 and 8 describe many practical ways of saving energy and therefore money.

Action 9 provides methods for reporting the results achieved.

School commitment



A broad based program is attractive if:

The Principal, teachers, students and members of the school community are involved.

The school administration is prepared to support the compilation and analysis of information.

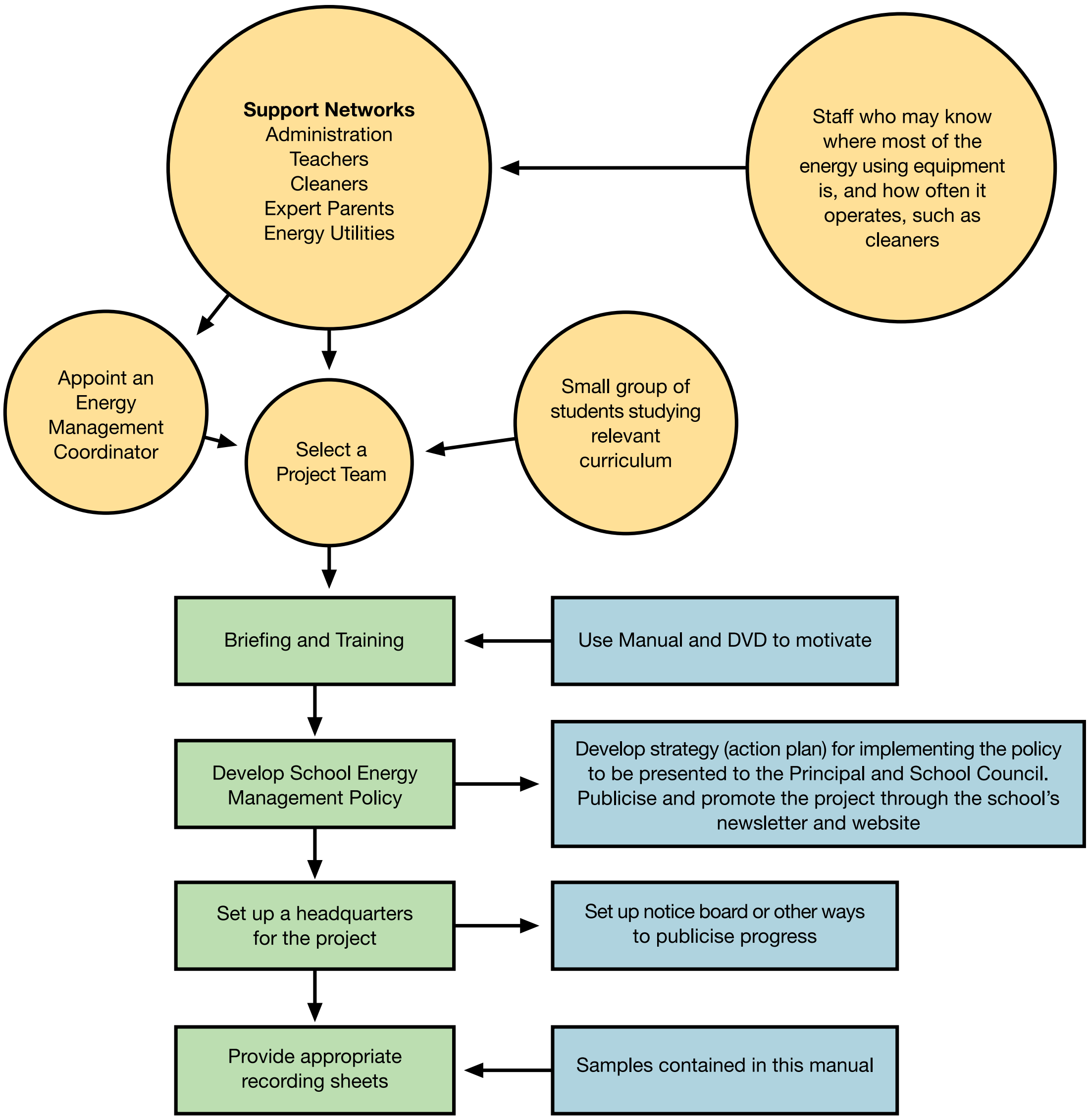
Links between school energy use, environmental issues, savings and curriculum are recognised.

Architects' and energy auditors' involvement in the design of new buildings, renovations or major equipment purchases are planned for the future.

You start small with a view to building support for a more ambitious approach.

You use the DVD to generate interest and support.

Initial Organisation



Safety Issues

Care must be taken when auditing equipment!

Students <u>must not:</u>

1. Open covers over electrical terminals and wires.
2. Switch equipment on or off, or move it.
3. Climb off floor level.
4. Enter restricted areas.

Contacts

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www.synergy.com.au

power to you HORIZON POWER

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Contributors

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Government of Western Australia

Utilities Management Program:
9264 4773
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Sustainable Energy Development Office
Government of Western Australia

Energy Smart Line: 1300 658 158
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energy

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Report to the school management

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Report to the School Management

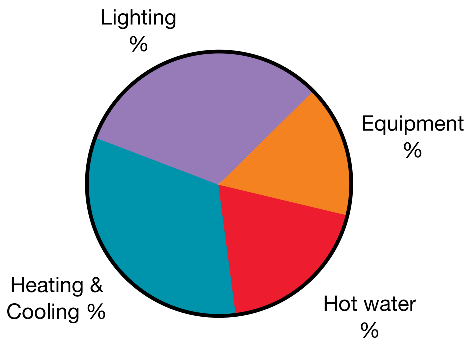
Name of School: ____________________

Project Coordinator: ____________________

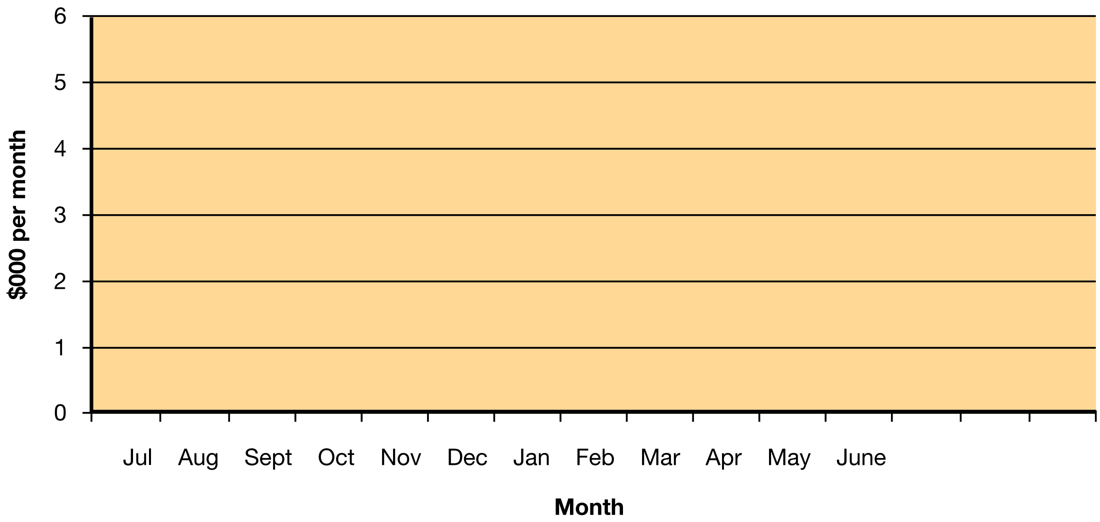
Team Members: ____________________ Date: ____________

1. Present Energy Consumption

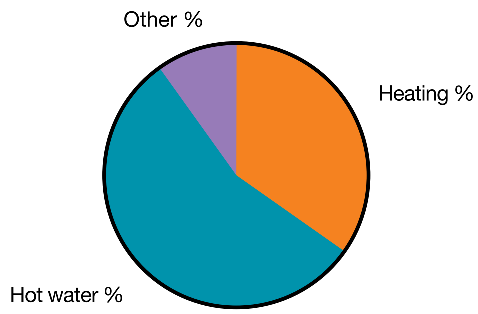
1.1. Electricity: (Information available from Sheets 5, 6, 8 and 9).



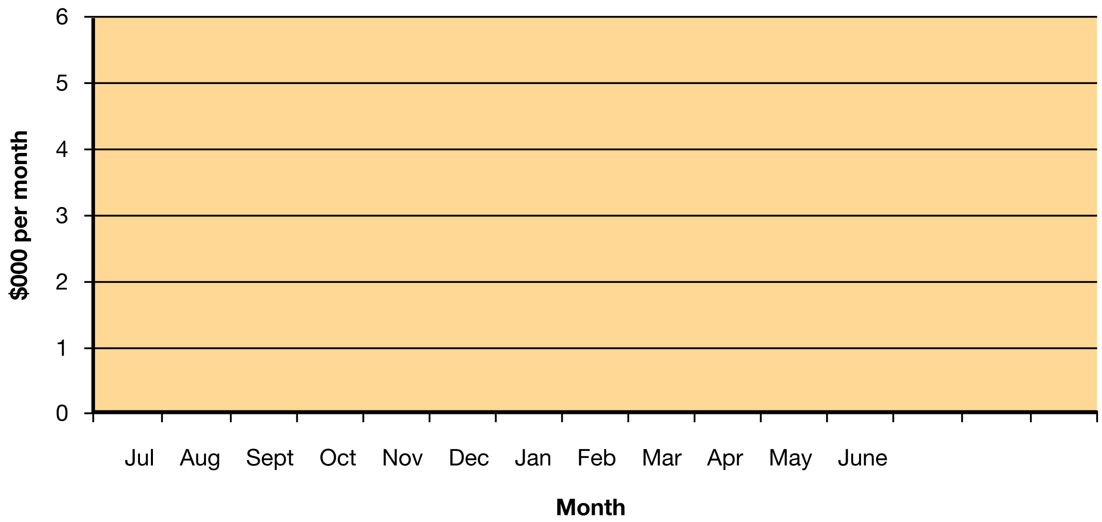
1.1.2. Cost for financial year: (Information available from Sheet 2).



Natural Gas: (Information available from Sheet 7).



1.2.2 (Information available from Sheet 3).



1.3 Present Energy Consumption: LPG and Heating Oil: (Information available from Sheet 3).

1.4 Total Energy Costs:

Fuel	Annual Cost
Electricity	
Natural gas	
LPG	
Oil	
Total	

Recommendations for Energy/Cost savings

Fuel & Use	Actions recommended	Carried out by	Cost $	Savings per year $	Payback period
ELECTRICAL: **1. Lighting**	1.1 1.2 1.3 1.4 1.5 1.6				
2. Heating	2.1 2.2 2.3				
3. Hot Water	3.1 3.2				
4. Plant and Equipment	4.1 4.2 4.3 4.4				
NATURAL GAS **1. Heating** **2. Hot Water**	1.1 1.2 2.1 2.2				
LPG **Heating Oil**					

Action 1

Creating a School Energy Management Policy

Creating a School Energy Management Policy

Why have an energy management policy?

An energy saving program will be more effective if the Energy Management Team and your school as a whole, have a clear policy directive on what is to be achieved.

- Clearly defined energy management roles and responsibilities endorsed in a policy statement by the School Administration will help ensure that a uniform commitment and operational priority is given to minimising energy consumption.
- An official written energy policy has the dual effect of publicly demonstrating your school's commitment and providing a working document to guide energy management practices through periods of staff changes and reallocation of duties.

How do we design a policy?

When developing your Energy Management Policy there are many issues to consider. Saving energy should not be pursued without regard for the effects that it may have on other aspects of your school such as staff morale, productivity and health and safety issues. Your Energy Management Policy should be developed in such a way that it enhances and protects your school's primary function.

A cohesive approach to energy management can lead to additional gains for your school as energy efficiency initiatives implemented in one area may also have a positive impact in other aspects of the school.

A comprehensive policy would include the following key sections:

- Introduction and purpose of the Energy Management Policy.
- An action plan that includes a commitment to examine procurement policy along with a timetable of planned energy saving initiatives. This could include procuring an energy assessment. The plan would include the resource requirements (including staffing levels, capital expenditure and training needs) necessary to successfully implement the program.
- Designated responsibility and accountability for the program.
- Review procedures for the program.

An example of an Energy Management Policy

Introduction:

In keeping with our school's policy of continuous improvement, **<Your School's Name>** is committed to responsible energy management and will practice energy efficiency throughout all our premises, plant and equipment wherever it is cost effective to do so.

(Your school's name) will focus on achieving the objectives of this policy statement through the implementation of energy management projects that minimise the economic burden on the school through the adoption of efficient environmental and financial management strategies.

Purpose:

This policy signifies ***(your school's name)*** commitment to control the level of energy consumed in the provision and delivery of its services by realising ongoing savings in our energy operating budgets and to quantify and publicly report on those savings and the consequent abatement of greenhouse gas emissions.

Objectives:

(Your school's name)'s long term objectives are:

- To reduce dependence on fossil fuels by at least 12% by June 2007 through energy conservation and efficiency practices.
- To reduce expenditure on energy by investing in cost-effective plant and equipment upgrades that have a simple payback return on investment of 5 years or less.
- To reduce pollution, particularly CO_2 emissions, by exploring options to obtain energy from less greenhouse intensive sources.
- To buy energy at the most environmentally, socially and economically sustainable cost.

Action Plan:

An Energy Management Team will be established at ***(your school's name)*** to identify and drive energy efficiency initiatives and to provide an integrated school-wide response to energy management. The Team will be responsible for the identification and implementation of energy efficiency practices and projects through an Action Plan.

The Action Plan will include details of the energy management activities that will be developed and undertaken by ***(your school's name)*** during the year. Key activities contained in the Action Plan are:

- Development of an internal communications strategy to raise staff awareness of energy use.
- Establishing an energy database that allows for the collection, monitoring and reporting of all data on energy consumption, energy costs, energy savings and key performance indicators.
- Developing an energy efficient purchasing policy for office equipment, office accommodation and for energy sources.

- Formulating a program of energy efficient upgrades including costs and timing of all work over a two year period.

Accountability and Structure:

While the Principal/Registrar will have ultimate responsibility for energy management the formulation and implementation of the Energy Management Policy will be delegated to the Energy Management Team. The Principal/Registrar will appoint an Energy Executive who will also chair the Energy Management Team. The Team will comprise of committed representatives from each of the student body, administrative staff, teaching staff and maintenance staff of ***(your school's name)*** and the Energy Executive will manage its activities.

The Energy Management Team will report to the Principal/Registrar on a bimonthly basis on the energy performance of ***(your school's name)***. This Report will include details of energy consumption, key performance indicators and progress on energy management activities initiated by ***(your school's name)***.

All staff and students have a responsibility for energy management since they all use energy. All staff should report wasteful activities and have an obligation to ensure energy consumption in their area is minimised.

Resources:

The number of staff and contractors employed in energy management will depend on what is required to complete the actions listed in the Action Plan. The Energy Executive is expected to seek out funding opportunities available to achieve the Policy objectives.

Review:

Energy management activities will be subject to ongoing review. The Energy Management Team will review the Policy and Action Plan on a regular basis and present recommendations for changes to the Principal/Registrar for their consideration.

An Annual Report on energy use will be prepared by the Energy Management Team for presentation to the Principal/Registrar. The Energy Use Annual Report will also be circulated to all staff and students and a summary included in ***(your school's name)'s*** Annual Report.

Principal

(Your school's name)

Date

(Adapted from a policy sample available at the Government of Western Australia's Sustainable Energy Development Office website: www.sedo.energy.wa.gov.au)

Action 2

Starting an Energy Audit

Starting an Energy Audit

Setting Up An On-Going Recording System:

It is vital to the effective implementation of an energy saving program that past patterns of energy use, both daily and annual, are known and understood. As well as providing a bench mark against which to measure energy saving it also provides an insight into areas where your school can go to work on saving energy. It is essential to systematically track on-going energy usage and cost so that you can measure and display the effectiveness of your energy saving program over time.

- Arrange for energy utilities to provide energy usage information over the past two-year period.
- Negotiate with your School Registrar or Office Manager to have copies made of all energy bills when they arrive and create a separate file for them.
- Arrange for a member of the Energy Management Team to draw graphs of consumption versus months and publicise the results.

Money And Energy Saving Opportunities:

Through your analysis of the school's energy costs and tariffs you may discover the following possibilities for savings:

- Change tariffs. This only applies to electricity.
- Switch from high cost fuels to cheaper alternatives. For example – heating oil to gas.
- Question unexpected levels of energy use over holiday periods, evenings and weekends.

Each of these possibilities may involve practical problems or changeover costs so careful analysis is required.

Be energy conscious. Do not assume that because a fuel is cheaper it can be used continuously. This can lead to increases in energy consumption, cost and greenhouse gas emissions.

Recording Energy Bills:

- Record details of fuels used, account numbers, contacts at energy utilities and fuel suppliers. (See Sheet 1).
- Record details of energy usage over the last two years as shown on bills for each fuel and for each meter. (See Sheets 2, 3 and 4).
- Calculate and draw bar graphs of energy use and cost per day, for billing periods recorded.

Explaining Energy Units:

UNIT OF ENERGY = **JOULE (J)** UNIT OF POWER = **WATT (W)**

1 WATT = 1 J/sec.

Electricity is sold in Units. One Unit of electricity is one kilowatt hour (kWh).

1 kilowatt hour = 1000 watts x 1 hour

= 1000 joule/sec x 3600 sec = 3,600,000 joule = **3.6 Megajoule (MJ)**

Some older electric motors may have their power rating stated in Horsepower (HP) instead of Watts. For conversion: **1 HP = 746 Watts**

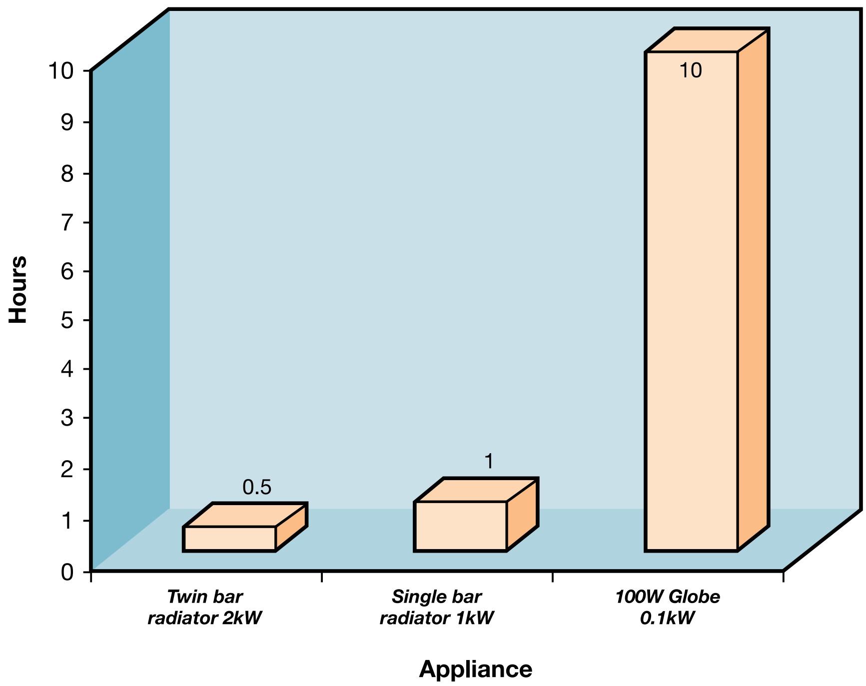


Figure 1. Time taken to use 1kWh of energy for 3 different appliances.

Natural Gas is also sold in Units. 1 Unit = 3.6 Megajoule (MJ) of natural gas. The power rating of a gas appliance is stated in Megajoules per hour (MJ/h).

Liquified Petroleum Gas (LPG) is normally sold by the litre (L). The power rating of LPG appliances is stated in Megajoules per hour. 1 litre of LPG produces about 26 Megajoules of energy.

Energy Tariffs:

In the energy industry the term **tariff** is used to denote the price paid by the customer.

The cost of energy varies according to the quantity purchased.

Electricity Tariffs:

Schools are most likely to use tariffs **L1** or **R1** in the Metropolitan area and South West and **L2** in the Pilbara and Regional Areas. Some very large schools may be on **S1** and should seek tariff advice from Synergy Energy by calling 131354.

In Regional areas and the Pilbara the cost of electricity supply is much higher than for the Metropolitan area and South West of the state. Consequently no alternative tariffs are currently available to schools in these regions and only tariff **L2** applies.

Supply Charge: This is the basic fixed charge regardless of the amount of energy consumed and is given in cents per day.

First Tariff Block: This is the cost per kWh of energy used per day up to the stated limit.

Balance: This is the cost per kWh of energy used per day above the stated limit.

2009 Tariffs for Horizon Power.

REGIONAL AREAS L2: This is a tariff applicable to schools and other government instrumentalities in remote country regions and charged at the same rate as L1.

PILBARA L2: This is a tariff applicable to schools and other Government instrumentalities connected to the North West Interconnected System (NWIS) and charged at the same rate as L1.

2009 Tariffs for Synergy Energy.

SOUTH WEST OF WESTERN AUSTRALIA: Available to any customer on the southwest interconnected system (SWIS) using supply at low voltage (240/415 volts), including business, commercial and industrial customers.

L1: Generally suitable for customers with little or no overnight or weekend usage.

kWh	Cents/kWh
First 1650 units per day	20.16
More than 1650 units per day	18.19

Supply Charge: 30.68c/day

R1: This is suitable for customers using more than 80 kWh/day with 20% or more consumption in off peak hours (peak hours are 8am-10pm weekdays).

kWh	Cents/kWh
Peak energy (8am-10pm Mon-Fri)	22.08
Off peak periods (all other times)	6.81

Supply Charge: $1.26/day

Evaluation of Benefits of Shifting from Synergy Energy's Tariff L1 to Tariff R1 For Electricity.

Consider a school with a 60 day electricity consumption of 24,000 kWh of which 4,000 kWh is off peak (overnight and weekend electricity use).

Cost of (C1) **Tariff R1** for 60 days (see Table 1)

C1	=	Supply charge	+	Peak Cost	+	Off peak cost
	=	*60 x $1:26*	+	*(0.2208x 20,000)*	+	*(0.0681 x 4,000)*
	=	*$75.60*	+	*$4,416.00*	+	*$272.40*
	=	*$4,764.00*				

Cost (C2) of **Tariff L1** for 60 days

C2	=	Supply charge	+	First block
	=	*60 x 0.3068*	+	*(0.2016 x 24,000)*
	=	*$18.41*	+	*$4,838.80*
	=	*$4,856.81*		

The school would be slightly better off for this billing period, on **Tariff R1**.

However, other factors need to be considered including:

- Daily consumption varies over the year. During periods of lower consumption (for example – summer holidays) **Tariff L1** could be cheaper.
- Energy saving strategies may reduce daytime usage making **Tariff R1** more attractive.

To do a thorough comparison, electricity consumption figures for at least one complete year will need to be analysed.

Procedure for Comparing R1 and L1 Tariff Charges in the South-West of Western Australia:

Step 1 Complete the energy consumption time of use assessment sheet on page 7 for a seven day period by reading your meter at 8.00am and 10.00pm Monday to Friday, and at 8.00am on the following Monday. An average value can then be calculated. **Meter reading assistance is provided on page 3 of Action 4.**

Step 2 Compare the R1 tariff cost with your current L1 tariff cost, using the Tariff Daily Cost Calculator on page 8 to determine if you save by converting to the R1 tariff.

Step 3 If you have identified that you would benefit by changing to the R1 tariff, please contact Synergy Energy on 131354.

Step 1: Energy Consumption time of use assessment sheet for 7-day test period.

Meter Readings	8.00am	10.00pm	Calculations: Peak	Calculations: Off Peak
Monday	............(1)	............(2)	............(2 - 1)	
Tuesday	............(3)	............(4)	............(4 - 3)	............(3 - 2)
Wednesday	............(5)	............(6)	............(6 - 5)	............(5 - 4)
Thursday	............(7)	............(8)	............(8 - 7)	............(7 - 6)
Friday	............(9)	............(10)	............(10 - 9)	............(9 - 8)
Saturday / Sunday	No readings necessary as Saturday and Sunday **all** off peak.			............(11 - 10)
Monday	............(11)			
			............(12) **Total Peak**	............(13) **Total Off Peak**

Total **Peak** consumption	**(12)** Total values in Peak column
Total **Off Peak** consumption	**(13)** Total values in Off Peak column
Total **Consumption (12 plus 13)**	**(14)** Total of Peak and Off Peak columns

NOTE: *(14)* ***MUST*** *equal (11) - (1). If not, you have made a meter reading error and* ***MUST*** *repeat the readings. If you cannot read the meter at 10.00pm, then read it as late as possible during the day and estimate the consumption from then to 10.00pm. Ensure that the 7-day test period is typical of your normal pattern of electricity use.*

Average **Daily** consumption = **(14)** divide by 7 days = ...units/day **(15)**

Percentage **Off Peak** consumption **(13)** divide by **(14)** x 100%
= ....% Off Peak **(16)**

(Rule of Thumb: Minimum 20-30% of total consumption needed in off peak to make savings)

Tariff Daily Cost Calculator (Based on 2009 Electricity prices).

Average Daily Consum-ption (kWh/day) **(15)**	**R1 Tariff Cost ($/day)** Off Peak Usage (Percent) **(16)**							**Current Tariff Cost** ($/day)
	20%	25%	30%	40%	50%	60%	70%	
30	$6.97	$6.74	$6.51	$6.05	$5.59	$5.14	$4.68	$6.35
40	$8.87	$8.57	$8.26	$7.65	$7.04	$6.43	$5.82	$8.37
50	$10.77	$10.39	$10.01	$9.25	$8.48	$7.72	$6.96	$10.39
60	$12.68	$12.22	$11.76	$10.84	$9.93	$9.01	$8.09	$12.40
70	$14.58	$14.04	$13.51	$12.44	$11.37	$10.30	$9.23	$14.42
80	$16.48	$15.87	$15.26	$14.04	$12.82	$11.59	$10.37	$16.43
90	$18.38	$17.70	$17.01	$15.63	$14.26	$12.89	$11.51	$18.45
100	$20.29	$19.52	$18.76	$17.23	$15.71	$14.18	$12.65	$20.47
125	$25.04	$24.09	$23.13	$21.23	$19.32	$17.41	$15.50	$25.51
150	$29.80	$28.65	$27.51	$25.22	$22.93	$20.64	$18.35	$30.55
175	$34.56	$33.22	$31.88	$29.21	$26.54	$23.87	$21.19	$35.59
200	$39.31	$37.79	$36.26	$33.20	$30.15	$27.10	$24.04	$40.63
225	$44.07	$42.35	$40.63	$37.20	$33.76	$30.33	$26.89	$45.67
250	$48.83	$46.92	$45.01	$41.19	$37.37	$33.56	$29.74	$50.71
300	$58.34	$56.05	$53.76	$49.18	$44.60	$40.01	$35.43	$60.79
400	$77.36	$74.31	$71.26	$65.15	$59.04	$52.93	$46.82	$80.95
500	$96.39	$92.57	$88.76	$81.12	$73.49	$65.85	$58.22	$101.11
600	$115.42	$110.84	$106.25	$97.09	$87.93	$78.77	$69.61	$121.27
700	$134.44	$129.10	$123.75	$113.06	$102.38	$91.69	$81.00	$141.43
800	$153.47	$147.36	$141.25	$129.04	$116.82	$104.60	$92.39	$161.59
900	$172.49	$165.62	$158.75	$145.01	$131.27	$117.52	$103.78	$181.75
1000	$191.52	$183.89	$176.25	$160.98	$145.71	$130.44	$115.17	$201.91
1100	$210.55	$202.15	$193.75	$176.95	$160.16	$143.36	$126.56	$222.07
1200	$229.57	$220.41	$211.25	$192.92	$174.60	$156.28	$137.95	$242.23
1300	$248.60	$238.67	$228.75	$208.90	$189.05	$169.19	$149.34	$262.39
1400	$267.62	$256.94	$246.25	$224.87	$203.49	$182.11	$160.73	$282.55
1500	$286.65	$275.20	$263.75	$240.84	$217.94	$195.03	$172.13	$302.71

Example Comparison

L1 Tariff

Average daily consumption = 700 kWh/day from **(15)** page 7.

off peak usage = 30% from **(16)** page 7.

From the Tariff Daily Cost Calculator above:

Average daily consumption column, 250kWh/day row and L1 column intersection gives:

L1 daily cost = $122.50 (17)

R1 Tariff

Average daily consumption column, 700kWh/day row and R1 30% off peak Usage column intersection gives:

R1 daily cost = $107.22 (18)

R1 tariff average daily savings

[(17) -(18)]= $15.28 **(19)**

Approximate annual savings

[365 x **(19)**]=$5,577.20/year **(20)**

Step 2: Now calculate your own comparison.

Go to the Daily Cost Calculator on page 8. Using the average daily consumption **(15)** and % off peak usage **(16)** to determine R1 cost, compare with the present L1 tariff cost.

Comparison of R1 and L1 Annual cost		
Daily Cost for L1 Tariff	= $	**(17)**
Daily Cost for R1 Tariff	= $	**(18)**
R1 Tariff:		
Average Daily Savings [(17) - (18)(	= $	**(19)**
Annual Savings [(19) x 365	= $	**(20)**

- If tariff savings are positive, the R1 tariff results in lower/cheaper electricity costs. If the tariff savings are negative, the R1 tariff is more expensive and results in higher electricity costs.
- This comparison is based upon your current method of operation. You may be able to identify activities that can be transferred to the off peak period, providing greater savings.
- Be careful to allow for a different pattern of electricity usage during school holidays. You may wish to take readings for a week of school holidays.

Step 3: Contact Synergy Energy.

If you are in the south west of Western Australia and you would like to request a change from your present tariff to the R1 tariff please contact Synergy Energy on 131354.

If your L1 tariff daily cost exceeds $250 (**17** above) and the R1 tariff offers lower charges you may wish to consider the more complex time based demand and energy tariff S1 which also provides low off peak energy rates.

Green Energy:

There are three types of Green Energy being offered by Synergy Energy.

- **NaturalPower.** This is electricity generated from 100% renewable sources such as the wind and sun and is fully accredited by the national Green Power program.

  Little or no greenhouse emissions are produced in NaturalPower generation.
- **Earth Friendly.** This power is generated in the traditional way, but emissions are counterbalanced by greenhouse gas reduction projects approved by the Australian Greenhouse Office.
- **Easy Green.** This energy is sourced from renewable sources but you pay what you can afford by choosing a fixed dollar contribution for your bill.

Natural Gas and LPG Tariffs:

Consult bills received or contact your supplier for details of costs.

Team Activities:

- Ask students to mark on school energy graphs important changes such as holiday periods, record hot or cold spells, the opening of new buildings, extended operating hours, etc. Can they find any links between these and the energy use? If so, why? If not, why not?
- Students can graph the amount the school pays for electricity and gas as consumption increases. They should repeat the exercise using residential tariffs and observe the differences.
- Students could set up a computer program or graph that calculates energy costs based on different tariffs for different energy usage patterns.

Energy Advantage:

This is a service designed by Synergy Energy to assist small to medium businesses and organisations in reducing energy usage.

For a fee, the customer receives a standard 2 hour energy review of their premise. Should a more detailed review be required the customer will be charged accordingly. The energy reviews will be completed in-house by experienced Synergy Energy consultants who have been trained in air conditioning, refrigeration and energy efficiency in buildings. To find out more information please call your Synergy Energy account manager **or e-mail info@synergyenergy.com.au**

Energy Management Information:

A considerable amount of energy management information is available on the Synergy Energy and Horizon Power websites. It is relevant, easy to understand and covers many topics related to small and medium sized businesses.
See **www.synergyenergy.com.au** or **www.horizonpower.com.au**

School's energy history — Sheet 1

School name: ______________________________

Address: ______________________________

____

Date: ____________ Phone: ____________ Fax: ____________

Program coordinator: ______________________ Number of students: ________

Account Number	Supplier Contact	
	Phone	Name
Electricity (i)		
(ii)		
(iii)		
(iv)		
Gas (i)		
(ii)		
(iii)		
(iv)		
LPG (i)		
(ii)		
Other (i)		
(ii)		

Note 1. The school Registrar or Office Manager should have a record of past energy bills.

Note 2. Mark on a plan of the school, the location of meters, tanks and other outdoor energy consumers. Attach it to this document. (See Action 3 for example of school plan)

Review each year

School's energy history — Sheet 2

Electricity

Meter	Meter No.	Tariff	Account No.	Location
(i)				
(ii)				
(iii)				
(iv)				

Meter (1) Example: **Year:** ______

Months	**Feb-Apr**				**Total**
Billing Days	100				
KWh used	36,000				
KWh per day	360				
Total Cost ($)	6,400				
Cost per day ($)	64				

Meter (2) Example: **Year:** ______

Months	**Feb-Apr**				**Total**
Billing Days	100				
KWh used	44,000				
KWh per day	440				
Total Cost ($)	7,600				
Cost per day ($)	76				

Example:

Total actual electricity consumption (If you have more than one electricity meter)					**Total**
Billing Days	100				
KWh used	80,000				
KWh per day	800				
Total Cost ($)	14,000				
Cost per day ($)	140				

▲ Transfer these figures to Sheet 9

Notes: ______

School's energy history — Sheet 3

Gas

Meter	Meter No.	Tariff	Account No.	Location
(i)				
(ii)				
(iii)				
(iv)				

Meter (1) **Year:** ______

Months						Total
Billing Days						
MJ used						
MJ per day						
Total Cost ($)						
Cost per day ($)						

Meter (2) **Year:** ______

Months						Total
Billing Days						
MJ used						
MJ per day						
Total Cost ($)						
Cost per day ($)						

Note: Gas meters read in cubic metres of gas, which is converted to Megajoules (MJ). In Western Australia one cubic metre of natural gas averages 38.5 MJ.

Total actual gas consumption (If you have more than one gas meter)						Total
Billing Days						
MJ used						
MJ per day						
Total Cost ($)						
Cost per day ($)						

▲ Transfer these figures to Sheet 9

Notes: ______

School's energy history — Sheet 4

LPG

Year: ____________

Months						Total
Billing Days						
KWh used						
KWh per day						
Total Cost ($)						
Cost per day ($)						

Note: LPG can be recorded in MJ by multiplying litres by 26.

Notes:

Action 3

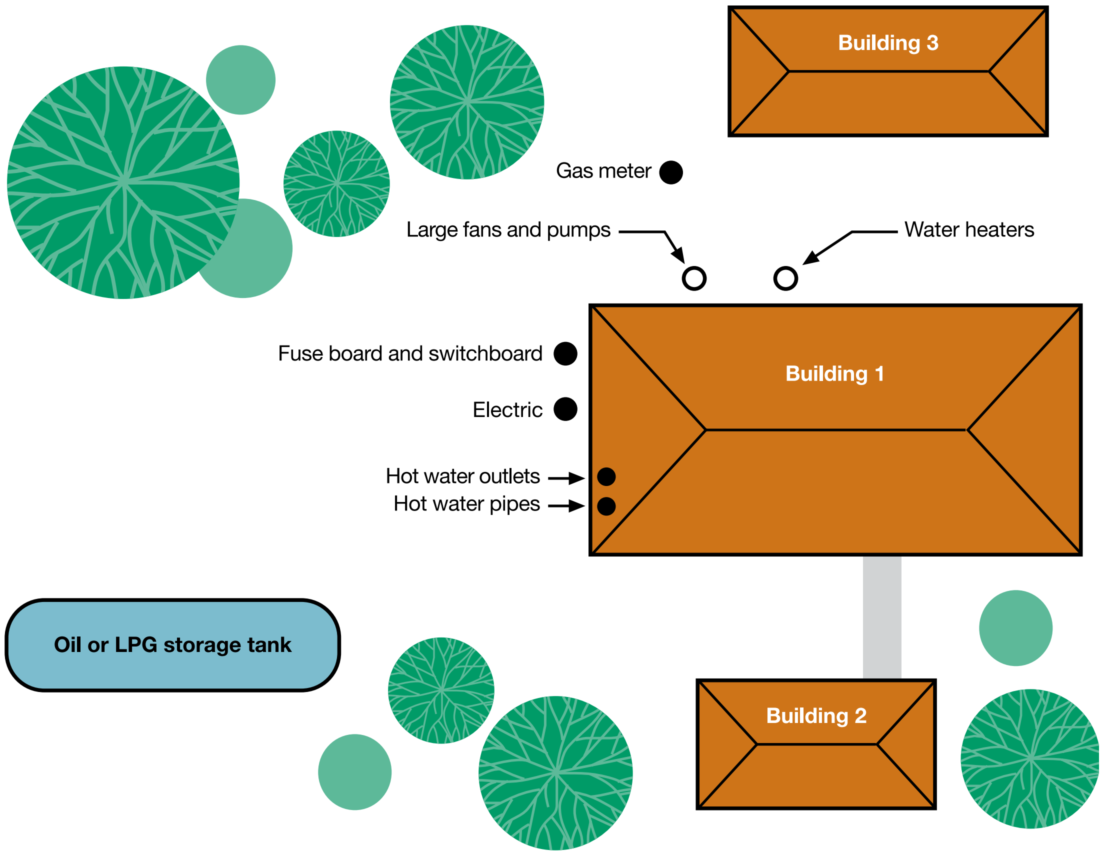
Survey of Equipment and Buildings

Action 3

Survey of Equipment and Buildings

School Plan:

Make a copy of the School Plan.



Lighting:

Lighting is usually the biggest energy cost in a south-west school and the second biggest in a north-west school. Amazing really, given that most school activities occur during daylight hours.

Analysis of lighting use can be divided into:

- Classrooms (general lighting and specific task lighting).
- Corridors and passageways.
- Special purpose areas such as the library, workshops, gymnasium, canteen and administration block.
- Toilets and changing rooms.
- Indoor and outdoor security lighting.

Classroom Lighting:

Sheet 5 should be completed for all locations in the school. Alternatively if this is not practical, choose a typical classroom and multiply by the number of similar classrooms in the school.

Record the:

- number of lamps.
- type of lamps (incandescent or fluorescent).
- size of lamps (number of watts).

Estimate the daily hours of usage:

- Visit the rooms - before school.
  - during morning classes.
  - at recesses and lunchtimes.
  - during afternoon classes.
  - after school.
  - night time.
- Check the school's timetable to see if rooms are used at night.
- Ask the cleaner how long lights are on during cleaning.
- Try to take into account weather conditions on the day of the survey; on a dull day, lighting use will be above average, and on a bright day, below average.

Lighting In Other Areas:

Repeat the approach used for classrooms for all areas where lighting is used.

Power Ratings of Lights:

Incandescent Lamps	
240 volt GLS clear and pearl	15 to 1000 Watt
Par 38 flood or spotlight	60 to 150 Watt
Wattage is normally marked on the globe.	

Fluorescent Lamps and Tubes		
Compact	10, 13 and 21 Watt	
Tubes (add 10 watts for ballast)	38 mm Conventional	26 mm Powersaver
600 mm (length)	20 Watt	18 Watt
1200 mm	40 Watt	30 Watt
1500 mm	65 Watt	58 Watt
1800 mm	75 Watt	
2400 mm	100 and 125 Watt	
Tri-phosphor		18 to 58 Watt
Miniature Tubes	26 mm - 10 and 15 Watt	16 mm - 4, 6, 8 and 13 Watt

Space Heating And Hot Water:

In most schools, almost all energy for space heating and hot water is provided by Natural Gas, LPG or Distillate. Bills for these fuels provide a good indication of energy use.

Electrical heating and electric hot water usage should be recorded on **Sheet 6**.

These include:

- Wall mounted electric hot water units (usually in staff rooms).
- Small electric hot water systems (often located in cupboards).
- Electric fan heaters and radiators (small offices). Hourly energy use varies depending on the input wattage. Ask the people who use them to estimate how many hours per day they are used.
- Distillate, Natural Gas or LPG heating usage can be recorded on **Sheet 7**.

Cooling:

Refrigerative air conditioners and evaporative (water) cooling systems range in size from small room air conditioners (up to 2.4 kW) to large ducted systems of around 8 kW. Cooling usage can be recorded on **Sheet 6**. Ensure that the electrical rating (kW) is used and not the thermal (cooling) rating.

Other Equipment:

Energy use can be recorded on **Sheet 8**. The lists below contain examples of typical energy use of different pieces of equipment.

Appliance nameplates can also be used to work out energy consumption (see page 7).

The Canteen	kWh per annum
Two door refrigerator (domestic)	900*
One door refrigerator (domestic)	650*
Large freezer (domestic)	700*
Two door display refrigerator	2000*
Plug-in pie warmer (3 hours per school day)	1200
Electric stove (2 hours per school day)	450
***Annual energy consumption depends on the appliances star-rating (energy efficiency), how hot the room is, where the refrigerator is located and usage.**	

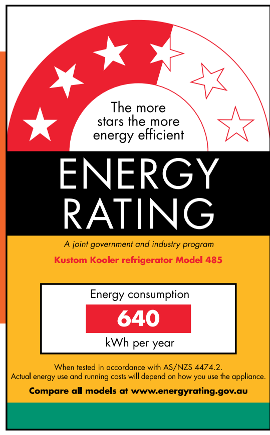
School Office or Business Studies Area	KWh per annum
Small photocopier (8 hours per school day)	250
Large photocopier (8 hours per school day)	1000
Computers with monitors (8 hours per school day)	80 - 250
Office printers (8 hours per school day)	25 - 200
Electric typewriters (8 hours per school day)	75
Phone system (internal)	500
Public address system	500
Fax	200

Computers*	Rating
IBM computer and monitor	150 Watts
Apple Macintosh	140 Watts
Printer	17 Watts
Scanner	8 Watts
***estimate time of usage per year to calculate kWh consumption**	

Library/Resource Centre*	Rating
IBM computer and monitor	150 Watts
Video-recorder	25 Watts
DVD	15 Watts
Television	135 Watts
Battery charger for video cameras operating continuously	100 Watts
Overhead, LCD/Data or slide projector	250 Watts
***estimate time of usage per year to calculate kWh consumption**	

Sports Facilities	Rating
Hand dryers	2000 Watts
Swimming pool pumps	use nameplate to estimate energy use
Workshops	
Energy use can be determined using nameplates.	

***Consult the Stars:** Energy rating labels are not only helpful when choosing energy efficient appliances for your school, but also may be helpful in providing energy consumption information for your existing appliances.



Putting The Information Together:

- Total your energy use and compare your result with that shown on the school's energy bills (see Sheet 9).
- There should be a reasonable match if you have been accurate and thorough. **If there are large differences, review your estimates or check you did not omit major areas or pieces of equipment.**
- Prepare a pie graph showing the energy used by each major activity. (Compare your graph with that shown in the Introduction).

You are now in a position to:

- Report your findings to the school community (see **Action 9**) and set priorities for energy saving actions.
- Carry out more detailed assessments of energy consumption using meter reading techniques (see **Action 4**).

Appliance Nameplates:

Using nameplate ratings provides an alternative for determining energy consumption. They give an upper limit measure of the consumption. However, please note that nameplates are fitted to equipment to ensure that supply systems are not overloaded rather than as an accurate measure of consumption.

Nameplates are found:

- On the back of an appliance.
- Underneath small appliances.

Nameplates are not located inside appliances. Do not look inside appliances as there may be dangerous bare wires.

A reasonable estimate of energy consumption can be obtained by multiplying the power rating by a factor as shown in the following table.

Energy Consumption	
Equipment	**Factor**
Electronic equipment: computers and videos	1/2
Manually controlled heaters:	
High	1
Medium	1/2
Low	1/4
Thermostatically controlled heater	1/3
Photocopiers	1/10
Boiling water units	1/10
Refrigerators	3/10
Electric motors in machinery	1/2
Welders (only while being used)	1
Lights:	
Incandescent	1
Fluorescent (Add 10 W for ballast)	1
Air conditioners - depends on location, daily cycle and hours switched on. Duty cycle = $\frac{\text{hours actually running}}{\text{hours actually switched on}} \times 100\%$	

Example: A thermostatically controlled electric heater may have a nameplate rating of 2000 watts. However, during operation the heater would cycle (i.e switch off and on) at its preset temperature. Therefore, in practice the unit may only use 2,000 watts 33% of the time. The actual energy use per hour may be only 33%> of 2,000 watts/hour which is 660 watts/hour or 0.66 kWh each hour.

Australian Building Greenhouse Rating Scheme:

The Australian Building Greenhouse Rating (ABGR) scheme provides accredited assessments of the greenhouse intensity of office buildings by awarding a star rating on a scale of one to five. A building with a high star rating will be more energy efficient and cheaper to run, and will result in lower greenhouse gas emissions. Three stars represents current market practice.

The scheme provides a national approach to benchmarking the greenhouse performance of buildings and tenancies. A higher star rated building is attractive to tenants and investors due to its lower operating costs and its enhanced greenhouse performance.

If you're a building owner/manager, tenant or developer you can use the Australian Building Greenhouse Rating Scheme to assess and demonstrate your superior greenhouse performance and environmental awareness to your employees, clients, suppliers, investors, business partners and government agencies.

The Australian Building Greenhouse Rating Scheme is administered and supported by various government agencies around Australia.

Visit the ABGR Scheme website at www.abgr.com.au for further formation.

Lighting Audit

Sheet 5

Room	Room Description	Globes / Tubes			Operating time/day (estimated hrs)	Daily Consumption (kWh)	Comments
		Number	Type	Rating (Watts)			
Eg. 10	Woodwork	2	I	100	3	0.60	Incandescent lights do not really need to be used
8	Library	12	F	40	5	2.4	
Total							Transfer this total to sheet 9

$$\text{Daily Consumption} = \frac{\text{Number x Rating x Operating time}}{1000} = \frac{2 \times 100 \times 3}{1000} = 0.60 \text{ kWh}$$

I = Incandescent F = Fluorescent H = Halide S = Sodium Vapour

Electrical Heating, Hot Water and Cooling Audit — Sheet 6

Room	Room Description	Types of Equipment	Power Rating (Watts)	Operating time per day (estimated hours)	Daily Consumption (kWh)	Comment
Eg. G5	Maths	Electric Boiling Unit	2400	7	16.8	
17A	Staff Room	Fan Heater	2400	2	4.8	
Total						Transfer this total to sheet 9

Natural Gas, LPG and Oil Heating Audit — Sheet 7

Room	Room Description	Types of Equipment	Power Rating (MJ/hr)	Operating time per day (estimated hours)	Daily Consumption (MJ)	Comment
Eg. F10	PE	Gas Hot Water Service	10	1.5	15	
Total						Transfer this total to sheet 9

Electrical - Other Equipment Audit — Sheet 8

Room	Room Description	Types of Equipment	Power Rating (Watts)	Operating time per day (estimated hours)	Daily Consumption (kWh)	Comment
Printing	Photocopier (large)	1	1440	8	11.52	In use all day
Room	Macintosh Computer Laser Printer	2 1	140 85	5 2	1,4 0.17	Faulty, dirty, needs repair
Total						Transfer this total to sheet 9

Summary — Sheet 9

Electrical Audit	Average daily consumption (kWh)	Average cost per day	Total cost per year
Total transferred from Sheet 5 Lighting			
Total transferred from Sheet 6 Heating, Hot Water and Cooling			
Total transferred from Sheet 8 Other Equipment			
TOTAL Electricity Consumption (calculated)			
ACTUAL ELECTRICAL Consumption as per bill (transferred from Sheet 2)			

Natural Gas, LPG, Oil Audit	Average daily consumption (MJ)	Average cost per day	Total cost per year
Total transferred from Sheet 7			
Natural Gas, LPG, Oil Actual			
Sheet 3 Gas			
Sheet 4 LPG			
Sheet 4 Heating Oil			
Total (Actual as per bill) Transferred from Sheet 3 and 4			

Notes

Action 4

Using Energy Bills to Detect Waste

Using Energy Bills to Detect Waste

Reading electricity and gas meters can provide clues to help track down energy wastage.

For example:

1. If energy use does not decline significantly during holiday periods and weekends then equipment is being left on unnecessarily.
2. If heating energy consumption does not go down on mild days there may be large heat losses from the heat distribution system.

Team members need to become familiar with reading electricity and gas meters by:

- Taking time to read meters around the school and comparing results. (Refer to Box 1-page 3).
- Reading meters at home and comparing them with readings noted on their household energy bills.

Using Meters to Track Energy Savings:

Use meter readings to estimate the savings from changes made, such as using students to switch off lights at lunchtimes or introducing lighting efficiency measures.

For example, read meters at the start and end of lunchtimes for a normal week. Use your Project Team to switch off some lights at lunchtimes for the next week and read the meters. The difference in energy use shows the benefits of switching off lights.

On this basis you can make a case for an energy saving campaign, such as using student monitors to switch off lights, installing automatic switches or other alternatives (see Action 5).

By reading meters before and after weekends or holidays you can assess whether equipment has been left on unnecessarily and track down energy wastage.

Most importantly, the reading of meters provides evidence of the savings achieved by your energy saving program. The evidence can then be presented to the rest of the school community. This is vital if your program is to gain due credit for saving money. It can be used to motivate not only your Project Team but also the whole school community. It can help justify investment in some of the more expensive energy saving measures discussed in Actions 5 to 8.

Box 1

Electricity Meters

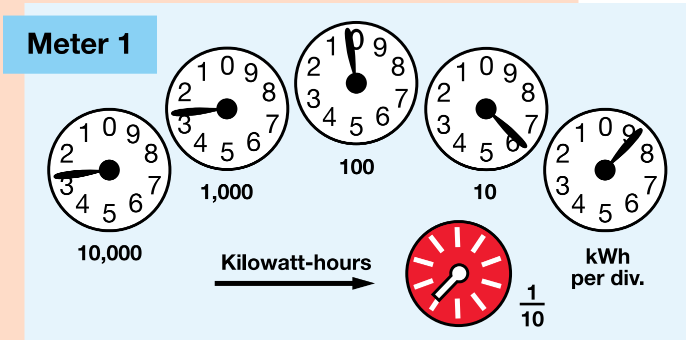
Electricity meters are very reliable precision instruments that register the amount of electricity consumed by all appliances.

There are four types of meters; dial, digital, SmartPower electronic and three phase electronic A1 tariff meter. However, in schools you will have either the dial meter or digital meter installed.

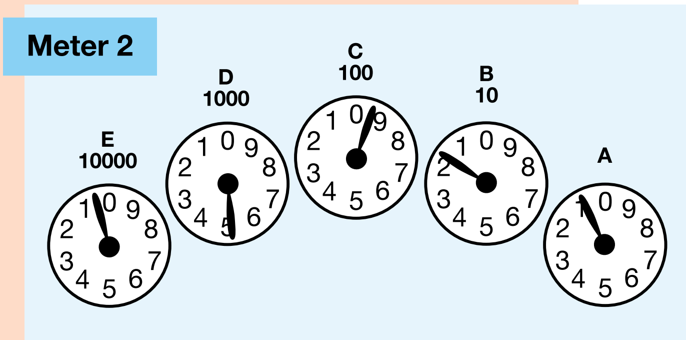
If a meter with a digital display instead of dials is installed, it is a simple procedure to read off the numbers which indicate the kilowatt-hours used since the meter was new. You can calculate the amount of electricity used since the last reading by subtracting the previous reading from the one just taken.

Example		
	Meter Reading	(Monday) = 3345 kWh
		(Friday) = 3701 kWh
	Consumption	356 kWh

Dial type displays for tariffs C1, C2, L1, N2 & L2 are read as follows:



Stand directly in front of the meter. Read each dial in turn going from right to left, writing down each figure, again from right to left, as you go. The reading in the illustration of **Meter 1** is read as 2-2-0-6-8. You would start by writing the 8 first i.e. right to left. When a dial points between two numbers, write down the lower of these two numbers . If a dial points between 0 and 1 write 0; between 9 and 0 write 9. It is important to only read dials that are black. When a dial hand appears to be exactly on a number, as on dial **(D)** in the illustration below, look to dial **(C)** on the right. If the hand on dial **(C)** has not passed zero, the number 5 has not been reached on dial **(D)** and the reading on that dial is the next lower number **4**. The additional dial marked in increments of 1/10 kWh can be used for more accurate assessment of energy use.



In larger schools, electricity meters may not directly read electricity usage. Where this is the case, the following may appear on the front of the meter:

Meter Factor: K80 (or K50, etc): actual electricity use is 80 times the reading; or 150/50 (or 100/5, etc.): actual electricity use is 30 times (i.e. 150 divided by 5) the meter reading.

Box 2

Gas Meters

Gas meters are large grey devices located at ground level outside. Their displays are similar to those used by electricity meters, and they are read in the same way.

However, gas meters do not directly give energy units; they measure the volume of gas which flows through them. This must be converted into kWh units using information from your gas supplier.

Gas meters measure either cubic metres of gas or if the meter is old, hundreds of cubic feet. Measurements in cubic feet can be converted into cubic metres by using the conversion 100 cubic feet = 2.832 cubic metres.

You can calculate the amount of energy used, **E** (in megajoules) with the following formula:

$$E = V \times HV \times PF^*$$

V is the volume of gas in cubic metres measured by the meter since the previous reading.

HV is the heating value of the gas, a measure of how much energy is in each cubic meter of gas. This value in Western Australia for natural gas, depending on the source of supply, varies between 37 and 40 MJ per cubic metre. A suitable average is therefore 38.5 MJ per cubic metre.

PF is the pressure factor, an adjustment factor used to correct for meters that operate at higher than standard pressure. When gas is compressed, each cubic metre will contain more energy, so the pressure factor is varied to reflect this. In this way your school is charged for the energy delivered in the gas, rather than the volume of gas.

Gas meters may have one or more extra dials that can be used to accurately measure rates of gas consumption.

Example

	Previous reading:	**2610m^3**
	Current reading:	**3860m^3**
	Gas used:	**3860 - 2610 = 1250m^3**

$$^*E = V \times HV \times PF$$

$$\text{Energy} = 1250 \times 38.5 \times 1.0 = 48{,}125\text{MJ}$$

If consumed over 480 hours, the average hourly rate of consumption is:

$$\frac{48125}{480} = 100.3\text{MJ/hour}$$

Using meter readings to draw your energy use profile:

Set up a Project Team to record meter readings at set times each day for a week to develop an understanding of the school's energy use profile. The team should also note important climatic conditions, such as air temperature or the amount of cloud cover. For example, meters could be read at the following times:

- Early morning before the cleaners arrive. Make sure someone knows how to turn off the security systems.
- When school starts.
- At the start and end of recesses and lunchtimes.
- When school finishes.
- After everyone leaves for the day.
- Before and after weekends and holiday periods.
- A day-use profile with readings every 1/2 or 1 hour.

As your Project Team gains experience, they may wish to take meter readings at other times to help develop a better understanding of how energy is being used.
For example, they may also wish to read meters half an hour before school starts.

By subtracting the previous reading from the most recent one and dividing by the number of hours between readings, a value of the average rate of energy use for the period of time between readings can be calculated.

Example	**Reading at 10.00 am**	**=**	**11,040 kWh**
	- Reading at 8.00 am	**=**	**11,004 kWh**
	Consumption in this period	**=**	**36 kWh**

If consumed over two hours, the average hourly rate of consumption is 18 kWh

Graphs can be plotted to show rates of energy use in each time period. These graphs can give valuable information on issues such as:

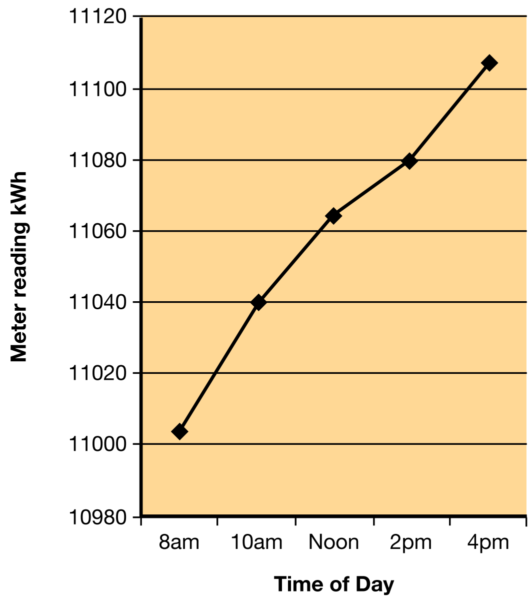
- Energy used by lights and equipment left on at recess/lunchtime and savings resulting from switching that equipment off.
- Effect of warmer and colder weather on energy use.
- Effect of sunny and cloudy weather on energy use.
- Energy use by cleaners.
- Overnight energy use and potential benefits of transferring to off peak or time-of-use tariffs.
- Weekend and holiday energy use so that equipment that has been left on or losses can be traced.
- Potential savings available through switching to off peak or time of use electricity tariffs.

Calculating an Energy Use Profile for your School:

Date:____________ Day:____________ Weather conditions:____________

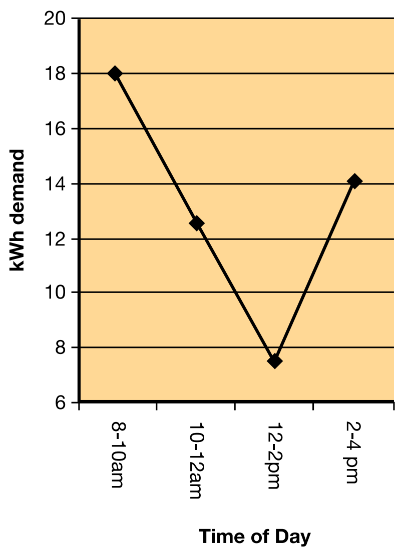
a) Actual Meter Reading.

Time of day	Meter Reading (kWh)	Energy Consumption (kWh)
8:00 AM	11004	
		36
10:00 AM	11040	
		25
12:00 AM	11065	
		15
2:00 PM	11080	
		28
4:00 PM	11108	



b) Actual Meter Reading.

Period	Hours in the Period	Energy Consumption (kWh)	Average Energy Consumption (kWh)
8-10am	2	36	18
10-12am	2	25	12.5
12-2 pm	2	15	7.5
2-4 pm	2	28	14



You take the Actual Meter Readings (a) above directly from the meter. As you can see in the first graph, the reading is cumulative and so the graph will always show an increase.

To obtain a graphic representation of the peak levels of consumption for a given period it is necessary to do calculation (b).

Sheet 10 gives you a checklist of activities to consider while doing this activity.

Analysing School's Energy Use Profile Checklist: Sheet 10

Activity	Observation
1. Monitor meter readings at the start and end of lunchtimes, with room lights on or off, for a week.	
2. Monitor meter readings before and after weekends and holidays.	
3. Record meter readings at set times each day for a week to establish the school's energy use profile.	
4. Draw a graph of the school's energy use profile.	
5. Analyse information from profile.	
5.1. Energy use by lights and equipment left on at recesses and lunchtimes.	
5.2. Effect of weather including cloudy or sunny days.	
5.3. Overnight energy use.	
5.4. Weekend and holiday energy use.	
5.5. Potential savings from switching to off peak or time-of-use tariffs.	

Action 5

Saving Energy Lights

Saving Energy On Lights

Overview:

Lights use over half of the electricity consumed in south west schools - and nearly 20% of electricity in north west schools at a cost of thousands of dollars each year. Yet most of the operations of a school are during daylight hours and most classrooms have large windows. Therefore, there is potential for very large savings. But these savings should be made through improved efficiency, not at the expense of safety (refer Australian Standards AS1680.1 for recommended minimum light levels) environmental quality or adequacy of light levels.

The basic energy saving strategies for lighting are:

- Make the most of natural light (while minimising glare, summer heat gain, and winter heat loss). Remove any posters, drawings that are adhered to windows. Indirect sunlight also emits less heat than most artificial lighting and therefore reduces internal heat gain.
- Increase light output of existing equipment.
- Switch off unnecessary lights.
- Replace inefficient lamps with more efficient ones.
- If lighting levels are higher than necessary, consider removing some lamps (de-lamping) or fitting lower wattage lamps.
- Use appropriate controls for security lights in little-used areas.
- Paint walls and ceilings light colours, to reflect light.

When lighting is provided by traditional incandescent lamps and some fluorescent tubes, most of the electrical energy is converted to heat energy in the room. This is highly inefficient. If the building requires cooling in summer, reducing the energy converted to heat by inefficient lights also helps reduce the amount of energy required for cooling.

No-cost or low-cost actions:

1. Ensure lights are switched off at breaks and after school.

Teacher or student monitors can be assigned to this task. Brief and train cleaners and teachers to work with adequate (rather than all) lights on and to switch off lights. School-wide savings can exceed $3,000 per school year, even though switching off each individual fluorescent tube only saves two-thirds to one cent per hour.

Savings can be monitored by reading electricity meters at the start and end of breaks for a week before and a week after the program has been introduced.

Remember, staff changes and loss of motivation over time can lead to reduced savings. (See **Action 8** for ways of overcoming this problem e.g. timers.)

Myth: Many people still think fluorescent lamps should be left on to save energy and money: this is wrong. Switch off fluorescent lamps when you leave the room for more than five minutes and save!

$ **"No-Cost or Low-Cost Actions" 2 to 6 should be done by a qualified electrical contractor to gain the greatest benefits.**

2. Ensure existing lighting equipment is providing as much useful light as possible.

Clean light fittings and remove or replace inefficient reflectors and diffusers. This can double light output, but beware of the possibility of increased glare. Replace old fluorescent tubes whose light output declines with age, with lower wattage, higher light intensity 'triphosphore' tubes to gain an increase in light output of up to 30% and a reduction in energy use of up to 15-18%.

3. Remove some lamps in areas where less light is needed, such as near windows and above shelving.

Make sure you explain the program to staff and students, and monitor attitudes. Each lamp removed saves more than half a cent per hour. That is around $5 to $10 per year in electricity, as well as the savings to be made on the cost of replacement tubes.

If an electrician is available, the ballasts which are no longer required should be disconnected, bringing additional savings of $1 to $2 per year per ballast removed.

Have the electrician replace single switches with multiple switches to isolate areas of high light levels, near windows, for example.

4. **Replace old style 20 Watt, 40 Watt, 65 Watt and 75 Watt fluorescent tubes with 18 Watt, 36 Watt or 58 Watt triphosphor fluorescent tubes.**

Older fluorescent tubes are thicker (40 mm diameter compared with 26 mm). Where wiring is more than 15 to 20 years old and substandard components were used in light fittings, there is a small risk of overheating wiring. If uncertain, check with your electrician. Do not use 36 watt tubes in dimmable circuits such as in school halls without advice from an electrician.

Tubes can either be changed in a "one-off" project so that savings are obvious, or replaced progressively under normal maintenance programs. Fluorescent tubes should be replaced every two years as their light output deteriorates with age.

As part of your school's Energy Management Policy you should ensure that the most energy efficient fluorescent tubes are purchased as standard procedure.

5. **Replace incandescent globes with compact fluorescent lamps.**

Replace globes used for long periods first. Save 80% on lighting costs, or around $100 per year for a continuously lit 100 Watt globe. The compact fluorescent lamps also have much longer life (6,000 hours or more, compared with 1,000 hours or less).

Pilfering of plug-in compact fluorescent lamps may be a problem where they are easily accessible. Here, you may have to install a new light fitting with a wired-in ballast.

As part of your school's Energy Management Policy you should ensure that compact fluorescent lamps are purchased instead of incandescent globes as a standard procedure.

6. **Where lights must operate for long periods, and a small number of lamps with high output are required, High Pressure Sodium (HPS) lamps are the most efficient, long lasting lights available. They also have the lowest lumen depreciation over their life.**

These are more efficient and effective than fluorescent lamps. However, they should be fitted with appropriate controls to minimise energy use, and the lowest suitable wattage unit should be installed. See Box 3 on page 10 for an example of how these efficient lamps can lead to higher costs, if used incorrectly.

Energy efficient lighting technology is developing rapidly and it is worth researching and exploring what is available before choosing. Most information from lighting manufacturers is available on the Internet.

7. **When specifying colours for the repainting of buildings, select light colours and avoid matt and/or heavily textured finishes.**

Investment actions your school administration might consider:

1. **Make the most of natural light. Install clear sections of roofing or skylights in unheated areas such as toilets, changing rooms, corridors and vestibules so that lights can be switched off.**

Do not install vented skylights because they increase heating bills. Ideally, automatic light controls should be used to ensure lights are not used unnecessarily.

In classrooms, gloss white or reflective louvres can direct light across the ceiling from high windows to provide a more even light without glare.

Use of transparent partitions/dividers/walls made from materials such as frosted glass, including decorative glass blocks, will allow light to penetrate further into enclosed areas. Beware of unwanted heat gain in summer.

2. **Install daylight and/or movement/occupation sensors or timers to control lights. A variety of options are available, from individual controls to school-wide systems.**

Daylight and movement sensors are the most efficient means of providing adequate light when it is needed.

The type of system chosen will impact on teachers and students, so pilot studies should be run. The school community should be briefed on how they work and the benefits of using them for the school. Some fine-tuning may also be required to synchronise controls with user requirements.

Timers controlling security lights should be adjusted seasonally to take advantage of longer daylight hours.

Where there is a risk of plunging an area into darkness with timer controls, it is important to provide low level emergency lighting to minimise the risk of accident.

Automatic switches use sensors to switch lights on and off: These include timers and light or movement sensors. A timer may switch lights on for set periods each day, or automatically switch a light off a certain time after someone has switched it on. Light sensors can switch lights off when there is adequate natural light. Movement sensors switch lights on when people are present, and switch them off when no-one is nearby. These sensors are similar to those used in security systems.

3. **Replace all double fluorescent fittings with energy efficient single tube fittings, reflectors and low level electronic ballasts.**

Triphosphor fluorescent tubes provide a low energy high light output alternative to traditional fluorescent tubes. Ideally, dimmable electronic ballasts should be used, and linked to movement and light sensors. In the short term, a small number of classrooms could be fitted with this type of system, to demonstrate its savings potential and provide practical experience. Rushing into major light replacement schemes means you run the risk of installing equipment which will be out of date quickly.

4. Rewire lights so they are grouped in functional ways.

Lights near windows should be switched separately from those in darker areas within a room. Multiple switches at both ends of a corridor can improve safety and facilitate energy saving.

5. Install efficient and appropriate task lighting over machinery, desks, etc.

This allows low background lighting levels to be used while ensuring safety and work effectiveness. Task lighting may be linked to switches that operate equipment, timers or movement sensors. However, beware, as excessive task lighting can add to energy bills and glare problems. See **Box 1** for recommended minimum lighting levels.

6. Security lighting is often a major expense.

Light sensors can switch lights off in daylight hours. Timers can be used to run lighting for the most critical times.

Currently the most suitable lights for security lighting are 360 watt High Pressure Sodium (HPS) lights or 400 watt Mercury Vapour (MV) lights. HPS units provide golden coloured, high luminance lighting. Where correct colour recognition is important, the whiter tones of MV units are recommended.

Lights linked to motion sensors normally use minimal energy, but give intruders a bright welcome and are highly visible from the street as they switch on.

Help with security lighting:

To take the hassle out of security lighting Synergy Energy has created PowerWatch Security Lighting which makes sure you get affordable security and the right security lights for your purposes. For more information contact Synergy Energy on 131354

The PowerWatch complete security lighting service provides:

- Dusk to dawn operation and maintenance.
- Lighting installed by Synergy Energy.
- Deterrent to vandals, burglars and other criminals.
- Floodlighting of premises and car parking areas.
- Assistance to staff, parents and students attending the school at night.
- In some instances, security lighting may assist with your insurance policy.
- Existing power poles on the street can often be used to anchor the security lighting.
- Light that cannot be turned off accidentally or intentionally.

7. Other lighting technologies:

The emergence of LED (Light Emitting Diode) technology is providing long life (LED's last for approximately 100,000 hours) and low energy (up to 90% energy saving) alternatives for all lighting requirements. Initially, LED lighting technologies have been most widely developed for signage and signaling devices, such as vehicle tail lights. However, the development of "superbright" white LEDs means that they will become more widely used in many other applications, such as commercial and domestic room lighting, task lighting, car park lighting and park and street lighting. LED technology is expensive, but costs are coming down as the technology develops. The costs will be offset by the enormous savings available through their use.

Box 1

How Much Light Do I Need?

The amount of light needed varies widely due to factors such as:

- **The level of glare.** When glare is present, the apertures in our eyes narrow in response making it more difficult for us to see clearly without extra light. This is why people often turn on lights in classrooms that have bright daylight near windows but dull areas away from them. Also glare can make reading from shiny, white paper difficult.
- **The kinds of tasks.** Detailed work requires higher light levels than simple tasks.

The Standards Association of Australia has developed guidelines for the light levels required for many actions. They are included in AS 1680.1 along with useful discussion of the issues affecting design of lighting systems. In schools, recommended light levels are.

Libraries and offices	300 to 400 lux
Classrooms and canteens	240 to 400 lux
Auditoriums and changing rooms	100 lux
Corridors	40 to 80 tux

While these light levels are often used as guidelines for light levels throughout rooms or offices, they are actually guidelines for light levels at the place where the task is carried out. Lower light levels may be acceptable in some parts of a room, such as circulation areas and above storage. Daylight may reduce or eliminate the need for lights in some areas and task lighting can provide high levels of light where it is needed.

To achieve an average light level of 200 lux using artificial lighting alone (that is, ignoring any daylight), one standard 1200 mm fluorescent tube mounted in an efficient fitting with a reflector would be required for every 10 square metres of area. For a typical 60 square metre classroom, 6 fluorescent tubes would achieve this result. Use of inefficient light fittings or dirty diffusers could double the number of tubes required to achieve this level of lighting.

Box 2

Units of Lighting

The units of lighting are the lumen and lux.

Lumen is a measure of an amount of light. Thus, a 60 watt incandescent globe produces about 600 lumens of light. A 13 watt compact fluorescent lamp would produce the same amount of light.

The efficiency of a light source in converting electricity to light is indicated by calculating the amount of light produced per unit of electricity consumed; that is the lumens of light per watt of electricity. The incandescent globe described above produces 10 lumens per watt (600 lumens from 60 watts of electricity), while the compact fluorescent lamp produces almost 50 lumens per watt (600 lumens from 13 watts of electricity). This rating is often called the efficacy of a lamp, and is a useful comparative measure.

$$\textbf{Efficacy of a light source} = \frac{\textbf{Amount of Light (Lumens) produced by a lamp}}{\textbf{Electricity consumed by the lamp in Watts}}$$

Lux is a measure of the intensity of light falling on a surface. Its units are lumens per square metre.

Table area	*= 3 square metres*
Light falling from 60 watt globe	*= 600 lumens*
Light falling per square metre of table	*= 600 ÷ 3 = 200 lumens per square metre*
	= 200 lux

Light meters can he used to measure light intensities.

The above is a guide only.

Box 3

Efficient lights alone are not enough

Lights must not just be efficient, they must also be appropriate to the task. Consider this example:

Two very efficient metal halide lamps are installed in a covered area and toilet. They run continuously. Each lamp is rated at 45 watts, and has a 10 watt ballast. Total daily energy consumption is just over 1 kWh. This would be 365 kWh every year, costing around $45 annually.

First, installation of a section of clear roofing and use of a daylight sensor could eliminate electricity use during daylight hours. If lower light levels are acceptable, replacing the 45 watt metal halide lamps with two 20 watt compact fluorescent lamps could increase total savings to over 75%. Even bigger savings could be gained through the use of movement sensors and/or a timer which would switch off lights after a set time.

Ideas for Student Projects:

1. Carry out a lighting inspection of the various rooms in your school. Use sheets numbered 11.1, 11.2 and 11.3. You will need one set for each room you inspect. Once you have done this for the whole or part of the school, go through all your answers and write in your own words what you think of the lighting situation in the areas you have audited.
2. If your school has a trade or technology training area it may be possible to design and make your own reflectors with assistance from the physics and/or trade teachers. This is a very practical application of optics.
3. Students could carry out a range of simple and then complex activities in a range of light conditions. They can record their experiences and compare them.
4. Investigate whether the school should purchase daylight and/or movement sensors.

Daylight and Motion/Occupation Sensors:

Get brochures on daylight and motion/occupation sensors from manufacturers.
If you don't know who they are use the Yellow Pages.

- Find out what they do (from the brochures).
- Determine areas in the school where they can be used.
- Work out the cost to purchase and install.
- Calculate how much energy can be saved. Don't take the manufacturers words' for granted. Work out what your school can save in the specific places where these will be installed:

Number of lights controlled by the sensor.

Before Sensor:	Wattage of each light. Normal hours for which these lights are on per day (estimate). Number of days in a year these lights are on (estimate).
After Sensor:	New estimate for hours per day for which these lights are on. New estimate number of days in a year.

Savings:	Savings in kWh as a result of sensor	=	___________	kWh
	Price of electricity per kWh	=	$ ___________	
	Savings $$ per year	=	$ ___________	
	Initial cost of buying and installing a sensor	=	$ ___________	
	Payback period in years	=	___________	years

1. Is the most use being made of natural light?
2. Are daylight and movement sensors or timers needed?
3. Is it necessary to replace light fittings with efficient luminaires which have reflectors, low loss ballasts and fewer fluorescent tubes? Why?
4. Do lights need rewiring? Which ones?
5. Is the installation of efficient and appropriate lighting over machinery, desk, etc. necessary? Where?
6. Would security lighting be of assistance? Where?

Make recommendations to the School Council as to what should be done.
Also mention what you have learnt and what you would like to learn more about.

Energy Saving Recommendations

Report prepared by:

____

Team: ____

Supervisor:

____

Date: ____________________

Recommendations: ____

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Worksheet: Effectiveness of lighting various work areas

Sheet 11.1

- ☐ Classroom:#__________
- ☐ Office
- ☐ Staffroom
- ☐ Library
- ☐ Gymnasium
- ☐ Multi-purpose
- ☐ Canteen
- ☐ Verandah
- ☐ Corridor
- ☐ Other

Tick appropriate room above

Investigations	Responses
1. Do students in the room think there is enough light?	
• those near windows.	
• those opposite windows.	
• on the blackboard.	
• at their desks.	
2. Is there anybody specifically responsible for the lighting in the room?	
3. Switches:	
3.1 Location of switches inside the room.	
3.2 Separate switches for sets of lights.	
4. What is the colour of the paint on the walls?	
5. Windows:	
5.1 How many?	

Worksheet: **Sheet 11.2**
Effectiveness of lighting various work areas

Investigations	Responses
5.2 What direction do they face?	
5.3 How does the light vary throughout the day?	
6. Blinds/Curtains:	
6.1 How many?	
6.2 What colour?	
6.3 Working?	
6.4 Clean?	
6.5 Who looks after them?	
7. Skylights:	
7.1 How many?	
7.2 Clean?	
7.3 Who is responsible for cleanliness?	

Worksheet: **Sheet 11.3**
Effectiveness of lighting various work areas

Investigations	Responses
8. Light switch: Using a light meter to measure light levels in different parts of the room. Discuss adequacy. 9. Light fitting: 9.1 How many? 9.2 Cleanliness? 9.3 Who is responsible for cleanliness? 10. Total wattage: Lamp: Type: Number: Watts 11. Is it practical to switch off light: a) during lunchtime? b) before school? c) after school? 11.1 Estimate energy and money savings possible. 12 De-lamping: 12.1 Determine if and which lamps could be removed without adversely affecting safety and health. 12.2 Estimate energy and money savings possible from de-lamping.	

Report prepared by:____________________________________

Date:________________ (A summary/total for the whole school can be compiled on the completion of the separate projects).

No-Cost or Low-Cost Actions Checklist — Sheet 12

Activity	Recommendations
1. Is natural light being used efficiently?	
2. Are the necessary lights being switched off?	
3. Is existing lighting being used?	
4 Lights:	
4.1 Has the school removed lamps where less light is needed?	
4.2 Are ballasts that are no longer required being removed?	
5. Replacing with more efficient lamps:	
5.1 Where appropriate, have incandescent lights been replaced with fluorescent tubes?	
5.2 Old style fluorescent with new ones?	
5.3 For long term operation, use metal halides or sodium lamps.	
6. Brighten up rooms with light coloured paint.	

Investment Action Checklist — Sheet 13

Activity	Recommendations
1. Is the most use being made of natural light? 2. Are daylight and movement sensors or timers needed? 3. Is it necessary to replace light fittings with efficient luminaires which have reflectors, low loss ballasts and fewer fluorescent tubes? Why? 4. Do lights need rewiring? Which ones? 5. Is the installation of efficient and appropriate lighting over machinery and desks necessary? Where? 6. Would security lighting be of assistance? Where?	

Action 6

Saving Energy on Heating and Cooling

Saving Energy on Heating and Cooling

In Western Australia, schools spend approximately 12% of their energy bills on heating in the south-west and around 70% on cooling in the north-west. All this energy is used in efforts to keep staff and students comfortable. The amount of heating and cooling required in a building is dependent upon the heat gain or loss from outside the building and the internal heat gain from within the building. Reducing these heat gains or losses will reduce heating and cooling needs.

Heating:

Western Australian schools have either electric strip heaters mounted on classroom walls or large gas heaters.

Identify and mark on a floor plan the heating and cooling equipment in your school, noting:

- locations.
- fuels.
- areas each heater serves.
- if the air is heated, is it drawn in from outside, or is indoor air recirculated?
- the locations and temperature settings of thermostats.
- the locations and settings of timers. Are they 7-day timers that stay switched on over weekends? Are they turned off over holiday periods?

Where does the energy go?

Now that you have identified your heating equipment, track where the heat it produces goes. Use the tests described in **Box 1** to pinpoint areas of loss.

Opportunities for savings:

The basic ways of saving energy in heating are:

- the use of high efficiency boilers and heaters.
- minimise losses from heat distribution systems.
- manage and maintain heating equipment for best performance.
- provide adequate comfort (avoid over or under-heating) only where people need it and only for the times it is needed.
- ensure buildings are made as energy efficient as possible.

No-Cost or Low-Cost Actions:

1. Room heaters

- Where room heaters release heat near head level, a slow moving ceiling fan installed nearby can bring it down to where it will be useful. This can improve summer comfort, too. Units are available for less than $100.
- Thermostatically controlled units are often misused. An education program can inform users on their correct operation and signs can point out the extra cost of setting the thermostat at a higher temperature. Ideally, heater thermostats should be set to a temperature between 18°C and 20°C, for optimum heating of the room.
- Heaters should be turned off when rooms are left vacant. Procedures can be developed (for example, monitors appointed) to ensure this is done. Leaving an LPG heater on for an hour in a room could cost up to 50 cents, so savings can add up quickly.
- Ideally, heaters should be controlled by timers, so they switch off after a set time. These are not yet available for gas heaters.
- Heaters should be switched off 30-45 minutes before closing time. The heat in the room is sufficient to maintain comfortable conditions.
- Ensure pilot lights in gas heaters are turned off for holidays and over summer. Every week a pilot light is switched off saves up to a dollar.

2. Buildings

Heat is lost from buildings through walls, ceilings, floors, windows and draughts. Heat may be gained through windows facing between north east and north west.

- Draughts are a major source of heat loss in schools. Often attempts to ensure adequate ventilation lead to excessive ventilation. Each time the volume of air (about 200 cubic metres) in a heated classroom is replaced, the cost of heating replacement air with natural gas is between 2 and 5 cents. This can happen many times each hour, losing heat worth up to 50 cents per hour from each classroom. Closing doors and windows and sealing up vents, particularly those in or near the ceiling and in skylights can reduce air leaks. But make sure adequate ventilation is provided **(see Box 2)**. Draught proofing of doors with adhesive door rubbers is an excellent way of reducing air leaks.
- Consider installing door closers on all doors to minimise the time that they remain open.

Investment Actions:

1. Room heaters

- If the currently installed heaters use LPG or oil and natural gas is available you should consider converting them. This also applies to demountable and relocatable buildings. It is cheaper to lay gas pipes when the services are being installed for a new building however, a working bee may be a good way of digging the trench for gas pipes.
- When replacing heaters, install high efficiency units.
- In staff areas, low wattage radiant panels (such as "Thermofilm" units) can replace high wattage portable heaters. However, they should be fitted with timers, so they are not inadvertently left on.
- In workshops, radiant heating or electrically heated mats are cheaper than heating large spaces.

2. Buildings

- Most classrooms have large areas of glass, supposedly to provide daylight. Yet much of this glass is not required for adequate light - it often creates glare problems and is a major source of winter heat loss and summer heat gain. Experiments can be conducted by covering over some glass with insulating panels. In a British experiment, glass areas facing directions other than south (north in Australia!) were halved with insulated panels. Heating savings of 25% were recorded, and;

  "There has been no discernible increase in the use of artificial lights due to the reduction in window area... "

- Improvements in the type of glass and window films are now available to reduce heat transfer through, or to provide shading if glare is a problem.
- Most school buildings are poorly insulated. Ceiling insulation can cost $200 or more per classroom, plus installation. However, it can dramatically improve comfort and save energy. Potential savings exceed 5 cents per hour per classroom. It may be possible to insulate a limited number of rooms first (for example, the coldest rooms in the school), to assess the benefits. A parents' working bee may cut installation costs.

Note: Improvements in the performance of buildings may produce lower than expected savings as occupants achieve higher comfort levels instead of some energy savings. This is still a worthwhile outcome because of potential health benefits and the positive contribution to teaching and learning conditions. Indeed, it may be preferable to aim to improve comfort first, then focus on energy saving. This will help create positive attitudes towards your Energy Saving Program.

Cooling:

The major types of cooling equipment are:

- **Evaporative coolers** use the evaporation of water as a means of cooling air. They increase the humidity of the air as they cool it, and are thus not suited to use in wet, humid areas. However, they work well in most parts of Western Australia. Because they only use energy to drive a fan and use water, they are relatively economical. Externally mounted units should be covered in winter to stop warm air leaking out of the building. They are available in a range of sizes from small portable units to large, roof mounted central units. Heating systems should not be added to evaporative cooling duct work as their high capacity fans can deliver very high heating bills.
- **Indirect Evaporative coolers** use a heat exchanger between the outside air cooled by the water and the air inside the building. In this way water vapour is not added to the inside air, thus reducing humidity problems inside the building. These systems are not very common, but are likely to be used more in the future even in humid climates, because they are much cheaper to run than refrigerative air conditioners.
- **Refrigerative air conditioners** remove heat from indoor air in the same way that a refrigerator removes heat from its cabinet. The most common type used in schools is the window or wall mounted room air conditioner. Operating costs vary greatly depending on size, model and star rating.
- The thermostat setting during hot periods should be set at no lower than 24°C.
- **Fans** improve comfort by mixing air and increasing the rate of evaporation from your skin. Slow moving ceiling fans or fast moving small, portable units may be used. The latter are noisier. Fans are an economical way of improving summer comfort. They can also improve comfort in winter by mixing warm air from near the ceiling with colder air from near the floor. Ceiling fans consume about 1.25 cents of energy per hour whereas, pedestal fans consume 0.70 of a cent an hour.

Note: Poorly maintained cooling equipment which uses water in its process (including evaporative coolers and water cooled refrigerative air conditioning plant) may provide an environment suitable for the growth of legionnella bacteria, which can cause Legionnaire's disease. To avoid this problem, you should strictly adhere to the manufacturers' guidelines.

Saving Opportunities:

- Make sure the air conditioner compressors and condensers are shaded and not in full sun or in a hot location (roof space/ceiling or alley) as this affects the efficiency of the plant and consequently, increases the running cost.
- Use of outside air. This involves a control device which takes air directly from outside the building bypassing the air conditioner. This can be done when the outside air is cooler than the inside air, such as overnight, to cool the building **(see Box 3)**. Switching off the air conditioner and opening windows is even better, where this can be done.
- Energy Smart controls and timers should be installed to manage the operation of air conditioners **(see Box 4)**.
- Use fans or evaporative coolers instead of refrigerative air conditioners where possible (but not in computer rooms, where the humidity may cause problems).
- Limit the use of air conditioners to a minimum, and set the thermostat at the highest setting, which provides adequate comfort (24°C to 26°C is more than adequate).
- Clean filters regularly.
- Insulate ceilings and shade or cover over windows exposed to direct sun as this not only reduces the amount of heat flowing into a room, but lowers the temperature of the surfaces in the room, reducing what is known as radiant discomfort. Light coloured shade cloth is a cheap and effective form of shading **(see Box 5)**.
- Use solar film/shading on windows, or choose low heat transfer glass. Consider changes to layout of buildings such as additional partitions **(see Box 5)**.
- Ensure air flow dampers are correctly set so that air flows are balanced particularly to areas containing thermostat controls **(see Box 6)**.
- Have air conditioning systems maintained and adjusted on a regular basis. This should include controls, air balance where applicable, and evaporators and condensers.
- Use high efficiency motors on fans and pumps.
- Use more efficient condensers and compressors, or more efficient air conditioning generally **(see Box 7)**.
- Consider using the waste heat.
- Look for and try to reduce/eliminate appliances that put heat into the classroom.
- Consider ways to enter and exit buildings and clusters that enables you to minimise the exchange of cooled and heated air.

Box 1

Some Important Tests.

You can find out if your heating or cooling system has big losses in several ways.

- Measure air temperatures at 7 metre vertical intervals at several places around a classroom. Is there more than a few degrees temperature variation? Where are the warmest places? Where are the coldest places?
- Find where the inlet air for central heating or cooling enters the heating or cooling system. Drawing air from outside instead of reheating or re-cooling inside air can double heating or cooling costs, but is often done as a way of providing a guaranteed supply of fresh air.

Central Heating Systems:

- Measure heat outlet temperatures in rooms by holding a thermometer in the stream of air leaving the outlet or by holding the bulb of a thermometer on the surface of incoming hot water pipes. If temperatures get lower as you move to rooms further away from the source of heat, there must be losses from ducts or pipes.
- Check daily gas or oil consumption on cold and mild days. If it does not change much, a lot of your fuel is probably being wasted.
- Check fuel consumption outside school operating hours by reading the meter at the start and the end of the day. If a lot of fuel is used overnight and on weekends the system is probably operating unnecessarily.

Central Cooling Systems:

- Measure cool air outlet temperatures in rooms by holding a thermometer in the stream of air leaving the outlet or by holding the bulb of a thermometer on the surface of incoming cold water pipes. If temperatures get higher as you move to rooms further away from the source of cooling, there must be losses from ducts or pipes.
- Check the buildings you are heating or cooling. Are ceilings and walls insulated? If they are, how thick is the insulation? Are there unnecessarily large glass areas? You can check for draughts by hanging a piece of cling-film over a piece of wire and holding it near the opening. If it moves, air is escaping or entering.

Box 2

What is Adequate Ventilation?

Australian Standards state that ventilation requirements are 10 litres of fresh air per second per person over the age of 16, and 12 litres per second for younger people. This is equivalent to replacing the air in a classroom about 5 times every hour when it is occupied by 30 students. This rate of air replacement would be achieved if two household exhaust fans were running. The cost of energy lost with this air would be between 10 and 25 cents per hour.

The theoretical requirements for fresh air are much lower than stated above. These are obviously designed to reduce odours as well as providing adequate fresh air.

In practice, while most school ventilation systems have large areas of open vents and often feel draughty in windy weather, they may not provide anywhere near the amounts of fresh air specified in the Standard, particularly on calm days.

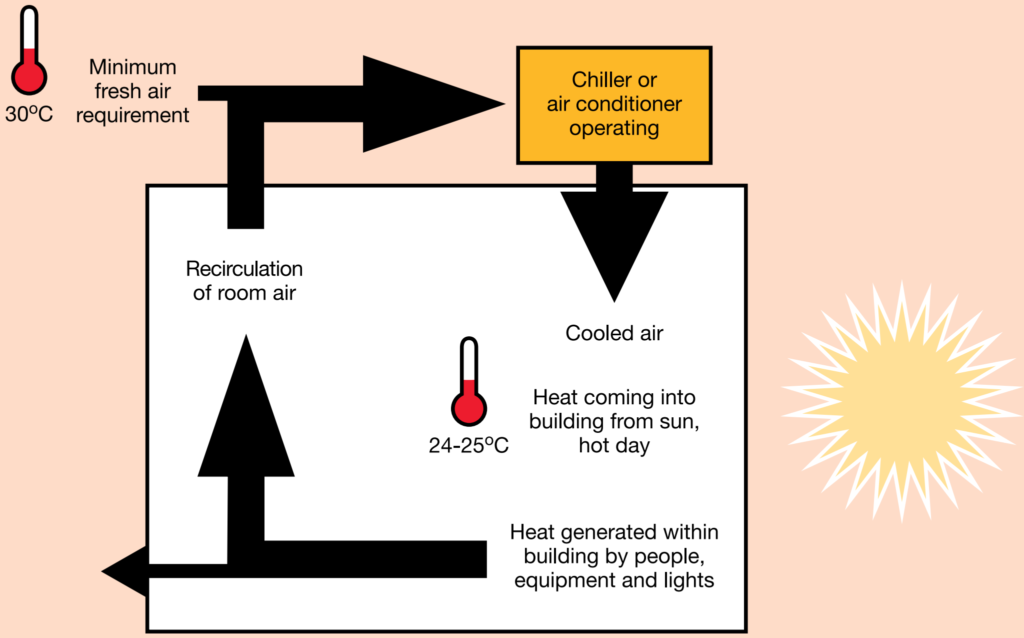
The use of outside air inlets for air heating systems is one way the required fresh air in schools may be provided. However, this is both inefficient and inappropriate. Lack of flexibility means that these systems provide too much fresh air to unoccupied rooms or those with small numbers of occupants. Often heater outlets are located directly below air vents, so the fresh air they deliver to a classroom escapes immediately, leaving cold, smelly, stagnant air in most of the room.

The ideal solution is to use a **Variable Capacity Mechanical Ventilation System** which senses the amount of fresh air required and uses a heat exchanger to transfer the heat from outgoing air to incoming air. Unfortunately, such systems are not yet cheaply available, although progress is being made in this direction.

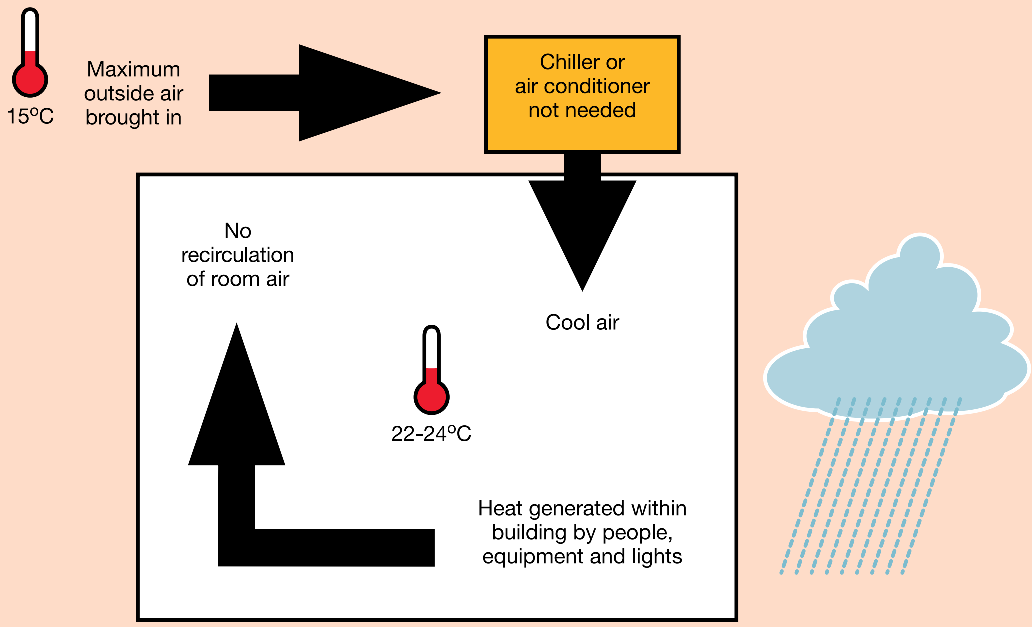
For now, the best compromise seems to be to have some fixed ventilation (not in or near the ceiling, where the warmest air is) at a point furthest from the entrance to each room. This can be supplemented by opening windows or using exhaust fans (of the self-sealing type) which, when activated, run for a set time (for example, 15 minutes). By asking for feedback from users, the need for changes can be assessed.

Box 3

How does an outside air economy cycle work?



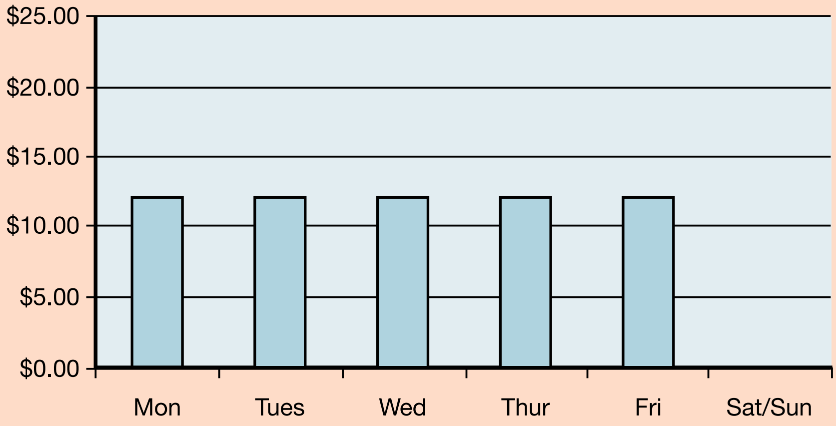
Hot outside: Outside air economy cycle off



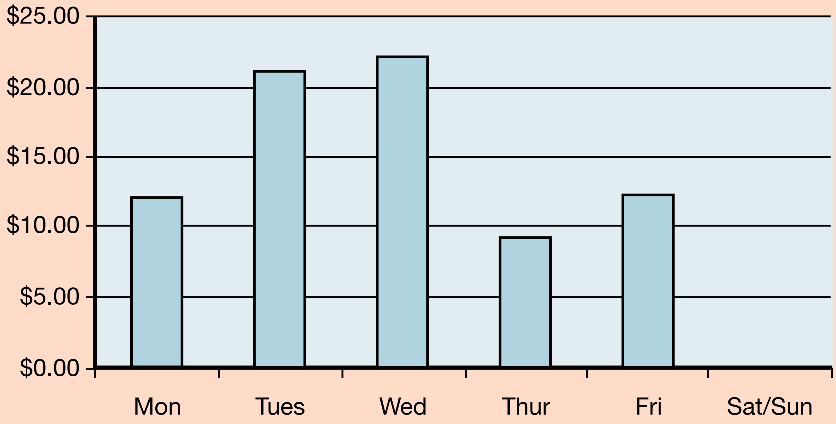
Cool outside: Outside air economy cycle on

Box 4

Comparison of air conditioner with and without weekly time controls.



Air conditioners costs with weekly time control



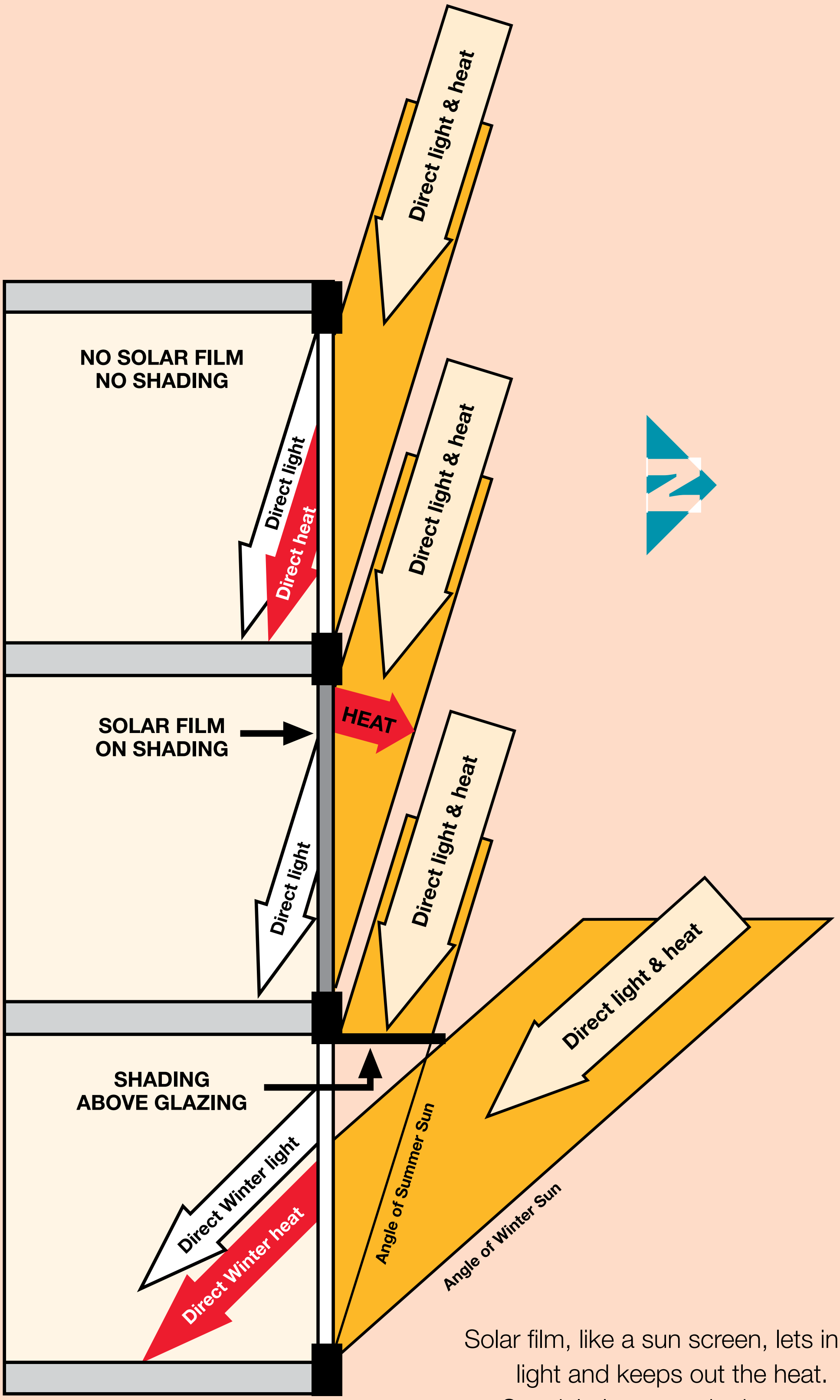
Air conditioners costs without weekly time control

Time clocks can be programmed to allow for public or school holidays.

(Courtesy of ESAA)

Box 5

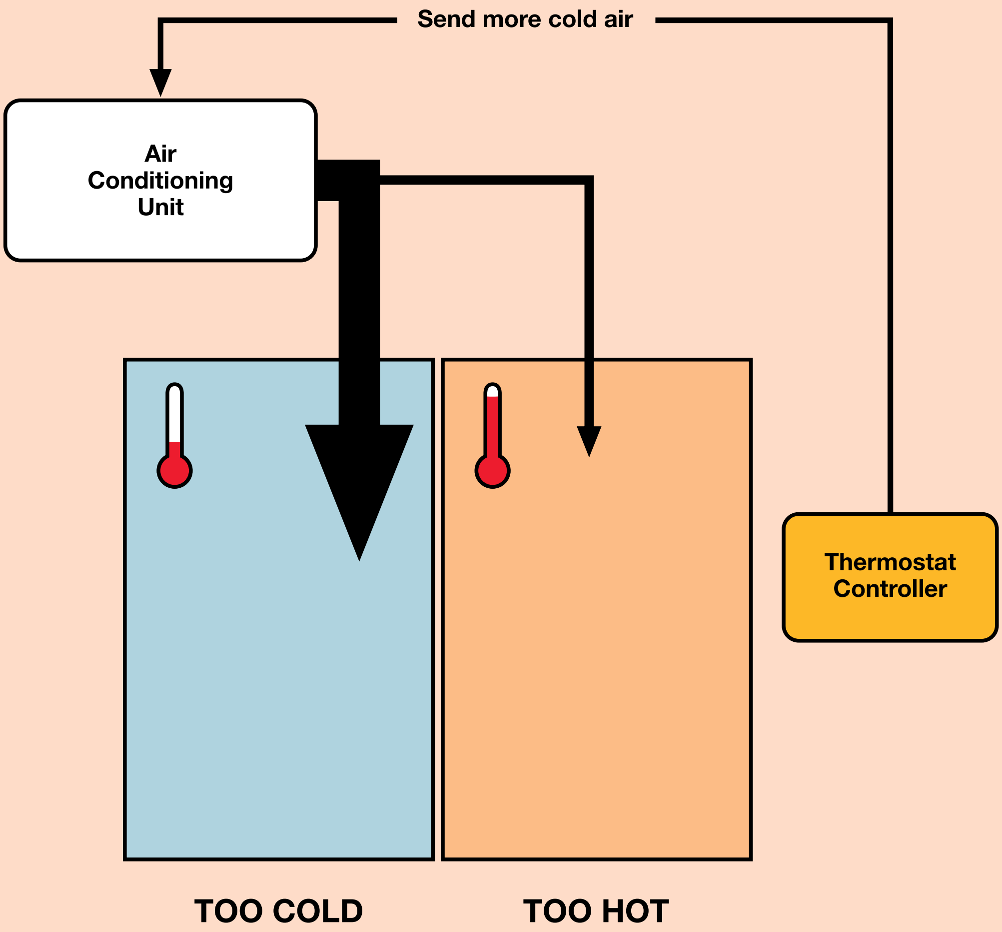
What do shading devices, special glass and solar film do?



Solar film, like a sun screen, lets in the light and keeps out the heat. Special glass can do the same.

Box 6

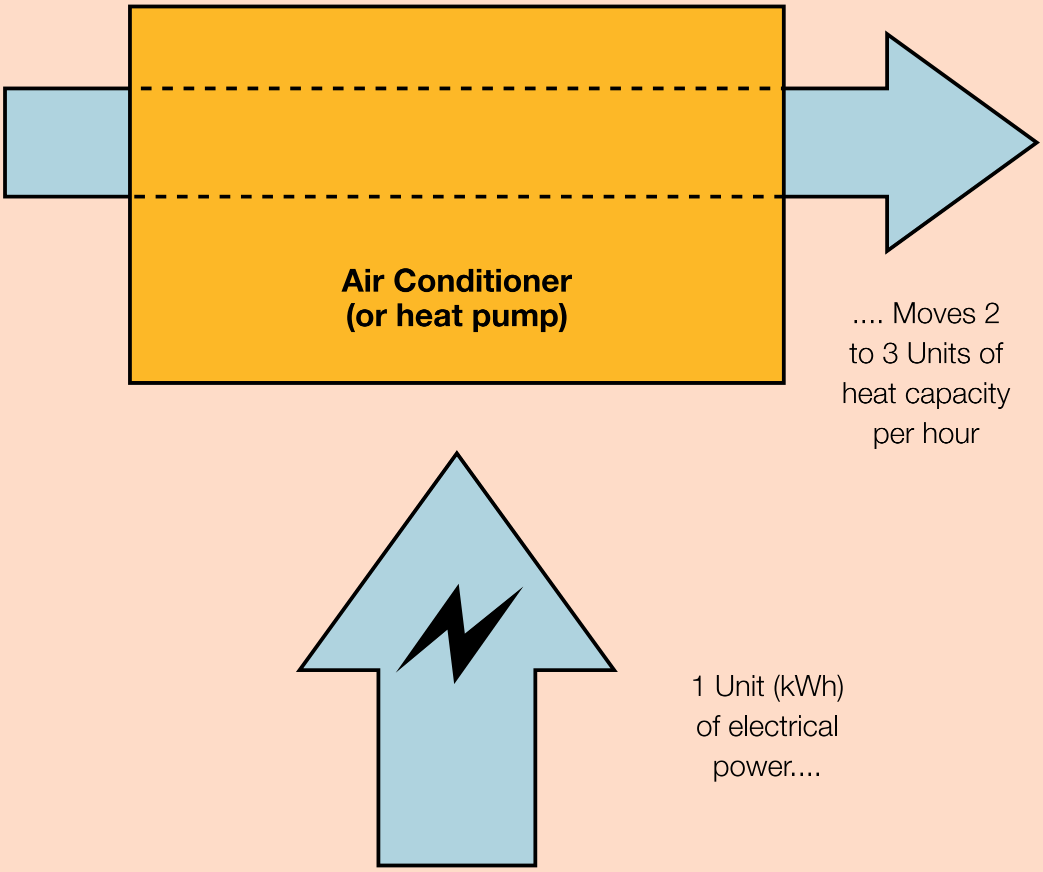
What happens if the air balance is not right?



(Courtesy of ESAA)

Box 7

How efficient is my air conditioner?



Air conditioner efficiency can be measured by the Coefficient Of Performance (COP)

$$\text{Heating COP} = \frac{\text{Heating Output Capacity}}{\text{Electrical power input}}$$

$$\text{Cooling COP} = \frac{\text{Cooling Output Capacity}}{\text{Electrical power input}}$$

The Cooling COP of most air conditioners is between 2 and 3.
A COP of around 2 is poor. A COP around 3 is excellent.

(Courtesy of ESAA)

No-Cost or Low-Cost Action Checklist — Sheet 14

Activity	Recommendations
1. Room Heaters:	
1.1 Are there ceiling fans in the room? • *Appropriate height?*	
1.2 Are thermostats set at correct temperature (18°-20°C)?	
1.3 Are heaters turned off in vacant rooms?	
1.4 Are pilot lights switched off during holidays and over summer?	
2. Buildings:	
2.1 Is the building draughty? What can we do about maintaining proper ventilation? • *Doors?* • *Windows?*	
2.2 Is there draught proofing installed on doors and windows? Can we install it?	

Investment Actions Checklist	Sheet 15

** You will need a qualified person to give advice on some items below.*

Activity	Recommendations
1. Room Heaters:	
1.1 Should we convert from Oil or LPG to Natural Gas?	
1.2 When replacing heaters, do we need to install high efficiency units?	
1.3 Do we need to use low wattage radiant panels (fitted with timers) in staff rooms?	
1.4 Do we need to use radiant heating or electrically heated mats in workshops?	
2. Buildings:	
2.1 Can we cover glass with insulating panels or replace windows with better performance glass (at least if it has been broken)?	
2.2 Do we need to install ceiling insulation?	

(Continued)	Sheet 15

Activity	Recommendations
3. Cooling:	
3.1 Are air conditioners located in cool places (most important for refrigerative air conditioners)?	
3.2 Can outside air be used when it's cooler?	
3.3 Are time delay switches needed or smart controls/timers?	
3.4 Can cheaper fans or evaporative cooling be used instead of refrigerative air conditioning?	
3.5 Check to ensure that the thermostat setting is no lower than 24°C.	
3.6 Are filters cleaned regularly?	
3.7 Where is insulation or shading needed?	
3.8 Are there opportunities for installing solar film on windows or low-heat transfer glass?	
3.9 Check to ensure that heating systems are not added to evaporative cooling ducts.	
3.10 Can you change the layout of buildings or add partitions?	

(Continued)	Sheet 15

Activity	Recommendations
3.11 Are airflow dampers set to ensure a balanced air flow?	
3.12 Is air conditioner maintenance and adjustment done on a regular basis?	
3.13 Is your air conditioning equipment efficient?	
3.14 Can you utilise waste heat?	
3.15 Are there unnecessary heat inputs into the room from appliances or lighting?	

Action 7

Saving Energy on Hot Water

Action 7

Saving energy on hot water

Hot water:

Hot water is supplied in Western Australian schools by electric, gas or solar hot water heaters in the following ways:

Electric or gas water heaters serving one or more outlets are often sited relatively close to the taps. They may be located in cupboards or outdoors. Water heaters are usually electric instantaneous or electric storage types. Electric instantaneous water heaters are gradually being replaced by electric storage water heaters.

- Solar hot water heaters are usually roof mounted, but sometimes the storage tank is located on the ground. They are very effective in our Mediterranean climate and apart from the need to use the booster during long periods of overcast winter weather or extreme usage, they use free solar energy and produce no greenhouse gases.
- Wall mounted boiling water units. These are usually used to provide hot water for tea and coffee.

Saving opportunities with central hot water systems:

- Water heaters supplying a large load, such as showers in a changing room, should be located right where they are needed. The heat losses from pipes in a remote system can cost hundreds of dollars annually.
- If it is too expensive or inappropriate to relocate the water heaters, fit a timer to restrict the hours of operation to a minimum. You may need a convenient override control for unusual sporting events and other irregular requirements.
- Insulate the hot water distribution pipe-work to minimise heat loses, particularly the first one metre of water pipe carrying hot water away from the water heater. This acts as a heat draw from the storage tank. Take care not to get burnt by touching this pipe-work.

Points-of-use units:

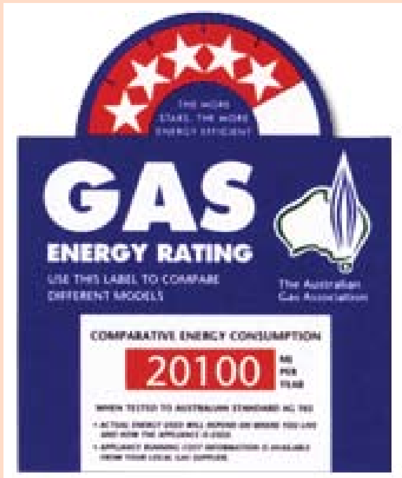
Many small electric and gas hot water heaters are located around schools. The heat losses from each small electric unit can cost over $200 annually, even if they are rarely used.

- A timer or a press button switch can cut waste. A 50-litre unit will reheat water from cold in less than an hour and some warm water will be available within minutes of it being switched on. Extra insulation around the tank (be careful not to insulate over the terminal cover) could also halve losses **(Action 8, Box 1)**. A timer can also be used to avoid weekend operation. In Western Australia it is often beneficial to install a timer for a solar hot water heater. This allows boosting first thing in the morning and then during the day water can be heated by the sun. Where time-of-use tariffs are involved it is best to boost in off peak times (between 10.00 pm and 8.00 am).

- Pilot lights in gas heaters can be surprisingly costly. The pilot light on a natural gas hot water service can cost up to $70 annually, although the newer, more efficient models cost about $25. Turning off pilot lights can save over $1 per week. Units with electronic ignition are available.
- Where hot water is used for showering, flow controls or low flow-rate shower fittings can reduce hot water consumption by up to half. However, if the shower rooms are draughty, avoid the types of low flow fitting which produce fine droplets, as these may not provide a comfortable shower in cold conditions. In these cases, flow controls fitted to existing shower fittings or low flow units that produce jets of water are preferable.
- Aerators can be fitted to taps to reduce hot water usage.
- When replacing gas hot water heaters look for high efficiency models. The Australian Gas Association rates all new gas hot water heaters for energy efficiency.

The Energy Rating label uses stars to show the energy efficiency of a heater. Quite simply, the more stars, the more energy efficient the heater and the lower its running costs when compared with another similar unit in the same situation. Greenhouse gas emissions are also lower.

Use the Energy Rating label to compare different models with the same heat output - the more stars, the more money you'll save and the better it will be for our environment. Even a one star improvement can save around 10% on running costs!



Boiling water units for tea and coffee:

Water boilers typically use 2,000 kWh of electricity each year. They cost up to a dollar a day to run even if they are not in use during weekends, night time and during school holiday periods.

A typical 30-litre unit is capable of supplying 150 cups of coffee instantly. Is that much hot water really needed? Are all the units needed? Is a kettle more appropriate?

- A timer can be fitted to save on overnight and weekend energy wastage. If your water boiler is a "Whelan" unit it works by sensing the water level, so some water must be drawn off before it will reheat properly. Alternatively, set the timer to switch on at least an hour before staff arrive.
- In most cases, a small water boiler unit with timer may be adequate. Even a 2.5 litre unit can supply 15 cups of hot water instantly and heat enough water for up to two additional cups per minute. Such a unit can save $200 per year. With a timer, savings can reach $250 per year, paying back its cost in only two years.
- Where only a small number of people need hot water an electric kettle or jug is much cheaper to operate.

Saving Opportunities Checklist: Sheet 16

Activity		Recommendations
1.	Centrally-based water heaters:	
1.1	*Should we replace a central collection of water heaters with a number of small efficient units located close to outlets?*	
1.2	*Should we use timer controls?*	
2.	Point of Use Units:	
2.1	*Should we use a timer?*	
2.2	*Is the unit set to off peak times/rates?*	
	If not, should it be?	
2.3	*Should we have flow controls or low flow rate shower fittings?*	
2.4	*Should we have aerators fitted to taps?*	
	Which ones?	
2.5	*Should we consider high efficiency replacement units?*	
3	Boiling water units:	
3.1	*Should we use timers?*	
3.2	*Could we do with a smaller unit?*	
3.3	*Should we consider even smaller units such as a kettle or jug? Where should these be located?*	

Action 8

Saving Energy with Office and Other Equipment

western power | plug in KIDS

Action 8

Saving energy with office and other equipment

Together, equipment items may consume up to 15% of the school's electricity usage. Major users include:

- Computers
- Refrigerators
- Audiovisual equipment
- Workshop machinery
- Office equipment
- Cookers
- Kilns

Broad Savings Strategies:

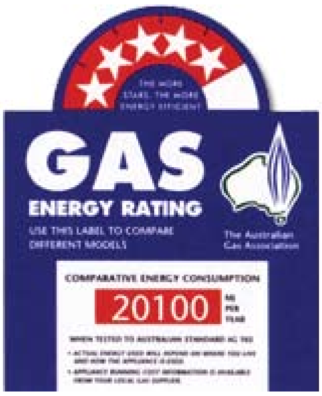
- Switch off equipment when it is not needed:

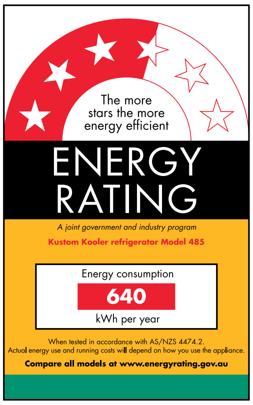
  (a) Manually - by operators or designated monitors and teachers.

  (b) Automatically - using timers, movement/occupation sensors or other devices.
- Energy saving mode on equipment saves minimal energy.
- Ensure equipment is properly maintained and operated.
- Modern appliances go into "Standby Mode" when switched off, such as televisions and VCRs. They are still consuming electricity in this mode and represent a leak of electricity. Switching off all unnecessary appliances at the power point will save hundreds of dollars each year.

Purchase **Energy Star** certified energy efficient office equipment as a matter of standard procedure. **Energy Star** reduces the amount of energy consumed by a product by either automatically switching it into a "sleep" mode when it's not being used and/or reducing the amount of power used when in "standby" mode.
Standby power is the electricity consumed by appliances when they are switched off or not performing their primary function. If your computer, printer, fax or photocopier complies with the **Energy Star** standard, it can automatically switch itself into a power-saving sleep mode after a certain amount of idle time. In the case of computers, the monitor will go dark and other components, such as the hard disk and main processor, will turn off to reduce the amount of power they're using by about two thirds.

- **Consult the stars:** When purchasing white goods such as cookers and fridges, choose the smallest appliances suited to the proposed task and use the Energy Rating labels to choose the most energy efficient appliance for its size. The more stars an appliance has the more energy efficient it is.





Computers:

- Switch off computers, monitors, printers and scanners that are not in use at the power point if possible. *Note: The screen saver feature does not save any energy and the standby mode for monitors and printers is still using energy.*
- Purchase **Energy Star** energy efficient computers, monitors, scanners and printers.
  - Laptop computers use as little as a tenth of the electricity as desktop computers and with new energy efficient laptop processors now available even greater savings are possible. This has the added advantage of extending the battery life for remote laptop computing.
  - laser printers use up to 150 watts, whereas inkjet printers use less than 10 watts and dot matrix printers 10 to 20 watts.
  - LCD (Liquid Crystal Display) monitors are marginally more energy efficient than standard CRT (Cathode Ray Tube) colour monitors.

Office Equipment:

- See above for computers and printers.
- Switch off photocopiers as they may use 150 to 300 watts when switched on but not copying.
- Purchase **Energy Star** energy efficient copiers. Look for these features:
  - quick warm-up so you don't have to wait to copy if the machine is switched off.
  - ability to use recycled paper.
  - built in timers.
  - double sided copying and reduction features save paper.
  - "energy save" stand-by button, but be careful as some "energy save" buttons save almost no energy. Ask to see evidence of the savings.

- Review the amount of copying actually done at the school.
- Use double-sided copying and reduction features to reduce the paper use and the numbers of copies.
- Your school's public address system can consume over 50 watts. Switch it off when not needed. However, check with the supplier first to make sure it will not be damaged by doing this.
- Minor office equipment such as electric staplers, duplicating machines, digital displays can each cost $5 to $10 annually to operate if they are left on. If it is convenient, switch them off at the power point.

For more information on enabling **Energy Star** in your school or procuring **Energy Star** energy efficient office equipment for your school, visit the **Energy Star** website at www.energystar.gov.au

Refrigeration:

- There are many refrigerators scattered around most schools, each costing about $100 per year to run. Are they all needed?
- When a refrigerator is purchased, buy the smallest most efficient unit suited to the task. "**Consult the stars**" (6 Star Energy Rating System) for the most energy efficient fridge for its size.
- Make sure the coils at the back of refrigerators are well ventilated and cleaned. Refrigerators need to be located in a cool spot out of the sun and away from heat sources such as ovens and pie warmers.
- In the school canteen put non-perishables in a separate refrigerator, which should only be operated for a few hours before lunchtime each day.
- Switch off the lights in display-type refrigerators as these use energy and make the refrigerator compressor work harder.
- Educate staff and students to choose what they want from the fridge before they open the fridge door to minimize the time the fridge door is left open.
- Throughout the school, switch off and clean out refrigeration equipment for holiday periods and where possible, over weekends. If fridges are off then leave door open to stop the build up of unpleasant odours.
- Drink machines are generally high-energy users.
- Door seals can leak. If a piece of paper can slip between the door and the seal then the seal may need to be replaced. *Note: Check to see if door is square on the refrigerator and level.*

Cookers, Stoves and Ovens:

- Most cooking is done in the Home Economics room and the Canteen.
- Use microwave ovens in preference to conventional cookers.
- Practice efficient cooking techniques (lids on pots, low simmer instead of boiling).
- Don't preheat cooking equipment for more than 5 minutes before use.
- Turn unused equipment off or to a lower setting during quiet periods as most equipment re-heats to operating temperature within a few minutes.
- Can **less** equipment be used to satisfy demand?
- Can heated products which sell in small quantities, be discontinued so cooking equipment can be shut down?
- Can microwave ovens be used instead of pie warmers?

Audiovisual Equipment:

- Switch off digital displays and battery chargers when the equipment is not in use. Each one adds up to $10 to annual electricity bills.
- Switch off overhead, slide and data/LCD projectors promptly after use. Remember the standby mode of LCD projectors is still using electricity. Switch appliances off at the power point.

Kilns and Workshop Equipment:

- Operate kilns fully loaded.
- Run electric kilns overnight or over weekends to take advantage of much cheaper off peak tariffs if your school is on one.
- Convert frequently used LPG kilns to natural gas, if possible, and save 40% on running costs. Natural gas kilns produce approximately half the amount of greenhouse gases for the same amount of heat energy.
- Switch off workshop equipment at the power point when it is not in use.
- Replace worn-out motors with high efficiency units. For small motors, savings of 20% are possible.
- For large, frequently used machinery, electronic variable speed drives may be cost effective.

Ideas for Student Projects:

- Evaluate each piece of equipment in your school using **Sheet 17**.
- Prepare a report listing your conclusions and recommendations. You may wish to present this graphically.
- Discuss in class.

Box 1

Timers

Timers play an important role in saving energy by ensuring that equipment is not left switched on unnecessarily. There are two basic types of timer:

1. Timers with clocks that operate equipment for set periods of the day or week. These are used when there is a regular routine. Often, an override button is provided so equipment may be operated at other times.
2. Timers, that when activated, supply energy for a set time and then switch off. These are used when equipment may be required at a variety of times, but a drawback is that they can be easily left on.

Timers may be pneumatic, electro-mechanical (usually with a clock mechanism) or digital (with electronic circuitry). Digital timers are more flexible but programming them can be difficult for the inexperienced.

It is also possible to install centralised systems that switch lights and equipment on/off at set times.

Where appliances plug into standard electricity sockets, plug-in timers available from hardware stores, can be used. Where appliances are permanently wired, an electrician must be called to install a higher capacity, permanently wired switch. These are available through electrical wholesalers. Specialist firms usually install centralised systems.

An important feature for timers is a clearly visible, easily operated override button. Without this, people trying to operate equipment outside normal hours may be tempted to unplug or interfere with the timer. Unfortunately, existing timers usually have small override buttons that are easily overlooked. These can however, be painted bright colours and clear signs placed near the timers so that this problem is overcome.

Timers should be checked regularly to ensure that they have not gained or lost time.

Some timers may consume up to $10 worth of electricity each year due to internal inefficiencies, so they should not be used to control single small appliances with power ratings of less than 10 watts.

Timers can be used to control a wide range of equipment in canteens, offices, staff rooms and classrooms.

Worksheet: Is equipment used efficiently? Sheet 17

Equipment: *Please tick appropriate appliance*	Computer	Monitor	Printer	Scanner	VCR	DVD	Photocopier	Fax
	Television	Projector	Cooker	Pie warmer	Microwave Oven	Machinery	Other:	

Location: ____________________

1. Is equipment switched off when not in use?	
2. Who is responsible for turning equipment on and off?	
3. If applicable:	
a) When is equipment first turned on?	
b) When is equipment finally turned off?	
4. Does equipment have a timer, movement sensor or other automatic device?	
5. How efficient is the equipment?	
a) What is the wattage?	
b) Does it have a quick warm up time?	
c) Is it an **Energy Star** appliance?	
d) Is **Energy Star** enabled?	
e) Is it suitable for the task? Not too big, not too small.	
6. Recommendations for using equipment more efficiently.	

Notes

Action 9

Reporting the Action

Reporting the action

Your Energy Saving Program will have to compete for resources and support with many other projects. What's more, many energy saving measures require an on-going commitment to maintain the level of savings while other measures require substantial capital investment. Many measures are best adopted during the construction of new buildings, renovations or through the purchase of new equipment.

So a planned strategy is needed.

Action 1 provides the policy framework for your school to implement and achieve a reduction in energy consumption. This establishes the school's greenhouse gas reduction and energy conservation commitment, the goals to be achieved, the time frame for their achievement and defines the accountabilities of the participants in the Project Team from the Principal through to the students.

Actions 2, 3 and 4 provide an understanding of how much energy is used, its cost and the activities which consume it.

Actions 5, 6, 7, and 8 provide information on ways to make savings. In these actions we look at how an integrated strategy can be planned and implemented.

How to Present the Information:

Information that you have gathered from the program, **including sheets 1-18**, can be presented in a variety of ways. These include:

- pictorial representations, written and verbal reports, wall charts.
- displays for the local community, development of a school plan for saving energy, individual group project.
- developing pages for the school's internet site.
- group or individual demonstrations.
- pie charts of total energy use and expenditure on energy and greenhouse gas emissions. Note that these will look different as some forms of energy cost more per unit and release different quantities than others. This raises the issue of what the Project Team's primary objective might be - saving money, energy or greenhouse gas emissions.
- graphs or bar charts showing energy costs and usage over time. These highlight seasonal and other long term trends for different fuels.

Where the Information can be Presented:

- in classrooms, the library and around the school.
- in the school newsletter.
- display a large graph in the staff room and on notice boards.
- as energy bills are received, update the graphs and release special information bulletins, to provide feedback on progress.
- supply articles to local newspapers.
- report to the school management.
- on the school internet site.

Involving the Students:

An important component in ensuring the success of the Energy Saving Kit for Schools is to increase the size of the school community involved in the program. However, it is also vital that students in the school understand the principles and practices associated with energy management.

In order to facilitate this understanding, there is a companion to the 'Energy Saving Kit for Schools' called 'Saving Energy, Money and CO_2' which has links to the Curriculum Framework.

Teaching Resources:

Saving Energy, Money and CO_2

The Science and Technology Teaching Resource for primary and secondary schools has been designed to complement the ESK. It can be used on an ongoing basis in schools for energy education and covers a broad range of levels and subject areas.

The manual contains practical ideas for use in classrooms to explain the features of the energy management program. The activities are designed so that they can be used as stand alone lessons in conjunction with the audit or as part of a major curriculum unit on energy management within the school. The manual can be downloaded from the Western Power Internet site at www.westernpower.com.au

Implementing your Savings Plan Checklist: Sheet 18

Items	Comments	Person Responsible
1. Energy Management Team:		
1.1 Appoint an Energy Management Coordinator.		
1.2 Establish an Energy Management Team.		
1.3 Develop an Energy Management Policy		
2. Establishing Credibility:		
2.1 Execute an audit process.		
2.2 Publish information gathered.		
2.3 Implement some low cost, "easy to do" energy saving initiatives.		
2.4 Track energy use and costs.		
2.5 Keep key people informed.		
2.6 Plan ahead.		
3. Maintain Motivation:		
3.1 Publicise the size and value of savings in terms of dollars, energy and CO_2.		
3.2 Offer concrete incentives using some of the savings.		
3.3 Use savings for purchasing equipment which produce more savings.		
3.4 Run "theme" months/ weeks where attention is given to a particular area of energy saving.		

(Continued) Sheet 18

Items	Comments	Person Responsible
4. Plan Ahead for Major Investment:		
4.1 Keep ongoing records.		
4.2 Seek commitment from key people.		
4.3 Consider capital investment.		
4.4 Develop fund raising projects.		
4.5 Apply for funding for greenhouse gas reduction projects and initiatives.		

Notes