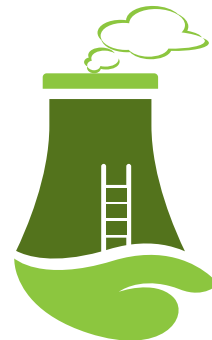


\$AVING ENERGY Money and CO₂



A science and technology teaching resource
for primary and secondary schools

Foreword

We all demand a high level of comfort from the appliances that we use in our homes. In Western Australia nearly 30% of electricity use and 5% of gas use is for domestic purposes. Electrical appliances such as air conditioners also help cause peak electricity generation loads. Our use of energy is increasing and is having an effect on the environment in which we live.

All Western Australian households regularly receive energy accounts for their electricity and gas consumption. In most cases this is a significant regular cost that families have to meet. By introducing simple low-cost or, in some cases, no-cost energy reduction initiatives, families can save as much as 30% off their energy bills.

The purpose of this Energy Management Kit is to help students develop energy management strategies that will reduce electricity and gas consumption in their homes. It is about processes, attitudes and technology.

Why save energy? By saving energy we will achieve three worthwhile objectives. They are:

1. Conserve our energy resources so that they last longer.
2. Minimise the impact of our energy use on the environment and help reduce the greenhouse effect and global warming.
3. Save money.

In other words, **Save Energy, Money and CO₂**.

Western Power has produced this teaching resource kit in consultation with the Department of Education and Training.

Curriculum Framework

This resource has been updated to indicate how the four steps of the publication link to the Overarching Learning Outcomes and the Learning Area Outcomes/Strands.



Values in the Curriculum Framework

1. A pursuit of knowledge and a commitment to achievement of potential.
2. Self-acceptance and respect of self.
3. Respect and concern for others and their rights.
4. Social and civic responsibility.
5. Environmental responsibility.

The integration of these values in the use of this resource will enhance the learning opportunities within school communities.



Overarching Learning Outcomes

1. Students use language to understand, develop and communicate ideas and information and interact with others.
2. Students select, integrate and apply numerical and spatial concepts and techniques.
3. Students recognise when and what information is needed, locate and obtain it from a range of sources and evaluate, use and share it with others.
4. Students select, use and adapt technologies.
5. Students describe and reason about patterns, structures and relationships in order to understand, interpret, justify and make predictions.
6. Students visualise consequences, think laterally, recognise opportunity and potential and are prepared to test options.
7. Students understand and appreciate the physical, biological and technological world and have the knowledge, skills and values to make decisions in relation to it.
8. Students understand their cultural, geographic and historical contexts and have the knowledge, skills and values necessary for active participation in life in Australia.
9. Students interact with people and cultures other than their own and are equipped to contribute to the global community.
10. Students participate in creative activity of their own and understand and engage with the artistic, cultural and intellectual values of others.
11. Students value and implement practices that promote personal growth and well being.
12. Students are self-motivated and confident in their approach to learning and are able to work individually and collaboratively.
13. Students recognise that everyone has the right to feel valued and be safe, and in this regard, understand their rights and obligations and behave responsibly.

Linking the Steps with Learning Area Outcomes/Strands

Outcomes/Strands	Step 1	Step 2	Step 3	Step 4
English				
• Speaking and Listening	x	x	x	x
• Viewing	x			x
• Reading		x	x	x
• Writing			x	x
Mathematics				
• Appreciating Mathematics		x	x	x
• Working Mathematically		x		x
• Number		x	x	x
• Measurement		x		x
• Chance and Data		x		x
• Algebra		x		
Science				
• Investigating		x		x
• Communicating Scientifically		x		x
• Science in Daily Life	x	x		x
• Acting Responsibly	x			x
• Science in Society	x	x		
• Earth and Beyond		x	x	
• Energy and Change	x	x	x	x
Society And Environment				
• Investigating, Communications and Participation		x	x	x
• Resources		x	x	x
• Active Citizenship	x	x	x	x
Technology and Enterprise				
• Information			x	
• Enterprise				x
• Technology and Society		x		

Teacher Guide:

The Four Steps to Energy Management

There are four basic steps to effectively carry out energy management in the home. They are the same four steps professional energy managers use in business. It is a formal approach, which is successful because it uses correct information as its basis, not fallacies or guesswork.

The four steps your students will carry out are:

1. Introduction – define and evaluate energy saving.
2. Do an energy audit and analyse the results.
3. Develop an Energy Management Policy.
4. Develop and implement an Energy Management Program.

The lesson sequence below is designed to fit into a school term.

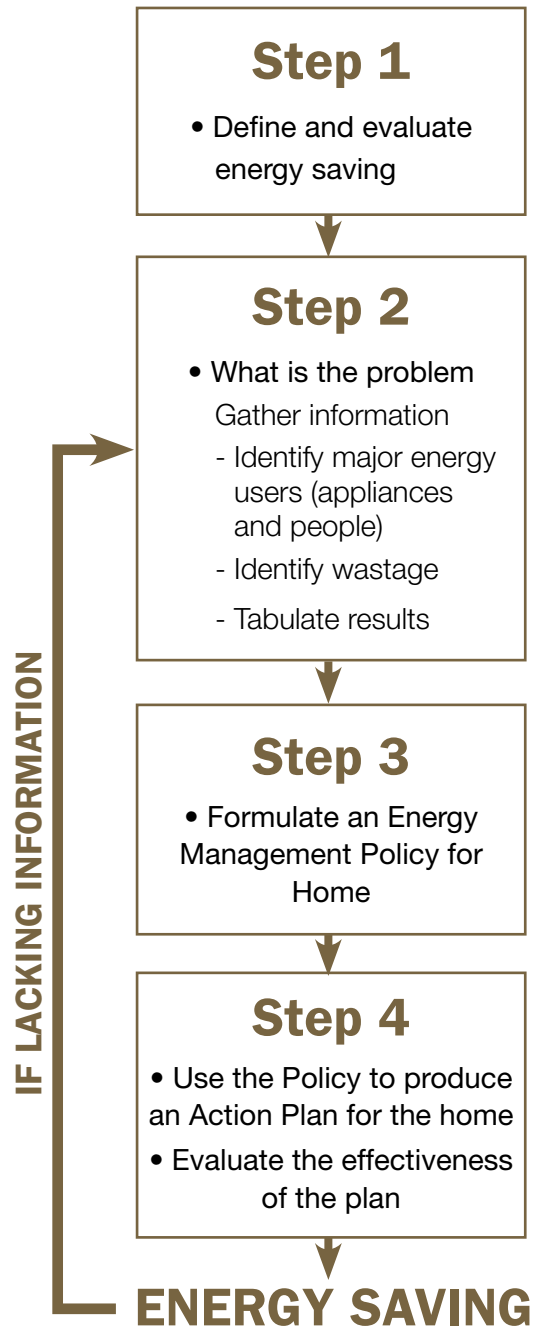
Program – 9 Week Period

Steps	Method	Materials	Time
1. Introduction.	Group Discussion.	Pads, pens and file.	30 minutes.
2. Do an Energy Audit.	Four homework assignments. Group discussion.	Hand out photocopies of Masters 1-8 (graphs and tables).	Assignment 1 & 2 1 week total. Assignments 3 & 4 2 weeks total. 30 minutes TOTAL TIME 3 WEEKS
3. Develop an Energy Management Policy.	Two homework assignments.		1 week for each assignment. TOTAL TIME 2 WEEKS
4. Develop an Energy Management Program.	Group discussion. Audio-visual/discussion. Class work. One homework assignment. Group discussion (final).	Pads and pens. DVD from Energy Saving Kit for Schools. Photocopy of Masters 9 and 10. Students require their completed energy management folders.	30 minutes 1 hour 1 hour 4 weeks 1 hour TOTAL TIME 4 WEEKS

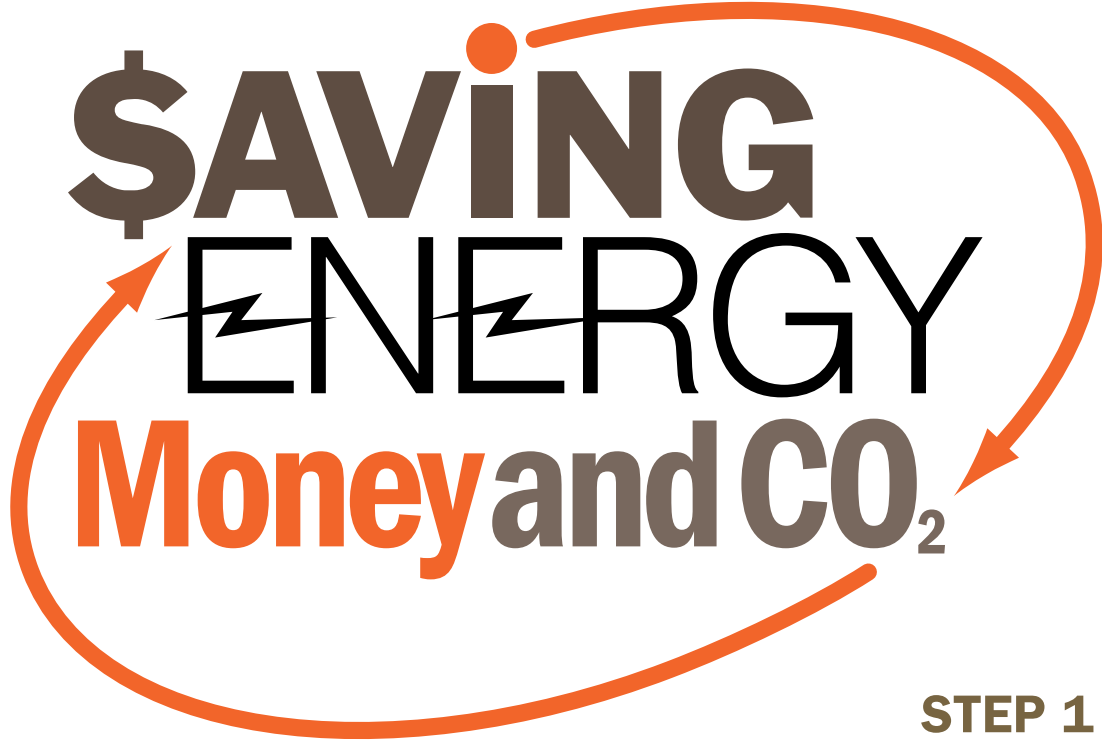
Resources:

See Teachers' Notes on energy saving – Section 5.

Flow Chart of Processes



Teacher: This chart may also be used as an overhead to show your class the processes they will be following.



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STEP 1

A Science and Technology Teaching Resource for Primary and Secondary Schools

Step 1: Learning Area Outcomes/Strands

This lesson can be used to develop student achievement in the following learning areas:

English

- **Speaking and listening**
 - Conventions
 - Processes and Strategies
- **Viewing**
 - Use of Texts
 - Contextual Understanding

Science

- **Science in Daily Life**
- **Acting Responsibly**
- **Science in Society**
- **Energy and Change**

Society and Environment

- **Active Citizenship**



Step 1: Lesson Plan

STEP	LESSON/ TIME	STUDENT OUTCOMES	STUDENT RESOURCES AND ACTIVITIES	TEACHER RESOURCES	ASSESSMENTS AND ASSIGNMENTS	NOTES AND TEACHING AIDS
1	1/30 mins.	<ul style="list-style-type: none"> To understand the meaning of 'Energy Saving'. To determine the value of 'Energy Saving'. To be able to predict benefits. To draw on existing knowledge. 	<p>Paper and pens to record the results of group discussion.</p>	<ul style="list-style-type: none"> Refer Photocopy Master 9. Western Power Energy Info Sheets. Synergy brochure Smartways, giving you the power to save. How much do appliances cost to run? www.synergyenergy.com.au Sustainable Energy Development Office Energy Smart information. www1.sedo.energy.wa.gov.au/pages/publications Energy Saving Kit for Schools. 		<p>An interest generating video may be required.</p> <ul style="list-style-type: none"> Saving Hieronymous. DVD from Energy Saving Kit for Schools.

Step 1: Introduction

Teacher

Organise a group discussion to stimulate interest in the topic and familiarise students with the issues involved. Break up class into groups of four to six students (ideal number for ideas and consensus). Provide discussion points below. Use videos to generate interest/social conscience. The first video from the Energy Saving Kit for Schools DVD provides a good introduction.

Once conclusions and estimates have been reached and group leaders have reported back, summarise the class findings.

STUDENT TASK: GROUP DISCUSSION – SAVING ENERGY.

(30 minutes)

Materials: Pads and pens.

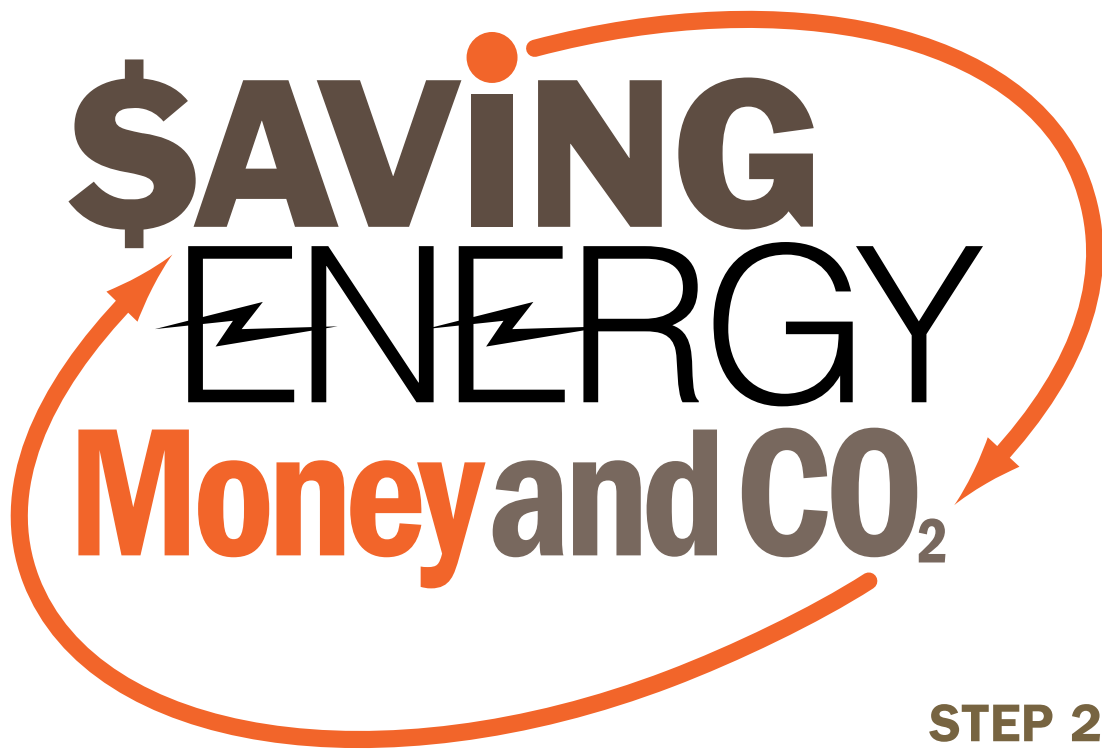
Purpose: The purpose of the discussion is to analyse what Saving Energy means to you.

1. Discussion points:

- What is energy?
- What does saving energy mean?
- Why save energy?
- Would your family want to save energy? Why?
- Does using electricity and gas affect the environment? How?
- What percentage of your energy accounts do you estimate your family could save?
- Which time of the day during the year do you think you and your family use the most energy?

2. Group leaders report back.

3. Summary.



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STEP 2



A Science and Technology Teaching Resource for Primary and Secondary Schools

Step 2: Learning Area Outcomes/Strands

This step can be used to develop student achievement in the following learning areas:

English

- **Speaking and listening**
 1. Conventions
 2. Processes and Strategies
- **Reading**
 1. Uses of Texts
 2. Conventions
 3. Processes and Strategies

Mathematics

- **Appreciating Mathematics**
- **Working Mathematically**
 1. Mathematical Strategies
 2. Reason Mathematically
 3. Apply and Verify
- **Number**
 1. Understand Numbers
 2. Understand Operations
 3. Calculate
- **Measurement**
 1. Understand Units
 2. Direct Measure
 3. Estimate
 4. Indirect Measure
- **Chance and Data**
 1. Collect and Organise Data
 2. Summarise and Represent Data
 3. Interpret Data
- **Algebra**
 1. Solve Equations and Inequalities

Science

- **Investigating**
- **Communicating Scientifically**
- **Science in Daily Life**
- **Science in Society**
- **Earth and Beyond**
- **Energy and Change**

Society and Environment

- **Investigation, Communication and Participation**

1. Planning and Investigation
2. Conducting Investigation
3. Processing and Interpreting Information
4. Evaluating and Applying Findings

- **Resources**

1. Use of Resources
2. Management and Enterprise
3. Active Citizenship

Technology and Enterprise

- **Technology in Society**



Step 2: Lesson Plans

STEP	LESSON/ TIME	STUDENT OUTCOMES	STUDENT RESOURCES AND OUTCOMES	TEACHERS' RESOURCES	ASSESSMENTS AND ASSIGNMENTS	NOTES AND TEACHING AIDS
2	2/30 min.	<ul style="list-style-type: none"> To be able to identify areas of energy waste. To be able to conduct an energy audit. To be able to interpret second hand data. To present data in table and graphical form. 	<ul style="list-style-type: none"> Photocopy Masters 2,3,4, & 5. Second-hand data (Western Power/Synergy and Alinta accounts). Task 1: Show yearly electricity and gas use and interpret findings. Task 2: Complete list of appliances. Plot daily energy use curve for household. 	<ul style="list-style-type: none"> Teachers need to read notes on saving energy. Refer to pages 48-60. Synergy brochures 'SmartWays of using electricity' and 'SmartWays new appliance checklist'. Photocopy Master 6. 	<ul style="list-style-type: none"> Assessment tasks 1 and 2. Check completion of tasks. Mark one nominated graphing task. 	<ul style="list-style-type: none"> Energy Saving Kit for Schools. Available at www.westernpower.com.au
2	3/30 min.	<ul style="list-style-type: none"> To be able to calculate energy use. To be able to manipulate equipment. To be able to identify areas of energy wastage. 	<ul style="list-style-type: none"> Photocopy Masters 7 and 8. Task 3: Complete Photocopy Masters 3 and 4. Task 4: Identify and record areas of wastage. Class discussion of results. 	<ul style="list-style-type: none"> Refer to page 13 'Points to consider'. Photocopy Master 9. 	<ul style="list-style-type: none"> Check students' calculations. Collect one nominated task for formal marking. Informal assessment of discussion. 	

Step 2: Do an Energy Audit

Teacher Background Notes:

Students need to establish what is happening in their homes before they can implement an energy management strategy. The first step is to undertake an **Energy Audit**. By completing the audit, students will find out why and when, what and who to target. They can then construct simple graphs and tables that will provide them with at-a-glance information identifying the main areas for potential savings in their homes.

The following four homework research tasks will complete the Audit:

- Peak periods of energy use during the year.
- Peak periods of energy use during the day.
- Appliances that use the most energy.
- Family members that use the most energy.
- Contributors to peak electricity demand.

Teacher: Audit Task 1 – Daily Energy Consumption Patterns.

Graphs giving examples of average daily consumption are shown in **Overhead/Photocopy Master 1**.

The graphs show the average consumption for all consumers. There is no “average” household as far as energy consumption is concerned because of the following:

- (a) Variations in the type and number of appliances used.
- (b) Variations in usage due to social and environmental conditions.
- (c) The number of people living in the house.

Synergy sends out electricity accounts every two months – six per year. These show actual household consumption in units (kWh) as well as the cost. Alinta accounts are forwarded every three months – four per year.

If parents have not kept past accounts Synergy (13 1353) and Alinta (13 1358) Customer Services will supply printouts. However, please encourage students to gather the information from home records.

Ideally, students should show patterns of energy use by plotting a graph of the electricity and gas units used for each account period (electricity in red and gas in blue). Peaks should be highlighted. A blank graph sheet – **Photocopy Master 2** is on page 25.

It is important that units of kilowatt hours (kWh) and not dollars are used for the students' graphs.

There are two reasons for this:

- 1) The price of gas is not fixed, but is based on a sliding scale. The more gas that is consumed, the cheaper it is. Therefore the total cost of the gas is not a good indication of consumption.
- 2) Electricity and gas prices may also change during the year.

Some students will have higher energy consumption in winter because of room heating and others may have high consumption in summer because of air conditioners and swimming pool/reticulation pumps. The highest demand for electricity in Western Australia is in the summer and not winter – the opposite to most other Australian States and Territories.

Student Task 1: Yearly Energy Consumption Patterns.

Materials – Photocopy Master 2.

- a) Draw a graph showing patterns of yearly electricity and gas usage in your home.
- b) Identify times of the year when most energy is being used.
- c) What is the value of (interpret) this data?

Teacher: Audit Task 2 – Daily Energy Use.

We now need to identify which appliances are using the most energy and when.

The higher the energy rating of the appliance and /or the more that it is used, the greater the energy use. Identifying the larger energy users will show which appliances should be targeted.

Students will need the ratings of electrical appliances in watts or kW, and gas appliances in megajoules (MJ). These are marked on the manufacturer's sticker or nameplate. **Warn students that they must ensure that all electrical appliances are turned off and that gas appliances are switched off when they are looking for the ratings labels.**

Some appliances, such as refrigerators, are large energy users and time of use and consumption is difficult to measure.

A table for students to record appliance usage is provided on **Photocopy Master 3**. Students will need to calculate kWh and cost. They will also need to know how to transpose the MJ rating of gas appliances to kW. This is done by dividing the MJ rating by 3.6 and using the kWh costs from energy accounts. **Photocopy Master 3** has an example to help the students fill in the required details. Domestic electricity meters have become more sophisticated and some students' homes may be fitted with a Smartpower time-of-use meter. Smartpower is available to residential customers connected to the South West Interconnected System, and calculates different rates for off-peak, peak and shoulder periods. By using power in the cheaper time period, customers can save up to 30% off their annual electricity accounts.

There are four different periods of time when electricity costs vary during weekdays and two at weekends. The rate applicable to that particular time of the day is charged, instead of the usual flat rate of 13.94 cents /kWh. In addition, the rates vary for summer weekdays (October to March) and winter weekdays (April to September). The weekend rates are the same all year round.

The Smartpower meter allows Synergy to offer cheaper prices for electricity used in the off-peak times and higher prices for use in peak times when additional generators must be used to maintain the electricity load. This encourages those residences with the Smartpower meter fitted, to use the electricity supply more efficiently. Managing their demand is called “demand management”.

In winter the peak electricity demand is between 6am and 10am and 4pm and 8pm. In summer there is a peak between 1pm and 3pm as this is the time of day when commercial air conditioning and industry are operating at full capacity.

Graphs showing peak demand are on **Overhead/Photocopy Master 4**. A blank graph sheet for students’ homework is at **Photocopy Master 5**.

Column five of the List of Appliances on **Photocopy Master 3** gives students the data to construct their household’s daily load curves. Comparisons with Verve Energy’s load curves can also be made.

Student Task 2: Homework Assignment – Daily Energy Use.

Materials – Photocopy Masters 3 and 5.

- a) Complete the ‘List of Appliances’ provided.
 - Calculate appliance consumption in kWh.
 - Identify and highlight appliances in your home that are large energy users.
- b) Using the blank graph sheet provided, show your household’s daily load curves. (Plot time of use against ‘kWh’ rating).
 - Why is it important to identify when electricity is being used?
 - How does this affect the cost to supply electricity?
 - If the price of electricity doubled for peak usage and halved for off-peak usage, predict how it would affect your household’s energy accounts. Show calculations.

Teacher: Audit Task 3 – Who uses what?

By identifying who uses what, families will learn if some people are using more energy than others, and who they are.

With the spotlight on energy consumption and who is using what, members of the family will suddenly become very conservative with their usage. This will result in an immediate energy saving and is an achievement in itself. However, as soon as the spotlight is off, some people will probably revert to their old ways.

Overhead/Photocopy Master 6 shows the make-up of typical Western Australian energy accounts. Pie chart (a) is for the South West of Western Australia. This is for a home using electricity and gas and presumes no solar or wood-fired appliances are being used. The chart shows proportions of energy used for each major appliance group and gives an idea where most savings can be made. Similarly, for the hotter North West of Western Australia, energy usage would look like pie chart (b). These charts are used to estimate home energy use and cost.

As you can see for the South West, the largest users of electricity are usually water heaters and the smallest are lights. For the North West the largest user is air conditioning with lighting again the smallest.

Applying these averages to their total energy bills for the year, students can work out approximately how much their families spend each year on each of the six appliance sectors.

A table needs to be drawn up to record the findings. An example is given in **Photocopy Master 7**. This particular example is for hot water use. Similar tables need to be designed for the other major appliances. Students will need to design other tables as required.

Example – Water Heaters.

Electric Water Heater:

Presume total electricity consumption for all appliances in a house for the year is 5,600 units. Using the pie chart for the South West, we note that the average yearly proportion for water heating is 32%. This means that around 1,800 units of electricity are for water heating each year. This can be broken down to an average daily consumption of five units per day (around 70c per day at one unit (kWh) costing 13.94c).

There are two areas of hot water usage – **communal** hot water usage such as washing dishes and clothes, and **individual** hot water usage such as showers and baths.

Communal use:

A proportion of the water heating energy and cost needs to be allocated to cover communal use. This can be divided by the number of people in the family and each costed with a share. Assume 1/3 of the water usage is 600 units in this example (this may vary between houses).

Individual use:

There are two alternative methods of working out individual hot water use in the shower and/or bathroom:

1. Calculating litres used (1 kWh heats 17 litres of water at 50°C).
2. Proportion method.

Method 1 is the most accurate, but the most difficult to calculate, therefore it is not recommended. It involves calculating litres used per minute and then working out energy and dollar costs. However, the problems with this method include:

- Flow rates of water heaters vary about 5 – 20 litres/minute.
- Water mains pressure (flow rate/minute) varies around the State.
- Individual preferences for shower flow vary from a light spray to a waterfall. (Usually preferred by people who do not have to pay for it).
- Some like it hot, some do not.

Method 2 is the simplest and recommended method. It still involves timing people in the shower (a hazardous assignment). However, instead of worrying about litres used, time spent showering is used as a proportion of the family total. **Use Overhead/Photocopy Master 6.**

Example: Total family showering time/day = 100 minutes

- Dad spends 15 minutes in the shower/day = 15%

Therefore Dad is allocated 15% of non-communal hot water usage.

If we assume that non-communal hot water usage is 0.66 of total:

- $1800 \times 0.66 = 1200$ units/year

Then Dad is responsible for 15% of 1200 = 180 units/year

Converted to daily rates, $180 \text{ units} \div 365 \text{ days} =$ approximately 0.5 unit/day or about 7 cents/day (electric) is recorded for Dad.

Time spent with water running is important – not simply the time spent in the bathroom.

Example continued:

What does this SAVE?

If Dad showers for 10 minutes instead of 15 minutes, his use will cost 4.5 cents per day instead of 7 cents per day. This becomes an actual saving of $(7 \times 365) - (4.5 \times 365) = \9.12 for one person and one appliance per year.

Also

Dad uses 0.18 units less each day

i.e. 0.18 units x 1.1 kg of CO₂ per day, or

0.18 units x 1.1 kg x 365 days @ 72.27 kg of CO₂ that is not released that year because one person has cut down on the length of a shower taken.

[See Teachers' Notes for cost the of CO₂]

Similar proportional methods can be used to allocate usage for other appliances.

End of example.



Student Homework Task 3: Who Uses What?

(Students have two weeks to complete both homework assignments 3 and 4).

Materials – Photocopy Master 7.

You are to:

- a) Find out what major appliances each member of your family is using.
- b) Record the information in table form.
- c) Find out if any appliances are needlessly left on. For example the TV or radio.

Points to consider:

- Do you anticipate any problems trying to gather all the information? What are they and how will you overcome them?
- How will you proportion hot water for dish washing, clothes washing and showering?
- How will you allocate usage of other communal appliances? Some appliances will be difficult to allocate.

Teacher: Audit Task 4 – Wastage.

Read Teachers' Notes on Saving Energy.

Students will need a standard bulb thermometer that reads from -20°C to 100°C and the instructions contained in Photocopy Master 8 to check that temperatures are not too high or too low.

Student Task 4: Identifying Energy Wastage.

Materials – Photocopy Master 8 and Thermometer.

Using the thermometer and instructions you are to:

- a) Identify and record areas where wastage is occurring.
- b) Adjust those appliances that can be adjusted. For example – air conditioners, electric water heaters and refrigerators.



Teacher: Audit task 5 – Analysing the Results.

By now students will have produced graphs, tables and measurements of energy wastage. From their audit, they will have a fairly accurate measure of how energy is being used in their homes.

Organise a group discussion so that students can share and compare results.

Student Task 5: Group Discussion – ‘The Energy Audit – Analysing the Results’ (30 minutes).

1. Discussion Points:

- Months of the year when the greatest energy use occurs.
- Times of the day when energy use is highest.
- Percentage of daily energy use during peak demand periods.
- Areas of energy wastage.
- How much does energy used vary within the class group?

2. Group Leaders report back.

3. Summary.

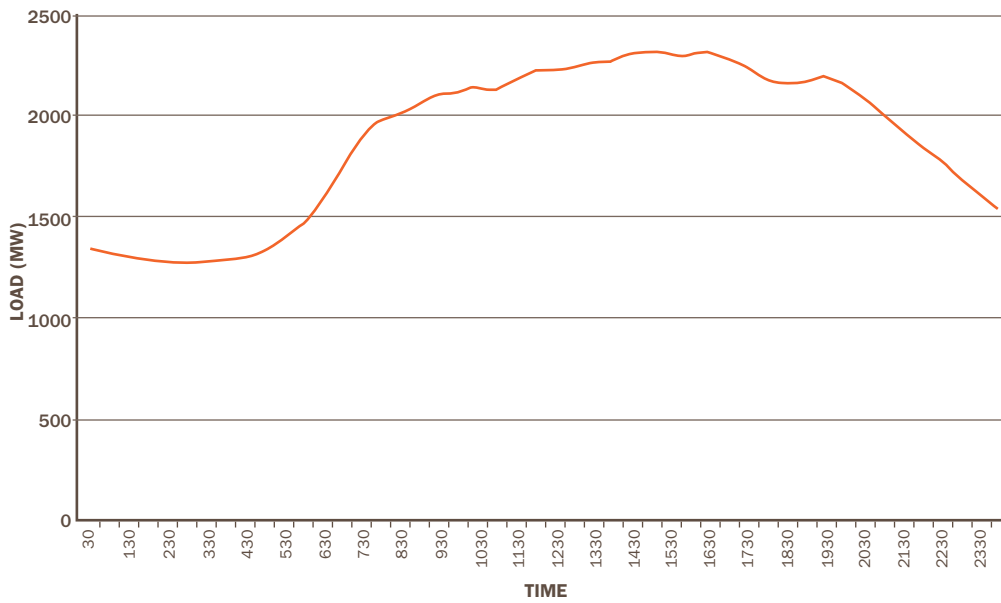
Teacher: Move to Step 3 – Develop an Energy Management Policy.



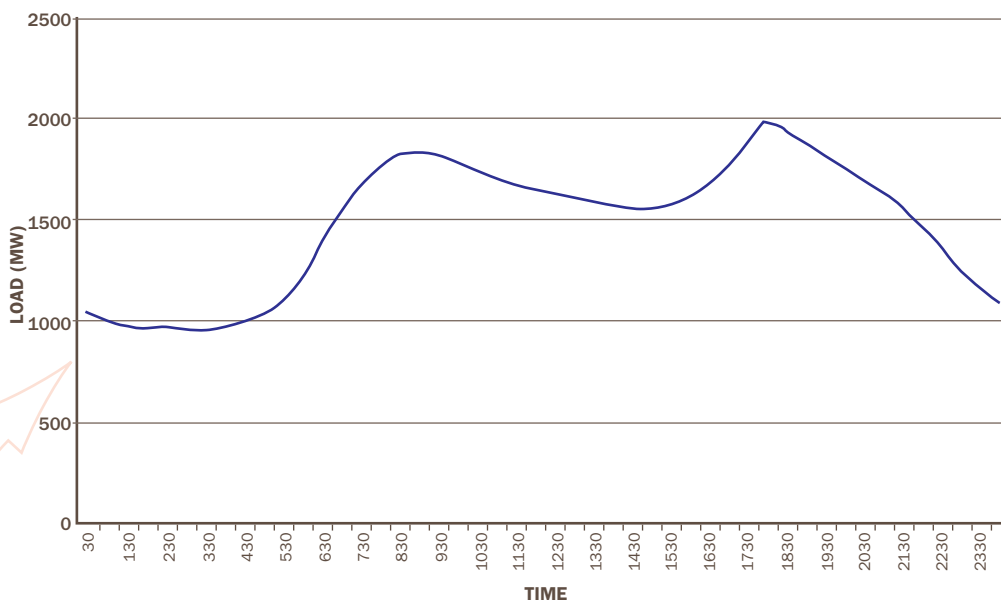
Overhead/Photocopy Master 1

Daily Energy Consumption:

TYPICAL SUMMER LOAD PROFILE

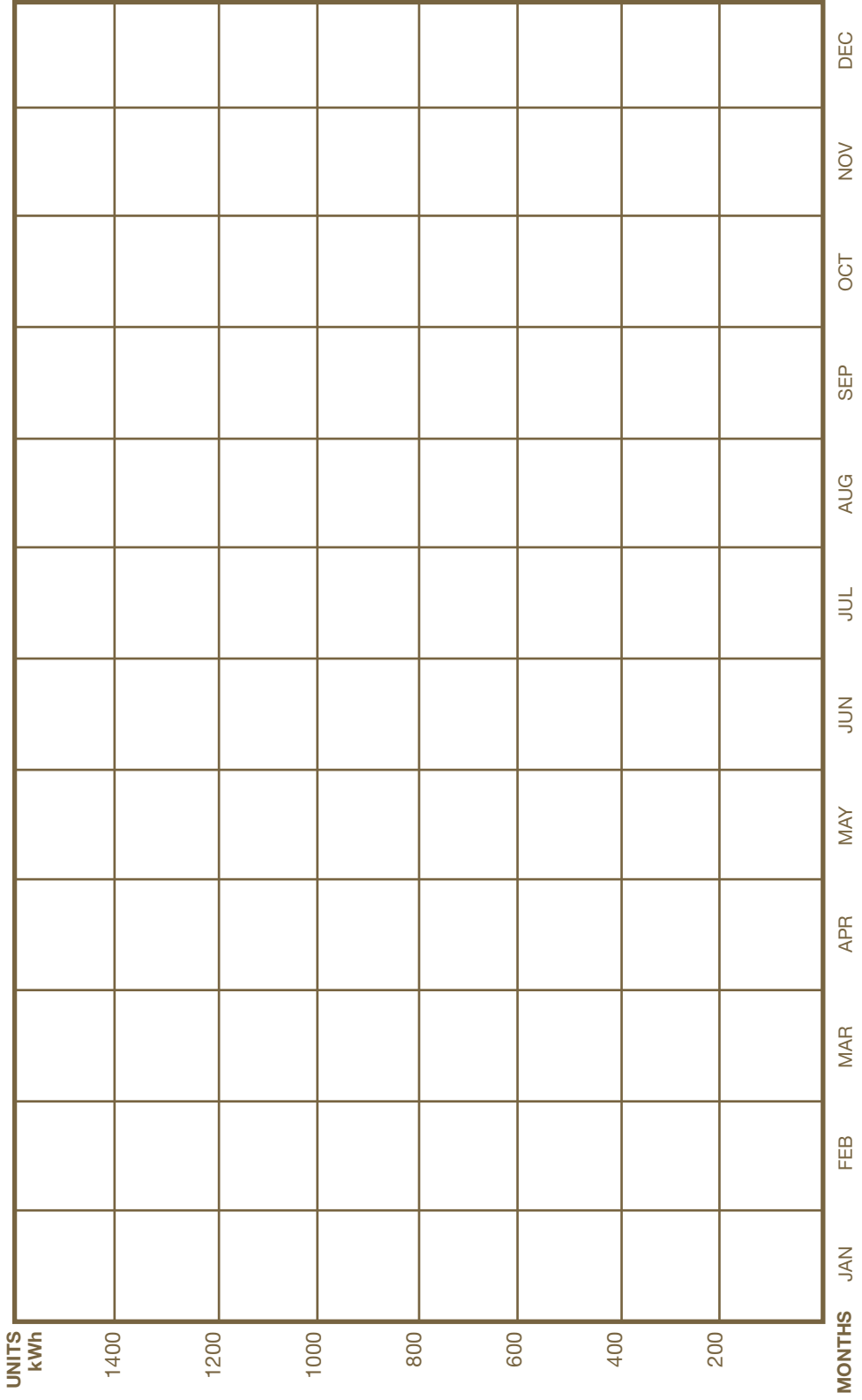


TYPICAL WINTER LOAD PROFILE



Photocopy Master 2

HOUSEHOLD'S YEARLY ENERGY CONSUMPTION PATTERN



Photocopy Master 3

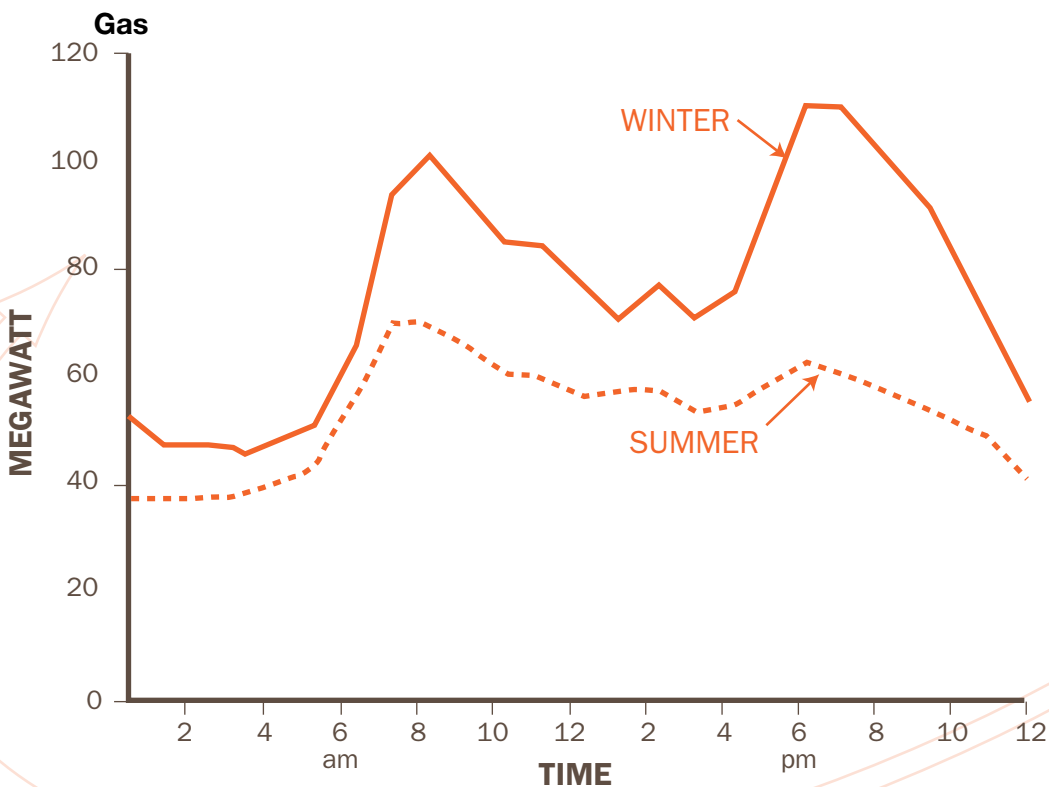
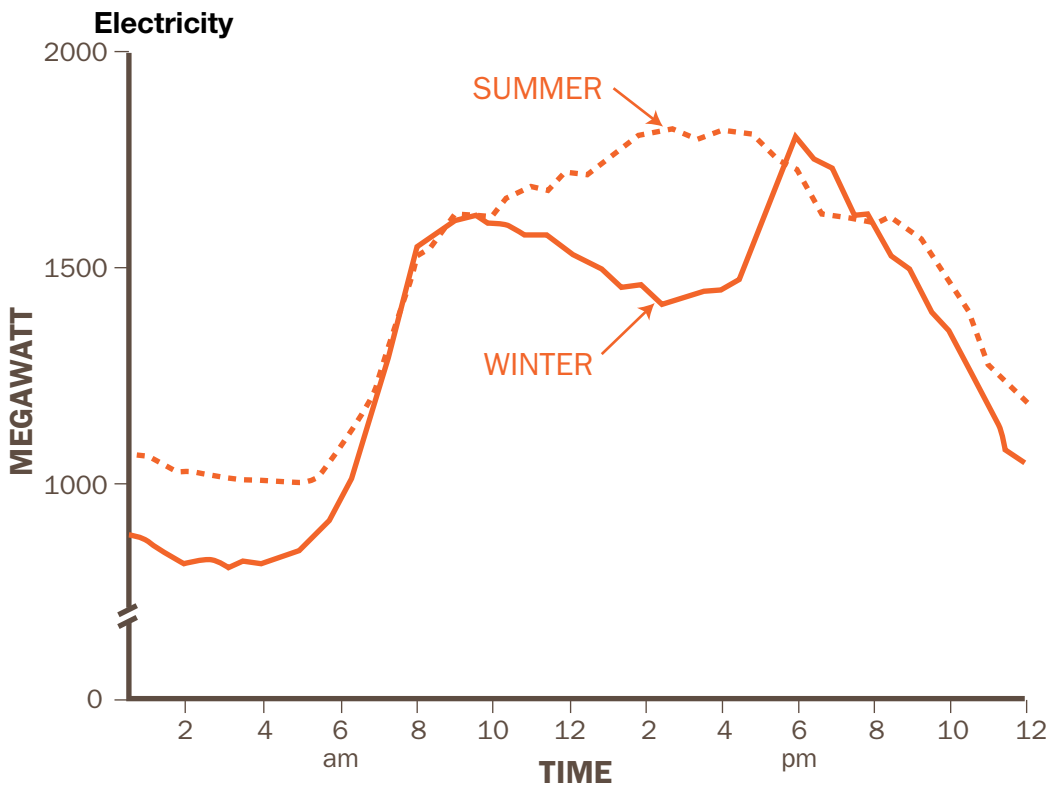
List of Appliances:

APPLIANCE	RATING [a](kW)	MINS [b]/DAY	KWh [a] x [b] = [c] 60	Cost [c] x from Account	TIME OF USE
Ant Zapper	1.0 kW	100 min	1.0 x $\frac{100}{60}$ = 1.6 kWh	1.6 x Cost from Account	Morning
Reverse Cycle Air Conditioner					
Evaporative Cooler					
Hot Water System					
Electric Instant					
Electric Storage					
Gas Storage					
Solar Electricity					
Solar Gas					
Electric Cooking					
Gas Cooking					
Exhaust Fan					
Microwave					
Dishwasher					
Refrigerator					
Freezer					
Washing Machine					
Clothes Dryer					
Toaster					
Kettle					
Percolator					
Sandwich Maker					
Bread Maker					
Electric Wok					
Electric Fry Pan					
Deep Fryer					
Food Processor					
Electric Fan Heater					
Gas Heater					
Television					
VCR/DVD					
Ceiling Fan					
Pedestal Fan					
Computer					
Vacuum Cleaner					
Hair Dryer					
Reticulation Pump					
Pool Pump					
Outdoor Spa					
Lighting					
Photocopier					
Iron					

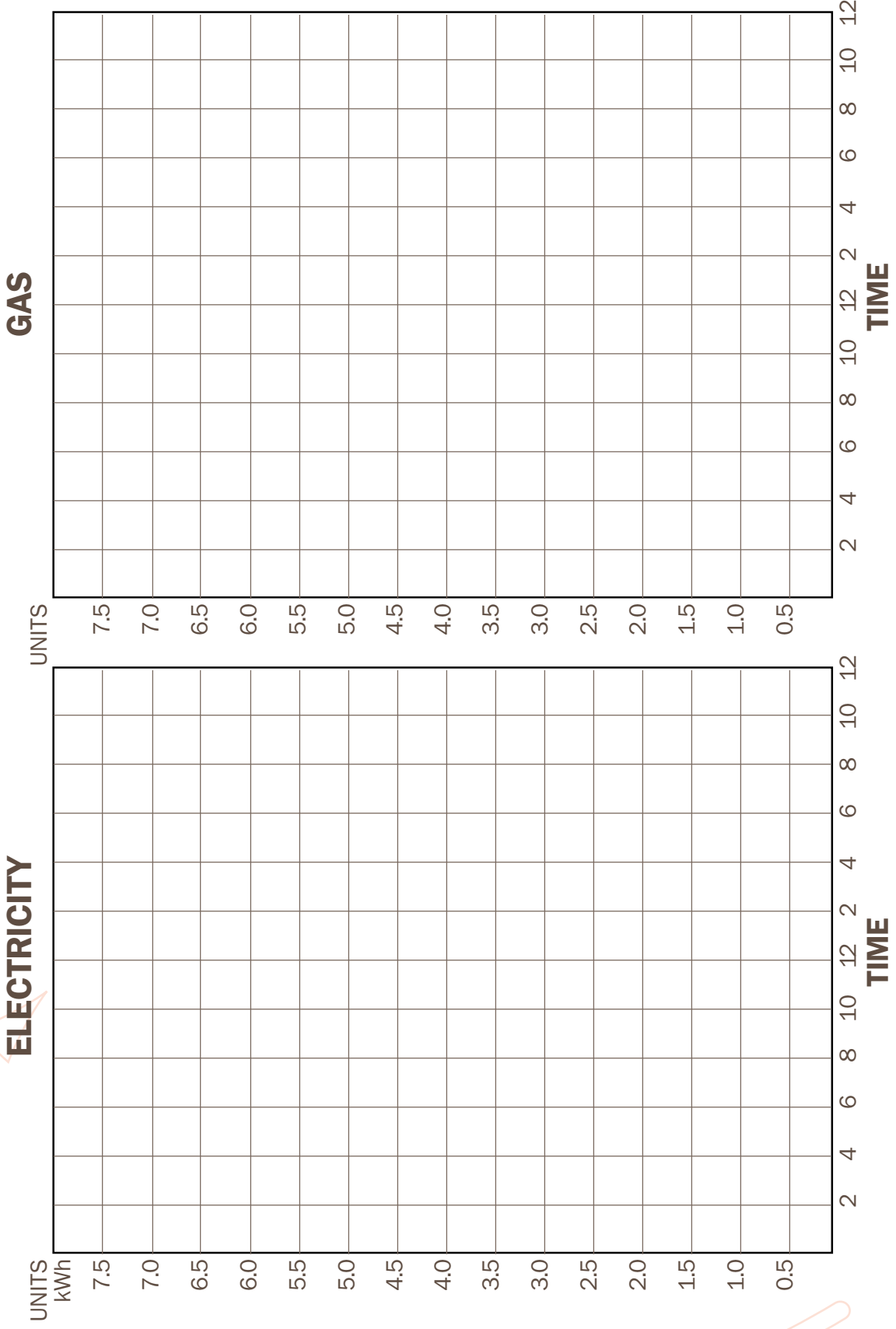
Overhead/Photocopy Master 4

Load Curves:

The following are only examples of how a summer and winter peak daily load curve might look for the South West electricity and gas systems.



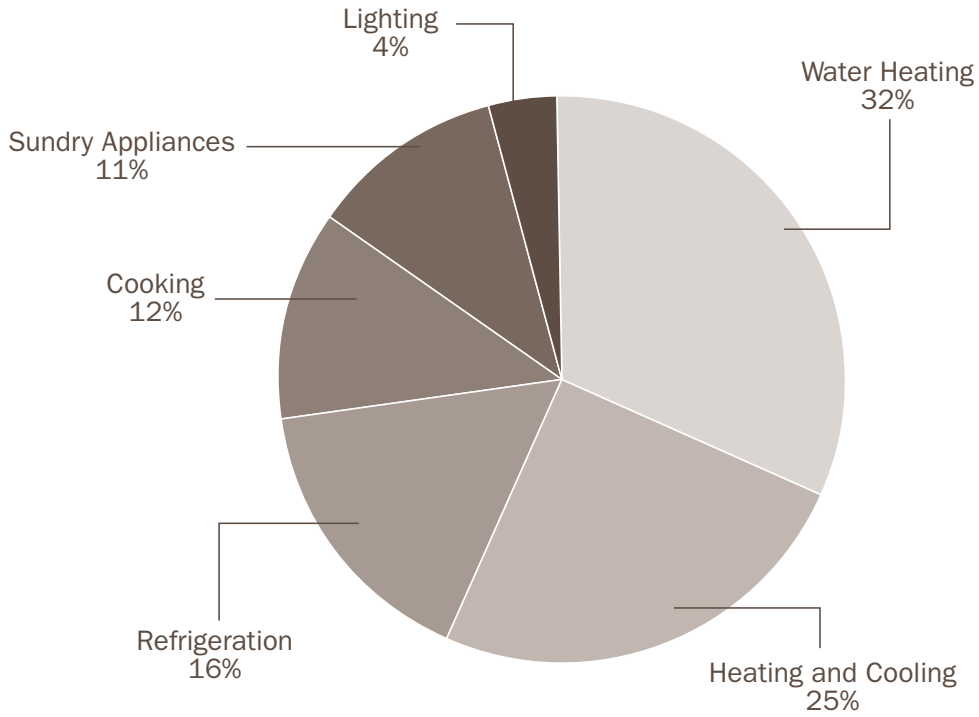
Photocopy Master 5



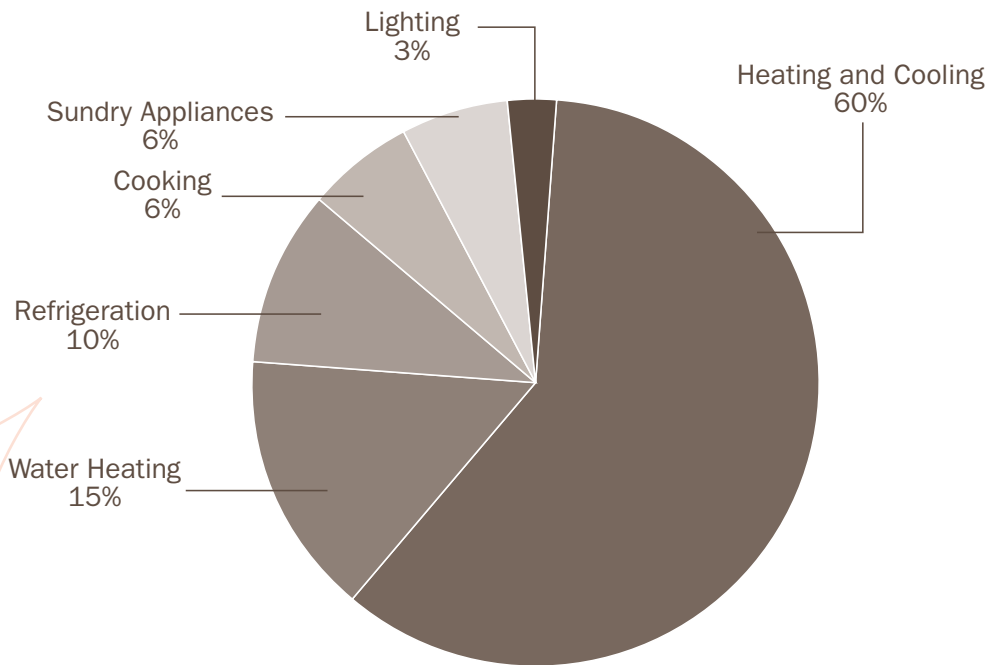
HOUSEHOLD'S DAILY LOAD CURVES

Photocopy Master 6

(a) TYPICAL ACCOUNT FOR SOUTH WEST



(b) TYPICAL ACCOUNT FOR NORTH WEST



Photocopy Master 7

Who uses what?

INDIVIDUAL HOT WATER USAGE COMMUNAL HOT WATER

PERSON	SHOWER/BATH MINUTES OF USAGE/DAY	kWh/Unit	¢	PEAK USER?	PROPORTION FOR WASHING CLOTHES AND DISHES/DAY	PEAK USER?	TOTAL HOT WATER USAGE/PERSON/DAY kWh/Unit	¢
--------	----------------------------------	----------	---	------------	---	------------	---	---

		kWh/Unit							¢
Dad									
Mum									
Me									
Brother									
Sister									

Total units (kWh) used for year _____
 Proportion for hot water _____
 Proportion for individual use _____
 Proportion for communal use _____



Photocopy Master 8

Instructions for Use:

Hot Water.

Run off water from the tap until the water is hot. Fill cup with hot water and place the thermometer in the water for several seconds.

Check the maximum temperature reached. If it is above 72°C, it is too hot and the setting on the thermostat on your hot water service should be lowered. The ideal setting should be between 68°C and 60°C. This operation can be simple where an adjustable thermostat is fitted or may have to be carried out by a plumber or electrician. (Contact the manufacturer if you have any doubts).

Important Safety Note.

Water from solar hot water heaters reaches very high temperatures in Western Australian summers. Extreme care must be taken when attempting to measure the hot water temperature. It is also possible that the thermostat may burst.

As the heat source is free there is not much point in trying to measure the water temperature for energy saving purposes.

Summer Cooling.

Place the thermometer in the room to be cooled. Let the air conditioner run for 30 minutes then check the temperature reading. The temperature of a cooled room should be between 24°C and 26°C. This range should provide large energy savings.

If the temperature is below 24°C, raise the thermostat setting on the air conditioner until the above temperatures are achieved. By cooling a small area or room instead of a larger area, further energy savings can be made.

Installing insulation will reduce the heat entering your home and the money spent to cool it.

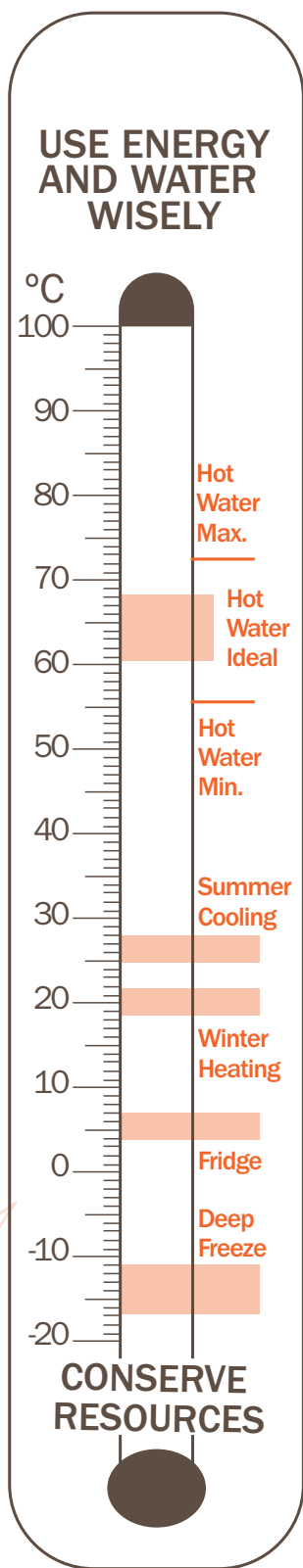
Winter Heating.

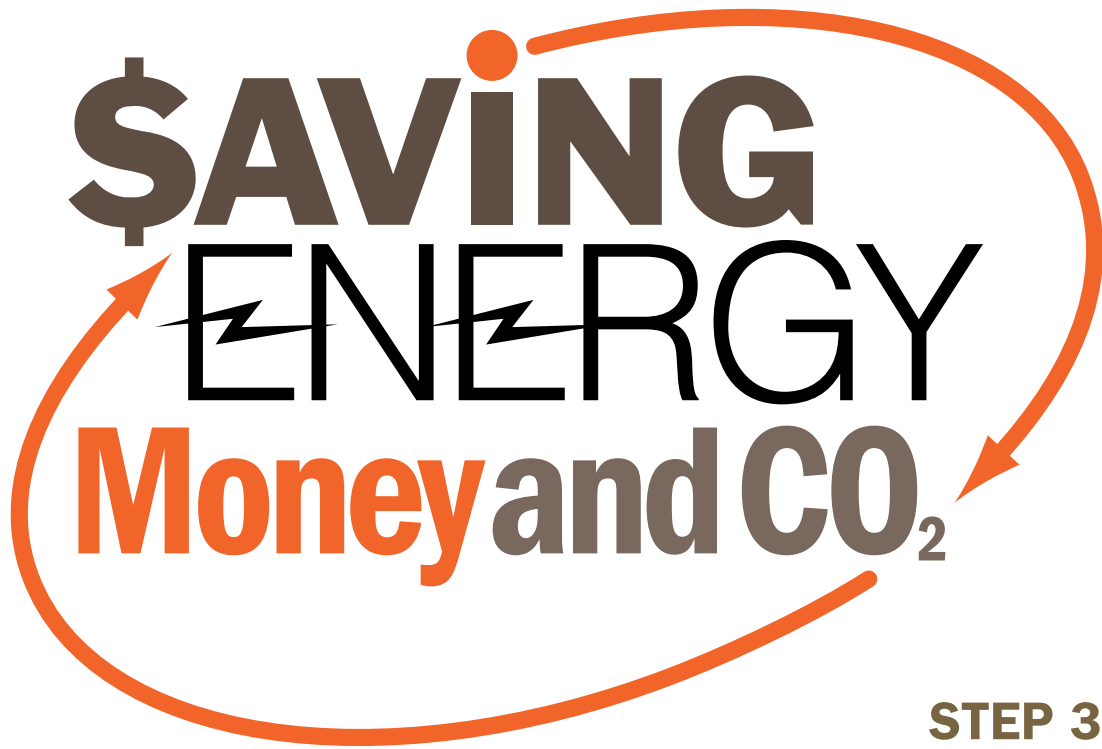
Place the thermometer in the room to be heated. Allow the heater to run for 30 minutes then check the temperature reading. The temperature of a heated room in winter should be between 19°C and 21°C. If the heated room is warmer than 21°C you should turn the heater down until it reaches the correct temperature.

Refrigerators and Deep Freezers.

Place the thermometer into the refrigerator or deep freezer and leave it for 15 to 20 minutes and then check the temperature reading. If the reading is below +3°C for the refrigerator or -18°C for the freezer, the temperature is too low and requires adjusting.

Suggested temperature settings for the refrigerator range from +4°C to +6°C. Temperatures for the freezer range from -18°C to -12°C for long-term food. Adjust the thermostat as necessary and retest after several hours to recheck the new temperatures.





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STEP 3

A Science and Technology Teaching Resource for Primary and Secondary Schools

Step 3: Learning Area Outcomes/Strands

This step can be used to develop student achievement in the following learning areas:

English

- **Speaking and Listening**
 - Conventions
 - Processes and Strategies
- **Reading**
 - Use of Texts
 - Contextual Understanding
 - Conventions
 - Processes and Strategies
- **Writing**
 - Use of Texts
 - Contexts and Understanding
 - Conventions
 - Processes and Strategies

Mathematics

- **Appreciating Mathematics**
- **Numbers**
 - Understand Numbers
 - Understand Operations
 - Calculate

Science

- **Earth and Beyond**
- **Energy and Change**

Society and Environment

- **Investigation, Communication and Participation**
 - Processes and Interpreting Information
 - Evaluation and Applying Findings
- **Resources**
 - Use of Resources
 - Management and Enterprise
- **Active Citizenship**

Technology and Enterprise

- **Information**
 - Nature
 - Techniques



Step 3: Lesson Plan

STEP	LESSON/TIME	STUDENT OUTCOMES	STUDENT RESOURCES AND ACTIVITIES	TEACHER RESOURCES	ASSESSMENTS AND ASSIGNMENTS	NOTES AND TEACHING AIDS
3	4/15 mins each class.	To be able to define what a Policy is. To be able to formulate a Policy. To exhibit group skills.	Clipboard, folder, paper and pens to complete two homework tasks. Task 1: Determine what a Policy is and list the steps required to form a Policy. Task 2: Develop an Energy Management Policy for your home.	Refer Photocopy Master 9. Key Question – What is in it for us?	Students to check each other's Policy Statement. Class discussion to check understanding. Teacher to check written Energy Management Policy.	Refer to the Energy Saving Kit for Schools.

Step 3: Develop an Energy Management Policy

Teacher Background Notes:

Co-operation.

In a commercial business situation, the Energy Manager would approach the General Manager or Chief Executive Officer of the organisation to get the co-operation of all departments and personnel. The students must decide who to approach – Mum, Dad or both.

Consultation.

Energy Managers seek input from departmental personnel to help formulate a policy – a general plan of action. Consultation is the key to get co-operation and agreement on a policy. Students will be asked the fundamental question – ***What is in it for us?***

An example Policy Statement might be:

Our family will reduce energy consumption by 25% this year to save money and help improve the environment.

Another might be:

Our family will reduce our household energy consumption by 30% this year and put the money saved towards our next family holiday.

The first homework task helps the students to establish what a policy is and its purpose.

In the second task they must formulate an Energy Management Policy with their families. Select three or four of the best policies and have the students read them out as good examples.

This will be the starting point of their Energy Management Programs.

STUDENT TASK 1: Policy – determine what a policy is and how to form one.

This can be completed in the library or as a homework assignment.

- a) What is a policy? – refer to a dictionary definition.
- b) What is its purpose?
- c) What must it contain to be meaningful?
- d) Give three examples of policies.

Teacher: Assess and discuss.

STUDENT TASK 2: Homework assignment – develop an energy management policy.

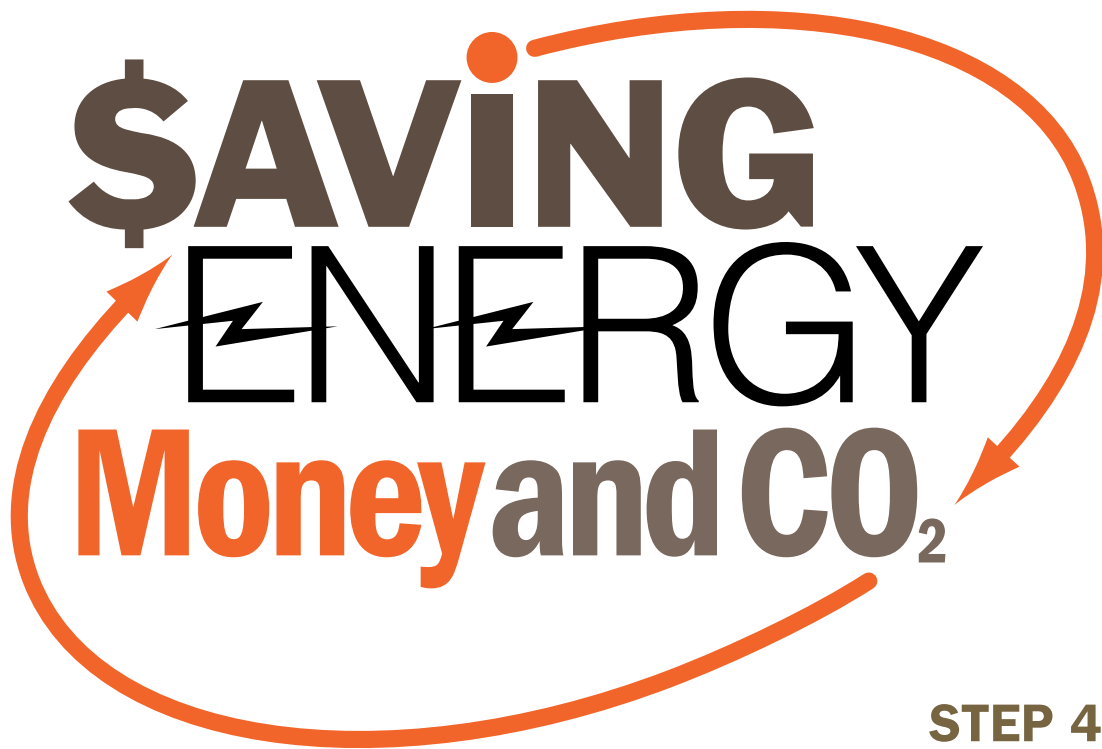
You are to carry out the role of Energy Manager for your home. Your first task is to develop an Energy Management Policy for your home. You will need to:

- Present the findings of your home energy audit.
- Involve your family. Why do you need to do this? How will you involve them?
- Consider the question that you might be asked. What is in it for us?
- Produce an energy management policy statement for your household.
- Make the Policy **'public knowledge'** in your home. How are you going to do this? (Could be a printed notice on the fridge door).
- Start a file for your Energy Management Program.

TEACHER: Assess and discuss.

Then move to Step 4 – Develop and implement an Energy Management Program.





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STEP 4

A Science and Technology Teaching Resource for Primary and Secondary Schools

Step 4: Learning Area Outcomes

This step can be used to develop student achievement in the following learning areas:

English

- **Speaking and Listening**
 - Use of Texts
 - Contextual Understanding
 - Conventions
 - Processes and Strategies
- **Viewing**
 - Use of Texts
 - Contextual Understanding
 - Conventions
 - Processes and Understandings
- **Writing**
 - Use of Texts
 - Contextual Understanding
 - Conventions
 - Processes and Strategies
- **Reading**
 - Use of Texts
 - Contextual Understanding
 - Conventions
 - Processes and Understandings

Mathematics

- **Appreciating Mathematics**
- **Working Mathematically**
 - Mathematical Strategies
 - Reason Mathematically
 - Apply and Verify
- **Number**
 - Understand Numbers
 - Understand Operations
 - Calculates
- **Measurement**
 - Understand Units
 - Estimates
- **Chance and Data**
 - Understand Chance
 - Summarise and Represent Data
 - Interpret Data



Science

- Investigating
- Communicating Scientifically
- Science in Daily Life
- Acting Responsibly
- Energy and Change

Society and Environment

- Investigation, Communication and Participation
 - Processing and Interpreting Information
 - Evaluating and Applying Findings
- Resources
 - Use of Resources
 - Management and Enterprise
- Active Citizenship

Technology and Enterprise

- Enterprise



Step 4: Lesson Plans

STEP	LESSON/ TIME	STUDENT OUTCOMES	STUDENT RESOURCES AND ACTIVITIES	TEACHER RESOURCES	ASSESSMENTS AND ASSIGNMENTS	NOTES AND TEACHING AIDS
4	Task 1/30 min. Task 2/60 min.	To be able to develop listening skills. To be able to work as part of a group. To be able to produce an energy management Plan.	Photocopy Master 9 and 10 Task 1: Group discussion and pooling ideas how to save energy. Task 2: Produce an Action Plan showing the energy saving program to be introduced.	Photocopy Master 10. Western Power Energy Info Sheets. Office of Energy, energy efficiency publications. Energy Saving Kit for Schools.	Informal assessments of tasks.	
4	1/60 min.	To be able to implement and monitor an energy management action plan. To be able to draw conclusions from data. To be able to make long-term predictions from results. To be able to present successful strategies to a group of peers.	Task 3: Homework assignment, implement and monitor the Action Plan. Task 4: Group Leaders report findings to the class. Complete group management folder.	Photocopy Master 9. Teachers' Notes this Section.	Major homework assignment. Check completion of Tasks. Comparison of energy bills (same periods of previous years). Informal assessment of discussion to gauge increase in understanding of program.	Teachers could do their own energy audit and compare results with students.

Step 4: Develop and Implement an Energy Management Program

Teacher:

Your students' next step is to weigh up all the information and decide how to use their findings to achieve their energy saving goals to meet their Policy undertaking.

They will need to target the highest **usage** appliances and the highest **users** in the household to achieve worthwhile savings. There will be some hard options and some soft options.

Hard options are where family members' attitudes and habits are concerned. Good negotiating skills will be needed, as it may be very difficult convincing some family members of the need to reduce their consumption. Soft options are simple methods such as changing thermostat settings on appliances.

There is a **Directory of Resources – Photocopy Master 9** to assist students. This is a current list of materials and resources that show ways of saving energy in each area. A copy should be given to each student. There is also an **Energy Saving Action Plan – Photocopy Master 10**, at the end of this section.

Student Task 1: Group Discussion – how to save energy.

(30 Minutes)

1. Discussion Points:

- Short term and long term savings. Define short and long terms.
- Sources of information about energy saving initiatives and ideas.
- Implementation of energy saving plans. How will your family react to your energy saving measures? How will you persuade them? Will you be the Energy Monitor? Are you going to have rewards and/or fines?

2. Group Leaders report back.

3. Summary.

Student Task 2: Class Work.

(60 Minutes)

Materials – Photocopy Masters 9 and 10.

Produce an Action Plan showing what you intend to do in your home to reduce energy consumption in short and long term periods.

Show:

- a) Anticipated savings in kWh, dollars/cents and CO₂.
(Refer to the Teachers' Notes for the calculation of CO₂).
- b) Expected percentage reduction to household energy accounts over each period.
- c) Put the plan into action. It may require some additional tasks to be included. For example – make sure that unused items are turned off. Check shower times.

Teacher:

Implementing any changes in households is not easy. Well-meaning students with sound ideas may face discouragement and disappointment. As they do not run their households, there may not be a lot that they can do if faced with stiff opposition from older family members.

Regardless of how much co-operation or opposition they find, they still need to measure and report the effect of their energy management programs.



Student Task 3: Homework Assignment.

(4 weeks)

a) Implement and monitor the Action Plan.

b) Follow-up and measure the success of the program.

1. How are you planning the follow-up and when will this be done? Measurements? Meter reading?

Comparisons with past accounts?

2. Did savings match the predictions? How successful was your program? (Percentage of accuracy, compare accounts).

3. How much energy, money and CO₂ did you actually save?

4. Did your program fall down in any areas? Which ones and why? What could you do, if anything, to rectify the problems?

5. What are the long-term effects in your household (attitudes, disagreements, appliance changes, insulation and other house design improvements)?

6. Did you report back the success/failure to all members of your household? Was this casually done or in tangible form? For example – these charts show our energy costs for the year and how much we saved.

7. Is this the best energy management that can be done in your household? If not, what are the restrictions and what else could be done in an ideal situation to save more energy?

Teacher:

Organise a group discussion (debriefing): **Is the Action Plan working?**

Suggest further ways to save energy. For example – use savings to change over from standard incandescent lamps to compact fluorescent lamps.

Student task 4: Is the Action Plan working?

(60 Minutes)

1. Discussion Points:

- Successful areas.
- Unsuccessful areas.
- Family attitudes – co-operation or confrontation.
- Check accounts and compare to previous accounts.
- If fewer units of electricity and/or gas are being used, then the savings and the reduction in CO₂ can be calculated.

[See Teachers' Notes]

2. Group Leaders report back.

3. Summary.

Photocopy Master 9

DIRECTORY OF RESOURCES.

Thermometer:

It is very important that all students have access to a thermometer that accurately shows the temperature for room heating and cooling, refrigerator and freezer as well as hot water minimum and maximum. By using a correctly calibrated thermometer, students can measure what is happening in their homes and find where energy wastage is occurring.

Energy Management Publications and Information.

- Western Power
 - Energy Info Sheets.
 - Energy Saving Kit for Schools.
- Synergy Energy:
 - SmartWays, giving you the power to save.
- Sustainable Energy Development Office, Government of Western Australia:
 - Choosing a hot water system.
 - Solar Smart, Save Money, Save Energy, Save the Environment.
 - Energy efficient housing.
 - Simple ways to save energy.
 - Ways to winter warmth.
 - Choosing a heater.
 - The first steps to summer cooling.
 - Choosing an air-conditioner.
 - Home insulation.
- Alinta:
 - Gas hot water systems and energy information www.alinta.net.au

Further information can also be obtained by telephoning the SEDO Energy Smart Line on 1300 658 158 or visiting the following Internet sites:

www.westernpower.com.au

www.sedo.energy.wa.gov.au

www.alinta.net.au

www.synergyenergy.com.au

www.horizonpower.com.au

Photocopy Master 10

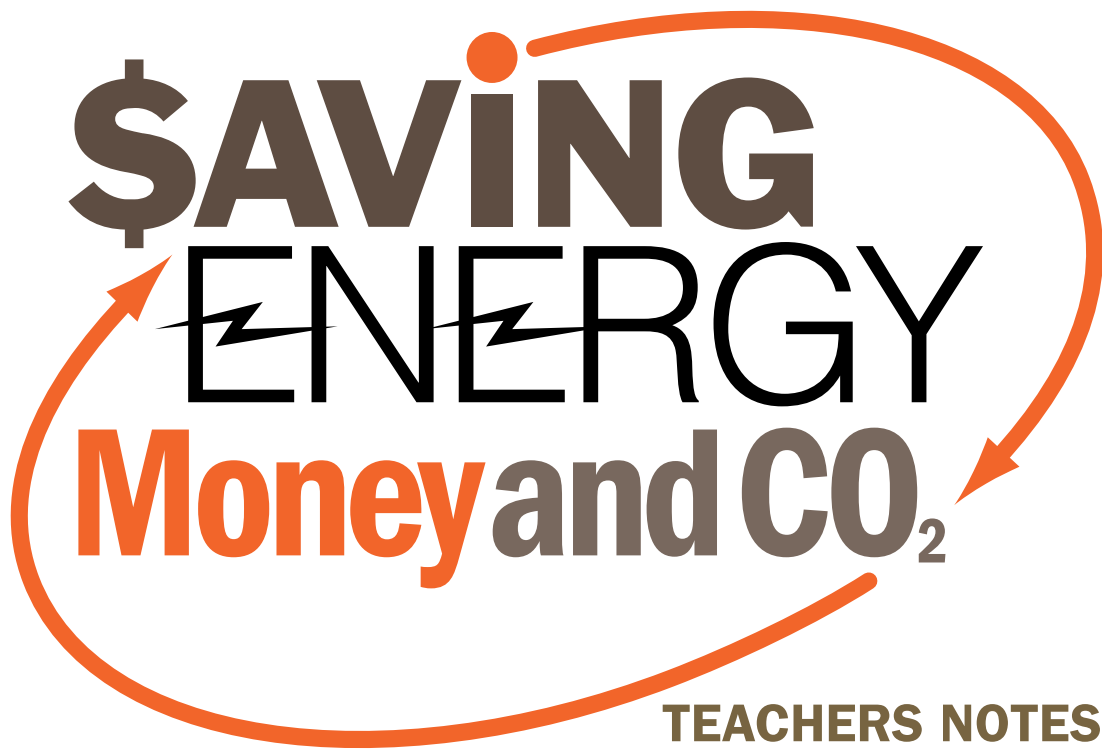
ENERGY SAVING ACTION PLAN:

Short Term Actions

The first actions that need to be undertaken are:	Person(s) Responsible	By When	Savings
1.			
2.			
3.			

Long Term Actions

Final Actions Required	Person(s) Responsible	By When	Savings



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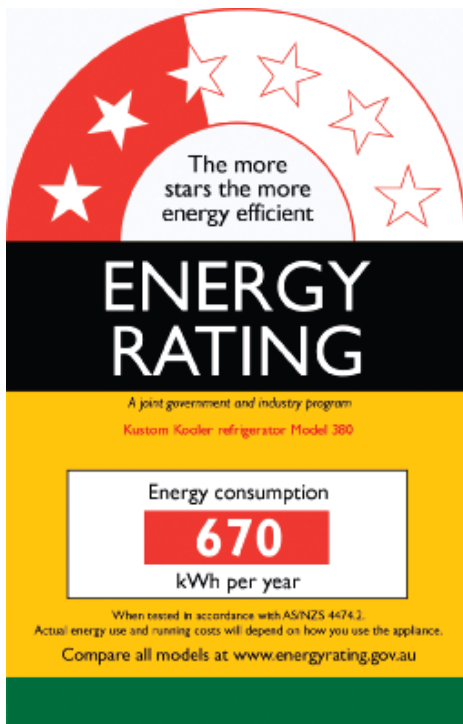
TEACHERS NOTES

A Science and Technology Teaching Resource for Primary and Secondary Schools

Teachers' Notes on Saving Energy

GENERAL:

Larger appliances, such as refrigerators, freezers, washing machines and gas heaters have star ratings labels. The more stars on the label, the more efficient the appliance and the less energy it uses. These labels also indicate the expected energy consumption of the appliance over a typical year. More information can be found at www.energyrating.gov.au



Questions to ask students:

1. How can you find out how much energy major appliances such as refrigerators use, and the expected running costs?
2. What effect does this indicator have on the manufacture of appliances?
3. Do any other significant energy users have a star rating?

Water Heaters:

In winter the water to be heated is colder than in summer. This means that storage hot water systems use more energy to heat the water to the required temperature set on the thermostat. Also when showering people use less cold water to moderate the temperature, the bathroom is cold and the water is nice and warm, so we tend to stay in the shower longer.

As much as 20 litres of water is used for every minute that we use the shower. This fact needs to be explained to all family members and agreement reached on the maximum time spent having a shower.

Hot water from storage systems can flow at more than twice the rate of water being used through an instantaneous hot water system.

Installing flow-reducing valves in the shower head can save as much as half the hot water used from a storage system and you still get a very good shower. Installing a water efficient shower head is also a cheap and effective way of reducing energy costs.

To check the flow rate of your shower place a nine litre bucket under the shower rose and turn the tap on full. If it fills in less than 50 seconds then you need a water saving device.

For every 5°C increase in the water temperature there is a corresponding 10% increase in energy use.

Some hot water systems have adjustable thermostats that can be turned down when:

- i. In summer hot showers are not needed.
- ii. The water flowing through an instantaneous system is warmer in summer and the same amount of energy is not required to reach the desired temperature.

Instantaneous Water Heaters:

Unfortunately, many of the older type of instantaneous hot water systems do not have any adjustment devices to vary the amount of energy used to heat the water. The older gas systems usually allow the water flow rate to be adjusted to vary the temperature of the water. However, the gas input rate remains the same.

Some instantaneous systems require a minimum flow rate to pass through the heater for it to turn on and continue heating the water. Low flow shower heads can sometimes restrict the amount of water passing through the heater causing it to turn on and off. This makes for an unsettling shower, particularly in the middle of winter.

Some of the newer instantaneous systems are able to achieve energy savings by varying the input rate to suit the flow rate.

Questions to ask students:

1. How will you persuade your family to have shorter showers?
2. Would some or all of your family accept the idea of having cold/lukewarm showers in summer when the outside air temperature is around 30°C?
3. What is the maximum flow rate (cold) of the showers in your home?
4. How much does it cost to purchase a flow-reducing valve or energy efficient shower head?
5. How much water and energy could be saved over 12 months?
6. What would be the pay back period if you fitted an energy efficient shower head?
7. Would it be a good idea to fit low flow control valves to all the taps and not just the shower heads?
If so why, and if not, why not?
8. Would there be an advantage in fitting a flow control valve in a house with an instantaneous hot water system?
9. Calculate approximately how much can be saved if you turned off the storage hot water system while you went on holidays.
10. Do you think that this is a worthwhile saving?
11. Does anyone in your house leave the hot water tap running instead of putting the plug in the basin?
 - i. Calculate the approximate wastage by not having the plug in?
 - ii. What action will you take to prevent this happening in the future?
12. What is the difference between an electric storage hot water heater and a solar hot water system with an electric booster?
13. If you washed clothes in cold water instead of hot water, approximately what percentage of your water heating costs would be saved?
14. How much water would be wasted from a tap that drips 45 times per minute?
15. Why is a dripping hot water tap twice as wasteful as a dripping cold water tap?
16. Used correctly, a solar hot water system can reduce annual hot water heating costs by what percentage?

Room Heating:

Thermostats on room heaters can save energy by switching off the heater when the room temperature has been reached. The heater will then only switch back on if the thermostat detects that the room temperature has dropped. Correctly adjusted thermostats ensure that room heaters do not turn on unnecessarily thus wasting energy.

However, in the following instances the thermostat may not operate correctly:

- a) If the area to be heated is too large for the heater or the rooms have very high ceilings.
- b) If the area is not closed off correctly so that the temperature can rise to the thermostat setting. If the heat is allowed to escape through open doors or windows the temperature setting will not be reached.

Reverse cycle air conditioners can heat a room as cheaply as natural gas heaters. However, this depends on how much gas is used in the home. The more gas that is used, the cheaper per unit it becomes.

Reverse cycle air conditioners are cheaper to run because they extract heat from the outside air, even on mid-winter nights, and transfer it inside. A refrigerant is passed through an external coil. This refrigerant is then passed through a compressor into a fan coil unit (or condenser) located inside the home releasing its heat into the room.

By transferring heat instead of making it, approximately 2.5kW of heat energy can be pumped into a room for 1kW input of electrical energy. Air conditioners use less energy on the heating cycle than they do on the cooling cycle.

Room Cooling:

The two main ways of cooling are:

- a) Refrigerative air conditioners cool a room in any weather, dry or humid, and use a compressor to compress a refrigerant. They are generally expensive to purchase and run compared to evaporative coolers and use considerably more energy for a given amount of cooling. This means that they contribute more to the summer peak electricity load and extra generating plant has to be run for short periods of time to meet this load. This increases overall electricity costs and puts ongoing pressure on the price of electricity for the consumers.
- b) Evaporative coolers contain only a small water pump and fan, making them cheaper to purchase and run. They operate by sending out moistened air (cooled by the evaporation of water), which passes through the room to the outside air taking heat with it. Unfortunately, they are not as effective as refrigerative air conditioners on humid days because the air evaporates less water and so is cooled less. Because the cool air needs to pass through the room to be effective, a door, window or ceiling to roof vent system must be open.

Questions to ask students:

1. How do thermostats operate and can they save money? In what situations would they not save money?
2. What ceiling height is best for economical heating and cooling of a home? What effect would a skylight have on heating or cooling?
3. Which electrical appliance can heat a room as cheaply as natural gas?
4. How does a refrigerative air conditioner heat/cool a room?
5. What are the advantages of an evaporative cooler? Are they effective in Western Australia's climate?
6. In what type of house construction is wall insulation essential?
7. Why is the colour of the roof tiles/sheets important?
8. What is the best type of floor to prevent heat loss and why?
9. What would ceiling insulation save on heating and cooling costs over one year in your home? What insulation rating would you use and why? How much would it cost to install insulation and what would the payback period be from savings? Is it worth it? How will you use this information?

Refrigerators and Freezers:

Other than choosing a new refrigerator by the best star rating label, there is not a lot that can be done to reduce the running costs. You can save energy by not having too large a refrigerator or too small (insufficient airflow around the food) and by having the thermostat set to the correct cooling temperature. These are between +4°C and +6°C for refrigerators and -18°C and -12°C for freezers.

Frost free refrigerators have a heating element inside behind the cooling panel. The element turns on when the thermostat turns off the compressor. It is designed to keep the refrigerator compartment and cooling panel frost free. However, it does also waste energy because it uses energy to warm up the panel inside the refrigerator and causes the compressor to turn on sooner to again cool down the panel. The energy wastage this causes needs to be determined as the frost free feature is not necessary in relatively dry climates.

However, one of the benefits of having a frost free refrigerator is that there is no ice build up in the freezer compartment. This in turn can save energy when compared to a standard freezer compartment with more than 5-8 mm of ice covering it.

Operation:

A refrigerator or freezer is basically a heat pump that transfers heat from the cabinet and its contents to the surrounding air. For this reason, it should always be placed in a well-ventilated position so that the heat can be dissipated from the coils at the back and/or underneath the unit. These coils should be brushed periodically to keep them free of dust and fluff.

The efficiency of a refrigerator is reduced if too much frost is allowed to build up. If the refrigerator is placed near a heat source such as a stove or in direct sunlight it will use more energy trying to keep cool.

Questions to ask students:

1. Apart from not opening the door excessively, what can be done to help the refrigerator run more efficiently and use less energy?
2. What would you look for when choosing a new refrigerator to ensure that your running costs are kept low?
3. What is the benefit of your freezer? Find out if your freezer is saving or costing your family money and provide a written analysis of your findings.

Cooking:

There are some differences between electricity and gas for cooking. Gas appliances generally cost less to run, as the gas burners are cheaper to operate than electric hot plates.

There is a good range of energy efficient electric cooking appliances now available. They range from traditional radiant coils and solid hotplates to the latest in instant response induction and halogen cooktops.

Gas ovens cost about the same to run as electric ovens. Fan forced ovens (convection ovens) cost a little more to run. However, more of the oven space can be used at any one time.

Microwave ovens are popular because they can cook food in a very short amount of time. They are also extremely efficient in their use of electricity because the microwave oven heats only the food and nothing else. They are cheaper to run than either gas or electric ovens. The main benefits are speed of cooking and nutrient retention in the food.

Questions to ask students:

1. Which is the cheapest form of cooking – gas oven, electric oven or microwave?
2. List the energy saving and environmental advantages and disadvantages of a gas oven, electric oven and microwave.

Sundries:

This includes all the small users of electricity (radios, fans) or large users (tumble dryers, vacuum cleaners) that are used for only short periods. Sundry appliances account for about 11% of the energy account. However, savings can be made.

For example, drying clothes outside by hanging them on the clothes line in summer or under the verandah in winter (if it is raining) instead of using the clothes dryer will save you between 8.5 cents per hour for a small machine to 9.61 cents per hour for a large dryer.

Pool and reticulation pumps can also increase your summer accounts quite noticeably. Pool pumps cost around 3.49 cents per hour to run and reticulation pumps 10.46 cents per hour.

Questions to ask students:

1. What is the largest energy user, per account period, of your sundry appliances?
2. What is its annual use?
3. What savings, if any, can be made?

Lighting:

Although lights are bright and noticeable when left on, they only account for about 4% of the annual electricity account. However, there are still ways that savings can be made. Consider replacing incandescent lamps with compact fluorescent lamps.

Questions to ask students:

1. What are the potential savings from replacing the incandescent lamps in the lounge room and bedroom?
2. Calculate the payback period for replacing all your incandescent lamps with compact fluorescents.

Photocopy Master 11



How to read your electricity meter.

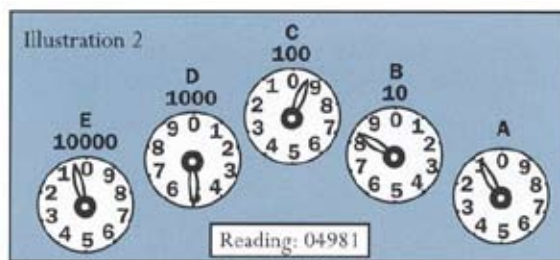
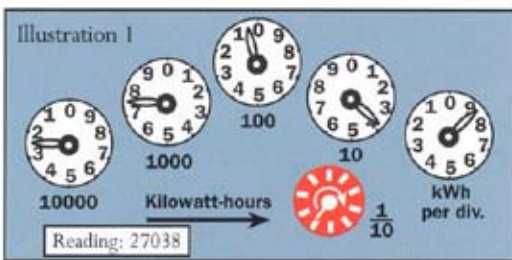
Electricity meters are very reliable precision instruments that register the amount of electricity consumed by all appliances. Meters are always tested by the manufacturer before leaving the factory. As a meter ages, the householder benefits because ageing meters, in nearly all cases, run slower due to wear and tear on working parts (except electronic meters).

There are four types of meters:

Dial meter.

This is read in the following way (refer to illustrations for help):

Stand directly in front of the dial meter. Read each dial in turn going from right to left, writing down each figure, again from right to left, as you go. In the first illustration the reading is 2-7-0-3-8 (you would start by writing the first 8 first i.e. right to left). When a dial points between two numbers write down the lower of the two numbers. If it 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 second illustration, look to dial (C) to the right. If the hand on dial (C) has not passed zero, the number 5 has not actually been reached on dial (D) and the reading on that dial is the next lower number... 4.

Digital meter

Is similar to a car's odometer, where you simply read the numbers.

SmartPower electronic meter

The SmartPower meter continuously scrolls through the display sequence pausing on each of the displayed IDs for a period of six seconds.

Displayed ID	Tariff Display Description
4	Current Time
5	Current Date
7	Total kWh's
10	On Peak kWhs
20	Off Peak kWhs
30	Weekday Shoulder kWhs
40	Weekend Shoulder kWhs

Three phase electronic A1 tariff meter

This meter continuously scrolls through the display sequence, pausing on each of the displayed IDs for a period of six seconds.

Displayed ID	Tariff Display Description
4	Current Time
5	Current Date
7	Total kWhs

Photocopy Master 12

Energy Audit Worksheet

Use.	Appliance.	(2) Cents per hour running cost from tables below.	(3) Average hours per day appliance is used.	(4) Daily running cost in \$ + column 2 x column 3 ÷ 100
Example	Fanforced Oven	25.09	2	\$0.50
Cooling Appliances				
Heating Appliances				
Cooking				
Kitchen Appliances				
Refrigerators and Freezers				
General Appliances				
Outdoor Appliances				
Laundry Appliances				
Hot Water Systems				
Lighting				
Entertainment				

Running Cost of Domestic Electrical Appliances

HEATING AND COOLING.

(based on 500 hour use per annum).

	Input (Watt)	Equivalent Output (Watt)	Cents Per Hour	Typical Cost Per Bill (2 months)
Reverse Cycle Air-Conditioning - Split System.				
Cooling 1 HP (eg. bedroom unit) 3.5 star	1,000	2,500	13.94	\$11.61
Heating 1 HP (eg. bedroom unit) 3.5 star	850	2,500	11.85	\$9.87
Cooling 2.5 HP (eg. living room unit) 2.5 star	2,000	5,000	27.88	\$23.23
Heating 2.5 HP (eg. living room unit) 2.5 star	1,700	5,000	23.70	\$19.75
Inverter Cooling 2 HP (eg. living Room unit)	1,410	4,800	19.66	\$7.21

Ducted Whole of House (Reverse Cycle or Evaporative).

Costs vary greatly dependent on size, model and star rating. Please refer to manufacturer's input wattage and use the calculation provided in this brochure.

	Input (Watt)	Cents Per Hour	Typical Cost Per Bill (2 months)
General Heating and Cooling.			
Mobile Evaporative Cooler Small	54	0.75	\$0.63
Mobile Evaporative Cooler Large	103	1.44	\$1.20
Ceiling Fan	90	1.25	\$1.05
Oscillating Fan	50	0.70	\$0.58
Electric Bar Heater Small	750	10.46	\$8.71
Electric Bar Heater Large	1,000	13.94	\$11.62
Electric Fan Convection Heater	2,400	33.46	\$27.88
Oil Filled Heater (mobile unit)	2,400	33.46	\$27.88
Four Bulb Bathroom Heat/Light/Fan	1,200	16.73	\$10.18
Two Bulb Bathroom Heat/Light/Fan	650	9.06	\$5.51

HOT WATER SYSTEMS.

(based on 200L per day average usage).

	Cents Per Hour	Typical Cost Per Day	Typical Cost Per Bill (2 months)
Electric Instantaneous	6.92	\$1.68	\$101.03
Electric Instantaneous High Efficiency	4.70	\$1.12	\$68.63
Electric Storage, 125 L	7.39	\$1.75	\$107.87
Electric Off Peak Storage 315 L Capacity with Smartpower Off Peak	3.59	\$0.86	\$52.41
Solar Electric Boosted 2 Panel, 300 L	1.18	\$0.30	\$17.21
Solar Electric Boosted Off Peak 2 Panel, 300 L	0.55	\$0.15	\$8.10

Cooking.

(based on 30 minutes per day).

	Input (Watt)	Cents Per Hour	Typical Cost Per Bill (2 months)
Induction Cooktop	1,200	16.73	\$5.02
Ceramic Cooktop	600	8.36	\$2.54
Electric Solid Cooktop 4 Plate	610	8.50	\$2.59
Electric Oven, Conventional (with grill)	2,400	33.46	\$10.18
Electric Oven, Fan Forced	1,800	25.09	\$7.63
Rangehood/Exhaust Fan	80	1.12	\$0.34
Electric BBQ	2,400	33.46	\$2.90

Refrigerators and Freezers.

	Star Rating	kWh Per Annum	Cents Per Hour	Typical Cost Per Bill (2 months)
Fridge Frost Free (fridge/freezer), Small	3	452	0.72	\$10.50
Fridge Frost Free (fridge/freezer), Medium	4.5	451	0.72	\$10.48
Fridge Cyclic Defrostr (fridge/freezer), Small	2.5	584	0.93	\$13.57
Fridge Cyclic Defrost (fridge/freezer), Medium	3	650	1.03	\$15.10
2 Door Frost Free (side by side), Large with Icemaker	3	872	1.39	\$20.26
Bar Fridge	3	279	0.44	\$6.48
Chest Freezer, Manual Defrost, Medium	1.5	416	0.66	\$9.67
Upright Freezer, Frost Free, Medium	2	696	1.11	\$16.17

Laundry.

Washing Machine Medium Top Loader (cold)	4	64	2.45	\$1.49
Washing Machine Medium Top Loader (hot)	4	312	11.95	\$7.25
Washing Machine Large Top Loader (cold)	2	87	3.33	\$2.02
Washing Machine Large Top Loader (hot)	2	676	25.89	\$15.71
Washing Machine, Front Loader	4.5	186	7.12	\$4.32
Clothes Dryer, Small	2	222	8.50	\$5.16
Clothes Dryer, Large	3	251	9.61	\$5.83

Kitchen.

	Average Wattage	Cents Per Hour	Typical Cost Per Bill (2 months)
Breadmaker	600	8.36	\$6.52
Cappuccino Maker	1,260	17.56	\$1.79
Coffee Percolator 10-12 Cups	1,000	13.94	\$1.42
Dishwasher (hot wash using cold tap connection 3 star)	NA	9.80	\$5.95
Microwave, Small	800	11.15	\$1.13
Microwave, Large	1,200	16.73	\$1.70
Microwave, Convection	1,500	20.91	\$2.13



	Average Wattage	Cents Per Hour	Typical Cost Per Bill (2 months)
Kitchen (continued).			
Deep Fryer	2,300	32.06	\$0.93
Electric Frypan	1,700	23.70	\$0.68
Electric Wok	2,000	27.88	\$0.81
Slender Blender	300	4.18	\$0.12
Food Processor	450	6.27	\$0.18
Juice Extractor	160	2.23	\$0.06
Kettle 1.8L	2,400	33.46	\$3.39
Food Steamer	700	9.76	\$0.28
Rice Cooker	700	9.76	\$0.42
Sandwich Maker	900	13.24	\$0.38
Toaster	1,100	15.33	\$0.44
Toaster Oven	1,500	20.91	\$0.60
Vertical Grill	1,850	26.83	\$0.78

Lighting.

Compact Fluorescent 9W (equivalent to 40 W)	9	0.13	\$0.31
Compact Fluorescent 11W (equivalent to 60 W)	11	0.15	\$0.37
Compact Fluorescent 15W (equivalent to 75 W)	15	0.21	\$0.51
Compact Fluorescent 20W (equivalent to 100 W)	20	0.28	\$0.68
Floodlights, Small	150	2.09	\$5.09
Floodlights, Large	300	4.18	\$10.18
Flourescent Tube 18W	18	0.25	\$0.61
Flourescent Tube 36W	36	0.50	\$1.22
Halogen Lights 20W	20	0.28	\$0.68
Halogen Lights 50W	50	0.70	\$1.70
Halogen Desk Lamp 20W	20	0.28	\$0.68
Incandescent Bulb 60W	60	0.84	\$2.04
Incandescent Bulb 75W	75	1.05	\$2.54
Incandescent Bulb 100W	120	1.67	\$4.07

Entertainment.

Compact Disk	20	0.28	\$0.24
DVD	15	0.21	\$0.18
Radio	20	0.28	\$0.24
Stereo System	120	1.67	\$1.45
Television	135	1.88	\$1.63
Rear Projection TV	80	1.12	\$0.97
Video Cassette Recorder	25	0.35	\$0.30

	Average Wattage	Cents Per Hour	Typical Cost Per Bill (2 months)
Home Office.			
Computer	150	2.09	\$2.54
Fax	115	1.60	\$1.95
Photocopier	1,350	18.82	\$22.90
Photocopier (standby)	48	0.67	\$0.81
Printer	17	0.24	\$0.29
Scanner	8	0.11	\$0.14

General.			
Aquarium Heater	150	2.09	\$30.53
Clock	2	0.03	\$0.41
Electric Blanket, Single (double cost for a double bed)	17	0.24	\$0.28
Foot Spa	40	0.56	\$0.02
Curling Wand	400	5.58	\$0.16
Hair Straightener	30	0.42	\$0.01
Hair Dryer	1,650	23.00	\$0.66
Hair Curlers (20 sticks)	320	4.46	\$0.13
Iron	1,300	18.12	\$1.57
Sewing Machine	150	2.09	\$0.06
Spa (indoor), 1300 L	3,600	50.18	\$1.45
Body Massager	40	0.56	\$0.02
Air Filter Portable, Small	90	1.25	\$2.17
Vacuum Cleaner Average Model	1,400	19.52	\$1.69

Outdoor.			
Bug Zapper	15	0.21	\$0.03
Electric Drill	700	8.36	\$0.24
Whippersnapper	350	4.88	\$0.14
Chainsaw	1,800	25.09	\$0.72
Garden Vacuum	1,550	21.61	\$0.62
Lawn Mower	1,150	16.03	\$0.46
Pond Pump	10	0.14	\$0.68
Bore	750	10.46	\$2.12
Saw, Portable	1,000	13.94	\$0.40
Soldering Iron	100	1.39	\$0.04
Spa (outdoor), 1300 L	3,600	50.18	\$4.35
Swimming Pool Chlorinator/Salt Water Generator	250	3.49	\$25.37
Welder	2,400	33.46	\$0.97

Calculation of Appliance Costs:

From an environmental point of view, it does not matter how much an appliance costs. However, to get a true cost comparison, the purchase cost, running costs and the life of the appliance must be taken into account.

Questions to ask students:

You are about to choose a new hot water system for your home:

1. Work out a formula to calculate the cost per year of owning and operating a hot water system over the anticipated life of the appliance.

Using the formula, compare the costs of electric, gas and solar hot water heating with usage rates of 100, 150 and 200 litres of water per day.

2. Does an energy-saving appliance use more or less energy to manufacture than a not-so-efficient one?

CALCULATION OF CO₂:

One unit of electricity – 1 kilowatt hour (kWh) of electricity used can produce approximately 1.1 kg of CO₂.

One unit of natural gas – 3.6 megajoules (MJ) of natural gas can produce approximately 0.5 kg of CO₂.

Questions to ask students:

1. How much CO₂ do your household appliances produce per year and how much is that per person?
2. What appliance changes could be made to reduce the amount of CO₂ produced by your household?

Further Information:

For further information please contact:

Western Power
363 Wellington Street
PERTH WA 6000

Telephone: (08) 9326 6012

Facsimile: (08) 9326 4984

Email: energyeducation@westernpower.com.au

Web: www.westernpower.com.au

