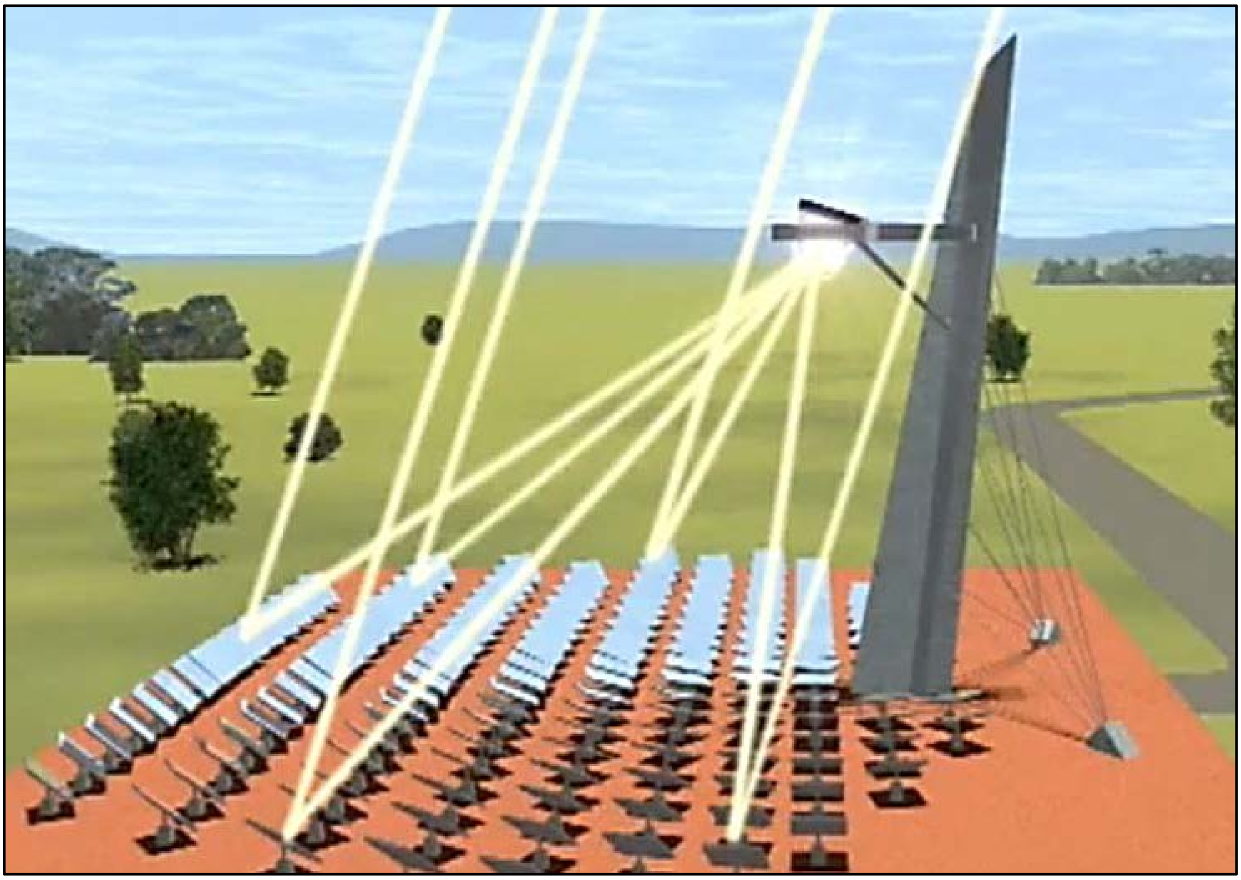
Science
Stage 5
Technology and electricity
Part 3



NSW GOVERNMENT Education & Communities

Distance Education Science Network

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Fig: http://www.3m.co.uk/intl/uk/3mworldly-wise/science-convection-p1-to-secondary.htm
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Fig: http://www.physics.louisville.edu/cldavis/phys298/notes/heat_transfer_mech.html
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Fig: http://carrotsareorange.com/hot-air-rise-preschool-science/
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Fig: http://www.layers-of-learning.com/heat-conduction-experiment/
Fig: http://industry.gov.au/Energy/EnergyEfficiency/WaterHeaters/ElectricWaterHeaterAlternatives/Solar/Pages/default.aspx
Fig: http://www.aurorapower.net/alternative-energy/solar-hot-water.aspx
Fig: http://www.switchon.vic.gov.au/how-can-i-take-charge-of-my-power-bill/why-is-my-power-bill-so-high
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Fig: http://www.wolf-passivehomes.com/products/solar-panels/solar-thermal-panels.html
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Fig: http://www.scienceimage.csiro.au/mediarelease/mr11-60.
Fig: BlueGen https://www.sa.gov.au/topics/water-energy-and-environment/energy/saving-energy-at-home/household-appliances-and-other-energy-users/heating-and-cooling/energy-efficient-cooling
Fig: http://www.yourhome.gov.au/passive-design/shading
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Fig: http://www.yourhome.gov.au/passive-design/insulation
Fig: http://www.ecofoil.com/Applications/Attic-Insulation
Fig: Pie graph http://airleak.com.au/thermal-imaging-and-smoke-testing/
Fig: http://www.yourhome.gov.au/energy/heating-and-cooling
Fig: http://www.isover.co.za/pages/prange/p_thermals.php
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Fig: Underground pipes http://www.yourhome.gov.au/energy/heating-and-cooling
Fig: House rating http://www.kingsenergy.com.au/serviceEnergy.asp

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Contents

Outcomes

By completing this unit, you are working towards achieving the following outcomes:

- undertake first-hand investigations to collect valid and reliable data and information, individually and collaboratively
- process, analyse and evaluate data from secondary sources to develop evidence-based arguments and conclusions
- apply scientific understanding and critical thinking skills to suggest possible solutions to identified problems
- present science ideas and evidence for a particular purpose using appropriate scientific language, conventions and representations.
- apply models, theories and laws to explain situations involving energy, force and motion
- explain how scientific understanding about energy conservation, transfers and transformations is applied in systems.

(Outcomes taken from the BOSTES NSW Syllabus for the Australian Curriculum SCIENCE Years 7 - 10, 2013)

Content Statements:

1VA, 2VA, 3VA, WS6a, WS6b, WS 7.1b, WS8a, WS8b, WS8g, WS9b, PW1a, PW1e, PW3d,

Resources

You will be sent a mini kit to use with this topic. You will also need to collect these items from home:

Part 1:

- a saucer or plate
- two AA batteries

Part 3:

Lesson 1

- piece of A4 paper
- scissors
- needle and thread or tape
- lamp
- saucepan
- teaspoon butter or margarine
- plastic spoon
- stove
- metal spoon
- wooden spoon

Lesson 3

- 2 identical glasses
- double-sided reflecting foil insulation
- two identical chocolates or two cubes of cheese

Please note that the mini-kit we have sent you contains the following items:

1.5V battery holder
2.5V flashlight bulb and holder
3 plastic coated wires with alligator clip ends
Steel wool
Steel pin
Insulating foil
Thermometer

Icons

Here is an explanation of the icons used in Parts 1, 2 and 3

Write a response as part of an activity.

Compare your response with the one in the suggested answers section. Give yourself a tick if you were correct. Make any corrections.

Complete the Worksheet Send-in exercises.

Perform a practical task or investigation.

Glossary

The following words, listed here with their meanings, are found in the learning material in this unit. They appear in bold the first time they occur in the learning material.

conduction	of heat: passing heat from one particle to the next. Of electricity – to travels through
conductor	of heat: a substance that allows heat to pass along it of electricity – a substance that allows a current to pass along it
convection	transfer of heat energy through liquid or gas by hot particles moving apart and rising, and cooler particles moving closer together and falling
dense	particle spacing. More dense refers to a large number of particles in a space
radiation	energy waves
thermal	heat
solar energy	heat and light energy from the Sun

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In Part 3 of this topic you will focus on more science research and development aimed at creating efficient energy production. To start with you will consolidate what you know about the ways heat energy can be transferred. You will use this knowledge to analyse solar heating technology.

Lesson 1: Heat transfer

Solar thermal technology produces hot water for:

- hot water taps
- hot water in pipes for space (room) heating.

The technology applies the scientific knowledge of the three ways heat energy (thermal energy) is transferred. You may not know it but you are quite familiar with heat transfer and use the three methods regularly in cooking and heating rooms in your home.

Heat transfer methods:

Convection is the transfer of heat energy in fluids (a gas or liquid). The gas or liquid particles move in currents. Hot fluids rise as they are less dense, with energetic particles further apart. When the fluid loses heat energy the particles are less energetic and move closer together increasing the fluid density.
The cooler, denser fluid falls.

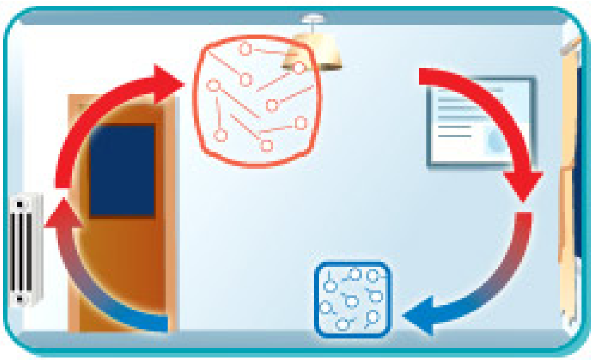


Figure 1

Conduction of heat is the transfer of energy through matter from the contact of particle to particle.

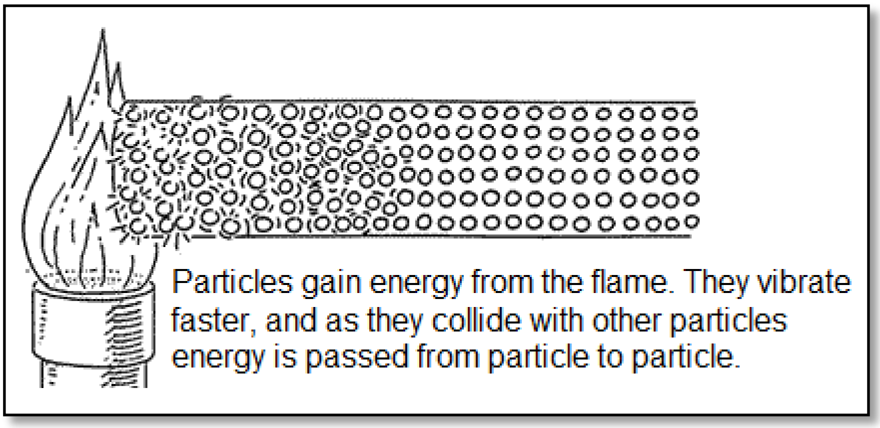


Figure 2

Radiation of heat energy is the transfer of heat by electromagnetic waves called infrared. Infrared radiation moves out from all hot bodies. We receive infrared waves from the Sun through space. No particles are required.

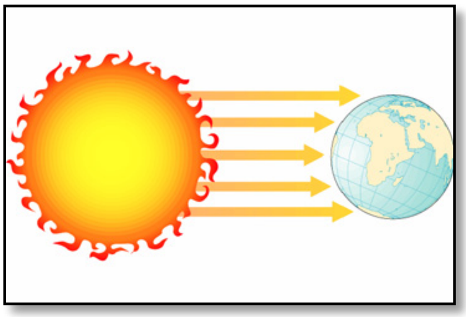


Figure 3

The diagrams below show how you use the heat transfer methods in cooking and heating in your home.

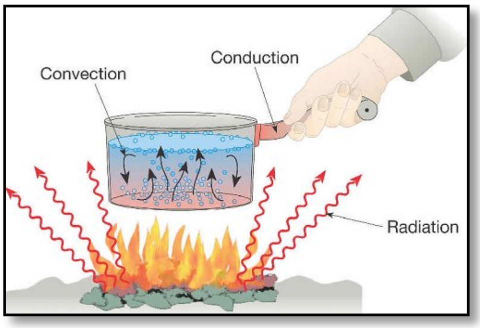


Figure 4

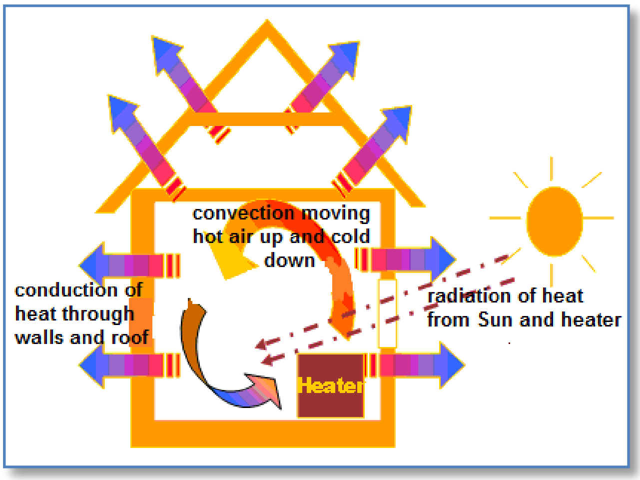


Figure 5

You will now perform some simple heat transfer activities.

Activity 1: Investigating heat energy in air

Aim: To see if hot air moves

Materials:

piece of A4 paper

scissors

needle and thread or tape

lamp

Figure 6

Method:

Step 1: Draw a spiral on the paper and cut it out as shown in Figure7.

Figure 7

Step 2: Put the needle and thread through the top of the spiral and tie it to make a “string handle” about 6cm long.

Step 3: Turn on the lamp and hold the thread four centimetres above the hot light bulb for 5 minutes. Turn off the lamp and hold the spiral for another 5 minutes.

Step 4: Record your observations as results and write a conclusion based on your observations (on the following page).

Figure 8

Results: *(complete the observation statements by crossing out the incorrect underlined words)*

After the light bulb became hot/cold the spiral twisted around/stayed still.
After the light bulb became hot/cold the spiral twisted around/stayed still.

Conclusion: *(Complete the following conclusion statements by crossing out the incorrect underlined words. Remember a conclusion statement must refer to the aim of the experiment)*

Hot air above a light globe can make a spiral move/stay still.

Discussion: (Answer the following questions)

1. What does the light bulb do to the air? ______________________________

   ____

2. Why does the spiral spin? ______________________________________

   ____

3. What happens as the lamp cools? ________________________________

   ____

Check your response by going to the suggested answers section

Activity 2: Investigating heat energy transfer in solids

Aim: To see if heat energy can be transferred along a solid object

Materials:

saucepan	teaspoon
butter or margarine	plastic spoon
stove	metal spoon
wooden spoon	

Method:

Figure 9a

Step 1: Place eight cups of water in a saucepan and heat the water on a stove until the water just boils. Once the water boils, turn the stove off and let the water cool for two minutes.

Step 2: Place a wooden spoon, a metal spoon and a plastic spoon in the saucepan as shown in Figure 9a

Step 3: Place a teaspoon of margarine or butter on the end of each spoon and watch for five minutes. Note any change in consistency of the butter.

Step 4: Record your observations as results in the Send-in exercises for Lesson 1 and write a conclusion based on your observations.

Add a discussion point to explain your conclusion.

Discussion:

Substances that transfer heat well are called good heat conductors. Substances that do not transfer heat are called insulators. Houses that have insulation materials in walls and ceilings reduce the transfer of heat both out of and into the house.

This reduces the electrical energy needed to cool a house in summer and heat a house in winter.

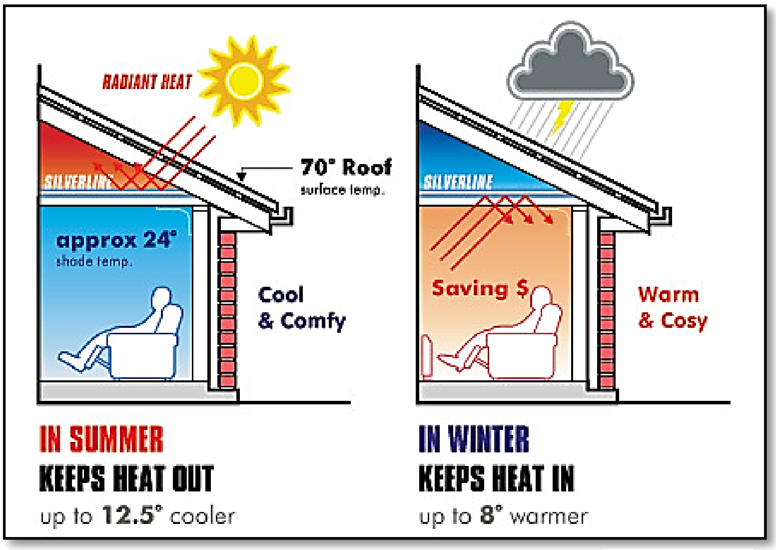


Figure 9b

Think back over the main points in the lesson then read the following summary.

Summary of Lesson 1

- Heat energy can be transferred by conduction, convection and radiation.
- Conduction and convection rely on the movement of particles to transfer heat.
- Metals are good conductors of heat energy.
- Substances that do not transfer heat are called insulators.

EXERCISE

Complete the Send-in exercises for Lesson 1

Lesson 2: Solar heating at home – Solar Thermal

In Part 2 of this topic you looked at the use of solar energy by solar photovoltaic cells to produce electricity. Now you will learn how solar energy is used to directly supply hot water for a home or business.

How Solar thermal works

1. Solar thermal panels can heat water to use for showering and washing.
   Water is heated by the heat energy from the Sun and is circulated by convection.

The cold water is more dense and falls. The hot water is less dense and lies on top of the solar collector panel and the storage tank as shown in Figure 10.

You use the hot water from the top of the tank when you turn on a hot water tap in your home.

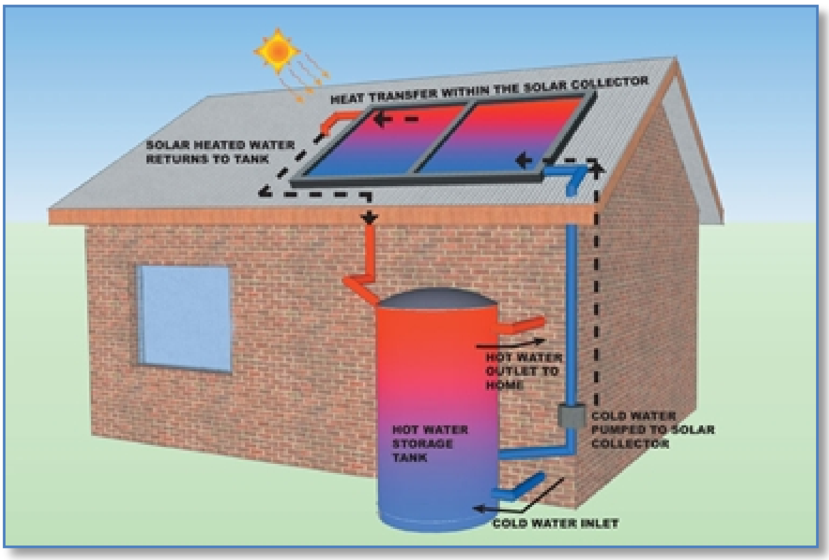


Figure 10

2. Water heated by the Sun can also be used to heat the air spaces in a home as shown in Figure 11. Heat passes from the hot water through metal pipes by conduction and then radiates from the surface of the metal pipes. Convection then moves the heat around a room.

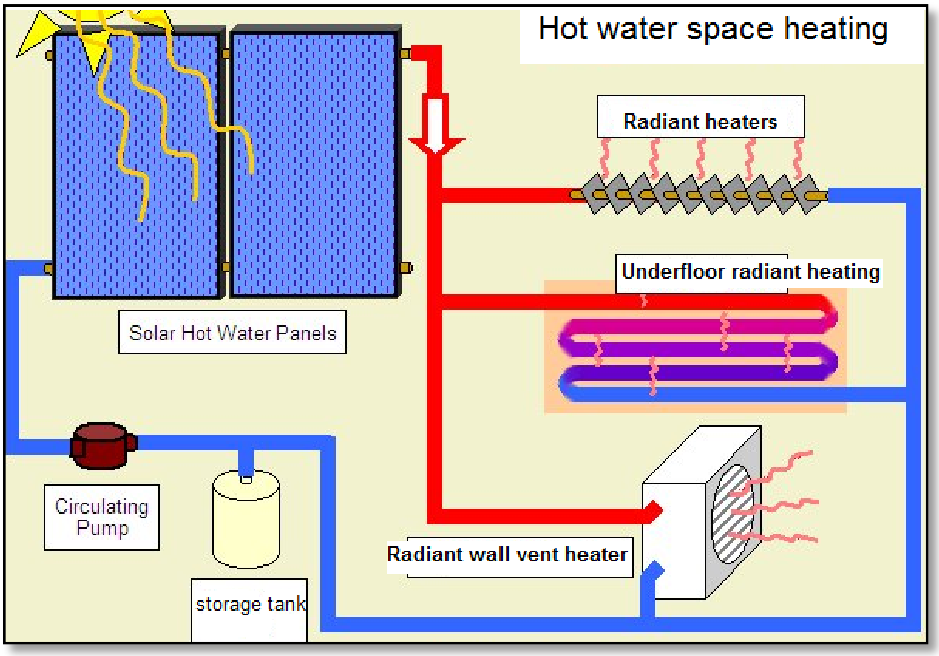


Figure 11

Using solar thermal for heating would reduce a household's use of electricity from the grid. Over 80% of grid electricity in Australia is produced by burning fossil fuels such as coal and gas. The use of solar thermal panels would reduce the combustion of fossil fuels and the emission of carbon dioxide and other pollutants.

The pie graph in Figure 12 below shows the amount of electrical energy from the grid used by the average household. Note the percentage of electricity used for *heating and cooling*, *water heating* for showers and *other appliances*.

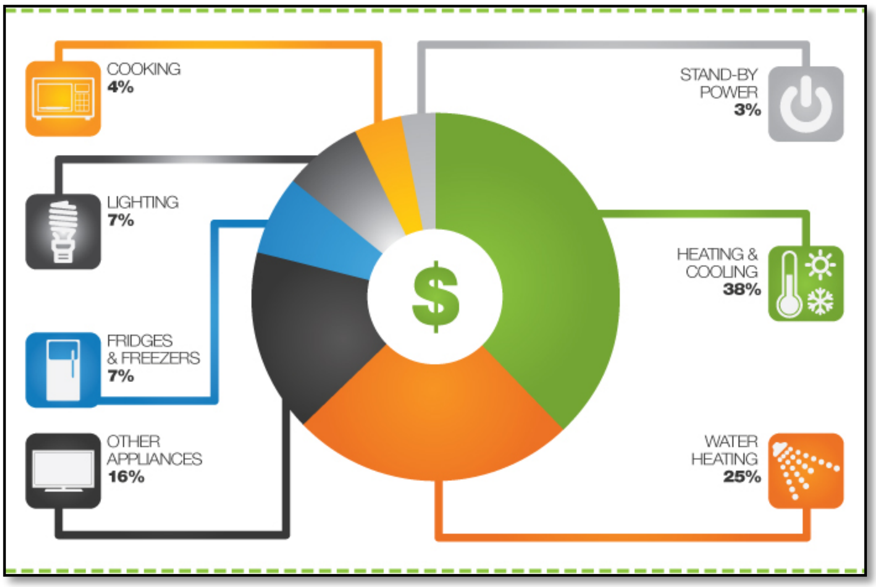


Figure 12

Activity 3: Analysing costs

1. Predict how much your winter electricity bill would be reduced if your family installed a roof top solar thermal unit (solar hot water) for :

   a) hot water for showers and taps ___________________________

   b) space heating in winter _________________________________

   c) both tap water and space heating __________________________

2. Would installing a solar thermal (to heat water) and a solar photovoltaic unit (to produce electricity) reduce your carbon dioxide (greenhouse gas) emission? ________

   Explain your answer: _______________________________________

   ____

Check your response by going to the suggested answers section

Activity 4: Testing solar energy

Aim: To see if the colour of a container affects the amount of solar energy it absorbs.

Materials:

two cans of the same size

white paint or white paper or white plastic sheet

black paint or black paper or black plastic sheet

thermometer

measuring jug

cold water

Method:

Step 1: Paint one can white (or wrap it in white paper) and the other can black (or wrap it in black paper).

Step 2: Measure 200mL or tap water and pour it into the white can. Measure 200mL or tap water and pour it into the black can.

Step 3: Place both cans side by side in direct sunlight for an hour using the thermometer to measure the temperature of the water every 10 minutes.

Step 4: Record the temperature of the water in the results table in the **Send-in Exercise for Lesson 2** and write a conclusion based on your results.

Figure 13

Activity 5: Relating experimental results to solar thermal applications

1. Explain why the water got quite hot in the black can.

____

2. Explain why the water in the white can stayed quite cool.

____

3. Figure 14 shows a cross section of a solar thermal panel. From the results in your experiment explain why the solar energy absorber section is black ____

____

Check your response by going to the suggested answers section

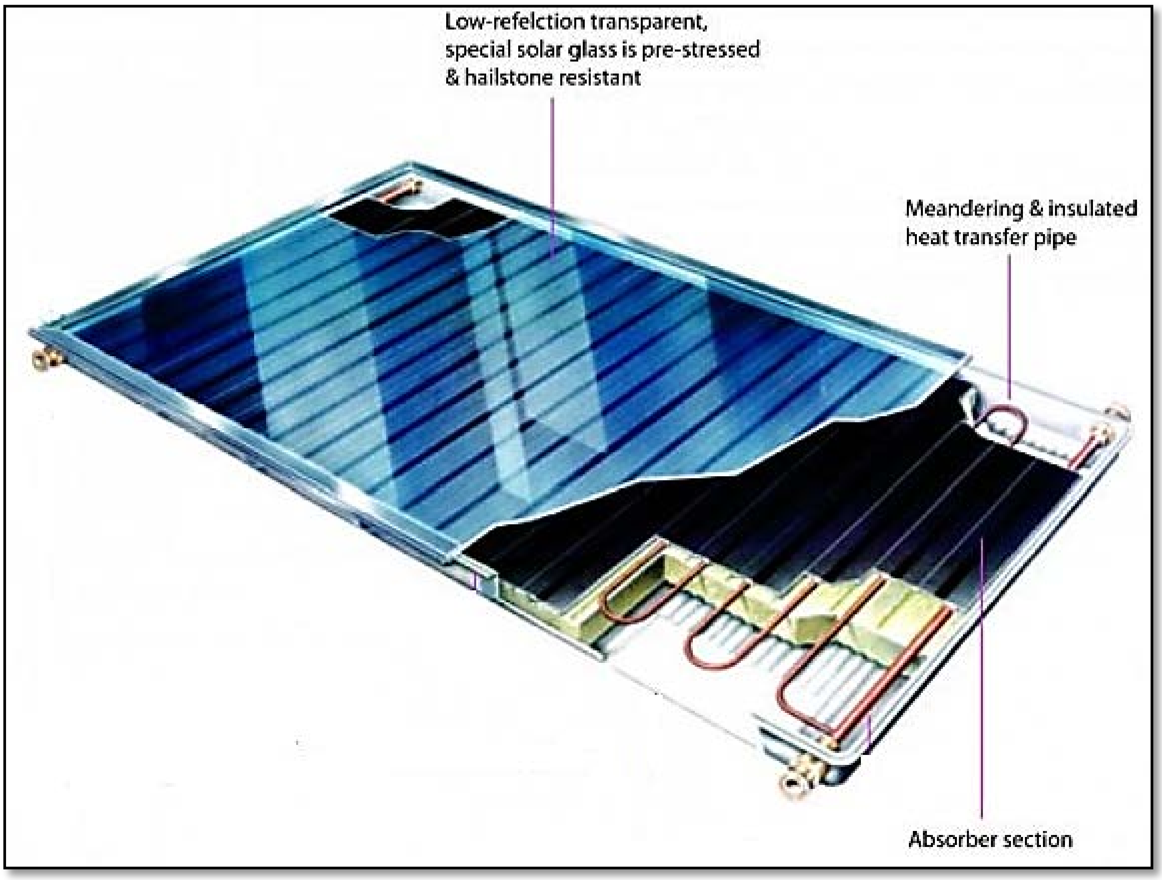


Figure 14: Inside a solar thermal panel

Summary of Lesson 2

- In homes, solar thermal panels use heat energy from the Sun to heat water to supply hot water and to warm rooms for warmth in winter.
- Solar thermal uses convection currents to circulate heat in water in hot water tanks
- Solar thermal space heating uses all three methods of heat transfer: conduction, convection and radiation.

EXERCISE

Complete the Send-in exercises for Lesson 2

Lesson 3: Research and development

In this lesson you will look at two examples of leading Australian research and development focusing on electricity production.

Australian research helps the world use solar

Australia has a proud history of scientific research into low emissions and renewable (continuous) energy production.

After World War II soldiers who had experience in engineering put their knowledge and experience into the solar power industry. They worked with teams of CSIRO scientists to lead global research and development.

Much of the technology that is now used by the large solar industries of Japan, Germany, China and the United States, was developed in Australia by research teams lead by Martin Green from the University of New South Wales (UNSW), David Mills of Sydney University and Roger Morse of the CSIRO.

The progress of the solar industry in Australia since the 1950’s varied depending on the policies of different governments. Policies influenced research funding and subsidies to homes and businesses. The solar industry in China has taken off in the last 20 years due to encouraging government policies.

Martin Green trained a PhD student who set up the biggest photovoltaic industry in the world in Beijing. He studied at New South Wales University and developed, under Martin Green, the technology that he's now applying and selling back to Australia. The Chinese government funded the early development of the industry.

China's goal for 2050 is to have close 100% of their energy supplied by renewable and clean energy sources. Solar energy is renewable as there is an endless supply from the Sun. It is called ‘clean energy’ as solar panels do not produce any emissions while operating.

Solar energy development in Australia

The following table outlines solar energy development in Australia.

Year	Solar energy development in Australia
1960	• Solaray Ltd, Perth exporting solar panels to the Middle East.
1968	• 30% of houses in Perth have solar water heaters.
1978	• Telecom (now Telstra) use solar panels for telecommunication equipment located in remote areas.
1983	• Solarhart Ltd becomes the second biggest manufacturer of solar technology in the world.
1983	• Solar World Congress in Perth. 1500 people from all around the world came to hear what was going on here.
1996	• Australian government changes from Labor lead by Paul Keating, to a Liberal coalition under John Howard. Funding for research and development declines. Researchers move overseas and companies close.
2007	• A Labor government lead by Kevin Rudd is elected. Increases in funding for scientific research occurs. Subsidies given for solar panel installations.
2008	• The Australian Research Council Photovoltaics Centre of Excellence produced the world's first 20% efficient silicon solar cell.
2010	• Australian Photovoltaic market grows by 431%.
2011	• Australia becomes the first country to achieve 'grid parity' whereby solar panels produce electricity at the same cost as the main power grid.

2011	• The number of solar PV (photovoltaic) systems in Australia reaches 500,000; 35 times greater than it was in 2007. • The Uterne Solar Power Station opened 5 km south of Alice Springs in the Northern Territory. It was the first Australian PV power plant connected to the grid. • Solar Air Turbine demonstrated. This is a new technology (world first) developed by the solar scientist team of the CSIRO. It uses solar energy to heat air to turn turbine blades to generate electricity for grid input. No water is needed for steam production to turn turbines (see Figure 15).
2012	• Greenough River Solar Farm near Geralton W.A. opened and was connected to the grid with a capacity of 10 MW (megawatts).
2013	• Scientists from over 20 countries come to a conference at CSIRO solar research facility in Newcastle.
2014	• Approval given for Australia’s largest solar energy power station in Tuggeranong Canberra (20 MW). • Change of government from Labor lead by Julia Gillard to Liberal coalition lead by Tony Abbot. Carbon tax funded research and development disappears. Funding to CSIRO reduced. Department of Science terminated.

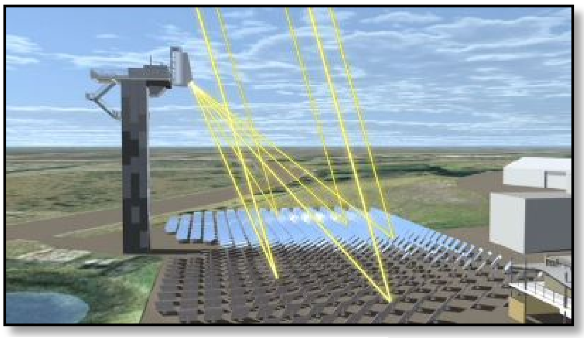


Figure 15: Solar Air Turbine

Figure 16: Prime Minister Julia Gillard with solar team at CSIRO Newcastle

Now read the following extract of an interview with Martin Green who has lead solar research teams at UNSW for many years.

Crickey independent media, independent minds Mar 07, 2013 10:45AM

'The Power Index'

Profile of Martin Green

By Cathy Alexander

Australian solar pioneer Martin Green is the man behind the solar entrepreneurs of the world. His early research and 40-year teaching career has driven a generation of solar development and commercialisation, but he keeps his head down when it comes to the politics of climate policy.

When Martin Green got hooked on solar power 40 years ago, it cost $50,000 (in 1974 dollars) to fit out a house with solar panels. As a PhD student, Green saw the extraordinary potential of using the sun to generate electricity. Solar could provide on-the-spot energy without fossil fuel imports. Millions of poor people could use it.

Fast forward four decades and Green has done more than just about anyone else to put affordable solar panels on rooftops from Geelong to Guangzhou. This engineer set up (and still co-runs) a solar school which has trained more than 500 engineers. You may not have heard of the University of NSW's School of Photovoltaic and Renewable Energy, but it probably designed parts of your neighbour's solar panels. It's one of the world's top three solar institutes, producing the world's most efficient silicon solar cell under lab conditions and offering the world's first undergraduate degree in PV (photovoltaic) engineering. Graduates work around the globe. The school made its mark when it began to train Asian, in particular Chinese, students. Ex-student, Shi Zhengrong, used his studies to turn the solar industry from expensive to cheaper, using Asian manufacturing. This precipitated the sustained solar price drop which explains why Australia now has 800,000 solar roofs.

Green says “What happened was that our students were the ones that drove that growth from the technological aspect,” he said from his home. “You could say that we were responsible for the change in the industry that allowed costs to get down to their current level. Shi Zhengrong, ’the Sun King’, is an Australian citizen (trained by Green) who set up Chinese solar manufacturer Suntech with the aid from the Chinese government. It thrived on his cheap thin-film silicon solar cells, was then floated on the New York stock exchange and sold 25 million panels employing 10,000 workers. Shi became the richest person in mainland China. The UNSW group has educated a large number of people who have gone on to become leaders in PV worldwide.”

Green has largely kept out of the climate debate. When John Howard toned down solar policy and manufacturing, and talent leaked overseas, Green was not a strident critic. He kept pretty quiet as governments changed solar policy, rewriting their rebates and feed-in-tariffs with eye-watering inconsistency (the ‘solar-coaster effect’). UNSW PV has succeeded without much cash from domestic industry or philanthropists. It has funding deals with overseas companies and half its students are Chinese. Its global heft insulates it from the wild ride of the domestic industry changes.

Activity 6: Analysing Australian solar history

1. Why do you think a huge solar industry developed in Beijng?

___

___

2. What happened in 2008 in Australia’s solar research program?

___

3. What is a Solar Air Turbine?

____

Check your response by going to the suggested answers section

Australian research produces most efficient energy conversion

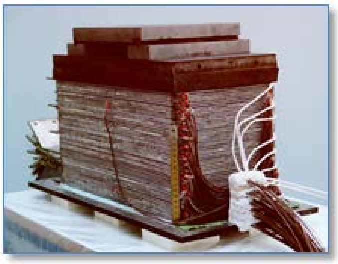
The following summary outlines the development of the very efficient, low emissions ceramic fuel cell (BlueGen) by a team of Australian scientists.

Summary of Ceramic Fuel Cell – BlueGem development

Source : http://www.csiropedia.csiro.au/display/CSIROpedia/Ceramic+Fuel+Cells

Research began in 1986 at the Australian government's Commonwealth Scientific and Industrial Research Organisation (CSIRO), under the leadership of Dr Sukhvinder Badwal. The company Ceramic Fuel Cells Limited (CFCL) was formed to help finance the project.

Results exceed projections



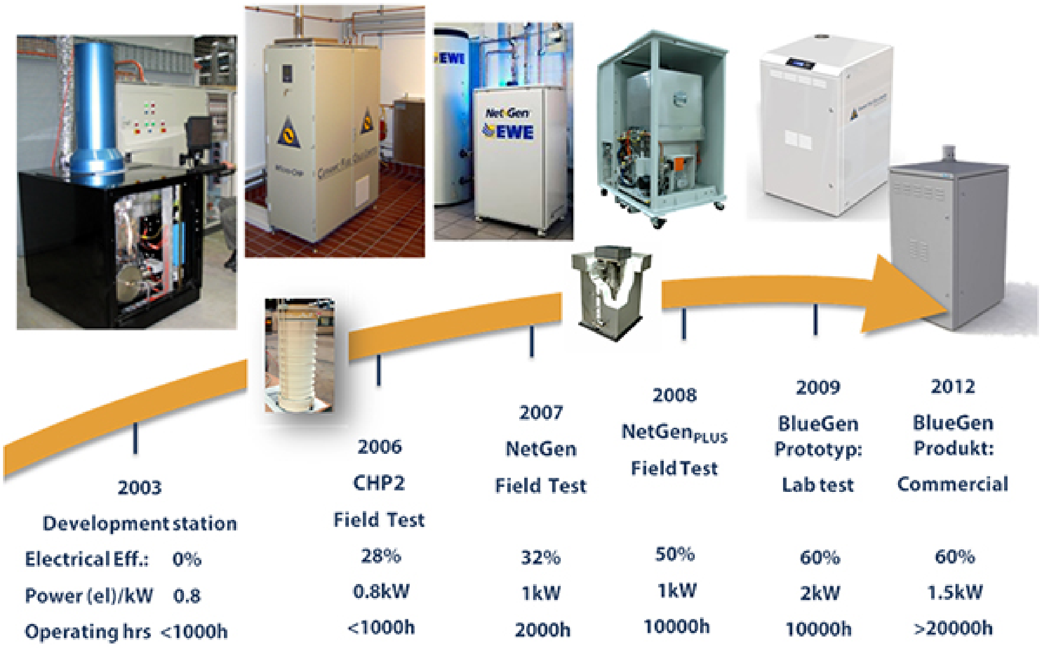
The effort and dedication of the well-trained scientists and engineers paid off. After five years, the project was not only on budget, but had demonstrated its 5kW fuel cell stack in 1997.

In 1997, the company acquired premises in Victoria to develop commercial prototypes. The CFCL company decided to operate independently of CSIRO.

Funding became uncertain. To raise funds, CFCL was converted to a shareholding company and was listed on the Australian and London stock exchanges.

By the end of 2005, CFCL installed the first ceramic fuel cell test units (called BlueGen) in Melbourne and in Oldenburg, Germany. In 2006, the company decided to focus on the European market and set up its manufacturing centre in Germany. The German government offered funding to support efficient energy production and reductions in greenhouse gas emissions.

After 17 years of hard work by a team of scientists and engineers applying their knowledge of chemistry and physics, CFCL presented its first pre-commercial system (BlueGen) at the Hannover Fair in Germany in 2009. **60% efficiency of converting fuel to electricity was a world first.** The figure below shows the history of the efficiency development.



The Global Financial Crisis of 2008 caused the cancellation of an order of 20,000 BluGen units by a European electricity company. Since then, sales in Europe have been slowly increasing due to government subsidies for low emission, efficient energy production. In Australia, no subsidies exist so only small numbers of BlueGen units have been sold.

CSIRO Team that contributed to CFCL's technology: Dr Sukhvinder Badwal, Dr Karl Föger, Dr John Drennan, Dr Manh Hoang, Richard Donelson, Fabio Ciacchi, John Newman, Dr David Hay, Dr San-Ping Jiang, Dr Paul Callus, Daniel Graham, Kylie Crane, Kristine Giampietro, Keith Wilshire, Bob Johnson, Natasha Wright (nee Rockelman), Viktor Zelizko, Dr Anselm Oh, Bob Hughan, Dr Mark Trigg, Dr Rob O'Donnell, Tom Behrsing, Dr Yvone Duan, Alex Yam, Dr Alan Morton, Dr Tracey Johnson, Mr Robert Wilson.

Remember in Part 2 you learnt that a BlueGen ceramic fuel cell not only produced electricity but also produced heat energy for heating water for the home. This makes it a very efficient energy provider.

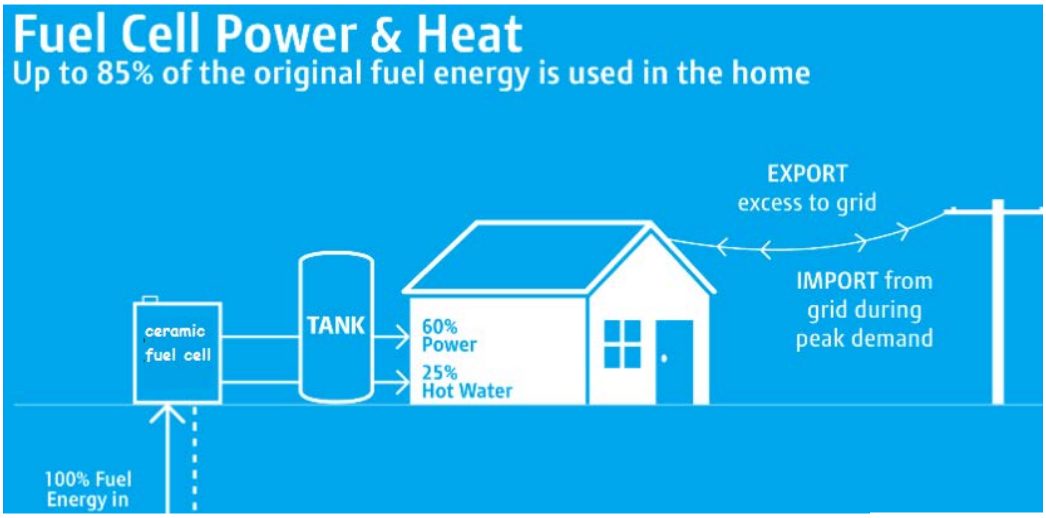


Figure 17

Activity 7: Analysing research and development

1. The history of the production of the efficient ceramic fuel cell tells us a lot about the nature of scientific research. List three things that were necessary for BluGen to go from an idea to a commercial product ____

____

____

2. What is the percentage efficiency of BlueGen producing electricity from the chemical reaction in the fuel cell?

____

Check your response by going to the suggested answers section

EXERCISE

Complete the Send-in exercises for Lesson 3

Lesson 4: Energy efficient homes

In this lesson you will apply what you have learnt to devise ways of making your home as energy-efficient as possible. You will also look at how engineers and architects use scientific concepts to design energy-efficient buildings.

Reflect on what you have learnt so far in this topic. List some things your family could do to make your home as energy-efficient as possible, reducing your electricity bill.

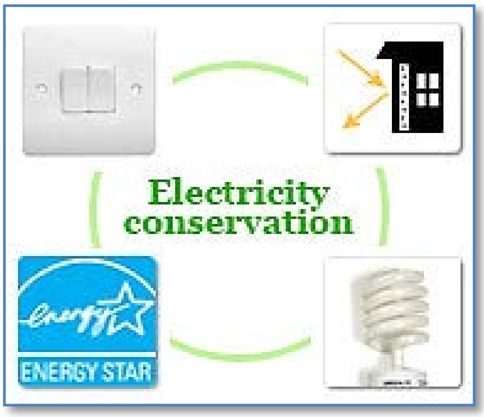


Figure 18

You may have thought of some of the following:

- Use compact fluorescent lights or LED lights.
- Turn lights off when not using them.
- Use a clothes drier as little as possible – use the Sun to dry clothes on a clothes line.
- Switch off appliances. Do not leave them on stand-by.
- Don't waste hot water. Fix dripping hot water taps. Wash clothes in cold or warm water.
- Only heat required amounts of water in electric kettles.
- Shut doors so convection of warm air from a heater can heat a room quickly.

- Buy appliances with a 4 or 5 star energy rating which do not use as much electrical energy to run.
- Install a solar thermal hot water service to use the energy from the Sun to supply hot water.
- Insulate ceilings and external walls.

In Australia about 15% of our total energy use is in providing electricity for household activities.

In the average home, a large percentage of electricity use is for heating and cooling.

Think about features of your own home that may help keep it warm or cool.

The electrical energy required for heating and cooling a home can be reduced by applying a number of factors when designing a house.

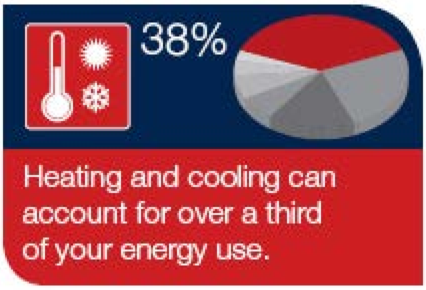


Figure 19a

In Australia, the Sun moves across the northern sky and is lower in winter than in summer. If a house is built with the living areas facing north, the radiant heat from the Sun will warm these rooms in winter. This will reduce the use of electricity for heating.

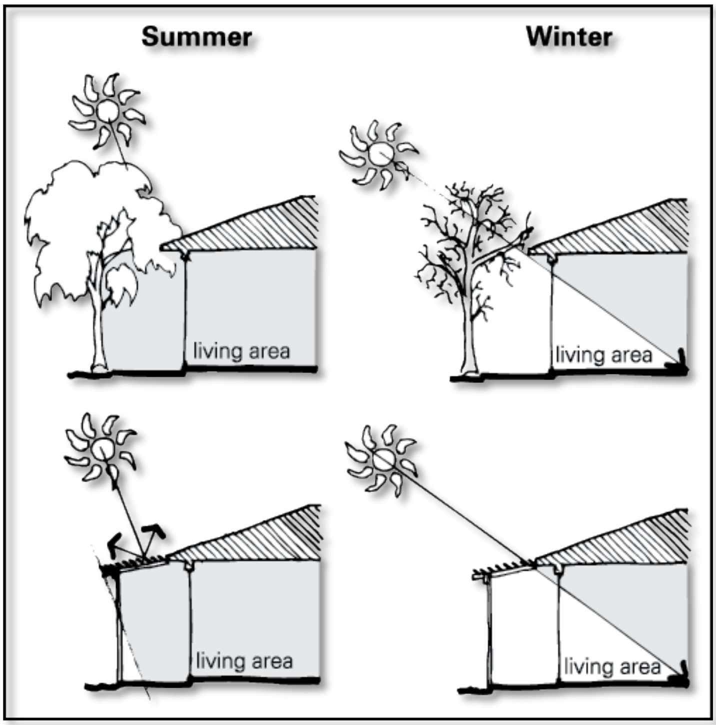


Figure 19b: Living areas facing north

Figure 19b shows that external awnings can be used to reflect the radiant heat in summer. Deciduous trees that lose leaves in winter can absorb the radiant heat, stopping it from entering the home in summer.

Do you have curtains on your windows?

Curtains are made of materials that do not conduct heat energy well. Remember in Lesson 1 you learnt that these are called insulators. Curtains can create an insulating layer on a window preventing heat energy being conducted to the outside of the house through the glass. Correctly fitted curtain pelmets can keep warm rising air in a room. Figure 20 shows how curtains and pelmets work.

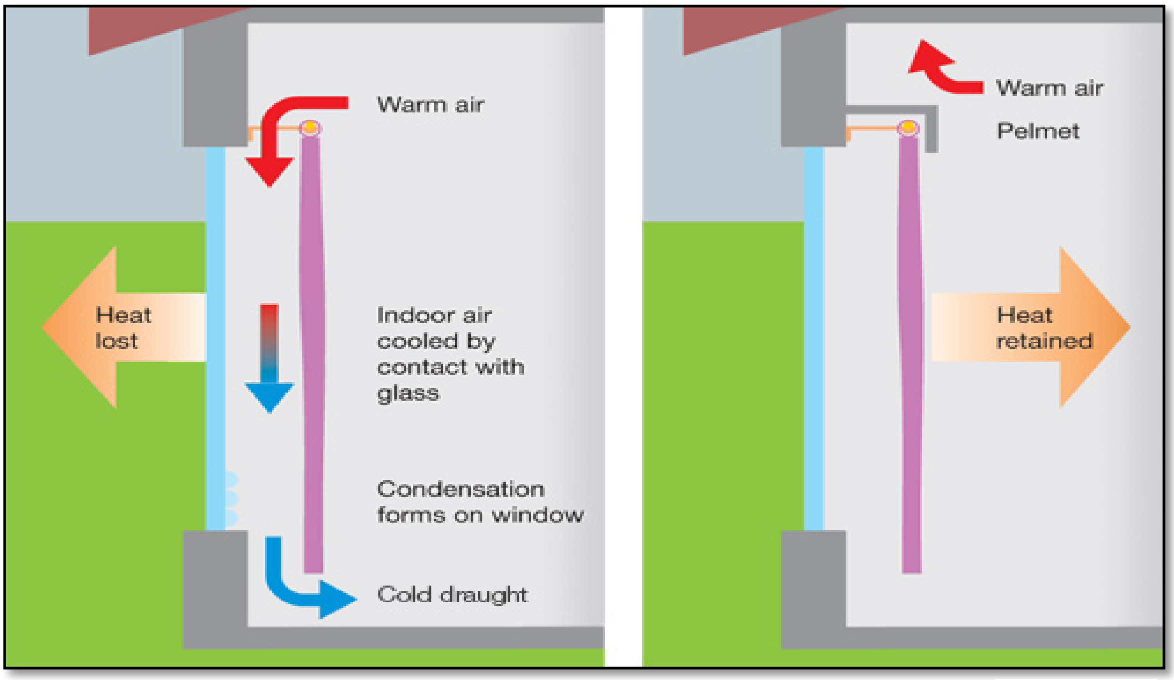


Figure 20

Does your home have a layer of insulating material in your ceiling and roof?

Adding insulation to the walls and ceilings of a home can help reduce the amount of electricity used for heating and cooling a home. Figure 21 shows the amount of heat energy an average house loses or gains by conduction.

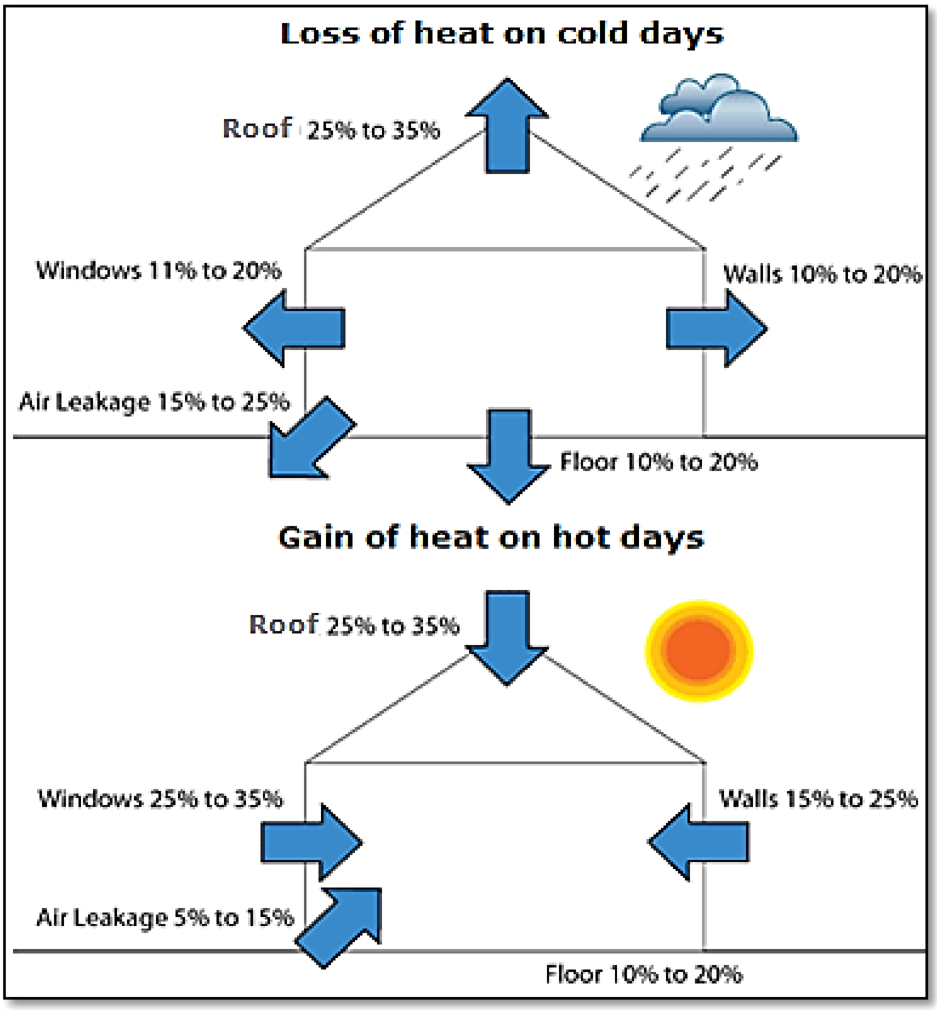


Figure 21

Activity 8: Testing insulation

Aim: To see if insulation affects heat transfer

Materials:

2 identical glasses

Double-sided reflecting foil insulation

two identical chocolates or two cubes of cheese

Method:

Step 1: Place a chocolate (or cheese cube) in the bottom of each glass.

Step 2: Wrap one of the glasses in the foil insulation.

Step 3: Place both glasses in the sun for 30 minutes.

Step 4: Unwrap the insulated glass

Step 5: Feel both glasses and the air inside and note any difference in temperature.

Step 6: Record any changes in the consistency of the chocolate or cheese.

Results:

Complete the following sentences to record your results by crossing out the incorrect words.

After the glasses had been left in the sun for 30 minutes the glass wrapped in the insulation felt cooler/hotter than the glass without the insulation.

The chocolate in the glass with the insulation did/did not melt.

Conclusion:

Complete the following sentences to write a conclusion by crossing out the incorrect word.

The glass with the insulation did/did not transfer heat energy to the air inside.

Check your response by going to the suggested answers section

Double sided foil insulation reflects radiant heat from the sun. When placed under roof tiles or in walls it greatly reduces the heat energy that is conducted into the house as shown in Figure 22. This will reduce the electricity required for cooling by fans and air conditioning.

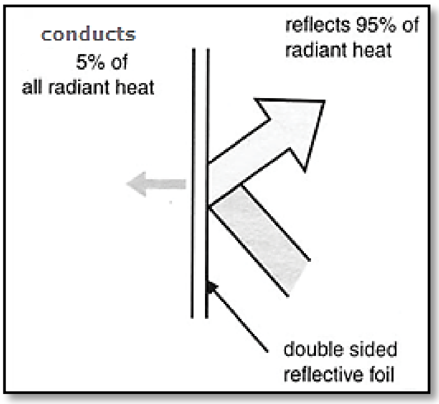


Figure 22: Foil

A layer of fibreglass or wool insulation above the ceiling stops heat energy being conducted into a room in summer. It also keeps the cool air from an air-conditioned room in the room during summer.

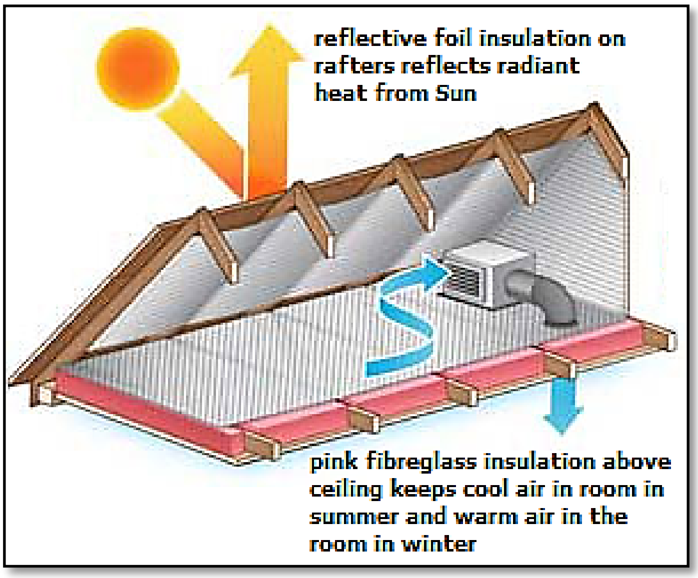


Figure 23

Do you have carpets in your home?

Carpets and rugs are made of insulating materials, so using them will stop heat energy being conducted out of the house through floors.

Do you have any draughts in your home?

Airtightness is an essential part of creating a healthy, comfortable, energy-efficient living environment.

Figure 24 shows the percentage of heat loss due to air leakages from gaps around plumbing and electrical wires entering a home.

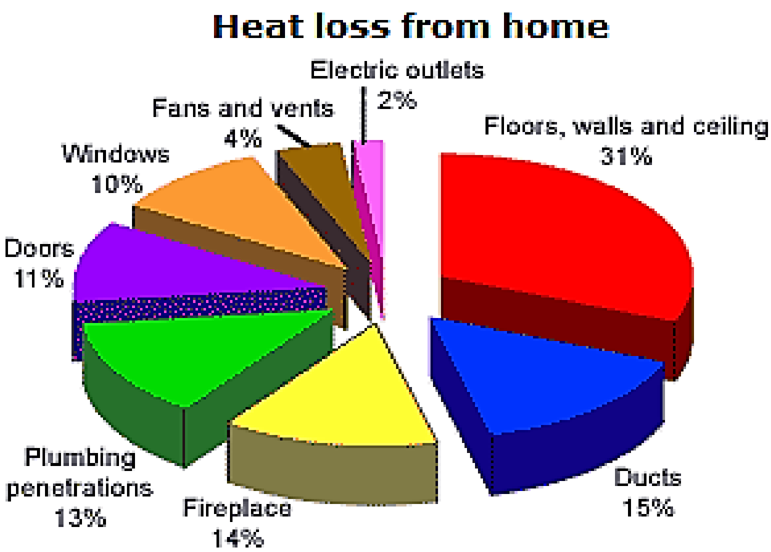


Figure 24

Sealing any gaps in the external walls will greatly reduce heat loss and reduce electricity use and heating bills.

Using internal doors or movable panels to create smaller spaces for heating will also reduce draughts and the cost of heating spaces.

Placing heaters to prevent draughts moving around seats will allow heaters to be on lower settings using less energy.

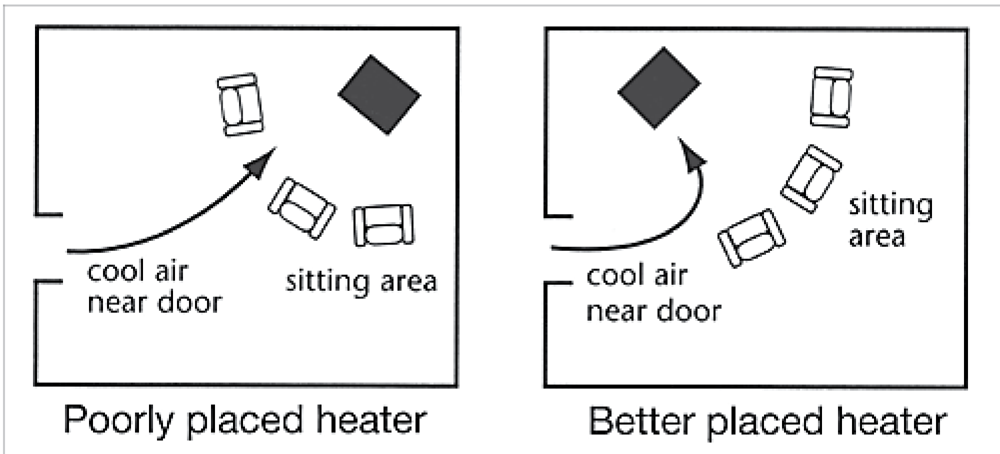


Figure 25

Do you have ceiling fans with summer/winter rotation options?

Installing ceiling fans can reduce energy used for cooling in summer and heating in winter.

In summer, the fan provides a circulating breeze which helps evaporate moisture from your skin. When liquid water on your skin evaporates the water particles gain heat energy from you. The particles move more quickly and leave the skin as water vapour gas particles. The heat energy lost from the skin reduces the temperature of your skin. It can make you feel up to 8°C cooler.

Figure 26: Ceiling fan circulating warm air in winter

Figure 27: Some fans use DC instead of AC electricity

Many fans have a forward and reverse option or a summer/winter option. By switching the fan to reverse/winter option in winter the fan can help circulate warm air. When a heater or air conditioner is warming a room the hot air rises by convection.

Switching a fan to reverse allows the fan blades to push the warm air against the ceiling and down the walls as shown in Figure 26. The warm air is recirculating so the heater or air conditioner does not need to operate on high. This saves electricity and reduces the energy bill for heating.

An electric fan is the cheapest way of cooling a room. The average ceiling fan uses about 60 watts to operate compared to an efficient air-conditioner as shown in Figure 28. Some fan models use DC electricity as shown in Figure 27.

Figure 28

Now think about the external building materials that have been used to build your home. Some materials are better conductors of heat than others.

As you can see from Figure 29, concrete, bricks and tiles do not conduct heat as well as steel. Concrete, bricks and tiles will not transfer heat into the home or out of the home very easily.

Thermal (heat) conductivity
the lower the K value the lower the heat flow through the product

Material	K-Value W/m.K
Corrugated Roof Sheet	43.000
Clay Roof Tile	1.150
Wooden Roof Truss	0.120
Gypsum Plasterboard	0.170
Glasswool Ceiling Board (50kg/m^3)	0.032
Glasswool Ceiling Insulation (11kg/m^3)	0.040
Polyester Ceiling Insulation (10kg/m^3)	0.045

Figure 29

This means that homes built with concrete floors, brick walls and tiled roofs have more stable internal temperatures than steel framed houses with steel roofs.

Activity 9: Analysing house design

If your family is going to buy a new home the energy efficiency of the home will be something to consider.

The Australian Building Codes Board introduced energy efficiency measures for houses into the Building Code of Australia (BCA) on 1 January 2003. It has been adopted by all Australian states and territories.

Figure 30

All new homes in Australia must be energy rated. A dwelling can be rated before or after it is built.

The rating depends on:

- the layout of the home
- the construction of its roof, walls, windows and floor
- the orientation of windows and shading to the sun's path and local breezes how well these suit the local climate.

This scheme is designed to:

1. reduce Australia’s fossil fuel energy consumption
2. reduce Australia’s greenhouse gas emissions

There are ten stars in the rating system:

No stars mean the building design and materials do practically nothing to reduce the discomfort of hot or cold weather. A 5 star rating indicates good, but not outstanding, thermal comfort. A 10 star home is unlikely to need any artificial cooling or heating. Such a home will be cheap to run as the electricity bill for heating and cooling will be extremely low.

When you leave home and buy or rent your first place you can consider what you have learnt to make choices to reduce your future electricity bills.

Summary of Lesson 4

- Energy efficient homes use small amount of electricity
- Many practices can help reduce a household's use of electricity.
- The external and internal design of a home can reduce the use of electricity for heating and cooling.
- New houses in Australia are rated for energy efficiency so potential buyers can assess future electricity costs and greenhouse emissions.

To complete this topic you will use what you have learnt about producing and saving electrical energy to design a very energy efficient house.

Complete the Send-in exercises for Lesson 4

Send-in Exercises:
Technology and electricity Part 3

Lesson 1: Heat Transfer

1. Describe what you observed when the butter was left on the spoons for five minutes.

Results:

____

____

2. Conclusion: (Complete the following conclusion statements by crossing out the incorrect words)
   a) Heat energy was <u>transferred/ not transferred</u> along the metal spoon.
   b) Heat energy was <u>transferred/ not transferred</u> along the wooden spoon.
   c) Heat energy was <u>transferred/ not transferred</u> along the plastic spoon.
   d) Some substances are better heat conductors than others and this activity showed <u>metal/plastic/wood</u> was the best conductor of heat energy.
3. Discussion:

Explain what happened to the particles in the metal spoon after the spoon was placed in the hot water.

____

____

Lesson 2: Solar heating at home – solar thermal

Activity 4: Testing solar energy

Results:

Table of temperature readings of water in white and black cans

Time (minutes)	Temperature (ºC)	
	White can	Black can
0		
10		
20		
30		
40		
50		
60		

Conclusion:

___

___

___

___

Lesson 3: Research and development

1. Australia is a very arid (dry) continent with a very sunny climate. Australia has large deposits of coal that will last another 100 years.

   Discuss one advantage and one disadvantage of generating electricity for power grids by each of the following methods:

   - using solar air turbines
   - burning coal

____

____

____

____

____

____

____

____

2. Which energy technologies do you think Australian governments should be supporting o make our society more energy efficient and less polluting?

   ____

   Justify your choice/s (give reasons to support your opinion).

   ____

   ____

   ____

   ____

   ____

   ____

Lesson 4: Energy efficient homes

Imagine that you are going to build a house in an isolated area of Australia away from any grid electricity network.

Design a house and draw a labelled diagram of your design. Your house will need to show that it:

- produces its own electricity
- uses good design strategies to reduce its use of electricity

You will need to draw a labelled diagram of your design

(The following website may help you with your design:

https://www.sa.gov.au/topics/water-energy-and-environment/energy/saving-energy-at-home/energy-efficient-home-design)