STUDENT BOOKLET

STELR

SUSTAINABLE HOUSING

SECOND EDITION

NAME

CLASS


ORICA
COMMISSIONING

STELR

SUSTAINABLE HOUSING

STUDENT BOOK

SUSTAINABLE HOUSING was written and produced by the STELR project team.

www.stelr.org.au

Science and Technology Education Leveraging Relevance (STELR) is the key school education initiative of the Australia Academy of Technology and Engineering (ATSE). www.atse.org.au

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CONTENTS

1 ENERGY AND SUSTAINABILITY

This unit introduces Energy and the choices you can make about housing to reduce your impact on the environment. Building houses sustainably means designing them so that they stay warm in winter and cool in summer and minimising the amount of energy used for heating and cooling. This reduces the amount of carbon dioxide going into the atmosphere and saves money. It also means choosing sustainably produced materials to build the house.

1.1 LESSON: YOUR IDEAS ABOUT ENERGY

KEY QUESTIONS

- What is climate change?
- How is energy transferred and transformed?
- How is heat transferred in different ways?

Before getting started with the activities, complete this short survey. It will help evaluate what you already know about energy and get you thinking about the upcoming lessons.

Choose the best answer to the following questions.

Question 1

Weather and climate are the same thing?

☐ true

☐ false

☐ I don't understand the question

☐ not sure

Question 2

Which of the following best describes the greenhouse effect on Earth?

☐ The greenhouse effect is the 'trapping' of some of the Earth's infrared radiation in the atmosphere.

☐ The greenhouse effect gives the sky its blue colour and the sea its blue-green colour.

☐ The greenhouse effect is the result of industrial pollution and human-caused fires.

☐ The greenhouse effect is caused by the hole in the ozone layer.

Question 3

Which answer best completes the following sentence correctly? The greenhouse effect is necessary for life on Earth because:

☐ it provides the carbon dioxide necessary for plants to photosynthesise.

☐ it provides us with the oxygen gas we need for life.

☐ it shields us from the Sun’s ultraviolet radiation.

☐ it helps keep the temperature of the Earth not too hot and not too cold.

Question 4

The invisible carbon dioxide released when coal, oil, and gas are burned is the single most important contributor to climate change.

☐ true

☐ false

☐ I don’t understand the question

☐ not sure

Question 5

This type of radiation from the sun is related to climate change:

☐ Infra-red

☐ Ultra violet

☐ I don’t understand the question

☐ not sure

Question 6

Energy sources that can be replenished by nature in a relatively short period of time are called renewable energy forms.

☐ true

☐ false

☐ I don’t understand the question

☐ not sure

Question 7

Consider the following situations:

Situation 1: A cold spoon is placed in a cup of hot tea.
Situation 2: An ice cube is placed in a cup of hot tea.
Is energy being transferred in either of these situations?

☐ Energy is transferred when an ice cube is placed in a cup of hot tea, but energy is NOT transferred when a cold spoon is placed in a cup of hot tea.

☐ Energy is transferred when a cold spoon is placed in a cup of hot tea, but energy is NOT transferred when an ice cube is placed in a cup of hot tea.

☐ Energy is transferred in both situations.

☐ Energy is NOT transferred in either situation.

☐ I don't understand the question / I am not sure.

Question 8

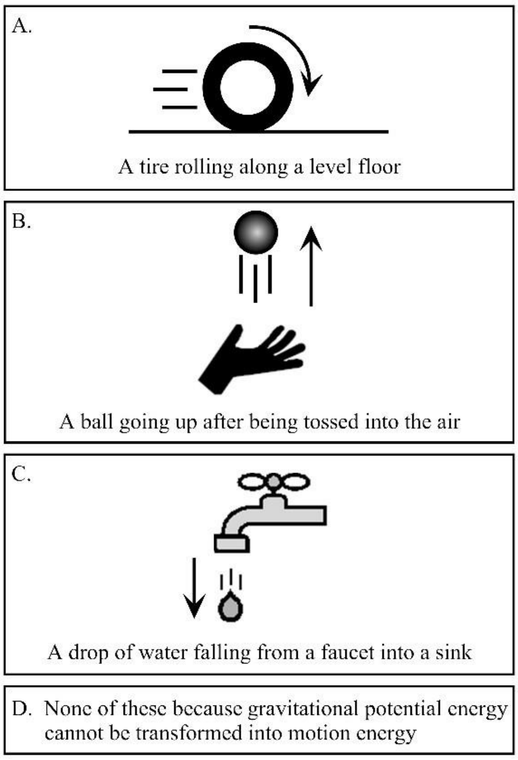
Which of the diagrams below is an example of the transformation of gravitational potential energy into motion energy (kinetic energy)?

☐ A

☐ B

☐ C

☐ D



Question 9

The particles in a solid that is heating up move farther and farther apart because:

- ☐ the particles slow down.
- ☐ the particles begin to lose their shape.
- ☐ the particles repel each other more intensely.
- ☐ the particles have more energy and bump into each other more often

Question 10

Which of the following has thermal energy?

- ☐ A piece of metal that feels cold but not a piece of metal that feels hot.
- ☐ A piece of metal that feels hot but not a piece of metal that feels cold.
- ☐ Both a piece of metal that feels hot and a piece of metal that feels cold.
- ☐ Neither a piece of metal that feels hot nor a piece of metal that feels cold.
- ☐ I don't understand the question / I am not sure.

Question 11

A student is holding a cold piece of metal in her hand. While she is holding the piece of metal, her hand gets colder. Does the piece of metal get warmer? Why or why not?

- ☐ Yes, the piece of metal will get warmer because some thermal energy is transferred from the student's hand to the metal.
- ☐ No, the piece of metal will stay at the same temperature because thermal energy is not transferred between the student's hand and the metal.
- ☐ No, the piece of metal will stay at the same temperature because an equal amount of thermal energy is exchanged between the student's hand and the metal.
- ☐ Yes, the piece of metal will get warmer because some thermal energy is transferred from the metal to the student's hand.
- ☐ I don't understand the question or I am not sure.

Question 12

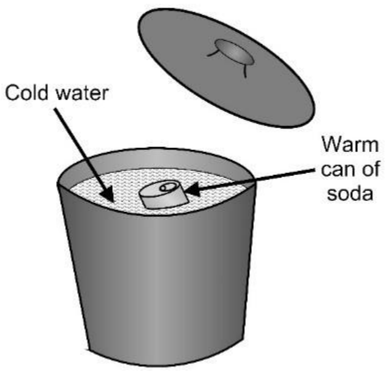
Consider a light bulb and an ice cream cone.

Which gives off energy by radiation and why?

- ☐ Both a light bulb and an ice cream cone because all objects radiate energy.
- ☐ Neither a light bulb nor an ice cream cone because only the sun radiates energy.
- ☐ Only a light bulb when it is glowing because only glowing objects radiate energy.
- ☐ Only a light bulb when it is hot because only hot objects radiate energy.
- ☐ I don’t understand the question or I am not sure.

Question 13

A student places a warm can of soda into a bucket filled with cold water. She puts the lid on the bucket. Which of the following describes the energy transfer between the water and the can of soda in the bucket?



- ☐ Thermal energy is transferred from the can of soda to the water so the can of soda gets cooler and the water stays the same temperature.
- ☐ Thermal energy is transferred from the can of soda to the water so the can of soda gets cooler and the water gets warmer.
- ☐ Coldness is transferred from the water to the can of soda so the can of soda gets cooler and the water stays the same temperature.
- ☐ Coldness is transferred from the water to the can of soda so the can of soda gets cooler and the water ice gets warmer.
- ☐ I don’t understand the question / I am not sure.

Question 14

A girl is sitting under an umbrella at the beach on a sunny day. When she moves out of the shade and into the sunlight, she will feel warmer. Why?

- ☐ Because energy is being transferred directly from the Sun to the girl.
- ☐ Because energy is being transferred from the Sun to the air and then from the air to the girl, but no energy is being transferred directly from the Sun to the girl.
- ☐ Because energy is being transferred from the Sun to the ground and then from the ground to the girl, but no energy is being transferred directly from the Sun to the girl.
- ☐ Because the Sun is shining on the girl, not because energy was transferred from the Sun to the girl.
- ☐ I don’t understand the question / I am not sure.

Question 15

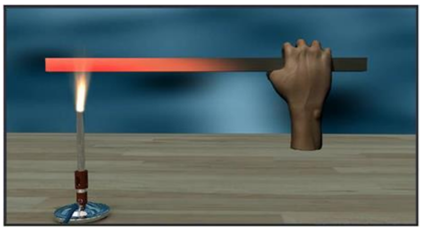
Garments that are made of wool keep you warm in winter as the material contains pockets of air. Explain how a woollen glove would keep your hand warm if, for example, you picked up a snow ball.

You can use text and/or drawings to provide an answer.

Question 16

If you place one end of an iron rod in a fire and you hold the other end after a while the end you are holding feels warm. Explain the process that results in your hand feeling warm.

You can use text and/or drawings to provide an answer.



Question 17

Imagine a bundle of energy that is emitted from the sun travels through space and reaches Earth. Describe the different ways in which the bundle of energy might interact with the Earth.

You can use text and/or drawings to provide an answer.

1.2 LESSON: WHAT IS SUSTAINABLE HOUSING?

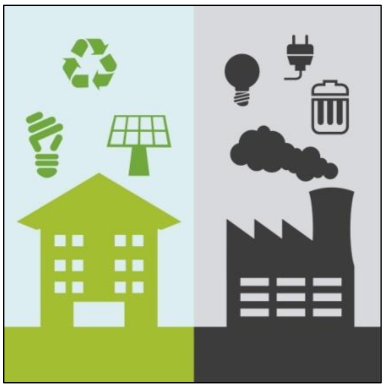
KEY QUESTION

- What does “being sustainable” mean?

Being sustainable means understanding that the Earth's resources are limited and working to conserve them so we can live comfortably now without affecting future generations.

Being sustainable means making smart choices about how we use things such as energy and water and how much waste we produce.

Being sustainable is important on a global and national scale, but everyone can help by being sustainable in their own home.



Question 1

Create a mind map on ENERGY to explore how you use and waste energy around your own home.

Now, go to this website to find answers to the following questions:

Australian Government Energy Website page Energy Basics for householders

https://www.energy.gov.au/households/energy-basics-householders

Question 2

About what percentage of home energy is used for heating and cooling?

____

____

Question 3

What is the recommended temperature range for:

Heating in winter? ________________________________

Cooling in summer? ________________________________

Question 4

What percentage of energy can be saved by sealing up gaps to prevent draughts in your house?

____

____

Question 5

Give two other examples that you can do to reduce heating and/or cooling costs.

____

____

____

____

1.3 CASE STUDY: ILLAWARRA FLAME HOUSE

In 2013, the University of Wollongong teamed up with TAFE Illawarra Institute to form Team UOW Australia. Team UOW was the first team from Australia to gain entrance into the Solar Decathlon, which is an international competition to develop and adopt "advanced building energy technology in new and existing homes".

Over 50 students and staff designed and built the Illawarra Flame House which won the competition.

Many materials in the house and its landscape are reclaimed or recycled, including hardwood and crushed terracotta roof tiles which could be sourced from an original fibro house under renovation.

You can see how they retrofitted an old house to make it into an award-winning solar-powered sustainable house by watching these videos. After watching the videos, answer the questions below.

VIDEO **Team UOW Australia's Illawarra Flame House**
www.youtube.com/watch?v=kOXFoRZ8y2k

VIDEO **Illawarra Flame House Animated Walk-Through**
www.youtube.com/watch?v=Q4P-NrYDGbo

Question 1

What proportion of Australia's carbon dioxide emissions come from people's homes?

- [ ] 3 %
- [ ] 5 %
- [ ] 10 %
- [ ] 13 %
- [ ] 15 %

Question 2

What does "retro-fit" mean?

- [ ] Demolishing a home
- [ ] Building new homes
- [ ] Adapting existing homes

☐ Making new homes look old-fashioned

Question 3

In Australia, on which side of the house should you put solar panels to collect the most energy from the Sun?

☐ North

☐ South

☐ East

☐ West

Question 4

In winter, the Sun is higher in the sky than in summer.

☐ True

☐ False

Question 5

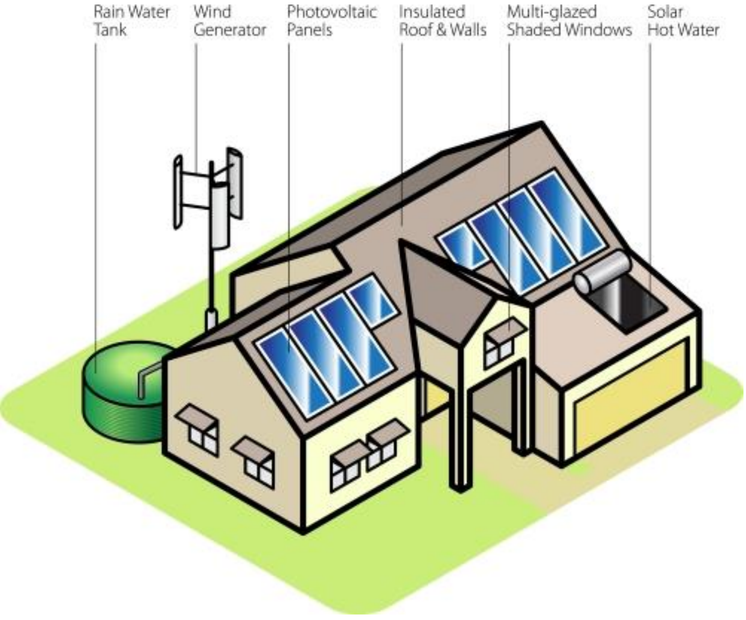
Explain how the thermal wall works.

1.4 NET-ZERO HOME

The picture represents a zero energy home.

A zero energy or net-zero home generates all the energy that it uses without having any negative impact on the environment, for example by burning a conventional fuel for heating.

Look carefully at the house in the picture and answer the following questions:



Question 1

Explain how this house is generating electricity.

____

____

____

____

Question 2

Explain how the house reducing the amount of lost energy.

____

____

____

Question 3

What features help this house stay cool in summer?

____

____

Question 4

Explain how the water for showers, baths or for washing dishes and clothes is heated.

Question 5

Water is a precious resource. How can we reduce the amount of water we use?

Question 6

Explain how we could minimise the impact on the environment when building the house

Sustainable living means to reduce our use of Earth's natural resources in our day-by-day life. It means "enough for everyone" without affecting generations to come.

Sustainable housing looks at:

- The building materials used
- The energy usage
- The waste generated by households

Question 7

Discuss with a partner the things you can do to live more sustainably in your home. Record your ideas below.

2 ENERGY

We need energy to hold up a phone, and energy to charge it...what have these things got in common?

It is hard to pin down exactly what energy is.

In this section, you will use the STELR equipment to learn more about energy.

2.1 LESSON: WHAT IS ENERGY?

KEY QUESTIONS

- Why do we need energy?
- What types of energy are there?
- What is the difference between energy transformation and energy transfer?
- What are energy resources?
- Why is energy important for housing?

Question 1

All of the pictures below have something to do with energy – often more than one type. With a partner, see how many types you can identify. Put your answers in the table on the next page.

Note: Do not worry if you are not sure – this is to see what you know now, and you will get a chance to come *back for another attempt later.*

	Energy type 1	Energy type 2	Energy type 3
Skier			
Wind turbines			
Sun			
Dog on trampoline			
Petrol pump			
Energy drink			
Radio			
Cow			
High jumper			
Power pylons			
Fire			

Question 2

Now, after discussing with your partner, have a go at saying what you think energy is.

___

___

___

___

Energy is about **moving** – either something *actually moving* or with the *potential* to move. Here are some examples.

Actually moving

- Anything that moves has **kinetic energy**.
- If it's a machine that's moving the kinetic energy is often called **mechanical energy**.
- **Light**, and all electromagnetic waves, move...they're a form of kinetic energy.
- **Heat** is the movement of the atoms that something is made up of, so it's a type of kinetic energy.
- **Sound** is the movement of atoms or molecules – also a type of kinetic energy.

Potentially moving

- Something above the ground has the potential to fall – that is, move – so it has **gravitational potential energy**.
- Anything that burns or is eaten as food contains **chemical potential energy**.
- **Electricity** can be used to make light, heat and sound, and to make things move – it is a form of potential energy.
- A spring, compressed or extended, will move when it's let go – it has **elastic potential energy**.

Question 3

When something is moving it has: *(choose the best answer)*

- ☐ potential energy
- ☐ electrical energy
- ☐ chemical energy
- ☐ mechanical energy
- ☐ kinetic energy

Question 4

Which of the following are types of potential energy? *(select one or more)*

- ☐ elastic energy
- ☐ gravitational energy
- ☐ sound energy
- ☐ kinetic energy
- ☐ chemical energy

Question 5

We classify heat as a type of _____________ energy because _____________.
(choose the best answer)

- ☐ kinetic; it can move from one object to another
- ☐ kinetic; the atoms in hot things move faster than in cold things
- ☐ potential; we store it in objects when they get hotter and hotter
- ☐ potential; though it doesn't involve movement itself, it can make things move, like a hot air balloon

Question 6

Think of your own examples and add them to the table in the right hand column.

Energy Type	Definition	Example	Your own Example
Kinetic Energy	Movement or motion	Any moving object like a car	
Elastic Potential Energy	The energy contained in a stretched or compressed elastic object	Springs	
Gravitational Potential Energy	Gravitational potential energy is the energy stored in an object as the result of its vertical position or height, due to the Earth's gravitational field.	Any raised object like a boulder on the top of a hill.	
Chemical Potential Energy	Energy stored in the bonds of molecules	Fossil fuels	
Thermal	Heat	Heat from fire	
Sound	Fossil fuels	Someone shouting	
Light	Energy found in photons	Visible light from the sun	
Electrical Energy	Energy possessed by electrons in a flow of electric charge	The energy in the power lines as they leave the power station	
Nuclear Potential Energy	Energy stored in the way that the particles in the nucleus are held together	A deposit of uranium ore	

Are you starting to understand more about the main energy types? Watch the following video and complete the second table.

Keep Moving Rover

www.youtube.com/watch?v=1KUmVTGoLzg

Question 7

For each of the scenes in the above animation, identify the main energy type that is being portrayed. Hint: each of the energy types listed in the previous table has been represented in its own scene.

Scene	Main energy type portrayed in the scene
1	
2	
3	
4	
5	
6	
7	
8	
9	

WRAP-UP

How have you gone in this lesson? These questions will check if you have understood the main points.

Question 8

Which is the best description of energy?

- ☐ what moving things have, and what can make them move
- ☐ how active you feel
- ☐ what anything made of atoms has
- ☐ how fast something is going, or how hot it is

Question 9

All the different types of energy:

- ☐ are in or come from living things
- ☐ are basically different – we call them all energy but in physics they're different things
- ☐ always involve objects that are moving, or have moving parts
- ☐ involve either things moving, or the potential to make things move

2.2 LESSON: TRANSFORMATIONS AND TRANSFERS

KEY QUESTIONS

- What is energy transformation and how can we represent it?
- What is energy transfer?

ENERGY TRANSFORMATION

Fossil fuels such as coal, oil and natural gas contain chemical energy. When we use them, it's not chemical energy that we want. We want:

- kinetic energy, for example using petrol to power cars;
- heat energy, for example in a gas home-heating system;
- electrical energy, for example to run an air conditioner in your home.

We start with energy in one form, and then change or **transform** it into another.

We can represent energy transformations with word formulas, using arrows. For example, for a car using petrol the transformation is:

chemical energy → kinetic energy

Burning gas for heat it's:

chemical energy → heat energy

and in a coal-fired power station it's:

chemical energy → electrical energy

Question 1

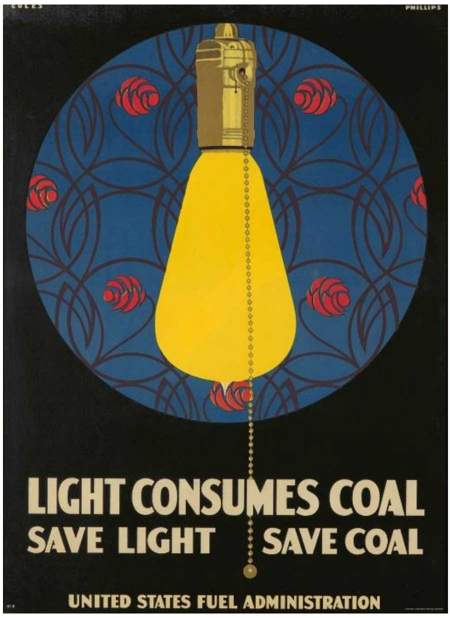
There are many appliances that you use at home that transform one type of energy into other types of energy. Write down the starting energy for each of these appliances and then then the main (useful) energy that it is transformed into. Sometimes there are other types of energy produced by an appliance that is not so useful.

For example, a hair dryer transforms electrical energy into heat (hot air) and movement (a fan to blow the air) which are both useful. It also produces sound energy which is not useful for drying your hair.

Complete the following table to show the energy transfers in the following appliances. (The first one has been completed for you.)

	Starting energy	Useful energy	Not so useful energy
Hair Dryer	**Electrical**	**Heat and movement (kinetic)**	**Sound**
Gas gook top			
Phone			
Ceiling fan			
Microwave oven			
Television			
Radio			
Light globe			
Central heating system			
Air conditioner			
Solar panels			
Candle			

Question 2



The poster to the left was issued in the United States during the First World War.

- Explain the message it is conveying.
- Do you think that 'consumes' is a good word to use here? What would be a more scientific way of saying 'light consumes coal'?

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ENERGY TRANSFER

Rather than staying in the same place, energy frequently moves from one place to another. This is known as energy transfer.

Imagine yourself at home, sitting down after a long day at school and switching the TV on to watch your favourite TV show. The TV lights up and the show theme song begins to play. How does the sound get from the TV to your ears?

The answer is that the TV's speakers produce the sound, which is then transferred through the particles in the air all the way to your ears. In fact, if there weren't any particles in the air (if you were watching your TV show in outer space, for example) you wouldn't hear anything at all!

Energy **transfer** is when energy stays in the same form, but moves from one place to another. Here are other examples:

- **The Sun warming your home**
  The heat produced by the Sun is transferred through space to surfaces outside or inside your home that then become warm.
- **Power lines**
  Electrical energy generated in power stations is transferred through power lines to houses and businesses where it is used.

Question 3

Describe two other examples of energy transfer that take place in your home.

Energy type	Transfer example

WRAP-UP

Are you on top of what energy transfers and transformations are?

Question 4

Which is the best description of what energy transformation is?

- ☐ when something gets more energy
- ☐ when energy in a particular form moves from one place to another
- ☐ when energy changes into matter
- ☐ when energy changes from one form into another

Question 5

Which is the best description of what energy transfer is?

- ☐ when something gets more energy
- ☐ when energy in a particular form moves from one place to another
- ☐ when energy changes into matter
- ☐ when energy changes from one form into another

2.3 ACTIVITY: TRANSFORMATIONS AND TRANSFERS

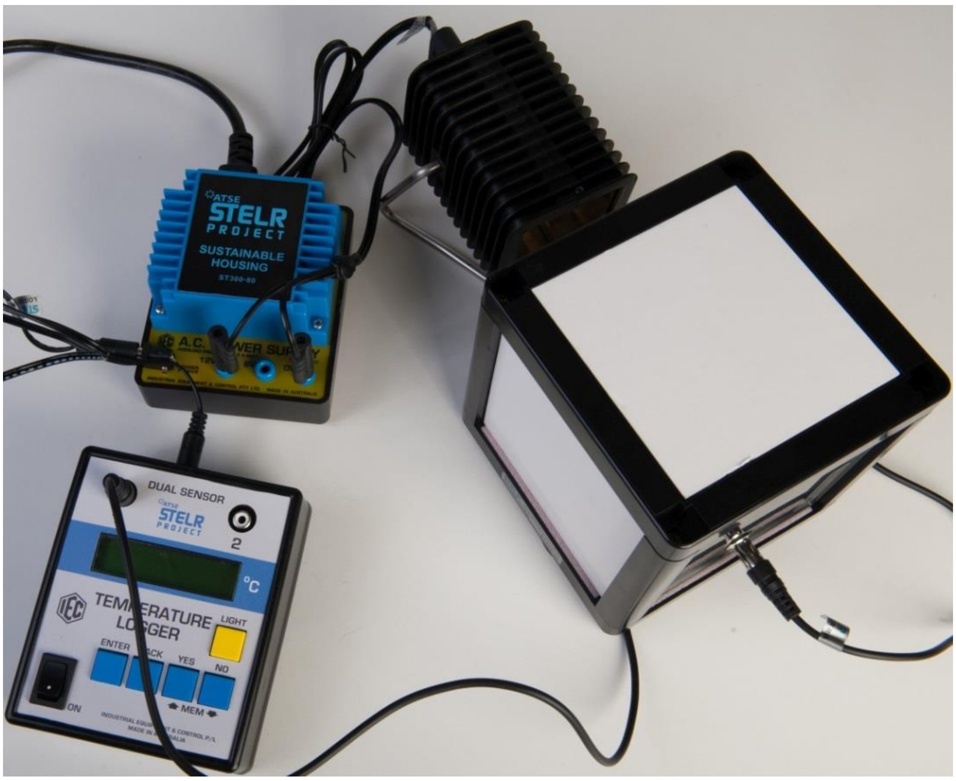
KEY QUESTIONS

- How dos the STELR Sustainable Housing equipment work?
- What energy transfers and transformations occur in a house?

In this activity, you will learn how to set up the STELR sustainable house and identify some energy transformations and transfers.

Materials

- STELR house cube
- STELR heat sensor panel
- Clear plastic panel
- 4 x white plastic panels
- STELR power supply
- STELR lamp
- STELR temperature logger
- connecting cables



WHAT TO DO

Set up the equipment as shown in the picture, following these steps:

- Set one house cube on the bench (feet down) and drop one white plastic panel into the Base to make a floor.
- Put the temperature sensor panel into one wall of the house. Make sure the green stripe is on the inside and is positioned horizontally.
- Put a clear plastic wall panel in the wall opposite the temperature sensor panel.
- Put a white plastic panel in each of the other two side walls.
- Drop another white plastic panel into the top of the cube to make a flat roof.

Now set up the heat lamp (imitation Sun)

- Attach the mains power cable to the STELR power supply (DO NOT SWITCH ON THE POWER)
- Plug one of the lamp cables into the 0V socket and the other lamp cable into the 12V socket of the power supply.
- Place the lamp so that it is facing the clear plastic window of the house and 10 cm from the house. (Your teacher may give you a template to use to get the positions right.

Take care as the STELR lamps can get quite hot. Always unplug them when they are not in use.

Now connect the temperature sensor panel to the temperature logger.

- First, turn on the temperature logger to see if it does not have a flat battery. If the display screen does not light up, connect the logger to the logger power socket on the power supply. Then turn the logger off.
- Connect the temperature sensor panel to socket 1 on the temperature logger.

You are now ready to go. Get your teacher to check your set-up before proceeding to the experiment.

- Turn on the power to the lamp.
- Turn on the temperature logger.
- Press YES, ENTER, NO, ENTER, YES.
- As soon as you press the last 'YES' the temperature start to be displayed.

Write down the temperature in the table below, every minute from 0 minutes to five minutes.

At five minutes, turn off the lamp by unplugging one of the lamp cables from the power supply. Move the lamp away from the house.

Continue to record the temperature every minute until you reach 10 minutes.

Turn off the temperature logger. Turn off the power to the power supply.

RESULTS

Heating up (lamp on)

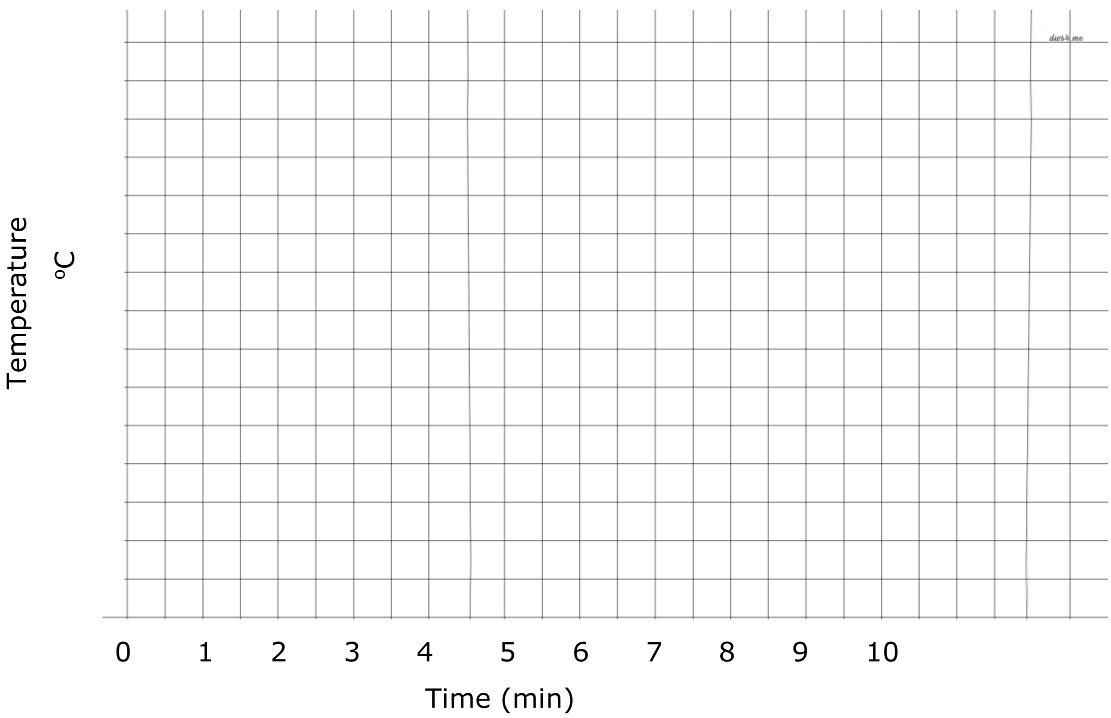
Time (Minutes)	0	1	2	3	4	5
Temp Degree C						

Cooling down (lamp off and removed)

Time (Minutes)	6	7	8	9	10
Temp Degree C					

Plot your results on the graph below

House Temperature v Time



Question 1

What was the highest temperature reached by your house?

____

After 10 minutes was your house cooler or warmer than when you started

____

Question 2

Compare you results with other groups in the class. Suggest some reasons why different groups had different results.

____

____

____

____

____

Question 3

There were a number of energy transformations and energy transfers taking place in this experiment. Complete the following sentences by using the word **transformed** or **transferred** to fill in the gaps:

The power cable ________________________ electrical energy from the power point to the STELR power supply.

The STELR lamp ________________________ electrical energy into light energy and heat energy.

Heat energy was ________________________ through the window to the sensor panel.

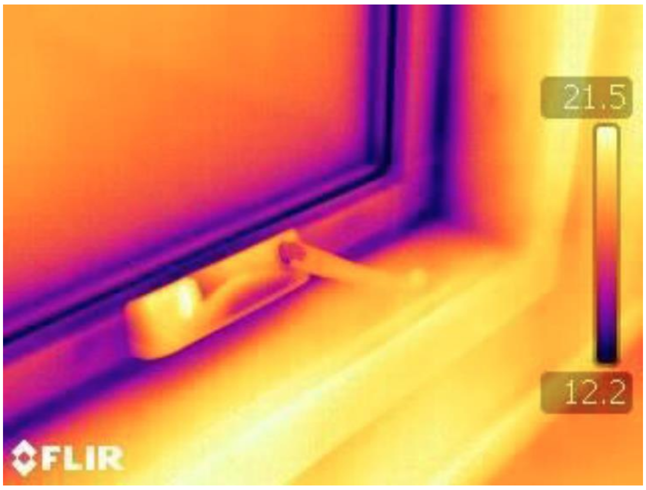
The heat sensor ___________________ heat energy into an electrical signal that was

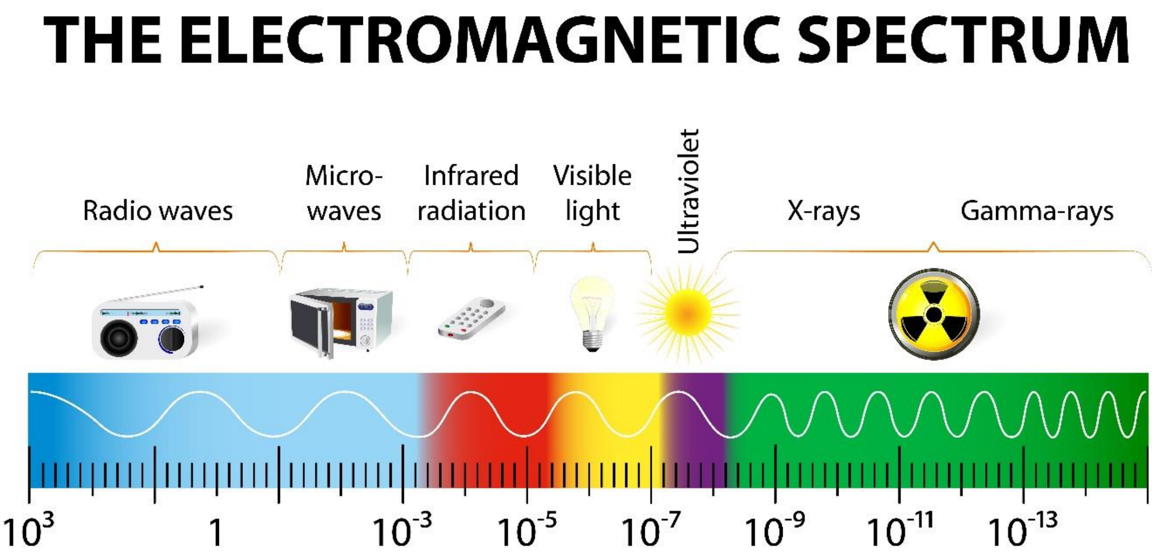
______________________ to the temperature logger.

When the lamp was turned off, heat energy from inside the house was

___________________ to the surrounding environment as the house cooled down.

3 TRANSFERRING HEAT ENERGY





In this section, you will learn about the three different ways that heat energy is transferred from one place to another and how this can help you design a more sustainable home.

3.1 LESSON: DIFFERENT WAYS HEAT CAN BE TRANSFERRED

KEY QUESTION

- How can heat energy be transferred from one system to another (or from a system to its environment)?

You may have also observed energy transfer occurring in your home kitchen. If you place a metal saucepan containing water on a hot stove, the water and saucepan handle soon become hot. This is because the heat energy of the flame or heating element is transferred from the base of the saucepan to the water and to the saucepan handle.

Heat energy can be transferred from one place to another in three ways:

Conduction – heat energy is transferred through a material or between materials (this happens in a heated saucepan).

Convection – liquids or gases gain heat energy and then move from one place to another.

Radiation – objects give off heat energy in the form of infrared radiation.

Did you know that convection and radiation are the reason your skin can sense the saucepan is hot without even touching it? Convection causes the air around the saucepan to heat up and rise to where you are holding your hand. A hot saucepan also emits invisible infrared radiation, which warms our skin when it reaches it.

Question 1

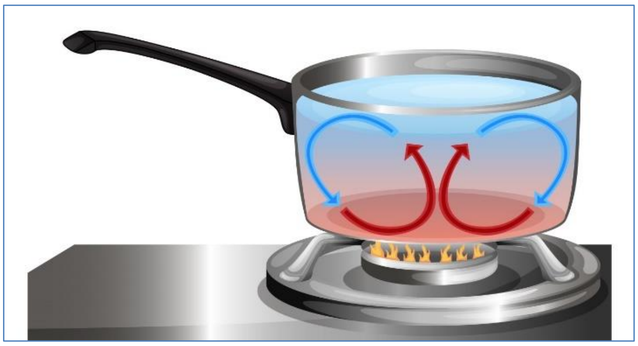
Which of these is an example of heat transfer by conduction?

- ☐ The handle of a metal spoon becomes hot when you use it to stir a pot of soup on the stove.
- ☐ The air near the ceiling is normally warmer than air near the floor.
- ☐ Smoke rises up a chimney.
- ☐ You feel the heat from a bonfire even though you are several meters away from it.

Question 2

Radiation is heat transfer by:

- ☐ direct contact.
- ☐ electromagnetic waves.
- ☐ molecular and electronic collisions.
- ☐ atmospheric currents.



Write down which of the following are examples of convection, conduction or radiation

Situation	Convection, conduction or radiation?
Saucepan being heated by the flame	
Saucepan handle becoming hot	
The hot water at the bottom of the pot rising up to the top and pushing the cold water down	
When you put your hands near the pot you can feel the heat.	

3.2 RADIATION

KEY QUESTIONS

- What is radiation?
- How can we use radiation to make our homes more sustainable?

Radiation is the transfer of energy from the movement of charged particles within atoms. This movement is converted to electromagnetic radiation, which can travel through space.

Radiation is how energy travels through a vacuum. This is how the energy generated by the Sun reaches the Earth.

Infrared radiation is part of the electromagnetic spectrum as is visible light and several other types of electromagnetic radiation. We cannot see the infrared radiation but our skin can detect it as heat.

All things at temperatures above absolute zero give out infrared radiation.

When radiation (including visible light and infrared radiation) hits a surface it can be **transmitted**, **reflected** or **absorbed**. Glass is a material that transmits visible light and infrared radiation. When a material absorbs radiation it is transformed into heat (thermal) energy.

The colour of an object depends on the frequencies of light that it reflects. Black objects absorb all visible wavelengths of light, white objects reflect all visible wavelengths.

3.2.1 LESSON: WHAT IS RADIATION

Watch the video below and answer the following questions.

Heat Transfer – Radiation

www.youtube.com/watch?v=tZliZyoYT80

Question 1

Radiation is one way heat is transferred from one place to another. Radiation travels by:

- ☐ waves
- ☐ particles
- ☐ convection currents
- ☐ conduction

Question 2

The best surfaces to absorb radiation are:

- ☐ dark coloured
- ☐ white
- ☐ shiny
- ☐ green

Question 3

What colour are solar panels? Why?

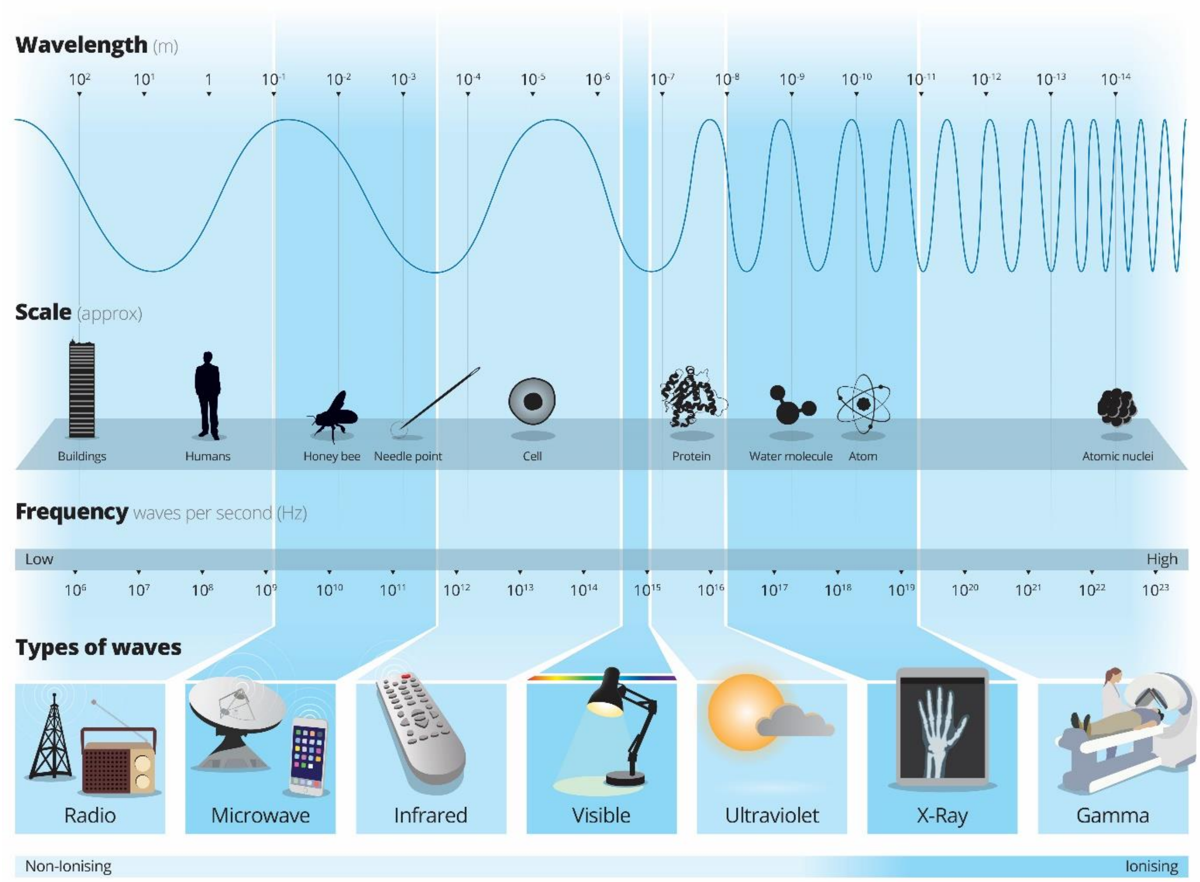
____

____

____

____

____



ELECTROMAGNETIC RADIATION; COURTESY OF THE AUSTRALIAN NUCLEAR SCIENCE AND TECHNOLOGY ORGANISATION – ANSTO

The image above illustrates different types of radiation their wavelengths

Question 4

Name five types of electromagnetic radiation and described how they are used.

3.2.2 ACTIVITY: ROOF COLOURS

The roofs of buildings are large areas that can absorb the Sun's radiation. Some of the radiant energy from the Sun is transformed into heat (thermal) energy, which will heat up the house. In this experiment, you will investigate how roof colour effects the amount of heat energy absorbed

Materials

- STELR touch sensor
- 3 x Bluescope roof panels (dark grey, light grey and white)
- 3 x white insulation panels
- STELR temperature logger
- connecting cables
- a sunny flat surface outside

If it is not sunny, you will also need:

- STELR power supply
- STELR lamp

WHAT TO DO

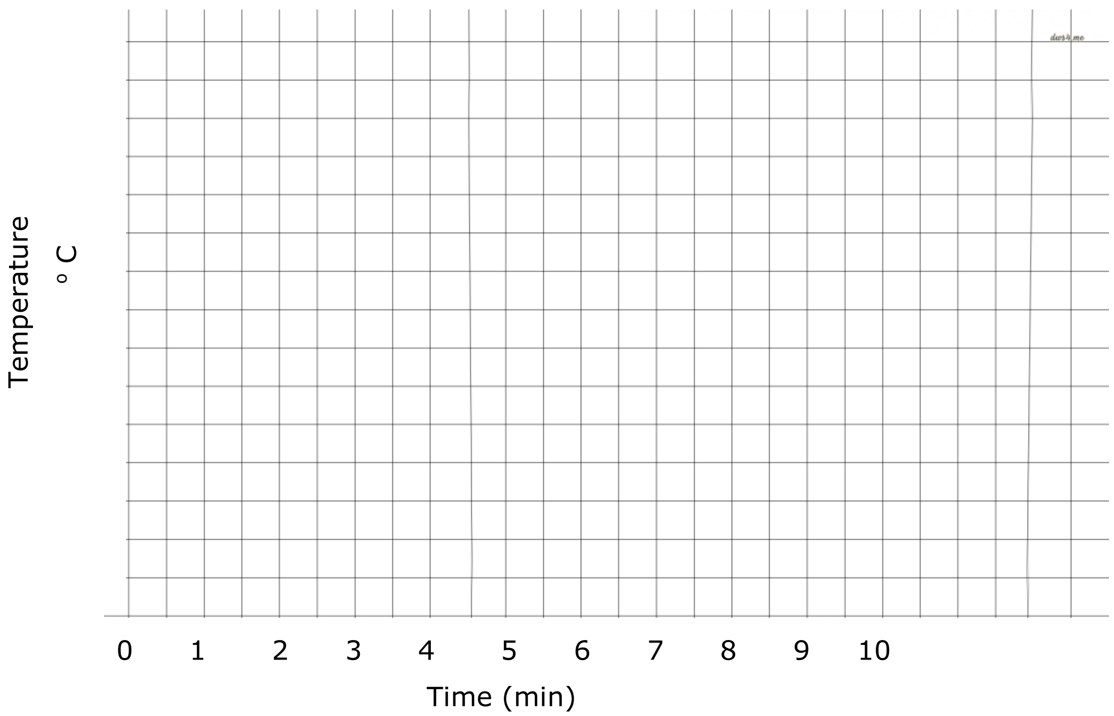
- Place each of the metal panels on an insulation panel.
- Before you put them in the sun or under the lamp, use the touch sensor to measure the temperature of each panel.
- Place the panels in direct sunlight (or use the STELR lamp if it is not sunny) for five minutes.
- Take the panels out of the sun and quickly measure the temperature of each one.
- Leave the panels for another five minutes (out of the sun) and measure their temperatures again.
- Record all of the temperatures in the table on the next page.

RESULTS

Colour	Starting Temp	Temp after 5 mins in sun	Temp after 5 mins out of sun
Surfmist (white)			
Shale grey (light grey)			
Monument (dark grey)			

Plot your results on the graph below using a different pen colour for each panel.

House Temperature v Time



Question 1

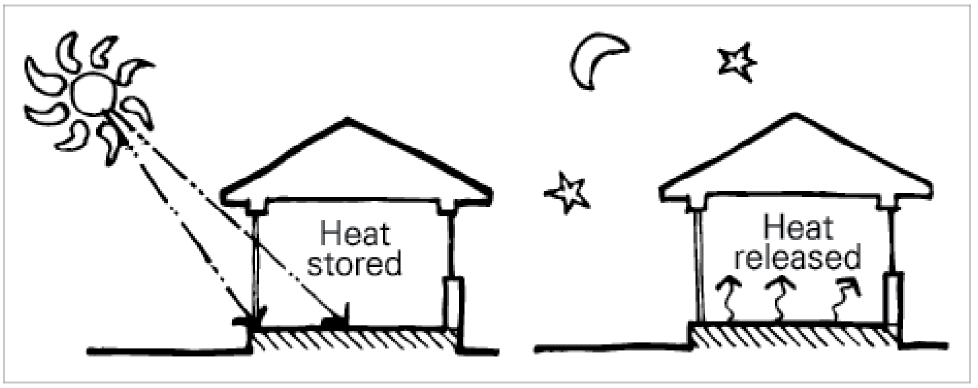
- Which roof colour was most effective at absorbing solar radiation?

- Which roof colour was most effective at reflecting solar radiation?

Question 2

Explain how you could use this information to choose a roof colour for an energy efficient home if you were living in a very cold climate or a very warm climate?

3.2.3 ACTIVITY: THERMAL MASS



Passive Storage of Heat

The thermal mass of a material is its ability to absorb and store heat energy. A lot of heat energy is required to change the temperature of high-density materials like concrete, bricks and tiles. They are therefore said to have high thermal mass. Lightweight materials such as timber have low thermal mass. Appropriate use of thermal mass throughout your home can make a big difference to comfort and heating and cooling bills.

If a house has a concrete floor, it can absorb radiant heat in daylight hours and re-radiate the heat energy back into the room at night.

Find out more about thermal mass by downloading this PDF brochure.

Thermal Mass

www.yourhome.gov.au/passive-design/thermal-mass

Materials

- STELR house cube
- STELR clear plastic window panel
- 3 x white insulation panels
- 1x STELR sensor panel
- clay tile, thick steel and thick aluminium sample
- STELR temperature logger
- connecting cables
- STELR power supply
- STELR lamp
- STELR Sustainable Housing data sheet for recording your results
- STELR Sustainable Housing Placement template (optional)

Risk assessment

Complete the following risk assessment.

Fact	Risk	Precaution
Halogen lamp gets very hot		
Ceramic tile can break easily		

Variables

In any experiment, it is essential to know what the variables are, and to control them appropriately. This ensures that the experiment addresses the activity aims and gives a meaningful result. You will need to consider the:

- **independent variable:** the variable you change to see the difference it makes;
- **dependent variable:** the variable you measure to see if/how it changes when you change the independent variable;
- **controlled variables:** other factors that you keep constant, so they don't have any impact on the dependent variable.

Identify which of the following variables are independent, dependent and controlled:

Type of wall panels | type of window glass | distance between lamp and house | temperature of the house | number of minutes with the lamp on and off | type pf roof panel | type of floor panels | position of the heat sensor

Independent variable:____

Dependent variable:____

Controlled variables:____

WHAT TO DO

- Place the temperature sensor in the back wall with the sensor at the top.
- Place the clear plastic window in the opposite face of the cube.
- Insert thick steel square into the floor.
- Place insulating panels in the side walls and on the top to make a flat roof.
- Connect the temperature sensor to the data logger.

- Place the lamp about 10cm from the window. (You may use the placement template to help you.)
- Angle the lamp so that it shines on the floor. Activate the lamp and the data logger at the same time.
- Record the temperature every minute for eight minutes on your data sheet.
- Turn off the lamp and move it away from the house. Record the temperature for a further 8 minutes as it cools.
- Repeat the experiment using the thick aluminium sample and then the ceramic tile.

Question 1

Discuss how to design this group investigation to support fair testing.

Question 2

Compare the results of your sample with other groups' samples. Determine which sample was best at storing and releasing heat.

3.2.4 LESSON: WINDOWS AND TRANSMISSION

How important are windows to the energy efficiency of a building? Watch these videos and answer the questions for each video.

VIDEO **What do Windows do?**

https://youtu.be/lpCbV95Q4Fg

Question 1

What are the main considerations for windows during hot weather? How about cold weather?

VIDEO **House and Window Design and Orientation**

www.youtube.com/watch?v=_4_IHSBGUr0

Question 2

What is the best way to orient a house? Why is this important?

Question 3

In Australia, which side of the house should have the most glass? Why?

Question 4

Explain cross ventilation. Why is it important?

Shading Windows

https://youtu.be/V-ZqeCqqQQM

Question 5

What can you do to allow winter sun into a room, but keep summer sun out?

Question 6

How can you protect the east and west sides of buildings from sunlight?

How is Glass Made? Watch the video below and answer the questions.

How is Glass Made?

https://youtu.be/mjnhTkdhfBw

Question 7

Name the four materials that are used to make glass.

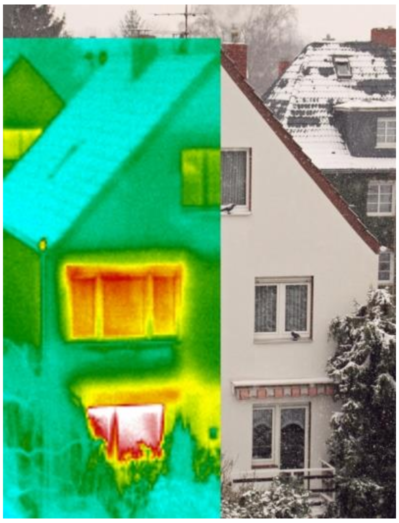
Question 8

To what temperature is the mixture heated to turn it into glass?

Question 9

What does the smart glass (low E) coating do?

This picture of a house was taken in partly using and infrared camera. It shows where heat is escaping from the house.



Question 10

Was it taken in winter or summer? Would you want it to be warmer or cooler inside compared to outside?

Question 11

What parts of the house emit more heat? How are they coloured?

Question 12

What could the owner do to reduce heat transfer through that part of the house?

3.2.5 ACTIVITY: TESTING DIFFERENT GLASS

In this activity, you will test the effectiveness of different types of glass and determine how they allow affect the temperature of a room when the window is in full sunlight. You will begin with one glass sample and then swap with another group until you have tested all three types:

- Clear glass
- Grey glass
- Low E glass

Materials

- STELR house cube
- 1 STELR glass panel
- 4 x white insulation panels
- STELR temperature logger
- connecting cables
- STELR power supply
- STELR lamp
- STELR Sustainable Housing data sheet for recording your results
- STELR Sustainable Housing Placement template (optional)

Risk assessment

Complete the following risk assessment.

Fact	Risk	Precaution
Halogen lamp gets very hot		
Glass can break easily		

Variables

In any experiment, it is essential to know what the variables are, and to control them appropriately. This ensures that the experiment addresses the experiment aims and gives a meaningful result. You will need to consider the:

- **independent variable:** the variable you change to see the difference it makes;
- **dependent variable:** the variable you measure to see if/how it changes when you change the independent variable;

- **controlled variables:** other factors that you keep constant, so they don't have any impact on the dependent variable.

Identify which of the following variables are independent, dependent and controlled:

Type of wall panels | type of window glass | distance between lamp and house | temperature of the house | number of minutes with the lamp on and off | type of roof panel | type of floor panels | position of the heat sensor

Independent variable:____

Dependent variable:____

Controlled variables:____

WHAT TO DO

- Place the temperature sensor in the back wall with the sensor at the top.
- Place the glass window in the opposite face of the cube.
- Insert an insulation panel into the floor.
- Place insulating panels in the side walls and on the top to make a flat roof.
- Connect the temperature sensor to the data logger.
- Place the lamp about 10cm from the window. (You may use the placement template to help you.)
- Turn on the lamp and the data logger at the same time.
- Record the temperature every minute for eight minutes on your data sheet.
- Turn off the lamp and move it away from the house. Record the temperature for a further eight minutes as it cools.
- Repeat the experiment using the other two glass samples. When you are changing the glass samples, allow the warm air to escape from the house cube.
- Record your results on the same data sheet. Plot a graph to show the temperature against time.

RESULTS

Question 1

When the lamp was on, which glass sample allowed the house to heat up the most?

____

____

Question 2

When the lamp was on, which glass sample allowed the house to heat up the least?

Question 3

When the lamp was off, which glass sample allowed the house to cool down the most?

Question 4

When the lamp was off, which glass sample allowed the house to retain the most heat?

Question 5

Discuss the results with your class and decide which type of glass would be best for keeping a house

a) Warm in winter

b) Cool in summer

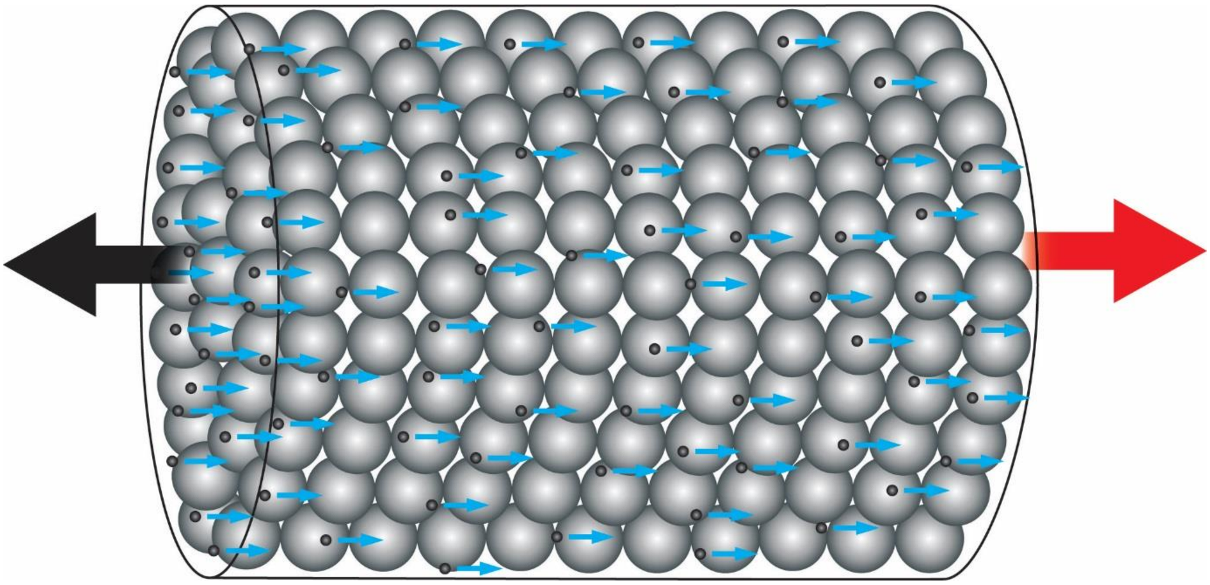
3.3 CONDUCTION

KEY QUESTIONS

- What is conduction?
- How can we use conduction to make our homes more sustainable?

Conduction is one of three ways heat can be transferred through a material. Heat is transferred by conduction when particles are heated, vibrate more and then pass on their energy to the particles around them.

Metals are good conductors because their electrons are more loosely bound and travel quickly and easily throughout the structure. Metal atoms become ions, and the electrons transfer heat by vibrating and colliding with other atoms and electrons in the metal. This kinetic energy travels from the hotter parts of the metal to the cooler parts by free electrons, transferring the heat energy. The hotter the metal, the more kinetic energy these vibrations have.



Non-metals are generally poor conductors. There are no loosely bound electrons to transfer the heat energy through the material. The heat is transferred only by contact between the atoms or molecules.

Gases are poor conductors as the atoms are much further apart than they are in liquids or gases. Insulators often contain small air pockets and they are also poor conductors.

Heat is transferred by conduction when particles are heated, vibrate more and then pass on their energy to the particles around them.

3.3.1 LESSON: CONDUCTORS AND INSULATORS

Watch the video below and then answer the following questions.

Heat Transfer
www.youtube.com/watch?v=9joLYfayee8

Question 1

Which materials are the best thermal conductors?

☐ solids

☐ liquids

☐ gases

Question 2

Which of the following solids do you think would be the best conductor?

☐ glass

☐ iron

☐ polystyrene

☐ wood

Question 3

Would you make the walls, doors and roof of a house from a conductor or an insulator? Why?

Question 4

What are the best materials to make windows and window frames? Why?

Double glazing has two pieces of glass separated by an air gap. Triple glazing has three pieces of glass and two air gaps.

Question 5

Explain how the air gap prevents heat transfer by conduction.

Insulation is the opposite of conduction. A good insulator is a poor conductor of heat.

Some solids contain trapped air which makes them better insulators. This roof insulation is made of glass fibres and trapped air.

Find out more about insulation by downloading this PDF brochure

Insulation

www.yourhome.gov.au/passive-design/insulation

Question 6

How much heat is gained or lost through the ceiling of an uninsulated house?

Question 7

What are the two main categories of insulation? Give one example of each.

Question 8

Where is the best place to put insulation in a house?

3.3.2 ACTIVITY: TESTING BUILDING MATERIALS

In this activity you will test the effectiveness of two different types of wall panels to determine how they are at insulating a house. The wall panels you will be using are the white plastic panels and the white insulating panels.

Materials

- STELR house cube
- STELR clear plastic window panel
- 4 x white insulation panels
- 4 x white plastic panels
- STELR temperature sensor panel
- STELR temperature logger
- connecting cables
- STELR power supply
- STELR lamp
- STELR Sustainable Housing data sheet for recording your results
- STELR Sustainable Housing Placement template (optional)

Risk assessment

Complete the following risk assessment.

Fact	Risk	Precaution
Halogen lamp gets very hot		

Variables

In any experiment, it is essential to know what the variables are, and to control them appropriately. This ensures that the experiment addresses the experiment aims and gives a meaningful result. You will need to consider the:

- **independent variable:** the variable you change to see the difference it makes;
- **dependent variable:** the variable you measure to see if/how it changes when you change the independent variable;
- **controlled variables:** other factors that you keep constant, so they don't have any impact on the dependent variable.

Identify which of the following variables are independent, dependent and controlled:

Type of wall panels | distance between lamp and house | temperature of the house | number of minutes with the lamp on and off | type of roof panel | type of floor panels | position of the heat sensor

Independent variable:____

Dependent variable:____

Controlled variables: ____

WHAT TO DO

- Place the temperature sensor panel in the back wall with the sensor at the top.
- Place the plastic window in the opposite face of the cube.
- Insert a white plastic panel into the floor.
- Place white plastic panels in the side walls and on the top to make a flat roof.
- Connect the temperature sensor to the data logger.
- Place the lamp about 10cm from the window, (you may use the placement template to help you)
- Turn on the lamp and the data logger at the same time.
- Record the temperature every minute for eight minutes on your data sheet.
- Turn off the lamp and move it away from the house. Record the temperature for a further eight minutes as it cools.
- Replace the four white plastic panels with four white insulation panels. When you are changing the panels, allow the warm air to escape from the house cube. Repeat the experiment.
- Record your results on the same data sheet. Plot a graph to show the temperature against time.

Question 1

Which of the two houses heated up quicker?

____

____

Question 2

Which of the two houses cooled down quicker?

____

____

Question 3

Which wall material is the better insulator.

Question 4

What do you think would happen if you wrapped the wall panels in shiny foil and repeated the experiment?

3.3.3 ACTIVITY: DOUBLE GLAZING

In this activity you will test the effectiveness of trapping air between two plastic window panels to simulate double glazing. The window panels have a ridge on one side and are flat on the other side. If two window panels are placed together with the ridges facing inwards (ridge to ridge) air is trapped between them. If the panels are placed with the flat sides facing each other, no air is strapped.

Materials

- STELR house cube
- 2 x STELR clear plastic window panels
- 4 x white plastic panels
- STELR temperature sensor panel
- STELR temperature logger
- connecting cables
- STELR power supply
- STELR lamp
- STELR Sustainable Housing data sheet for recording your results
- STELR Sustainable Housing Placement template (optional)

Risk assessment

Complete the following risk assessment.

Fact	Risk	Precaution
Halogen lamp gets very hot		

Variables

In any experiment, it is essential to know what the variables are, and to control them appropriately. This ensures that the experiment addresses the experiment aims and gives a meaningful result. You will need to consider the:

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- **dependent variable:** the variable you measure to see if/how it changes when you change the independent variable;
- **controlled variables:** other factors that you keep constant, so they don't have any impact on the dependent variable.

Identify which of the following variables are independent, dependent and controlled:

Type of wall panels | distance between lamp and house | temperature of the house | number of minutes with the lamp on and off | type of roof panel | type of floor panels | position of the heat sensor | the orientation of the two window panels

Independent variable:____

Dependent variable:____

Controlled variables:____

WHAT TO DO

- Place the temperature sensor panel in the back wall with the sensor at the top.
- Place two plastic window panels in the opposite face of the cube ridge to ridge creating an air gap.
- Insert a white plastic panel into the floor.
- Place white plastic panels in the side walls and on the top to make a flat roof.
- Connect the temperature sensor to the data logger.
- Place the lamp about 10cm from the window, (you may use the placement template to help you)
- Turn on the lamp and the data logger at the same time.
- Record the temperature every minute for eight minutes on your data sheet.
- Turn off the lamp and move it away from the house. Record the temperature for a further eight minutes as it cools.
- Take out the two window panels and now put them with the flat sides together so that there is no air gap. When you are changing the window, allow the warm air to escape from the house cube. Repeat the experiment.
- Record your results on the same data sheet. Plot a graph to show the temperature against time.

Question 5

Which of the two houses heated up quicker?

Question 6

Which of the two houses cooled down quicker?

Question 7

What do you think would happen if you used three plastic window panels to make triple glazing?

3.4 CONVECTION

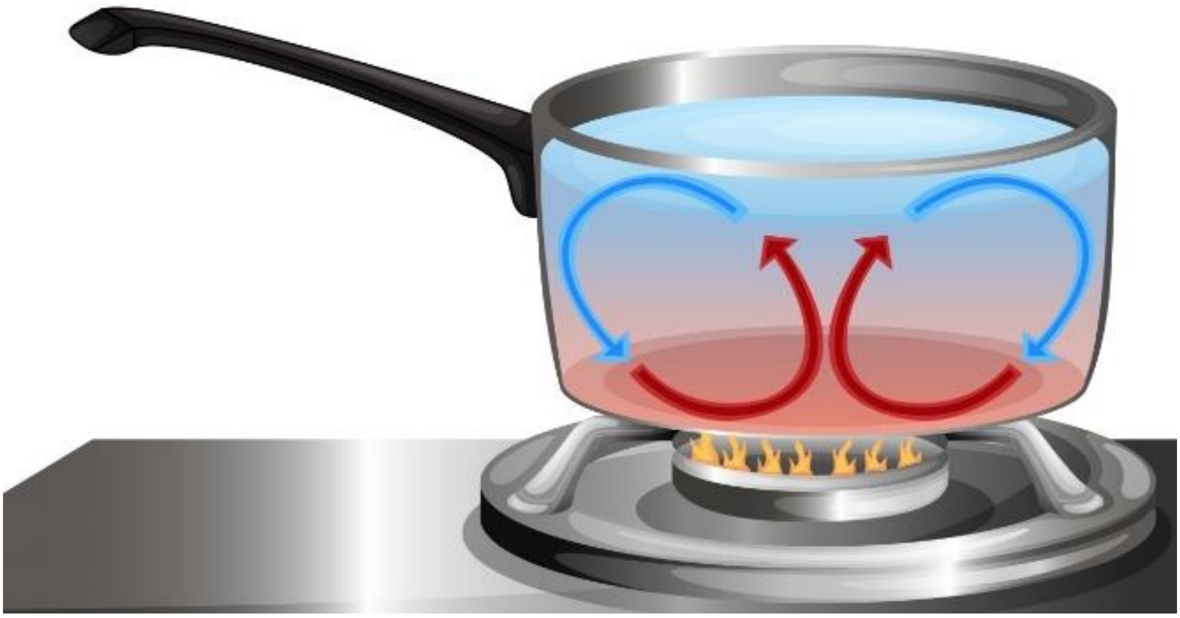
KEY QUESTIONS

- What is convection?
- How can we use convection to make our homes more sustainable?

When a fluid (for example air in a room or water in a saucepan) is heated it becomes less dense and rises. As it rises, colder, higher density fluid moves in to replace the hot fluid.

When the colder fluid reaches the source of heat it is also heated up and rises. The process starts again and continues indefinitely until the source of heat stops. This cycling creates convection currents.

In the same way, convection currents can move air around your home.



3.4.1 LESSON: HOT RISES, COOL FALLS

Watch the video and answer the following questions.

Convection in Lava Lamps
www.youtube.com/watch?v=DL3Ez9bxMTo

Question 1

Convection takes place in:

- ☐ liquids and gases
- ☐ solids only
- ☐ liquids only
- ☐ gases only

Question 2

Rising air tends to:

- ☐ expand and become warmer
- ☐ become denser and warmer
- ☐ become denser and cooler
- ☐ expand and become cooler

Now watch this video

Tricks with Convection Currents
www.youtube.com/watch?v=RCO90hvEL1I

Question 3

What colour was the cold water?

Question 4

What colour was the hot water?

Question 5

Explain what you think happened when the hot water was placed on top of the cold water.

Question 6

Explain what you think happened when the cold water was placed on top of the hot water.

Question 7

Explain what you think would happen to the movement of air in a cold room when you turn on a floor heater.

3.4.2 ACTIVITY: AIR LEAKAGE AND CONVECTION

Sealing your home against air leakage is one of the simplest ways you can increase your comfort while reducing your energy bills and carbon emissions by up to 25%.

Air leakage accounts for 15–25% of winter heat loss in buildings and can contribute to a significant loss of coolness in climates where air conditioners are used.

In this experiment you will investigate how air leakage disrupts the convection currents inside a house by deliberately designing a house which is not airtight.

Materials

- STELR house cube
- STELR clear plastic window panel
- 2 x white insulation panels
- STELR temperature sensor panel
- Stiff card
- Scissors
- STELR temperature logger
- connecting cables
- STELR power supply
- STELR lamp
- STELR Sustainable Housing data sheet for recording your results
- STELR Sustainable Housing Placement template (optional)

Risk assessment

Complete the following risk assessment.

Fact	Risk	Precaution
Halogen lamp gets very hot		

Variables

In any experiment, it is essential to know what the variables are, and to control them appropriately. This ensures that the experiment addresses the experiment aims and gives a meaningful result. You will need to consider the:

- **independent variable:** the variable you change to see the difference it makes;
- **dependent variable:** the variable you measure to see if/how it changes when you change the independent variable;
- **controlled variables:** other factors that you keep constant, so they don't have any impact on the dependent variable.

Identify which of the following variables are independent, dependent and controlled:

Type of wall panels | distance between lamp and house | temperature of the house | number of minutes with the lamp on and off | type of roof panel | type of floor panels | position of the heat sensor | the orientation of the window panels

Independent variable:____

Dependent variable:____

Controlled variables:____

WHAT TO DO

- Cut two 10cm squares from the stiff card to make the side walls of the house
- Place the temperature sensor panel in the back wall with the sensor at the top.
- Place the plastic window panel in the opposite face of the cube.
- Insert a white insulation panel into the floor.
- Place a card square into each of the side walls.
- Place an insulating panel in the roof.
- Connect the temperature sensor to the data logger.
- Place the lamp about 10cm from the window. (You may use the placement template to help you.)
- Turn on the lamp and the data logger at the same time.
- Record the temperature every minute for eight minutes on your data sheet.
- Turn off the lamp and move it away from the house. Record the temperature for a further eight minutes as it cools.
- Take out the two card walls. Cut off one corner of each. Allow the warm air to escape from the house cube. Place the walls so that the cut-off corner is at the bottom on one side and at the top on the opposite side. Repeat the experiment.
- Record your results on the same data sheet. Plot a graph to show the temperature against time.

Question 1

Which of the two houses heated up quicker?

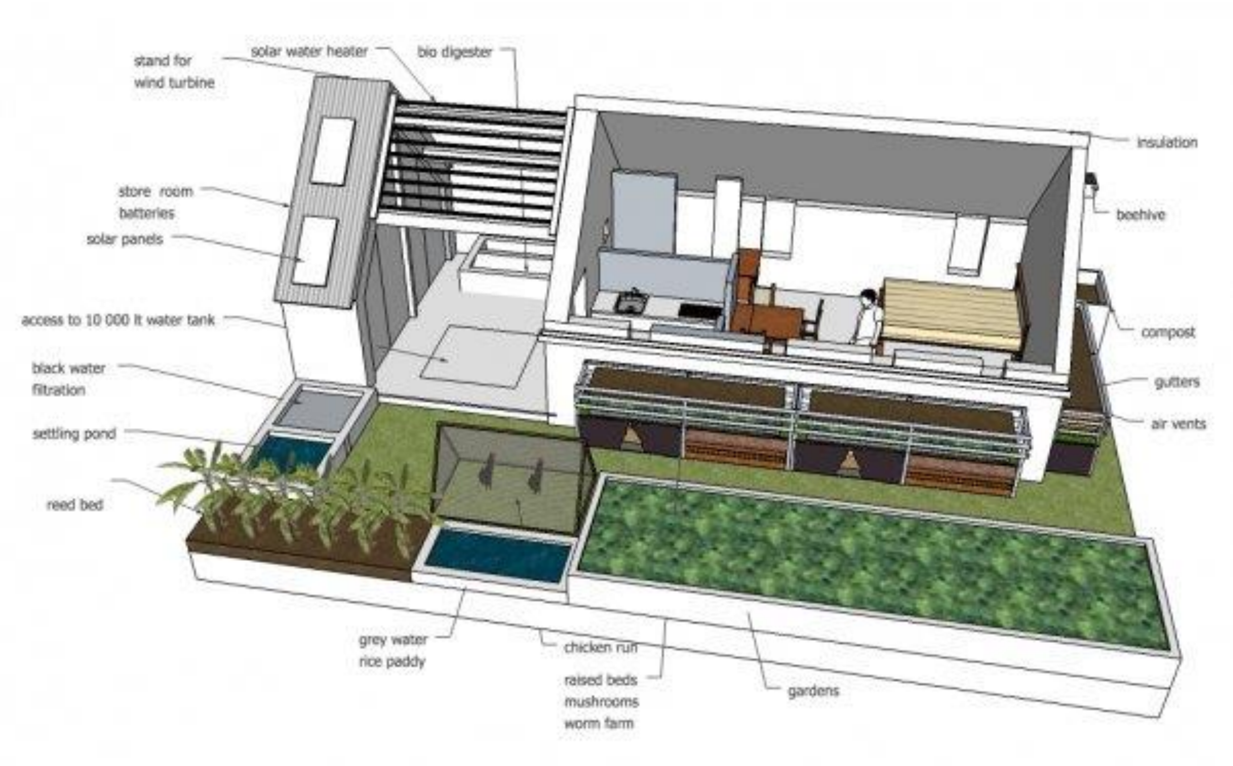
Question 2

Which of the two houses cooled down quicker?

Question 3

Discuss these results with your group and explain how your results could be used to make a more sustainable home in summer and winter climates

4 SUSTAINABLE DESIGN



The previous section investigated different materials that you can use in building a sustainable house. This section investigates how the design of a house can make it more energy efficient and sustainable for the particular climate in which it is situated.

4.1 LESSON: ORIENTATION AND SHADING

KEY QUESTION

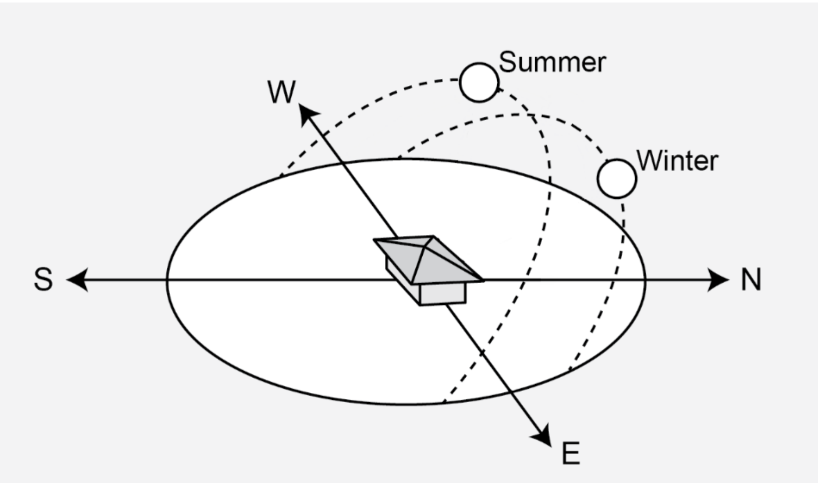
- How can the orientation of a house and shading make it more sustainable?

The way in which a house is facing is called its orientation.

This isn't simple because the Sun moves across the sky in two different ways:

- daily – across the sky from east to west;
- yearly – the daily path shifts from south to north and then back again.

The Sun's position in the sky depends on the time of day and the time of year. It also depends on where you are on the planet.



Important: This diagram is for the southern hemisphere.

Every day, the sun goes from east to west (the dotted paths), but in summer the path is closer to the south, making the sun higher at noon (in the southern hemisphere), and in winter the path is more to the north, making the sun lower in the sky at noon.

Watch this video.

The 17 Things: Orientation and Shading

https://www.youtube.com/watch?v=2JIwFDFCXrk

Question 1

What does “passive design” mean?

Question 2

What is “passive heating”?

Question 3

What is the best orientation for the largest window in your living room?

Question 4

What happens when sunlight passes through glass?

Question 5

How does passive shading keep the house cool in summer?

Question 6

What does the correct width of the shading depend on?

Question 7

What does ‘active shading’ mean?

4.2 ACTIVITY: SUMMER AND WINTER SUN

KEY QUESTIONS

- How does the angle that sunlight strikes a house affect the temperature inside the house?
- Can the design of eaves over windows keep a house cooler in summer and warmer in winter?

In this activity, you will investigate how the angle of the sun influences temperature. Use the STELR sustainable house to model infrared radiation in summer and winter.

Materials

- STELR house cube
- STELR clear plastic window panel
- 4 x white insulation panels
- STELR temperature sensor panel
- STELR temperature logger
- connecting cables
- STELR power supply
- STELR lamp
- retort stand and clamp
- STELR Sustainable Housing data sheet for recording your results

Use the retort stand and clamp to alter the angle of the Sun from 60° in the summer to 30° in the winter.

DESIGN AND RUN THE EXPERIMENT

Write up your experiment.

You must include:

- aim;
- hypothesis;
- method (consider including diagrams or photographs of your set-up);
- risk assessment;
- variables (note: it is important to keep all variables except the independent variable at the same levels, to make your test fair);
- results, presented clearly (use the Sustainable Housing data sheet)
- conclusion (addressing the aim)

Important! Have your teacher check your preparation before you carry out the experiment.

Now test the effect of adding eaves to shade the window from the summer Sun. You will have to think about how to construct the eaves and put them in place.

DISCUSSION

Did your results agree with your hypothesis? If so, repeat the hypothesis here. If not, describe how the results differed. Can you explain the results?

Assess the experiment that you carried out. For example, did it go well and do you think it was a fair test? (Reasons might be that the basic design was flawed or you had practical difficulties carrying it out.

Write a conclusion for you experiment.

4.3 ACTIVITY: NORTH OR SOUTH FACING HOUSE

KEY QUESTION

- How does the angle that light strikes a solar panel affect the voltage?

In this activity, you will investigate how the orientation of a house affects the temperature.

Using similar equipment as in the previous experiment, design and experiment to test the difference between having north facing or south facing windows in your house.

DESIGN AND RUN THE EXPERIMENT

Write up your experiment.

You must include:

- aim;
- hypothesis;
- materials
- method (consider including diagrams or photographs of your set-up);
- risk assessment;
- variables (note: it is important to keep all variables except the independent variable at the same levels, to make your test fair);
- results, presented clearly (use the Sustainable Housing data sheet)
- conclusion (addressing the aim)

Important! Have your teacher check your preparation before you carry out the experiment.

DISCUSSION

Did you results agree with your hypothesis? If so, repeat the hypothesis here. If not, describe how the results differed. Can you explain the results?

Assess the experiment that you carried out. For example, did it go well and do you think it was a fair test? (Reasons might be that the basic design was flawed or you had practical difficulties carrying it out.

Write a conclusion for your experiment.

4.4 PROJECT: SUSTAINABLE HOUSING

Research one of the sustainable housing features and make a presentation of your findings to the class.

Work in groups of three or four. Each group should investigate a different feature.

These could include:

- PV (photovoltaic) panels ('solar panels')
- solar water heating
- geothermal heating
- rammed-earth houses
- straw-bale houses
- different types of insulation materials used in building
- 'switchable' windows that can be turned to opaque
- green roofs (living roofs)
- the use of skylights
- building materials and their embodied energy
- the most energy efficient heating or cooling systems
- The Nationwide House Energy Rating Scheme (NatHERS)

WHAT TO FIND OUT

What is the science and technology behind the feature?

- How does this feature work?
- When was it invented or when did it first come into use?
- How does it make a house or building more sustainable?
- How commonly used is the feature?
- What sort of cost is involved?

HOW TO PRESENT YOUR PROJECT

The main product of your project is the class presentation, but upload any files that you use in the project space below:

- copy text into the text widget, so your teacher can read it in Stile;
- upload presentation files (e.g. PowerPoint) with the files and media widget;
- upload photographs of posters, models or other static material;
- if possible, upload a video of your presentation.

Think about the best way to present your information so that it engages your audience. For example, use:

- photographs;
- diagrams, models, flow charts and maps;
- tables and graphs of data;
- video clips;
- posters;
- your own recordings of interviews and site visits;
- a PowerPoint presentation.

RESOURCES YOU CAN USE

- experts in the field – it will help your project a lot if you can ask someone working in the industry questions about it;
- see the subject resources menu on the STELR website; and
- books and/or websites, but be sure to use trustworthy sites. Ask your teacher if you are not sure.

Important: You must include a bibliography, showing where you got all your information.

Answer the following question after you have seen all the other project presentations for your class.

Question 1

You should have learned a lot about your sustainable house feature and quite a bit about other resources as well from other students' presentations.

What more would you like to find out about sustainable housing?

5 OPEN INQUIRY

In groups, conduct your own investigation with the STELR Sustainable Housing equipment.

There are some suggestions below, but try to think of your own ideas. Of course, you will have to agree on your investigation as a group.

You must design, conduct and report on your investigation, using the same format as in previous experiments.

Important: Get permission from your teacher before you carry out your experiment.

Possible inquiry questions:

- How do different window materials perform in different climates?
- Different wall materials (cut your own) or roof materials
- Different paint colours on interior or exterior walls (use square paint samples from the hardware store)
- Why are houses often on stilts in warm climates?
- Are houses that are attached to each other (units or terrace houses) or above each other (multistorey apartments) more energy efficient than free-standing houses?
- Is a pitched roof more energy efficient than a flat roof?
- What is the effect of using a ceiling fan in summer or winter?

PLAN, CARRY OUT AND REPORT

First, plan your experiment. You will need to include enough information in your plan to convince your teacher that you are ready to go ahead. Use the investigation planner on the following page.

When you have permission, carry out the experiment. It may not work properly straight away – you may need to change materials and/or procedure before you take your data readings.

Finally, record your data and present it in a meaningful way. Then discuss what it shows.

In your final report, make sure you include:

- inquiry question (also, because this is your own question, include any background discussion to explain why you are interested in this question);
- aim;
- hypothesis;
- variables;
- materials;
- procedure;
- risk assessment;
- data table and, if appropriate, a graph;
- discussion, including:
  a) how the experiment went, including any problems encountered and whether they were overcome;
  b) if the results agreed with your hypothesis;
- conclusion.

INVESTIGATION PLANNER

What are you investigating?	
What are you going to investigate?	What do you think will happen? Explain why.
What is your hypothesis?	What is the aim of your investigation?
Designing your experiment	
What variables might affect the outcome of your investigation?	What variable(s) will you test?
How will you make your tests fair?	What observations and measurements will you need to take?
How will you ensure that your measurements are reliable?	What calculations (if any) will you need to make?
What risks might there be? What safety precautions do you plan to take?	What materials and equipment will you need?

Your results	
How will you record your observations and measurements?	What graphs can you draw? What spreadsheets can you design to display your results?
Conducting your investigation	
Once your teacher has approved your plans and you have the materials, conduct your investigation. Record how the investigation was performed. Include any modifications that you made and why you made them.	
Analysing your results: your conclusions	
Examine your results. Use them to answer your aim.	From your conclusions, were your predictions and hypothesis correct? Does your hypothesis need to be modified? Discuss.
Evaluating the investigation	
How reliable do you think your results were? Discuss.	How could you modify your procedure to make your results more reliable?
If you were given the opportunity, what further investigation would you carry out to build on what you learned from the investigation?	

6 STEM AT WORK

There are many careers in STEM-related fields (science, technology, engineering and mathematics) – and not always as scientists, technicians, engineers or mathematicians. Renewable energy is a particular growth area.

Watch the video below and choose one person from the STELR *Career Profiles, Sustainable Housing* web page. Then answer the questions that follow.

Davina Rooney, Civil Engineer
https://stelr.org.au/career_profiles/davina-rooney/

STELR Career Profiles, Sustainable Housing
https://stelr.org.au/stem-at-work/career-profiles-sustainable-housing/

Question 1

Fill in some basic information about Davina and the person you chose from the STELR website.

	Person 1	**Person 2**
Name	Davina Rooney	
Organisation & what it does		
Role		
High school subjects		
Other qualifications		
Job duties		
What they like about the job		

Question 2

In the video, Davina talks about a volunteer project building the Druk White Lotus School in the Indian Himalayas as being 'life changing'.

- What do you think this term means?

Question 3

All of the people profiled carry out a variety of tasks within their jobs, often mixing fieldwork, office work on the computer, and liaising with a diverse range of people.

- From the two profiles that you have looked at, which type of task would you like best?

How could you train yourself to be better at this type of task?

Question 4

Do you think there will still be jobs like the two you have looked at in 20 years? If not, do you think your two career profile people will be well equipped to adapt? Explain.

Find out more about the Druk White Lotus School here:

https://www.arup.com/projects/druk-white-lotus-school

GLOSSARY

Word or term	Meaning

STELR

stelr.org.au

INVESTIGATION

SUSTAINABLE HOUSING

GROUP	
MATERIAL BEING TESTED	
DISTANCE TO LAMP	

Heating up

TIME minutes											
TEMP °C											

Cooling down

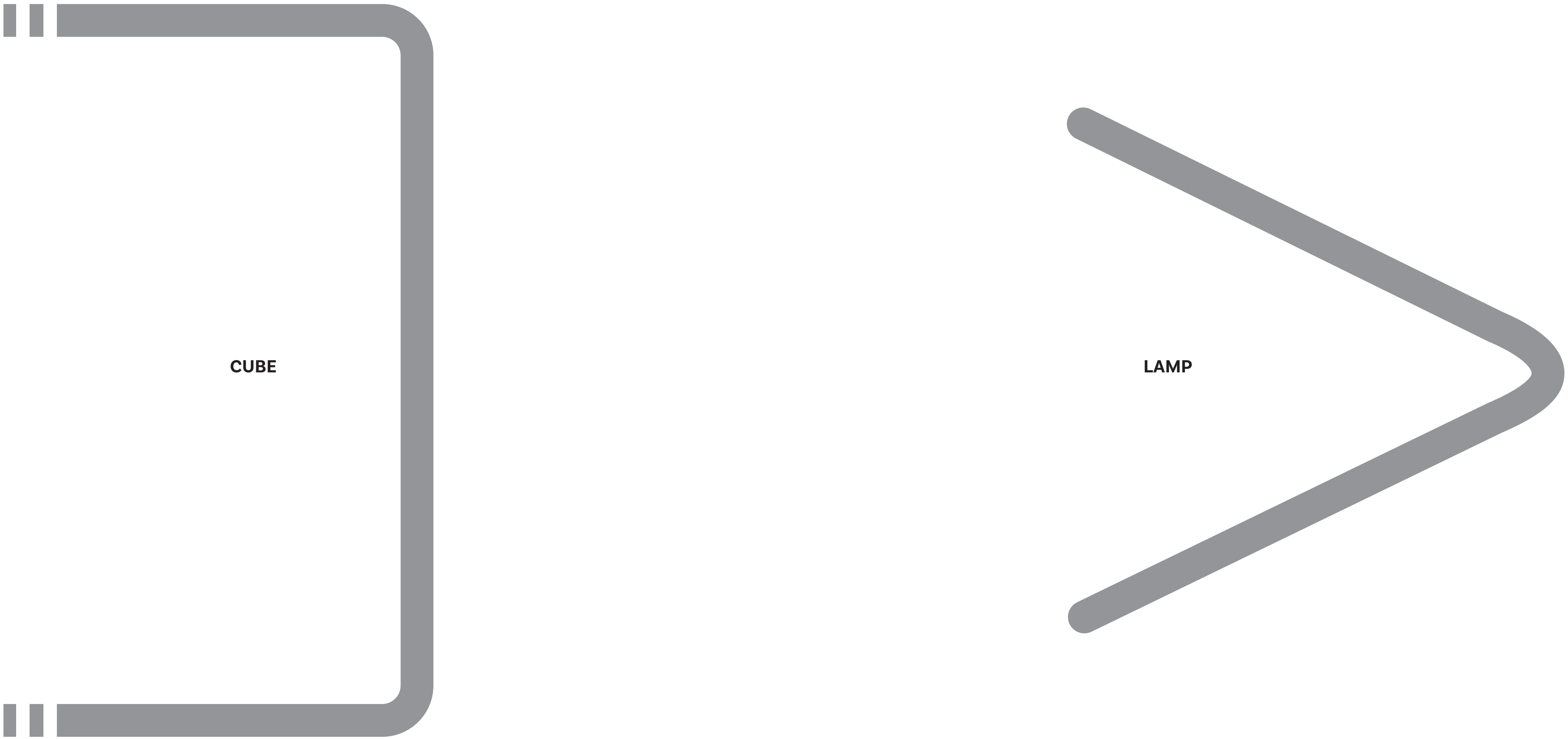
TIME minutes											
TEMP °C											

Graph

Conclusion

STELR **SUSTAINABLE HOUSING — PLACEMENT TEMPLATE**

Print this page at 'actual size' — do not scale to fit the page as this will shrink the template.
Place the cube (house) directly in front of the lamp. There should be 11cm between the edge of the cube and the bulb (inside the lamp hosusing).



VIDEO PROFILES OF WOMEN IN STEM CAREERS AND ENTREPRENEURSHIP

View them all at www.stelr.org.au/WomenInSTEM

#WomeninSTEM #BeAChangemaker #DoSTEMMakeChange

STELR

An initiative of the Australian Academy of Technology and Engineering

This project received grant funding from the Australian Government

The Australian Power Insititute (API) proudly supports science, technology, engineering and maths education in Schools.

ENGINEERING THE FUTURE

Engineers in the Energy Industry help to:

- Provide the "bridge" between science & community
- Take up climate change challenges
- Address technological challenges
- Transition to a renewables future
- Implement energy efficiency initiatives
- Continue providing essential service to community
- Raise living standards & tackle poverty in developing countries.

ABOUT API

The API is a not for profit organisation established by the energy industry companies in Australia to facilitate the provision of tomorrow's technical leaders equipped to deliver Australia's energy future through initiatives such as:

- API Bursary Program to support students at university study engineering and technology courses
- Support for programs to encourage young female students to study STEM and pursue engineering and technology careers.

CONTACT US

www.api.edu.au   info@api.edu.au

API SOLAR CAR CHALLENGE

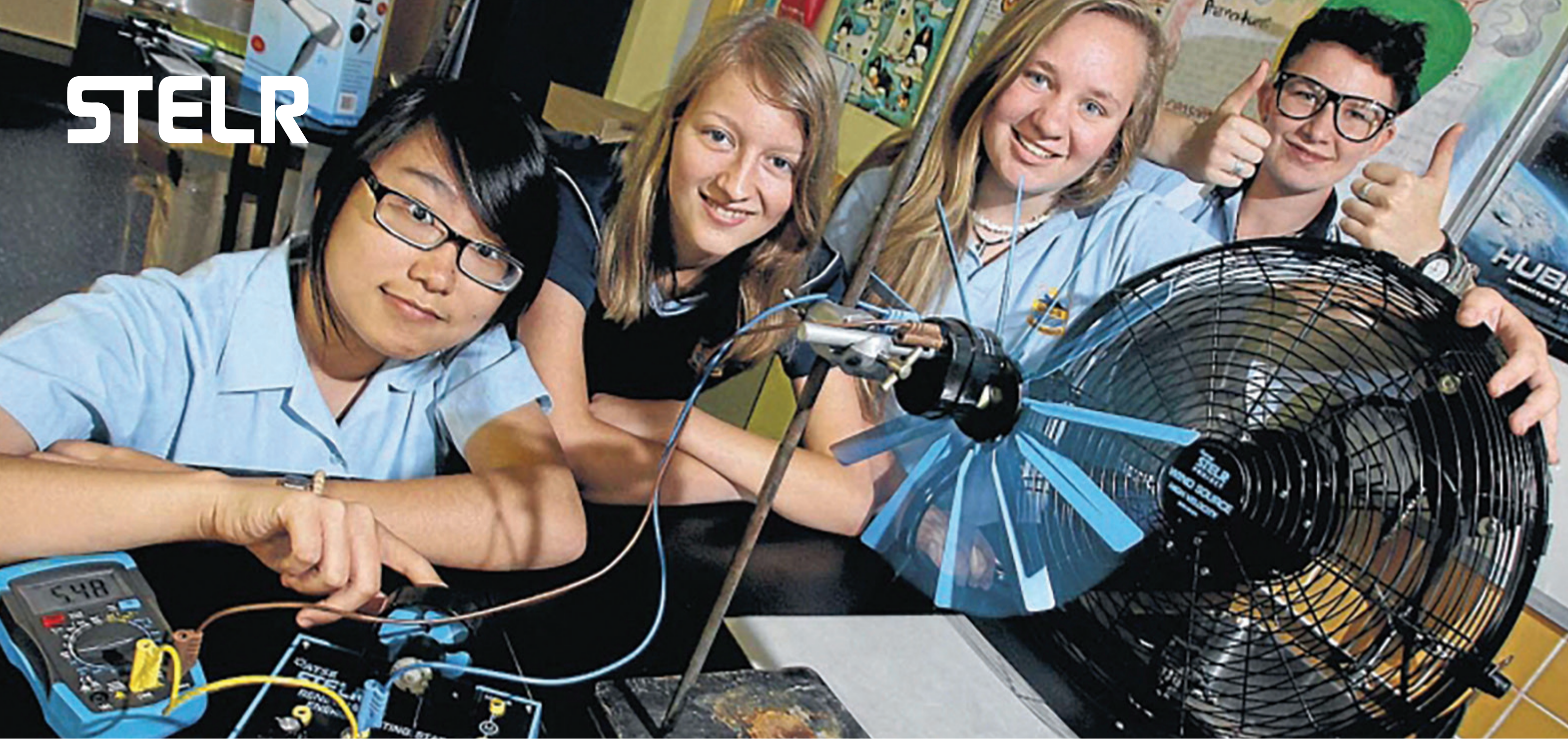
As API is committed to improving STEM education, API provides part funding for STELR, which is an initiative of The Australian Academy of Technological Sciences & Engineering (ATSE). API supports this program by providing class sets of re-usable model solar car kits to over 250 schools Australia wide using the Science and Technology Education Leveraging Relevance (STELR) Renewable Energy Module.

API also encourages involvement between university undergraduate engineering students by sending an API Bursary Holder to a participating high school to deliver a presentation about careers related to the renewable energy and power industry. During these visit the young undergraduate engineers also assist with solar car construction, judge the cars, and award prizes. The API, the high school teachers and students consider the Solar Car Challenge a great program to be invlolved in!

API BURSARY PROGRAM

As The API is constantly working to support the education and professional development of engineers & technologists in the energy industry across Australia, API offers scholarships to engineering & technology students with an interest in areas of engineering relevant to the electric power industry. The bursaries provide financial assistance over 4 years plus the opportunity where available for paid employment with member companies during the univeristy summer vacations.

Applications open February-May 2020 via API website.



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ATSE Australian Academy of Technology & Engineering

STELR is an initiative of the Australian Academy of Technology & Engineering

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