HORRIBLE SCIENCE

SHOCKING ELECTRICITY

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illustrated by TONY DE SAULLES

INTRODUCTION

Electricity has always existed in the form of lightning in the sky. In early times people would have identified the force of such electricity by its ability to split trees and create fires. They may also have discovered the fact that certain rocks, such as amber, attracted light objects or that specific areas of land felt 'unusual' due to electric nodes in the earth. Today it is know that electricity is created through a flow of electrons and people have discovered efficient methods for producing and harnessing such power.

Over the next term this Electricity Unit of Work (EUW) will lead you to discover how people came to understand that electricity was more than merely lightning in the sky, how energy can be created and harnessed, some of the seemingly infinite uses society has for electricity and methods for conserving and managing electricity effectively.

Electricity Unit of Work is broken into five distinct parts. The first four of these are cross-curricular and contain a number of projects and lesson plans for activities. Some of these activities include creating circuits, giving presentations and completing fun sheets such as crosswords and find-a-words. Students will have opportunities to revise that which they have learnt and to demonstrate an understanding of the work they have covered. The fifth section of Electricity Unit of Work contains printable worksheets and activities for students to complete during their visit to Delta Electricity's Mt Piper Power Station.

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HISTORY

TEACHER LED DISCUSSION (1 LESSON)

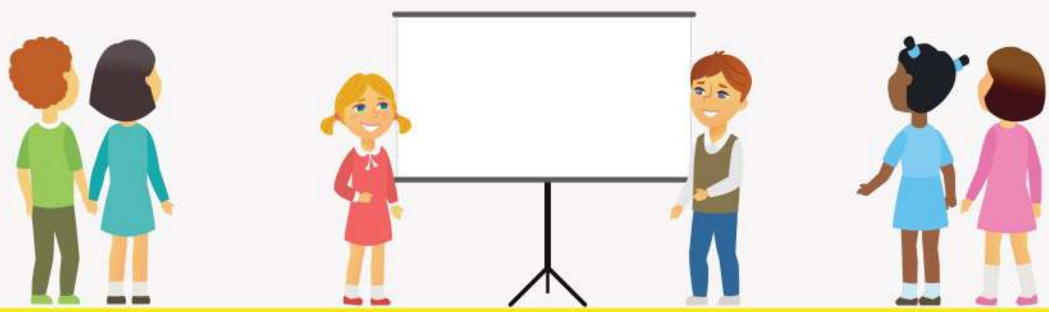
Electricity is a basic part of nature and can be seen every time there is a thunder storm in the form of lightning. Today electricity is created from the conversion of non-renewable energy sources such as coal and renewable energy sources such as solar energy.

Before the discovery that electricity could be generated on demand cities and towns had to be built next to waterways. Canals and rivers were needed so that the energy from the flowing water could be harnessed to turn water wheels to make work easier. Street lamps had to be lit manually, meat was kept in a safe and cooled with blocks of ice and rooms were warmed by open fires.

In this teacher led discussion students will suggest how they believe man learnt to create electricity. A brainstorming map should be created so that students can compare their knowledge at the beginning and end of this unit of work and discover just how much they have learnt.

MIDI PROJECT 1: POWER POINT PRESENTATION (7 LESSONS)

Students should form pairs and select one scientist who contributed to the history of electricity. Once they have selected their scientist they should use either the internet or school library resources to research important information about that person. Using the information gathered students should then create a Power Point demonstration to allow them to share their research with the rest of the class.



Students can be set a limit of three or four slides and be asked to use sound and display effects to make the information more impressive. It is important to ensure that students have collected their information before beginning their Power Point demonstration as they may waste a lot of time 'beautifying' their presentation. It is also important to ensure that students do not directly copy and paste from the internet but rather rewrite what they find in their own words and correctly reference where they found any information they use.

It is anticipated that students will spend three lessons (2½ to 3 hours) researching their scientist to find enough useful information, two lessons (1½ to 2 hours) preparing their slides for presentation and two lessons (1½ to 2 hours) presenting their information to the rest of the class. A four slide Power Point demonstration should take a pair of students about two minutes to present.

MINI PROJECT 1: TIME-LINE CONSTRUCTION (2 LESSONS)

The student should be given an envelope containing each of the following sections of the timeline and the matching dates below cut out so that they can match the two halves and place them in the correct order. Once the correct order has been established the information can be recorded on the sheetprovided next to the appropriate date.

It is anticipated that this project should take students about two lessons (1½ to 2 hours) to complete. If desired the lessons could be separated into sorting the information one lesson and writing it up in another lesson.

Important Years in the History of Electricity			
600 BCE	Early 1700's	1786	1827
1600 CE	1710	1792	1831
1660	1752	Early 1800's	1878
	1900's		

The earliest recorded discovery of electricity was by Thales, the Greek philosopher, who found that by rubbing an 'electron' (a hard fossilised resin that today is known as 'amber') against a fur cloth, it would attract particles of straw.

Dr. William Gilbert was the first modern scientist to investigate the reactions of amber and magnets and first recorded the word 'Electric' in a report on the theory of magnetism.

In 1660, the German experimenter, Otto Von Guericke, built the first electricity generating machine. He showed that electricity could be transmitted by using a wet string to conduct electricity several feet.

More than forty years and a new century after Guericke, Francis Hauksbee, removed air from a glass globe and made the globe rotate while rubbing it with a wool cloth. The globe gave off such a bright light that Hauksbee could read large letters in a dark room.

During the same time as Hauksbee, Stephen Gray, discovered conductivity. He found that electricity could be transmitted through any matter including water.

In the mid 1700's Benjamin Franklin's supposed kite experiment proved that lightning and the spark from amber were one and the same thing - electricity.

It was 34 years after Franklin's discovery that Luigi Galvani discovered that when the leg of a dead frog was touched by a metal knife, the leg twitched violently. Galvani thought that the muscles of the frog must contain electricity.

The idea that frogs contained electricity was dispelled in 1792 by Alessandro Volta who proved that when moisture occurs between two different metals, in this case, a steel knife and tin plate, electricity is created. This led Volta to invent the first electric battery, the Voltaic Pile, which he made from thin sheets of copper and zinc separated by moist pasteboard. The unit of electricity, the volt, is named after Volta.

Before Ohm published his work in 1827, Andre Marie Ampere was the first to explain the electro-dynamic theory. As a memorial to Ampere his name is used for the unit of electric current.

George Simon Ohm, a German mathematician and physicist, published, "The Galvanic Circuit Investigated Mathematically" in which he showed the relationship between voltage, current and resistance in a circuit using direct current. The relationship is called Ohm's Law. His name has been given to the unit of electrical resistance.

The credit for generating electric current goes to the famous English scientist, Michael Faraday. In 1831, Faraday found that when a magnet is moved inside a coil of copper wire, a tiny electric current flows through the wire.

In the late 1800's Joseph Swan, a British scientist, invented the incandescent filament lamp and within twelve months Thomas Edison made a similar discovery in America. Edison coupled his lamp with a direct current (D.C.) generator he created to provide electricity to light his laboratory and later to illuminate the first New York street to be lit by electric lamps, in September 1882.

One of Edison's employees, Nikola Tesla, an inventor from Croatia, developed a motor for generating alternating current (A.C.). Purchased by Westinghouse, a famous American inventor and industrialist, American society soon realised that the future lay with A.C. rather than D.C. All electric motors today, such as fans, air conditioners and refrigerators, run on A.C. power.

THE HISTORY OF ELECTRICITY TIME-LINE

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Early 1700's
1710
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ANSWERS

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MINI PROJECT 2: PERSPEX RODS AND FUR (2 LESSONS)

As has been shown earlier the first recorded experiments with electricity were performed by Greek philosophers such as Thales who found that by rubbing an 'electron' (a hard fossilised resin that today is known as 'amber') against a fur cloth, it would attract particles of straw.

Today it is know that some materials become electrically charged when rubbed together because electrons are transferred between the two materials. The material losing electrons becomes positively charged while the material gaining the electrons becomes negatively charged. The two materials are said to be charged with static electricity because their charge remains in position or static.

As the Greeks discovered, amber became positively charged when rubbed with fur, while the fur became negatively charged. This meant that neutral materials such as small pieces of paper or straw were attracted to the negatively charged amber. This knowledge of static electricity is used today to conduct police fingerprinting, in photocopying and to remove soot from chimneys.

In this project students will have an opportunity to perform a very similar experiment to that performed with amber over 2500 years ago. Due to the high cost of amber it is suggested that students use Perspex rods or large amber coloured plastic beads (available at discount variety shops) to perform this experiment. Students will rub the Perspex or bead with a piece of real or synthetic fur (available from craft shops) and then attempt to pick up small objects such as pieces of paper. Alternately, although not ideally, this experiment could be performed using a plastic pen and the student's school jumper.

Once students have performed the experiment they should write up their findings on the attached scientific procedure page. It is anticipated that this experiment and subsequent completion of the procedure page should take about two lessons (1½ to 2 hours).

PERSPEX RODS AND FUR EXPERIMENT

Experiment:

To rub perspex or plastic rods with fur to create a negatively charged rod which can attract light weight neutrally charged objects such as small pieces of paper.

MINI PROJECT 3: CURRENTS AND COMPASSES (2 LESSONS)

Hans Christian Oersted is reportedly, in 1820, the first person to notice that when a compass was placed next to an active current the compass needle would move. He noted that the needle was neither attracted to nor repelled from the current but rather would stand at right angles.

Although Oersted was unable to explain this phenomena Andre-Marie Ampere, in France, researched whether the current in a wire was exerting a magnetic force on the compass needle and thus the two wires were interacting magnetically. After a number of experiments he proved that the interaction was based on the fact that parallel or straight currents attract while anti-parallel currents repel. He is credited with finding that the force between two long straight parallel currents were inversely proportional to the distance between them and proportional to the intensity of the current flowing in each.

In this project students will have an opportunity to repeat Oersted's experiment with currents and compasses so that they can see the way in which a current will affect a compass needle and thus magnetism. To perform this experiment each group of students will need a compass and one 'D' size battery (a voltage small enough not to cause any risk to the compass).

Students will momentarily place the battery on top of the compass and should notice that the compass needle will swing to a 90 degree position. It is not good for the compass or batteries to perform this experiment for an extended period of time. The experiment can be repeated with one student momentarily holding the battery underneath the compass students should notice that the compass needle will swing in the opposite direction.

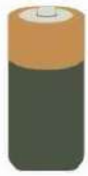
Once students have performed the experiment they should write up their findings on the attached scientific procedure page. It is anticipated that this experiment and subsequent completion of the procedure page should take about two lessons (1½ to 2 hours).

CURRENTS AND COMPASSES EXPERIMENT

Experiment:

To use a battery to create an electrical current both above and below a compass to see how electricity affects magnetism.

1 Compass



1 'D' Size Battery

Procedure:

Materials:

Results:

Conclusion:

EXTRA LESSON 2: NIGHT FLIGHTS WITH KITES

For this art activity the students can be reminded of the common legend that Benjamin Franklin went out into a lightning storm and decided to fly a kite with a metal key on the end of it. It is suggested that he did this in a bid to prove that lightning was a form of electricity. As a renowned scientist it is highly questionable whether Franklin would have been foolish enough to perform such an obviously life threatening experiment. Nonetheless it provides a nice art activity to illustrate this first section of EUW. For this activity the students will create a storm picture with a man flying a kite. They may want to put a warning on it along the lines of "This is a shocking idea so please don't try it at home". It is anticipated that this art activity should take about two lessons (1½ to 2 hours) to complete with additional drying time between those two lessons.

Materials Required:

A4 art paper

Colourful wax crayons

Black paint

Paint brush or other sharp ended tool

Scissors

Glue

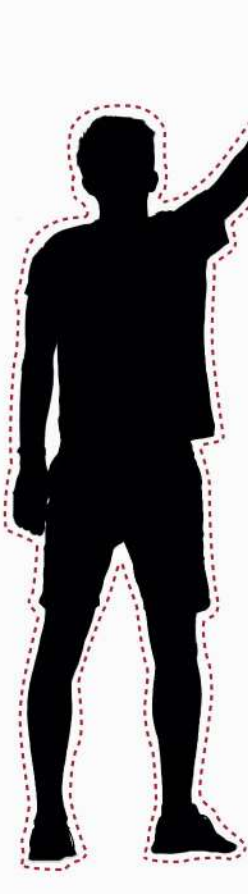
Nylon thread

Scrap of bright material

Copy of the picture below or a similar drawing

Method:

1. Brightly colour the piece of paper in a random fashion using the crayons.
2. Cover the entire page in black paint and leave it to dry completely.
3. Using the end of a paintbrush scratch off thin lightning bolt lines of paint.
4. Cut out a copy of the picture below and paste it on the bottom of the page.
5. Cut out the material into a small kite shape.
6. Paste a piece of thread from the man's hand to the top half of the page.
7. Paste the kite on the other end of the nylon thread so that it appears as if the man is flying the kite.
8. Type the warning and paste it onto the page.



BENJAMIN FRANKLIN FIND-A-WORD

The following 23 words are written forwards, backwards, vertically and horizontally. See if you can find them all.

Amber	Current	Magnets	Volta
Ampere	Edition	Metal	Water
A.C.	Electricity	Ohm	Watt
Battery	Faraday	Static	Westinghouse
Cloth	Franklin	Swan	Wire
Copper	Lightning	Tesla	

W	E	S	T	I	N	G	H	O	U	S	E
T	B	L	F	R	A	N	K	L	I	N	R
L	A	T	E	M	S	T	A	T	I	C	E
H	T	O	L	C	O	P	P	E	R	C	P
A	T	T	A	W	T	H	A	C	I	U	M
M	E	W	T	S	I	R	S	A	D	R	A
B	R	A	L	N	O	S	I	D	E	R	W
E	Y	T	O	A	H	W	N	C	G	E	I
R	E	E	V	R	M	A	O	U	I	N	R
S	I	R	M	A	G	N	E	T	S	T	E
A	L	S	E	T	F	A	R	A	D	A	Y
D	L	I	G	H	T	N	I	N	G	E	A

The remaining letters when read in order from left to right down the page will tell you what Franklin supposedly said as he flew his kite in a storm

FAMOUS ELECTRICIANS CROSS-WORD

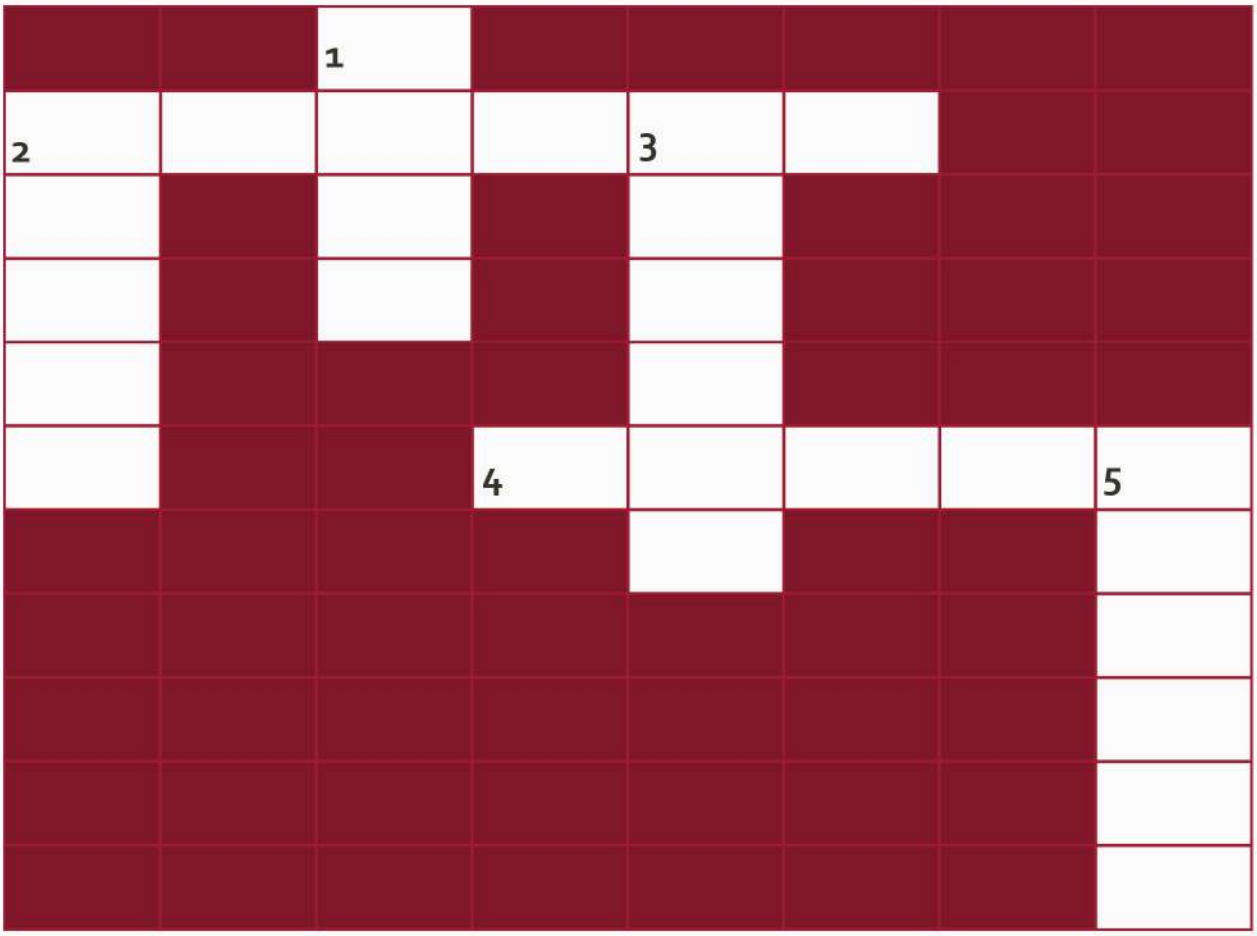
After students have constructed the time line and every group has given their Power Point demonstrations let the class see how much information they can each remember by completing the cross-word below.

Down:

1. What do we call an electric unit of power?
2. Who invented alternating current?
3. Who brought light to American streets?
5. What do we call a unit of electric current?

Across:

2. Who discovered that amber could pick up straw?
4. Who invented the first battery?



Famous Electricians Cross-Word

Down:
1. Watt
2. Tesla
3. Edison
5. Ampere

Across:
2. Thales
4. Volta

Find-a-Word - Franklin's Shocking Experiment

This is a dangerous idea

W	E	S	T	I	N	G	H	O	U	S	E
T	B	L	F	R	A	N	K	L	I	N	R
L	A	T	E	M	S	T	A	T	I	C	E
H	T	O	L	C	O	P	P	E	R	C	P
A	T	T	A	W	T	H	A	C	I	U	M
M	E	W	T	S	I	R	S	A	D	R	A
B	R	A	L	N	O	S	I	D	E	R	W
E	Y	T	O	A	H	W	N	C	G	E	I
R	E	E	V	R	M	A	O	U	I	N	R
S	I	R	M	A	G	N	E	T	S	T	E
A	L	S	E	T	F	A	R	A	D	A	Y
D	L	I	G	H	T	N	I	N	G	E	A

PRODUCTION OF ELECTRICITY

TEACHER LED DISCUSSION (1 LESSON)

Having already explored the history of electricity this next section of the unit allows students to learn how electricity is produced.

Initially a teacher led discussion and construction of a brainstorm map would ascertain how students believe electricity is produced and how they currently perceive the role of renewable versus non-renewable energy sources.

MIDI PROJECT 1: ENERGY BROCHURE

Students should use the internet to research a method for energy production. Once they have collected their information they can produce a brochure of one A4 page folded into thirds showing the advantages and disadvantages for consumers on one of these methods of power production. It is anticipated that this project would take students about five lessons (4 to 5 hours) to complete. Alternately it could be set as homework over a couple of weeks with time given for students to conduct research at school.

MINI PROJECTS 1, 2 AND 3

The following three experiments to build a waterwheel, a solar fan and a small windmill allow students to explore some alternate forms of energy production. Students should work in pairs or small groups to complete each project and ideally both the water wheels and solar cells would be completed on a warm, sunny day. It is anticipated that each project should take students about two lessons (1½ to 2 hours) to complete depending on time allowed for 'playing' with the finished product.

MINI PROJECT 1: HYDRO-ELECTRICITY

BUILD A WATERWHEEL (2 LESSONS)

Experiment:

To create a waterwheel

Materials Required:

3 plastic cups

2 plastic plates
(paper plates may
be used but these will disintegrate
with prolonged use)

A stapler

A wooden skewer

Water

Flowing water

Procedure:

1. Pierce the middle of each plate with the skewer and remove.
2. Cut each cup in half lengthwise to create 6 scoops.
3. Staple the side of each cup to the plate so that they are spaced evenly around the outside of the plate.
4. Staple the cups in the same fashion to the second plate (this is harder as they are already joined to one plate).
5. Insert the skewer through the middle of the two plates and remove sharp end of skewer.
6. Place one scoop under running water while holding each end of the skewer.

MINI PROJECT 2: SOLAR POWER

USE THE SUN TO RUN A FAN (2 LESSONS)

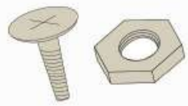
Experiment:

To determine the most efficient location to place a solar cell to run a fan.

Materials Required:

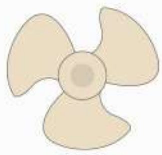
2 solar cells bracketed together

1 small DC motor



Screws and nuts

Wire with motor clips



Plastic fan spinner

(Note: All this equipment can be purchased as a preassembled educational pack for less than $15 from most electronics suppliers)

Procedure:

1. Remove the nuts connecting the two solar cells and place on the wire clips which are already connected to the DC motor.
2. Replace the nuts and screw on tightly.
3. Insert the plastic fan onto the end of the motor.
4. Place the solar cell in various locations and record the spinning speed of the blades as slow, medium or fast.

(Note: If the motor is new it may be necessary to run it for a while in a very sunny location to allow it to wear in.)

Results:

Solar Cell Location	Fan Speed

MINI PROJECT 3: WIND ENERGY

CREATE A SMALL WINDMILL (2 LESSONS)

Experiment:

To create a windmill and see how many paper clips it is able to lift.

Materials Required:


Cork


Drawing pin


Empty pen casing

Glue


Magnet


Paper clips


2 pieces A4 cardboard

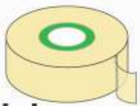

Pencil


Ruler


Scissors

Skewer


Stapler


Sticky tape


Thread

Procedure:

1. Cut a 12cm square out of one of the pieces of cardboard.
2. Draw two diagonal lines joining the corners to find the centre of the square.
3. Measure 2cms from the centre on each line and cut to that mark.
4. Fold alternate corners to the central point – slightly further than the centre will ensure all four corners are held by the pin.
5. Insert the pin through the centre of the windmill and into one end of the cork.

1. Cut two circles 8cms in diameter out of the second piece of cardboard.
2. Pierce the centre of each circle using the skewer.
3. Cut a rectangle 10cms x 13cms and measure a line 1cm from each end.
4. Divide this into 3 x 2cm wide teeth with a 1cm gap between each tooth.
5. Fold the gaps at right angles to the rectangle and teeth and carefully cut off.
6. Fold the teeth at right angles to the rectangle.
7. Pierce the middle of the rectangle and thread through the string.
8. Sticky tape the string to the inside of rectangle, roll the rectangle into a cylinder and sticky tape.
9. Sticky tape, glue or staple the teeth to the circles to create a cylinder.

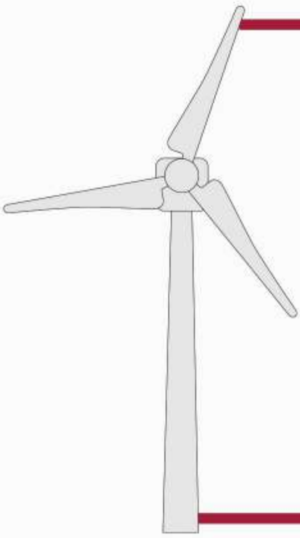
Joining all three templates together:

1. Insert the skewer through the pre-pierced holes in each circle.
2. Insert the sharp end of the skewer into the cork and sticky tape the cork to the closest circle.
3. Insert the blunt end into the pen casing.
4. Tie a double knot in the end of the string and attach a magnetised paper clip.
5. Holding the pen casing, blow on the windmill and use the magnetised clip to pick up one paper clip at a time to see how many paperclips the windmill is able to lift.

EXTRA LESSON 1: WINDMILLS OF NSW (2 LESSONS)

In this lesson students will use the internet to research windmills found around the world. Students should summarise the information about a particular windmill or a location where a number of windmills could be found on a piece of cardboard.

They should find the following pieces of information about each windmill and stick them on a map of the world to see which country had and now has the most windmills.



Where is the windmill located?

How long has it been there?

What is it used for today?

Any information about this windmill.

It is anticipated that this project should take students about two lessons (1½ to 2 hours) to complete.

EXTRA LESSON 2: THE HISTORY OF WATERMILLS COMPREHENSION

Watermills, in their simplest form, have been in use since ancient times. Primarily used for processing grain into flour they would, initially, have been used to simply crush the grain. An early example of this can be seen in Egyptian carvings of rough stone rollers moving forwards and backwards on a long flat surface.

It is believed that revolving mill stones were first introduced in Italy around 1 C.E. with the first recorded reference to a water mill being made by Antipater, a Greek poet in 85 C.E. The first recorded description of a vertical water wheel, which gave much greater power, came in 27 C.E. by Roman architect Vitruvias.

It is believed that watermills were introduced to Britain during the medieval period by the Romans with their presence being recorded in William the Conqueror's 1085 Doomsday Book. They are recorded in Ireland in the 9th and 10th centuries, can be found in Denmark from the second half of the 11th century and in Iceland from around the 1200s. The first recorded sawmill use of a watermill is on the Niagra River in the United States of America in 1757. Watermills have played a very important role in industry over the past 2000 years and are still in use today in the Himalayan ranges.

Question

1. For what were mills originally used?

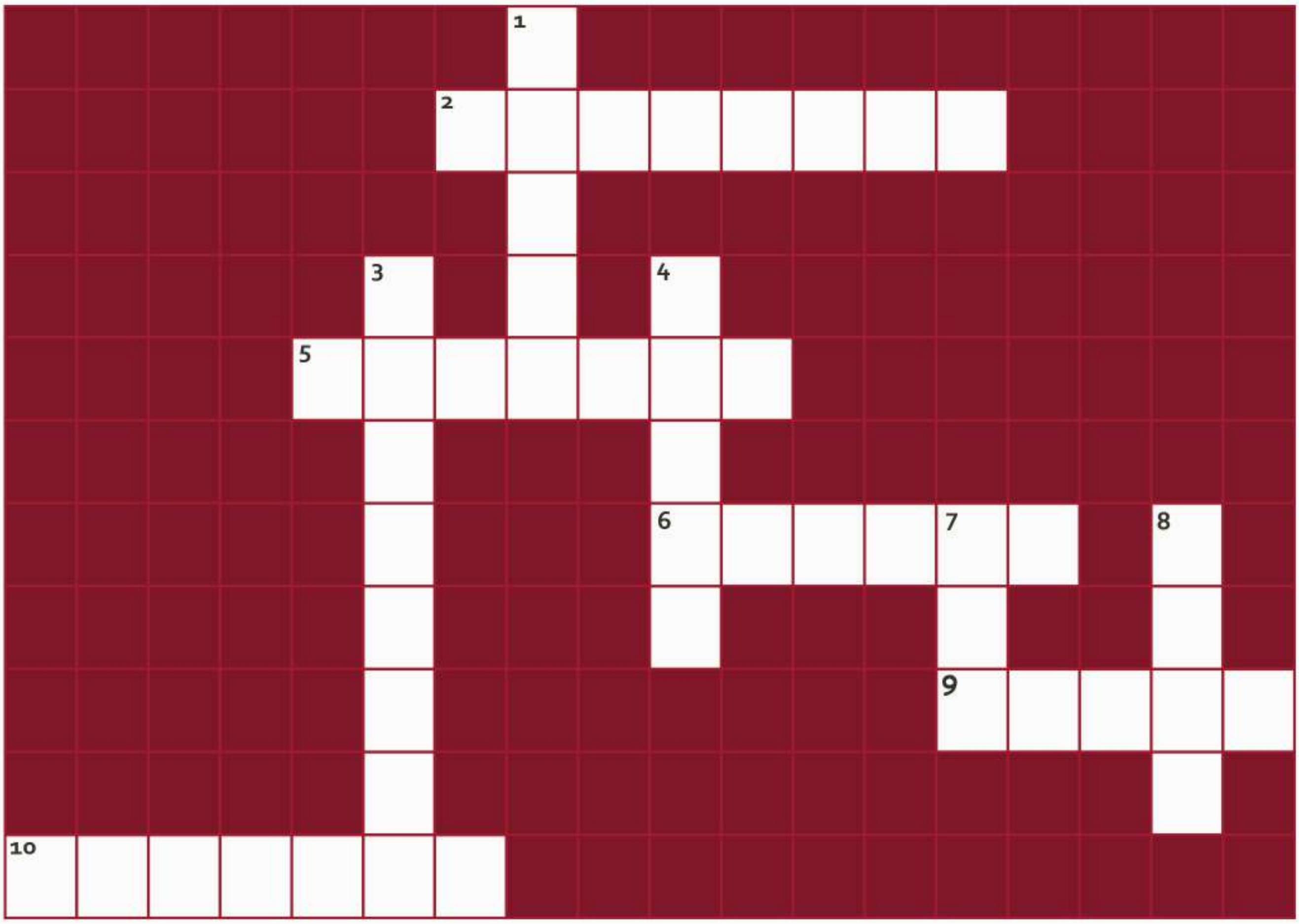
2. When were revolving mills stones first introduced?

3. Why did people switch to verticle water wheels?

4. When and where was the first waterwheel used in the USA?

5. How have watermills played an important part in history?

CROSS WORD - ALTERNATE POWER SUPPLIES



Clues

Down:

1. Energy derived from the periodic variation in the surface level of a large body of water such as the ocean.
3. Machines with blades connected around their internal wheel or cylinder.
4. A clear liquid used to produce steam.
7. A natural occurring clear substance used as an alternative to electricity in many homes.
8. A black rock dug from the earth and burnt at Mt Piper to produce heat to create steam and thus turn the turbines.

Across:

2. A very old device for harnessing the wind to produce energy.
5. An energy deriving from the destruction and recreation of atoms.
6. A source of usable power
9. Energy released from the sun.
10. Energy stored in plant material, vegetation or agricultural waste.

FIND-A-WORD - POWER TO THE PEOPLE

The following 25 words are written forwards, backwards, horizontally, vertically and diagonally. See if you can find them all.

Ash	Condenser	Furnace	Plant	Steam
Boiler	Cooling tower	Generator	Power Station	Supply
Bunkers	Electricity	Heat	Pulverising mill	Transformer
Burn	Emission stack	Mining	Rotor	Turbine
Coal	Fabric filter	Mt Piper	Stator	Water

P	A	Y	T	I	C	I	R	T	C	E	L	E	B	C
O	U	R	O	T	O	R	C	K	D	W	A	T	E	R
W	E	L	F	G	H	I	O	C	J	S	K	R	M	E
E	Q	P	V	R	O	N	N	A	M	T	L	O	T	T
R	R	S	R	E	T	E	D	T	U	E	V	T	P	L
S	E	F	X	W	R	N	E	S	S	A	T	A	I	I
T	L	U	S	O	A	I	N	N	R	M	G	R	P	F
A	I	R	T	T	N	B	S	O	E	A	N	E	E	C
T	O	N	A	G	S	R	E	I	K	B	I	N	R	I
I	B	A	T	I	F	U	R	S	N	F	N	E	C	R
O	T	C	O	N	O	T	R	S	U	G	I	G	R	B
N	Y	E	R	L	R	N	E	I	B	W	M	A	Q	A
N	R	U	B	O	M	A	U	M	O	P	A	I	S	F
H	E	A	T	O	E	L	I	E	S	C	O	A	L	H
D	B	G	P	C	R	P	S	U	P	P	L	Y	K	L

ANSWERS

The History of Watermills Comprehension

1. Mills were originally used to process grain.
2. Revolving mill stones were first introduced in Italy around 1 C.E.
3. People switched to vertical water wheels because they gave much greater power.
4. The first recorded sawmill waterwheel was on the Niagra River in the USA in 1757.
5. Watermills have played an important part in industry because they have allowed man to increase the work load he is able to complete. Watermills have also been responsible for powering machinery which has increased the

Cross Word – Alternate Power Supplies

Down:

1. Tidal
3. Turbine
4. Water
7. Gas
8. Coal

Across

2. Windmill
5. Nuclear
6. Energy
9. Solar
10. Biomass

Find-A-Word – Power to the People

P	A	Y	T	I	C	I	R	T	C	E	L	E	B	C
O	U	R	O	T	O	R	C	K	D	W	A	T	E	R
W	E	L	F	G	H	I	O	C	J	S	K	R	M	E
E	Q	P	V	R	O	N	N	A	M	T	L	O	T	T
R	R	S	R	E	T	E	D	T	U	E	V	T	P	L
S	E	F	X	W	R	N	E	S	S	A	T	A	I	I
T	L	U	S	O	A	I	N	N	R	M	G	R	P	F
A	I	R	T	T	N	B	S	O	E	A	N	E	E	C
T	O	N	A	G	S	R	E	I	K	B	I	N	R	I
I	B	A	T	I	F	U	R	S	N	F	N	E	C	R
O	T	C	O	N	O	T	R	S	U	G	I	G	R	B
N	Y	E	R	L	R	N	E	I	B	W	M	A	Q	A
N	R	U	B	O	M	A	U	M	O	P	A	I	S	F
H	E	A	T	O	E	L	I	E	S	C	O	A	L	H
D	B	G	P	C	R	P	S	U	P	P	L	Y	K	L

USES OF ELECTRICITY

TEACHER LED DISCUSSION (1 LESSON)

By now your class should have already explored the history of electricity and how it is produced at Mt Piper. They should have had an opportunity to perform some basic experiments and construct models of some alternate power sources. In this third section of EUW students will learn how electricity is used and the role it plays in their lives.

In this initial section, the teacher led discussion, students should suggest some of the magnitude of uses society has for electricity. The information generated during this discussion should produce a brainstorm map which can be used as a comparison at the end of this section to see just many more examples the students' can suggest for ways in which we use electricity in our everyday lives.

MIDI PROJECT 1: SAFETY AND ELECTRICITY (3 LESSONS)

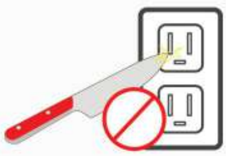
Electricity flows through water almost as easily as it travels through wire. With over 70% of the human body being made up of water – people make great electrical conductors. As such hundreds of thousands of people across Australia are injured every year from electricity related accidents. Some of these accidents are fatal while others result in no more than a slight zap or tingling sensation but all can be prevented.

In this project students will create a checklist similar to that below both for home and school of ways to prevent electrical accidents. Once they have done this they can design an awareness poster to be displayed in some of the junior classrooms and around the school where electrical appliances are being used such as computer labs and in the staff room. It is anticipated that this project should take students about three lessons (2 to 3 hours) to complete.

CHECKLIST

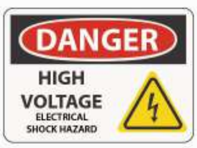
1. Do not touch electrical cords which are broken and if you see a frayed wire tell an adult.
2. Do not play with or bite electrical cords.

3. Do not stick fingers or any other objects (especially knives) into light sockets, appliances such as toasters or electrical outlets.



4. Do not plug too many appliances into one socket.
5. Do not pull on cords to unplug appliances. Hold on to the plug itself.
6. If you are wet or standing in water do not touch anything electrical such as light switches or hair dryers.
7. Do not use electrical equipment near water such as in the bathroom, while washing the car or around the pool.
8. If you ever find a fallen power line stay away from it and report it immediately to an adult.

9. Do not fly kites, model airplanes or balloons near power lines.
10. Do not climb power poles, ladders or trees close to power lines.



11. Do not touch or go near electrical equipment marked "Danger", "High Voltage" or "Keep Out" and stay away from electrical substations.
12. Disconnect appliances before cleaning them.
13. Do not swim during an electrical storm.
14. Install a safety cut-out switch at the main switchboard.
15. Use surge protected power outlets and extension leads.
16. Insert safety plugs into all unused power points.
17. Ensure that electrical appliance cords and leads are shortened to prevent dangling and subsequently being pulled by young children.
18. Get all work carried out by a qualified electrician.

MIDI PROJECT 2: ENERGY USE OVER TIME (2 LESSONS)

In developed countries most people live their lives surrounded by electrical equipment, yet how many people actually know how much electricity these appliances are using? In this activity students will calculate the energy usage of a number of common electrical appliances using the wattage listed on the item. Every home appliance has a panel attached to it or stamped into it which clearly lists the wattage, or maximum power, which that appliance consumes. The wattage is calculated by multiplying the appliance's current by its voltage (w = current x voltage).

Students have been given sample wattages for a number of common household appliances including a clock radio, coffee machine, clothes washer, clothes dryer, dishwasher, ceiling fan, hair dryer, clothes iron, microwave, refrigerator, computer, television or stereo. This wattage will need to be multiplied by the local utility rate per kilowatt hour (this can be found on the school's electricity bill) to calculate the annual cost of running that appliance for a year. It is anticipated that this project should take students about two lessons (1½ to 2 hours) to complete.

The table below will assist students to complete this activity.

Appliance	Wattage	Hours of Use Per Day	Hours of Use Per Year	Cost Per Year
Clock radio	100			
Coffee machine	1500			
Clothes washer	1150			
Clothes dryer	5400			
Dishwasher	1500			
Ceiling fan	300			
Hair dryer	1200			
Clothes iron	1200			
Microwave	800			
Refrigerator	500			
Computer	300			
Television	300			
Stereo	100			

Note: Remember to divide by 1000 for kWh.

Students can then calculate how much coal Mt Piper will have to burn to power each of these appliances if they estimate that 1 kilogram of coal will produce around two kilowatt hours of electricity.

Appliance	Wattage	Hours of Use Per Day	Hours of Use Per Year	Coal Burnt Per Year
Clock radio	100			
Coffee machine	1500			
Clothes washer	1150			
Clothes dryer	5400			
Dishwasher	1500			
Ceiling fan	300			
Hair dryer	1200			
Clothes iron	1200			
Microwave	800			
Refrigerator	500			
Computer	300			
Television	300			
Stereo	100			

MINI PROJECT 1: INDUSTRY AND POWER (2 LESSONS)

Electricity is employed by many different people for many different reasons. Undoubtedly, the largest consumer of electricity is the industrial sector. Industry and the community at large use electricity on a continuous basis without really stopping to consider just how much it is a part of their everyday lives.

Every time a student boards a train, passes a set of traffic lights or visits a shopping centre they are experiencing the benefits generated by electricity. It is unlikely though, that students have stood in a supermarket and considered just how many of the products around them have relied on electricity to be there, available for them, on the supermarket shelves. Every product packaged in cardboard has had to begin with a tree being milled and processed, every baked product has involved the use of an oven and every cold product is being constantly refrigerated. Students could look around them in any supermarket aisle and count some of the seemingly infinite number of ways electricity has been employed to produce that which they can see. Not to mention the fact that all these products are being lit from above by electrical neon lights, will be tallied and totalled at an electronic register and are being monitored by a very high tech, multi-platform, electronic surveillance system. So what would happen in a blackout?

Many buildings today are so reliant on electricity that they are unable to function without it. This may be because a power shortage could cause loss of life such as in a hospital, would harm others and the community such as a gaol or could result in theft of billions of dollars such as a bank. In these situations the building is equipped with a back-up generator so that in the event of a blackout power can be maintained. In this activity students are asked to select one industry or building which cannot function without electricity and explore some of the ramifications a loss of electricity may have. Students may select a particular building such as an airport, shopping centre or multi-story office building or a company which would lose so much revenue from a blackout both in terms of the time machinery was not operating and time required to power up machinery that they are equipped with back-up generators.

Students should present a half A4 page of information about the particular building or business and the necessity for that building having a back-up generator. Encourage creative thought and logical thinking and possibly internet based research if desired (remembering of course uninterrupted power supply (UPS) systems) as they do it. It is anticipated that this project should take students about two lessons (1½ to 2 hours) to complete.

MINI PROJECT 2: METERING THE METERS (2 LESSONS)

Every building in Australia has an electricity meter which measured how much electricity passes into a building and is used by that building's occupants. Meters are read on a fairly regular basis by a member of the electricity company so that they are able to charge appropriately for electricity consumed over a given period of time. For most households a meter reading is taken every quarter prior to a bill being issued.

For this activity students will need to study their home electricity meter reading and bring to school their current reading to compare against classmates. Reading an electricity meter is not immediately easy and students will need some assistance. Every electricity meter has five dials with the numbers 0-9 on each dial. The dials are not identical though. On the first dial, the numbers increase in a clockwise direction while on the next meter, the numbers increase in the opposite direction, in a counter-clockwise direction. Each dial alternates from clockwise to counter-clockwise. To read a meter, students read the dials from right to left and record the numbers. If the pointer is between two numbers, they should record the smaller number. In addition students can measure in seconds how long it takes for the disk at the base of their dial to complete one revolution – the faster the disk is spinning the more electricity the house is consuming. It may be worth asking students to complete this activity on a number of occasions such as first thing in the morning, when they get home from school and on the weekend when most appliances are off.

As a discussion topic it would be worth considering why some houses have a much higher meter reading than others – age of the meter is the general reason for higher readings. Students should also be asked to record the electricity used in the past year or four quarters on their household electricity statements. These can be compared to see which households are most energy efficient and reasons why this may be the case such as the number of occupants, the time most occupants go to bed or the number of computers/televisions in use in the house.

Once students have their quarterly readings they can, as a whole class, compare which sections of the year most energy is consumed and suggest why this may be the case – the heights of winter and summer tend to be the most costly due to extreme heating and cooling requirements. Students can also be asked to calculate how far their energy provider would have over or under charged them if they were charged say 20 kWh for the summer quarter and 15 kWh for the spring quarter. It is anticipated that this discussion and subsequent calculations should take the class about two lessons (1½ to 2 hours) to complete.

HOMEWORK ASSIGNMENT: BLACKOUT STORY

Students will imagine they are travelling home from school one afternoon when a terrible storm hits. During the storm a lightning bolt hits the local power sub-station for their area. As a result they are faced with a twelve hour blackout. They are to write a one page story about what they would do for the evening.

Some important points to remember are that lights, microwaves, electric cook tops and ovens, fridges, freezers, televisions, computers even some doorbells and telephones will not work once a blackout occurs. In addition local traffic lights, street lights, shops and restaurants will also be without power. It is important also that students are not allowed to simply say they will go and stay with a relative in another suburb where there is power.

Stories should be about 200 words long and students should present both their story plan and final story for this homework assignment.

EXTRA LESSONS 1: ELECTRICAL APPLIANCE COLLAGE

Students will be spilt into pairs or groups of three and given one A3 letter from the word ELECTRICITY. They will also need a number of shopping catalogues and glossy magazine to find pictures of electrical appliances. They should cut out as many electrical appliances as they can and paste these onto their letter to form a colourful collage. If some students are very artistic they may wish to draw some electrical appliances instead. These letters can then be used to form the centre piece of a classroom display of this term's electricity work.

EXTRA ACTIVITIES 1: FIND A WORD
AN ELECTRICAL TIME TO BE ALIVE

The following 47 words are written forwards, backwards, vertically and horizontally. See if you can find them all.

Air Conditioner	Clock Radio	Food Processor	Juicer	Projector	Toaster Oven
Air Purifier	Coffee Maker	Freezer	Lights	Rice Cooker	Tumble Dryer
Amplifier	Dehumidifier	Fridge	Microwave	Sewing Machine	Vacuum Cleaner
Blender	Dishwasher	Game Cube	Mini System	Shaver	Washing Machine
Boombox	Dreamcast	Hair Dryer	Mixer	Steam Cleaner	Waste Disposal
Bread Maker	DVD Player	Ice Maker	Oral Care	Steam Press	Water Dispenser
Cooler	Fan	Indoor Grill	Oven	Television	XBox
CD Player	Food Dehydrator	Iron	Play Station	Toaster	

X	T	E	L	E	V	I	S	I	O	N	R	E	K	O	O	C	E	C	I	R	L
V	S	T	E	A	M	P	R	E	S	S	O	I	D	A	R	K	C	O	L	C	A
A	F	R	F	S	E	L	W	B	I	N	D	O	O	R	G	R	I	L	L	V	S
C	R	E	A	T	T	A	A	S	E	W	I	N	G	M	A	C	H	I	N	E	O
U	M	I	N	I	S	Y	S	T	E	M	T	S	A	C	M	A	E	R	D	N	P
U	I	F	O	V	E	S	H	A	V	E	R	X	M	O	E	N	P	E	Q	D	S
M	C	I	R	O	N	T	I	W	E	X	D	H	I	F	C	E	M	C	E	A	I
C	R	R	X	R	V	A	N	F	P	O	H	V	C	F	U	V	E	I	D	R	D
L	O	U	E	A	B	T	G	O	R	B	A	N	R	E	B	O	G	U	E	R	E
E	W	P	T	L	X	I	M	R	E	X	I	M	O	E	E	N	D	J	B	O	T
A	A	R	G	C	T	O	A	S	T	E	R	T	W	M	P	L	I	G	H	T	S
N	V	I	N	A	U	N	C	D	D	V	D	P	L	A	Y	E	R	D	X	C	A
E	E	A	E	R	I	A	H	Y	W	A	R	E	I	K	E	S	F	E	R	E	W
R	R	W	V	E	E	X	I	H	R	E	Y	R	D	E	L	B	M	U	T	J	O
R	E	L	O	O	C	O	N	I	F	H	E	R	S	R	B	O	O	M	B	O	X
R	I	R	R	V	D	O	E	W	A	S	R	E	K	A	M	E	C	I	E	R	E
E	F	E	E	A	P	R	E	S	N	E	P	S	I	D	R	E	T	A	W	P	U
Z	I	D	T	C	L	D	I	S	H	W	A	S	H	E	R	E	R	H	F	X	O
E	L	N	S	B	A	F	O	O	D	D	E	H	Y	D	R	A	T	O	R	Q	P
E	P	E	A	O	Y	S	H	I	D	R	E	I	F	I	D	I	M	U	H	E	D
R	M	L	O	R	E	N	O	I	T	I	D	N	O	C	R	I	A	M	I	E	A
F	A	B	T	X	R	O	S	S	E	C	O	R	P	D	O	O	F	I	D	T	G
S	T	E	A	M	C	L	E	A	N	E	R	R	E	K	A	M	D	A	E	R	B

ANSWERS

Find-A-Word – An Electrical Time to Be Alive

X	T	E	L	E	V	I	S	I	O	N	R	E	K	O	O	C	E	C	I	R	L
V	S	T	E	A	M	P	R	E	S	S	O	I	D	A	R	K	C	O	L	C	A
A	F	R	F	S	E	L	W	B	I	N	D	O	O	R	G	R	I	L	L	V	S
C	R	E	A	T	T	A	A	S	E	W	I	N	G	M	A	C	H	I	N	E	O
U	M	I	N	I	S	Y	S	T	E	M	T	S	A	C	M	A	E	R	D	N	P
U	I	F	O	V	E	S	H	A	V	E	R	X	M	O	E	N	P	E	Q	D	S
M	C	I	R	O	N	T	I	W	E	X	D	H	I	F	C	E	M	C	E	A	I
C	R	R	X	R	V	A	N	F	P	O	H	V	C	F	U	V	E	I	D	R	D
L	O	U	E	A	B	T	G	O	R	B	A	N	R	E	B	O	G	U	E	R	E
E	W	P	T	L	X	I	M	R	E	X	I	M	O	E	E	N	D	J	B	O	T
A	A	R	G	C	T	O	A	S	T	E	R	T	W	M	P	L	I	G	H	T	S
N	V	I	N	A	U	N	C	D	D	V	D	P	L	A	Y	E	R	D	X	C	A
E	E	A	E	R	I	A	H	Y	W	A	R	E	I	K	E	S	F	E	R	E	W
R	R	W	V	E	E	X	I	H	R	E	Y	R	D	E	L	B	M	U	T	J	O
R	E	L	O	O	C	O	N	I	F	H	E	R	S	R	B	O	O	M	B	O	X
R	I	R	R	V	D	O	E	W	A	S	R	E	K	A	M	E	C	I	E	R	E
E	F	E	E	A	P	R	E	S	N	E	P	S	I	D	R	E	T	A	W	P	U
Z	I	D	T	C	L	D	I	S	H	W	A	S	H	E	R	E	R	H	F	X	O
E	L	N	S	B	A	F	O	O	D	D	E	H	Y	D	R	A	T	O	R	Q	P
E	P	E	A	O	Y	S	H	I	D	R	E	I	F	I	D	I	M	U	H	E	D
R	M	L	O	R	E	N	O	I	T	I	D	N	O	C	R	I	A	M	I	E	A
F	A	B	T	X	R	O	S	S	E	C	O	R	P	D	O	O	F	I	D	T	G
S	T	E	A	M	C	L	E	A	N	E	R	R	E	K	A	M	D	A	E	R	B

ENERGY CONSERVATION

TEACHER LED DISCUSSION (1 LESSON)

By this stage in the term students should have covered the history of electricity, how it is produced and some of its seemingly infinite uses. In this, the final section of EUW, students will gain an appreciation of the limited nature of fossil fuels and the very real dangers society faces when they are eventually depleted. By the end of this section students should be able to identify a number of methods for reducing their personal level of energy consumption and how businesses are trying to make a difference on a larger scale.

Students should begin this topic by brainstorming ways in which they can reduce the amount of energy they consume on a daily basis and how they could teach others to conserve energy. It may also be worth revisiting renewable methods of producing energy so that students can be reminded that there are alternatives to burning fossil fuels. At the conclusion of this section of EUW it would be useful for students to reflect on all four of their brainstorm maps so they can see just how much they have learnt over the term.

MIDI PROJECT 1: BUILDINGS OF DISTINCTION (5 LESSONS)

Students will select one building from the list below and research that building. Each building has been reviewed on the Australian Building Greenhouse website which can be found at http://www.abgr.com.au. Students should prepare a one minute presentation on the building in question including information such as location, age, energy rating and methods whereby energy conservation has been integrated into the building's design. It is anticipated that this project should take students about five lessons (4 to 5 hours) to complete including three lessons for research and two lessons for presenting the buildings to the class.

- Hall Chadwick Centre at 120 Edward Street, Brisbane
- 40 Miller Street, North Sydney
- NSW Police Service
- 'The Bond' at Hickson Road, Sydney
- Henry Deane Building, Sydney
- Gosnells Civic Complex "The Agonis"
- Newcastle City Council Administration Building
- Melbourne Central Tower at 360 Elizabeth Street, Melbourne
- Central Park, Perth
- Dumas House, Perth
- Mount Newman House

MINI PROJECT 1: POLLUTANT CHART (2 LESSONS)

Students should select one pollutant from the list below as found on the National Pollutant Inventory (NPI) on Delta Electricity's Website. The NPI is a web based database which provides the community, industry and government with information on the types and amounts of certain substances being emitted into the environment.

Once students have chosen a pollutant they should access the Delta Electricity Website at http://www.de.com.au and select 'environment' on the left hand side of the page. This will then allow them to select the NPI and eventually their chosen pollutant. Alternately, if computer time is scarce the teacher could access the NPI pages and print off the required information for students to summarise.

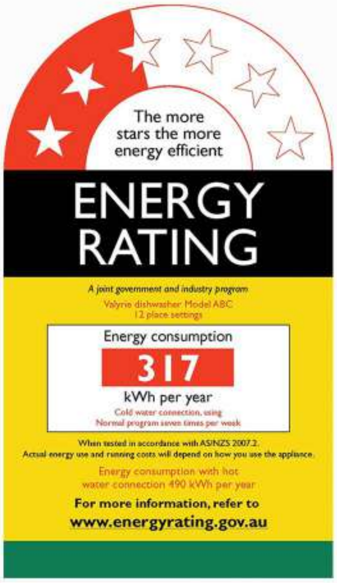
Once a pollutant has been chosen the students should create an A4 page summarising: What the pollutant is? How it is released from the power station? What happens after it is released and a graph of the level of the chosen pollutant released by the power station against the levels for Sydney, Melbourne, Brisbane or Rural community as provided. It is anticipated that this project should take students about two lessons (1½ to 2 hours) to complete.

Pollutants List

- ☐ Arsenic
- ☐ Benzene
- ☐ Cadmium
- ☐ Chromium
- ☐ Carbon Monoxide (CO)
- ☐ Cobalt
- ☐ Dioxins and Furans
- ☐ Fluorine
- ☐ Lead
- ☐ Mercury
- ☐ Nitrogen Oxides (NOx)
- ☐ Polyaromatic Hydrocarbons (PAHs)
- ☐ Particles (PM_{10})
- ☐ Sulphur Dioxide (SO_2)
- ☐ Sulfuric Acid
- ☐ Xylene

MINI PROJECT 2: ENERGY RATING LABELS (2 LESSONS)

An 'Energy Rating' label similar to that pictured below can be found on any new refrigerator, freezer, clothes washer, clothes dryer, dishwasher or air-conditioner (single phase only). These stickers allow consumers to compare the energy efficiency of various domestic appliances on a fair and equitable basis. It also provides an incentive for manufacturers to improve the energy performance of their appliances so that consumers are more likely to purchase their product over a less efficient competitor.



©https://www.eeca.govt.nz/standards-ratings-and-labels/the-energy-rating-label/

Energy Rating labels, first introduced in New South Wales and Victoria in 1986, are compulsory in all Australian states and territories. The star ratings are determined based on the energy consumption and size of a product and ensure consumers can quickly assess which models provide the most efficient use of energy. The energy consumption number lets the consumer estimate the annual energy consumption of each product in kilowatt hours per year based on typical household use. As a whole, the Energy Rating label encourages producers to improve technology and create more efficient white goods. It also allows consumers to select products which allow them to use less energy which not only saves them money but also reduces harmful greenhouse gas emissions from the burning of fossil fuels.

As an additional activity it may be fun for students to be given a page from a white goods retailer (these can be accessed on-line at sites such as 'The Good Guys') and have them calculate the initial outlay plus ten year running costs to see which products are actually most cost effective.

HOMEWORK ASSIGNMENT: LIGHTING THE WAY

Using a table similar to that in the 'Uses of Energy' section of EUW students will calculate how much energy, money and coal can be saved if they were to use energy saving light bulbs in their home. For this homework assignment students will need to count up all the light globes in their home. They will also need to estimate how many hours per night, for each night of the school week, each light bulb is on. Using the table below they can then calculate how many kilowatt hours they are using in lighting to light their home for one school week (5 days). Once they have achieved this they can calculate the cost of lighting their home, using the same price per kilowatt hour as that charged to the school, and in terms of coal burned, based on one kilogram of coal producing two kilowatt hours of electrical energy.

Once students have found the kilowatt hour figure for energy usage of their lights they should recalculate it as if they were using eleven watt energy efficient bulbs in all their lights. These bulbs produce just as much incandescent light yet use up to 90% less power and produce almost no heat. Students can recalculate the cost of lighting their home again both in a monetary and environmental sense. The table below will assist in calculating the energy usage in each student's home.

CURRENT LIGHTING

Rooms	Number of Lights	Watts Used	Hours in Use	Cost in $	Kilos of Coal
Living Room		100			
Dining Room		100			
Kitchen		100			
Bedrooms		60			
Bathrooms		75			
Hallways		75			
Family Room		100			
Outside Lights		60			
Total					

EXTRA ACTIVITIES: CUTTING DOWN WHILE POWERING UP: FIND-A-WORD

The following 33 words are written forwards, backwards, vertically and horizontally. See if you can find them all.

Air-Conditioner
Arsenic
Benzene
Cadmium
Carbon Monoxide
Chromium
Clothes Dryer
Clothes Washer
Cobalt
Consumption
Dioxins
Dishwashers
Efficiency
Energy
Energy Rating
Fluorine
Fossil Fuels
Furans
Freezers
Global Warming
Greenhouse Gases
Label
Lead
Mercury
Pollutant Inventory
Nitrogen Oxide
Particles
Refrigerators
Renewable
Sulphuric Acid
Sulphur Dioxide
Unsustainable
Xylene

M	B	C	S	S	R	E	H	S	A	W	S	E	H	T	O	L	C	T	J
G	X	D	F	U	H	R	E	W	Q	N	N	X	E	U	P	C	A	S	F
R	P	O	L	L	U	T	A	N	T	I	N	V	E	N	T	O	R	Y	M
E	A	S	X	P	A	Z	I	V	M	T	Y	X	N	S	L	N	B	R	D
E	R	R	R	H	R	D	R	Z	U	R	C	S	I	U	A	S	O	U	I
N	T	O	E	U	S	I	C	A	I	O	N	R	R	S	B	U	N	C	C
H	I	T	Y	R	E	O	O	E	M	G	E	E	O	T	O	M	M	R	A
O	C	A	R	D	N	X	N	E	O	E	I	H	U	A	C	P	O	E	C
U	L	R	D	I	I	I	D	N	R	N	C	S	L	I	S	T	N	M	I
S	E	E	S	O	C	N	I	E	H	O	I	A	F	N	R	I	O	E	R
E	S	G	E	X	A	S	T	L	C	X	F	W	U	A	E	O	X	N	U
G	L	I	H	I	D	R	I	Y	X	I	F	H	R	B	Z	N	I	E	F
A	E	R	T	D	M	E	O	X	I	D	E	S	A	L	E	I	D	R	L
S	B	F	O	E	I	N	N	G	O	E	W	I	N	E	E	T	E	G	U
E	A	E	L	G	U	W	E	L	E	A	D	D	S	X	R	R	X	Y	S
S	L	R	C	A	M	A	R	U	F	O	S	S	I	L	F	U	E	L	S
E	N	E	Z	N	E	B	G	N	I	M	R	A	W	L	A	B	O	L	G
G	N	I	T	A	R	Y	G	R	E	N	E	W	A	B	L	E	G	Y	N

Find-A-Word – Cutting Down While Powering Up

M	B	C	S	S	R	E	H	S	A	W	S	E	H	T	O	L	C	T	J
G	X	D	F	U	H	R	E	W	Q	N	N	X	E	U	P	C	A	S	F
R	P	O	L	L	U	T	A	N	T	I	N	V	E	N	T	O	R	Y	M
E	A	S	X	P	A	Z	I	V	M	T	Y	X	N	S	L	N	B	R	D
E	R	R	R	H	R	D	R	Z	U	R	C	S	I	U	A	S	O	U	I
N	T	O	E	U	S	I	C	A	I	O	N	R	R	S	B	U	N	C	C
H	I	T	Y	R	E	O	O	E	M	G	E	E	O	T	O	M	M	R	A
O	C	A	R	D	N	X	N	E	O	E	I	H	U	A	C	P	O	E	C
U	L	R	D	I	I	I	D	N	R	N	C	S	L	I	S	T	N	M	I
S	E	E	S	O	C	N	I	E	H	O	I	A	F	N	R	I	O	E	R
E	S	G	E	X	A	S	T	L	C	X	F	W	U	A	E	O	X	N	U
G	L	I	H	I	D	R	I	Y	X	I	F	H	R	B	Z	N	I	E	F
A	E	R	T	D	M	E	O	X	I	D	E	S	A	L	E	I	D	R	L
S	B	F	O	E	I	N	N	G	O	E	W	I	N	E	E	T	E	G	U
E	A	E	L	G	U	W	E	L	E	A	D	D	S	X	R	R	X	Y	S
S	L	R	C	A	M	A	R	U	F	O	S	S	I	L	F	U	E	L	S
E	N	E	Z	N	E	B	G	N	I	M	R	A	W	L	A	B	O	L	G
G	N	I	T	A	R	Y	G	R	E	N	E	W	A	B	L	E	G	Y	N