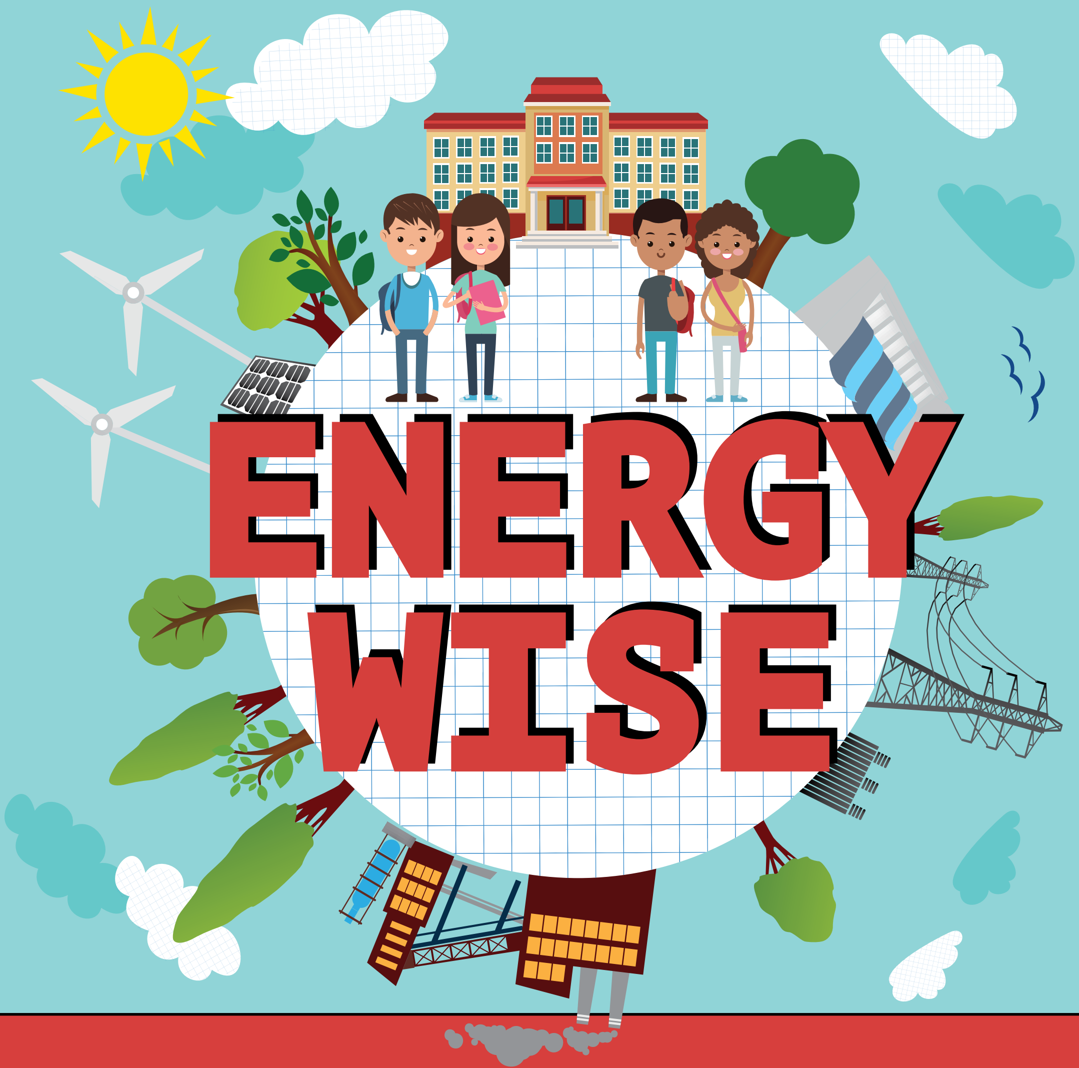


ENERGY WISE

GIVING YOUNG TASMANIANS THE POWER OF KNOWLEDGE

STEM RESOURCE STARTER PACK

YEAR 7-8

Greening Australia

TasNetworks
Delivering your power

CONTENTS

ENERGY WISE

Energy solutions are changing dramatically; globally, and in our homes, schools and vehicles.Our electricity generation and supply is getting smarter and cleaner, bringing more control to electricity consumers.Energy literacy is the understanding of these changes, the nature and role of energy in our lives and how we can use this understanding to better meet our needs.

An energy literate person will have the life skills to make informed energy-use decisions based on their needs, and the costs and environmental impacts. Educating young people to be more energy literate will improve the way they understand and use energy in the long term.

Energy Wise will help students to:

- understand the use of energy in the school
- understand energy production systems and sources of energy in their community
- investigate, plan and communicate changes to energy use and efficiency to improve sustainability

Energy Wise will support teachers and students with the following four focus areas

The resource is primarily designed for Year 7 and 8 but some activities may be relevant for Years 9 and 10.

1

Introduction to Energy Literacy

- Renewable vs non-renewable **(Yr7)**
- What is energy **(Yr7,8)**
- Chemical energy **(Yr7,8)**
- Analyse data on energy use **(Yr8)**
- Investigate how products evolve considering sustainability and social issues in energy use **(yr7,9)**

2

Electricity Networks

- Introduction to the Grid **(Yr7,8,10)**
- Types of Generation Energy Generation and Carbon Emissions **(Yr7)**
- Peak Load **(Yr7,8,10)**
- Network constraints **(Yr10)**
- Conservation of energy, **(line losses) (Yr7,10)**

3

Productivity and Tariffs

- Demand based tariffs **(yr10)**
- Energy Efficiency Energy monitoring **(Yr7,8)**
- Understanding Energy Bills Interpret graphs **(Yr7)**

4

Innovation and Technology

- Design simple engineered solutions to electro mechanical system. Evaluate design ideas.**(Yr7,8,10)**
- Wind Power, Mini hydro, Biodigesters **(Yr7,8,9,10)**
- Battery Technology **(Yr8,10)** Electric Vehicles **(Yr7,10)**

RENEWABLE ENERGY Investigating Energy Literacy

YEAR 7

KEY IDEAS mapped to AC Maths Science and Technology

Renewable vs non-renewable.

- Tasmania: **The renewable energy state?** Global energy
- **How energy efficient is our school? How can we make our school more energy efficient?** Energy monitoring.
- Solutions to contemporary issues
- Energy productivity, The Grid
- Climate change
- Energy usage and energy loss. Summarise data from different sources- (e.g. energy use in the school)
- Design an electro-mechanical system such as a water turbine- Forces

LEARNING OBJECTIVES

Students will:

- Understand that energy can be generated in a variety of ways and some of these ways are renewable
- Understand that forces act on objects and that forces, motion and energy can be used to manipulate electromechanical systems
- Understand the difference between renewable and non-renewable energy and issues related to climate change
- Understand that real world problems can be solved by using technology and that science and mathematics informs the design process
- Calculate the best energy efficient appliances to purchase
- Analyse the impact of design ideas on motion force and energy of an electro mechanical system.

YEAR 8

KEY IDEAS mapped to AC Science and Technology

- **What is energy?** Design a sustainable 'shoe-box' house with a circuit
- Investigate insulation properties
- Energy conservation and transfer

LEARNING OBJECTIVES

Students will:

- Construct a model of a renewable energy system
- Investigate, question, predict and evaluate heat loss and insulation values and communicate their findings
- Investigate energy use in the home.

YEAR 7 and 8 OUTLINE

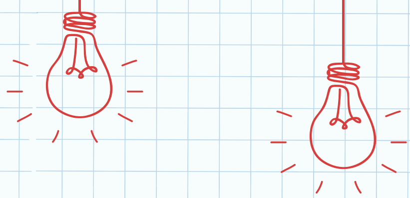
Focus Module	Curriculum links	Elaboration	Overview	Activities	Time
YEAR 7					
7.1 Introduction to energy resources	ACSSU116	What do we know about the Earth's energy resources? Renewable and non-renewable.	Identify individual student understanding.	Energy Surveys.	30 mins
7.2 Understand the difference between renewable and non-renewable energy and issues related to climate change	ACSSU116 ACMSP169 ACMSP171 ACMSP172 ACMSP168	Consider what is meant by 'renewable' in relation to the Earth's resources. Considering timescales for regeneration of resources. Comparing renewable and non-renewable energy sources, including how they are used in a range of situations. Investigate data on climate change collected from secondary sources.	Whole class focus: students brainstorm renewable vs non-renewable energy. Local, national to global perspectives. Climate change-local modeling and predictions in Tasmania.	Collect data on energy sources globally (world energy consumption). Compare Tasmania's level of renewable energy to national and international averages. Research renewable energy in Tasmania. Investigate how engineers in the energy field (i.e. TasNetworks) use their science. Compare pros and cons of different energy sources. Investigate climate change impacts. Canvas Discussion: The Science of Climate Change. Canvas Quizzes. Implications for climate change projections in Tasmania for 2100. Tasmania's Greenhouse Gas Emissions.	120 mins and research

YEAR 7 and 8 OUTLINE continued

Focus Module	Curriculum links	Elaboration	Overview	Activities	Time
YEAR 7					
7.3 Global Energy	ACSIS129 ACSIS130 ACTDEK029 ACSSU116	Compare Tasmania's renewable energy data with national and international averages.	Global vs state energy data.	Research data on renewable energy graph data and draw conclusions. Consider social, ethical and sustainability considerations in development of renewable technologies. Research Tasmania's renewable energy production and how services have evolved. E.g. wind energy, Basslink.	120 mins and research

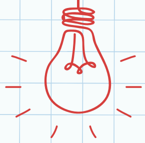
YEAR 7 and 8 OUTLINE continued

Focus Module	Curriculum links	Elaboration	Overview	Activities	Time
YEAR 7					
7.4 Energy productivity: The Grid	ACTDEK031 ACTDEK034 ACTDEP035 ACTDEP036 ACTDEP039 ACSHE120	Generating energy - the Grid. Analyse design solutions selecting and combining characteristics and properties of materials, systems, components, tools and equipment. Explore function of the electricity network and the electricity supply system. Consider cost and design when building, operating and maintaining the towers and how this translates to the network.	Grid Design Challenge. Building model transmission towers. Managing energy generation – circuits - peak loads.	The Grid Design Challenge- Testing transmission towers. Design, build and test towers. Calculate costings.	120 minutes



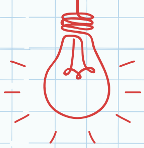
YEAR 7 and 8 OUTLINE continued

Focus Module	Curriculum links	Elaboration	Overview	Activities	Time
YEAR 7					
Energy Productivity Practical investigations	ACMNA280 ACMNA151 ACMNA152 ACMNA153 ACMNA158 ACMSP171 ACMSP172 ACMNA173 ACMNA174	Saving energy. Investigate home and classroom energy use. Calculate short-term school energy use. Analyse school's power consumption as percentages. Calculate best buys on electrical appliances.	The mathematics of heating and lighting. Energy bills. Energy use back in time. Analyse your power bills. Analyse the school's power bills. Sources of energy and how energy can be saved. Stand by energy. Investigate star ratings in relation to appliance costs.	Sample power bills. Identify percentages of use for heating, lighting and total. Audit of school usage. Analyse data on school energy use-interpreting authentic information. Is buying on price alone the best? Design digital monitoring software for energy use.	One term and research



YEAR 7 and 8 OUTLINE continued

Focus Module	Curriculum links	Elaboration	Overview	Activities	Time
YEAR 7					
Introduction to the Home Energy Audit Toolkit	ACMNA151 ACMNA152 ACMNA280 ACMNA153 ACMNA154 ACMNA155 ACMNA156 ACMNA157 ACMSP168 ACMSP171 ACMSP172 ACMNA173 ACMNA174 ACMSP169 ACSIS130	Use of scientific equipment. Compile, construct and compare range of data, using simple ratios. Calculate best buys from first hand investigations using numerical data.	How can we use a Home Energy Audit Toolkit to measure energy use? Units of energy. How can we save energy? Investigate and evaluate energy use in the home/ school. Report upon different household uses of energy. Look for ways to create more efficient energy use in the home/ school.	Investigate energy meter and thermal radiometer. One-hour whole school audit. Survey electrical appliances used at home. Appliance investigation – improving the use and efficiency of appliances. Ranking Appliances. Classroom energy use. Investigate the power use of appliances on 'standby' mode.	120 mins plus home work
Monitoring Energy Use in the School	ACMNA280 ACMSP169 ACSIS131	Energy monitoring in the school.	One-hour Energy Audit.	Data collection and analysis of electricity use in the school.	2 lessons
Transport Energy	ACSHE135 ACSIS145 ACMSP284	The challenge of electric vehicles.	Energy Efficient vehicles.	Comparison between electric and petrol and diesel vehicles. Design for energy efficiency. Barriers for uptake of electric vehicles.	1 lesson



YEAR 7 and 8 OUTLINE continued

Focus Module	Curriculum links	Elaboration	Overview	Activities	Time
YEAR 7					
7.5 Understand that forces act on objects and that forces (motion and energy) can be used to manipulate	ACMNA173 ACSSU117 ACSIS124	What is a force?	How does gravity affect motion? Analyse how motion, force and energy are used to manipulate and control electromechanical systems when designing simple engineered solutions.	Describe the energy forms and changes that occur as water drives a watermill. Draw flowcharts for other energy transfer processes around them (i.e. boiling a kettle, running a car).	90 mins
Forces: Water	ACMNA173 ACSSU117 ACSIS124 ACSIS125 ACSIS126	Students apply their knowledge of water to design a model water-wheel.	Design a water wheel. Include generator to connect turbine to power a light bulb.	Generate and design a water wheel: 1. General sketches. 2. Build a prototype by first sourcing and costing up-cycled materials. 3. Students consider other applications of their design and how this might be useful in a wider context to make a positive impact.	120 mins and research

YEAR 7 and 8 OUTLINE continued

Focus Module	Curriculum links	Elaboration	Overview	Activities	Time
YEAR 8					
8.1. What is energy? Energy can be generated in a variety of ways.	ACSSU155 ACSSU225	What is energy and what are different forms of energy?	Energy survey. Definition of the term energy based on observation of the world.	Energy Survey. Whole class energy focus: student brainstorm	60 mins
8.2 Different types of energy	ACSSU116 ACSSU155	Why we need energy?	Identify different types of energy (potential, kinetic, heat, chemical, stored, mechanical, magnetic). Why humans need energy?	Brainstorm energy ideas. Categorise types of energy. Energy transfer with chemical and physical changes. Bio-carbonate experiment. Lemon Battery.	30 mins
8.3 Construct a model of a renewable energy system. e.g. Build a shoe box house with renewable energy solutions.	ACTDEP035 ACTDEP036 ACTDEP037 ACTDEP038 ACTDEP039 ACTDEK029 ACTDEK031 ACTDEK034	Design a model sustainable building. Circuits. Energy Loss.	Assess an existing house for energy efficiencies. Design an energy efficient model showing energy loss in a system. Design a circuit that illustrates the grid.	Consider passive solar, insulation, thermal mass, site orientation and surface colors. Design a circuit.	2 weeks

YEAR 7 and 8 OUTLINE continued

Focus Module	Curriculum links	Elaboration	Overview	Activities	Time
YEAR 8					
8.4 Insulation Energy loss	ACSIS141 ACTDEP035 ACMSP204 ACMSP284 ACMSP206	Conduction, heat transfer	What is heat? Energy transfer Sun as primary energy source. Convection, conduction, radiation, absorption and reflection as important components of heat.	Investigate heat – ways in which different materials gain and lose heat energy. Investigate various insulating materials. Role of heat in energy transfer and electricity production? Understand conversion of electrical energy to heat and what efficiency losses are. E.g. Incandescent and CFL globes.	1x hour lesson Work-sheet provided

YEAR 7 and 8 OUTLINE continued

Focus Module	Curriculum links	Elaboration	Overview	Activities	Time
YEAR 8					
8.5 Energy Conservation and Energy Transfer	ACSSU155 ACTDEK031 ACTDEK034 ACTDEK029 ACTDEP035 ACTDEP036 ACTDEP037 ACTDEP039 ACSIS148	What is the connection between energy and electricity? How can we represent energy transfer? Connect energy transfer to the production of electricity. Identify and label a system of energy transfer. Understand the law of conservation of energy. Use the specific example of waterpower to explore the connection between energy and electricity. Motion, force and energy affects electromechanical systems.	Conservation of energy. Energy vs electricity. Exploring kinetic energy. Energy transfer. Design processes and production skills.	Design and build a water mill, windmill or a land yacht using everyday items. Develop design ideas from range of materials, tools, equipment and processes to develop design ideas. Create and adapt design ideas. Test, evaluate results and present reflections. Develop criteria for success including sustainability considerations. Communicate to different audiences.	2 weeks

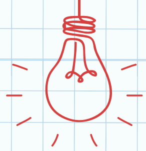
YEAR 7 7.1 Introduction to Energy Resources

WHAT IS ENERGY?

Survey

We buy energy, eat energy lose energy and use energy. This survey is designed to get you thinking about energy. There are no right or wrong answers but ideas to start some discussion.

WHAT TYPES OF RENEWABLE ENERGY ARE THERE? What do you think?		Yes/ true	No/ false	Don't know
1	I am energetic			
2	Food gives you energy			
3	Non-renewable energy use contributes to climate change			
4	There is more solar energy striking the earth's surface in one and a half hours than all worldwide energy consumption in the year from all sources combined			
5	Heating uses half the energy costs in a Tasmanian home			
6	A hot shower costs about 10 cents per minute			
7	Fossil fuels are non-renewable			
8	1 kW/h of electricity costs approximately 27 cents in Tasmanian households			
9	We have photo voltaic solar panels on our school			
10	100% of our electricity comes from renewable energy			
11	Lighting uses a quarter of the energy costs in an average Tasmanian home			
12	We could save energy in our school			
13	Six stars means an appliance is energy efficient			
14	Tasmania is a renewable energy state			
15	Saving energy will reduce greenhouse gases			
16	Electrical items on stand-by use no energy			



7.2 Renewable and non-renewable energy and climate change

ACSSU116 Some of the earth's resources are renewable including water that cycles through the environment, but others are non-renewable.

RENEWABLE AND NON-RENEWABLE ENERGY RESOURCES

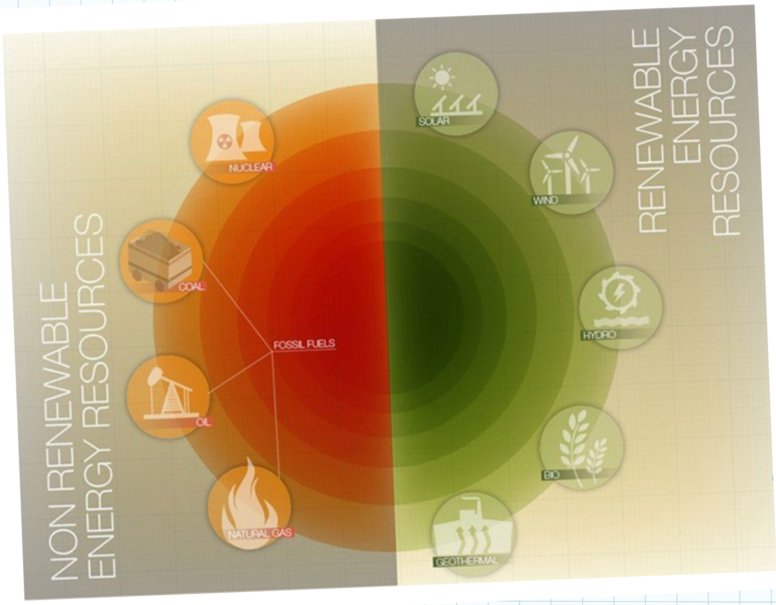
All life on earth is sustained by energy from the sun. Plants and animals can store energy and some of this energy remains with them when they die. The remains of these ancient animals and plants make fossil fuels.

Fossil fuels are non-renewable because they will run out one day. Burning fossil fuels generates green- house gases into the atmosphere. Around 80% of the world's energy comes from fossil fuels, however, the burning of fossil fuels is the biggest source of carbon dioxide emissions in the world today. 95% of our electrical energy in Australia is generated from non-renewable energy resources. Hence there is a need to find more renewable, sustainable ways of generating energy.

Renewable energy resources are sources of power that quickly replenish themselves and can be used again and again. We get renewable energy from the sun, the wind, wave and water power.

Some resources can be thought of as both renewable and non-renewable. Wood can be used for fuel and is renewable if trees are replanted. Biomass, which is material from living things, can be renewable if plants are replanted.

Interview with Jack Gilding from Tasmanian Renewable Energy Alliance (TREA).



Check out Student Energy - Energy Systems map

www.studentenergy.org/map

NON-RENEWABLE AND RENEWABLE ENERGY: COSTS AND BENEFITS

ACSSU116 Some of Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable.

ACSIS130 Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence.

ACTDEK029 Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures.

RENEWABLE ENERGY

Renewable energy is energy that is generated from natural processes that are continuously replenished. This includes sunlight, geothermal heat, wind, tides, water, and various forms of biomass. This energy cannot be exhausted and is constantly renewed. The main forms of renewable energy are listed below.

Solar Energy: Sunlight or solar energy is an enormous resource for generating clean energy.18 sunny days produce the same amount of energy as all our reserves of non- renewable resources of coal, oil and gas. Solar power can be used directly for heating and lighting buildings for generating electricity and for hot water heating. Rooftop solar photovoltaics (PV) convert energy from the sun into electricity. Their effectiveness will depend on roof space and the direction and orientation of the panels towards the sun.

Environmental impacts of solar power can include land use and habitat loss and the use of hazardous materials in the manufacture.

Wind generators: Wind generation is one of the cleanest ways to generate electricity. Wind is abundant in Tasmania and inexhaustible. Wind generators or turbines use the wind to turn a rotor that drives a generator. The most common generator is the horizontal axis turbine with blades like an aircraft propeller and a tail or vane to direct it into the wind. Medium to large wind generators are more suited to non-urban areas as the turbine needs to be mounted on a tower and emits some noise in operation.

There are a variety of other environmental impacts with wind power. TasNetworks, in partnership with the University of Tasmania has been working to mitigate the effects of electricity infrastructure such as lines and wind generators on birds such as the threatened wedge tailed eagle and orange bellied parrots.

They are investigating the following questions:

- **Are there particular landscape traits that increase the exposure of eagles to the hazard of collisions and electrocutions?**
- **How do eagles behave around electrical infrastructure that has been mitigated, compared to infrastructure that has not been mitigated?**
- **Is the risk equal throughout the seasons and are birds of a particular age/sex at more risk?**

Hydro: Water is the most commonly used renewable energy resource in Tasmania which uses the force of flowing water to be captured and turned into electricity. The most common type of hydroelectric power plant uses a dam on a river to store water in a reservoir.

Water released from the reservoir flows through a turbine, spinning it, which in turn activates a generator to produce electricity. Hydropower ensures energy is readily available; engineers can control the flow of water through the turbines to produce electricity on demand. But hydroelectric power does not necessarily require a large dam. Some hydroelectric power plants use a small canal to channel the river water through a turbine.

The environmental impacts of damming rivers can destroy wilderness, wildlife, and other natural resources. The Gordon-below-Franklin Dam project was proposed in 1978, to build a dam to generate hydro-electricity on the Gordon River in South West Tasmania. The Commonwealth Government succeeded in stopping the dam and was later listed as a UNESCO World Heritage Area.

Dams can also pose a strain on the communities around them. The Three Gorges dam on China's Yangtze River displaced an estimated 1.3 million people and flooded thousands of villages.

Micro-hydro generators: A micro-hydro generator is a small scale residential renewable energy source which converts the energy from flowing water to electrical energy. This is popular for houses that only require a small amount of electricity. It provides a reliable source of as it runs continuously 24 hours a day and produces no greenhouse gas emissions.

Biomass: Biomass is renewable organic matter, and can include biological material derived from living, or recently living organisms, such as wood, waste, garbage, and crops that are in plentiful supply.

Wood energy: Wood energy comes from harvested wood and from wood waste products. Waste energy can be generated from municipal waste, manufacturing waste, and landfill gas. Biomass alcohol fuel, or ethanol, comes mostly from corn. Energy from biomass can be expensive to harvest, store and extract.

Biodiesel: Biodiesel is fuel made from plant oils that can be used in diesel engines. They are typically made of renewable organic raw materials such as soybean or rapeseed oils, animal fats, waste vegetable oils or microalgae oils.

Ocean energy: Ocean energy comes from a number of sources including tidal energy, and wave energy which are driven by both the tides and the winds. The sun also warms the surface of the ocean more than the ocean depths, creating a temperature difference that can be used as an energy source. All these forms of ocean energy can be used to produce electricity. Wave power is in the early developmental stages and currently the costs of set up and maintenance are very high. Power farms close to shore can cause conflict with local tourism and local amenities.

Geothermal energy: Geothermal energy comes from accessing heat stored deep within the earth. The temperature of the earth gets warmer with increasing depth. Geothermal energy is reliable and has a low impact on the landscape. However geothermal plants are expensive to build.

NON-RENEWABLE ENERGY

Resources like coal, nuclear, oil, natural gas are available in limited supply. These fossil fuels make up a large part of today's energy market. Carbon is the main element of fossil fuels that formed 360-300 million years ago in the Carboniferous period. Australia has abundant coal and gas which means it is cheap fuel and readily available. Burning fossil fuels releases carbon dioxide, a heat-trapping gas, into the atmosphere, causing the climate to change.

Nuclear Energy: Uranium is a non-renewable scarce metal used by nuclear plants for nuclear fission when atoms are split to release energy. The generation of electricity through nuclear energy emits low amounts of carbon dioxide and reduces the amount of energy generated from fossil fuels (coal and oil). Less use of fossil fuels means lowering greenhouse gas emissions (CO2 and others). However, nuclear waste remains radioactive and hazardous to health for thousands of years. Accidents in nuclear power plants create serious threats to health and well-being. At Fukushima in 2011, an earthquake and tsunami caused a nuclear emergency with a nuclear meltdown and radiation leaks causing 390,000 people to be evacuated.

TASK: Compare renewable and non-renewable energy resources. Identify the pros and cons of the different energy systems and draw conclusions based on productivity, cost effectiveness, environmental and social considerations.

Energy System	Renewable/ Non Renewable	Pro	Con
coal/ oil			
nuclear			
solar			
wind			
hydro			
mini hydro			
biomass			
ocean			
geothermal			
Conclusions:			

TASK: Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures. ACTDEK029

DISCUSS: **How do we create a sustainable energy future that is economically, socially and environmentally responsible and does not compromise future generations?**

CLIMATE CHANGE IN TASMANIA

ACSIS124 Identify problems that can be investigated scientifically and make predictions based on scientific knowledge.

Climate Change is a change in the average pattern of climate over a long time. Greenhouse gases such as vapour, carbon dioxide, methane, nitrous oxide and ozone play an important role in determining climate and causing climate change. Greenhouse gases particularly carbon dioxide, act like an insulating blanket keeping the earth's surface warm. Except for water vapour, the concentrations of all these gases in the atmosphere are being directly influenced by human activities. Scientists predict that the continuing high reliance on fossil fuels will lead to a significantly warmer world.

There is overwhelming scientific evidence that the Earth is warming and that increased concentrations of greenhouse gases caused by human activity is contributing to our changing climate. The need to understand the consequences and impacts of climate change on Tasmania and to enable planning for adaptation and mitigation of climate change at a regional level has been recognised by both the state and federal governments.

Increased temperatures are just one aspect of climate change. Global warming also causes changes to rainfall, wind, evaporation, cloudiness and other climate variables. These changes will not only become apparent in changes to average climate conditions but also in the frequency and intensity of extreme events such as heatwaves, flooding rains or severe frosts.

While climate change is a global phenomenon, its specific impacts at any location will be felt as a change to local weather conditions. This means we need regional research to understand the effects of climate change on specific areas. Climate Futures for Tasmania is one such regional study, producing fine scale climate change projections that will allow for the analysis of climate impacts at different locations within Tasmania, and of changes to seasons and extreme events.

Climate Futures for Tasmania uses climate modelling techniques to describe the most likely climate scenarios on a local scale that will affect us and help us to respond to these changes. Produced by the Antarctic Climate and Ecosystems Cooperative Research Centre it predicts the following climate change impacts for Tasmania.

Over the past fifty years in Tasmania:

- The average temperatures have increased by 0.8-1.0 Celsius.
- Rainfall has declined in most settled areas by up to 20 mm per decade in the North-West and South East.
- Rainfall has increased a little in the South-West.

Climate modelling predicts that annual rainfall in Tasmania will increase by 7-11% in the West and Central areas and will decrease by around 8% in the North-East. Increased rainfall is expected in all areas of Tasmania in winter and early spring. Wind speeds are projected to increase for each season.

Projected change in frost
The incidence of frost is predicted to

DISCUSS: What are the implications of these projections in your area?

Projected change in frost
The incidence of frost is predicted to reduce by about half by the end of the century. For many areas in Tasmania, the period of frost risk is also projected to shorten from March-December to May-October.

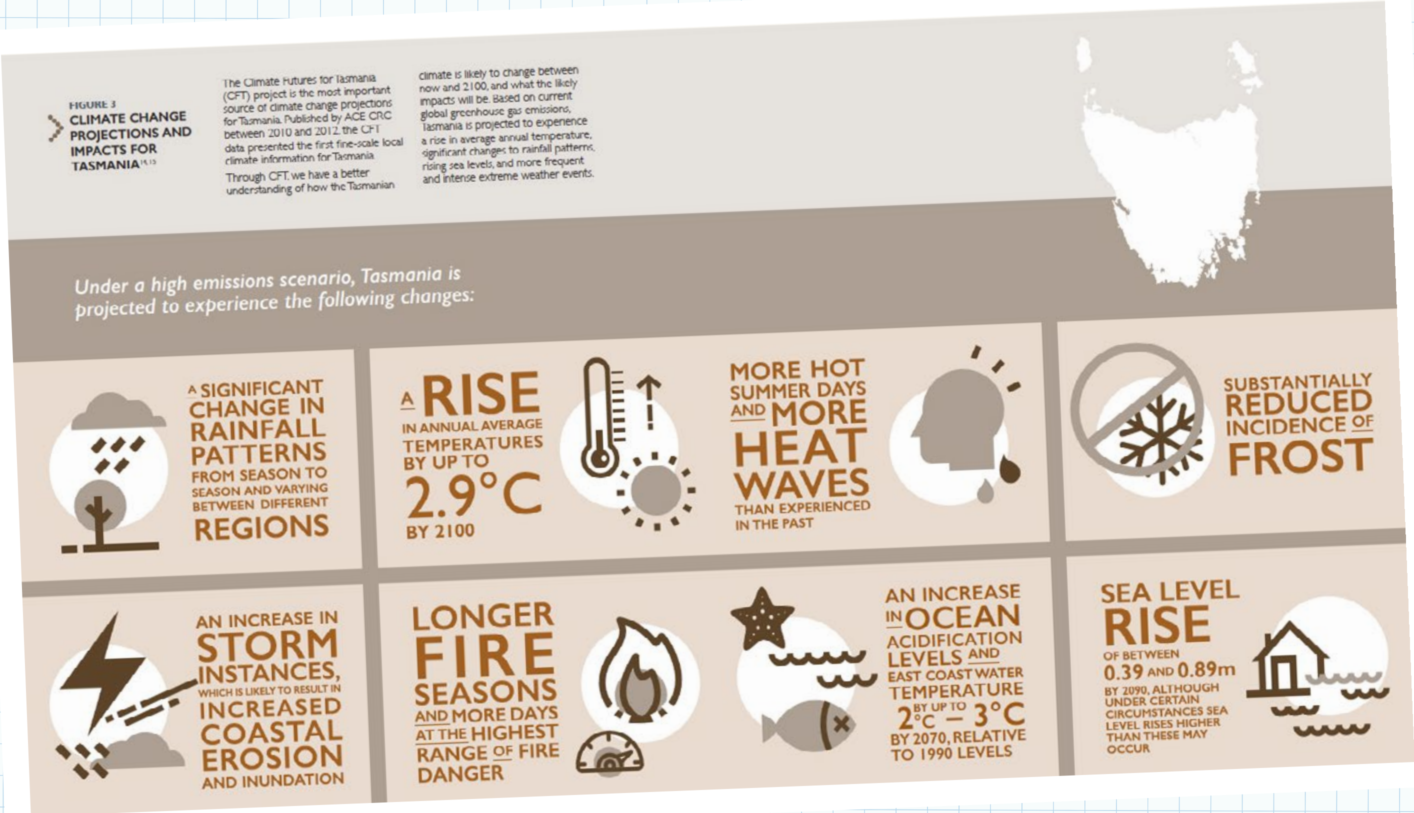
Projected change in run-off
Water runoff is affected by changes to both rainfall and evapo-transpiration. There is projected to be a slight increase in the total amount of runoff in the state by 2100, though there are different responses in different regions.

Extreme events
Increasing energy in the atmosphere resulting from increases in greenhouse gases means that there will be changes to the frequency and severity of extreme events. For example, rainfall intensity is projected to increase across Tasmania. Other predicted extreme events are:

- Droughts - annual rainfall will decrease further in the north-east and increase in the west, with more of the rainfall occurring in winter and spring.
- Warmer weather - annual maximum temperatures will increase across the state. This will bring more days of extreme fire danger and hot weather. Warmer water will lead to changes in fishing, endangering species such as crayfish and kelp forests and introducing warm water pests such as sea urchins. It also will affect plant growth leading to extinction of some species particularly in alpine areas.
- Drier - annual potential evaporation will increase in all area except the west coast. Wind speeds will increase, particularly in winter. This will bring storms and power failures. Sea level rise- between 39 and 89 cm by 2095 with increased storm damage. Explore an interactive map of sea level rise predictions for Australia at www.coastalrisk.com.au

DISCUSS: How will these changes create challenges for Tasmania, such as impacts on our fisheries, energy, the agricultural sector, coastal communities, and our biodiversity? A hotter, drier climate in mainland Australia will lead to increased migration to Tasmania which will create additional challenges.

CLIMATE CHANGE PROJECTIONS FOR TASMANIA



http://www.dpac.tas.gov.au/divisions/climatechange/tasmanias_climate_change_action_plan_20172021/climate_change_in_tasmania

For further research: Climate Futures for Tasmania: General Climate Impacts: local information for local Communities

IMPLICATIONS FOR CLIMATE CHANGE PROJECTIONS IN TASMANIA FOR 2100

If I'm lucky my age will be .... in 2100

- Reduced incidence of frosts
- Less rain over summer
- Increased water temperature
- Rise in annual temperatures up by 2.9 degrees C.
- Sea level rise to 0.89m
- Bigger storms
- More heat waves
- Longer fire seasons
- More rain in winter
- Change in rainfall patterns
- Summer heatwaves and climate change refugees arriving from the mainland
- Increased water run off
- Increased evaporation
- Increased ocean acidification

- Coast erosion and inundation
- Bushfires
- Power failures
- Low levels of Hydro dams leading to power failures
- People dying of heat stress
- Increase in warm water pests such as sea urchins
- Loss of life, houses and property
- Decrease in kelp forests and crayfish
- Threat to stone-fruit industry
- Extinction of plant and animal species
- Floods
- Population pressures - good planning needed for housing traffic
- Stress on agriculture
- Drought
- Forest die back
- Increased ocean temperatures attracting pests like sea urchins
- Erosion

Note: This quiz is interactive on CANVAS: Sustainability: Global Systems - A Tasmanian Perspective

TASK: **Research** and determine the probabilities for particular events. **What are the implications? What can happen when there are multiple impacts?** E.g. On the West Coast with 18% less rain over summer and more rain in winter, this will have implications for the water catchments for Hydro Power.

TASMANIA'S GREENHOUSE GAS EMISSIONS

ACSHE119 Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available.

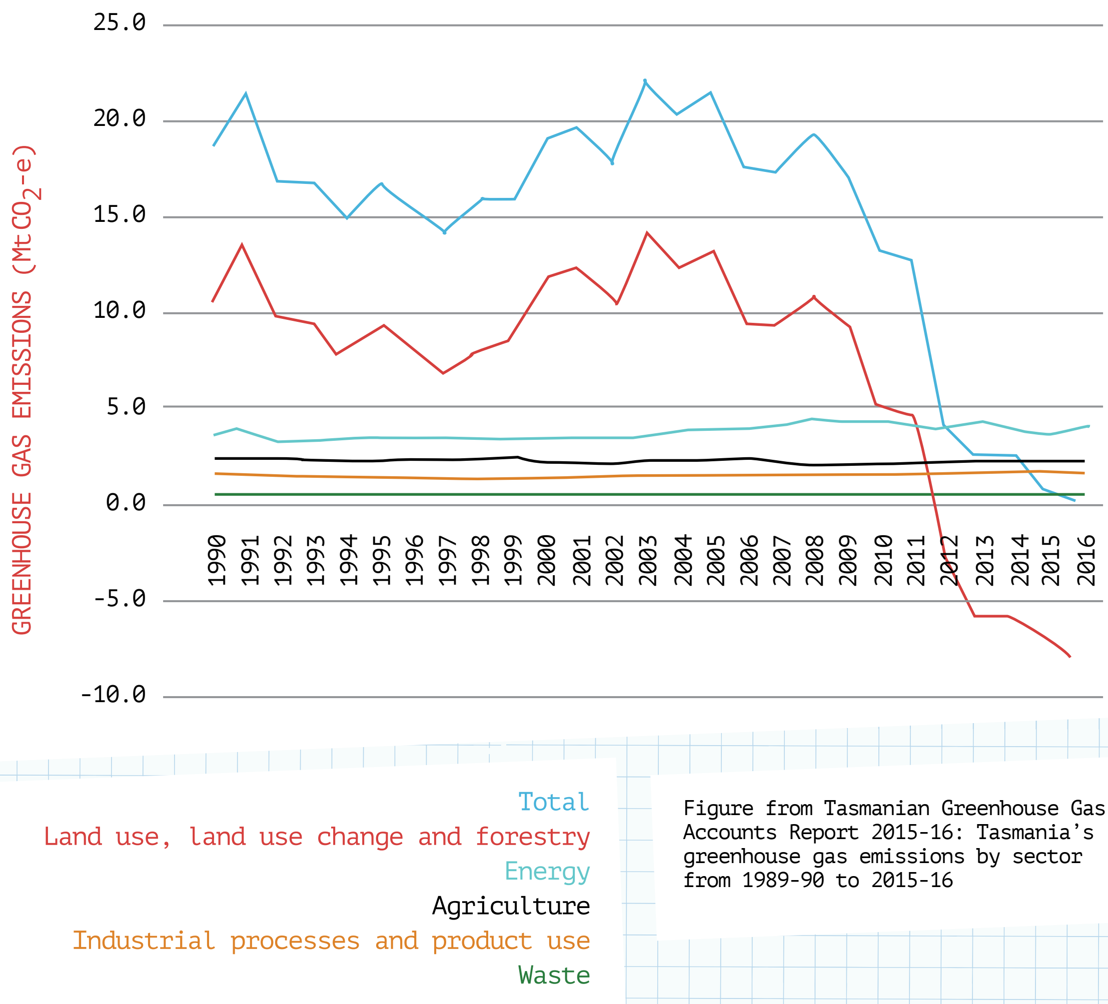


Figure from Tasmanian Greenhouse Gas Accounts Report 2015-16: Tasmania's greenhouse gas emissions by sector from 1989-90 to 2015-16

Tasmania achieved zero net greenhouse gas emissions in 2016, 35 years ahead of the government target. This result is linked to the logging industry downturn and the resulting stored carbon.

TASK: Analyse the graph
Tasmania's Greenhouse Gas Emissions: **What does the graph tell us?**

1. **What does the blue line show?**
   - ◯ Total greenhouse gas emissions from 1990 to 2016
   - ◯ Total greenhouse gas emissions from energy use.
   - ◯ Total greenhouse gas emissions from agriculture.
   - ◯ Total greenhouse gas emissions from waste.
   - ◯ Total greenhouse gas emissions from Industrial processes and products.
   - ◯ Total greenhouse gas emissions from land use, land use change and forestry
2. **What does the red line show?**
   - ◯ Total greenhouse gas emissions from 1990 to 2016
   - ◯ Total greenhouse gas emissions from energy use.
   - ◯ Total greenhouse gas emissions from agriculture.
   - ◯ Total greenhouse gas emissions from waste.
   - ◯ Total greenhouse gas emissions from Industrial processes and products.
   - ◯ Total greenhouse gas emissions from land use, land use change and forestry.
3. **What does the purple line show?**
   - ◯ Total greenhouse gas emissions from 1990 to 2016
   - ◯ Total greenhouse gas emissions from energy use.
   - ◯ Total greenhouse gas emissions from agriculture.
   - ◯ Total greenhouse gas emissions from waste.
   - ◯ Total greenhouse gas emissions from Industrial processes and products.
   - ◯ Total greenhouse gas emissions from land use, land use change and forestry.
4. **Describe the total emissions from Energy, Agriculture, Waste and Industrial Processes between 1990 and 2016.**
   - ◯ They stay at about the same level between 1990 and 2016.
   - ◯ They fall rapidly in 2011.
   - ◯ They steadily increase over time.
   - ◯ They are greater than 25 mega-tonnes per year.
5. **Why does the blue line drop rapidly in 2012?**
   - ◯ Reduced emissions from forestry activities.
   - ◯ Reduced emissions from energy emissions.
   - ◯ Reduced emissions from energy emissions.
   - ◯ Reduced emissions industrial processes.
6. **Why do you think the red line drops below zero in 2011?**
   - ◯ Reduced forestry activity means fewer trees are removed and this has increased the storage of carbon dioxide in forests.
   - ◯ Emissions from energy, agriculture and waste all increased at this time and forestry emissions compensated for this.
   - ◯ Total emissions went down and this was reflected in the forestry emissions.
   - ◯ Greenhouse gasses increased and this made the trees grow faster and store more carbon dioxide.

Note: An interactive quiz is available on Canvas Commons- Tasmanian Greenhouse Gas Emissions Graph.

Explore this interactive pie chart of Tasmanian Greenhouse Gas Emissions by sector from 2011 to 2015.

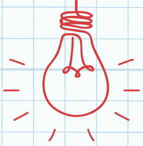
THE SCIENCE OF CLIMATE CHANGE

ACSIS124 Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge.

ACSIS133 Communicate ideas, findings, and evidence-based solutions to problems using scientific language and representations using digital technologies as appropriate.

“The Australian Academy of Science provides independent, authoritative and influential scientific advice, promotes international scientific engagement, builds public awareness and understanding of science, and champions excellence in Australian science.”

Australian Academy of Science August 2010,
https://www.science.org.au



TASK: Assign students into groups to randomly select and discuss one of the following statements from the Australian Academy of Science. Have students read out these statements from the scientists and discuss what it means and how this will affect their lives in the next ten years. Groups feedback to the class.

1	Climate change is a change in the statistical properties of the climate system that persists for several decades or longer—usually at least 30 years. These statistical properties include averages, variability and extremes. Climate change may be due to natural processes, such as changes in the Sun's radiation, volcanoes or internal variability in the climate system, or due to human influences such as changes in the composition of the atmosphere or land use. Greenhouse gases act like an insulating blanket warming the earth's surface. Ocean temperatures around Australia will be 1 degree warmer in 2030 than in 1910. A two-degree temperature rise could mean more heat waves, fewer cold spells, changes to rainfall, changes in ecosystems and biodiversity, rising sea levels and less Arctic ice cover.
2	Greenhouse gas emissions from humans are the main cause of global warming. The main greenhouse gas causing this warming is carbon dioxide which comes from the burning of fossil fuels such as petrol and coal. Carbon dioxide is being added to the atmosphere faster than it can be removed by plants or absorbed into the ocean.
3	The clearest present-day impacts of climate change in Australia and elsewhere are seen in the natural environment and are associated with warming temperatures and increases in the number, duration and severity of heatwaves. Because a warmer atmosphere contains more moisture, rainfall extremes are expected to become more frequent and intense as global average temperatures increase.
4	These impacts of climate change include changes in the growth and distribution of plants, animals and insects; poleward shifts in the distribution of marine species; and increases in coral bleaching on the Great Barrier Reef. Some of these changes can directly affect human activities; for example, through the effects of changing distributions of fish and other marine organisms on commercial and recreational fisheries, and the impacts of coral bleaching on tourism.
5	The average surface temperature of the Earth has increased over the last century. Climate models predict that by 2100 the average global temperature will rise by more than 2 degrees C (from 1900). Reduction of greenhouse gas emissions could significantly reduce long term warming.
6	Rising average sea levels mean that extreme sea levels of a particular height are exceeded more often during storm surges. For the east and west coasts of Australia, this happened three times more often in the second half compared to the first half of the 20th century. This effect will continue with more than a ten-fold increase in the frequency of extreme sea levels by 2100 at many locations and a much-increased risk of coastal flooding and erosion.

CLIMATE CHANGE: MANAGING THE RISKS

ACSHE121 Solutions to contemporary issues that are found using science and technology may impact on other areas of society and may involve ethical considerations.

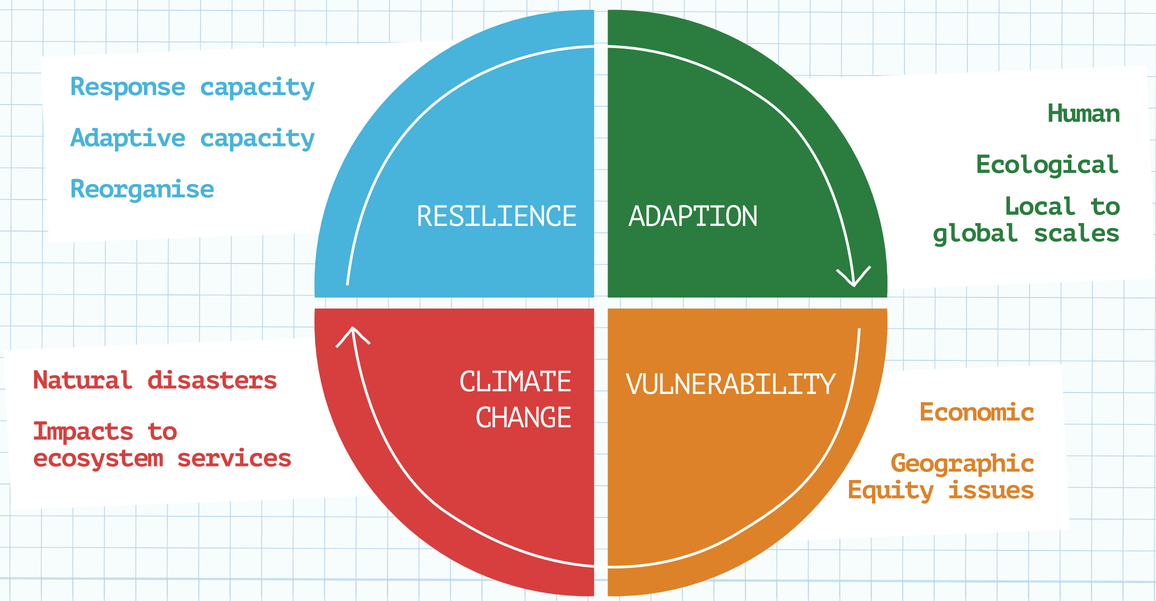
ACSHE119 Scientific knowledge has changes people's understanding of the world and is refined as new evidence becomes available.

According to the Australian Academy of Science (https://www.science.org.au) "managing the risks from future human-induced climate change will be based on some combination of four broad strategies:

- **Emissions reduction:** reducing climate change by reducing greenhouse gas emissions.
- **Sequestration:** removing carbon dioxide (CO2) from the atmosphere into permanent geological, biological or oceanic reservoirs.
- **Adaptation:** responding to and coping with climate change as it occurs, in either a planned or unplanned way.
- **Solar geoengineering:** large-scale engineered modifications to limit the amount of sunlight reaching the earth, in an attempt to offset the effects of ongoing greenhouse gas emissions.

Each involves a range of specific options, with associated risks, costs and benefits. The four strategies can affect each other: for example, doing nothing to reduce emissions would require increased expenditure to adapt to climate change, and increased chances of future resorting to geoengineering".

DISCUSS: - the following resilience model.



TASK: Manage the Risks of Climate Change. Cut up the boxes of the table below and shuffle the cards. Allocate cards for students to match the strategies to the examples, risks, costs and benefits.

Make up another table of strategies with blank boxes for examples, risks costs and benefits. Students provide examples and discuss.

MANAGING THE RISKS OF CLIMATE CHANGE				
Strategies	**Example**	**Risks**	**Costs**	**Benefits**
Emissions reduction: reducing climate change by reducing greenhouse gas emissions.	Converting to renewable energy such as solar panels	Not always enough sun.	Much more expensive to produce solar panels than coal or gas.	Supports technology, reduces emissions.
Sequestration: removing carbon dioxide (CO2) from the atmosphere into permanent geological, biological or oceanic reservoirs. Eg mangroves, seagrass beds and salt marshes are significant carbon sinks.	Protecting forests Ecosystem restoration of coastal areas	Fire, disease, changes in land use. Coastal strip is a small area.	Loss of farmlands could reduce farm productivity. Reduces urban development.	Enhance wildlife habitat and water quality Enhance wildlife habitat and water quality
Adaptation: responding to and coping with climate change as it occurs, in either a planned or unplanned way.	Covering glaciers and ski fields with blankets to reduce melting Building sea walls.	Small scale so may have limited impact. Vulnerable to storm surges. How high to build?	High costs. High costs of maintenance.	Protecting urban areas from flooding. Reducing coastal erosion.
Solar geoengineering: large-scale engineered modifications to limit the amount of sunlight reaching the earth, in an attempt to offset the effects of ongoing greenhouse gas emissions.	Reflect sunlight away from the earth solar engineering by sending giant sun shade into orbit.	Sharp temperature change could impact wildlife and agriculture.	Very expensive. Huge technological challenge: Needs considerable research.	Stemming permafrost melt, reducing energy-sector emissions.

https://www.science.org.au/learning/general-audience/science-booklets-0/science-climate-change/9-what-does-science-say-about

7.3 Global Energy

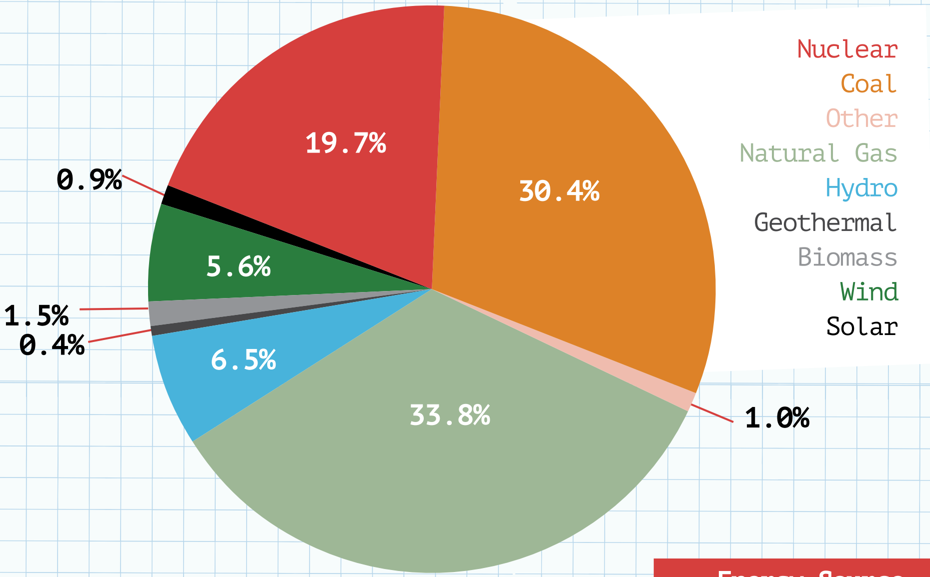
ACMNA180 Investigate, interpret and analyse graphs from authentic data.

ACMSP169 Identify and investigate issues involving numerical data.

TASK: Investigate the World Energy Consumption by renewable and non-renewable power sources in 2016 and compare with national and local data.

CONSUMPTION FOR ELECTRICITY GENERATION BY ENERGY SOURCE:2016

(Energy Information Administration, FAQ)



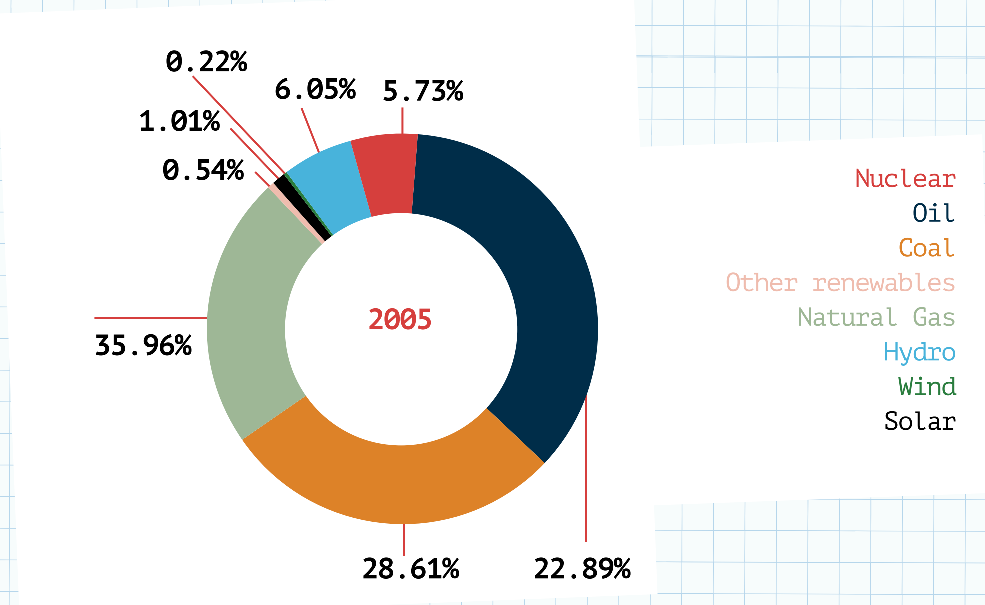
Energy Source	Percentage
Coal	30.4%
Nuclear	19.7%
Natural Gas	33.8%
Hydro	6.5%
Wind	5.6%
Biomass	1.5%
Geothermal	0.4%
Solar	0.9%
Other	1.0%

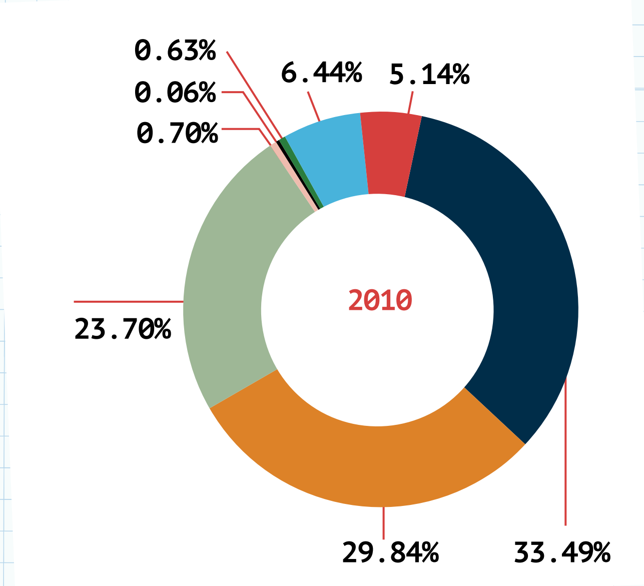
Credit: Energy Information Administration, FAQ

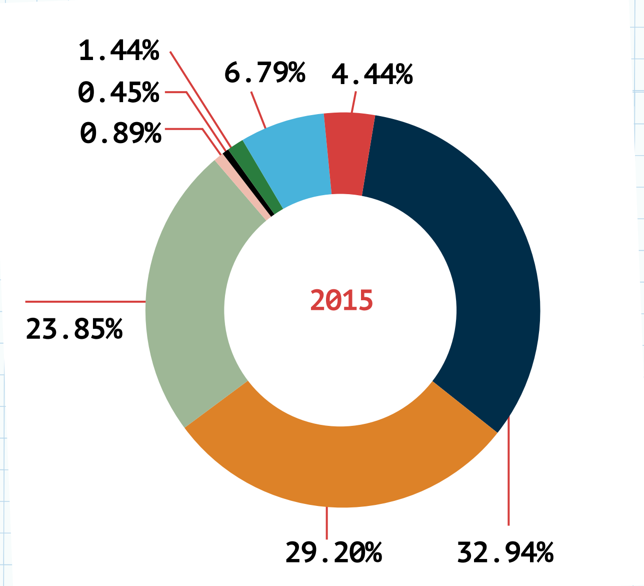
https://www.e-education.psu.edu/egee401/content/p7_p2.html

In 2016 the total world energy consumption came from 64% fossil fuels, 20% nuclear and 17% renewable (hydro, wind, solar, geothermal and biofuels). Discuss these differences in the percentages of the pie chart.

What percentages of the Global Power Source are from renewable and non-renewable sources? Why are the percentages of renewable so high and non-renewables so low? Draw a pie chart of your predictions for a graph of electricity generation in 2050.

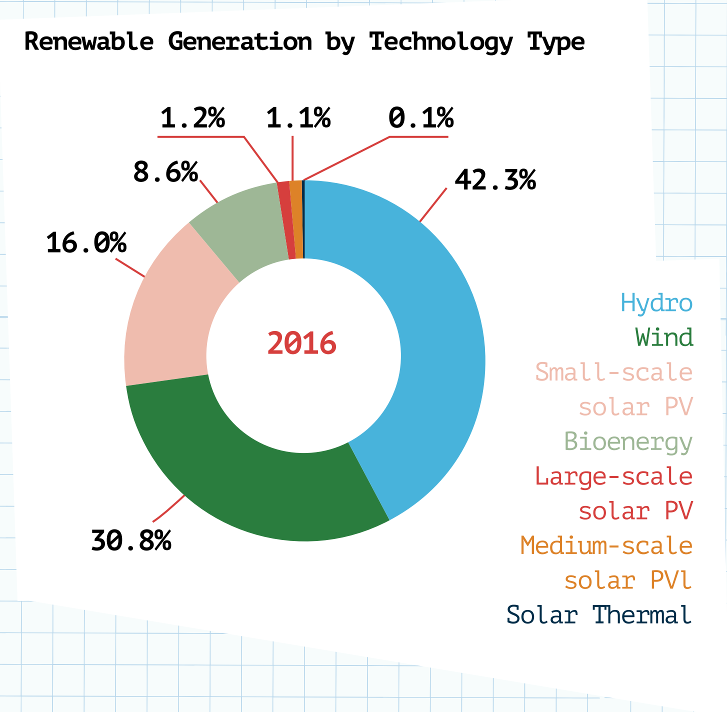


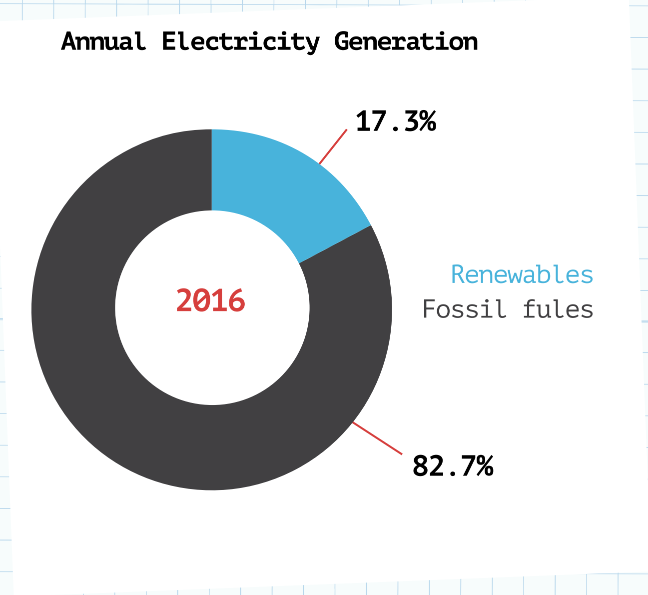


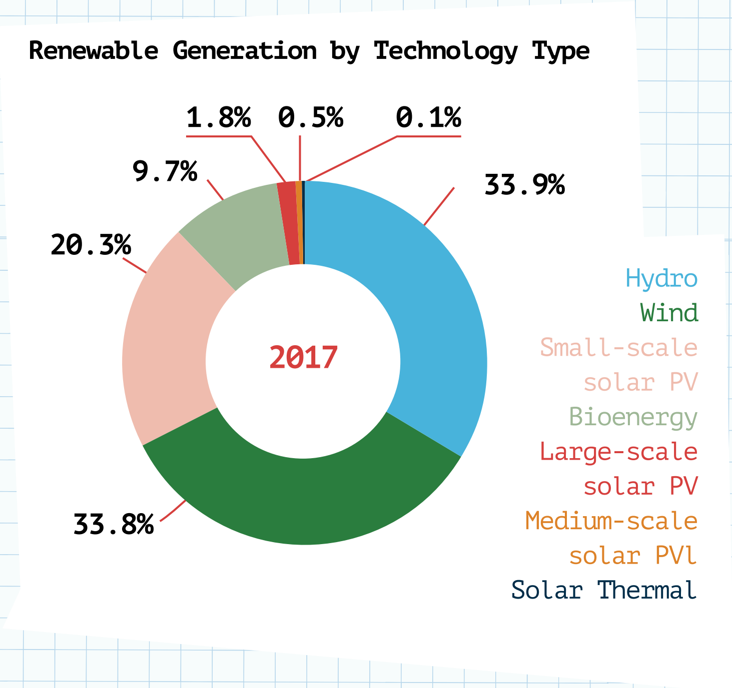


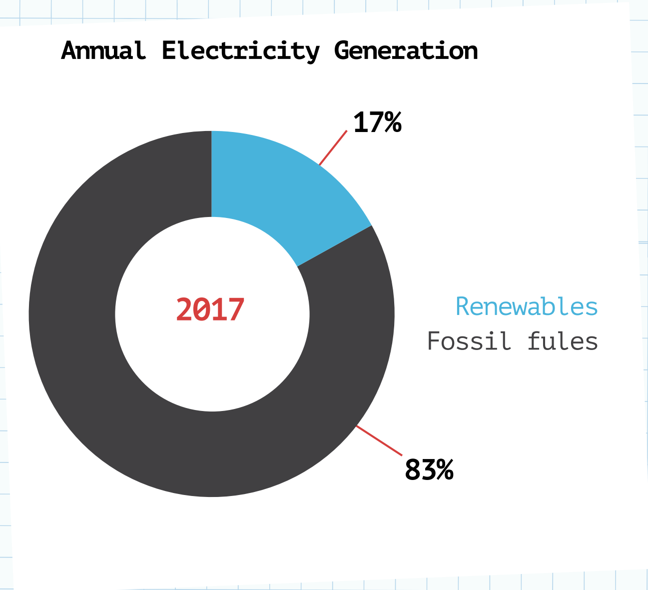
Comparative Global Energy Consumption from 2015-2015
https://www.worldenergy.org/wp-content/uploads/2016/10/World-Energy-Resources-Full-report-2016.10.03.pdf

AUSTRALIAN CLEAN ENERGY 2016-2017





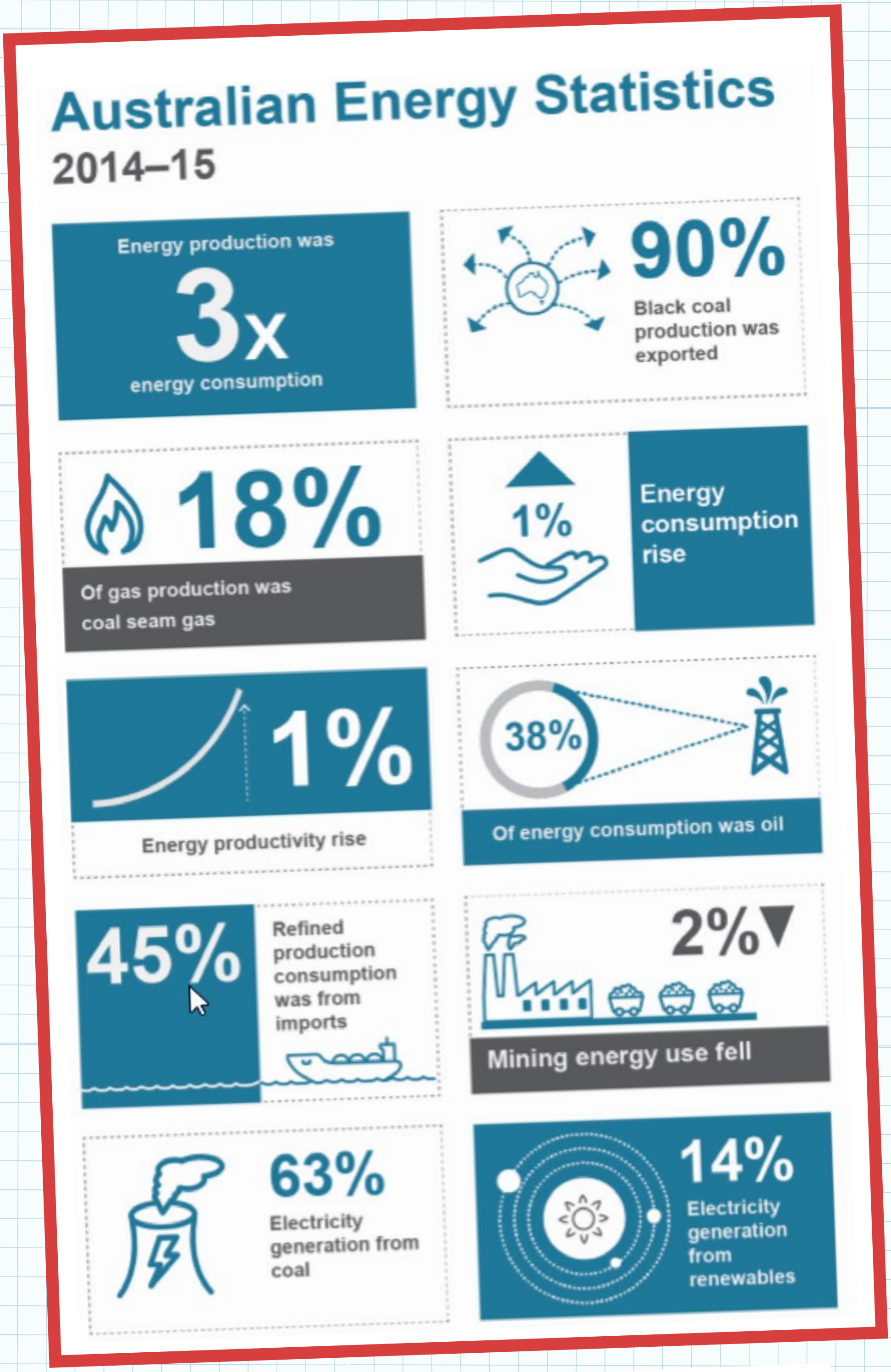




https://www.cleanenergycouncil.org.au/policy-advocacy/reports/clean-energy-australia-report.html

TASK: Investigate and analyse these pie charts. **What are the main differences in between the global and Australian percentages? What is surprising?**

Research and create a similar pie graph for Tasmania.



https://industry.gov.au/Office-of-the-Chief-Economist/Publications/Documents/aes/2016-australian-energy-statistics.pdf

TASK: Identify and investigate issues from this numerical data. ACMSP169

What does this info graphic tell about oil and gas consumption? Energy production was 3x consumption because of Australia's black coal exports. Investigate these statistics. Summarise this data and use scientific understanding to identify relationships and draw conclusions based on evidence. ACSIS130

Percentage of electricity generation from renewables in Australian states in 2016.

TAS	SA	VIC	WA	NSW	QLD
95%	40%	10%	13%	6%	7%

Source: https://www.cleanenergycouncil.org.au

TASK: Convert these percentages as fractions. ACMNA157

Tasmania has a goal to be self-sufficient in renewables by 2022. Currently 95% of the power Tasmania uses is renewable, predominantly from hydro-generated electricity.

TASK: Research the kinds of renewable energy Tasmania produces.

Investigate why Tasmania is an optimal location for renewable energy?

Compare and analyse Tasmania's level of renewable energy with national and international averages. ACSIS130

https://reneweconomy.com.au/nem-watch

Investigates the live supply and demand analysis of the different energy sources of the Australian Energy Grid at the present time.

This is graph generated from live data which will change day to day in 5 minute intervals.

It shows Megawatt production of electricity in each Australian state. Energy sources are shown in different colours.

1. Compare production of electricity in Tasmania with one other state. What do you notice about sources of renewable and non-renewable energy production?
2. Record the NEM date, time and MegaWatt demand and production in Tasmania for each energy source. (Hydro, wind and small solar).
3. Repeat this 3 times at different times in the day and record the data in a table.
4. Why do you think there are changes in energy production and demand in Tasmania at different times of the day?

The free Pocket NEM App shows live data on imports and exports of Tasmanian Energy.

For an overview on energy sources: Energy Systems map

https://www.studentenergy.org/map.

INVESTIGATE: - countries with 100% renewable energy. Consider the social ethical and sustainability considerations in the development of the technology. E.g. Costa Rica, Iceland, Albania, Paraguay, Bhutan and Paraguay are promoted as being 100% renewable. What about Germany, Denmark and Spain? ACTDEK029

- products that have evolved locally through the creativity, innovation and enterprise of individuals and groups. For example local engineer, Ross Heather, has developed a solar tracker in his back yard to maximise the solar capacity of his panels.

- how services have evolved in Tasmania. The TasNetworks Bruny Island Battery Trial is researching how batteries can be used by householders to manage their energy while simultaneously being used to feed in and help manage the network. ACTDEK029

- how engineers and innovators use their science understanding and how this has influenced the renewable energy initiatives in Tasmania.E.g. Biofuels in Tasmania.

Electricity cannot displace petrol and diesel used in heavy transport, in many industrial processes, and in the manufacturing of many products and agricultural activities in Tasmania. Innovative farmers such as Midlands whisky distiller Peter Bignell have developed biodiesel refining to power machinery. A boutique vineyard in Tasmania's Huon Valley is using a small-scale, mobile biodiesel refiner to power the machinery needed to harvest the grapes. Local food and hospitality businesses deliver about 200 litres of used vegetable oils to storage vessels at the vineyard each week, with an average biodiesel output of 200 litres. When running continuously at full capacity, the mobile refiner can produce 100 litres per hour or up to one million litres each year. When used as a substitute for petroleum-based fuels, this amount of biodiesel can reduce annual greenhouse gas emissions by up to 1,200 tonnes.

https://epa.tas.gov.au/news-site/Pages/Uncorking-the-Power-of-Biodiesel.aspx

ACSSU116

- how have people in developing countries solved energy challenges? Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available.
ACSHE119

Decentralised renewable sources of energy include mini- hydro, small wind, biogas and solar hot water heating. Check out Litre of Light which began in the Philippines developing a solar-powered light that is cheap and easy to assemble and whose main feature began with a plastic bottle and bleach. The 'almost no-cost solution' has improved the quality of life of poor families in developing countries with no access

- how engineers and innovators use their science understanding and how this has influenced the renewable energy initiatives in Tasmania.E.g. Biofuels in Tasmania.

Do it yourself by building a Solar Bottle Bulb
www.instructables.com/id/How-to-build-a-SOLAR-BOTTLE-BULB

WHOLE CLASS ACTIVITY: Measure light output with a light meter. Discuss the implications of this simple invention on communities with no electricity.

7.4 Energy productivity: the Grid

ACSSU155 Energy appears in different forms including movement, (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems.

Where Our Energy Comes From: The Grid
Electricity networks transfer energy to our cities and our homes via an electrical grid. The "Grid" is the electrical transmission and distribution network from power stations to consumers across Australia. The Australian electricity grid servicing eastern and southern states, called the National Electricity Market (NEM) is the largest interconnected power system in the world, spanning 4500 km. The 209 km transmission line across Bass Strait is one of the longest submarine cables in the world. The Basslink cable supplies some of the peak load capacity to Australia's eastern regions using Hydro Tasmania's renewable energy.

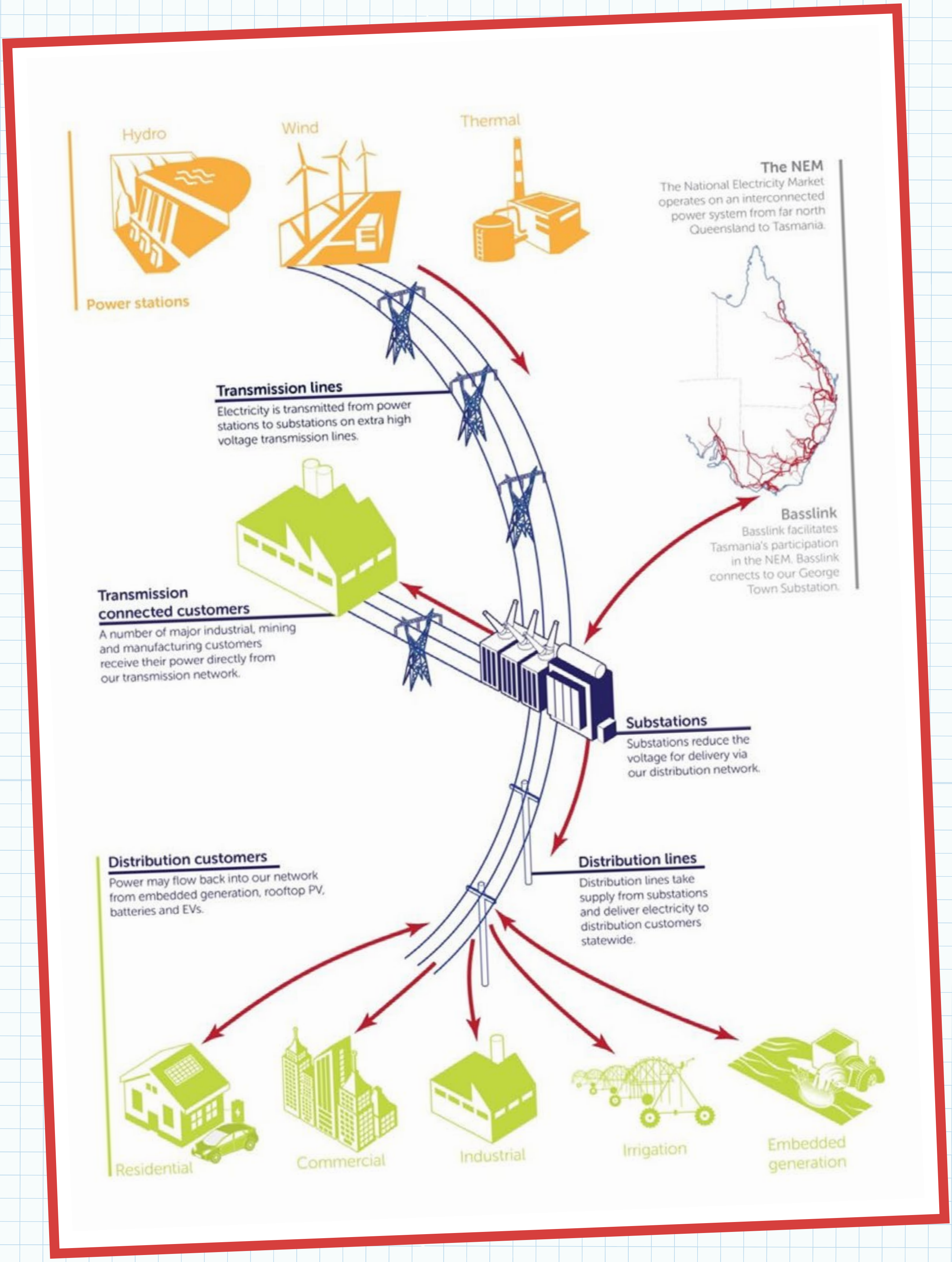
The Grid consists of generators, a transmission and distribution network of poles and wires and energy retailers. In Tasmania generation is supplied by Hydro Tasmania and predominately comes from hydroelectric power stations. These power stations utilise the renewable energy of water to generate electricity. The transmission network utilises very high voltages (up to 220,000 volts in Tasmania) to move the electricity large distances from remote power stations to where it is needed. The high voltages help to minimise the amount of power lost. Once closer to the end consumer the electricity enters the distribution network. In the distribution network voltages are kept lower as the distances the electricity has to travel is shorter. Voltages in the distribution network range from 33,000 volts for lines carrying electricity further down to the 240 volts found in most homes. TasNetworks operates and maintains both the transmission and distribution networks within Tasmania.

TASK: Investigate where our electricity supply comes from. Explain and sketch the energy chain, the transformations that take place in the production of energy from the power station to the home or school.

In 2015-2016 Tasmania had an energy crisis. The severing of the Basslink undersea cable together with an ongoing drought meant that Hydro Tasmania had to access 80 diesel generators to maintain Tasmania's power security. The cost of the generators was $40 million up-front and $11 million per month to run.

WHOLE CLASS ACTIVITY: Investigate the ethical considerations of this issue on our energy security.

1. Watch the 8-minute video Diesel Coffee.
2. Discuss the reasons for the energy crisis. **Why did it happen?**
3. Record the different opinions relating to the solution to the issue.
4. **What is our greatest greenhouse-gas emitter in Tasmania?**
5. **What will support Tasmania's energy security in the future?** Describe innovations such as micro- hydro and electric vehicles and the limitations to these for our energy.



Hydro
Wind
Thermal
Power stations
The NEM
The National Electricity Market operates on an interconnected power system from far north Queensland to Tasmania.
Transmission lines
Electricity is transmitted from power stations to substations on extra high voltage transmission lines.
Basslink
Basslink facilitates Tasmania's participation in the NEM. Basslink connects to our George Town Substation.
Transmission connected customers
A number of major industrial, mining and manufacturing customers receive their power directly from our transmission network.
Substations
Substations reduce the voltage for delivery via our distribution network.
Distribution customers
Power may flow back into our network from embedded generation, rooftop PV, batteries and EVs.
Distribution lines
Distribution lines take supply from substations and deliver electricity to distribution customers statewide.
Residential
Commercial
Industrial
Irrigation
Embedded generation

THE GRID DESIGN CHALLENGE: SPAGHETTI AND MARSHMALLOW TRANSMISSION TOWERS

Developed by the TasNetworks Graduate

Aim to develop student understanding of key concepts; the purpose and function of the electricity network, the electricity supply system (generators, the network and customers) and how we need to consider both cost and design when it comes to building, operating and maintaining the network.

Design and technologies

ACTDEK031 Analyse how motion, force and energy are used to manipulate and control electromechanical systems when designing simple, engineered solutions.

ACTDEK034 Analyse ways to produce designed solutions through selecting and combining characteristics and properties of materials, systems, components, tools and equipment.

Design and technologies, processes and production skills

ACTDEP035 Critique needs or opportunities for designing, and investigate materials, components, tools, equipment and processes to achieve intended designed solutions.

ACTDEP036 Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation.

ACTDEP039 Use project management processes when working individually and collaboratively to coordinate production of designed solutions.

Introduce Design Challenge
Background on Transmission Network

How does power get to your home and school?
(Spaghetti Tower Challenge Powerpoint)

Consider basic principles of tower building.

Build stable towers – e.g. strength of triangles and considering other factors such as the weight of materials, reinforcement and tension/compression.

TASK: Design and construct a model of a transmission tower using the least amount of resources while remaining standing for a period of time.

Teams of three or four students design a transmission tower from a set budget of materials (Appendix A). Consider design strength and cost. Include design constraints (Appendix B). Material properties will be a key focus, identifying the strengths and limitations of the spaghetti and marshmallows. Students consider where the tower is most likely to fail.

Building the Towers

Build team designs and redesign in response to any issues in the building process. Reflect on original predictions. Track the cost of the materials used (see Table 1).

Table 1 - TOWER COST AND TEAM RANKINGS

Team name	Initial cost of materials provided	Value of materials not used	Value of additional materials used	Total cost of structure	Time standing before critical failure	Score (rank for cost + rank for time standing)
Team A						
Team B						
Team C						
Team D						

Testing the Towers
Testing is achieved by attaching string "conductors" to the tower that spans from 'testing rigs' on either side. Chairs could be used as the testing rigs to hold up the conductors at each end. Load the lines with weights to determine if the tower can support the weighted conductors. If teams successfully complete the loading tests, then they can choose to continue adding more weight until the tower fails. As each tower fails compare the predicted failure with how the tower actually fails.

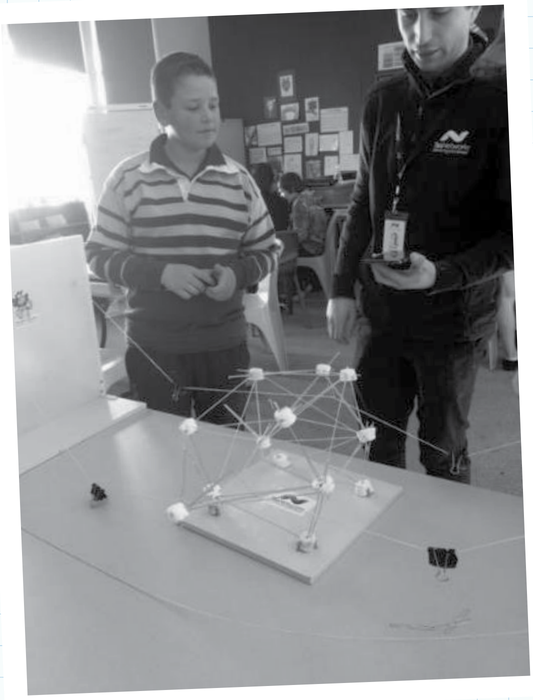
Evaluate: Student teams communicate ideas, findings and solutions.

Reflection:

- What are the engineering considerations that needed to be taken into account when building a tower?
- What are some of the challenges TasNetworks may face in delivering power successfully?
- What skills do you think made your team successful?
- What would you do differently next time?
- What do you think you could do to improve the design challenge?

Resources: Each group will be given:

- 50 pieces of spaghetti ($75)
- 12 marshmallows ($36)
- one base (with eight pins)
- Lengths of string (conductors)
- two conductor connections (bull dog clips) to attach weights to
- Weights to test tower strength/stability
- Testing rig: something to anchor the conductor (string) - such as an upturned chair



Design constraints: The teams will be given the following constraints:

- the conductors must connect inside a specific window (see attached template)
- each conductor must connect with only one paper clip
- the paper clips can connect to the tower in any way
- the tower must fit within the base footprint

Design phase: The teams will have 10 minutes to design the towers. They should be prompted to:

- identify the strengths and weaknesses of the materials
- design a basic tower and an inventive tower
- chose a design
- estimate material needs
- identify possible points of failure

Extra questions:

- Material Properties
  - **What is the best way to transfer load through the spaghetti?**
  - **Would heat or moisture improve or reduce the properties of the materials?**
  - **Do you need whole marshmallows?**
- **What would happen if it failed at their expected point of failure?**
- **How could you reduce the cost?**

Building: Using the materials given each team must build their towers.

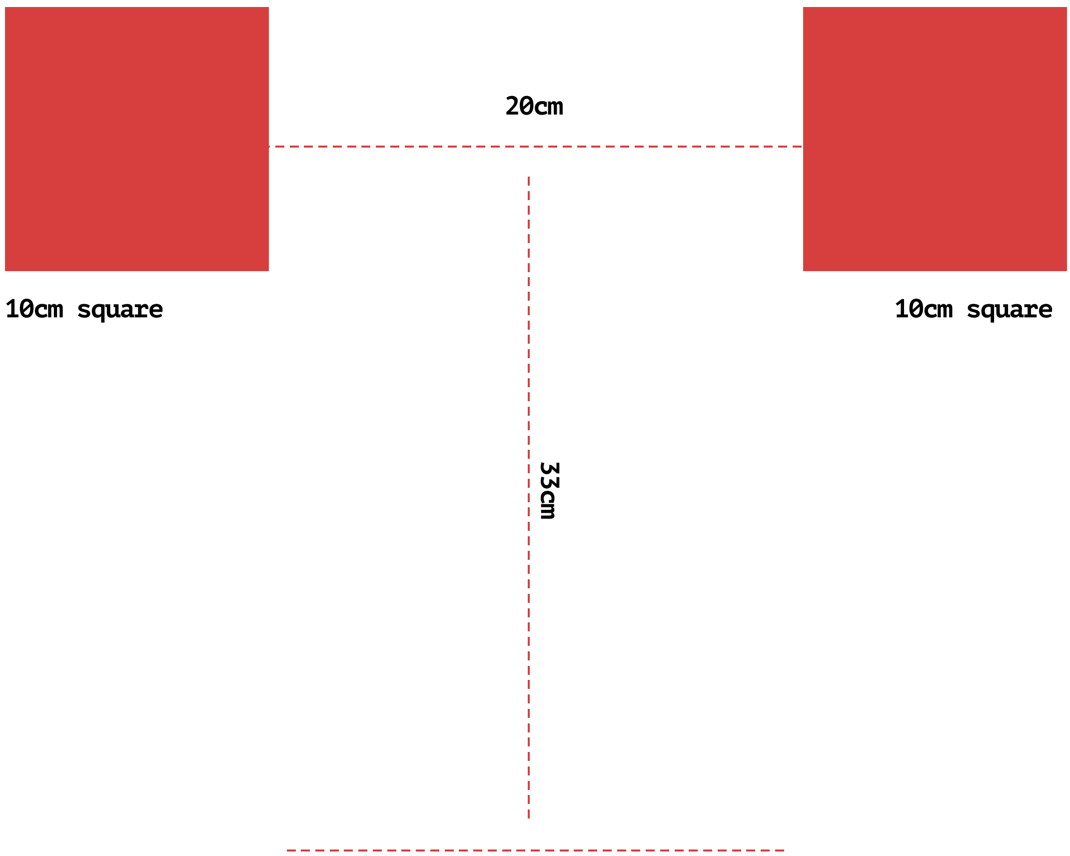
If they don't use some of their spaghetti or marshmallows they will save:

- $100 per spaghetti
- $200 per marshmallow

If they need extra they will be charged:

- $200 per spaghetti
- $400 per marshmallow

Appendix B - Design Constraints:
The towers can be any shape or design, but the conductors MUST pass through the area inside the bounding boxes. The ideal conductor height is 33 cm with a separation of 33 cm.



ENERGY PRODUCTIVITY: SAVING ENERGY

The main source of energy we use in the home and school is electricity. Through investigating productivity we come to understand the impact that our use of this energy has on resources and climate. What are the issues with using too much energy and why is this important to understand?

ENERGY COSTING SURVEY

A student survey to explore understanding of electricity costings.
Circle your answers

Approximately how much does electricity cost per kW hour to a household?

1c | 13c | 27c | 40c | $1

To run a 2 kW fan heater on high for one hour costs approximately

1c | 10c | 25c | 50c | $1

What is the average cost of a 3 minute shower?

1c | 10c | 20c | 30c | $1

What is a comfortable winter temperature for a classroom?

14°C | 18°C | 22°C | 26°C | 30°C

The percentage cost of hot water in a Tasmanian home is?

10% | 30% | 50% | 70% | 80%

Why should we not waste energy? Tick which ones you think

Save money | Slow down climate change | Improve air quality | Reduce greenhouse gasses | All of these

THE MATHEMATICS OF HEATING AND LIGHTING

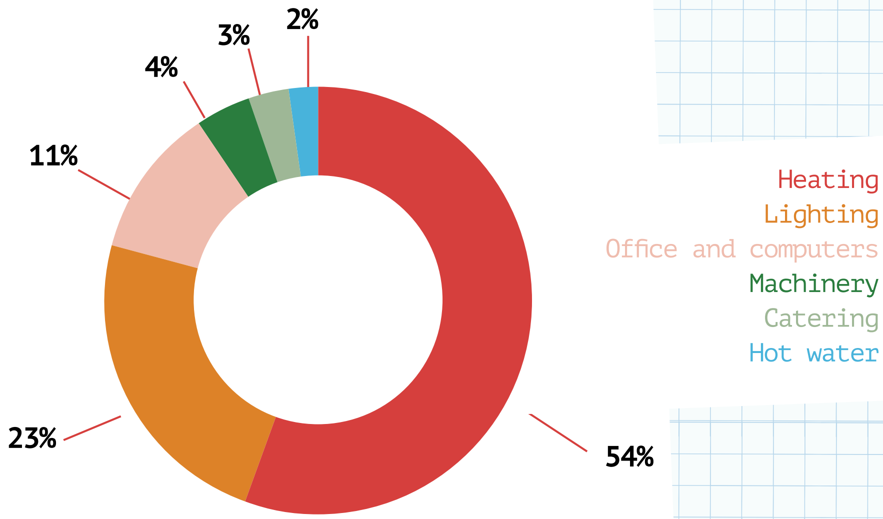
ACMNA158 Find percentages of quantities and express one quantity as a percentage of another, with and without digital technologies.

Heating and lighting use the biggest percentage of electricity in a school. On average, Tasmanian schools use half their energy on heating and a quarter on lighting. Similarly, heating uses 50% of energy in Tasmanian homes.

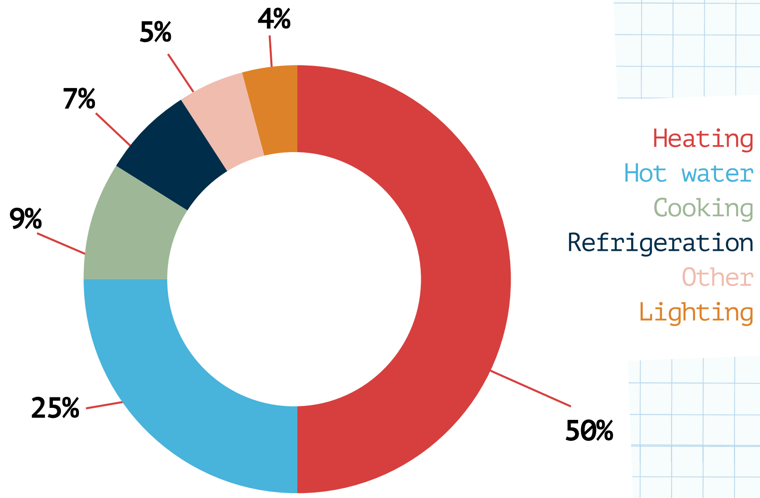
TASK: Compare and explain the different fractions in electricity use in schools and homes.

Compare lighting and hot water use. Why are they so different?

ELECTRICITY USE IN TASMANIAN SCHOOLS



TYPICAL ELECTRICITY USE IN A TASMANIAN HOME



ENERGY USE: BACK IN TIME

History: Research what people did before electrical appliances, heating and lighting.

Interview people in your house hold. Call your grandma.

Ask them and circle which decade they lived in when they were ten years old.

1930's	1940's	1950's
1960's	1970's	1980's
1990's.		

What did people cook on?

How were houses heated?

What appliances were there?

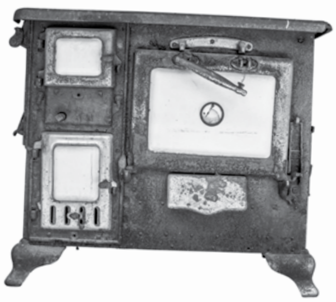
Where did food come from?

How did people warm their beds?

Did families grow vegetables and have chooks?

How have things changed?

Make a display of old electrical appliances - hand beaters whisk-mix masters.



Future scenario: Predict what is going to happen in the future in 30 years and 50 years? What would it look like?

How would you answer students' questions in 2040 or 2060?

What happens to appliances at the end of their life?

ANALYSING ENERGY BILLS

ACMNA280 Compare, order add and subtract integers.

ACMNA152 Compare fractions using equivalence. Locate and represent positive fractions and mixed numbers on a number line.

ACMNA173 Recognise and solve problems involving sample rates.

ACMNA153 Solve problems involving addition and subtraction including those with unrelated denominators.

Reading your bill will help you find out where your energy is being spent and what it is costing. This is the first step in taking action to reduce your bills.

Electricity use in the school or home is measured by a meter that is read every quarter (3 months) and then sent to households and schools with an invoice.

Your Energy Account

aurora energy

141598/A01/000001 FR-VIC
Mr J Citizen
123 Sample Street
SUBURB TOWN TAS 7000

CONTACT US
1300 132 003 (Home)
1300 132 045 (Business)
Monday to Friday
8am–6pm
auroraenergy.com.au
Aurora Energy Pty Ltd
ABN 85 082 464 622
Tax Invoice No:
123456789000

Amount Due: **$728.84**
Due Date: **16 Jul 2018**
Account No: 12345678 0
Issue Date: 27 Jun 2018

ACCOUNT SUMMARY
STATEMENT FOR THE PERIOD: 28 Mar 2018 to 27 Jun 2018

Opening balance	$456.37
Payments received thank you	$456.37 CR
Balance brought forward	**$0.00**
Energy usage and supply charges	$728.84
Other items	$0.00
Closing Balance	**$728.84**

BALANCE IN DEBIT. PLEASE PAY BY DUE DATE.

Typical electricity cost breakdown
July 2018*

For more information visit auroraenergy.com.au

SAMPLE ONLY

Amount Due: **$728.84**
Due Date: **16 Jul 2018**
Account No: 12345678 0

YOUR PAYMENT OPTIONS
See over for more payment options

DIRECT DEBIT
Choose automatic payments through your financial institution or call us on **1300 132 003** to set up Direct Debit on your account.

CENTREPAY
Use Centrepay to make regular voluntary deductions from your Centrelink payments. Call us on **1300 132 003** to set up a Centrepay deduction.

BPAY
Biller Code: 5595
Ref: 12345678 0
BPAY® this payment via internet or phone banking.
BPAY View® – View and pay this bill using internet banking.
BPAY View Registration Ref: 12345678 0

Post Billpay *755 12345678 9

+00000000000000> +000788+ <0123456780> <0000072884> +444+

The electricity bill shows the total charges for the supply and use of electricity for every house connected to the grid in Tasmania. Page 1 is a summary with the account number, amount due and pay by date. Page 2 shows the details of payments and charges. Page 3 shows supply details.

The bill comes quarterly. Quarterly means a quarter of a year = approximately every 91 days (about three months).

Fixed Charges consist of meter reading, billing costs, part of the meter capital cost and some of the costs of maintaining and connecting to the electricity distribution system. This is the same cost no matter how much electricity you use.

Energy Charge is the charge for each unit of electricity (kWh) that covers the cost of generating the electricity and some of the transmission and distribution costs.

Page 3 of 3

Account No: 12345678 0

aurora energy

YOUR SUPPLY DETAILS

Electricity Supply: 5 Sample Ave,Sample Town,TAS,7000
Connection Type: Dwelling
Supply Period: 27 Mar 2018 to 25 Jun 2018 (91 days)
NMI: 8000000000

Supply faults and emergencies: TasNetworks on 13 2004 available 24/7

ENERGY USAGE AND SUPPLY CHARGES	QUANTITY	RATE($)	AMOUNT($)
Residential light and power - Tariff 31			
Daily Supply Charge	91 Day/s	0.92736	84.39
Energy Charge	1,456 kWh	0.259	377.10
Heating and Hot Water - Tariff 41			
Daily Supply Charge	91 Day/s	0.17292	15.74
Energy Charge	1,496 kWh	0.16819	251.61
TOTAL			**728.84**
Includes GST payable of			**66.29**

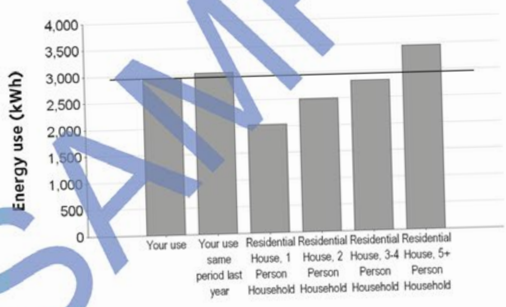
METERING INFORMATION	UNITS	QUANTITY
Hot Water - 41 Meter B932595 Reading from 62,733 to 64,229	1,496	1,496 kWh
Residential - 31 Meter B931906 Reading from 60,639 to 62,095	1,456	1,456 kWh

*Transmission Loss Factor 1.0155 | *Distribution Loss Factor 1.0351

YOUR APPROXIMATE NEXT METER READ DATE IS 24 Sep 2018

AVERAGE DAILY USE	SAME PERIOD LAST YEAR	AVERAGE DAILY COST
32.439 kWh	33.318 kWh	$8.01

Billing Period Comparison



The Billing Period Comparison graph is a guide only. If you have a Feed-In Tariff, the figure provided for average daily usage may not accurately reflect your energy use. Please visit **auroraenergy.com.au** for more information.

Compare your usage to other households in Tasmania www.energymadeeasy.gov.au

TASK: Investigate the sample electricity bill and answer these questions:

What are the different rates for hot water (hydro heat) and light and power?

The bill is calculated quarterly but it is not always exactly 91 days. **What is the number of days for this bill?**

What fraction of the bill is fixed charges compared with energy charge?

Find the average daily consumption at the bottom left hand side of the bill.

What is the percentage difference in energy use this year with last year?

What is the average daily cost?

Bills differ with the seasons. **What season is this bill? How do you think it would differ from other seasons?**

Discuss this bill with a partner. Compare this bill with your school bill or a bill from home.

BEST BUY APPLIANCES

ACMNA174 Investigate and calculate 'best buys', with and without digital technologies.

Investigating star ratings

The star rating of an electrical appliance shows the energy efficiency in comparison to other models of the same size. More stars mean more efficiency and more savings, as the appliance will cost less to run. The labels show the average energy consumption in kilowatt hours (kWh) of electricity that an appliance uses over a year. In Australia all new refrigerators, freezers, clothes washers, clothes dryers and dishwashers must carry an **Energy Efficiency Label**.

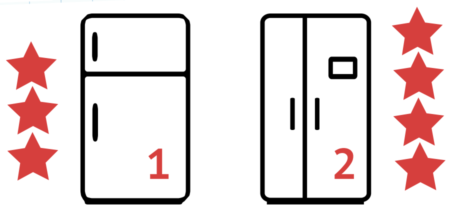
Energy rating labels display electrical consumption on a 1-6-star scale. They have two main features:

- Star rating (1-6) – the more stars the more energy efficient the appliance.
- Energy Consumption – the lower the kilowatt per hour number, the less electricity the appliance will use and the less it will cost to run.

The star rating of an appliance is calculated from the energy consumption and size of the product based on average estimated usage. E.g. Fridges- 24 hours per day. Dishwashers and washing machines: 7 times per week.

Each star is 20% more efficient than the previous star. Energy efficient appliances use less electricity to do the same thing as similar-sized models. Higher star appliances usually cost more. The challenge is to find out how much an appliance will cost to run and compare it with the cost of the appliance.

The Energy Rating label encourages manufacturers to improve the energy efficiency of appliances. Choosing an energy efficient appliance can reduce greenhouse gas emissions and save money.

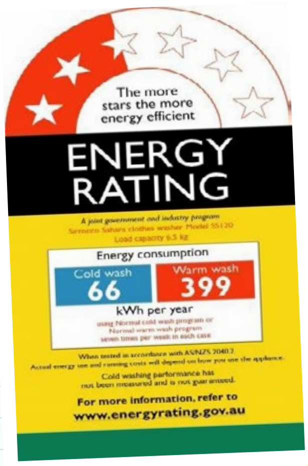


Comparison of two 420 litre fridges shows:
Fridge 1: with a 2.5-star energy rating, costs $1,300 and uses 468kWh of energy per year, with an approximate running cost of $126 per year. (@ 27 cents per kWh)
Fridge 2: with a 4-star energy rating, costs $1,400, uses 318kWh of energy per year, with an approximate running cost of $86 per year.

Fridge 1 saves $100 in the purchase cost but will cost around $40.00 more in running costs over the year. With Fridge 2, you will save $100 in running costs compared to Fridge 1 in two and a half years. Assuming the fridge lasts for the average lifespan of 14 years, Fridge 2 will save you over $560 in terms of running costs in electricity bills over that time.

HOW MANY STARS?

ACMNA183 Carry out the four operations with rational numbers and integers, using efficient mental and written strategies and appropriate digital technologies.



TASK: This 4.5-star appliance uses 505 kilowatt hours of electricity per year. If a kilowatt hour costs 27 cents calculate the cost per year.

Find other appliances in your school and home with different star ratings and calculate their costs.

This is an example of an energy rating showing the difference between warm and cold washing. When a dishwasher heats its own water, it is more efficient than one that uses water from a hot water cylinder.

INVESTIGATE: How many washes does your household do in a week?

Test a washing machine with a Powermate. **Calculate the cost of one wash with hot and one with cold water?**

Calculate the cost of running a 1.5-star dryer that costs $1.00 per cycle compared to a 6-star dryer that costs $.40 cents per cycle, at 5 cycles per week over 5 years.

Simple calculation of running costs of an appliance

Use the Energy Rating Label to work out rough running costs of appliances.

Take the energy consumption figure – and divide it by 4. For example, if the Energy Rating Label on a washing machine says it uses 400 kWh, it means it will roughly cost $100 per year to run.

Energy rates in Tasmania are 27 cents per kWh – so using 25 c (¼ of a dollar) is an easy approximation.

To calculate more accurately use the Energy Rating Calculator.

Discuss why this might be the case.
When electricity costs 27 cents per kWh calculate the difference between the costs of using this appliance with hot and cold water for a year.

Hot water	399 x .27 c=	
Cold water	66x .27 c=	
Difference		

ENERGY SAVINGS

The first step to achieving energy savings is to take a tour through your school or house – looking at how energy is used and where it goes. To take a whole approach, think of your home or school as an energy system with interdependent parts – heating, cooling, lighting, refrigeration, cooking and hot water.

How does your school or home use energy?
Think about the building shell, this includes:

- the design of your house or school - orientation and materials
- protection from prevailing weather
- insulation.

Is the house or school protected from the cold winds or summer glare? Does it face north? Does it get sun into the rooms?

The fittings and appliances (what you've got):
Your home or school will contain a range of fittings, curtains, white-goods and appliances – such as lights, hot water systems, heaters, fridges, kitchen appliances and tools. People are surprised to find how much unnecessary energy is lost every day. For example, hot water cylinders can lose one third of their energy through heat loss. Insulating pipes will help to significantly reduce heat loss.

Standby electricity is often wasted electricity. For example, if an electric toothbrush is left on it continues to charge even without the appliance being attached.

Your lifestyle choices (what you do):
This is about how you, students and staff manage the school and how you and your family manage your home - your habits, preferences and choices. We tend to manage our home through habit, rather than by deliberate choices. To keep a home at 23°C in winter uses much more energy than keeping it at a comfortable 20°C. The temperature of your house or classroom may be a lifestyle choice or a preference – or you may not have thought about it.

One of the biggest energy wasters in a school is leaving outside doors open in winter. Another big energy waster is leaving heaters on in empty classrooms and turning up the thermostat to maximum.

TASK: What ways could you reduce your energy use in your home, classroom or school?

Reference: Home Energy Booklet, Sustainable Living

Most schools can reduce their energy usage from looking at these areas:

- heating
- computers and monitors
- printers and copiers
- lights

More tips on saving energy

Do we waste energy?

What can we change? How can we change?

Develop a plan for action. Include steps to follow. Share the plan with the family and respond to suggestions.

ENERGY WASTERS TOUR: SUPER SLEUTHS

Energy efficiency can be improved with good energy habits. The first stage to saving energy is to a walk around. The aim of the walk is to 'snoop' for wasted energy and bad habits and where changes could be made. Ask questions as you go. Take a digital laser non-contact thermometer with you to check the different temperatures around the school and your home.

Rate your findings with a number in order of importance. Write up a report and make an action plan. Identify the most serious problems and address these first.

Key questions to get started:

ENERGY DETECTIVE WALK AT SCHOOL	Yes	Some	No	Don't know	Action rating priority score 1-5
Record the temperatures in different rooms as you go around.					
Do the school windows have double-glazing or energy-saving glass?					
Are the windows well sealed with no gaps or draughts around them?					
Are outside doors self-closing?					
Do people leave doors open?					
Are inside doors self-closing?					
Does each classroom have its own heating thermostat?					
Is the heating set to an energy efficient temperature? (23 degrees C or less)					
Are low-energy light bulbs (LED's) and fluorescent tubes used in your school?					
Are printers, faxes and photocopiers in energy-saving mode when not in use?					
Are lights and electrical items turned off when not in use?					
Are lights and computers turned off at night?					
Is external lighting turned on only at night?					
Do external lights have sensors?					
Are fans and air filters regularly cleaned?					
Can you find energy wasted in unoccupied rooms?					
Examples?					
Are lights off when there is enough daylight?					
Does the school have renewable energy (such as photovoltaic solar panels)?					
Are there solar water panels?					
Are all windows and doors closed keeping the heat in?					

Other snoopy ideas

Rate your findings with a number in order of importance. Write up a report and make an action plan. Identify the most serious problems and address these first.

Key questions to get started:

ENERGY DETECTIVE WALK AT HOME	Yes	Some	No	Don't know	Action rating priority score 1-5
Record the temperatures in different rooms as you go around.					
Are the windows well sealed with no gaps or draughts around them?					
Are appliances turned off at the power point when not being used?					
Are lights and electrical items turned off when not in use?					
Are lights and appliances turned off at night?					
Are lights off when there is enough daylight?					
Is there insulation around hot water pipes?					
Is the hot water set to the correct temperature (not more than 60 degrees)?					
Is the fridge set at between 5 and 7 degrees Celsius?					
Is the freezer set at between -7 and -18 degrees Celsius?					
Are there low-energy light bulbs (LED's) and fluorescent tubes?					
Are all windows and doors closed to keep the heat in?					
Are there draught stoppers under door gaps?					
Is there insulation in the ceiling?					
Is the ceiling insulation even? (test with the radiometer)					
Does your family have short showers (4 mins or less)?					
Do you have low flow shower heads?					
Is everyone good at remembering to turn off lights and heaters?					
Are there curtains to keep in the heat?					
Are the places where heat can escape blocked off, (like an unused fireplace)?					
Is the jug or kettle only filled with just enough water for the purpose?					
Does your family wear warm clothes in winter?					

Other snoopy ideas

INTRODUCTION TO THE HOME ENERGY AUDIT TOOLKIT (HEAT)

HEAT kits are available for loan from most local Councils*. The most useful items in this kit are the Powermates that measure electricity use of appliances and the digital thermal thermometers. If the HEAT kit is not available, cheap energy meters and digital thermal thermometers can be purchased on-line or from electronics stores.

Background: The Home Energy Toolkit (HEAT) is a set of equipment which helps to measure the energy efficiency of your school or home. When you calculate your energy use it is then possible to decide on ways to reduce energy use and save money and greenhouse gases.

*The Powermate is the most critical piece of equipment from the HEAT kit and can be purchased separately: http://steplight.com.au/products/power-mate-professional-power-meters

THE HEAT KIT	
Power-Mate	To measure electricity consumption of all electrical appliances with a standard 3-pin plug. Measure how much electricity is used by fridges; televisions, microwaves and computers and their standby rates.
Infrared thermometer	This is a fancy thermometer. It is used to check for leaks around fridge doors or the effectiveness of ceiling insulation (such as finding uneven temperatures in the ceiling, indicating gaps in the insulation). Best used in colder weather.
Stopwatch	Assists in measuring flow rate of hot water from showers & taps (e.g. litres per minute).
Silva compass	Helps to identify: (i) the orientation of the home or school buildings for angle to the sun- solar aspect and (ii) orientation of roof aspect suitable for hot water and electricity solar panels.
Thermometer	To measure air temperature around houses and schools, hot water system, water temperature, fridges and freezers.

HEAT STUDENT INVESTIGATION

1. Choose a piece of equipment from the HEAT KIT and decide what it can be used for.
2. How would it help you to make your home more energy efficient?
3. Brainstorm a list below of all the possible uses for this piece of equipment.

Name of piece of equipment:

What are the possible uses?

USING THE POWERMATE

ACMNA280 Compare, order, add and subtract integers.

The Power-Mate allows the measurement of electricity of various appliances.

SAFETY ATTENTION: ALWAYS TURN OFF THE ELECTRICITY AT THE POWER POINT WHEN PLUGGING APPLIANCES INTO THE POWER-MATE.

Turn off the power point, unplug the appliance and plug the Power-Mate into the power point. Plug the appliance into the back of the Power-Mate plug. Turn on the power point and the Power-Mate screen will come on. The screen will show the power used in Watts (W).

Before starting- clear the memory. Press the MODE button 7 times till CLEAR comes up on the screen. Then press ENTER and shows "done" on the screen. All memory will be cleared. Then press MODE again and you are ready to start.

Power-Mate Instructions
The '+' and '-' buttons can be used to access additional information as shown in the following Table. Probably most useful is the cost function because it shows how much it will cost if the appliance is used continuously for one hour, or for a whole year.

Mode		Press '+'	Press '-'	Press 'Enter'
POWER	Watts (now)			
COST	Cost* (dollars)	Cost per year		Cost per hour

* when the memory is cleared, these values go back to zero and start building up again.

HOME ENERGY USE-APPLIANCES Power-Mate Calculations					
Room:	**Date:**				
Name of appliance	**Number**	**Watts when used Active**	**Hours of use**	**Watts on Standby**	**Hours on standby**
e.g. television	**1**		**4**		24
TOTAL					

POWERMATE CALCULATIONS

ACMSP168 Assign probabilities to the outcomes of events and determine probabilities for events.

1. Collect some electrical appliances such as a blow-heater, hair dryer, pop-corn maker, toaster and kettle.
2. Put them in order of the appliances that you think will use most electricity to the one you will think will use the least amount.
3. Most appliances will have a label that says how much electricity they use. Test different appliances with the Powermate.
4. Measure and record the wattage of your favourite appliances.

Appliance	Measured Watts	KWh (Divide by 1000)

Check your findings with the numbers below.
Remember **1000 watts = 1 kilowatt**

1000-watt heater switched on for 1 hour 1000 = 1000 Watt hours ÷ 1000 = 1 kWh

2000-watt clothes dryer switched on for 1 hour = 2000-Watt hours ÷ 1000 = 2.0 kWh

The cost of 1 kw is approximately 27 cents per hour for households and 17 cents per hour for schools.

Appliance	Average Watts	Cost =27 cents per 1 Kwh for householdsv
Blow Heater	2000 watts	54 cents per hour
Computer	200 watts	5.4 cents per hour
Electric blanket	200 watts	5.4 cents per hour
Hair dryer	2000 watts	54 cents per hour
Laptop	20 watts	0.5 cents per hour
Iron	1000 watts	27 cents per hour
Kettle	2000 watts	54 cents per hour
Fridge	100 watts	2.7 cents per hour
Clock radio	4 watts	0.1 cents
Energy saver light globe	10 watts	0.2 cents per hour
Television (large)	200 watts	5.4 cents per hour

ENERGY USE CALCULATIONS

A very fit secondary student can produce 100-150 Watts of electricity on a pedal-powered bicycle. How does this compare to the power required for these household items?

Calculate:

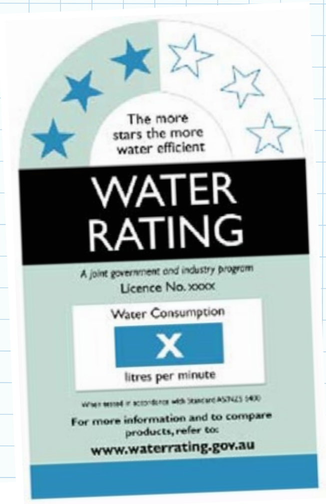
1. The annual cost of a 2000 watt blow heater running three hours per day for 150 days.
2. If a 2000 watt blow heater is left on while a student is at school for 8 hours what is the cost per day?
3. The annual cost of a clock radio (2 watts) and computer (200 watts) running 24/7?
4. Measure the stand-by wattage of one computer. Multiply this figure by the number of computers in the school and then multiply by the total days in the year and by 24 hours.
5. Think about how you use energy. What other calculations can you make for appliances you use?

GETTING INTO HOT WATER

Hot Water

About 35% of the power usage of the average home comes from hot water. The long, hot shower is the biggest user of hot water.

How can you save on hot water? Discuss ideas about what people can do such as shorter showers, using a timer or insulating the hot water cylinder to reduce hot water usage. Eg Using a 3-Star-rated showerhead can save up to 60% on water and energy.



A bath uses about 100 litres of water. A spa bath uses about 350 litres of water.

Calculate which uses most water and electricity - a shower or a bath?

INVESTIGATE: How might you compare shower and bath water comparisons? Measure your water use in the shower.

SHOWER SLEUTHS

Use the stopwatch and a bucket to calculate how many litres of water your shower uses in a minute.

My shower uses [ ] litres of hot water per minute.

It costs about 0.5 cents to heat one litre of water to 40oC for a shower (it uses 0.045 kWh of electricity).

About how much does each minute of shower time cost your household?

Multiply number of litres x 0.5 cents [ ]

Quietly measure the shower times of different members of your family.

Who takes the longest shower?

Who takes the shortest shower?

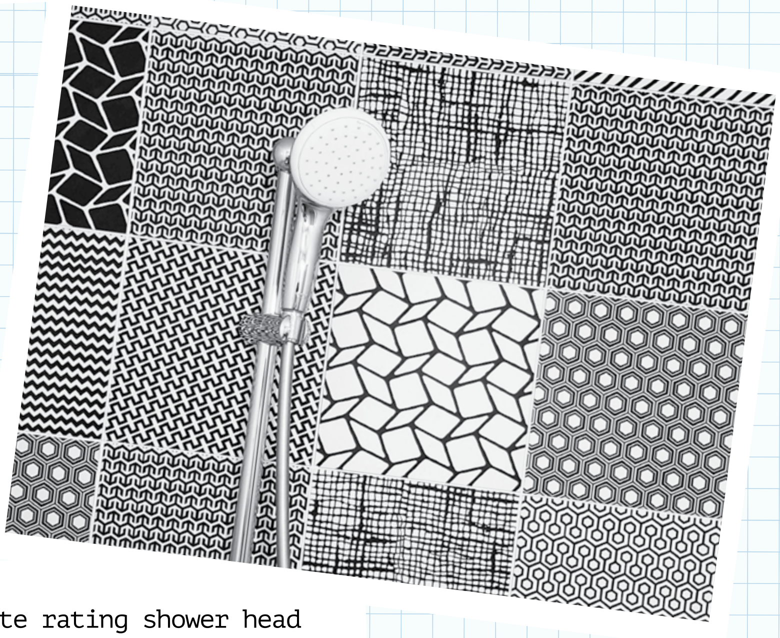
Time everyone in the shower. Work out what each person's shower costs per year.

Use a rough calculation An average shower costs about 10 cents per minute.

A recommended shower time is 4 minutes which costs $146.00 over a year. (Multiply the shower time in minutes x 0 .10 x 365 days per year.)

What does it cost your family to shower each year?

Hold a family meeting and reveal your findings.



AAA 3 star 5 litres per minute rating shower head

SAVING ON HOT WATER HEATING

There are a number of easy ways to reduce your hot water bills.
Here are six quick tests.

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1. **The pipes**

Are the hot water pipes insulated? yes ☐ no ☐

Check that the pipes that are outside and the first two metres of pipes coming out of the HW cylinder are well insulated.

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2. **The cylinder cabinet** The radiometer can be used to measure the surface temperature of the HW cylinder. Compare this to a nearby surface. Most HW cylinders are 1 to 2 degrees warmer than their surroundings. This shows they are constantly losing heat.

Is the cylinder outside in the cold? yes ☐ no ☐

Outside or in, is it insulated? yes ☐ no ☐

Much heat loss can be saved by wrapping the tank with extra insulation - especially older cylinders.

Warning: Don't cover the pressure relief valve.

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3. **The water temperature**

What temperature is our hot water supply?

Place a thermometer under the tap. What is the temperature?
If it's well above 60C, then, on most cylinders, you can simply turn down the thermostat - on the side of the cylinder.

Warning: Don't drop it below 55 degrees C as harmful bacteria can build up.

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4. **The shower**

Do you have a AAA-rated shower head? yes ☐ no ☐

A standard showerhead uses about 15 to 25 litres of water per minute. A three star rated water efficient showerhead uses as little as 6 or 7 litres per minute. AAA shower heads will give you a satisfying shower at more than half the energy and water costs.

5. **The taps**

Are any leaking? yes ☐ no ☐

Ideas to save on hot water heating?

Reference: http://www.sustainablelivingtasmania.org.au/HomeEnergyDec07.pdf.pdf

HOW MUCH ENERGY ARE WE USING?

ACMNA280 Compare, order, add and subtract integers.

TYPICAL APPLIANCE COSTS

The following table shows the calculation of annual appliance costs in kilowatt hours (kWhs).

	A	B	C	D	E	F	G
Appliance	Watts	Hour **Divide minutes by 60**	Hours **Divide minutes by 60**	Number of days	Hours per year **(multiply hours by number of days)** **C x D =**	kWh per year **Multiply watts x hours per year and divide by 1000** **A x E =**	Cost per year **Multiply kWh x 27 cents + Divide by 100 to get dollars** **F x 0.27 =**
electric heater	2000	5 hours	5	150	750	2000 x 750 = 1,500,000 Divide by 1000 = 1500 (kWh per year)	1500 x 27 = 37,500 divided by 100 = $405
kettle	2000	15 minutes	0.25	360	90	180	$48.6
hair dryer high	1150	5 minutes	0.08	300	24	27.6	$7.4
hair dryer low	300	5 minutes	0.08	300	24	7.2	$1.9
sandwich maker	1700	5 minutes	0.08	100	8	13.6	$3.6
toaster	1300	10 minutes	0.16	300	48	62.4	$16.8
computer & monitor	150	24 hours	24	365	8760	1314	$354
laptop	20	8 hours	8	300	2400	48	$12.96
dehydrator	350	24 hours	24	8	192	67	$18.09
clock radio	4	24 hours	24	365	8760	35	$9.45

What can you find out from this table? What is surprising?

WATT APPLIANCES?

Make a list of appliances in one room - eg the kitchen.

Check the label to see the wattage.

Rank them in order from the highest wattage to the lowest.

1 is the highest.

Appliance	Wattage	Ranking
Eg kettle	2000-2400	

WHAT USES MOST ELECTRICITY OVER THE YEAR?

ACMNA280 Compare, order, add and subtract integers.

WHAT APPLIANCES USE THE MOST ELECTRICITY IN YOUR HOME?

The Price is Right Energy Game: Work out which energy cost is associated with each appliance. The estimated costs are for a three-month billing period

ITEM	Quarterly kWh	Cost	kWh	Hours per day
Electric 3 bar heater 2400 watt (6 hours per day)	4320	$ 691	8	6
Column oil 1000 watt heater (6 hours per day)	1296	$ 363	2.4	6
Heat pump (6 hours per day)	1296	$ 207	2.4	6
Hot Water 6 (2 person household)	720	$ 160	8	1
Cooking dinner (2 hotplates for 45 minutes)	351	$ 98	5.2	0.75
Light a room with 4 halogen downlights	108	$ 30	0.2	6
TV (4 hours per day 102 cm plasma screen)	50	$ 14	0.138	4
Light a room with 4 compact fluorescent downlights	26	$ 7	0.048	6
Kettle (jug boiled twice a day)	22	$ 6	2.4	0.1

TEACHERS: **Cut up these items and costs and ask students to match.**

RANKING APPLIANCES

ACMSP168 Assign probabilities to the outcomes of events and determine probabilities for events.

1. Create a list of appliances in your home that use electricity.
2. Make an estimate as to how often this appliance is used.
3. Make an estimate of how much you think it costs to run.
4. Using your best guess, rank the appliances from most expensive to least expensive to run.

(There are a few examples to get you started.)

Name of appliance	How regularly do you use this appliance?	Guess how much this appliance costs to run over a week? (estimate only)	Rank the appliances from most to least expensive (best guess)
Toaster	Every morning for 10 minutes		
Rice cooker	Once a week		
Refrigerator	Runs constantly		

What surprises you?

APPLIANCE INVESTIGATION: **Brainstorm** ways of improving the use and efficiency of appliances in your home. E.g. turn off printer when not in use, check fridge temperature, turn off bar fridges.

STAND BY

ACSIS130 Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions.

ACMSP169 Identify and investigate issues involving numerical data collected from primary and secondary sources.

Myth Buster: Is it true that electrical items on standby use no electricity?
Standby power is the energy used by an appliance when it is not being used.
It now accounts for 10% of the energy used in Australian homes.
Often equipment on standby will be warm to the touch, have an indicator light (such as a camera charger) or a clock (such as a microwave or television).

Average standby annual costs

Appliance	Standby power- Watts	Annual cost
Television	10	$15
Microwave	4	$ 6
Clock radio	4	$ 6
VCR	8	$ 11
Mobile phone charger	1	$ 2
Computer	5	$ 8
Monitor	5	$ 8
Printer	8	$ 11

Source: Resource Smart.vic.gov.au.documents/running-elect.pdf

TASK: Using the Power-Mate from the Home Energy Audit Tool Kit, test various electrical items at school and home which use standby mode.

1. Fill in the table below with electrical appliances that are left on standby at home.
2. Use the table above to estimate or measure the cost of electricity your appliances use and add the totals.

Appliance	Standby power- Watts	Annual cost
TOTAL		

Standby power is one of the largest potential energy saving opportunities in homes. Think about strategies that would save you energy at home. E.G. Turn off printer when not being used. Make on/off switches accessible.

CLASSROOM ENERGY USE

ACMNA280 Compare, order, add and subtract integers.

1. Calculate the number of appliances in the classroom and their costs per day on active and standby.
2. Calculate the total costs of classroom appliances over a year.

Classroom	Date	Recorders			
	A	**B**	**C**	**D**	**Cost 27 cents/kWh**
Appliance e.g. Computer	**Number**	Wattage Active	**Estimated Hours of use**	Total watts per day B x C =	0.27 x D
	10	200	6	12,000	3.24
		Wattage Standby	**Estimaed hours on Standby**	B x C	
	10	20	18	3600	0 .97 cents
Smartboard	**Number**	Wattage Active	**Estimated hours of use**	Total watts per day B x C =	0.27 x D
		Wattage Standby	**Estimaed hours on standby**	B x C =	
Monitor	**Number**	Wattage Active	**Estimated hours of use**	Total watts per day B x C =	0.27 x D
		Wattage Standby	**Estimatd hours on standby**	B x C =	
	Number	Wattage Active	**Estimated hours of use**	Total watts per day B x C =	0.27 x D
		Wattage Standby	**Estimaed hours on standby**	B x C =	
TOTALS					

Observations

MONITORING CLASSROOM ENERGY USE

ACMNA280 Compare, order, add and subtract integers.

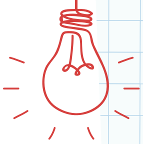
ACMSP169 Identify and investigate issues involving numerical data collected from primary and secondary sources.

Monitor the following hours of energy use in your classroom over one week. You may need to allocate tasks for different students.

Date			
Equipment	**Hours left on**	**Hours in use**	**Hours in use Hours not used but left on**
Computers			
Lights			
Heaters			
Printer/Copier			

Date			
Equipment	**Hours left on**	**Hours in use**	**Hours in use Hours not used but left on**
Computers			
Lights			
Heaters			
Printer/Copier			

What did you find?



What do these results tell you about how you can save energy in your classroom?

Computer Standby in Schools

Standby power consumption in Australia is decreasing with the exception of computers. Check out **Australia's Standby Strategy 2002-2012** (for Australian Local Government Buildings)

www.energyrating.gov.au/library/pubs/200522-standby-local-gov.pdf

The most standby energy in offices and schools is used by computers (49%) and monitors (28%).

Power management is a significant energy conservation measure with savings of between 4 % and 8% of total consumption with a total of 200- 500 kW per employee.

How does your school compare?

Has your school taken steps to reduce stand-by electricity on computers and monitors?

Keep a record of ways in which you save energy by turning off appliances.

Equipment	Action e.g. turn off computer at end of the day		
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			

MONITORING SHORT-TERM SCHOOL ENERGY USE

ACMSP169 Identify and investigate issues involving numerical data collected from primary and secondary sources

ENERGY AUDITING

Auditing is measuring and monitoring the use of resources. Measuring and monitoring the school's energy use provides a starting point of base-line data, to help be more energy efficient and reduce waste. This will save the school money and reduce greenhouse gases.

Energy Survey

To help raise awareness of how efficiently energy is used in the school and to assist with promoting the energy audit, an energy survey can be a good starting point. What do students know about energy costs and usage?

ENERGY USE SURVEY

Circle your answers				
How much does electricity cost per kW hour to a household?				
1 c	12c	27c	75 c	$1.00
If you leave a 2000 watt fan heater on in your room for 8 hours it will cost approximately				
8c	80c	50c	$4:00	$10.00
Approximately what is the school's electricity bill per year				
$1000	$10,000	$50,000	$100,000	$200,000
About how much does the electricity cost the school per person? (Divide the total cost by number of students and staff.)				
5c	10c	$1	$5	$10
What is a comfortable winter temperature for a classroom?				
14 C	18C	22 C	26 C	30 C
What uses most energy in the school?				
lights	heaters	computers	refrigerators	hot water
Why shouldn't we waste energy? Tick which ones you think				
Save money	Slow down climate change	Improve air quality	Reduce greenhouse gases	All of these

WHOLE SCHOOL ENERGY AUDITING (One Hour)

ACMSP169 Identify and investigate issues involving numerical data collected from primary and secondary sources.

ACMNA280 Compare, order, add and subtract integers.

ACSIS131 Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements.

ACSIS132 Use scientific knowledge and findings from investigations to evaluate claims based on evidence.

A whole school energy audit will measure the school's energy use and will show where the electricity is being used and wasted. Students can then make recommendations how energy can be saved. This will help the school to save money and also reduce greenhouse gases. An audit undertaken in winter in Southern Australia will be a more effective time to calculate peak energy.

Find out if there have been previous energy audits. The school business manager will have copies of the school's energy bills and the history. Aurora monitors the energy use in a school in 15 minute intervals.

Locate the main electricity meter in the school. Beware of not handling any electrical equipment.

By taking a reading on the hour and then another reading one hour later will give a snapshot of energy consumption. In this time a student assessment of heating, lighting and computers around the school will give an indication of percentages of usage.

The three main purposes of a school's energy audit are to:

1. record all the electrical usage and average room temperatures in the school for one hour,
2. determine what were the main uses of electrical energy in the school, and
3. make recommendations to reduce energy costs.

It is recommended that students work in groups and are allocated to particular areas of the school to measure temperatures and appliance use in each area. Download a map of the school and mark team areas.

Sample Process: The sample one-hour energy audit was undertaken at Huonville High school on a cool morning in September to provide a snap shot of the school's energy use. The main meter board was accessed and the meter reading was recorded with the current time. It was then re-read and recorded 60 minutes later. The outside temperature was 12 degrees C. Students were allocated to different buildings in the school to record the energy use (heaters, lights and computers) and average temperatures in the room. It was also noted if the room was in use and if doors were open

WHOLE SCHOOL ENERGY AUDIT - DATA COLLECTION

Date and Time ____

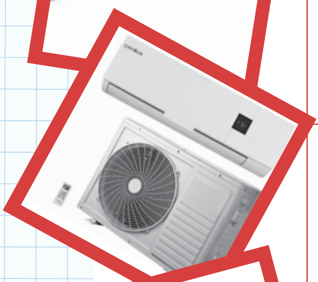
Energy meter reading at TIME ____________________kWh ______________________

Reading one hour later TIME _____________________kWh ______________________

You will need digital thermometers and a data collection sheet for each room.

Team Names ____

Outside Temperature (C) ____



Block No	Data		
OUTSIDE DOORS Open or closed?			
Room Name	In use/ Empty	Door Open/ Closed	Average Temperature (C) at eye level
Heaters	**Number**	**On**	**Off**
Ceiling			
Heat Pumps			
Fan heaters - wall or under desk			

Block No	Data		
OUTSIDE DOORS Open or closed?			
Room Name	In use/ Empty	Door Open/ Closed	Average Temperature (C) at eye level
Lights	**Number**	**On**	**Off**
Fluorescent tubes CFL			
Fluorescent lights			
Quartz halogen/ downlights			
Incandescent globe			
Computers			
Laptops			
Refrigerator Temperature	C		
High Energy Appliances	**Number**	**On**	**Off**
Stove/Oven			
Instant boil tap			

Observations

Energy saving opportunities

SUMMARY OF TEMPERATURE DATA recorded at Huonville High School

15 September 2017

ACSIS131 Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements.

The Average Temperatures for all rooms in the school	
Block	**Average Temperature (C)**
A	19.22
B	18.20
C	17.10
Science	18.73
Gym	12.63

Note: These average temperatures are low as they included closed-up store rooms.

Rooms heated at and above 22C			
Room	**IU = in use** **E = empty**	**Door** **O = Open** **C = Closed**	**Average Temperature (C)**
A1-22 ICT Support Room (heat from Servers)	IU	C	28.7
A1-15 80 HG room (ceiling heaters)	IU	C	23.13
AG-20 Main staffroom (ceiling heaters)	IU	O	24.3
AG-15 French Room (ceiling heaters)	IU	O	22.06
AG-16 Internal Suspension area (adjacent to assistant-principal's office)	E	O	22.5
B1-10 Graphic Design Room	IU	C	22
B1-17 Senior Staffroom	IU	O	22.6
C1-20 Computer Rm (heat pump)	IU	O	26.36
C1-18 Computer Rm (heat pump)	IU	C	22.03
S-12 Science Classroom (ceiling heaters)	IU	C	22.7
S-11 Science Staffroom	E	O	23.1

Note: 6 out of 11 of the over-heated rooms had the door open and that 2 out of the 11 rooms were not occupied. Room A1-22, the ICT Support room will always overheat due to the heat coming off all of the servers.

Room	Temp C	Room in Use	Heaters On	Doors open	Lights on?	Extra info
Headspace	29	N	Y	C	N	Room not used for several days
Music	25	Y	N	C	Y	
S01	25	N	Y	O	Y	
S03	25	N	Y	C	Y	
Art	24	N	Y	C	N	
Drama	23	N	N	O	Y	
Library	22	N	Y	C	some	
H05	22	Y	Y	O	Y	
G09	21	Y	Y	O	Y	
Cafe	20	Y	Y	O	Y	
Staff Office	20	N	Y	C	Y	
S02	18		Y	O	Y	
H06	18	Y	Y	C	Y	
Kitchen	18	Y	Y	O	Y	
Prep room	16	Y	Y	C	Y	
S04	16	N	N	O	Y	
Breakout	16	Y	Y	O	N	
Staffroom	16	Y	Y	O	Y	
Science tr office	15	N	Y	C	Y	
Staff toilet	12	N	Y	C	Y	
Entry	15	Y	Y	O	Y	
H07	15	Y	Y	O	Y	
Hospitality	15	N	N	C	N	
Printer room	15	N	N	C	Y	
H04	15	Y	Y	O	Y	
Learning	15	N	Y	O	Y	
Room1	14	N	Y	O	Y	
Room3	14	N	Y	O	N	
Hallway	14	N	N	C	N	
Room2	14	N	Y	O	Y	
Girls toilets	10	N	N	C	Y	
Canteen	9.5	N	N	C	N	
Gym	9	Y	N	C	N	
E01	6	Y	N	O	N	
Admin	22	Y	Y	C	Y	

What does this data indicate?
There were thirteen rooms not in use that had lights on and ten rooms in areas not in use that had heaters on.

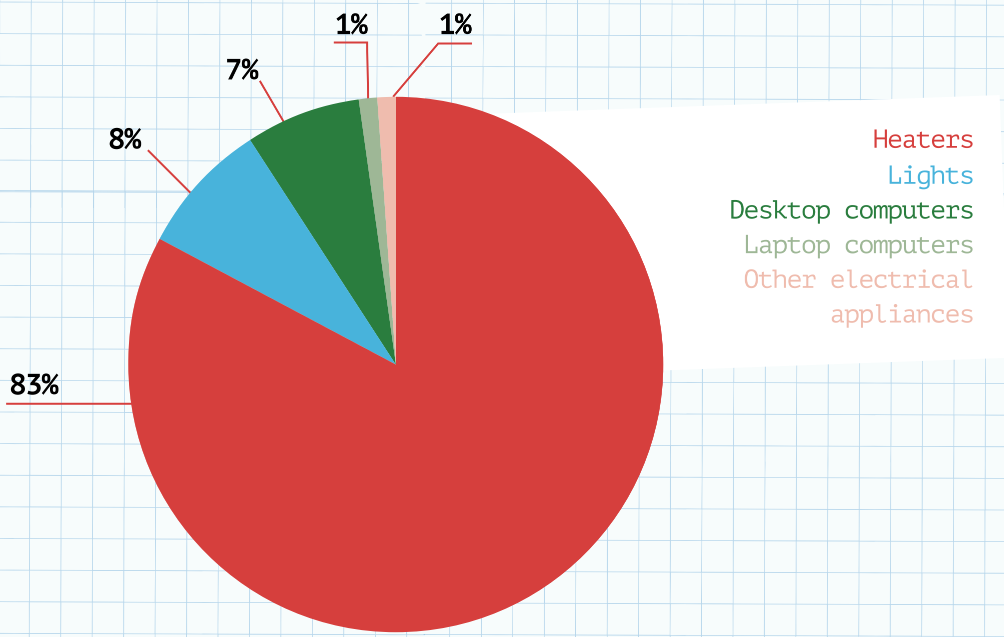
What was the temperature range? Seven rooms in use were at 16 degrees C or below. Music, Arts and Drama had very high temperatures in unoccupied rooms.

What do you notice about the Science rooms?

ANALYSIS OF SCHOOL ENERGY USE:

Huonville High School
15 September 2017

Energy Data (kWh) for One Hour (10.30-11.30am)



Student Observations

- Lights and heaters were left on in many unoccupied rooms.
- Desktop computers were left on when not in use.
- Doors and windows were open in rooms with the heater on.
- Thermostats are turned up to maximum on cold mornings in an effort to heat up the room quickly which does not make any difference to the rate of heating but results in rooms getting overheated.
- Many extra fan heaters were being used on high (in addition to radiant heaters) by teachers in staffrooms with doors open.
- Many external doors left open creating draughts in corridors and rooms.

Student Recommendations

- Ensure windows and doors are closed when heaters are on.
- Swap the ceiling heaters with the more energy efficient heat pumps.
- Turn off desktops when they are not being used.
- Ensure lights are turned off in unoccupied rooms.
- Turn off heaters when the room is warm enough.
- Turn the lights off when there is sufficient light coming in through the windows.
- The school uniform should select thicker and warmer jumpers, to reduce the need to put on heaters.
- Only use heaters when necessary.
- Turn off any electrical appliances when they are not in use.
- Automatic lights that turn off when there is no movement in the room.
- Open blinds to allow more sunlight to light the rooms.

TASK: Overnight Reading

1. Take a reading at the end of a school day and then first thing in the morning.
2. Calculate the overnight reading. Overnight consumption (8:00 am reading minus 3:00pm reading)

   Reading at 3:00 pm ....kWh

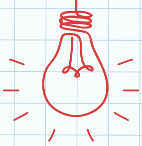
   Reading at 8:30 am..................kWh

3. How does this compare with a 24-hour reading?
4. Discuss ways to reduce the use of overnight electricity.
5. Try a weekly reading and a weekend reading. What is the difference?
6. Identify where electricity is being used. Get a map of the school and organise teams to check different areas.
7. Check lights, heaters, numbers of computers.

TASK: Analysing the School's Energy Data

1. Get copies of the school's energy bills. The school office manager has access to these.
2. Identify the total use and cost per quarter.
3. Calculate the daily use.

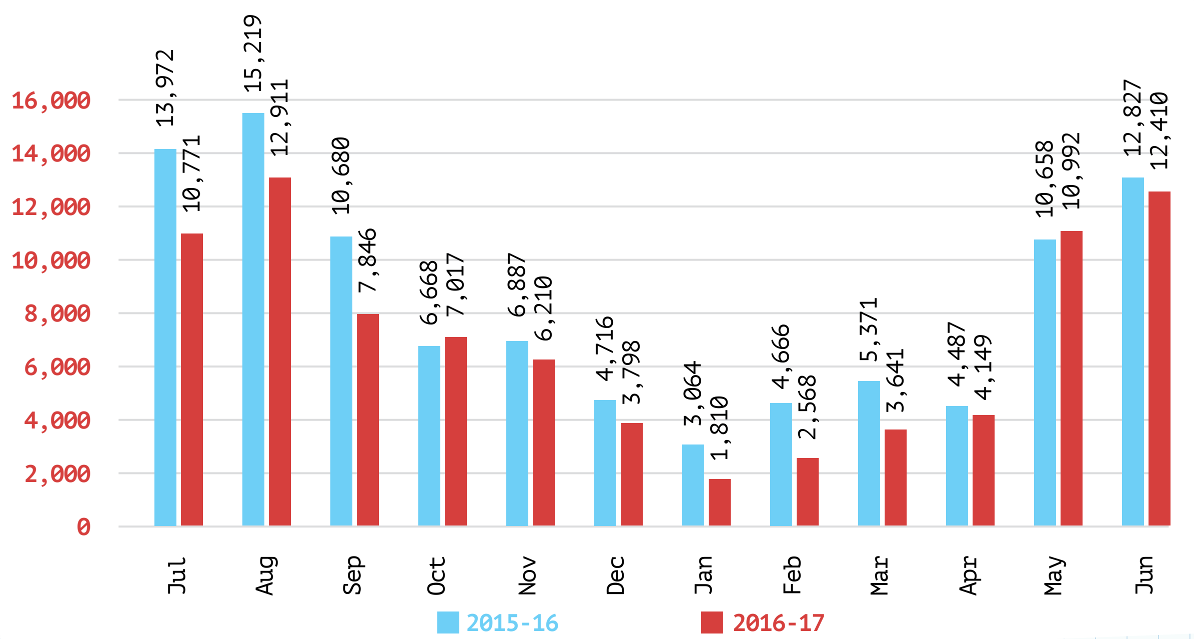
Divide this by the school population to calculate the kWh per person.



ENERGY DATA AT HUONVILLE HIGH SCHOOL (dollars per month)

2015						2016					
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
13,972	15,219	10,680	6,668	6,887	4,716	3,064	4,666	5,371	4,487	10,658	12,827
2016						**2017**					
Jul	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
10,771	12,911	7,846	7,017	6,210	3,798	1,810	2,568	3,641	4,149	10,922	12,410

Huonville High School: Monthly Consumption in $



TASK: Analyse the differences between the years.

What is the total difference in cost?

What is the difference in the costs between the most and least expensive months?

DISCUSS: In January 2015 the cost of electricity for the school was $3064 when the school was closed.

What else do you notice?

EXTENSION: Investigate suitable/possible renewable energy opportunities if the school had $100,000 to spend

What are the best options for the school? Collect solar, wind and rainfall (stream flow) data. Calculate the area of north facing roofs, investigate rivulet flows on site and wind speeds.

TRANSPORT ENERGY

ACSHE135 Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations.

ACSIS145 Summarise data from students own investigations and secondary sources and use scientific understanding to identify relationships and draw conclusions based on evidence.

ACMSP284 Investigate techniques for collecting data, including census, sampling and observation.

In Tasmania we produce most of our electrical energy but import almost all our transport energy. We use more energy in our transport than we use in our houses. Tasmania imports $1 billion in imported fuel per year- making it our greatest greenhouse gas emitter. The biggest shift in reducing transport energy will be increased uptake of cost-effective electric vehicles.

Electrical vehicles (EV's) are becoming more common on Tasmanian roads. While EV's were invented over 100 years ago, battery technology has limited their wide use. As battery technology improves EV's will reduce our reliance and vulnerability to oil prices and supply.

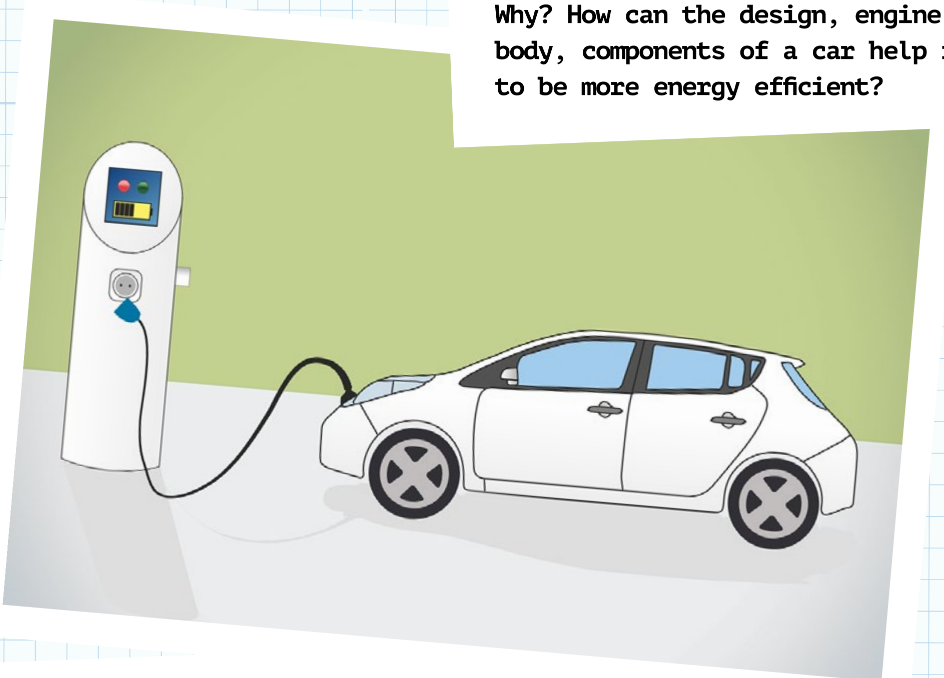
The advantages of EV's compared with conventional petrol or diesel engines include being cheaper to run, quieter and smoother to drive, and have zero emissions when powered from Tasmania's renewable electricity sources. New EVs are more expensive to buy and take a long time to charge. Fast charging stations and lighter, cheaper, more sustainable batteries with higher energy storage would encourage the uptake of electric cars.

E-BIKE
Electric
Eco-Friendly
Energy Efficient
Economical

INVESTIGATE: How fuel efficient is your family vehicle? This is often calculated at litres per 100 km.

Collect and compare data on fuel efficiencies of different vehicles.

Which cars are most fuel efficient? Why? How can the design, engine, body, components of a car help it to be more energy efficient?



RESEARCH:

- how internal combustion engines, hybrid and electric cars work.
- the environmental impacts of petrol, diesel, hybrid and electric vehicles.
- the advantages and disadvantages of using hybrid and electric vehicles.
- major challenges facing the uptake of hybrid and electric vehicles.

Explore possible positive and negative impacts of electric vehicles in Tasmania. What are the opportunities and challenges for the community? Investigate the global uptake of electric vehicles.

How do you predict vehicles will be powered in 2050?

Brainstorm what your school could do to save transport fuels, such as a transport audit, car-pooling, walk to school day or encouraging students to bike to school.

7.5 Energy Forces

ACSSU117 Changes to an objects motion is caused by unbalanced forces including Earth's gravitational attraction acting on the object.

ACSSU116 Some of the Earth's resources are renewable, including water that cycles through the environment, but others are non-renewable.

Analyse how motion force and energy are used to manipulate and control electromechanical systems when designing simple engineered solutions.

Analyse ways to produce designed solutions through selecting and combining characteristics and properties of materials systems, components tools and equipment

ACTDEK031 Analyse how motion, force and energy are used to manipulate and control electromechanical systems when designing simple, engineered solutions.

ACTDEK034 Analyse ways to produce designed solutions through selecting and combining characteristics and properties of materials, systems, components, tools and equipment.

ACTDEP035 Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to design ideas.

ACTDEP036 Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical presentation techniques.

ACTDEP037 Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions.

ACTDEP038 Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability.

ACTDEP039 Use project management processes when working individually and collaboratively to coordinate production of designed solutions.

Electro-mechanical systems work both ways, mechanical forces acting on an object converted to electrical energy (generator) OR electrical energy fed into an object creates mechanical force (motor). Investigate forces that might be considered when constructing a simple machine or transporting water up a hill.

What is a force? What is pulling on me? Students examine forces exerted on objects by gravity, understand the difference between mass and weight and also that the earth's gravitational force on an object depends on the mass of the object.

Introduction to Forces (PowerPoint)

Outcome: Students identify contact forces and give examples of each, represent forces using arrows and explain the effects of balance and unbalanced forces.

Resources: What is a force

Force and Motion interactive

Exploring the force of water energy
Throughout time, people have used the energy of falling and flowing water to produce power - from waterwheels used to grind grain to modern hydro-electric dams to power cities. Engineers design many of these technologies. In Tasmania, water is a reliable, clean and inexpensive renewable energy source unlike fossil fuel-burning power plants on the mainland of Australia. Today civil, mechanical, environmental and electrical engineers work together to harness the energy of water and generate electricity from that resource. Water video

TASK: Build a renewable energy system such as a water wheel that uses the same wheel-and-axle machine concept behind the windmill.

Materials

- Litre plastic bottle
- Empty thread spool
- Various materials from which turbine blades can be constructed, such as index cards, plastic bottles, paper or plastic cups, cardboard, particle board, thick poster board, foam board, thin dowel rods and bamboo skewers.
- Pencil, tape, string, scissors, paper-clips and glue.

  1 or 2 multi-meters or volt-meters
- Jug or bowl, plastic bottles or cups to hold and pour water (the more the better)
- Water (from a tap or hose).

Method

1. Cut off the top of a one litre soft drink bottle at the point when it starts to narrow.
2. Cut two slits about 5 cm long and 1 cm wide on the top edge, directly across from each other.
3. Cut four holes near the base of the bottle about a quarter of an inch wide.
4. Cut the index cards so that you have four blades that are the length of the spool.
5. Make a small crease on the sides of the index cards to glue the blades to the spool, evenly spaced. Wait for the glue to dry completely.
6. Put a pencil through the hole in the middle of the spool.
7. Tie one end of the string (about 30 centimetres long) to the paper clip and glue the other end to the pencil. Let it dry completely.
8. Rest each end of the pencil in the slits you made at the top of the bottle.
9. Place your waterwheel under a tap, positioning the opening over the spool.
10. Turn on the tap.

http://00.edu-cdn.com/static/science-fair/engineering_windmill/water-wheel-diagram

Background research Investigate what's out there already. Draw and label a flowchart or diagram that describes the energy forms and changes that occur as water drives the system or how water is released from a dam and runs into a power station. Students could draw flow-charts for other energy transfer processes around them (i.e. boiling kettle, running the car).

TASK 2: Design a small-scale renewable energy system that generates power (such as a light bulb with wind, water, solar or methane).

Students define the problem and refine exactly what they will need to complete this activity. Students should develop a set of criteria for success that their finished project can be measured against. For example, the product will move a given amount of water over time without wasting/spilling water.

Imagine
Groups generate sketches for possible improved design solutions for the water wheel or wind turbine.

Design
Students detail how long they think their prototype will take to build and cost out materials (re/upcycling is recommended). Select appropriate materials for the design and explain the choice of particular materials. Designs sketching to be communicated and interpreted by others without background knowledge so easy to follow with all parts well named and purposes explained (annotations). Develop a work schedule.

Produce
During construction of the prototype, test and modify their solutions. As their designs evolve, students draw physical/digital scale plans. Students demonstrate they know how to safely operate tools that might be required to complete their design project.

Elaborate
In the production and implementation phase, students apply knowledge about components, materials and their properties. Justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions.

Evaluate and Improve
Students evaluate their designs against their own set of established criteria for success and against the designs from other groups. Students suggest modifications to their design to improve functionality.

Use project management processes when working individually and collaboratively to coordinate production of designed solutions.

Extension
Calculate project cost.

Calculate flow rates to work out the efficiency of their product.

Ratios of fractions and their unit rates: Students use ratio tables and ratio reasoning to compute unit rates associated with ratios of fractions in the given context.

- Flow Rate: Students apply their knowledge of volume to real-world contexts to solve problems involving rate of flow of liquid.
- Flow rate of a tap

ACTIVITY: Determine the flow rate of a tap and use the data to calculate flow rates.

Measure how much electrical energy is created.

Wider applications
Students consider other applications of their design and how this might be useful in a wider context. For example, in a remote aboriginal community or an African village. Students explain how their design has solved a problem and can make a positive impact on the lives of others.

Results Discussion
- What parts of your designs seemed to produce greater efficiencies in the turbines' abilities to convert water's energy into electricity?
- What parts of your designs seemed to produce lower efficiencies?
- How could we combine different design ideas from all the groups into one turbine that might have a greater efficiency than the individual turbines?

CLASS PRESENTATION: Student groups present their designs, including descriptions of how well the waterwheels worked and what improvements they might make to their designs.

YEAR 8 8.1 What is Energy?

ENERGY SURVEY

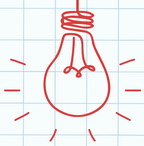
We buy energy, eat energy lose energy and use energy. This survey is designed to get you thinking about energy. Some have no right or wrong answers but ideas to start some discussion.

What does energy make you think of?

What do you think?		Yes/ true	No/ false	Don't know
1	I am energetic			
2	Food gives you energy			
3	The kilowatt is equal to 1000 watts.			
4	There is more solar energy striking the earth's surface in one and a half hours than all worldwide energy consumption in the year from all sources combined			
5	Energy can transform from one form to another.			
6	Electricity is a major source of energy in cities and industry.			
7	Energy transformations relate to change - forming new hemicals, things heating or moving.			
8	One kW/h of electricity costs approximately 27 cents in Tasmanian households.			
9	We have photo voltaic solar panels in our school.			
10	An uninsulated ceiling could waste 35% of winter heating costs.			
11	Lighting uses a half of the energy costs in an average Tasmanian home.			
12	We could save energy in our school.			
13	One star means an appliance is energy efficient.			
14	Non-renewable energy use contributes to climate change.			
15	Saving energy will reduce greenhouse gases.			
16	Electrical items on stand-by use no energy.			
17	Most electricity power plants in Australia get their energy from hydro power.			

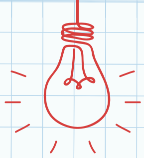
ENERGY COSTING SURVEY

Circle your answers				
Approximately how much does electricity cost per kW hour to a household?				
1 c	13c	27c	40 c	$1.00
To run a 2 kW fan heater on high for an hour costs approximately?				
1c	10c	25c	50c	$1.00
What is the average cost of a 3 minute shower?				
1c	10c	20c	30c	$1.00
What is a comfortable winter temperature for a classroom?				
14 C	18C	22 C	26 C	30 C
What uses most energy in the school?				
lights	heaters	computers	refrigerators	hot water
Why shouldn't we waste energy? Tick which ones you think				
Save money	Slow down cli-mate change	Improve air quality	Reduce greenhouse gases	All of these



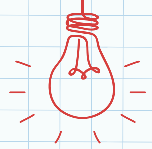
ENERGY SURVEY - ANSWERS

	What do you think?	Yes/ true	No/ false	Don't know
1	I am energetic			
2	Food gives you energy	Y		
3	The kilowatt is equal to 1000 watts.	Y		
4	There is more solar energy striking the earth's surface in one and a half hours than all worldwide energy consumption in the year from all sources combined	Y		
5	Energy can transform from one form to another. Like in a hydroelectric dam that transforms the kinetic energy of water into electrical energy. While energy can be transferred or transformed, the total amount of energy does not change - this is called energy conservation.	Y		
6	Electricity is a major source of energy in cities and industry.	Y		
7	Energy transformations relate to change - forming new chemicals, things heating or moving.	Y		
8	One kW/h of electricity costs approximately 27 cents in Tasmanian households. The cost to schools is approximately 17 cents.	Y		
9	We have photo voltaic solar panels in our school.	Y		
10	An uninsulated ceiling could waste 35% of winter heating costs.	Y		
11	Lighting uses a half of the energy costs in an average Tasmanian home. No 4% in a home, 23% in a school. Heating uses half both in schools and homes.		N	
12	We could save energy in our school. By behaviour change- closing doors, turning off lights and heaters in empty rooms.	Y		
13	One star means an appliance is energy efficient. No, 5 stars.		N	
14	Non-renewable energy use contributes to climate change.			
15	Saving energy will reduce greenhouse gases. Using less fossil fuels.	Y		
16	Electrical items on stand-by use no energy. Standby energy is Vampire energy! Standby power is responsible for 5.9 per cent of Australia's total residential electricity consumption, equal to $860 million annually!		N	
17	Most electricity power plants in Australia get their energy from hydro power. Hydro is 5% Wind 2% Coal 75% and gas 16% account of electricity generation.		N	



ENERGY COSTING SURVEY - ANSWERS

Circle your answers				
Approximately how much does electricity cost per kW hour to a household?				
1 c	13c	**27c**	40 c	$1.00
To run a 2 kW fan heater on high for an hour costs approximately?				
1c	10c	25c	**50c**	$1.00
What is the average cost of a 3 minute shower?				
1c	10c	20c	**30c**	$1.00
What is a comfortable winter temperature for a classroom?				
14 C	**18C**	**22 C**	26 C	30 C
What uses most energy in the school?				
lights	**heaters**	computers	refrigerators	hot water
Why shouldn't we waste energy? Tick which ones you think				
Save money	Slow down climate change	Improve air quality	Reduce greenhouse gases	**All of these**



8.2 Investigate different types of energy

ACSSU155 Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems.

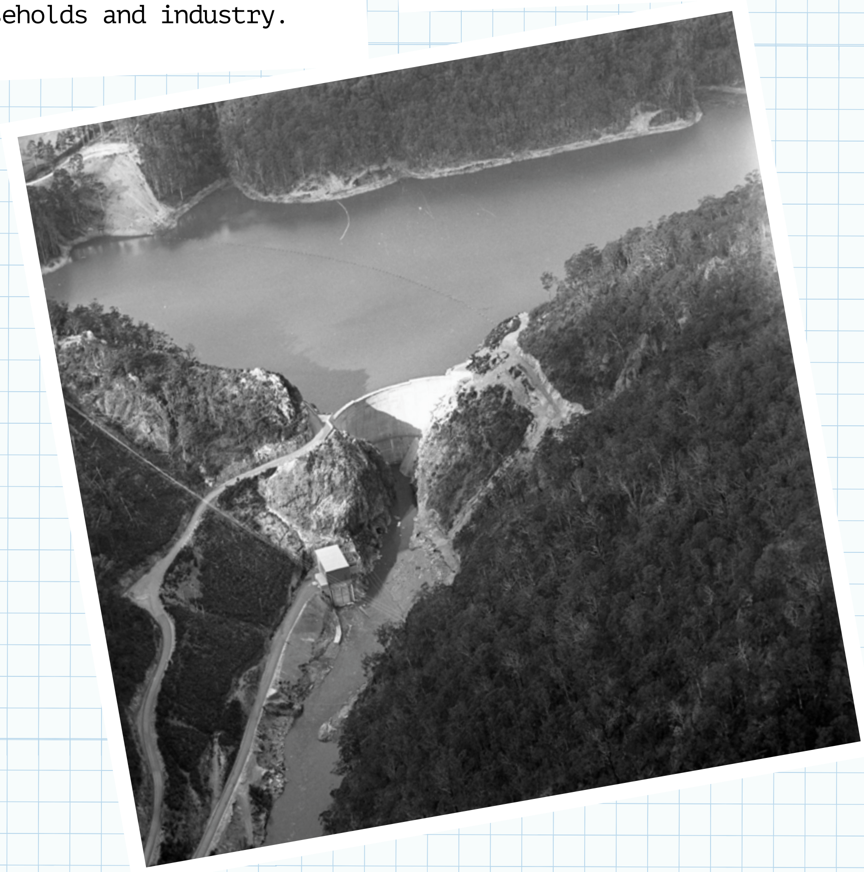
We buy energy, eat energy, waste energy, lose energy, and we use energy to ride a bike, run skip and play. When an object is moving it has energy, when you run you have energy. There are different types of energy (thermal, mechanical, electrical, etc.) that enable a person, an animal or a physical system to change and make something happen. Energy comes in different forms-for example, heat energy, light energy, chemical energy mechanical energy and nuclear energy.

The two main types of energy we use for energy generation in Tasmania are kinetic (moving) and potential (saved) energy. Kinetic energy is the energy in moving objects such as a wind or water turbine. Potential energy is stored energy that can be accessed, such as water in a dam for hydro-generation. Electrical energy is used to power most things in our households and industry.

There are many sources of energy. In 2015 around 55% of Tasmania's energy came from burning fossil fuels (like petrol used in our vehicles and coal and natural gas used in our industries). Around 40% of our energy came from electricity, principally generated using the power of hydro and wind (but also from mainland coal-fired power stations and local diesel generators).

In Tasmania, big industry uses 43% of our total energy and 24% is used to power our motor vehicles. Around 13% is used in our homes, mainly in the form of electricity.

One third of the energy we use in homes in Tasmania comes from wood used for heating. Most of the energy used in our homes and schools in Tasmania is electrical.energy, so this is the focus of the activities in this unit.



TASK: Sources of Energy.

DISCUSS: **Why do people need energy?**
How many motor vehicles (cars, motorbikes etc) does your family own?
How many did your parents/grandparents family own when they were children?
How do most people travel around their town, Australia and the world?
How does this differ from 50 and 100 years ago?

Think about all the electrical/gas appliances (entertainment, cooling, heating, lighting, cooking, cleaning) you have in your home - when did they become available? Before these appliances were available what did people use instead

TASK: Think about what you would do if there was no electricity, gas or petrol.
How would you:
Light your house?
Communicate with a friend?
Take a hot shower?
Clean the floor?
Store food in summer?
Cook food? **Get to the 10th floor of a building?**
Wash your clothes?
Keep warm?
Keep cool?
Travel to school or the next town or overseas?

WHOLE CLASS ACTIVITIES: Identify different types of energy (potential, kinetic, heat, chemical, stored, mechanical, magnetic) on Science by Doing. (This a free resource which requires teacher registration.) Brainstorm energy ideas and categorise these ideas as examples of heat, chemical, potential, kinetic, sound, thermal, electrical, magnetic or energy. Some things will fit into more than one category.

In small groups – Ask students to explore a selection of objects and describe what kind of energy each has. Example objects to provide include wind-up toy, rubber band, battery powered torch, tennis ball, candle, yoyo, firewood, coiled spring, spinning top, whistle, food, insulated cup, solar cells, rock (on the edge of the desk) balloon, compass or magnets.

Example answers: Potential kinetic energy: Rock on the edge of the table, coiled spring, stretched rubber band, yoyo before its released, child at the top of a slide, Slinky at the top of the stairs, soccer ball.

Potential chemical energy: Charged battery, wood in a fireplace, wax in a candle

Potential thermal energy: Contents of thermos, black brick

Sound Energy - whistle, balloonElectrical Energy:, fan, toaster
Heat energy: The sun, your body

Electro-magnetic energy: Microwave, x-rays

Magnetic-compass, magnets

CHEMICAL POTENTIAL ENERGY

ACSSU225 Chemical change involves substances reacting to form new substances.

Potential energy can be released as a product in the form of heat when fossil fuels are combined with oxygen. The energy in fossil fuels is chemical energy which is released when it is heated. Food energy such as glucose is chemical energy which releases energy when combined with oxygen in your body.

Bicarbonate Test
This easy and safe experiment allows students to observe a chemical reaction releases energy. This experiment shows a chemical change. Baking soda and vinegar activate into water and carbon dioxide which creates lots of fizzing energy.

Aim:
Undertake an experiment to observe a chemical reaction creating energy.

Materials

1. Baking soda – (sodium bicarbonate)
2. Vinegar - A dilute solution of acetic acid in water.
3. A small container with pop-off lid such as a play doh or toy container.
4. A small zip lock plastic bag.

Method

Mix a teaspoon or baking powder with a teaspoon of vinegar into the plastic bottle.

Quickly close the lid.

Place into the zip lock and shake vigorously.

Results:

The chemical reaction
When baking soda is mixed with vinegar, something new is formed. The mixture quickly foams up with carbon dioxide gas. If enough vinegar is used, all of the baking soda can be made to react and disappear into the vinegar solution. The reaction will pop the top of the plastic bottle and create a bang!

Discussion:

The baking powder has STORED energy. When the baking powder reacts with the vinegar, this **energy** is **released**. The more baking powder that is used, the more energy will be released. The stored energy released when the baking powder reacts with the vinegar is CHEMICAL energy. The reaction makes carbon dioxide gas.

What did you expect to happen?

What happened? Was your experiment successful? If not why not?

Try using a balloon instead of a plastic bag. What happens?

What did you find out about energy?

NOTE: *The products of the reaction are relatively safe (Remember - no chemicals should be touched. They can be disposed of by washing down the sink with plenty of water*

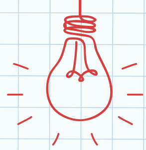
EXPLORING ENERGY TRANSFER

ACSIS145 Summarise data from students own investigations and secondary sources, use scientific understanding to identify relationships and draw conclusions based on evidence.

ACSIS148 Communicate ideas, findings, and evidence-based solutions to problems using scientific language and representations, using digital technologies, as appropriate.

ACSIS146 Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements.

ACTDEK031 Analyse how motion, force and energy are used to manipulate and control electromechanical systems when designing simple, engineered solutions.



Aim: Research and design an experiment to test the energy transfer of a rubber band vehicle.	
Equipment Vehicle body: sturdy cardboard, foam board, or balsa wood Straws Axles: wooden dowel or chopsticks Wheels: use plastic bottle caps, film canister caps, foam board, toy wheels - or coffee cups, computer discs Rubber bands Scissors Duct tape Rubber bands (at least 3) Paperclips Pencil or pen Metal washers for weights Coins Stopwatch	**Method** • Students research internet to gather ideas. • Collect the necessary materials. • Work in teams to build and test the speed of materials. The more the rubber band is twisted around the axle, the more potential energy is built up. When let go, the rubber band will snap back to its original form, spinning the axle in the process. The potential energy in the stretched band is converted into kinetic energy propelling the car forward! There are many ways to change the vehicle car design to make it go faster or further. Experiment with different types of wheels.

Results:

Elastic **potential energy** is stored in the rubber band when it is twisted up. When the rubber band is released, the potential energy built up in twisting gets unloaded and turned into **mechanical energy**. The 'car' pushes against the ground as the rubber band unwinds so that the only place the mechanical energy has left to go is into the wheels in the form of **torque**, or force around an axis. This enables the car to roll forward.

Discussion:

Will the car go further if you use bigger wheels, or wheels with less friction? What if you use bigger wheels in the back and smaller in the front? Or a 3-wheeled design? Try building a car with CDs for wheels. Does the weight of the car affect how it travels? Try adding a load like coins or washers to the car and see how it changes the distance or speed. What happens if the chassis is longer? If the car starts on a ramp, how much further will it travel?

Try building two cars with different features and race them against each other!

What do you expect to happen?

8.3 Energy Systems

ACTDEP037 Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions.

ACTDEP035 Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas.

ACTDEP036 Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques.

ACTDEP038 Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability.

ACTDEP039 Use project management processes when working individually and collaboratively to coordinate production of designed solutions.

ACTDEK029 Investigate the ways in which products, services and environments have evolved locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures.

RESOURCES:

Renewable Energy Tasmania http://tasrenew.org.au/

Hydro Tasmania https://www.hydro.com.au/clean-energy

Hydrogen Fuel https://www.eia.gov/kids/energy.php?page=hydrogen_home-basics

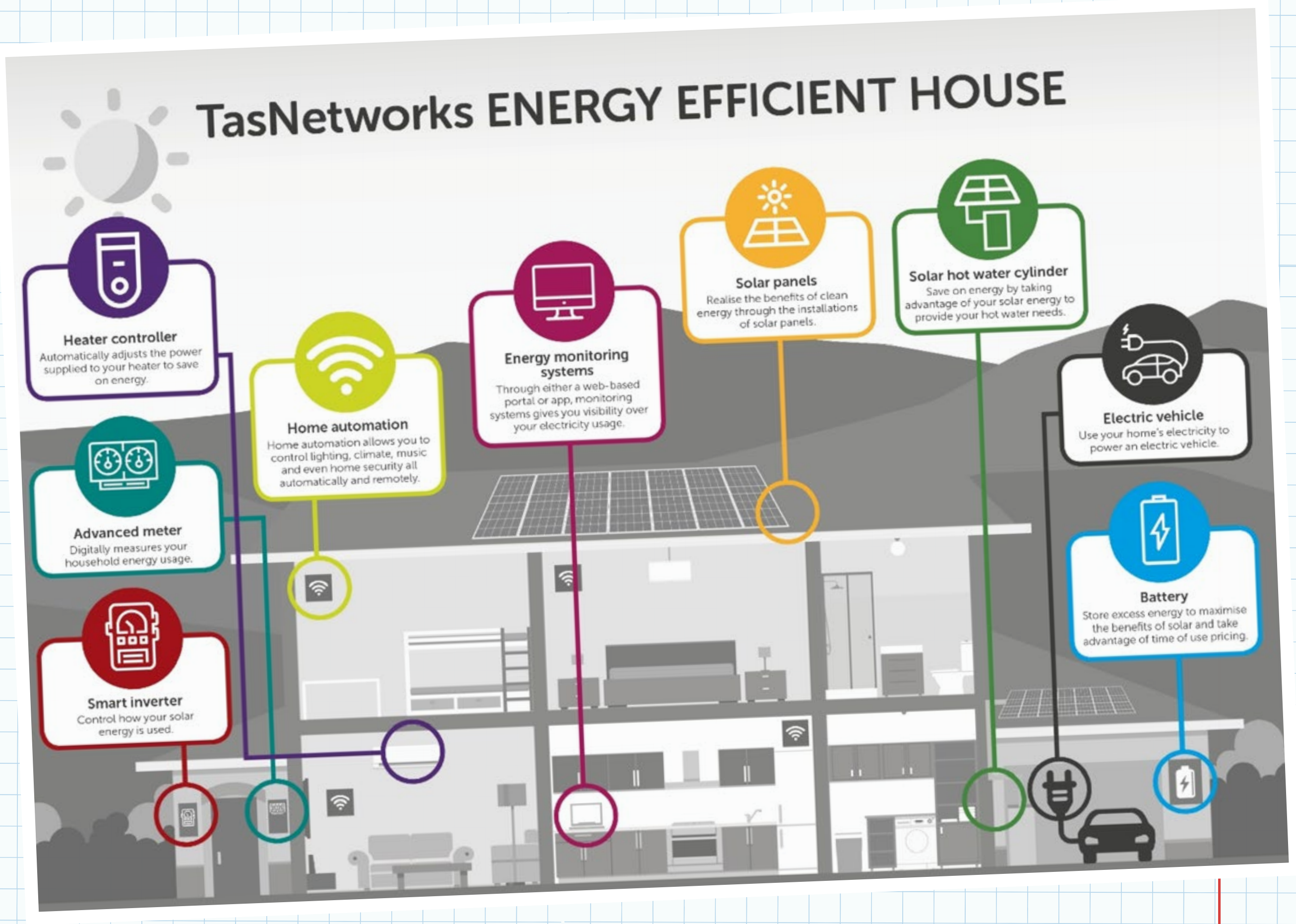
Bruny Island Battery Trial http://brunybatterytrial.org/

Explore the technology relating to an energy efficient house

ACSHE120 Solutions to contemporary issues that are found using science and technology, may impact on other areas of society and may involve ethical considerations.

ACTDEP037 Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions.

ACTDEP038 Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability.



Explore the impact of the monitoring, metering and renewable energy technology on energy efficiency.

Evaluate these innovations and information systems in terms of meeting the needs of consumers to be more sustainable.

Research the source of raw materials, manufacture and technological impact of the equipment used for this energy efficient house.

DESIGN AND MAKE AN ENERGY-EFFICIENT HOUSE

Research and explore modelling of a 'shoe box' or scrap cardboard house with renewable energy solutions for Tasmanian conditions with passive solar design, considering energy use, and cost savings. Include insulation, thermal mass, site orientation and surface colours.

Use a cardboard box to make the basic shape. Collect a variety of construction materials, insulation, window materials (eg 10cm x 10cm glass, perspex)

Think about:

- orientation, so the house is **north facing** to absorb maximum solar energy
- **maximising the light** - a long narrow house will allow more solar energy to be absorbed than a 'boxy' house
- **cladding** - brick, wood, tin, concrete
- **windows** - double glazed, argon filled, low e glass, aluminium or wood frames
- **insulation** in the walls, floors and ceilings
- **passive solar design** - using north facing windows, trombe walls*, thick floors which absorb and store heat
- small windows which face **south** to avoid major heat loss in the winter
- windows that allow good **airflow** from one side of the house to the other to cool the house in summer
- good insulating **curtains** or blinds with close-fitting pelmets to reduce heat loss
- placement and design of pergolas to ensure they don't keep out the warm winter sun
- using **recycled materials**
- **natural lighting** - sky lights

- energy **efficient lighting** such a LED's
- catching and storing **rain-water**
- **reusing grey water** (such as from sinks and showers)
- a **vegetable garden** with wicking beds
- a **water wise garden** - using native plants
- **placement of trees** which will not shade north facing walls
- **renewable energy** - photo voltaic (pv) cells, solar hot water, wind turbine
- **fire management** - reduce tall vegetation close to the house
- **low maintenance** - minimise the amount of painting, cleaning and replacing - use long lasting materials
- **recycled materials**
- **living areas** which are light and warm
- **laundry**, **bathroom**, **bedrooms** don't require so much light and heat.

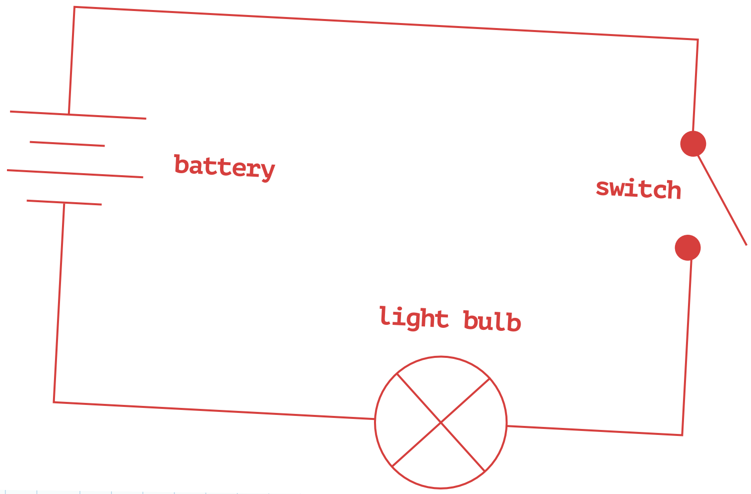
**A trombe wall is a sun-facing black brick wall separated from the outdoors by glass and an air space, which absorbs solar heat and releases it inside at night.*

ENERGY EFFICIENT BUILDING DESIGN

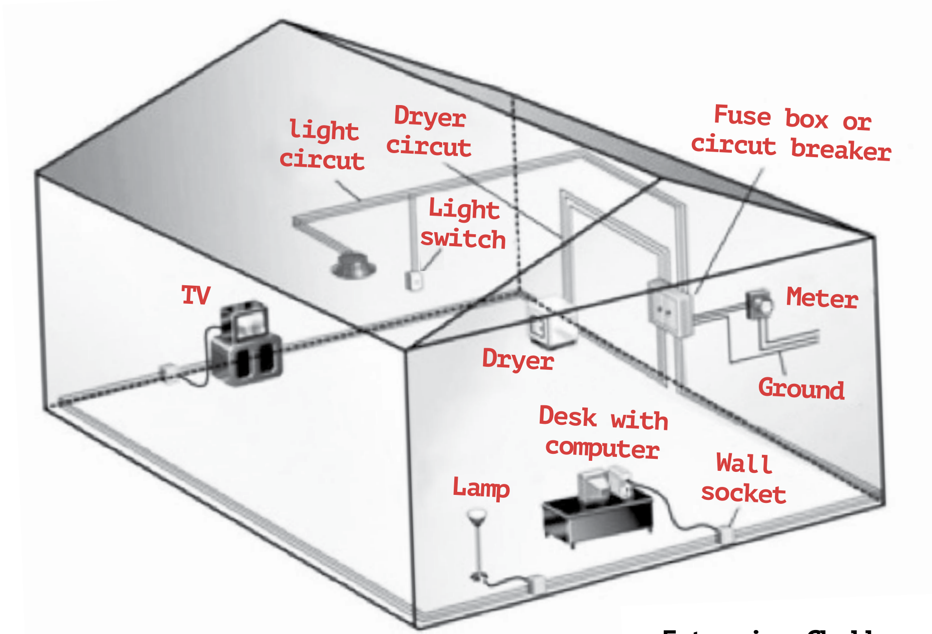
Draw your building plan

Building Specifications	Details / Notes / Materials	Tick
Orientation - facing North?		
Shape – allow maximum sun to rooms		
Building materials		
Floors		
Walls		
Windows		
Window frames		
Large windows facing North		
Small windows facing South		
Air flow from windows		
Curtains/pelmets		
Passive solar		
Insulation		
Natural lighting		
Electrical lighting		
Water tanks		
Vegetable garden		
Native garden		
Reusing grey water		
Renewable energy		
Photovoltaics (pv's)		
Solar hot water		
Wind turbine		
Fire management		
Recycled materials		
Low maintenance		
Non-toxic materials		
Heating		
Other		

TASK: Use Google SketchUp or Planner 5D to draw up your plans.
Design a circuit for the house. Show the energy loss in the system. A circuit is a closed loop that an electrical current flows through, to power something like a light or a motor.



Parallel Circuits Most circuits in a house are parallel so that even if one device stops working, the others will still function.



Extension Challenge: Mount a data-logging thermometer in each model, to calculate which house maintains the most comfortable temperature over a period (a week). Model houses need to sit outdoors in an un-shaded location to be subjected to the same climatic conditions as a real house.

Add little 10W heaters for supplementary heating, controlled by a Raspberry Pi. Optimize heating controls and temperature sensors to determine when to turn on & off.

http://z-diagram.com/circuit-diagram/a-simple-circuit-diagram

8.4 Insulation

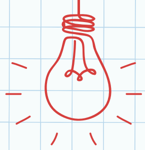
ACSIS139 Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge.

Insulation is anything that helps reduce the transfer of heat. Marine mammals have a thick insulating layer of blubber, sheep have a woolly coat, the Earth has greenhouse gases and our homes have ceiling bats.

Heat loss by conduction in a building happens through the ceiling, walls, windows and the floor, Moving air, such as a draught, takes heat with it. Air is a poor heat conductor so if the air is trapped, such as in double glazing, it will help to insulate the building.

Investigating the effectiveness of different materials at keeping in heat, can be important for understanding energy efficiency. Using the infrared radiometer, go on a trip around the school or your house and check to see where heat is escaping through the ceiling, floors, window frames and walls. Point at the surface, pull the trigger and the temperature will show on the screen.

The infrared radiometer measures the surface temperature of whatever it is pointing at (not shiny surfaces). This can be useful for finding poorly insulated spots on walls, ceilings, floors, hot water cylinders and fridges. Typically, the biggest loss of heat from a building occurs through the ceiling (up to 35%), floors (up to 15%) and walls (up to 30%).



TESTING INSULATION MATERIALS

To keep a hot drink warm for as long as possible, what kind of material is the best insulator? Design an experiment to test the insulation properties of different insulating materials: such as newspaper, wool, foam, wet-suit material.

Questioning and Predicting:

1. What equipment will you need to conduct the experiment?
2. Why would you need a thermometer and stopwatch?
3. How will you make the experiment a fair test?
4. How will you record your results?
5. How could you improve the experiment?

Making Predictions:
Which material do you think will be the best insulator? Explain why you think this will be the case, referring to energy transfer.

Extension Activity: What difference would it make to have a lid on the jars?

Method:

1. List all the items to be tested.
2. Wrap each of the jars in one of the insulating materials. Leave one jar uncovered.
3. Record the temperature of the hot water in the jug and then fill each jar.
4. Put lids on the jars. Leave for 60 minutes.
5. Remove the insulating material and measure the temperature of the water in each jar with a radiometer.
6. Which materials are most effective at keeping the water warm, closest to the original temperature?

Experiment with different lengths of time and thicknesses of insulation. How long does it take for all the jars to reach room temperature? Compare this with a thermos.

TASK: Design an experiment to test materials
Insulating materials - such as clothing - (cotton, wool and synthetic), newspaper, foam, etc.

House insulation material - wool, pink batts, fiberglass (only handle with gloves)

Jars with lids: all the same size, on a tray

A large jug of hot water from the tap or kettle.

Thermometers

INSULATION EXPERIMENT RESULTS

Insulation Type	Temperature of water	60 minutes later

Discussion Questions:
What do these results tell you?

What material makes the best insulation for houses and for people? Investigate insulation and R factors. The R factor is a measure of how well the material resists the flow of heat through it. www.yourhome.gov.au/passive-design/insulation

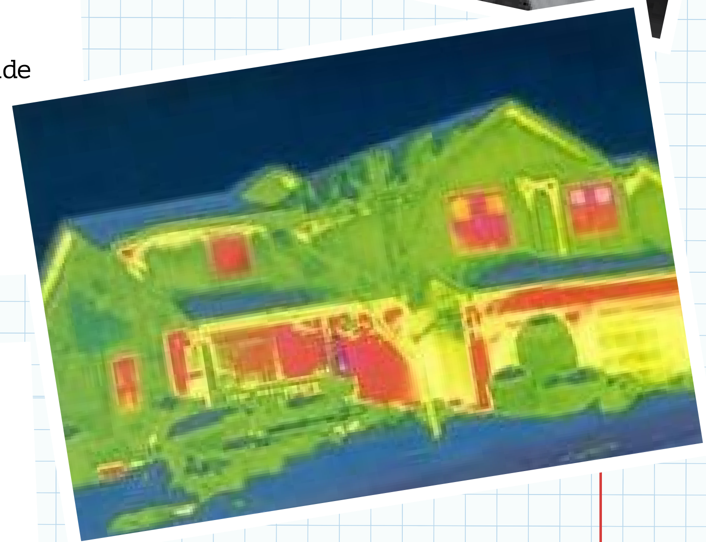
LOCATING HEAT LOSS – OUTSIDE

How this works: When objects increase in temperature, two things happen. First, they produce more light. Second, the wavelength of light gets shorter. Note that they don't just produce one wavelength, but in general the hotter the object the shorter the wavelength.

If you look at the wavelength of light (technically, the wavelength of the highest intensity light), you can get an estimate for the temperature of that object.

In this thermal imaging photograph, you can see where heat is escaping from a house (red = high heat loss, yellow green = medium heat loss, blue = low heat loss).

On a cold night, walk around the outside of your house and use the infrared radiometer to identify where heat is escaping.



Tick the box when you find heat loss:

- ☐ where pipes come out of walls
- ☐ where wiring comes out of walls
- ☐ out the chimneys
- ☐ around doors
- ☐ around windows
- ☐ entrances to under the house
- ☐ cracks and holes in the mortar
- ☐ other

Download a free Thermal Infrared Camera App to explore thermal effects using tonal mapping which simulates an infrared spectrum.

Take a phot of your house with the infrared app and show where the heat can escape:

TASK: Identify problems and actions that could make a difference.

Problem	Solution
Gap under back door	Attach door seal
Gap under back door	Smooth out insulation
Heat escaping up unused fireplace	Seal (for example, with a piece of foam) in fireplace when not being used

Discussion Questions:
Which rooms are warmest and coolest?

Where is heating being lost in these rooms?

8.5 Energy Conservation and Transfer

ACSSU155 Energy appears in different forms, including movement (kinetic energy), heat and potential energy, and energy transformations and transfers cause change within systems.

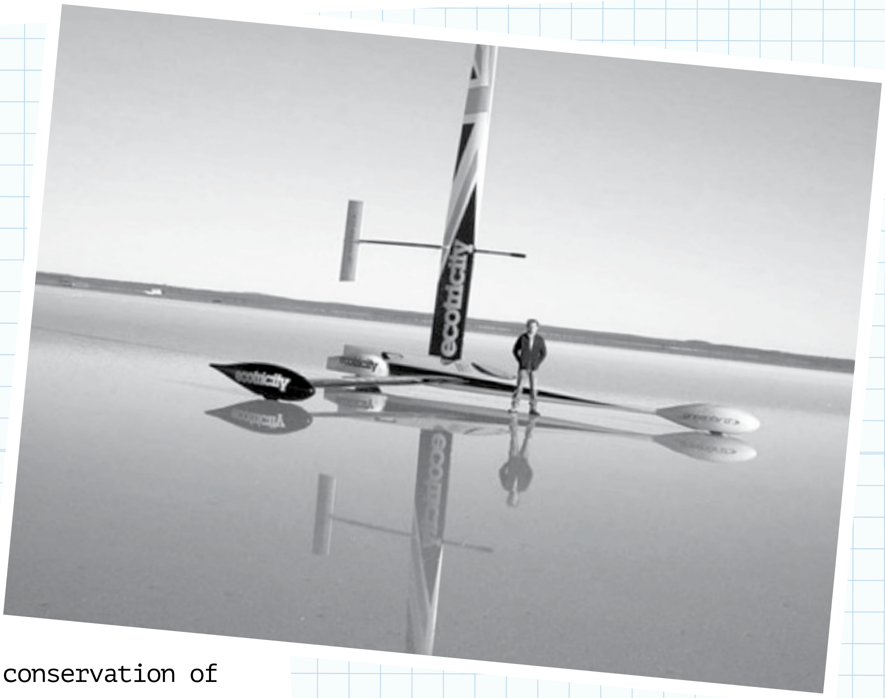
ACSIS148 Reflect on scientific investigations including evaluating the quality of the data collected and identifying improvements.

ACTDEP037 Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions.

ACTDEP038 Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability.

ACTDEP039 Use project management processes when working individually and collaboratively to coordinate production of designed solutions.

ACSIS141 Measure and control variables, select equipment appropriate to the task and collect data with accuracy.



Understand the law of conservation of energy. (The first law of thermodynamics is a physical law of science says that energy cannot be created or destroyed but is changed from one form to another.

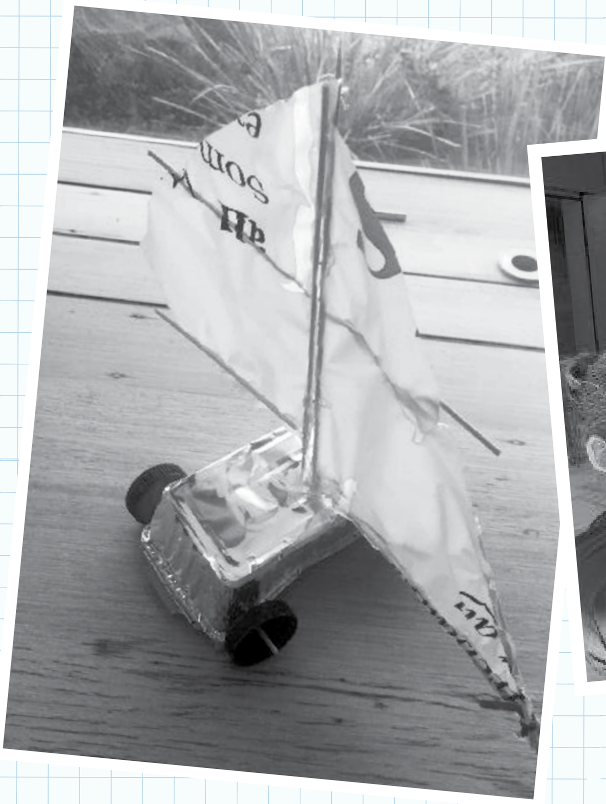
Why do things move? Connect energy transfer to the production of electricity. Identify and label a system of energy transfer.

Exploring Wind Energy with Land Yachts
The first land yacht was invented in 1600 by a Flemish scientist Simon Stevin. The world land speed record for a wind-powered vehicle was broken in 2009 by Richard Jenkins in his yacht *Greenbird* with a speed of 202.9 km/h. Research the history of Land Yachts.

https://inhabitat.com/ecotricity-greenbird-attempts-wind-powered-landspeed-record/?variation=d

A Model of a Land Yacht or a wind turbine can be made from waste materials. They are light-weight and can move wind, generated by a desk fan. Students can experiment with different sizes, shapes and numbers of sails.

Suggested recycled materials	Tools
• Milk bottle tops • Frame such as recycled containers • Skewers • Plastic bags, plastic sheets • Straws	• Drill (to drill out the holes in the bottle tops and the base frame) • Glue Gun • Tape • Fan



High School students designing land yachts and wind turbines in Abu Dhabi and New Town High.

High School students designing land yachts and wind turbines in Abu Dhabi and New Town High.

Predictions:

Does the size of the sail make a difference?

Does the shape of the sail make a difference?

Do two sails on the same mast make a difference?

Do straight sails or 'angled' sails make a difference?

Explain Findings

Measure distance travelled comparing effectiveness of various designs.

SCIENCE					
Science Understanding	A	B	C	D	E
Earth and Space Sciences Some of Earth's resources are renewable, including water that cycles through the environment, but others are not renewable. ACSSU116	Critical analysis of how the sustainable use of resources depends on the way they are formed and cycle through Earth systems.	Informed analysis of how the sustainable use of resources depends on the way they are formed and cycle through Earth systems.	Analysis of how the sustainable use of resources depends on the way they are formed and cycle through Earth systems.	Description of how the sustainable use of resources depends on the way they are formed and cycle through Earth systems.•	Statements about sustainable use of resources.
Science as a Human Endeavor					
Nature and development of science Scientific knowledge has changed peoples' understanding of the world and is refined as new evidence becomes available. ACSHE134 Science knowledge can develop through collaboration across the disciplines of science and the contributions of people from a range of cultures. ACSHE226	Thorough description of situations where scientific knowledge from different science disciplines and diverse cultures used to solve a real-world problem.	Informed description of situations where scientific knowledge from different science disciplines and diverse cultures has been used to solve a real-world problem.	Description of situations where scientific knowledge from different science disciplines and diverse cultures has been used to solve a real-world problem.	Identification of situations where scientific knowledge from different science disciplines and diverse cultures has been used to solve a real-world problem.	Statements about scientific knowledge being used to solve a real-world problem.
Use and influence of science People use science understanding and skills in their occupations and these have influenced the development of practices in areas of human activity. ACSHE136	Justified explanation of possible implications of the solution for different groups in society.	Informed explanation of possible implications of the solution for different groups in society.	Explanation of possible implications of the solution for different groups in society.	Description of implications of the solution for different groups in society.	Statements about how the solution impacts on different groups.

SCIENCE Science Inquiry Skills	A	B	C	D	E
Questioning and Predicting Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge. ACSIS124	Identification of questions that can be investigated scientifically and the making of justified predictions.	Identification of questions that can be investigated scientifically and the making of plausible predictions.	Identification of questions that can be investigated scientifically.	Guided identification of questions that can be investigated scientifically.	Directed identification of questions that can be investigated. scientifically.
Planning and Conducting Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed. ACSIS125 Measure and control variables, select equipment appropriate to the task and collect data with accuracy. ACSIS126	Planning of fair experimental methods that: – identify and describe how variables are changed, measured and controlled – select appropriate equipment that improves fairness and accuracy – describe how to manage safety. considerations. • accurate collection of reliable data	Planning of fair experimental methods that: – identify variables to be changed, measured and controlled – select appropriate equipment that improves fairness and accuracy – describe the implications of safety considerations. • accurate collection of data	Planning of fair experimental methods that: – identify variables to be changed and measured – select equipment that improves fairness and accuracy – describe how safety is considered.	Partial planning of fair experimental methods that identify: • variables to be changed and measured • equipment to be used • safety considerations.	• use of provided experimental methods • identification of safety considerations

SCIENCE **Science Inquiry Skills**	A	B	C	D	E
Processing and analysing data and information Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate. ACSIS144 Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions based on evidence. ACSIS145	Drawing on evidence to justify conclusions through: • explanation of relevant trends and relationships in data • accurate summaries of relevant data from different sources.	Drawing on evidence to inform conclusions through informed description of relevant trends and relationships in data • summaries of relevant data from different sources.	Drawing on evidence to support conclusions through: • description of trends in data and summaries of data from different sources.	Drawing of conclusions identification of trends in data. • summarising data.	Directed statements about data.
Evaluating Reflect on scientific investigations including evaluating the quality of the data collected, and identifying improvements. ACSIS146 Use scientific knowledge and findings from investigations to evaluate claims based on evidence. ACSIS234	Reflective reference to the quality of data when explaining how effective improvements would enhance methods.	Reference to the quality of data when suggesting effective improvements to methods.	Reference to data when suggesting improvements to methods.	Suggestions of improvements to methods.	Statements about methods.

SCIENCE					
Science Inquiry Skills	A	B	C	D	E
Communication Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate. ACSIS148	Concise and coherent communication of ideas, methods and findings using relevant scientific language and appropriate and accurate representations.	Coherent communication of ideas, methods and findings using relevant scientific language and appropriate and accurate representations.	Communication of ideas, methods and findings using scientific language and appropriate representations.	Communication of ideas, methods and findings using everyday language and representations.	Fragmented communication of ideas, methods and findings.
Digital Technologies					
Knowledge and understanding Investigate the ways in which products, services and environments evolve locally, regionally and globally and how competing factors including social, ethical and sustainability considerations are prioritised in the development of technologies and designed solutions for preferred futures. ACTDEK029	Comprehensive explanation of: • factors that influence the design of products, services and environments to meet present and future needs • the contribution of design and technology innovations and enterprise to society.	Detailed explanation of: • factors that influence the design of products, services and environments to meet present and future needs • the contribution of design and technology innovations and enterprise to society.	Explanation of: • factors that influence the design of products, services and environments to meet present and future needs • the contribution of design and technology innovations and enterprise to society.	Description of: • factors that influence the design of products, services and environments to meet present and future needs • the contribution of design and technology innovations and enterprise to society.	Statements about: • factors that influence the design of products, services and environments to meet present and future needs • the contribution of design and technology innovations and enterprise to society.

SCIENCE Digital Technologies	A	B	C	D	E
Analyse how motion, force and energy are used to manipulate and control electromechanical systems when designing simple, engineered solutions. ACTDEK031 Analyse ways to produce designed solutions through selecting and combining characteristics and properties of materials, systems, components, tools and equipment. ACTDEK034	Comprehensive explanation of how the features of technologies impact on designed solutions and influence design decisions for each of the prescribed technologies contexts.	Detailed explanation of how the features of technologies impact on designed solutions and influence design decisions for each of the prescribed technologies contexts.	Explanation of how the features of technologies impact on designed solutions and influence design decisions for each of the prescribed technologies contexts.	Partial explanation of how the features of technologies impact on designed solutions and influence design decisions for each of the prescribed technologies contexts.	Statements about how the features of technologies impact on designed solutions and influence design decisions for each of the prescribed technologies contexts.

SCIENCE Processes and Production Skills	A	B	C	D	E
Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas. ACTDEP035 Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques. ACTDEP036 Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions. ACTDEP037 Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability. ACTDEP038 Use project management processes when working individually and collaboratively to coordinate production of designed solutions. ACTDEP039	Comprehensive evaluation of needs or opportunities for each of the prescribed technologies contexts.	Detailed evaluation of needs or opportunities for each of the prescribed technologies contexts.	Evaluation of needs or opportunities for each of the prescribed technologies contexts.	Explanation of needs or opportunities for each of the prescribed technologies contexts.	Statements about needs or opportunities for each of the prescribed technologies contexts.
	Purposeful creation and adaptation of design ideas and solutions for intended purpose, making well-considered decisions.	Effective creation and adaptation of design ideas and solutions for intended purpose, making considered decisions.	Creation and adaptation of design ideas, making considered decisions.	Partial creation and adaptation of design ideas, making decisions.	Fragmented creation and adaptation of design ideas.
	Comprehensive and effective communication to different audiences: • appropriate technical terms a range of technologies and graphical representation technique.	Confident communication to different audiences: • appropriate technical terms a range of technologies and graphical representation techniques.	Communication to different audiences using: • appropriate technical terms a range of technologies and graphical representation techniques.	Partial communication to audiences using: • technical terms technologies and graphical representation techniques.	Fragmented communication to audiences using • everyday language graphical representation techniques.

SCIENCE Processes and Production Skills	A	B	C	D	E
Critique needs or opportunities for designing and investigate, analyse and select from a range of materials, components, tools, equipment and processes to develop design ideas. ACTDEP035 Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques. ACTDEP036	Development of comprehensive criteria for success, including sustainability considerations.	Discerning use of developed criteria for success (including sustainability considerations) to judge the suitability of: • their ideas designed solutions and processes.	Use of developed criteria for success (including sustainability considerations) to judge the suitability of: • their ideas designed solutions and processes.	Partial use of developed criteria for success (including sustainability considerations) to describe the suitability of: • their ideas designed solutions and processes.	Fragmented use of developed criteria for success to make statements about: • their ideas designed solutions and processes.
Select and justify choices of materials, components, tools, equipment and techniques to effectively and safely make designed solutions. ACTDEP037 Independently develop criteria for success to evaluate design ideas, processes and solutions and their sustainability. ACTDEP038 Use project management processes when working individually and collaboratively to coordinate production of designed solutions. ACTDEP039	Comprehensive application of project management skills, including detailed documentation and informed use of project plans, to manage production processes both as an individual and part of a team.	Application of project management skills, including detailed documentation and informed use of project plans, to manage production processes both as an individual and part of a team.	Application of project management skills, including documentation and use of project plans, and use of production processes both as an individual and part of a team.	Application of project management skills, including partial documentation and use of project plans, and use of production, processes both as an individual and part of a team.	Limited application of project management skills, including partial documentation and use of project plans, and some use of production processes , both as an individual and part of a team.

SCIENCE **Processes and Production Skills**	A	B	C	D	E
Acquire data from a range of sources and evaluate authenticity, accuracy and timeliness. ACTDIP025 Analyse and visualise data using a range of software to create information, and use structured data to model objects or events. ACTDIP026 Define and decompose real-world problems taking into account functional requirements and economic, environmental, social, technical and usability constraints. ACTDIP027 Design the user experience of a digital system, generating, evaluating and communicating alternative designs. ACTDIP028	Proficient production of designed solutions: • demonstrating safe work practices • identifying appropriate technologies and techniques.	Effective production of designed solutions: • demonstrating safe work practices • identifying appropriate technologies and techniques.	Production of designed solutions: • demonstrating safe work practices • identifying appropriate technologies and techniques.	Partial production of designed solutions: • demonstrating safe work practices • identifying technologies and techniques.	Guided designed solutions: • demonstrating safe work practices • identifying aspects of technologies and techniques.
	Comprehensive explanation of how products, services and environments are designed to best meet needs of communities and their environments.	Detailed explanation of how products, services and environments are designed to best meet needs of communities and their environments.	Explanation of how products, services and environments are designed to best meet needs of communities and their environments.	Description of how products, services and environments are designed to best meet needs of communities and their environments.	Statements about products, services and environments are designed to meet needs of communities and their environments.
	Considered evaluation of ideas and designed solutions against identified criteria for success, including environmental sustainability considerations.	Informed evaluation of ideas and designed solutions against identified criteria for success, including environmental sustainability considerations.	Evaluation of ideas and designed solutions against identified criteria for success, including environmental sustainability considerations.	Explanation of ideas and designed solutions against identified criteria for success, including aspects of environmental sustainability considerations.	Statements about ideas and designed solutions against identified criteria for success.

MATHEMATICS					
By the end of Year 8, students solve everyday problems involving rates, ratios and percentages. They make sense of time duration in real applications. They chose appropriate language to describe events and experiments. They explain issues related to the collection of data and the effect of outliers on means and medians of that data.					
Proficiency Strands	A	B	C	D	E
Problem Solving Includes formulating and solving authentic problems using numbers and measurements, working with transformations and identifying symmetry, calculating angles and interpreting sets of data collected through chance experiments.	Systematic application of relevant problem-solving approaches to investigate unfamiliar situations.	Application of relevant problem-solving approaches to investigate complex familiar situations.	Application of problem-solving approaches to investigate simple familiar situations.	Some identification of simple mathematical concepts.	Statements about obvious mathematical concepts.
Numbers and Algebra					
Real Numbers Solve problems involving addition and subtraction of fractions, including those with unrelated denominators. ACMNA153 Multiply and divide fractions and decimals using efficient written strategies and digital technologies. ACMNA154 Express one quantity as a fraction of another, with and without the use of digital technologies. ACMNA155 Round decimals to a specified number of decimal places. ACMNA156 Find percentages of quantities and express one quantity as a percentage of another, with and without digital technologies. ACMNA158 **Money and financial mathematics** Investigate and calculate 'best buys', with and without digital technologies. ACMNA174	Clear explanation of mathematical thinking and reasoning, including justification of choices made, evaluation of strategies used and conclusions reached. Development of mathematical models and representations in unfamiliar situations.	Explanation of mathematical thinking and reasoning, including reasons for choices made. Development of mathematical models and representations in complex familiar situations.	Description of mathematical thinking and reasoning, including discussion of choices made, strategies used and conclusions reached. Development of mathematical models and representations in simple familiar situations.	Statements about choices made, strategies used and conclusions reached. Statements about simple mathematical models and representations.	Isolated statements about given strategies or conclusions. Isolated statements about given strategies or conclusions.

Chance	A	B	C	D	E
Assign probabilities to the outcomes of events and determine probabilities for events. ACMSP168 **Data representation and interpretation** Identify and investigate issues involving numerical data collected from primary and secondary sources. ACMSP169 Calculate mean, median, mode and range for sets of data. Interpret these statistics in the context of data. ACMSP171 Describe and interpret data displays using median, mean and range. ACMSP172	Clear explanation of mathematical thinking and reasoning, including justification of choices made, evaluation of strategies used and conclusions reached.	Explanation of mathematical thinking and reasoning, including reasons for choices made.	Description of mathematical thinking and reasoning, including discussion of choices made, strategies used and conclusions reached.	Statements about choices made, strategies used and conclusions reached.	Statements about obvious mathematical concepts.
	Development of mathematical models and representations in unfamiliar situations.	Development of mathematical models and representations in complex familiar situations.	Development of mathematical models and representations in simple familiar situations.	Statements about simple mathematical models and representations.	Isolated statements about given strategies or conclusions.

This unit addresses the *sustainability* cross curricula priority. The organising ideas relevant for this energy use and efficiency unit are below.

Organising idea 3
Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems. (Systems)

Organising idea 4
World views that recognise the dependence of living things on healthy ecosystems, and value diversity and social justice are essential for achieving sustainability. (World views)

Organising idea 5
World views are formed by experiences at personal, local, national and global levels, and are linked to individual and community actions for sustainability. (World views)

Organising idea 6
The sustainability of ecological, social and economic systems is achieved through informed individual and community action that values local and global equity and fairness across generations into the future. (Futures)

Organising idea 7
Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments. (Futures)

Organising idea 8
Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgments based on projected future economic, social and environmental impacts. (Futures)

DEFINITIONS

Climate Modelling The use of mathematical or software that simulates the environmental interactions between air, water, and land. Altering variables in the model will produce a change which provides useful information on local, national, or even global conditions for our future climate.

Conservation of energy The total energy of a system remains constant regardless of changes in the system. Energy cannot be created or destroyed.

Energy efficiency can be used to describe how much energy is lost in a process. The more efficient a process, the more energy that is retained and less lost.

Electricity is the flow of an electric charge through wires. A convenient and preferred form of energy used by people, homes, business, cities, and industry.

Electrical grid is the electrical power system network comprised of the generating plant, the transmission lines, the substation, transformers, the distribution lines and the consumer.

Electro mechanical device An electric signal is used to create mechanical movement of a device.

Energy the capacity to do work or make a change, measured in watt-hours

Force the push or pull on an object

Kinetic energy is the energy of motion.

Mechanical energy The sum of both potential energy and kinetic energy in an object used to do work.

Chemical energy Energy stored in the bonds of chemical compounds (atoms and molecules). It is released in a chemical reaction, often producing heat as a by-product (exothermic reaction). Batteries, biomass, petroleum, natural gas, and coal are examples of stored chemical energy.

Hydro electricity Hydroelectric power plants produce electricity from the flow of the water through the dam. Once the water reaches the turbines, it is traveling at about 38 meters per second. That flow contains a lot of kinetic energy. The water gets this kinetic energy because of a drop in elevation from the reservoir to the outlet. This drop, in height, converts the water's potential energy into kinetic energy.

Kilowatts kWh this equals 1000 watts of electricity. When you are billed 1kWh of electricity consumption that means you used 1kW of electricity for one hour. (i.e. you left ten 100w light bulbs on for one hour or a 1 kW heater on for one hour.

Power is the amount of energy produced in a given amount of time. Power is often measured in watts or kilowatts. Power is energy per unit of time. The standard unit of electrical power is the watt, which is defined as a current of one ampere, pushed by a voltage of one volt. One watt of electrical power, maintained for one hour, equals one watt-hour of energy. Electric power is the rate at which electrical energy is transferred.

Renewable energy Any type of energy generated from natural resources that is infinite or constantly renewed such as solar, wind or hydro power.

Non-renewable energy Energy that is in limited amounts and cannot be readily replaced. Fossil fuels such as oil, natural gas and coal are non-renewable because their formation takes billions of years.

Tariff The price payed for the energy supply includes fixed supply charge and a cost for the electricity used.