Level

F	1	2	**3**	**4**	**5**	6	B6

Alternatives in energy

Strand
Energy and Change

Key concept
There are different ways of obtaining and utilising energy and these have different consequences.

Purpose

Activities in this module are designed to help students understand that there are alternative ways to obtain and use energy. Students have opportunities to:

- collect information about obtaining energy from fossil fuels, hydroelectric schemes, wind, geothermal sources, the sun, and nuclear reactions;
- collect information about using energy from fossil fuels, hydroelectric schemes, wind, geothermal means, the sun and nuclear reactions;
- examine and evaluate the reasons for using energy from particular sources;
- create presentations about energy sources and energy uses;
- construct and operate models demonstrating different uses of different forms of energy.

Overview of activities

The following table shows the activities in this module and the way in which these are organised in **introductory**, **developmental** and **culminating** phases.

Introductory ►	Developmental ►	Culminating
Sources of energy: sharing ideas	Designing a land yacht	Energy and the future
Energy art	Researching alternative sources of energy	
Mapping knowledge about energy sources	Using the sun's energy	

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Core learning outcomes

This module focuses on the following core learning outcomes from the Years 1 to 10 Science Syllabus:

Energy and change

3.3 Students identify different ways of obtaining energy.

4.3 Students present alternative ways of obtaining and using energy (including energy from the sun and from fossil fuels) for particular purposes.

5.3 Students discuss the consequences of different ways of obtaining and using energy (including nuclear energy).

Core content

This module incorporates the following core content from the syllabus:

Energy and change

Sources of energy

- fossil fuels, sun (wind energy), geothermal, hydroelectric, tidal, nuclear

Alternative ways of obtaining energy

- solar cells, solar hot water, wind turbines

Ways of utilising energy

- coal-fired power stations
- nuclear power stations
- use of fuels in transport

Assessment strategy

Suggestions for gathering information about student learning are provided in each of the activities in this module. Once sufficient information has been collected, judgments can be made about students' demonstrations of outcomes. Typical demonstrations of this module's intended outcomes are provided here to indicate the pattern of behaviour to look for when making judgments.

Energy and change

3.3 Students identify different ways of obtaining energy.

Students may:

- create a drawing or collage identifying different ways of obtaining energy;
- in small groups or as a class, discuss examples of different ways of obtaining energy;
- collect and present information in a report.

Energy and change

4.3 Students present alternative ways of obtaining and using energy (including energy from the sun and from fossil fuels) for particular purposes.

Students may:

- collect and present information on alternative ways of obtaining and using energy;
- design, construct and evaluate models that use energy for different purposes;
- compare different ways of obtaining and using energy;
- create drawings and/or collages illustrating various ways of obtaining and using energy from different sources.

Energy and change

5.3 Students discuss the consequences of different ways of obtaining and using energy (including nuclear energy).

Students may:

- describe the consequences of different ways of obtaining and using energy.

Background information

Current scientific conceptions

Energy

Energy is used when work is done. Energy can be classified as kinetic (that is, energy of motion) and potential (that is, energy that is stored, or energy of position). Energy comes in many forms — for example, heat, light, sound and electricity. **Forms** of energy are distinguished from **sources** of energy: sources of energy produce the different forms of energy.

This module contains activities about heat and electricity.

Fossil fuels

There are three major forms of fossil fuel: coal, oil and natural gas. All three were formed many millions of years ago.

Fossil fuels are made up of decomposed plant and animal matter that became buried under layers of rock. There, under conditions of high pressure and temperature, in a process taking millions of years, the remains of these living things were transformed into coal, oil and natural gas.

Energy stored in fossil fuels is released when the fuel is burnt. Fossil fuels are used extensively for producing electricity, for providing power for factories, and for transport.

Because fossil fuels take many millions of years to make, they are not renewable. There is a need to conserve fossil fuels because, once they are used up, they cannot be re-made.

Energy from the sun

The sun produces energy of different wavelengths. Some wavelengths of radiant energy are converted to heat energy when they come into contact with matter. Other wavelengths are in the visible spectrum and are called 'sunlight'.

Life on Earth relies on the sun as an energy source. Plants transform light into chemical energy stored in plant tissues and used for growth and reproduction. Animals eat plants for food.

When laundry is hung out to dry, radiant energy from the sun is used to do work — that is, to dry the clothes.

Energy from the sun can be used to heat water — for example, collector panels on a house roof have a long pipe that goes back and forth at the rear. The panels absorb energy from the sun, heating the pipe and the water within.

Energy from the sun can also be used to make electricity — for example, large parabolic mirrors are used to focus the sun's rays onto large pipes or troughs containing water. The water boils, producing steam, and the steam is used to rotate turbines to generate electricity.

Sunlight can be converted directly into electricity by means of solar cells, also called 'photovoltaic cells' ('PV cells'). They are used to power remote telephone exchanges, yachts, street and garden lights, lighthouses and spaceships.

Solar cells are made of specially treated silicon. When sunlight strikes the solar cell, a negative charge is created on the front side of the cell that is facing towards the sun, and a positive charge is induced on the back. When an electrical conductor connects the two surfaces, a current of electricity flows from the negative side to the positive side. Individual solar cells may be arranged together in a PV module. Some modules are mounted on special tracking devices that follow the sun all day.

Geothermal energy

'Geo' means 'Earth', and 'thermal' means 'heat', so geothermal means heat from the Earth. At the centre of the Earth is an extremely hot core. This heat is transferred through the mantle, so these rocks remain semi-molten, and then to the solid crust of the Earth. Heat is also produced in the lower crust by radioactive decay. This heat can raise the temperature of water in underground deposits to 100°C and more. Pressure builds up in these deposits and the water shoots out through weaknesses in the ground, forming hot springs or geysers. If it can be harnessed, this hot water or steam can be used to turn a turbine, driving a generator to make electricity in a geothermal power plant. This hot water or steam can also be used directly to heat nearby buildings. Geothermal energy is usually obtained in areas that are seismically active — for example, Rotorua in New Zealand.

Wind energy

The kinetic energy of wind can be changed into other forms of energy — either mechanical or electrical. Sailboats use wind energy directly to move them through water. For many years, farmers have used windmills driven by wind energy to pump water from wells. In Holland, windmills have been used for centuries to pump water to drain low-lying areas. Windmills have also been used to turn large grinding stones to make flour from grain.

Today, wind is used to make electricity. Wind spins the blades on a wind turbine that looks something like a toy pinwheel, but is much larger. The blades are attached to a hub on a shaft. The shaft is connected to a generator that makes electricity.

Water energy

Moving water (for example, rivers, streams, dam overflows and the sea) is another energy source. For hundreds of years, moving water has been used to turn wheels connected to grinding stones to make flour from grain. Today, moving water can also be used to make electricity.

Hydroelectricity means electricity generated using the kinetic energy of moving water. Some dams are built to stop the flow of a river and the area upstream of the dam becomes a reservoir storing water. Other dams are built without making a reservoir, so that the river is channelled through a hydroelectric power plant. The water flows through a pipe called a 'penstock' and pushes against blades in a turbine. The turbine rotates and drives a generator that makes electricity.

The Earth's oceans may one day provide electricity to power homes and businesses. At present, the technology needed to generate electricity from the ocean is mainly experimental.

Three ways to tap the ocean's energy to generate electricity are:

- by using the rise and fall of the waves;
- by using the motion of ocean's high and low tides;
- by using temperature differences in the water.

Wave energy systems use the up-and-down motion of waves to turn a turbine and generator. Tidal energy systems trap water in a reservoir at high tide. When the tide ebbs, the water in the reservoir can be fed through a power plant, just as is done in a regular hydroelectric plant.

Nuclear energy

Another major source of energy is nuclear reactions that release the energy held inside every atom of matter.

One way of obtaining energy from atoms is through nuclear fission — that is, splitting the nuclei of atoms. When this is done, a tremendous amount of heat, light energy and other forms of radiation are released. If it is released slowly under controlled conditions, this energy can be harnessed to generate electricity. When it is released all at once, it makes a tremendous explosion, known as an atomic bomb.

Another way of obtaining energy from atoms is through nuclear fusion — that is, joining ('fusing') smaller nuclei together to make a larger nucleus. The energy given off by the sun comes from nuclear fusion reactions in which hydrogen atoms are joined together to form helium atoms. During this reaction, heat, light and other radiation are emitted.

Scientists have been working for a long time on controlling nuclear fusion, trying to make a fusion reactor for producing electricity. They have had trouble controlling the reaction in a contained space. Nuclear fusion is thought to be potentially a better energy source than fission as it does not give off as much deadly radiation.

Students' prior understandings

Students' prior understandings may differ from current scientific conceptions in a range of ways.

Energy

Students may:

- use the terms 'energy source' and 'energy form' interchangeably;
- have heard about energy only in relation to food, such as bread, breakfast cereals and 'sports drinks';
- not know about potential (stored) energy;
- believe that energy is associated only with living things or moving things;
- believe that energy can be 'used up'.

Teachers can enhance students' understandings by emphasising the correct use of the terms 'energy source' and 'energy form', and by providing opportunities for students to consider different forms of energy, including potential energy.

Alternative sources of energy

Students may have considered only the negative aspects of using some sources of energy.

Teachers can enhance students' understandings by encouraging students to consider the advantages as well as the disadvantages of all sources of energy.

Terminology

Terms associated with the sources and uses of energy are essential to the activities in this module — for example:

energy forms	fusion	nuclear energy
energy sources	geothermal energy	renewable resources
fission	non-renewable resources	solar energy
fossil fuels		

Students may already be familiar with some of these terms and understand their meanings and use in scientific contexts. If so, the activities in this module will provide opportunities for them to evaluate current usage. If not, these activities will provide opportunities for students to develop their understandings.

School authority policies

Teachers need to be aware of and observe school authority policies that may be relevant to this module.

Safety policies are of particular relevance to the activities that follow. It is essential that demonstrations and student activities are conducted according to procedures developed through appropriate risk assessments at the school.

In this module, teachers need to consider safety issues relating to students using:

- scissors and glue;
- hand tools, such as hammers and saws.

Support materials and references

California Energy Commission, *Energy Quest*. Available URL: http://www.energy.ca.gov/education/index.html (accessed May 2000).

Ginns, I. et al. 1994, *Science Alive: Exploring Energy*, Shortland Publications, Auckland.

Queensland Department of Education 1982, *Primary Science Sourcebook: Activities for Teaching Science in Year 6*, Brisbane.

ACTIVITY

Sources of energy: sharing ideas

Introductory

Focus

This activity provides opportunities for students to reflect on, discuss and present their current knowledge of various sources of energy.

Materials

- butcher's paper or overhead transparency
- suitable pens

Working scientifically

Time: 60 minutes

Collecting information
Constructing meaning
Discussing thinking
Exploring and elaborating ideas

▶ Students share their understandings of the word 'energy' and the differences between a form of energy and a source of energy. They discuss their ideas and develop definitions for these terms. Students' ideas should be listed on the board or overhead transparency. Through class discussion, one definition is produced for each term.

▶ Individually, students list as much information as they can about sources of energy, including examples, descriptions and uses.

▶ Students share their ideas with a partner and record any new ideas. Three or four pairs then join together in a group. Each pair shares their ideas with the other student pairs. Groups record their collective ideas on a large sheet of paper or overhead transparency.

▶ Groups present their ideas to the whole class. Similarities and differences between different groups' ideas can be discussed as they arise.

▶ The groups' ideas are displayed in the classroom for future reference.

▶ Individually, students review their original ideas about sources of energy and make any amendments necessary. They add anything that they have learned.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' notes of their ideas about sources of energy.

ACTIVITY

Energy art

Introductory

Focus

This activity provides opportunities for students to clarify their ideas about sources of energy and their uses.

Materials

- magazines, newspapers, coloured paper
- large sheets of cardboard or paper
- scissors
- glue

Teaching considerations

Encourage discussion throughout the activity. When necessary, assist students' flow of ideas by prompting them, guiding their thinking and allowing them to view what other students are doing.

Safety

Inform students of safe practices for using scissors and glue.

Working scientifically

Time: 60 minutes

Accessing resources
Handling materials
Creating presentations
Discussing thinking
Explaining ideas and decisions
Expressing points of view

▶ Students form small groups and discuss their ideas about different sources of energy and their uses.

▶ Students answer the following questions about each source of energy:

- What do you know about this source of energy?
- What are your opinions on using this source of energy?

▶ Students then create a collage that reflects their opinions on the use of various sources of energy. They can work individually or in small groups.

▶ Each individual or group presents the collage to the class and explains the ideas it represents. Finished collages can be displayed in the classroom.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' collages;
- the explanations of ideas that students give in their presentations.

ACTIVITY

Mapping knowledge about energy sources

Introductory

Focus

This activity provides opportunities for students to explore, explain and discuss what they know about various energy sources and how these are used.

Materials

- butcher's paper or overhead transparency
- suitable pens
- Resource Sheet 1, 'Using fossil fuels'

Teaching considerations

Ensure that each of the alternative sources of energy is covered by at least one group when students work on their concept maps.

Some teacher input may be needed during the activity to assist students.

Resource Sheet 1

A sample layout for a concept map about using fossil fuels is provided on Resource Sheet 1.

Working scientifically

Time: 45 minutes

Discussing thinking
Explaining ideas and decisions
Exploring and elaborating ideas

▶ A concept map is developed and drawn on the board using student input. The term 'fossil fuels' is written in the centre of the board and circled. Students provide the names of types of fossil fuel. These names are written around the term 'fossil fuels'. From each of the fossil fuels, lines are drawn to panels labelled 'Uses', 'Benefits' and 'Drawbacks' (or similar terms). Students' ideas about each fuel are added to this map.

▶ Led by the teacher, students discuss how the sun, water, Earth (the source of geothermal energy) and wind can be used as sources of energy.

▶ Students form small groups. Each group is allocated one of the sources of energy mentioned in the previous paragraph. Each group then constructs a concept map about their allocated energy source, using the same format as the concept map about fossil fuels.

▶ Groups display their concept maps and explain their ideas to the rest of the class.

Gathering information about student learning

Sources of information could include:

- students' concept maps;
- students' contributions to discussions;
- groups' reports to the class.

ACTIVITY

Designing a land yacht

Developmental

Focus

This activity provides opportunities for students to design, construct and evaluate a wind-propelled land vehicle.

Materials

Suggestions for materials that could be used include:

For the sail:

- fabric remnants
- tissue paper
- plastic cling-wrap
- plastic ice-cream container lids
- aluminium foil

For the axles and mast:

- drinking straws
- wooden skewers
- thin dowel
- fencing wire

For the fastening materials:

- wood or craft glue
- masking or insulating tape
- stapler and staples

For the wheels:

- lids from drink bottles
- cardboard
- toy wheels
- plastic tubing or strong plastic straws

For the chassis:

- plywood
- thick cardboard
- sheets of polystyrene foam
- corks
- cardboard tubes
- fencing wire

For the testing equipment:

- variable-speed floor fan
- stopwatch

Teaching considerations

Evaluation

Students' evaluation of their vehicles could include a competition — for example, to find:

- the vehicle that travels the longest distance in a straight line;
- the fastest vehicle over a distance of 10 metres;
- the most unusual design that works;
- the most aesthetically pleasing design that works.

Prizes could be awarded to the winner of each category.

Consider making up an entry form that outlines the requirements and specifications of the vehicle and the competition conditions.

Safety

Inform students about safe practices when using sharp instruments or materials — for example, skewers and wire.

Working scientifically

Time: Setting the scene, 60 minutes; design and construction, 1–2 hours; competition, 1 hour

Accessing resources
Designing and performing investigations
Engaging with problems
Handling materials
Making plans
Applying ideas and concepts
Examining and evaluating
Generalising
Making comparisons
Using ideas, theories and principles
Constructing and using models
Discussing thinking

▶ As a class, students discuss how different vehicles move and the source of energy that they use in moving. The teacher ensures that sailboats or yachts are discussed. Pictures of yachts are displayed in the classroom.

▶ Using pictures of yachts or a video on sailing for beginners as a starting point, students gather information about the design of sailing boats in relation to the way that they move. Design elements to consider include:

- the position, structure and shape of the sails;
- the size of the mast relative to the boat;
- the boom and how it is used;
- how the wind makes sailing boats move;
- how the wind could be used to move a land vehicle.

▶ Students make generalisations about the design of a wind-propelled land vehicle. They discuss and agree upon criteria that can be used to evaluate the models constructed. Points to consider could include:

- Are the wheels able to move freely?
- Is the sail large enough to capture enough energy from the wind to make the model move?
- Can the sail move to capture wind coming from different directions?
- Is the vehicle light or heavy?

▶ Students work in groups of three or four to design, construct and test a model wind-powered vehicle. Specifications for the vehicle could include:

- it has wheels;
- it has base measurements no greater than 15 x 30 centimetres, excluding the wheels;
- it is propelled by wind power using a sail;
- it must travel at least 2 metres under sail.

▶ Students evaluate their own vehicles and those of other groups using the agreed criteria.

▶ As a class, students and the teacher discuss why the vehicles work or do not work, and how the vehicles might be improved.

Gathering information about student learning

Sources of information could include:

- students' discussions of the ways that vehicles move;
- students' identification of the major features of wind-propelled vehicles;
- students' contributions to the identification of criteria for evaluating the models;
- students' designs for the vehicles;
- students' contributions to the construction of the models;
- the constructed models;
- students' analysis of the performance of the models.

ACTIVITY

Researching alternative sources of energy

Developmental

Focus

This activity provides opportunities for students to collect and present information about alternative ways of obtaining and using energy.

Materials

- Resource Sheet 2, 'Project planning sheet'

Teaching considerations

Ensure that students are familiar with the research process. Model note-taking skills and how to reword notes into coherent statements. Advise students of the need to balance their use of words and illustrations (pictures, tables, graphs).

Inform students that, when including information from other sources in their own work (including printed texts, material on the World Wide Web or from electronic media such as videos), they must cite the original author, source and date, using a standard referencing convention.

Encourage students to present the results of their independent research in a form other than a written research report or a chart. An interview, an expert panel made up of students, a structured debate, a brochure, a newspaper report or feature article, and a video are some alternative modes of presentation.

Working scientifically

Time: modelling, 1–3 hours; independent research, 1–2 hours per week for about 4 weeks, plus time outside school hours

Accessing resources
Collecting information
Making plans
Creating presentations
Summarising and reporting


Resource Sheet 2

▶ Students use Resource Sheet 2, 'Project planning sheet', to work through the research process with the teacher. As a class, they produce a presentation on the topic 'Using fossil fuels as sources of energy'.

▶ Students working individually or in groups choose a topic from the following:

- using energy from the sun;
- using energy from the wind;
- using energy from water;
- using geothermal energy;
- using nuclear energy.

▶ Students use Resource Sheet 2, 'Project planning sheet', to guide them in researching their topics and presenting their information. They also model their work on the class project 'Using fossil fuels as sources of energy'.

Gathering information about student learning

Sources of information could include:

- students' participation in the modelling process;
- students' progression through the stages of their research;
- students' final presentations.

ACTIVITY

Using the sun's energy

Developmental

Focus

This activity provides opportunities for students to investigate a means of using energy from the sun.

Students design and build a model solar hot-water system and evaluate its effectiveness.

Materials

- Resource Sheet 3, 'A model solar hot-water system'
- pamphlets from commercial suppliers or manufacturers of solar hot-water systems, showing how the systems work
- plastic bottles
- wooden boxes
- paper, plastic or metal sheets
- plastic piping
- glue suitable for joining wood, plastic or metal
- insulating materials such as aluminium foil, paper, polystyrene foam
- nails
- saws
- hammers
- black paint
- paintbrushes

Teaching considerations

Preparation

The best way of showing students how a solar hot-water system works is to construct a working model (see the diagram on Resource Sheet 3).

Ensure that students have a sound understanding of how a solar hot-water system works before they design and construct their own models. Encourage students to use the correct terminology — for example, 'convection', 'insulation', 'collector plate', 'inlet' and 'outlet'.

If students are not familiar with the information report genre, this will have to be modelled for them.

Safety

If students are to use tools, inform them about safe practices for using hammers and saws.

Working scientifically

Time: Part 1, 30 minutes; Part 2, 60 minutes; Part 3, as required

Handling materials
Making and judging observations
Drawing conclusions
Interpreting data

Resource Sheet 3

Part 1

▶ Students examine Resource Sheet 3, 'A model solar hot-water system', or a working model of a solar hot-water system. They discuss how a solar heating system works.

Part 2

▶ Working in small groups, students draw their design for a model solar hot-water system. They label all parts of the diagram and explain the function of each. They should be able to relate each item in their design to the model or diagram that they examined in Part 1.

▶ Students construct their model using the materials provided.

Part 3

▶ Students design an investigation into the effectiveness of their models and develop criteria by which their models can be judged. The criteria must relate to how the model hot-water system transforms energy from the sun into heat. In designing the investigation they could consider:

- where the models are to be placed;
- what data will be collected to provide information on effectiveness, and how the data will be recorded;
- when the investigation will be carried out (considering, for example, time of day and weather conditions);
- length of the testing period.

▶ Students present the results of their investigation as an information report.

Gathering information about student learning

Sources of information could include:

- students' designs for model solar hot-water systems;
- students' participation in the construction of their models;
- the models produced;
- students' designs for the investigation of the models' effectiveness;
- students' information reports.

ACTIVITY

Energy and the future

Culminating

Focus

This activity provides opportunities for students to present possible, probable and preferred options for the use of energy sources in the future.

Students construct futures wheels on the consequences of the use of fossil fuels and of the use of solar energy.

Materials

- Resource Sheet 4, 'Futures wheel: Fossil fuels as an energy source'
- Resource Sheet 5, 'Futures wheel: The sun as an energy source'

Teaching considerations

Students may need help to understand the concepts of possible, probable and preferred options.

The process of constructing a futures wheel is as follows. Write down the name of a possible future event in the centre of a large sheet of paper, on the board or an overhead transparency. In a ring surrounding the name of this future event, write the possible consequences of that event. It is important to ensure that all possible future consequences, both positive and negative, are considered. A second ring of consequences deriving from any of the first-listed can be written around the first, and so on. This mapping allows consideration of all possible foreseeable effects and consequences of the event.

Resource Sheets 4, 5

Examples of futures wheels are given on Resource Sheet 4, 'Futures wheel: Fossil fuels as an energy source' and Resource Sheet 5, 'Futures wheel: The sun as an energy source'.

A suggested product of this activity is a modified information report. Students use the basic structure of an information report but also include their ideas on the short-term and long-term consequences of the future event that they are considering.

Working scientifically

Time: 2 hours

Engaging with problems
Forecasting
Predicting
Analysing
Developing possible, probable and preferred options
Recognising and analysing options
Envisioning alternative futures
Expressing points of view

▶ Guided by the teacher, the class develops two futures wheels: one on the use of fossil fuels as an energy source and one on the use of solar energy. These may be drawn on the board or on an overhead transparency.

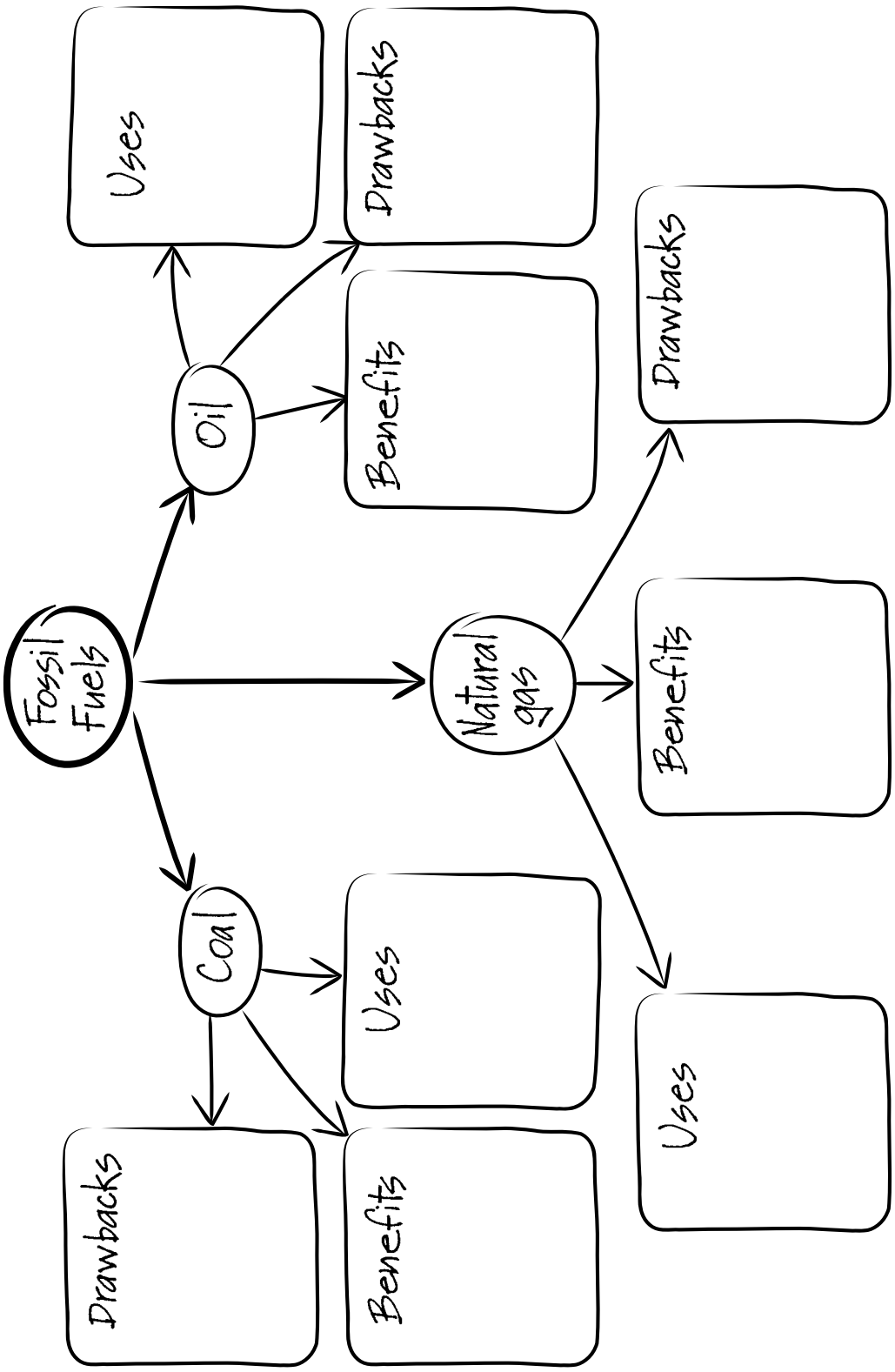
▶ Using the futures wheels, as well as other sources of information, students prepare a poster or modified information report on the consequences of using fossil fuels and solar energy in the future. Their poster or report should identify possible, probable and preferred options related to the use of energy from each source.

Gathering information about student learning

Sources of information could include:

- students' contributions to the development of the futures wheels;
- students' posters or reports.

Using fossil fuels



Project planning sheet

Resource Sheet 2

Project title: _____

Group members: _____

_____

Strategy	Notes
1. Questions to ask What are we trying to find out? What are the key words? What do we already know?	
2. Getting started Find out meanings of terms that we don't know. Brainstorm synonyms of terms. Brainstorm related ideas. Construct a concept map of related ideas to explore. Organise ideas under possible headings.	
3. Finding resources Visit the school library. Visit local libraries. Search the Internet.	

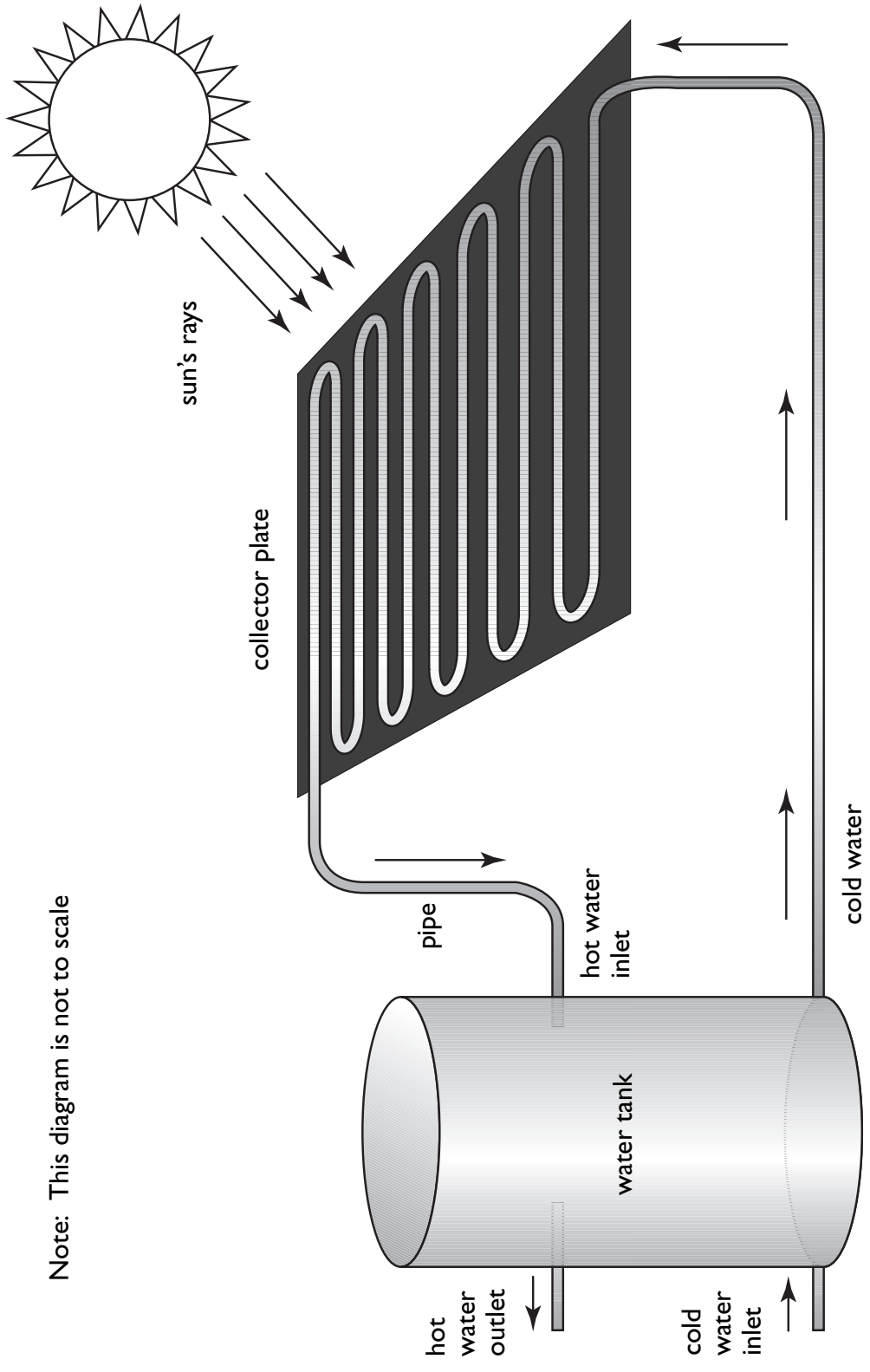
(continued)

Project planning sheet *(continued)*

Strategy	Notes
4. Sorting the information Skim through the resources to find the most useful ones. Return resources that are not needed. Put the resources into groups that fit the headings developed in 2. Take notes from relevant resources. List the resources that we have taken notes from. Include these in the bibliography.	
5. Present the information Decide how we are going to present the results of our research. Write a final draft. Include suitable illustrations (for example, pictures, tables, graphs) that are relevant to the text.	

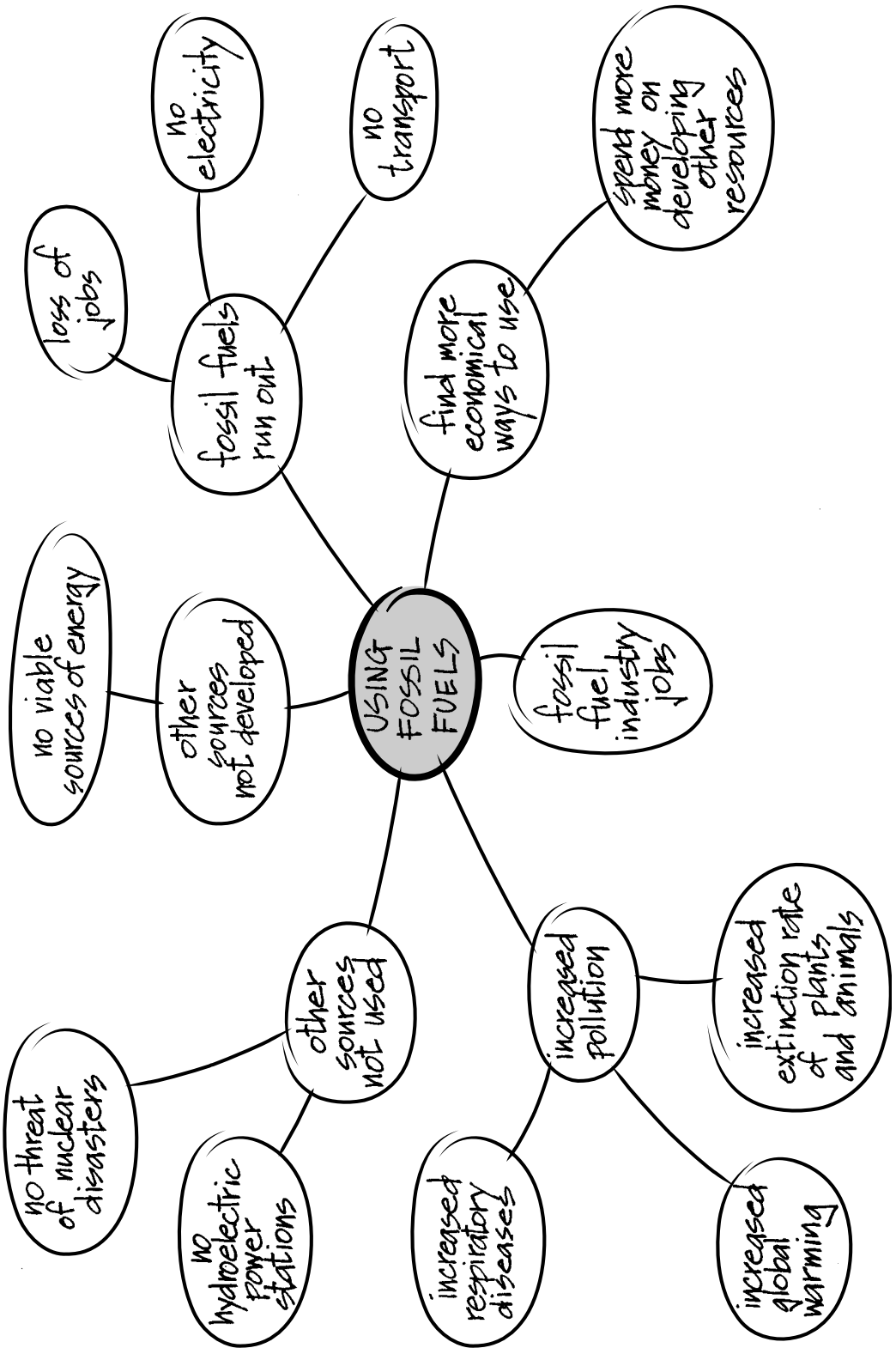
A model solar hot-water system

Resource Sheet 3

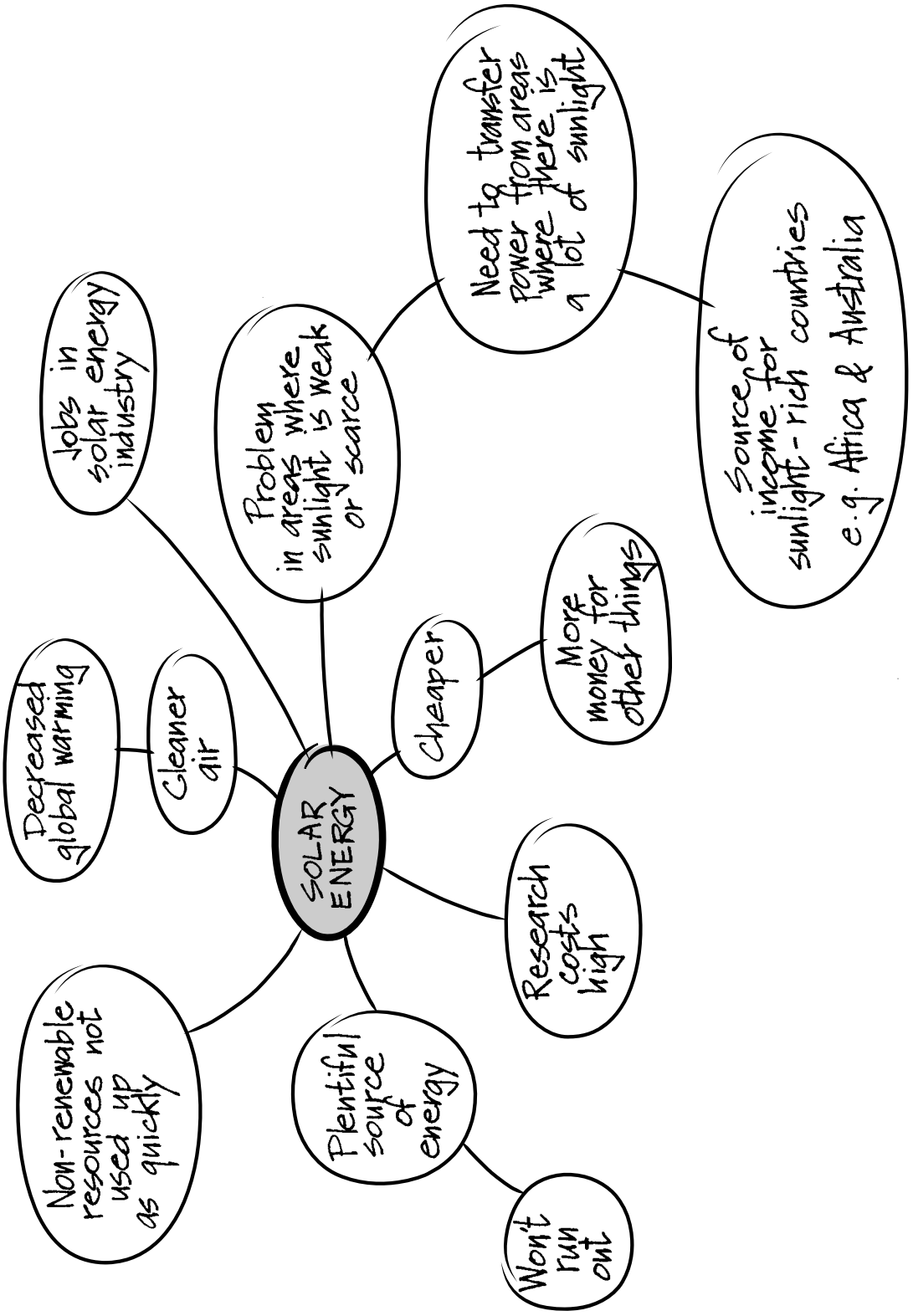


Futures wheel: Fossil fuels as an energy source

Resource Sheet 4



Futures wheel: The sun as an energy source



Acknowledgments

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This sourcebook module should be read in conjunction with the following Queensland School Curriculum Council materials:

Years 1 to 10 Science Syllabus

Years 1 to 10 Science Sourcebook: Guidelines

Science Initial In-service Materials

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