Unit outline for teachers

WithOnePlanet

> Module 1:
  Carbon

> Level:
  Years 7 to 8

> Section:
  Carbon is energy

> Unit outline
  for teachers

Module: Carbon

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Years 7 to 8

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INQuIRY

WithOnePlanet
Open education
An xpand Foundation initiative

Australian Curriculum covered in this unit:

INQuIRY

Learning area		General capabilities		Cross-curriculum priorities	
	English	✓	Literacy		Aboriginal and Torres Strait Islander histories and cultures
	Mathematics	✓	Numeracy	✓	Asia and Australia's engagement with Asia
✓	Science	✓	Information and communication technology (ITC) competence	✓	Sustainability
	History	✓	Critical and creative thinking		
	Geography	✓	Social and personal competence		
		✓	Ethical behaviour		
		✓	Intercultural understanding		

Carbon is energy

A unit for Years 7 to 8

Unit outline for teachers

Introduction

We all use energy every day. Energy is available to us in many different forms - food, heat, electricity, petrol. But where does it all come from? When we switch on the light, it starts to glow. Where did it get the energy it needed? The ***Carbon is energy*** unit is an ideal way to investigate the science of energy and improve the scientific literacy of students in the classroom. It provides opportunities for students to investigate their understandings of energy – where we get it from and how we use it - and through discussion and debate, arrive at their own considered opinion about our energy sources – both renewable and non-renewable – and what we can do to sustain these into the future.

*'The **Carbon is energy** unit is an ideal way to investigate the science of energy and improve the scientific literacy of students in the classroom.'*

Units at a glance – INQuIRY teaching and learning model

The WithOnePlanet **INQuIRY** teaching and learning model provides problem- and challenge-based activities, designed to build sequential and experiential learning, practical skills and actions, critical thinking, knowledge and awareness about the impacts of climate change on plants, people and place in our region.

Inquiry model	Lesson sequence	At a glance
INQuIRY Introduce	Lesson 1 **Carbon – the source of our energy** Students contribute their knowledge about carbon and the carbon cycle.	To capture students' interest and find out what they think they know about carbon as an element and an energy store, the different global spheres it occupies (including the biosphere, hydrosphere, lithosphere and atmosphere) and how we can use carbon in these spheres to provide us with our energy.
INQuIRY Question	Lesson 2 **It's a question of energy** Students develop an essential question about the energy from carbon.	To elicit students' questions about carbon as an energy store and an energy provider, and the implications of releasing the energy from carbon for our own use. To develop an essential question about carbon and energy that students can investigate.
INQuIRY Investigate	Lesson 3 **Carbon is energy, carbon is life** *Session: Carbon under the microscope.* Students investigate the properties of carbon and carbon compounds. *Session: Carbon – the great provider.* Students investigate how carbon stores and releases energy.	To provide students with hands-on, shared experiences of carbon as an element and a molecule, including the properties that enable it to store and release energy.
(continued)	Lesson 4 **Hitch a ride on the carbon cycle!** *Session: Round and round the carbon cycle.* Students investigate the transfers and transformations of energy within the carbon cycle. *Session: The power of carbon!* Students investigate how energy is released from the carbon cycle and used to generate electricity.	To provide students with hands-on, investigation experiences of: > The different forms that carbon can take in the different spheres of the carbon cycle and the different processes that allow carbon to move between these spheres. > The different energy transfers and transformations that can occur as carbon moves through the carbon cycle and the way that humans can manipulate the energy transfers of the carbon cycle to generate electricity and heat. To support students to represent and explain their understanding of the energy transfers and transformations within the carbon cycle and the generation of electricity and heat from it.

Inquiry model	Lesson sequence	At a glance
INQuIRY **Investigate**	Lesson 5 **Life's a carbon balancing act** *Session: Carbon can change the climate.* Students investigate how energy production and use can contribute to climate change. *Session: Reduce and renew.* Students investigate renewable and non-renewable resources and debate the impacts of changing our energy use behaviours from a range of different perspectives.	To provide students with hands-on, investigation experiences of: > The connections between the release of energy from carbon, the enhanced greenhouse effect and climate change. > The similarities and differences between renewable and non-renewable resources and their relative impacts on sustainability. To support students to represent and explain their understanding of the energy that can be released from carbon and its consequences for the Earth. To support students to plan and conduct a problem-based learning investigation about the many possible ways that people can – both individually and as a nation - reduce their dependency on non-renewable resources.
	Lesson 6 **Return to the carbon source** Students review their progress with their essential question and determine if it has been answered.	To provide students with an opportunity to reflect on their progress with their essential question and determine whether or not it has been fully answered. To support students to conduct additional investigation and research in order to answer their essential question.
INQuIRY **Review**	Lesson 7 **What's at the end of the carbon cycle?** Students review their understanding of the unit.	To provide opportunities for students to represent what they know about carbon as an energy provider and its impacts on the planet, and to reflect on their learning during the unit.
INQuIRY **Your future**	Lesson 8 **Next stop on the carbon express** Students decide on where to go next on their own carbon futures learning journey.	To provide opportunities for students to take their learning about carbon futures into a new cycle of inquiry in their own preferred direction.

WithOnePlanet Big questions about big ideas

The WithOnePlanet curriculum seeks to engage students in the big idea of carbon and its effects on their immediate environment and that of their neighbours in the Asia Pacific region. The *WithOnePlanet Carbon curriculum* is based on 5 big questions. These questions can be explored at all levels from Foundation to Year 10, with ever increasing complexity as students move through each unit.

The table below outlines these big questions and provides specific detail about how these ideas can be tackled in Years 7 and 8.

Big Ideas	What is carbon?	What is the carbon cycle?	What is climate change and what role does carbon play in it?	What is my carbon footprint and how can I reduce it?	What can be done to mitigate climate change on a regional scale?
Big ideas	At its core, carbon is a chemical element. Its physical and chemical properties make it the most essential element for life on Earth, and possibly the most versatile.	Carbon is essential for life and can be found in all Earth's spheres. There are many processes that allow carbon to be cycled through these spheres.	Carbon dioxide is a greenhouse gas. When carbon leaves the biosphere and lithosphere and enters the atmosphere and hydrosphere, it enhances the greenhouse effect. This is when the impacts of climate change become visible.	Every living thing is made of carbon and uses carbon in its various forms every day to survive and thrive. But humans have the capacity to determine how much carbon they use and to implement changes to reduce it.	The carbon emissions from everyday activities of Australians not only impact our own carbon footprints, but can have significant effects on others in our local region. Furthermore, as Australians we can not only influence our own carbon footprints, but, through positive actions, we can impact positively on the lives of our neighbours.
Years 7 to 8	The chemical bonds between carbon atoms in molecules such as carbon dioxide, crude oil and sugars can be broken to release energy.	Energy is transferred between different forms to generate electricity. The inefficiencies of energy transformations can result in the production of heat.	Some of the consequences of climate change are short term and some are long term. Some of the consequences of climate change are reversible and some are permanent.	I can reduce my carbon footprint by reducing my energy consumption from non-renewable resources.	Countries in the Asia-Pacific region have renewable and non-renewable resources and can make individual and collective decisions about their energy sources and use.

Alignment with the Australian Curriculum: Science

This *Carbon is energy unit* embeds all three strands of the Australian Curriculum: Science. The table below lists sub-strands and their content for Years 7 to 8. This unit is designed to be taught in conjunction with other units at Years 7 to 8 to cover the full range of the Australian Curriculum: Science content.

For ease of assessment the table below outlines the sub-strands and their content aligned to lessons.

Strand	Sub-strand	Year level	Code	Years 7 to 8 content descriptions	Lesson
Science understanding	Biological sciences	7	ACSSU111	There are differences within and between groups of organisms; classification helps organise this biodiversity.	
			ACSSU112	Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions.	4
		8	ACSSU149	Cells are the basic unit of living things and have specialised structures and functions.	
			ACSSU150	Multi-cellular organisms contain systems of organs that carry out specialised functions that enable them to survive and reproduce.	
	Chemical sciences	7	ACSSU113	Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques.	1, 3, 4
		8	ACSSU151	The properties of the different states of matter can be explained in terms of the motion and arrangement of particles.	1, 3, 4, 5
			ACSSU152	Differences between elements, compounds and mixtures can be described at the particle level.	3
			ACSSU225	Chemical change involves substances reacting to form new substances.	3, 4
	Earth and space sciences	7	ACSSU115	Predictable phenomena of Earth, including seasons and eclipses (and tides), are caused by the relative positions of the Sun, Earth and the Moon.	
			ACSSU116	Some of Earth's resources are renewable, but others are non-renewable.	1, 2, 3, 4, 5, 6
			ACSSU222	Water is an important resource that cycles through the environment.	
		8	ACSSU153	Sedimentary, igneous and metamorphic rocks contain minerals that are formed by processes that occur within Earth over a variety of timescales.	4
	Physical sciences	7	ACSSU117	Change to an object's motion is caused by unbalanced forces acting on the object. Earth's gravity pulls objects towards the centre of the Earth.	
		8	ACSSU118	Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes changes within systems.	3, 4, 5

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Strand	Sub-strand	Year level	Code	Years 7 to 8 content descriptions	Lesson
Science as a human endeavour	Nature and development of science	7 & 8	ACSHE119	Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people's understanding of the world.	4, 5
			ACSHE223	Science knowledge can develop through collaboration and connecting ideas across the disciplines of science.	5
	Use and influence of science		ACSHE120	Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may have an impact on other areas of society and involve ethical considerations.	4, 5
			ACSHE121	Science understanding influences the development of practices in areas of human activity, such as industry, agriculture and marine and terrestrial resource management.	4, 5
			ACSHE224	People use understanding and skills from across the disciplines of science in their occupations.	5
Science inquiry skills	Questioning and predicting	7 & 8	ACSIS124	Identify questions and problems that can be investigated scientifically, and make predictions based on scientific knowledge.	1, 2, 5, 7
	Planning and conducting		ACSIS125	Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safe and ethical guidelines are followed.	3, 4, 5, 8
			ACSIS126	In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task.	3
	Processing and analysing data and information		ACSIS129	Construct and use a range of representations, including graphs, keys and models, to represent and analyse patterns or relationships, using digital technologies as appropriate.	3, 4, 5
			ACSIS130	Summarise data from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions.	3, 4, 5
	Evaluating		ACSIS131	Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method.	5
			ACSIS132	Use scientific knowledge and findings from investigations to evaluate claims.	5
	Communicating		ACSIS133	Communicate ideas, findings and solutions to problems using scientific language and representations, using digital technologies as appropriate.	1, 2, 3, 4, 5, 6, 7, 8

Alignment with Australian Curriculum: Science - Overarching Ideas

Overarching idea	Incorporation in *Climate change – fact, forecast or fiction?*
Patterns, order and organisation	Students compare similarities and differences and identify patterns in: > the movement of carbon throughout the carbon cycle > the production of electricity from fossil fuels and renewable resources > opinions about renewable and non-renewable energy from various perspectives. Students organise their ideas and understanding in: > the analysis of second-hand data > developing essential questions about carbon > exploring the energy transfers and transformations > expressing the viewpoint of a particular stakeholder in renewable and non-renewable energy production.
Form and function	Students explore how their senses are used to gather information from their environment. They explore energy transfers and transformations of various practical situations.
Stability and change	Students discuss how: > the needs and desires of people and the planet can be both similar and different to one another at the same time > humanity's desire for energy can affect the stability of different elements of the carbon cycle.
Scale and measurement	Students compare the proportions of fossil fuels used in energy production and the proportion of energy use in different Australian sectors. Students determine the scale of renewable energy roll out given a range of variables and perspectives.
Matter and energy	Students investigate the absorption, storage and emission of carbon in different spheres of the carbon cycle, including the role of humans in moving carbon and energy through the cycle. Students investigate energy transfers and transformations in general and those that are part of the human manipulation of the carbon cycle. They investigate electricity production from renewable and non-renewable resources.
Systems	Students investigate large-scale Earth systems including the Earth's climate, particularly in terms of the greenhouse effect, and the carbon cycle. They also identify inputs and outputs necessary for the maintenance of stability in these systems.

Alignment with Australian Curriculum: Science - Curriculum focus

The Australian Curriculum: Science is described by year level, but provides advice across four year groupings on the nature of learners. Each year grouping has a relevant curriculum focus.

Curriculum focus Years 7 to 8	Incorporation in *Carbon is energy*
Explaining phenomena involving science and its applications.	The contemporary context of climate change is used to develop students' understanding of important scientific concepts such as how the idea of equilibrium is important in dynamic systems and how a change in one component of a system can affect all components of that system. Current research into climate change and its effects on living systems, including human populations, is used to motivate and engage students.

Alignment with Australian Curriculum: Science – Achievement standards

The achievement standards of the Australian Curriculum: Science indicates the quality of learning that students typically demonstrate by a particular point in their schooling, for example, at the end of a year level. These standards will be reviewed regularly by ACARA and are available on the ACARA website.

By the end of this unit, teachers will be able to make evidence-based judgments on whether the students are achieving below, at or above the Australian Curriculum: Science Years 7 and 8 achievement standards.

Alignment with Australian Curriculum: General capabilities

The skills, behaviours and attributes that students need to succeed in life and work in the 21st century have been identified in the Australian Curriculum as General capabilities. There are seven general capabilities and they are embedded throughout the science curriculum.

For further information go to :

ACARA 2012, General Capabilities in the Australian Curriculum, viewed 20 December 2013, <http://www.australiancurriculum.edu.au/GeneralCapabilities/Overview/General-capabilities-in-the-Australian-Curriculum>.

For examples of our unit-specific General capabilities information see the table below.

General capabilities	Australian curriculum description	*Carbon is energy* example
Literacy	By learning the literacy of science, students understand that language varies according to context and they increase their ability to use language flexibly. Scientific vocabulary is often technical and includes specific terms for concepts and features of the world, as well as terms that encapsulate an entire process in a single word, such as 'photosynthesis'. Students learn to understand that much scientific information is presented in the form of diagrams, flow charts, tables and graphs.	The literacy focuses are: > tables > articles in science journals and newspapers > websites > diagrams > maps > graphs > infographics

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Numeracy	Many elements of numeracy are evident in the Science Curriculum, particularly in Science inquiry skills. These include practical measurement and the collection, representation and interpretation of data from investigations. Students are introduced to measurement, first using informal units then formal units. Later they consider issues of uncertainty and reliability in measurement. As students progress, they collect both qualitative and quantitative data, which is analysed and represented in graphical forms. Students learn data analysis skills, including identifying trends and patterns from numerical data and graphs. In later years, numeracy demands include the statistical analysis of data, including issues relating to accuracy and linear mathematical relationships to calculate and predict values.	Students: > collect data in tables > represent and communicate data intables, diagrams and graphs > interpret data in graphs, tables and diagrams.
Information and communication technology (ICT) competence	Students develop ICT capability when they research science concepts and applications, investigate scientific phenomena, and communicate their scientific understandings. In particular, they employ their ICT capability to access information; collect, analyse and represent data; model and interpret concepts and relationships; and communicate science ideas, processes and information. Digital technology can be used to represent scientific phenomena in ways that improve students' understanding of concepts, ideas and information. Digital aids such as animations and simulations provide opportunities to view phenomena and test predictions that cannot be investigated through practical experiments in the classroom and may enhance students' understanding and engagement with science.	Students: > use digital devices to record their ideas, responses to questions and data > use interactive resource technology to view, record and analyse information.

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Critical and creative thinking	In the science learning area, critical and creative thinking are embedded in the skills of posing questions, making predictions, speculating, solving problems through investigation, making evidence-based decisions, and analysing and evaluating evidence. Students develop understandings of concepts through active inquiry that involves planning and selecting appropriate information, and evaluating sources of information to formulate conclusions. Creative thinking enables the development of ideas that are new to the individual, and this is intrinsic to the development of scientific understanding. Scientific inquiry promotes critical and creative thinking by encouraging flexibility and open-mindedness as students speculate about their observations of the world. Students' conceptual understanding becomes more sophisticated as they actively acquire an increasingly scientific view of their world.	Students: > formulate, pose and respond to questions for inquiry > consider different ways of thinking about contemporary environmental issues > develop evidence-based opinions about environmental issues.
Personal and social competence	Students develop personal and social capability as they engage in science inquiry, learn how scientific knowledge informs and is applied in their daily lives, and explore how scientific debate provides a means of contributing to their communities. This includes developing skills in communication, initiative taking, goal setting, interacting with others and decision-making, and the capacity to work independently and collaboratively. The science learning area enhances personal and social capability by expanding students' capacity to question, solve problems, explore and display curiosity. Students use their scientific knowledge to make informed choices about issues that impact their lives such as health and nutrition and environmental change, and consider the application of science to meet a range of personal and social needs.	Students: > work collaboratively in teams > participate in discussions > follow directions to work safely > follow detailed instructions when completing practical and written tasks.

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Ethical behaviour	Students develop the capacity to form and make ethical judgments in relation to experimental science, codes of practice, and the use of scientific information and science applications. They explore what integrity means in science, and explore and apply ethical guidelines in their investigations. They consider the implications of their investigations on others, the environment and living organisms. They use scientific information to evaluate claims and to inform ethical decisions about a range of social, environmental and personal issues, for example, land use or the treatment of animals.	Students: > ask questions respecting each other's points of view > consider their rights and responsibilities as a global citizen and an environmental steward.
Intercultural understanding	There are opportunities in the science learning area to develop intercultural understanding. Students learn to appreciate the contribution that diverse cultural perspectives have made to the development, breadth and diversity of science knowledge and applications. Students become aware that the raising of some debates within culturally diverse groups requires cultural sensitivity. They recognise that increasingly scientists work in culturally diverse teams and engage with culturally diverse communities to address issues of international importance.	Students are given opportunities to: > compare their livelihoods with others in other cultures > investigate Important contributions made to science by people from a range of cultures > recognise the value of collaboration with peoples of different cultures in identifying and implementing solutions to global issues.

Alignment with Australian Curriculum: Cross-curriculum priorities

There are three cross-curriculum priorities identified by the Australian Curriculum:

> Aboriginal and Torres Strait Islander histories and cultures
> Asia and Australia's engagement with Asia
> Sustainability.

For each cross-curriculum priority, a set of organising ideas reflects the essential knowledge, understandings and skills for the priority. The organising ideas are embedded in the content descriptions and elaborations of each learning area as appropriate.

Aboriginal and Torres Strait Islander histories and cultures

Carbon is energy primarily focuses on the Western science way of making evidence-based claims about things required for survival.

Indigenous cultures might have different explanations about the needs for survival, and they might prioritise their relative importance in different ways depending on their culture.

WithOnePlanet recommends working with indigenous community members to access contextualised, relevant indigenous perspectives. (See table on next page)

Code	Organising ideas	Incorporation in *Climate change – fact, forecast or fiction?*
Country/Place		
011	Australia has two distinct Indigenous groups, Aboriginal Peoples and Torres Strait Islander Peoples.	N/A
012	Aboriginal and Torres Strait Islander communities maintain a special connection to and responsibility for Country/Place throughout all of Australia.	N/A
013	Aboriginal and Torres Strait Islander Peoples have unique belief systems and are spiritually connected to the land, sea, sky and waterways.	N/A
Culture		
014	Aboriginal and Torres Strait Islander societies have many language groups.	N/A
015	Aboriginal and Torres Strait Islander Peoples' ways of life are uniquely expressed through ways of being, knowing, thinking and doing.	N/A
016	Aboriginal and Torres Strait Islander Peoples have lived in Australia for tens of thousands of years and experiences can be viewed through historical, social and political lenses.	N/A
People		
017	The broader Aboriginal and Torres Strait Islander societies encompass a diversity of nations across Australia.	N/A
018	Aboriginal and Torres Strait Islander Peoples have sophisticated family and kinship structures.	N/A
019	Australia acknowledges the significant contributions of Aboriginal and Torres Strait Islander people locally and globally.	N/A

Asia and Australia's engagement with Asia

Asia and Australia's engagement with Asia is a key component of the *Carbon* curriculum and is integrated into the curriculum throughout F to10.

The table below outlines the organising ideas for Asia and Australia's engagement with Asia and their content aligned to lessons.

Code	Organising ideas	Incorporation in *Climate change – fact, forecast or fiction?*
Asia and its diversity		
011	The peoples and countries of Asia are diverse in ethnic background, traditions, cultures, belief systems and religions.	N/A
012	Interrelationships between humans and the diverse environments in Asia shape the region and have global implications.	Students discuss the interactions between humans and the specific geological environments in the Asian region.

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Achievements and contributions of the peoples of Asia		
013	The peoples and countries of Asia have contributed and continue to contribute to world history and human endeavour.	Students investigate the different perspectives of various stakeholders in energy production.
Asia-Australia engagement		
015	Collaboration and engagement with the peoples of Asia support effective regional and global citizenship.	Students discuss the merits and value of collaboration and engagement with the peoples of Asia in reducing global and regional greenhouse gas emissions.
016	Australia is part of the Asia region and our histories from ancient times to the present are linked.	Students develop an understanding that the historical and future actions of Australia directly influence the ability of the Asian region to mitigate climate change.
017	Australians play a significant role in social, cultural, political and economic developments in the Asia region.	Students develop an understanding that the historical and future actions of Australia directly influence the ability of the Asian region to reduce energy consumption from fossil fuels and mitigate climate change.
018	Australians of Asian heritage have influenced Australia's history and continue to influence its dynamic culture and society.	Students investigate the different perspectives of various stakeholders in energy production.

Sustainability

Sustainability is a key component of the *Carbon* curriculum and is integrated into the curriculum throughout F-10. The table below outlines the organising ideas for Sustainability and their content aligned to lessons.

Code	Organising ideas	Incorporation in *Climate change – fact, forecast or fiction?*
Systems		
011	The biosphere is a dynamic system providing conditions that sustain life on Earth.	The biosphere is an integral component of the carbon cycle and changes in the biosphere can have a direct impact on the movement of matter and energy throughout the carbon cycle.
012	All life forms, including human life, are connected through ecosystems on which they depend for their well-being and survival.	Carbon moves through ecosystems and the nature of this movement can affect the well-being and survival of all life forms.
013	Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems.	The global nature of greenhouse gas emissions and the consequent effect on climate change highlight and reveal the interdependence of social, economic and ecological systems.
World views		
014	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 on climate change highlight the diversity of opinion that currently exists and the importance of reliable data and evidence-based decision making in the quest for diversity, social justice and sustainability.
015	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 on climate change can result from a range of different experiences and can impact on actions to reduce greenhouse gas emissions and change lifestyles.

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Futures		
016	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.	Global equity and inequity are both highlighted in the levels of greenhouse gas emissions, their impacts and the actions of different regions in mitigating these impacts.
017	Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments.	Recognition of the need for understanding and action on climate change encourages care, respect and responsibility for the environment.
018	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.	Students design actions to reduce their personal ecofootprints, as well as mitigate the impacts of climate change on their and other neighbouring regions.
019	Sustainable futures result from actions designed to preserve and/or restore the quality and uniqueness of environments.	Students design actions to reduce their personal ecofootprints, and compare the relevance of these changes to those in neighbouring regions.

Key lesson outcomes

In the *Carbon is energy* unit, students begin to develop their understanding of carbon as an atom, an element, and a component of some typical molecules (e.g. carbon dioxide). They are introduced to the idea that elements chemically bond with one another and these bonds store energy. Students continue to delve into the movement of carbon within the carbon cycle, identifying the different global spheres it occupies. They begin to understand that energy transfers also occur when carbon moves between the spheres. Students examine the link between the release of energy from non-renewable carbon sources and the release of greenhouse gas that contributes to climate change. Students are given the tools and an opportunity to refine their problem-solving skills in order to examine energy and resource consumption–based problems in a variety of contexts – including environmental, social and economic – and are challenged to arrive at a solution that ensures the short-term and long-term futures of us, as Australians, and our regional neighbours.

Carbon chemistry, the carbon cycle, energy and climate change.

First and foremost, carbon is an atom and an element. Carbon can form chemical bonds with other elements, forming many different molecules, including carbon dioxide (a greenhouse gas).

It can be found in its many different forms throughout the different spheres of the carbon cycle - the biosphere (as sugar), the lithosphere (as minerals and non-renewable resources, such as coal and oil), the hydrosphere (dissolved in water), and the atmosphere (most commonly as carbon dioxide and methane gases).

As carbon cycles through these spheres, the bonds that bind it to other atoms can be made or broken, increasing the energy stored by carbon or releasing energy into the atmosphere. When energy is released into the atmosphere it often does so as heat. However, with the intervention of humans, this energy can be captured and harnessed for electricity generation. This energy stored in carbon can only be effectively used once, and the result is that while the carbon continues to cycle (in the first instance as carbon dioxide – a greenhouse gas), the energy has been used. Thus, carbon-based energy resources (e.g. fossil fuels) are non-renewable.

The resultant greenhouse gas produced during electricity generation is the main contributor to climate change. Therefore, there is much interest in reducing human dependence on non-renewable resources, and instead looking to renewable (non-carbon based) forms, such as solar and wind energy, as our main power source.

To a certain level, each individual, child, student, or adult, has some control over how much energy from non-renewable resources they wish to consume. Changes in the use of non-renewable resource use affect an individual's carbon footprint and, as a result, the individual's contributions to climate change.

Actions to reduce carbon footprints can be both individual and collective. Individuals have opportunities to collaborate with others, including those in their local and national region and with their Asia-Pacific neighbours. Changes that occur as a result of collaboration often have many more positive effects for communities, particularly those where livelihoods are less affluent.

Students' conceptions

Taking account of students' existing ideas is important in planning effective teaching approaches that help students learn science. Students develop their own ideas during their experiences in everyday life and might hold more than one idea about an event or phenomenon.

Students often find it difficult to grasp the subtle differences between atoms and elements. While they are often more familiar with common carbon molecules, such as carbon dioxide, the idea that these molecules involve chemical bonds between carbon and other atoms is often a new concept. Many students do not connect elemental or molecular carbon (that is, carbon chemistry) to carbon in living and non-living structures on the Earth (or carbon in the biological and earth sciences).

Students generally feel comfortable with the separate spheres within the carbon cycle, particularly when concrete examples of carbon compounds are provided. It is when they are introduced to the more abstract concepts of carbon and energy moving between these spheres that confusion can arise. It is useful to give some more accessible examples of the movement of carbon between spheres, such as burning wood, or decomposition of dying matter, so that students can begin to comprehend the cyclical nature of carbon movement.

While the movement of carbon is somewhat concrete, the movement or transfer of energy is more abstract, and this can present difficulties for some students. Often students' preconceptions about energy are simplistic, e.g. you can get energy from food; when you are tired you have less energy, etc. Using these ideas as a starting point and remoulding them in a scientific framework, with correct scientific terms, can allow students to move from the unscientific, simplistic view of energy, to a more sophisticated scientific view.

Energy in the form of electricity is something that students are generally more familiar with. Some students may be aware of the origin of this energy, e.g. fossil fuels such as coal or oil. However, for others, the connection between electricity and the earth's resources is not as well established. The concept of electricity itself is a difficult one, as it is recommended that in-depth discussions at this stage of a students' conceptual development be considered on a student-by-student basis, rather than as a topic for general class discussion. It is not necessary for students to have a sophisticated level of understanding of the nature of electricity for this unit.

Students generally feel comfortable linking the carbon dioxide, greenhouse gases and climate change. However, it is quite common for students to have embedded misconceptions surrounding the terms climate change and global warming. When discussing the effects and impacts of climate change, students can mistakenly assume that 'global warming' means that the world will be a hotter place. While true on a general scale, the effects that are both happening now and forecast for the future, are much more intricate and region-based. It is essential that students are introduced to the subtlety of this idea, in order that, over time, they can learn to distinguish one from the other. One means to this end is to use the term climate change in preference to global warming.

Students bring a large variety of attitudes and beliefs to the issue of climate change, its existence, and the role that humans do play, and should play, in its causes and solutions. Each student may already have a firm opinion on how much they are willing to engage in the science and politics of this issue, as well as how much, or little they are prepared to do or feel they can do, about its mitigation. This can be a very sensitive issue for some students, particularly in secondary school, as they grapple with their place in the family, their friendship groups and in society at large. However, by reframing the issue around the use of non-renewable resources, students can often feel more comfortable to engage.

It is also important to allow students to feel empowered to create meaningful change to reduce their dependence on non-renewable resources. This can be achieved by creating in students a sense of ownership and control over their own beliefs and actions, and establishing the idea that all positive action, large or small, has value and potential to create positive change.

Safety

Learning to use materials and equipment safely is central to working scientifically. It is important, however, for teachers to review each lesson before teaching in order to identify and manage safety issues specific to a group of students.

The following guidelines will help minimise risks:

> Be aware of the school's policy on safety in the classroom and for excursions and lessons conducted in the outdoors
> Check students' health records for allergies or other health issues
> Be aware of potential dangers by trying out activities before students do them
> Caution students about potential dangers before they begin an activity
> Clean up spills immediately as slippery floors are dangerous
> Instruct students never to taste, smell or eat anything unless they are given permission
> Discuss and display a list of safe practices for science activities.

Carbon futures program

Out of the classroom and into the bush

Carbon futures is an engaging, inquiry-based program developed by WithOneSeed in association with the Royal Botanic Gardens, Melbourne.

The program is available as a field trip to the Royal Botanic Gardens, Cranbourne and Melbourne, yet most elements of this program can also be completed within a school setting. Specific elements of the *field trip* are embedded within the lessons of this unit.

Carbon futures aims to 'plant' seeds to enable Australian students to better understand their environment, the carbon cycle and their rights and responsibilities as citizens of the Asia-Pacific region.

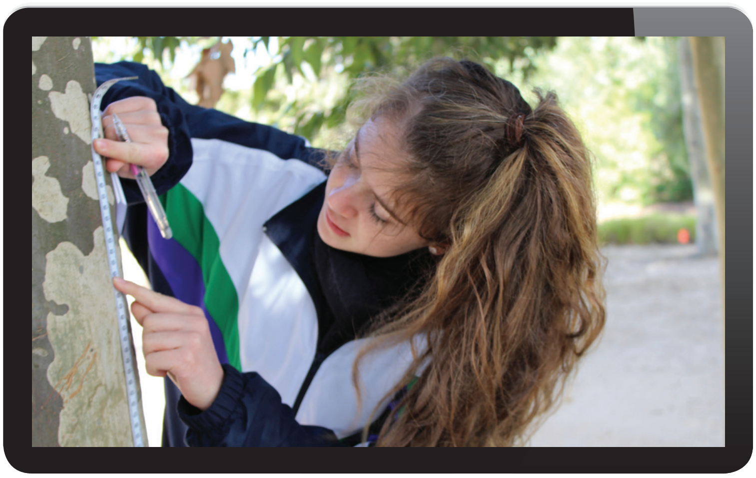
The *Carbon futures* program takes students out of the classroom and into the bush to gain a practical look at carbon in the environment. Students will learn about how carbon works in different natural systems through ocean acidification experiments and measuring carbon in trees. Students will also discover the many other services a forest has to offer people anywhere on the planet. The program also aims to connect schools in Australia with subsistence school communities in Timor Leste, as part of WithOnePlanet's open education and WithOneSeed's community forestry initiatives.

Teachers can arrange a *Carbon futures field trip* through the Royal Botanic Gardens Education Program.

Primary school bookings: http://www.rbg.vic.gov.au/learn/programs/primary-cranbourne
http://www.rbg.vic.gov.au/learn/programs/primary-melbourne

Secondary schools bookings: http://www.rbg.vic.gov.au/learn/programs/secondary-cranbourne
http://www.rbg.vic.gov.au/learn/programs/secondary-melbourne

Carbon futures program info video – http://vimeo.com/51257037



WithOneSeed Replenishing the planet An xpand Foundation initiative

WithOnePlanet Open education An xpand Foundation initiative

Royal Botanic Gardens Melbourne