WithOnePlanet

> Module 1:
> Carbon

> Level:
> Years 5 to 6

> Section:
> Caring for our carbon

Unit outline for teachers

Unit outline for teachers

Module: Carbon
Unit outline for teachers

Years 5 to 6

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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		

Caring for our carbon

A unit for Years 5 to 6

Unit outline for teachers

Introduction

We all live, eat, breathe and use carbon every day … without even thinking about it! Carbon is all around us and available to us in many different forms – as an atmospheric gas, as an energy source, and as a food source. When we eat a sandwich, turn on the engine in the car, or switch on the television, we are literally consuming carbon. But where did this carbon originally come from? Besides being able to watch our favourite program and eat our favourite food, what else happens when we use this carbon? The ***Caring for our carbon*** unit is an ideal way to investigate the science of carbon and improve the scientific literacy of students in the classroom. It provides opportunities for students to investigate their understandings of carbon – where it comes from and how we use it, and what happens when we use too much of it – and through discussion and debate, arrive at their own considered opinion about how we should be using carbon to live sustainably in the future.

*'The **Caring for our carbon** unit is an ideal way to investigate the science of carbon and improve the scientific literacy of students in the classroom.'*

Unit 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** **Where in the world is carbon?** Students contribute their knowledge about carbon as a chemical and an electricity source as well as the consequences of using carbon for life on Earth.	To capture students' interest and find out what they think they know about carbon as a chemical and a component of other chemicals, as well as a source of electricity. To gauge students' understanding of how their environmental footprints connect with using carbon, and ways that they can reduce their dependence on carbon, as well as the impacts of this on our neighbours in the Asia-Pacific.
INQuIRY Question	**Lesson 2** **The real question about carbon** Students develop an essential question about carbon.	To elicit students' questions about carbon as a chemical and a source of electricity, as well as the impact of using carbon on life on Earth. To develop an essential question about carbon and electricity that students can investigate.
INQuIRY Investigate	**Lesson 3** **Constructing carbon compounds**	To provide students with hands-on, shared experiences of carbon as a chemical and a component of other chemicals.
	Lesson 4 **The carbon detectives** Session: Carbon in the sea, carbon on the land, carbon and fire Students investigate a range of different forms that carbon can take in different spheres of the carbon cycle. Students also investigate how trees are made of carbon and how this carbon can be released back into the atmosphere through burning. Session: Carbon is electric! Students investigate how carbon can be released from plant material and used to generate energy and 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 > the ways that carbon can move and energy can be transferred between these spheres > the ways 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 transformations within the carbon cycle including the generation of electricity and heat from it.

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INQuIRY model	Lesson sequence	At a glance
INQuIRY **Investigate**	Lesson 5 **Counting the cost of carbon** Session: Analysing carbon dioxide concentrations Students analyse a range of data sets showing trends in carbon dioxide concentrations. Session: Calculating carbon emissions Students calculate their own carbon footprints and compare them to others both locally and across the globe.	To provide students with hands-on, investigation experiences of: > a range of data sets showing changes in carbon dioxide emissions over different time periods > the connection between the release of energy from carbon compounds and climate change.
	Lesson 6 **Carbon's call to action** Students analyse a recent climate change advertising campaign and create a school-based version.	To support students to analyse a recent energy-saving, greenhouse gas reducing advertising campaign and plan and conduct a similar school-based campaign.
	Lesson 7 **Round and round the carbon cycle** 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 8 **Seeing carbon in your own reflection** Students review their understanding of the unit.	To provide opportunities for students to represent what they know about carbon as an energy and electricity source and the impacts of this on the planet, and to reflect on their learning during the unit.
INQuIRY **Your future**	Lesson 9 **Carbon present, carbon future** 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 5 and 6.

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 5 to 6	Carbon is a chemical substance that can join chemically to other substances to form molecules such as carbon dioxide and crude oil.	Humans can make use of natural processes that occur in the carbon cycle to generate electricity. Some of these processes produce carbon dioxide as a by-product.	When atmospheric temperatures rise, there are many consequences for the living and non-living things on the Earth.	I can reduce my carbon footprint by making some simple changes to my daily life.	People in other places in the Asia-Pacific region have lifestyles with a variety of carbon footprints for a variety of reasons.

Alignment with the Australian Curriculum: Science

This *Caring for our carbon* unit embeds all three strands of the Australian Curriculum: Science. The table below lists sub-strands and their content for Years 5 and 6. This unit is designed to be taught in conjunction with other units at Years 5 and 6 to cover the full range of the Australian Curriculum: Science content.

The table below outlines the sub-strands and their content aligned to lessons.

Strand	Sub-strand	Year level	Code	Years 5 to 6 content descriptions	Lesson
Science as a human endeavour	Nature and development of science	5 & 6	ACSHE081	Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena.	4, 5, 6, 7
			ACSHE082	Important contributions to the advancement of science have been made by people in a range of cultures.	5
	Use and influence of science		ACSHE083	Scientific understandings, discoveries and inventions are used to solve problems that directly affect people's lives.	5, 6
			ACSHE217	Scientific knowledge is used to inform personal and community decisions.	4, 5, 6
Science understanding	Biological sciences	5	ACSSU043	Living things have structural features and adaptations that help them to survive in their environment.	4
		6	ACSSU	The growth and survival of living things are affected by the physical conditions of their environment.	4, 5
	Chemical sciences	5	ACSSU077	Solids, liquids and gases have different observable properties and behave in different ways.	3
		6	ACSSU	Changes to materials can be reversible, such as melting, freezing, evaporating, or irreversible, such as burning and rusting.	3, 4
	Earth and space sciences	5	ACSSU078	The Earth is part of a system of planets orbiting around a star (the Sun).	
		6	ACSSU	Sudden geological changes or extreme weather conditions can affect Earth's surface.	4, 5
	Physical sciences	5	ACSSU080	Light from a source forms shadows and can be absorbed, reflected and refracted.	
		6	ACSSU	Electrical circuits provide a means of transferring and transforming electricity.	4 , 6
			ACSSU	Energy from a variety of sources can be used to generate electricity.	4, 5, 6

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Strand	Sub-strand	Year level	Code	Years 5 to 6 content descriptions	Lesson
Science inquiry skills	Questioning and predicting	5 & 6	ACSIS231	With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be.	1, 2, 6, 8, 9
	Planning and conducting		ACSIS086	With guidance, plan appropriate investigation methods to answer questions or solve problems.	1, 2, 6, 8
			ACSIS087	Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate.	8
			ACSIS088	Use equipment and materials safely, identifying potential risks.	3, 4
Science inquiry skills (continued)	Processing and analysing data and information	5 & 6	ACSIS090	Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data, using digital technologies as appropriate.	1, 3, 4, 5, 6, 8
			ACSIS218	Compare data with predictions and use as evidence in developing explanations.	4, 5, 6, 7, 8
	Evaluating		ACSIS091	Suggest improvements to the methods used to investigate a question or solve a problem.	5, 6
	Communicating		ACSIS093	Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts.	1, 2, 3, 4, 5, 6, 7, 8, 9

Alignment with Australian Curriculum: Science – Overarching Ideas

Overarching idea	Incorporation into *Caring for our carbon*
Patterns, order and organisation	Students compare similarities and differences and identify patterns in: > a range of carbon compounds > burnt and unburnt forests > data showing carbon dioxide concentrations over time > carbon footprints from different individuals and cultures. Students organise their ideas and understanding in: > the analysis of first- and second-hand data > developing essential questions about carbon > analysing the carbon stored in trees > planning a black balloon survey and commercial.
Form and function	Students explore how different elements are connected using chemical bonds to form a variety of carbon compounds. They compare the growth of trees to their ability to store carbon.

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Overarching idea	Incorporation into *Caring for our carbon*
Stability and change	Students discuss how: > forest fires can impact on the survival success of forests and the biodiversity they contain > the needs and desires of people and the planet can be both similar and different to one another at the same time > humanity's demand for energy can affect the stability of different elements of the carbon cycle.
Scale and measurement	Students compare the circumference of tree trunks with their ability to store carbon. Students compare the geologic time scale to their everyday concept of time.
Matter and energy	Students investigate the absorption, storage and emission of carbon in different spheres of the carbon cycle, including the role of plants, geological structures and Earth's natural processes in moving carbon and energy through the cycle. Students investigate human manipulation of the carbon cycle to encourage energy transfers and transformations.
Systems	Students investigate large-scale Earth systems including the Earth's climate 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 5-6	Incorporation into *Caring for our carbon*
Recognising questions that can be investigated scientifically and investigating them	This *Carbon* unit is primarily structured around questions, and big scientific questions in particular. With guidance and support, students are encouraged to develop their own scientific questions and are then provided with structured and modelled pathways through which to investigate possible answers and solutions.

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 5 and 6 achievement standards.

Alignment with the Australian Curriculum: English

This *Caring for our carbon* unit also embeds a number of content descriptions from the Literacy strand of the Australian Curriculum: English. The table below lists those content descriptions for Years 5 and 6 that are covered in this unit.

Strand	Sub-strand	Year level	Code	Years 5 to 6 content descriptions	Lesson
Literacy	Interacting with others	5	ACELY1699	Clarify understanding of content as it unfolds in formal and informal situations, connecting ideas to students' own experiences and present and justify a point of view.	1, 2, 7, 8, 9
		6	ACELY1709	Participate in and contribute to discussions, clarifying and interrogating ideas, developing and supporting arguments, sharing and evaluating information, experiences and opinions.	1, 2, 3, 4, 5, 6, 7, 8, 9
			ACELY1816	Use interaction skills, varying conventions of spoken interactions such as voice volume, tone, pitch and pace, according to group size, formality of interaction and needs and expertise of the audience.	1, 2, 3, 4, 5, 6, 7, 8, 9
	Interpreting, analysing, evaluating	5	ACELY1796	Use interaction skills, for example, paraphrasing, questioning and interpreting non-verbal cues and choose vocabulary and vocal effects appropriate for different audiences and purposes.	1, 2, 3, 4, 5, 6, 7, 8, 9
			ACELY1703	Use comprehension strategies to analyse information, integrating and linking ideas from a variety of print and digital sources.	1, 4, 5, 6, 7
			ACELY1700	Plan, rehearse and deliver presentations for defined audiences and purposes incorporating accurate and sequenced content and multimodal elements.	1, 6, 7, 8
		6	ACELY1712	Select, navigate and read texts for a range of purposes, applying appropriate text processing strategies and interpreting structural features, for example, tables of contents, glossary, chapters, headings and subheadings.	4, 5, 6, 7
			ACELY1713	Use comprehension strategies to interpret and analyse information and ideas, comparing content from a variety of textual sources including media and digital texts.	1, 4, 5, 6, 7

Alignment with the Australian Curriculum: Mathematics

This *Caring for our carbon* unit also embeds a number of content strands of the Australian Curriculum: Mathematics. The table below lists those content descriptions for Years 5 and 6 that are covered in this unit.

Strand	Sub-strand	Year level	Code	Years 5 to 6 content descriptions	Lesson
Measurement and geometry	Units of measurement	5	ACMMG108	Choose appropriate units of measurement for length, area, volume, capacity and mass.	4, 5
Statistics and probability	Data representation and interpretation		ACMSP118	Pose questions and collect categorical or numerical data by observation or survey.	4, 5
			ACMSP119	Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies.	4, 5
			ACMSP120	Describe and interpret different data sets in context.	4, 5

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	*Caring for our Carbon* 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 > graphs > websites > diagrams > maps > graphic organisers > videos.

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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 and analyse data in tables > analyse, represent and communicate data in tables, 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 online tools and software programs to view, record and analyse information.

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 developing 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.

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 global citizens and environmental stewards.
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

Caring for our carbon 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 *Caring for our carbon*
Country/Place		
011	Australia has two distinct Indigenous groups, Aboriginal Peoples and Torres Strait Islander Peoples.	
012	Aboriginal and Torres Strait Islander communities maintain a special connection to and responsibility for Country/Place throughout all of Australia.	
013	Aboriginal and Torres Strait Islander Peoples have unique belief systems and are spiritually connected to the land, sea, sky and waterways.	
Culture		
014	Aboriginal and Torres Strait Islander societies have many language groups.	
015	Aboriginal and Torres Strait Islander Peoples' ways of life are uniquely expressed through ways of being, knowing, thinking and doing.	
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.	
People		
017	The broader Aboriginal and Torres Strait Islander societies encompass a diversity of nations across Australia.	
018	Aboriginal and Torres Strait Islander Peoples have sophisticated family and kinship structures.	
019	Australia acknowledges the significant contributions of Aboriginal and Torres Strait Islander people locally and globally.	

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 *Caring for our carbon*
Asia and its diversity		
011	The peoples and countries of Asia are diverse in ethnic background, traditions, cultures, belief systems and religions.	Students compare their ecological footprints with peoples of other cultures and discuss why they may be similar or different.
012	Interrelationships between humans and the diverse environments in Asia shape the region and have global implications.	Students discuss the differences and similarities in ecological footprints between different Asian environments.

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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 different data sets developed and collected by a range of different global scientific institutions.

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, while improving quality of life, particularly of poorer Asian regions.
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 and improve livelihoods.
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 mitigate climate change and improve livelihoods.
018	Australians of Asian heritage have influenced Australia's history and continue to influence its dynamic culture and society.	Students investigate the impacts of energy-saving advertising campaigns on all Australians, including those that involve Australians of Asian heritage, and design new campaigns for Australians, including those of Asian heritage.

Sustainability

Sustainability 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 Sustainability and their content aligned to lessons.

Code	Organising ideas	Incorporation in *Caring for our carbon*
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 directly 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 climate change both highlights and necessitates the interdependence of social, economic and ecological systems.

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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.
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.	Comparisons of carbon footprints between individuals and regions can be linked to differences and similarities between individual and regional environments. Reduction of carbon footprints and the impacts of climate change on regions is linked to the values mentioned.
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 theirs, their school community's 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 the energy use of their school community, and compare the impact of these changes to peoples in neighbouring regions.

Key lesson outcomes

In the *Caring for our carbon* unit, students begin to develop their understanding of carbon as a chemical element, and a component of some typical carbon compounds (e.g. carbon dioxide). They are introduced to the idea that elements chemically bond with one another to form compounds. Students continue to delve into the movement of carbon within the carbon cycle, identifying the different global spheres it occupies. They begin to develop their understanding that energy transfers and transformations also occur when carbon moves between the spheres. Students examine the link between the release of energy from non-renewable carbon sources to produce electricity, and the release of greenhouse gas that contributes to climate change. Students are given the tools and opportunity to refine their data analysis and creative problem solving skills in order to examine an resource and energy (electricity) use issues and are challenged to arrive at solutions that ensure the short- and long-term futures of themselves, their school communities, their fellow countrymen and our regional neighbours.

Teacher background information

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

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

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

As carbon cycles through these spheres, the energy stored by carbon can be transformed into other forms of energy, including electricity. 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.

Each individual is able to make some decisions regarding how much energy from non-renewable resources they consume. Changes in energy use can affect an individual's carbon footprint, and, as a result, the individual's contribution 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 differences between elements and compounds. While they are often more familiar with common carbon compounds, such as carbon dioxide, the idea that these compounds involve chemical bonds between carbon and other atoms is often a new concept. Many students do not connect elemental carbon or carbon compounds as chemical structures (that is, carbon chemistry) to carbon in living and non-living structures on the Earth (or carbon in the biological and Earth sciences).

Students may find the new scientific terms associated with different spheres of the carbon cycle difficult to grasp. As such it is particularly important to provide as many concrete examples of carbon compounds that exist in these spheres as possible. When students are introduced to the more abstract concepts of carbon and energy moving between these spheres, 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 far more abstract, and this can present difficulties for many 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 somewhat 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 can be a particularly difficult one, as it is recommended that in-depth discussions at this stage of a students' conceptual development are 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 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 how little, they are prepared to do, or feel they can do, about its mitigation. This can be a very sensitive issue for some students, 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 energy, and more specifically electricity, 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.
- 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.
- 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

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Royal Botanic Gardens Melbourne