

WithOnePlanet

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Investigate

Lesson 4

Teacher notes

Hitch a ride on the carbon cycle!

Years

7 to 8

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Hitch a ride on the carbon cycle!

Lesson 4: Teacher notes

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This document provides the teacher with the details of the lesson.

At a glance

To provide students with hands-on, shared 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 within the carbon cycle, and the generation of electricity and heat from it.

Activity 1: Round and round the carbon cycle

Students:

- > investigate the different forms that carbon can take within the carbon cycle and the processes that allow carbon to move around the carbon cycle.

Activity 2: The power of carbon!

Students:

- > investigate the energy transfers and transformations that can occur as carbon moves through the carbon cycle
- > investigate how energy is released from some of the processes that occur in the carbon cycle.

Lesson focus

The *Investigate* phase is designed to provide students with hands-on experiences of the science phenomenon. Students explore ideas, collect evidence, discuss their observations and keep records, such as science journal entries. The *Investigate* phase ensures all students have a shared experience that can be discussed and explained.

In the *Investigate* phase students develop a literacy product to represent their developing understanding. They discuss and identify patterns and relationships within their observations. Students consider the current views of scientists and deepen their own understanding.

Assessment focus

This assessment guide supports teachers in identifying the types of assessment that are appropriate for this lesson.

Formative assessment is an important aspect of the *Investigate* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. It involves monitoring students' developing understanding of:

- > the different forms that carbon can take in the different spheres of the carbon cycle, the transfers and transformations of energy between these spheres, and the way that humans can manipulate the energy transfers of the carbon cycle to generate electricity and heat.

You will also monitor their developing science inquiry skills.

Summative assessment of the science inquiry skills is another important focus of the *Investigate* phase. Rubrics can be used to gauge the level of student achievement on performance tasks.

Key lesson objectives

Science

Students will be able to:

- > understand carbon storage and the processes involved in moving carbon around the carbon cycle
- > understand the difference between energy transfers and transformations and apply this understanding in a practical setting
- > explain the energy transfers and transformations that occur when carbon from fossil fuel is used to produce electricity in a power station.

Literacy

Students will be able to:

- > contribute to discussions about carbon's role in the carbon cycle and how transfers and transformations of energy can result in electricity production
- > record ideas, descriptions and explanations in diagrams and words in a variety of written modes including experimental report templates.

This lesson also provides opportunities to monitor the development of students' general capabilities.

Teacher background information

The carbon cycle is one of the most essential elemental cycles to sustain life on Earth. Most of the chemicals that make up living tissue contain carbon. When living things die the carbon is recycled and can then be used in other processes in other parts of the cycle.

Carbon moves between four main spheres, or components, of the Earth - the living sphere, or biosphere, the atmosphere (the air), the hydrosphere (the water) and the lithosphere (the soil).

In each of these spheres carbon exists in different types of compounds. Carbon is able to move between the spheres as a result of specific processes that occur on the Earth.

Carbon enters the atmosphere as carbon dioxide from cellular respiration, which occurs in all living things, and combustion (or burning). It can also be removed from the atmosphere via the process of photosynthesis, which occurs in plants and a small number of other living things. The carbon in carbon dioxide is used by these living things to make carbohydrates (or sugars).

When animals feed on plants, most of the carbon they consume is used in the process of cellular respiration to produce energy for daily activities. The carbon itself is then exhaled as carbon dioxide.

These animals and plants eventually die and the dead organisms are eaten by decomposers, such as fungi and bacteria. The decomposers are able to return the carbon from the dead bodies to the atmosphere as carbon dioxide. In some conditions, decomposition is blocked and the plant and animal material may then form fossils over millions of year, ultimately then available as fossil fuel in the future for combustion by humans.

In the sea, marine animals may convert some of the carbon in their diet to **calcium carbonate** which is used to make their shells. Over time the shells of dead organisms collect on the seabed and form limestone. Owing to Earth's movements, this limestone may eventually become exposed to the air where it's weathered allowing the carbon to be released back into the atmosphere as **carbon dioxide**. Volcanic action may release **carbon dioxide** from the lithosphere back into the atmosphere.

There are many energy transfers and transformations that occur when carbon moves between the different spheres of the carbon cycle. A good example of this is when carbon moves from being stored as fossil fuel in the lithosphere (e.g. as coal underground) to becoming carbon dioxide in the atmosphere. This is also known as burning or combustion.

Fossil fuels – coal, oil and natural gas – are huge stores of carbon underground. Over time, particularly since the beginning of the Industrial Revolution around 1760 AD, humans have developed more and more sophisticated ways of digging up those carbon stores and burning them to release energy.

The energy released from the combustion of fossil fuels is heat energy. Heat energy is a very inefficient form of energy – it is hard to contain, store, transport or do anything much with. So humans invented power stations so that they could transform the heat energy from fossil fuels into electrical energy.

Regardless of its type, the job of a power station is to transform a particular form of energy, such as the chemical energy stored in fossil fuels, into electrical energy. Power stations use a chain of energy transformations to do this. These include the transformation from chemical energy in the fossil fuel to heat energy during combustion; the transformation of heat energy in the hot steam into mechanical energy in the turbine and so on.

Once the electricity is produced at the power station, it needs to be prepared for travelling to our homes. This involves being transformed (a different use of the same word) into a different voltage so that it can be carried long distances over wires to substations. At substations, the electricity is again transformed into a suitable voltage for our homes.

Activity 1: Round and round the carbon cycle

Equipment

For each student

- > Access to a computer and the internet
- > A copy of the *Round and round the carbon cycle - Student worksheet*.

Preparation

- > Read through all worksheets and check that all weblinks contained within are working.

Lesson steps

1. Students to watch 'Episode 1: *Global Warming, It's all about carbon*' video from YouTube: <http://youtu.be/ypbb9Zi5Tao>¹
2. Use the video as a prompt for a class discussion around the following focus question:
 - > Where on the Earth can carbon be found?
 Generate a list of student responses.
3. Show the students the diagram of the carbon cycle from the following interactive: <http://www.sciencelearn.org.nz/Contexts/The-Ocean-in-Action/Sci-Media/Animations-and-Interactives/Carbon-cycle>²

Ask students to identify where the responses from the discussion can be placed on the diagram. Their responses should all fall into some or all of the 'carbon stores' that are present on the diagram.
4. Click on each carbon store on the diagram to learn more about it.
5. Provide students with the *Hitch a ride on the carbon cycle – Student worksheet*, which has an alternative diagram of the carbon cycle, and give students time to complete *Task 1: Identify the carbon stores* on the diagram and write a list of their stores in the table provided.
6. Explain to students that the carbon stores can be categorised into 4 main areas – hydrosphere, lithosphere, biosphere and atmosphere. Ask students what they think these scientific terms mean. Students to complete *Task 1: Identify which sphere each carbon store occupies*.
7. Explain to students that carbon is able to move between the different spheres in the carbon cycle. As a result, the carbon compounds undergo chemical reactions to form new compounds. The 'processes' of the carbon cycle allow these chemical reactions to happen and therefore allow carbon to move between the different spheres.
8. Return to the diagram of the carbon cycle from the following interactive: <http://www.sciencelearn.org.nz/Contexts/The-Ocean-in-Action/Sci-Media/Animations-and-Interactives/Carbon-cycle>²
9. Click on each 'process' on the diagram to learn more about it.
10. Students to complete *Task 2: Identify the processes that allow carbon to move* on the diagram on the *Hitch a ride on the carbon cycle – Student worksheet*.
11. Students to complete *Task 3: Summarising the carbon cycle* on the *Hitch a ride on the carbon cycle – Student worksheet*.
12. Use the game as a prompt for a class discussion about their experiences using the following focus questions:
 - > Was everyone's journey the same? Why not?
 - > How many stops did you make on your journey? How many stops can you make on your journey?
 - > Will your journey as a carbon atom ever end?
 - > What would happen to the carbon atoms in the game if humans burned more fossil fuels?

Activity 2: The power of carbon!

Equipment

For the Class

- > Equipment set up around the room for the *Energy transfer and transformation stations! Practical task* (refer to the *Energy transfer and transformation stations! – Teacher notes* for details of the equipment required and instructions).

For each Student

- > Access to a computer and the internet
- > A copy of the following three student worksheets:
 - *Energy transfer and transformation stations! – Student worksheet*
 - *The most outrageous way to share a Coke – Student worksheet*
 - *The power of carbon! – Student worksheet*

Preparation

- > *Energy transfer and transformation stations! Practical task* (refer to the *Energy transfer and transformation stations! – Teacher notes* for details of the equipment required and instructions)
- > Read through all worksheets and check that all weblinks contained within are working.

Lesson steps

1. Students to complete the *Energy transfer and transformation stations! - Student worksheet*. This includes the *Energy transfer and transformation stations! Practical task*.
2. Show students the following tutorial to review their understanding of energy and energy transfers: http://www.bbc.co.uk/bitesize/ks3/science/energy_electricity_forces/energy_transfer_storage/revision/1/⁴
3. Students to watch *The most outrageous way to share a Coke* video: <http://youtu.be/Kc8TCivr10U>⁵ and complete *The most outrageous way to share a Coke – Student worksheet*.
4. Refer students to the carbon cycle diagram in *The power of carbon! - Student worksheet*. (Students have already seen this in the *Hitch a ride on the carbon cycle – Student worksheet*.) Explain to students that there are many energy transfers and transformations that occur when carbon moves between the different spheres of the carbon cycle. A good example of this is when carbon moves from being stored as fossil fuel in the lithosphere (e.g. as coal underground) to becoming carbon dioxide in the atmosphere. This is also known as combustion. Ask students if they can think of any other energy transfers or transformations that occur as carbon moves between spheres.
5. Students to watch the following videos and answer the questions in *The power of carbon! - Student worksheet*.
 'Episode 2: Global Warming, It's all about carbon' video from YouTube: <http://youtu.be/cOJ3MUpDrfl>⁶
 'Episode 3: Global Warming, It's all about carbon' video from YouTube: <http://youtu.be/Q9u8vM8YjeU>⁷
6. Students to complete the following interactives and answer the questions in *The power of carbon! - Student worksheet*:
 Build your own power station: (Energy transformations): <http://www.eon-uk.com/EnergyExperience/708.htm>⁸
 Energy sources: <http://www.eon-uk.com/EnergyExperience/491.htm>⁹
 Tour of a power plant: <http://www.eon-uk.com/EnergyExperience/164.htm>¹⁰
 How do power stations work? <http://www.eon-uk.com/EnergyExperience/497.htm>¹¹

Energy transfer and transformation stations!

Station #	Equipment	Instructions*
1	A toy car	Push the toy car along the desk with your finger
2	A match and matchbox	Light the match (and then blow it out)
3	A transistor radio tuned to a radio station	Turn on the radio
4	A pinwheel	Blow on the pinwheel
5	A battery operated torch	Turn on the torch
6	A hairdryer plugged into an electric socket	Turn on the hairdryer
7	A battery operated clock and a battery	Insert the battery into the clock
8	A glowstick (enough for one glowstick per person or group)	Crack the glowstick to make it glow

* These instructions will need to be provided at each station, along with the Station number

Sources:

1. NPR 2009, *Episode 1: Global Warming, It's All About Carbon*, [Online Video] 3 February, viewed 31 December 2013, <<http://youtu.be/ypbb9Zi5Tao>>
2. The University of Waikato 2010, *Carbon Cycle Sciencelearn Hub*, viewed 31 December 2013, <<http://www.sciencelearn.org.nz/Contexts/The-Ocean-in-Action/Sci-Media/Animations-and-Interactives/Carbon-cycle>>
3. BBC 2013, BBC - KS3 Bitesize Science – *Energy transfer and storage: Revision*, viewed 31 December 2013, <http://www.bbc.co.uk/bitesize/ks3/science/energy_electricity_forces/energy_transfer_storage/revision/1/>
4. Dornswalo Wilkins-McCorey 2013, *The most outrageous way to share a Coke*, [Online Video] 24 July, viewed 31 December 2013, <<http://youtu.be/Kc8TCivr10U>>
5. NPR 2009, *Episode 2: Global Warming, It's All About Carbon*, [Online Video] 3 February, viewed 31 December 2013, <<http://youtu.be/cOJ3MUpDrfl>>
6. NPR 2009, *Episode 3: Global Warming, It's All About Carbon*, [Online Video] 3 February, viewed 31 December 2013, <<http://youtu.be/Q9u8vM8YjeU>>
7. E.ON UK 2013, *E.ON UK – Energy Experience – Energy*, viewed 31 December 2013, <<http://www.eon-uk.com/EnergyExperience/708.htm>>
8. E.ON UK 2013, *E.ON UK – Energy Experience – Energy*, viewed 31 December 2013, <<http://www.eon-uk.com/EnergyExperience/491.htm>>
9. E.ON UK 2013, *E.ON UK – Energy Experience – Energy*, viewed 31 December 2013, <<http://www.eon-uk.com/EnergyExperience/164.htm>>
10. E.ON UK 2013, *E.ON UK – Energy Experience – Energy*, viewed 31 December 2013, <<http://www.eon-uk.com/EnergyExperience/497.htm>>