

Topic 3.4

How do human activities affect the natural greenhouse effect?

Key Concepts

- Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.
- Canadians add to the increase of greenhouse gases in the atmosphere.

Key Skills

Literacy

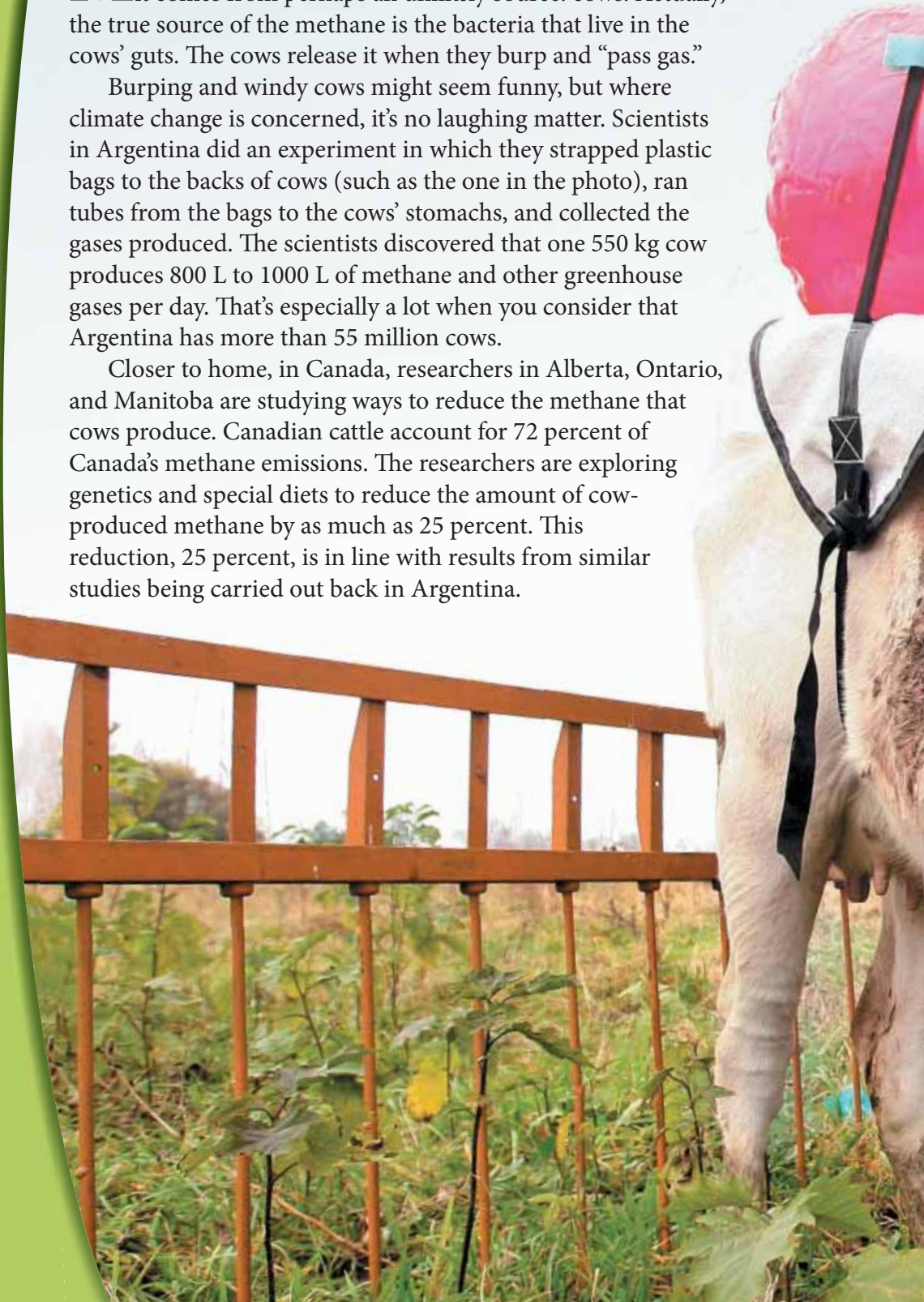
Key Terms

anthropogenic
greenhouse effect

Methane is one of the more powerful greenhouse gases, and it comes from perhaps an unlikely source: cows. Actually, the true source of the methane is the bacteria that live in the cows' guts. The cows release it when they burp and "pass gas."

Burping and windy cows might seem funny, but where climate change is concerned, it's no laughing matter. Scientists in Argentina did an experiment in which they strapped plastic bags to the backs of cows (such as the one in the photo), ran tubes from the bags to the cows' stomachs, and collected the gases produced. The scientists discovered that one 550 kg cow produces 800 L to 1000 L of methane and other greenhouse gases per day. That's especially a lot when you consider that Argentina has more than 55 million cows.

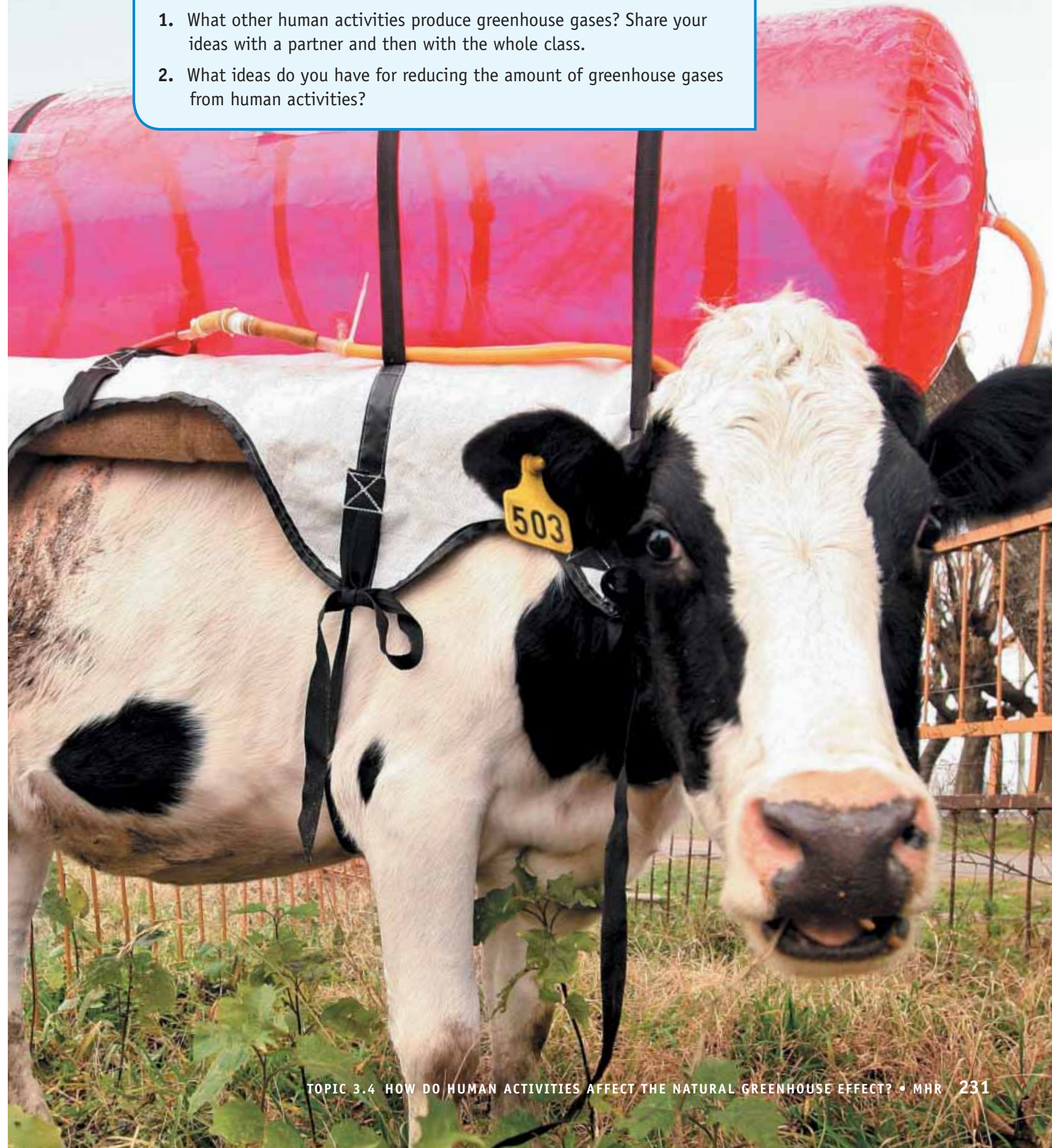
Closer to home, in Canada, researchers in Alberta, Ontario, and Manitoba are studying ways to reduce the methane that cows produce. Canadian cattle account for 72 percent of Canada's methane emissions. The researchers are exploring genetics and special diets to reduce the amount of cow-produced methane by as much as 25 percent. This reduction, 25 percent, is in line with results from similar studies being carried out back in Argentina.



Starting Point Activity

Methane is produced naturally in the environment. But it also is produced by human activities such as raising cows for their milk and meat.

1. What other human activities produce greenhouse gases? Share your ideas with a partner and then with the whole class.
2. What ideas do you have for reducing the amount of greenhouse gases from human activities?



Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.

anthropogenic greenhouse effect: a process in which human produced greenhouse gases in Earth's atmosphere absorb heat energy from the Sun and Earth's surface



▲ **Figure 3.17** The world we live in today is a product of the industrial revolution, which sparked a shift from farming communities in the countryside to industrialized communities in cities. It also marked the start of the kind of wide-scale pollution that cities are responsible for.

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Earth's average temperature is increasing at a much faster rate than it has in the past. Along with this warming come other changes in climate as well. Most scientists agree that these changes are happening so quickly because human activities are adding more greenhouse gases into the atmosphere. In other words, human activities are enhancing the natural greenhouse effect. This enhanced greenhouse effect is called the **anthropogenic greenhouse effect**. Anthropogenic means “human-caused.”

The anthropogenic greenhouse effect is linked to the start of the industrial revolution about 300 years ago. At that time, people who lived in the countryside began moving to cities to work in factories such as those shown in **Figure 3.17**. These factories used a new technology—the steam engine—that was fueled by the burning of coal.

As more factories were built, more coal was burned to run them, and more people moved into ever-growing cities to find work.

Since the industrial revolution, people have been adding more and more greenhouse gases into the atmosphere. Human activities produce many of the same greenhouse gases that are produced naturally. These include carbon dioxide, methane, and nitrous oxide. Others, such as halocarbons, do not occur naturally. They are produced only by human activity. Read about human activities that produce these greenhouse gases on the next page.

LEARNING CHECK

1. Explain how the anthropogenic greenhouse effect is different from the natural greenhouse effect.
2. Describe how cutting down trees increases the amount of carbon dioxide in the atmosphere.
3. Use a cause-and-effect map to show the link between the start of the industrial revolution 300 years ago and the increased amount of carbon dioxide in the atmosphere today.
4. One molecule of nitrous oxide warms the atmosphere much more than one molecule of carbon dioxide. Why, then, do you think the news media report more on the effects of carbon dioxide than on the effects of nitrous oxide?

How Carbon Dioxide Results from Human Activities

Most anthropogenic carbon dioxide comes from burning fossil fuels (coal, oil, and natural gas). Fossil fuels are burned to carry out industrial processes, generate electricity, heat homes, and power vehicles. Deforestation also has added carbon dioxide to the atmosphere. When large areas of forest are cleared of their trees, less carbon dioxide is removed from the atmosphere through photosynthesis. As well, the branches, leaves, and other debris that result from logging are often burned. This also adds carbon dioxide.



How Methane Results from Human Activities

Methane is produced when bacteria break down vegetation in an oxygen-free environment. Methane absorbs 25 times more heat than carbon dioxide does. So even though there is less methane in the atmosphere than carbon dioxide, methane is a more potent greenhouse gas. Farming is the main human activity that produces methane. For instance, cows, goats, and sheep have methane-releasing bacteria in their guts to help them break down the food they eat. Growing rice is another source of methane. Rice is grown in flooded fields. Plants under the water decompose, and this releases methane. Decomposing garbage in landfills also produces methane, and so does extracting fossil fuels from the ground.



How Nitrous Oxide Results from Human Activities

Nitrous oxide is an even more potent greenhouse gas than methane. In fact, nitrous oxide absorbs 300 times more heat than carbon dioxide does. Human sources of nitrous oxide include farming of crops and livestock, use of fertilizers, and vehicle exhaust.



How Halocarbons Result from Human Activities

Halocarbons are the only greenhouse gases produced solely by human beings. Halocarbons are industrial chemical compounds. The best known are the chlorofluorocarbons, or CFCs. In the past they were used as solvents and as coolants in refrigerators. CFCs were banned many years ago because of the damage they cause to the atmosphere's ozone layer. However, once they are in the atmosphere, CFCs take thousands of years to break down. To make the problem worse, they are thousands of times more potent as greenhouse gases than carbon dioxide. Fortunately, CFCs make up only 2 percent of greenhouse gases produced by human activities.



Canadians add to the increase of greenhouse gases in the atmosphere.

Canada has less than 1 percent of the world's population. However, Canada contributes about 2 percent of the world's greenhouse gas emissions. Some of the activities that are responsible for Canada's role in greenhouse gas emissions are described below.

Home Heating Canada is one of the coldest countries in the world. We generate a great deal of greenhouse gases as we burn wood and fossil fuels to keep our homes, schools, and workplaces warm.

Deforestation Forestry is a major industry in British Columbia, as well as in Ontario and other heavily forested provinces. Harvesting trees means less carbon dioxide is removed from the air by photosynthesis. Burning leftover vegetation also emits greenhouse gas.

Oil Sands The Alberta oil sands are the second-largest reserve of oil in the world. They are also the fastest-growing source of greenhouse gases in Canada. Producing one barrel of oil from oil sands generates three times as much greenhouse gas as producing one barrel of conventional oil.

Land Travel On average, one tree absorbs about one tonne of carbon dioxide in its lifetime. In a forested country such as ours, road construction clears a lot of trees that would otherwise absorb carbon dioxide. The cars and trucks that drive on Canadian roads also burn fossil fuels, producing carbon dioxide and nitrous oxide.

Industry and Manufacturing Industry and manufacturing centres such as southern Ontario produce carbon dioxide, methane, nitrous oxide, and halocarbons in various production processes.

LEARNING CHECK

1. How do you think that you, as a Canadian, compare to people in other countries in terms of greenhouse gas production?
2. Hydroelectric dams are often considered a sustainable way to produce electrical energy. Explain why this is not entirely true.
3. Choose at least one of the activities that produce greenhouse gases. Suggest at least two ways of decreasing the amount of greenhouse gases that are produced by this activity.
4. For each activity that you listed in your answer to question 3, identify the top one or two provinces and territories that you think are responsible for the producing the greatest amount of greenhouse gases. Give reasons to justify your answers.

Urbanization The border between Canada and the United States is the most urbanized region in Canada. Urbanization (the spread of cities into rural areas) involves clearing land, building roads, and increased transportation. All of these activities produce greenhouse gases.

Agriculture Clearing land for farming, using fertilizers (both natural and human-made), and raising crops and livestock all produce greenhouse gas.

Hydroelectric Dams Hydroelectric dams generate greenhouse gases. Flooding of land to build the dams and large volumes of standing water are sources of methane. The dams also produce significant amounts of carbon dioxide.

Coal-fired Power Plants The majority of the electrical energy produced in the Maritimes, as well as in Alberta and Saskatchewan, comes from burning coal, which releases greenhouse gas.

Landfills Landfills in numerous communities in every province and territory generate greenhouse gases. The main offender is methane.

Air Travel Canada is a country of vast distances. The fastest way to cover these distances is by plane. Unfortunately, air travel burns up large amounts of fossil fuel. It is the fastest growing source of greenhouse gas emissions globally.

Skills

- ✓ initiating and planning
- ✓ performing and recording
- ✓ analyzing and interpreting
- ✓ communicating

Cross-Country Climate Change

Canada's provinces and territories produce different levels of greenhouse gas emissions. Find out more about Canadian greenhouse gas emissions and climate change impacts in this investigation.

What To Do

1. With your group, review the information in the table.
2. Your teacher will assign your group one of the Canadian provinces or territories. Work together in your group to answer the questions below.
 - a) How do you think the population of your province or territory affects its overall greenhouse gas emissions?
 - b) Identify one province or territory that you think produces more greenhouse gas than yours and one you think produces less. Explain why you chose as you did.
 - c) Which activity do you think produces the most greenhouse gas in your province or territory? Why do you think this is the case?
 - d) Create a brief plan that explains how your province or territory could reduce its greenhouse gas emissions.
3. Choose one of the greenhouse gas producing activities in your province or territory. Explain how this activity is linked to a climate change impact in your province or territory. To do this, answer the following questions.
 - a) Which greenhouse gas does this activity produce?
 - b) Explain the link between this greenhouse gas and climate change.
 - c) Identify at least one climate-change impact that will affect your province or territory.
4. Use your answers in parts 2 and 3 to present how your province produces greenhouse gases and experiences various climate change impacts. This will be part of a class *Cross-Country Climate Change* presentation.

What Did You Find Out?

1. Work together with other groups to create a *Cross-Canada Climate Change* presentation that summarizes all that you have found out. For example, you could design a mural or a web site.
2. Do you think a plan to reduce greenhouse gas emissions across the whole country should let provinces with larger populations produce more greenhouse gases? What about provinces with more industries that produce greenhouse gases? Explain your answers.

Inquire Further

Do research to find out how Canada compares with other countries in terms of greenhouse gas emissions.

Province/Territory (population in 2008)	Main Activities That Produce Greenhouse Gases
Yukon (33 100)	<ul style="list-style-type: none"> • Heating • Transportation • Mining
Northwest Territories (43 300)	<ul style="list-style-type: none"> • Oil and natural gas production • Heating • Transportation • Mining
Nunavut (31 400)	<ul style="list-style-type: none"> • Heating • Transportation • Mining
British Columbia (4 381 600)	<ul style="list-style-type: none"> • Forestry • Natural gas production • Energy production • Mining • Agriculture • Transportation • Heating
Alberta (3 585 100)	<ul style="list-style-type: none"> • Oil and natural gas production • Agriculture • Mining • Forestry • Transportation • Heating
Saskatchewan (1 016 000)	<ul style="list-style-type: none"> • Oil and natural gas production • Agriculture • Mining • Forestry • Heating • Transportation • Electricity production
Manitoba (1 208 000)	<ul style="list-style-type: none"> • Agriculture • Electricity production • Mining • Heating • Transportation

Province/Territory (population in 2008)	Main Activities That Produce Greenhouse Gases
Ontario (12 929 000)	<ul style="list-style-type: none"> • Urbanization • Manufacturing and industry • Forestry • Mining • Heating • Agriculture • Transportation • Electricity production
Quebec (7 750 500)	<ul style="list-style-type: none"> • Urbanization • Manufacturing and industry • Transportation • Agriculture • Heating • Electricity production • Mining • Forestry
Newfoundland and Labrador (507 900)	<ul style="list-style-type: none"> • Oil and gas production • Energy production • Mining • Heating • Forestry • Transportation
Prince Edward Island (507 900)	<ul style="list-style-type: none"> • Agriculture • Manufacturing • Transportation • Heating
Nova Scotia (938 300)	<ul style="list-style-type: none"> • Electricity production • Manufacturing and industry • Agriculture • Heating • Mining • Forestry • Transportation
New Brunswick (747 300)	<ul style="list-style-type: none"> • Manufacturing and industry • Agriculture • Mining • Heating • Forestry • Transportation

Case Study Investigation: Can Biofuel Solve the Problem of Climate Change?

Corn tortillas are an important and nourishing food in Central America and the southern United States. As prices rise, many people may no longer be able to afford them.

What's the Issue?


Biofuel is any fuel that is derived from living (or very recently living) plant material. Ethanol is an example. Biofuel has a lot of supports. It's renewable, and burning it releases only as much carbon dioxide as the plants take up from the air. This means there is no net build-up of greenhouse gases in the atmosphere. But not everyone is sold on biofuel. In fact, some people suggest that biofuel may accelerate climate change just as much as fossil fuel—perhaps even more.

The Science behind the Issue

The idea seems so simple. People have been using the oils and sugars in plants to make fuels for thousands of years. Since plants and plant wastes such as sawdust are so abundant, why not use them to make fuel, instead of rely on fossil fuels? The problem is that many of the favourite choices for making biofuel are already used for something equally important: food.

Food Shortages

In North and Central America, the main plant used to make biofuel is corn. This means a lot of land that once grew corn to feed people is now being used to produce biofuel. This affects the price of corn both locally and on the world market. Many people around the world, in both developed and developing countries, depend on corn to feed themselves and their livestock.



Corn is the major biofuel crop in North America.

Tropical Deforestation

Brazil has a thriving sugar cane-to-biofuel industry. However, to gain more land to grow this profitable crop, tropical rainforests are being cut down. This presents a real problem. The forests take up vast amounts of carbon dioxide during photosynthesis—more than any other forest. In fact, logging rainforests increases carbon dioxide levels more than biofuel use reduces them. The end result is that Brazil's biofuel industry is enhancing the greenhouse effect. What about the rest of the world? Joe Fargione, a scientist with the Nature Conservancy of Canada, has been studying the impact of biofuel on climate. According to the Canadian scientist, "Our study found that any biofuel that causes clearing of natural ecosystems will increase global warming."



Cutting down vast areas of trees in rainforests for biofuel production increases atmospheric carbon dioxide.

Nitrous Oxide

Fertilizer use also increases greenhouse gases. Plants that are used to produce biofuel on a large scale need a lot of nutrients. However, the production and use of nitrogen-rich fertilizers generates a lot of nitrous oxide. This greenhouse gas captures much more heat than carbon dioxide. So taking fertilizer use into account, biofuel production emits more greenhouse gas than fossil fuel production does.

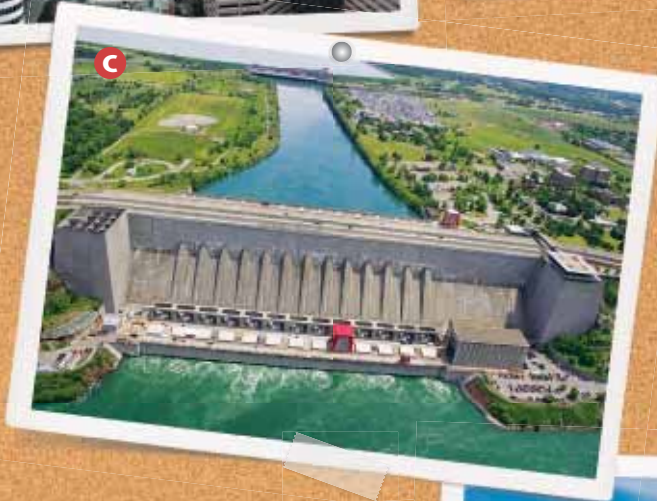
Over To You

1. Based on your understanding of greenhouse gases, determine which causes greater warming effects: an increase in atmospheric carbon dioxide or nitrous oxide.
2. Use your knowledge of climate change impacts to identify three ways that biofuel production could affect aquatic and terrestrial ecosystems.
3. Burning biofuel increases ground level ozone, which is the main component of smog.
4. Do you think that biofuel is the only solution to the problem of reducing our dependence on fossil fuels? As part of your answer, propose an alternative to biofuel that you think would be effective, and explain why you think so.

Activity 3.10

WHICH GREENHOUSE GAS?

These photos show human activities that produce greenhouse gases. Design a table to identify the type of activity or activities in each photo that produces greenhouse gases, and identify the gases produced in each case.



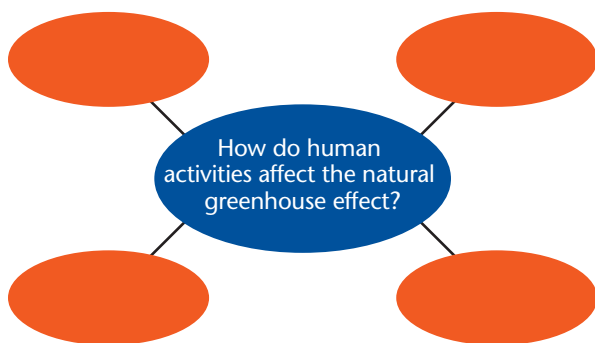
Topic 3.4 Review

Key Concept Summary

- Human activities produce more greenhouse gases, which enhance the natural greenhouse effect.
- Canadians add to the increase of greenhouse gases in the atmosphere.

Apply the Concepts

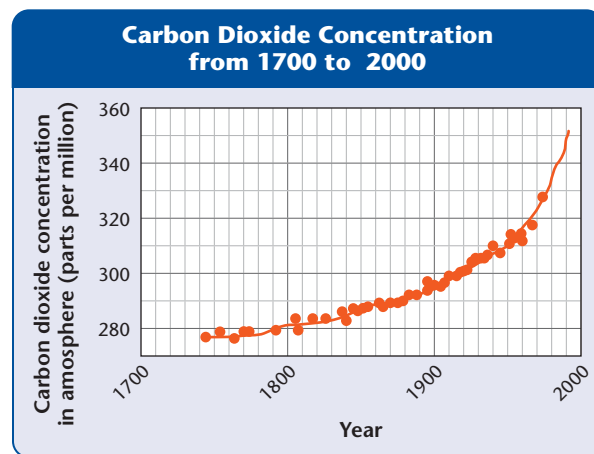
1. Answer the question that is the title of this topic. Copy and complete the graphic organizer below in your notebook. Fill in four examples from the topic using key terms as well as your own words.



2. **K/U** Describe three human activities that enhance the natural greenhouse effect.
3. **A** Name two ways that you contribute to the anthropogenic greenhouse effect.
4. **K/U** Which greenhouse gas or gases are produced solely by human beings?
5. **A** Think about ice cream.
 - a) Name the greenhouse gas that is emitted into the atmosphere by the animals used to make ice cream.
 - b) List two other ways going to the store to buy ice cream can contribute to the anthropogenic greenhouse effect.
6. **C** Write a letter to the head of your local school board explaining how a single change could significantly reduce the amount of greenhouse gases your school releases into the atmosphere.

6. **T/I** The graph below shows how the concentration of carbon dioxide in the atmosphere has changed from the year 1750 to the year 2000.

- a) Why did the level of this greenhouse gas start to increase in the mid-1700s?
- b) State a hypothesis that explains this graph.



8. **C** NASA astronaut Sandra Magnus described Earth's atmosphere from the International Space Station: "It looks very fragile from here," she said, "and it's very easy to take it for granted when we're living on it, when it seems so big and so massive. But it's not. It's very small and very fragile." How does this statement relate to what you have been learning in this topic? Write or describe your ideas to a partner.