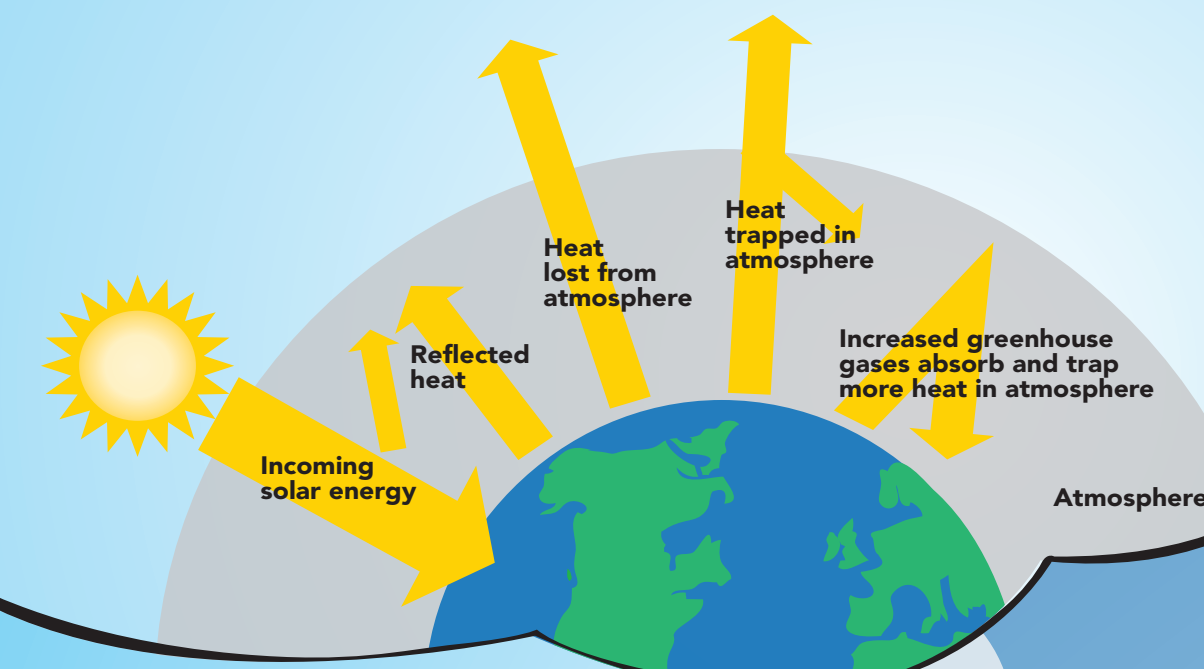


# The Greenhouse Effect



## Did you know we live in a greenhouse?

The Earth's atmosphere is made up of many gases. The greenhouse gases (GHG's) absorb and emit infrared radiation; they trap the heat from the sun and keep the Earth warm. This is known as the 'greenhouse effect'. The greenhouse effect is important for our survival because it maintains the Earth's climate.

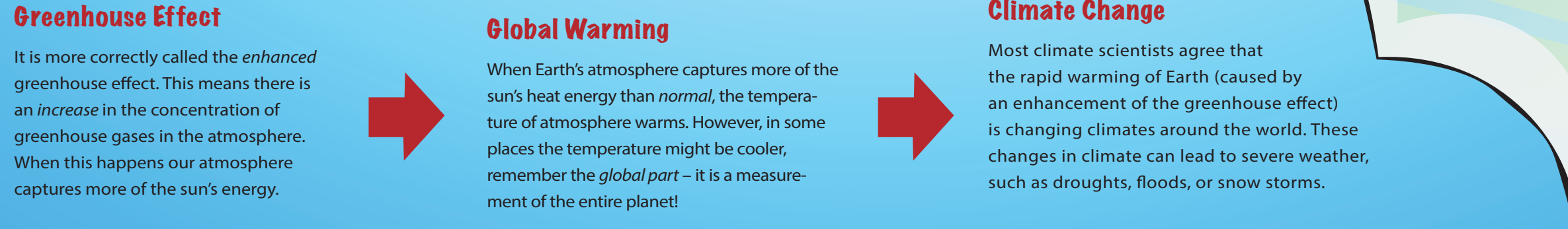
## What are the greenhouse gases?

- Carbon dioxide (CO<sub>2</sub>)
- Water vapour (H<sub>2</sub>O)
- Methane (CH<sub>4</sub>)
- Nitrous oxide (N<sub>2</sub>O)
- Perfluorocarbons (PFCs)
- Sulphurhexafluoride (SF<sub>6</sub>)
- Hydrofluorocarbons (HFCs)
- Ozone (O<sub>3</sub>)

There are different levels of greenhouse gases in the Earth's atmosphere; with water vapour, carbon dioxide, methane, nitrous oxide and ozone being the most abundant. While other gases have a stronger warming effect (ie: CH<sub>4</sub> is approximately 30 times more potent than CO<sub>2</sub> and N<sub>2</sub>O is approximately 298 times more potent than CO<sub>2</sub>) carbon dioxide gets a lot of attention because we've recorded significant increases in our atmosphere. These increases have been connected to human activity, especially the burning of fossil fuels.

## The greenhouse effect, global warming and climate change

You have probably heard the terms **climate change**, **global warming** and **greenhouse effect**. But what do they mean? These terms describe three concepts that are different but all connected.



So remember, there is a *relationship between these important ideas*, but it is important to know the difference between them. In fact, they are the building blocks of the science and issues surrounding climate change!

# STEWARDSHIP

## Energy, Climate, and You

### What is climate?

Think about the seasons where you live. Do you have hot summers? Does it usually snow heavily during the winter? Is there a lot of rain in the spring? By studying the average weather over decades, we describe our climate.

### What is weather?

What is the temperature outside right now? Is it raining or snowing? Are there clouds in the sky? Is it windy? Weather is what is happening in the atmosphere at a given time.

### What is stewardship?

Stewardship means to look after something that is important to you and society. The Earth is important to all of us. The Earth provides all the natural resources we need for our food, clothing and shelter. It takes three things to be a good steward of our planet -- Awareness, Attitude and Action.

- Awareness** - I learn about the issues and what I can do to help.
- Attitude** - I value the Earth, our home, and I want to take care of it.
- Action** - I make changes in my life based on what I have learned about what I value.

### How do we know the climate is changing?

Scientists know the climate is changing by looking at the evidence. They compare the past using things like tree rings, ice cores, and fossils. This tells scientists what the climate and atmosphere used to be like hundreds, thousands or millions of years ago. Scientists also compare measurements taken over the last couple of centuries with measurements taken now.

### What are the possible effects of climate change?

- ECOSYSTEMS & BIODIVERSITY:** When a climate changes too quickly, plants and animals do not have time to adapt. This leads to a changing mix of native species and the threat of invasive species altering the dynamics of our ecosystems.
- AGRICULTURE:** Changing growing conditions may change the types of crops that we are able to grow as well as the timing of seeding and harvest. There are also financial implications of severe weather events on livestock, infrastructure and crop yields.
- COMMUNITIES:** Floods, droughts, and fires are expected to be more common and/or more intense. This puts communities at risk - both the people and the infrastructure, like buildings, bridges and roads.
- FORESTRY:** Warmer temperatures, changing growing conditions and shifting ecoregions will impact the forest sector. We also expect insect and disease outbreaks and increased frequency and severity of forest fires.
- WATER & NATURAL RESOURCES:** We rely on a safe reliable supply of water and have grown accustomed to having access to energy. Climate change may disturb both the reliability and access to the natural resources we depend on.

## Has the climate changed before?

By studying fossils, scientists know that millions of years ago Alberta's climate was different. It was hot and humid. Over time the climate has changed and we now live in a temperate zone with four different seasons.

The change in climate took many years to occur, but this is proof that climates always have and always will change. The concern scientists have today is the speed at which the climate is changing, in particular, how fast Earth's atmosphere is warming.

We do not know what will happen to our climate and Earth's ecosystems as the climate changes. What we do know is what we can do now to help reduce the effects of climate change as well as how to adapt to a changing climate. For example, we can protect, conserve and enhance our wetlands, forests and other natural spaces to act as carbon sinks - places where carbon can be taken out of the atmosphere and stored. We can also reduce our use of energy and be more energy efficient to emit less greenhouse gases.

### How do Canadians contribute to climate change?

Humans have increased the amount of naturally occurring GHGs by burning fossil fuels such as coal, oil and natural gas. Scientists believe that the GHGs that humans are putting into the atmosphere are causing the climate to change more quickly than normal.

Canadians produce a lot of greenhouse gases, partly because of where we live. Our winters are very cold. We heat our homes to stay warm. Canada is also a large country, and often we have to travel further than people who live in smaller countries. Canada has a modern economy that produces many goods. We build cars, drill for oil and gas, produce food on farms and products from our forests. Tourism is also a very important part of our economy. In all of these cases, energy is consumed and greenhouses gases are released into the atmosphere.

Canadian industries, governments, communities and individuals all need to find ways to conserve energy and to be more efficient in the energy we use. This will help us balance a healthy economy and a healthy environment.

## Electricity Resources

There is no perfect source of energy or source of electricity. Each resource has its challenges and opportunities in its production and use. Several sources of electricity are described below along with one challenge and opportunity for each. *Can you think of others?*

	How does it work?	Challenge	Opportunity
<b>Coal</b>	Coal is burned to create heat energy. This heat is used to turn water into steam. The steam spins a turbine which turns a mechanism inside the electrical generator to produce electricity.	Burning of coal, a carbon-based fossil fuel, creates emissions that include CO <sub>2</sub> - a greenhouse gas. It also releases particulate matter into the atmosphere.	New technology that will convert coal to a cleaner-burning gas, and capture carbon dioxide from power plants to help reduce greenhouse gas emissions.
<b>Natural gas</b>	Natural gas is burned to create heat energy. This heat is used to turn water into steam. The steam spins a turbine which turns a mechanism inside the electrical generator to produce electricity.	The price of natural gas often swings from high to low. This makes it hard to predict the price of electricity production. When the price is high, this is a very expensive way to make electricity.	Natural gas burns cleaner than coal. It releases fewer greenhouse gases and no particulate matter into the air.
<b>Hydro-electricity</b>	Water, often stored in dams, is forced to move past blades of a turbine. The spinning turbine turns a mechanism inside the electrical generator to produce electricity.	Most hydropower stations require building a dam. This can affect the natural flow of water downstream of the dam and generator.	Hydropower does not burn any fossil fuels, so there are no GHG emissions.
<b>Wind</b>	The wind! Large wind turbines are constructed in very windy places. The force of the wind turns the blades. The spinning turbine turns a mechanism inside the electrical generator to produce electricity. The electrical generator is located just behind the blades of the wind turbine.	Sometimes it is not windy, and sometimes it is too windy! When there is not enough wind, wind turbines can not operate. Too much wind can make it difficult for wind turbines to operate properly. This can make it hard to rely on as the only source of electricity generation.	Wind energy itself does not consume any fossil fuels. It produces electricity while creating no emissions.
<b>Solar</b>	Photovoltaic solar panels capture the sun's energy and convert it into electrical energy.	Solar energy is not available at night. On cloudy days only limited energy can be captured.	Solar energy captures energy from the sun and uses no fuels to make electricity. Battery storage technology is improving to add the ability to store solar energy.

Climate change action plans indicate the phase out of coal-fired electricity generation by the year 2030.

## Carbon Capture and Storage

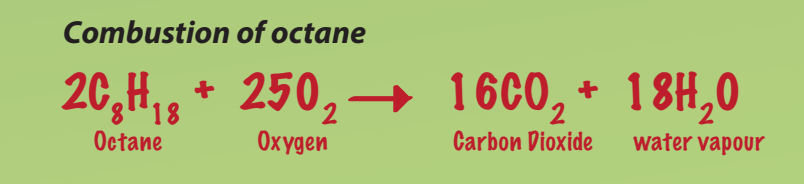
When industry generates electricity to light our homes or produce gas to run our furnaces, CO<sub>2</sub> is released. The idea behind Carbon Capture and Storage (CCS) is to capture the CO<sub>2</sub> produced by industry before it goes into the atmosphere. The CO<sub>2</sub> is compressed and injected deep into underground formations, such as rock chambers that once held oil and natural gas. The CO<sub>2</sub> fills up spaces where the oil and natural gas once was and when the chambers are full they are sealed off.

The Government of Alberta has invested in research and technology to implement this approach in Alberta. Geologists, who study rock formations, will make sure the safest, most stable rock formations are found. Engineers

will work on capturing the CO<sub>2</sub> from the stacks, separating it from other gases and then pumping it underground.

Some people think that even if CCS works it will not be enough to make a difference. As well, they believe that money spent could be better used for other projects to reduce the effects of climate change. Alberta is suited to CCS because we have our geology and well developed oil and gas industry. Emissions reducing technology should be accompanied with energy conservation and efficiency initiatives and investment in alternative and renewable energy sources to have the biggest impact.

## Carbon chemistry



This chemical equation helps to explain where some of the carbon dioxide (CO<sub>2</sub>) humans add to Earth's atmosphere comes from.

When we burn gasoline in our vehicles, we are adding oxygen (O<sub>2</sub>) to octane (C<sub>8</sub>H<sub>18</sub>). Octane is a main component of gasoline. Carbon dioxide (CO<sub>2</sub>) and water vapour (H<sub>2</sub>O) are created and released out of the tailpipes and into the atmosphere. This chemical reaction happens whenever a hydrocarbon - any substance containing both carbon (C) and hydrogen (H) - is burned. Hydrocarbons include compounds like propane (C<sub>3</sub>H<sub>8</sub>) and natural gas, also called methane (CH<sub>4</sub>).

As you can see by this equation, a lot of cars on the road means a lot of CO<sub>2</sub> going into the atmosphere. To help reduce the amount of carbon dioxide we put into the atmosphere, try to walk, bike, carpool or take a bus whenever you can!

### Students take environmental action in school

There are lots of ways students and schools can take action on climate change. Check out the teachers guide for ideas!

## Hearts and suns legend

- |                                                    |                                  |
|----------------------------------------------------|----------------------------------|
| <b>Hearts</b>                                      | <b>Suns</b>                      |
| 1) Push Mower                                      | A) The Sun                       |
| 2) Reusing Foods                                   | B) Conventional Oil              |
| 3) Triple paned windows                            | C) Oil Sands                     |
| 4) Energy efficient appliances                     | D) Nuclear Energy                |
| 5) Insulated hot water heater                      | E) Natural Gas                   |
| 6) Controlling temperature                         | F) Biodiesel                     |
| 7) Recycling                                       | G) Hydroelectric power           |
| 8) Replanting trees                                | H) Wind Farms                    |
| 9) Properly inflated tires                         | I) Solar power                   |
| 10) Use Public transportation                      | J) Cogeneration                  |
| 11) Retrofitting homes for energy efficiency       | K) Coal Mine                     |
| 12) Composting                                     | L) Methane Recovery              |
| 13) Development of new more efficient technologies | M) Batteries - Chemical Reaction |
| 14) High-efficiency light bulbs                    |                                  |
| 15) Buy locally manufactured goods                 |                                  |
| 16) Rent infrequently used items                   |                                  |
| 17) Ride a bike, walk or jog                       |                                  |
| 18) Low-flow shower heads                          |                                  |
| 19) Eco-friendly recreational activities           |                                  |