

Becoming Greenhouse Gases

Description:

This activity will help students understand the five main greenhouse gases (GHGs) and their effects in our atmosphere. The activity emphasizes the key characteristics that distinguish each GHG through a game that requires students to recall information and collaborate with others. This lesson introduces students to the basic science behind Earth's atmospheric systems, which forms the basis of all climate science. Some of the human impacts on these systems are discussed in the extension of this lesson, and in later lessons within this module.

Objectives:

- Explore the Earth's atmospheric system
- State the unique qualities for each GHG and their impacts
- Identify the key properties of greenhouse gases and non-greenhouse gases

Vocabulary:

Carbon dioxide, carbon sequestration, chlorofluorocarbons (CFCs), deforestation, ecosystem services, Industrial Revolution, methane, nitrous oxide, ozone, precipitation, water vapor

Materials:

- Scrap paper
- Hat or concealed container

Background Information:

It is important to understand some distinct characteristics of the five key greenhouse gases that exist in the atmosphere. Below is a brief description of each, adapted from [NASA's Climate Kids resources](#). It might be helpful to also show students the corresponding molecular structures so they can associate an image with each gas.

- **Water Vapor (H₂O):** The most abundant greenhouse gas in the Earth's atmosphere. While not directly potent, water vapor still plays a role in climate change. As the Earth's atmosphere warms, water vapor increases, which in-turn, increases the amount of clouds in the atmosphere and total precipitation.¹
- **Carbon Dioxide (CO₂):** A potent gas released from human activities such as deforestation, land use changes, and the burning of fossil fuels, or through natural processes such as respiration and volcanic eruptions. Because humans have exponentially increased the atmospheric CO₂ concentration since the Industrial Revolution, CO₂ acts as the primary driving force behind climate change.¹
- **Methane (CH₄):** An extremely destructive hydrocarbon gas produced from both natural sources and human activities, including the decomposition of waste in landfills, wastewater treatment, agriculture as well as activities associated with domestic livestock. Cow gas is a funny and memorable example of a main source of methane emissions.¹

¹ [NASA The Causes of Climate Change](#)

- Nitrous Oxide (N₂O): A powerful greenhouse gas produced primarily from the use of commercial and organic fertilizers, fossil fuel combustion, and biomass burning.¹
- Chlorofluorocarbons (CFCs): Synthetic compounds that have been linked to ozone depletion. Historically, CFCs were used as refrigerants and propellants in aerosol cans, but have now been phased out of production.¹

While many of our daily activities and the systems we rely on emit greenhouse gases, we can also help to manage and reduce these emissions through proper land use and sustainable practices. For example, 75% of NYC's upstate watershed is forested. These rich and well-managed forests help to sequester carbon dioxide. This is an important ecosystem service that improves air quality, increases biodiversity, and helps to naturally filter our drinking water. The sequestration of harmful greenhouse gases can also be found in NYC, where DEP is currently capturing and re-using methane gas as renewable energy at the City's wastewater resource recovery facilities.

Method:

- Present students with the background information on GHGs using [NASA's short online video](#) to illustrate the differences in each gas. Make sure students take notes because the information will be necessary for the next part of the activity.
- Write down each gas on pieces of scrap paper. Make sure to divide each gas evenly based on the number of students in your class. Put each piece of scrap paper in a hat or concealed container.
- Assign each student a GHG secretly by having students choose their gas from the

hat or concealed container. Make sure students keep their assigned GHG a secret!

- 1: Water Vapor (H₂O)
- 2: Carbon Dioxide (CO₂)
- 3: Methane (CH₄)
- 4: Nitrous Oxide (N₂O)
- 5: Chlorofluorocarbons (CFCs)
- Have students walk around the classroom and quickly pair with a classmate to describe each of their assigned GHGs. After each student describes their GHG, the pair must try and guess which GHG the description matches.
- Have students pair and share with as many classmates as possible until they can guess the descriptions correctly. When pairs guess correctly, the two must form a group and continue to pair and share until their group is made up of each GHG (meaning each group would end up with five people in it).
- Once all groups of five are formed, discuss using the prompts below.

Discussion:

- In groups, ask students to discuss:
 - How do GHGs impact our environment and atmosphere?
 - What role do humans play in shifting GHGs in the atmosphere?
 - What are some actions we can take to reduce the GHGs we emit?
 - Why is it important to learn about GHGs?
- Conclude by asking groups to share their responses to the whole class and address any questions students might have.

Extension:

- Share a few examples of greenhouse gas levels in the atmosphere changing due to

human actions. Ask students to consider how GHGs would change in their group as a result of different human actions. For example, deforestation causes an increase of carbon dioxide in the atmosphere, whereas planting trees causes a decrease of carbon dioxide in the atmosphere due to the sequestration taking place through increased vegetation.

- Complete the [U.S. Geological Survey's activity on GHGs](#). This activity has students analyze the thermal properties of three major GHGs (water vapor, carbon dioxide, and methane).
- Learn more about DEP's efforts to reuse methane gas from the wastewater resource

recovery process by taking your class on a field trip to the Newtown Creek Wastewater Resource Recovery Facility in Brooklyn. For more information, [click here](#).

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