# Green House Gases

**Overview:** Students will understand the role of green house gasses in Earth's atmosphere and what are major contributors to green houses gas build up in the atmosphere.

**Keywords:** Green House Gas (GHG), Carbon Dioxide, Methane, Green House Effect, Radiation, Climate Change, Global Warming Potential (GWP)

**Age / Grade Range:** **5th-6th Grade**

**Background:** There are 4 sources of green house gases (GHG) that contribute to the green house effect; carbon dioxide, methane, nitrous oxide and fluorinated gases. (http://www.epa.gov/climatechange/ghgemissions/gases.html) These gases trap heat radiated from the surface of the Earth. The bonds between the green house gas molecules is responsible for this effect. As thermal radiation is radiated from the Earth's surface into space the molecule absorbs this energy. The bonds holding the molecule together vibrate which allows the molecule to retain the thermal energy and release it back into atmosphere where other green house gases can absorb the energy. This process "traps" the heat radiated from the Earth in the atmosphere. (https://www.ucar.edu/learn/1_3_1.htm, http://www.epa.gov/climatestudents/basics/today/greenhouse-effect.html) With enough green house gases the overall temperature of the Earth can be raised. This is called the Green House Effect, named for the same principals green houses use.

Of all energy received from the sun 6% is scattered by the atmosphere, 20% is reflected by clouds, 19% is absorbed by clouds, 4% is reflected from the Earth's surface and 51% is absorbed by the Earth's surface. (https://www.ucar.edu/learn/1_3_1.htm)

Green house gases are measured using the Global Warming Potential (GWP) scale. Carbon dioxide is the standard unit which all GHG effects are measured against. Methane has a GWP of 20, which means 1 pound of methane would have the same GWP as 20 pounds of carbon dioxide. Nitrous oxide has a GWP of 300 and some fluorinated gasses have GWP over 10,000. An example of a fluorinated gas would be aerosol cans and refrigerant gases used in the 1970-1990. These gases have been phased out of use after their environmental impact was studied. (http://www.epa.gov/climatechange/ghgemissions/gases/co2.html)

Based on 2012 GHG emission in the US alone, 82% is from carbon dioxide, 9% is from methane, 6% is from nitrous oxide, and 3% is from fluorinated gases.

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It is important to note **that without green house gases Earth** would not be warm enough to support life. Mars is an example of not enough GHG (also very thin atmosphere) with -50 ˚C the average temperature

(http://quest.nasa.gov/aero/planetary/mars.html) during the day while Venus is an example of having too much GHG with an average temperature 464 ˚C (http://nssdc.gsfc.nasa.gov/planetary/factsheet/venusfact.html).

**Next Generation Science Standards & Common Core:**

**Goals:**

Green houses gases can raise the temperature of the atmosphere. Not all green house gas is bad, we need the right balance to survive. Too much GHG we overheat, too little we freeze.

What is the green house effect?

What are green house gases?

What do green house gases do to the climate?

**Objectives:**

Students will understand that green houses gases are natural for Earth.

Students will understand that since the industrial revolution, humans have been altering the carbon cycle and releasing more GHG's into the atmosphere in the form of carbon dioxide.

Students will differentiate the effect that different amounts of GHG will effect the climate of Earth.

Students will identify everyday methods to reduce carbon dioxide emissions.

**Materials:**

Multiple outer layers

IR Thermometer / (Surface temperature Probe)

(Labquest needed if using the surface temperature probe)

(Masking tape if using Labquest)

**Set up:**

Bring extra outer layers with you before you run this activity.

Have the materials ready for use.

**Classroom Time:** 5-25 minutes

**Note: Text in "quotations" signifies suggested dialogue to engage students in and is not intended to be a script. Use your best judgment when delivering these lessons.**

**Introduction (Engage):**

"What do you know about the green house effect?" (Field answers)

"What do you think causes the green house effect?" (Field answers)

"This activity will explore the effects of the green house effect on Earth.

Lets see what happens when they hang around in our atmosphere?"

"I will need 3 volunteers!" (Try to pick students with a lot of layers already. If doing this activity during warmer conditions have extra blankets or clothes from the washing room/salmon A)

*Field or Indoor Activity:*

"We will have 3 different situations to look at with our 3 different Earth's! (you can gesture to the volunteers) First each Earth will have to go down to your base layer ( t-shirt, long sleeves shirt, no jackets or sweaters) Each layer of clothing represents a layer of green house gas. We're going to record the temperature of these Earths before we add green house gases to them. (Record their temperature. If using IR thermometer aim for the collar bone, if using surface temperature probes, tape the probe on their collar bone. Advantage of using the labquest is that you'll be able to record the change in temperature.)

**Activity (Explore):**

"Great, now Earth one has a lot of cars that produce Carbon dioxide, lots of cows that can produce methane so they have a lot of green house gases. (heap clothing onto the volunteer, make them super bundled) Earth 2 has less cars, a more balanced amount of carbon dioxide and methane in the atmosphere (give volunteer 2 one layer) Earth 3 has no green house gas at all (give volunteer 3 no new layers). Lets see how their temperatures will change after some time."

**IMPORTANT CONSIDERATION: Factor weather conditions when doing this activity and plan accordingly. Do not let students freeze in winter and overheat in summer.**

Time options: You can have students walk at the same pace for 1 minute or jog in place for 30 seconds. Something short that all students can do at the same pace to control the variables between students.

(while volunteers are moving or sitting) "We need to create heat that can be reflected from the surface of the Earth, which is their skin, to see effect of green house gases on our Earths'. (after the allotted time has passed measure

their temperature again) Lets see our results!"

(The student who has not layers should have the lowest temperature rise while the student with the most clothes should have the highest temperature rise).

*Program Host Optional Morning Activity*

Same as Option A with a few modifications

1. Use the Labquest instead of the IR thermometer. This way you will be able to project the data recorded onto the Smartboard with the Program Host Computer using Photobooth application.

2. Instead of having the volunteer sit for a minute have them engage in a brief time period of cardio. Instead of representing the whole Earth they can represent 1 side. As they exercise it demonstrates the sun heating that side, after they stop it can represent the "night" side of the planet.

**Explanation**

Which Earth had the greater increase in temperature? (Field answers)

Why do you think that? (Field answers)

In a green house, light from the sun passes through the green house and warms the plants inside. The energy is absorbed by everything in the green house such as the plants, the ground, the shelves, and pots. This energy is radiated back out into the environment except the green house glass or plastic traps the heat causing the green house to be warmer inside of it than outside of it. This is called the green house effect and the Earth has a similar process. The Earth is heated by the sun. 49% of the energy never reaches the surface of the Earth, 51% actually makes it down to the Earth's surface. The energy that makes it to the surface is radiated back into space. However there are specific gases that trap the heat inside the Earth's atmosphere causing the temperature to rise, just like the plastic or glass in the green house. These gases that trap heat are called green house gases. Does anyone know what one of the 4 is called?" (Field answers)

**Elaboration:**

"The four main green house gases are Carbon dioxide, methane, nitrous dioxide, and fluorinated gases. Carbon dioxide and methane are the two most common GHG. Of the green house gases present in our atmosphere 82% is from carbon dioxide." (Depending on the age group and time you can add information about the percentages each GHG makes up out of the total GHG's being studied.)

What are some sources of carbon dioxide? (Field answers. Cars, and electricity generation are major contributors. )

Program Host Option: If you were to do this during the morning it would be a good fit after you reviewed energy audit to tie in that generating electricity is

a contributing factor to adding green house gases into the atmosphere

"Should we try and get rid of all green house gases? Why?" (field answers, refer back to the volunteer students when explaining this next part.)

We currently have a lot of GHG's, we are on track to being in on an Earth like volunteer 1, lots of layers trapping that heat. However, if we remove all those GHG's we find Earth in a situation like volunteer 3, no layers. As our planet revolves around the sun it tilts and we get seasons. What is the temperature like in winter to you? (field answers). That's with green house gases present, what do you think would happen to the temperature if they were gone? (pause and let them think about that while fielding answers.) This issue isn't an easy one. We must strive to find balance in our actions, our choices. Too much of anything can harm us, water, food, and sunlight. Too little of anything can also harm us as well, not enough water, not enough food, and not enough sunlight. We need to be mindful of what we do and the effects they may have.

What are some ideas that we could do to reduce the amount of carbon dioxide released into the atmosphere? (field answers)

"You can make a difference, let me show you real quick.

1 60watt light bulb left on for 1 year uses 525.6 kw/hr

Average amount of carbon dioxide produced per kw = 1.52 lbs/kw

Left on for a full year this bulb will produce 789.91 lbs of carbon dioxide.

(http://www.epa.gov/cleanenergy/energy-resources/refs.html; metric tons converted to pounds)

But, that never happens right? Let's focus on a minute. 1 60 watt light bulb left on for an minute releases .00152 lbs of carbon dioxide. However we don't have one light bulb in our house for everyone to use, lets say there are 5 light bulbs this house. Left on for 1 minute the total carbon dioxide emissions are .0076 lbs or about the weight of 3 plain chocolate m&m's. (1 oz of m&m = 31.25 m&ms from: http://food-drink.blurtit.com/2107454/how-many-mampms-per-ounce) Lets say that each of you has your own home. (multiple students by .0076 to get total amount of carbon dioxide released from each home leaving on 5 light bulbs for 1 minute. ie, 45 students x 0.0076 = 0.342 lbs or 135 m&m's worth of carbon dioxide released) If you begin to turn off the bulbs you aren't using you begin to save energy and reduce the amount of carbon dioxide released. Imagine saving 15 minutes per day over a year in 1 house, that's reducing carbon dioxide emissions by 41.61 lbs or 16,425 m&m's. That's just one house!

I wonder else we could do to reduce the carbon dioxide amount in our

atmosphere? Maybe you'll learn more about it this week!

**Content Tie-in**

This activity can be referred back to when teaching Energy Audit, Toil for Oil Option A, Toil for Oil Option B, Value of a Tree, firebox, and fire boards.

Energy Audit: You could refer back to this activity when you have a discussion on electricity energy sources and expand the talk to carbon dioxide emissions

Toil for Oil Option A and B: Different energy sources release different amounts of carbon dioxide at different stages in their use. ie. Coal has carbon dioxide emissions during mining, transportation, and burning while wind will have carbon dioxide emissions from manufacturing, transportation and assembly.

Value of a Tree: when discussion slash piles you can tie in carbon dioxide is a result of burning slash piles instead of processing them for biofuel or letting them decompose back into their environment.

Firebox and Fireboards: When talking about wild fires and forest management you could tie in how carbon dioxide is released as forests burn which is an additional environmental impact on top of the displaced animals, damaged ecosystem and affected humans.

Field Group Activity:

Have students create an action plan they can use at home to reduce the amount of electricity used and carbon dioxide released.

**Evaluation:**

Program Host:

Evaluation will have to be done with each groups field instructor.

**Additional resources:**

Green house Gas information: https://www.ucar.edu/learn/1_3_1.htm

Overview of the Green House Effect:
http://www.epa.gov/climatestudents/basics/today/greenhouse-effect.html

Information on Green House Gas Emissions:
http://www.epa.gov/climatechange/ghgemissions/

http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html