

# Reducing Your Carbon Foot Print, One Step At A Time

- Overview:** During this lesson, students will understand that carbon dioxide (CO<sub>2</sub>) is one of the largest contributors to climate change and learn how they can reduce CO<sub>2</sub> emissions at home and within their state. Students will also examine how biofuels and other renewable resources can be used as an alternative to nonrenewable resources.
- Keywords:**
- Renewable resource:* A resource that can be replaced quickly and naturally, such as biomass, water, wind and sunlight.
- Nonrenewable resource:* A limited resource that cannot be replaced as quickly as it is used, such as coal, petroleum and natural gas.
- Climate change:* Any significant change in the measures of climate lasting for an extended period of time.
- Carbon:* A chemical element that is essential to all living things.
- Biofuel:* A renewable resource derived from biological material (plants and animals) that can be used as a fuel.
- Fossil Fuel:* A fuel that forms over millions of years as dead plant and animal material and is extracted from deep within the Earth. Fossil fuels contain carbon and are burned to produce energy, creating carbon dioxide.
- Carbon dioxide:* A gas found within the atmosphere that is produced through respiration and combustion.

**Age / Grade Range:** Grades 7-12

**Background:** The Earth is currently experiencing a warming trend at a rate unprecedented in the past 1,300 years. This experienced change in climate is most likely caused by a heat-trapping gas know as carbon dioxide (CO<sub>2</sub>). CO<sub>2</sub> is released mainly through human-related activities, such as the burning of fossil fuels and deforestation, in addition to natural processes such as respiration. [2]

In 2012, 82% of all U.S. greenhouse gas emissions were from CO<sub>2</sub>. The leading cause of human-related CO<sub>2</sub> emissions is the combustion of fossil fuels, such

as coal, natural gas, and oil, for energy and transportation. In the U.S. CO<sub>2</sub> is mainly emitted through electricity, transportation and industry sources. Electricity is used to power homes, industries and everyday life necessities. The largest single source of CO<sub>2</sub> emissions in the U.S. is from the combustion of fossil fuels to generate electricity. Furthermore, the combustion of fossil fuels such as gasoline and diesel used to transport people and goods by means of vehicles, air travel, marine transportation and rail, account for the second largest source of CO<sub>2</sub> emissions. Industrial processes also emit CO<sub>2</sub> through fossil fuel combustion and non-combustion chemical reactions. These industrial processes additionally use electricity in the production of metals, such as iron and steel, and chemicals. [1]

Renewable energy such as biomass, wind, solar and hydropower play a prominent role in mitigating climate change. Renewable energy sources contain little to no fossil carbon atoms that are typically formed during the combustion phase. As we move into a future with an increasing supply of renewable energy, replacing carbon-intensive energy sources, we can anticipate a reduction in CO<sub>2</sub> emissions and climate change impacts. [3]

With an increasing demand for energy use and potential rise in CO<sub>2</sub> emissions, switching to low-carbon fuels is a priority. Biofuels are one renewable resource that is becoming very important in sustainable energy production and consumption. Biofuels that are made from waste biomass or biomass grown on degraded and abandoned agriculture lands that do not affect food production crops are potential low-carbon energy sources. Since biomass feedstocks are part of the aboveground carbon cycle when biofuels are burned, the carbon dioxide they recently had captured is now released back into the atmosphere. [4]

NGSS: LS2.A, LS2.B, PS3.A, PS3.B, PS3.C, PS3.D, ESS2.A, ESS2.C, ESS2.D, ESS3.A, ESS3.C, ESS3.D

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

CCSS- English Language Arts: RI.7-12.1, RI.7-12.2, RI.7-12.3, RI.7-12.4, RI.7-12.9, W.7-12.1, W.7-12.2, W.7-12.4, W.7-12.6, W.7-12.8, W.7-12.9, SL.7-12.1, SL.7-12.2, SL.7-12.4, SL.7-12.5, RST.6-12.1, RST.6-12.4, RST.6-12.5, RST.6-12.7, WHST.6-12.1, WHST.6-12.4, WHST.6-12.6, WHST.6-12.7, WHST.6-12.8, WHST.6-12.9

CCSS- Math: 7.NS.1, 7.NS.2, 7.NS.3, 7.EE.1, 7.EE.3, 7.SP.1, 8.SP.1, 8.SP.2, HSF-LE.2, HSF-LE.3, HSS-ID.1, HSS-ID.2

**Goals:**

- Students will understand that CO<sub>2</sub> is a leading contributor of climate change.
- Students will learn how they can reduce CO<sub>2</sub> emissions at home and in their state.
- Students will understand how biofuels and other renewable resources can be used as an alternative to nonrenewable sources for energy.

This lesson aims to provide students the knowledge and understanding of carbon dioxide emissions and climate change to make effective energy related decisions. As part of this lesson, students will research and examine CO<sub>2</sub> emission levels in their state and write a proposal that explores different avenues in which these emission levels can be reduced.

- Why is CO<sub>2</sub> a leading contributor to climate change?
- What are the main sources of CO<sub>2</sub> emissions within my state?
- What renewable and nonrenewable resources are used within my state?
- How can CO<sub>2</sub> emissions be reduced in my state?

**Objectives:**

Students will understand the link between CO<sub>2</sub> emissions and climate change.

Students will become familiar with the main sources of CO<sub>2</sub> emissions within their state and be aware of ways to reduce emission levels at home and in the future.

Students will be able to realize they can have an impact on reducing climate change.

Students will understand the importance renewable energy sources have in reducing CO<sub>2</sub> emissions and climate change impacts.

**Materials:**

- State CO<sub>2</sub> Emission from Fossil Fuel Combustion data sheet

- Computer access (internet)
- CO<sub>2</sub> Emissions worksheet
- Renewable Energy worksheet
- Map of state where school is located
- Color pencils/ markers
- Drawing paper for map

**Set up:** Print worksheets (CO<sub>2</sub> Emissions, Renewable Energy, and State CO<sub>2</sub> Emissions from Fossil Fuel Combustion data sheet, The Earth in the Past)

**Classroom Time:** 1-2, 60 minute class periods (depending on written proposal completed during class time or for homework)

**Introduction (Engage):** Begin the lesson by asking students to formulate a definition for climate change. Once a definition has been created, ask student to think about the ways climate change presently or will in the future effect them. Have students discuss the effects climate change will have on: health, agriculture, water resources, species and natural areas, economy and other aspects.

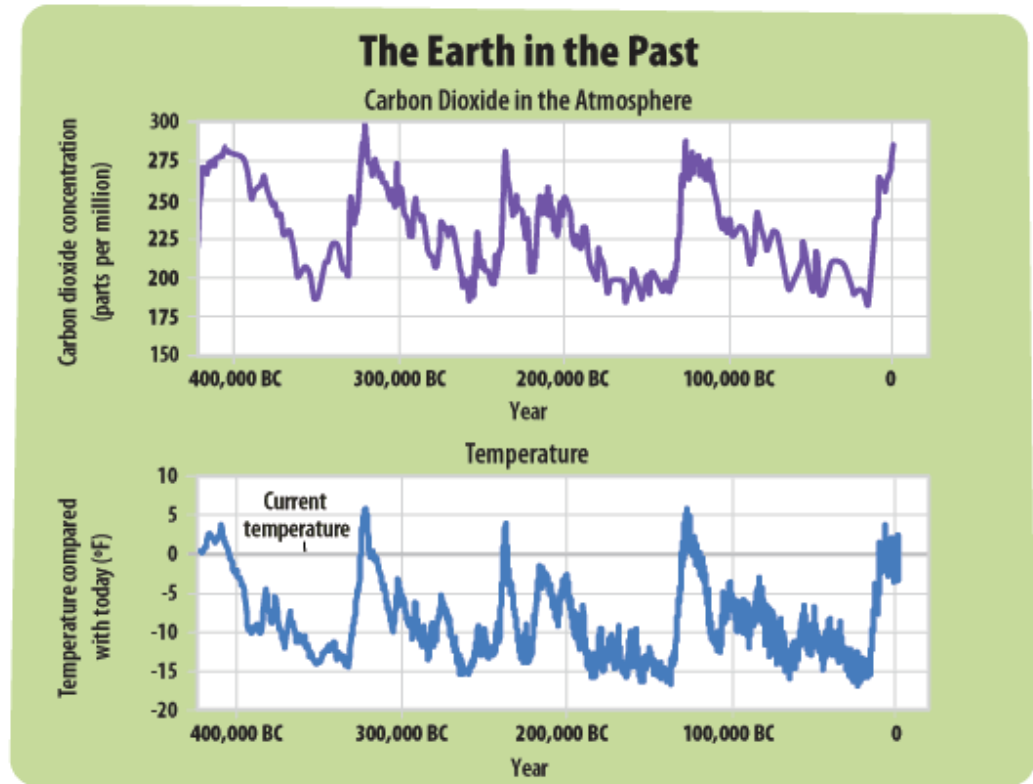
**Activity (Explore):** Have students examine the Environmental Protection Agency's (EPA) State CO<sub>2</sub> Emission from Fossil Fuel Combustion data sheet. Have students pay particular attention to CO<sub>2</sub> levels within their state from 1990-2012, amounts of CO<sub>2</sub> per million metric ton in each source listed (commercial, industrial, residential, transportation, electric power), and annual CO<sub>2</sub> levels compared between states. After examining the data, have students complete the CO<sub>2</sub> Emissions worksheet. Once students have filled out the worksheet, if computers and internet access is available, have them explore the Facility Level Information on Greenhouse Gases Tool (FLIGHT) (<http://ghgdata.epa.gov/ghgp/main.do>). This online tool allows users to view facilities within their state that emit large quantities of CO<sub>2</sub> and other greenhouse gases. Students can sort data by industry type, emission level and energy sector. This tool will be valuable for students to explore the main CO<sub>2</sub> contributors in their state.

**Explanation:** Once students have had the opportunity to explore the sources of CO<sub>2</sub> emissions within their state, it's time to help students understand where the CO<sub>2</sub> is coming from and how it's correlated with climate change. To help students visualize CO<sub>2</sub>, provide an example of where this gas can be found in

everyday tangible products in school, such as the bubbles in soda or the “rise” in their lunch baked goods. However, make sure students realize CO<sub>2</sub> is also a very significant greenhouse gas that traps energy from the Earth’s surface and warms the atmosphere in return.

CO<sub>2</sub> comes from automobile exhaust, volcanoes, factories, power plants, and decaying plants and animals. Plants and animals release CO<sub>2</sub> when they extract energy from their food during cellular respiration. CO<sub>2</sub> is also released when organic matter burns such as in a forest fire. Introduce the terms “sources” and “sinks” to the students and have them think about things that fall into each category.

Anything that releases CO<sub>2</sub> into the atmosphere is a source. Whereas anything that absorbs and holds CO<sub>2</sub> is a sink. Overtime CO<sub>2</sub> sources and sink generally balance out. However, what we’re experiencing in our atmosphere now as CO<sub>2</sub> levels rapidly increase is evidence that there are greater sources than sinks. This opens up an area for great discussion with students. Have the students discuss reasons for why we are currently experiencing excess in CO<sub>2</sub>?



Source: [EPA's Climate Change Indicators \(2014\)](#) and [Petit et al. \(2001\)](#).

Display The Earth in the Past (show above and as an attachment) to students to begin discussion regarding the connection between CO<sub>2</sub> concentrations and temperature. Explore trends in data for students to develop an understanding of why we're experiencing a changing climate. Note: This is good time to examine the different between weather and climate.

At this time in the lesson students have 1) learned where CO<sub>2</sub> emissions come from and 2) the connection between CO<sub>2</sub> emissions and climate change. Next, discuss practical ways of reducing CO<sub>2</sub> emissions, paying particular attention to renewable resources.

Have students complete the Renewable Energy worksheet. This worksheet will allow students to examine the renewable energy sources used within their state and how they are contributing to a sustainable energy future. In order for students to complete this worksheet they may need access to the internet.

The transportation sector usually accounts for a large portion of CO<sub>2</sub> emissions. Have students examine major sources of transportation within their state, looking specifically at airports and major distribution centers. For students to develop a deeper understanding of how renewable resources can be used for fueling transportation, direct students to the Northwest Advanced Renewables Alliance (NARA) (<https://www.nararenewables.org>). NARA is working towards the creation of biojet fuel from woody biomass. This is just one example that can be used in-class for students to start discovering the benefits renewable energy sources, such as biofuel, can have on reducing their state's overall CO<sub>2</sub> emissions.

**Elaboration:**

In the next phase, students will have the task of taking their knowledge of CO<sub>2</sub> emissions, climate change and renewable energy and directly applying it in a new domain. Students will be tasked with writing a proposal as a state representative. Acting as a representative for their home state, students will have to develop a proposal on how they plan to reduce CO<sub>2</sub> emissions in their state. Looking at specific factories, major sources of emissions, and potential for renewable energy substitutes, students will construct a cohesive plan on the actions they would take to reduce CO<sub>2</sub> levels and the threat of climate change.

**Evaluation:**

Worksheets completed throughout the duration of the lesson will supplement as summative assessment. Students' written proposal will act as this lessons formative assessment, in addition to creating a hand drawn map of their state that details high levels of CO<sub>2</sub> emissions as well as areas of potential for renewable energy use and production.

**Additional resources:**

1. Environmental Protection Agency's Climate Change Resource (<http://www.epa.gov/climatechange>)
2. Facility Level Information on Greenhouse Gases Tool (FLIGHT) (<http://ghgdata.epa.gov/ghgp/main.do>)
3. Northwest Advanced Renewables Alliance (<https://www.nararenewables.org>)

## References

1. Environmental Protection Agency- Overview of Greenhouse Gases  
<http://www.epa.gov/climatechange/ghgemissions/gases.html>
2. NASA- Climate change: How do we know?  
<http://climate.nasa.gov/evidence/>
3. Renewable Energy Standards—Mitigating Global Warming  
[http://www.ucsusa.org/clean\\_energy/smart-energy-solutions/increase-renewables/renewable-energy.html#.VPOQOrPF8mV](http://www.ucsusa.org/clean_energy/smart-energy-solutions/increase-renewables/renewable-energy.html#.VPOQOrPF8mV)
4. Fargione, J., Hill, J., Tilman, D., Polasky, S., & Hawthorne, P. (2008). Land clearing and the biofuel carbon debt. *Science*, 319(5867), 1235-1238.
5. University Corporation for Atmospheric Research- Where in the World is Carbon Dioxide? [http://www.ucar.edu/learn/1\\_4\\_2\\_17t.htm](http://www.ucar.edu/learn/1_4_2_17t.htm)