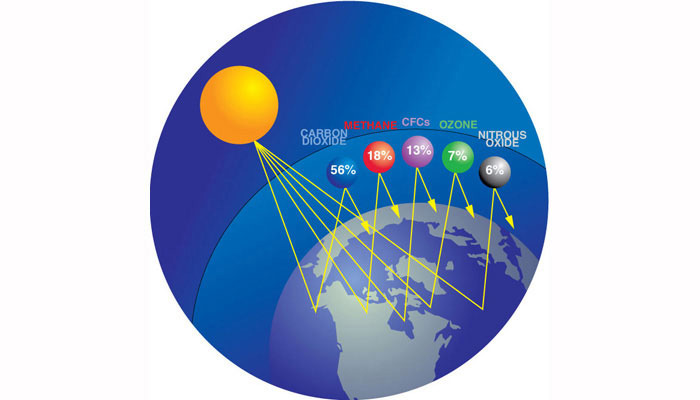
SMILE Teacher Workshop 2013

**Activity – Carbon Footprint**

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| **Time needed:** 50 min    **Goal:** Students will discover how their life choices influence their carbon footprint and how they can lower it. | **Materials needed:**   * Computer with internet access * Worksheet(s) |

**Introduction:** Global warming is a serious problem for our generation and the generations to come. Global warming is an increasing in the temperature of the earth’s atmosphere, which has increased by 1.4 °F since 1900. Even though this change may seem insignificant, this temperature change is believed to already be causing climate change in some parts of the world. Steps can be taken to educate future generations on the many negative effects of global warming and how their individual actions can help prevent these effects. Everyone has a carbon footprint and it is highly dependent on lifestyle choices such as transportation, diet, and purchases. This activity will help students understand the effect of their life choices on their carbon footprint. It will also help them recognize the lifestyle choices available to them that would lower their carbon footprint. Additionally, students will also be asked to critically think whether the options for lowering their carbon footprint available are actions that they are willing to take.

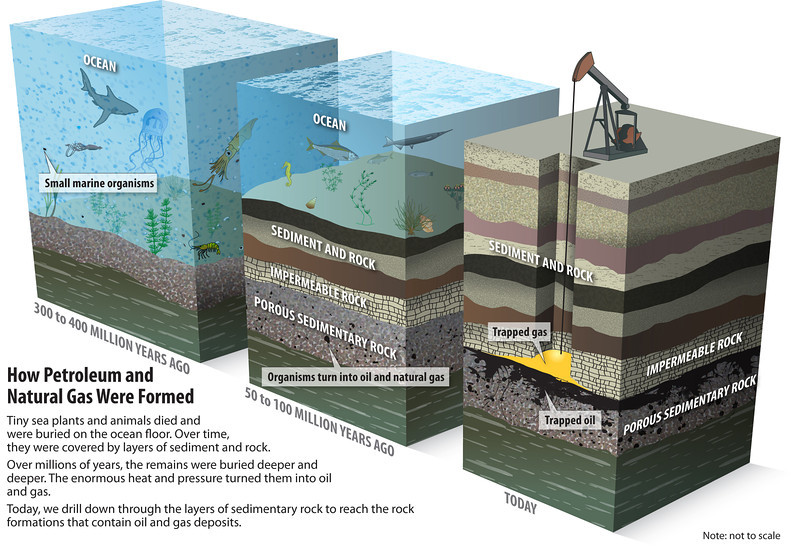
**Background:** A carbon footprint is the amount of greenhouse gases (GHGs) an individual, system, or activity is responsible for releasing into the environment. GHGs include carbon dioxide, methane, water vapor, ozone and nitrous oxide. These gases are needed in the atmosphere at their natural levels to regulate the earth’s temperature and maintain life in our planet. These gases maintain some of the heat in the atmosphere that is radiated to the earth from the sun instead of letting it be released back into space. Above natural levels of GHGs in the atmosphere leads to more heat being trapped, which translates to climate change around the world. For example, 275 parts per million (ppm) of carbon dioxide (CO2) was present in the atmosphere until about 200 years ago. Scientists believe that the safe upper limit is 350 ppm, but there is currently 400 ppm of CO2 in the atmosphere. Furthermore, some of these gases remain in the atmosphere longer than others. Water vapor leaves the atmosphere every time it rains. Methane, which is primarily produced by livestock and fossil fuel production, can remain in the atmosphere for hundreds of years. The following diagram shows the greenhouse effect and the relative amounts of GHGs in the currently in the atmosphere.



<http://www.learner.org/courses/envsci/unit/text.php?unit=2&secNum=4>

Fig. 1 The relative amounts of GHG produced by human activities and cause of the greenhouse effect that causes climate change.

Diverse energy sources such as coal, petroleum, natural gas, hydroelectricity, solar, nuclear, and biomass have shaped our nation and played an important role in our prosperity. This prosperity has come with a cost, and our nation like many others is dependent on fossil fuels for energy. These fossil fuels release high amounts of GHGs when burned for energy. We are releasing carbon dioxide and other GHGs into the atmosphere in a relatively short amount of time, while it took nature millions of years to sequester that energy in the form of coal, petroleum, and natural gas. The following diagram demonstrates the lengthy process of creating coal.



<http://need-media.smugmug.com/Graphics/Graphics/17024036_Bdmf8C/1295822961_pTXRmmn#!i=1295822961&k=pTXRmmn>

Fig. 2 The process by which coal is produced

Nature does play an important role in sequestering carbon, but it can’t keep up with our rapid burning of fossil fuels. Recent studies have showed that the natural processes for absorbing carbon dioxide are not keeping up with the increased rate of emissions. This leads to an accumulation of GHGs in the atmosphere.

Three of our country’s primary energy sources of our country – petroleum, natural gas and coal – are burned to produce energy. This energy is used to do work such as powering a TV or a game system, driving school buses, etc. This is why the amount of energy we consume greatly affects our carbon footprint. Household activities that produce a carbon footprint are those that require electricity, such as lighting, heating and cooling a house, showering, etc. For most individuals, most GHGs are produced in an indirect way, like in the production of electricity to run appliances or transport goods. However, GHGs gases can also be produced directly when burning gasoline to fuel a car or burning wood in a fireplace for heat. A carbon calculator and lifestyle questionnaire estimate the amount of GHGs released over a period of time. Recognizing the amount of GHGs produced by the way we live our lives is an important step in stopping climate change. Knowing about the consequences of everyday actions will empower students to have a meaningful consideration of what they can do help combat climate change. Since there are various types of GHGs, for convenience, most carbon calculators convert all GHGs to carbon dioxide equivalents (CO2e), or the amount of CO2 that would cause the equivalent amount of damage as the other GHGs.

**Problem:** Carbon emissions have dramatically increased over the past decades as nations such as China, India, and Brazil have become industrialized. Industrialized nations require more energy due to technological advances and economic prosperity. Goods that require energy, such as TVs, cars, and other appliances are more readily available to everyone. Industrialized nations house an increased amount of infrastructure such as roads, bridges and buildings that require large amounts of raw materials and energy to build. In addition to this, industrialized nations tend to consume more meat products, which require a large amount of energy and resources to produce. Higher amounts of GHGs are already showing evidence of producing climate change. This climate change is dangerous for humans and other species as it can cause raised ocean levels, droughts, natural disasters and extreme temperatures.

**Challenge:** Since climate change is an irreversible process, there must be an organized mitigation effort in order for life to survive on this planet. High carbon emissions are a large problem for industrialized nations. The United States has high carbon emissions due to our dependence on fossil fuels as our primary source of energy. Problems arise when trying to mitigate our carbon footprint while still maintaining the lifestyle we are used to. One could live a virtually zero carbon emission life, but it would be extremely challenging and inconvenient in our culture. Further, the life choices that lead to less CO2e emissions are not available to everyone, especially in rural and low socioeconomic communities.

The challenge is to find things that are readily available to lower our carbon footprint and that we are also willing to do. Some of these things are simpler than others. For example, it might be easy and fairly inexpensive to change incandescent light bulbs with fluorescent or LED ones. However, flying in an airplane has a disproportionately large effect compared to other forms of transportation. For many of us, this is not an easy choice and we have to fly to visit family or to go on vacation. One does not have to alter the way one lives their life completely to have a meaningful part in lowering climate change. For instance, upgrading to energy efficient appliances can save large amounts of energy annually. In many cases, lowering our carbon footprint has additional benefits in addition to preventing further climate change. For example, biking to school and eating less meat and processed food are beneficial for your health as well as for the environment.

**Procedure:**

1. Start with a discussion about carbon footprints and global warming. Make sure students understand that it is neither good nor bad to have a large carbon footprint, that the type of life they want to live is a personal choice, and that they won’t be judged upon that.

2. Students should hypothesize what activities in their daily lives have the largest carbon footprint and fill out the page 1 of the attached document to calculate their personal carbon footprint.

3. Have students discuss and compare their calculations. What surprised them?  
4. Have students brainstorm things that they and/or their families can change in their lifestyle to lower their carbon footprint.

5. Students should fill out page 2 of the attached document and follow through with their plan. They should have their parents help them fill out the household questionnaire on page 3. Teacher can also send a letter home to ask the parents to help the students determine how much their household spends on the things asked and ensure them that their information will remain confidential. Students fill out page 3 of the attachment.

6. Students estimate the calories they eat from meat, dairy, etc.

7. Each student should use the Berkeley carbon calculator to determine his or her household’s carbon footprint.

<http://coolclimate.berkeley.edu/carboncalculator>

8. Students reflect on this activity on page 4 of the attachment.

**Ponder this:**

1. Define in your own words: Mitigation, global warming and greenhouse effect.

2. Discuss with the students and make a list of what alternatives are available for them to mitigate their carbon footprint in your community.

2. Why might some of these alternatives not be convenient or possible for some students?

3. What activities or behaviors in your daily life are having the greatest impact on climate change? Which activities or behaviors in your daily life have the least impact?

4. Do you think someone in a larger city such as New York City would have a harder or easier time changing their life to have a lesser carbon footprint than someone from a rural community?

5. Do you think your friends and family are aware of actions to take to reduce climate change? What do you think you can do to inform them?

6. How did this assignment change how you feel about the issue of climate change?

**Extensions:**

1. Students go to <http://climate.nasa.gov/interactives/climate_time_machine> and write how higher sea levels and temperatures might present a problem for life on planet earth.

2. Discuss how the energy demands of your community might differ from those of a larger city. What might be the differences in the primary uses of energy? Watch http://www.youtube.com/watch?v=Z9Ctt7FGFBo

3. How might our country compare to others in carbon emissions and energy use? What are possible causes?

4. What are carbon credits? How might these help mitigate an individual’s carbon footprint? Do you think this is an effective method of combating global warming?

5. Calculate the carbon footprint of one of your school lunches. Estimate the carbon footprint if everyone at your school ate that lunch every day for a year. Perform calculations if the lunch was changed to a nutritious salad. What do you think you can do to influence to what food your school offers you?

**Oregon Content Standards:**

* H.3 Scientific Inquiry: Scientific inquiry is the investigation of the natural world by a systematic process that includes proposing a testable question or hypothesis and developing procedures for questioning, collecting, analyzing, and interpreting multiple forms of accurate and relevant data to produce justifiable evidence-based explanations and new explorations.
  + H.3S.5 Explain how technological problems and advances create a demand for new scientific
  + knowledge and how new knowledge enables the creation of new technologies
* H.4 Engineering Design: Engineering design is a process of formulating problem statements, identifying criteria and constraints, proposing and testing possible solutions, incorporating modifications based on test data, and communicating the recommendations.
  + H.4D.1 Define a problem and specify criteria for a solution within specific constraints or limits based on science principles. Generate several possible solutions to a problem and use the concept of trade-offs to compare them in terms of criteria and constraints.
  + H.4D.4 Recommend a proposed solution, identify its strengths and weaknesses, and describe how it is better than alternative designs. Identify further engineering that might be done to refine the recommendations.
    - * S.ID Summarize, represent, and interpret data on a single count or measurement variable.
  + S.ID.2 Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

**Next Generation Science Standards-**[**http://www.nextgenscience.org/next-generation-science-standards**](http://www.nextgenscience.org/next-generation-science-standards)**:**

* HS-ESS3-1
* HS-ESS3-3
* HS-ESS3-6

**Background Resources:**

* <http://www.pbslearningmedia.org/resource/35529f7e-1c9d-4544-8415-592b046ca254/35529f7e-1c9d-4544-8415-592b046ca254/> P.B.S.
* http://climate.nasa.gov/climate. N.A.S.A.
* <http://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_whatkindoffootprint/cub_footprint_lesson1.xml> Carbon footprint activity
* http://www.noaanews.noaa.gov/stories2012/20120801\_esrlcarbonstudy.html

**Resources used:**

* <http://www.pbs.org/teachers/stem/professionaldevelopment/030/>
* http://climate.nasa.gov/interactives/climate\_time\_machine<http://www.teachengineering.org/view_lesson.php?url=collection/cub_/lessons/cub_whatkindoffootprint/cub_footprint_lesson1.xml>
* <http://www.ase.org/Carbon%20FootPrint%20Lesson%20Plan>
* <http://myfootprint.org/en/your_carbon_footprint/>
* <http://science.howstuffworks.com/environmental/green-science/carbon-footprint.htm>
* <http://www.edcc.edu/sustain/documents/Haas-Whatismycarbonfootprint.pdf>
* <http://www.iclimate.org/ccc/Files/footprint.pdf>