Lesson 2 – Why do we need alternative transportation systems and fuels?

Concepts

1. Fossil fuels are in limited supply.
2. Global consumption of fossil fuels is increasing, and much of that increase is from the transportation sector.
3. While automobile fuel efficiency has improved over the last 30 years, improvements have been fairly level since the mid 1980's. Efforts to improve fuel efficiency are limited by the increased use of heavy vehicles such as sport utility vehicles and light trucks for personal use.
4. Fossil fuel combustion releases large amounts of greenhouse gases, the most significant being carbon dioxide.
5. Greenhouse gases trap heat in the earth's atmosphere.
6. In a greenhouse, visible sunlight easily penetrates glass or plastic walls, but heat (in the form of infrared radiation) does not escape.
7. Most scientists concur that the average temperature of the Earth is increasing, and if human activity is the principal cause.
8. Increased concentrations of carbon dioxide in the atmosphere contribute to global warming, which is receiving world-wide attention as a significant environmental problem.
9. Individuals can have a positive impact on the environment by making appropriate choices in our daily lives – mostly with respect to transportation, home energy use, and waste disposal.

Relationship to Guiding Question

The main intent of this set of activities is to help students gain an appreciation for the problems that exist with our current transportation system that is based primarily on the combustion of fossil fuels. Realizing the existence of these problems will help the students recognize the need for a change and, hence, will bring relevancy the work they do as they create their problem solution.

Key Questions

1. What is Peak Oil?
2. What do issues like increased fossil fuel consumption and peak oil have to do with the transportation industry?
3. How are energy consumption patterns changing throughout the world?
4. What factors limit improvements to vehicle fuel efficiency?

5. What are the most significant sources of CO_2 emissions in the U.S.?
6. What are some of the impacts of increased levels of CO_2 in the atmosphere?
7. What is global warming, and what are some of the impacts that this warming has on the earth?
8. Is it possible to calculate how much CO_2 I emit through my daily activities, and how can I reduce that amount?

Student Learning Objectives

Learning Objectives	Standards
Students will demonstrate their understanding of an issue of global concern that is related to the combustion of fossil fuels for energy use.	
Students will demonstrate the ability to synthesize relevant information about a topic of global concern, and communicate that information to the rest of the class.	
Students will be able to explain the relationship between increased CO_2 concentrations and temperature change in the atmosphere.	
Students will be able to calculate how much CO_2 they emit through their (or their family's) driving habits.	
Students will be able to identify one way that they can reduce their personal CO_2 emissions.	

Background

Problems associated with fossil fuel combustion

Current transportation technologies that are based on fossil fuel combustion have created a fragile and environmentally harmful system. The system is fragile because it relies on a continuous supply of energy-rich fossil fuels. While we are consuming increasing amounts of fossil fuel to meet our transportation and energy needs, the supplies are finite. The U.S. is importing more and more of the oil that it consumes (currently imports about 70%), and many scientists believe that we are near the peak in global oil production. World-wide, fossil fuel use by the transportation sector is increasing, due mostly to the increase in personal automobile use. This is true not only in the developed world but – perhaps more importantly – in the developing countries, as countries such as China and India strive to improve standards of living and thus increase per capita energy use.

Fossil fuel combustion is harmful to the environment because of the emissions that they contain, among other toxic and carcinogenic pollutants, greenhouse gases such as Carbon Dioxide. Scientific evidence shows that increased atmospheric

concentrations of greenhouse gases are contributing to global warming and global climate change.

Greenhouse Gas Emissions and Global Climate Change

See basic details and latest from the EPA at - http://www.epa.gov/epahome/learn.htm#climate

Recently greenhouse gases (GHGs) have been receiving more attention world-wide due to their impacts on the global climate. Global climate change is caused primarily by increases in GHGs and also by changes in land use patterns. The theory linking GHGs with global climate change is such that greenhouse gases trap solar radiation, thus increases in greenhouse gases provide an increase in this trapping of solar radiation. The trapping of solar radiation by means of atmospheric gases is called the greenhouse effect. The GHGs trap the gas and heat up the Earth in a similar manner to how the glass panes in a greenhouse trap solar radiation.

Growing evidence supports the claim that increasing greenhouse gases, specifically carbon dioxide, has been the major cause of increasing global temperatures. The scientific community has developed a very strong interest in global climate change and has begun insisting that politicians begin passing laws to limit future increases in global emissions such as carbon dioxide.

The Earth's greenhouse effect is a natural consequence of the chemical makeup of its atmosphere. If it were not for the greenhouse effect, life as we know it could not exist on Earth: it would be too cold. Our atmosphere is made mostly of nitrogen and oxygen, but also contains several other gases. These include carbon dioxide, methane, nitrous oxide, water vapor and ozone, which are known as greenhouse gases. They absorb very little visible light, so most sunlight passes through these gases to Earth's surface. However, Earth radiates heat in the form of infrared radiation, which greenhouse gases absorb. The gases then re-radiate infrared radiation, and some of it heads back toward the ground. In this way the greenhouse gases act like a blanket, insulating the earth.

Greenhouse gases are released naturally through geologic processes and the metabolic activity of living things. However, there is an ongoing debate over human effects on Earth's global climate. Human industrial activity on the planet has increased the quantities of greenhouse gases through agriculture, manufacturing, power generation, and engines used for transportation. Key questions include: Is the average temperature of Earth increasing? Does the presence of human beings contribute to global warming? If the temperature of Earth does become warmer, how will it affect us?

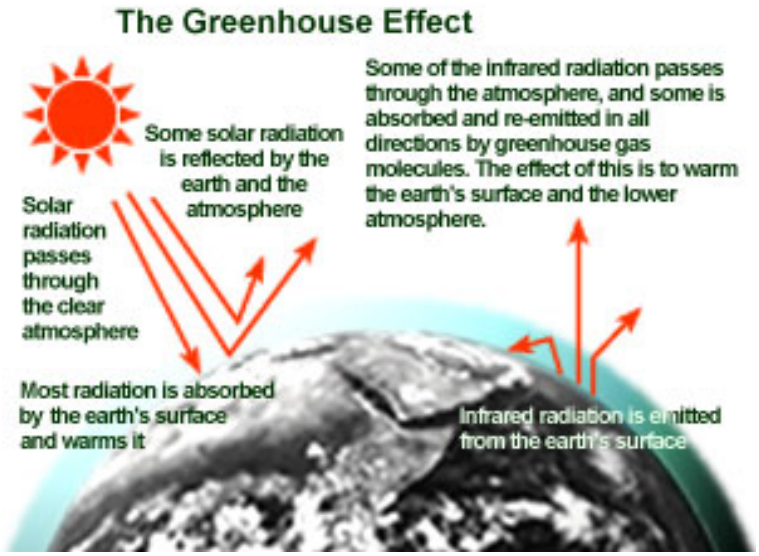


Figure 1: Basic greenhouse gas process
(http://www.epa.gov/climatechange/science/index.html)

CO_2 concentrations in the atmosphere have been measured at an altitude of about 4,000 meters on the peak of Mauna Loa mountain in Hawaii since 1958 (Figure 2). The measurements at this location, remote from local sources of pollution, have clearly shown that atmospheric concentrations of CO_2 are increasing. The mean concentration of approximately 316 parts per million by volume (ppmv) in 1958 rose to approximately 387 ppmv in 2009. The annual variation is due to CO_2 uptake by growing plants. The uptake is highest in the northern hemisphere springtime.

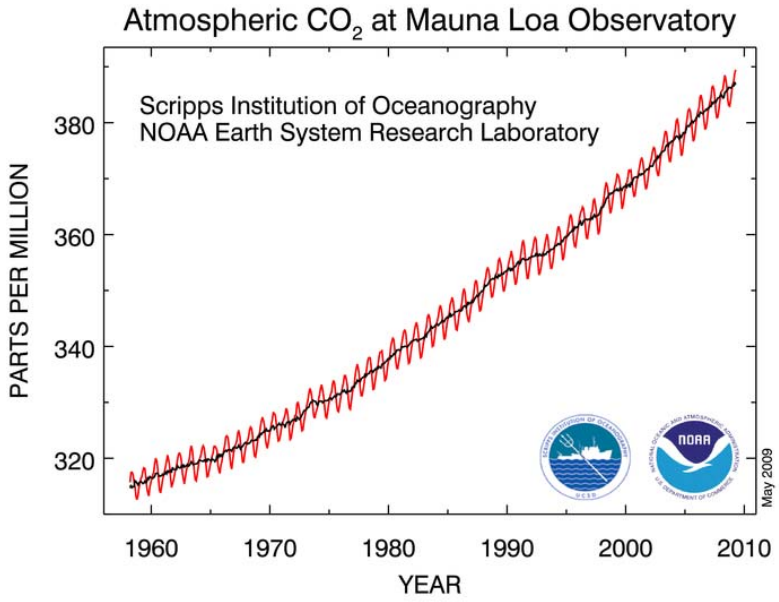


Figure 2: CO_2 concentrations at the Mauna Loa Observatory in Hawaii (as of May 2009)
(http://www.esrl.noaa.gov/gmd/ccgg/trends/co2_data_mlo.html)

Ice cores have provided a means of estimating CO_2 concentrations dating back hundreds of thousands of years. The data shown in Figure 3 illustrate that form much of the earth's history, the concentrations ranged from 200-280 ppm. CO_2 concentrations fluctuated regularly for hundreds of thousands of years in a somewhat regular pattern. What it also clearly shows is that, since the Industrial Revolution (1800s), CO_2 concentrations have risen far above what was experienced for the last 400,000 years.

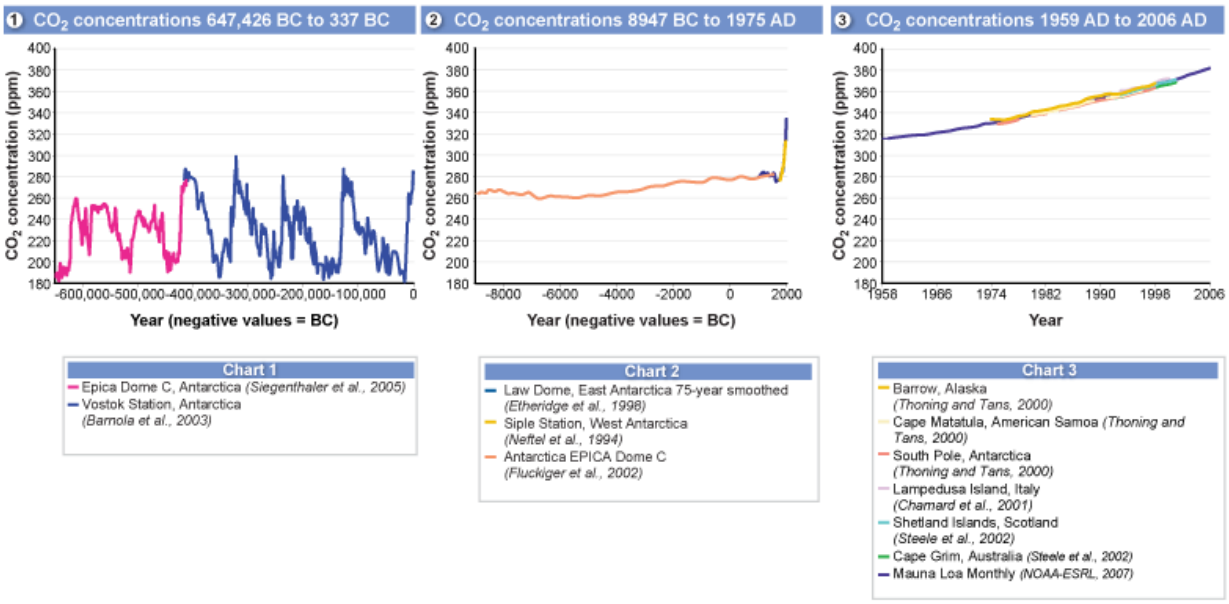


Figure 3: Long-term historical CO_2 concentrations
(http://www.epa.gov/climatechange/science/recentac_majorghg.html#fig1)

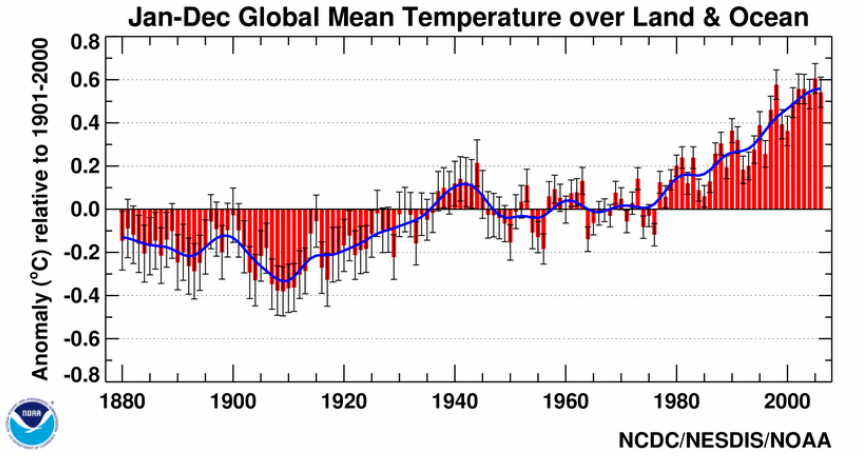


Figure 4: Changes in the average global temperature relative to the mean temperature during the 20th century (http://www.epa.gov/climatechange/science/recenttc_triad.html)

The evidence strongly implicates the increase in greenhouse gases on recent changes in global climate conditions. Figure 4 shows that the temperature has recently risen over the average temperature last century. The US government agencies (NOAA, NASA) and international panels of experts (IPCC) have studied climate change extensively. The following are the overall conclusions regarding global temperatures (as of 2009) that these experts agree upon (from http://www.epa.gov/climatechange/science/recenttc.html#ref)

- Since the mid 1970s, the average surface temperature has warmed about 1°F.
- The Earth's surface is currently warming at a rate of about 0.32ºF/decade or 3.2°F/century.
- The eight warmest years on record (since 1850) have all occurred since 1998, with the warmest year being 2005.
- The warming trend is seen in both daily maximum and minimum temperatures, with minimum temperatures increasing at a faster rate than maximum temperatures.
- Land areas have tended to warm faster than ocean areas and the winter months have warmed faster than summer months.
- Widespread reductions in the number of days below freezing occurred during the latter half of the 20th century in the United States as well as most land areas of the Northern Hemisphere and areas of the Southern Hemisphere.
- Average temperatures in the Arctic have increased at almost twice the global rate in the past 100 years.

What are the sources of anthropogenic (man-made) greenhouse gases?

In the U.S., our greenhouse gas emissions come mostly from energy use. These are driven largely by economic growth, fuel used for electricity generation, and weather patterns affecting heating and cooling needs. Energy-related carbon dioxide emissions, resulting from petroleum and natural gas, represent 85 percent of total U.S. human-made greenhouse gas emissions (Figure 5). Methane (CH_4) and nitrous oxide (N_2O) are primarily from agricultural activities.

Figure 6 illustrates that fossil fuel combustion for energy is by far the most substantial contributor of carbon dioxide emissions. Of that total, electricity generation produces the most carbon dioxide emissions, closely followed by the transportation sector (Fig. 7).

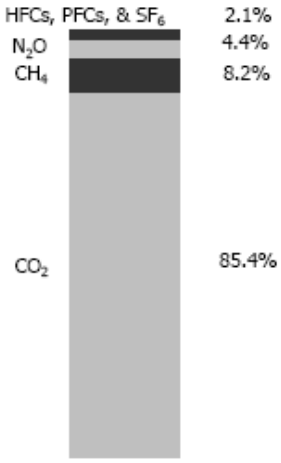


Figure 5: 2007 Greenhouse Gas Emissions by Gas (percents based on Tg CO2 Eq.) (Tg – teragram = 10^{12} g) (http://www.epa.gov/climatechange/emissions/downloads09/ExecutiveSummary.pdf)

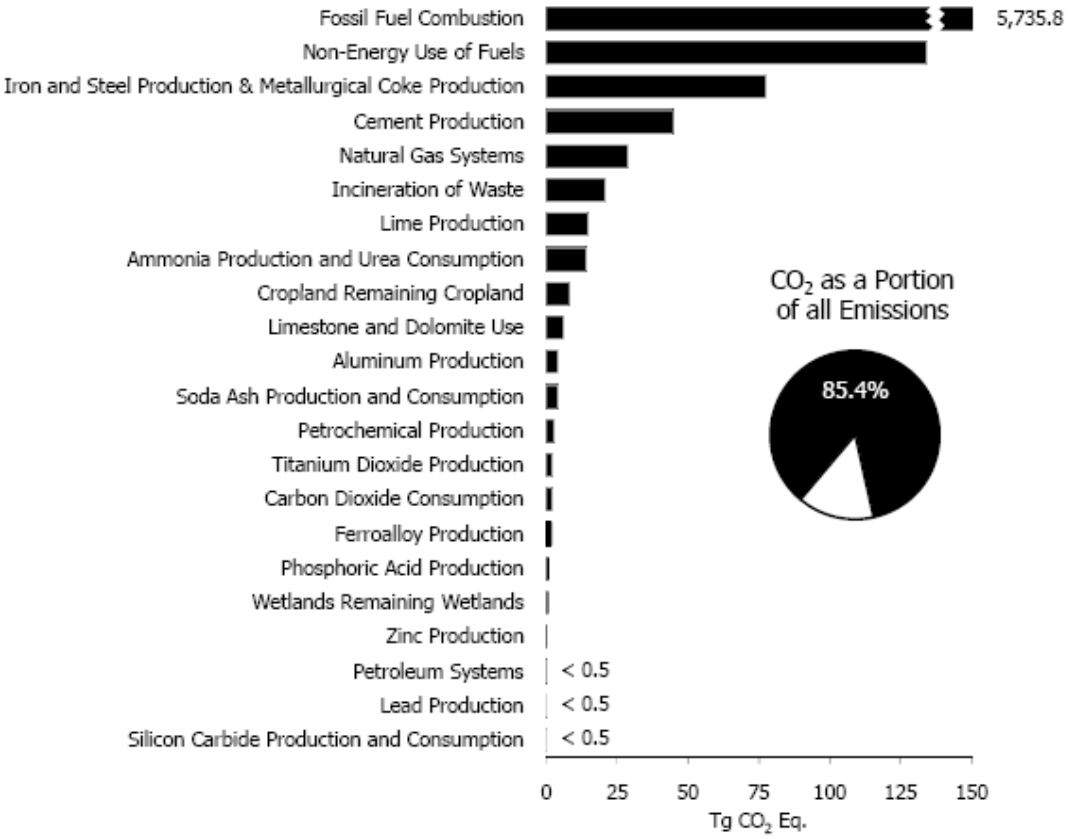


Figure 6: 2007 Sources of CO2 Emissions
(http://www.epa.gov/climatechange/emissions/downloads09/ExecutiveSummary.pdf)

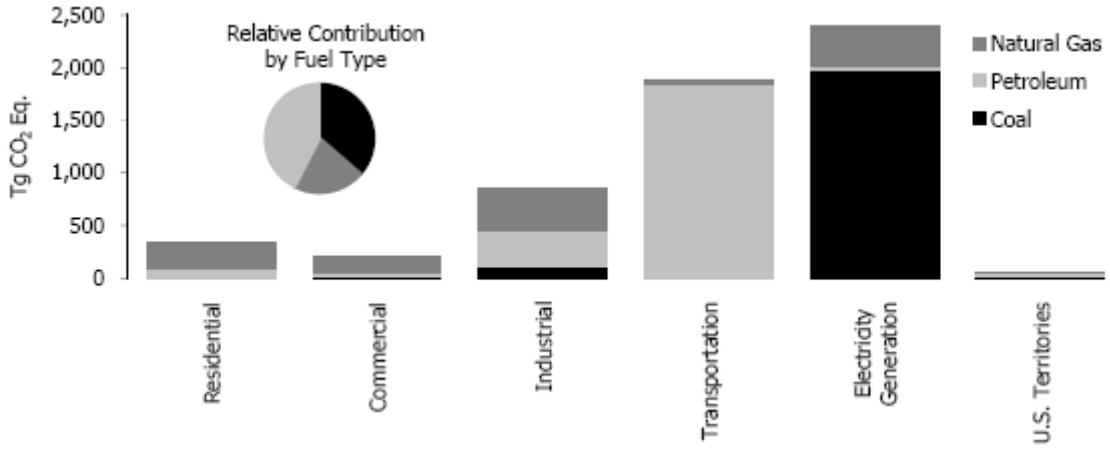


Figure 7: 2007 CO2 Emissions from Fossil Fuel Combustion by Sector and Fuel Type
(http://www.epa.gov/climatechange/emissions/downloads09/ExecutiveSummary.pdf)

The science of predicting global temperatures is complicated. When the temperature starts to rise, other physical and biological processes change too. Some of these changes help to stabilize the temperature (negative feedback loops),

other mechanisms exacerbate the warming trends (positive feedback loops). These feedback mechanisms include:

Negative Feedback loops: global warming → global cooling

- increase in algae > algae utilizes carbon dioxide for photosynthesis > global cooling
- increase in carbon dioxide > stimulate land plant growth > land plants absorb carbon dioxide > global cooling.
- polar regions receive more precipitation from warmer air carrying more moisture > increase snow and ice buildup>solar energy reflected from Earth's surface > global cooling.
- more water evaporates from the ocean > more clouds > clouds reflect sunlight > global cooling.

Positive Feedback Loops: global warming → more global warming

- more water evaporates from the ocean > water vapor is a greenhouse gas which causes more warming > more warming
- permafrost melts > methane released (a greenhouse gas) > more warming
- less snow > less solar reflection > more warming
- people use more air conditioning > fossil fuels burned for electricity > carbon dioxide released > more warming

What can we do?

It helps to realize that students can make a positive environmental impact just by making choices in their personal lives. There are a number of activities designed to help calculate our "global footprint", which is a measure of the impact our lifestyle has on the land and water resources of the earth. A large portion of that footprint has to do with energy-related activities such as consumption of natural resources, environmental degradation, and global climate change.

Our "carbon footprint" is a measure of our contribution to global climate change or, more specifically, our annual emissions of CO_2. Some interesting facts:

- CO_2 emissions represent about 83% of the total GHG emissions.
- Total CO_2 emissions in the U.S. are about 6.6 tons of CO_2 per person per year.
- About 1/3 are from the transportation industry – and that fraction is increasing, mostly from an increase in personal vehicle use.
- The average car in the U.S. emits about 1 pound CO_2 per mile driven.

Most of a person's Carbon Footprint results from transportation and home energy use. The EPA estimates that we can reduce our personal CO_2 emissions by as much as 1/3, just by making different choices in transportation, energy use, and waste disposal.

Activities

This series of classes is comprised of a short introduction followed by a learn/present group activity focused on issues of global concern, and a calculations of each student's own CO_2 footprint.

Days 1 and 2 – Global Issues

- Briefly recap from previous day – recall problem statement and the problem solving spiral. At this point, we need to understand the problem better before we can assess the effectiveness of various solutions.
- (note: the ten minute video clip identified under "peak oil" hits many of the highlights of this research activity. It can be shown as an introduction, especially if "End of Suburbia" was not shown.)
- Activity– Global Issues. Introduce activity and relationship to guiding question (we are really still establishing the problem). Why do we need to consider alternative developments in transportation technology? What is wrong with our current system? Brief class discussion about problems associated with:
    - Consumption of limited fossil fuel resources
    - Poor mileage of existing cars
    - Environmental impacts associated with fossil fuel combustion
- Introduce Activity – chose the issues you wish the class to focus on and divide students into groups. Assign each group to one global Issue:
    - Fuel Economy
    - Peak Oil
    - Global Climate Change
    - Petroleum consumption for transportation
    - CO_2 concentrations in the atmosphere
    - Emissions of greenhouse gases
- Distribute activity sheets with questions to each group. Provide access to computers and the internet during the class period or assign materials for homework.
    - Students will review the materials, answer the questions and prepare a brief "lesson" on their issue, using a few powerpoint slides.
    - Be sure to explain that the questions are only meant as a guide – they should not answer each question, first to last.
    - Each 5-10 minute presentation should include a variety of text, pictures, and graphics.
- All students should take notes during presentations on their activity sheets. Materials will be available for students to use as a resource if needed.
- Distribute HW needed as preparation for carbon footprint activity.

Day 3 – CO_2 footprint activity

- Introduction. – recap yesterday's presentations and the idea of global warming. So – why are we discussing this? (investigating problems associated with our current fossil fuel-based transportation system). Optional – use the carbon_footprint.ppt presentation.
- OK, so we suspect that CO_2 emissions are causing global warming. Where do CO_2 emissions come from? (recall some pertinent information from student presentations). Depending on what is covered, discuss some pertinent facts from the background section (personal emissions, 1/3 from transportation, etc..)
- Activity – Carbon Footprint. This is an individual activity (possibly pairs) but students will need some help with the math and access to computers. They may choose to do in pairs. Make sure they answer the discussion questions at the end of the activity.
- Wrap-up. ***Collect worksheets for possible later use!*** Discuss and compare the student's personal CO_2 emissions. Try to bring into perspective the huge amounts that are represented – e.g., one ton of CO_2 (gaseous) – how large would that volume be?? Discuss their ideas about how they can reduce their individual CO_2 emissions. Can they make a difference as individuals? YES – EPA estimates that an individual can reduce their CO_2 emissions by 1/3 just by making more appropriate lifestyle choices. Reducing our per-capita emissions from 6.6 tons to 4.4 tons per year WOULD be significant.

Resources

Botkin & Keller's "Environmental Science: 4th edition" Chapter 22. 2003, Wiley

all of web sites included in global issues activities

Materials needed

Activity sheet – Global Issues

Activity Sheet – Carbon footprint (includes pre-activity homework)

Access to computers with internet connections (both activities)

Powerpoint slides on carbon footprint

Activity – Global Impacts of Energy Consumption

Background and Purpose

Current transportation technologies that are based on fossil fuel combustion have created a fragile and environmentally harmful system. Fragile, because the system relies on a continuous supply of energy-rich fossil fuels. While we are consuming increasing amounts of fossil fuel to meet our transportation and energy needs, the supplies are finite. The U.S. is importing more and more of the oil that it consumes (currently imports about 70%), and many scientists believe that we are near the peak in global oil production. World-wide, fossil fuel use by the transportation sector is increasing, due mostly to the increase in personal automobile use. This is true not only in the developed world but – perhaps more importantly – in the developing countries, as countries such as China and India strive to improve standards of living and thus increase per capita energy use.

Fossil fuel combustion is harmful to the environment because of the emissions that they contain, among other toxic and carcinogenic pollutants, greenhouse gases such as Carbon Dioxide. Scientific evidence shows that increased atmospheric concentrations of greenhouse gases are contributing to global warming and global climate change.

The purpose of this activity is to explore in more depth the specific impacts of our consumption of fossil fuels for transportation needs and to share our findings with the class. The issues considered include:

- Fuel Economy
- Peak Oil
- Global Climate Change
- Petroleum consumption for transportation
- CO_2 concentrations in the atmosphere
- Emissions of greenhouse gases

Activity

Each group of students will use the latest scientific resources to explore one issue related to fossil fuel consumption for transportation.

1. Review the questions associated with the issue assigned to your group.
2. Use the resources provided (graphs, spreadsheet or internet resources) to answer the questions. Note: The internet resources included are from government agencies whenever possible to provide the highest caliber and defensible data.
3. Organize your findings into a 5-10 minute presentation to teach your classmates what you learned. Use Powerpoint or similar presentation software to include bullets, graphs, diagrams, etc. to convey your findings.

Global Issues: Fuel Economy

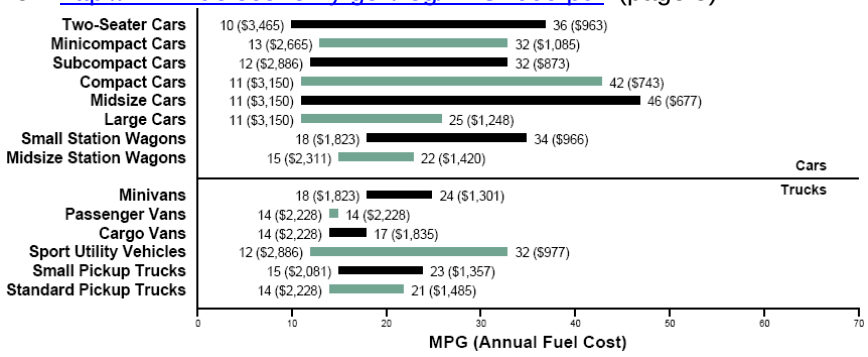
Try to address the following major questions in your presentation. Sample questions are provided with each topic – you do not have to answer each question, they are meant to help you focus your research.

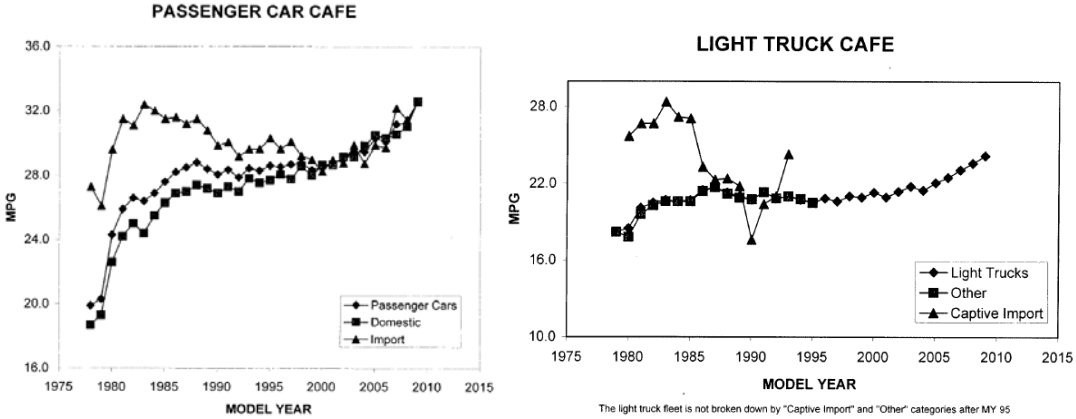
1. How has the annual average fuel economy changed in the last 30+ years?
2. How have cars and trucks changed last 30+ years?
3. What are the cars/trucks with the current best fuel standards (MPG)? Worst? What are the primary characteristics that cause the differences between the best and worst?
4. What are the CAFÉ standards? What recent policies are affecting these goals?
5. Why is the fuel economy of our vehicles important? Describe both the importance for individual consumers as well as our nation.
6. What are some examples of current technologies available to increase fuel economy and are they economically feasible?
7. What personal decisions can you make in terms of what you drive and how you drive to reduce your gasoline consumption?

Sources:

http://www.fueleconomy.gov/
http://www.fueleconomy.gov/feg/FEG2009.pdf
http://www.nhtsa.dot.gov/ (→ fuel economy)

Example graph from http://www.fueleconomy.gov/feg/FEG2009.pdf (page 5)



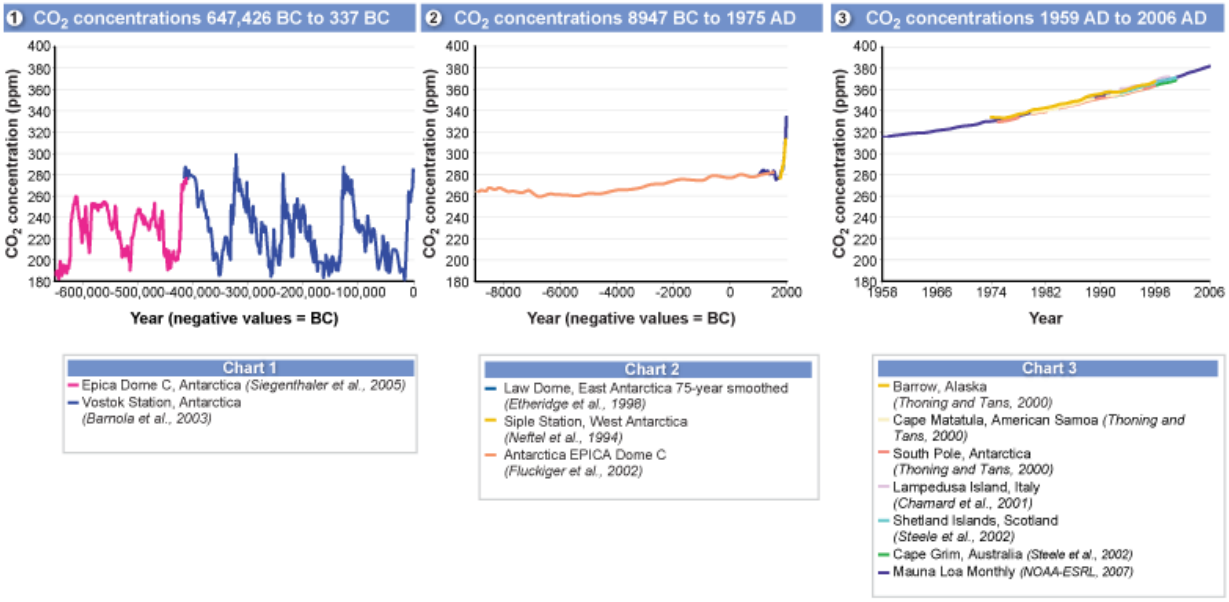


Example graphs from - Summary of Fuel Economy Performance, March 2009
(http://www.nhtsa.dot.gov/portal/site/nhtsa/menuitem.d0b5a45b55bfbe582f57529cdba046a0/)

Global Issues: Atmospheric Concentrations of CO_2

1. How have carbon dioxide concentrations in the atmosphere changed in the last 200 years? 400,000 years?
2. How and where are these concentrations determined?
3. What do scientists define as the primary cause of the ancient variation in CO_2 concentration? The recent (100 years) changes in CO_2 concentrations?
4. What are other greenhouse gases?
5. How much of the total greenhouse gas emissions are attributed to CO_2?
6. How do atmospheric concentrations of CO_2 impact global temperature?

Sources:
http://www.epa.gov/climatechange/emissions/co2.html
http://www.epa.gov/climatechange/science/recentac.html
http://www.esrl.noaa.gov/gmd/ccgg/trends/
http://www.ncdc.noaa.gov/oa/climate/globalwarming.html



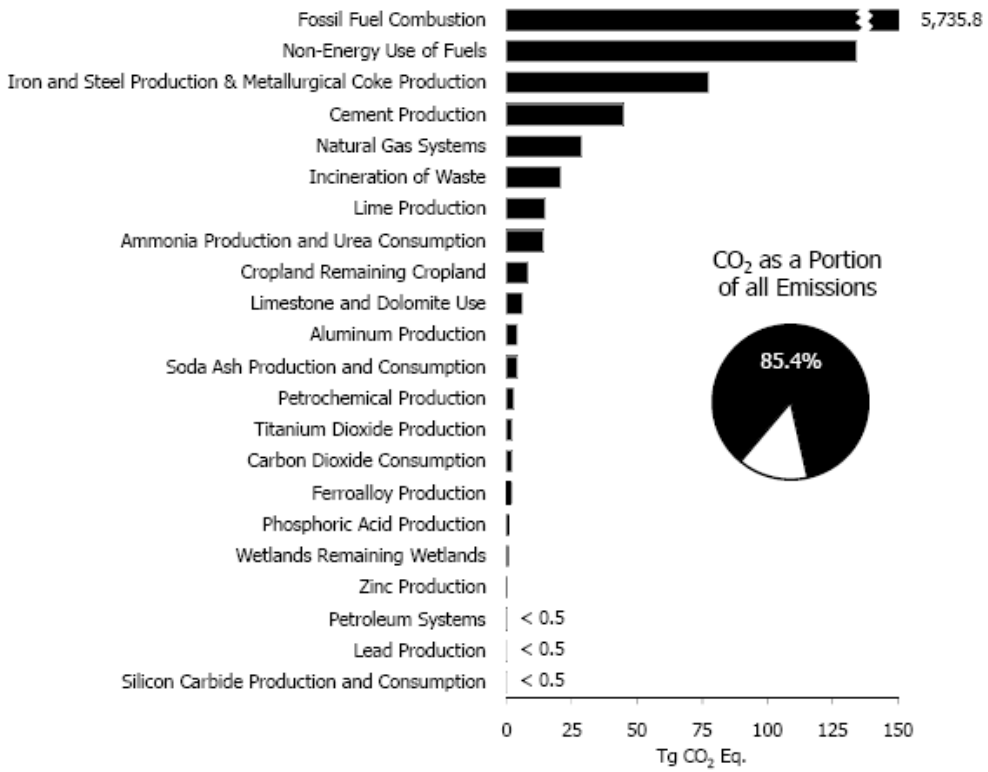
Example figure - Long-term historical CO_2 concentrations
(from http://www.epa.gov/climatechange/science/recentac.html)

Global Issues: Sources of CO_2 Emissions

Discuss major sources of carbon dioxide and possible solutions for reducing atmospheric concentrations.

1. Overall, what source produces the most $C0_2$?
2. How do man-made CO_2 emissions compare with natural CO_2 emissions?
3. What are the primary sources of other greenhouse gases (GHGs)?
4. What can you do to reduce GHG emissions?
5. How do GHG emissions differ between different countries of the world (or developed versus developing nations)?
6. Discuss potential problems associated with the US's large share of GHG emissions. How might this affect the world?

Sources:
http://www.epa.gov/climatechange/science/recentac.html
http://www.epa.gov/climatechange/emissions/co2_human.html
http://www.epa.gov/methane/sources.html
http://www.epa.gov/climatechange/emissions/othercountries.html
http://www.eia.doe.gov/

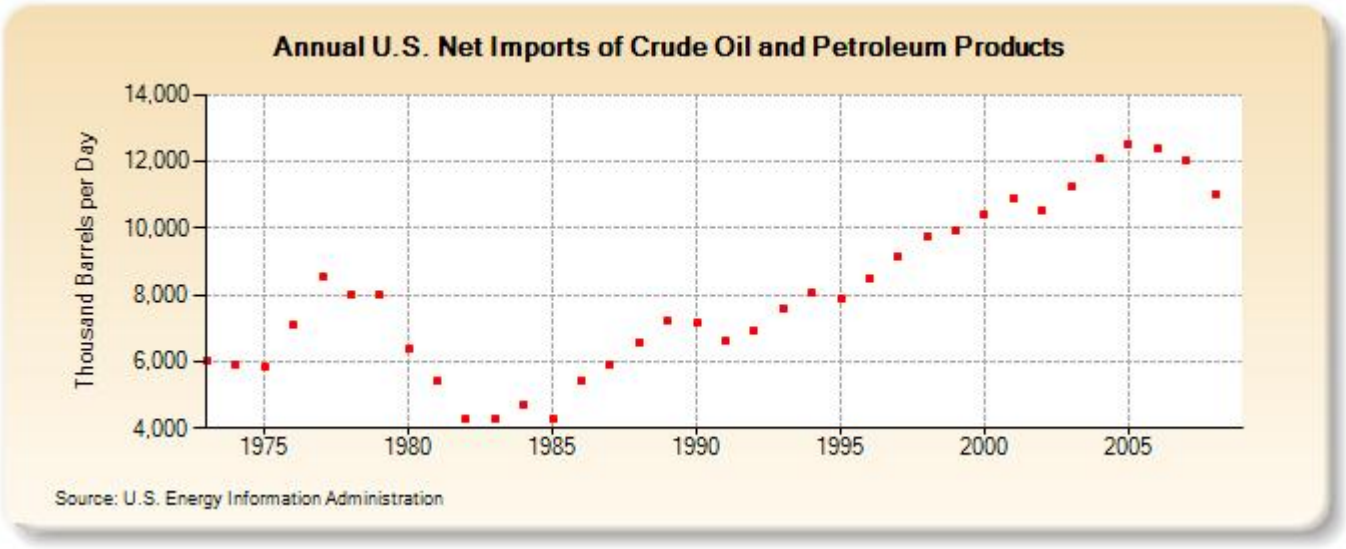


Example graph - 2007 Sources of CO2 Emissions
(from - http://www.epa.gov/climatechange/emissions/downloads09/ExecutiveSummary.pdf)

Global Issues: Transportation Energy Consumption

1. How much petroleum does the US consume? How much of that is for transportation? How much of it is imported?
2. What countries export oil? How much?
3. From which countries do we import most of our oil?
4. How does the fraction of oil that we import affect our national security?
5. How does the percentage of petroleum that we consume for transportation impact other uses for the petroleum? (plastic, other energy needs, industrial chemicals etc.)

Sources:
Excel spreadsheet (from teacher) – petroleum-graphs.xls (summary of data from www.eia.doe.gov)
http://www.eia.doe.gov/basics/quickoil.html
http://www.eia.doe.gov/basics/petroleum_basics.html



Example graph from
http://tonto.eia.doe.gov/dnav/pet/pet_move_neti_a_ep00_IMN_mbblpd_a.htm

Global Issues: Peak Oil

Note: the US federal government has very little information about the theory, reality or consequences of peak oil. Some use this absence of information as an indication that the science is not certain enough. Others feel that it is some kind of conspiracy to prevent public knowledge about peak oil.

1. Define "Peak Oil." What does this mean?
2. Discuss the peaking of oil production in the U.S. When did US oil production peak? How did the peak oil theory align with the actual peak in US oil production?
3. Discuss the current projections and debate for a peak in the global oil production.
4. What kinds of changes might we experience after global oil production peaks?
5. What about "new" sources of oil? (e.g., the Arctic national Wildlife Reserve, Canadian oil sands, oil shale in the American west) Do these new sources represent a real solution to our problem?

Sources:

Hirsch Report: http://www.netl.doe.gov/publications/others/pdf/oil_Peaking_NETL.pdf (summary of this long report available at: http://www.acus.org/docs/051007-Hirsch_World_Oil_Production.pdf)

About M.K. Hubbert: http://www.hubbertpeak.com/hubbert/

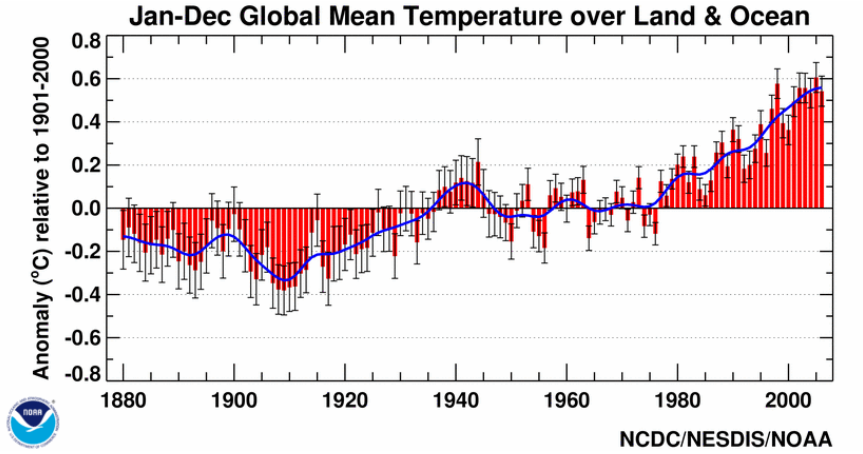
Video summary overview: http://www.youtube.com/watch?v=DMQd5nGEkr4

Debate:
http://business.timesonline.co.uk/tol/business/industry_sectors/natural_resources/article3207311.ece

Global Issues: Climate Change

1. How has the global average temperature changed over a long period? Over the last few hundred years? Are the recent trends consistent with the long-term history?
2. What are the factors (feedback mechanisms) that contribute to global warming and cooling?
3. What other climatic and environmental side effects will the change in temperature impact? What are the predictions for the magnitude for these changes?

Sources:
http://www.epa.gov/climatechange/science/index.html
http://www.ncdc.noaa.gov/oa/climate/globalwarming.html
http://oceanservice.noaa.gov/education/lessons/getting_hot.html
http://www.epa.gov/climatechange/effects/index.html



Example Figure: Changes in the average global temperature relative to the mean temperature during the 20th century (from: http://www.epa.gov/climatechange/science/recenttc_triad.html)

Activity – What is your Carbon Footprint?

Background and Purpose

Your Carbon footprint is a representation of the effect your everyday activities have on climate change, in terms of the greenhouse gases you produce (measured in Carbon Dioxide, CO_2). This is true because CO_2 emissions account for about 85% of all emissions. The EPA estimates that about 1/3 of all CO_2 emissions in the U.S. are from transportation with just over ½ from personal vehicles. When you drive a car every gallon of fuel that is burned produces a certain amount of CO_2 that is emitted to the atmosphere. Depending on the fuel efficiency (miles per gallon) and the distance traveled, a car can easily emit its own weight in CO_2 in one year!

Some major sources of CO_2 emissions stem from the generation of electricity, that we use for instance to power our homes and the energy Industry uses to create its products. The average American is responsible for about 20 tons of CO_2 emissions per year. The EPA estimates that we can reduce as much as 1/3 of our individual CO_2 emissions by making appropriate choices regarding transportation, waste production and disposal and home energy use.

The purpose of this activity is to calculate the amount of CO_2 you add to the atmosphere through your daily habits.

Activity

Break into groups of two and choose one of the following internet sites. These sites ask a series of questions that cover home electricity habits, driving habits, air travel and recycling. If you do not know an answer, choose the default answer or ask a fellow student/teacher for an appropriate estimate.

Sites:

American Forests Climate Change Calculator

www.americanforests.org/resources/ccc/

EPA Personal Emissions Calculator

www.epa.gov/climatechange/wycd/calculator/ind_calculator.html

Al Gore “An inconvenient Truth” Calculate Your Impact

www.climatecrisis.net/takeaction/carboncalculator/

Carbon Footprint

www.carbonfootprint.com/calculator.aspx

At The end of the activity (15 minutes at the computer), we will discuss the class findings and look at the average CO_2 emissions per person.

Questions:

1. What is your "transportation CO_2 footprint?" (How many pounds of CO_2 do you add to the atmosphere by driving your car? Flying in airplanes?)

2. The average U.S. car emits a little over 10,000 pounds, or 5 tons, of CO_2 per year. How do your transportation emissions compare? Can you list a few reasons why they are different?

3. The US EPA estimates that transportation-related activities are responsible for 1/3 of all CO_2 emissions in the U.S. What fraction of your total emissions are related to transportation?

4. An average tree absorbs about 670 pounds of CO_2 per year. About how many trees does it take to absorb your "CO_2 footprint?"

5. What are some of the problems with sequestering (trapping) CO_2 in trees?

6. List some ways that you can reduce your CO_2 emissions and determine the actual reductions in CO_2 emissions (as mass CO_2 and % reduction). Do you really think that you can reduce your emissions by 1/3, as the EPA claims?

Homework – Your Energy Consumption

Tomorrow we will try to quantify your greenhouse gas emission footprint. Collecting some data about your fuel use and habits will help to maximize the value of that lesson.

Transportation Related

Model, make and year of your automobile	
Expected gasoline mileage (from purchase information or http://www.fueleconomy.gov/)	
Approximate Frequency of gasoline purchase	
Approximate gallons gasoline purchased each time	
Estimated actual fuel economy (miles per gallon)	
Total miles driven (annual)	
Total gasoline consumed per year (including gasoline used for recreation or lawn equipment)	
Estimated fraction of your total miles that could be cut through conservation measures (carpooling, walking, more efficient trips)	

Home Energy Use Related

Total electricity consumed per year (kWh)	
Annual electric bill ($)	
Total heating fuel consumed per year (cf or gallons)	
Annual heating bill ($)	

Material consumption

~ pounds of trash and recyclables created each year	