TRAVEL SOLUTIONS TO GLOBAL WARMING Grades 5 - 8

OBJECTIVES

Students will:

- Investigate carbon cycle and fossil fuels
- Graph the carbon dioxide production and populations of six nations.
- Generate suggestions to reduce travel-related carbon dioxide production.
- Complete Trip Log with trip saving measures.

TIME

One 45-minute class plus minimal time over one week to collect and tabulate personal travel information.

MATERIALS NEEDED

- candle, glass cover, matches
- Fossil Fuels & Climate Change overhead
- two worksheets,
- Give Your Car a Break-Trip Log and instructions.

VOCABULARY

renewable resources	fossil fuels
carbon dioxide	carbon
oxygen	hydrocarbon

Developed by NESEA, based on lesson by Denny Dart, EPA Region 1

BACKGROUND INFORMATION

All energy comes from the sun. Photosynthesis uses carbon dioxide (CO_2) from the air to build carbon-based plant matter. Plant and animal carbon material stored underground for millions of years turns into fossil fuels such as oil and coal. This reservoir of stored carbon is released back to the atmosphere when it is burned.

Carbon dioxide is a greenhouse gas which traps heat from sunlight. Many scientists believe the increasing CO_2 level is causing global warming.

The US produces a disproportionate amount of the world's CO_2. The greatest source of CO_2 production is transportation. For each six pound gallon of fuel burned, 20 pounds of CO_2 are produced.* A tremendous amount of CO_2 production can be eliminated through simple conservation measures that students can practice.

In April of 2001, 1,250 students from the Pioneer Valley in Massachusetts recorded avoiding production of 42 tons of CO_2 during one week, by carpooling, combining trips, and using buses, bikes, and walking. What can your school accomplish?

LESSON OVERVIEW

Teacher demonstrates a burning candle experiment with students posing hypotheses, to review the relationship of the carbon cycle, fossil fuels, and the atmospheric CO_2 level. Students then graph the relative populations and production of CO_2 by different countries and discuss the results. Students follow up by using a personal trip log to discover simple but powerful solutions.

* www.fueleconomy.gov

ACTIVITY - 10 min.
The teacher lights a candle.

- *What is burning when a candle is lit?*
  The candle wax is burning which comes from petroleum or beeswax.
- *What is needed for combustion to occur?*
  A fuel, oxygen (O_2), and heat are needed for combustion to occur.
- *What will happen when the burning candle is covered?*
  Combustion of the candle wax uses O_2 and produces CO_2. When the CO_2 replaces enough O_2 the flame will go out.

The teacher covers the candle with a tall glass. Have students estimate how long the candle will burn.

LECTURE - 10 min
For this discussion use *Fossil Fuels & Climate Change* as an overhead or handout.

Ask students to suggest other materials that burn and list them on the black-board. Almost everything that burns originally came from a plant source. Review the list of materials and trace them back to their original living source. (Objects will quickly trace back to plants or fossil fuels such as petroleum.)

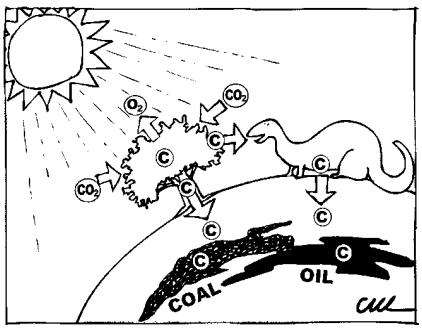
Sunlight and photosynthesis are responsible for all the carbon-based burnable material on earth. Fossil fuels such as oil and coal come from animal and plant material that died, was buried, and was put under pressure for millions of years. These fuels are considered non-renewable because they take so long to create.

The first plants changed ancient atmospheric carbon dioxide (CO_2) and water (H_2O) into carbon-based material (burnable plant material) and oxygen (O_2) (breathable). Earth had very little free oxygen before plants evolved. Increased plant life increased free oxygen and hydrocarbons until there were enough to support animal life and fire.

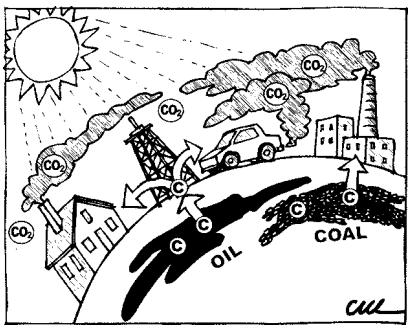
Respiration and combustion consume hydrocarbons and oxygen and give off carbon to the air in the form of CO_2. The use of fossil fuels to meet the world's

"Scientific evidence strongly suggests that the rapid buildup of greenhouse gases in the atmosphere is raising the earth's temperature and changing the earths climate with many potentialy serious consequences. [We conclude] that human activity is influencing the global climate."

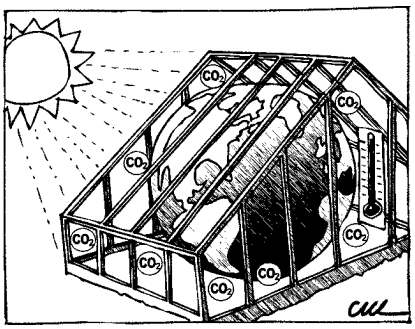
- Intergovernmental Panel on Climate Change



Carbon In



Carbon Out



Greenhouse Effect

energy demands moves carbon from the ground into the air and has contributed to increased concentrations of carbon dioxide in the atmosphere. Atmospheric CO_2, a greenhouse gas, traps heat like the windows of a car on a sunny day.

Climate change is quite complicated, and continues to be studied. Yet, according to the Intergovernmental Panel on Climate Change, representing more than 2000 of the worlds leading climate scientists, "human activity is influencing the global climate."

Because of this, many countries in the world are trying to reduce their production of CO_2.

When plant-based fuels are burned, carbon dioxide is produced. When the plant grows back, the carbon is taken back from the air, and put into new plants. Renewable resources such as plant-based fuels, wind, hydro, and solar power provide energy without increasing CO_2 levels.

WORKSHEETS - 15 min.
Have students graph both population and CO_2 production from six countries using the figures given. Students should use one color for CO_2 production and one color for population bars. Have students answer the questions on the back of the sheet (Worksheet 2).

DISCUSSION - 15 min.
Discuss the answers to worksheet questions.

Countries around the world are concerned with this issue and are working to reduce the amount of CO_2 they produce.

- *How could people in the US produce less CO_2?*
  For the average American, driving produces sizably more CO_2 that any other consumer behavior. This is followed by heating and cooling our homes, and use of electricity for appliances and lighting.
- *What sources of energy don't produce CO_2?*
  Hydro, wind, and solar are some examples.
- *What sources of carbon-based energy can be quickly replenished?*
  Fuels derived from plants

Concluding comments:
Increased reliance on renewable energy sources is an excellent solution that requires development of new infrastructure. Conservation of the resources we already use is a more immediate solution.

Did you know that your choice of transportation is the single most important environmental decision you make? Transportation uses 67% of all oil used in the United States, and produces one-third of the air pollution and greenhouse gases.

TRANSPORTATION HOMEWORK - 10 minutes introduction and one week of minimal record keeping with 20 minutes for end of week class totals.

Review the instruction sheet and Trip Log.

At the end of the week total up and publicize your class savings to encourage others to do the same!

Let us know your savings and we will display them on our website, www.nesea.org. Send information to tally@nesea.org.

REVIEW QUESTIONS

Use the *Review Questions* handout for this discussion.

- *What is the earth's major source of energy?*
  The sun. The sun's energy creates wind for windmills, drives the watercycle for hydropower, and provides energy to build plants.
- *How is that energy stored?*
  The energy of the sun is captured by plants which take carbon dioxide (CO_2) from the air to build carbon-based plants. There is energy bound up in the new form of carbon that makes the plant.
- *What happens when that energy is used?*
  When the carbon-based fuel is burned it releases energy. This releases the carbon back to the air in the form of CO_2.
- *Why are climate scientists concerned about our use of fossil fuels for energy?*
  Use of fossil fuels for energy contributes to increased amounts of CO_2 in the atmosphere which most scientists believe is causing global warming.
- *How does US consumption of fossil fuels compare to other countries?*
  The U.S. has 5% of the population and consumes 24% of the fossil fuels, producing 24% of the CO_2 emmisions.
- *Why are we looking to reduce how much we drive?*
  Driving is the average American's largest contribution to CO_2 emissions followed by home heating or cooling, and home electrical use.

TALLYING TRIP LOG RESULTS

Divide students into groups of four or five. As a class, discuss:

- *How did the trip tally homework go?*
- *What worked well?*
- *What did not?*

Tell the students that you will now see how much CO_2 the class avoided producing over the last week. Give each group a new Trip Log sheet. Have them sum their individual totals and record the group's totals on the new Trip Log. As a class, sum and record all group totals on a Trip Log overhead to obtain class totals.

Multiply the class's total miles (saved and used) by .9 to get pounds of CO_2 saved and used.

CLOSING

As a class discuss: (1) Did you learn anything new? If yes, please describe briefly. (2) Will you change your travel habits? (3) If yes, why and how? If no, why not?

EXTENSION ACTIVITY WORKSHEET - GAS MILEAGE AND CO_2 PRODUCTION

Students calculate their family car's gas mileage using actual fuel consumption or look it up on the web at www.fueleconomy.gov. Students may then use their miles per gallon rating to figure out their precise CO_2 production savings from their trip log.

MILES PER GALLON (mpg) is a standard term used to compare fuel efficiency. This number tells how many miles a car travels on one gallon of fuel.

1. Record odometer reading when filling up the car with fuel.
2. Record odometer reading when filling up again.
3. Record the amount of fuel put into the car the second time. This is the amount of fuel used to travel since the first fill up.
4. Subtract the first odometer reading from the second to get miles traveled.
6. Divide miles traveled by gallons of fuel used to get miles per gallon.

SAMPLE
2nd odometer reading 56,850
- 1st odometer reading 56,400
= miles traveled 450

450 miles traveled divided by 15 gallons of fuel used
= 30 miles per gallon.

OPTION: Students can also check their family car's mpg at www.fueleconomy.gov. They will need to know their car's engine size and transmission type.

CO_2 PRODUCTION
The average vehicle produces 20 pounds of CO_2 for every gallon of fuel used. To get lbs of CO_2 produced per mile, divide 20 lbs CO_2 per gallon by your vehicle's mpg figure.

SAMPLE
For a 30 mpg car: 20 lbs CO_2 per gallon divided by 30 mpg
= .666 lbs of CO_2 per mile

CO_2 PRODUCTION AVOIDED
To figure out lbs of CO_2 production avoided, multiply lbs of CO_2 produced per mile by miles saved.

SAMPLE
For a 30 mpg car that avoided driving 10,000 miles:
0.666 CO2/mi x 10,000 miles =
666 lbs of avoided CO_2 production

RESEARCH OPTION
Find a car that would meet your family's needs and increase fuel economy by 10%.

Suggested sources:

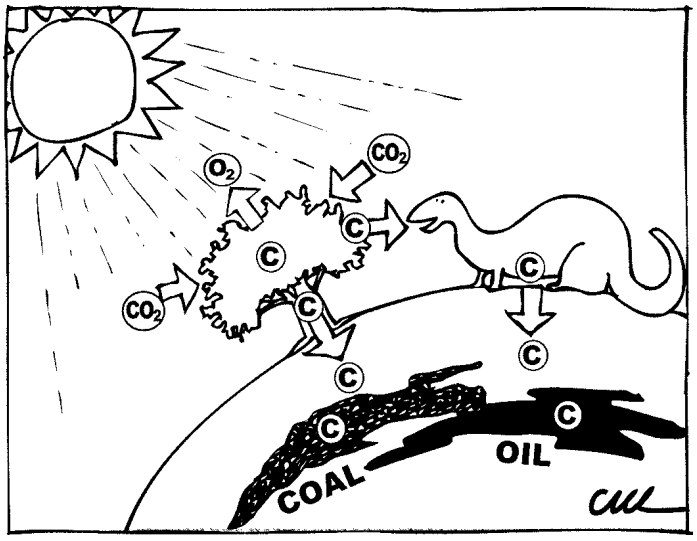
http://aceee.org/greencars

www.fueleconomy.gov

www.edf.org/cgi-bin/tailpipetally

Green Guide to Cars and Trucks. Decicco, John M., Jim Kliesch, and Martin Thomas. American Council for an Energy-Efficient Economy. 2001

Carbon Moves Into the Ground

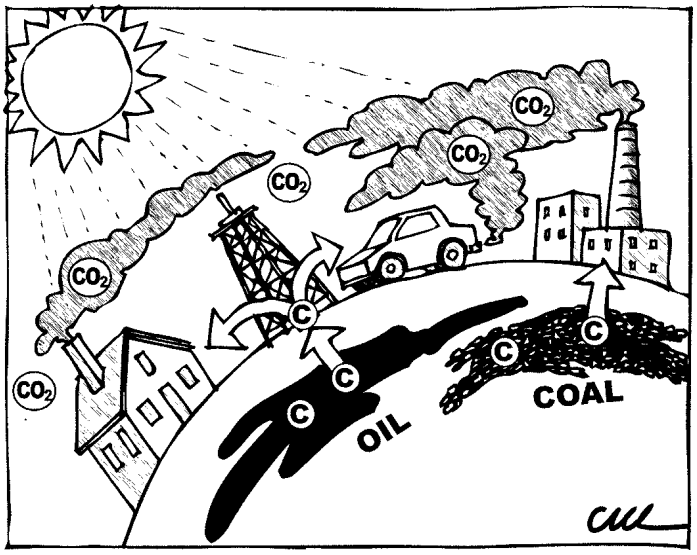


Through photosynthesis, plants use energy from the sun (sunlight) and carbon dioxide from the air to grow. This changes sunlight into chemical energy and moves carbon from the air into plants.

Through the food chain, carbon and the stored chemical energy moves into all other living things.

As living things die and decompose, the carbon and chemical energy moves into the ground. Over millions of years, this becomes *fossil fuels* such as coal and oil.

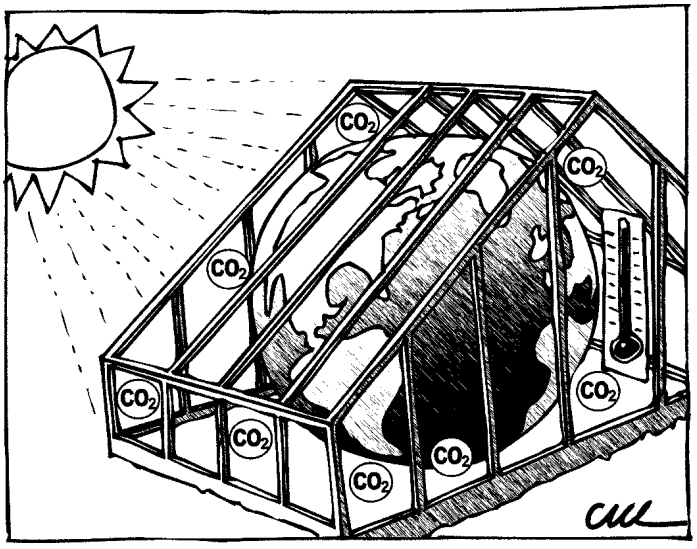
Carbon Moves Into the Atmosphere



Millions of years of accumulated carbon, in the form of oil and coal, is released back to the atmosphere when we burn these fuels to heat our homes, make electricity, run factories, and drive vehicles.

For the average American, driving produces sizably more CO_2 that any other consumer behavior. Other significant contributors include home heating or cooling and running appliances and lighting.

Carbon Dioxide Traps Heat Like a Greenhouse



CO_2 and other gases in the atmosphere trap the sun's energy like a greenhouse.

The right amount of CO_2 and other greenhouse gases protects us and keeps us warm, especially at night.

In the last 100 years we have been increasing greenhouse gas levels, in part, by burning fossil fuels. This appears to be increasing the temperature of the earth.

Table 1

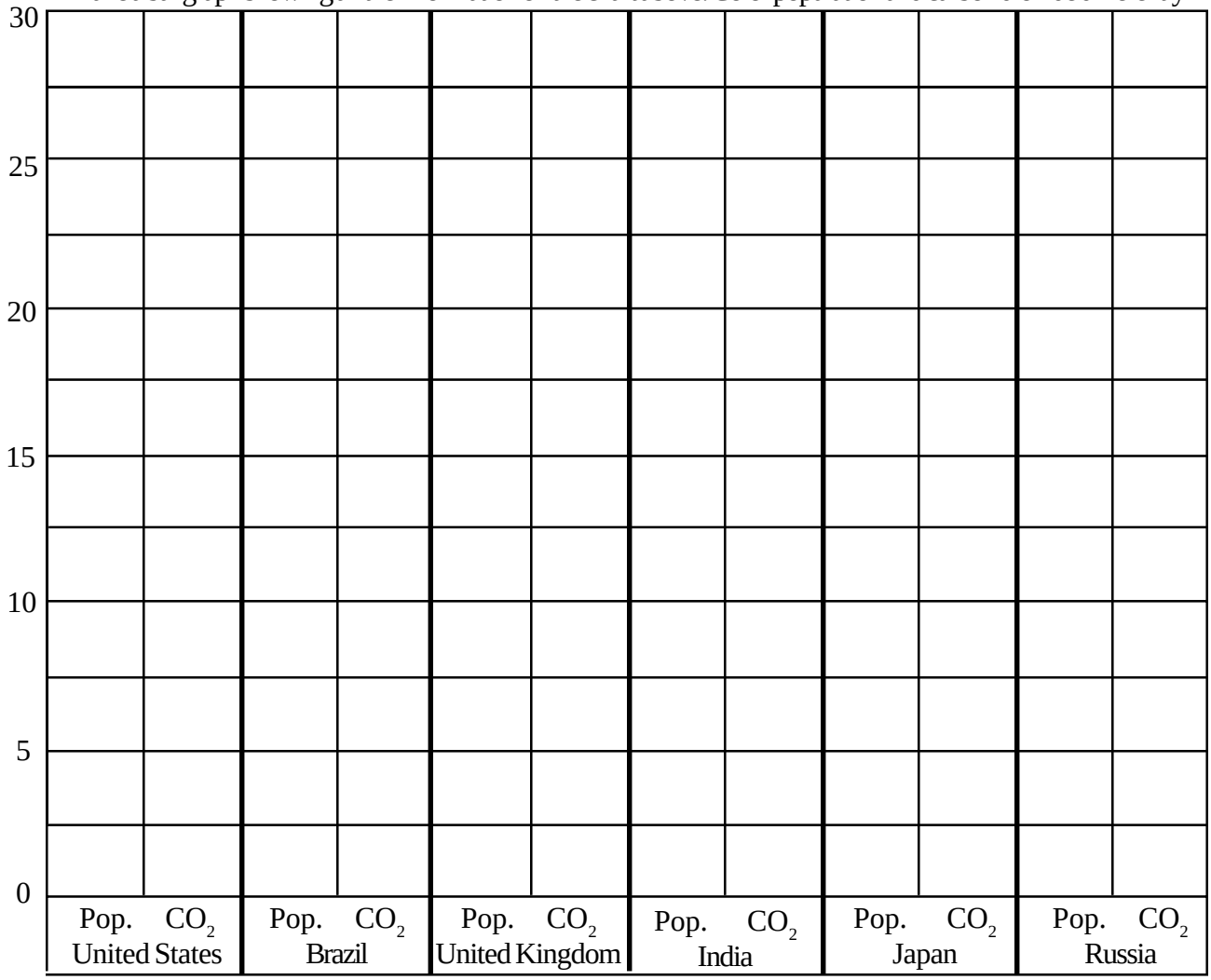
Name Class

1995 Population and Carbon Dioxide Production Chart

Country	% of World Population	% of Carbon Dioxide Production
United States	5	24
Brazil	3	1
United Kingdom	1	3
India	16	4
Japan	2	5
Russia	3	7

Source: United Nations Environmental Programme, International Energy Agency, 1998, http//grida.no/climate/vital/11.htm

Make a bar graph showing all the information on the chart above. Color population and carbon dioxide differently



Worksheet 2

1. Which country produces the most carbon dioxide? _____

2. Which of the countries has the most people? _____

3. Divide each country's percent of CO_2 production by its percent of world population. This will show the relative CO_2 production per person for the different countries.

United States _____

Brazil _____

United Kingdom _____

India _____

Japan _____

Russia _____

4. Why do some countries produce more carbon dioxide per person than others?

_____

_____

_____

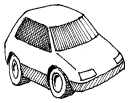
_____

_____

Developed by the Northeast Sustainable Energy Association- www.nesea.org

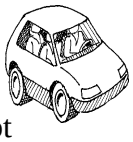
GUIDE TO "GIVE YOUR CAR A BREAK - TRIP LOG"

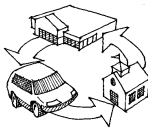
Help clean the air by avoiding miles driven in cars!



Car trip miles are the number of miles your car goes on a trip. Record this in the first column whenever you take a trip in a car.

Carpooling is when the car is driven for more than one person. If a car driver takes you and two friends to a movie 5 miles away and 5 back, you used 10 car miles for yourself and saved 10 car miles for each extra rider (10+10=20)! You would enter 10 miles in the *car trip* column and 20 in *the carpool* column. The driver and first student passenger are considered to be essential, and therefore, not extra people.





Combining Trips is like carpooling. If several purposes are accomplished with one car trip, record the total car trip miles and multiply by the number of extra purposes. If you go shopping on the way to visiting relatives, you had one extra purpose. If the total trip is 20 miles, enter 20 in the *car trip* column and 20 miles in the *combined trip* column.

Buses travel whether or not you use them. Any trip you take by bus is a car trip saved and saves pollution. Enter the distance of your bus trip in the *bus* column.

Biking and Walking don't pollute, provide freedom from cars, and increase strength and health. Engines run poorly until warmed up, so saving short trips reduces extra pollution per mile. For any biking or walking trip, round up to the nearest mile and enter in the *biking* or *walking* column.

Other If you save driving miles by using a different method write it down and include the miles you saved in the "other" column. Skateboarding and rollerblading are great fun ways to get around. Phoning ahead can avoiding wasting trips, save time, money, and pollution.

NAME: Joe Biker CLASS: Ms. Carpool

Give Your Car a Break - Trip Log- (Log miles saved)		All Car Trips	Saved Trips					
			Carpool	Combined	Bus/Train	Bike	Walk	Other
								
Day	**How you got where**	**Miles for every car trip**	**Trip miles x extra people**	**Trip miles x extra purposes**	**Trip miles**	**Trip miles rounded up**	**Trip miles rounded up**	**New way to save**
Monday	Rode bus to school and back				4			
	Rode car to friend's, store, and movies	25		x 2 = 50				
	Phoned to learn didn't need to go shopping							12
Tuesday	Rode car to school (one way)	2						
	Took bus home from school				2			
	Biked to ballfield and back					4		
Wednesday	Took bus to school and back				4			
	Walked to the store and back					1		
Thursday	Walked to school and back						4	
	Rode car to go bowling with 3 friends.	7	x 3 = 21					
	Total Car Miles	34						
	SAVED Car Miles!	21	50	10	5	4	12	

SAMPLE

Each row represents a trip, or a trip and back.

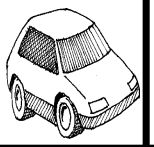
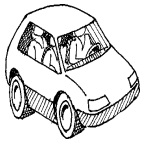
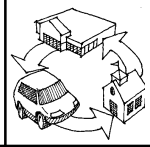
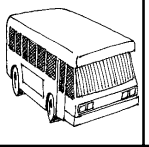
According to the EPA, driving a car is the single most polluting thing Americans do. In addition to pollution, each gallon of gas burned produces 20 pounds of carbon dioxide (CO_2), a green-house gas, widely believed to contribute to global warming. The average vehicle produces .9 lbs of CO_2 per mile.

In the spring of 2001, 1,250 Students from the Pioneer Valley in Massachusetts documented saving enough vehicle miles to go around the Earth 3.7 times, in one week, avoiding the production of 42 tons of CO_2 !

Please send results to tally@nesea.org or fax to 413-774-6053 *Each row represents a trip, or a trip and back.*

NAME: CLASS:

Give Your Car a Break
- Trip Log-
(Log miles saved)

Day	How you got where	All Car Trips	Saved Trips					
			Carpool	Combined	Bus/Train	Bike	Walk	Other
								
		Miles for every car trip	Trip miles x extra people	Trip miles x extra purposes	Trip miles	Trip miles rounded up	Trip miles rounded up	New way to save miles
Total Car Miles								
Total SAVED Car Miles!								

Developed by the Northeast Sustainable Energy Association

with Funds from the US Dept of Transportation and Mass Highway

Review Questions

Name _____

1) What is the earth's major source of energy?

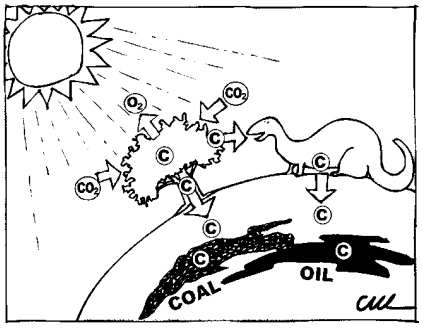
2) How is that energy stored?

3) What happens when that energy is used?

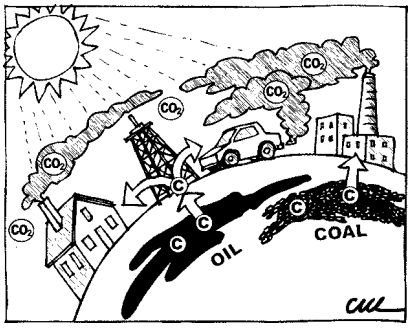
4) Why are climate scientists concerned about our use of fossil fuels for energy?

5) How does US consumption of fossil fuels compare to other countries?

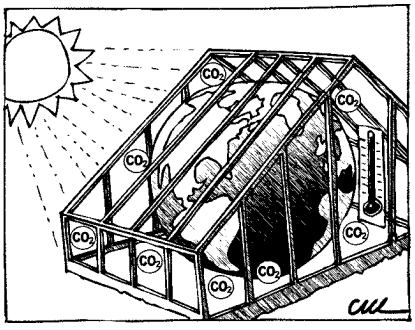
6) Why are we looking to reduce how much we drive?



Carbon In



Carbon Out



Greenhouse Effect