



6-12TH GRADE: The COST of TRANSPORTATION

GREEN GUIDE TRANSPORTATION UNITS

Transportation Location: three lessons, history/science (3-6)

Pollution and Evolution: one lesson, science (6-8)

3-D Bike Maps: one lesson, science (6-8)

Marketing Strategy and Transportation: two lessons, health/art (6-12)

The Cost of Transportation: one lesson, science (6-12)

What Do I Stand For?: one lesson (6-12)

Travel Journal: three lessons (6-12)

History of Transportation: two lessons (9-12)



MARIN COUNTY

SAFE ROUTES TO SCHOOLS
CURRICULUM

Find our curriculum online at : http://www.saferoutestoschools.org/green_curriculum.html

TEENS GO GREEN



www.saferoutestoschools.org



Safe Routes to Schools is a program of the Transportation Authority of Marin.

Part of the *Marin Safe Routes to Schools Curriculum*. Engaging lessons K thru 12 that include applicable state educational standards.

This curriculum was created by James Sievert, Shumit DasGupta and Gwen Froh and edited by Wendi Kallins and Connie Breeze.

UNIT DESCRIPTION

THE COST OF TRANSPORTATION

(Values Clarification)

Grade 6-7, 45-60 minutes, classroom setting.

INTRODUCTION

This lesson focuses on the variety of transportation methods available and the costs and consequences associated with each mode of travel. Both upfront and “hidden” costs are experienced first-hand through an activity using fake money.

The lesson concludes with a discussion aiming to inspire and empower students to take action by exploring what stands in the way for them to use more sustainable transportation choices in their community.

OBJECTIVES

Students will be able to:

- Identify modes of transportation, roughly how much energy they require, and the source of the energy that powers their motion.
- Link popular energy sources for transportation (gas, electricity, food) with their origin, renew-ability and utility.
 - Burning of fuels like gas create environmental and health problems that costs our society in hidden ways.
 - Unlike direct costs, the hidden costs are often paid by society as a whole, or left for future generation to pay.

**California Education Standards:
6th Grade Science.**

6a-b. Energy & resources origin, renewability, and consequences.

6. Sources of energy and materials differ in amounts, distribution, usefulness, and the time required for their formation. As a basis for understanding this concept:
 - a. Students know the utility of energy sources is determined by factors that are involved in converting these sources to useful forms and the consequences of the conversion process.

- b. Students know different natural energy and material resources, including air, soil, rocks, minerals, petroleum, fresh water, wildlife, and forests, and know how to classify them as renewable or nonrenewable.

MATERIALS

- Printed images including: 8.5” X 11” picture of “Sailing Stones” in Death Valley http://en.wikipedia.org/wiki/Sailing_stones
- Transportation efficiency and CO₂ graphs
- Cotton Ball
- Paper and pencil/pens for students
- Whiteboard and marker or large writing surface
- Fake money: \$10 bills (print using black ink, not green) http://en.wikipedia.org/wiki/File:US10dollarbill-Series_2004A.jpg
- “Hidden Cost” Cards

VOCABULARY

Transportation: a means of moving people or goods

Renewable Energy: energy that is natural and nearly limitless

Sustainable: able to be maintained, continued indefinitely

Direct Cost: price to be paid up-front by person using the goods or service

Hidden Cost: the toll not paid by the user, such as health or environmental damage

PROCEDURE

1. Introduce yourself as an instructor for the Teens Go Green program.

- Briefly highlight your relevant background and experience.
- Teens Go Green is the Middle/High School program for Safe Routes to Schools (SR2S). SR2S teaches classes in over 50 Marin schools K thru 12.
SR2S is a program of Transportation Authority of Marin.
- Thank the class/teacher for having you as a guest.
- Briefly overview the rest of the lesson.

2. What is transportation? Ask students to help define 'transportation' (the act of moving from one location to another). Write the definition in the center of the white board. You may also want to mention that the etymology of the word comes from Latin: *trans*, "across" & *portare* "to carry".

- Ask students to work in pairs. Give students 30 seconds to make the longest list of *transportation modes*. The winner will be the person with the most modes of transportation.
- Write the answers on the white board organized into unlabeled categories sorted by energy source (gasoline, food, electric, wind, etc.).
- Have the students tally their transportation modes to see who named the most modes.



3. Energy required for Transportation: "Sailing Stones" of Death Valley

The laws of physics dictate that movement requires energy. Therefore all means of transportation require energy, or fuel.

"Sailing Stones" are mysterious rocks that move across Death Valley deserts.

Ask students to consider the connection between *transportation and energy*.

Are the rocks moving themselves? What energy source moves the rock?

Rocks don't move unless something is pushing them.

Put a cotton ball on a central table that all students can see. Ask a volunteer to transport the ball from one side of the table to another without touching it (student will likely blow on it).

We know that transportation requires energy, such as wind to move the cotton ball or these rocks, which move in high winds when the clay soil is wet and slippery.

PROCEDURE CONT.

4. Categorizing transportation modes by energy requirement.

Students sort the list of modes on the white board between oil, electricity, and food.

How much energy is needed?

Energy required varies by transportation mode. While heavy and fast objects require more energy, the ability to carry many passengers splits the impact among a number of people.

Renewable or nonrenewable sources of energy?

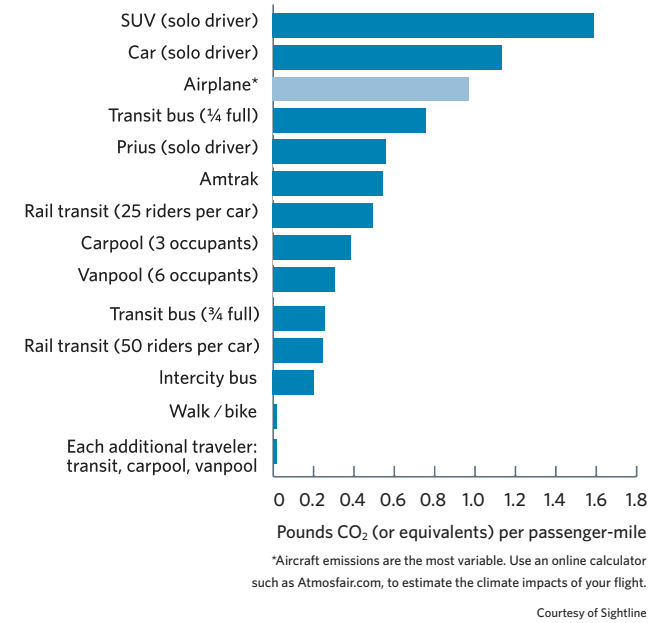
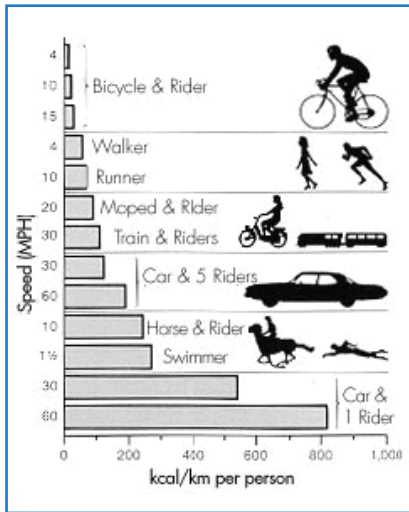
Renewable energy is energy that is available continuously.

What sources of energy are renewable?

Wind, solar, tides, geothermal (volcano heat), and food.

Nonrenewable energy is a limited supply that does not quickly replenish.

Gasoline, derived from oil, takes millions of year to create. Since the supply of gas is limited and will one day run out, gas is considered nonrenewable.



Consequences or "utility" of energy sources. Using energy has side-effects.

- i. What are negative impacts of burning gasoline? It is a top cause of both air pollution which creates health problems and greenhouse gases that contribute to global warming.
- ii. Have the class assess the side-effects of electric and food powered transportation. Electricity and food can have a minimal impact on people and the planet, especially when created with sustainability in mind.

ACTIVITY: COSTS & CONSEQUENCES OF OUR MAJOR MODES OF TRANSPORTATION



PROCEDURE CONT.

5. Activity: Costs and Consequences of our Major Modes of Transportation.

What are the costs of transportation?

What must be paid for?

- Ask students to provide a few of examples of the cost of transportation.
- Direct monetary costs like insurance, paying for the car, paying for bridge tolls, paying for fuel.
- Other costs are hidden, such as health and environmental damage. The cost is “hidden” because those responsible do not pay the cost of fixing the damage.
- Ask groups for examples of hidden costs. (See Appendix 3)

Hidden Cost Cards

<p>WALK</p> <p>A distracted car driver injures you. Everyone pays \$10 for medical bills.</p>	<p>BUS</p> <p>Air pollution from cars makes you sick. Everyone pays \$10 for medical bills.</p>	<p>CAR</p> <p>No exercise makes you sick. Everyone pays \$10 for medical bills.</p>
<p>CAR</p> <p>A distracted car driver injures you. Everyone pays \$10 for medical bills.</p>	<p>BIKE</p> <p>Air pollution from cars makes you sick. Everyone pays \$10 for medical bills.</p>	<p>BUS</p> <p>No exercise makes you sick. Everyone pays \$10 for medical bills.</p>

TRANSPORTATION COSTS ACTIVITY:

- Designate a volunteer as “the banker.” Give them the fake money to be divided evenly amongst students (\$60-100 per student).

- Divide students into four groups and assign each group a corner of the room and a mode of transportation (walk, bike, car, bus). Have each group display the sign with an image depicting their mode.
- Each group takes two minutes to come up with the direct costs of their mode of transportation.

Direct Costs of Transportation

Mode of Transport	Taxes for Roads	Insurance/Registration	Ticket/Bridge Toll	Gas	Parking
Car	\$10	\$10	\$10	\$10	\$10
Bus	\$10		\$10		
Walk	\$10				
Bike	\$10				

Draw a *Direct Costs Chart* on the board, and have the students fill in the amounts. Have each student pay the banker all the direct costs that correspond to their mode of transportation.

- Go over all the costs from every group. How much money is left in each group?
- There are important hidden costs that have not been addressed. Distribute “hidden cost” cards one at a time to volunteers from the designated modes, noted at top of card. Have the volunteer read the card and help the banker collect money.
- Ask the students for observations about direct and hidden costs for transportation. Is it fair that everyone must pay the hidden costs? Hidden costs are often paid by society, or left unpaid for future generations.

ACTIVITY: COSTS & CONSEQUENCES OF OUR MAJOR MODES OF TRANSPORTATION



PROCEDURE CONT.

6. What can we do about the cost of transportation?

The rest of the class will be devoted to group-thinking about concrete ways that we can help reduce our direct and hidden costs of transportation.

Introduce the word: Sustainability. Ask students what they think it means. There are many definitions to this word and concept. Some examples include:

"Meet present needs without compromising the ability of future generations to meet their needs"

- UN World Commission on Environment and Development 1987

"That which can be maintained over time."

- Richard Heinberg, Post Carbon Institute, 2012

- What are the requirements for transportation to be sustainable? Are there any transportation choices can we make now that are sustainable?
- Ask what is standing in the way for more students to engage in sustainable transportation? Devote some time to listen to the challenges and to brainstorm solutions.

7. CONCLUSION

- There are many forms of transportation and different sources of fuel or energy.
- Some energy like food or electricity can be renewable while other sources like oil or gas are limited.
- Burning of fuels like gas create environmental and health problems that costs our society in hidden ways.
- Unlike direct costs, the hidden costs are often paid by society as a whole, or left for future generation to pay.
- Acknowledge key points from the final discussion of sustainable transportation.

APPENDIX 1:

Science Standard: "Utility" of energy source.

ADDITIONAL RESOURCES

THE HIDDEN COST OF TRANSPORTATION: HEALTH¹

¹ Source: "The hidden health costs of transportation."

A report prepared by Urban Design 4 Health, Inc. and the American Public Health Association, February 2010.

TABLE 2 THE COST OF TRANSPORTATION-RELATED HEALTH OUTCOMES

The consequences of inactivity, obesity, exposure to air pollution, and traffic crashes in the U.S. are staggering when viewed in terms of cost. Fortunately, with certain policy changes, these costs are largely preventable.

The National Health Costs of...	\$\$ (Billions)	Estimate Includes	Source
Obesity and overweight	\$142	<ul style="list-style-type: none"> Healthcare costs Lost wages due to illness & disability Future earnings lost by premature death 	<p>National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases. Statistics Related to Overweight and Obesity: The Economic Costs.</p> <p>Available at: http://win.niddk.nih.gov/statistics/index.htm</p>
Air pollution from traffic	\$50-80	<ul style="list-style-type: none"> Health care costs Premature death 	<p>Federal Highway Administration. 2000. Addendum to the 1997 Federal Highway Cost Allocation Study Final Report, May 2000.</p> <p>Available at: www.fhwa.dot.gov/policy/hcas/addendum.htm</p>
Traffic crashes	\$180	<ul style="list-style-type: none"> Healthcare costs Lost wages Property damage Travel delay Legal/administrative costs Pain & suffering Lost quality of life 	<p>AAA. Crashes vs. Congestion? What's the Cost to Society? Cambridge, MD: Cambridge Systematics, Inc.; 2008.</p> <p>Available at: www.aaanewsroom.net/assets/files/20083591910.crashesVscongestionfullreport2.28.08.pdf</p>

All cost estimates adjusted to 2008 dollars.

APPENDIX 2:



THE HIDDEN COST OF TRANSPORTATION: PETROELUM SUPPLY CHAIN²

1. Exploration, development, and production

The environmental impacts that result from taking an oil development project from its initial exploratory phase to commercial extraction can exceed those of a major oil spill.

87 Significant impacts include:

- Deforestation, resulting from the clearing of land (especially in remote locations) for the construction of roads and building of drilling pads for the placement of drilling platforms
- Soil compaction
- Soil erosion due to increased surface runoff
- Disturbance of benthic ecosystems
- Chemical contamination of land, water, and marine sediments.
- Drilling during the exploratory and commercial phases requires the use of large amounts of water, which becomes contaminated with petroleum waste, drilling muds/fluids, and by-products of drilling such as well water, drill cuttings, and other material from the boreholes. This water may then be released (either by accident or design) into the environment.

2 Bottom of the Barrel: The Hidden Costs of Petroleum Use in California, Sierra Club, 2006

- Short and long-term harm to wildlife (particularly migratory birds, marine mammals, and other coastal and bottom dwelling organisms).

2. Shipping and Storing Oil and Refined Oil Products

The National Academy of Sciences estimates that on average more than 64,000 barrels (2,700,000 gallons or 9,100 metric tons) of crude oil and refined products are spilled into North American waters annually, while annual spills worldwide total in excess of 1 million barrels (44,000,000 gallons or 150,000 metric tons). The National Academy noted that,

“Although the number of spill incidents and the amounts of oil spilled have shown a meaningful decreasing trend in recent years, significant and large spills worldwide continue to characterize the industry. In addition, history has shown that one very large accident can change the statistics in a major way. It should be noted that most of the large catastrophic tanker accidents are single rare events, and the amount of oil spilled during these events tends to overshadow all other spills.”

There are 200,000 miles of oil pipeline in the United States, and these carry about two thirds of the nation’s crude oil and refined oil products. California has roughly 2,800 miles of pipelines that transport refined petroleum products to market.



Monitoring and preventing pipeline corrosion is a constant battle for the pipeline owners. Pipeline accidents can pollute the water, ground, and air, lead to property damage, injury or death and can be a major cause of fires.... The National Energy Policy Development Group — convened by Vice President Dick Cheney for the Whitehouse — noted in its 2001 report that the number of inland oil spills were increasing and referred to federal government data that indicated the average number of inland oil spill notifications grew from 9,000 notifications a year in the early 1990s to between 10,000 - 12,000 a year in the late 1990s. Many of these yearly inland oil spills were over 100,000 gallons each.

3. The Refinery

Oil refineries are sources of toxic air and water emissions, hazardous wastes, thermal and noise pollution.... There is evidence that the incidence of childhood leukemia and other cancers are higher for children living near oil refineries and oil infrastructure facilities. Minority and low- income communities tend to be located near refineries, and are impacted disproportionately by the pollutant releases from refineries.¹⁵³

4. The Use of Petroleum Derived Fuels in Transportation

Combustion of petroleum-based fuels has resulted in the state's transportation sector accounting for nearly 40% of California's GHG emissions; the

largest source in the state.¹⁶¹ Climate change is expected to have major impacts on California.

The National Academy of Sciences estimates that releases associated with the consumption of petroleum account for nearly 85 percent of the petroleum that finds its way into North American waters. These releases originate either from individual boat owners, non- tank vessels, or runoff from paved urban areas. Nearly 600,000 barrels (25,000,000 gallons or 84,000 metric tons) of petroleum compounds are released into North American waters on average each year.

A study conducted by the Institute for Economic and Environmental Studies found that poor air quality — due to the levels of ozone and particulate matter — in the San Joaquin Valley costs the valley's residents \$3 billion per year. The cost of air pollution represents:

- 460 premature deaths among those age 30 and older
- 23,300 asthma attacks
- 188,000 days of school absences
- 3,230 cases of acute bronchitis in children
- 3,000 lost work days
- 325 new cases of chronic bronchitis
- 188,400 days of reduced activity in adults
- 260 hospital admissions
- More than 17,000 days of respiratory symptoms in children

APPENDIX 3: HIDDEN COST CARDS

<p>WALK</p> <p>A distracted car driver injures you.</p> <p>Everyone pays \$10 for medical bills.</p>	<p>BUS</p> <p>Air pollution from cars makes you sick.</p> <p>Everyone pays \$10 for medical bills.</p>	<p>CAR</p> <p>No exercise makes you sick.</p> <p>Everyone pays \$10 for medical bills.</p>
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