AVAILABILITY AND DISTRIBUTION

TIME

10 days

OBJECTIVES

- *To understand the extent and costs of our nation's dependence on foreign sources of oil.*
- *To understand how our communities are affected by fuel shortages and the fluctuating availability and pricing of fuel.*
- *To identify fuel alternatives that now exist in the community.*
- *To investigate alternatives, specifically their long-term availability and social and environmental costs, as well as the safety issues involved with their extraction, processing, storage, and delivery.*

MATERIALS NEEDED

For background reading and community research

Student handouts

- *Availability and Distribution: The Challenge*
- *Transportation Fuels, Engines, and Motors*
- *Who's Interested in AFVs? Who Cares About Availability and Distribution?*
- *Fuels That Power Your Community: Guide to Community Research*
- *Community map that shows primary roads*

Other useful resources

- *Sample utility bill describing sources of power in the power grid*
- *Yellow pages*
- *Access to the Internet*
- *Public relations departments of your local utility company, Public Transit Authority, Department of Transportation, or other companies and organizations that operate fleets of vehicles*

For fuel research and student presentations

Student handouts

- *Availability and Distribution: Guide to Fuel Team Research*
- *Fuel Review Worksheet: Availability, Distribution, and Pricing*
- *Alternative fuels fact sheets (to be distributed to appropriate teams)*
- *Resource Guide*
- *Evaluating Team Reports and Presentations*

Other useful resources for research

- *Access to the library and Internet publications listed as references for this unit*

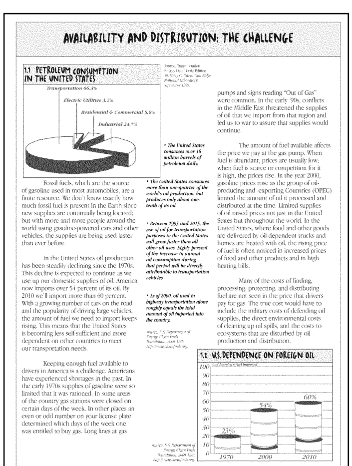
Useful resources for student presentations

- *Flip charts, poster board, transparencies, and use of an overhead projector*
- *Access to word processing or presentation software*

STEP 1 - Background Reading and Discussion

AVAILABILITY AND DISTRIBUTION: PRESENTING THE CHALLENGE

TIME: 45 minutes; to save time in class, readings may be assigned for homework



AVAILABILITY AND DISTRIBUTION: THE CHALLENGE

1.1 PETROLEUM CONSUMPTION IN THE UNITED STATES

Source: Transportation Energy Data Book: Edition 19, Stacy C. Davis, Oak Ridge National Laboratory, September 1999.

Fossil fuels, which are the source of gasoline used in most automobiles, are a finite resource. We don't know exactly how much fossil fuel is present in the Earth since new supplies are continually being located; but with more and more people around the world using gasoline-powered cars and other vehicles, the supplies are being used faster than ever before.

In the United States oil production has been steadily declining since the 1970s. This decline is expected to continue as we use up our domestic supplies of oil. America now imports over 54 percent of its oil. By 2010 we'll import more than 60 percent. With a growing number of cars on the road and the popularity of driving large vehicles, the amount of fuel we need to import keeps rising. This means that the United States is becoming less self-sufficient and more dependent on other countries to meet our transportation needs.

Keeping enough fuel available to drivers in America is a challenge. Americans have experienced shortages in the past. In the early 1970s supplies of gasoline were so limited that it was rationed. In some areas of the country gas stations were closed on certain days of the week. In other places an even or odd number on your license plate determined which days of the week one was entitled to buy gas. Long lines at gas pumps and signs reading "Out of Gas" were common. In the early '90s, conflicts in the Middle East threatened the supplies of oil that we import from that region and led us to war to assure that supplies would continue.

The amount of fuel available affects the price we pay at the gas pump. When fuel is abundant, prices are usually low; when fuel is scarce or competition for it is high, the prices rise. In the year 2000, gasoline prices rose as the group of oil-producing and -exporting Countries (OPEC) limited the amount of oil it processed and distributed at the time. Limited supplies of oil raised prices not just in the United States but throughout the world. In the United States, where food and other goods are delivered by oil-dependent trucks and homes are heated with oil, the rising price of fuel is often noticed in increased prices of food and other products and in high heating bills.

Many of the costs of finding, processing, protecting, and distributing fuel are not seen in the price that drivers pay for gas. The true cost would have to include the military costs of defending oil supplies, the direct environmental costs of cleaning up oil spills, and the costs to ecosystems that are disturbed by oil production and distribution.

• The United States consumes over 18 million barrels of petroleum daily.

• The United States consumes more than one-quarter of the world's oil production, but produces only about one-tenth of its oil.

• Between 1995 and 2015, the use of oil for transportation purposes in the United States will grow faster than all other oil uses. Eighty percent of the increase in annual oil consumption during that period will be directly attributable to transportation vehicles.

• As of 2000, oil used in highway transportation alone roughly equals the total amount of oil imported into the country.

Source: U.S. Department of Energy, Clean Fuels Foundation, 2000. URL: http://www.cleanfuels.org

1.2 U.S. DEPENDENCE ON FOREIGN OIL

Source: U.S. Department of Energy, Clean Fuels Foundation, 2000. URL: http://www.cleanfuels.org

AVAILABILITY AND DISTRIBUTION / HANDOUT 1A 22

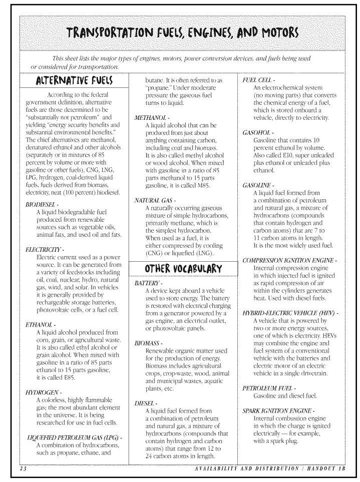
1) Copy and distribute student handouts for this section. Students will be receiving two more packets of handouts in the next sections, plus some additional resources used throughout the course of this unit. Advise students to keep the handouts in a project notebook.

2) Refer to the student handout "AVAILABILITY AND DISTRIBUTION: THE CHALLENGE," to stimulate discussion about the need to secure sources of fuel. Introduce the discussion by explaining that our ability to keep cars on the road ultimately depends on the source of the fuel they use and its long-term availability.

3) Have students read the handout and analyze charts 1.1 and 1.2: "Petroleum Consumption in the United States" and "U.S. Dependence on Foreign Oil."

Key points for students to understand are the large fuel requirements of our transportation system, our growing dependence on foreign oil, the high costs of defending supplies originating in foreign countries, and the environmental cost of

extracting and transporting fuel. Safety issues involved in the extraction, production, and delivery of fuel are additional considerations in changing to alternative fuels.


TRANSPORTATION FUELS, ENGINES, AND MOTORS

ALTERNATIVE FUELS

OTHER VOCABULARY


WHO'S INTERESTED IN AFVS? WHO CARES ABOUT AVAILABILITY AND DISTRIBUTION?

4) Refer to the handout "TRANSPORTATION FUELS, ENGINES, AND MOTORS," to be used as a reference for the activities in this unit. It lists the vocabulary that students may encounter while doing research, including brief descriptions of the alternative fuels they'll be studying in depth.

Briefly explain that according to the federal government definition, alternative fuels are those that are "substantially not petroleum" and yield "energy security benefits and substantial environmental benefits." The chief alternatives are methanol, denatured ethanol and other alcohols (separately or in mixtures of 85 percent by volume or more with gasoline or other fuels), CNG, LNG, LPG, hydrogen, coal-derived liquid fuels, fuels derived from biomass, electricity, neat (100 percent) biodiesel.

5) Ask students to identify various types of people who may be concerned with fuel availability and distribution, and with the hidden costs that are associated with our reliance on oil, and what their chief concerns might be.

Refer to the student handout "WHO'S INTERESTED IN AFVS? WHO CARES ABOUT AVAILABILITY AND DISTRIBUTION?" Have students read the various concerns and ask which of the people most reflect their own concerns. Which people are likely to be in their community? Who else in their community may have an interest in AFVs, and what would their concerns be? What people may be in the audience during their presentations?

EXTENSION: Ask students to make up a sheet similar to the "WHO'S INTERESTED IN AFVS?" handout for local residents.

STEP 2 - Class Mind Mapping Exercise

THE RIPPLING EFFECT ON THE COMMUNITY OF RISING FUEL PRICES

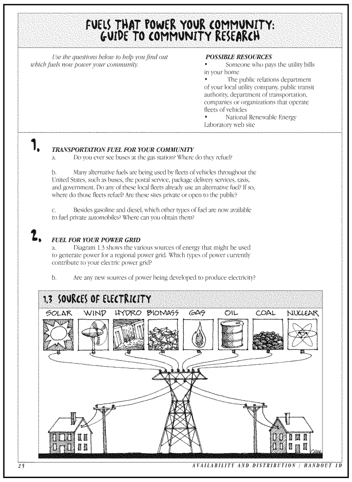
TIME: 10 minutes

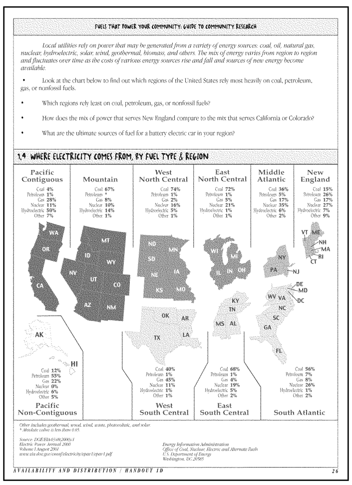
1) Bring the fuel issues home by developing a "mind map" on the chalkboard that demonstrates the rippling affect of rising prices of fuel. Start by presenting this situation:

Imagine the prices of gasoline rising to $4.00 a gallon (two to three times the cost in 2000) because of a fuel shortage. What effect would it have on you or your family, and on businesses?

If students need help, ask them if high prices would limit the amount of gasoline or diesel their family buys, or the amount of money spent on other things. Would they have to change their vacation plans or the number of car trips they make out of town? What businesses depend on transportation fuel? If your community depends on tourism, would rising prices of transportation fuel affect the number of travelers to your region?

2) Ask the students how people already conserve fuel. How often do they see people biking or waiting for a bus? Do they know anyone who carpools, cycles, or uses mass transit? If fuel prices went up, would more people do this? Why or why not?





STEP 3 - Class Community Research

DISCOVERING THE FUELS THAT POWER YOUR COMMUNITY

TIME: 30 minutes, plus 30 additional minutes of discussion over several days as the students report on their research; requires out-of-class time for some students.

1) Refer to the student handout "FUELS THAT POWER YOUR COMMUNITY: GUIDE TO COMMUNITY RESEARCH." In this class activity, students learn more about the effect of fuel shortages, the variety of fuels that power their community, and the alternatives being developed close to home. Briefly discuss the questions and diagrams.

2) If students are not able to answer all the questions, they may need to contact various people in the community. Help students generate a list of possible sources, and work with them to develop clear questions to obtain the information they need. Ideas for possible sources include:

TRANSPORTATION FUEL FOR YOUR COMMUNITY

#1a. Contact the maintenance department of the bus depot or the mass transit service.

#1b. Have students generate a list of fleets found in your town (package delivery services, postal service, police, government vehicles, private corporations, etc.) and call their maintenance or service departments.

#1c. Refer students to the list of alternative fuels included in the handout "TRANSPORTATION FUELS, ENGINES, AND MOTORS." Use the list as a basis for researching the availability of each. Call the state department of transportation or view the web site of the National Renewable Energy Laboratory (NREL). Maps showing locations of alternative fueling stations across the country are posted on the NREL web site at www.afdc.nrel.gov/refueling.html.

FUEL FOR YOUR POWER GRID

#2a. A list of power sources is sometimes found on utility bills. If not, call the community or public relations department of your utility company.

#2b. Contact the community or public relations department of your utility company.

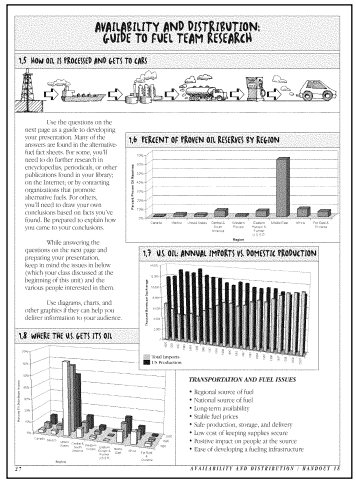
Assign one or more students to make calls to various fleet operators (#1b), the department of transportation (#1c), the utility company (#2a and b), and so on. Help them formulate the questions they'll ask. Revisit this discussion over several days until all the questions have been answered. The answers will be useful in later activities.

EXTENSIONS

- Regarding question #1c, your community may or may not have fueling sites for alternative fuels, which may or may not be open to the public. If they do exist, have the students mark them on a map of the community and display it in the classroom. Suggestion: Use symbols to represent the various kinds of alternative fuels found in your community.
- Have students talk to their parents or grandparents about the fuel crisis of the '70s to find out how people adapted to the shortage of fuels.

STEP 4 - Introduction to Fuel Team Research

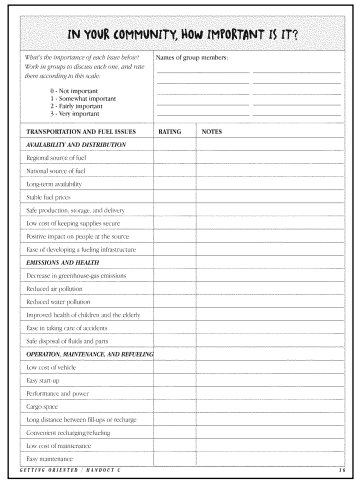
LEARNING ABOUT THE AVAILABILITY AND DISTRIBUTION OF ALTERNATIVE FUELS


AVAILABILITY AND DISTRIBUTION: GUIDE TO FUEL TEAM RESEARCH

TIME: One day

1) Refer to the handout "AVAILABILITY AND DISTRIBUTION: GUIDE TO FUEL TEAM RESEARCH." Introduce this research activity by discussing the flowchart and graphs, which show where we in the United States get our petroleum, where proven oil reserves exist, and how petroleum moves from well to wheels. Key discussion points include the complex infrastructure that has been developed to deliver fuel; the technology that has been developed to make distribution relatively safe and convenient; and the regional, national, and long-term availability of petroleum.

Explain that in this research activity, fuel teams will investigate how alternative fuels are developed, how they might be distributed to your community, which safety issues are involved with processing and distribution, and whether or not the fuels will be available over the long term. This research addresses the first section of the handout "IN YOUR COMMUNITY, HOW IMPORTANT IS IT?"


IN YOUR COMMUNITY, HOW IMPORTANT IS IT?

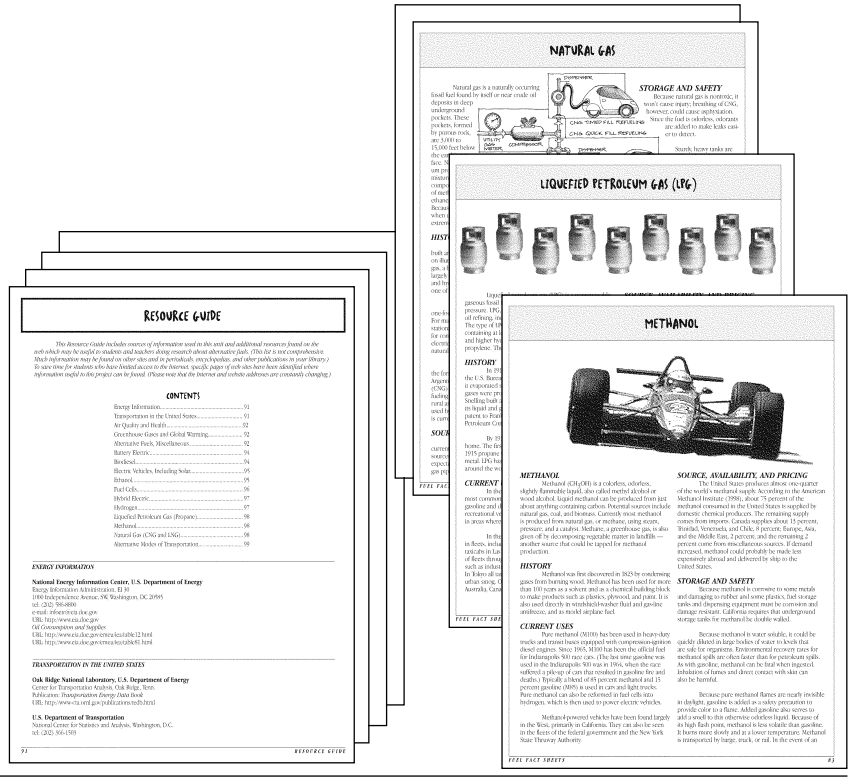
2) For this and the two other research sections in this unit, up to nine fuel teams will prepare mini-presentations (with or without a written report) on various alternative fuels. Each presentation will last 5 to 10 minutes, with additional time provided for their classmates to ask questions.

Divide the class into research teams to investigate and become experts on one of the alternative fuels listed below:

- biodiesel
- ethanol/E85
- liquefied petroleum gas (propane)
- methanol/M85
- natural gas: compressed (CNG) and liquefied (LNG)
- battery
- fuel cell (hydrogen)
- photovoltaic cells
- hybrid electric

Note: If you plan to do other research sections of *Cars of Tomorrow*, these teams should continue to work together.

3) Distribute to the appropriate teams copies of the alternative fuel fact sheets. Distribute to all researchers copies of the Resource Guide, which directs them to sites on the Internet with additional information they may need. Take time to review the headings in the Resource Guide so the students know which sites may have information about their particular fuels.


NATURAL GAS

LIQUEFIED PETROLEUM GAS (LPG)

METHANOL

RESOURCE GUIDE

STEP 5 - Team Research and Preparation for Presentations

LEARNING TO SPEAK ABOUT THE AVAILABILITY AND DISTRIBUTION OF ALTERNATIVE FUELS

TIME: Three days

1) Once the teams have been selected, refer to the handout "AVAILABILITY AND DISTRIBUTION: GUIDE TO FUEL TEAM RESEARCH." Discuss where the students might find the answers to the questions. Much information is already available in the fact sheets. Some of the answers are found in encyclopedias. Additional information can be found at the web sites listed for the alternative fuels in the Resource Guide. Some organizations listed there provide 800 numbers or hotlines to call for additional help. Some questions require that students pull together information and form their own opinions. For question 4b, students may find a mechanic or recycling center helpful in thinking this through.

2) Over the next three days, provide students with the opportunity to meet in their teams, to divide up the research tasks, and to decide how they will present their findings and who will do it. Encourage them to develop diagrams and other graphics to help present their findings. Remind them that these presentation aids may be further developed for a public presentation.

3) Coach students as they do their research. It may be helpful for you to investigate some of the recommended web sites to have a better understanding of the information found there.

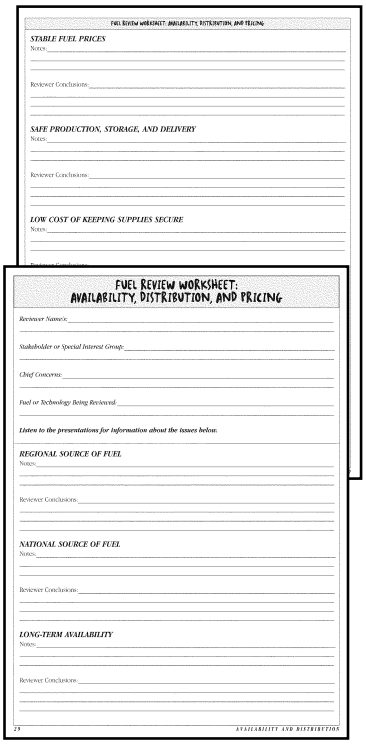
4) Distribute copies of the handout "EVALUATING TEAM REPORTS AND PRESENTATIONS" (page 64), so that students will know in advance what is expected in their presentations.

STEP 6 - Team Presentations and Class Discussions

AVAILABILITY AND DISTRIBUTION

TIME: Four days (10 to 15 minutes for each team's presentation and questions, plus 20 to 30 minutes for follow-up panel and class discussion)

1) Make a list of stakeholders or special interest groups for the students to represent while listening to and evaluating the fuels being presented. Remind students that a wide variety of people are interested in these issues: diplomats, environmental advocates, the petroleum industry, and so on, as you discussed earlier in "WHO'S INTERESTED IN AFVS? WHO CARES ABOUT AVAILABILITY AND DISTRIBUTION?"


FUEL REVIEW WORKSHEET: AVAILABILITY, DISTRIBUTION, AND PRICING

STABLE FUEL PRICES
Notes:

Reviewer Conclusions:

SAFE PRODUCTION, STORAGE, AND DELIVERY
Notes:

Reviewer Conclusions:

LOW COST OF KEEPING SUPPLIES SECURE
Notes:

FUEL REVIEW WORKSHEET: AVAILABILITY, DISTRIBUTION, AND PRICING

Reviewer Name(s):

Stakeholder or Special Interest Group:

Chief Concerns:

Fuel or Technology Being Reviewed:

Listen to the presentations for information about the issues below.

REGIONAL SOURCE OF FUEL
Notes:

Reviewer Conclusions:

NATIONAL SOURCE OF FUEL
Notes:

Reviewer Conclusions:

LONG-TERM AVAILABILITY
Notes:

Reviewer Conclusions:

23 AVAILABILITY AND DISTRIBUTION

2) Decide if the students will evaluate the presentations as individuals or as part of a review panel. Then assign (or have the members of the class select) the stakeholders or special interest groups they will represent. If they're working in review panels, allow the panel members to sit together.

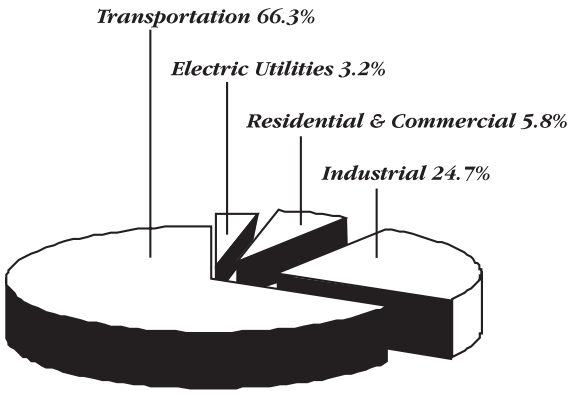
3) Refer students to the handout, "FUEL REVIEW WORKSHEET: AVAILABILITY, DISTRIBUTION, AND PRICING." They will use this worksheet as a guide for taking notes during a fuel presentation and writing down their (or their panel's) conclusions. (They will need one copy of this worksheet for each fuel presentation given.) Before the presentations, allow students time to make note of their interest group's chief concerns. After each presentation, allow them time to discuss and make note of their conclusions.

4) Remind presenters to keep in mind the concerns of the stakeholders in the audience. Presentations should last 5 to 10 minutes, with additional time for the audience to ask questions. Encourage students in their audience to ask follow-up questions from the points of view of the stakeholders they represent.

5) At the end of each day and again after all presentations have been given, allow time for the panels to compare the fuels and discuss the advantages and disadvantages of each with respect to safety, availability, and social and environmental costs.

AVAILABILITY AND DISTRIBUTION: THE CHALLENGE

1.1 PETROLEUM CONSUMPTION IN THE UNITED STATES



Source: Transportation Energy Data Book: Edition 19. *Stacy C. Davis. Oak Ridge National Laboratory. September 1999.*

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Keeping enough fuel available to drivers in America is a challenge. Americans have experienced shortages in the past. In the early 1970s, supplies of gasoline were so limited that gas was rationed. In some areas of the country, gas stations were closed on certain days of the week. In other places, an even or odd number on one's license plate determined which days of the week one was entitled to buy gas. Long lines at gas pumps and signs reading "Out of Gas" were common. In the early '90s, conflicts in the Middle East threatened the supplies of oil that we import from that region and led us to war to assure that supplies would continue.

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• The United States consumes more than one-quarter of the world's oil production, but produces only about one-tenth of its oil.

• Between 1995 and 2015, the use of oil for transportation purposes in the United States will grow faster than all other oil uses. Eighty percent of the increase in annual oil consumption during that period will be directly attributable to transportation vehicles.

• As of 2000, oil used in highway transportation alone roughly equals the total amount of oil imported into the country.

Source: U.S. Department of Energy, Clean Fuels Foundation, 2000. URL: http://www.cleanfuels.org.

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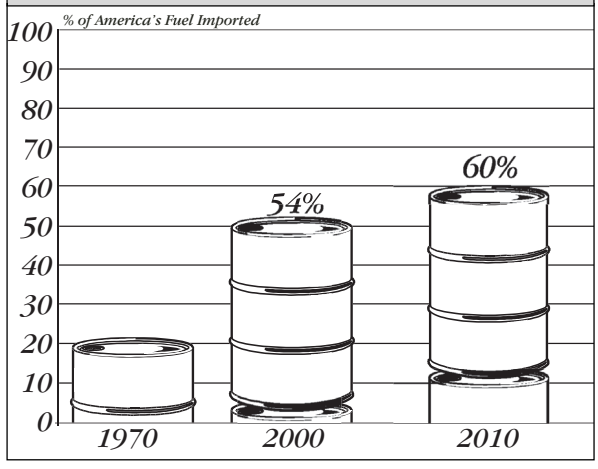
1.2 U.S. DEPENDENCE ON FOREIGN OIL



Source: U.S. Department of Energy, Clean Fuels Foundation, 2000. URL: http://www.cleanfuels.org.

TRANSPORTATION FUELS, ENGINES, AND MOTORS

This sheet lists the major types of engines, motors, power conversion devices, and fuels being used or considered for transportation.

ALTERNATIVE FUELS

According to the federal government definition, alternative fuels are those determined to be "substantially not petroleum" and yielding "energy security benefits and substantial environmental benefits." The chief alternatives are methanol, denatured ethanol and other alcohols (separately or in mixtures of 85 percent by volume or more with gasoline or other fuels), CNG, LNG, LPG, hydrogen, coal-derived liquid fuels, fuels derived from biomass, electricity, neat (100 percent) biodiesel.

BIODIESEL -
A liquid biodegradable fuel produced from renewable sources such as vegetable oils, animal fats, and used oil and fats.

ELECTRICITY -
Electric current used as a power source. It can be generated from a variety of feedstocks including oil, coal, nuclear, hydro, natural gas, wind, and solar. In vehicles it is generally provided by rechargeable storage batteries, photovoltaic cells, or a fuel cell.

ETHANOL -
A liquid alcohol produced from corn, grain, or agricultural waste. It is also called ethyl alcohol or grain alcohol. When mixed with gasoline in a ratio of 85 parts ethanol to 15 parts gasoline, it is called E85.

HYDROGEN -
A colorless, highly flammable gas; the most abundant element in the universe. It is being researched for use in fuel cells.

LIQUEFIED PETROLEUM GAS (LPG) -
A combination of hydrocarbons, such as propane, ethane, and butane. It is often referred to as "propane." Under moderate pressure the gaseous fuel turns to liquid.

METHANOL -
A liquid alcohol that can be produced from just about anything containing carbon, including coal and biomass. It is also called methyl alcohol or wood alcohol. When mixed with gasoline in a ratio of 85 parts methanol to 15 parts gasoline, it is called M85.

NATURAL GAS -
A naturally occurring gaseous mixture of simple hydrocarbons, primarily methane, which is the simplest hydrocarbon. When used as a fuel, it is either compressed by cooling (CNG) or liquefied (LNG).

OTHER VOCABULARY

BATTERY -
A device kept aboard a vehicle used to store energy. The battery is restored with electrical charging from a generator powered by a gas engine, an electrical outlet, or photovoltaic panels.

BIOMASS -
Renewable organic matter used for the production of energy. Biomass includes agricultural crops, crop waste, wood, animal and municipal wastes, aquatic plants, etc.

DIESEL -
A liquid fuel formed from a combination of petroleum and natural gas, a mixture of hydrocarbons (compounds that contain hydrogen and carbon atoms) that range from 12 to 24 carbon atoms in length.

FUEL CELL -
An electrochemical system (no moving parts) that converts the chemical energy of a fuel, which is stored onboard a vehicle, directly to electricity.

GASOHOL -
Gasoline that contains 10 percent ethanol by volume. Also called E10, super unleaded plus ethanol or unleaded plus ethanol.

GASOLINE -
A liquid fuel formed from a combination of petroleum and natural gas, a mixture of hydrocarbons (compounds that contain hydrogen and carbon atoms) that are 7 to 11 carbon atoms in length. It is the most widely used fuel.

COMPRESSION IGNITION ENGINE -
Internal compression engine in which injected fuel is ignited as rapid compression of air within the cylinders generates heat. Used with diesel fuels.

HYBRID-ELECTRIC VEHICLE (HEV) -
A vehicle that is powered by two or more energy sources, one of which is electricity. HEVs may combine the engine and fuel system of a conventional vehicle with the batteries and electric motor of an electric vehicle in a single drivetrain.

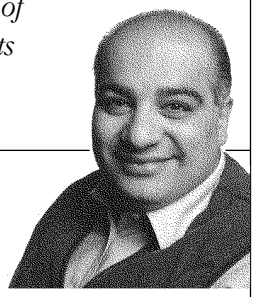
PETROLEUM FUEL -
Gasoline and diesel fuel.

SPARK IGNITION ENGINE -
Internal combustion engine in which the charge is ignited electrically — for example, with a spark plug.

WHO'S INTERESTED IN AFVS? WHO CARES ABOUT AVAILABILITY AND DISTRIBUTION?

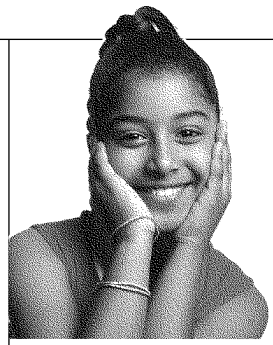
A wide variety of people have a stake in a change to AFVs. They vary from human rights activists to auto salespeople to environmental scientists to physicians to diplomats.

This group is largely interested in the availability of fuels, their safe distribution, and the reduction of some of the hidden social and environmental costs related to gasoline-powered vehicles.



ADVOCATES FOR THE ENVIRONMENT, HUMAN RIGHTS, AND PEACE

Much of the fuel used in the United States comes from politically oppressive or unstable parts of the world. Conflicts over oil endanger our own soldiers and the people in the oil-producing countries. War over oil supplies inevitably results in massive environmental damage. If we develop domestic sources of fuel, we could reduce these losses to human life and the environment, and be in a better position to stand up to oil-producing countries that oppress their own people.

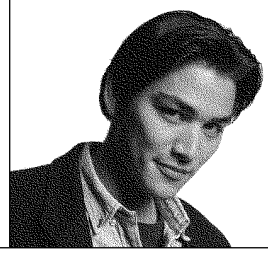


PETROLEUM INDUSTRY

As a business that employs a lot of people in drilling and refining oil for fuel, plastics, fertilizers, and other products, we want to keep the industry thriving. We expect to keep discovering new sources of fossil fuels for some time. Still, there is pressure from the government and environmental groups to change to alternatives that burn more cleanly and don't contribute to global climate change. With people demanding alternatives, should our industry be diversifying? If so, what other types of fuel should we be exploring?

NATIONAL SECURITY PERSONNEL: Advisers, Diplomats, FBI, CIA, Department of Defense

So much oil comes from unstable parts of the world. Our dependence on foreign oil led us to war in the early '90s when Iraq invaded Kuwait and threatened oil supplies there. Costly wars can't be the only answer to protecting our interests. If we develop domestic sources of fuel, we could reduce our military presence in unstable parts of the world and reduce the loss of life that results when fuel sources need protecting.

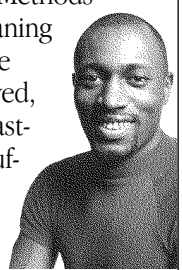


ECONOMIST

The cost of fuel has a large impact on industry and the strength of our economy. How can we keep that cost down? An increasing amount of oil is being bought overseas, leading the United States to send more money out of the country than it gets back. Which domestic sources of fuel could help us to balance imports and exports and reduce this trade deficit?

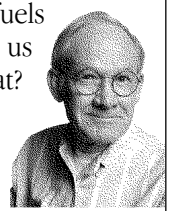
MARINE SCIENTISTS

The number of oil spills reported in the news is a fraction of those that actually occur. Methods for cleaning up have improved, but coastlines suffer for years after a spill. Some areas are permanently damaged from frequent spills. People like to blame the spill on miscalculations at the ship's wheel, but we're interested in cutting down the risk of spills by finding safer, alternative fuels that don't need to be shipped.



BUSINESSES OF ALL SIZES AND CONSUMERS

We need energy for every aspect of our lives — to run industry so the economy is strong and people are employed, to produce goods, to transport goods and people, to meet heating and cooking needs. We need ongoing supplies of fuel we can depend on at stable prices. Which fuels provide us with that?



AMERICAN FARMER

Henry Ford wanted to run his Model T on fuel made from corn; diesel engines were designed to run on peanut oil. Is there a future for fuel crops? If so, which crops would they be? The Department of Agriculture's National Resources Inventory shows that we're losing almost two million acres of valuable farmland each year to urban sprawl and industry. That's almost four acres every day! If we were growing fuel crops on that land, wouldn't people be more willing to protect it?

FUELS THAT POWER YOUR COMMUNITY: GUIDE TO COMMUNITY RESEARCH

Use the questions below to help you find out which fuels now power your community.

POSSIBLE RESOURCES

- Someone who pays the utility bills in your home
- The public relations department of your local utility company, public transit authority, department of transportation, companies or organizations that operate fleets of vehicles
- National Renewable Energy Laboratory web site

1.

TRANSPORTATION FUEL FOR YOUR COMMUNITY

a. Do you ever see buses at the gas station? Where do they refuel?

b. Many alternative fuels are being used by fleets of vehicles throughout the United States, such as buses, the postal service, package delivery services, taxis, and government. Do any of these local fleets already use an alternative fuel? If so, where do those fleets refuel? Are these sites private or open to the public?

c. Besides gasoline and diesel, which other types of fuel are now available to fuel private automobiles? Where can you obtain them?

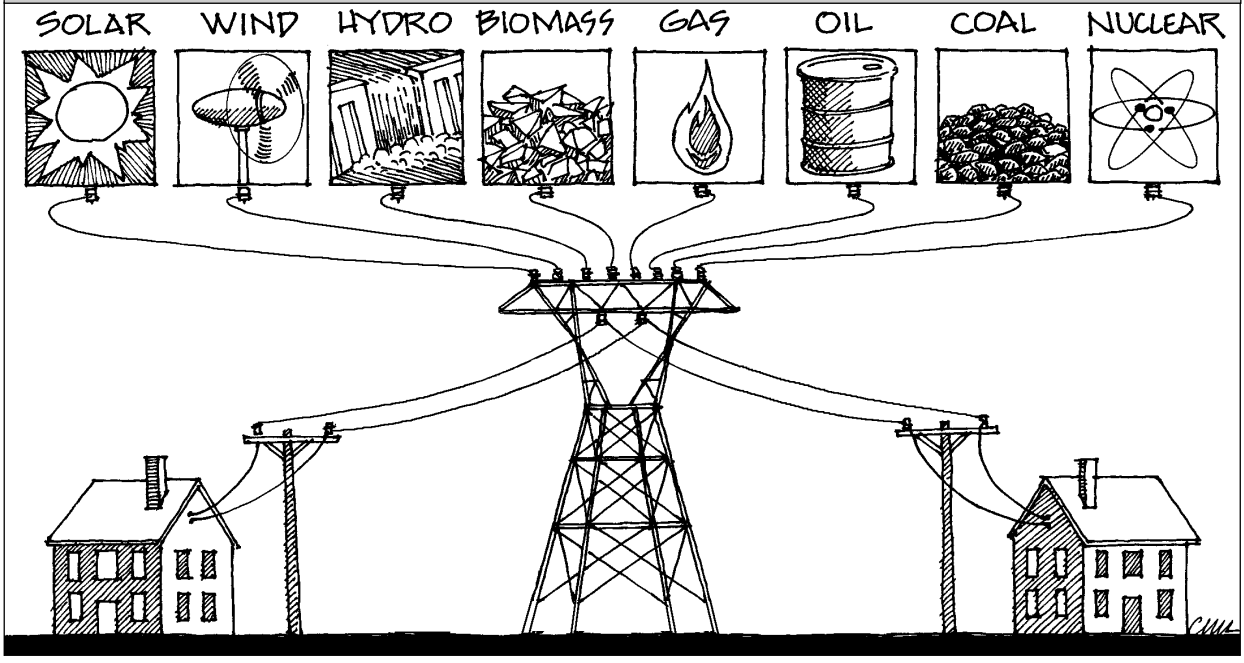
2.

FUEL FOR YOUR POWER GRID

a. Diagram 1.3 shows the various sources of energy that might be used to generate power for a regional power grid. Which types of power currently contribute to your electric power grid?

b. Are any new sources of power being developed to produce electricity for your community?

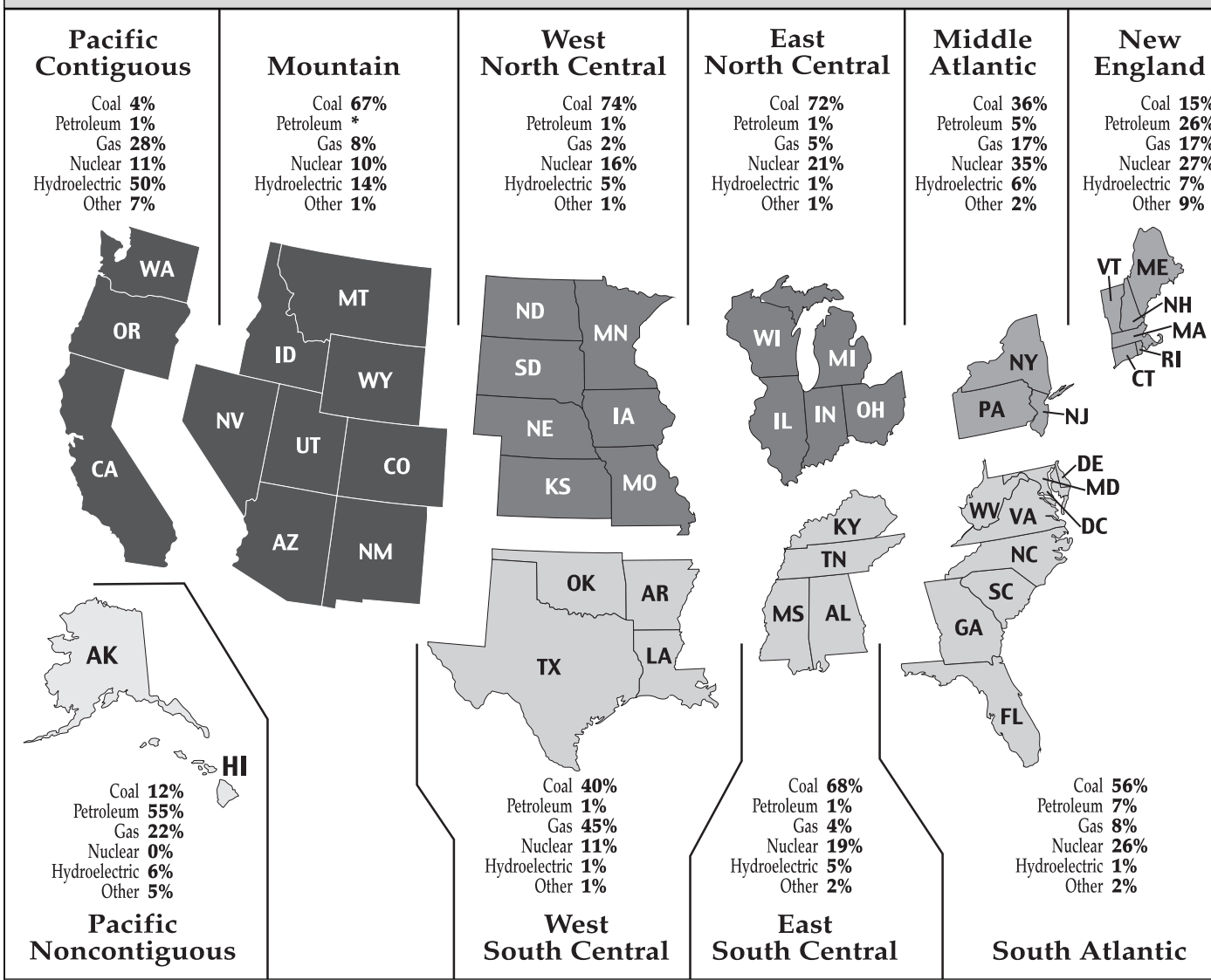
1.3 SOURCES OF ELECTRICITY



Local utilities rely on power that may be generated from a variety of energy sources: coal, oil, natural gas, nuclear, hydroelectric, solar, wind, geothermal, biomass, and others. The mix of energy varies from region to region and fluctuates over time as the costs of various energy sources rise and fall and sources of new energy become available.

- Look at the chart below to find out which regions of the United States rely most heavily on coal, petroleum, gas, or nonfossil fuels.
- Which regions rely least on coal, petroleum, gas, or nonfossil fuels?
- How does the mix of power that serves New England compare to the mix that serves California or Colorado?
- What are the ultimate sources of fuel for a battery electric car in your region?

1.4 WHERE ELECTRICITY COMES FROM, BY FUEL TYPE & REGION



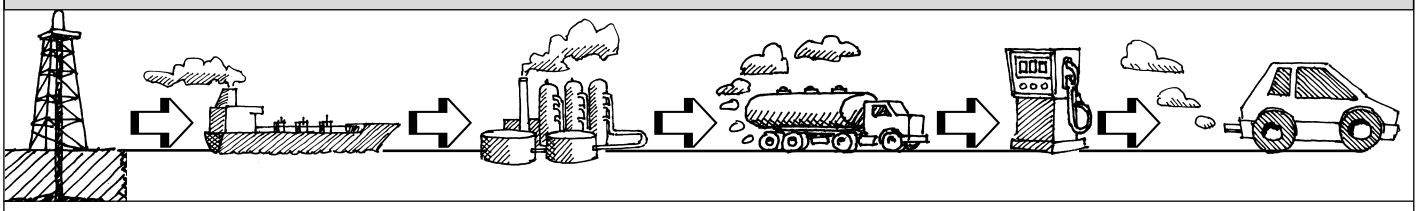
Other includes geothermal, wood, wind, waste, photovoltaic, and solar.
** Absolute value is less than 0.05.*

Source: DOE/EIA-0348(2000)/1
Electric Power Annual 2000
Volume I, August 2001
www.eia.doe.gov/cneaf/electricity/epav1/epav1.pdf

Energy Information Administration
Office of Coal, Nuclear, Electric and Alternate Fuels
U.S. Department of Energy
Washington, DC 20585

AVAILABILITY AND DISTRIBUTION: GUIDE TO FUEL TEAM RESEARCH

1.5 HOW OIL IS PROCESSED AND GETS TO CARS

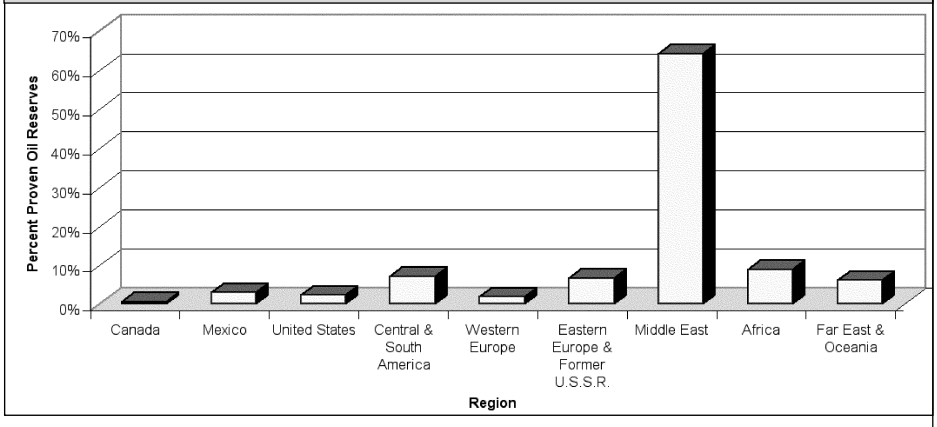


Use the questions on the next page as a guide to developing your presentation. Many of the answers are found in the alternative-fuel fact sheets. For some, you'll need to do further research in encyclopedias, periodicals, or other publications found in your library; on the Internet; or by contacting organizations that promote alternative fuels. For others, you'll need to draw your own conclusions based on facts you've found. Be prepared to explain how you came to your conclusions.

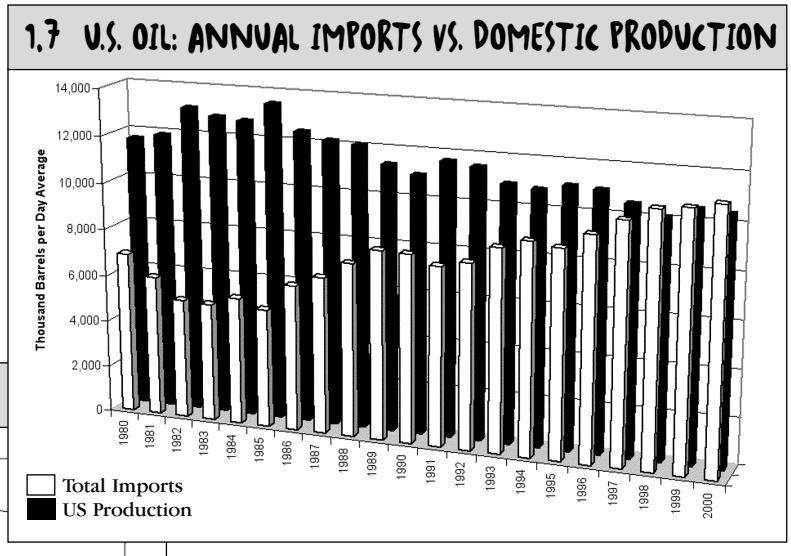
While answering the questions on the next page and preparing your presentation, keep in mind the issues below (which your class discussed at the beginning of this unit) and the various people interested in them.

Use diagrams, charts, and other graphics if they can help you deliver information to your audience.

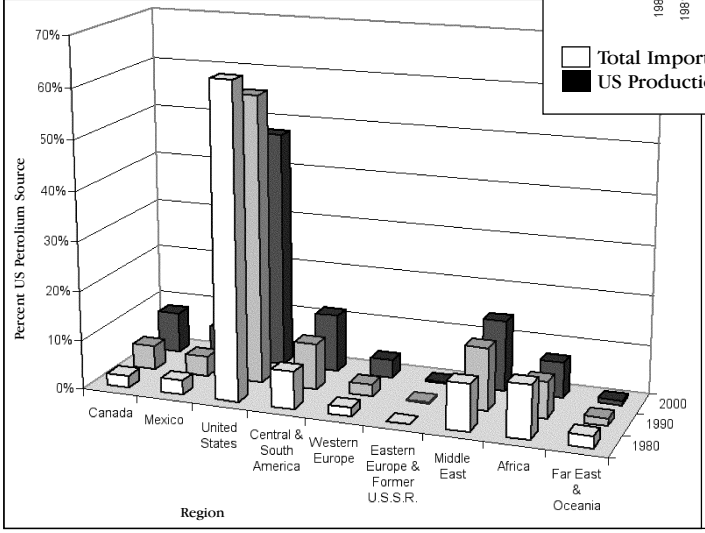
1.6 PERCENT OF PROVEN OIL RESERVES BY REGION



1.7 U.S. OIL: ANNUAL IMPORTS VS. DOMESTIC PRODUCTION



1.8 WHERE THE U.S. GETS ITS OIL



TRANSPORTATION AND FUEL ISSUES

- Regional source of fuel
- National source of fuel
- Long-term availability
- Stable fuel prices
- Safe production, storage, and delivery
- Low cost of keeping supplies secure
- Positive impact on people at the source
- Ease of developing a fueling infrastructure

1. *FUEL DESCRIPTION*

The physical state of a fuel — solid, liquid, or gaseous — is important because traditional engine technologies are designed to burn fuels only in liquid forms. The physical state and its chemical makeup—simple, complex, small, or large molecules — also influences the way it is distributed and stored. Each fuel is characterized by other properties that determine whether it is safe for widescale use, such as ignitability, explosiveness, and flammability. All fuels have the potential to be used safely, but necessary precautions must be taken. They may involve design modifications to the vehicles, the fueling infrastructure, or both.

a. What are the physical properties of your fuel?

b. Explain how its physical properties affect how it is stored, transported, and used.

2. *GETTING THE FUEL*

a. Where on the earth is the fuel found; that is, in what region/s of the world and in what part of the earth's core or surface? Is it found in the region where you live? Is it found in the United States?

b. How is the fuel extracted (or grown) and processed? Is the environment damaged in the process? What safety concerns need to be addressed during extraction and processing? How are people and the environment protected?

c. Does the fuel originate in a politically unstable region of the world, in which the fuel's extraction might require careful diplomacy or military protection? How might this affect fuel prices and the costs of keeping supplies secure?

d. How might extracting (or growing) and processing the fuel change the lives of the people who live nearby? (For example, new fuels might create new jobs for certain people or disrupt their environment.)

3. *DISTRIBUTING THE FUEL*

a. How would the fuel be distributed from the source to your community? Are there any safety or environmental concerns to consider during distribution?

b. Where in your community could fueling stations and fuel tanks be safely located?

4. *ABUNDANCE AND AVAILABILITY*

a. Is this fuel currently abundant enough for widespread use by transportation? If not, might supplies increase? If so, will supplies continue to be available in the future?

b. Which other sectors of society (domestic heating and cooking, agriculture, shipping, fishing, manufacturing) use this fuel? How might prices of transportation fuel be affected by competing demands for it?

TERMS YOU MAY ENCOUNTER

ALCOHOLS -
Organic compounds that include a hydroxyl group; the two simplest alcohols are methanol and ethanol.

CORROSIVE -
Apt to chemically decompose another substance.

CRYOGENIC STORAGE -
Extreme low-temperature storage.

EXPLOSIVENESS -
The likelihood of exploding under certain conditions.

FEEDSTOCK -
Any material converted to another form of fuel or energy product; e.g., cornstarch can be used as a feedstock for ethanol.

ESTER -
An organic compound formed by reacting an acid with an alcohol. Biodiesel is an ester.

IGNITABILITY -
The ability to start to burn.

FLAMMABLE -
Capable of being easily ignited and of burning with extreme rapidity.

REACTIVE -
Tending to react with other chemicals.

TOXICITY -
The harmfulness of a fuel to living organisms. Measures of a fuel's toxicity include exposure limits for inhalation, ingestion, skin absorption, and contact over time.

VOLATILE -
Easily changing into a vapor at normal temperatures and pressures.

FUEL REVIEW WORKSHEET: AVAILABILITY, DISTRIBUTION, AND PRICING

Reviewer Name/s: _____

_____

Stakeholder or Special Interest Group: _____

_____

Chief Concerns: _____

_____

Fuel or Technology Being Reviewed: _____

_____

Listen to the presentations for information about the issues below.

REGIONAL SOURCE OF FUEL

Notes: _____

_____

_____

Reviewer Conclusions: _____

_____

_____

_____

NATIONAL SOURCE OF FUEL

Notes: _____

_____

_____

Reviewer Conclusions: _____

_____

_____

_____

LONG-TERM AVAILABILITY

Notes: _____

_____

_____

Reviewer Conclusions: _____

_____

_____

_____

STABLE FUEL PRICES

Notes: _____

_____

_____

Reviewer Conclusions: _____

_____

_____

_____

SAFE PRODUCTION, STORAGE, AND DELIVERY

Notes: _____

_____

_____

Reviewer Conclusions: _____

_____

_____

_____

LOW COST OF KEEPING SUPPLIES SECURE

Notes: _____

_____

_____

Reviewer Conclusions: _____

_____

_____

_____

POSITIVE IMPACT ON PEOPLE AT THE SOURCE

Notes: _____

_____

_____

Reviewer Conclusions: _____

_____

_____

_____

EASE OF DEVELOPING FUELING INFRASTRUCTURE

Notes: _____

_____

_____

Reviewer Conclusions: _____

_____

HEALTH, POLLUTION, AND SAFETY

TIME

10 days

OBJECTIVES

- *To understand the impact of our current transportation system on public safety and on the human and environmental health of our communities.*
- *To understand the global importance of reducing carbon dioxide emissions.*
- *To identify ways that alternative fuels can alter local and global impacts.*

MATERIALS NEEDED

For background reading and community research

Student handouts

- *Health, Pollution, and Safety: The Challenge*
- *Automobile-Related Emissions*
- *Who's Interested in AFVs? Who Cares About Health, Pollution, and Safety?*
- *Health, Pollution, and Safety: Guide to Community Research*

Other useful resources

- *Access to the library and Internet*
- *Telephone directory or list of phone numbers for these local resources: local or state police or fire department; Coast Guard; local or regional planning department; state department of environmental protection or management; board of health; American Lung Association and its web site; a regional Environmental Protection Agency office and its web site; service stations*
- *In-class speaker to talk about automobile emissions, air quality, global warming, or releases of toxic substances (Regional EPA offices or state environmental agencies often have people available for educational outreach if booked far enough in advance.)*

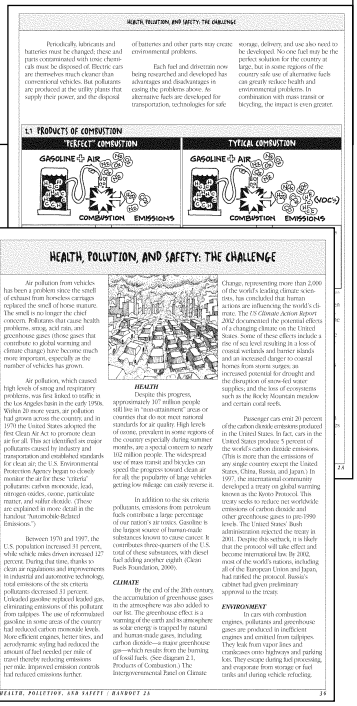
For fuel research and student presentations

Student handouts

- *Health, Pollution, and Safety: Guide to Fuel Team Research*
- *Comparing Alternative Fuels for Pollutants and Greenhouse Gases*
- *Fuel Review Worksheet: Health, Pollution, and Safety*
- *Alternative fuels fact sheets (to be distributed to appropriate teams)*
- *Resource Guide*
- *Evaluating Team Reports and Presentations*

Other useful resources

- *Access to the library and Internet*
- *Publications listed as references for this unit*
- *Flip charts, poster board, transparencies, and use of an overhead projector*
- *Access to word processing or presentation software*


HEALTH, POLLUTION, AND SAFETY: THE CHALLENGE

Periodically, lubricants and batteries must be changed; these and parts contaminated with toxic chemicals must be disposed of. Electric cars are themselves much cleaner than conventional vehicles. But pollutants are produced at the utility plants that supply their power, and the disposal of batteries and other parts may create environmental problems.

Each fuel and drivetrain now being researched and developed has advantages and disadvantages in easing the problems above. As alternative fuels are developed for transportation, technologies for safe storage, delivery, and use also need to be developed. No one fuel may be the perfect solution for the country at large, but in some regions of the country safe use of alternative fuels can greatly reduce health and environmental problems. In combination with mass transit or bicycling, the impact is even greater.

2.1 PRODUCTS OF COMBUSTION

"PERFECT" COMBUSTION

GASOLINE + AIR → COMBUSTION → EMISSIONS

TYPICAL COMBUSTION

GASOLINE + AIR → COMBUSTION → EMISSIONS (HOCs)

HEALTH, POLLUTION, AND SAFETY: THE CHALLENGE

Air pollution from vehicles has been a problem since the smell of exhaust from horseless carriages replaced the smell of horse manure. The smell is no longer the chief concern. Pollutants that cause health problems, smog, acid rain, and greenhouse gases (those gases that contribute to global warming and climate change) have become much more important, especially as the number of vehicles has grown.

Air pollution, which caused high levels of smog and respiratory problems, was first linked to traffic in the Los Angeles basin in the early 1950s. Within 20 more years, air pollution had grown across the country, and in 1970 the United States adopted the first Clean Air Act to promote clean air for all. This act identified six major pollutants caused by industry and transportation and established standards for clean air; the U.S. Environmental Protection Agency began to closely monitor the air for these "criteria" pollutants: carbon monoxide, lead, nitrogen oxides, ozone, particulate matter, and sulfur dioxide. (These are explained in more detail in the handout "Automobile-Related Emissions.")

Between 1970 and 1997, the U.S. population increased 31 percent, while vehicle miles driven increased 127 percent. During that time, thanks to clean air regulations and improvements in industrial and automotive technology, total emissions of the six criteria pollutants decreased 31 percent. Unleaded gasoline replaced leaded gas, eliminating emissions of this pollutant from tailpipes. The use of reformulated gasoline in some areas of the country had reduced carbon monoxide levels. More efficient engines, better tires, and aerodynamic styling had reduced the amount of fuel needed per mile of travel thereby reducing emissions per mile. Improved emission controls had reduced emissions further.

HEALTH

Despite this progress, approximately 107 million people still live in "nonattainment" areas or counties that do not meet national standards for air quality. High levels of ozone, prevalent in some regions of the country especially during summer months, are a special concern to nearly 102 million people. The widespread use of mass transit and bicycles can speed the progress toward clean air for all; the popularity of large vehicles getting low mileage can easily reverse it.

In addition to the six criteria pollutants, emissions from petroleum fuels contribute a large percentage of our nation's air toxics. Gasoline is the largest source of human-made substances known to cause cancer. It contributes three-quarters of the U.S. total of these substances, with diesel fuel adding another eighth (Glass Fuels Foundation, 2000).

CLIMATE

By the end of the 20th century, the accumulation of greenhouse gases in the atmosphere was also added to our list. The greenhouse effect is a warming of the earth and its atmosphere as solar energy is trapped by natural and human-made gases, including carbon dioxide—a major greenhouse gas—which results from the burning of fossil fuels. (See diagram 2.1, Products of Combustion.) The Intergovernmental Panel on Climate Change, representing more than 2,000 of the world's leading climate scientists, has concluded that human actions are influencing the world's climate. The *US Climate Action Report-2002* documented the potential effects of a changing climate on the United States. Some of these effects include a rise of sea level, resulting in a loss of coastal wetlands and barrier islands and an increased danger to coastal homes from storm surges; an increased potential for drought and the disruption of snow-fed water supplies; and the loss of ecosystems such as the Rocky Mountain meadow and certain coral reefs.

Passenger cars emit 20 percent of the carbon dioxide emissions produced in the United States. In fact, cars in the United States produce 5 percent of the world's carbon dioxide emissions. (This is more than the emissions of any single country except the United States, China, Russia, and Japan.) In 1997, the international community developed a treaty on global warming known as the Kyoto Protocol. This treaty seeks to reduce net worldwide emissions of carbon dioxide and other greenhouse gases to pre-1990 levels. The United States' Bush administration rejected the treaty in 2001. Despite this setback, it is likely that the protocol will take effect and become international law. By 2002, most of the world's nations, including all of the European Union and Japan, had ranked the protocol. Russia's cabinet had given preliminary approval to the treaty.

ENVIRONMENT

In cars with combustion engines, pollutants and greenhouse gases are produced in inefficient engines and emitted from tailpipes. They leak from vapor lines and crankcases onto highways and parking lots. They escape during fuel processing, and evaporate from storage or fuel tanks and during vehicle refueling.

HEALTH, POLLUTION, AND SAFETY / HANDOUT 2A

STEP 1 - Background Reading and Discussion

HEALTH, POLLUTION, AND SAFETY: PRESENTING THE CHALLENGE

TIME: 45 minutes, depending on students' prior knowledge of air pollutants and global warming; may be assigned for homework

1) Copy and distribute the student handouts listed above for background reading and community research. Have students identify the major health and environmental issues related to a transportation system made up of private gasoline-powered cars. To stimulate discussion, refer to the student handout "HEALTH, POLLUTION, AND SAFETY: THE CHALLENGE."

A key point for students to understand is that with small numbers of vehicles in operation, their impact on public health and the environment is relatively small.