

SUGGESTED REFERENCES

- *A categorical listing of many alternative fuels*
<http://www.fueleconomy.gov/Feg/current.shtml>
- *U.S. Department of Energy Fuel Cell Technologies Program*
<http://www1.eere.energy.gov/hydrogenandfuelcells/>
- *Alternative Fuels Data Center - A vast collection of information on alternative fuels and the vehicles that use them. Topics covered include biodiesel, electricity, ethanol, hydrogen, natural gas, and propane.*
<http://www.eere.energy.gov/afdc/index.html>
- *How Fuel Cells Work - Plain English explanation of how fuel cells work.*
<http://www.howstuffworks.com/fuel-cell.htm>
- *How Electric Cars Work - Plain English explanation of electric car technology.*
<http://auto.howstuffworks.com/electric-car.htm>

NATIONAL SCIENCE EDUCATION STANDARDS

Grades K - 4, 5 - 8

Science & Technology

Abilities of technological design
Understandings about science & technology

Grades 5 - 8

Physical Science

Properties & changes of properties in matter
Transfer of energy

*Source: *National Science Education Standards, 1996, National Academy Press*

Grades 5 - 8

Science in Personal & Social Perspectives

Populations, resources, & environments
Science & technology in society

CREDITS

EDUCATOR ADVISORY PANEL

Patricia Heydet-Kirsch, Ed.D.
John A. Murnan III, M.S.
Debra A. Murnan, B.A.

PRODUCTION CREDITS

WRITER/PRODUCER:
ASSOCIATE PRODUCER:
EDITOR:
NARRATORS:

Jon Glassman
Judi Sitkin
Stuart Scoon
Nancy Duerr & Katie Duerr



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ENGINEERING - *Fueling a Greener Planet*

SYNOPSIS

Revolutionary changes are taking place in the automobile industry. The standard petroleum gasoline fueled engine has some new competition from gas-electric hybrids, electric vehicles, hydrogen fuel cell vehicles, natural gas vehicles, and even some automobiles that get some of their power from the Sun.

Alternative fuel vehicles produce minimal harmful emissions. Many of these fuels can be derived from renewable resources. Hybrid vehicles such as ones that are powered by a combination of gasoline combustion engines and electric motors are becoming more common. Other vehicles that are in development are powered by fuels such as ethanol, biodiesel, natural gas, propane, and hydrogen fuel cells.



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BACKGROUND

Alternative fuel vehicle manufacturers are offering transportation with little or no emissions that are harmful to our environment. In addition, they hope to lessen our reliance on foreign oil. Rising taxes on liquid petroleum based fuel and the potential for peak oil are putting pressure on the industry to make these changes.

Peak oil is a concept that refers to the point in time when the maximum rate of global petroleum extraction is reached. It is theorized that the rate of production will enter a terminal decline once peak oil is reached. It is derived from the Hubert Curve, which shows that the production rate of a limited resource will have a roughly symmetrical bell shaped curve based on several factors. There is speculation that this will cause increases in the price of oil and result in negative implications on the global economy.

Engineers have developed fuel cells that are powered by hydrogen. Hydrogen is the simplest and most abundant element but is rarely found alone in nature because it is usually bonded with other elements. It is found in enormous quantities in water, hydrocarbons, and other organic matter. Fuel cells are electrochemical devices that convert chemical energy into electrical energy. Hydrogen fuel cell vehicles are highly efficient and their only emissions are heat and water.

Electric vehicles use electric motors powered by rechargeable battery packs. They have no tailpipe emissions and are extremely energy efficient as they convert roughly 75% of the chemical energy from the batteries to power the wheels as opposed to internal combustion engines which convert 20% of the energy stored in gasoline. Electric vehicles often can accelerate faster than gasoline powered vehicles. They are extremely quiet and often require less maintenance because they have fewer moving parts. Many electric vehicles use a regenerative braking system that converts some kinetic energy into a useful form of energy that is restored to the batteries.

Natural gas vehicles use fuel that mainly consists of methane and hydrocarbons. Hydrocarbons are compounds that contain hydrogen and carbon, bound together by single bonds. Methane is the simplest hydrocarbon, containing one carbon atom and four hydrogen atoms. This makes natural gas combustible. These factors allow it to burn very cleanly, resulting in extremely low emissions. Compressed natural gas vehicles also run at about half the cost of a gasoline vehicle.

The United States government plans to put one million plug-in hybrid vehicles on America's roads by 2015. They are investing heavily in research and development of the next generation plug-in hybrid vehicles and advanced battery components. The government is also implementing several plans such as the National Low Carbon Fuel Standard, which will reduce the carbon in our fuels 10% by 2020 and require 60 billion gallons of bio-fuels to be phased into our fuel supply by 2030.

CRITICAL THINKING EXERCISES

1. Create a chart detailing the strengths and weaknesses of several fuel types. Using the chart, defend which fuel type would be the best to consider for a large research project.
2. Compare and contrast the following vehicle types: gas-electric hybrids, electric and fuel cell.
3. Research steps the government is taking to encourage automobile manufacturers to improve their fuel efficiencies and emissions.
4. Predict the effect of fuel efficient vehicles on energy transfer in the environment.
5. Design a new "fuel station" for the future, where alternative-fuel vehicles could replenish their resources.

CAREER POSSIBILITIES

- CHEMIST
- ENGINEER
- MECHANIC

ADVANCED ORGANIZERS

Prior to viewing this program, students should have some understanding of the following Benchmarks for Science Literacy, Oxford University Press which are excerpted and, in some cases, abbreviated below. Refer to the Benchmarks for more information.

Benchmark 3. The Nature of Technology Section A: Issues in Technology, Grades 3-5

- Factors such as cost, safety, appearance, environmental impact, and what will happen if the solution fails must be considered in technological design.

Grades 6-8

- Technology is largely responsible for the great revolutions in agriculture, manufacturing, sanitation, medicine, warfare, transportation, information processing, and communications that have radically changed how people live and work
- Societies influence what aspects of technology are developed and how these are used. People control technology (as well as science) and are responsible for its effects.
- Scientific laws, engineering principles, properties of materials, and construction techniques must be taken into account in designing engineering solutions to problems.

Benchmark 8. The Designed World Section C: Energy Sources & Use, Grades 3-5

- Sunlight is used to run many devices.
- Some people try to reduce the amount of fuels they use in order to conserve resources, reduce pollution, or save money.

Grades 6-8

- Different ways of obtaining, transforming, and distributing energy have different environmental consequences
- Some resources are not renewable or renew very slowly. Fuels already accumulated in the earth, for instance, will become more difficult to obtain as the most readily available resources run out. How long the resources will last, however, is difficult to predict. The ultimate limit may be the prohibitive cost of obtaining them.
- By burning fuels, people are releasing large amounts of carbon dioxide into the atmosphere and transforming chemical energy into thermal energy which spreads throughout the environment.

*Benchmarks can be found at www.project2061.org/tools/benchol/bolintr.htm

VOCABULARY

- Anode** The positively charged element of an electrical device, such as a vacuum tube or a diode, to which electrons are attracted.
- Cathode** The negative electrode in an electrolytic cell, toward which positively charged particles are attracted.
- Ethanol** An alcohol obtained from the fermentation of sugars and starches or by chemical synthesis. It is used as a solvent, in explosives, and as an additive to, or replacement for petroleum-based fuels.
- Fuel Cell** A device that produces electricity by combining a fuel, usually hydrogen, with oxygen. In this reaction, electrons are freed from the hydrogen in the fuel cell by a catalyst, and gain energy from the chemical reaction binding hydrogen and oxygen; this provides a source for electric current. The exhaust of hydrogen fuel cells consists of only water. Fuel cells are currently used in spacecraft and increasingly in ground transportation.
- Hydrocarbons** Any of numerous organic compounds that contains only carbon and hydrogen.
- Lithium Ion Battery** Rechargeable battery in which lithium ions move from a negative electrode to positive electrode during discharge, and back when charging.
- Methane** A colorless, odorless, flammable gas that is the simplest hydrocarbon. It is the major constituent of natural gas and is released during the decomposition of plant or other organic compounds, as in marshes and coal mines.
- Peak Oil** The point in time when the maximum rate of global petroleum extraction is reached. At this point, it is speculated that the rate of production will enter a terminal decline.
- Petroleum** A thick, flammable, yellow-to-black mixture of gaseous, liquid, and solid hydrocarbons that occurs naturally beneath the Earth's surface. It is believed to originate from the remains of fossilized plants and animals.
- Regenerative Braking** Converts the energy generated by braking into electrical energy to charge the batteries for the electric motor portion of the propulsion system.