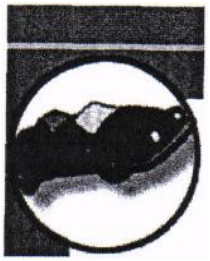
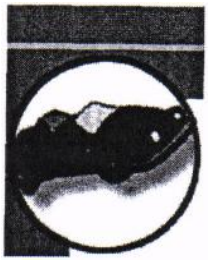




TRANSPORTATION

ENERGY

POLLUTION

POLLUTION is when the air, water, or land becomes dirty through the actions of people. Some types of pollution - such as litter along the beach - are easy to see. Other types of pollution, such as chemicals in the water or air, are not as easy to see but can be even more harmful.

Most transportation fuels - gasoline and diesel fuel, for example - *are* made from oil. Oil is a fossil fuel and is considered a non-renewable fuel. The oil, coal and natural gas being extracted today for use as an energy source took millions of years to make. When gasoline is burned, carbon dioxide *(CO_2),* carbon monoxide *(CO)* and volatile organic hydrocarbons that make ozone pollution are added to the atmosphere. CO_2 emissions are of great concern because it contributes to global warming. When diesel fuel is burned two more dangerous pollutants are released to the atmosphere — fine particulates and sulfur. As long as we use these fuels, these pollutants will continue to be added to our planet and the amount of these fuels will continue to decrease.

What is the alternative?

When plants are used to make fuels, these fuels are renewable. When renewable fuels are burned, CO_2 is added to the atmosphere, but in this case there is a balance, since growing plants remove CO_2. In a perfectly renewable system, the same number of plants that are harvested are replanted. This way, the amount of *CO2* being added to the atmosphere is the same amount that the growing plants are using, and there is no net increase.

What are the common energy sources?

It comes in different forms -- heat (thermal), light (radiant), mechanical, electrical, chemical, and nuclear energy.

There are two types of energy -- stored (potential) *energy* and working (kinetic) energy. For example, the food you eat contains chemical *energy,* and your body stores this *energy* until you release it when you work or play.

All forms of energy are stored in different ways, in the energy sources that we use every day. These sources are divided into two groups -- **renewable** (an energy source that we can use over and over again) and **nonrenewable** (an energy source that we are using up and cannot recreate in a short period of time). Renewable energy sources include **solar** energy, which comes from the sun and can be turned into **electricity** and heat. **Wind, geothermal** *energy* from inside the earth, **biomass** from plants, and **hvdropower** from water are also renewable energy sources.

However, we get most of our energy from nonrenewable energy sources, which include the fossil fuels -- **oil**, **natural gas**, and **coal**. They're called fossil fuels because they were formed over millions and millions of years by the action of heat from the Earth's core and pressure from rock and soil on the remains (or "fossils") of dead plants and animals. Another nonrenewable *energy* source is the element **uranium**, whose atoms we split (through a process called nuclear fission) to create heat and ultimately electricity.

We use all these energy sources to generate the electricity we need for our **homes, businesses, schools, and factories**. **Electricity** "energizes" our computers, lights, refrigerators, washing machines, and air conditioners, to name only a few uses. - 5

We use energy to **run our cars**. The gasoline we burn in our cars is made from oil. We use energy to cook on an outdoor grill or soar in a beautiful hot-air balloon. The **propane** for these recreational activities is made from oil and natural gas.

Energy is in everything. We use energy to do everything we do, from making a jump shot to baking our favorite cookies to sending astronauts into space -- energy is there, making sure we have the power to do it all.

Alternative Fuel Vehicles...

They're in Your Future!

What is an alternative fuel vehicle?

An alternative fuel vehicle is a vehicle that has been modified to run on alternative fuels. Today, all of the automobile companies manufacture "flexible fuel vehicles" or FFVs. FFVs can run on gasoline or E85 (85% ethanol and 15% gasoline). School, transit and shuttle buses can be purchased that are equipped with engines powered by compressed or liquid natural gas and liquid propane gas. Special on-board tanks are required to carry the fuel.

What is an alternative fuel?

"Alternative fuels" are vehicle fuels that aren't made from petroleum. There are many kinds of fuels that vehicles can run on that aren't made from petroleum. The United States Department of Energy officially recognizes this list of alternative fuels:

- **Alcohols** - ethanol and methanol.
- **Compressed natural gas (CNG) -** natural gas under high pressure.
- **Liquefied natural gas (LNG) -** natural gas cooled to -260°F.
- **Electricity** - stored in batteries that must be recharged from the utility grid.
- **Hydrogen (H_2)** - a gas commonly bound to other elements, e.g. water (HzO)
- **Liquefied petroleum gas (LPG)** (also called propane) - hydrocarbon gases under low pressure primarily used in liquid form.
- **Liquids made from coal** - transportation fuels that do not come from petroleum.
- **Biodiesel** - diesel fuel blended with plant oil or animal fat. *A* common used biodiesel is 820, 20% soybean oil with 80% diesel fuel.

Almost all of the fuel we use for transportation is made from petroleum.

The most commonly used "alternative fuel" today is LPG. It is used in sightseeing buses, bakery trucks and in almost all forklifts.

Natural gas is used primarily as a compressed gas in vehicles. In Pennsylvania, transit authorities, school districts, universities, local municipalities and private industries use natural gas n their vehicles. The largest natural gas fleets are operated by the natural gas utilities. A vehicle must be equipped with special high pressure tanks and a fuel system with pressure valves in order to use the fuel. Because natural gas is a very clean burning domestically produced fuel, state and federal governments provide incentives to help build the stations and buy down the added cost of the cars.

Alcohol fuels, namely, methanol, have been used in race cars for decades. In the late 1970's, in an attempt to reduce gasoline demand, methanol was added to gasoline. "Gasohol" (commonly 5% methanol and 95% gasoline) was used in cars without any modifications to the vehicles. Due to the toxic and corrosive nature of methanol, its use was discontinued. Ethanol is found in gasoline today to meet federal clean air requirements. It is normally blended at a 10% level with 90% gasoline (E10). Cars do not require modification to use E10. Ethanol is also a popular "alternative fuel in the mid-west where there are many ethanol production facilities. Ethanol as an alternative fuels is a blend of 85% ethanol with 15% gasoline (E85). E85 burns cleaner in vehicles than E10. E85 can be distributed in the existing gasoline infrastructure and used in a large variety of gasoline vehicles available today. E85 can be used only in FFVs.

CLEAN FUELS

**Alternative fuels are also called "clean fuels."
They produce less air pollution
than our common gasoline or diesel fuels.
They can be produced in the United States and
they are better for the vehicles.**

True Or False: *We* have no choice - we have to use fuels that can damage our environment and our health.

Answer: False; there are many available clean fuels fop our use. They are not used because the petroleum and automotive industry continually resist any changes in laws that might require their use.

Some types of clean fuels are:

Propane: Also known as "LPG" (Liquefied Petroleum Gas). Made from fossil fuels, as a byproduct of the refining process or found in natural gas reserves. **Propane** produces less carbon monoxide, and helps engines last longer. Most forklifts and many bakery trucks and sightseeing buses in the United States operate on propane.

Natural Gas: is a fossil fuel produced domestically from gas wells in the United States. It can be used in vehicles in a gaseous compressed or liquefied form. Many mass transits, school and shuttle buses, in the United States operate on compressed natural gas. Natural gas is one of the cleanest burning fuel alternative fuels currently available.

Alcohols: There are 2 types: "ethanol" and "methanol." Most of the **ethanol** is made from corn or sugarcane. New processes can make ethanol from municipal waste, paper, yard trimmings or sawdust. **Methanol** is usually made from natural gas but could also be made from coal, wood or sugarcane. Alcohol fuels produce less carbon monoxide.

Biodiesel: Made from vegetable (canola, soybean, etc.) oils, including used cooking oil (such as oil used in frying French fries). Its lubricating qualities are good for engines. Biodiesel can be used in diesel powered trucks and cars and is commonly blended with diesel as 20% soybean oil with 80% diesel fuel (B20). B20 produces less, sulfur, smoke and particulates and the exhaust smells better than diesel fumes.

Electricity: Not really a "fuel" like gasoline or diesel; rather, a form of energy. Electrical energy can be made by burning oil, coal, solid waste

(trash), biomass, or other fuels. Or, electricity can be made without burning anything - by using the energy of the wind, the sun, or flowing water.
Electric vehicles run on electricity stored in rechargeable batteries (the batteries are re-charged by plugging into an electrical outlet). Electric vehicles are "zero emission" vehicles - nothing is burned on-board the vehicle. All emissions are at the power plant.

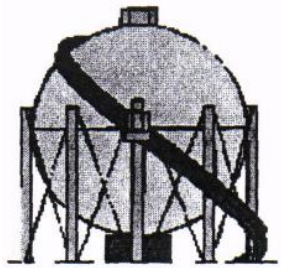
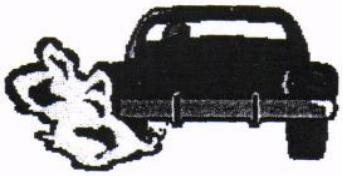
Hybrid electric vehicles: A hybrid vehicle is powered by a combination of electric motors, batteries and a small gasoline engine. The electric motor powers the hybrid at low speeds while using gasoline for highway travel. The gas engines recharge the electric batteries with more recharging occurring when the cars brake or coast. This allows the hybrids to offer better fuel economy and lower emissions.

Today there are only three hybrid vehicles available for the public to buy, the Toyota *Prius.* (pronounced "pree-us"), the Honda Civic and the Honda *Insight.* The 2005 Ford Escape hybrid will be available before the end of this year. The battery systems in the cars are different from the standard 12 volt gasoline lead-acid batteries found in other cars. The battery voltage in the hybrids range from 144 to over 300 volts and are composed of nickel-metal hydride. The batteries are recharged by on-board vehicle operation. Because the Japanese manufactured hybrids are compact, constructed of light-weight materials and are aerodynamically designed, they get very good gas mileage. On average, the hybrids can get 40 - 60 miles to the gallon. The Honda Insight is a very small two-seater and gets the highest mileage. It has been estimated that the Ford Escape, which is a small SUV may get an average of 38 miles to the gallon. Hybrids are not only fuel efficient, but they are also the cleanest gasoline cars available.

"Fuel cell" cars are another type of electric vehicle in the developmental stages and viewed as the cars of the future. The research vehicles are operating on the electricity produced by fuel cells using hydrogen as the fuel source.

Picture the Fuels

Can you match the fuels (left) with their vehicles (right)?

	A. **Traditional fossil fuel for cars**	**ETHANOL**	
	B. **Liquefied petroleum gas (LPG)**	**ELECTRIC**	
	C. **Corn to make alcohol fuel**	**PROPANE**	
	D. **Used cooking oil**	**GASOLINE**	
	E. **Recharging station**	**BIODIESEL**	

Clean air is not the only benefit from alternative fuels.
Alternative fuels can help with national concerns too:

BALANCE OF TRADE, JOB CREATION,
and **NATIONAL ENERGY SECURITY.**

Natural *Gas* Fact Sheet

What is Natural Gas?

Natural gas is a mixture of hydrocarbons—mainly methane —and is produced either from gas wells or in conjunction with crude oil production. In its purest form, such as the natural gas that is delivered to your home, it is almost pure methane. Methane is a molecule made up of one carbon atom and four hydrogen atoms, and is referred to as CH4.

Natural gas might be considered a very uninteresting gas - it is colorless, shapeless, and odorless in its pure form. Unlike other fossil fuels, like coal and oil, natural gas is clean burning and emits lower levels of potentially harmful byproducts into the air.*

Natural gas is a combustible mixture of hydrocarbon gases. While natural gas is formed primarily of methane, it can also include ethane, propane, butane and pentane. The composition of natural gas can vary widely, but below is a chart outlining the typical makeup of natural gas before it is refined.

Typical Composition of Natural Gas

Methane	**CH_4**	**70-90%**
Ethane	**C_2H_6**	**20%**
Propane	**C_3H_8**	
Butane	**$C4H_{10}$**	
Carbon Dioxide	**CO_2**	**0-8%**
Oxygen	**O_2**	**0-0.2%**
Nitrogen	**N_2**	**0-5%**
Hydrogen sulphide	**H_2S**	**0-5%**
Rare gases	**A, He, Ne, Xe**	**Trace**

Where does natural gas come from?

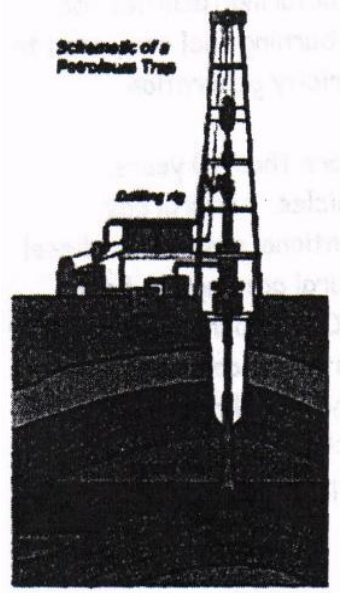
Natural gas is a fossil fuel. Like oil and coal, this means that it is, essentially, the remains of plants and animals and microorganisms that lived millions and millions of years ago. But how do these once living organisms become an inanimate mixture of gases?

There are many different theories as to the origins of fossil fuels. The most widely accepted theory says that fossil fuels are formed when organic matter (such as the remains of a plant or animal) is compressed under the earth, at very high pressure for a very long time. This is referred to as thermogenic methane. Similar to the formation of oil, thermogenic methane is formed from organic particles that are covered in mud and other sediment. Over time, more and more sediment and mud and other debris are piled on top of the organic matter. This sediment and debris puts a great deal of pressure on the organic matter, which compresses it.

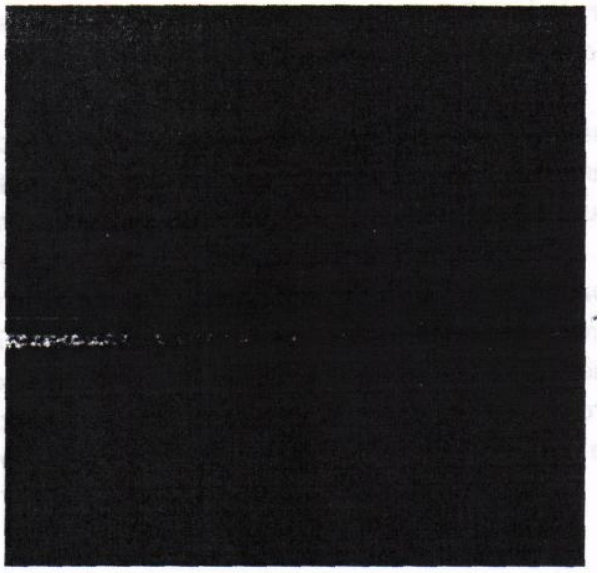
Natural gas can also be formed through the transformation of organic matter by tiny microorganisms. This type of methane is referred to as biogenic methane. Methanogens, tiny methane producing microorganisms, chemically break down organic matter to produce methane. These microorganisms are commonly found in areas near the surface of the earth that are void of oxygen. These microorganisms also live in the intestines of most animals, including humans. Formation of methane in this manner usually takes place close to the surface of the earth, and the methane produced is usually lost into the atmosphere. In certain circumstances, however, this methane can be trapped underground, recoverable as natural gas. An example of biogenic methane is landfill gas. Waste-containing landfills produce a relatively large amount of natural gas, from the decomposition of the waste materials that they contain. New technologies are allowing this gas to be harvested and used to add to the supply of natural gas.

Although there are several ways that methane, and thus natural gas, may be formed, it is usually found underneath the surface of the earth. Most of this methane will simply rise to the surface and dissipate into the air. However, a great deal of this methane will rise up into geological formations that 'trap' the gas under the ground. These formations are made up of layers of porous, sedimentary rock (kind of like a sponge, that soaks up and contains the gas), with a denser, impermeable layer of rock on top. This impermeable rock traps the natural gas under the ground. If these formations are large enough, they can trap a great deal of natural gas underground, in what is known as a reservoir.

With natural gas trapped under the earth in this fashion, it can be recovered by drilling a hole through the impermeable rock. *Gas* in these reservoirs is typically under pressure, allowing it to escape from the reservoir on its own.

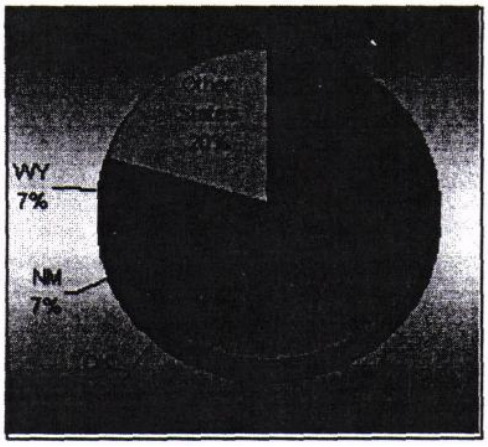


Source: U.S. Energy Information Administration



Off-shore Drilling

Drilling for natural gas can be done by drilling through the Earth's surface from the land or off-shore in the ocean. Below is a chart of the primary states in the U.S where natural gas is found.

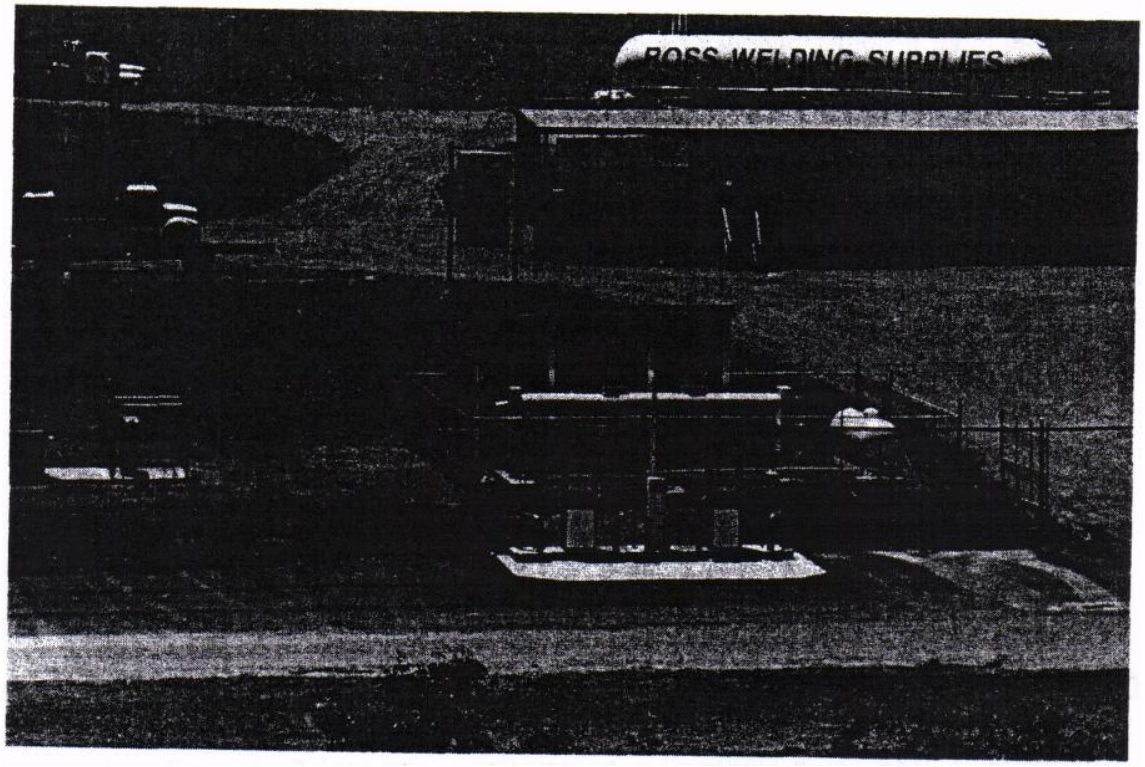


Legend: TX - Texas; *LA* - Louisiana; OK - Oklahoma; NM - New Mexico and WY - Wyoming

What is Natural *Gas* Used for?

Natural gas is domestically produced and readily available to end-users through the utility infrastructure. Most commonly, natural gas is used to heat homes and commercial building and hot water. Some industrial manufacturing facilities use natural gas. Recently, because natural gas is a very clean burning fuel compared to coal and oil, utilities are switching to natural gas for electricity generation.

Natural gas has been used to power cars and trucks for more than 40 years. Natural gas can be compressed or liquefied to operate vehicles. Natural gas produces significantly fewer harmful emissions than conventional gasoline or diesel fuel. Commercially available medium- and heavy-duty natural gas engines have demonstrated over 90% reductions of carbon monoxide (CO) and particulate matter and more than 50% reduction in nitrogen oxides (NO_X) relative to commercial diesel engines. The use of natural gas in vehicles has grown slowly over the last 20 years due to the added costs of son-board storage tanks in vehicles, the cost to build refueling stations combined with cheap gasoline and diesel prices.



Propane Refueling Station - Pittsburgh, PA

PROPANE FUEL FACT SHEET

What is it?

L

Propane is a hydrocarbon (C_3H_8) and is sometimes referred to as liquefied petroleum gas, LP-gas or *LPG.* Propane is produced from both natural gas processing and crude oil refining, in roughly equal amounts. It is nontoxic, colorless and virtually odorless. *As* with natural gas, a strong identifying odor is added so the gas can be readily detected.

Why Use Propane?

Propane is widely available throughout the United States and is a very versatile fuel.

- **Propane is used by millions of people in many different environments** -- homes, industry, farming and more.
- **More than 14 million families use propane** to fuel their furnaces, water heaters, air conditioners, outdoor grills, fire places, dryers and range tops.

- **Because propane produces minimal emissions**, it is safe to use indoors for vehicle power. As a result, nearly 500,000 forklift trucks are powered by propane. Millions more choose this clean-burning alternative for bus, taxi, delivery and other fleets to minimize air pollution in metropolitan areas.
- **Propane is used on 660,000 farms** for irrigation pumps, grain dryers, standby generators and other farm equipment. It is an essential fuel for crop drying, flame cultivation, fruit ripening, space and water heating and
- **Propane gas is nontoxic**, so it's not harmful to soil and water. Because propane does not endanger the environment, the placement of propane tanks either above or below ground is not regulated by the Environmental Protection Agency (EPA).
- **Propane is easy to transport** and can be used in areas beyond the natural gas mains. Because it is 270 times more compact as a liquid than as a gas, it is economical to store and transport as a liquid.

Did you know Propane is a Transportation Fuel?

Propane is used as an alternative to gasoline and diesel fuel in automobiles. Because propane is a simple molecule, it is one of the cleanest burning alternative fuels. The United States has close to 4000 refueling sites throughout the nation.

There are 3.5 million propane vehicles worldwide. In the U.S., more than 350,000 vehicles are fueled by propane. Propane is the third most widely used motor fuel, ranking behind gasoline and diesel. Propane has been used as an alternative transportation fuel for more than 60 years.

Both General Motors and Ford manufacture propane vehicles.

BIODIESEL FUEL FACT SHEET

What is it?

Biodiesel is a liquid fuel that can replace regular diesel fuel. It's made from vegetable oil. Biodiesel can run diesel engines that are commonly found in big vehicles such as trucks, buses, or boats. On the island of Maui, Biodiesel fuel is already available to county and private fleets.

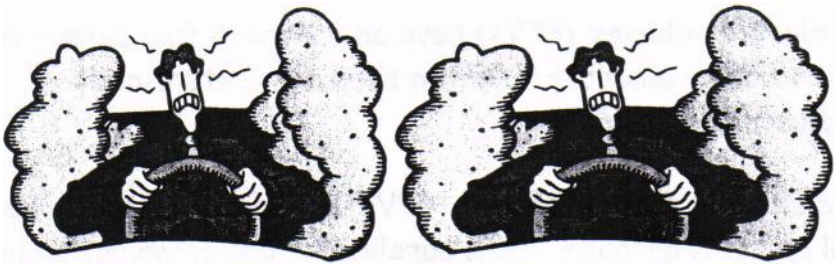
Why Biodiesel?

- Regular diesel fuel particulates are carcinogenic (can cause cancer). Using biodiesel fuel, or blending it with regular diesel fuel, can reduce the production of these cancer-causing emissions. In other words, it's healthier!
- Biodiesel can be made from waste vegetable oil (such as used oil from deep fryers at restaurants). This waste oil can be difficult to dispose of. Making fuel out of it can put it to a good use, and at the same time, reduce disposal problems.
- Biodiesel is a renewable fuel.
- Biodiesel can help create new jobs; also, keeping our air clean helps everybody (residents and tourists alike) enjoy Hawaii more.

Did you know?

- Biodiesel can be used in pure form or blended with regular diesel in any proportion.
- Biodiesel can even make engines smell better. An engine powered by biodiesel actually smells like French fries!
- Biodiesel fuel is a good lubricant, which helps engines to last longer. It also has a high cetane rating, which improves engine operation.
- Adding just 20% biodiesel to regular diesel improves the diesel's cetane rating by 3 points, which makes it a "premium" fuel.
- Biodiesel buses are in use in Europe and in the Midwestern United States.

Biodiesel is used in sensitive wetland areas to reduce the danger of fuel spills to endangered wildlife.



ALCOHOL FUEL FACT SHEET

What is it?

Alcohol fuels are made from renewable resources like locally grown crops and even waste products such as waste paper or grass and tree trimmings. **Methanol and Ethanol** are two types of alcohol fuels used in cars. Ethanol can be produced from a variety of renewable resources, most commonly corn and sugarcane. Methanol can be made from renewable resources also, but today, methanol is primarily made from natural gas.

Why Alcohol Fuels?

- Alcohol fuels burn cleaner than regular gasoline and produce less of the pollutants that contribute to ozone formation.
- Alcohol fuels have high octane giving vehicles more power.
- Crops to produce alcohol fuels can be grown in Pennsylvania and can support agricultural jobs.
- Supporting local business keeps dollars in the state and contributes to a healthy state economy.
- Production of fuels in state provides energy self-sufficiency.

Did you know?

- **Methanol** has been used as a racing fuel at the Indianapolis 500 Motor Speedway (for reasons of safety and performance) for the past 20 years!
- **Ethanol** was the fuel preferred by Henry Ford back in the early days of the Model T.

"Flexible fuel" alcohol vehicles (FFVs) have an on-board fuel sensor that senses the percentage of alcohol present in the fuel mixture and automatically adjusts the engine.

- There are flexible fueled vehicles (FFVs) capable of operating on 85 % ethanol and 15% gasoline, 100% gasoline, or any combination in between. A special sensor on the fuel line senses the ethanol/gasoline mixture, sends the information to the engine's computer, and the air/fuel ratio and timing are instantaneously adjusted. There's even a digital readout on the dashboard that shows the driver what the alcohol fuel percentage is at that moment!
- All of the major automakers manufacture FFVs available for the same price as gasoline vehicles.
- The most popular cars purchased by Americans, Ford Explorer, pickup trucks and a few sedans can operate on alcohol fuels.

FUEL CELL VEHICLE FACT SHEET

What is it?

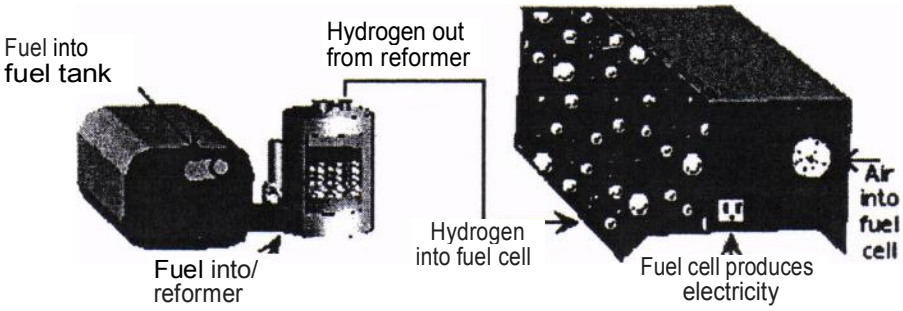
Fuel Cell vehicles are still in the developmental stage. From a technical point of view, they are electric vehicles, since electricity (generated by the fuel cell) is used to drive an electric motor. But the vehicle doesn't have to recharge as an electric vehicle does - the fuel cell is filled up with a liquid (or gaseous) fuel, in the same way that an internal combustion engine vehicle (such as gasoline or diesel) fuel tank is filled up.

Why Fuel Cells?

- Fuel cells are cleaner and much more efficient than internal combustion engines. For example, if a 40-miles-per-gallon gasoline-fueled internal combustion engine vehicle had its engine replaced by a fuel cell, it could get (theoretically) 60 to 100 miles per gallon! (The systems are still under development, so there's some uncertainty as to EXACTLY how much more efficient they would be in large scale use - but there's no disagreement that they would be more efficient.)

- So, if fuel cell vehicles should someday replace internal combustion engine vehicles, the existing gasoline, alcohol, or propane *fueling infrastructure (stations,* pipelines, pumps, etc.) could still be used. And, if fuel cell vehicles were to replace electric vehicles, the *electric vehicle technology (motors,* batteries, controllers, etc.) would also still be used!

Fuel Cell



In the fuel cell, hydrogen combines with oxygen to produce electricity, water, and heat.

Did you know?

- On the space shuttle, fuel cells are used to provide electricity and water.
- DaimlerChrysler, Toyota, Ford, General Motors, and others have announced plans to sell fuel cell cars.
- Fuel cell buses are in use in Ontario, Canada and Chicago, Illinois.