

"It's not that easy bein' green."

How Natural-Gas Vehicles Work

Information from:

<http://auto.howstuffworks.com/fuel-efficiency/alternative-fuels/ngv.htm>

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Kermit the Frog once said, "It's not that easy bein' green." Although he wasn't referring to cars, his observation seems particularly appropriate for the auto industry today: Designing, developing and marketing "green" cars has not been an easy task, which is why gasoline-powered vehicles still rule the road and fossil fuels still account for almost 75 percent of the world's energy consumption. As gasoline prices soar and concern over harmful emission mounts, however, cars that run on alternate fuel sources will become increasingly important. A natural-gas vehicle, or NGV, is the perfect example of such a car -- it's fuel-efficient, environmentally friendly and offers a relatively low cost of ownership.





Honda Civic NGV- natural gas vehicle

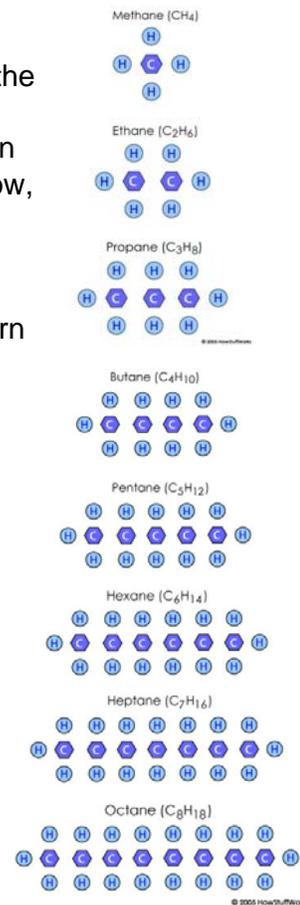
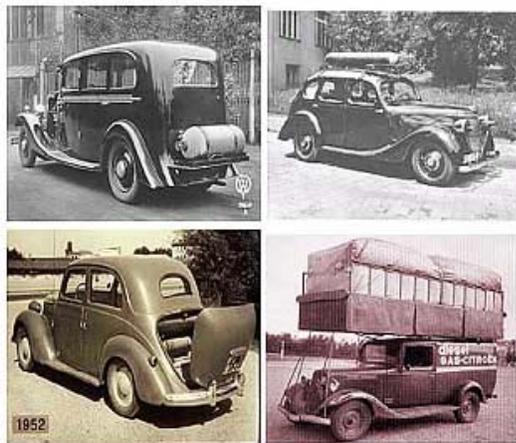


The word "gas" is a confusing term because it is used to describe many different substances that are similar but not exactly the same. For example, the "gas" you put in your car is gasoline, one component of crude oil, or petroleum. Petroleum is a dark, sticky liquid mixture of compounds formed underground by the decay of ancient marine animals.

Natural gas also comes from the decay of ancient organisms, but it naturally takes a gaseous form instead of a liquid form. Natural gas commonly occurs in association with crude oil. It is derived from both land plants and aquatic organic matter and forms above or below oil deposits. It is often dissolved in crude oil at the high pressures existing in a reservoir. There are also reservoirs of natural gas, known as non-associated gas, that contain only gas and no oil.

Natural gas consists primarily of methane and other hydrocarbon gases. Hydrocarbons are organic compounds composed only of the elements carbon and hydrogen. The hydrocarbons in natural gas are called saturated hydrocarbons because they contain hydrogen and carbon bound together by single bonds. As the diagrams show, methane is the simplest saturated hydrocarbon.

Like gasoline, natural gas is combustible, which means it can be used in a combustion [engine](#) like gasoline. But cars that could burn natural gas didn't appear on the scene until the 1930s.

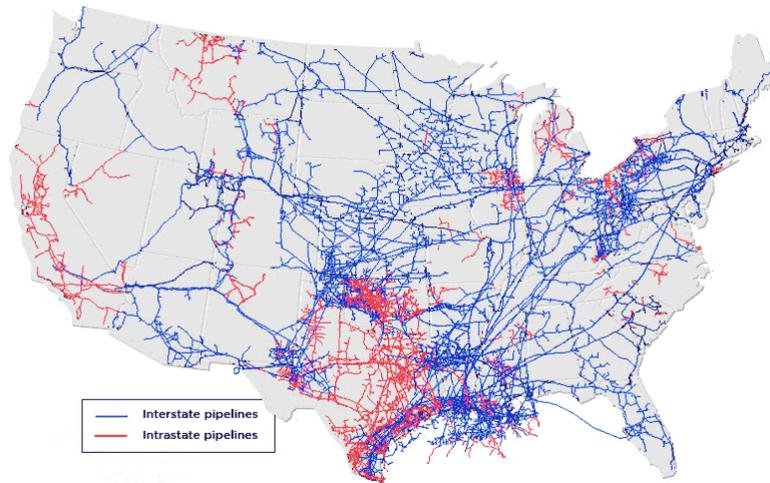


We extract natural gas trapped in underground reservoirs by [drilling](#) wells into the earth. A modern well, equipped with [diamond](#)-studded drill bits, can drill to depths approaching 25,000 feet.

Extraction and Processing

Most modern wells extract both crude oil and natural gas at the same time. Some natural gas can be used as it comes from the well without any refining, but most requires processing. Natural gas processing consists of separating all the various hydrocarbons and fluids from the "wet" natural gas until it is "dry." Dry natural gas is pure methane, which is the fuel of choice for many consumer applications, including natural-gas vehicles.





Throughout the 19th century, the use of natural gas remained localized because there was no way to transport large quantities of gas over long distances. In 1890, the invention of a leak-proof pipeline coupling made it possible to transport gas miles from the source. Improvements in pipeline technology continued over the next two decades until long-distance gas transmission became practical. From 1927 to 1931, laborers constructed more than 10 major natural gas transmission systems in the United States, making natural gas a viable energy source for many applications. The oil shortages of the late 1960s and early 1970s brought renewed interest in natural gas as a fuel source, especially for automobiles.

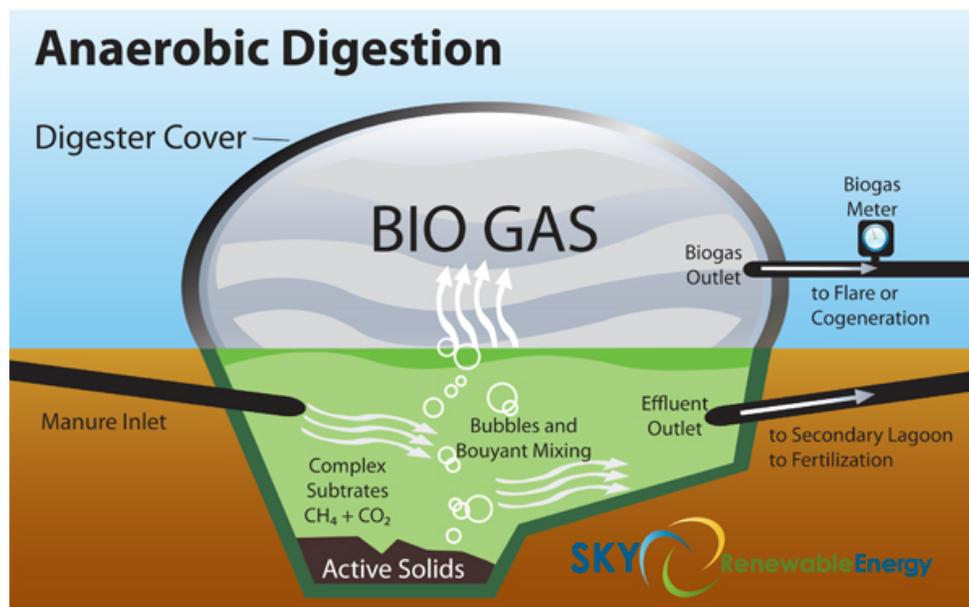


Today, owners of natural-gas vehicles can fill up their cars at one of 1,300 fueling stations located in the United States. Honda also offers a personal natural gas pump to people who purchase its natural-gas-powered Civic. The pump uses a home's existing natural gas lines and can be installed for \$500 to \$1500.

Natural gas is not the only source of methane.

There is also Bio-Gas

Natural gas is not the only source of methane. Methane can also be obtained by fermenting organic matter, such as manure, in low levels of oxygen. In such conditions, bacteria will use the nutrients in manure as a food source and will release methane and carbon dioxide as waste products. This methane, known as bio-gas, can be collected and used as a fuel source.



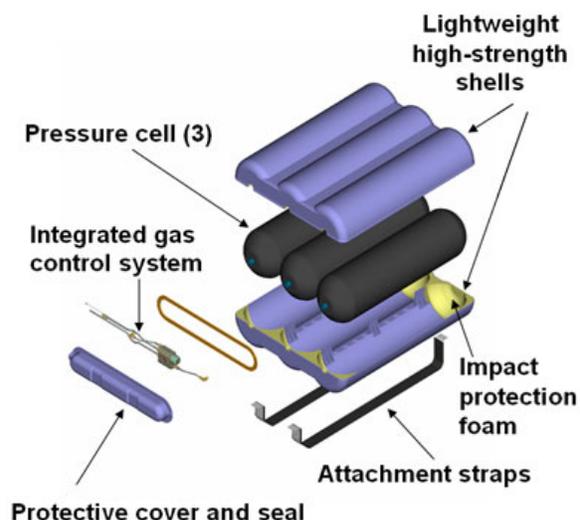
Natural-gas vehicles use the same basic principles as gasoline-powered vehicles. In other words, the fuel (natural gas in this case) is mixed with air in the cylinder of a four-stroke engine and then ignited by a spark plug to move a piston up and down. Although there are some differences between natural gas and gasoline in terms of flammability and ignition temperatures (see chart below), NGVs themselves operate on the same fundamental concepts as gasoline-powered vehicles.

Property	Natural Gas	Gasoline	Diesel
Flammability Limits (volume % in air)	5-15	1.4-7.6	0.6-5.5
Auto-Ignition Temperature (°F)	842	572	446
Peak Flame Temperature (°F)	3423	3591	3729

Still, some modifications are required to make an NGV work efficiently. These changes are primarily in the fuel storage tank, the engine and the chassis.

Fuel Storage

Most NGVs operate using compressed natural gas so the fuel takes up less space. At a fueling station, gas is compressed to 3,000-3,600 pounds per square inch before being pumped into high-pressure, tube-shaped cylinders that are attached to the rear, top or undercarriage of the vehicle. The storage tanks of early NGVs were bulky and took up much of the vehicle's cargo space, but newer, more lightweight cylinders have been developed. Called Integrated Storage Systems (ISSs), these all-composite cylinders are contained within a fiberglass shell and impact-absorbing foam to protect them in the event of a crash. The cylinders also have a smaller diameter so that three of them can be housed together in a size and shape resembling a conventional gasoline tank.



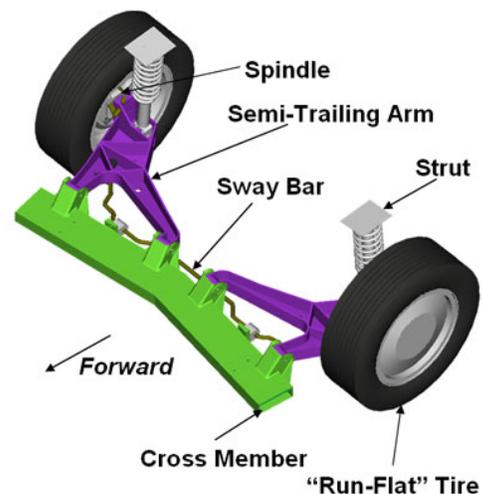


Engine Modifications

When the engine in an NGV is started, natural gas flows from the storage cylinders into a fuel line. Near the engine, the natural gas enters a regulator to reduce the pressure. Then the gas feeds through a multipoint gaseous [fuel-injection system](#), which introduces the fuel into the cylinders. Sensors and computers adjust the fuel-air mixture so that when a spark plug ignites the gas, it burns efficiently. A natural-gas engine also includes forged aluminum, high-compression pistons, hardened nickel-tungsten [exhaust valve](#) seats and a methane-specific [catalytic converter](#).

Chassis Modifications

Some modifications in the suspension of a NGV may be required to create space for the fuel-storage containers. In the rear of the vehicle, a semi-trailing arm suspension sometimes replaces the lateral-link suspension that comes standard in many gasoline-powered cars. This creates more open space in the rear undercarriage, yet still provides a smooth, comfortable ride. NGVs also remove the spare [tire](#) and jack, which allows for a flat floor plan. "Run-flat" tires, such as the Extended Mobility Tires from Goodyear Tire, are installed to compensate for the fact that the spare tire and jack are missing.

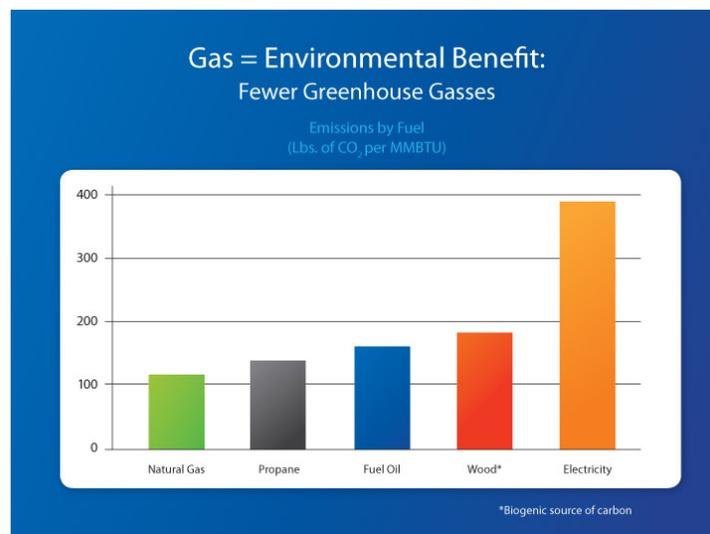


Differences in Refueling

Refueling a natural-gas vehicle may also be a little different. The fueling point is typically at the front of the vehicle, although in some NGVs, such as the Honda Civic GX, the fueling point is in the rear. An NGV can be fueled at a "fast-fill" pump in about the same time it takes to fuel any gasoline- or [diesel](#) -powered vehicle. Alternatively, an NGV can be fueled in five to eight hours using a "slow-fill" method. The home refueling stations offered by Honda are of the slow-fill variety, requiring car owners to refuel their vehicles overnight.



The biggest advantage of NGVs is that they reduce environmentally harmful emissions. natural-gas vehicles can achieve up to a 93 percent reduction in carbon monoxide emissions, 33 percent reduction in emissions of various oxides of nitrogen and a 50 percent reduction in reactive hydrocarbons when compared to gasoline vehicles. NGVs also rate higher in particulate matter 10 (PM10) emissions. PM10 particles transport and deposit toxic materials through the air. NGVs that operate in diesel applications can reduce PM10 emissions by a factor of 10.





Build vs. Buy NGVs can be built from scratch to include the design enhancements described above. A brand-new natural-gas vehicle costs \$4,000 to \$8,000 more than a comparable gasoline vehicle. It's also possible to modify conventional gasoline vehicles to run on natural gas. This, too, can be expensive, with the modifications typically costing \$3,000 to \$5,000. Vehicles that run solely on natural gas are known as "dedicated" NGVs. Vehicles that can operate on both natural gas and gasoline are known as "bi-fuel" vehicles. In bi-fuel vehicles, the driver can safely switch from one fuel to another while driving.



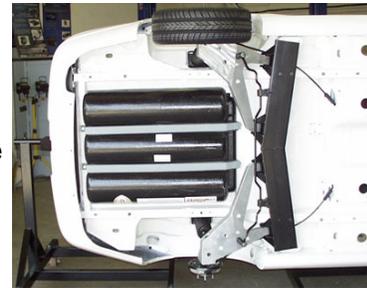
- NGVs are safer. The fuel storage tanks on an NGV are thicker and stronger than gasoline or diesel tanks. There has not been an NGV fuel-tank rupture in more than two years in the United States.
- Natural gas costs are lower than gasoline. On average, natural gas costs one-third less than gasoline at the pump.
- Natural gas is convenient and abundant. A well-established pipeline infrastructure exists in the United States to deliver natural gas to almost every urban area and most suburban areas. There are more than 1,300 NGV fueling stations in the United States, and more are being added every day.
- Natural gas prices have exhibited significant stability compared to oil prices. Historically, natural gas prices have exhibited significant price stability compared to the prices of petroleum-based fuels. This stability makes it easier to plan accurately for long-term costs.
- NGVs have lower maintenance costs. Because natural gas burns so cleanly, it results in less wear and tear on the engine and extends the time between tune-ups and oil changes.

One of the biggest complaints about NGVs is that they aren't as roomy as gasoline cars. This is because NGVs have to give up precious cargo and trunk space to accommodate the fuel storage cylinders. Not only that, these cylinders can be expensive to design and build -- a contributing factor to the higher overall costs of a natural-gas vehicle compared to a gasoline-powered car.



- Limited driving range of NGVs, which is typically about half that of a gasoline-powered vehicle. If a dedicated NGV ran out of fuel on the road, it would have to be towed to the owner's home or to a local natural gas refueling station, which might be harder to find than a "regular" gas station.

- Natural gas, like gasoline, is a fossil fuel and cannot be considered a renewable resource. While natural gas reserves in the United States are still considerable, they are not inexhaustible. Some predict that there are enough natural gas reserves remaining to last another 67.1 years, assuming that the 2003 level of production continues.



- Despite some of the advantages offered by NGVs, they are still relatively uncommon. Gas-powered vehicles outnumber NGVs almost 1,100 to one in the United States.

Two car companies leading the way in NGV design and engineering are Honda and DaimlerChrysler. Honda is the first manufacturer to offer a retail NGV -- the Honda Civic GX sedan, which also comes with a home refueling station the company has dubbed "Phill." The Civic GX is a dedicated NGV, which means it can only run on natural gas.



DaimlerChrysler is manufacturing an E-class Mercedes that runs on both gasoline and natural gas. It is given a classification of "NGT," which stands for "Natural Gas Technology," and can travel 621 miles on a single fueling -- 186 miles using natural gas and 435 miles using gasoline.

While vehicles such as the Civic GX and the E 200 NGT are only available in very limited markets (the former in certain western states, the latter in Europe), NGVs are expected to become more widely available to consumers in the next two decades, especially as the price of oil continues to rise. When that happens, being green will be a little bit easier.

