ALTERNATIVE FUELS

WHAT ARE ALTERNATIVE FUELS

Alternative Fuels are derived from resources other than petroleum. Most are cleaner burning, produced domestically, and often cheaper than gasoline.

CNG - Made by compressing natural gas, a hydrocarbon gas mixture consisting primarily of methane. Used at high pressures, clean burning, limited infrastructure

LPG - A by-product of natural gas processing. The most popular alternative fuel available today. Used at low pressures, clean burning, easy to obtain.

LPG CNG

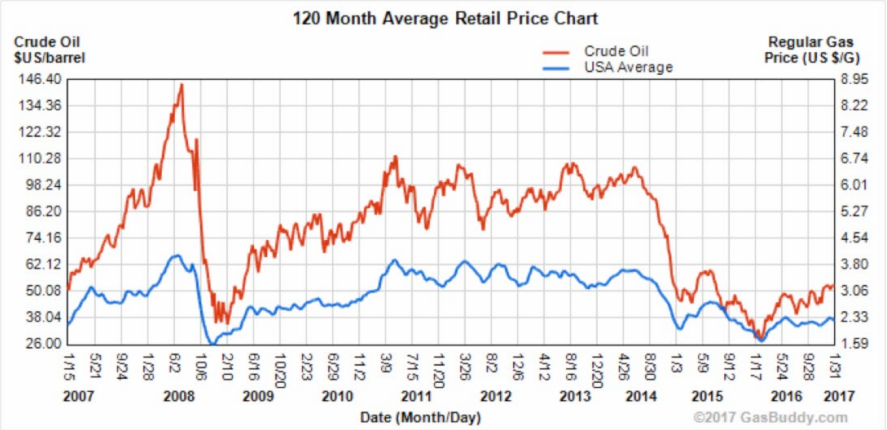
Viable Alternative Fuels

Liquid Propane Gas and Compressed Natural Gas are the most economically viable alternative fuels in the US. Over 90% of CNG and LPG are produced in North America, helping mitigate our dependence on foreign oil.

Established Alternative Fuels

LPG and CNG are also the most widely available fuels with substantial existing infrastructure. These fuels have a long history of use in Public Transportation, Waste Management, Residential and Commercial Construction, Landscaping, as well as many more.

AVERAGE FUEL PRICING



CNG:

$.54 - $2.50
per gallon (equivalent)

LPG:

$.85 - $3.65
per gallon (equivalent)

PROPANE FUEL BASICS

Also known as liquefied petroleum gas (LPG) or propane autogas, propane is a clean-burning, high-energy alternative fuel that's been used for decades to power light, medium, and heavy-duty propane vehicles.

Propane is a three-carbon alkane gas (C3H8). It is stored under pressure inside a tank and is a colorless, odorless liquid. As pressure is released, the liquid propane vaporizes and turns into gas that is used in combustion. An odorant, ethyl mercaptan, is added for leak detection.

Propane has a high-octane rating, making it an excellent choice for spark-ignited internal combustion engines. It presents no threat to soil, surface water, or groundwater. Propane is produced as a by-product of natural gas processing and crude oil refining. It accounts for about 2% of the energy used in the United States. Of that, less than 2% is used for transportation fuel. Its main uses include home and water heating, cooking and refrigerating food, clothes drying, and powering farm and industrial equipment. Rural areas without natural gas service commonly rely on propane as a residential energy source. The chemical industry also uses propane as a raw material for making plastics and other compounds.

PROPANE AS AN ALTERNATIVE FUEL

Interest in propane as an alternative transportation fuel stems mainly from its domestic availability, high-energy density, clean-burning qualities, and its relatively low cost. It is the world's third most common transportation fuel and is considered an alternative fuel under the Energy Policy Act of 1992.

Propane autogas is specified as HD-5 propane and is a mixture of propane with smaller amounts of other gases. According to the Gas Processors Association's HD-5 specification for propane, it must consist of at least 90% propane, no more than 5% propylene, and 5% other gases, primarily butane and butylene.

Propane is stored onboard a vehicle in a tank pressurized to about 150 pounds per square inch—about twice the pressure of an inflated truck tire. Under this pressure, propane becomes a liquid with an energy density 270 times greater than its gaseous form. Propane has a higher octane rating than gasoline, which prevents engine knocking. However, it has a lower British thermal unit (Btu) rating than gasoline, so it takes more fuel to drive the same distance.

PROPANE BENEFITS AND CONSIDERATIONS

Also known as liquefied petroleum gas (LPG), propane is a domestically produced, well-established fuel. Using propane as a vehicle fuel increases energy security, provides convenience and performance benefits, and improves public health and the environment.

ENERGY SECURITY

In 2014, the United States imported about 27% of the petroleum it consumed and transportation accounted for more than 69% of total U.S. petroleum consumption. With much of the worldwide petroleum reserves located in politically volatile countries, the United States is vulnerable to supply disruptions.

Fueling vehicles with propane is one way to diversify U.S. transportation fuels. The vast majority of propane consumed in the United States is produced here and distributed via an established infrastructure. Using propane vehicles instead of conventional vehicles increases U.S. energy security.

VEHICLE AND INFRASTRUCTURE AVAILABILITY

A variety of light, medium, and heavy-duty propane vehicle models are available through original equipment manufacturers (OEMs) and select dealerships

While propane vehicles can cost several thousand dollars more than comparable gasoline vehicles, the cost of propane is typically lower than gasoline, so the return on investment can be quick. Fleets and consumers also have the option of economically, safely, and reliably converting in-use light, medium, and heavy-duty gasoline vehicles for propane operation using qualified system retrofitters. It's critical that all vehicle and engine conversions meet the emissions and safety regulations and standards instituted by the U.S. Environmental Protection Agency, the National Highway Traffic Safety Administration, and state agencies like the California Air Resources Board.

Propane stations are categorized as either primary or secondary, and the methodologies section explains the categories, based upon their experience fueling vehicles. Fleets can use existing public infrastructure or work with local propane marketers to establish private infrastructure. It is important that fleets understand how to negotiate a supply contract. Costs will depend on the volume of fuel that's indicated in the contract and the complexity of the equipment being installed.

FUEL ECONOMY AND PERFORMANCE

Propane at primary infrastructure sites costs less per gallon than gasoline and offers a comparable driving range to conventional fuel. Propane has a higher-octane rating than gasoline (104 to 112 compared with 87 to 92 for gasoline) and potentially more horsepower, but its lower British thermal unit (Btu) rating per gallon results in lower fuel economy. However, the price per gallon can quickly offset the lower fuel economy.

The potential for lower maintenance costs are one reason behind propane's popularity for high-mileage vehicles. Propane's high octane rating, combined with its low-carbon and low oil-contamination characteristics, has resulted in improved engine life compared to conventional gasoline engines. Because the fuel's mixture of propane and air is completely gaseous, cold start problems often associated with liquid fuels can be reduced.

PUBLIC HEALTH AND ENVIRONMENT

Compared with vehicles fueled by conventional diesel and gasoline, propane vehicles can produce lower amounts of some harmful air pollutants and greenhouse gases, depending on vehicle type, drive cycle, and engine calibration.

PROPANE FUELING INFRASTRUCTURE DEVELOPMENT

Infrastructure availability is a driving force behind the acceptance of any fuel. Fleets depend on being able to locate fuel within a reasonable distance at a competitive price, and propane infrastructure is well-established across the United States.

TYPES OF INFRASTRUCTURE

Fuel providers and fleets can place propane dispensers alongside gasoline, diesel, or other alternative fuels. The infrastructure needed for propane is very similar to gasoline and diesel refueling equipment. Propane is transported to the site via a delivery truck and put into onsite storage, traditionally above ground. The fueling dispenser is also similar to a gasoline dispenser. The difference is that propane is delivered to the vehicle under a low pressure so it remains a liquid. When the vehicle tank is full, the dispenser stops automatically, just like gasoline dispensers.

CODES AND SAFETY

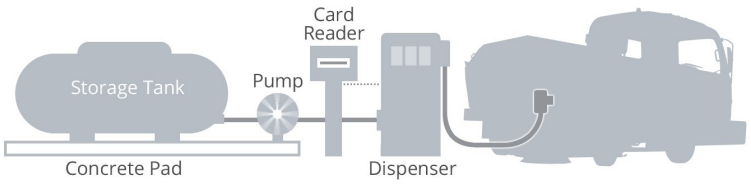
As with any fuel, it's important to know and consider the safety guidelines when establishing infrastructure. This includes the National Fire Prevention Association's NFPA 58 Vehicular Liquefied Petroleum Gas Code, which applies to the design and installation requirements of propane refueling facilities. Your local fire marshal can help with this. In addition, your local propane supplier can help determine the right amount of storage needed to adequately meet vehicle fueling needs.

LPG autogas is less flammable than gasoline, diesel, or CNG and nontoxic. Autogas tanks are 20x stronger than conventional fuel tanks. In the event of an accident autogas dissipates in the air unlike diesel or gasoline.

COST OF FUELING INFRASTRUCTURE

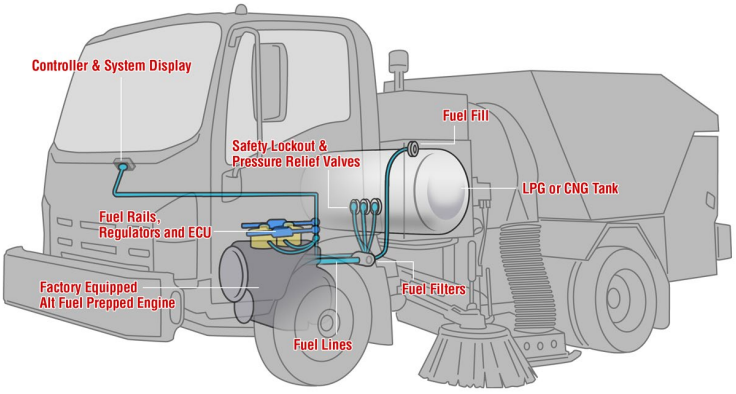
Fortunately, propane production, storage, and bulk distribution capabilities already exist across most of the U.S. That means establishing propane fueling infrastructure for vehicle refueling only requires the build-out of dispensing equipment—including the storage tank, pump, dispenser, and card reader at a station.

PROPANE STATION



Building a New Station: Many suppliers offer an inexpensive lease of the tank, pump, and dispensing equipment in return for a fuel supply contract. In these cases, the station owner or fleet is only responsible for the cost of equipment that cannot be removed from the site when the fuel contract expires, such as the electricity line or the concrete pad for the storage tank. This can make the upfront cost of propane infrastructure very affordable. The cost of establishing private infrastructure, not through a lease, includes purchasing and installing the necessary equipment for storing and dispensing propane and typically runs from $30,000 to $175,000, but varies based on situation and need.

Upgrading Existing Retail Sites: Most propane vehicles can refuel at existing retail sites that sell propane in small volumes, for example to fill grill canisters and mowers. With adequate demand, those sites may upgrade their dispensing equipment to a retail-style metering dispenser with a card reader to accommodate broader vehicle refueling. The pump may also need an upgrade to give vehicles a faster fill rate. It is important to be knowledgeable about what fuel will cost when using existing retail sites that are not primarily vehicle fueling sites.

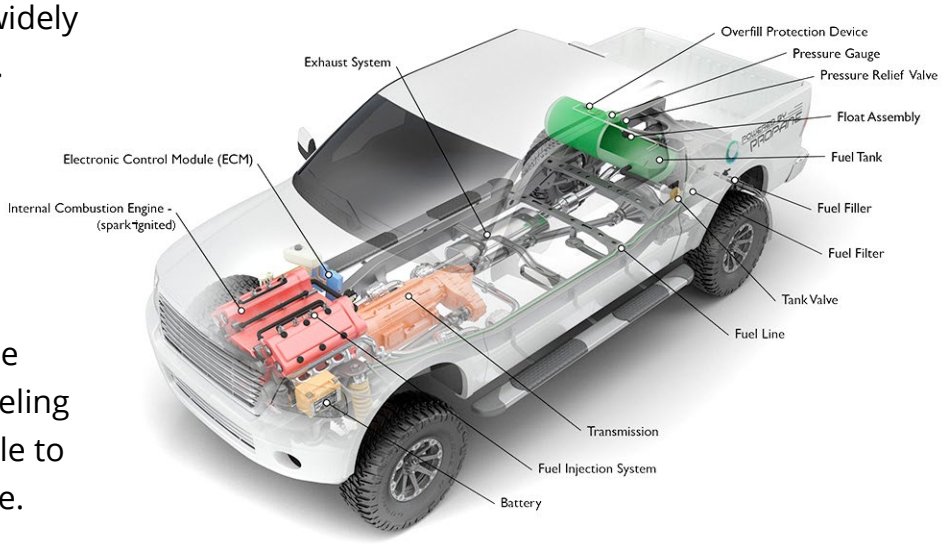


PROPANE VEHICLES

Per the Propane Education and Research Council, there are more than 270,000 on-road propane vehicles in the United States and over 25 million vehicles worldwide. The availability of new light and medium duty propane vehicles has surged in recent years, especially for fleet use. Propane vehicles can either be from an original equipment manufacturer (OEM) or conversions. Engines and fueling systems are also available for heavy-duty vehicles, such as street sweepers and school buses, including some prep-ready engines from OEMs, which are included in equipment packages with components that allow conventional vehicles to run on propane.

TYPES OF PROPANE VEHICLES

Propane vehicles have been widely used and refined for decades. There are two types of propane vehicles: dedicated and bi-fuel. Dedicated propane vehicles are designed to run only on propane, while bi-fuel propane vehicles have two separate fueling systems that enable the vehicle to use either propane or gasoline.



A propane vehicle's power, acceleration, and cruising speed are similar to those of conventionally fueled vehicles. The driving range for dedicated and bi-fuel vehicles is also comparable. Extra storage tanks can increase range, but the tank size and additional weight affect payload capacity.

The potential for lower maintenance costs are one reason behind propane's popularity for use in light and medium duty vehicles. Propane's low carbon and low oil contamination characteristics may result in longer engine life. Propane performs well in cold weather climates because the fuel's mixture (propane and air) is completely gaseous. This factor allows propane-powered vehicles to avoid many cold-start issues associated with using liquid fuels.

270,000

Compared to vehicles fueled with conventional diesel and gasoline, propane vehicles can produce lower amounts of harmful tailpipe emissions, depending on vehicle type, age, and drive cycle.

Propane vehicles are similar to their gasoline counterparts with regard to power, acceleration, cruising speed, and driving range. Because a gallon of propane has 27% less energy than a gallon of gasoline, the fuel economy of propane vehicles is slightly lower. However, propane has a higher octane rating than gasoline (104-112 compared to 87-92 for gasoline), and some original equipment manufacturers (OEMs) offer dedicated engines optimized to take advantage of this higher rating. This can result in improved performance and fuel economy over non-optimized engines.

PROPANE VEHICLE EMISSIONS

Propane has a lower carbon content. When used as a vehicle fuel, propane can offer life cycle greenhouse (GHG) emissions benefits over conventional fuels, depending on vehicle type, age, and drive cycle.

Increasingly stringent emissions regulations have led to the development of improved emissions control systems in conventional light and heavy duty vehicles. These systems effectively control the levels of air pollutants emitted from the vehicle as a result of the combustion of gasoline or diesel fuel. Consequently, emissions from propane vehicles are comparable to those of gasoline and diesel vehicles with modern emissions controls.

Propane is frequently used to replace gasoline in smaller applications, such as forklifts and commercial lawn equipment. Because propane is a low-carbon fuel, a switch to propane in these applications can result in substantial reductions of GHGs.

LIFE CYCLE EMISSIONS

Life cycle analysis is a technique used to assess the environmental impacts of all stages of a product's life, including raw material extraction, processing, manufacturing, distribution, use, and disposal or recycling. When comparing fuels, a life cycle analysis may focus on particular portions of a fuel's life cycle, such as extraction-to-use or well-to-wheels, to determine the merits or problems associated with each fuel.

Argonne National Laboratory's GREET model estimates the life cycle petroleum use and GHG emissions for multiple fuels. When this model is used to evaluate vehicles running on propane, it found that propane use reduced GHG emissions by nearly 10%, and when derived as a by-product of natural gas production, propane reduced petroleum use by 98% to 99%, The Propane Education and Research Council compared GHG emissions from forklifts, buses, and light-duty trucks operating on various fuels in Propane Reduces Greenhouse Gas Emissions: A Comparative Analysis.

CONVERTED VEHICLES

Converting conventional vehicles is a viable option for incorporating propane into medium- and heavy-duty fleet operations. EPA requires conversion system manufacturers to demonstrate that converted vehicles or engines meet or exceed the same emissions standards as the original vehicle or engine. Therefore, it's important that conversions be performed by careful and reputable qualified system retrofitters.

NATURAL GAS FLEET VEHICLES

What is a Natural Gas Vehicle (NGV)?

It's a vehicle powered by natural gas rather than traditional gasoline or diesel fuel. NGVs operate on the same basic principles as traditionally-fueled vehicles but are cleaner for the environment, quieter and more economical.

Urban transportation is a leading cause for poor air quality. Many environmentally conscious individuals are looking hard at NGVs as an energy efficient, cleaner alternative to gasoline vehicles. Many corporations, governmental agencies and other institutions also can benefit greatly by incorporating NGVs into their fleet plans.

Compressed Natural Gas (CNG) vehicles operate on natural gas that has been compressed to take up less storage space. CNG also may be used in diesel-type engines where natural gas replaces the majority of the fuel, but a small amount of diesel is injected as the ignition source.

Liquefied Natural Gas (LNG) also may be used in some applications because the fuel occupies even less space in liquid form. LNG vehicles operate basically the same way as CNG vehicles but the fuel is stored in liquid form and then is vaporized before being introduced to the engine.

KEY BENEFITS OF AN NGV FLEET

- Proven and Reliable – nearly 9 million NGVs are in use worldwide, with more than 120,000 in the U.S.
- Eco-conscious – CNG vehicles are cleaner than traditional vehicles, producing up to 90% fewer emissions than gasoline or diesel. They greatly reduce pollutants from emissions such as CO and NOX, and produce little or no evaporative emissions during fueling and use.
- Energy Efficient – natural gas supplies are abundant domestically, reducing our dependence on foreign oil and weather-related shortages
- Economical – Recent trends in geopolitical events and fuel supply have increased the cost advantage of natural gas over oil and gasoline.
- Reduced Greenhouse Gases - NGVs reduce greenhouse gases 20-29% over diesel and gasoline.
- Quieter – Heavy-duty NGVs have an 80-90% lower decibel level than comparable diesel vehicles

SAFETY

Natural gas is an inherently safe fuel and, unlike gasoline, dissipates into the atmosphere in the event of an accident. The high ignition temperature and limited flammability range make accidental ignition or combustion of natural gas unlikely.

How do I compare the cost/fuel economy of CNG vs. gasoline?

Natural gas is sold in Gasoline Gallon Equivalents (GGE).

One GGE = 1.25 therms of natural gas (approximately)

For example: if the cost of natural gas were $1 per therm, it would be $1.25 per GGE. Now compare that to today's cost of gas at the pump.

There typically is no difference in fuel economy between a CNG vehicle and a gasoline vehicle – if you get 25 mpg with gasoline, you would average 25 miles per GGE with natural gas but it would likely cost much less to fill up.

NGV FUELING

At CNG stations, the gas is typically taken from the local gas utility's line at low pressure, compressed, then dispensed into the vehicle's storage tanks at high pressure. There are two basic types of fueling equipment: fast-fill and time-fill.

- Fast-fill systems combine a compressor and a high-pressure storage system. The storage system, called a cascade, fills the vehicle's fuel tank in about the same time it takes to fuel a regular vehicle.
- Time-fill systems do not have a storage system and typically refuel vehicles overnight at a rate of about one gallon per hour.

Public CNG stations are currently limited, but individual consumers or public/private fleet operators may choose to install their own CNG fueling stations.

WEBSITES

www.afdc.energy.gov

www.buyaltfuels.com