

Comparison between Gasoline, Diesel, CNG, LPG



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Comparison Between

Gasoline

Diesel

CNG

LPG



Gasoline:

Gasoline consists of mixture of **Hydrocarbons** that are **extracted from crude petroleum**. Usually they consist of Hydrocarbons of **low molecular weight** that are quite **volatile** in nature and cover a range normally from **C₅ – C₁₂**.

1) Trade name:

Gasoline is called with different names in different fields. Some of them are mentioned here...

a) Commonwealth countries:

In common wealth countries **gasoline** is usually named as **Petrol**. Word petrol has been taken from **Petroleum spirit**.

b) North America:

In North America fraction is usually known as **Gasoline**.

c) Aviation fields:

In aviation two common terms are spoken as written below...

1. **MOGAS:**

MOGAS is actually the abbreviation of (**Motor + Gasoline**).

2. **AVGAS:**

AVGAS is actually the abbreviation of (**aviation + Gasoline**).

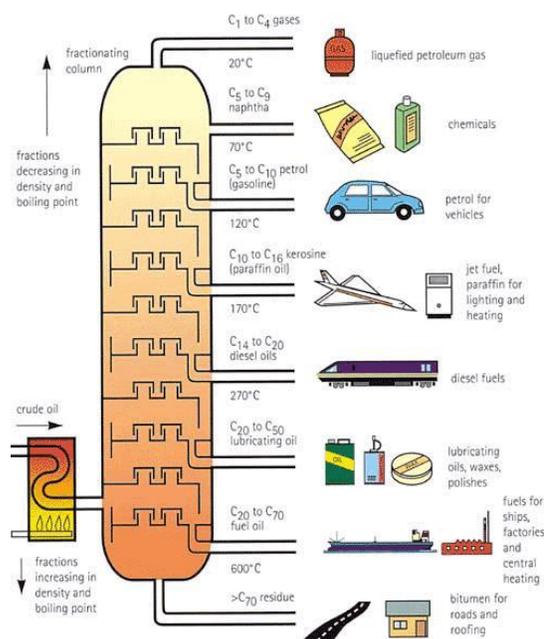
Purpose of these two terms is to differentiate between the **Motor Gasoline & Aviation Gasoline**. As the Gasoline used in **Aviation** is of somewhat **different composition** & hence **different properties**.

2) Production:

Source of gasoline is the **Petroleum or Crude oil**.

Crude oil is **extracted from earth crust** and is further **processed** in order to **separate** those **different fractions** from crude oil that are of significant important and are helpful in meeting the demands of the world.

Gasoline is extracted from crude petroleum via **fractional distillation**. **Heavy fractions** remains at the **bottom** & **light fractions** like gasoline are collected at the **top**.



3) Uses:

Gasoline is used extensively for energy production in different fields. Some of its uses are...

- **Fuel:**

Gasoline is used as fuel for engines in Gasoline engines where sophisticated type of spark plugs Are used to ignite the fuel in a cyclic process and mechanical energy produced during the process is used to run vehicles.

- **chemical agent:**

Previously when it was not used in vehicles extensively than in America it was sold in small bottles as an agent to kill **Lice** & their **Eggs**.

Soon its **use as chemical reagent** against these species was **stopped** because of the **fire hazard** of gasoline and many **skin diseases**.

- **Cleaning fluid:**

Primarily gasoline was also used as **cleaning fluid** to remove **grease stains from clothing** due to its **non- polar nature**.

- **Kitchen ranges:**

Extensively used in **stoves** to be ignited & used as **fuel for kitchen**

- **Lighting:**

It is burned in **lanterns** & hence used for **lighting**.

- **Camping fuel:**

It is used as **camping fuel** for different purposes. This of its use is very extensive in **military**.

4) Advantages:

Advantages of gasoline have been mentioned above in its uses.

5) Volatility:

Gasoline is more volatile than diesel or kerosene because inherently it contains molecules of low molecular weight & high volatility. However, volatility of gasoline is not completely dependent upon its hydrocarbon atom range.

Volatility of gasoline actually depends upon two things.

- Base constituents
- Additives

Additives are added to get desired properties but as a result its volatility is compromised so, to finally control its volatility it is blended with **Butane**.

Reid vapor pressure (RVP) test is used to measure the volatility of Gasoline.

6) Disadvantages:

Gasoline has no. of disadvantages which restrict its use as an extensively used fuel. However, some of them are discussed below.

- **Carcinogenic chemicals:**

It contains Non – aliphatic hydrocarbons especially aromatics like C_6H_6 that are carcinogenic in nature.

- **Source of pollutant gases:**

Gasoline is also one of the sources of pollutant gases. Even gasoline which does not contain lead or sulfur compounds produces carbon dioxide, nitrogen oxides, and carbon monoxide in the exhaust of the engine which is running on it.

- **Photochemical smog:**

Unburnt gasoline when in the atmosphere, react in sunlight to produce photochemical smog. Addition of ethanol increases the volatility of gasoline.

- **Large quantity of soot:**

Uncontrolled burning of gasoline produces large quantities of soot.

- **Vapor phase burning:**

Gasoline burns in vapor phase. If ignition source is present then leaks may be very dangerous.



7) Ignition problems:

Following are the problems with gasoline engines.

- **Hotter climates:**

In hot climates, excessive volatility results in what is known as "vapor lock" where combustion fails to occur, because the liquid fuel has changed to a gaseous fuel in the fuel lines, rendering the fuel pump ineffective and starving the engine of fuel.

Solution:

In hotter climates, gasoline components of higher molecular weight and thus lower volatility are used.

- **Cold climates:**

In cold climates, too little volatility results in cars failing to start.

Solution:

Two things are applied to solve the problem

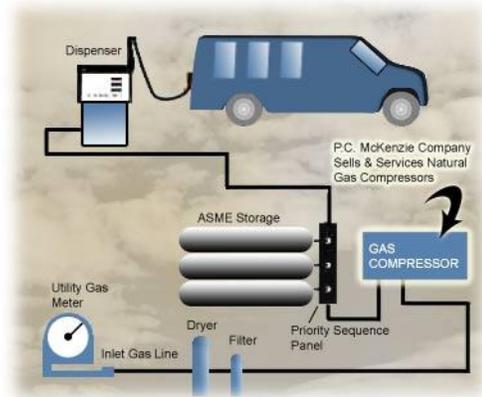
- Using Gasoline component of high molecular weight & lower volatility
- Finally blending with some additives to achieve desired properties

Compressed Natural Gas (CNG)

1. **Compressed Natural Gas (CNG)** is a **fossil fuel** substitute for **gasoline (petrol), diesel, or propane fuel**.
2. Although its combustion does produce greenhouse gases, it is a **more environmentally clean** alternative to those fuels.
3. CNG may also be **mixed** with **biogas**, produced from **landfills or wastewater**, which doesn't increase the concentration of carbon in the atmosphere.

PRODUCTION OF CNG:

- **CNG** is made by **compressing natural gas** (which is mainly composed of **methane [CH₄]**), to less than 1% of its volume at **standard atmospheric pressure**.
- It is **stored** and **distributed** in hard containers, at a normal pressure of **200–248 bar (2900–3600 psi)**, usually in **cylindrical or spherical shapes**.



USES OF CNG:

CNG IS USED IN

- In traditional **gasoline internal combustion** engine cars that have been **converted into bi-fuel** vehicles (gasoline/CNG).
- CNG is starting to be used also in tuk-tuks and pickup trucks, transit and school buses, and trains.
- CNG can be used in **Otto-cycle (gasoline)** and modified **Diesel cycle** engines.



Advantages of CNG:

- ✓ **Low NOX emission** due to **lower combustion** temperature.
- ✓ **High possible power output:** A suitably designed natural gas engine may have a higher output compared with a petrol engine
- ✓ **High octane number than gasoline**
- ✓ **Higher compression ratio:** the **octane number** of natural gas is **higher than that of petrol** as this would allow for an engine design with a **higher compression ratio**
- ✓ **No possibility of fouling of spark plug:** Due to the **absence of any lead or benzene** content in CNG, the **lead fouling of spark plugs is eliminated.**
- ✓ **lower maintenance costs:** when compared with **other fuel-powered vehicles**
- ✓ **No spill and evaporation losses:**
- ✓ **Increased life of lubricating oils:** **CNG** does not contaminate and **dilute the crankcase oil.**
- ✓ **Easy mixing with air for combustion:** **CNG** mixes easily and evenly in air being a gaseous fuel.
- ✓ **High auto ignition temperature:** since it has a **high auto-ignition temperature (540 °C)** and a **narrow range (5%-15%) of inflammability.**
- ✓ **Low pollution content as compared to petrol:** lesser emissions of pollutants like **carbon dioxide (CO₂), hydrocarbons(UHC), carbon monoxide (CO), sulfur oxides (SO_x) and particulate matter (PM),** as compared to petrol

I. An engine running on **petrol** for **100kms** emits **22,000 grams of CO₂**, while covering the **same distance** on **CNG** emits only **16,275 grams of CO₂.**



DISADVANTAGES OF CNG:

- Greater storage space as compared to gasoline gallon equivalent(GGE)
- More number of equipment for gas supply: **pressure regulator , gas injectors , gas mixer**



Comparison of CNG and LNG:

1. **CNG** is gas that is stored (as a gas) at **high pressure**, while **LNG** is in **uncompressed liquid form**

2. **CNG has a lower cost of production and storage** as it does not **require an expensive cooling process**
3. **LARGE VOLUME FOR STORAGE:** CNG requires a **much larger volume** to store **the same mass of gasoline or petrol.**

L N G (LIQUIFIED NATURAL GAS):

Liquefied natural gas or **LNG** is natural gas (predominantly methane, CH_4) that has been converted temporarily to liquid form for ease of storage or transport.

Liquefied petroleum gas

Liquefied petroleum gas is a flammable **mixture of hydrocarbon gases** used as a fuel in heating appliances and vehicles, and increasingly replacing chlorofluorocarbons as an aerosol propellant and a refrigerant to reduce damage to the ozone layer.

1) Trade name:

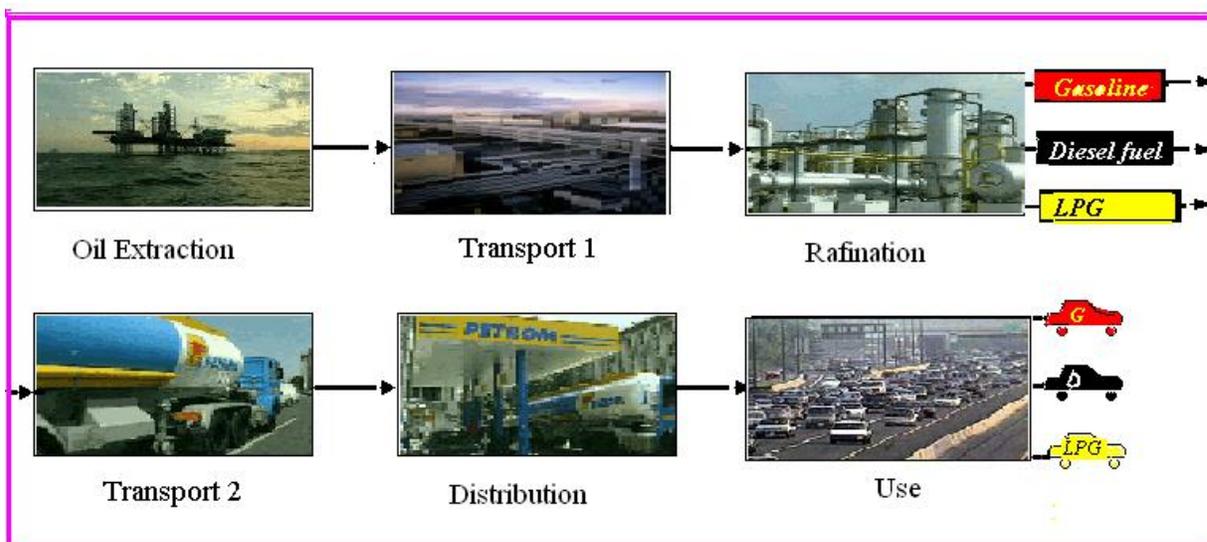
Liquefied petroleum gas has different names. Some of them are mentioned below.

- **LPG (Liquefied petroleum gas)**
- **GPL**
- **LP Gas**
- **Auto gas**

2) Production:

LPG is **synthesized by refining petroleum or "wet" natural gas**, and is usually **derived from fossil fuel sources**, being **manufactured during the refining of crude oil**, or extracted from oil or gas streams as they emerge from the ground. It was **first produced in 1910 by Dr. Walter Snelling**, and the **first commercial products appeared in 1912**.

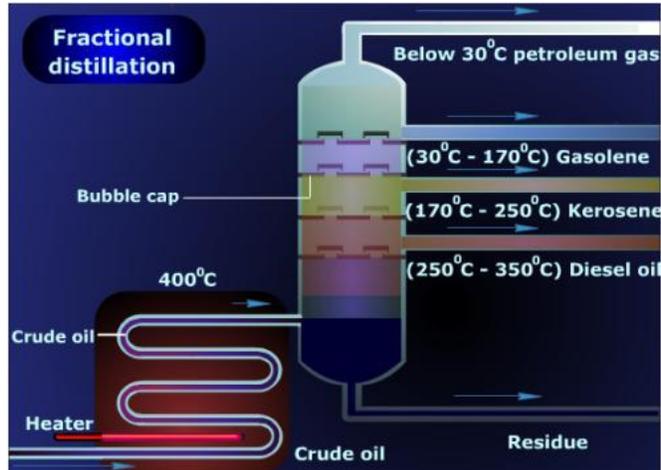
It currently provides **about 3% of the energy consumed**, and **burns cleanly with no soot** and very **few sulfur emissions**, posing **no ground or water pollution hazards**.



Varieties of **LPG** bought and sold include mixes that are **primarily propane**, mixes that are **primarily butane**, and the **more common**, mixes including both **propane C_3H_8 (60%)** and **butane C_4H_{10} (40%)**, depending on the season — in **winter more propane**, in **summer more butane**.

Propylene and butylenes are usually also present in small concentration.

A powerful odorant, ethanethiol, is added so that leaks can be detected easily. The international standard is EN 589. In the United States, thiophene or amyl mercaptan is also approved odorants.



3) Uses:

Use of liquefied petroleum gas is increasing day by day. Let us have a brief look, now days where it is being used?

- Rural heating
- Motor fuel
- Refrigeration
- Cooking

4) Advantages:

- Because LPG vaporizes when released from the tank and is not water soluble, LPG does not pollute underground water sources.
- Power, acceleration, payload and cruise speed are comparable to those of an equivalent vehicle fueled on gasoline. Propane has a high octane rating of 104, in-between Compressed Natural Gas (CNG) (130) and regular unleaded gasoline (87).
- Refueling a propane vehicle is similar to filling a gas grill tank; the time it takes is comparable with that needed to fill a CNG, gasoline or diesel fuel tank.
- Its high octane rating enables it to mix better with air and to burn more completely than does gasoline, generating less carbon. With less carbon buildup, spark plugs often last longer and oil changes are needed less frequently.
- Because it burns in the engine in the gaseous phase, propane results in less corrosion and engine wear than do gasoline.

5) Disadvantages:

The drawbacks of LPG include

- In cold conditions, below 32 degrees Fahrenheit, starting could be a problem because of the low vapor pressure of propane at low temperatures.
- One gallon of LPG contains less energy than a gallon of gasoline. The driving range of a propane vehicle is about 14 percent lower than a comparable gasoline-powered vehicle.
- LPG is generally higher priced than other fuel alternatives such as CNG and gasoline.

- There are over 4,000 LPG refueling sites in the US, more than all of the other alternative fuels combined. Most of these stations, however, are not readily available to consumers on a 24/7 basis. This is one of the reasons why most on-road applications are bi-fuel vehicles, which burn LPG and gasoline.

Diesel fuel:

Diesel fuel in general is any liquid fuel used in Diesel Engines.

Types of diesel:

Diesel fuel as from its definition is the word generally used for any liquid fuel that can be used as a source of energy in diesel engines so, from here it can be of different forms, from different sources and inherently of different nature.

Some of the commonly known types of diesel are written below...

1) Petroleum diesel/petro diesel:

Commonly known diesel which is extensively used in diesel engines of our vehicles is the one we get from the fractional distillation of petroleum or crude oil.

This contains the hydrocarbon atoms ranging from $C_8 - C_{21}$.

Different names of petro diesel:

To distinguish between different types of diesel fuels petro diesel is known with some specific names. These names are either due to some cultural point of view or due to some standards that define the quality of different diesel fractions.

Some of the names commonly known are...

a) Petro diesel:

Because its origin is petroleum

b) Petroleum diesel:

Because diesel has been extracted from crude oil

c) Fossil diesel:

Petro diesel is got from fossil fuels i.e. crude oil.

d) Ultra low sulfur diesel (ULSD):

ULSD is a standard for defining diesel fuel with substantially low sulfur contents. In 2007 all the diesel used in America & Europe was of ULSD type .

e) Diesel Engine Road Vehicle (fuel)/DERV:

In UK, diesel is commonly abbreviated as DERV standing for Diesel Engine Road Vehicle.

2) Biodiesel:

Biodiesel refers to a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat (tallow)) with an alcohol.



Biodiesel is good for your Diesel Car and Environment:

- Fewer emissions
- No contribution to Global warming
- Lubricates Engines
- Equal amount for MPG for petro diesel
- Clean Burning
- Safe
- Saves money

3) Other types of Diesel:

Other types of diesel includes

- Biomass to Liquid (BTL) diesel
- Gas to Liquid (GTL) diesel etc.

4) Uses of Diesel fuel:

Diesel is very commonly used in these fields while many other uses are there as well.

1. Use as **Vehicle Fuel**
2. Use as **Car fuel**
3. Use as **Generator & Ship fuel**

5) Advantages of Diesel fuel:

Following are some of the advantages of using diesel as fuel...

1. No Spark ignition:

Unlike petroleum ether and liquefied petroleum gas engines, **diesel engines do not use high voltage spark ignition (spark plugs).**

An **engine running on diesel compresses the air** inside the cylinder to **high pressures and temperatures (compression ratios from 15:1 to 21:1 are common).**

The **diesel** is generally **injected** directly into the cylinder near the end of the compression stroke. The **high temperatures** inside the cylinder **cause the diesel fuel to react** with the **oxygen** in the mix (burn or oxidize), **heating and expanding the burning mixture** in order to **convert the thermal/pressure difference into mechanical work**; i.e., **to move the piston**. (**Glow plugs** are used to assist starting the engine to preheat cylinders to reach a minimum operating temperature.) **High compression ratios** and **throttle less** operation generally result in **diesel engines being more efficient** than many spark-ignited engines.

2. High Efficiency:

High compression ratios and **throttle less** operation generally result in **diesel engines being more efficient** than many spark-ignited engines.

3. Lower flammability:

High Efficiency and lower **flammability** and **explosivity** of Diesel than gasoline are the main reasons for **military use** of diesel in **armoured fighting** vehicles like **tanks** and **trucks**.

4. Torque:

Engines running on diesel also provide **more torque** and are **less likely to stall** as they are controlled by a mechanical or electronic governor.

5. **Runway failure:**

Since diesel engines **do not require spark ignition**, they can sustain operation as long as diesel fuel is supplied.

6. **Extraction agent:**

Poor quality (high sulfur) diesel fuel has been used as a **palladium extraction agent** for the **liquid-liquid extraction** of this metal from nitric acid mixtures.

Such use has been proposed as a means of **separating the fission product palladium from PUREX raffinate** which comes from **used nuclear fuel**.

In this system of **solvent extraction**, the **hydrocarbons of the diesel act as the diluent** while the **dialkyl sulfides act as the extractant**. This extraction operates by a solvation mechanism.

7. **Better mileage than Gasoline:**

Since **diesel engine is more efficient than Gasoline engine** which results **better Mileage in same quantity of fuel**.

8. **High heating value:**

Diesel provides **high heating value** as compared to gasoline.

6) Disadvantages of diesel fuel:

1) **Environment hazard of Sulfur:**

High levels of sulfur in diesel are harmful for the environment because they prevent the use of catalytic diesel particulate filters to control diesel particulate emissions, as well as more advanced technologies, such as nitrogen oxide (NO_x) adsorbers (still under development), to reduce emissions. Moreover, sulfur in the fuel is oxidized during combustion, producing sulfur dioxide and sulfur trioxide that in presence of water rapidly convert to sulfuric acid, one of the chemical processes that result in acid rain. However, the process for lowering sulfur also reduces the lubricity of the fuel, meaning that additives must be put into the fuel to help lubricate engines. Biodiesel and biodiesel/petro diesel blends, with their higher lubricity levels, are increasingly being utilized as an alternative. The U.S. annual consumption of diesel fuel in 2006 was about 190 billion liters (42 billion imperial gallons or 50 billion US gallons).

2) **Messiness**

Diesel, with its greater viscosity than gas, **is cruder and messier**. It is much easier to spill and slower to evaporate once spilled, making it easy for dirt and dust to settle on it. Diesel in its usable form is generally putrid. Diesel also emits dirty black smoke

when used to run an engine. This is unpleasant to breathe in and to see and can cause air pollution.

3) Noise

Diesel engines are noisier than petrol engines. Despite substantial advances in diesel-engine technology, diesel engines still remain louder as a result of the way the fuel is processed and the manner in which the fuel provides energy

4) Cost

In most countries, diesel costs less than gas, but the long-term costs far outweigh the lower retail price. Diesel engines are less versatile, energetic and fuel efficient than gas engines. Because of this, they require more fuel in the long run, resulting in considerably higher costs. The specialized storage required for diesel also adds to the costs.

In the table below, a brief description of properties has been mentioned and according to each property best fuel with respect to that property has been mentioned in next column. From here we can conclude the best fuel we need for our vehicle & environment.

S. No.	Properties	Gasoline	Petro Diesel	CNG	LPG	Preferred fuel
1	Chemical structure	C ₄ – C ₁₂	C ₁₀ – C ₂₀	CH ₄	C ₃ H ₈ – C ₄ H ₁₀	
2	Cetane no.	5 – 20	40 – 55	-	-	CNG - LPG
3	Octane no.	86 – 94	8 – 15	120+	104	CNG
4	Main fuel source	Crude oil	Crude oil	UNDERGROUND RESERVES	A byproduct of petroleum refining or natural gas processing	CNG
5	Energy content /gallon	109,000-125,000 BTU	128,000-130,000 BTU	At 3000 Psi 33,000-38,000 BTU At 3600 Psi 38,000-44,000 BTU	84,000 BTU	Diesel
6	Energy ratio compared to Gasoline	100%	115% Relative to gasoline	At 3000 Psi $\cong \frac{3.94}{1} \cong 25\%$ At 3600 Psi $\cong \frac{3}{1}$	$\frac{1.36}{1} \cong 74\%$	Diesel
7	Physical state	Liquid	Liquid	Compressed gas	Liquid	Gasoline - Diesel
8	Types of vehicles available today	All type of vehicle classes	Many type of vehicle classes	Many type of vehicle classes	Light-duty vehicles, which can be fueled with propane or Gasoline, Medium & Heavy-duty	Gasoline

					Trucks & Buses that run on propane	
11	Environmental impacts of burning fuel	Produces harmful emissions; however gasoline & Gasoline vehicles are rapidly improving & emissions are being reduced	Produces harmful emissions; however diesel & diesel vehicles are rapidly improving & emissions are being reduced especially with after treatment devices	CNG vehicles can demonstrate a reduction in ozone forming emissions Compared to some conventional fuels; however, HC emissions may be increased	LPG vehicles can demonstrate a 60% reduction in ozone forming emissions compared to reformulated Gasoline	LPG - CNG
12	Energy security impacts	Manufactured using mostly imported oil, which is not an energy secure option	Manufactured using imported oil, which is not an energy secure option	CNG is domestically produced & Pakistan has large reserves of Natural gas	LPG is most widely available alternative fuel. The disadvantage of LPG is that 45% of the fuel in U.S is derived from oil	CNG
13	Fuel availability	Available at all fuel stations	Available at all fuel stations	Now in Pakistan many thousand CNG gas stations are available	LPG is most accessible alternative fuel in Pakistan. Many fuel stations are there at almost every position.	Gasoline
16	Maintenance issues	Tuning required after every month	Tuning required when needed	Tuning required after every month	Some fleets report service lives that are 2-3 years longer, as well as extended intervals between required maintenance	LPG

17	Safety	Gasoline is a relatively safe fuel since people have learned to use it safely. Gasoline is not Biodegradable though, so a spill could pollute soil & water.	Diesel is a relatively safe fuel since people have learned to use it safely. Gasoline is not Biodegradable though, so a spill could pollute soil & water.	Handling somewhat difficult due to storage at high pressure compressed state	Adequate ventilation is important for fueling an LPG vehicle due to increased flammability of LPG. LPG tanks are 20 times more puncture resistant than gasoline tanks & can withstand high impact.	Gasoline - Diesel
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Conclusion:

From the table above and through the whole of this discussion, fact came in front of us that keeping environmental aspects on one side, different fuels are suitable depending upon availability & other factors mentioned above at different places.

In **Pakistan**, as **availability** is of **no issue** & main things concerned are **fuel cost & environmental aspects** so CNG is the best solution

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