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Evolution of Automobile Fuels: The Past, Present and Future: A Review Paper

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Abstract: ***This paper summarises the current state of understanding on Evolution of Automobile Fuels. It explains how the fuels for automobiles have changed over the years since steam as a fuel to biodiesel as a fuel. It also explains what the future of alternative fuels in India is. This paper also shows a comparison between different fuels.***

Keywords: Alternative Fuels, CNG, Biodiesel, Hydrogen Fuel, Electricity as a Fuel

1. Introduction

Over the first 127 years of the automobile, liquid hydrocarbons largely won the battle to serve as transportation fuels because they were best suited to the task. Evolution is all about the ability to adapt to surroundings. Organisms with traits suited to where they exist will thrive, everything else faces extinction or assimilation. What goes in the natural world is often equally true in the realm of the automobile.

It's been more than three centuries since Sir Isaac Newton penned his laws of motion. We'll skip the calculus of how force equals the rate of change of momentum and just cut to the chase. Making a vehicle move requires energy; fuels carry that energy. To be practical for transportation, we need carriers that are energy-dense, inexpensive and easy to handle. Engineers, inventors and other hopefuls have long experimented with a wide assortment of fuels, the vast majority of which fell by the wayside as gasoline and diesel oil rose to dominance in the twentieth century.

As early as 1806, Nicéphore Niépce ran a single-cylinder riverboat engine using a mixture of coal dust and moss spores. Coal dust made a return appearance in an early series of experimental engine tests by Rudolf Diesel in 1892 before he settled on his eponymous compression ignition design. It popped up again in the 1970s when General Motors researchers were looking for alternatives to Middle East oil.

While coal dust is energy dense, plentiful and cheap, it's messy to handle and has some explosive tendencies, as miners can readily attest. This particular evolutionary line has largely died out, but not before sharing some of its DNA with other parts of the fuel family tree through coal-to-liquid processes for producing synthetic gasoline. By the time Karl Benz rolled out his Motorwagen in 1886, gasoline was the preferred energy source, though there were those that preferred batteries. Unfortunately, the batteries of the late 19th and early 20th centuries were sorely lacking in both energy density and durability. The limited range and high cost of early electric vehicles such as the Lohner-Porsche and Detroit Electric prevented them from gaining mainstream acceptance. Despite advances in battery chemistry, that problem persists today.

Discoveries of easily accessible crude petroleum in the late 1800s largely doomed batteries as an automotive fuel source for the next 100 years. Liquid hydrocarbons had all the desired traits with the main downsides being emissions, including carbon dioxide, and supplies that became increasingly concentrated in unstable parts of the world. While gasoline has been the dominant transport fuel, even it has evolved. In fact, there's no such thing as pure gasoline. What we know as gasoline is actually a blend of organic compounds including heptane and octane, plus additives to provide desirable traits like improved cold-start capability and knock resistance. For more than 50 years, tetraethyl lead was added to give gasoline more resistance to self-ignition. Octane inherently has this characteristic but because it comes out later in the crude oil distillation process, it's more expensive. Adding lead to the blend allowed the use of more heptane while staying knock free.Of course, lead has its own problems, including potential brain damage when ingested. The catalytic converter ultimately killed lead in gasoline. The remarkable devices that did so much to clean up automotive emissions were fatally damaged by lead deposits on the catalyst. Since the mid-1970s, lead has been supplanted by a variety of other knock inhibitors, but most pump gasoline today is blended with up to 10 percent ethanol as an alternative.

While various refined petroleum products remain the dominant species today, what the future holds is anyone's guess. Batteries continue to evolve, hydrocarbons derived from non-fossilized biomass, and even hydrogen all show tremendous potential for the future.

2. Discussion

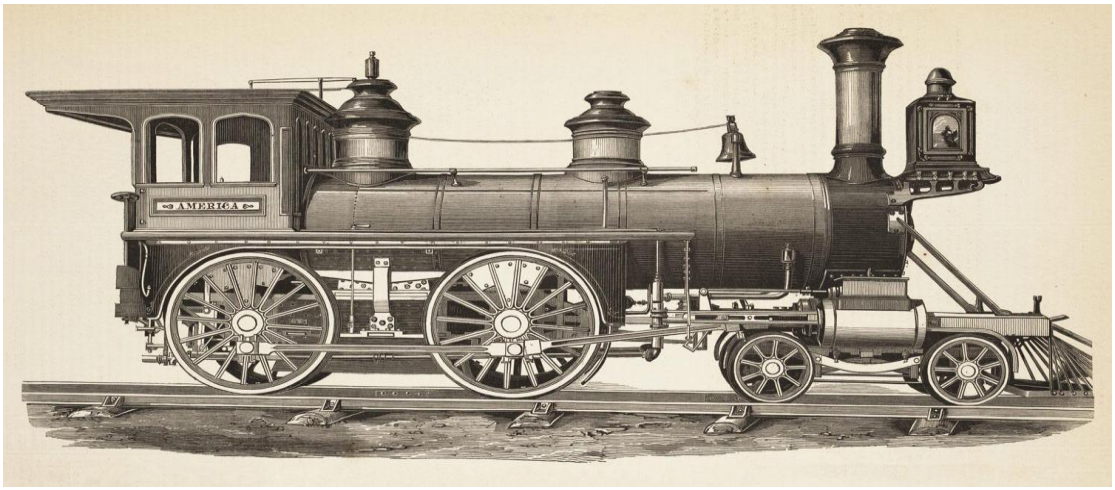
Steam as a Fuel

Most historians agree that Nicolas-Joseph Cugnot of France [1] was the constructor of the first true automobile. Cugnot's vehicle was a huge, heavy, steam-powered tricycle, and his model of 1769 was said to have run for 20 minutes at 2.25 miles (3.6 km) per hour while carrying four people and to have recuperated sufficient steam power to move again after standing for 20 minutes. Steam buses were running in Paris about 1800. English inventors were active, and by the 1830s the manufacture and use of steam road carriages was flourishing. The most successful era of the steam coaches in Britain was the 1830s. Ambitious routes were run, including one from London to Cambridge. But by 1840 it was clear

that the steam carriages had little future. The decline of the steam carriage did not prevent continued effort in the field, and much attention was given to the steam tractor for use as a prime mover. Beginning about 1868, Britain was the scene of a vogue for light steam-powered personal carriages; if the popularity of these vehicles had not been legally hindered, it would certainly have resulted in widespread enthusiasm for motoring in the 1860s rather than in the 1890s. Some of the steamers could carry as few as two people and were capable of speeds of 20 miles (32 km) per hour. The public climate remained unfriendly, however. Light steam cars were being built in the United States, France, Germany, and Denmark during the same period, and it is possible to argue that the line from Cugnot's lumbering vehicle runs unbroken to the 20th-century steam automobiles made as late as 1926. The grip of the steam automobile on the American imagination has been strong ever since the era of the Stanley brothers—one of whose "steamers" took the world speed record at 127.66 miles (205.45 km) per hour in 1906. The car designed by them and sold as the Locomobile became the first commercially successful American-made automobile (about 1,000 were built in 1900). It is estimated that in the early 21st century there were still some 600 steam cars in the United States, most of them in running order.

Why steam engines are no longer manufactured?

The reason is steam lost favour when you consider fuel efficiency and power to weight ratio, compared to diesel engines. [2] Another factor is that the fuel used (coal) is less convenient to handle/load than liquid fuels such as diesel or heavy oil. That said, steam engines are still used in some military vessels that are nuclear powered. In those cases, nuclear fuel heats water and the steam formed drives a turbine (piston engines ceased to be used 100 years ago). However, in the vast majority of cases the engine does not drive the propeller directly, rather it drives an electrical generator, which then provides power to an electrical motor that drives the propeller. This is because the RPM of the steam turbine is too high for a propeller, and gear reductions add a lot of mechanical bulk, complexity and points of failure. Also, development was hampered by adverse legislation from the 1830s and then the rapid development of internal combustion engine technology in the 1900s, leading to their commercial demise. Huge size of Engine adds to the weight of the automobile leading to bad handling, economy etc. Also, steam locomotives demanded expensive maintenance. Once a month, by law, the cisterns had to be cleaned up, each engine required a consistent, broad renovation; and etc. With all of these cares and renovations, the machines were only available for work just 35% of the time, while diesel engines had an availability of 95% since they didn't require that much maintenance. More expensive cars as compared to IC engine vehicles. Underdeveloped technology as compared to IC engine.



Diesel Fuel

After World War II the diesel engine, particularly for light trucks and taxis, became popular in Europe because of its superior fuel economy and various tax incentives. [3] During the 1970s General Motors converted some gasoline passenger-car engines to the more economical compression-ignition diesel operation, and Mercedes-Benz, Volkswagen, and Peugeot marketed diesel lines in America that derived from their European models. The ebbing of fuel shortages and the easing of gasoline prices, combined with various drawbacks to diesel engines (noise, poor cold-weather starting, limited fuel and service in some communities), reduced American demand by the early 1980s. Europe, which had not embraced diesels for private passenger cars, reversed course with the development of environmentally friendly common rail direct-injection diesel engines in the late 1990s. By 2005 diesel cars represented roughly half of all European passenger car sales.

Petroleum products normally used as fuel for diesel engines are distillates composed of heavy hydrocarbons, with at least 12 to 16 carbon atoms per molecule. These heavier distillates are taken from crude oil after the more volatile portions used in gasoline are removed. The boiling points of these heavier distillates range from 177 to 343 °C (351 to 649 °F). Thus, their evaporation temperature is much higher than that of gasoline, which has fewer carbon atoms per molecule. In the United States, specifications for diesel fuels are published by the American Society of Testing and Materials (ASTM).Water and sediment in fuels can be harmful to engine operation; clean fuel is essential to efficient injection systems. Fuels with a high carbon residue can be handled best by engines of low-speed rotation. The same applies to those with high ash and sulphur content. The cetane number, which defines the ignition quality of a fuel, is determined using ASTM D613 "Standard Test Method for Cetane Number of Diesel Fuel Oil."

In addition, they have been used in automobiles, albeit on a limited scale. Although diesels provide better fuel economy than gasoline engines, they do not run as smoothly as the latter and emit higher levels of pollutants.

- **Petrol Fuel (Gasoline)**

Most authorities are inclined to honour Karl Benz and Gottlieb Daimler of Germany [4] as the most important pioneer contributors to the gasoline-engine automobile. Benz ran his first car in 1885, Daimler in 1886. Although there is no reason to believe that Benz had ever seen a motor vehicle before he made his own, he and Daimler had been preceded by Étienne Lenoir in France and Siegfried Marcus in Austria, in 1862 and 1864–65, respectively, but neither Lenoir nor Marcus had persisted. Benz and Daimler did persist—indeed, to such a purpose that their successor firm of Daimler AG can trace its origins as far back as 1885. Gasoline was originally considered dangerous and was discarded and destroyed at early refineries, which were manufacturing kerosene for lamps. As the gasoline engine developed, gasoline and the engine were harmonised to attain the best possible matching of characteristics. The most important properties of gasoline are its volatility and antiknock quality. Volatility is a measure of the ease of evaporation of gasoline, which is adjusted in the production process to account for seasonal and altitude variations in the local market. Properly formulated gasoline helps engines to start in cold weather and to avoid vapour lock in hot weather. To suit the needs of a modern engine, a gasoline must have the volatility for which the fuel system of the engine was designed and an antiknock quality sufficient to avoid knock under normal operation. Although other specifications must also be met, volatility and knock rating are the most important. The size and structural arrangement of the molecules principally determine the knocking tendency of a gasoline as well as its volatility. Tetraethyl lead, added to gasolines for many years to improve antiknock fueling, has been found to contaminate the

exhaust gases with poisonous lead oxides, and so the practice has ended. Lower compression ratios and improved combustion-chamber designs have eliminated the need for extremely high-antiknock gasoline. Lubricating oil is added to gasoline used in crankcase-compression two-stroke-cycle engines.

- **LPG and Gasoline**

Also known as liquefied petroleum gas (LPG) or propane [5] autogas, propane is a clean-burning alternative fuel that's been used for decades to power light-, medium-, and heavy-duty propane vehicles. It is stored under pressure inside a tank as a colourless, odourless liquid. As pressure is released, the liquid propane evaporates 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. If spilled or released from a vehicle, 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.Interest in propane as an alternative transportation fuel stems from its domestic availability, high-energy density, clean-burning qualities, and relatively low cost. It is the world's third most common transportation fuel, behind gasoline and diesel, and is considered an alternative fuel under the Energy Policy Act of 1992.For vehicle fueling, the quick-release "Type K15" dispenser connector is required to be installed on all new vehicles beginning January 1, 2020, per National Fire Protection Association Code 58. This connector allows for one-handed fueling and does not require the use of personal protective equipment such as gloves and face shield (which are required for the older style connector).

Propane is stored onboard a vehicle in a tank pressurised 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, so it can be used with higher engine compression ratios and is more resistant to engine knocking.

- **Why we should try to avoid petroleum fuel?[6]**

1) **Combustion contributes dangerous gases to the environment:** Petroleum, when it is combusted, generates high levels of carbon dioxide. Methane and other greenhouse gases can be produced as well, depending on how the petroleum has been refined. Traces of sulphur enter the atmosphere as well, even when the petroleum is classified as being sweet. This may be a contributing factor to environmental changes that have been observed since the 1970s.
2) **Petroleum is a finite resource:** Petroleum is a fossil fuel, so it is a resource that has limitations. We do keep finding new deposits of petroleum to exploit, which provides new reserves for us to stockpile, but at some point, those reserves may run out. Some estimations suggest that two-thirds of the world's petroleum resources may have already been used.
3) **The refinement process of petroleum can be toxic:** Petroleum on its own can be lethal to all forms of life in some way. At just 0.4% concentration levels, it is lethal to fish. The benzene that is present in crude oil and the fuels refined from it is a known carcinogen. Exposure to petroleum lowers white blood cell counts in humans, which makes them more susceptible to illnesses. Research from La Leva di Archimede suggests it may take just 5 years of exposure in just a few parts per billion to terminal cancers and immune system diseases.
4) **Petroleum can be a trigger for acid rain:** When petroleum combusts, it creates a high temperature impact with the surrounding air. That causes the nitrogen in the atmosphere to oxidise. Nitrous oxide, when combined with the sulphur content that is found in petroleum, can combine with atmospheric moisture to create acid rain. When it falls, acid rain can create acidic waters in lakes, ponds, and rivers. Even coral reefs can be directly affected by acid rain when it falls.
5) **Petroleum transportation isn't 100% safe:** Business Insider reports that more than 9 million gallons of petroleum have spilled from US transportation networks from 2010-2016. More than 1,300 total spills occurred during that period, which equates to one spill every 2 days. More than 73,000 miles of pipeline transport petroleum every day, plus more is transported by tankers and trains.
6) **It is a commodity that is exploited for political purposes:** The value of petroleum makes it a resource that every side of the political spectrum rainbow attempts to exploit. Nations go to war over petroleum resources. Terrorists attempt to sabotage petroleum networks. Dictators can take control over a nation's resources, amass billions or trillions in funds, and then use that value to violently suppress people.

- **Need of Alternative Fuels [7]**

1) Conventional fuels are going to run out: One day, our sources for traditional fuels including petroleum would be depleted. Owing to the fact that these fuels are typically not renewable, a lot of people are worried that a day would come when the demand for these fuels would be more than the supply, triggering a considerable world crisis.
2) To reduce pollution: The use of alternative fuels considerably decreases harmful exhaust emissions (such as carbon dioxide, carbon monoxide, particulate matter and sulphur dioxide) as well as ozone-producing emissions.
3) To protect against global warming: According to a commonly accepted scientific theory, burning fossil fuels was causing temperatures to rise in the earth's atmosphere (global warming). Though global warming continues to be just a theory, a lot of people across the globe are of the belief that discovering sources of cleaner burning fuel is an essential step towards enhancing the quality of our environment.
4) To save money: Alternative fuels can be less expensive to use not just in terms of the fuel itself but also in terms of a longer service life. This in turn means savings for the long term.
5) Can reuse waste: Biofuels, bioproducts, and biopower provide modern and fresh relevance to the old belief that trash for one person is a treasure for another. That's good news considering that Americans produce in excess of 236 million tons of waste each year.
6) More choices: People are different. Each person has his own requirements, opinions, and preferences. One great thing about alternative fuels and the corresponding vehicles that run on them is that there is something to suit any lifestyle.
7) You'll be helping the farmers: The use of biofuels that depend on crops produced and processed locally help to support farmers for their dedicated and hard labour. Biodiesel and ethanol cooperatives are a result of the great outmoded farmer cooperatives that assist with returning power to the hands of the people.
8) Can frequently be produced domestically: Often, alternative fuels can be developed domestically, utilising a country's resources and thereby strengthening the economy.
9) Fuel economy: Vehicles driven on hydrogen fuel cells and diesel are more economical with respect to fuel compared to an equivalent gasoline vehicle.
10) More convenience: Wireless charging is one of the factors that make alternative fuels more convenient. Automaker Nissan already displayed the technology in concert along with a parking assist system which mechanically guides the vehicle to its "docking station" or parking spot. The driver just presses a button or utters a command, releases control over the wheel, and the vehicle takes care of the rest. Once the vehicle is parked, the driver just turns the car off, closes the door, and carries on with his business. No need to go to the gas station and no plugs. All that's required is low-cost electricity and adequate gas in the tank whenever you have to travel in your car.

- **Electricity as a Fuel**

Electricity is considered an alternative fuel under the Energy Policy Act of 1992. Electricity can be produced from a variety of energy sources, including natural gas, coal, nuclear energy, wind energy, hydropower, as well as solar energy and stored as hydrogen or in batteries. Electric vehicles (EVs) [8] —the collective term for plug-in hybrid electric vehicles (PHEVs) and all-electric vehicles—are capable of drawing electricity from off-board electrical power sources (generally the electricity grid) and storing the energy in batteries. Though not yet widely available, fuel cell electric vehicles (FCEVs) generate electricity from hydrogen onboard the vehicle.In EVs, onboard batteries store energy to power one or more electric motors. These batteries are charged using electricity from the grid and energy recaptured during braking, known as regenerative braking. Vehicles that run only on electricity produce no tailpipe emissions, but there are upstream emissions associated with the production of electricity. Powering EVs with electricity is currently cost effective compared to using gasoline, but EVs typically cost more to purchase. However, initial vehicle costs can be offset by energy cost savings, a federal tax credit, and state incentives.

Electricity for charging vehicles is especially cost effective if drivers can take advantage of off-peak residential rates and other incentives offered by many utilities. The cost is dependent on the price of electricity, which can vary by region, type of generation, time of use, and access point. Many EV owners choose to do the majority of their charging at home (or at fleet facilities, in the case of commercially owned fleets) where the cost to charge will typically be lower than at public chargers. Some employers offer access to workplace charging. In many cities, EV drivers also have access to public charging stations in a variety of places, such as shopping centres, public parking garages and lots, hotels, and businesses. Public charging infrastructure is rapidly expanding, providing drivers with the convenience, range, and confidence to meet their transportation needs.

- **Advantages and disadvantages of using electricity as an alternative fuel**

Advantages	Disadvantages
• Produced almost entirely from domestic resources	• Less environmental advantages in areas where electricity is produced from fossil fuels
• Typically more cost-efficient and prices more stable than gasoline	• Vehicles are typically more expensive
• Vehicles can be charged at home	• Vehicle range is typically shorter than for gasoline and diesel vehicles
• Availability of public charging stations growing rapidly	• Re-charging takes significantly longer than re-fueling with other fuels
• Electric motors are more efficient than internal combustion engines	
• Federal tax incentives available for plug-in vehicles; Delhi Govt. provides subsidy on purchase of electric vehicles	

- **CNG**

Natural gas [9] is an odourless, gaseous mixture of hydrocarbons—predominantly made up of methane (CH4). It accounts for about 30% of the energy used in the United States. About 40% of the fuel goes to electric power production and the remaining is split between residential and commercial uses, such as heating and cooking, and industrial uses. Although natural gas is a proven, reliable alternative fuel that has long been used to power natural gas vehicles, only about two-tenths of 1% is used for transportation fuel. Alternatively, renewable natural gas (RNG), also known as biomethane, is a pipeline-quality vehicle fuel. It is produced by purifying biogas, which is generated through anaerobic digestion of organic materials—such as waste from landfills and livestock—or through thermochemical processes, such as gasification. RNG qualifies as an advanced biofuel under the Renewable Fuel Standard. Because RNG is chemically identical to fossil-derived conventional natural gas, it can use the existing natural gas distribution system and must be compressed or liquefied for use in vehicles.

Two forms of natural gas are currently used in vehicles: compressed natural gas (CNG) and liquefied natural gas (LNG). Both are domestically produced, relatively low priced, and commercially available.

Compressed Natural Gas: CNG is produced by compressing natural gas to less than 1% of its volume at standard atmospheric pressure. To provide adequate driving range, CNG is stored onboard a vehicle in a compressed gaseous state at a pressure of up to 3,600 pounds per square inch. CNG is used in light-, medium-, and heavy-duty applications. A CNG-powered vehicle gets about the same fuel economy as a conventional gasoline vehicle on a GGE basis. One GGE equals about 5.66 pounds of CNG.

Liquefied Natural Gas: LNG is natural gas in its liquid form. LNG is produced by purifying natural gas and super-cooling it to -260°F to turn it into a liquid. During the process known as liquefaction, natural gas is cooled below its boiling point, removing most of the extraneous compounds found in the fuel. The remaining natural gas is primarily methane with small amounts of other hydrocarbons. Because of LNG's relatively high production cost, as well as the need to store it in expensive cryogenic tanks, the fuel's use in commercial applications has been limited. LNG must be kept at cold temperatures and is stored in double-walled, vacuum-insulated pressure vessels. LNG is suitable for trucks that require longer ranges because liquid is denser than gas and, therefore, more energy can be stored by volume. LNG is typically used in medium- and heavy-duty vehicles. One GGE equals about 1.5 gallons of LNG.

- **Advantages and Disadvantages of Using CNG as an alternative fuel**

Advantages	Disadvantages
• Environment Friendly: CNG is clean fuel. It produces very less hydrocarbon emissions than LPG and petrol.	• CNG Gas stations have limited availability. So if your country or state doesn't have CNG stations, it is of no use. In India some states have good CNG Stations networks.
• CNG is Economic: CNG is cheaper than petrol and LPG. It saves money.	• A CNG tank requires large boot space and it is heavy. So it affects car performance.
• Clean Engine: CNG is good for car engines. CNG doesn't harm car engines which happens in LPG. Also spark plugs and converters remain good in CNG.	• CNG gas kit Cost: CNG gas kit prices are between 20000 Rs to 30000 Rs. But it can be recovered by fuel savings.
• Ease of Use and Flexibility: Car runs on both CNG and Petrol. So it's an option for petrol.	
• Lubrication: It requires less lubrication.	

- **Hydrogen Fuel**

Hydrogen (H2) [10] is an alternative fuel that can be produced from diverse domestic resources. Although the market for hydrogen as a transportation fuel is in its infancy, government and industry are working toward clean, economical, and safe hydrogen production and distribution for widespread use in fuel cell electric vehicles (FCEVs). Light-duty FCEVs are now available in limited quantities to

the consumer market in localised regions domestically and around the world. The market is also developing for buses, material handling equipment (such as forklifts), ground support equipment, medium- and heavy-duty trucks, marine vessels, and stationary applications. Hydrogen is abundant in our environment. It's stored in water (H2O), hydrocarbons (such as methane, CH4), and other organic matter. One challenge of using hydrogen as a fuel is efficiently extracting it from these compounds.

Currently, steam reforming—combining high-temperature steam with natural gas to extract hydrogen—accounts for the majority of the hydrogen produced in the United States. Hydrogen can also be produced from water through electrolysis. This is more energy intensive but can be done using renewable energy, such as wind or solar, and avoiding the harmful emissions associated with other kinds of energy production.

Hydrogen is considered an alternative fuel under the Energy Policy Act of 1992. The interest in hydrogen as an alternative transportation fuel stems from its ability to power fuel cells in zero-emission vehicles, its potential for domestic production, and the fuel cell's fast filling time and high efficiency. In fact, a fuel cell coupled with an electric motor is two to three times more efficient than an internal combustion engine running on gasoline. Hydrogen can also serve as fuel for internal combustion engines.

- **Advantages and Disadvantages of Using FCEV as an Alternative Fuel**

Advantages	Disadvantages
• The propulsion in hydrogen fuel cell cars is purely electrical hence almost zero emissions.	• Currently, the biggest shortcoming of hydrogen fuel cell cars is the sparsity of options for refueling. At the end of 2019 there are only around 40 in the U.S., and approx. 80 in Germany.
• Quick charging time.The hydrogen tanks of fuel cell cars are full and ready to go again in less than five minutes.	• They are relatively expensive to buy. They almost cost twice as much as comparable fully electric or hybrid vehicles.
• For the time being, hydrogen cars still have a longer range than purely electric cars.	• Storage of hydrogen fuel is more complex due to its highly inflammable property.
• The range of fuel cell vehicles is not dependent on the outside temperature. In other words, it does not deteriorate in cold weather.	

- **Biodiesel Fuel**

Biodiesel [11] is a renewable, biodegradable fuel manufactured domestically from vegetable oils, animal fats, or recycled restaurant grease. Biodiesel meets both the biomass-based diesel and overall advanced biofuel requirement of the Renewable Fuel Standard. Renewable diesel, also called “green diesel,” is distinct from biodiesel.

Biodiesel is a liquid fuel often referred to as B100 or neat biodiesel in its pure, unblended form. Like petroleum diesel, biodiesel is used to fuel compression-ignition engines.

Biodiesel and conventional diesel vehicles are one and the same. Although light-, medium-, and heavy-duty diesel vehicles are not technically alternative fuel vehicles, almost all are capable of running on biodiesel blends.[12] The most common biodiesel blend is B20, which ranges from 6% to 20% biodiesel blended with petroleum diesel. However, B5 (a biodiesel blend of 5% biodiesel, 95% diesel) is also commonly used in fleet vehicles. B20 and lower-level blends can be used in many diesel vehicles without any engine modification.

Biodiesel raises the cetane number of the fuel and improves fuel lubricity. A higher cetane number means the engine is easier to start and reduces ignition delay. Diesel engines depend on the lubricity of the fuel to prevent moving parts from wearing prematurely. Improved lubricity reduces friction within the moving parts, avoiding additional wear. A primary advantage of biodiesel is that it can improve the lubricity of the fuel at blend levels as low as 1%.

All original equipment manufacturers (OEMs) approve the use of B5. However, it is important to check the OEM engine warranty to ensure that higher-level blends of this alternative fuel are approved, such as B20.

- **Advantages and Disadvantages of Using Biodiesel as an Alternative Fuel**

Advantages	Disadvantages
• Produced From Renewable Resources	• Variation in Quality of Biodiesel
• It can be used in existing diesel engines with little or no modifications at all and can replace fossil fuels.	• Not Suitable for Use in Low Temperatures
• Less Greenhouse Gas Emissions Experts believe that using biodiesel instead of petroleum diesel can reduce greenhouse gases up to 78%.	• Biodiesel Could Harm the Rubber Houses of Some Engines
• Biofuel refineries, which mainly use vegetable and animal fat into biofuel, release less toxic chemicals, if spilled or released to the environment.	• Biodiesel is Way More Expensive than Petroleum
• When biofuels are burnt, they produce significantly less carbon output and few pollutants.	• Clogging in Engine
	• Fuel Distribution

- **What is the future of alternative fuels in India?**

Alternative fuels are non-conventional and advanced fuels, which can be used in place of existing fossil fuels like petroleum products, coal, natural gas and others. They are preferred across the globe over conventional fuels because of their obvious advantages like relatively low cost, environmental and emission benefits, domestic availability, employment generation, storage benefit etc. Bio-diesel, bio-alcohol like methanol, ethanol, butane, refuse or waste-derived fuel, chemically stored electricity like batteries and fuel cells, hydrogen, non-fossil methane, non-fossil natural gas, vegetable oil, propane and other biomass sources are some of the alternative fuels, being used across the globe. Owing to the rising cost and environmental factors attached to conventional fuels, options for alternative fuel vehicles are getting larger in number. From electricity-run cars and propane vehicles to natural gas-powered buses and trucks running on biodiesel, the use of alternative fuels is becoming a craze like never before. The flashpoint for biodiesel is much higher than the petroleum products, which is also good for automobiles. Moreover, unlike conventional energy sources, alternative fuels have various sources to be harnessed for varied purposes. In a country where we need millions of new jobs every year, renewable energy creates new job opportunities also. Nitin Gadkari, [13] in a recent programme, stated that automobile companies will start manufacturing flex-fuel variants within six months and that most vehicles in India will soon run on 100% ethanol. Gadkari also said that the government is working on a plan to shift public transportation to 100% clean energy sources. Flex-fuel has been gaining traction as an alternate, environment-friendly fuel that can combat rising fuel prices, as well as aid in switching to full electrification in the future.

Interestingly, Green Hydrogen can be generated from renewable energy and abundantly available biomass. Introduction and adoption of technology to tap into the Green hydrogen's potential will play a key role in securing a clean and affordable energy future for India.

In recent years, central and various state governments have focused much on the use of ethanol as an alternative energy source. The good thing is that the ratio of ethanol to petrol can be adjusted to any combination, but presently the most commonly used flex-fuels use 85% petrol and 15% ethanol. It is also important to mention that flex-fuel requires minimal modifications to the fuel system and engine to effectively use the fuel. This is in contrast with CNG cars. Therefore, flex-fuel compatibility has to be factory-engineered and cannot be fitted or modified in the after-market. Though, the need of alternative fuels is always there, however a crisis like Russia-Ukraine conflict, often gives a rise to this need. The way crude oil prices remain to be up, causes a great deal of economic stress to a country which depends hugely on crude imports. As per the data from the oil ministry's Petroleum Planning and Analysis Cell (PPAC), India's crude oil import may exceed 100 dollar in the current fiscal year as India has already spent 94.3 billion dollar in the first 10 months of the ongoing financial year. In January this year alone, India spent 11.6 billion dollars. The problem gets exacerbated as India faces a steady decline in domestic output of crude oil. India has produced 23.8 million tonnes of crude oil in the first 10 months of this year. In such a scenario, focus shifts on alternative fuels.

3. Conclusion

Advantages	Disadvantages
• Environmental benefits: Low or zero carbon emission .Solar and wind power virtually produce zero carbon emissions.	• High cost. Unfortunately, the technologies that utilise alternative sources of energy remain relatively expensive.
• Increased energy security: Utilisation of alternative energy significantly reduces dependence from the international energy supplies which in turn increase energy security by providing a stable and cost-effective energy supply.	• Low efficiency. Alternative energy technologies are relatively new in offices and are not particularly efficient.
• Sustainability: alternative forms of energy are renewable which means that they offer sustainable and stable energy supply in the long term.	• Issues with the stability of the system. The energy sector is not only seeking alternative solutions to lower carbon dioxide emissions but to meet the rising demand for energy as well.

References

[1] **[ONLINE]** https://www.britannica.com/technology/automobile/History-of-the-automobile#ref259060
[2] **[ONLINE]** https://www.quora.com/Why-do-we-no-longer-use-steam-engines
[3] **[ONLINE]** https://www.britannica.com/technology/diesel-engine
[4] **[ONLINE]** https://www.britannica.com/technology/gasoline-engine/Fuel
[5] **[ONLINE]** https://afdc.energy.gov/fuels/propane_basics.html

[6] **[ONLINE]** https://vittana.org/12-advantages-and-disadvantages-of-petroleum
[7] **[ONLINE]** https://www.cleverism.com/10-reasons-to-use-alternative-fuels/
[8] **[ONLINE]** https://afdc.energy.gov/fuels/electricity_basics.html#:~:text=Electricity%20is%20considered%20an%20alternative,as%20hydrogen%20or%20in%20batteries.
[9] **[ONLINE]** https://afdc.energy.gov/fuels/natural_gas_basics.html
[10] **[ONLINE]** https://afdc.energy.gov/fuels/hydrogen_basics.html#:~:text=Hydrogen%20is%20considered%20an%20alternative,filling%20time%20and%20high%20efficiency.
[11] **[ONLINE]** https://afdc.energy.gov/fuels/biodiesel_basics.html
[12] **[ONLINE]** https://afdc.energy.gov/vehicles/diesel.html
[13] **[ONLINE]** https://newsonair.com/2022/03/16/alternative-fuels-fast-becoming-the-preferred-ones-know-how-and-why/

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