Fuel Energy

Subjects: Energy & Fuels

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Most fuels are natural compounds, such as petro fuel, diesel, and natural gas, either taken directly from the ground or refined from petroleum. Fuels can be categorized according to various forms. They are classified as solid, liquid, and gaseous fuels based on their physical appearance. Primary and secondary sub-classifications categorize wood, coal, and peat as primary fuels and coke and charcoal as secondary solid fuels. Similarly, petroleum is a primary liquid fuel; diesel, gasoline, kerosene, LPG, ethanol, and biodiesel are secondary biofuels. Finally, there is another category of fuels similar to gaseous fuels, in which natural gas is a perfect sample of primary gaseous fuel. On the other hand, hydrogen, propane, methane, coal gas, and water gas are secondary gaseous fuels. In addition, petrol, gas oil, diesel fuel, fuel oils, aviation fuel, jet fuel, and marine fuel are typical forms of fuel. Another classification is based on the purpose of fuel. For example, materials burnt to generate nuclear energy are called nuclear fuels, and those producing heat are called thermal fuels. The burning of plutonium produces nuclear energy. When burning coal, wood, oil, or gases, they produce heat.

biofuels Fuel Energy

1. Classification of Fuels

Table 1 shows the general classification of fuels, and **Figure 1** shows the detailed classification based on their physical state and occurrence.

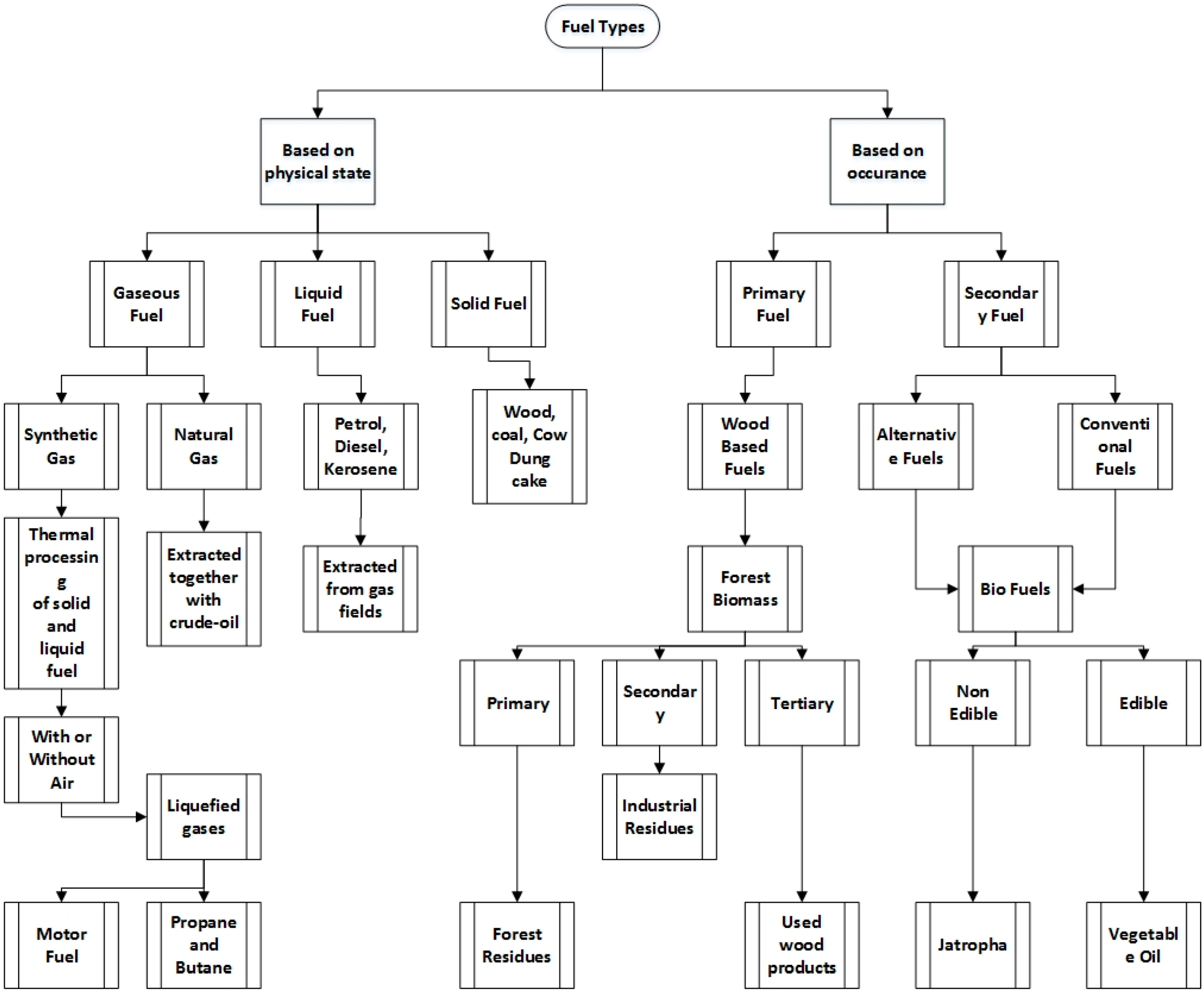

Figure 1. Classification of fuels based on their physical state and occurrence.

Table 1. General classification of fuels.

Fuel Type	Primary Fuels	Secondary Fuels
Solid Fuels	wood, coal, peat, dung, sugarcane, charcoal, etc.	coke, charcoal
Liquid fuels	Petroleum, Biodiesel, Bio alcohols, Vegetable oil	diesel, gasoline, kerosene, LPG, coal tar, naphtha, ethanol

Fuel Type	Primary Fuels	Secondary Fuels
Gaseous fuels	Natural gas, Biogas	hydrogen, propane, methane, coal gas, water gas, blast furnace gas, coke oven gas, CNG

Petroleum fossil fuels are common fuels. Currently, the combustion of fossil fuels supplies about 80% of the world's energy requirements [1]. However, Fossil fuels are not a sustainable energy resource despite the rules to reduce the environmental effect of their burning. In certain countries like India, fossil fuels satisfy energy needs, and coal power plants generate 70% of the required electricity. As their resources are limited, we should think about alternate sources. The production rate of conventional oil will soon enter a phase of permanent decline [2]. Fossil fuel pollution puts the entire globe in trouble. Other analysts have projected 3 to 8% decline rates in world oil production [3]. Fossil fuel ruminants, non-renewable sources, are usually hazardous to the environment. The transportation of petroleum products is another challenging task. It may cause oil spills [4][5][6]. Moreover, fossil fuels take millions of years to produce. Petroleum fields that are formed after millions of years will not produce accordingly based on the current consumption.

The second most utilized fuel is biomass. Over 840 million people depend on traditional biomass to satisfy their energy necessities [7]. Around 2.4 billion people, or roughly 40% of the world's population, rely on biomass fuels (wood, charcoal, dung, and agricultural waste) to satisfy their cooking and heating needs [8]. On the other hand, fossil fuels provide about two-thirds of the world's energy demands [9]. As a result, many individuals work in the fossil fuel business worldwide. However, there is a growing recognition of the fossil fuel sector's apparent flaws, which have plagued the global economy in recent years [10].

Furthermore, some renewable energy sources are always available and can exist for a long time. These include solar energy from the sun, geothermal energy from the earth, wind energy, biomass from plants, and Hydropower from flowing water. **Figure 2** shows the percentage energy consumption of different fuels.

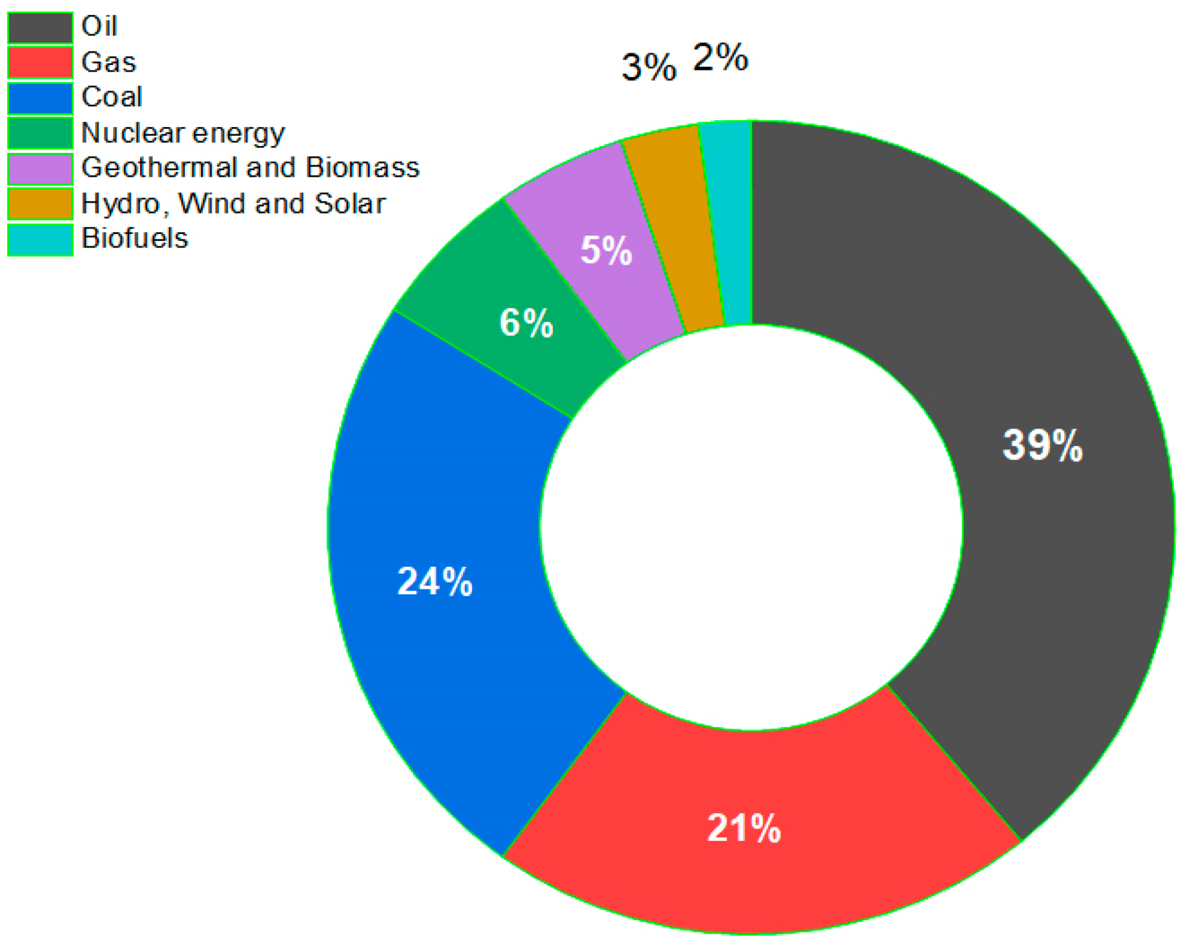

Figure 2. Percentage of energy consumption of fuels.

3. Dynamic Changes in Consumption of Fuels

The situation will likely change rapidly, and the difference between crude oil demand and supply will continue to increase. Nonrenewable fossil fuels are being depleted quicker than ever, putting the world's resources on the verge of depletion. For example, in 2000, India produced 32 million tons of oil and imported 90 million tons (73% of its total demand). The cost of imports in 2002–2003 was around INR 90,000 crores, which is expected to rise further due to rising oil prices and demand-pull prices. According to estimates, India will rely on imported oil for approximately 95% of its energy by 2030. As a result, the oil import bill will significantly impact the economy. This dangerous situation necessitates a significant increase in the usage of non-conventional energy sources. This condition applies to developing countries like India and many developed countries with low fossil fuel reserves [11]. Burning fuels causes hazardous environmental pollutants, but fossil fuels are widely used because no alternative solutions meet energy needs. Numerous energy sources are now being investigated as potential alternatives to gasoline to reduce the pollution rate and protect nature [12][13][14][15][16]. Due to the global depletion of conventional energy sources, especially fossil fuels, alternative energy sources have gotten much attention.

4. Advantages and Disadvantages of Biofuels

Biofuels are considered sustainable and ecologically acceptable energy sources since they are made from natural resources [17]. Biofuels are derived from plants and crops at earlier ages. They may be utilized in various energy-related areas, including electricity generation, power generation, and transportation. Different scenarios regarding the estimated biofuels from multiple sources in the future energy system are being developed [18]. The biofuel policy encourages the production and use of biomass-based fuels. Although biofuels have both good and negative consequences, global biofuel production has steadily increased [19][20][21][22][23]. Biofuels are made from sustainable sources, such as wheat, corn, soybeans, sugarcane, and Jatropha, which can be generated on demand [24][25][26][27]. Bioethanol, known as ethanol, is the most widely extracted and utilized biofuel. It is mixed with gasoline and can substitute gasoline in vehicles. Ethanol is an alcohol used as a blending agent with gasoline to increase octane and cut down carbon monoxide and other smog-causing emissions [28]. Fuels generated from plants are an ideal candidate since they are from renewable resources, which can be cultivated everywhere and emit less carbon than fossil fuels [29][30]. As crude oil prices remain highly uncertain, most applications are turning towards biofuels, which lessen their dependence on the commodity [30]. The advantages of biofuels over fossil fuels [31][32][33][34][35][36][37][38][39] are listed in **Table 2**.

Table 2. Advantages of biofuels over fossil fuels.

Advantages	Description
Efficient Fuel	Compared to fossil diesel, biofuel is generated from renewable resources and is less combustible. It has far superior lubricating qualities.
Cost-Benefit	They are producing high-value biomass products and lowering the cost of creating biopower.
Durability of machinery	Biofuels may be easily adapted to contemporary engine layouts and operate without hassles. Higher cetane number and greater lubrication advantages. In addition, biodiesel improves the engine's durability.
Easy to Source	Biofuels may be generated from various sources, including manure, agricultural waste, other wastes, algae, and plants cultivated expressly.
Renewable	Crops cultivation is cyclic.
Reduce Greenhouse	Burning coal and oil contributes to global warming. People worldwide use biofuels to minimize the impact of greenhouse emissions.

Advantages	Description
Gases	
Economic Security	The demand for appropriate biofuel crops rises due to biofuel production, giving the agriculture business a boost. Biofuels are less costly than fossil fuels for powering homes, businesses, and automobiles. With a rising biofuel business, more employment will be generated, ensuring the economy's stability.
Reduce reliance on imported oil	Alternate solution for fossil fuel.
Lower Levels of Pollution	Although carbon dioxide is produced as a byproduct of biofuel production, it helps plants with photosynthesis. [40][41][42][43]

- Second generation fuels are not commercially available due to high manufacturing costs and a lack of technical proof;
- Current harvesting, storage, and transportation technologies are insufficient for processing and distributing biomass on a wide scale;
- A clear and long-term policy framework is required to guarantee the industry and confidence in financiers;
- The changing needs of the agricultural/forestry industry for biomass feedstock from residues and crops need a substantial shift in the present business model. As a result, using edible oil fuels is connected with a higher risk of food crisis in developing countries or a negative impact on consumer prices in developed ones [44][45][46][47][48]. Hence, using non-edible oils is mostly preferred.

In addition, **Table 3** lists the disadvantages of biofuels over fossil fuels [49][50][51][52][53][54][55][56].

Table 3. Disadvantages of biofuels over fossil fuels.

Disadvantages	Description
High Cost of Production	Mass production is expensive
Monoculture	Monoculture might be economically attractive; however, the soil quality will be affected;

Disadvantages	Description
	hence there is a possibility of a decrease in the yield rates
Fertilizers	Chemicals from the fertilizers risk both soil and water pollution
Food Shortage	The use of feedstocks increases the food process
Industrial Pollution	Large-scale industries meant for churning out biofuel are known to emit large amounts of emissions and cause small-scale water pollution as well
Water Consumption	Irrigation of biofuel crops throughout the year is challenging owing to water scarcity. Water management is necessary to handle the water issue
Future Price Hike	Fluctuation of the commodity prices may risk the biodiesel production cost

se of their Humans consume edible oils from vegetable or plant sources. Additionally, animal fat is considered edible oil. Nowadays, the productions of edible oils are not up to the consumption rate. Therefore, food scarcity and deficiency will be the main challenge if we consider biofuels [57] more widely. Non-edible oils can be widely used as fuel because they are not food items. These are mainly obtained from plant sources and have higher calorific values and properties than edible oils. Popular non-edible oils include Jatropha oil, rice bran non-edible oil, soapstock, and wax. Non-edible oils are not rich in nutrition, and it does not usually require any chemical processing for their extraction from oilseeds, nut, or fruits. The main examples of non-edible oilseed crops are the Jatropha tree (Jatropha curcas), castor bean seed (Ricinus communis), and rubber seed tree (Hevea brasiliensis) [58]. Among these, Jatropha has a high oil content [59]. Compared to edible oils, non-edible oils are cheaper and have instant availability. Hence, non-edible oils are mostly preferred as a biofuel by all means.

Non-edible oils are currently rising in popularity due to their widespread availability in many world regions, particularly in wastelands where food oil crops are not able to be grown. In addition, they minimize food competition, improve production efficiency, reduce deforestation, and are more cost-effective than edible oils [57][60][61][62][63].

The selection of oils for fatty acid alkyl esters (FAAE) synthesis is mainly based on the feedstocks' economic perspective and the oil content [62][63][64][65][66][67][68][69]. The feasibility of biodiesel production can be designed based on the content of FAAE. Sunflower and soybean edible oil are the key feedstocks currently used worldwide [64]. However, the non-edible oil Jatropha was a promising feedstock in developing countries with crop shortages and food scarcity [60][70][71][72][73].

According to the aforementioned publications, an alternate fuel source is essential to replace fossil fuels. Among different renewable sources, biofuels are one of the most satisfying fuels since early days. Studies are underway to make Jatropha one of the future common biofuel available. Hence, this research focuses on Jatropha as a promising source for future energy production.

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