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INNOVATION AND DEVELOPMENT OF BIOCHEMICAL FUELS FROM THE FIRST AND SECOND GENERATIONS

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Abstract

Transportation and industries use more fossil fuels, degrading the environment. Many scientists and researchers are interested in developing renewable energy sources. This article examines the pros and cons of first- and second-generation biofuels research and development products in relation to feedstocks and process technologies. Biodiesel, ethanol, bio-oil, syngas, Fischer-Tropsch H2, and methane may be made from agricultural plant byproducts, microalgae, and other biomass wastes utilising thermo-bio-chemical processes. Industrial and transportation biofuels reduce fossil fuel consumption. A scientific review suggests making biofuels from energy crops and microalgae. Genetic engineering has made large-scale biofuel manufacturing more likely. However, large-scale production is still difficult, thus cutting-edge technology is needed to convert biomass into biofuels to meet present and future energy needs.

Second-generation biofuels (2G) are seen as a solution to the rising dispute about 1G biofuels. Second-generation biofuels may not be sustainable. Controversies can draw attention to crucial, often value-related questions that need to be answered to solve larger societal difficulties, according to Science and Technology Studies study. This study examines how 1G biofuel debates affect 2G biofuel sustainability assessments. We address the biggest issues with 1G networks, how they apply to 2G, and the challenges policymakers have in directing the shift. We investigate possible friction points along the bioenergy value chain and the social environment in which bioenergy research and policy are produced to fill gaps in sustainability evaluations.

Keywords: Biofuel, Innovation, First Generation Fuel, Second Generation fuel.

Introduction:

Biofuels are gaining popularity as a viable alternative to petroleum-derived transportation fuels in light of rising energy prices, concerns about the reliability of liquid fossil fuel supplies, and worries about their impact on climate change. In this context, the word "biofuel" refers to any liquid fuel created from plant material that may be used in place of fuel obtained from petroleum. Biofuels range from those that are already well-known, such ethanol from sugar cane or diesel-like fuel from soybean oil, to those that are more novel, like dimethyl ether (DME) or Fischer-Tropsch liquids (FTL) generated from lignocellulosic biomass.

Recently, the distinction between "first-generation" and "second-generation" liquid biofuels has become increasingly common. These words lack precise, technical meanings. Their primary difference is the kind of feedstock they employ. First-generation fuels are often those derived from sugars, grains, or seeds, as they need just a little amount of the above-ground biomass generated by a plant and may be processed into a completed fuel with minimal effort. Numerous nations are currently producing first-generation fuels in large commercial volumes. Non-edible wastes of food crop production (such as maize stalks or rice husks) or non-edible entire plant biomass are the main ingredients of second-generation fuels (e.g. grasses or trees grown specifically for energy). To far, no country has begun commercial production of second-generation fuels.

Biofuels' capacity to replace conventional, petroleum-based fuels is seen in Figure 1. Spark-ignition engines may utilize alcohol fuels in place of gasoline, whereas compression-ignition engines can use biodiesel, green diesel, or dimethyl ether (DME). There are several distinct hydrocarbon fuels that may be made using the Fischer-Tropsch method, the most common of which is a diesel-like fuel for compression ignition engines.

Although biofuels' ability in the transportation sector has garnered the most attention, their prospective usage for cooking (Figure 2) has a far broader global and, in particular, rural importance. Pollutant emissions from biofuel combustion for cooking are guaranteed to be lower than those from solid fuel combustion. About three billion people live in areas where indoor air pollution is a major health risk due to the use of solid fuels for cooking (World Health Organization) (2006). IEA: International Energy Agency (2006). To that end, biofuels may have a major impact on the well-being of the global population. Notably, the quantity of biofuels required to satisfy domestic cooking energy demands is far lower than that required to satisfy transportation fuel needs. It has been estimated (Goldemberg *et al.*, 2004) that three billion people only need about four to five exajoules2 per year of clean cooking fuel to fulfill their very minimum requirements for preparing their own food. This is about equal to one percent of current industrial energy use worldwide.

Biofuels have attracted a lot of interest in the transportation industry, but they also have an It is becoming increasingly popular in many developing countries to "modernize" the use of biomass in their countries and provide greater access to clean liquid fuels, and many industrialized countries are actively pursuing the development of expanded or new biofuels industries for the transport sector. Many underdeveloped nations may find biofuels, particularly appealing for a variety of reasons. There are many of places across the world with ideal climates for growing biomass. Since biomass production is often located in more rural areas and requires a large amount of human work, it might create new job opportunities in underserved areas. Some communities may also be interested in restoring degraded land for biomass-energy production. Attractive is the possibility of generating rural income through the manufacture of high-value items (such as liquid fuels). Fuel exports to developed nations' economies might be an additional selling point. In addition, there's a chance that carbon saved through measures like the Clean Development Mechanism's emission credits can be sold for money.

Concerns about expanding biofuels production and usage include the potential loss of arable land that could otherwise be used to grow food or fiber or protect biodiversity or for some other vital purpose. Many people are worried about the increased demand placed on the world's freshwater supplies by the cultivation of biofuel feedstocks.

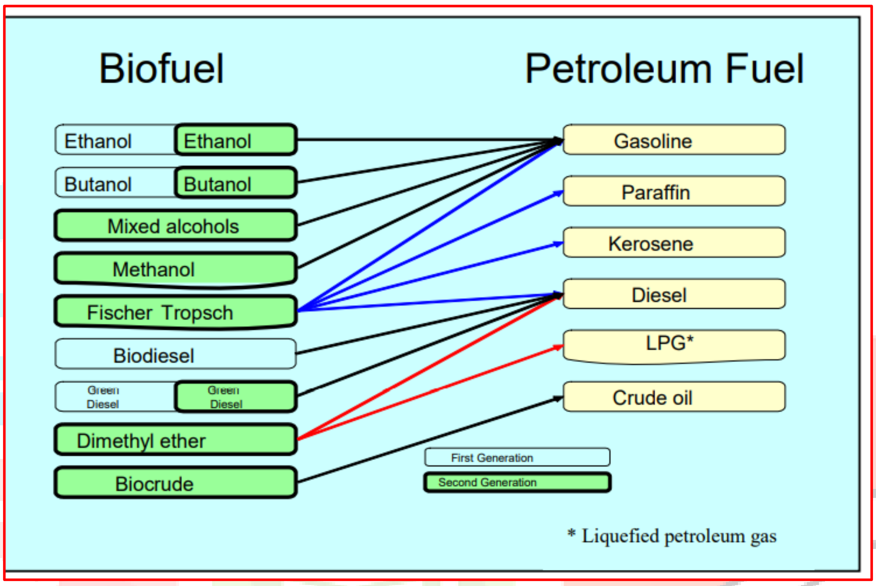
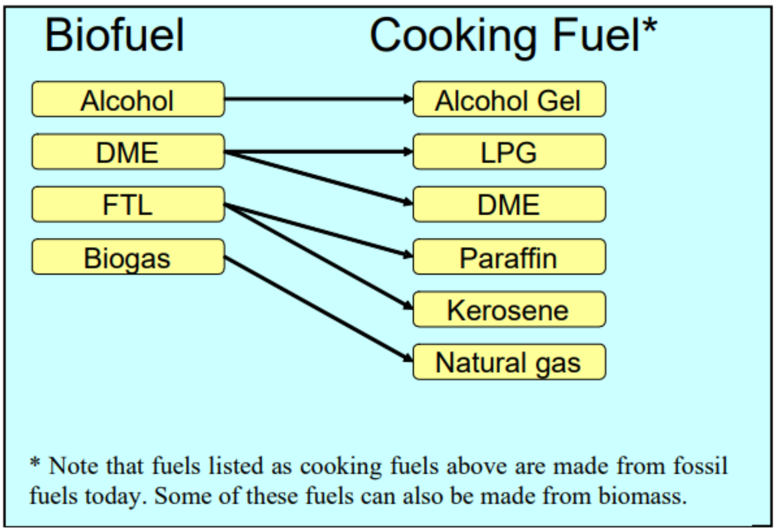


Figure 1. The capacity to replace conventional gasoline and diesel with biofuels

. Figure 2. Biofuels' potential as a clean-burning fossil fuel stove replacement



The technological ramifications of the biofuels industry are explored in this paper. The goals of this paper are to

(a) establish a foundation for comprehending the shortcomings of first-generation biofuels;

(b) provide meaningful descriptions of second-generation biofuel technologies that are accessible to non-experts;

(c) present significant energy, carbon, and economic comparisons between first- and second-generation biofuels; and

(d) finally, speculate on the implications for trade and development of future expansion in global production and use of biofuels.

	1st Generation of biofuels	2nd Generation of biofuels
Type	Edible oils	Non-edible oils
Feedstocks	• Vegetable oils, corn, sugar and animal fats	• Aquatic biomass, forest residue, abundant plant waste biomass and agricultural waste
Products	• Biodiesel, corn ethanol, sugar alcohol	• Biodiesel, butanol, mixed alcohols
Name of oils	• Coconut, sunflower, palm, peanut, rapeseed, corn, groundnut oil, etc.	• Jatropha, mahua, Pongamia, neem, rubber seed, castor oil, etc.
Problems	• Restricted feedstock • Mix together partly with diesel fuel	• Available in forest areas
Benefits	• Environmentally friendly for trade and industry • Social safety	• Cannot compete with foodstuff • It helps to progress to diminish the cost of conversion

Figure 3. Differences between First- and Second-Generation Biofuels

There have been three generations of biofuel developed thanks to research and development efforts. There are advantages and disadvantages to each successive generation's feedstock. First-generation biofuels include maize ethanol and soy biodiesel, both of which are derived from conventional row crops. Cellulosic biomass, such as that found in perennial grasses, is the source of second-generation biofuels. Algae will be used to produce next-generation biofuels.

Vegetable oil, starch, and sucrose are the primary ingredients of first-generation biofuels. Simple biochemical treatments can convert vegetable oil to biodiesel or starch and sucrose to ethanol for use as a transportation fuel. The food sector has already created many of these procedures, reducing the amount of new research and development required to create transportation fuels. However, compared to perennial grasses, which require less agricultural input (water), these crops want substantial amounts of fertilizer.

First-generation biofuels.

Food-grade biomass, such as corn, soy, and sugarcane, is used to create first-generation biofuels. Biomass oils, sugars, and starches are converted into liquid fuels by fermentation or chemical processes to produce these biofuels. While the markets and methods for first-generation biofuels like the maize ethanol that is now mixed into the majority of gasoline sold in the United States are well-established, more refinement is necessary before the fuel can be used in engines.

Ethanol, produced by fermenting sugar taken from sugar cane or sugar beets or sugar extracted from the starch present in maize kernels or other starch-laden crops, is the most well-known example of a first-generation biofuel. Butanol, another alcohol, may be made using the same methods as ethanol production with a different set of fermenting organisms. While ethanol has a well-established market, efforts to commercialize butanol are still in the works (Dupont, 2007). Around 51 billion liters of first-generation bio-ethanol were produced worldwide in 2006 (Renewable Fuels Association website), with roughly 18 billion liters each produced in Brazil (from sugar cane) and the United States (from maize). Feedstocks for ethanol production include a cane, corn, and various other sugar or starch crops; but, in 2006, China and India accounted for 11% of worldwide ethanol output (sugar beets, wheat, potatoes). Many nations are developing or discussing expanding their first-generation ethanol output, with Brazil and the United States having by far the greatest development ambitions. From now until 2013, Brazil's ethanol output is predicted to increase by more than 100% (Macedo 2007). After the completion of the new facilities that are now under development, American production capacity will increase by a factor of two compared to its 2006 level.

Many first biofuels have low promise as petroleum substitutes or carbon emission reducers depicts the expected 2007 U.S. ethanol production in the country, which is around 34 billion liters and utilizes 27% of the nation's maize harvest (Collins *et.al.*,2007). When combined with gasoline, this ethanol will only supply around 4% of the energy used in the United States in 2007. While photosynthesis in maize plants does reduce carbon emissions, the massive amounts of fossil fuel required to make this ethanol more than cancel out these benefits. From the point of view of petroleum replacement or carbon emissions reductions, the potential for sugarcane-based ethanol is far more substantial. Brazil's ethanol use in 2006 was about comparable to gasoline consumption, and the country saw significant reductions in carbon emissions as a result. This was made possible by using sugar cane fibre as the energy source for ethanol production. Brazil may be home to the largest sugar cane-ethanol business on the planet, but it is not alone in its capacity to convert sugar cane into fuel. Sugar cane is grown in more than 80 nations, and some of them also generate fuel ethanol.

A second well-known first-generation biofuel is biodiesel, which is derived from oil-seed crops. The website of the European Biodiesel Board reports that in 2005, Germany generated over 2.3 billion liters of biodiesel (mostly from rapeseed and sunflower). Since 2005, production on a global scale has increased substantially. Biodiesel output (mostly from soybeans) in the United States increased from an estimated 284 million liters in 2005 to 950 million liters in 2006. The Brazilian government has required increasing the amount of biodiesel blended into regular fuel from 2% in 2008 to 5% in 2013. About 800 million liters of biodiesel will be needed in 2008 to reach the target. It is projected that Brazil's biodiesel production capacity, which stood at around 590 million liters/year as of the end of 2006 (Bioproducts Alberta), will more than quadruple this year (2006). In South East Asia (Malaysia, Indonesia, and Thailand), where the bulk of the world's palm oil for food consumption is produced, there has been a rise in interest in palm biodiesel. The non-edible oil tree Jatropha is gaining popularity for its capacity to yield oil seeds on a broad variety of soil types. According to the Government of India Planning Commission, Jatropha biodiesel is being explored as part of a wasteland restoration plan in India (2005). Biodiesel made from oil-bearing seeds is comparable to starch-based alcohol fuels in terms of their ability to reduce greenhouse gas emissions.

Second-generation biofuels.

Second-generation biofuels are produced from non-food biomass such as perennial grass and fast-growing trees. One common method includes converting cellulose, a fibrous, non-edible material, into fuel, a technique that is more challenging and has received less attention than the production of first-generation biofuels. There is presently no commercial-scale production of these fuels in the United States, but there has been much study into them because of their potential economic and environmental benefits over first-generation biofuels. share the commonality of being fabricated from lignocellulosic biomass, hence enabling the use of less expensive, non-edible feedstocks and lowering the likelihood of direct competition between food and fuel.

The method used to transform biomass into fuel is another way to categorize second-generation biofuels. Biochemical processing would be used to produce second-generation ethanol or butanol, whereas thermochemical processing would be used to produce the other second-generation fuels considered here. Since there are no first-generation analogs, it's possible that most readers will be less familiar with second-generation thermochemical biofuels than they are with second-generation ethanol. However, numerous second-generation thermochemical fuels are now being produced commercially from fossil fuels, employing processing procedures that are sometimes identical to those used for biofuel synthesis. Included in this group of fuels are methanol, refined Fischer-Tropsch liquids (FTL), and dimethyl ether (DME). Additionally, mixed alcohols may be produced from fossil fuels, but due to the immaturity of several components of systems for creating them, there is currently no commercial production. Green diesel, the other thermochemical biofuel has no clear fossil fuel analog. However, the thermochemical production of unrefined fuels like pyrolysis oils requires extensive refining before they can be utilized in engines.

Conclusions

Depending on the individual conditions or circumstances that prevail throughout the implementation of 2G biofuels, several key takeaways from 1G may or may not be applicable to the evaluation of their long-term viability as a fuel source. We come to the conclusion that problems with sustainability that are traditionally classified as either economic, environmental, or social are, in fact, more complexly intertwined (so that an artificial separation of these categories is problematic).

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