MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Open Access Journal of Agricultural Research
ISSN: 2474-8846

Market Trends in Biofuel

Sophonthammaphat S[1], Apiwatanapiwat W[2] and Edyvean RGJ[3]*

[1]Department of Alternative Energy Development and Efficiency, Thailand
[2]Kasetsart Agricultural and Agro-Industrial Product Improvement Institute, Thailand
[3]Department of Chemical and Biological Engineering, The University of Sheffield, UK

***Corresponding author:** Robert GJ Edyvean, Department of Chemical and Biological Engineering, The University of Sheffield, Mappin St, Sheffield, city Centre, Sheffield S1 4LZ, UK, Email: r.edyvean@sheffield.ac.uk

Research Article
Volume 8 Issue 3
Received Date: July 25, 2023
Published Date: August 11, 2023
DOI: 10.23880/oajar-16000311

Abstract

Biofuels, (ethanol and biodiesel primarily derived from corn, sugarcane and vegetable oils) are a growing area of renewable energy. For example, in the transport sector ethanol can be used in suitable internal combustion engines or blended with petrol while biodiesel can be used in diesel vehicles with little engine alteration. This study looked at biofuel supply and demand in a number of countries as it recovers from the 2019-2022 COVID-19 pandemic and found that demand fluctuated over this period since external factors which influence oil prices, have a greater effect on the smaller, and mostly newer, biofuel industry. Such fluctuations would happen with any major shift in energy resources but have been exacerbated by the pandemic and recent conflicts. While governments must evaluate the role of biofuels in energy security, food security and GHG objectives in a changing political and financial environment, there are countries where they can play a significant role in the energy supply. How Governments might look longer term to pave the way to a "new normal" energy base is discussed.

Keywords: Bioenergy; Bioenergy Market; Biofuel; Biofuel Trend and Covid-19

Abbreviations: FFV: Flex-Fuel Vehicle; UCO: Used Cooking Oil; LCFS: Low Carbon Fuel Standards; RFS: Renewable Fuel Standards; IESR: Institute for Essential Services Reform; SAF: Sustainable Aviation Fuel; CCUS: Carbon Capture, Utilization and Storage.

Introduction

The biofuel market, which primarily derives from corn, sugarcane, vegetable oils and used cooking oil (UCO), is relatively small and new in most countries and has been considerably affected by the 2019-2022 COVID-19 pandemic, political problems and conflicts. The industry is sensitive to external factors and government policies. This study investigates biofuel policy and markets in a number of countries and how biofuels might help some countries to achieve their COP26 and net zero 2050 targets.

The global revenue from the sales of biofuels in 2021 was USD 140.43 to 154.76 billion. The industry is forecast to expand at a compound annual growth rate of 5-7% between 2022-2032 [1,2]. This expansion is dependent on governmental policy, production plant capacity, feedstock prices and the effects of instability in the petrochemical markets.

The main biofuels are ethanol and biodiesel. Global biodiesel feedstocks are palm oil (31%), soybean oil (27%), rapeseed oil (20%), used cooking oil (UCO) (10%), waste animal fats (7%) and others (5%) [3]. Biodiesel production

from waste materials (UCOs and industrial waste oils and fats) is now quite a mature industry and is established in most countries. Biodiesel can produce relatively low levels of pollutants and GHGs. Studies have estimated that using biodiesel, pollutants can be reduced by an average value of 40% (SO2 could be reduced up to 100%) and CO2 emissions by 78.45% when compared to petrodiesel [4]. However, apart from UCO use, there are potential problems for "primary" biodiesel feedstocks as they are in competition with food for agricultural land, may encourage deforestation and there can be problems of engine suitability (however, in July 2021, VW announced an R&D initiative for biofuel based engines targeted at emerging markets [2].

Corn and sugarcane feedstocks account for over 50% of all biofuel production as ethanol with the US and Brazil accounting for over 75% of the world ethanol production, but they also account for nearly 50% of demand. Corn and sugarcane prime use is in the production of food, and, while these and similar feedstocks for biofuels currently take only a small percentage of agricultural land, a balance will need to be struck between the demands of food and the demands of biofuels [5].

The global biofuels industry is highly competitive with key participants involved in R&D and innovation. Some of the prominent players operating in the market are: Air Liquide, Archer Daniels Midland Company, Bunge North America, Inc., Butamax Advanced Biofuels LLC, Green Plains Inc., Petrobras, Renewable Energy Group, Inc., Royal Dutch Shell Plc, and Scandinavian Biogas Fuels International AB, Wilmar International Ltd [6].

The study looked at a range of published information on biofuel policy and markets in the transport industries under 3 categories: 1) the past (pre the 2020 Covid pandemic), 2) the current situation (2023) and 3) future trends (after 2023, post covid-19). It reviews countries policy announcements, journals, wider public access reports, news articles and country leader interviews. Data was gathered and analysed for key messages.

Background

In 2021, biofuel demand was still being influenced by the effects of Covid, remaining near 2019 levels at 155,400 million litres (ML) [7]. Global biofuel demand was expected to be 6% or 9,100 million litres per year higher in 2022 than in 2021 [8].

Even though ethanol demand rose in 2021 it remained 7% below 2019 levels [7]. In contrast the use of RE diesel increased by around 70% from 2019 and biodiesel demand rose 0.2% from 2019 [7] (RE - Renewable diesel, previously known as green diesel, is a hydrocarbon produced most often by hydrotreating and also via gasification, pyrolysis, and other biochemical and thermochemical technologies (in the EU called hydrogenated Vegetable Oil, HVO). It meets ASTM D975 specification for petroleum diesel. Biodiesel is a mono-alkyl ester produced via transesterification. Biodiesel meets ASTM D6751 and is approved for blending with petroleum diesel).

Biodiesel prices rose in 2021 by between 20-30% globally because of high feedstock prices [7]. In response, governments have, or are proposing to, relax, delay or postpone indefinitely biofuel blending requirements. The stated rationale for these policy decisions is to reduce additional fuel costs borne either by consumers or by governments despite higher than planned GHGs emission and the need for more fossil oil to make up for biodiesel reductions.

In Feb 2022, Russia's invasion of Ukraine, on top of the lingering effects of Covid, caused more instability and increases in the price for crude oil. This created an unstable outlook for the global economy resulting in GDP growth assumptions being lowered to 3.4% in April compared to 4.3% in January [7]. Higher oil prices and weaker GDP growth combine to decrease transportation demand. This is particularly felt in key biofuel markets like the US, EU and Brazil. If the higher price and lower economic outlook persist, growth in transport demand may weaken further which, in turn, leads to reduced biofuel demand estimates. While these downward pressures may partially be countered by an increase in demand for biofuels stemming from its lower price relative to other fuels and its greener credentials, it is ironic that lowered fuel demand, generally to be welcomed for reducing GHGs, disproportionally affects the supply and demand for RE alternatives.

Feedstock and Biofuel Prices

In April 2022, vegetable oils were 65-164% more expensive than in 2019 [7]. This has fueled higher prices for biodiesel and RE diesel. Corn prices also increased putting upwards pressure on ethanol prices. Sugar, used primarily locally in Brazil and India, was less affected.

The USDA mentions several factors causing global agricultural commodity prices to be at near-record levels. These are the potential loss of exports from Ukraine, increased global demand, weather-related supply disruptions, rising energy prices, increased fertilizer costs and countries imposing export restrictions on certain food crops [7]. For example, Indonesia's decision in April 2022 to temporarily ban the export of some components of palm oil put further upward pressure on biodiesel feedstock prices [7]. The

Russia/ Ukraine conflict and the very recent (June 2023) flooding in southeastern Ukraine (Collapse of Ukraine's Nova Kakhovka dam) is forecast to adversely affect the corn, wheat and sunflower seed supply [9,10].

It is unclear how or when commodity prices will come down, especially since the impact on markets are interrelated and widespread. While higher prices should encourage farmers to grow more crops, the cost of fertilizer, energy, wages and other costs all go to make such decisions difficult. For example, reducing fertilizer use due to cost, while potentially benefitting the environment, may limit overall yields and thus the benefits of more planting. Export barriers could also limit increased production from countries since farmers would be less able to capture export benefits.

In 2022, the agricultural industry was struggling with price shocks. Increases varied by region and by commodity. For example, Brazil's ethanol prices increased 20% while in the US it increased by 30% [7]. Global biodiesel prices rose 20-30% as reported in December 2021 [7]. The response by governments of relaxing or delaying policies to increase the use of biofuels further contributed to a slowing of demand growth. Thus, in 2022, biofuel demand grew more slowly than previously forecast [8]. However, global biofuel demand in transportation is still expected to increase YoY by 5%, or 8,500 ML in 2022, and by a further 3%, or 5,200 ML, in 2023 [7]. Government policies do continue to drive global demand for biofuels [8].

Biofuel Demand and Growth by Country

Brazil and South America: Brazil accounts for the majority of the decline in global biofuel demand growth. Demand expectations in 2022 were revised downwards across all transportation fuels from the Jan 2022 estimate. However, Brazil's biofuel demand still grew by 40% while gasoline was down by -0.2% and diesel down by -0.7% versus 2021 levels. This actually benefits Brazil's RenovaBio mechanism (a carbon reduction scheme) [8] as the market share of biofuels is growing.

The Brazillian Government has mandated the blending of 27% ethanol in gasoline, a 3% increase. They have a large flex-fuel vehicle (FFV) programme enabling higher or lower ethanol blending with gasoline depending on price [8].

Brazil will maintain its biodiesel blending mandate at 10% for biodiesel, from an intended 15% target for 2022. The move to 10% was made in 2021 and then continued in 2023 to reduce diesel prices [8]. In contrast, some information suggests that Brazil will still reach 15% biodiesel blending by the end of 2023. This depends on the diesel base fuel price [7] and, perhaps, the engine development programmes active in Brazil.

Neighboring Argentina passed a law to reduce the biodiesel blend rate from 10% to 5% because of high crop costs. The law also authorizes the government to lower the biodiesel blend rate to 3%, and to halve the corn ethanol volume entering the fuel sector if required [7,11].

The Colombian government reduced its ethanol blending mandate from 10% to 4% from April 2021, with the aim of returning blending to 10% in September 2021. However, in August of that year, Colombia delayed this return to January 2022 and is now proposing blending at 6% [7]. These are examples of how short term pressures can have severe, often much longer term, negative effects on the emerging renewable energy industry and on a countries GHG reduction goals.

USA: In the US, gasoline and diesel use has recovered to pre-Covid levels and, while the IEA have revised downward biofuel growth by 15% from January's forecast the US still leads global biofuel growth with demand expected to increase by 6% in 2022 [7]. The US government has permitted blending of up to 15% ethanol during summer months to help lower gasoline bills (IEA, 2022). However, only 2% of gas stations provide 15% blended fuel and thus this policy change will only slightly increase ethanol demand. Even so, California's low carbon fuel standards (LCFS), and renewable fuel standards (RFS), together with the federal biodiesel blenders' tax credits will all combine to drive expansion in biofuels.

EU: The EU has a "Fit for 55" package that aims to reach net zero by 2050. In 2022, gasoline and diesel demand were expected to be 1.5% and 1.1%, lower than forecasted in January of that year respectively [7]. Several governments are also proposing to, or have already, reduced blending obligations because of high biofuel prices. Belgium, Croatia, the Czech Republic, Finland, Germany and Sweden have all announced changes. Thus, biofuel demand growth slowed in 2023 [7]. Even so, European biofuel demand was expected to increase by 6% or 1,600 ML in 2022 compared to 2021 [7]. This growth is supported by stronger long term state-level policies and a planned decline in gasoline and diesel demand due to increasing energy efficiency. In addition, EV use outpaces it's predicted growth from strengthening policies and customer choice.

Belgium's green coalition has proposed to remove current biofuel mandates to reduce fuel and food costs and then slowly fade out crop-based fuels by 2030 [7]. This may look odd to any country encouraging biofuels, but in a small country such as Belgium, agricultural land has to be prioritized for food production. It also indicates that not all

countries have suitable conditions for large-scale biofuel production.

Croatia will remove penalties on blenders that miss their targets [7] while the Czech government has proposed removing blending targets, but this is not yet confirmed and GHGs reduction requirements would still apply [7].

Finland will reduce its renewable energy requirement to 12% from 20% for 2022. It estimates this will reduce fuel prices by 12 cents per litre [7], while also increasing its long-term blending target from 30% to 34% by 2030 [7]. Sweden is proposing to pause its GHG targets for the transport sector for 2023 holding them at 2022 levels. Increases in these targets will continue post 2023 [7]. Again, this shows how Governments feel that they have to react to short term pressures by abandoning (at least temporarily) their long term goals.

Germany's Environment Minister proposed to "further reduce the use of agro-fuels from food and feed crops" in response to high food prices resulting from the Russia/Ukraine war [7]. There is as yet no change, but should high prices persist other governments may also pause or delay their plans. The EU Commission has noted it will support member states that reduce mandates in favour of food security.

Asia and the Pacific Region: Despite the potential benefits, the use of biodiesel in Asian countries is still low compared to petrodiesel because of issues including high feedstock costs, insufficient feedstock supply, the higher viscosity of biodiesel, and concerns around emissions of nitrogen oxides (NOx) [11].

The IEA estimated that growth in biofuel demand was down 36% in 2022 compared to its January 2022 forecast for the Asian/Pacific region. However, biofuel demand still grew, though at a lesser extent of 9% in 2022 and 12% in 2023 [7]. This is due to robust gasoline and diesel growth and strengthening government policies in India which continued to increase the amount of ethanol blended into gasoline, reporting an average 9.7% blending rate in April 2022 [7].

China's 14th Five-Year Plan provides little insight on its intentions for biofuels other than reiterating its intent to "vigorously support advanced biofuels". China has warned ethanol producers that it will "strictly control processing of fuel ethanol from corn" [7].

The IEA had expected that Indonesia would begin implementing its 40% blending mandate in 2026 [7,8]. But in April 2021, it delayed because of the effects of the Covid-19 pandemic [7] and in Feb 2023 Indonesia announced it will blend biodiesel at 35% which still pushes demand [12]. Indonesia is known for significant investment in biofuel infrastructure to meet its alternative fuel goals. The Indonesian Institute for Essential Services Reform (IESR) has projected biofuel demand to reach 190 Million Tonnes (MT) by 2050. At the same time, like many other countries, Indonesia is strongly encouraging EVs and expects a strongly growing lithium battery industry. There is thus a tension between the support for biofuels and that for EVs [1,2].

In Singapore, a company, Alpha biofuels, is producing and blending biofuel into fuel oil for marine transport [2].

Future Global Trends: Global demand for biofuels is set to grow by 41 billion litres, or 28%, over the period 2021-2026. The recovery to pre-Covid-19 demand levels accounts for one-fifth of this demand growth. Renewable diesel demand is expected to nearly triple between 2020 and 2026 [7,8]. Climate and energy goals underpin this robust forecast.

Overall, the RE share in transport energy consumption is expected to grow from 9% in 2020 to 16% in 2027 [8]. The FAO has recommended actions to manage current high prices, including maintaining trade policies, diversifying food supplies and supporting vulnerable groups. Nevertheless, it is obvious that countries are very concerned that demand for biofuel will take away land for food production [7,13,14]. This would always have eventually been the case if the demand for crop-based biofuel continued to grow but this "tipping-point" has potentially been reached far earlier due to global issues, particularly from Ukraine. Thus, biofuel blending requirements remain relaxed or even suspended because of high feedstock prices despite higher GHGs and the need for more oil to make up for these reductions.

Biodiesel and RE diesel are likely be under the most pressure since prices for these fuels have risen faster than oil prices and the vegetable oil market which will tend to take oil away from the food supply. However, this does open up opportunities for second, third and even fourth generation feedstocks (as well as encouraging even greater use of UCO and other waste oils and fats). The demand for waste and residue oils and fats are expected to nearly exhaust supplies of the most readily available sources by 2027 [8]. This needs not be considered a bad thing in itself – almost total recycling of a waste product is to be celebrated. Second generation feedstocks include wastes from food production (wastes from oil palm, sugar cane, cassava etc.) as well as non-food crops grown on more marginal land. Third generation feedstocks are those requiring no or little agricultural land. These include the intensive cultivation of oil-rich single celled algae in ponds or photo-bioreactors. However, prices for these feedstocks will rise as demand rises.

Asia's first plant to mass-produce biofuel that does not reduce food stocks will be built in Thailand. The Japanese Sumitomo Corp. has signed a memorandum of understanding for the project with Global Green Chemicals, a subsidiary of the Thai petrochemical group PTT Global Chemical. The partners are discussing commercial production of bioethanol made from bagasse molasses, which is left over after sugarcane. Another Japanese company, Kao, is looking to produce ethanol from cassava waste in Thailand with production due to start in 2027 [15].

Governments are expected to tread carefully when considering reducing requirements for biofuel use. Any reduction in biofuel demand comes with an increase in both oil deliveries and GHGs, which runs counter to longer term priorities. These policy priorities will likely make any changes temporary in order to address short-term challenges. In the transport sector, countries will need more ambitious transport decarbonisation programmes, including both biofuel and EVs. The IEA and Biofuel International forecast that biofuel demand will increase between 2021 and 2027 by some 20% and the global renewable energy's share in transport could reach 20% by 2027 [8,13].

The US, Canada, Brazil, Indonesia and India make up 80% of global expansion in biofuel use [8]. This is due to these 5 countries having comprehensive policy packages to support growth. RE diesel is expected to lead the policy driven global expansion of biofuels for the first time in the 2022-2027 period. Bio jet fuel or RE diesel demand is expected to expand significantly to 3,800 ML/D (over 2021-2022) (35 times the 2021 level) to account for 1-2% of total jet fuel consumption [8]. Recent US tax incentives and the EU's ReFuelEU targets will push most of the growth in biojet fuel. The US Sustainable Aviation Challenge sets a goal for the airline industry to use 11 billion litres of sustainable aviation fuel (SAF) by 2030, equivalent to 15% of current jet fuel demand [16].

Meanwhile, increasing ethanol and biodiesel use occurs almost entirely in emerging economies. These aim to reduce oil imports while benefiting the local economy by using indigenous resources. Unprecedented demand, coupled with food insecurity, is straining supply chains. Government policies and innovation may help here but, as has been shown, Governments have to react to short term problems.
In advanced economies, vegetable oil supplies for biofuel production are forecasted to expand from 17% to 23% between 2022-2027 [8]. However, these oils command higher prices due to strong demand. Hopefully this will prompt companies and governments to improve feedstock supply chains, seek out new supplies and develop new techniques, policies and innovations enabling the use of more widely available feedstocks for sustainable biofuel production. New investments include biodiesel from agricultural and municipal organic waste in Sweden and from microalgae in the US and the production of ethanol from molasses and cassava in Thailand [2,15].

The IEA expects 2023 to show growing demand in Asia offsetting declines in the United States and Europe [8]. Asian countries are expected to account for nearly one-third of new production over the forecast period (to 2026). The combination of Government policies, transport fuel demand, export-driven production and agricultural opportunities pushes Asian biofuel production past that of Europe. However, the factors influencing biofuel demand are all subject to uncertainty [16].

There is still a considerable way to go. Biofuel demand must nearly double by 2026 to align with the IEA Net Zero Scenario. Liquid biofuels are required to reduce emissions in road transport and to a lesser extent for aircraft and ships. The London agreement (July, 2023) decided that shipping should aim to become net zero by 2050. Countries will need to both implement and strengthen policies before 2026 to meet such goals. These policies must also ensure that biofuels are produced sustainably and avoid the risk of negative impacts on biodiversity, freshwater systems, and food prices and availability [17].

Conclusion

There are increasingly ambitious energy targets in the EU, growth in ethanol consumption in Brazil, biofuel blending in India and a rise of sustainable aviation fuel (SAF) development. Recognition of the role of biofuel as a tool for countries to accelerate their GHGs reduction means it is important to scale up technologies such as carbon capture, utilization and storage (CCUS) to reach net zero carbon.

Where biofuel markets are well established, such as in Brazil, there is greater resilience to Global pressures. This indicates the value of localized RE industries. However, recent problems, such as the Covid-19 pandemic and the Russia/Ukraine conflict, have considerably affected fledgling biofuel industries. Governments face problems in evaluating the role of biofuels in energy security, food security and GHGs objectives. These forces are playing out differently in various countries and regions. There is a basic fact of politics that long term aspirations will be modified or abandoned under short term pressures, even with the weight of evidence that the long term financial and environmental costs will be much higher. Food security is top of the agenda for many governments. Balanced against this is the positive security that can come from a well-developed in-country energy supply.

In many countries, such as the UK and other parts of Europe, biofuels play a very small part in the energy supply, both now and in future plans. This is to be expected; not all countries have suitable agriculture and climate for large scale biofuel feed stocks. Feedstock choice is important; production costs suggest the need to exploring alternatives to palm oil for biofuel feed stocks in ASEAN countries.

Growth in the renewable fuels market faces major problems from unprecedented demand for feed stocks and that the planned renewable fuel capacity is set to outpace domestic primary feedstock supply leading to questions as to where the additional feedstock will come from.

There should be maximal use of waste materials and a carefully monitored use of primary feed stocks to ensure no risk to food production. ASEAN has the climate and resources to be developing secondary (non-food crop) and tertiary (low land occupying feed stocks such as microalgae) biofuel industries.

It is unlikely that biofuels can play any more than a minor part in future global energy provision, especially as the global population, and hence food demand, rises. However, there are countries, such as ASEAN, where biofuels can be an important energy source and bio-based solutions could make significant long-term contributions with innovative technologies.

References

1. (2022) Biofuels market growth Outlook (2022-2032). FACT MR, pp: 170.

2. (2022) Biofuels Market, By Product Type (Biodiesel, Ethanol, Biogas, and Others), By Feedstock (Corn, Sugarcane, Vegetable Oil, and Others), By Form (Solid Biofuel, Liquid Biofuel, and Gaseous Biofuel), and By Region Forecast to 2030. EMERGEN Research, pp: 250.

3. UFOP (2018) UFOP report on global market supply 2018/2019.

4. Coronado CR, de Carvalho JA, Silveira JL (2009) Biodiesel CO2 emissions: a comparison with the main fuels in the Brazilian market, Fuel Process. Technol 90(2): 204-211.

5. (2022) Biofuel feedstocks supply and demand - two key challenges, An overview of the challenges facing biofuel market players as demand will outpace supply for the next ten years. Fastmarkets.

6. (2023) Biofuels Market Size, Share & Trends Analysis Report By Feedstock (Corn, Sugarcane), By Application (Transportation, Aviation), By Form (Solid, Liquid), By Product (Biodiesel, Ethanol), By Region, And Segment Forecasts, 2023 – 2030. Market Analysis Report, pp: 120.

7. (2022) Renewable Energy Market Update Outlook for 2022 and 2023. IEA.

8. (2023) Renewables 2022 Analysis and forecast to 2027. IEA.

9. (2023) Crop Explorer-World Agricultural Production (WAP) Brifs-Ukrain, Moldova and Belarus. USDA Foreign Agricultural Service US Department of Agriculture.

10. Naddaf M (2023) Ukraine dam collapse: what scientists are watching. Nature.

11. Syafiuddin A, Chong JH, Yuniarto A, Hadibarata T (2020) The current scenario and challenges of biodiesel production in Asian countries: A review. Bio resource Technology Reports 12: 100608.

12. (2023) Indonesia to Implement Biodiesel B35 in February 2023. USDA Foreign Agricultural Service.

13. (2023) Renewable Energy Market Update Market Update Outlook for 2023 and 2024. 6th Jan, 2023. Global biofuel demand to grow 20% in next five years. Biofuel International.

14. (2013) Biofuel and food security. Committee on World Food Security.

15. Asia N (2022) Japan looks to Thailand for bioethanol that doesn't fuel food insecurity.

16. (2021) Office of Energy Efficiency & Renewable Energy.

17. (2021) Renewables 2021, Analysis and forecast to 2026, IEA (International Energy Agency). IEA.