9 Biofuels

This chapter describes market developments and medium-term projections for world biofuel markets for the period 2022-31. Projections cover consumption, production, trade and prices for ethanol and biodiesel. The chapter concludes with a discussion of key risks and uncertainties which could have implications for world biofuel markets over the next decade.

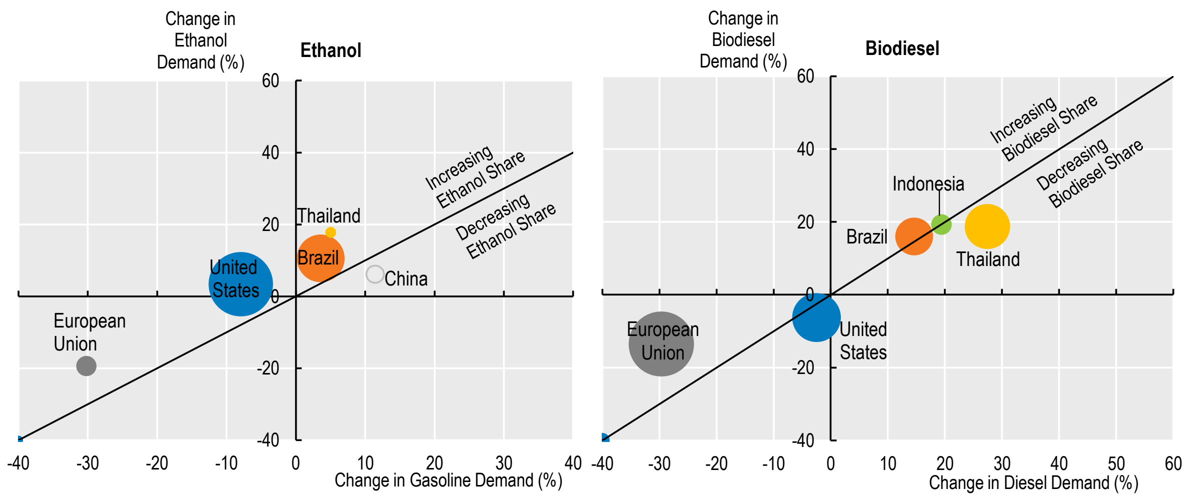
9.1. Projection highlights

Policies are key drivers in biofuel markets

The COVID-19 pandemic in 2020 caused a drop in global transport fuel use due to restrictions on people's movements and disruptions in trade logistics around the globe. Ethanol use fell most, whereas biodiesel use continued to increase but at a slower pace. Following the economic recovery in 2021 and the lifting of mobility restrictions, the fossil fuel and biofuel market recovered. However, consumption of ethanol has not yet returned to the 2019 level. The biodiesel market expanded, due to higher blending requirements, tax credits, direct subsidies and decarbonisation initiatives in the market. Higher feedstock prices (vegetable oil, maize, sugar cane, and molasses) and bottlenecks in domestic supply chains increased production costs and constrained biofuel production in most countries and regions. The *Outlook* foresees biofuel markets remaining largely driven by fossil fuel demand and significantly influenced by domestic support policies. Over the medium term, middle-income countries are foreseen to lead biofuel market expansion by implementing blending mandates and providing subsidies to support domestic production and the use of blended fuels. In high-income countries, biofuel expansion will be limited due to decreasing fossil fuel demand and reduced policy incentives.

Global biofuel use is expected to grow over the projection period (Figure 9.1). The IEA *World Energy Outlook* (on which the fossil fuel demand projections of this *Outlook* are based) foresees a reduction in the total transport fuel use in the European Union and the United States, suggesting limited growth potential for biofuel consumption. In the United States, biofuel demand is expected to be sustained by the post-Renewable Fuel Standard (RFS) regime and consumption will be almost constant during the projection period. In the European Union, the RED II (Renewable Energy Directive) classified palm oil-based biodiesel under a high ILUC (Indirect Land Use Change) risk category as potentially increasing greenhouse gas (GHG) emissions from deforestation or the conversion to cropland. It limits the use of palm oil by fulfilling certain rules and certification schemes. Consequently, the consumption of palm oil-based biodiesel is expected to decline rendering a negative impact on total biodiesel demand.

Figure 9.1. Biofuel demand trends in major regions



Note: Shares calculated on demand quantities expressed in volume. The size of each bubble relates to the consumption volume of the respective biofuel in 2021.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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Fuel consumption trends and policy developments in emerging economies also play a significant role. In Brazil, Colombia and Paraguay, total fuel consumption should increase over the projection period, with both ethanol and biodiesel consumption projected to grow. In Indonesia, the blending rate is expected to slightly decrease around its current level remaining above 30% (B30), with diesel use and biodiesel consumption expected to increase in parallel. In Southeast Asian countries, the use of biodiesel is expected to increase due to increases in both transport fuel demand and industrial use. Due to high soybean oil prices and increasing production costs, the government of Argentina reduced the biodiesel blend rate to 5% in 2021. Although over the projection period fuel consumption and the blend rate are expected to increase, total biodiesel use will remain below pre-COVID-19 levels. In India, sugarcane-based ethanol should contribute significantly to reach an ethanol blend rate of about 20% by 2031, although still falling short of the E20 government target.

Globally, biofuel will continue to be produced predominantly from traditional feedstocks: maize and sugarcane for ethanol and vegetable oil for biodiesel production. COVID-19 reduced the availability of used cooking oil (UCO) in many countries, due to restaurant closures. However, UCO based biodiesel production is projected to recover and continue playing an important role in the European Union, United States and Singapore. In most countries, biofuel policies target domestic objectives aiming at reducing GHG emissions and dependency on fossil fuels while supporting domestic agricultural producers. Domestic production typically covers most of the demand, thus leaving a relatively low international trade share. By 2031, world biodiesel trade is projected to decrease to 10% of total production, but ethanol trade will remain at about 7.5%.

International biofuel prices are projected to remain constant over the outlook period in nominal terms, while decreasing in real terms. Biofuel prices only partially reflect their fundamental drivers, such as feedstock prices, crude oil price and distribution costs as well as customers’ disposable income and consumption preferences. It is policies, such as domestic support, consumer tax credits and blending mandates tying biofuel consumption to fossil fuels, that also tend to shape the path of prices over time.

The policy environment, heavily influenced by energy and environmental issues, is the main source of uncertainty in the projections. This *Outlook* expects no substantial increase in advanced biofuels such as cellulose-based ethanol or hydrogenated vegetable oil (HVO) based biodiesel before the end of the outlook period. Sustainable aviation fuel (SAF) consumption and production could increase in the long term; however, its success relies on technological advancements, ambitious policies and securing sustainable feedstock. The number of global electric vehicles (EV) stock has been increasingly since the mid-2000s. More than 20 countries have announced the complete phasing out of internal combustion engine (ICE) vehicle sales over the next 10-30 years. Many countries and the European U have introduced EV deployment targets and other supporting programmes for increasing EV utilisation and promoting R&D for EV. Uncertainty in the projections arises from the assumptions about future developments in the transportation sector. Unforeseen advances in technology and potential changes in the regulatory framework may result in substantial deviations from current market projections for biofuels.

9.2. Current market trends

The global economic recovery and the easing of mobility restrictions favoured the recovery of global fossil fuel demand, which had a positive influence on the biofuels market. Moreover, increasing support with higher mandates accelerated biofuel demand in 2021. Global ethanol and biodiesel consumption increased to 126 bln L and 55 bln L, respectively, in 2021. Despite the recovery, production margins for biofuels were affected by higher feedstock and producing costs, which had a negative impact on biofuel production in some major producing countries. For instance, because of the higher vegetable oil prices and increasing production costs, Argentine reduced biodiesel blend rates in 2021. Nonetheless, several countries continue supporting biofuels production with higher mandates, tax credits and subsidies, such as India and

Indonesia. To some extent, the high fossil fuel prices have provided more leverage to the biofuels industry. Due to demand recovery and higher feedstock prices, ethanol and biodiesel nominal prices were historically high in 2021.

9.3. Market projections

9.3.1. Consumption and production

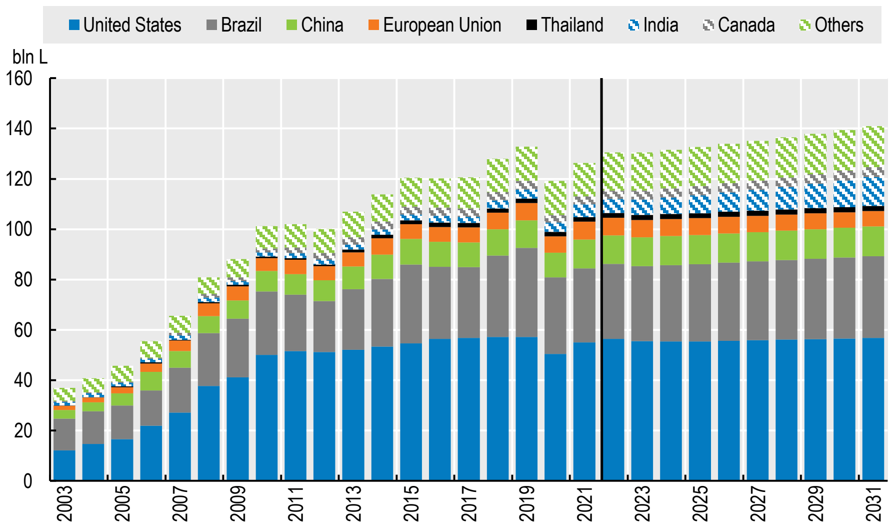
Asian countries are driving biofuel supply and demand

Globally, this *Outlook* expects biofuel consumption and production to increase at a much slower pace during the projection period than in previous decades primarily as result of reducing support policies in developed countries. Demand for biofuels is expected to increase due to developments in transportation fleets, domestic policies that favour higher blends, and greater demand from consumers.

Global ethanol and biodiesel production is projected to increase to 140 bln L and 55 bln L, respectively, by 2031, due to expansion in Asian countries which favours domestic production through subsidies, tax credits and low interest loans for investments. Feedstocks for biofuel products vary from country to country. Global biofuel production will continue to be dominated by traditional feedstocks despite the increasing sensitivity to the sustainability of biofuel production observed in many countries (Figure 9.3).

The share of energy that enters the transport sector through biofuels exceeds 10% only in Brazil. However, a goal of many biofuel policies, especially in developing countries, is to reduce energy dependency from fossil fuel sources.

Figure 9.2. Development of the world ethanol consumption



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en

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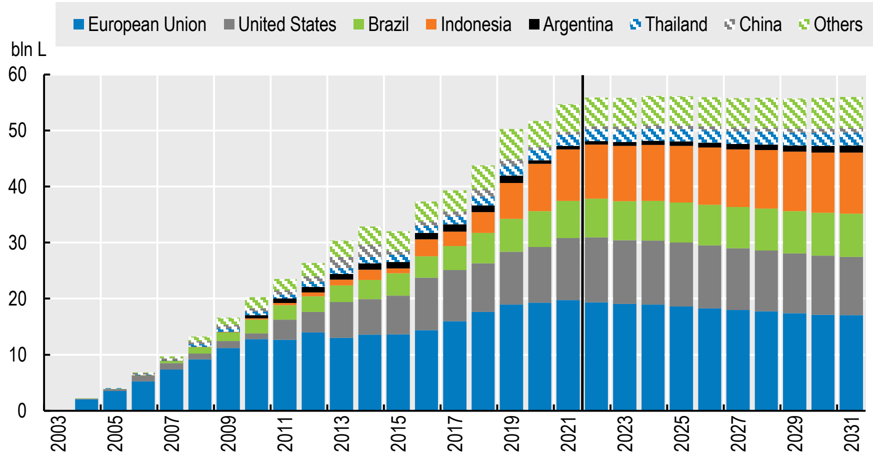
Figure 9.3. Development of the world biodiesel consumption



Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en

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Box 9.1. Biofuels at a glance

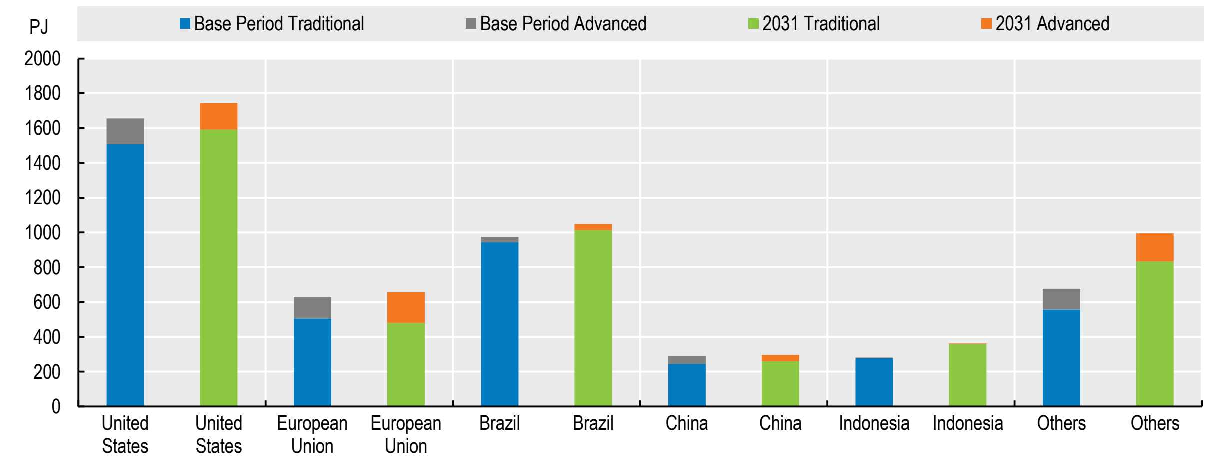
Biofuels (bioethanol and biodiesel[1]) are fuels produced from biomass. Currently, about 59% of ethanol is produced from maize, 22% from sugarcane, 2% from molasses, 2% from wheat, and the remainder from other grains, cassava or sugar beets. About 73% of biodiesel is based on vegetable oils (14% rapeseed oil, 24% soybean oil, and 31% palm oil) and used cooking oils (21%). More advanced technologies based on cellulosic feedstock (e.g. crop residues, dedicated energy crops, or woody biomass) do not account for large shares of total biofuel production. The international biofuel sectors are strongly influenced by national policies that have three major goals: farmer support, reduced GHG emissions, and/or increased energy supply and independence.

Table 9.1. Biofuel production ranking and major feedstock

	Production ranking (base period)		Major feedstock	
	Ethanol	Biodiesel	Ethanol	Biodiesel
United States	1 (46.7%)	2 (18.4%)	Maize	Soybean oil, used cooking oils
European Union	4 (4.9%)	1 (30.7%)	Sugar beet / wheat / maize	Rapeseed oil /Palm oil/ used cooking oils
Brazil	2 (26.3%)	4 (13.1%)	Sugarcane / maize	Soybean oil
China	3 (8.4%)	8 (2.8%)	Maize / cassava	Used cooking oils
India	5 (2.9%)	14 (0.4%)	Molasses / sugarcane / maize / wheat / rice	Used cooking oils
Canada	6 (1.6%)	13 (0.8%)	Maize / wheat	Canola oil / used cooking oil/soybean oil
Indonesia	20 (0.1%)	3 (17.5%)	Molasses	Palm oil
Argentina	8 (0.9%)	5 (3.6%)	Molasses / sugarcane/ maize	Soybean oil
Thailand	7 (1.4%)	7 (3.0%)	Molasses / cassava/ sugarcane	Palm oil
Colombia	14 (0.4%)	11 (1.3%)	Sugarcane	Palm oil
Paraguay	11 (0.5%)	18 (0.02%)	Maize/ sugarcane	Soybean oil

1. Numbers refer to country ranking in global production; percentages refer to the production share of countries in the base period.
2. In the *OECD-FAO Agricultural Outlook 2022-2031*, biodiesel includes renewable diesel (also known as Hydrotreated Vegetable Oil or HVO), although these are different products.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

Figure 9.4. World biofuel production from traditional and advanced feedstocks



Note: Traditional feedstocks are here defined as food and feed crop based biofuels. Values in Petajoules = 1015 Joules.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en

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United States

In the United States, biofuels are expected to be sustained by the post-Renewable Fuel Standard (RFS) regime set by the EPA at recently announced levels in volume terms, with a projected decrease in the use of transportation fuel. Most of gasoline will continue to be used for 10% ethanol blend (E10). Some growth is projected in 15% ethanol blend (E15), but infrastructure and other constrain limit the growth over and expansion of mid-high level blending is not alone sufficient to prevent declining US domestic fuel use.[1] The ethanol blend rate will increase to 11% by 2031.

Both the production and consumption of ethanol are expected to increase by 0.2% p.a. (Figure 9.4) over the next decade. Corn (maize) is assumed to be the main feedstock for ethanol production, accounting for 98% of production in 2031. Cellulosic ethanol production capacity is assumed to remain constant over the projection period. Although the United States should maintain its position as the world's largest ethanol producer, its share of global production should decrease from 47% to 44%.For biodiesel production is projected to decrease by 1.4% p.a. (Figure 9.5), to account for 16% for global production in 2031.

The European Union

Since 2010, EU legislation related to biofuel support has been based on the 2009 Renewable Energy Directive (RED), which required that at least 10% of transport energy use in EU Member States should be based on renewables by 2020. In 2018, agreement was reached to increase the transport sector target to 14%, with national caps on food and feed crop-based biofuels at 1 percentage point above 2020 levels, but not exceeding 7%. A new framework was adopted under Directive 2018/2001. RED II entered into force in 2021 to be implemented by 2030.[2] RED II set a new overall renewable energy target of 32% by 2030. It classified palm oil-based biodiesel under a high ILUC risk category and thus consumption of this biodiesel source is expected to decline.

According to the International Energy Agency's (IEA) baseline, total energy use in the transport sector is projected to decrease for diesel and gasoline with ethanol and biodiesel consumption decreasing (-1 bln L and -2.6 bln L, respectively). Palm oil-based biodiesel constitutes a large share of this decrease in view of

EU sustainability concerns associated with palm oil production, while production from used cooking oils is projected to increase. Given the demand projections for the biodiesel sector, the European Union is expected to remain the world's largest biodiesel producing region in 2031, although global production shares are expected to decrease from 30.7% to 28%. Total EU biofuel consumption is projected to decrease by 1.5% p.a., but the share of advanced biofuel sources should increase from 24% at present to 37% by 2031 (Figure 9.3).

Brazil

Brazil has a large fleet of flex-fuel vehicles that can run on either gasohol (a mix of gasoline and anhydrous ethanol) or on hydrous ethanol. For gasohol, the government can vary the ethanol blend rate between 18% and 27%, depending on the price relationship between domestic sugar and ethanol. The current percentage requirement for ethanol is legislated at 27%. The current differentiated taxation system favours hydrous ethanol over blended gasohol in key Brazilian states. For biodiesel, the government is assumed to maintain biodiesel blend ratio at 11% through 2031.

Brazilian ethanol consumption is projected to increase by 1.0 % p.a., sustained by the RenovaBio programme.[3] This programme, signed in January 2018, is intended to reduce the emissions intensity of the Brazilian transport sector in line with the country's commitments under COP21. To create the necessary incentive structure, RenovaBio will introduce a system of tradeable carbon credits. Brazilian production is projected to increase by 0.9% p.a., with strong competition for sugarcane used for sugar production. By 2031, more than half of total Brazilian ethanol production is projected to be consumed by high blend flex-fuel vehicles, implying an increase in this fleet.

In contrast to the United States and the European Union, total fuel consumption of gasoline and diesel in Brazil is projected to increase over the coming decade, underpinning the potential growth of blending biofuels to gasoline and diesel. Consequently, this *Outlook* projects that ethanol market volumes and biodiesel consumption will increase in Brazil, but the growth rates will lower than the past decade.

Indonesia

The implementation of B30 (Biodiesel 30% blend) aims at reducing the country's dependency on imported fossil fuels, stabilising palm oil price, reducing GHG emissions and sustaining the domestic economy as it accounts for nearly half a million jobs in the country. In recent years, biodiesel production has steadily increased due to a national biodiesel programme, which provides support to biodiesel producers, and it is financed by the crude palm oil (CPO) fund. The projected international reference prices for vegetable oil and exports, together with a levy projected on average at USD 85/t on exports in 2022 which decreases by USD 10/ton per year to reach USD 55/ton in 2025 remaining at that level until 2031[4], is assumed to be sufficient to maintain B30 over the period. The support to biodiesel producers covers the gap between biodiesel and diesel prices. The biodiesel price is calculated as the CPO price plus production costs, set at USD 80/t, plus freight and transports costs. In 2021, the average estimated subsidy to biodiesel production increased to about USD 0.22/L owing to high CPO and low diesel prices. However, this subsidy should decrease over the outlook period to about USD 0.16/L as oil prices are expected to recover, driving fossil fuel prices up. Based on these assumptions, biodiesel production in Indonesia is projected to increase to 10.9 bln L by 2031. In view of the EU environmental regulation and declining use of diesel in high-income countries, exports are projected to remain negligible over the outlook period.

India

India has accelerated ethanol production aiming to achieve the ambitious target of E20 (Ethanol 20% blend) by 2025 rather than 2030. However, the Outlook foresees limitations on the feedstock supply to increase biofuel production to reach the target levels over the outlook period. While the Outlook assumes a significant increase in the use of new feedstuffs such as sugarcane, maize, wheat and rice, molasses would remain as the primarily feedstuff, thus limiting domestic supply such that production will not be sufficient to meet increasing demand from the biofuels industry. Aided by soft loans, sugar mills are investing and developing the capacity to produce ethanol from sugarcane juice; in 2021, reports indicate that this source of ethanol could account for about 13% of the total ethanol production to reach nearly 25% in 2031. In spite of such developments, sugar export subsidies are expected to slow down the transition towards sugarcane-based ethanol. This, in combination with accelerating gasoline demand, would increase the blending rate to 11% in 2025 and 20% in 2031. Ethanol production is expected to be 11 bln L in 2031. The limited supply of vegetable oils, for which India is a net importer, in combination with high international prices will remain as the main constrains to significantly increase biodiesel production.

China

In 2017, China announced a new nationwide E10 mandate aimed at eliminating excessive maize stocks. In 2018, the government announced it would expand this programme from 11 to 26 provinces[5] by 2020. As maize stocks have declined since 2017, the main incentive to step up ethanol use is disappearing. This *Outlook* nevertheless assumes that the blending rate of 2% will be maintained to 2031. Chinese ethanol consumption will increase with higher overall fuel use, although the growth rate will decrease compared with the last decade. This is projected to correspond to a production increase of 0.28% p.a. during the projection period. This *Outlook* assumes most of the ethanol demand will be produced from domestic feedstock.

Argentina

Due to the higher soybean oil prices and increasing production costs, the government reduced the biodiesel blend rate from 10% to 5% in 2021, which is expected to increase to 8.5% in 2031. Consumption and production will increase by 7.8% and 3.1%, respectively, during the projection period. However, these will remain lower than 2019 levels. Tax exemptions should continue to boost the development of the country's biodiesel industry, which exports almost half of its production. However, weak production and trade barriers by the United States, and the Argentinian export tax will lower its exports by 1.6% p.a.

Thailand

The domestic feedstock sources – molasses, cassava and palm oil – constrain biofuels production. Without increased production of these commodities or including a broader range of commodities in the feedstock basket, the projected production lags behind the targets set for 2036. In addition, the government will gradually reduce the current subsidy on ethanol by 2022, although higher blend (E85) is expected to be less affected than lower blend (E10); on average, blending is expected to reach 16% over the outlook period and production is projected to increase marginally to 2 bln L in 2031. Biodiesel demand is expected to be supported by the obligatory blending rates, with subsidies favouring B20 and B10 against B7. However, limited domestic palm oil supply and high vegetable oil prices will constrain domestic supply and demand will marginally increase to 2.3 bln L by 2031.

Colombia

Ethanol demand is projected to increase over the outlook period in line with the recovery of gasoline demand. Due to the local supply shortages, the government decreased the ethanol blend rate to 4% between April and September 2021, with the average blending rate in 2021 about 8%. Over the medium term, the blending rate is projected to return to 10%. This *Outlook* assumes sugarcane to continue as the main feedstock; moreover, in 2030 biofuels use will account for about 27% of the sugarcane production against 17% in the base period, thus consolidating ethanol as an important element in sustaining the

Colombian sugarcane industry. Biodiesel demand was subdued in 2019 and 2020 due to a decline in diesel demand, but the blending rate increased close to B12. This *Outlook* assumes this level will continue over the medium term and production is projected to reach 0.8 bln L by 2031.

Other countries

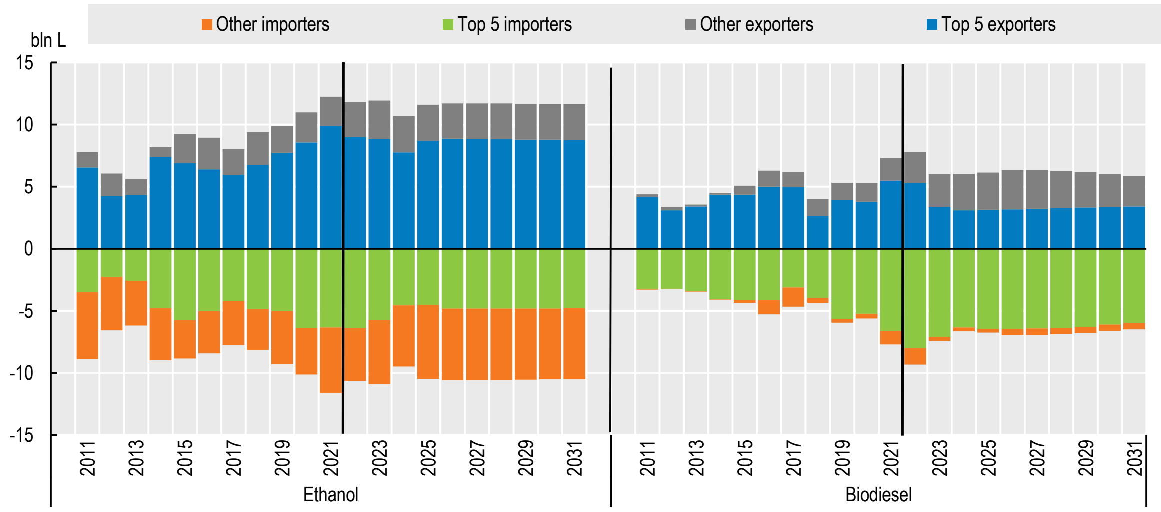
Other relatively important producers of ethanol include Paraguay, the Philippines, and Peru, where production could reach 0.9 bln L, 0.6 bln L and 0.3 bln L, respectively, by 2031; the blending rate in these three countries is assumed to remain stable at around 30%, 10% and 7%, respectively. Malaysia, the Philippines and Peru are also major biodiesel producers, where production could reach 1.6 bln L, 0.3 bln L and 0.2 bln L, respectively, by 2031. In Malaysia, blending is projected to remain around 10%, whereas in Peru and the Philippines around 6% and 3%, respectively. Other Asian countries, in particular Singapore, would increase production to reach around 1.4 bln L of biodiesel from UCO in 2031. Unlike most countries where biofuels are domestically used to reduce GHG emissions and to reduce national dependency on imported oil, production of biodiesel in Singapore is largely exported.

9.3.2. Trade

Global trade in biofuels will be slacken over the next decade

Global ethanol trade is projected to remain at about 7% by 2031. The United States and Brazil are expected to remain net exporters of maize- and sugarcane-based ethanol. However, US and Brazilian ethanol exports will decrease over the outlook period as the main importers, Colombia and India, continue expanding domestic production, thus becoming less dependent on trade.

Figure 9.5. Biofuel trade dominated by a few global players



Note: Top five ethanol exporters in 2031: United States, Brazil, European Union, Pakistan, United Kingdom. Top five ethanol importers in 2031: Brazil, United States, Japan, Canada, United Kingdom. Top five biodiesel exporters in 2031: Argentina, European Union, United States, Indonesia, Canada. Top five biodiesel importers in 2031: European Union, United States, United Kingdom, Canada, Peru. Classification of biofuels by domestic policies can result in simultaneous exports and imports of biofuels in several countries.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en

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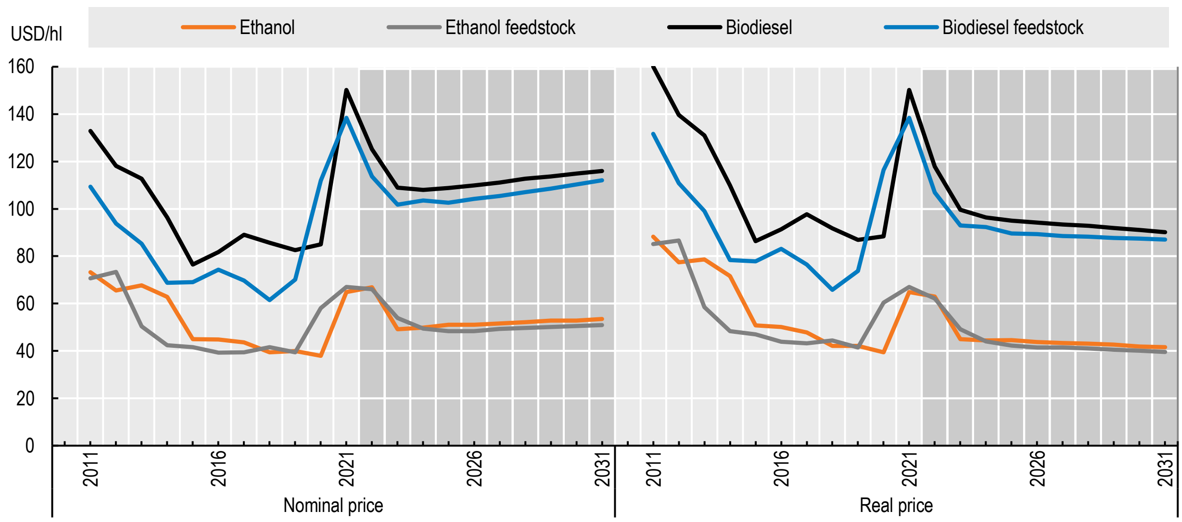
Global biodiesel trade is projected to decrease from 6.6 bln L to 5.8 bln L by 2031. Chinese and Indonesian biodiesel exports will decrease dramatically, reflecting weak production and high domestic demand, respectively. The European Union and the United States are assumed to remain the leading biodiesel exporter. Argentina exports are projected to decrease by 1.6% over the period due to weak production and trade barriers.

9.3.3. Prices

Prices in real terms are expected to decrease

Nominal biodiesel and ethanol prices reached historical high levels in 2021. Nominal and real ethanol and biodiesel prices will decrease in 2023, due to decreasing feedstock prices, but after 2024, nominal prices are projected to remain constant through to 2031. In real terms, a combination of policies, feedstock and crude oil prices, and distribution costs, will lead to a slow decrease in ethanol and biodiesel prices.

Figure 9.6. The evolution of biofuel prices and biofuel feedstock prices



Note: Ethanol: wholesale price, US, Omaha; Biodiesel: Producer price, Germany, net of biodiesel tariff and energy tax. Real prices are nominal world prices deflated by the US GDP deflator (2021=1). As proxy for the biodiesel feedstock price, the world vegetable oil price is used and for ethanol a weighted average between raw sugar and maize is applied.
Source: OECD/FAO (2022), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en

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9.4. Risks and uncertainties

Evolution of policies and relative prices are key

The major risks and uncertainties for the future development of the biofuels sector are largely related to the policy environment, feedstock and oil prices. Policy uncertainty concerns changes in mandate levels, enforcement mechanisms, investment in non-traditional biofuel feedstock, tax exemptions and subsidies for biofuels and fossil fuels, and policies promoting EV and SAF technology.

The policy environment will remain uncertain because it crucially depends on agricultural feedstock and oil prices developments. Fossil fuel prices affect biofuel competitiveness and are consequently linked to subsidies allocated to the biofuel sector. Russia's war against Ukraine causes to increase fossil fuel prices and can impact on biofuel market structure. Another uncertainty arises from feedstuff supply. Traditionally, countries sought to use commodities for biofuels for which they have a surplus so as not to reduce food availability and threaten food security. As biofuels compete with food use and may require extra, undesired land use, countries are cautious on expanding biofuel production at a faster pace. Nevertheless, blending mandates are expected to lead to more biofuel production in some emerging economies.

The global EV stock has been increasing since the mid-2000s. More than 20 countries have announced the complete phasing out of ICE vehicle sales and eight countries plus the European Union have announced net-zero emission vehicle pledges over the next 10-30 years.[6] Many countries and the European Union have introduced EV deployment targets, purchase incentives and other supporting programmes for increasing EV utilisation and promoting R&D for EV. SAF consumption and production could increase in the long term; however, its success relies on technological advancements, ambitious policies and securing sustainable feedstock (Box 9.2). Advances in technology and potential changes in the regulatory framework of the transport sector could result in substantial deviations from current market projections for biofuels. Countries are expected to adopt policies to advance the implementation of new technologies to cut greenhouse emissions, via blending mandates, subsidies, and tax reductions. All these measures transfer uncertainty in energy to agricultural markets. As a consequence, future biofuel demand is related to the response of the private sector to these measures. The industries currently investing in EV and SAF could, depending on the uptake of this technology and the policies supporting its adoption, add to either a decrease or increase in the use of biofuels over the next decade – and beyond.

Box 9.2. Sustainable Aviation fuel (SAF)

In 2019 the aviation sector emitted 915 million tonnes of carbon dioxide (CO_2), accounting for 2% of total emissions and 12% of all transport emissions.[1] As the aviation industry needs to reduce CO_2 emissions, it is committed to a 50% reduction of CO_2 by 2050 and targeting a sustainable aviation fuels (SAF) share of 2% by 2025. SAF is biofuel used for aviation fuels with lower carbon emissions than conventional fuels. Most of the SAF is produced from hydrotreatment of fats, oils and greases such as used cooking oils. These are known as hydrotreated esters and fatty acids (HEFA) and hydrated vegetable oils (HVO). Furthermore, it is produced from lignocellulose/biomass feedstocks (such as agricultural residuals and woody biomass).[2] SAF can reduce GHG emissions compared to conventional aviation fuel in life cycle base. The use of SAF is expected to reach the industry targets.

Global SAF production is estimated to increase from 7 million L in 2018 to 140 million L in 2019. Production has increased dramatically but it is less than 1% of fuels currently used for aviation.[3] While the technology of HEFA is at the commercial level, the industry has concerns for the higher cost of feedstock, and current and future restrictions on use of food-based feedstock.[4] Furthermore, the feedstocks used in HEFA can compete with those use on road vehicle and SAF. The main obstacle for introducing SAF is the high production cost. The current SAS amounts to 3-6 times the price for conventional jet fuel.[5] However, higher jet fuel prices from high crude oil prices can mitigate the cost differences between conventional aviation fuel and SAF. Furthermore, advanced R&D can be expected to reduce the production cost of SAS in the long-term. SAF is required to be safe, and credible, and the aviation industry's feedstocks need to be shown to be sustainable in a lifecycle assessment.

Some European countries have introduced SAF blending mandates. Norway and Sweden have introduced SAF blending mandates on fuel suppliers since 2020. Furthermore, France introduced SAF mandates for the aviation sector from 2022. The European Commission proposed minimum SAF blending volumes in aviation fuel, rising from 2% in 2025 to 5% in 2030 and 63% in 2050. The U.S. announced a new SAF goal to produce 3 billion gallons of SAF and reduce aviation emissions by 20% by 2030. IEA expects that SAF demand will range from 2 to 6 billion L by 2026, up from 0.1 billion L in 2021.[6] The low carbon fuel standard programme for jet fuels can encourage SAF markets. SAF consumption and production could increase in the long term; however, its success relies on technological advancements, appropriate policies, setting sustainable criteria and securing sustainable feedstock. Policies and financial support are required for R&D for SAF production, securing feedstocks, logistics, sustainability assessments, etc.

1. https://aviationbenefits.org/media/166152/beginnersguide-to-saf_web.pdf.
2. https://irena.org/publications/2021/Jul/Reaching-Zero-with-Renewables-Biojet-Fuels.
3. IRENA analysis based on Dickson, N. (2019), "Stocktaking results", ICAO Stocktaking Results (pp. 1–13), ICAO.
4. https://www.europarl.europa.eu/RegData/etudes/BRIE/2020/659361/EPRS_BRI(2020)659361_EN.pdf.
5. https://irena.org/publications/2021/Jul/Reaching-Zero-with-Renewables-Biojet-Fuels.
6. https://www.iea.org/articles/are-conditions-right-for-biojet-to-take-flight-over-the next-five-years ?

Notes

[1] See https://www.usda.gov/oce/commodity-markets/baseline.

[2] See https://ec.europa.eu/jrc/en/jec/renewable-energy-recast-2030-red-ii.

[3] See http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2017/lei/L13576.htm.

[4] The assumptions related to the levy collection to sustain the CPO fund are based on information available in March 2022. Calculations for the subsidies are based on production costs in nominal terms accounting for domestic inflation and the nominal prices for vegetable oil and oil in the model.

[5] Eleven provinces accounted for 46.1% of China's total population in 2017.

[6] See http://www.iea.org/reports/global-ev-outlook-2021.