9. Biofuels

This chapter describes the market situation and highlights the medium-term projections for world biofuel markets for the period 2020-29. Price, production, consumption and trade developments for ethanol and biodiesel are discussed. The chapter concludes with a discussion of important risks and uncertainties affecting world biofuel markets during the coming ten years.

9.1. Market situation

Global biofuel production increased in 2019 in all major producing regions, although at slower rates than in the previous decade, and ample supplies translated into lower prices for ethanol and biodiesel. Biodiesel producing margins decreased, however, due to the increase in vegetable oil prices, while production margins of ethanol decreased in part because of higher sugar prices. Policies also played a strong role in the pricing of biofuels given specific subsidies, taxes and mandates.

Demand for biofuels has been sustained by various policies, including obligatory blending, preferential taxes, and subsidies, and growing global fuel demand. In some countries, increases in mandates and differential taxation systems or subsidies have supported demand for biofuels and influenced price developments.

9.2. Projection highlights

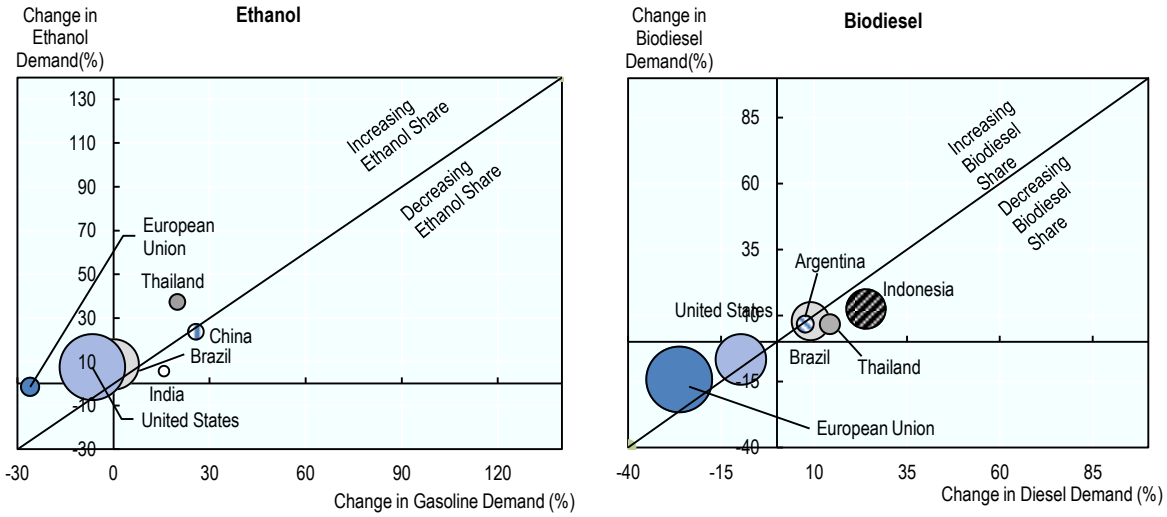
Global biofuel consumption is expected to continue to increase, primarily in developing countries, largely driven by higher blending targets. In developed countries, the expansion of biofuels will be limited in view of a decrease in total fuel demand and reduced policy incentives. World prices for biofuels are closely linked to developments in feedstock prices (which are mostly declining in real terms), crude oil prices (constant in real terms) and distribution costs, as well as biofuel policies. International biofuel prices are expected to increase over the outlook period in nominal terms but remain largely unchanged in real terms.

Future developments in biofuel markets will be largely driven by national support policies and fuel demands. The *IEA World Energy Outlook* (on which this *Outlook* bases its energy projections) foresees decreasing total fuel demand in the European Union and the United States, suggesting limited growth in biofuel consumption (Figure 9.1). In the European Union, the Renewable Energy Directive (RED) II classifies palm oil-based biodiesel under a high Indirect Land Use Change (ILUC) risk category. As a result, biodiesel consumption in the European Union is expected to fall below current levels. In the United States, biofuel demand is expected to be sustained by the Renewable Fuel Standard (RFS). However, the 10% ethanol blend wall is expected to constrain increases of domestic ethanol consumption during the projection period.

In Brazil, total fuel consumption is expected to increase. This, combined with the RenovaBio law which aims to reduce fuel emissions by 10% by 2028, is expected to lead to an increase in both ethanol and biodiesel consumption over the projection period. Biodiesel consumption is expected to keep pace with total diesel consumption, while the share of ethanol in gasoline consumption will increase slightly. Ethanol consumption in Brazil is projected to reach 39 bln L in 2029.

In 2017, the government of the People's Republic of China (hereafter "China") announced that a new nationwide E10 mandate would be implemented by 2020 to eliminate excessive maize ending stocks. With declining maize stocks, the main incentive to step up ethanol use has disappeared. This *Outlook* therefore assumes that the lower blending rate of 2% will be maintained up to 2029. Chinese ethanol consumption will increase with higher overall fuel use; however, the growth rate will decrease compared to the last decade.

Figure 9.1. Developments in biofuel demand 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 2019.
Source: OECD/FAO (2020), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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In Indonesia, total diesel use is expected to increase over the outlook period. In Argentina, biodiesel use is projected to reach the 15% blending mandate over the outlook period. It is expected that in Thailand the government will gradually reduce the current subsidy on biofuels and that its domestic feedstock supply to the biofuel industry will remain limited over the outlook period. Ethanol consumption growth in India is not expected to keep pace with total gasoline consumption growth (which is expected to almost double in the next ten years); however, by 2029, the ethanol-blending rate is projected to reach close to 5%.

As biofuel policies in many countries tend to support national markets, international trade volumes are relatively low. Global trade for biodiesel and ethanol as a share of total production is assumed to decrease over the coming decade. World biodiesel trade is expected to decrease drastically from current levels, largely reflecting declining demand for palm oil-based biodiesel in the European Union; ethanol trade will decrease moderately. On the export side, Argentine biodiesel exports are expected to increase slightly while exports from Indonesia are expected to decrease, reflecting high domestic demand.

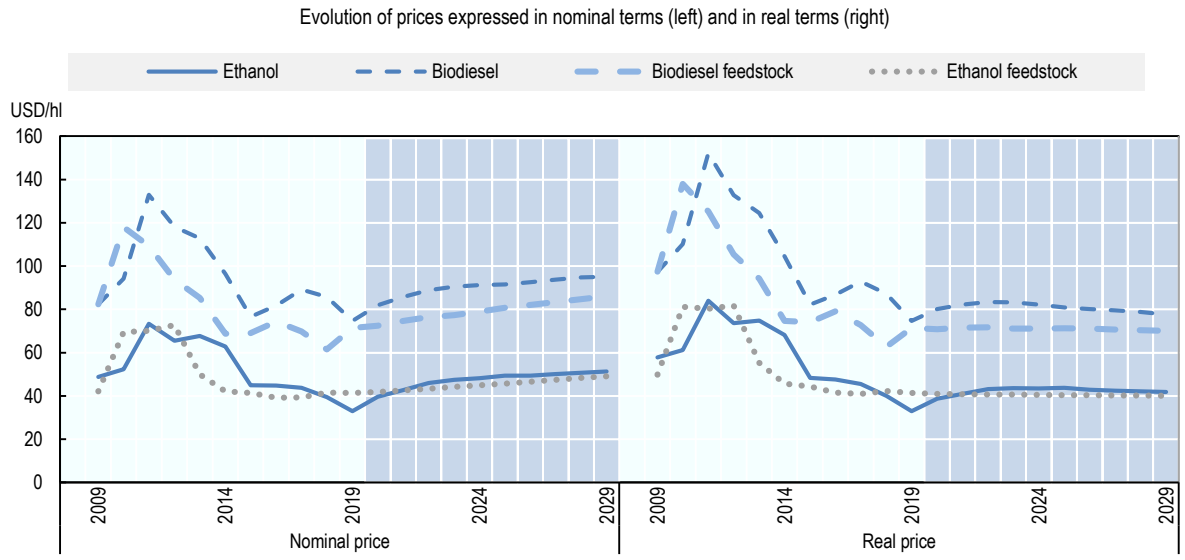
The major risks and uncertainties for the future developments of the biofuel sector are related to the policy environment. This *Outlook* assumes the government of Indonesia will implement the B30 programme nationwide as planned, but reaching the intended target to increase biofuel demand will largely depend on the relationship between domestic and palm oil international prices. Higher production costs driven by higher palm oil prices and engine durability could jeopardise this target.

This *Outlook* expects that most of the biofuels produced will be based on agricultural feedstock. No substantial increase in advanced biofuels is expected before the middle of the outlook period. There is uncertainty over the price trajectory for crude oil, which is assumed to see moderately rising quotations over the projection period. Although countries are expected to advance on the implementation of new technologies in order to reduce greenhouse gas (GHG) emissions, there is uncertainty concerning subsidies and tax reductions as they apply to the energy and agricultural markets. New technologies will impact another driving factor of future biofuel demand, which is the development of electric vehicles (EV). Depending on the uptake of this technology and the policies that support its promotion, EVs could add to a potential decrease in the use of biofuels over the outlook period.

9.3. Prices

Influenced by developments on the vegetable oil markets, nominal biodiesel prices are projected to increase at a slower pace (1.5% p.a.) than ethanol prices (2.5%). Expressed in real terms, biodiesel prices are expected to decrease after 2023 and ethanol prices to resume a decreasing trend after 2026. The main reason for nominal ethanol prices performing more strongly than biodiesel is that ethanol prices are currently at historical lows and the recovery expected in the first years of the projection period will start from this low base. It should be borne in mind, however, that due to policies that include fiscal benefits or supported prices, international and domestic biofuel prices often diverge.

Figure 9.2. 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 calculated based on the GDP deflator in the United States. 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 (2020), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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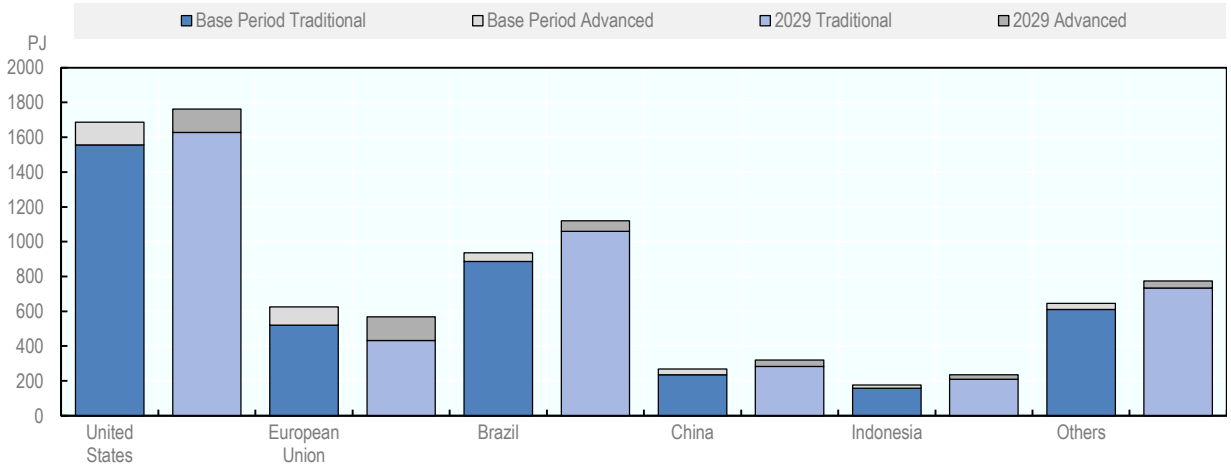
Globally, this *Outlook* expects biofuel production to increase at a much slower pace during the projection period than in previous decades. The primary reason is that changes in US and EU policies are reducing support to this sector. However, demand for biofuels is expected to grow in major developing countries given expected developments in the transportation fleet and domestic policies that favour higher blends and greater demand at the consumer level.

Global ethanol production is projected to increase to 140 bln L by 2029, while global biodiesel production is projected to reach almost 46 bln L, driven principally by the mandate increase in the United States over the initial projection years. Feedstocks for biofuel products vary from country to country. Global biofuel production will continue to be dominated by traditional feedstocks, despite the fact that increasing sensitivity to the sustainability dimension of biofuel production is observed in many countries (Figure 9.3).

Sugarcane and maize will continue to dominate ethanol feedstock. Ethanol production is projected to use 25% and 14% of global sugarcane and maize production respectively by 2029. Vegetable oil is expected to continue to be the feedstock of choice in biodiesel production. Biodiesel production based on used cooking oils will continue to play an important role in the European Union, Canada, and the United States.

Figure 9.3. World biofuel production from traditional and advanced feedstocks



Note: Traditional feedstocks are defined here as food and feed crop based biofuels. Values in Petajoule = 10^{15} Joule.
Source: OECD/FAO (2020), "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. At present, about 64% of ethanol is produced from maize, 26% from sugarcane, 3% from molasses, 3% from wheat, and the remainder from other grains, cassava or sugar beets. About 77% of biodiesel is based on vegetable oils (37% rapeseed oil, 27% soybean oil, and 9% palm oil) or used cooking oils (23%). More advanced technologies based on cellulosic feedstocks (e.g. crop residues, dedicated energy crops, or woods) do not account for large shares of total biofuel production. The international biofuel sectors are strongly influenced by national policies having three major goals: farmer support, reduced GHG emissions, and/or reduced energy independency.

Table 9.1. Biofuel production ranking and major feedstocks

	Production ranking (base period)		Major feedstocks	
	Ethanol	Biodiesel	Ethanol	Biodiesel
United States	1 (48.2%)	2 (19.5%)	Maize	Soybean oil
European Union	4 (4.9%)	1 (34.1%)	Sugar beet /wheat /maize	Rapeseed oil / used cooking oils
Brazil	2 (26.2%)	4 (12.0%)	Sugarcane / maize	Soybean oil
China	3 (8.1%)	8 (2.2%)	Maize / cassava	Used cooking oils
India	6 (2.1%)	14 (0.4%)	Molasses	Used cooking oils
Canada	7 (1.4%)	10 (0.7%)	Maize / wheat	Canola oil / soybean oil
Indonesia	21 (0.2%)	3 (12.3%)	Molasses	Palm oil
Argentina	9 (0.9%)	5 (6.6%)	Molasses / maize	Soybean oil
Thailand	8 (1.4%)	6 (3.6%)	Molasses / cassava	Palm oil
Colombia	13 (0.4%)	10(1.4%)	Sugarcane	Palm oil
Paraguay	14 (0.4%)	17 (0.03%)	Sugarcane	Soybean oil

Note: Numbers refer to the position that countries take in global production ranking; percentage numbers refer to the production share of countries in the base period.
1. Biodiesel includes renewable diesel (also known as Hydrotreated Vegetable Oil or HVO) in the accounting of this *Outlook* although both are different products.
Source: OECD/FAO (2020), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

The share of energy that enters the transport sector through biofuels exceeds 10% in only one country, Brazil. Yet a goal of many biofuel policies, especially in developing countries, is to reduce energy dependency from fossil sources. This goal is far from being achieved.

United States

In 2019, the Environmental Protection Agency (EPA) decided to increase the advanced biofuel mandate in 2020 (+0.6 bln L) and to maintain the biodiesel sub-mandate in 2021. An important part of the initial Renewable Fuel Standards (RFS2) proposed in the 2007 Energy Independence and Security Act (EISA) were waived for the total advanced and cellulosic mandates on the basis that the production capacity for cellulosic ethanol had not been developed; the conventional gap,[1] often referred to as an implied maize mandate, was maintained at 56.8 bln L.

This *Outlook* assumes that the US government will keep all mandates set by EPA at recently announced levels in volume terms despite the projected decrease in the use of transportation fuel. The consumption of ethanol is projected to increase from 55.4 bln L to 59.8 bln L by 2029 (Figure 9.6). The 10% ethanol blend wall[2] is assumed to constrain domestic ethanol use over the next decade, which is projected to increase only moderately to 11.2% by 2029 as current discussions about developing E15 infrastructures have not been promoted nationwide.

Growth in ethanol production is projected to be limited to 0.5% annually (Figure 9.6). Corn is assumed to be the main feedstock for ethanol production, accounting for 98% of production in 2029. The production capacity for cellulosic ethanol is assumed to remain constant over the projection period. This *Outlook* does not expect a large export potential for the United States. Although it is projected to maintain its position as the world's largest ethanol producer, US global production shares are projected to decrease from 48% to 45%. The US production of biodiesel is projected to decrease 0.1% annually (Figure 9.6). The US global production shares are projected to decrease from 20% to 18%.

The European Union

Since 2010, EU legislation related to biofuel support has been based on the 2009 Renewable Energy Directive (RED), which requires that at least 10% of transport energy use in EU Member States be based on renewables by 2020. In June 2018, agreement was reached to increase the biofuel target to 14%, with national caps to food and feed crop-based biofuels at 1 percentage point above 2020 levels but not exceeding 7%. The new framework was adopted under Directive 2018/2001 (the RED II) on 11 December 2018 and will be implemented by 2030.[3] RED II classifies palm oil-based biodiesel under a high ILUC risk category and thus consumption of this biodiesel is expected to decline.

According to the IEA baseline used for this *Outlook*, total energy use in the transport sector is projected to decrease for diesel and gasoline. The decrease for diesel-type fuels is strong; ethanol consumption is projected to increase (+0.1 bln L), while biodiesel consumption is projected to decrease in absolute terms (-1.7 bln L). Palm oil-based biodiesel constitutes a large share of this decrease in view of the EU sustainability concerns associated with palm oil production. Biodiesel produced from other vegetable oils is expected to decrease as well, but less significantly, while production from used cooking oils is projected to remain stable. Given these projected demands for the biodiesel sector, the European Union is expected to continue being the world's largest biodiesel-producing region in 2029, although global production shares are expected to decrease from 34% to 28%.

Total EU biofuel consumption in 2029 is projected to decrease by 0.7% annually, but the share of advanced biofuel sources is projected to increase from 17% today to 24% by 2029 (Figure 9.3).

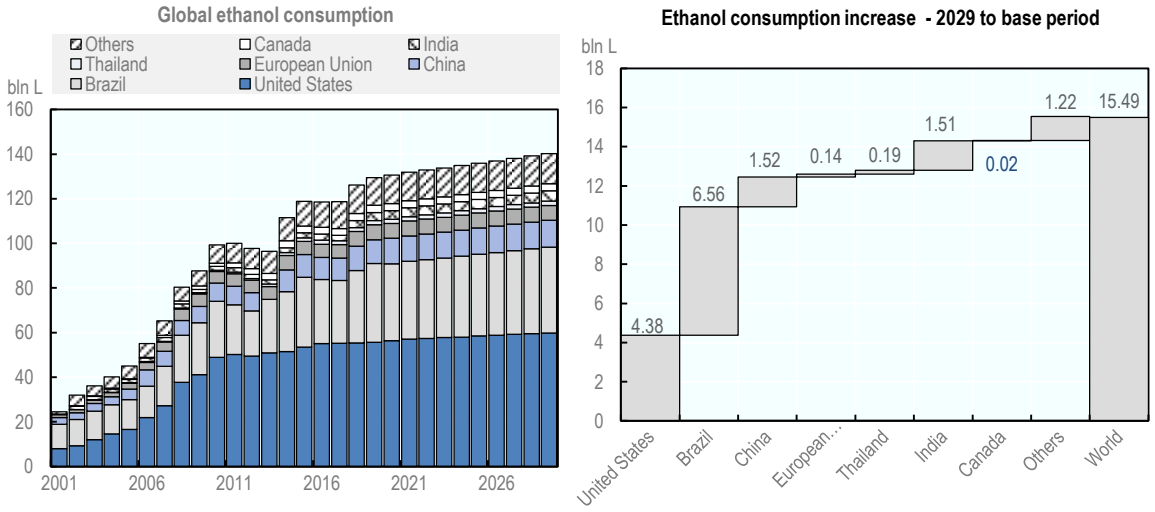
Brazil

Brazil has a large fleet of flex-fuel vehicles that can run on either gasohol (a mix of gasoline and anhydrous ethanol) or on E100 (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%. There is also a differentiated taxation system that favours hydrous ethanol over blended gasohol in key Brazilian states. For biodiesel, the government is assumed to increase biodiesel blend ratio from 11% to 12% during the projection period.

The largest ethanol consumption and production increases projected in this *Outlook* are expected to come from Brazil (Figure 9.4), due mainly to its RenovaBio programme.[4] This programme was officially signed in January 2018 and is intended to reduce the emissions intensity of the Brazilian transport sector in line with the country's commitments under COP 21. To create the necessary incentive structure, RenovaBio will introduce a system of tradeable carbon savings credits similar to those in California's Low Carbon Intensity Program. It might take a few years until current production trends change, but strong increases in production should be expected once trends change. Brazil is assumed to contribute 39 bln L to global production and use growth (+6 bln L). In 2029, more than half of the total Brazilian ethanol production is projected to be consumed by high blend flex-fuel vehicles, implying an increase of 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 (Figure 9.4), underpinning the potential growth of blending biofuels to gasoline and diesel. As a consequence, this *Outlook* projects that both ethanol market volumes and biodiesel consumption will increase in Brazil.

Figure 9.4. Development of the world ethanol market



Note: Blue shaded number means reduction in the right graph.
Source: OECD/FAO (2020), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

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China

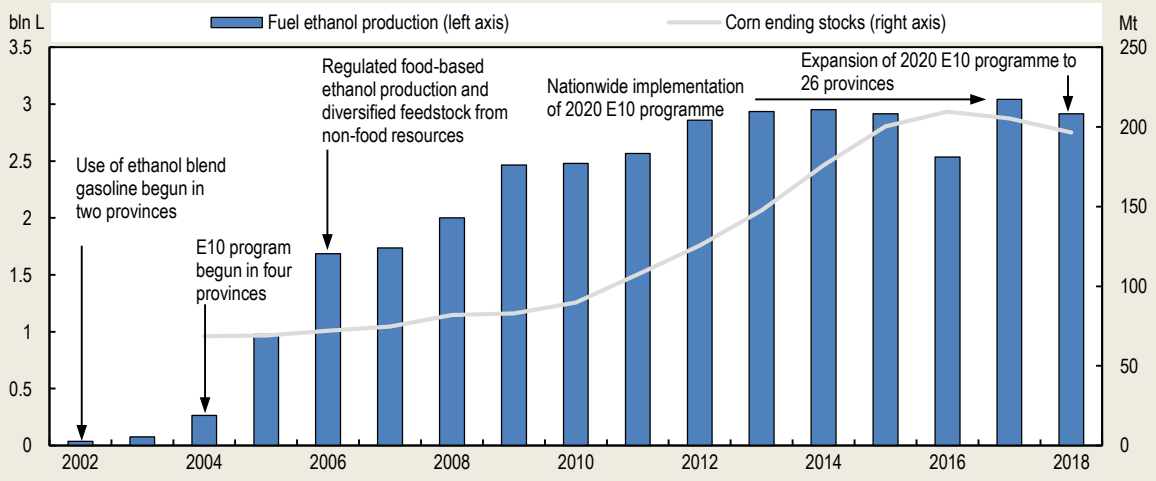
In 2017, China announced a new nationwide E10 mandate aimed at eliminating excessive maize stocks. In 2018, the government announced it would expand this programme from 11 to 26 provinces[5] by 2020. As these stocks decline, which has been the case since 2017, the main incentive to step up ethanol use is disappearing. This *Outlook* assumes that the blending rate of 2% will be maintained to 2029. 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 2 bln L as the *Outlook* assumes most of the ethanol demand will be produced from domestic feedstocks. Biodiesel in China will continue to be used more for cooking oil, which has limited growth potential.

Box 9.2. Chinese biofuel programme

To deal with excessive grain stocks, energy security, and air pollution, the Chinese government has imposed the use of E10 (10% blend of ethanol to gasoline) since 2002. Maize is a major feedstock for ethanol production. Between 2007 and 2015, a temporary purchasing and storage price system stimulated domestic maize production; however, a large share of this production remained unsold and eventually piled up as excessive ending stocks. These stocks are estimated to have increased from 82 Mt in 2008 to 209 Mt in 2016 (Figure 9.5).

It became essential for the government to eliminate this excessive stock and in 2017 it implemented the E10 utilisation programme. In August 2018, the government announced it would extend this programme from 11 to 26 provinces by 2020 and projected that as result ethanol consumption would increase to 13.6 bln L by that same year. In 2018, maize accounted for 65.1% of ethanol production, 25.6% of ethanol production was produced using cassava and 9.3% using wheat[1].

Figure 9.5. Chinese ethanol production and corn ending stocks



Source: Agricultural Market information System (AMIS) (2019) database. http://www.amis-outlook.org/. US Department of Agriculture, Foreign Agricultural Service (USDA-FAS) (2019) China – Peoples Republic of Biofuels Annual. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuels Annual Beijing China - Peoples Republic of_8-9-2019.pdf.

Chinese petroleum consumption for transport has nevertheless increased steadily, causing serious air pollution problems. For example, the release of PM 2.5 particles[2] is very high in Beijing and other urban areas. The E10 programme seeks to alleviate this pollution, but its implementation would require large amounts of additional maize, cassava, wheat and/or sugarcane as feedstock. It should be noted that the Chinese government has actively promoted the implementation of the New Energy Vehicles (NEV)[3] credit mandate, which imposes a 10% minimum production requirement for the car manufacturing industry in 2019. This will increase to 12% in 2020. Several additional incentives exist to encourage the use of rechargeable batteries and the government issues specific vehicle plates for NEV users. These developments have made China the largest user of electric vehicles (EV). In 2018, the country accounted for 45% of global EV stocks, and the market share of EVs in China itself increased to 4.5%, higher than in the United States and Japan. The Chinese government has targeted that by 2030 NEVs would comprise 40% to 50% of all vehicles.

In the interim, the government has continued to promote the use of ethanol as a transport fuel. During the early 2000's, energy security and air pollution problems were the main incentives for this. Fuel ethanol production and maize ending stocks had a positive correlation (0.8209 from 2006 to 2015), and the country's biofuel programme came to depend on these stocks. Based on data from the Agricultural Market Information System (AMIS), there has been a decreasing trend since 2018 of maize ending stock levels (Figure 9.5), with the result that the government is losing the incentive to achieve its goal of increasing fuel ethanol use nationwide. It is therefore assumed that the blend rate will not change from its current level (2.1% in 2018), and that there will be a decreasing trend for maize ending stocks in the short term. There is also uncertainty whether the government can satisfy the NEV share target by 2030, which will depend on R&D and policies to promote its utilisation.

Notes: 1. US Department of Agriculture, Foreign Agricultural Service (USDA-FAS) (2019) China – Peoples Republic of Biofuels Annual. https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Biofuels Annual_Beijing_China - Peoples Republic of_8-9-.
2. PM2.5 particles are air pollutants with a diameter of 2.5 micrometres or less, small enough to invade even the smallest airways. These particles generally come from activities that burn fossil fuels, such as traffic, smelting, and metal processing.
3. NEV includes Electric Vehicles (EV), Plug-in Hybrid Electric Vehicles (PHEV), and Fuel Cell Electric Vehicles (FCV).

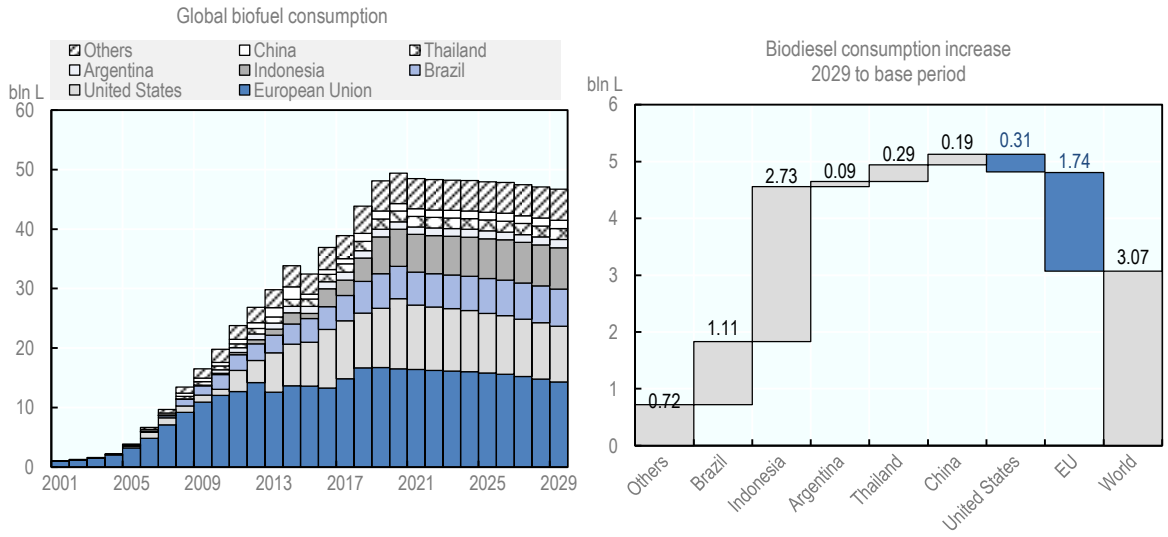
Indonesia

The implementation of B30 (Biodiesel 30% blend) aims to reduce the country's dependency on imported fossil fuels. In recent years, biodiesel production has increased due to the national biodiesel programme, which provides support to biodiesel producers and is financed by the crude palm oil (CPO) fund. Biodiesel production in Indonesia is projected to remain stable at around 7.0 bln L by 2029. The policy to support biodiesel producers relies on international prices, specifically the price wedge between domestic and international palm oil prices that defines the amount of the levy to be collected. The blending rate is projected to remain around 30% over the projection period and domestic use could increase to reach 7.0 bln L. Exports are expected to decrease considerably due to EU regulations that favour biodiesel imports produced with soybean oil.

Argentina

Argentina has blending mandates of 10% for biodiesel and 12% for ethanol. Increases to the biodiesel mandates are under discussion, especially in view that the two major export markets, the United States and the European Union, have filed anti-dumping import duties on Argentina. Tax exemptions should continue to boost the development of the Argentinean biodiesel industry, which exports more than half of its production. However, trade barriers set by the United States will likely limit export demand for this country's biodiesel. The production and export are projected to increase by 2.0% and 2.9%, respectively.

Figure 9.6. Development of the world biodiesel market



Note: Blue shaded number means reduction in the right graph.
Source: OECD/FAO (2020), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.
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India

The National Policy on Biofuels came into effect in May 2018. The main objectives are to achieve 20% ethanol and 5% biodiesel blending. These are substantially above the current 1.4% and 0.1% blending levels. The main limitation to biofuel production growth assumed over the outlook period is the availability of feedstocks. Projected molasses production in India would not be sufficient to meet the increasing demand from the biofuels industry. Although non-edible grains would be eligible for producing ethanol, projected decreases in stocks-to-use ratio of feed grains (maize and other coarse grains) indicate tight markets and no increase of grain-based ethanol is expected. Limited access to feedstock, limited production capacity, and the lack of a proper distribution system are constraints for biofuel production in India.

Thailand

Thai cassava production is heavily focussed on export markets because international prices are higher than those offered by the local biofuels industry. Feedstock availability constrains ethanol production from molasses, cassava and palm oil. The government will gradually reduce the current subsidy on ethanol and biodiesel until 2022, foresees cuts in the ethanol and biodiesel targets by 2036. As a result, domestic supply to the biofuels industry will remain limited over the outlook period. While sugarcane would be an alternative, investment in sugarcane mills that can process ethanol is limited and no policy changes to allow for this are envisaged. Domestic feedstock supply to the biofuel industry will remain limited over the outlook period.

Canada

The Canadian Clean Fuels Standard (CFS) and provincial blend mandates promote biofuels use in Canada. The CFS policy, currently under negotiation, aims to reduce GHG emissions from the fuels consumed by introducing Carbon Savings Credits. The ethanol use ratio to gasoline is projected to increase to 7% by 2029 and biodiesel use ratio is assumed to stay at the current level.

Colombia

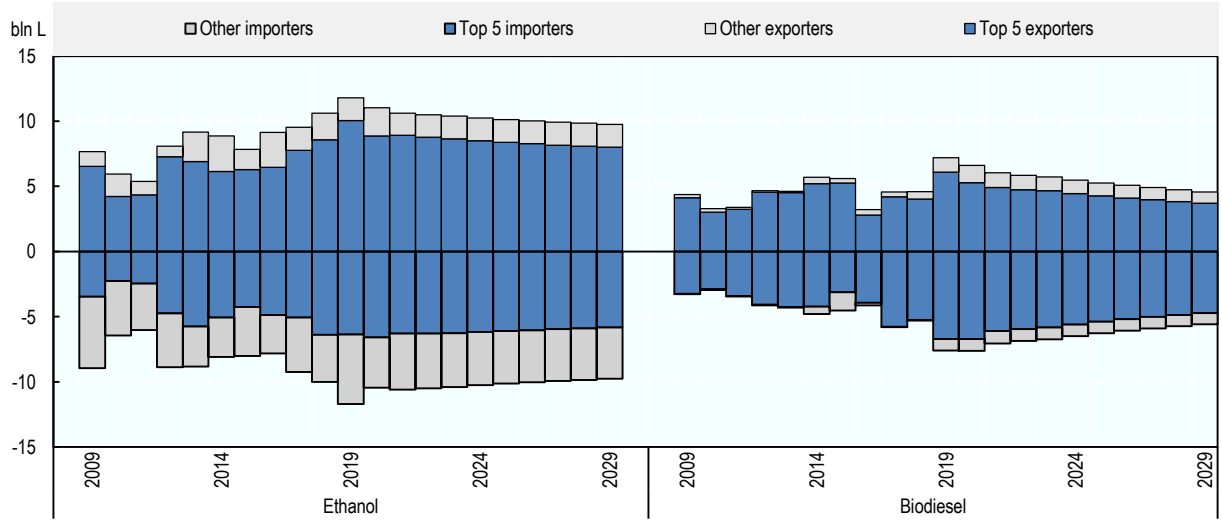
Ethanol demand is projected to increase over the projection period. Since the projected growth rate in ethanol demand is less than the projected growth rate in fossil fuel demand, the blend rate is expected to decrease slightly. This *Outlook* assumes that the E10 mandate is already fulfilled. The main feedstock is currently sugarcane and projections assume this will continue over the outlook period. In line with historical developments, ethanol is expected to increase in importance as an alternative source of income for the Colombian sugarcane industry. By 2029, it is projected that about 22% of the sugarcane production will be used for ethanol production. Biodiesel demand is projected to increase marginally at 1.8% p.a. over the projection period, to reach 0.7 bln L in 2029.

9.4. Trade

Global ethanol trade is projected to remain as a low share of global production, decreasing from 9% over the base period to 7% by 2029. The United States is expected to remain a net exporter of maize-based ethanol. However, US ethanol exports should decrease over the projection period because of a combination of strong domestic demand and weak production. Brazilian ethanol exports are not expected to expand over the projection period given that the Brazilian ethanol industry will mostly fill sustained domestic demand.

Argentine biodiesel exports are expected to increase while exports from Indonesia are expected to decrease, reflecting high domestic demand in Indonesia. Argentina should remain the lead biodiesel exporter, followed by the European Union (mainly exports to the United Kingdom) and United States. Argentinian exports are not expected to expand over the projection period due to weak international demand.

Figure 9.7. Biofuel trade dominated by a few global players



Note: Top five ethanol exporters in 2029: United States, Brazil, European Union, Pakistan, United Kingdom. Top five ethanol importers in 2029: Brazil, United States, Japan, Canada, United Kingdom. Top five biodiesel exporters in 2029: Argentina, European Union, United States, Indonesia, Canada. Top five biodiesel importers in 2029: European Union, United States, United Kingdom, Canada, Peru.
Source: OECD/FAO (2020), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://dx.doi.org/10.1787/agr-outl-data-en.

StatLink https://doi.org/10.1787/888934142938

9.5. Main issues and uncertainties

The major risks and uncertainties for the future development of the biofuels sector are related to the policy environment and oil prices. Policy uncertainty includes uncertainties about changes in mandate levels, enforcement mechanisms, investment in non-traditional biofuel feedstocks, tax exemptions for biofuels, and EV technology and policies for its promotion. This *Outlook* makes many projections on the expected fill rates of mandates and in many cases these are considerably lower than 100%.

This *Outlook* assumes the government of Indonesia will have successfully introduced B30 programme. However, reaching this target will largely depend on the relationship between domestic and international prices. At the time, the government first promoted biodiesel production, the price of palm oil increased rapidly from 2006 to 2008, and feedstock costs thereafter accounted for 86% of total production costs. These costs reduced biodiesel output and the original national target was not attained as scheduled by 2010.[6] The engine durability for B30 could also put the blending target into jeopardy.

The international crude oil price has dropped sharply since March 2020 because of weak global demand resulting from COVID-19, and the global imbalance of supply and demand. These factors may be transitory in nature, but could also usher in a longer period of low crude oil prices. This would contribute to a more lasting decline in gasoline and diesel prices, which in turn would lower demand for biofuels, including hydrous ethanol demand for Flex Fuel Vehicles (FFV). The Brazilian ethanol demand could be impacted from the crude oil price shock as hydrous ethanol accounted for 68% of total ethanol demand.[7] Most biofuels in Brazil are used for blending with fossil fuels. The blending targets are mandated on the biofuel industries in the medium to long term. However, the price shock could affect costs of production and supply chains, and thereby risk delaying the implementation of the policy targets and initiatives. In addition, an economic recession due to COVID-19 could reduce global transportation fuels and biofuel demand.

This *Outlook* expects that most biofuels will continue to be based on agricultural feedstock. No substantial increase in advanced biofuels technology is expected before the middle of the outlook period. The price trajectory for crude oil, which is assumed to see moderately rising quotations, could create some uncertainty for this sector. As such, a driving factor of future biofuel demand is related to the development of national transportation fleets. The automotive industries in the European Union, China, United States, and Japan are currently investing in EVs and, depending on the uptake of this technology and the policies supporting its promotion, these vehicles could add to a potential decrease in the use of biofuels by 2029.

Notes

[1] The conventional gap is the difference between the total and advanced mandates as defined by the Renewable Fuel Standard (RFS2).

[2] The blend wall in this context is the maximal achievable national average blending rate, given that most pumps in the United States offer only E10. This assumes that several E15 pumps will be developed over the coming years.

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

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

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

[6] Tatsuji Koizumi (2014), *Biofuels and Food Security: Biofuel impact on Food Security in Brazil, Asia and Major Producing Countries*, Springer, pp. 50-51.

[7] US Department of Agriculture, Foreign Agricultural Service (USDA-FAS) (2019) "Brazil, Biofuels Annual, 2019", https://apps.fas.usda.gov/newgainapi/api/report/downloadreportbyfilename?filename=Biofuels%20Annual_Sao%20Paulo%20ATO_Brazil_8-9-2019.pdf.