

# 9 Biofuels

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This chapter describes recent market developments and highlights the medium-term projections for world biofuel markets for the period 2021-30. Price, production, consumption and trade developments for ethanol and biodiesel are discussed. The chapter concludes with a discussion of important risks and uncertainties that might affect world biofuel markets over the next ten marketing years.

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## 9.1. Projection highlights

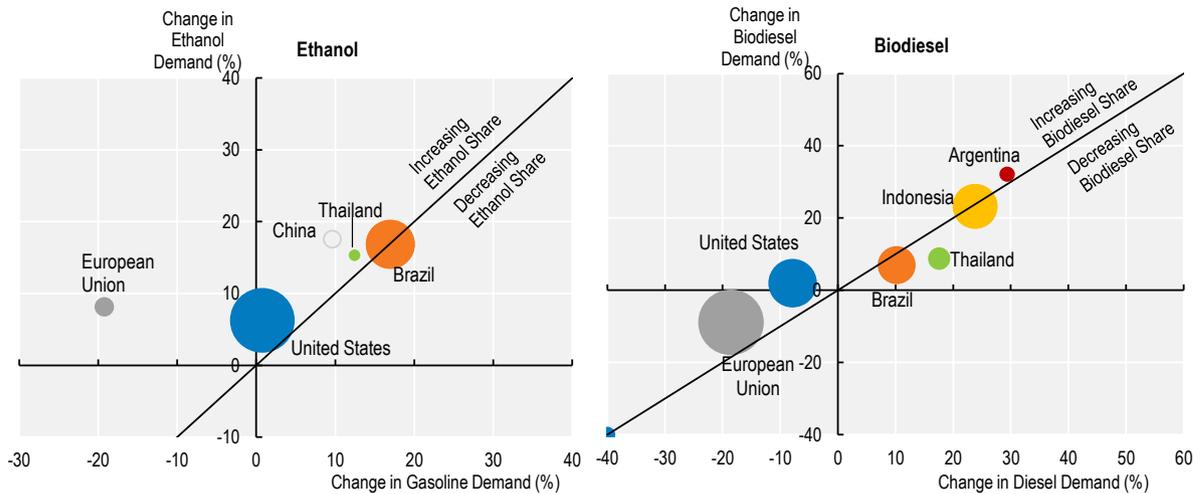
The COVID19 pandemic caused a drop of 8.5% in global transport fuel use in 2020 with respect to the previous year due to restrictions on people's movements and disruption in trade logistics around the globe. Consequently, biofuel use fell by 8.7% in 2020 with respect to 2019. This year's edition of the *OECD-FAO Agricultural Outlook* projects that biofuel markets will continue to be largely influenced by national support policies and fossil fuel demand. Global biofuel demand is expected to recover in 2021 and 2022, in line with the expected total fuel demand recovery. Over the medium term, global biofuel consumption is expected to further increase, mainly driven by higher blending targets in developing countries. In developed countries, biofuel expansion will be limited due to decreasing fossil fuel demand and reduced policy incentives. International biofuel prices are projected to increase over the outlook period in nominal terms, while remaining almost constant in real terms. Biofuel prices generally relate to market fundamentals such as feedstock prices, crude oil price, and distribution costs; however, policies have a strong impact on shaping the path of prices over time by covering part of production costs and binding biofuel use to fossil fuels use via mandates.

Global biofuel use is expected to grow over the projection period (Figure 9.1). The *IEA World Energy Outlook* (on which this *Outlook* bases its own fossil fuel demand projections) foresees decreasing total fuel use in the European Union and the United States, suggesting limited growth in biofuel consumption. 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 and the consumption of palm oil-based biodiesel is expected to decline under RED II requirements, resulting in decreased biodiesel consumption. In the United States, biofuel demand is expected to be sustained by the Renewable Fuel Standard (RFS). However, the 10 % ethanol blend wall<sup>1</sup> is assumed to constrain increases of domestic ethanol consumption during the projection period.

Fuel consumption trends and policy developments in emerging economies play a significant role. In Brazil, total fuel consumption is expected to further increase over the projection period, and ethanol and biodiesel consumption are projected to grow proportionately. The People's Republic of China (hereafter "China") is not expected to implement a nationwide E10 mandate, as proposed in 2017, because this programme depends on maize stock levels which have been decreasing since 2017. This *Outlook* therefore assumes that China will maintain the lower blending rate of 2% to 2030.

Blending mandates are expected to evolve over the projection period for some emerging economies. In Indonesia, both total diesel use and biodiesel consumption are expected to increase over the outlook period. Indonesia introduced the B30 (Biodiesel 30% blend) programme in 2020, which together with increasing fossil fuel demand stimulates biodiesel use. This *Outlook* assumes that the biodiesel blending rate will remain around 30% over the projection period. In Argentina, the current 10% biodiesel blend rate is assumed to be maintained. By 2030, India's ethanol blending rate is projected to be about 8%, with sugarcane-based ethanol contributing significantly to meet this target. However, the projection is expected to remain below the E20 goal the government seeks to achieve by 2030 owing to the limited supply of feedstuffs, mainly molasses, which would remain as the main feedstuff.

Global biofuel production will continue to be supplied predominantly by traditional feedstock; sugarcane and maize for ethanol and various vegetable oils for biodiesel production. Biodiesel produced from used cooking oil will continue to play an important role in the European Union, Canada, the United States, and Singapore. In most countries, biofuel policies aim to reduce GHG emissions and dependency on fossil fuels. Therefore, markets are mainly supplied domestically, leaving the international trade share relatively low and projected to decrease even further over the coming decade. World biodiesel trade is projected to decrease by 25% 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, shipments from Indonesia are expected to decrease, reflecting high domestic demand.

**Figure 9.1. Biofuel demand developments 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 2020.

Source: OECD/FAO (2021), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), <http://dx.doi.org/10.1787/agr-outl-data-en>.

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This *Outlook* expects that most biofuels will be produced from primary agricultural commodities. No substantial increase in advanced biofuels such as cellulose-based ethanol and recycled oil-base biodiesel are expected before the end of the outlook period. 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. Recent market development

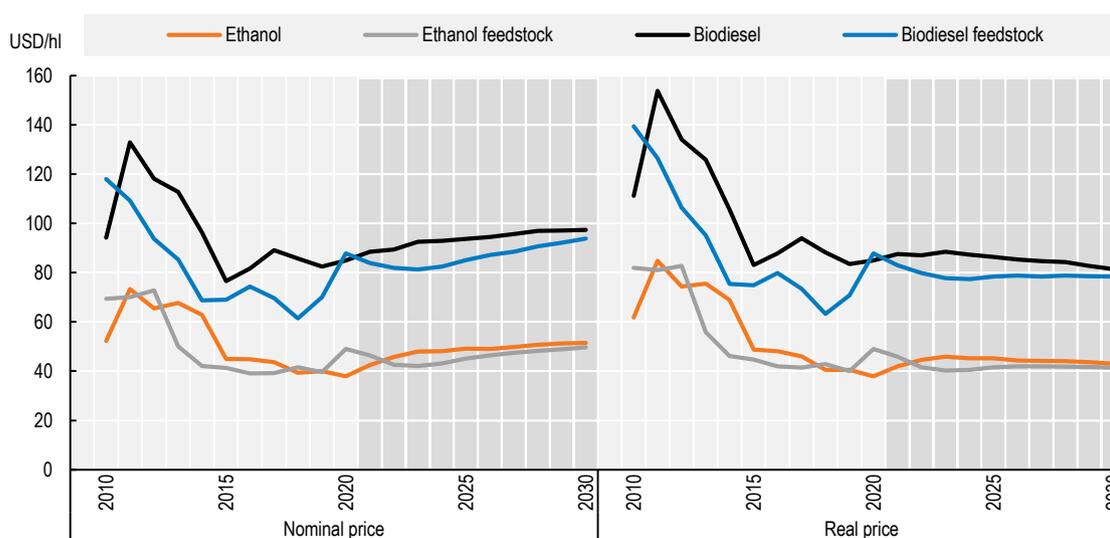
The lockdown measures and economic decline resulting from the COVID-19 pandemic decreased global fuel demand in 2020. COVID-19 curtailed the global transportation oil use; however, industrial use of fossil fuels was less affected. The United States and Brazil recorded the highest reductions in ethanol consumption and drove down global demand. Indonesia and Thailand increased biodiesel use owing to higher blend rates, while decreasing diesel use. Production margins for biofuels were affected by the higher maize and vegetal oil prices, which, combined with declining fossil fuel prices, created an unstable scenario; government support relieved some of the pressure on markets. Increasing use of ethanol in industry, driven by its use as a sanitizer in response to the COVID-19 pandemic, also helped sustain biofuels production. Biodiesel also played a more significant role in the production of electricity. The use of biofuels in sectors other than transportation was less affected. Despite government support, and in line with decreasing demand, the overall level of global ethanol and biodiesel production decreased for the first time in the last decade by 13.2 bln L and 1.9 bln L respectively in 2020 compared to 2019.

These negative effects on the biofuels sector in 2020 were partially offset by current and new policies, in particular those that regulate domestic prices of biofuels by providing specific subsidies and preferential taxes, in addition to the obligatory mandates that bind the demand of biofuels to that of fossil fuels. Global biofuel demand is assumed to recover from 2021 as part of the expected economic recovery and the higher blend mandates and decarbonisation initiatives. Overall demand will be lower than in 2019, however.

### 9.3. Prices

Influenced by developments on the vegetable oil markets, nominal biodiesel prices are projected to increase at a slower pace (1.1% p.a.) than ethanol prices (1.8% p.a.). Expressed in real terms, biodiesel prices are projected to decrease after 2024 and ethanol prices to resume a decreasing trend after 2026. Nominal ethanol prices will perform more strongly than biodiesel primarily because 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 that due to policies that include fiscal benefits or support 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 nominal world prices deflated by the US GDP deflator (2020=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 (2021), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), <http://dx.doi.org/10.1787/agr-outl-data-en>.

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### 9.4. Production and consumption

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

### Box 9.1. Biofuels at a glance

Biofuels (bioethanol and biodiesel<sup>1</sup>) are fuels produced from biomass. At present, about 60% of ethanol is produced from maize, 25% from sugarcane, 2% from molasses, 3% from wheat, and the remainder from other grains, cassava or sugar beets. About 75% of biodiesel is based on vegetable oils (20% rapeseed oil, 25% soybean oil, and 30% palm oil) or used cooking oils (20%). More advanced technologies based on cellulosic feedstock (e.g. crop residues, dedicated energy crops, or wood) 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 independence.

**Table 9.1. Biofuel production ranking and major feedstock**

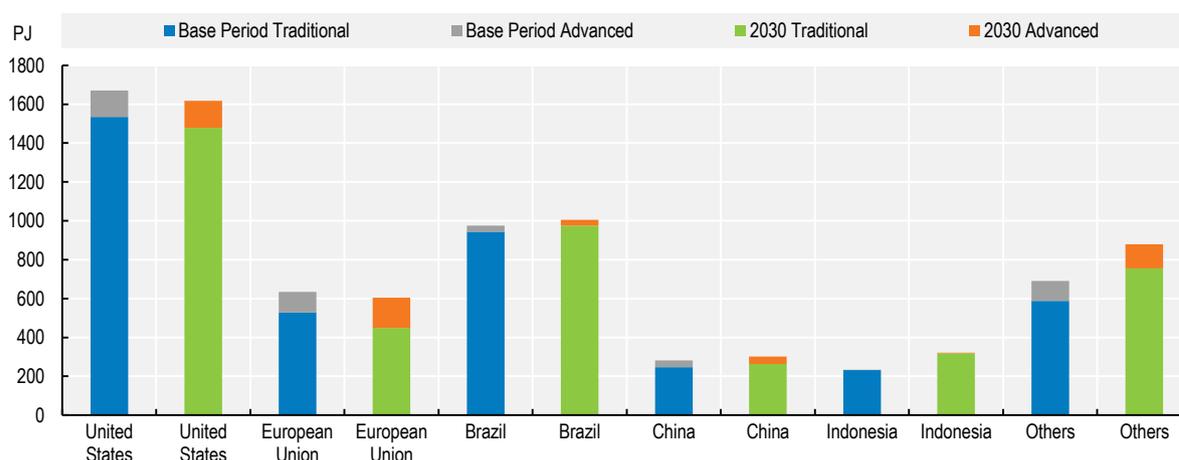
	Production ranking (base period)		Major feedstock	
	Ethanol	Biodiesel	Ethanol	Biodiesel
United States	1 (48.2%)	2 (18.1%)	Maize	Soybean oil, used cooking oils
European Union	5 (4.8%)	1 (32.3%)	Sugar beet /wheat /maize	Rapeseed oil /Palm oil/ used cooking oils
Brazil	2 (26.7%)	4 (12.2%)	Sugarcane / maize	Soybean oil/
China	3 (8.3%)	9 (2.3%)	Maize / cassava	Used cooking oils
India	5 (2.3%)	15 (0.5%)	Molasses	Used cooking oils
Canada	6 (1.6%)	13 (0.7%)	Maize / wheat	Canola oil / used cooking oil/soybean oil
Indonesia	20 (0.1%)	3 (15%)	Molasses	Palm oil
Argentina	8 (1.0%)	5 (5%)	Molasses / sugarcane/ maize	Soybean oil
Thailand	7 (1.4%)	7 (3.8%)	Molasses / cassava/ sugarcane	Palm oil
Colombia	13 (0.44%)	11 (1.3%)	Sugarcane	Palm oil
Paraguay	14 (0.42%)	19 (0.03%)	Maize/ sugarcane	Jatropha

#### Notes

- Numbers refer to country ranking in global production; percentages refer to the production share of countries in the base period.
- In the *OECD-FAO Agricultural Outlook 2021-2030*, biodiesel includes renewable diesel (also known as Hydrotreated Vegetable Oil or HVO), although these are different products.

Source: OECD/FAO (2021), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), <http://dx.doi.org/10.1787/agr-outl-data-en>.

Global ethanol production is projected to increase to 132 bln L by 2030, while global biodiesel production is projected to increase to 50 bln L, driven principally by Indonesia's mandate increase over the initial projection years. Feedstock for biofuel products vary from country to country. Global biofuel production will continue to be dominated by traditional feedstock despite the increasing sensitivity to the sustainability dimension of biofuel production observed in many countries (Figure 9.3).

**Figure 9.3. World biofuel production from traditional and advanced feedstock**

Note: Traditional feedstocks are here defined as food and feed crop based biofuels. Values in Petajoules = 1015 Joules.

Source: OECD/FAO (2021), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), <http://dx.doi.org/10.1787/agr-outl-data-en>.

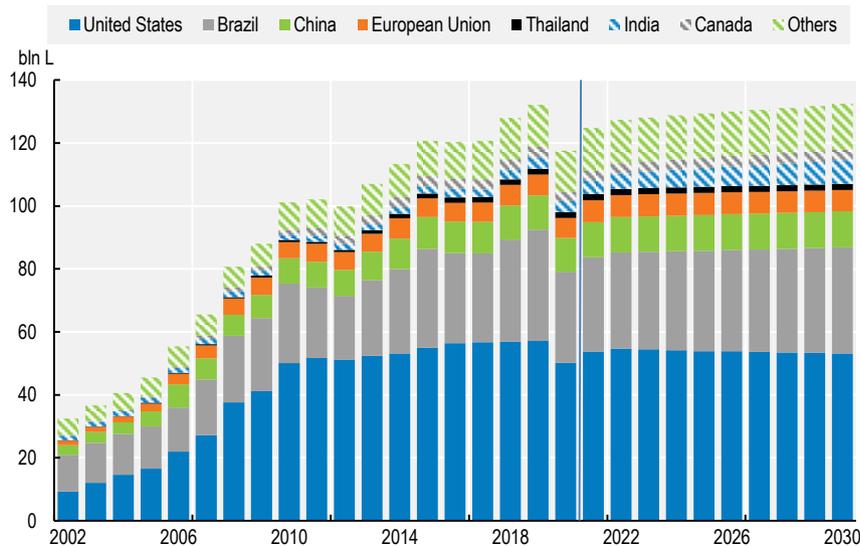
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The share of energy that enters the transport sector through biofuels exceeds 10% only in Brazil. Yet a goal of many biofuel policies, especially in developing countries, is to reduce energy dependency from fossil fuel sources.

#### 9.4.1. United States

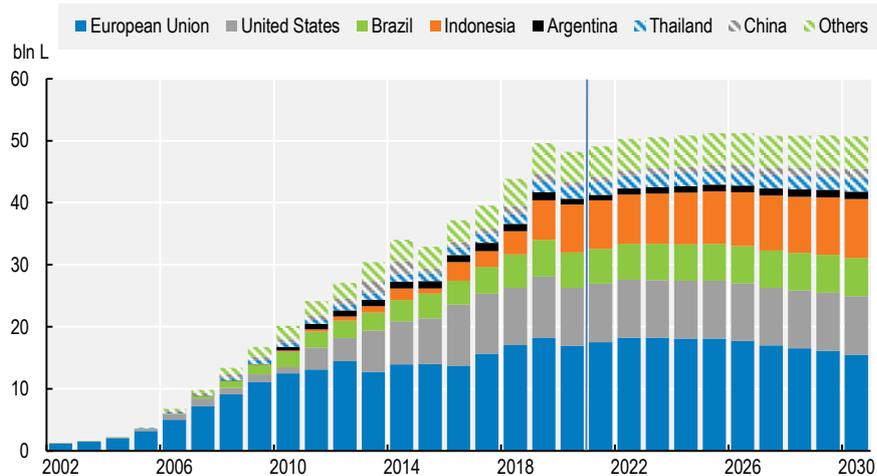
This *Outlook* assumes that the US government will keep all mandates set by EPA at recently announced levels in volume terms despite the projected decrease in the use of transportation fuel. The consumption of ethanol is projected to decrease by 0.2% p.a. (Figure 9.4). The 10% ethanol blend wall is assumed to constrain domestic ethanol use over the next decade, which is projected to be constant at 10% by 2030 as current discussions about developing E15 infrastructures have not been promoted nationwide.

Growth in ethanol production is projected to decrease by 0.4% p.a. Corn is assumed to be the main feedstock for ethanol production, accounting for 99% of production in 2030. The production capacity for cellulosic ethanol is assumed to remain constant over the projection period. Although it is projected to maintain its position as the world's largest ethanol producer, US global production shares are projected to decrease from 47% to 44%, and US production of biodiesel is projected to decrease by 0.3% p.a. (Figure 9.5). US global production shares are projected to decrease from 18% to 17%.

**Figure 9.4. Development of the world ethanol consumption**

Source: OECD/FAO (2021), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), <http://dx.doi.org/10.1787/agr-outl-data-en>.

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**Figure 9.5. Development of the world biodiesel consumption**

Source: OECD/FAO (2021), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), <http://dx.doi.org/10.1787/agr-outl-data-en>.

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### 9.4.2. 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 be based on renewables by 2020. In June 2018, agreement was reached to increase the biofuel 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) in 2018 and will be

implemented by 2030.<sup>2</sup> 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 International Energy Agency's (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 (+0.2 bln L), while biodiesel consumption is projected to decrease in absolute terms (-2.0 bln L). Palm oil-based biodiesel constitutes a large share of this decrease in view of EU sustainability concerns associated with palm oil production. Biodiesel produced from other vegetable oils is also expected to decrease, but less significantly, 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 2030, although global production shares are expected to decrease from 32% to 28%.

Total EU biofuel consumption is projected to decrease by 1.1% p.a., but the share of advanced biofuel sources is projected to increase from 17% at present to 26% by 2030 (Figure 9.3).

### 9.4.3. 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%. 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% during the projection period.

The largest ethanol consumption and production increases projected in this *Outlook* are expected to be in Brazil (Figure 9.4), due mainly to its RenovaBio programme.<sup>3</sup> 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 COP21. To create the necessary incentive structure, RenovaBio will introduce a system of tradeable carbon savings. Brazilian production is projected to increase by 1.3% p.a. By 2030, more than half of the 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. As a consequence, this *Outlook* projects that ethanol market volumes and biodiesel consumption will increase in Brazil.

### 9.4.4. 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<sup>4</sup> 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 2030. 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 0.1% p.a. during the projection period. This *Outlook* assumes most of the ethanol demand will be produced from domestic feedstock. Biodiesel in China will continue to be produced mostly from cooking oil, which has limited growth potential.

#### **9.4.5. Indonesia**

The implementation of B30 (Biodiesel 30% blend) aims at reducing the country's dependency on imported fossil fuels and reducing GHG emissions. In recent years, biodiesel production has 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 the levy collection of USD 55/t on exports will be sufficient to maintain B30 over the projection 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 2020, the average 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 as oil prices are expected to recover, driving fossil fuel prices up. On the basis of these assumptions, biodiesel production in Indonesia is projected to increase to 9.7 bln L by 2030. In view of the EU environmental regulation and declining use of diesel in developed countries, export are projected to remain low over the outlook period.

#### **9.4.6. Argentina**

Argentine ethanol use ratio to gasoline and biodiesel use ratio are assumed to remain at current levels. Tax exemptions should continue to boost the development of the country's biodiesel industry, which exports almost half of its production. However, trade barriers set by the United States and the Argentinian export tax will constrain biodiesel exports, which are projected to decrease by 0.6% p.a.

#### **9.4.7. Thailand**

The domestic feedstock – molasses, cassava and palm oil – supply constrains biofuels production. Without increased production of these commodities or including a broader range of commodities in the feedstuff basket, the projected production lags the targets set for 2036. In addition, the government will gradually reduce the current subsidy on ethanol by 2022, although higher blend (E85) are expected to be less affected than lower blend (E10); on average, blending is expected to remain around 14% over the outlook period and production is projected to increase marginally to 2.0 bln L in 2030. 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 will constrain the domestic supply and by 2030 demand will marginally increase to 2.1 bln L.

#### **9.4.8. India**

The National Policy on Biofuels came into effect in May 2018, with the aim to achieve 20% ethanol and 5% biodiesel blending; these targets are substantially above the current 4% and 0.1% blending levels. The main limitation to the increase in biofuel production over the outlook period is the availability of current feedstock, mainly molasses, the production of which will not be sufficient to meet increasing demand from the biofuels industry. Recent developments indicate that sugarcane will become a relevant feedstock in ethanol production. Aided by soft loans, sugar mills are investing and developing the capacity to produce ethanol from sugarcane juice; in 2021, reports indicate that ethanol from sugarcane juice could account for as much as 15% of the total ethanol production. In spite of such developments, sugar exports subsidies are expected to slow down the transition towards sugarcane juice ethanol. This in combination with accelerating gasoline demand will constrain the expansion of blending and, by 2030, the average is expected to be only around E8. Ethanol production is expected to be nearly 7 bln L in 2030, but this would not meet the growing demand; as such, increased imports would fill the gap.

### 9.4.9. Canada

The Canadian Clean Fuels Standard (CFS) and provincial blend mandates maintain biofuels use in Canada. The CFS policy, currently under negotiation, aims to reduce GHG emissions by introducing Carbon Savings Credits. The ethanol use ratio to gasoline and biodiesel use ratio are assumed to remain at current levels.

### 9.4.10. Colombia

Ethanol demand is projected to increase over the outlook period in line with the recovery of gasoline demand. In 2020, the blending increased marginally above E10 because the use of gasoline decreased; ethanol demand did not react to the same extent. Over the medium term, the blending rate is projected to return to E10. This *Outlook* assumes sugarcane to continue as the main feedstock; moreover, in 2030 biofuels use will account for about 22% 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 has been subdued over the last three years due to a decline in diesel demand, although the blending rate remained stable at around B10. This *Outlook* assumes this level will continue over the medium term. Production is projected to reach 0.6 bln L by 2030, nearly identical to the high historical rate of 2018.

### 9.4.11. Other countries

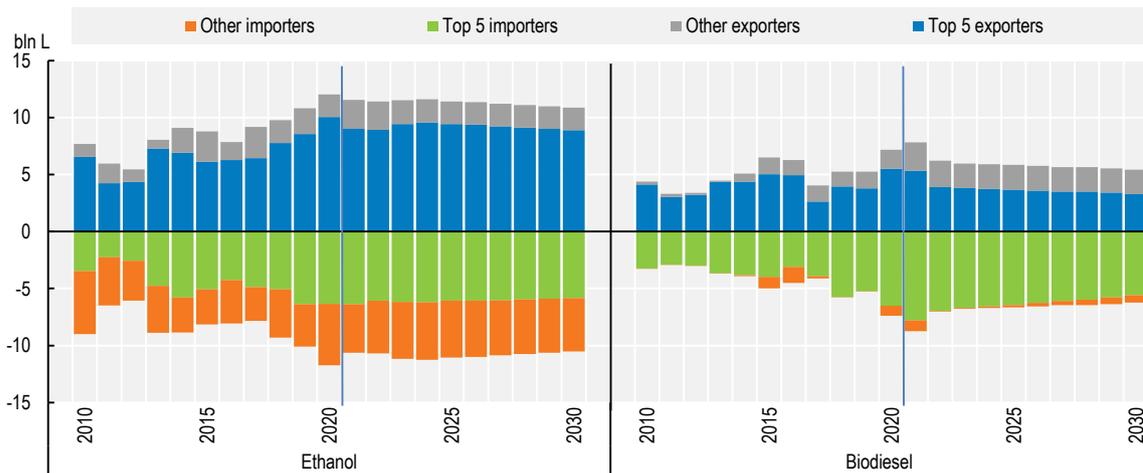
Other relatively important producers of ethanol include Paraguay, the Philippines, and Peru, where production could reach 0.8 bln L, 0.6 bln L and 0.3 bln L respectively by 2030; the blending rate in these three countries is assumed to remain stable at around 10%.

Other major biodiesel producers are Malaysia, the Philippines and Peru, where production could reach 1.6 bln L, 0.3 bln L and 0.2 bln L respectively by 2030. In Malaysia blending is projected to remain around 10%, whereas in Peru and Philippines around 6% and 3% respectively. Other Asian countries, in particular Singapore, would continue to produce around 0.9 bln L of biodiesel from cooking oil over the outlook period. Unlike the vast majority of countries where biofuels are domestically used in order to reduce GHG emissions and to reduce national dependency on imported oil, production of biodiesel in Singapore is largely exported.

## 9.5. Trade

Global ethanol trade is projected to remain as a low share of global production, decreasing from 9% over the base period to 8% by 2030. The United States is expected to remain a net exporter of maize-based ethanol. However, US ethanol exports should decrease over the outlook period due to the weak production. Brazilian ethanol exports are projected to increase by 0.1% p.a. over the outlook period given that the Brazil's ethanol industry will mostly fill sustained domestic demand.

Global biodiesel trade is projected to decrease from 7.1 bln L to 5.3 bln L by 2030. Indonesian biodiesel exports are projected to decrease dramatically, reflecting high domestic demand. Although Argentina is assumed to remain the leading biodiesel exporter, followed by the European Union and the United States, Argentinian exports are projected to decrease by 0.6% over the projection period due to weak international demand.

**Figure 9.6. Biofuel trade dominated by a few global players**

Note: Top five ethanol exporters in 2030: United States, Brazil, European Union, Pakistan, United Kingdom. Top five ethanol importers in 2030: Brazil, United States, Japan, Canada, United Kingdom. Top five biodiesel exporters in 2030: Argentina, European Union, United States, Indonesia, Canada. Top five biodiesel importers in 2030: 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 (2021), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), <http://dx.doi.org/10.1787/agr-outl-data-en>.

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## 9.6. 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 changes in mandate levels, enforcement mechanisms, investment in non-traditional biofuel feedstock, tax exemptions and subsidies for biofuels and fossil fuels, and electric vehicles (EVs) technology and policies for its promotion.

The policy environment will remain uncertain because it depends on agricultural and oil prices developments. Oil market developments affect policies since fossil fuel prices affect biofuel competitiveness and the subsidies allocated to the biofuel sector. Another uncertainty arises from the feedstuff supply; traditionally, countries sought to use commodities for which they have a surplus so as not to reduce food availability. As biofuels compete with food use and may have undesired land use effects, countries are cautious on expanding biofuel production at a faster pace. Despite this, blending mandates are expected to evolve positively over the projection period for some emerging economies.

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 so as to cut greenhouse emissions; this includes via blending mandates, subsidies, and tax reductions. All these measures helped transfer uncertainty in energy to the agricultural markets. Therefore, a driving factor of future biofuel demand is related to the response of the private sector to these measures. The automotive and other industries are currently investing in EVs which, depending on the uptake of this technology and the policies supporting its adoption, could add to a potential decrease in the use of biofuels over the next decade and beyond.

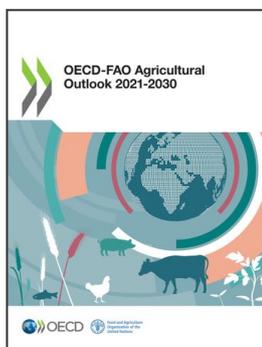
## Notes

<sup>1</sup> The blend wall in this context is the maximum achievable national average blend rate, given that most pumps in the United States offer only E10.

<sup>2</sup> <https://ec.europa.eu/jrc/en/jec/renewable-energy-recast-2030-red-ii>.

<sup>3</sup> [http://www.planalto.gov.br/ccivil\\_03/\\_ato2015-2018/2017/lei/L13576.htm](http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2017/lei/L13576.htm).

<sup>4</sup> Eleven provinces accounted for 46.1% of China's total population in 2017.



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