OECD-FAO Agricultural Outlook 2013

Chapter 3

Biofuels

Market situation

World ethanol prices[1] declined early in 2012 but regionally, market conditions varied. In the United States, ethanol prices began to rebound later in the year as the extent of the drought in the United States became apparent, driving up feedstock prices. In Brazil, an improved sugar cane crop in the latter half of the year improved supplies and pulled down domestic ethanol prices.

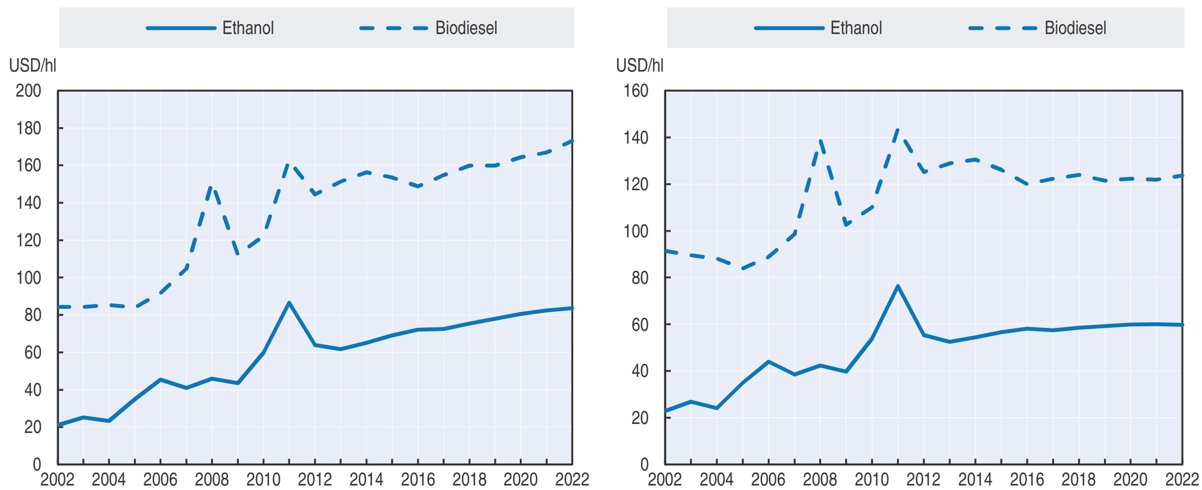
World biodiesel prices[2]fell in 2012 off record highs in 2011, in a context of strong vegetable oil prices – partly due to the drought in the United States – and high crude oil prices. Contrary to ethanol, global biodiesel production did increase in 2012. The four major biodiesel producing regions (the European Union, the United States, Argentina and Brazil) increased their supply and production in Malaysia recovered from a historical low in 2011.

Projection highlights

- Ethanol and biodiesel prices (Figure 3.1) are projected to return to an increasing trend given the expected high crude oil prices and biofuel policies around the world that promote biofuel demand. However, evident uncertainties around the implementation of policies will continue to significantly affect biofuel markets.
- Global ethanol and biodiesel production are both expected to expand, mainly driven by demand promoting policies and reach respectively 168 bnl and 41 bnl by 2022. This amount should require 12%, 29% and 15% of world coarse grains, sugar cane and vegetable oil production respectively. Ethanol markets are dominated by the United States, Brazil and, to a smaller extent, the European Union. Biodiesel markets should be dominated by the European Union and more marginally by the United States, Argentina and Brazil.
- At the end of the outlook period, biodiesel should become more competitive in the United States because the ethanol RIN[3] prices are expected to increase strongly in order to bring ethanol prices to the energy equivalent of gasoline since the E15[4] blend wall is expected to be reached. The European Union should remain shy of its objective of 10% renewable fuel in the transport sector by 2020. According to the outlook, the increase in production of second generation biofuel will remain very limited and for that reason the European Union should only reach 8.6% of transport fuel by 2022.
- Biofuel production in most developing countries serves mainly the purpose of energy independence except for Brazil, Argentina, Indonesia, Malaysia and Thailand; these will also be important exporters of ethanol or biodiesel. Brazil will also remain a large consumer of ethanol on the basis of the assumption that Petrobas will stop freezing the retail price of gasoline and also that the minimum blend requirement rises from 20% to 25% since May 2012. The consumption of ethanol by flex-fuel car owners in Brazil should therefore increase significantly as a result of the anticipated growing crude oil price. The cultivation of non-edible crops to produce biofuels is expected to remain on a project or small-scale level in most developing countries.

Figure 3.1. **Strong ethanol and biodiesel prices over the Outlook period**

Evolution of prices expressed in nominal terms (left) and in real terms (right)



Notes: Ethanol: Brazil, Sao Paulo (ex-distillery), Biodiesel: Producer price Germany net of biodiesel tariff.
Source: OECD and FAO Secretariats.

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Market trends and prospects

Prices

A strong decline in the world price of sugar at the beginning of the outlook, caused by a recovery in sugar cane production in Brazil and lower imports of sugar from China and the Russian Federation, has put downward pressure on the world ethanol prices in the short term (Figure 3.1). In order to re-equilibrate the ethanol market, the Brazilian authorities have increased the maximum amount of ethanol in low blend from 20% to 25% in May 2012. The American market is integrated into the world market since 1 January 2012 following the elimination of the large specific tariff. Further the expiring tax credits for blending ethanol lead to increasing ethanol blending activities in order to get as much of that subsidy as possible. As a consequence the American price of ethanol also fell in 2012, in spite of the large increase in the price of maize. The combination of these two factors and difficulties in the introduction of E15 blends generated, with some delays, an explosion in the ethanol RIN price at the beginning of 2013.

Since both the sugar and maize prices are slightly falling in real terms (but from high levels) over the projection period, they will not contribute to the projected increase of the world ethanol price in real terms over the medium term. The world crude oil price is expected to increase in real terms by 7% between 2012 and 2022. This will lead to an increase in demand and consumption of ethanol by owners of flex-fuel cars in Brazil of almost 50% over the same period putting upward pressure on the world price of ethanol in the medium-term. This result is based on the assumption that Petrobas will stop freezing the retail price of gasoline.

National ethanol policies, in particular the United States, are strongly impacting on biofuel prices. Until now, the US Environment Protection Agency (EPA) has not reduced the total and advanced mandates[5] despite large reductions in the cellulosic biofuel mandate. It was assumed in the baseline that the fulfilment of the cellulosic mandate will pass from

1.4% to 27% between 2012 and 2022. Considering the increasing size of the cellulosic mandate in the Renewable Fuel Standard final rule (RFS2), it was assumed that the EPA will reduce the total and advanced mandates by a portion of the reduction in the cellulosic mandate. That portion is assumed to start at 29% in 2013-14 and to reach 87% in 2022-23. In spite of this large reduction in the advanced mandate, the other advanced gap (define as advanced minus biodiesel and cellulosic ethanol) has the potential of increasing by almost 50% in the medium term compared to the implicit numbers in RFS2. Since maize based ethanol is not eligible to fulfil this mandate, most of it will be satisfied with imported sugar cane based ethanol from Brazil. This will also put upward pressure on the world price of ethanol in the medium term.

Further, the interaction between the biodiesel and ethanol markets is projected to become quite relevant. In the United States, contrary to maize based ethanol, biodiesel is eligible to capture a share of the other advanced gap. The ability of the US biodiesel producers to do so is enhanced by the biodiesel blender tax credit that was reinstated for 2013,[6] and by the ethanol blend wall. In the United States the maximum amount of ethanol that can be mixed with gasoline in low blends is 15% for cars built after 2001. Since older cars will eventually leave the fleet, the amount of ethanol being consumed in low blend mix is continuously increasing until 2020 in this baseline. This is based on the assumption that E15 blends will have no difficulties reaching consumers, which is not necessarily the case at present. In the absence of an E15 market, the E10 blend wall will influence the American ethanol market right from the outset of the Outlook. Under these circumstances and total motor fuel consumption being on a decreasing trend the American biofuel policy would absolutely need an E85 market to be functional. Even if the E15 market becomes operational, a flex-fuel car sector would be needed in the last three years of the Outlook in order to satisfy all the ethanol mandates. This is only possible if the ethanol to gasoline consumer price ratio falls to the energy content of ethanol. This should be the case in the last three years of the baseline and is realised through an increase in the retail price of gasoline to reflect the rising cost caused by the higher price of Renewable Identification Number (RIN) for ethanol. The ethanol RIN price reaches sufficiently high levels to make biodiesel competitive on the market for the other advanced gap, while at the same time reducing demand for American imports of Brazilian ethanol.

Two other considerations influence this result. The amount of biodiesel consumed in the United States is much smaller than the amount consumed by low blend vehicles and for that reason the price ratio does not have to fall to the energy content of biodiesel relative to diesel which, in any case, is much higher than for ethanol (0.92 versus 0.67). The other incentive to use more biodiesel comes from a particularity of the American biofuel policy which states that a unit of biodiesel counts for 1.5 units of mandate. The competition for the other advanced gap by biodiesel in the last three years of the baseline mitigates to some extent the upward pressure on the world ethanol price generated by the large increase in the American other advanced gap.

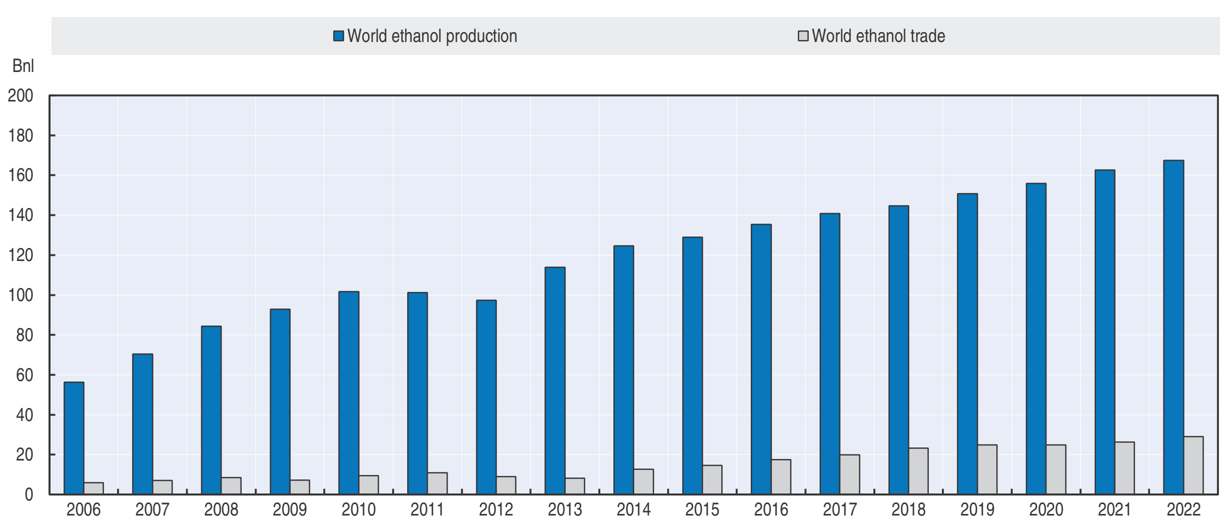
The net effect of all these factors is an increase in the world price of ethanol in real terms by 8% between 2012 and 2022, slightly higher than the 7% increase in oil prices assumed in this *Outlook*. The United States maize based ethanol price should not grow as much because the United States is projected in the second half of the *Outlook* to become a large exporter of this type ethanol and would have to support increasing transport costs. This ability to export would be mostly determined by the high world price of ethanol caused by the increasing demand generated by the growing imports from the United States to fill the other advanced gap. Therefore, the *Outlook* suggests, like last year, a policy driven two-way trade for United States ethanol. The United States exports will not necessarily all go to Brazil, since Canadian and European production is expected to be much smaller than consumption. The exact amount going to Brazil will be strongly influenced by the conclusion of the actual trade dispute[7] between the United States and the European Union.

The world biodiesel price declined in 2012 from the high level recorded in 2011. The vegetable oil price, which is the main feedstock used to produce biodiesel, remained high in 2012 partly because of the reduction in supply caused by the American drought. It generally takes two years following such a drought for the world price ratio between biodiesel and vegetable oil to return to the long term equilibrium. For the rest of the *Outlook* period, this ratio is fairly stable. Since the vegetable oil price is falling in real terms, the biodiesel price also falls in real terms but from historically high levels. The crude oil price has a much smaller influence on the world biodiesel price than on the world ethanol price simply because consumption is determined by government regulation and rarely by demand from the market in most countries covered in the baseline.

Production and use of biofuels

Global ethanol production has fallen in calendar year 2012 for the first time since 2000, due to declines in the United States and in Brazil. With lower prices of maize and sugar anticipated in 2013-14, a large increase in production is anticipated in both countries. By 2022, world ethanol production is projected to increase by almost 70% compared to the average of 2010-12 and reach some 168 bnl by 2022 (Figure 3.2). The three major producers are expected to remain the United States, Brazil and the European Union (Figure 3.3). Production and use in the United States and the European Union are mainly driven by the policies in place (i.e. RFS2 and the Renewable Energy Directive (RED), respectively). The growing use of ethanol in Brazil is linked to the development of the flex-fuel industry and the import demand of the United States to fill the advanced biofuel mandate as well as to their increase in blending minimums.

Figure 3.2. **Development of the world ethanol market**



Source: OECD and FAO Secretariats.

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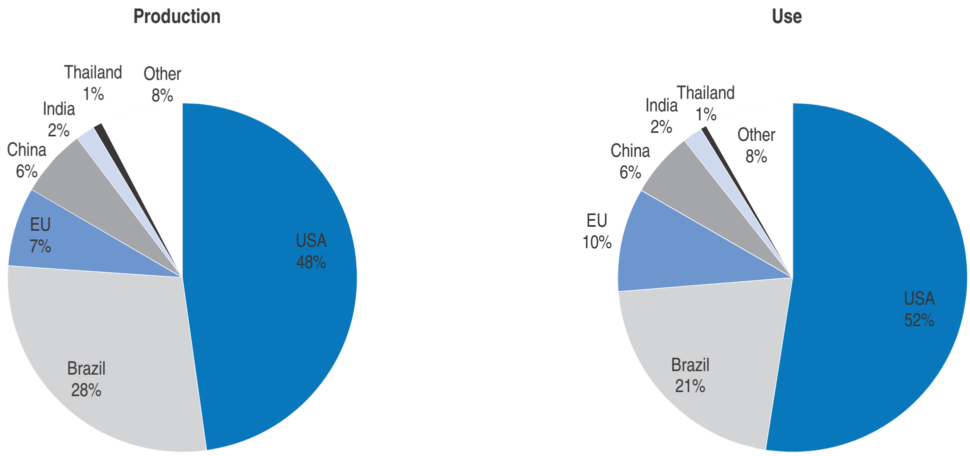
Figure 3.3. **Regional distribution of world ethanol production and use in 2022**



Source: OECD and FAO Secretariats.

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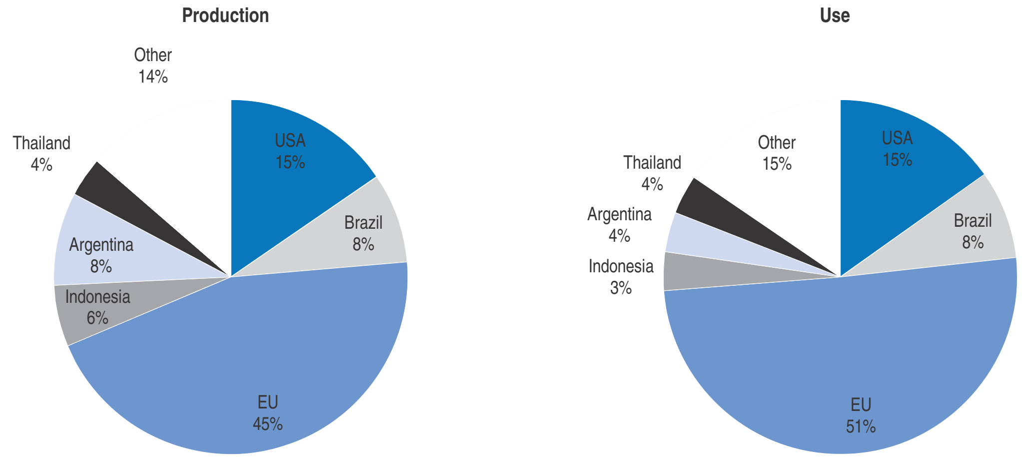
In calendar year 2012, ethanol production stagnated in developing countries mainly due to the supply reduction in Brazil that was partially offset by other developing countries, where increases were observed (Argentina, India, African and other South American countries). The ethanol production in developing countries is projected to increase from 42 bnl in 2012 to 72 bnl in 2022, with Brazil accounting for 80% of this supply increase and a large part of the rest coming from China, where less than half of their ethanol production is consumed in the fuel market, the rest is consumed as alcohol in many food and non-food preparations. The growth in China should come from cassava and sorghum since the use of maize for ethanol production is no longer allowed to increase.

Global biodiesel production is expected to reach 41 bnl in 2022. The European Union is expected to be by far the major producer and user of biodiesel (Figure 3.4). Other significant countries are Argentina, the United States and Brazil, as well as Thailand and Indonesia. Consumption in almost all countries will be dictated by the on-going policies.

Biodiesel production in developing countries, contrary to ethanol, did increase slightly beyond the trend of previous years with most of the growth taking place in Brazil, Indonesia, Thailand and Malaysia, with the latter recovering from a strong production decline in 2011. Total biodiesel production of developing countries is projected to stay constant in 2013 at about 10 bnl and increases thereafter to 14 bnl by 2022.

In the United States, the total biofuel mandate is projected to be binding throughout the projection period.[8] Ethanol use will, however, not be equal to the total mandate minus the biodiesel mandate in 2013 and in the last three years of the *Outlook* because biodiesel will capture parts of the other advanced mandate since its RIN should be cheaper than those of ethanol. In 2013, this is primarily due to the biodiesel blender tax credit, which is assumed not to be renewed in the baseline. For 2020-22, it is due to the effect of the E15 blend wall on the ethanol RIN market. Nevertheless, consumption of ethanol is expected to increase strongly, almost doubling between the average of 2010-12 and 2022 (from 46 bnl to 88 bnl). Most of the increase will be due the cellulosic mandate (growing from 0.05 bnl to 16.4 bnl) and the other advanced gap (growing from 1.1 bnl to 14.4 bnl).

Figure 3.4. **Regional distribution of world biodiesel production and use in 2022**



Source: OECD and FAO Secretariats.

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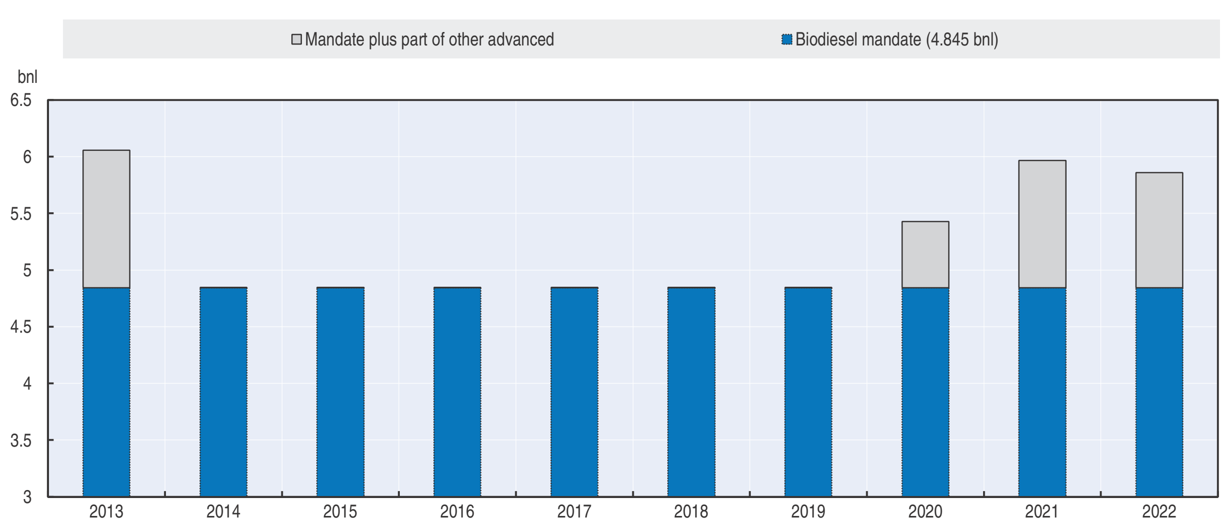
The mandate for biodiesel, as defined in the United States RFS2, was extended from 3.8 bnl to 4.8 bnl effective in 2012 and subsequent years. Consumption will be higher in four of the ten years of the outlook for the reasons explained above (Figure 3.5). By 2022, consumption should therefore reach 6 bnl, strongly influenced by the assumed level of fulfilment of the cellulosic ethanol mandate and the difficulty of overcoming the ethanol blend wall. The EPA could deliberately choose a lower level to avoid the effect of the blend wall on the ethanol market and this would return biodiesel consumption to the mandate level. In any case, biodiesel from tallow or other animal fat is expected to represent about 45% of total US production and an increasing share of the oil used to produce biodiesel will be coming from a better extraction of the oil in distiller's dry grains (DDGs) a by-product of ethanol production.

Figure 3.5. **The effective US biodiesel mandate is larger than in RFS2 in four years of the Outlook**



Source: OECD and FAO Secretariats.

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The European Union RED[9] states that renewable fuels (including non-liquids) should increase to 10% of total transport fuel use by 2020 in the European Union on an energy equivalent basis. The *Outlook* assumes that only 7.6% can be reached by 2022 from first generation biofuels. However, since each unit of second generation biofuel (including those produced from used cooking oil) consumed counts double for the purpose of the Directive, the fulfilment percentage becomes 8.6% in 2022.[10] In that context, European Union fuel ethanol production mainly from wheat, coarse grains and sugar beet is projected to reach 12.3 bnl in 2022 and ethanol fuel consumption amounts to an average share of 8.1% in gasoline types for transport fuels. Second generation ethanol is not assumed to play a major role throughout the projection period (only 3.5% of total production by 2022). As a result the ethanol deficit of the European Union is expected to double during the course of the *Outlook*.

Given mandates and tax reductions by European member states, total biodiesel use is projected to reach 18.3 bnl by 2022, representing an average share of biodiesel in diesel type fuels of 7.4%. Domestic biodiesel production should increase to keep pace with demand. Second generation biodiesel production is assumed to remain very small (only 1% of total production by 2022) while the amount produced from used cooking oil should reach 18% of the total in 2022. For both ethanol and biodiesel these results would obviously be seriously modified if the European Union decides to go ahead with the biofuel proposal announced on 17 October 2012. This proposal was analysed by the European Commission and a summary is presented in Box 3.1.

Box 3.1. **Latest EC biofuel proposal: Limited impact on world prices**

On 17 October 2012, the European Commission (EC) published a proposal to limit land conversion to biofuel production and to improve the climate benefits of biofuels used in the European Union. The aim is to reduce indirect land use change (ILUC) by limiting the amount of first generation biofuels that can be counted towards the 10% renewable energy target to 5%. In addition, advanced biofuels with no or low ILUC are promoted by weighting their contribution towards fulfilling the target more favourably. Biodiesel produced from waste oil will continue to be accounted for twice its energy content, but second generation biofuels will be weighted by a factor of four.

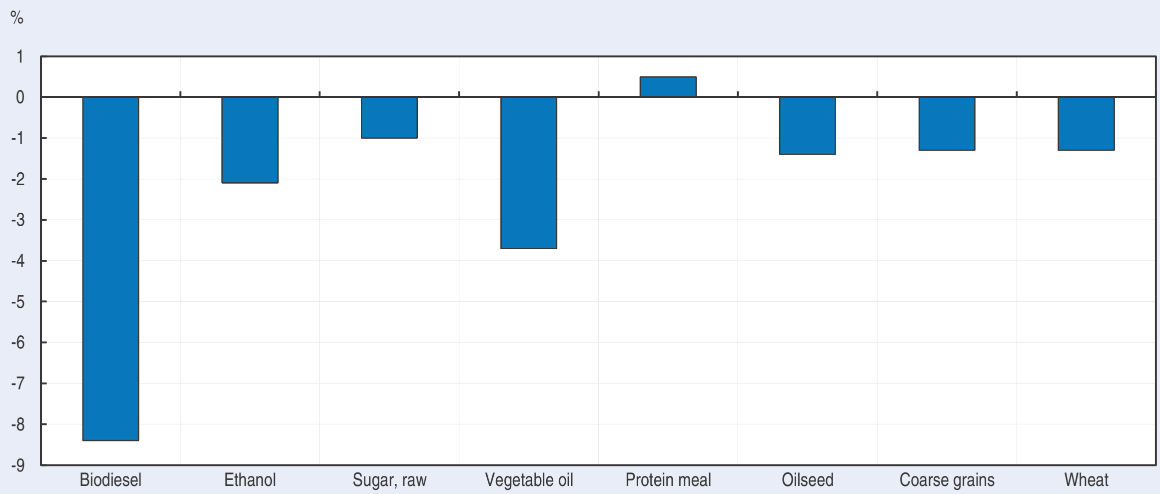
The scenario and the baseline discussed in this box were published by the EC in *Prospects for agricultural markets and income in the EU 2012-2022*. In this scenario, the share of first generation biofuels is set at a maximum of 5% of fuel use on an energy basis. The proposal promotes second generation biofuels via the accounting procedure. However, because of the limited availability of waste oil and little progress in the production of second generation biofuel, it was assumed that the increase in the share of these biofuels would not be significant. The share of biodiesel from waste oils in fuel use would increase by only 0.3% in this scenario (but a 27% increase in production compared to the baseline), while the share of second generation would only increase by 0.2% (100% increase in production by definition). Therefore, with this proposal, the renewable energy share in transport is 8.1% which is slightly smaller than in the EC baseline in 2022 in spite of the more favourable accounting procedure.

Biodiesel consumption is 10% lower than in the EC baseline, but maintains a significant share (6.4%) of diesel use while ethanol consumption falls by 28% in 2022. Respectively, 43% and 68% of the decline in biodiesel and ethanol use is reflected by lower imports. Reduction in domestic production makes the rest of the adjustment. These lower imports reduce the world prices of biodiesel and ethanol by 8.4% and 2.1% respectively in 2022 (Figure 3.6).

Box 3.1. **Latest EC biofuel proposal: Limited impact on world prices** *(cont.)*

The main feedstocks used in the European Union (EU) for biofuel production are vegetable oil, maize, wheat and sugar beets. Lower first generation biofuel production in the EU reduces demand and prices of these commodities (Figure 3.6). However, since the European Union is integrated into the world market, the effects on EU prices are similar to those at the world level. The impacts on these sectors are transmitted to some extent to other sectors through substitution or joint product effects. The lower vegetable oil price reduces the crusher's margin leading to lower demand and price of oilseeds. Reduced crushing will lower meals supply and increase the price. The reduction in the world ethanol price generates a shift in favour of more sugar production in countries like Brazil for example. This increases supply and lowers the world sugar price. In general, when the price of feed falls, this leads to higher livestock production and lower prices of meats. The impact on the price of sugar, oilseeds and cereals is small.

Figure 3.6. **Change in world prices between the EC outlook and the biofuel proposal scenario, 2022**



Source: European Commission.

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Argentina is expected to increase biodiesel production (37%) and exports (14%) over the *Outlook* period. For Brazil, the increasing other advanced gap in the United States offers a strong growth opportunity for ethanol production and exports. Ethanol production is projected to increase by 22 bnl or 87% while net exports (exports minus imports) will rise from 1.8 bnl to 11.8 bnl, a six-fold increase.

In recent years, an increasing number of developing countries have implemented ambitious biofuel targets or even mandates. Their motivation is based mainly on two objectives – achieving a high level of energy supply security/independency and increasing domestic value added products for export. Only a few of these countries act as notable exporters. For biodiesel, these are Argentina, Indonesia and Malaysia and for ethanol, Brazil, Pakistan and Thailand. The *Outlook* assumes increasing biofuel production in developing countries, but only 50% of the levels of ambitious national targets or mandates are expected to be achieved. The *Outlook* also assumes that national authorities will not insist on these mandates if large parts would have to be imported. One limiting factor is the availability of alternative feedstocks such as jatropha which are not yet suitable to produce biofuels on a larger scale.

Trade in ethanol and biodiesel

Global ethanol trade is set to increase strongly. Most of this increase is due to the growing ethanol trade between Brazil and the United States. The United States is expected to import about 14.6 bnl of sugar cane based ethanol mostly from Brazil[11] by 2022, since it the cheapest alternative to fill the advanced biofuel mandate. At the same time, the United States is expected to export 6.6 bnl of maize based ethanol by 2022. The European Union is set to import an additional 2 bnl of ethanol while biodiesel imports are projected to increase to the level reached in 2011 (3.1 bnl) by 2016 and decrease to the base year level in 2022 again (2.3 bnl). This outcome for biodiesel partly reflects the limitations generated by the sustainability criteria required by the European Union as rapeseed oil, palm oil and soybean oil feedstock do not fulfil in their default values the minimum greenhouse gas emission reduction by 50% applicable as of January 2017. It also partly reflects the inability of North America to generate a large surplus of biodiesel over the entire period of the *Outlook*.

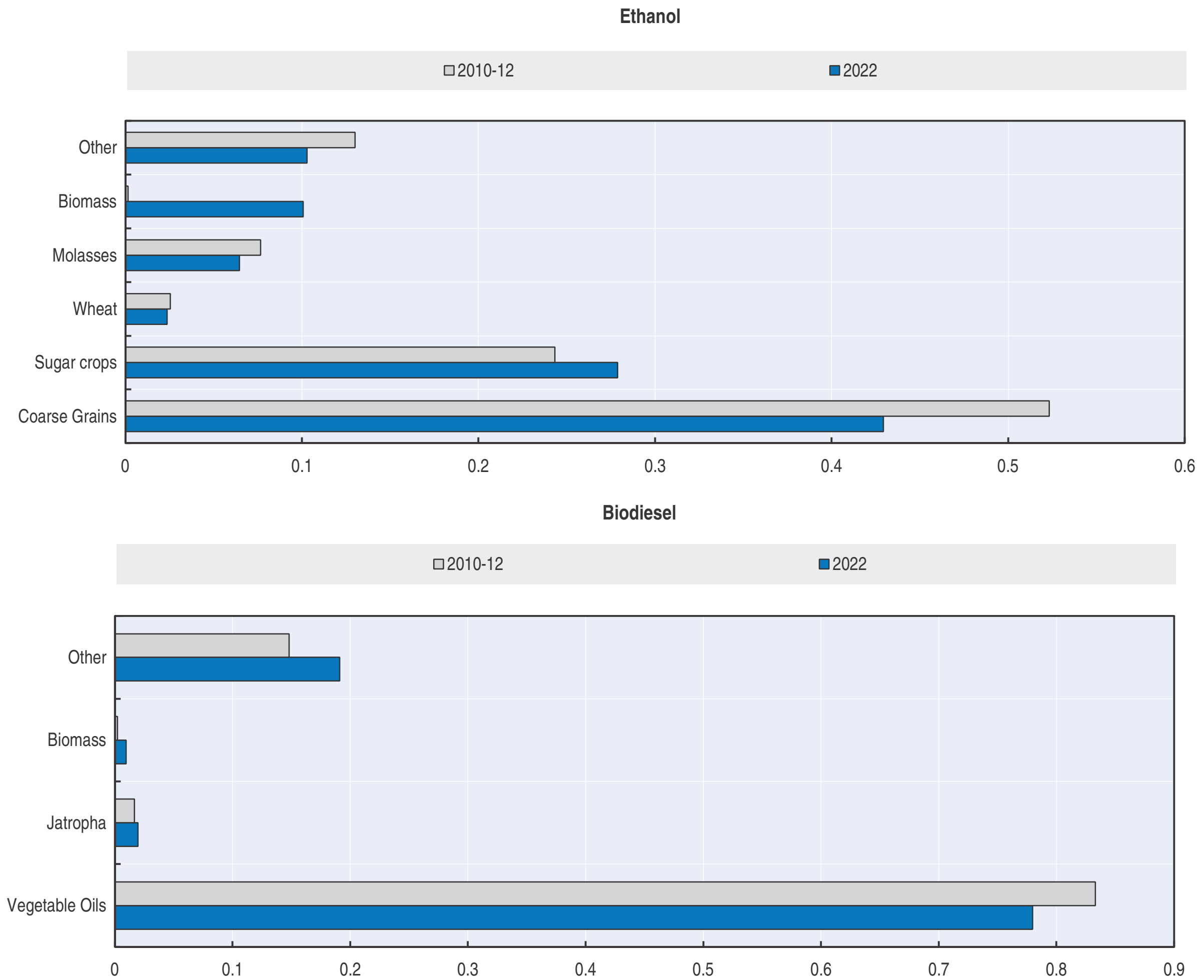
Developing countries are net exporters for both biodiesel and ethanol. Argentina (2 bnl), Indonesia (0.8 bnl) and Malaysia (0.1 bnl) are projected in the *Outlook* to be the largest net exporters of biodiesel by 2022 while Brazil (12 bnl), Pakistan and Thailand (0.5 bnl each) are expected to be the largest net exporters of ethanol among developing countries.

Feedstocks used to produce biofuels

Coarse grains and sugar cane will remain the dominating ethanol feedstock while vegetable oil continues to dominate biodiesel production (Figure 3.7). The share of coarse grain based ethanol production in global ethanol production in 2022 is expected to lose about ten percentage points to 43%, which corresponds to 12% of global coarse grain production. Sugar crops (cane and beets but mostly cane) share of world ethanol production should increase from 24% to 27% and should require 28% of global sugar cane production in the last four years of the *Outlook*. Production from other sources is mostly composed of residues of all kinds and in particular of wood as well as from roots and tubers.

While the share of ethanol produced from wheat and molasses decreases slightly, biomass based ethanol is projected to account for almost 10% of total ethanol production by 2022, mostly all stemming from production in the United States and based on the assumption of a fulfilment rate of 27% of the cellulosic mandate in 2022. It is also assumed that by 2022, 60% of this amount will not be produced from crop residue but from crops like switchgrass. The share of biodiesel produced from vegetable oil in global biodiesel production is expected to decrease from 83% to 78%, which corresponds to 15% of global vegetable oil production in 2022 (Figure 3.7). Production from other sources is mostly composed of used cooking oil and animal tallow.

Figure 3.7. **Share of feedstocks used for biofuels production**[1]



1. Sugar crop includes ethanol produced from sugar beets in the European Union.

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Risks and uncertainties

The global biofuel projections are strongly influenced by biofuel policies around the world and many decisions have to be taken each year which cannot be anticipated today. The *Outlook* assumes certain decisions, for example of the EPA on the waiving of mandates in the United States, but these decisions might be different in reality. Last year's *Outlook* provided a detailed analysis of alternative EPA options. The same is true for the EU biofuel policies as seen in Box 3.1.

Given the sustainability criteria, national authorities increasingly aim at replacing the first generation of biofuels produced from agricultural feedstocks progressively by advanced biofuels produced from lignocellulosic biomass, waste material or other non-food feedstocks. Since these technologies are still far away from being able to fulfil future goals and their development strongly depends on current investors' decisions, spending on research and development and on the continuation of biofuel policies, this sector is highly uncertain.

Ethanol markets have been strongly influenced by the level of crude oil prices over the past few years. Since ethanol production is expected to represent a sizeable part of the demand for agricultural feedstock, the uncertainties in the fossil energy sector become uncertainties for the ethanol and agricultural sectors. Finally, the sector is also vulnerable to perturbations in agricultural production caused by unfavourable climatic conditions. In order to better ascertain this risk and the mitigating factors already included in the United States biofuel policy, two scenarios were produced with AGLINK-COSIMO and are presented in Box 3.2.

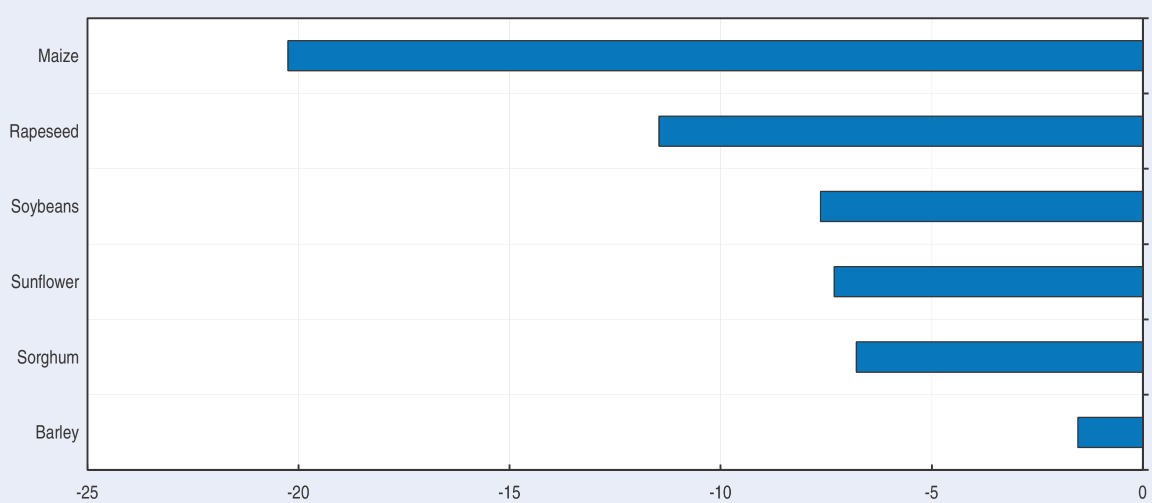
Box 3.2. **The flexibility in the US mandates through the roll-over provision**

The calendar year quantitative national mandates are laid out in the Energy Independence and Security Act of 2007. These mandates are, however, subject to some flexibility. Besides the flexibility given to the Environmental Protection Agency (EPA), which can waive part of any mandate in any given year, biofuel blenders are allowed to "rollover" or run a "deficit" of Renewable Identification Numbers (RIN is the mechanism used to insure consumption of biofuel equal the quantities specified in the mandates) into the following year.

Up to 20% of a given mandate may be met with RINs produced in the previous year. This allows a certain "stock holding" of obligations which can be drawn down in years where RIN prices rise. The blender can hold an additional stock of RINs as a hedge against rising biofuel and RIN costs or other compliance issues. On an individual basis, blenders may fall short of the mandate in a particular year if in the following year they make up for that "deficit" and fully comply with the mandate in the current year. Running a deficit in the current year introduces considerable rigidity in the following year for blenders, as failure to comply with mandates can result in a fine of USD 37 500 per day plus any economic benefit derived from non-compliance. Such flexibility in the mandate should mitigate swings in feedstock and biofuel prices from transient shocks in energy prices and crop production.

To illustrate this, a reproduction of the 2012 drought in the United States which led to a 20% decrease of maize yields compared to normal levels was simulated in the AGLINK-COSIMO model. The drought was simulated in 2016 for those crops where a yield reduction in 2012 was observed as shown in Figure 3.8.

Figure 3.8. **Yield shocks in the United States applied to 2016**



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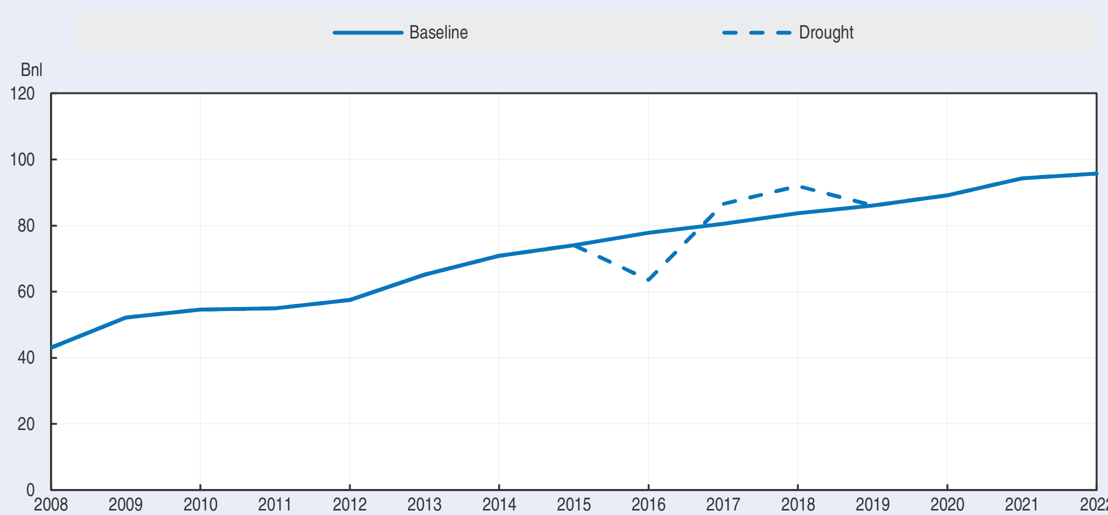
Box 3.2. **The flexibility in the US mandates through the roll-over provision** *(cont.)*

The simulations were carried out firstly with no rollover flexibility allowed and secondly with the maximum deficit allowed for maize based ethanol and biodiesel – 20% of the respective mandates in 2016. That deficit is not entirely recovered in the subsequent year because another 10% deficit was assumed in 2017. The net effect in 2017 and 2018 is a consumption of ethanol and biodiesel 10% above the mandate because blenders had to process the 20% deficit of the 2016 mandate and are borrowing 10% of the 2017 mandate which will be processed in 2018. All those changes are summarised through the effective total biofuel mandate presented in Figure 3.9. This assumption was chosen in order to evaluate the maximum mitigation effect that the rollover provision might have on feedstock prices.

Figure 3.9 shows the impacts on US ethanol production of the simulated yield shocks in 2016. Subsequently, Figure 3.10 presents the role of rollover flexibility on maize prices, showing that half of the price spike for maize is mitigated (18% versus 35%). The price for ethanol in the United States in 2016 rises sharply if no rollover is allowed, while with active rollover there are almost no price effects observed. This is due to the fact that the downward shift in demand caused by the rollover mitigates almost perfectly the effect on price that a downward shift in supply (caused by the higher price of maize) would have generated.[1] But contrary to maize, the ethanol price spike is transferred to the following years when the RINs that have not been filled in 2016 need to be produced. This also contributes to higher demand and price of maize in subsequent years.

Figure 3.9. **Impacts of 2016 drought scenario on US ethanol production**



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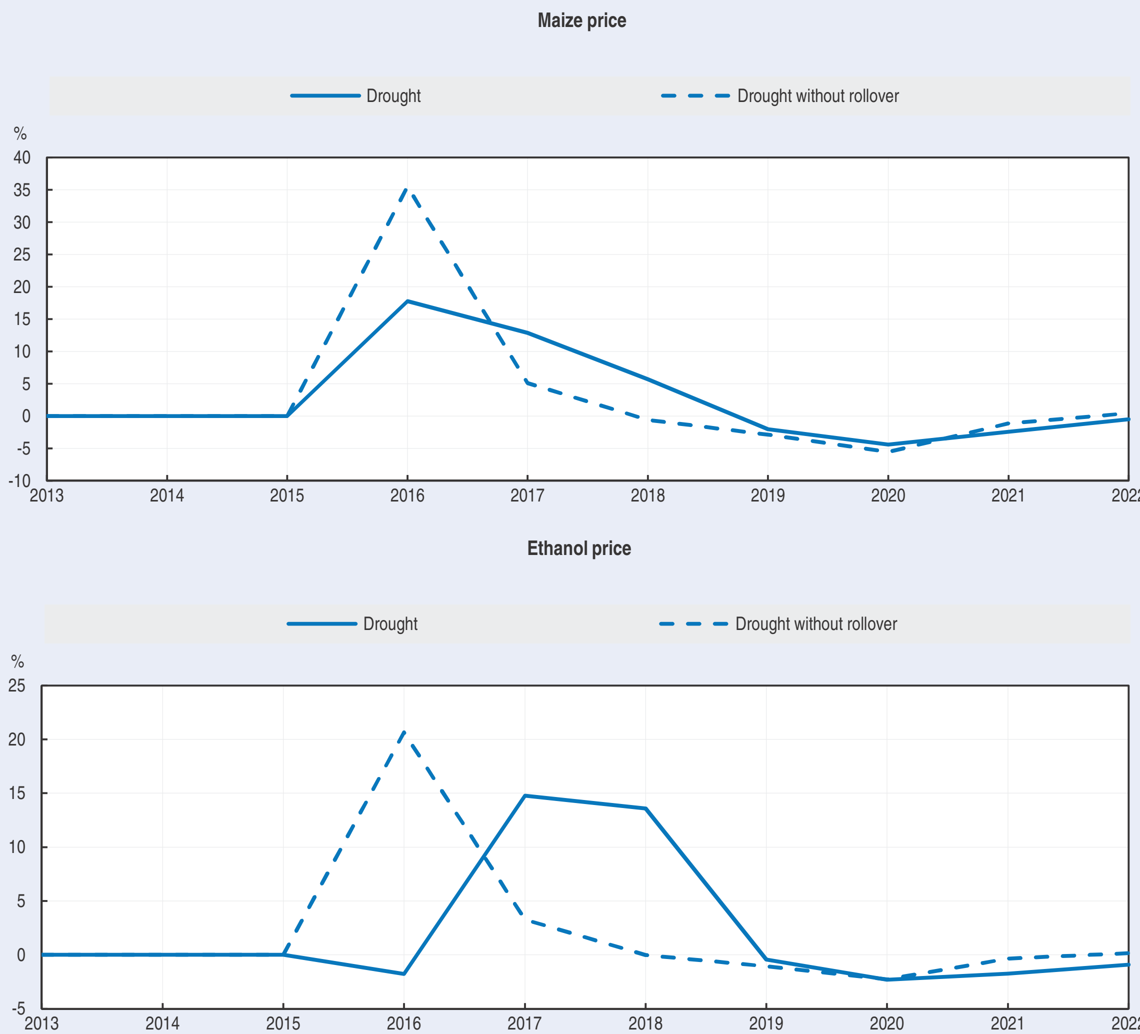
On the biodiesel and vegetable oil markets, the effects are comparable but lower, given the smaller sectors in the United States and the smaller reduction in soybean yield simulated.

Clearly, this application of the AGLINK-COSIMO model shows that the flexibility in US biofuel mandates built in through the rollover provision, mitigates price spikes in feedstock markets as it spreads the increase in the maize price over multiple years (Figure 3.10). Therefore the maize price increases over the period 2016-22 are quite similar (3.7% with rollover and 4.3% without).

Box 3.2. **The flexibility in the US mandates through the roll-over provision** *(cont.)*

Figure 3.10. **Price impacts of the 2016 drought scenario with and without rollover flexibility**



Source: OECD and FAO Secretariats.

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1. In fact the maximum amount of rollover used lead to a small decline of the ethanol price in 2016.

Notes

1. Brazil, Sao Paolo (ex-distillery).
2. Producer price Germany net of biodiesel tariff.
3. RIN stands for Renewable Identification Number and is the market mechanism used in the United States to insure the mandates are fulfilled. A RIN is one unit of mandate consumed. When market conditions are not favourable to the consumption of ethanol the RIN price increases. Since blenders recover this additional cost by increasing the price gasoline, consumption of ethanol becomes more favourable. The RIN price will increase until the gasoline price has increased sufficiently to allow the consumption of the ethanol mandates.
4. E15 is expected to become the low blend in the United States at the end of the *Outlook*. E15 means that 15% ethanol is included in the fuel. By 2020 the physical amount that it represents is expected to become lower than the sum of all the ethanol mandates and thus requiring E85 or flex-fuel cars. Even though it is assumed that some consumers will consume E85 even though the price of ethanol has not fallen to the energy equivalent of gasoline, by 2020 the marginal consumers will require that level of price in order to consume the last amount of the ethanol mandates.
5. According to the Renewable Fuel Standards final rule (RFS2) there are four biofuel mandates; total, advanced, biodiesel and cellulosic. The difference between total and advanced is the conventional gap which can be met with maize based ethanol. A detailed explanation of RFS2 is available in the *OECD-FAO Agricultural Outlook 2012-21,www.oecd.org/site/oecd-faoagriculturaloutlook/*.
6. The blender tax credit was also reinstated retroactively for 2012. Having being done after the fact it was assumed to be market neutral.
7. The European Union has launched an anti-dumping and anti-subsidy action against exports of American ethanol. A key element of the case is the credit from the US federal excise tax on gasoline. That credit has not been renewed in 2012 and in 2013 and the same is assumed in all the years of the *Outlook*.
8. If only the ethanol conventional gap existed the mandate would not be binding in most years of the *Outlook* because of the high crude oil price.
9. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF
10. This assumption responds to likely market developments and is in line with the recently published *Prospects for Agricultural Markets and Income in the EU 2012-2022*.
11. Even though AGLINK-COSIMO is not a spatial model, Brazil is the only country in the *Outlook* that will generate a large enough surplus of ethanol to cover the largest share of the United States import demand.

Table A.4.1. Biofuel projections: Ethanol

	PRODUCTION (Mn l)		Growth (%)[1]	DOMESTIC USE (Mn l)		Growth (%)[1]	FUEL USE (Mn l)		Growth (%)[1]	SHARE IN GAZOLINE TYPE FUEL USE (%)				NET TRADE (Mn l)[2]	
										Energy Shares		Volume Shares			
	Average 2010-12est	2022	2013-22	Average 2010-12est	2022	2013-22	Average 2010-12est	2022	2013-22	Average 2010-12est	2022	Average 2010-12est	2022	Average 2010-12est	2022
NORTH AMERICA															
Canada	1 572	1 474	-0.85	1 920	2 202	0.20	1 920	2 202	0.20	3.2	3.5	4.7	5.1	-349	-729
United States	47 906	79 997	3.79	46 383	87 773	4.39	44 216	85 393	4.51	5.8	10.9	8.4	15.5	1 624	-7 874
of which second generation	37	16 353	..	..	..	..	..	..	..	..	..	..	..	..	..
EUROPE															
European Union	6 554	12 261	6.76	8 243	16 098	7.18	5 683	13 803	8.99	3.1	8.1	4.5	11.7	-1 689	-3 837
of which second generation	42	425	..	..	..	..	..	..	..	..	..	..	..	..	..
OCEANIA DEVELOPED															
Australia	349	427	-0.71	372	453	-0.67	372	453	-0.67	1.3	1.6	2.0	2.4	-23	-26
OTHER DEVELOPED															
Japan	101	101	0.15	950	1 551	4.61	350	966	8.84	0.0	0.0	0.0	0.0	-877	-1 450
of which second generation	79	78	..	..	..	..	..	..	..	..	..	..	..	..	..
South Africa	367	319	-1.19	190	199	0.08	4	6	1.02	..	..	..	..	177	121
SUB-SAHARIAN AFRICA															
Mozambique	36	72	6.94	34	45	2.35	2	15	8.60	..	..	..	..	2	27
Tanzania	34	42	2.92	43	50	2.89	3	19	9.69	..	..	..	..	-9	-8
LATIN AMERICA AND CARRIBBEAN															
Argentina	355	1 015	8.04	512	1 154	7.62	344	980	9.76	3.4	6.6	5.0	9.6	-157	-139
Brazil	25 373	47 376	5.10	23 549	35 558	4.23	21 886	33 642	4.45	46.4	56.8	56.2	66.2	1 823	11 818
Columbia	352	598	3.63	409	603	2.55	342	539	2.89	..	..	..	..	-58	-5
Mexico	210	252	0.99	342	404	0.99	0	0	..	0.0	0.0	0.0	0.0	-132	-151
Peru	181	402	3.15	90	193	2.99	70	173	3.35	..	..	..	..	90	209
ASIA AND PACIFIC															
China	8 643	10 531	1.83	8 566	10 090	0.96	2 133	3 890	3.72	1.5	1.8	2.2	2.7	77	441
India	2 258	2 971	2.41	2 294	3 057	2.62	262	964	11.65	..	..	..	..	-36	-86
Indonesia	193	260	2.96	156	225	2.26	31	95	6.08	..	..	..	..	38	35
Malaysia	89	96	0.16	91	96	0.11	0	0	4.93	..	..	..	..	-2	-1
Philippines	129	269	5.57	425	547	0.68	230	362	1.00	..	..	..	..	-297	-279
Thailand	781	1 461	4.28	640	958	3.83	461	783	4.90	..	..	..	..	141	502
Turkey	84	130	3.37	123	143	1.29	50	68	2.78	..	..	..	..	-39	-13
Viet Nam	345	690	2.77	257	437	2.12	94	264	3.72	..	..	..	..	88	253
TOTAL	**100 130**	**167 391**	**4.10**	**99 776**	**167 293**	**4.12**	**79 051**	**145 202**	**4.77**	**6.2**	**10.7**	**9.0**	**15.2**	**3 749**	**12 259**

Note: .. : Not available.

Average 2010-12est: Data for 2012 are estimated.

1. Least-squares growth rate (see glossary).
2. For total net trade exports are shown.

Source: OECD and FAO Secretariats.

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Table A.4.2. Biofuel projections: Biodiesel

	PRODUCTION (Mn l)		Growth (%)[1]	DOMESTIC USE (Mn l)		Growth (%)[1]	SHARE IN DIESEL TYPE FUEL USE (%)				NET TRADE (Mn l)[2]	
							Energy share		Volume share			
	Average 2010-12est	2022	2013-22	Average 2010-12est	2022	2013-22	Average 2010-12est	2022	Average 2010-12est	2022	Average 2010-12est	2022
NORTH AMERICA												
Canada	248	346	-3.91	319	665	0.43	0.9	1.8	1.1	2.3	-71	-318
United States	3 721	6 267	1.65	3 477	6 158	1.76	1.4	2.2	1.8	2.7	244	109
EUROPE												
European Union	10 707	18 282	6.28	13 430	20 530	5.03	5.2	7.4	6.5	9.1	-2 723	-2 248
of which second generation	52	225	..	..	..	..	..	..	..	..	..	..
OCEANIA DEVELOPED												
Australia	649	734	1.10	649	734	1.10	2.9	2.4	3.6	3.0	0	0
OTHER DEVELOPED												
South Africa	72	98	2.38	72	98	2.38	..	..	..	..	0	0
SUB-SAHARIAN AFRICA												
Mozambique	66	84	0.78	9	49	5.81	..	..	..	..	57	36
Tanzania	61	96	4.29	0	58	119.70	..	..	..	..	61	38
LATIN AMERICA AND CARIBBEAN												
Argentina	2 524	3 451	2.01	784	1 467	2.98	5.6	8.4	7.0	10.3	1 740	1 984
Brazil	2 599	3 337	2.85	2 603	3 278	2.70	4.9	4.6	6.0	5.7	-4	59
Columbia	537	926	3.54	537	925	3.55	..	..	..	..	0	1
Peru	68	105	1.68	213	316	2.64	..	..	..	..	-145	-211
ASIA AND PACIFIC												
India	276	776	9.15	347	1 205	10.54	..	..	..	..	-71	-429
Indonesia	1 353	2 279	3.70	341	1 432	10.10	..	..	..	..	1 012	847
Malaysia	125	783	13.64	50	650	14.82	..	..	..	..	75	133
Philippines	142	378	9.43	142	378	9.43	..	..	..	..	0	0
Thailand	706	1 465	4.93	706	1 465	4.93	..	..	..	..	0	0
Turkey	11	17	2.73	11	17	2.73	..	..	..	..	0	0
Viet Nam	18	103	11.18	18	103	11.21	..	..	..	..	0	0
TOTAL	**24 011**	**40 620**	**4.46**	**23 837**	**40 620**	**4.46**	**3.0**	**4.0**	**3.7**	**4.9**	**2 029**	**2 152**

Note: ..: Not available.

Average 2010-12est: Data for 2012 are estimated.

1. Least-squares growth rate (see glossary).
2. For total net trade exports are shown.

Source: OECD and FAO Secretariats.

StatLink http://dx.doi.org/10.1787/888932861168

Table A.5. Main policy assumptions for biofuel markets

		2012/13est	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
ARGENTINA												
Biodiesel												
Export tax	%	18.3	20.1	21.7	20.8	19.3	21.2	22.9	22.9	24.0	24.0	24.0
BRAZIL												
Ethanol												
Import tariffs	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Incorporation mandate[1]	%	14.3	16.1	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8	16.8
Biodiesel												
Tax concessions[2]	BRL/hl	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Import tariffs	%	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
CANADA												
Ethanol												
Tax concessions[2]	CAD/hl	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4	6.4
Import tariffs	CAD/hl	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Incorporation mandate[1]	%	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Direct support												
Federal	CAD/hl	7.0	6.0	5.0	4.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0
Provincial	CAD/hl	4.3	4.3	4.3	4.3	4.3	0.0	0.0	0.0	0.0	0.0	0.0
Biodiesel												
Tax concessions[2]	CAD/hl	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Incorporation mandate[1]	%	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Direct support												
Federal	CAD/hl	14.0	12.0	10.0	8.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0
Provincial	CAD/hl	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COLOMBIA												
Ethanol												
Import tariffs	%	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7	9.7
Blending target[3,4]	%	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Biodiesel												
Blending target[4]	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
EUROPEAN UNION												
Biofuel												
Energy share in fuel consumption[5]	%	4.5	5.0	5.4	5.8	6.2	6.6	7.0	7.5	8.0	8.3	8.6
Ethanol												
Tax concessions[2]	EUR/hl	20.5	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3
Import tariffs	EUR/hl	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2	19.2
Biodiesel												
Tax concessions[2]	EUR/hl	20.1	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4	19.4
Import tariffs	%	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
INDIA												
Ethanol												
Import tariffs	%	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0	8.0
Share of biofuel mandates in total fuel consumption	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Biodiesel												
Import tariffs	%	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Share of biofuel mandates in total fuel consumption	%	1.9	2.8	3.7	4.6	5.5	6.4	7.3	8.2	8.2	8.2	8.2
INDONESIA												
Ethanol												
Import tariffs	%	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3	26.3
Blending target[4]	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Biodiesel												
Blending target[4]	%	3.0	3.0	3.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0	7.0
MALAYSIA												
Ethanol												
Import tariffs	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blending target[4]	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Biodiesel												
Blending target[4]	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
PERU												
Ethanol												
Import tariffs	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blending target[4]	%	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8
Biodiesel												
Import tariffs	%	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blending target[4]	%	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0

