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Biofuels Annual

EU Biofuels Annual 2018

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Report Highlights: On June 14, 2018, an agreement on the successor to the Renewable Energy Directive (RED) was reached for 2021-2030. The RED II sets a limit of 7 percent on the blending of conventional (food based) biofuels, well above the blended 4.1 percent forecast for this year. This is less stifling than some of the previous proposals but conventional biofuels must compete with other forms of renewable transport energy and current imports of biodiesel and potentially bioethanol are a threat for the domestic producers. Based on the readiness of the technology and the double counting factor, biofuels produced from waste fats and oils have the best outlook for further expansion on the short term. The RED II set ambitious goals for biofuels produced from cellulosic feedstocks, but so far commercial production of these advanced biofuels have been limited. The EU market for wood pellets is expected to continue its growth during 2018-2020, but further expansion could be limited by individual Member State sustainability requirements.

Post: The Hague

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I. Executive Summary

Policy and Programs

The current EU policy for renewable energy is established in the EU Energy and Climate Change Package (CCP) and the Fuel Quality Directive (FQD). The Package includes the "20/20/20" mandatory goals for 2020, one of which is a 20 percent binding target for renewable energy in the overall energy mix of the EU, and a 10 percent renewable-energy blending target for the transport sector. According to the EU's most recent biannual progress report (2017), the EU is on track to meet its 20 percent target, but will likely not meet the binding 10 percent renewable energy target for the transport sector.

In the Renewable Energy Directive (RED), which is part of the CCP, specific sustainability requirements are defined for conventional liquid biofuels. The European Commission (EC) amended these sustainability requirements in the Indirect Land Use Change (ILUC) Directive, most notably by capping the use of conventional (food based) biofuels at 7 percent and setting non-binding national targets for advanced biofuels (non-food based) at 0.5 percent for overall energy use.

Presently, the EC, Parliament, and Council are finalizing the successor to RED, RED II for the period of 2021-2030. On June 14, 2018, parties forged a political agreement committing to a new overall renewable energy target of 32 percent by 2030. The legislation is not finalized but decision makers made several key provisions of the political agreement public. The final legislation of RED II is expected in the fall of 2018 and will go into effect January 1, 2021.

- The RED II sets a 14 percent renewable energy target for the transport sector. The EU capped the RED II share of conventional based biofuels to 1 percent above consumption levels by Member States (MSs) in the year 2020, up to the overall cap of 7 percent for each MS.
- The RED II also sets binding targets for the use of advanced (non-food based) biofuels to 3.5 percent by 2030.
- The EU introduced sustainability criteria for biomass and expanded sustainability criteria for biofuels, which is likely to impact palm oil imports and potentially soy.

All three parties are also gearing up to negotiate the post-2020 Common Agricultural Policy (CAP), which programs all the EU-wide funding for agricultural and rural development. At this stage in the process, it is difficult to assess what changes are to come and what their impacts on biofuels production and imports will be.

Finally, there have been several recent developments related to the EU's Anti-Dumping (AD) duties the EC imposed on Argentina and Indonesia's biodiesel exports to the EU. In September 2017, the World Trade Organization found that the EC incorrectly calculated these AD duties, and with this finding, the EC has significantly reduced the duties resulting in increased biodiesel imports from these two countries. The large increase in imports is likely to be tempered by a recent subsidy investigation the EC has launched into Argentina's biodiesel sector. The result of the investigation will be known by year's end.

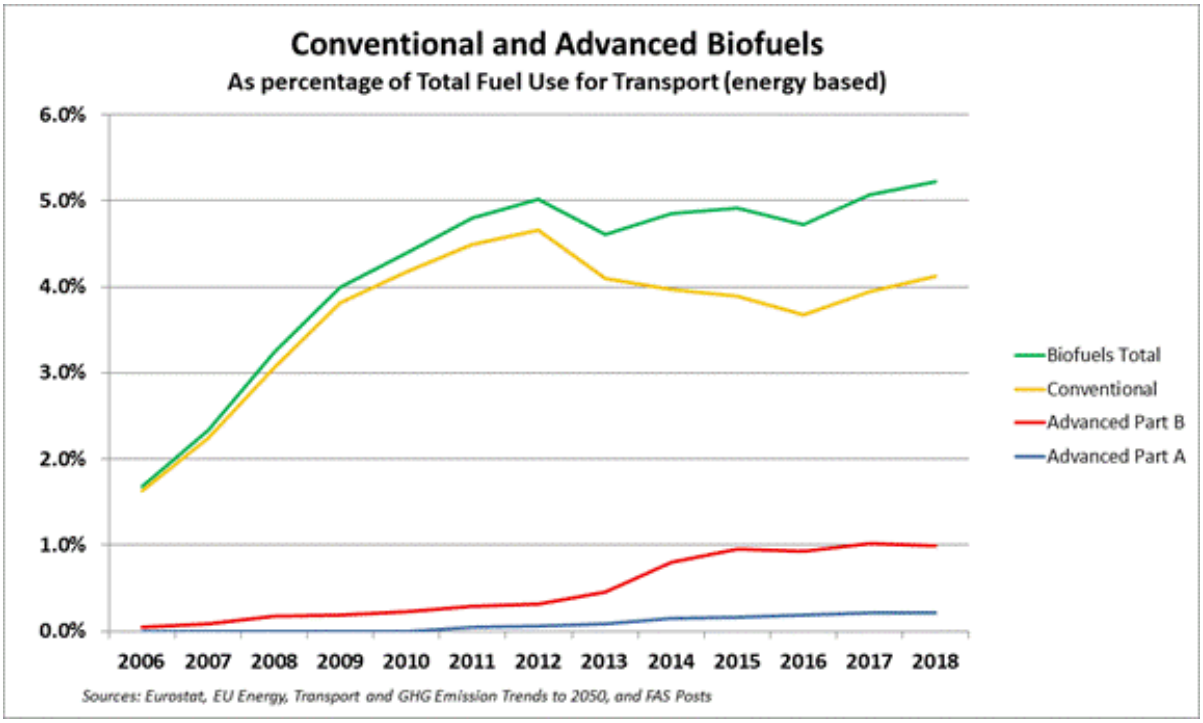
Conventional and Advanced Biofuels

Consumption of both bioethanol and biodiesel is forecast to continue to increase in 2018, mainly due to increasing EU MS mandates. Due to import tariffs and antidumping duties on U.S. ethanol imports, domestic production of bioethanol is expected to take advantage of this increased demand. In contrast, domestic production of conventional biodiesel is significantly affected by the elevated soybean oil based biodiesel imports from Argentina. As a result, the production of rapeseed oil based biodiesel is forecast to be cut and the use of rapeseed oil is expected to decline by about 1 MMT in 2018. Production of biodiesel, made of waste fats and oils, which can be double counted according to EU rules and the production of drop-in fuel hydrogenated vegetable oil (HVO), are less affected by these competitive imports.

In 2018, total biofuels blending with fossil fuels is forecast at 5.2 percent (energy basis, exclusive of double-counting, see graph below), 3.6 percent for bioethanol and 5.8 percent for biodiesel and

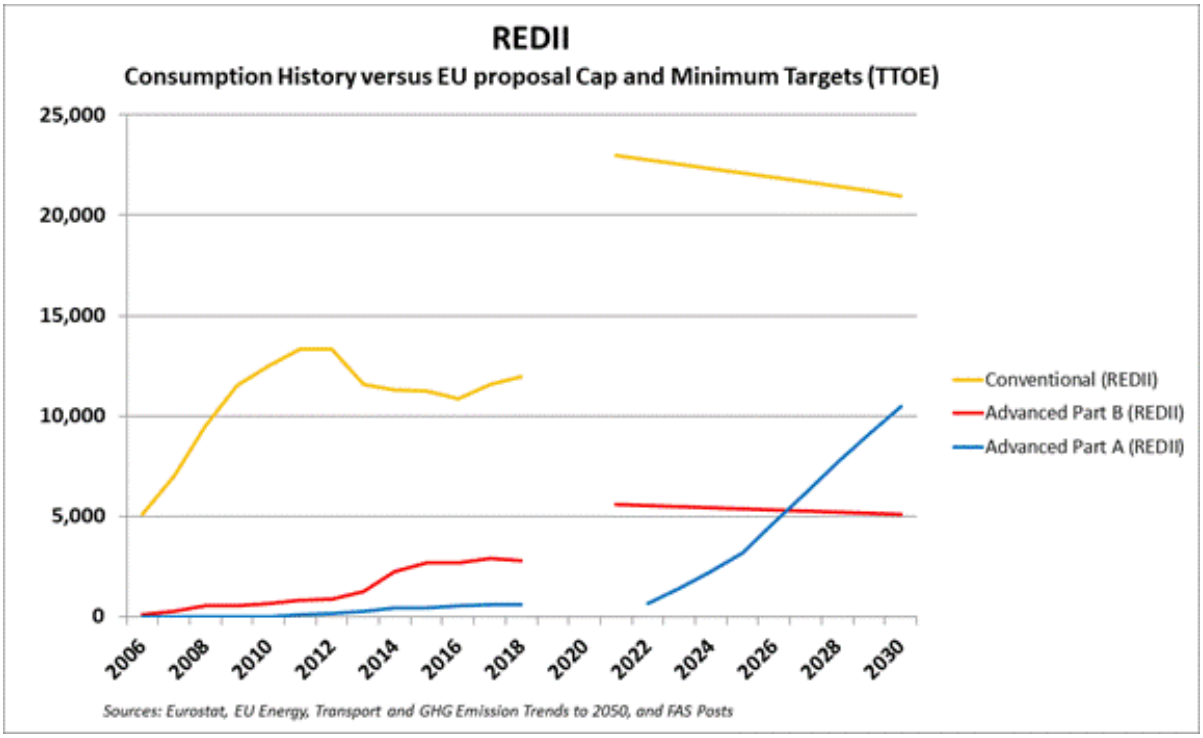
HVO, and thus well below the 10 percent target for 2020. Blending of conventional (food based) biofuels is estimated at 4.1 percent, still well below the 7 percent cap set by the ILUC Directive, and for 2021-2030 by the RED II.

Blending of advanced (non-food based) biofuels is estimated at 1.2 percent. The majority of these advanced biofuels blended, 1.0 percent, is produced from waste fats and oils (listed in Part B of Annex IX of the RED), and only a small percentage, 0.2 percent, is produced from agricultural and forestry by-products such pine oil and cellulosic feedstocks oils (listed in Part A).



The historical Eurostat transport fuel statistics and EC projections for transport fuel use (EU Energy, Transport and GHG Emission Trends to 2050) combined with the 7 percent cap for conventional biofuels in the RED II translate to a consumption maximum of about 23,000 thousand metric tons of oil equivalent (TTOE) in 2022 and 21,000 TTOE in 2030 (see graph below). It should be noted that this volume can be cut by the proposed multipliers for reaching the overall mandate of 14 percent renewable energy in transport; electric transport (4x for road and 1.5x for rail transport), the use of biofuels by the aviation and maritime sector (1.2x) and advanced biofuels produced from agricultural and forestry by-products (Part A) and waste fats and oils (Part B) which both count double to the mandate. It should also be noted that EU MSs may decide to set lower limits for the contribution from food based biofuels.

Given the double counting and the readiness of the technology, in particular the renewable diesels and HVO (produced with Part B inputs) are likely to be the preferred transport biofuel. The RED II sets a limit of 1.7 percent (actual blending is 1.0 percent in 2018) but MSs can modify this limit if justified taking into account the availability of the feedstock. Sourcing feedstocks from third countries could support a production expansion in order to keep these renewable transport fuels competitive. The EC is able to add feedstocks to Part A and B of Annex IX, but cannot remove them.



Based on the proposed minimum blending rates for advanced biofuels produced with feedstocks listed in Part A of the RED II the consumption of these second generation biofuels must increase significantly as from 2020 (see graph above). The RED II target for advanced biofuels (Part A) of 0.2 percent in 2022 equals the current consumption level, but the target is set to increase to 3.5 percent in 2030, which is equivalent to a quantity of about 10,000 TTOE. This would almost equal the current production of conventional biofuels, and require about a hundred cellulosic bioethanol plants with an annual capacity of 200 million liters. This necessitates investments in domestic biorefineries and sourcing of eligible feedstocks or as an alternative sourcing of such advanced biofuels outside the EU. The current available cellulosic biofuels are produced from pine oil (biodiesel), glycerol (biomethanol) and saw dust (bioethanol).

Biomass for heat and power

With a consumption of about 21.7 MMT of pellets in 2016, the EU is the world's largest wood pellet market. Based on EC mandates and Member State (MS) incentives, the demand is expected to expand further to nearly 24 MMT in 2018. Residential use for heating, about 45 percent of the total pellet market, is a relatively stable market compared to industrial heat and power generation. In some EU MSs, households receive subsidies or tax deductions for heating with biomass as input. In most countries, however, government funding is limited. Italy and Germany are the main growth markets for residential pellets.

Demand for industrial pellets, mostly for power generation, depends primarily on EU MS mandates and incentives. The main market for industrial pellets is the United Kingdom, which is anticipated to grow over the next two years. The Dutch power sector is expected to start sourcing pellets again this year, after they have been out of the market for almost two years. If EU demand and trade flows remain consistent with current patterns, the United States has the potential to supply 65 percent of the EU import demand, which would represent a trade value of potentially US$1.2 billion in 2020. Third country imports could, however, be affected by the implementation of sustainability requirements by individual EU MS governments.

II. Policy and Programs

The EU's Renewable Energy Directive (RED)

The EU Energy and Climate Change Package (CCP) runs from 2010-2020. The Renewable Energy Directive (RED), which is part of the CCP package, entered into force on June 25, 2009 and expires on December 31, 2020. The CCP requires the EU to achieve a binding target whereby 20 percent of its overall energy use would be powered from renewable sources by 2020. The RED also requires that the transport sector reach a renewable energy-blending target of 10 percent. Concerned that several CCP measures were having adverse environmental impacts and that not all EU Member States (MS) were contributing to the EU-wide 20 percent renewable energy target, the European Commission (EC) adopted the Indirect Land Use Chance or ILUC Directive in 2015; this amended both the RED and the Fuel Quality Directive (FQD). The amendment put a cap on the share of conventional biofuels that can be used to meet the transport sector's 10 percent blend target at 7 percent and a requirement that advanced biofuels comprise a minimum share of 0.5 percent of transport sector's energy use by 2020. To further incentivize advanced biofuel use, the amendment allowed MS to double count the contribution of advanced biofuels to meeting these binding targets.

Member States RED Initiatives: Under the RED, each MS is responsible for developing policy and tools to implement the provisions outlined by the RED. As such, the RED required that all MSs transpose RED legislation and targets into national legislation; in the past, several MSs did not fully comply. Please see the EU Biofuels Annual 2017 for information on the Commission's action against various MSs for RED compliance. MSs also had to develop National Renewable Energy Action Plans (NREAPs) by June 30, 2010. These NREAPs provided detailed roadmaps of how each MS expects to reach its legally binding 2020 targets. Every two years, the EC produces an EU-wide report based on the national reports and on other available data to assess progress in meeting the RED's targets. The report also gives an overview of renewable energy policy developments in each EU MS. In February 2017, the EC published its most recent and fourth Renewable Energy Progress Report, with the latest official data, the year 2015. This report concludes that the EU is on track to meet its overall 20 percent target, but it will probably not achieve the 10 percent target for the transport sector. In 2015, the EU as a whole achieved a 16.7 percent share of renewable energy with the transport sector achieving 6.7 percent (with double counting). The next report will likely be published in early 2019.

RED and Sustainability Criteria: To qualify for RED and FQD targets, biofuels consumed in the EU must comply with strict sustainability criteria provided in Article 17 of the RED. Rigorous requirements are set by the RED on the minimum level of greenhouse gas (GHG) savings, appropriate land use, and monitoring requirements for any potentially adverse effects. Therefore, to be considered sustainable, biofuels must achieve GHG savings of at least 50 percent in comparison to fossil fuels. Since the beginning of 2018, this number rose to 60 percent for operations that have come online after October 5, 2015 and 50 percent for all other plants. This includes emissions from cultivation, processing, and transport.

Environmental sustainability criteria covering biodiverse and high-carbon-stock lands are also laid out in the RED. The biodiversity criteria apply to land that would have been classified as highly biodiverse in January 2008. The criteria state that biofuels may not be made from raw materials obtained from land with high biodiversity value, such as primary forest and other wooded land, biodiverse grasslands, or areas designated for nature protection purposes. Biofuels also cannot be made from raw materials produced on land with high carbon stock such as wetlands, peatlands, or

continuously forested areas. Agricultural raw materials produced within the EU, including biofuels, must be produced in accordance with the minimum requirements for good agricultural and environmental conditions that are established in the common rules for direct support schemes under the Common Agricultural Policy (Cross compliance Article 17 § 6 of the RED).

GHG Savings: GHG impact of biofuels, bioliquids and their fossil fuel comparators are calculated using 'default' values outlined in the FDQ and listed in the RED Annex V. The EC Joint Research Center (JRC) defines the GHG emissions savings for various raw materials, and production and supply pathways associated with the cultivation of the biomass, processing, transport, and distribution. Emissions savings and carbon emissions resulting from land-use change, adoption of improved agricultural practices, carbon capture and storage, or generation of excess electricity through cogeneration are also included. For fuel production pathways that are not included in Annex V, life cycle analyses (LCAs) must be developed to calculate carbon intensities.

Table 1: Carbon Savings for Biofuels Produced with No Net Carbon Emissions from Land-use Change

CROP	Typical GHG savings	Default GHG Savings
Rape seed biodiesel	45%	38%
Soy bean biodiesel	40%	31%
Sun flower biodiesel	58%	51%
Palm oil biodiesel (Process not specified)	36%	19%
Palm oil biodiesel (process with methane capture at oil mill)	62%	56%
Corn ethanol, Community produced (natural gas as process fuel in CHP plant)	56%	49%
Sugar beet ethanol	61%	52%
Sugar cane ethanol	71%	71%
Waste vegetable or animal oil biodiesel	88%	83%

Source: EU Official Journal, RED 2009/28/EC

When the default values are calculated, the Commission applies a "discount factor" from the typical value to ensure that the biofuel pathway is not inflated. For example, the RED's GHG savings default value for soy diesel is 31 percent, which is below the minimum 35 percent GHG threshold defined in the RED sustainability criteria. The default GHG value for soybeans was calculated using a pathway where soybeans were first shipped from Brazil, and then transformed into soy oil and biodiesel in the EU. If the GHG value was calculated for soy-based biodiesel produced in the United States and shipped from the United States then it would have a GHG savings value of 40 percent and be above the 35 percent threshold. However, EC officials have stated they do not wish to have GHG saving numbers for different geographical areas, but prefer to base GHG numbers on specific pathways, such as no-till farming, to allow for easier updates. Amendments to Annex V of the RED (rules for calculating the GHG impacts of biofuels and bioliquids) and Annex IV of the FQD (environmental specifications for market fuels to be used for vehicles equipped with compression ignition engines) were made by Directive (EU) 2015/1513. The adoption of these amendments created alterations to how GHG impacts of biofuels, bioliquids, and their fossil fuel counterparts were calculated.

Voluntary Schemes: One way to ensure that biofuels meet the sustainability and GHG savings requirements of the RED is to have the biofuel certified by a voluntary scheme. Some of the MS have developed national voluntary systems, while others rely on voluntary schemes adopted by the EC. The EC considers voluntary schemes as its preferred mean of obtaining certification, but

there are no negotiations for bilateral agreements on biofuels certification even though this option was mentioned in the RED. For a more in depth discussion on voluntary schemes and a full listing of the 20 schemes approved by the Commission, please see the EU Biofuels Annual 2017.

Biomass Sustainability: While the current RED sets clear sustainability criteria guidelines for liquid biofuels, the EC deferred setting mandatory sustainability criteria for pellets and other forms of solid biomass. In the absence of EU-wide binding criteria for solid biomass, several MSs including Belgium, Denmark, and the Netherlands, developed their own rules in response to the growing use of imported wood pellets, particularly in industrial power plants. All MSs sustainability schemes on biomass have to be notified to the EC even though there are no specific EU criteria on sustainability. There is likely to be EU wide criteria for RED II as discussed below.

The Fuel Quality Directive

The FQD complements the RED and mirrors some of the RED's content such as the sustainability criteria. A key requirement of the FQD is that all fuel suppliers must meet a 6 percent reduction in GHG emissions by 2020 across all fuel categories supplied to the market. This is designed to be consistent with the 10 percent use of biofuels and shift demand towards biofuels with higher GHG savings. In addition, the FQD limits bioethanol blends to 10 percent or less when ethanol is used as an oxygenate, and places limits on palm oil and soy oil content of biodiesel.

The Renewable Energy Directive II (RED II)

The three European institutions – the European Commission (EC), the Parliament, and the Council of the EU are finishing negotiations on RED II, post 2020. The EC presented its RED II proposal in November 2016 as part of its "Clean energy for all Europeans" campaign. The RED II will establish new binding targets for renewable energy in the overall energy mix of the EU post 2020. The main sources of disagreement in the negotiations were the renewable energy target-levels through 2030 and the specific targets for conventional biofuels, advanced biofuels, renewables in transport, and sustainability criteria for biofuels.

On June 14, 2018, negotiators forged a political agreement; at the time of writing, the text of the RED II agreement has not been made available, but decision makers highlighted key provisions. For more information see our FAS report EU Reaches a Political Agreement on Renewable Energy of June 22, 2018. The EU has set a binding renewable energy target of 32 percent by 2020, which was more ambitious than the EC and Council's original target proposal of 27 percent. The parties committed to reconsidering whether to revise the target upward in 2023. For the transport sector, the parties also leaned towards adopting the most aggressive target under consideration, which was put forward by Parliament—14 percent by 2030 for the transport sector. For conventional/first generation (food based) biofuels in the transport sector, the RED II caps these fuels at MS's 2020 levels up to 1 percent higher, but with a maximum cap of 7 percent for each MS. RED II also introduces minimum targets for advanced (non-food) biofuels at 1 percent in 2025 and 3.5 percent by 2030. Further details of the proposal will be made available upon publication of the agreement in the coming weeks.

RED II Sustainability Criteria for Biofuels and Biomass: One of the more heated debates of the RED II surrounded the use of biofuels produced from areas that have undergone recent deforestation or conversion of grasslands to croplands. These areas are referred to as indirect land use change (ILUC) areas. In January 2018, the EU Parliament made international headlines by calling for a total phase-out of palm oil by 2021 for its renewable energy targets due to concerns over ILUC in palm oil production. With the political agreement forged in June 2018, the RED II reportedly restricts the use of biofuels from these high-risk ILUC areas at the 2019 levels, and will phase them out completely by 2030. Policy analysts believe this will greatly impact palm demand and

potentially some soybean products. EU businesses would be free to import ILUC palm oil but these would not count towards meeting RED II's targets. The EC will likely have to adopt a Delegated Act to set out the specific criteria on what the EU will consider a high-risk ILUC biofuel.

The EC, the Parliament, and the Council of the EU also agreed upon establishing EU-wide sustainability criteria for biomass in the RED II; notably RED I only had sustainability criteria for liquid biofuels. Sustainability will be assessed at the sourcing level, and not as the forest-holding level, as originally proposed by the EC. This move should enable the United States to efficiently demonstrate the sustainability of its wood pellets and continue to export to the EU. Although the RED II text is not finalized, it appears that MSs will be able to adopt additional national criteria, which could pose a problem for U.S. biomass exports.

The Common Agricultural Policy (CAP), 2021-2027

The CAP funds agricultural and rural development support throughout the EU and represents a significant portion of the total EU budget today—around 38 percent. At present, EU decision makers are looking back at the current CAP performance to date and considering those results to shape programming for the CAP post-2020. On June 1, 2018, the EC published its legislative proposals for CAP 2021-2027. The EC proposals cut rural development program funds. It is likely that European Council and Parliament will debate these proposals over the next 12 – 24 months. CAP programming will certainly impact biofuels markets in the EU, but the CAP 2021-2027 policy remains in a dynamic stage of development.

Market Access

Duties: The EU also has changed its anti-dumping and anti-subsidy rules in the reporting year. In December 2017, the EU published a new regulation (2017/2321) changing how the EU calculates anti-dumping duties. The EU then instituted new rules for all AD and anti-subsidy investigations after June 8, 2018. The rules shorten the investigation period for provisional measures to 7 months, makes changes to "lesser duty rules" that allow the EU to impose higher duties, and expands the ability to incorporate the cost of compliance with EU social and environmental legislation. Duty rates for fuels are listed below; for a historical discussion of how EU harmonized system (HS) customs codes have changed and influenced trade please see the EU Biofuels Annual 2017.

Table 2: Duty Rates for Fuels

HS Code	Description	Duty Rate
3826001	FAMAE 96.5-100%	6.5% (plus AD and CV duties for U.S. and most Canadian companies)
38260090	FAMAE below 96.5%	6.5% (plus AD and CV duties for U.S. and most Canadian companies)
271020	B30 and below	3,5%
220710	Undenatured ethanol	€19.2/hl
220720	Denatured ethanol	€10.2/hl

Bioethanol: In February 2018, the European Commission (EC) initiated a 15-month review of the current anti-dumping duties of 9.5 percent for U.S. bioethanol, which were set to expire that month. The EU had originally put in place these definitive measures in February 23, 2013, Regulation (157/2013). The EU General Court ruled against the duties in 2016, which the Commission appealed. For background information on case developments, see: EU Biofuels Annual 2017. Regardless of the final outcome of the AD case, U.S and other non-preferential trade

agreements, EU suppliers will continue to face hurdles that place them at a competitive disadvantage. Additional short-term factors limiting U.S. export potential include sustainability certification requirements, and a minimum GHG savings threshold (which rose from 50 to 60 percent this year) required to meet the RED goals. In the longer run, a projected long-term decline in EU gasoline use and the FAS outlook for emerging post-2020 EU policy on biofuels used in transport suggests that sales growth opportunity for all ethanol suppliers is constrained, and U.S. exports are unlikely to reach the previous export record level highs that occurred in 2011.

Biodiesel: There have been several recent developments related to anti-dumping (AD) duties and market defense. On September 19, 2017, the EC removed anti-dumping duties on Argentine and Indonesia's biodiesel exports, see: WTO final report. The EC had imposed duties since spring of 2013 with final duties imposed in November 2013 at 22-25.7 percent for listed companies and 25.7 percent for all other companies. The AD duties applied to Indonesia range from 8.8-20 percent for listed companies and 20.5 percent for all other companies. At that time, Argentina was the top biodiesel supplier to the EU market, with Indonesia following closely behind in second position. Since the end of the AD in September 2017, Argentina and Indonesia ramped up exports to the EU. Argentina and Indonesia exported respectively 886,000 tons and 27,000 tons of biodiesel to the EU between October 2017 and March 2018, while they did not export biodiesel to Europe during the same period in 2016-2017. However days after lifting the AD duties on biodiesel, the EC announced a Notice of Initiation of anti-subsidy proceedings for Argentina in January 2018. In Argentina, the country has twice raised its export tax on biodiesel from 0 percent in December 2017 to 8 percent and on July 1, 2018, the export duty will be raised to 15 percent. These export duties coupled with Argentina's reduced taxes on refined soybean oil are likely to temper Argentina's biodiesel exports to the EU during the EU's biodiesel anti-dumping investigation. Indonesia has not been targeted by an anti-subsidy proceedings from the EU (for more information see the Biodiesel Chapter).

New Free Trade Agreements

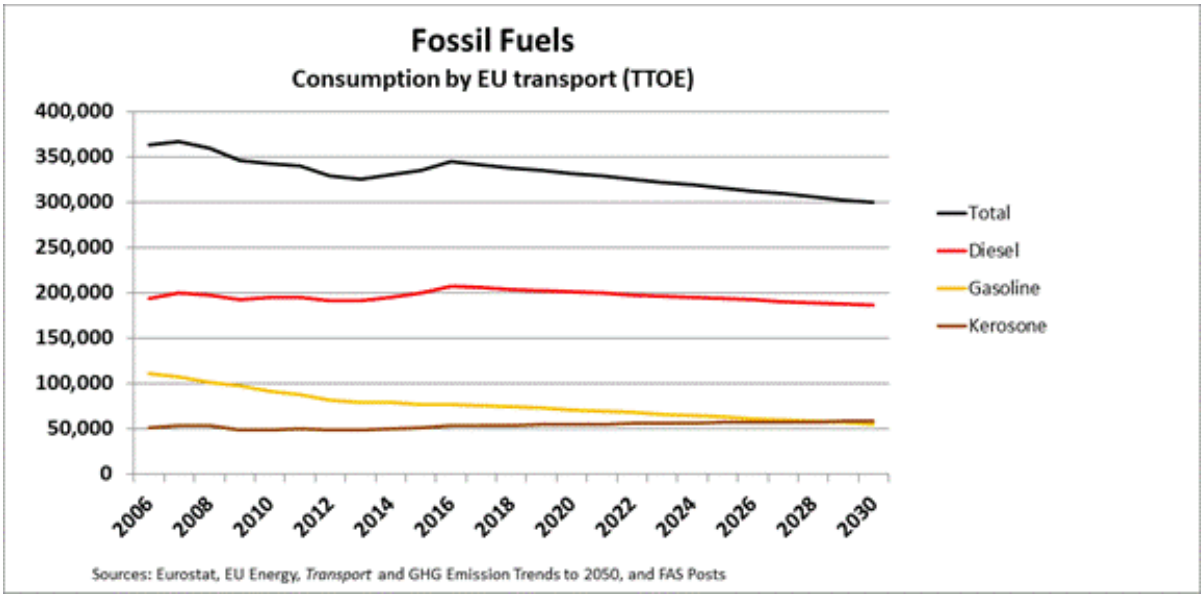
The EU is in negotiations for a Free Trade Agreement with Argentina, Brazil, Paraguay and Uruguay—"Mercosur," and a major sticking point is market access for ethanol.

III. Gasoline and Diesel Pools

Table 3. Fuel Use Projections (Million liters)

Calendar Year	2011	2012	2013	2014	2015	2016	2017[e]	2018[e]
Gasoline Total	114,278	106,571	102,968	102,680	100,697	100,766	98,700	96,640
Diesel Total	245,668	241,583	240,661	241,007	248,341	252,414	257,575	262,700
On-road	192,348	188,852	189,002	193,962	199,059	205,233	210,000	215,000
Agriculture	11,714	11,192	11,282	11,059	11,279	11,575	11,600	11,600
Constr./mining	2,733	2,670	2,765	2,784	2,925	3,037	3,125	3,250
Shipping/rail	6,072	6,048	5,174	4,827	4,960	4,848	4,850	4,850
Industry	6,163	6,074	5,210	4,776	5,382	4,953	5,000	5,000
Heating	26,638	26,747	27,229	23,599	24,736	22,769	23,000	23,000
Jet Fuel Total	57,509	56,066	55,823	56,296	58,280	60,622	61,050	61,480
Total Fuel	417,455	404,221	399,452	399,982	407,317	413,802	417,329	420,820

Source: Eurostat. Figures of 2017 and 2018 are Post's estimates partly based on: EU Reference Scenario 2016 - Energy, transport and GHG emissions Trends to 2050



Based on the current outlook of positive economic growth, the European Commission (EC) projects the transportation sector to continue growing until 2030. While passenger road transportation is forecast to increase, the efficiency of vehicles is also expected to improve. In addition, the demand for electrically chargeable vehicles is forecast to emerge as a more viable option for consumers. Both the increased efficiency and electrification will reduce the use of gasoline significantly by 2030. The use of diesel is expected to remain relatively stable and continues to be the primary fuel for heavy duty vehicles. Regarding international shipping, fossil fuels continue to be by far the dominant energy source. Air transport is projected to be the highest growing sector of all passenger transport modes. Consumption of jet fuels in aviation increases steadily by 2050 due to the increase in transport activity and despite improvements in efficiency. Use of energy by agriculture, construction and mining, and by other industries heavily depends on the economic outlook in the European Union. For more information see the publication of the EC: EU Energy, Transport and GHG Emission Trends to 2050.

IV. Ethanol

Bioethanol (ethyl alcohol) or simply ethanol is made by fermenting the carbohydrate components of plant materials. The most commonly used feedstocks are grains (corn, other coarse grains, and wheat kernels) and sugarcane. 'Synthetic' ethanol made from petroleum fuels is restricted to a very small market and is not included in this report. Ethanol used as transport fuel is referred to as bioethanol in this report

EU Production, Supply and Demand Table

Table 4. Ethanol Used as Fuel and Other Industrial Chemicals (Million Liters)								
Calendar Year	**2011**	**2012[r]**	**2013[r]**	**2014[r]**	**2015[r]**	**2016[r]**	**2017[e]**	**2018[f]**
Beginning Stocks	446	322	91	255	313	195	205	205
Fuel Begin Stocks	408	283	56	218	275	149	169	175
Production	5,170	5,348	5,741	5,950	6,080	5,850	6,066	6,239

Fuel Production	4,392	4,658	5,000	5,190	5,165	5,127	5,316	5,468
-of which cellulosic (a)	0	0	0	50	50	50	50	10
Imports	1,935	1,536	1,245	1,068	878	884	859	802
Fuel Imports	1,285	886	595	418	228	234	209	152
-of which ETBE (b)	261	188	197	109	107	31	9	10
Exports	149	145	113	221	170	158	189	189
Fuel Exports	99	95	63	171	120	108	139	139
Consumption	7,080	6,970	6,708	6,739	6,907	6,566	6,728	6,831
Fuel Consumption	5,703	5,676	5,370	5,380	5,399	5,233	5,380	5,468
Ending Stocks	322	91	255	313	195	205	212	227
Fuel Ending Stocks	283	56	218	275	149	169	175	188
Production Capacity, First Generation								
Number of Refineries	68	70	71	66	60	55	55	55
Capacity	7,759	8,468	8,480	8,560	8,430	8,180	8,180	7,920
Capacity Use (%)	67	63	68	69	72	71	74	79
Production Capacity, Cellulosic Ethanol								
Number of Refineries	0	0	0	1	1	1	2	2
Capacity	0	0	0	50	50	50	60	60
Co-product Production(c) (1,000 MT)								
DDG	2,932	2,962	3,223	3,379	3,443	3,492	3,639	3,654
Corn Oil	86	136	148	159	147	143	151	152
Wheat	4,458	3,285	3,200	3,303	3,642	3,791	4,183	4,175
Corn	2,965	4,687	5,092	5,479	5,077	4,947	5,197	5,250
Barley	735	400	647	448	430	383	368	434
Rye	692	367	790	821	754	680	532	420
Triticale								
Sugar Beet	9,477	10,588	11,694	11,351	10,163	9,176	8,920	10,253
Cellulosic Biomass	0	0	0	200	200	200	200	50
Fuel Ethanol	5,703	5,676	5,370	5,380	5,399	5,233	5,380	5,468
Gasoline	114,278	106,571	102,968	102,680	100,696	100,766	98,700	96,640
Blend Rate (Vol. %)	5.0	5.3	5.2	5.2	5.4	5.2	5.5	5.7

Sources/Notes: r = revised / e = estimate / f = forecast EU FAS Posts. Original data collected in MT, then converted to liters using a conversion rate of 1 MT = 1,267 liters for bioethanol. Ethanol production: Eurostat statistics, ePure, and FAS Post projections. Production capacity as of December 31 of year stated. Ethanol use: EC, Eurostat statistics and FAS Posts projections. The ethanol production and exports for industrial chemicals is estimated at respectively 650 and 50 million liters per year. Trade data: See Notes section. (a) For more information see section Advanced Biofuels. (b) ETBE in million liters of ethanol. HS code 29091910, ETBE contains 45 percent ethanol. (c) Data is not available, the figures above represent estimates by EU FAS posts. Calculated co-product production (theoretical maximum) based on estimated feedstock use in fuel ethanol production.

Consumption

Table 5. Fuel Ethanol Consumption Main Consumers (million liters)								
Calendar Year	**2011[r]**	**2012[r]**	**2013[r]**	**2014[r]**	**2015[r]**	**2016[r]**	**2017[e]**	**2018[f]**
Germany	1,568	1,581	1,532	1,557	1,485	1,485	1,460	1,485
France	768	790	778	797	803	823	840	860

United Kingdom	823	981	1,038	808	789	757	780	825
Poland	301	305	305	311	323	329	330	340
Netherlands	292	244	246	252	278	237	250	275
Spain	443	395	337	371	375	253	280	280
Italy	480	463	362	267	281	287	235	235
Sweden	399	406	356	327	263	225	220	215
Total	5,703	5,676	5,370	5,380	5,399	5,233	5,380	5,468

r = revised / e = estimate / f = forecast EU FAS Posts. Source: EU FAS Posts

In 2017 and 2018, domestic production and consumption are about in balance. The falling demand in 2012-2016 is a result of cutting off imports, the double counting of biodiesels, the adjustment of national blending mandates and the decline of gasoline use. For more information see our report: Biofuel Mandates in the EU by Member State in 2018 of June 22, 2018. In 2017, an upturn of bioethanol consumption to 5.4 billion liters is reported. This trend is expected to continue this year. This recovery is mainly caused by the gradual increase of blending targets towards the 2020 mandate and the improved competiveness of bioethanol versus gasoline. Rising feedstock prices for bioethanol could, however change this situation. The forecast recovery of consumption during 2017-2018 is based on increased blending in France, the United Kingdom, Poland, the Netherlands, Spain and Belgium.

- In France, bioethanol consumption is increasing due to an expansion of the number of gas stations that sell E10 and E85 combined with a lower price for these fuels compared to pure fossil gasoline. Moreover, total demand for gasoline (renewable and fossil) is growing whereas demand for diesels is stagnating. In 2017, the share of E10 in sales of gasoline was 38.8 percent (3.9 billion liters). Additionally, the tax was reduced for E10 and increased for gasoline. E85 represents less than one percent of gasoline sales in France but consumption is growing fast because it is cheap. At the beginning of 2018, it was 40 percent cheaper than gasoline. Between 2016 and 2017, E85 consumption increased by 23 percent to 118 million liters. E85 can only be used in FlexFuel vehicles. However, since December 2017, it has also been possible to turn any vehicle into a FlexFuel vehicle thanks to a "DriveCleanBox" that costs between 500 and 1,000 euros. Since the beginning of 2016, a new fuel called ED95 has been commercialized. It contains 95 percent bioethanol and 5 percent additives. It is exclusively consumed by buses and trucks with specific motors.
- In the United Kingdom, the consumption of bioethanol is forecast to increase as a result of an adjustment of the blending mandate in the new biofuels legislation. However, the gradual reduction to the year 2032 for the 4 percent to 2 percent cap on crop-based biofuels means that, even if E10 were introduced, the prospects for significant increases in ethanol demand are limited compared to biodiesel. In addition, ethanol is unlikely to qualify for as many double counting certificates.
- Polish consumption of bioethanol is expected to slightly increase during 2018 as mandates gradually rise, and a limited share is fulfilled through double counting biodiesels.
- In the Netherlands, consumption in 2018 is forecast to increase as a result of higher mandates and increased taxes on diesel cars. In April, 2017, the Dutch Government announced their intention to introduce E10 before 2020. A detailed plan of this market introduction has not been made public but the availability is expected to be phased in during 2018.
- In Spain, the elimination of the bioethanol specific targets in 2016 reduced the marketing opportunities. Currently, consumption of bioethanol depends on the gasoline demand and its price competitiveness compared to other renewable fuels. A slight growth in bioethanol consumption is anticipated for 2018 based on the increasing gasoline demand.

- In Belgium, the demand for bioethanol has increased since the blending mandate has been adjusted upwards from 4 to 8.5 percent on January 1, 2017.

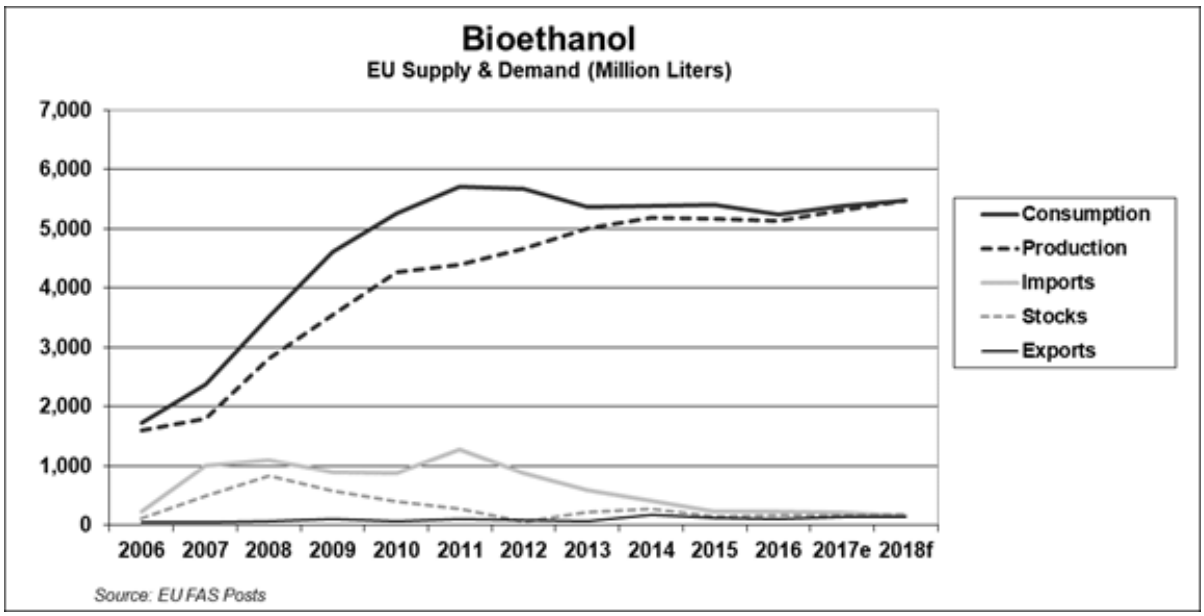
During 2017-2018, bioethanol consumption is forecast to stagnate or decline in Germany, Italy, Sweden, the Czech Republic, Austria, Hungary and Romania:

- In 2017, German bioethanol production decreased by 8.8 percent. The German Bioethanol Industry Association attributes the decline to a lower German consumption of E10 versus E5 gasoline and lower ETBE use. A slight recovery is forecast for 2018.
- In Italy, the consumption of bioethanol declined due to the shutdown of the single bioethanol producer in the country. The cellulosic ethanol plant with a capacity of about 50 million liters, started production in 2013 and has been closed since November 2017.
- In Sweden, bioethanol consumption has been falling since 2012. The main reason for this decline is the lower E85 sales as government energy taxes and taxes for flex fuel cars disadvantaged the use of this fuel.
- In the Czech Republic, a reduced tax return on E85 from January 1, 2016, to June 30, 2017, temporarily cut the consumption of this biofuel. For 2017, the volume based mandate for bioethanol remained the same at 4.1 percent.
- In Austria, bioethanol consumption has stagnated since 2014. But the high share of diesel consumption may decrease in the future if the government withdraws the current tax incentive for diesel and introduces a law to ban the entry of older diesel cars in cities.
- In line with the EU's objectives, Hungary's Renewable Energy Action Plan aims at achieving 10 percent renewable energy content in transport fuels by the end of the decade. The government set the percentage ratio at 4.9 percent until December 31, 2018. In compliance with the EU's Renewable Energy Directive and the national objectives, biofuel blend ratio should be progressively increased in 2019 and 2020.
- In Romania, the blending mandate has been flat at 4.5 percent since January 2014. The rate was set to rise to 8 percent starting with January 2018. However due to the inability of domestic producers to supply the volume resulting from the higher blend, the government postponed the date of implementation with one year to January 2019.

A surplus of bioethanol will be available in Hungary, Belgium, the Netherlands and France. Germany and Italy are expected to remain the main deficit markets in 2017 and 2018.

The ILUC Directive and the newly proposed EU Renewable Energy Directive (RED II) set a limit of 7 percent on the blending of conventional (food based) biofuels, well above the achieved 4.1 percent forecast for this year. This difference would offer an opportunity for the domestic biofuels sector, but conventional biofuels must compete with electric transport and biofuels produced from non-food inputs which received multipliers for counting towards the overall renewable energy target of 14 percent for the transport sector in 2030.

Production & Production Capacity



In 2016, EU bioethanol production dipped due to financial problems within the sector but recovered to about 5.3 billion liters in 2017 due to increasing demand and falling imports. In addition low feedstock prices benefitted profit margins of the producers (see graphs further below). Due to this recovery, the EU nearly reached self-sufficiency in 2017. Based on the assumption that the market will remain protected, EU production is forecast to fully cover domestic demand in 2018. As a result of growing demand, bioethanol production is forecast at about 5.5 billion liters in 2018. At the same time, the restructuring of the sector has resulted in a lower overall EU bioethanol production capacity.

Table 6. Fuel Ethanol Production
Main Producers (million liters)

Calendar Year	2011[r]	2012[r]	2013[r]	2014[r]	2015[r]	2016[r]	2017[e]	2018[f]
France	846	829	995	1,018	1,039	987	1,000	1,000
Germany	730	776	851	920	937	935	850	910
United Kingdom	89	215	278	329	538	660	685	760
Hungary	190	291	392	456	589	590	590	595
Belgium	400	410	451	557	557	570	570	570
Netherlands	275	451	524	519	563	320	530	560
Spain	462	381	442	454	494	328	375	380
Poland	167	213	235	181	214	240	255	265
Austria	216	216	223	230	223	224	230	230
Total	4,392	4,658	5,000	5,190	5,165	5,127	5,316	5,468

r = revised / e = estimate / f = forecast EU FAS Posts. Source: EU FAS Posts

EU Member States that are increasing production in 2017 and 2018 include the United Kingdom, Hungary, the Netherlands, Spain, and Poland.

- In the United Kingdom production is increasing solely due to the increased use of existing capacity from two plants. During 2011–2014, the United Kingdom was deficient by 400-600 million liters of bioethanol. This shortage is anticipated to shrink to only 50 million

liters this year.

- In Hungary, both capacity and production expanded significantly during the past five years. Fuel grade ethanol is produced by two plants each processing about one million MT (MMT) of corn. Hungarian bioethanol production is fully corn-based. Combined these plants produce annually about 590 million liters. Almost 100 percent of the bioethanol production is exported. Investments in second generation bioethanol production are not yet foreseen.
- Similar to the situation in the United Kingdom and Hungary, production expansion in the Netherlands is caused by the increasing use of existing capacity. Due to a lack of capital by the Spanish owner, one of the bioethanol plants in the Netherlands temporarily stopped production. In July, 2016 this plant was taken over by a Belgian company and reportedly resumed production a few months later. This plant, located in the port of Rotterdam, covers about 75 percent of the existing capacity.
- Spain's largest grain-based in-land bioethanol plant halted production from 2016 to August 2017 due to tight margins. Since September 2017 all plants are operative. Consequently, the country's bioethanol production levels grew in 2017 and are anticipated to register further growth in 2018.
- In Poland, capacity in bioethanol production is below 30 percent. It is anticipated that increasing domestic demand will result in higher use of this capacity. Due to the significant surplus of production capacity further investments in this area are not expected.

Production in France, Belgium and Austria stabilized and is expected to remain flat this year. A significant reduction was reported in Germany during 2017.

- In France, the number of plants and production capacity are stable. Bioethanol production is expected to remain at the same level in 2018 and 2019. Production may increase if cellulosic ethanol is produced at a commercial scale but this is not expected to happen in the next two years.
- On January 1, 2017, the German mandate increased from 3.5 to 4 percent greenhouse gas (GHG) savings, which was expected to result in a small increase in biofuels use. However, German bioethanol production decreased by 8.8 percent last year. The German Bioethanol Industry Association attributes the decline to a lower consumption of E10 versus E5 gasoline and lower ETBE use.

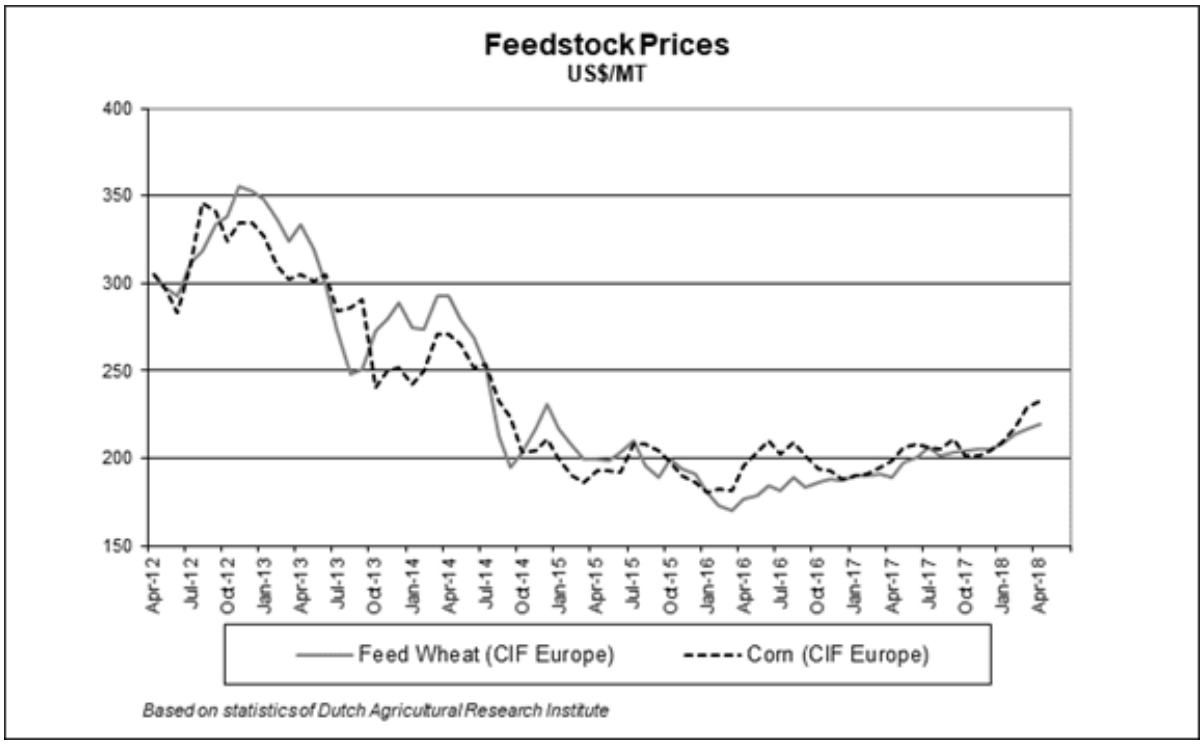
Total EU ethanol production capacity, for fuel, industrial and food uses, is estimated at about 9 billion liters in 2018. Further expansion of first generation bioethanol is expected to be limited. Expansion of cellulosic bioethanol production is restrained due to the lack of certainty in the EU policy making process (see Policy and Advanced Biofuels Chapter).

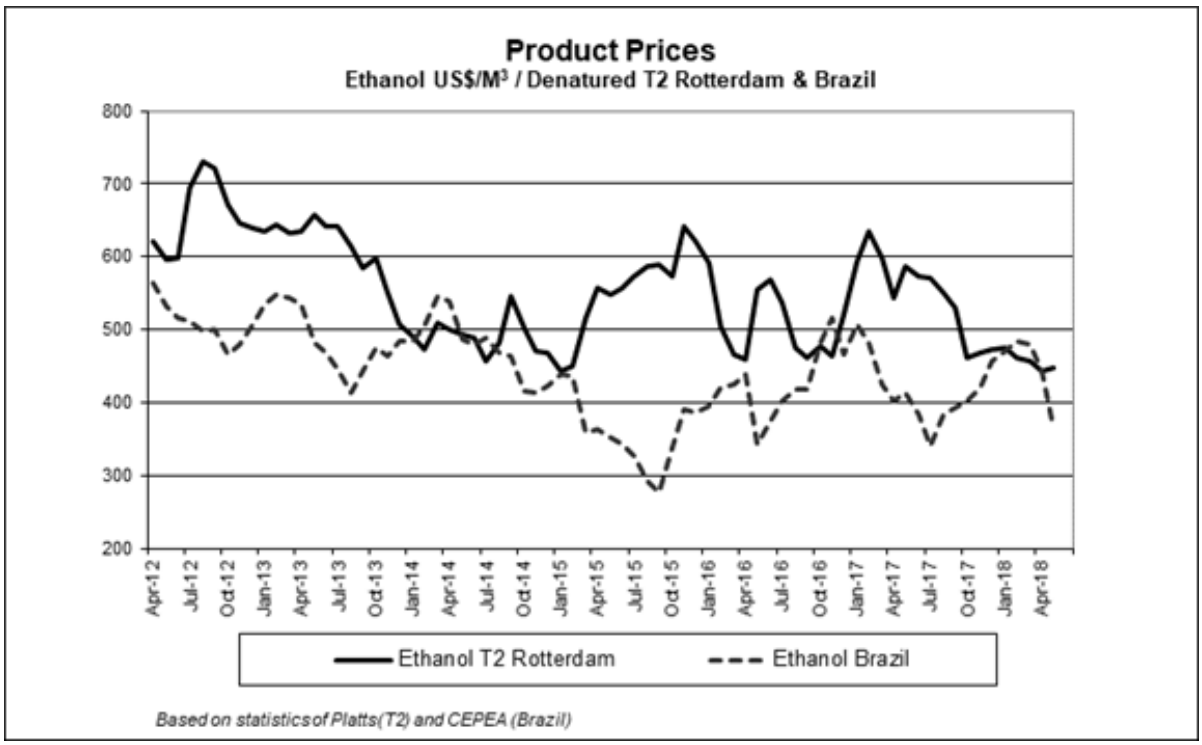
Feedstock Use and Co-products Production

In the EU, bioethanol is mainly produced from grains and sugar beet derivatives. Wheat is mainly used in Germany, France and the United Kingdom, while corn is predominantly used in Central Europe. An abundance of corn on the domestic market benefits production in Central Europe, in particular in Hungary. But corn is also the preferred grain in the Netherlands and Spain, where the majority of the ethanol plants are located at sea ports, and the corn is predominantly sourced from the Ukraine. This is partly because of its non-genetically modified (non-GM) content. Producers in northwestern Europe prefer to market their distillers dried grains (DDG) as non-GM to the domestic feed market.

In France, Germany, the United Kingdom, the Czech Republic, and Belgium sugar beets and its derivatives are also used for the production of bioethanol. Sugar beets are only processed for bioethanol in a few sugar beet processing plants in France with on-site ethanol distillation capacity. In some other MS, like Austria and Belgium, beet pulp may serve as a feedstock for ethanol production. Bioethanol produced from sugar beets faced tough competition from decreasing grain prices (see graph below), and as a result fell during 2013-2016. Since October 2017, the EU sugar market has been liberalized which resulted in a production expansion and falling prices. In 2018, use of beets for bioethanol production is forecast to increase solely because of increased use in Germany.

In the EU, the required feedstock for 2018 production (5,468 million liters of bioethanol) is mainly from cereals, estimated at 11.7 MMT. This is about 3.9 percent of total EU cereal production. Co-products of the bioethanol production are DDG (Distillers Dried Grains), wheat gluten and yeast concentrates. In 2017, the maximum theoretical production of co-products is forecast to reach 3.6 MMT. This is about 2.1 percent of total EU feed grain consumption.

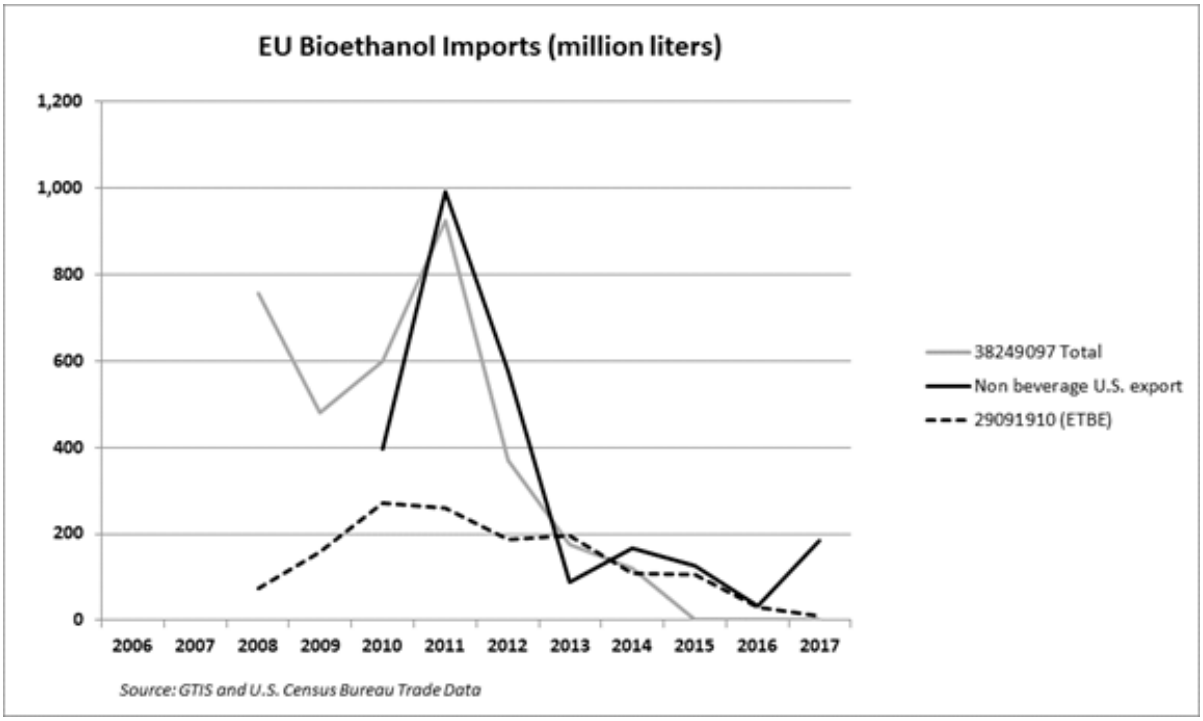




Trade

EU bioethanol imports declined from about 234 million liters in 2016 to about 209 million liters in 2017. This is mainly due to the reduced imports through the zero duty quotas, about 185 million liters were imported from the United States, and about 9 million liters were imported as ethyl-tert-butylether (ETBE). The non-taxed imports from preferred origins declined as a result of competitive EU domestic production, which is supported by low feedstock prices and an overcapacity of the sector.

The EC imposed an anti-dumping duty on the bioethanol imports from the United States. On February 23, 2013, the duty was set at €49.20 per 1,000 liters for the coming five years (see the Policy Chapter). Adding up to the already imposed import tariff of €102 per 1,000 liters, a volume of 1,000 liters of ethanol from the United States is charged with €151.2. This rate significantly cut U.S. exports of bioethanol to the EU. Currently EU domestic ethanol prices are too low to even attract significant volumes of duty free ethanol from foreign markets. Another barrier is the minimum greenhouse gas (GHG) savings criteria. Given these constraints it is not expected that even after full abolishment of the antidumping duty, U.S. exports will increase significantly in 2018.



V. Biodiesel / Renewable Diesel

Unless mentioned otherwise in this chapter the term biodiesel includes traditional biodiesel, fatty acid methyl ester (FAME) and hydrogenated vegetable oil (HVO).

The EU is the world's largest biodiesel producer. Biodiesel is also the most important biofuel in the EU and, on an energy basis, represents about 75 percent of the total transport biofuels market. Biodiesel was the first biofuel developed and used in the EU in the transportation sector in the 1990s. At the time, rapid expansion was driven by increasing crude oil prices, the *Blair House Agreement* and resulting provisions on the production of oilseeds under Common Agricultural Policy (CAP) set-aside programs, and generous tax incentives, mainly in Germany and France. EU biofuels goals set out in Directive 2003/30/EC (indicative goals) and in the RED 2009/28/EC (mandatory goals) further pushed the use of biodiesel.

EU Production, Supply and Demand Table

Table 7. Biodiesel & Renewable Diesel (HVO) (Million Liters)								
Calendar Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018[f]**
Beginning Stocks	530	575	580	520	565	585	580	960
Production	11,475	11,382	12,014	13,765	14,385	14,263	14,980	13,730
>HVO Production	278	800	1,444	2,151	2,313	2,440	2,583	2,840
Imports	3,031	3,294	1,392	631	540	580	1,352	2,200
Exports	98	115	416	181	245	408	404	400
Consumption	14,363	14,556	13,050	14,170	14,660	14,440	15,548	15,860
Ending Stocks	575	580	520	565	585	580	960	630

Production Capacity, Biodiesel (Million Liters)								
Number of Biorefineries	266	264	245	220	201	196	190	190
Nameplate Capacity	25,171	25,494	25,024	22,634	21,928	21,476	21,064	21,064
Capacity Use (%)	44.5	41.5	42.2	51.3	55.1	55.1	58.9	51.7
Production Capacity, Renewable Diesel (HVO) (Million Liters)								
Number of Biorefineries	4	4	5	10	11	11	12	14
Nameplate Capacity	1,694	1,694	1,828	2,831	3,395	3,395	3,446	5,010
Capacity Use (%)	16.4	47.2	79.0	76.0	68.1	71.9	75.0	56.7
Feedstock Use for Biodiesel + Renewable Diesel (HVO) (1,000 MT)								
Rapeseed oil	6,800	6,500	5,710	6,200	6,290	5,962	6,145	5,120
UCO	690	760	1,150	1,890	2,370	2,595	2,843	2,735
Palm oil	980	1,540	2,340	2,240	2,300	2,300	2,452	2,260
Animal fats	340	350	420	920	1,000	792	795	770
Soybean oil	950	730	870	840	510	609	700	680
Sunflower oil	280	300	290	310	200	244	162	160
Other (pine oil/tall oil/fatty acids)	5	60	150	335	370	485	558	571
Market Penetration, Biodiesel + Renewable Diesel (HVO) (Million Liters)								
Biodiesel+HVO, on-road use*	13,525	14,391	13,011	14,415	14,105	13,997	15,100	15,400
Diesel, on-road use	192,348	188,852	189,002	193,962	199,059	205,233	210,000	215,000
Blend Rate (Vol. %)	7.0	7.6	6.9	7.4	7.1	6.8	7.2	7.2
Diesel, total use	245,668	241,583	240,661	241,007	248,341	252,414	257,575	262,700

Sources/Notes: r = revised / e = estimate / f = forecast EU FAS Posts. Original data collected in MT, then converted to liters using a conversion rate of 1 MT = 1,136 liters for biodiesel; 1,282 liters for HVO; 969.8 liters for diesel. Production capacity as of December 31 of year stated. Diesel use 2009-2016: Eurostat; all other: FAS Posts. Trade data: Global Trade Atlas (GTA); HVO trade is assumed to be happening under a biodiesel customs code as no separate trade code for HVO exists. Feedstock use: Data is not available. The figures above represent estimates by EU FAS posts. Beginning/ending stocks: In the absence of reliable data and with the exception of 2009 and 2017, data for stocks is based on the assumption that average stocks amount to the equivalent of two weeks supply of consumption. *=2009-2016 Eurostat data in TOE converted to liters using a conversion rate of 1 TOE = 1267.8 liters.

Consumption

Biodiesel (FAME and HVO) consumption is driven almost exclusively by MS mandates and to a lesser extent by tax incentives. Only when biodiesel is cheaper than fossil diesel consumption exceeds the mandated volumes. For more information see our report: Biofuel Mandates in the EU by Member State in 2018 of June 22, 2018.

For 2018, EU biodiesel consumption is expected to increase by 2 percent, as a result of mandate increases in a number of MSs (Croatia, Finland, Italy, the Netherlands, Poland, Portugal, Spain, and the United Kingdom). In 2017, France, Germany, Italy, Spain, and Sweden were the largest biodiesel consumers in the EU accounting for 62 percent of the total EU biodiesel consumption (see table). Projections for 2018 indicate that the mandate increases do not change the MS consumption ranking.

In 2017, biodiesel consumption increased by almost 8 percent as a result of 1) mandate increases in Croatia, Czech Republic, Finland, Germany, Greece, Ireland, Italy, the Netherlands, and Spain; and 2) increases of overall diesel use.

From 2014 through 2016, biodiesel use fluctuated as increases in mandates and over-all diesel use in some MSs were off-set by reduced biodiesel volumes consumed due to the extensive use of

double counting feedstock in a number of MSs such as the Netherlands and Portugal. Another reason was that Germany transitioned from an energy-based use mandate to a minimum greenhouse gas (GHG) reduction mandate (2015). The latter means that companies are inclined to calculate actual GHG values rather than using the default values of the RED because fuel companies favor biofuels with a better GHG reduction value. This reduces the physical amount of fuel needed to meet the mandate. In addition, in the Czech Republic an increase in the excise tax for biofuels made biodiesel more expensive compared to fossil diesel. The Czech Republic also introduced a GHG saving component to its mandates, however, unlike in Germany this does not affect the consumption as the volume based mandates remain in place. Italy saw a large decline in consumption in 2016 as a result of over-fulfilling its mandate in 2015. Consumption picked up again in 2017, when the mandate increased.

2013 was the first year of a decline in consumption after years of rapid biodiesel use increases. The ten percent decline was largely a result of two factors: double-counting and reduced mandates. Double-counting of certain biofuels was/is applied in Germany (2011-2014), Austria, Belgium, Croatia, France, Hungary, Ireland, Italy (2012 until early 2014), the Netherlands, Poland, Portugal, Slovakia, Slovenia, and the United Kingdom. Double-counting diminishes the physical demand even if the blending mandates remain unchanged. In addition, Spain reduced its consumption mandates from 7 percent down to 4.1 percent at the beginning of 2013.

Table 8. EU Biodiesel/HVO Consumption
Main Consumers (million liters)

Calendar Year	2011[r]	2012[r]	2013[r]	2014[r]	2015[r]	2016[r]	2017[e]	2018[f]
France	2,624	2,653	2,658	2,931	2,954	2,954	2,954	3,025
Germany	2,756	2,874	2,581	2,752	2,483	2,498	2,550	2,540
Spain	1,921	2,563	941	1,036	1,091	1,293	1,545	1,560
Italy	1,654	1,598	1,447	1,269	1,581	1,132	1,410	1,500
Sweden	289	415	569	805	1,127	1,136	1,136	1,140
Poland	1,079	837	843	730	795	909	954	970
Belgium	344	354	364	375	436	452	795	795
UK	1,034	493	863	839	736	724	750	760
Austria	576	567	575	708	710	641	716	720
Finland	137	131	195	469	475	477	477	480
Portugal	476	359	336	391	422	326	356	400
Others	1,473	1,713	1,678	1,864	1,850	1,898	1,904	1,970
Total	**14,363**	**14,556**	**13,050**	**14,170**	**14,660**	**14,440**	**15,548**	**15,860**

r = revised / e = estimate / f = forecast EU FAS Posts. Source: FAS EU Posts based on information collected in MT, then converted to liters using a conversion rate of 1 MT = 1,136 liters for biodiesel and 1,282 liters for HVO.

Production and Production Capacity

In 2018, and as a result of elevated imports and high stocks, EU FAME producers do not benefit from increased domestic consumption. EU produced FAME faces strong competition from domestically produced HVO and even more so from cheap FAME imports from Argentina (mostly soybean oil methyl ester, SME) and Indonesia (mostly palm oil methyl ester, PME). For details see policy section. As a result, EU FAME production is forecast to decrease by 7 percent. The decreases are expected to be most pronounced in Germany, Spain, France, and to a lesser extent in Italy. In contrast, EU HVO production is forecast to continue to increase as new HVO plants go into production in France and Italy. At the time of writing (May 2018) the amount of imports from Argentina and Indonesia is difficult to predict. EU FAME production would decrease further, should

the imported amounts be higher than our forecast.

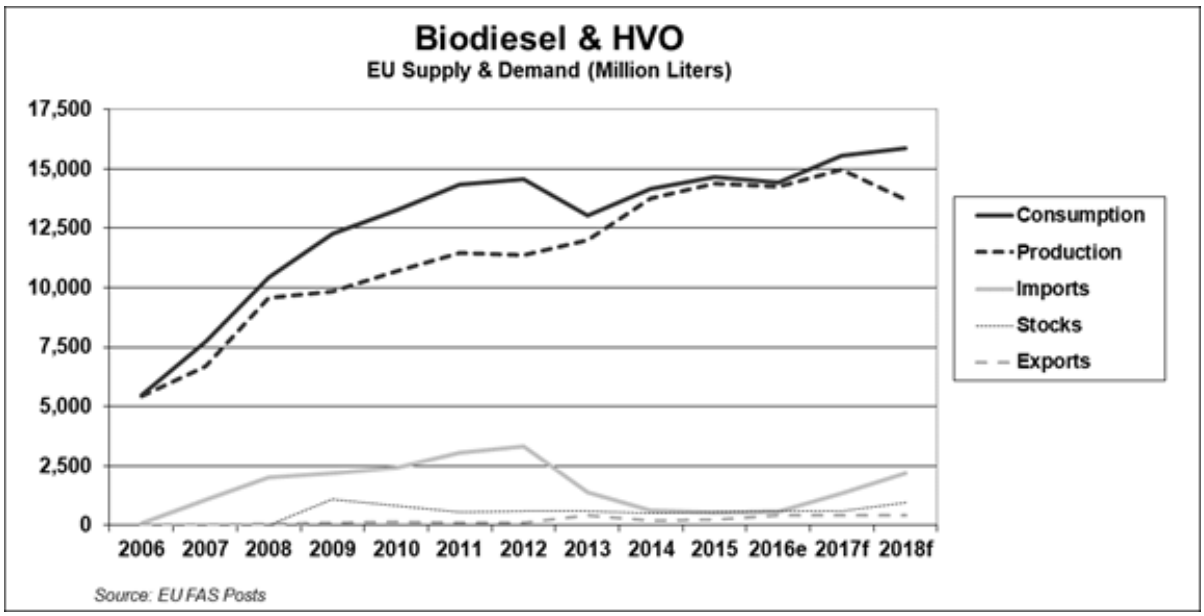
In 2017, EU FAME and HVO production did benefit from higher domestic consumption, as elevated imports only commenced in September. FAME production increased by 5 percent, mainly due to expansion in Spain, Italy, Portugal, Belgium, and Poland. HVO production increased by 5 percent, driven by elevated production in the Netherlands and Spain, and a new co-processing unit coming into production in Portugal.

Table 9. EU FAME Main Producers (Million Liters)								
Calendar Year	**2011[r]**	**2012[r]**	**2013[r]**	**2014[r]**	**2015[r]**	**2016[r]**	**2017[e]**	**2018[f]**
Germany	3,408	3,106	3,307	3,911	3,555	3,592	3,522	2,610
France	2,090	2,175	2,170	2,386	2,442	2,215	2,181	1,700
Spain	787	538	659	1,017	1,103	1,319	1,680	1,200
Poland	414	673	736	786	861	985	1,029	1,030
Netherlands	558	974	790	1,056	795	638	568	570
Belgium/Luxemburg	536	568	568	568	535	521	568	570
Italy	704	326	521	452	625	398	599	560
United Kingdom	261	352	640	554	572	496	503	510
Portugal	419	356	329	349	386	333	388	400
Austria	352	301	247	332	386	349	352	365
Other	1,667	1,214	604	203	811	977	1,007	1,375
Total	**11,197**	**10,582**	**10,570**	**11,614**	**12,072**	**11,823**	**12,397**	**10,890**

Ranked by production in 2018 r = revised / e = estimate / f = forecast. Source: FAS EU Posts based on information in MT and converted to liters using a conversion rate of 1 MT = 1136 liters.

Table 10. EU HVO Production (Million Liters)										
Calendar Year	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016[r]**	**2017[e]**	**2018[f]**
Netherlands	-	-	-	410	872	1,013	1,192	1,154	1,218	1,220
Finland	281	365	250	317	392	438	536	545	545	545
Spain	-	-	28	73	179	377	262	418	465	470
Italy	-	-	-	-	-	323	323	323	323	445
France	-	-	-	-	-	-	-	-	-	128
Portugal	-	-	-	-	-	-	-	-	32	32
Total	**281**	**365**	**278**	**800**	**1,444**	**2,151**	**2,313**	**2,440**	**2,583**	**2,840**

Ranked by production in 2017 r = revised / e = estimate / f = forecast. Source: FAS EU Posts based on information in MT and converted to liters (conversion rate of 1 MT = 1282 liters).



The structure of the EU biodiesel sector is very diverse and plant sizes range from an annual capacity of 2.3 million liters owned by a group of farmers to 680 million liters owned by a large multi-national company. Biodiesel (FAME) production facilities exist in every EU member state with the exception of Finland, Luxemburg, and Malta. In contrast, HVO production is concentrated in only six countries (see table above). The majority of HVO capacity consists of dedicated HVO plants, while in Spain HVO is co-processed with conventional fuel in oil refineries.

EU FAME production capacity is expected to decrease by 5 percent in 2018 to 20.3 billion liters, as plants are closed for good as result from strong competition. In addition, numerous plant run below capacity or are temporarily shut down. For example, in Germany three plants announced to either temporarily (at least until the end of June) or until further notice run at half of their capacity. In France, *Saipol* announced that it would cut its production by between 400,000 and 600,000 MT in 2018.

EU HVO production capacity is forecast to increase to 5.3 million liters in 2018, when two new facilities will start production in Italy and France.

Feedstock Use and Co-products Production

Rapeseed oil is still the dominant biodiesel feedstock in the EU accounting for 45 percent of total production in 2017. However its share in the feedstock mix has considerably decreased compared to the 72 percent share in 2008 mostly due to higher use of recycled vegetable oil/used cooking oil (UCO) and palm oil. For 2018, rapeseed oil use is forecast to take a further dip as rapeseed oil based FAME (RME) has a hard time competing with cheap imported soybean oil methyl ester (SME) and palm oil methyl ester (PME).

UCO was the second-most important feedstock in 2017, with 21 percent of total feedstock. The use of UCO had received a push after some MSs (Austria, Belgium, Croatia, France, Hungary, Ireland, the Netherlands, Poland, Portugal, Slovenia, and the United Kingdom) introduced double-counting (for details see Policy section). Since 2015 increases have become smaller and for 2018 the use of UCO is forecast to decrease by 5 percent because of lower FAME production. However, its share in the feedstock mix is expected to increase to 22 percent. In 2017, the largest EU

producers of UCO-methyl ester (UCOME) were the Netherlands, Germany, and the United Kingdom.

Palm oil came in third place in terms of feedstock use in 2017 (18 percent). Its use has further increased mainly because of its use for HVO production (Italy) and competitive price (biodiesel production in Spain). Currently palm oil is mainly used in Spain, Italy, France, and the Netherlands, and to a much lesser extent in Germany, Finland, and Portugal. Negligible amounts are being used in Greece, Romania, the United Kingdom, and Poland. For 2018, palm oil use is forecast to decrease by 7 percent, yet increase its share in the feedstock mix to 19 percent.

Animal fats benefitted far less from double-counting than UCO as the range of MSs that allow double-counting for animal fat (Denmark, Finland, France, the Netherlands, and the United Kingdom) is smaller than that for UCO. In addition, in Germany tallow methyl ester (TME) use does not count against the biofuel mandate at all and its production is exported to other MSs. Increases of animal fat use are a result of new plants (or capacity increases of existing plants) rather than a function of feedstock price as using animal fat requires changes to the technical equipment. In 2017, the Netherlands was by far the largest user of animal fat for biodiesel production followed by Finland and France. Germany, the United Kingdom, Denmark, Spain, Austria, Ireland, Italy, and Hungary also used animal fats but to a much lower extent.

The use of soybean and palm oil in conventional biodiesel is limited by the EU biodiesel standard DIN EN 14214. Soybean-based biodiesel does not comply with the iodine value prescribed by this standard (the iodine value functions as a measure for oxidation stability). Palm oil-based conventional biodiesel reportedly does not provide enough winter stability in northern Europe. However it is possible to meet the standard by using a feedstock mix of rapeseed oil soybean oil and palm oil. The vast majority of soybean oil is used in Spain. Smaller amounts are being used in Germany, Italy, Portugal, France, Bulgaria, Romania, and Greece.

Sunflower oil only comprised one percent of the total biodiesel feedstock and is mainly used in Greece; accounting for 56 percent of EU sunflower oil based biodiesel production. The category "other" includes pine oil and wood (Sweden), fatty acids (Finland and Germany), tall oil (Finland), and cottonseed oil (Greece).

Origin of feedstocks and by-products of feedstock generation

The majority of palm oil is imported while a large share of soybean oil is crushed from imported soybeans. In contrast, the majority of rapeseed oil is of domestic origin. The 5.1 MMT of rapeseed oil feedstock projected for 2018 is equivalent to about 12.8 MMT of rapeseed. This also generates about 7.7 MMT of rapeseed meal as byproduct most of which is used for animal feed. Similarly the 0.68 MMT soybean oil will have to be crushed from 3.4 MMT of soybeans. This will generate about 2.7 MMT soybean meal (see also FAS EU Oilseeds Annual).

Trade

EU imports of biodiesel/HVO are expected to continue to increase, albeit not at the same rate as in 2017. In response to a January 2018 WTO ruling, the EU abolished its anti-dumping (AD) duties on biodiesel from Indonesia in March 2018. As a result, imports from Indonesia surged. Imports from Argentina also continued to increase (see below) and in total the EU imported almost 900 million liters of biodiesel in the first three months of the year. However, the EU decided to launch an anti-subsidy investigation against Argentina and since May 24, 2018, all biodiesel imports from Argentina have to be registered, so that countervailing duties could be imposed retro-actively, should the EU investigation conclude these to be justified. In addition, Argentina will increase its

export tax on biodiesel from 8 percent to 15 percent, effective July 1, 2018. These two factors combined are expected to lead to lower imports from June through the rest of 2018.

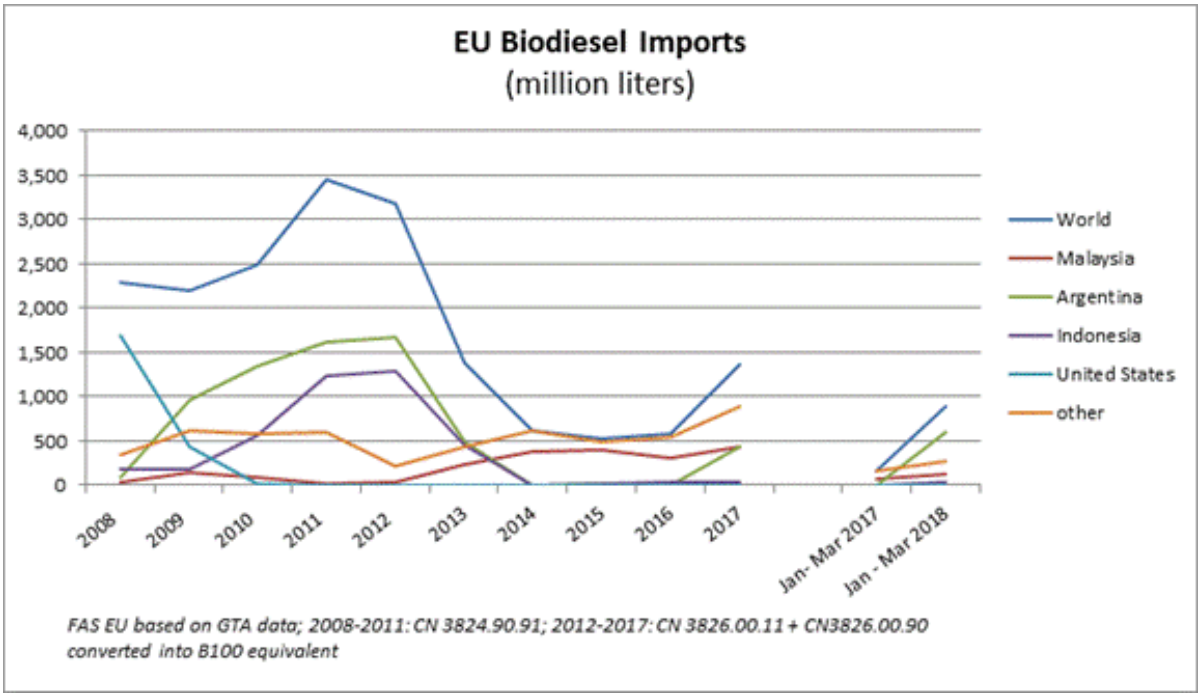
In September 2017, the EU lowered the AD duties on biodiesel imports from Argentina, following a WTO ruling (for details please see policy section). As a result, from September through December 2017 alone, almost 440 million liters of biodiesel from Argentina entered the EU. This amount equals 75 percent of the EU's imports from all sources in the entire year of 2016. The increase in EU consumption was not large enough to absorb the additional amounts, so the authors of this report assume that large shares of these imports were put in stocks to be consumed throughout 2018.

In 2017, the dominant suppliers of biodiesel to the EU were Malaysia and Argentina each with 32 percent of EU biodiesel imports originating there. However, all of the imports from Argentina occurred in the last four months of the year. The following ranks were occupied by China, Norway, Bosnia & Herzegovina, and Taiwan with 17, 7, 3, and 3 percent, respectively.

In 2017, most biodiesel, about 1.3 billion liters, was imported under HS/CN code 3826.00.10 containing at least 96.5 percent biodiesel. The equivalent of 1 million liters and 4.9 million liters was imported as blend under HS/CN code 3826.00.90 (containing between 30 and 96 percent of biodiesel) and 2710.20.11 (containing at most 30 percent biodiesel), respectively. It is assumed that most of the product traded under the last HS/CN code is B5. The majority of biodiesel imports occur through the Netherlands and Spain.

Currently, the EU does not have a separate customs code for HVO. Thus HVO could enter the EU under a variety of CN codes and imports are potentially underestimated.

EU biodiesel exports to destinations outside the bloc are marginal and normally only amount to around one percent of production and are thus not discussed in this report.



VI. Advanced Biofuels

The Renewable Energy Directive (RED) establishes an overall policy for the production and promotion of energy using advanced biofuels in the EU. As biofuels replace fossil fuels in the transportation sector and generally have lower greenhouse gas (GHG) emissions, they are considered an important component of the bio-economy, in particular advanced or second generation biofuels (fuels produced from non-fossil, non-food materials) which commonly have lower GHG emissions than fossil fuels. Because hydrogenated vegetable oils (HVO) can supply specific fuel markets such as aviation, and can fully replace fossil fuels in a mix (drop-in fuels) they are considered advanced biofuels in this report, but are not necessarily produced from non-food feedstocks.

Previous Proposals for Advanced Biofuels

The European Commission (EC) Proposal for the RED II

On November 30, 2016, the EC published its legislative proposal further revising the Renewable Energy Directive (RED II). The proposal for the RED II supports the marketing of advanced biofuels with the following elements:

-A declining cap of food crop-based biofuels from 7 percent in 2021 to 3.8 percent in 2030.
-A minimum share of energy from advanced biofuels from 0.5 percent in 2021 to 3.6 percent by 2030. In Annex IX Part A of the proposal, the EC lists the acceptable feedstock for the production of advanced biofuels: palm oil mill effluent, tall oil, bagasse, grape residues, nut shells, husks, corn cobs, straw, energy crops, forest residues and biomass sourced from forests except saw logs and veneer.
-A maximum sub-target of 1.7 percent for advanced biofuels produced with feedstocks listed in Part B of Annex IX: used cooking oil, animal fats not suitable for feeding, and molasses.
-Advanced alternative fuels used for aviation and maritime can be counted 1.2 times toward the blending obligation of 6.8 percent on fuel suppliers.

The European Council Proposal for the RED II

On December 18, 2017, the European Council adopted its general approach for the RED II. The proposal supports the marketing of advanced biofuels with the following elements:

-For conventional biofuels the Council proposes to keep the 7 percent limit in the RED II through 2030.
-For advanced biofuels the Council starts with a minimum target of one percent in 2025 (not 2021) increasing to a minimum target of 3 percent in 2030.
-The Council sets no limit for advanced biofuels produced with feedstocks listed in Part B of Annex IX and allows double counting of these fuels towards the mandates. The proposal deletes molasses from the list in Part B of Annex IX.
-Advanced alternative fuels used for aviation and maritime can be counted 1.2 times toward the blending obligation on fuel suppliers.

The European Parliament Proposal for the RED II

On January 17, 2018, the EU Parliament adopted its position on the RED II.

-The Parliament proposes to keep the limit at the levels of 2017 actuals, with the exception of EU Member States with a consumption below 2 percent.
-For advanced biofuels the Parliament has the same position as the Commission: at least 0.5 percent in 2021 and 3.6 percent by 2030.
-A maximum sub-target of 1.7 percent for advanced biofuels produced with feedstocks listed in

Part B of Annex IX. Molasses is deleted from the list in Part B of Annex IX.
-Advanced alternative fuels used for aviation can be counted two times, and for maritime 1.2 time toward the blending obligation on fuel suppliers.

The proposals for the RED II are listed in the table below.

Table 11. Proposals for biofuel blending targets in the RED II

	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Max. Conventional										
-Commission	7.0%	6.7%	6.4%	6.1%	5.8%	5.4%	5.0%	4.6%	4.2%	3.8%
-Council	7.0%									
-Parliament	2017 actuals or 2.0%									
Min. Advanced Part A										
-Commission	0.5%	0.7%	0.9%	1.1%	1.3%	1.8%	2.2%	2.7%	3.1%	3.6%
-Council					1.0%	1.4%	1.8%	2.2%	2.6%	3.0%
-Parliament	0.5%	0.7%	0.9%	1.1%	1.3%	1.8%	2.2%	2.7%	3.1%	3.6%
Max. Advanced Part B										
-Commission	1.7%									
-Council	No maximum, Double Counting									
-Parliament	1.7%									

Note the targets include multipliers for electric transport, aviation, marine and rail (for more information see the Policy Chapter).

Trilogue Proposal

On June 14, 2018, EC, EU Parliament and Council negotiators forged a political agreement on the new RED. The agreed RED II adopted the 7 percent cap for conventional biofuels put forward in the Council Proposal, and set a climbing target for advanced biofuels produced from agricultural and forestry by-products (Part A of Annex IX) of 0.2 percent in 2022 to 3.5 percent in 2030. These targets are set later and lower than proposed by the EC and Parliament, but impose a steep path up towards 2030. The RED II sets a limit of 1.7 percent for biofuels produced with waste fats and oils (Part B of Annex IX) but MSs can modify this limit if justified taking into account the availability of the feedstock. The EC is able to add feedstocks to Part A and B of Annex IX, but cannot remove them.

In Part A, Annex IX of the RED II, agricultural and forestry feedstocks listed are: palm oil mill effluent, tall oil, bagasse, grape residues, nut shells, husks, corn cobs, straw, forest residues and biomass sourced from forests except saw logs and veneer. Part B of Annex IX lists: used cooking oil (UCO) and animal fats not suitable for feeding.

With the goal to support the commercialization of advanced biofuels and a bio-based economy in general, the EC developed the following programs:

-On February 13, 2012, the EC adopted a strategy entitled "Innovating for Sustainable Growth: a Bioeconomy for Europe". The main goal of the strategy is to reduce the EU's dependency on fossil resources; for more information see the Bioeconomy website of the EC. One of the policy areas under the strategy is supporting biorefinery operations, including the production of biofuels. The EC funds biorefinery research and commercialization by the Horizon 2020 program.

-In July 2014, the Bio-Based Industries Joint Undertaking (BBI JU) was launched. The Bio-Based Industries Joint Undertaking is a €3.7 billion Public-Private Partnership between the EC and the

Bio-based Industries Consortium. The fund is a summation of €975 million of EU funds (Horizon 2020) and €2.7 billion of private investments. The goal of the program is to convert biomass into common consumer products through innovative technologies by biorefineries. On October 17, 2017, the BBI JU published a study on the "Current Situation and Trends of the Bio-Based Industries in Europe".

An example of a project funded by the Bio-Based Industries Joint Undertaking (BBI-JU) is the Bioforever project. On September 1, 2016, a consortium of fourteen companies including the Rotterdam Port Authority announced the start of a demonstration project for the conversion of woody biomass into value-adding chemical building blocks. The project is the last technical hurdle before the construction of commercial-scale biorefineries in logistical hubs such as the port of Rotterdam and other European ports. The companies are located in the Netherlands, Germany, France, Norway, Finland, the United Kingdom and Greece. The demonstration project started in September 2016 and will run for three years. The overall budget is €16.2 million with a €9.9 million contribution from the EC.

Another example of an activity funded by the BBI-JU is the LIGNOFLAG project. The project aims to build and operate a commercial flagship production plant for biochemical lignocellulose conversion to cellulosic ethanol with a yearly production capacity of up to 75 million liters. The companies are located in Germany, Hungary and Austria. The project started in June 2017 and will run for 5 years. The overall budget is €35.0 million with a €24.7 million contribution from the EC.

Production of Advanced Biofuels

Since 2012, the production of hydrogenated vegetable oils (HVO) has taken off in the EU. HVO can be produced from waste oils and fats and can be fully substituted for petroleum fuels, such as kerosene. In 2017, HVO production is estimated at 2.6 billion liters, and is expected to increase slightly to 2.8 billion liters in 2018. But with new plants in France, Italy and Sweden, production could further expand to about 4 billion liters in 2020. The commercialization of cellulosic ethanol is lagging behind compared to the development of HVO. The main factors that prevent operators from investing in cellulosic biofuels are high research and production costs and regulatory uncertainty. The current capacity is about 60 million liters in the EU. But production has been halted in Spain and Italy (see section Cellulosic Ethanol). Expansion of capacity has been announced in Finland (100 million liters in 2020) and outside the EU, in Norway (50 million liters in 2021). It is anticipated that the EU capacity for cellulosic ethanol production could possibly increase to about 150 million liters in 2020.

Specific mandates are important for the further commercialization of advanced biofuels. Italy was the first EU Member State to mandate the use of advanced biofuels. A December 2017 Italian Decree requires gasoline and diesel to contain at least 0.1 percent of advanced biofuel made of waste and non-food feedstocks as of January 2018, rising to 0.2 percent in 2019, and 1 percent in 2020. Mandates for advanced biofuels will go into effect in the United Kingdom and the Slovak Republic in 2019 and in Bulgaria and Germany in 2020. Denmark also approved a specific target for advanced biofuels, namely a 0.9 percent blending mandate by 2020 for use in transportation. The mandate excludes used cooking oil (UCO) and animal fats. For more information on applicable mandates please refer to our report: Biofuel Mandates in the EU by Member State in 2018 of June 22, 2018.

Below the table with the operational or close to operational advanced biofuel plants at commercial scale in the EU.

Table 12. Advanced Biofuels Plants in the EU					
Country	**Process**	**Biofuel**	**Feedstock**	**Capacity (mill ltrs/yr)**	**Year of opening**
Thermochemical					
Finland	H	HVO	Oils and fats	430 (2 lines)	2007
The Netherlands	P/FT	Methanol	Biogas	250	2010
Spain	H	HVO	Oils and fats	945 (7 plants)	2011
The Netherlands	H	HVO	Oils and fats	1,280	2011
Italy	H	HVO	Palm Oil	465	2014
Finland	H	HVO	Tall Oil	115	2015
Italy	H	HVO	Palm Oil, oils and fats	680	2018
France	H	HVO	Oils and fats (50% palm oil)	640	2018
Sweden	H	HVO	Tall Oil	220	2015
Biochemical					
Italy	HL/F	Ethanol	Wheat straw	75	2013
Finland	HL/F	Ethanol	Saw dust	10	2017

Source: EU FAS Posts BtL=Biomass to Liquid, DME=Dimethyl Ether, F=fermentation, FT=Fischer Tropsch synthesis, G=gasification, H=hydrogenation, HVO=Hydrogenated Vegetable Oils, HL=hydrolysis, OS=oxygenate synthesis, P=pyrolysis

Hydrogenated Vegetable Oil (HVO)

Finland and the Netherlands: Neste Oil has developed a process of hydrogenation to produce hydrogenated vegetable oils (HVO). The product is sold as drop-in fuel for road transport and used by commercial airlines. In addition to drop-in biofuels, the Neste plants produce renewable naphtha, propane and alkanes. In Finland, Neste operates one plant with two lines of about 215 million liters each. In 2010, Neste Oil opened up a renewable diesel plant in Singapore with an annual capacity of 910 million liters and a similar scale plant in Rotterdam in 2011. Current annual production capacity of the plant in Rotterdam is a maximum of 1,280 million liters. In 2017, 76 percent of the feedstock consisted of waste fats and oils (78 percent in 2016). The waste and residues consist of unused cooking oil (UCO), palm fatty acid distillate (PFAD) and animal fats.

Spain: In July 2011, the company CEPSA and since 2013, the company REPSOL started producing HVO. Spanish HVO production in 2017 is estimated at about 465 million liters. For more information see. GAIN Report SP1723 – Spain's Biodiesel and Renewable Diesel Overview.

Italy: In 2014, an HVO plant was opened by Energy Group Eni SpA in Venice, Italy. Since then, the plant has been able to produce approximately 325 million liters per year. Production is forecast to increase to 540 million liters in 2020 as a result of additional upgrades. The feedstock, currently palm oil, will include an increasing proportion of used oils, animal fats, and by-products from palm oil production. Following the model adopted for Venice, Eni is converting the Gela refinery in Sicily into a renewable diesel production facility to produce 680 million liters per year. The reconversion started in April 2016 and the facility is likely to be operational by the end of 2018.

Finland: In 2015, the forest product company UPM opened a HVO plant in Lappeenranta. The capacity of the plant is about 115 million liters per year. The feedstock used is tall oil, a residue of pulp production. The company is studying the opening of another plant in Finland with a capacity of about 550 million liters. The targeted feedstocks are mainly forest by-products. Another

Finnish company, St1 plans to produce renewable diesel in Gothenburg, Sweden, starting from 2020. The capacity is planned at about 220 million liters.

Sweden: In Gothenburg, the company Preem produces about 160 million liters of HVO. The feedstock used is mainly tall oil. The company recently expanded their production capacity to 220 million liters, and is currently investigating the use and sourcing of other raw materials.

France: Commercial production of HVO has not yet taken off in France but several projects have been announced. In 2018, France is expected to produce 100 to 200 million liters of HVO when the new Total plant located in La Mede (southern France) is put into operation in the summer 2018. This plant has a maximum capacity of 640 million liters per year and feedstocks are expected to be 60 to 75 percent vegetable oils, mainly palm oil, and 25 to 40 percent waste oil such as frying oils and animal fats. French environmental activists and farm unions are opposed to this project, and as a result the percentage of vegetable oil has been cut. Current biodiesel producers have expressed concern that this project would lead to an overcapacity situation in the French biodiesel sector and to a drop in rapeseed production in France. Another project in France is the BioTFuel project, a cooperation of Avril, Axens, CEA, IFPEN, ThyssenKrupp and Total. This project aims at producing 230 million liters of advanced biodiesel and bio-jet fuel per year from one MMT of biomass by 2020. The demonstration-scale plant is located at Total's former Flandres refinery in Dunkerque.

Biomethanol

The Netherlands: The advanced biofuel plant BioMCN, which started production in 2010 has a capacity of 250 million liters and produces biomethanol from biogas. Biomethanol can be blended with gasoline or used for the production of bio-methyl tertiary butyl ether (bio-MTBE), bio-dimethyl ether (bio-DME), or synthetic biofuels. On April 11, 2017, BioMCN announced they would begin using CO_2, a byproduct of biogas production, to produce an additional volume of 19 million liters of biomethanol.

Cellulosic Ethanol

Spain: With the sale of all Abengoa's non-core assets in 2016, the bioenergy plant in Salamanca no longer produces advanced biofuels. This was a demonstration plant completed in 2008 with an annual capacity of 5 million liters and adapted to process urban solid waste in 2013.

Italy: In November 2017, the Beta Renewables cellulosic ethanol plant in Crescentino, Piedmont shut down. Beta Renewables is a joint venture between Biochemtex, a company of the Italian Mossi Ghisolfi Group and the U.S. fund Texas Pacific Group (TPG). Operational since 2013, the Crescentino plant had an annual production capacity of 50 million liters using 200,000 MT of biomass. The feedstock consisted of wheat straw, rice straw and husks, and Arundo donax, an energy crop grown on marginal land. Wood waste from the forest industry and lignin from the ethanol plant were used as feedstock at the attached power plant, which was a critical source of revenue for the plant.

Finland: A cellulosic ethanol plant with an annual capacity of 10 million liters started operation in 2018. There are plans to expand production to about 50 million liters. The feedstock is saw dust. This Cellunolix® project is managed by St1 Biofuels Oy in cooperation with North European Bio Tech Oy. Another plant with a capacity of 50 million liters is scheduled to be operational in 2020. This plant will use saw dust and recycled wood as feedstock and will be located at UPM's Alholma industrial area.

Norway (outside the EU): The company Borregaard operates a plant with an annual capacity 20 million liter. A paper mill is planned to be converted in a Cellunolix® ethanol plant in Follum, Norway. The plant will have a capacity of 50 million liters, will use forest residues as feedstock and is forecast to be operational in 2021.

More biorefinery projects have been announced for the conversion of woody biomass into cellulosic ethanol. Projects are being planned for plants in Slovakia and Romania. Other projects focus on the conversion of the sugars and lignin into high value products. An example is the cooperation of the U.S. technology provider Sweetwater Energy and the Estonian wood pellet producer Graanul to integrate their technology into existing and new plants in the Baltic States. Another example is the cooperation of the Dutch companies Avantium and Akzo Nobel to build a demonstration biorefinery in the port of Delfzijl in the Netherlands. For more information about biorefineries see our report Case Studies for a Biorefinery of May 8, 2018.

Advanced Biofuels for Aviation

The EC forecasts the consumption of jet fuels in aviation to increase steadily by 2050 due to the increase in transport activity and despite improvements in efficiency. Fossil fuels continue to dominate, and only after 2035 bio-kerosene is forecast to slowly start penetrating the aviation fuel mix. For more information see the publication of the EC: EU Energy, Transport and GHG Emission Trends to 2050.

In 2011, the EC, Airbus, and the aviation and biofuel producers industries, launched the European Advanced Biofuels Flightpath. This action is scheduled to achieve two million tons, about 2.5 billion liters, of sustainable biofuels used in the EU civil aviation sector by the year 2020. Since 2008, the aviation sector has been conducting test flights with biofuels.

VII. Biomass for Heat and Power

This Chapter describes the EU market for biomass intended for the household and industrial production of heat or power. In the EU, about half of the renewable energy is generated from the combustion of biomass. The biomass is sourced from the agricultural and related food processing sector, and the forestry sector. Wood chips and pellets are increasingly used as input for renewable heat and power production. Because wood pellets are generally traded over longer distances than chips, this chapter is restricted to the wood pellet market.

EU Production, Supply and Demand Table

Table 13. Wood Pellets (1,000 MT)

Calendar Year	2010	2011	2012	2013	2014	2015	2016	2017[c]	2018[c]
Beg. Stocks	467	696	713	642	506	948	1,270	1,550	1,595
Production[a]	9,186	9,470	10,652	12,200	13,100	14,100	14,000	14,250	14,750
Imports[b]	2,515	3,115	4,367	6,096	6,547	7,163	8,098	8,691	9,250
Exports[b]	72	68	90	132	105	141	118	200	250
Consumption[c]	11,400	12,500	15,000	18,300	19,100	20,800	21,700	22,700	24,000
Ending Stocks	696	713	642	506	948	1,270	1,550	1,595	1,345
Production Capacity									
No. of Plants[a]			497	516					
Capacity[a]	14,845	15,000[c]	15,980	17,000[c]	18,500[c]	19,000	19,250	19,500	19,750

Cap. Use (%)	62	63	67	72	71	74	73	73	75

Source: (a) The European Biomass Association (AEBIOM), (b) GTIS, (c) FAS Post Estimates

The EU is the world's largest wood pellet market, with consumption of about 22.7 MMT of pellets in 2017 (see table). Based on the European Commission (EC) mandates and Member State (MS) incentives, the demand is expected to expand further to about 24 MMT in 2018. Future consumption will significantly depend on a range of market factors and EU Member State incentives and conditions.

Consumption

While the EU produces about fifty percent of world production, EU demand represents about 75 percent of the market. In 2017, total EU consumption was about 22.7 MMT. In 2016, 43 percent was used residential heating, 35 percent for commercial power, 12 percent for commercial heating and 11 percent for combined heat and power (Source: AEBIOM). The major users of wood pellets in the EU are the United Kingdom, Italy, Denmark, Germany, Sweden, Belgium, France and Austria.

Table 14. Main Pellet Consumers (1,000 MT)

Calendar Year	2011	2012	2013	2014	2015	2016	2017[e]
United Kingdom	1,000	1,400	3,700	4,900	6,700	7,300	7,400
Italy	1,950	2,200	2,500	3,400	3,300	3,200	3,300
Denmark	1,600	2,100	2,400	2,450	2,500	2,400	3,000
Germany	1,400	1,700	2,080	1,840	1,760	2,000	2,100
Sweden	1,880	1,700	1,860	1,650	1,650	1,605	1,530
Belgium	1,200	1,700	1,500	1,200	1,600	1,250	1,250
France	450	550	740	900	950	1,100	1,240
Austria	720	790	880	950	950	1,000	1,050
Poland	450	390	500	490	700	700	700
Spain	200	250	380	425	450	475	475
Netherlands	1,000	1,250	1,200	500	120	120	150
Total	**12,500**	**15,000**	**18,300**	**19,100**	**20,800**	**21,700**	**22,700**

Source: AEBIOM and Member State sector organisations, e = estimate EU FAS Posts

Residential Use of Pellets

Residential use for heating, about 45 percent of the total pellet market, fluctuates annually but is a relatively stable market compared to industrial heat and power generation. The demand depends on the winter temperatures and fossil fuel prices. The past two winters of 2016/2017 and 2017/2018 were relatively colder than the preceding four winters which is expected to have supported the use of wood pellets for residential heating. Medium-size use of pellets for energy generation by industries or public buildings such as hospitals and swimming pools is generally less dependent on weather conditions.

In Italy, Germany, France and Austria pellets are mainly used in small-scale private residential and medium-sized industrial boilers for heating. In some EU Member States, such as Sweden, Germany, Austria, France and Spain, household heating with biomass as input receives subsidies or tax deductions by the federal and local governments. In most countries, however, government funding is limited.

- Italy is forecast to be the largest European market for the household use of pellets. According to the National Renewable Energy Action Plan statement, the use of pellets is expected to increase to 5 MMT in 2020. However, only 15 percent of the demand is met by domestic production, with the remaining 85 percent being covered by increasing imports. Bagged pellets represents almost the total market. The pellets are mainly distributed through retail shops, hardware stores and fossil fuel suppliers. Currently, Italy sources pellets mainly from Austria, Germany, and Croatia. Imports from the United States fell from 180,000 MT in 2014 to 20,000 MT in 2016, due in part to a warm winter and the higher price of U.S. wood pellets over European competitors. In 2017, imports from the United States recovered to 40,000 MT. Market logistics and economics indicate that in the near future imports from North America will expand further.
- The vast majority of wood pellets in Germany are used for heating, because the government does not financially support the use of wood for electricity generation. German law mandates that all buildings erected in or after 2009 have to use a certain share of renewable energy to satisfy their heating and cooling requirements. Wood pellets are one of the options. The replacement of heating systems with wood pellet ovens is subsidized.
- Around 70 percent of total French consumption of wood pellets is used in individual residential heating systems. A minor use of wood pellets is collective residential heating. However, the share of industry and of collective residential heating has increased since 2005 and is expected to continue to increase in the future as a result of incentive policies.
- In Austria, wood pellets are mainly and increasingly used in household heating systems which receive subsidies by the federal government, the state governments and the communities.
- In the Czech Republic the number of pellet heaters is still relatively low. The situation might change soon though, because there is a subsidy program aimed at elimination of old heaters with high emissions. Citizens who decide to buy a new pellet heater can apply for a "heater subsidy" that can cover up to 85 percent of the price of the new heater.
- Another relatively small market with growth potential is Greece. The current pellet market is estimated at 40,000 MT.

Industrial Use of Pellets

Demand for industrial pellets depends primarily on EU MS mandates and incentives, which accessibility in some EU Member States, such as the Netherlands, has been uncertain or put on hold. In the industrial market most pellets are used for power generation. In markets such as the United Kingdom, Belgium, and the Netherlands residential use is negligible and the demand is dominated by large scale power plants. The large scale use of wood pellets by power plants is driven by the EU mandates for renewable energy use in 2020. The governments of these countries opted to fulfill their obligations mainly by the use of biomass for the generation of electricity. As these countries lack a sufficient domestic production of pellets they largely dependent on imports.

- The conversion of large electricity plants to fire on biomass instead of coal is a key factor in the UK Government's plans to reach renewable energy targets. The main support mechanism within the UK's energy policy that has enabled the conversions is under the Levy Control Framework and called 'Contracts for Difference'. This involves the government paying a premium above the market price of the electricity generated by the biomass power plant. The largest user of pellets in the United Kingdom is converting the fourth unit of their plant from coal to biomass combustion. This unit is anticipated to be finished in August 2018. Each of these four units combust 2.3 MMT of wood pellets per year. Actual wood pellet consumption of this power company was about 7.4 MMT, of which 62 percent was

sourced from the United States. The second largest user started their operations in May 2018. At full capacity the power generation of this plant will utilize about 1.4 MMT of pellets, of which at least 800,000 MT is expected to be sourced from U.S. suppliers. For 2018, the total use of pellets in the United Kingdom is forecast at 8.0 MMT.

- Sweden and Denmark have a high target for renewable energy use in 2020, 49 and 30 percent respectively. Both goals have already been reached, with a major part obtained from biomass. In Sweden pellet consumption declined during the past four years. Explanations are relatively warm winters and the declining prices of fossil inputs. During 2012 – 2016, Danish consumption of pellets stagnated around 2.1 MMT but as another combined heat and power (CHP) plant has been converted to using pellets, use is expected to have grown significantly in 2017. Danish pellet imports jumped from 2.0 MMT in 2016 to 3.1 MMT in 2017. The pellets were mainly sourced from the Baltic Region (1.7 MMT), Russia (0.4 MMT) and the United States (0.3 MMT). Finland has a target of 38 percent for renewable energy use in 2020. A large share is covered by the use of wood chips, but only a limited portion is wood pellets.
- Current Belgian industrial use is estimated at about 1.3 MMT per year. Of this, some 1.2 MMT is used for electricity production to the grid, while small private units are operated in the agricultural and other industry sectors for heating purposes.
- Also in France, there is a potential for industrial use of pellets. In October 2016, the French new Multi-Year Energy Plan entered into force. The objective is to increase the power generation capacity from wood from 540 MW in 2018 to 790-1,040 MW in 2023. The development of renewable energy power is supported by two complementary systems: feed-in tariffs and tenders. In 2016, imports of pellets from the United States were high because of a single new biomass plant. However, the objective of this plant is to use 100 percent of local pellets in 2019, and as a result, imports from the United States fell in 2017. Local wood is favored in subsidized facilities.
- In the Netherlands, demand for industrial pellets has been uncertain due to stringent Dutch sustainability requirements. In the Dutch Energy Accord co-firing of biomass is capped annually at about 3.5 MMT of wood pellets. In the Accord it was furthermore decided that biomass will be subject to specific sustainability criteria (for more information see *Pellet Sustainability Criteria*). Since the last quarter of 2017, Dutch imports of pellets slightly recovered. A major part of these pellets is reportedly made of saw dust due to the less stringent sustainability requirements for pellets made of wood waste. The pellets are sourced from a wide range of European sources with Portugal, the Baltic Region and Russia as the main suppliers (for more information see GAIN Report – *Current Opportunities for Wood Pellets in The Netherlands*, dated May 14, 2018). Dutch consumption of wood pellets is forecast at 0.5 MMT in 2018. Apart from the Dutch power sector, the Dutch chemical sector is planning to use wood pellets on the longer term.
- Besides Western Europe, in Central Europe the use of biomass for power generation is also growing. In Hungary, many previously coal-fired power and heating plants began to use renewable energy sources instead of fossil fuels. This is supported by subsidies for electricity production with biomass utilization. At the same time, Hungary's National Renewable Energy Action Plan prefers more efficient and smaller heating centers that are close to biomass sources and can meet the local energy or heating demand.

Besides wood pellets, large quantities of wood chips and briquettes are used. The EU sector estimates the current EU consumption of wood chips at 15-20 MMT and expects it to grow to 28 MMT in 2020. Growth in demand is supported by increased investments in medium sized combined heat and power (CHP) plants. The main wood chips consuming EU MSs are: Germany, Finland, France, Sweden and Poland. Most chips are sourced locally, but Scandinavia is regarded as a potential growth market for imports from non-EU destinations.

Production

Table 15. Main Pellet Producers (1,000 MT)							
Calendar Year	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017[e]**
Germany	1,880	2,200	2,250	2,100	2,000	1,930	2,250
Latvia	710	980	1,100	1,380	1,500	1,550	1,550
Sweden	1,340	1,340	1,310	1,490	1,550	1,550	1,420
France	550	680	750	1,040	950	1,150	1,250
Austria	940	893	962	945	1,000	1,050	1,200
Estonia	380	500	590	1,000	900	900	1,100
Poland	600	600	600	610	850	900	950
Spain	240	250	300	410	475	550	550
Portugal	675	700	800	700	700	500	500
Total	**9,470**	**10,652**	**12,200**	**13,100**	**14,100**	**14,000**	**14,250**

Source: IEA, AEBIOM and Member State sector organizations, e = estimate EU FAS Posts.

With a production of about 14.3 MMT in 2017, about fifty percent of global production, the EU is the world's biggest producer of wood pellets. In 2016, production dipped slightly mainly due to the relatively warm winter of 2015/2016. Compared to production plants in North America, plants in the EU are mainly small or medium-sized. Most of the main pellet producing countries have a sizeable domestic market for residential heating pellets. Recent growing demand for pellets has supported a further increase in domestic production. Exceptions are Latvia, Estonia and Portugal, which are producing mainly for export for use in large scale power plants abroad.

- Germany is the third largest wood pellet producer in the world after the United States and Canada. It has currently about seventy production facilities for wood pellets with a total annual production capacity of 3.6 MMT. In 2017, production amounted to 2.25 MMT, 95 percent of which were produced from residues of the timber industry. The vast majority of the wood pellets produced in Germany are used for heating. The use for electricity production is negligible. A substantial amount of the current production has to be exported as the installation of wood pellet based heating systems is not as dynamic as it used to be.
- Wood pellet production has expanded rapidly in the Baltic Region (Latvia, Estonia and Lithuania) during the past five years. Since 2015, expansion of Latvian exports stagnated at 1.6 MMT, while exports from Estonia and Lithuania combined rose with almost 0.5 MMT. The Baltics are producing both for the residential and industrial markets. The main markets are Denmark, the United Kingdom, Italy and Sweden.
- The third largest producer in the EU is Sweden. Swedish self-sufficiency fluctuates between 70 and 90 percent. In 2017, Swedish imports declined for the fourth successive year, due rising domestic production and a slackening demand by households. The production number of 2017 is based on incomplete statistics of the Swedish Pellet Association PelletsForbundet.
- There are around 60 pellet producers in France. In 2015, French production decreased after two warm winters and a decrease in the price of fossil fuels. But in 2016 production increased and it is expected to further increase in 2018 based on expanding domestic demand.
- In 2017, Austria produced 1.2 MMT of wood pellets in 43 plants. Austrian pellet production increased for the fourth year in a row. This expansion is based on an increasing domestic as well as foreign demand, mainly in Italy.
- Since 2014, Poland has steadily increased production and exports, each by about 50,000 MT. The main export markets are Germany, Italy and Denmark.

- There is an excess of capacity present in most EU Member States, but particularly in Spain. Only about forty percent of the Spanish production capacity is being used.
- In 2016 and 2017, Portuguese exports of pellets were reduced by about 200,000 from the level reported in 2013-2015.
- Czech production increased from about 150,000 MT in 2010 to 332,000 MT in 2016. About half of this production expansion is exported, mainly to Italy and Austria. Two thirds of the pellet production is exported.

The major raw material for pellets has traditionally been sawdust and byproducts from sawmills. With increasing competition for sawdust resources, a broader sustainable raw material is becoming necessary. There is increased interest in forest residues, wood waste and agricultural residues, but even the volume of these additional feedstocks will not be sufficient for supplying the full demand in Western Europe. Overall, EU wood pellet production is not expected to be able to keep up with the demand from both the residential heating market and for power generation.

Trade

Table 16. Main EU Importers of Wood Pellets (1,000 MT)

	Total Imports[a]		Imports from U.S.	
Calendar Year	**2016**	**2017**	**2016**	**2017**
United Kingdom	7,069	6,833	4,128	4,266
Denmark	2,052	3,083	94	307
Italy	1,642	1,793	19	41
Belgium	929	1,091	533	578
Sweden	271	269	0	0
Germany	443	392	0	1
Austria	392	403	0	0
France	248	263	95	10
Netherlands	141	381	22	0
Total EU28	**-**	**-**	**4,902**	**5,205**

Source: GTIS (HS Code: 440131) (a) Includes EU intra-trade.

Due to their location at seaports and limited domestic production, the large power utilities in the United Kingdom and Belgium are sourcing over 75 percent of their pellet demand from non-EU suppliers. Despite their significant domestic production, the Scandinavian countries, mainly Denmark and Sweden, partly depend on imports from the Baltic Region and Russia. The port restrictions in Scandinavia are favoring the Baltic Sea supply, which generally ship with smaller vessels than used in the Atlantic trade. In Denmark, one plant is located at a deep seaport and is supplied from North America. Improved flexibility in the infrastructure is expected to further increase the sourcing from North America. The markets for pellets in Germany, Austria and lesser extent France and Italy are more isolated and depend mostly on the production in this region itself.

Table 17. Main Suppliers of Wood Pellets to EU (1,000 MT)

Calendar Year	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
United States	1,764	2,776	3,890	4,278	4,902	5,205
Canada	1,346	1,963	1,259	1,475	1,685	1,478
Russia	645	702	826	786	837	1,268
Ukraine	217	165	136	149	165	214

Belarus	112	116	122	158	145	212
Brazil	0	0	4	23	33	103
Other	283	374	310	294	331	211
Total	**4,367**	**6,096**	**6,547**	**7,163**	**8,098**	**8,691**

Source: GTIS (HS Code: 44013020 and 440131 as from 2012)

EU demand for pellets has significantly outpaced domestic production for the past ten years. This has resulted in increased imports from the United States. In 2017, U.S. exports to the EU totaled 5.2 MMT, representing a value of $985 million. If EU demand and trade flows remain consistent with current patterns, the United States has the potential to supply 65 percent of the import demand, which would represent a trade value of potentially US$1.2 billion in 2020. Other significant exporters of pellets to the EU are Canada and Russia. In response to the EU demand for industrial pellets, capacity has expanded in the supplying regions. These third country imports could, however, be affected by the implementation of sustainability requirements by the individual EU Member State governments.

Pellet Sustainability Criteria

A key factor to being able to capture the demand in the EU market and benefit from its growth potential is the sustainability of the supply. European traders and end-users of industrial wood pellets are calling for clear, consistent, harmonized and long term government regulations. In the absence of EU-wide binding criteria for solid biomass, several EU Member States including Belgium, Denmark, and the Netherlands, developed their own rules in response to the growing use of imported wood pellets.

In the RED II, sustainability of biomass production will be assessed at the sourcing level, and not at the forest-holding level, as originally proposed by the EC. Although the RED II text is not published, it appears that MSs may place additional sustainability requirements on biomass fuels. By December 31, 2026 the EC shall assess the impact that such additional criteria may have on the internal market, to ensure harmonization of sustainability criteria for biomass fuels (for more information see the Policy Chapter of this report).

Meanwhile, the industry is actively formulating their own criteria. For *non-industrial wood pellets*, the European Pellet Council (EPC) developed sustainability criteria called ENplus, based on EN 14961-2. It includes sustainability requirements for the entire supply chain. For *industrial pellets*, the Sustainable Biomass Partnership (SBP) developed a sustainability scheme based on existing programs, such as the Forest Stewardship Council (FSC) or Program for the Endorsement of Forest Certification (PEFC). The SBP made their program compliant with the current requirements in the United Kingdom, Denmark, and Belgium.

In the Netherlands, the Dutch Energy Accord of September 2013 adopted strict sustainability criteria for biomass, such as forest level certification, information on greenhouse gas (GHG) emissions, carbon debt and indirect land use changes (ILUC). These strict conditions may make it difficult for Dutch buyers to implement long term contracts with pellet producers. For more information see GAIN Report – *Current Opportunities for Wood Pellets in The Netherlands*, dated May 14, 2018.

VIII. Notes on Statistical Data

Bioethanol

Production capacity, production and consumption figures are based on statistics of the European Commission, Eurostat, the European Renewable Ethanol Association (ePURE) and FAS Posts. FAS Posts based their estimates on figures of national industry organizations and government sources. Ethyl tert-butyl ether (ETBE) is not included in ethanol production, but is included in the consumption figures. ETBE is predominantly consumed in France, Spain, the Netherlands and Poland.

Bioethanol import figures during 2006-2009 are based on estimates of ePURE. Other trade figures are based on Global Trade Atlas (GTA) data, which are sourced from EU MS customs data, and the U.S. Bureau of Census. As the EU has no Harmonized System (HS) code for bioethanol, trade numbers are difficult to assess. The estimation of the EU import figures after 2009 is based on EU imports through preferential trade under HS 2207, EU imports from Brazil under HS code 3824.90.97, U.S. exports to the EU under HS 2207, and EU imports of HS code 29091910 (ETBE, 45 percent ethanol).

Feedstock and co-product figures: Official data for feedstock use is scarcely made available by industry and government sources. The figures in this report represent FAS Posts estimates and are based on the conversion and yield rates listed in Appendix II.

Biodiesel

Production and consumption figures are based on statistics of Eurostat and MS official statistics and adjusted by EU FAS Posts using additional information obtained from national industry organizations and government sources.

Trade figures are based on Global Trade Atlas (GTA) data, which are sourced from EU MS customs data, and the U.S. Bureau of Census, and adjusted for U.S. exports of biodiesel blends. A specific customs code for pure biodiesel (B100) and biodiesel blends down to B96.5 (HS 3824.90.91) was first introduced in the EU in January 2008. In January 2012 the code was changed to HS 3826.00.10 for blends containing at least 96.5 percent biodiesel, HS code 3826.00.90 (containing between 30 and 96 percent of biodiesel), and HS 2710.20.11 for blends containing at most 30 percent biodiesel. In this report it is assumed that these codes represent a blend of 99, 95, and 5 percent, respectively.

The U.S. Bureau of the Census introduced HTS export code 3824.90.40.30 in January 2011 which exclusively covers pure biodiesel (B100) and biodiesel blends above B30.

Feedstock and co-product figures: Data for feedstock use is not available. The figures in this report represent estimates by EU FAS posts and based on the conversion and yield rates listed in Appendix II.

Appendix I - Abbreviations

Biodiesel = FAME and/or HVO produced from agricultural feedstock (vegetable oils, animal fat, fatty acids, recycled cooking oils) used as transport fuel to substitute for petroleum diesel
Bioethanol = Ethanol produced from agricultural feedstock used as transport fuel
BtL = Biomass to Liquid
Bxxx = Blend of mineral diesel and biodiesel with the number indicating the percentage of biodiesel in the blend, e.g. B100 equals 100% biodiesel, while B5 equals 5% biodiesel and 95% conventional diesel.

CEN = European Committee for Standardization (Comité Européen de Normalisation)
DDG = distillers dried grains
EBB = European Biodiesel Board
EC = European Community or European Commision - depending on the context
Exxx = Blend of mineral gasoline and bioethanol with the number indicating the percentage of bioethanol in the blend, e.g. E10 equals 10% bioethanol and 90% conventional gasoline.
FAME = Fatty acid methyl ester produced from agricultural feedstock (vegetable oils, animal fat, recycled cooking oils) used as transport fuel to substitute for petroleum diesel
GHG = greenhouse gas
GJ = Gigajoule = 1,000,000,000 Joule or 1 million KJ
Ha = Hectares, 1 hectare = 2.471 acres
HS = Harmonized System of tariff codes
HVO = Hydrotreated Vegetable Oil
Ktoe = 1000 MT of oil equivalent = 41,868 GJ = 11.63 GWh
MJ = Megajoule
MMT = Million metric tons
MS = Member State(s) of the EU
MT = Metric ton (1,000 kg)
Mtoe = Million tons of oil equivalent
MWh = Mega Watt hours = 1,000 Kilo Watt hours (KWh)
Nordics = Denmark, Sweden, Finland, Norway, and Iceland
PVO = Pure vegetable oil used as transport fuel
RED = EU Renewable Energy Directive 2009/28/EC
RME = Rapeseed Methyl Ester
SME = Soybean Methyl Ester
TME = Tallow Methyl Ester, biodiesel made from animal fat
Toe = Tons of oil equivalent = 41,868 MJ = 11.63 MWh
TWh = Tera Watt hours = 1 billion Kilo Watt hours (KWh)
UCO = Used cooking oil/ recycled vegetable oil
UCOME = UCO based methyl ester biodiesel
USD = U.S. Dollar

Appendix II - Energy Content and Conversion Rates

1 MT Gasoline = 1,342 Liters = 1.03 TOE
1 MT BtL = 1,316 Liters = 0.80 TOE
1 MT of HVO = 1,282 Liters = 1.00 TOE
1 MT Ethanol = 1,267 Liters = 0.64 TOE
1 MT Diesel = 1,195 Liters = 1.02 TOE
1 MT Biodiesel = 1,136 Liters = 0.90 TOE
1 MT Pure veg Oil = 1,087 Liters = 0.83 TOE

<u>Yields Ethanol</u>
Corn kernels: 1 MT = 402 to 417 liters (has risen since 2006)
Wheat kernels: 1 MT = 393 liters
Rye/Barley kernels: 1 MT = 241 liters
Sugar beets: 1 MT = 95 liters

<u>Yields Biodiesel</u>
Soybean oil, crude: 1 MT = 1,113 liters
Soybean oil, 1x refined: 1 MT = 1,128 liters

Crude palm oil (CPO): 1 MT = 1,087 liters
Animal fats/grease: 1 MT = 1,043 liters
Used cooking oil (UCO): 1 MT = 1,043 liters

Yields Ethanol Co-products (maximum theoretical yield)
Corn kernels: 1 MT = 313 kg of DDGs + up to 29 kg of corn oil
Other grain kernels: 1 MT= 313 kg of DDGs (negligible vegetable oil)

Appendix III - Related Reports from USEU Brussels and MS Posts in the EU

Country	Report Nbr	Title	Date
EU	GM18024	Biofuel Mandates in the EU by Member State in 2018	06/22/18
EU	E18044	EU Reaches a Political Agreement on Renewable Energy	06/22/18
Netherlands	NL8017	Current Market Opportunities for Wood Pellets	05/17/18
Netherlands	NL8015	Case Studies for a Biorefinery	05/14/18
EU	E17061	EU to Cut Anti-Dumping Duties on Argentinean Biodiesel	09/20/17
Italy	IT1728	Italian Wood Pellets Overview	09/06/17
Spain	SP1724	Spain's Bioethanol Sector Overview	08/14/17
Portugal	SP1722	Portugal Biofuel Market Outlook	07/03/17
Spain	SP1723	Spain's Biodiesel and Renewable Diesel Overview	06/29/17
EU	NL7015	EU Biofuels Annual 2017	06/27/17
Romania	RO1711	Romania Biofuels Market Overview	06/23/17
EU	GM17017	Biofuel Mandates in the EU by Member State in 2017	06/07/17
EU	E17030	EU Sugar Annual	04/24/17
EU	-	EU Grain and Feed Annual	04/06/17
EU	AU1704	EU Oilseeds and Products Annual	04/05/17
Italy	IT1636	The Italian Wood Pellet Market	08/16/16
Czech R.	EZ1607	Biofuels Annual - Czech Republic	08/02/16
Estonia	-	Biofuels Annual - Estonia	07/12/16
Latvia	-	Biofuels Annual - Latvia	07/11/16
Lithuania	-	Biofuels Annual - Lithuania	07/06/16
Poland	-	Biofuels Market Outlook in Poland	07/05/16
EU	NL6021	EU Biofuels Annual 2016	07/04/16
EU	E16025	EU Rules Against Anti-Dumping Duty on U.S. Ethanol	06/17/16
Italy	IT5104	Biofuels Overview – Italy	01/06/16

The GAIN Reports can be downloaded from the following FAS website:

http://gain.fas.usda.gov/Pages/Default.aspx

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