ETC/CME Eionet Report | 2/2021

Greenhouse gas intensities of transport fuels in the EU in 2019

Monitoring under the Fuel Quality Directive

October 2021

European Environment Agency
European Topic Centre on Climate change mitigation and energy

Authors:
Giorgos Mellios (EMISIA S.A.) Evi Gouliarou (EMISIA S.A.)

ETC/CME consortium partners: *AETHER* Interprofessional Technical Centre for Studies on Air Pollution (*CITEPA*) Czech Hydrometeorological Institute (*CHMI*) Energy and Environmental Studies and Software Development (*EMISIA)* Institute for Applied Ecology (*ÖKO-INSTITUT*) *ÖKO-RECHERCHE* Norwegian Institute for Air Research (*NILU*) Netherlands Environmental Assessment Agency (*PBL*) National Institute for Public Health and the Environment (*RIVM*) Environment Agency Austria (*UBA*) Flemish Institute for Technological Research (*VITO*)

Cover photo: Stephanie Schilling©.

More information on the European Union is available on the Internet (http://europa.eu).

European Topic Centre on Climate
change mitigation and energy
Boeretang 200
B-2400 Mol, Belgium
Tel.: +32 14 33 59 77
Web: www.eionet.europa.eu/etcs/etc-cme
Email: etccme@vito.be

Contents

Acknowledgements

This report was prepared for the European Environment Agency (EEA) by its European Topic Centre on Climate change mitigation and energy (ETC/CME). The authors of the report were Giorgos Mellios and Evi Gouliarou (ETC/CME partner Emisia S.A., Greece).

The EEA project manager was Stephanie Schilling. The EEA acknowledges comments received on the draft report from the European Commission’s Directorate-General for Climate Action and from the European Environment Information and Observation Network (Eionet).

Executive summary

About this report

This report provides a summary of the information on the greenhouse gas (GHG) emission intensity of road transport fuels in the European Union (EU) in 2019, as reported by EU Member States, Iceland and Norway ([1]) under Article 7a of Directive 98/70/EC ([2]) relating to the quality of petrol and diesel fuels (the Fuel Quality Directive, FQD).

Article 7a of the Fuel Quality Directive sets out reporting requirements concerning the volume and type of fuels (including fossil fuels, other non-biofuels and biofuels) supplied for road transport and non-road mobile machinery as well as their life cycle greenhouse gas (GHG) emissions (from their extraction, processing and distribution). This includes the emissions resulting from indirect land use change (ILUC) for biofuels. The FQD sets a reduction target for fuel suppliers to reduce the GHG intensity of transport fuels (life cycle GHG emissions per unit of energy from fuel and energy supplied) by a minimum of 6 % by 2020 compared with 2010 levels. Member States must also analyse the share of biofuels in the total amount of fuels consumed.

The EEA supports the European Commission in the compilation, quality checking and dissemination of information reported under Article 7a of the FQD.

Main findings

Fuel suppliers are not sufficiently reducing the GHG intensity of fuels supplied in the EU

According to the data reported in 2020 by the 28 Member States, the average GHG intensity of the fuels supplied in these countries in 2019 (excluding the ILUC emissions intensity for biofuels) was 90 g carbon dioxide equivalent (CO_2e), 4.3 % lower than the 2010 levels. This corresponds to a saving of 54 Mt CO_2e in the year 2019. It also represents an additional reduction of only 0.6 percentage points compared to 2018 (3.7 % reduction compared to 2010, for also 28 EU Member States). Therefore in 2019, EU fuel suppliers in the 28 reporting Member States were, on average, behind their objective of reducing the GHG intensity of transport fuels by 6 % by 2020 compared to 2010 (see Figure ES.1) ([3]). In order to reach the obligatory 6 %, target, an additional 1.7 % reduction in the GHG intensity of all fossil fuels and biofuels supplied will be needed by 2020.

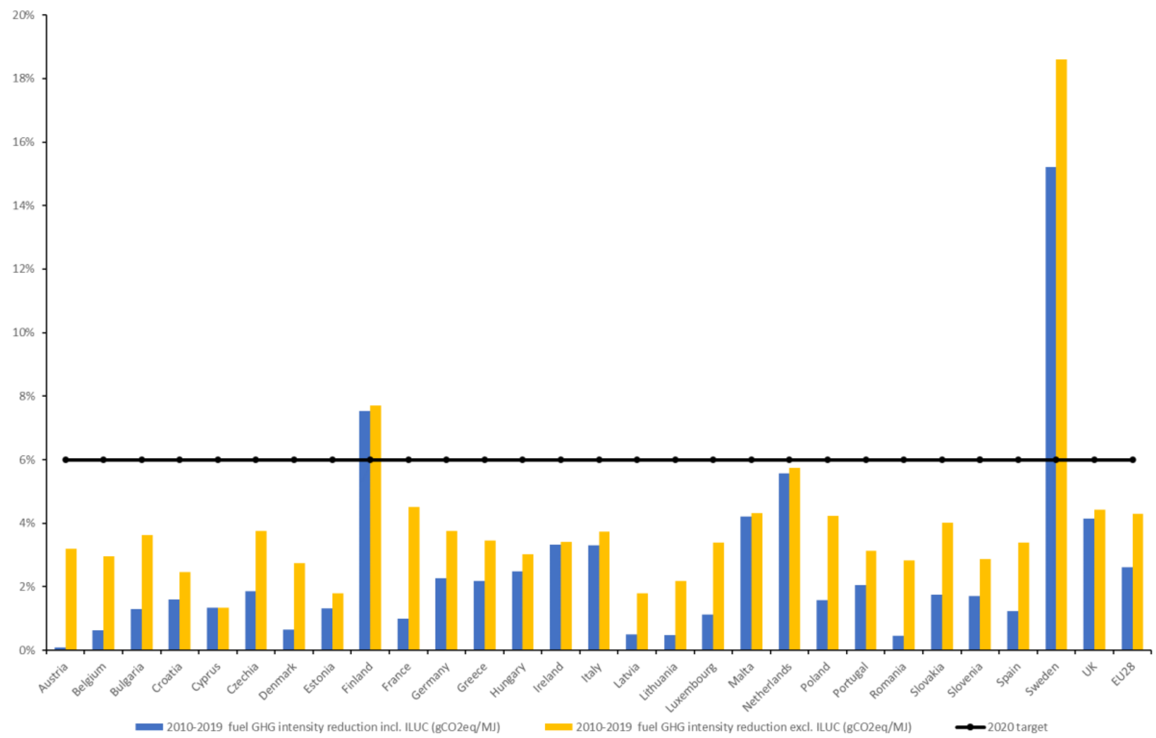
The progress achieved by fuel suppliers varies greatly across Member States. Sweden and Finland are the only Member States where fuel suppliers already exceeded the 6 % reduction target for 2020 (by 12.6 and 1.7 percentage points respectively). Netherlands made significant progress within a year and is close to achieve the target with a 5.8 % reduction. France is also on track to achieve the target with a 5 % reduction. Nine more Member States have reported reductions of around 4 %, and another 11 Member States reported reductions around 3 %. In five Member States the reductions remain lower than 3 %.

Direct land-use change (DLUC) emissions result from the conversion of non-agricultural land, such as forests, into agricultural land to grow biofuels or to displace food production (grazing land) resulting from biofuel production. Indirect land-use change (ILUC) emissions result from the expansion of cropland for production of displaced agricultural (food/feed) products induced by feedstock growth for biofuel production. As biofuels production increased since 2010, taking these ILUC emissions into account results in lower reductions of the GHG intensity of fuels. The average GHG intensity of the fuels

([1]) Iceland and Norway have no reporting obligation and submit information on a voluntary basis.
([2]) Directive 98/70/EC of the European Parliament and of the council of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC.
([3]) In 2019, upstream emission reductions were reported by Hungary and the United Kingdom. These are expected to contribute to the 6 % reduction target only in the year 2020.

consumed in 2019 was only 2.6 % lower than the 2010 levels – this corresponds to a saving of 33 Mt CO_2e in the year 2019. There is wide disparity per Member State to the type of feedstocks used to produce biofuels that are consumed in their national territories that is a factor in the performance of each Member State towards meeting the target

Figure ES.1 Reductions in GHG intensity of fuels achieved by EU fuel suppliers in Member States, 2010-2019.



Source: EEA
Note: The 2020 target of 6 % refers to GHG intensity reduction excluding ILUC

Diesel and biodiesel dominate fossil fuel and biofuel supply

The total fuel supply of road transport in 2019 for the 28 MS was 13 675 petajoules of which 94 % came from fossil fuels and 6 % from biofuels. The fuel supply was dominated by diesel (56.6 %) and petrol (23.8 %), followed by gas oil (12.1 %), biodiesel (FAME) (3.9 %), bioethanol (0.8 %) and HVO (0.7 %).

Regarding the main feedstock and pathways used to produce biofuels, biodiesel is produced mainly from rapeseed, used cooking oil and palm oil; bioethanol is produced mainly from corn, wheat and sugar beet; and HVO is produced mainly from palm oil, tallow and palm fatty acid distillate (PFAD).

In addition to the reporting on fossil fuels and biofuels, fuel suppliers may also voluntarily report on the quantity of electricity consumed by electric vehicles and motorcycles. In 2019, this quantity accounted for 0.01 % the total energy supply, as reported by 12 Member States.

ILUC and effects of substitution by biofuels on GHG intensities

The biofuel feedstock is important when assessing the GHG reduction potential of biofuels, especially when including the ILUC effect. For biodiesel, a substantial part (above 62 %) is produced from oil crops, which have a high GHG intensity compared to other feedstocks when ILUC default reporting values are included ([4]). Also when considering ILUC, this biodiesel is only marginally better than fossil fuel diesel (87 vs 95.1 g CO_2e/MJ). In the case of HVO, the majority is produced from other feedstocks (such as tallow, PFAD, waste oils and fats, above 60 %) with a low GHG intensity, whereas the quantities produced from oil crops, which have a much higher GHG intensity, are much lower (around 35 %).

Bioethanol is mainly produced from cereals and other starch-rich crops (above 78 %) and sugars (around 14 %) which have a moderate GHG reduction potential compared to other feedstocks (mainly non-food/feed crop-based feedstocks such as starch slurry, industrial/municipal waste, bio-waste etc.). When including ILUC the average GHG intensity of bioethanol increases, however it remains much lower than fossil petrol (33.9 vs 93.3 g CO_2e/MJ).

Substitution of diesel with biodiesel and HVO results in GHG emission reductions around 42 % including ILUC and nearly 76 % excluding ILUC, while substitution of petrol with bioethanol and bio-ethyl tert-butyl ether (bio-ETBE) leads to reductions of around 63 % and 75 % respectively.

([4]) Annex V, Part A. Provisional estimated ILUC emissions from biofuels of Directive (EU) 2015/1513 of the European Parliament and of the council of 9 September 2015.

1 Introduction

The role of fuels and their contribution to decreasing air pollution and GHG emissions has been recognized in EU legislation, which has stipulated minimum quality requirements and GHG intensity reduction targets for a range of petroleum and bio-based fuels. The reduction targets are likely to be achieved with the use of sustainable biofuels, electricity consumed by electric vehicles, less carbon-intense fossil fuels, renewable fuels of non-biological origin, and a reduction in GHGs emitted during the crude oil production phase.

EU Member States report annually information on the volumes, energy content and life cycle GHG emissions of fuels used in road transport and non-road mobile machinery, in line with their obligations under the Fuel Quality Directive 98/70/EC (FQD) Article 7a.

The reporting on data pursuant to Article 7a applied for the first time in 2018 in relation to the year 2017, following the application and transposition of Council Directive (EU) 2015/652.

The key documents that lay out the official requirements for the quality and GHG intensity of fuel sold in the EU, as well as its monitoring and reporting for Article 7a, are the following:

- Directive 98/70/EC of 13 October 1998 relating to the quality of petrol and diesel fuels and amending Council Directive 93/12/EEC;
- Directive 2015/652 of 20 April 2015 laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC of the European Parliament and of the Council relating to the quality of petrol and diesel fuels;
- Directive 2009/30/EC of 23 April 2009 amending Directive 98/70/EC as regards the specification of petrol, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32/EC as regards the specification of fuel used by inland waterway vessels and repealing Directive 93/12/EEC; the Directive introduces Article 7a on GHG emission reductions;
- Directive 2009/28/EC of 23 April 2009 on the promotion of the use of energy from renewable sources (Renewable Energy Directive RED) defines, like the FQD, the sustainability criteria for biofuels (Article 17); in addition, it defines the lower calorific values to be used for biofuels (Annex III) and the default GHG emissions for biofuels not fulfilling the sustainability criteria (Annex V D).

This report summarises the information reported by the EU Member States and subsequently collected, checked and compiled by the EEA on the volume, energy consumption, and GHG intensity of fossil fuels and biofuels.

Chapter 2 describes the reporting requirements and the summary format for each Member State's submission under FQD Article 7a.

Chapter 3 provides an overview of the Article 7a reported information aggregated at EU level.

Chapter 4 summarises the progress to 2020 targets under the Fuel Quality Directive, whereas Chapter 5 discusses the effects of ILUC on GHG intensities.

Chapter 6 compares the information provided under Article 7a with other sources.

2 Reporting by European Union Member States

2.1 Reporting requirements

The information provided by the Member States under Article 7a comprises the following aspects:

1. fossil fuels and other non-biofuels information: possible data confidentiality issues, fuel or energy type, raw material source and process, fuel quantity supplied, energy quantity supplied and greenhouse gas (GHG) intensity;

2. biofuels information: possible data confidentiality issues, biofuel or energy type, sustainability of biofuel, feedstock used, biofuel production pathway, biofuel quantity supplied, energy quantity supplied, GHG intensity and indirect land use change (ILUC) feedstock category and emissions intensity;

3. information on electricity consumed by electric vehicles and motorcycles, on a voluntary basis: energy quantity, including and excluding the powertrain efficiency and the GHG intensity.

2.2 Quality of Member States' reporting in 2019

The EEA is responsible for the collection, quality assurance/quality control (QA/QC) and compilation of the data submitted at EU level and is assisted in these tasks by the European Topic Centre on Climate change mitigation and energy (ETC/CME) ([5]).

An Excel template is used by EU Member States for their reporting obligations under Article 7a of the FQD ([6]). Its purpose is to provide the necessary information and guidance for the preparation of national reports and to ensure that all the required information has been provided.

In 2020, in relation to reference year 2019, 28 EU Member States plus Iceland and Norway submitted their fuel quality reports in accordance with the requirements of the FQD. During the QA/QC procedure, the ETC/CME reviewers posed clarifying questions to the reporting countries, relating to the completeness and consistency of their submitted data sets. The most common findings communicated to the countries following the quality checks performed on the information reported were:

- data reported not corresponding to the data lists provided in the template;
- missing information, mainly on feedstock and/or production pathway;
- data reported in aggregated form.

Most of these issues could be solved directly with the Member States in the communication process, by their completing missing information, correcting erroneous values or providing the necessary clarifications. Following the QA/QC procedure, 21 Member States submitted revised data sets. The last resubmission was received on the 30.03.2021.

([5]) The ETC/CME is a consortium of 11 European organizations contracted by the EEA to carry out specific tasks identified in the EEA strategy in the area of climate change mitigation and energy.
([6]) http://cdr.eionet.europa.eu/help/fqd

3 Supplied quantities of road transport fuels in 2019

3.1 Fossil fuel and biofuel quantities supplied

Fuel suppliers must report annually to the authority designated by the Member State on the greenhouse gas (GHG) intensity of fuel and energy supplied within each Member State by providing as a minimum the total volume or quantity of each type of fuel or energy supplied and the life cycle GHG emissions per unit of energy.

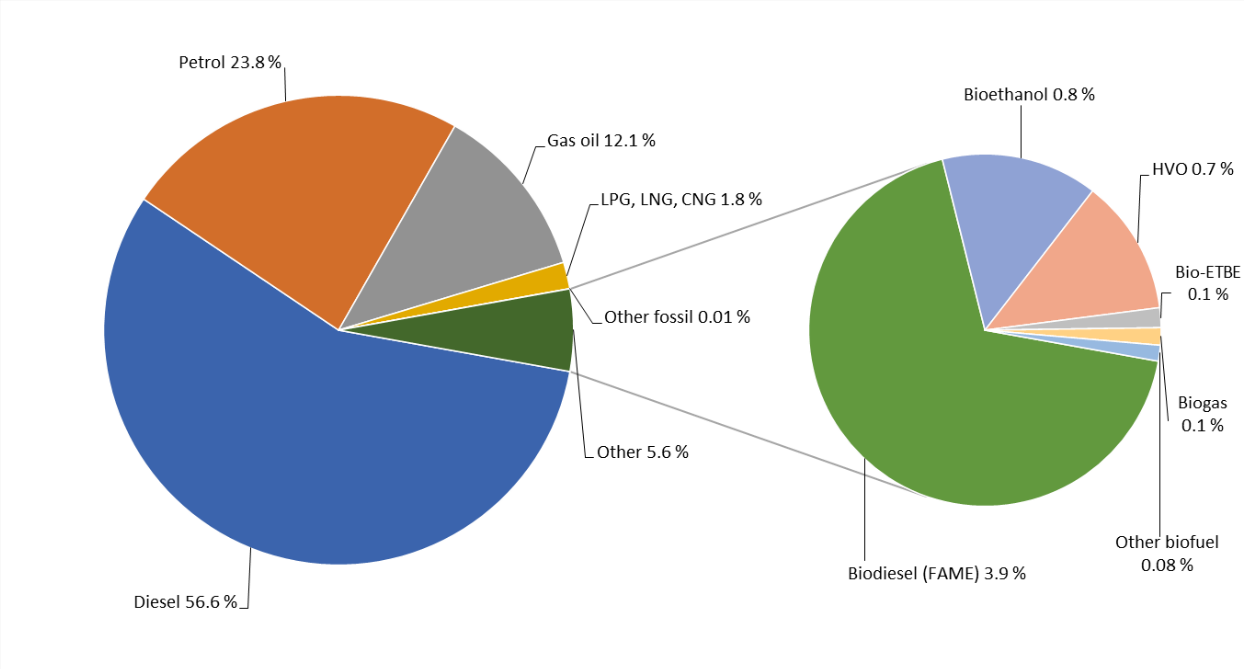
The total energy quantities supplied by suppliers are presented in Table 3.1for the different fossil fuels and biofuels marketed in the 28 Member States that have provided relevant data.

Table 3.1 Total quantities of fossil fuels and biofuels.

	Total quantity (PJ)
Fossil fuels	12 904
Diesel	7 740
Petrol	3 258
Gas oil	1 654
Liquid petroleum gas (LPG)	200
Compressed natural gas (CNG)	43
Liquefied natural gas (LNG)	7
Other	1
Biofuels	771
Biodiesel	527
Bioethanol	111
Hydrotreated vegetable oil (HVO)	96
Bio-ETBE	14
Biogas	12
Other	11

Total fuel supply reported was 13 675 petajoules (PJ), of which 94.4 % was from fossil fuels, and 5.6 % was from biofuels (Figure 3.1). The only renewable fuel of non-biological origin that was reported for 2019 is the renewable non-bio methanol reported by the United Kingdom but at a negligible percentage in relation to the total energy quantity.

Figure 3.1 Fuel energy supply shares per fuel type in 2019.



Notes: In category "other biofuel" the following types are included: off road biodiesel, cracked HVO, hydrotreated vegetable oil, to petrol, bio-naphtha, bio-petrol, bio-methanol, bio-LPG (liquid petroleum gas), naphtha, diesel (origin bio), bio-kerosine, bio-propane, bio-MTBE, methyl tert-butyl ether; FAEE, fatty acid ethyl esters; pure vegetable oil, LBG, liquefied biogas; synthetic hydrocarbons, bioethanol diesel, biofuel oil, methanol (non-bio, renewable), biobutanol, bio-gasoline, bio-TAEE, bio-tert amyl ethyl ether.

The fossil fuel supply in 2019 was dominated by diesel (56.6 %; 7 740 PJ ([7])), followed by petrol (23.8 %; 3 258 PJ) and gas oil (12.1 %; 1 654 PJ). Liquified petroleum gas (LPG), liquified natural gas (LNG) and compressed natural gas (CNG) had a total share of 1.8 % (250 PJ).

The biofuels energy consumption in the 28 EU Member States is dominated by biodiesel (Fatty acid methyl esters - FAME) (3.9 %; 527 PJ), followed by bioethanol (0.8 %; 111 PJ) and hydrotreated vegetable oil (HVO; 0.7 %; 96 PJ). (Bio-ETBE and biogas account for 0.2 % (26 PJ). All other biofuels used in road transport and non-road mobile machinery in 2019 present a much smaller share (about 0.08 %) (Figure 3.1).

3.2 Biofuel production pathways and feedstocks used

Member States must report on the feedstock and the biofuel production pathway used for each of the biofuels consumed in their territories. Feedstock is relevant for estimating the potential indirect land use change (ILUC), whereas the biofuel production pathways are relevant for calculating the GHG intensity of the produced fuels and the potential emissions savings from their use.

Feedstocks used for biofuel production may be derived from plants grown directly for the purpose of energy production, or from plant parts, processing wastes, residues and materials from human and animal activities. In relation to the feedstock used, different production pathways may be followed to develop the final biofuels that are available in the market. Hence, feedstocks refer to the origin and to

([7]) A petajoule (PJ) is equal to one thousand terajoules (TJ) or one million gigajoules (GJ) or one billion megajoules (MJ).

the raw material source of the biofuel while production pathways refer to the different processes used for the production of the biofuel always relevant to the respective feedstock.

The main feedstocks and production pathways for the three main biofuels are summarised in Table 3.2 below. The share of undefined production pathways (N/A) largely explains the differences in the shares of the different feedstocks and pathways. Any remaining differences are due to the shares reported as "Other" by the Member States.

Table 3.2 Summary of main feedstock and production pathways by biofuel.

Biodiesel	**Feedstock**	**Pathway**
Rapeseed	35.3 %	29.4%
Used cooking oil / waste vegetable oil or animal fat	25.9 %	22.4 %
Palm oil	12.8 %	6.9 %
Other	25.8 %	17.9 %
N/A	0.2 %	23.6 %
Bioethanol	**Feedstock**	**Pathway**
Corn (maize)	51.4 %	26.0 %
Wheat	18.1 %	14.6 %
Sugar beet	8.3 %	7.6 %
Other	21.6 %	16.4 %
N/A	0.5 %	35.4 %
Hydrotreated vegetable oil	**Feedstock**	**Pathway**
Palm oil	50.3 %	48.3 %
Tallow / Used cooking oil / waste vegetable oil or animal fat	31.1 %	32.3 %
Palm fatty acid distillate (PFAD)	8.4 %	8.3 %
Other	10.2 %	3.0 %
N/A	0.03 %	8.0 %

Feedstocks

- The main types of feedstock used to produce **biodiesel** (3.9 % of total fuel consumption) are rapeseed (35.3 %), used cooking oil and waste vegetable oil or animal fat (25.9 %) and palm oil (12.8 %). These three feedstocks account for about 74 % of the total biodiesel quantities supplied to the 28 Member States.
- **Bioethanol** (0.8 % of total fuel consumption) is mainly produced from corn (maize, 51.4 %), wheat (18.1 %) and sugar beet (8.3 %). These three feedstocks account for about 77.9 % of the total bioethanol quantities supplied to the 28 Member States.
- For **HVO** (0.7 % of total fuel consumption) production, palm oil accounts for 50.3 %, tallow, used cooking oil and waste vegetable or animal oils for 31.1 % and palm fatty acid distillate (PFAD) for 8.4 %. These three feedstocks account for about 89.8 % of the total HVO quantities supplied to the 28 Member States.

Production pathways

- **Biodiesel** is derived mainly from four production pathways: rapeseed biodiesel (29.4 %), used cooking oil and waste vegetable oil or animal fat biodiesel (22.4 %), palm oil biodiesel (6.9 %) and soybean biodiesel (8.9 %). These four production pathways account for about 67.7 % of the total biodiesel quantities supplied to the 28 Member States. There is also a substantial share of 23.4 % for which the production pathway of biodiesel has not been defined by the reporting Member States. This incomplete reporting also explains the lower shares of the different production pathways compared to the respective values for the feedstocks indicated above.

- For the production of **bioethanol**, corn ethanol (26 %) is the most common pathway, followed by wheat (14.6 % of which 12.2 % is out of process fuel not specified, and sugar beet (7.6 %). These three pathways account for the production of about 48.2 % of the total bioethanol quantities supplied to the 28 Member States. There is also a substantial share of 35.4 % for which the production pathway of bioethanol has not been defined by the reporting Member States. Similar to biodiesel, this share explains the differences between feedstocks used and production pathways.
- **HVO** originates mainly from palm oil (48.3 %), tallow, used cooking oil, waste vegetable oil or animal fat PFAD (32.3 %) and PFAD (8.3 %). These pathways account for the production of about 89 % of the total HVO quantities supplied to the 28 Member States. Also, there is good agreement of these values with the respective feedstock shares, due to the low share (8 %) of unknown pathways.

3.3 Electricity consumption

The reporting of the quantity of electricity consumed by electric vehicles and motorcycles by fuel suppliers is voluntary although it is considered for the 6 % reduction target by 2020. Only twelve Member States reported the electricity consumed by electric vehicles and motorcycles while one of them, Slovenia, did not report the GHG intensities of the electricity consumed and the information on some GHG intensities of the United Kingdom was inconsistent and not included. In Table 3.3 the energy quantities consumed by electric vehicles, excluding and including powertrain efficiency, are summarized for the twelve Member States. An adjustment factor of 0.4 for powertrain efficiency is assigned to the battery electric powertrain ([8]). This includes all electric powertrains, without distinguishing between battery electric vehicles and plug-in hybrid electric vehicles.

Actual electricity consumption in the different Member States may be larger since it is not a compulsory field under Article 7(a) and is not reported towards the target by most of the Member States. GHG intensities reported by Member States under Article 7a are compared with data provided by the Joint Research Centre (JRC) of the European Commission ([9]) on the average carbon intensity of the electricity consumed at low voltage in the EU in 2015 and are also presented in Table 3.3.

([8]) Based on Annex I (f) of Council Directive (EU) 2015/652 of 20 April 2015.
([9]) Improved calculation of carbon intensity of electricity consumed in the EU Member States in 2015 including upstream emissions and trade, Ispra, 7 February 2018.

Table 3.3 **Electricity consumed by electric vehicles and motorcycles in 2019 as a reported contribution by fuel suppliers to their GHG reduction target.**

Member State	Quantity of energy		GHG intensity		
	excluding powertrain efficiency (GJ)	including powertrain efficiency (GJ)	reported by Member State (g CO_2e/MJ)	reported by Member State (g CO_2e/kWh)	JRC data (g CO2e/kWh)
Bulgaria	128 502	51 401	522.9	1 882	637
France	1 467 058	586 823	10.8	39	80
Germany	1 209 600	483 840	147.0	529	541
Hungary	5 779	2 312	139.5	502	415
Ireland	92 426	36 970	127.5	459	569
Italy[10]	229 605	91 842	110.3	397	426
Netherlands	532 307	212 923	154.2	555	594
Portugal	42 430	16 972	71.0	256	483
Slovakia	2 652	1 061	46.4	167	421
Slovenia	1 854	742	-	-	-
Sweden	2 431	972	13.1	47	24
United Kingdom[11]	51 261	20 504	5.6	20	487

Note: Member States data are for 2019 whereas JRC data refer to 2015.
Ireland's value for GHG intensity remains the same with 2018 because it is not available for 2019. Hungary and UK reported different GHG intensities. For this table the values were combined.

The above data on GHG intensity are not directly comparable as individual Member States may have used a calculation methodology different from that used by the JRC ([12]). For example, electricity consumed versus electricity generated and/or applied corrections for the effect of cross-border electricity trade may have an impact on the calculated intensities. JRC's data refer to electricity production before cross-border trading and not to the electricity actually available for consumption. In addition, JRC data refer to the year 2015 whereas Member States data are for 2019.

([10]) Italy shows a signficant decrease in the reported electricity values in comparison to 2018. Further investigations with the authorities revealed that the 2018 values were too high due to the reporting of one supplier.
([11]) UK shows a significant decrease in the reported electricity values in comparison to 2018. Explanations were asked, but the answer is pending.
([12]) As foreseen by Council Directive 2015/652, Annex I Part 2, Point 6.

4 Progress to 2020 targets under the Fuel Quality Directive

4.1 Average GHG emissions intensity of transport fuels in 2019

The Fuel Quality Directive (FQD) requires a reduction in the GHG intensity of transport fuels by a minimum of 6 % by 2020 compared with 2010 levels via the suppliers' monitoring mechanism ([13]) and by an additional optional 4 % via reduction technologies and the Clean Development Mechanism of the Kyoto Protocol. The baseline for this reduction is the average GHG intensity of the EU's fuel mix in 2010, which was 94.1 g CO_2/MJ ([14]). The fuel baseline standard is calculated based on EU average fossil fuel consumption of petrol, diesel, (non-road) gasoil, LPG and CNG.

For each Member State Table 4.1 shows the GHG emissions from the consumption of all fuels (fossil fuels and biofuels) and electricity used in road transport. The average GHG intensity has been calculated for each Member State as well as the relative reduction over the 2010 default baseline value is also shown in the same table.

The average GHG intensity of the fuels supplied in the 28 EU Member States (excluding ILUC for biofuels) was 90 g carbon dioxide equivalent (CO_2e) in 2019. Thus, a reduction of 4.3 % was achieved in 2019 compared to 2010. This corresponds to a saving of 54 Mt CO_2e compared to the 2010 level in the year 2019. It also corresponds to an additional reduction of 0.6 percentage point, compared to 2018 (3.7 % reduction compared to 2010, for 28 EU Member States). In order to reach the obligatory 6 % target, an additional reduction of 1.7 percentage points in the GHG intensity of all fossil fuels and biofuels supplied will be needed for 2020, on average in the EU ([15]). Consequently, extra efforts from fuel suppliers are necessary to meet the 6 % target by 2020. In 2019, upstream emission reductions from Hungary and United Kingdom were reported (see details in section 1.1) for the first time which contributed to a further reduction of the GHG intensity of about 0.2 % to reach 4.3 % in total.

The average GHG intensity and hence also the relative distance to target depends on the share and type of fossil fuels and biofuels in the total fuel mix. Diesel and gas oil have the highest GHG intensity (95.1 g CO_2e/MJ) of all fuels whereas substitution with HVO (14 g CO_2e/MJ, excluding ILUC) and biodiesel (24.6 g CO_2e/MJ, excluding ILUC) reduces significantly the GHG intensity, providing thus the highest GHG benefits.

The distance to target varies from 4.7 % (for Cyprus) to 0.2 % (for the Netherlands) across Member States. The three Member States with the lowest achievements in reducing their GHG intensities over the 2010 – 2019 period (lower than 2 %) are Cyprus (1.3 %), Latvia and Estonia (1.8 %). The main reason for these low performances is the low biofuels share (1.7 % in Cyprus and 2.6 % and 2.8 % in Latvia and Estonia). In addition to this, Latvia has a high GHG intensity for biofuels (32 g CO_2eq/MJ). In comparison, the GHG intensity in Cyprus is low (14.1 g CO_2eq/MJ) and in Estonia it decreased substantially in 2019 compared to 2018 (20.2 vs 35.1 g CO_2eq/MJ).

On the other hand, Finland and Sweden have achieved the highest reductions in the average GHG intensity of their fuels with 7.7 % and 18.6 % respectively (excluding ILUC). These two are the only Member States having exceeded the target for both 2018 and 2019. The Netherlands is close to achieve the target, having recorded a 5.8 % reduction. Finland has a biofuel share of 9.1 % (of which 69 % is HVO that has the lowest GHG intensity among biofuels, 18 % is bioethanol and 9 % is biodiesel) while diesel, petrol and gas oil represent 46 %, 27 % and 17 % of the mix respectively. Sweden has the highest biofuel share among all Member States amounting to 22.2 % (of which 63 % is HVO, 23 % is biodiesel 8 % is biogas) and diesel and petrol share in the total fuel mix is 50 % and 27 % respectively. Netherlands'

([13]) For the purposes of Article 7a of the FQD, Member States shall ensure that suppliers use the calculation method set out in Annex I of Directive 2015/652 to determine the GHG intensity of the fuels they supply.

([14]) Baseline value for 2010, according to Annex II of the Council Directive (EU) 2015/652.

([15]) Determined across the 28 Member States that reported data.

biofuel share is 6.8 % (of which 56 % is biodiesel, 22 % is bioethanol and 14 % is HVO) and the share of diesel, petrol is 53 % and 38 % out of the total fuel supply. The reductions achieved by these three Member States are attributed to the high biofuels share, as well as the low GHG intensity of biofuels reported (10.4 g CO_2eq/MJ in Finland, 15.2 g CO_2eq/MJ in Netherlands and 14.1 g CO_2eq/MJ in Sweden).

Table 4.1 shows wide disparities of performances across Member States when ILUC is accounted for due to the different type of feedstocks used for the biofuels production. Whereas for many Member States the difference with and without ILUC is relatively small (in the order of 1 percentage unit), for some other Member States these differences are significant. France's performance without ILUC is 4.5 % and with ILUC it is 1.0 % due to the extensive use of oil crops (76 % of its feedstock, mainly produced from rapeseed and palm oil) that have the highest GHG intensity among feedstock categories. Denmark's performance is also largely reduced when ILUC emissions are considered (from 2.7 % excl. ILUC to 0.6 %) because the majority of its feedstock (about 70 %) is rapeseed (an oil crop). Austria presents another example of high discrepancy in the reduction achieved with and without ILUC (3.2 % without ILUC vs 0.1 % with ILUC). This is due to the prevalence of rapeseed and soybeans, which have almost equal GHG intensity to diesel and petrol, in the feedstock used (about 80 %).

Table 4.1 Average GHG emissions intensity reported by fuel suppliers by Member State in 2019 and reductions compared with 2010.

Member State	Fossil fuels		Biofuels		Electricity (incl. powertrain efficiency)		Average fuel GHG intensity (g CO_2e/MJ) (excl. ILUC)	2010-2019 GHG intensity reduction (excl. ILUC) (%)	Average fuel GHG intensity (g CO_2e/MJ) (incl. ILUC)	2010-2019 GHG intensity reduction (incl. ILUC) (%)
	Energy consumption (TJ)	GHG emissions (kt)	Energy consumption (TJ)	GHG emissions (kt)	Energy consumption (TJ)	GHG emissions (kt)				
Austria	343 314	32 524	21 267	690	-	-	91.1	3.2%	94.0	0.1%
Belgium	391 164	36 990	21 281	673	-	-	91.3	3.0%	93.5	0.6%
Bulgaria	116 255	10 808	5 974	254	51	27	90.6	3.7%	92.8	1.4%
Croatia	97 692	9 216	3 457	67	-	-	91.8	2.5%	92.6	1.6%
Cyprus	28 382	2 673	481	7	-	-	92.8	1.3%	92.8	1.3%
Czechia	256 186	24 061	12 908	311	-	-	90.6	3.8%	92.4	1.9%
Denmark	174 492	16 495	8 933	293	-	-	91.5	2.7%	93.5	0.6%
Estonia	41 788	3 947	1 184	24	-	-	92.4	1.8%	92.9	1.3%
Finland	181 946	17 198	18 276	192	-	-	86.9	7.7%	87.0	7.5%
France	1 826 752	172 906	147 385	4 543	587	6	89.8	4.5%	93.1	1.0%
Germany	2 408 685	227 229	123 621	2 061	484	71	90.5	3.8%	91.9	2.3%
Greece	211 301	19 707	8 281	243	-	-	90.9	3.5%	92.1	2.2%
Hungary	219 278	20 652	8 717	154	2	0.3	91.3	3.0%	91.8	2.5%
Ireland	158 115	14 979	7 972	114	37	5	90.9	3.5%	90.9	3.4%
Italy	1 438 104	134 315	56 122	1 028	92	10	90.6	3.8%	91.0	3.3%
Latvia	51 336	4 826	1 356	44	-	-	92.4	1.8%	93.6	0.5%
Lithuania	83 490	7 842	2 948	115	-	-	92.1	2.2%	93.6	0.5%
Luxembourg	88 402	8 381	5 436	150	-	-	90.9	3.4%	93.0	1.1%
Malta	9 207	869	483	4	-	-	90.0	4.3%	90.1	4.2%
Netherlands	434 680	40 861	31 626	480	213	33	88.6	5.8%	88.8	5.6%
Poland	956 697	89 122	52 353	1 821	-	-	90.1	4.2%	92.6	1.6%
Portugal	233 680	22 100	11 516	250	17	1	91.1	3.1%	92.1	2.1%
Romania	237 040	22 447	12 405	363	-	-	91.4	2.8%	93.7	0.5%
Slovakia	105 809	9 979	6 524	167	1	0.05	90.3	4.0%	92.5	1.7%
Slovenia	88 549	8 381	4 049	83	-	-	91.4	2.9%	92.5	1.7%
Spain	746 712	70 547	43 665	1 311	-	-	90.9	3.4%	92.9	1.2%
Sweden	255 212	24 102	73 034	1 038	1	0.01	76.6	18.6%	79.8	15.2%
United Kingdom	1 719 283	160 473	78 315	1 177	5	0.11	89.9	4.4%	90.2	4.2%
EU (28 Member States)	**12 903 552**	**1 213 628**	**769 570**	**17 655**	1 490	154	**90.0**	**4.3%**	**91.6**	**2.6%**

4.2 Upstream emission reductions

Upstream emissions refer to the GHG emissions produced during the extraction, processing, handling and transport of raw material from their original state to the refinery or processing plant gate where the fuel was produced. Upstream emission reductions (UER) are the GHG emissions reductions that can occur prior to the crude oil entering the refinery, during extraction, processing, handling and transport, including reductions in flaring and venting emissions. The UER claimed by a supplier have to be quantified and reported in accordance with the requirements set out in Council Directive (EU) 2015/652. There are several options for suppliers to reduce the GHG intensity of fuels and energy towards the 2020 reduction target. More detailed information on approaches to quantify, monitor and report on UER can be found in the guidance note ([16]). However, there is no obligation to use UER as a compliance option.

Two out of 28 Member States that have submitted data under Article 7a have claimed UER, Hungary (53.8 kt CO_2e) and United Kingdom (2 026.9 kt CO_2e). Consequently, the total reported UER was 2 081 kt CO_2e in 2019 and it resulted in an additional 0.2 % reduction of the fuel GHG intensity from 4.1 % to 4.3 %.

([16]) https://ec.europa.eu/clima/sites/default/files/guidance_note_on_uer_en.pdf

5 Effects of indirect land use change on GHG intensities

5.1 Greenhouse gas emission intensities of crop types

According to Article 23 paragraph 5(f) of the RED ([17]), fuel suppliers have to report the life cycle greenhouse gas emissions per unit of energy, including the provisional mean ([18]) values of the estimated ILUC emissions from biofuels to the Member States. ILUC emissions may significantly reduce the GHG benefits from the use of the different biofuels. Depending on the land types converted to cropland because of biofuels production, these GHG savings may be completely cancelled out. Hence, in an encompassing life cycle analysis, the ILUC-related GHG emissions intensity should be added to the GHG intensity directly attributed to the production and transport of biofuels. For the reporting of ILUC emissions, the mean values included in Annex V of the RED are used. ILUC emissions are not taken into account for assessing compliance with the obligatory 6 % reduction target.

Table 5.1 provides an overview of the energy supplied by the different crops from which biofuels are produced. The default GHG intensities for each crop type are also included.

ILUC emissions related to biofuel consumed were around 22 Mt CO_2e in 2019, an amount almost equivalent to the annual total emissions (excluding ILUC) of Portugal. Oil crops were responsible for 93.4 % of these ILUC emissions.

Table 5.1 ILUC summary table.

Feedstock category	Cereals and other starch-rich crops	Sugars	Oil crops	Other
Quantity of energy supplied (TJ)	99 315	18 066	368 259	285 836
Default ILUC intensity provisional mean ([19]) values of the estimated ILUC emissions (g CO_2e/MJ)	12	13	55	0
Total ILUC GHG emissions (kt CO_2e)	**1 192**	**235**	**20 254**	-

Based on the provisional mean values of the estimated indirect land-use change emissions in the FQD (see Annex VIII, Directive 2018/2001), an average value of 1.6 g CO_2e/MJ has been calculated for the additional GHG intensity of ILUC based on the total energy consumption of all fossil fuels and biofuels. Adding this value to the average GHG intensity of 90 g CO_2e/MJ (without ILUC) of the fuels consumed in the 28 EU Member States as calculated above (Table 5.1), this results in a total value of 91.6 g CO_2e/MJ (with ILUC). If ILUC was included in the calculation of the GHG intensity, the relevant reduction from the baseline (in the year 2010) would be 2.6 % as opposed to the 4.3 % reduction when excluding ILUC, see Table 4.1. The GHG intensity including ILUC decreased in 2019 in comparison to 2018 (92.1 g CO_2e/MJ in 2018) due to the small reduction of use of oil crops that have the highest GHG intensity (55 g CO_2e/MJ) that was shifted to the use of sugars that have a much lower GHG intensity (13 g CO_2e/MJ).

The GHG intensity reduction including ILUC is below 2 % for 17 the Member States and the highest performances are noted in three Member States (Sweden, Finland and Netherlands). Estonia and Lithuania increased their performance significantly compared to 2018 where they had negative

([17]) Directive 2009/28/EC of the European Parliament and of the council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

([18]) For the purposes of Article 7a of the FQD, Member States shall ensure that suppliers use the calculation method set out in Annex I of Directive 2015/652 to determine the GHG intensity of the fuels they supply.

([19]) The mean values included here represent a weighted average of the individually modelled feedstock values (Annex VIII, Directive 2018/2001 of the European Parliament and of the council of 11 December 2018 on the promotion of the use of energy from renewable sources).

reductions (-0.06 % for both in 2018) while in 2019 the reductions are 1.32 % and 0.48 % respectively. This is due to the reduction of use of oil crops (25 % in 2019 and 72 % in 2018 for Estonia and 83 % in 2019 and 89 % in 2018 for Lithuania) to produce biofuels, and in particular biodiesel, as the GHG intensity of oil crops is only marginally better than fossil fuel diesel when ILUC is included (87 vs 95.1 g CO_2e/MJ).

5.2 Greenhouse gas emission savings by substituting fossil fuels with biofuels

In order to estimate the decarbonization potential of biofuels, i.e. the GHG savings from the substitution of their fossil fuel counterparts, data on the actual biofuel use and the respective GHG intensities, as reported by the different EU Member States, are used.

To this aim, GHG emissions from the use of biofuels differentiated for the biofuel feedstock have been calculated with and without ILUC, by using the reported GHG intensities. These emissions are then compared with the calculated GHG emissions from the use of equal quantities — in terms of energy content — of conventional fuels.

The most relevant biofuels for this analysis are biodiesel, bioethanol and HVO, which account for 95 % of the total biofuel energy consumption in the 28 EU Member States. The relevant data for this comparison is summarised in Table 5.2. The average GHG intensity and corresponding GHG emissions with and without ILUC are presented for the different feedstocks for each of the selected biofuels.

Table 5.2 GHG emissions from the use of biofuels and different feedstocks.

	Energy quantity (TJ)		Average GHG intensity (g CO_2e/MJ)				GHG emissions (kt CO_2e)			
			Excluding ILUC emissions		Including ILUC emissions		Excluding ILUC emissions		Including ILUC emissions	
	2018	2019	2018	2019	2018	2019	2018	2019	2018	2019
Biodiesel	**504 122**	**526 806**	**26.44**	**24.64**	**62.64**	**58.89**	**13 328**	**12 982**	**31 577**	**31 023**
Cereals and other starch-rich crops	1	24	15.33	34.21	27.33	46.21	0	1	0	1
Sugars	-	-	-	-	-	-	-	-	-	-
Oil crops	331 808	329 376	33.92	32.22	88.92	86.99	11 256	10 612	29 506	28 652
Other	167 404	197 406	11.61	12.00	11.61	12.00	1 943	2 369	1 943	2 369
HVO	**92 899**	**96 298**	**15.60**	**14.00**	**34.05**	**33.31**	**1 449**	**1 348**	**3 164**	**3 207**
Cereals and other starch-rich crops	1 898	48	10.94	7.57	22.94	19.57	21	0.4	44	1
Sugars	-	-	-	-	-	-	-	-	-	-
Oil crops	30 761	33 795	30.20	26.39	85.24	81.39	930	892	2 622	2 751
Other	60 240	62 455	8.27	7.30	8.27	7.30	498	456	498	456
Bioethanol	**110 523**	**110 866**	**24.27**	**22.64**	**35.83**	**33.87**	**2 682**	**2 511**	**3 960**	**3 755**
Cereals and other starch-rich crops	89 742	87 010	23.63	22.51	35.63	34.51	2 120	1 959	3 197	3 003
Sugars	15 439	15 417	31.91	26.81	44.91	39.79	493	413	693	613
Oil crops	1	5	34.18	24.60	89.18	79.60	0.04	0.1	0.09	0.4
Other	5 296	8 435	12.74	16.39	12.74	16.39	67	138	67	138

Note: ILUC emissions correspond to provisional mean values of the estimated ILUC emissions

The above table shows that the biofuel feedstock is important when assessing the GHG reduction potential of biofuels, especially when including the ILUC effect.

For biodiesel, a substantial part (above 62 %) is produced from oil crops, which have a high GHG intensity compared to other feedstocks. When considering ILUC, this biodiesel is only marginally better than fossil fuel diesel (87 vs 95.1 g CO2e/MJ).

In the case of HVO, the majority is produced from feedstocks with no ILUC value attached (such as tallow, waste oils and fats, around 65 %) and with a low GHG intensity, whereas the quantities produced from oil crops, which have a much higher GHG intensity (26.4 g CO2e/MJ without ILUC and 81.4 g CO2e/MJ with ILUC), are much lower (around 35 %).

Bioethanol is mainly produced from cereals and other starch-rich crops (above 78 %) and sugars (around 14 %) which have a moderate GHG reduction potential compared to other feedstocks. When including ILUC the average GHG intensity of bioethanol increases, however it remains much lower than fossil petrol (33.9 vs 93.3 g CO_2e/MJ).

Table 5.3 shows the calculated GHG emissions saved by replacing fossil fuels with corresponding biofuels. Substitution of diesel by biodiesel and HVO results in GHG emission reductions in the order of 75 % when ILUC is excluded, whereas these reductions are in the order of 40 % when including ILUC. The respective reductions for petrol and bioethanol with ETBE are somewhat lower without ILUC but in the same order of magnitude and higher with ILUC. This higher reduction in petrol compared to diesel is due to the high GHG ILUC values of oil crops from which mainly biodiesel is produced from and the much lower GHG ILUC values of cereals from which ethanol is produced. The percentage reductions for natural gas are of the order of magnitude with petrol, but the overall effect is rather small due to the small quantities of CNG supplied.

Table 5.3 GHG emissions savings from the use of biofuels.

Fossil fuel	Substituting biofuel	Excluding /including provisional mean values of the estimated ILUC emissions	GHG emissions from fossil fuels (kt CO_2e)	Emissions savings (kt CO_2e)	GHG emission reduction from substitution (%)
Diesel	Biodiesel + HVO	Excluding	59 257	44 926	75.8
		Including	59 257	25 027	42.2
Petrol	Bioethanol + ETBE	Excluding	11 653	8 743	75.0
		Including	11 653	7 328	62.9
CNG	Biogas	Excluding	851	632	74.2
		Including	851	539	63.3

6 Consistency between fuel volumes reported under Article 7a and other sources

6.1 Fuel volumes reported under Article 7a and Article 8

To ensure consistency, the reported fuel volumes under Article 7a are compared with those reported under Article 8 of the Fuel Quality Directive (FQD). The comparison is carried out for petrol and diesel only, as no other fuels are reported under Article 8.

The total volumes of petrol and diesel reported under Article 8 already includes blended biofuels, i.e. mainly bioethanol in petrol and biodiesel (and HVO) in diesel. To enable the comparison, all volumes of bioethanol, bio-ETBE and other petrol substitutes were added to the petrol volumes as reported by Member States under Article 7a. Similarly, all volumes of biodiesel, HVO and other diesel substitutes were added to the diesel volumes. Table 6.1 shows the results of the comparison for the 28 Member States that have reported under both Articles 7a and 8.

Table 6.1 Total quantities of fossil fuels and biofuels (million litres).

Member State	Petrol		Diesel		Difference (%)	
	Article 7a	Article 8	Article 7a	Article 8	Petrol	Diesel
Austria	2 223	2 210	8 237	8 416	0.6%	-2.1%
Belgium	2 930	2 592	8 169	7 686	13.1%	6.3%
Bulgaria	679	681	2 547	2 716	-0.3%	-6.2%
Croatia	658	655	2 189	2 145	0.5%	2.1%
Cyprus	452	452	399	399	0.0%	0.1%
Czechia	1 947	2 153	5 576	6 005	-9.6%	-7.1%
Denmark	1 742	1 793	3 254	3 276	-2.9%	-0.7%
Estonia	296	303	923	942	-2.3%	-2.0%
Finland	1 843	1 864	3 106	3 087	-1.1%	0.6%
France	11 695	11 646	39 613	39 157	0.4%	1.2%
Germany	25 401	24 018	47 830	44 972	5.8%	6.4%
Greece	3 041	3 049	3 147	3 279	-0.2%	-4.0%
Hungary	1 977	1 984	812	4 510	-0.3%	-82.0%
Ireland	1 042	1 374	3 723	3 723	-24.2%	0.0%
Italy	9 761	8 256	2 964	30 820	18.2%	-90.4%
Latvia	229	205	1 212	1 223	11.9%	-0.9%
Lithuania	342	341	2 010	2 146	0.1%	-6.3%
Luxembourg	485	480	2 201	1 912	0.9%	15.1%
Malta	109	112	172	195	-2.8%	-11.8%
Netherlands	5 898	5 771	7 618	7 786	2.2%	-2.2%
Poland	6 331	6 356	20 544	20 865	-0.4%	-1.5%
Portugal	1 378	1 430	5 529	5 488	-3.6%	0.7%
Romania	1 575	1 904	5 621	7 703	-17.3%	-27.0%
Slovakia	759	759	2 421	2 421	0.0%	0.0%
Slovenia	573	540	2 069	2 303	6.0%	-10.2%
Spain	4 080	7 148	15 878	27 661	-42.9%	-42.6%
Sweden	2 965	2 904	6 480	5 945	2.4%	9.0%
United Kingdom	16 788	15 007	30 213	28 523	11.9%	5.9%
EU (28 Member States)	**107 200**	**105 988**	**232 371**	**275 302**	**1.14%**	**-15.59%**

For many Member States, the differences for both petrol and diesel are relatively small, within ±10 %. However, there are also many Member States for which larger differences are observed, where total volumes reported under Article 7a are lower or higher than those reported under Article 8. The main reasons include fuel quantities purchased and sold in different years, or incomplete reporting by Member States. It is not possible to distinguish to what extent the differences can be attributed to each of these reasons. In some cases, there are indications of incomplete reporting as in the case of Italy where, as in 2018, the diesel quantities reported under Article 7a in 2019 are much lower than those reported under Article 8 and also much lower compared to other Member States of similar size. For 2019, Italy confirmed that the reported quantity of petrol under Article 8 is lower than the quantity reported under Article 7a because it relates only to summer and winter period and if the excluded periods of the year were added, the quantity would be the same as in Article 7a. Regarding the difference in diesel quantities, Italy claims that it occurs because the value reported under Article 8 is the sum of diesel plus gasoil (blended), while the value reported under Article 7a refers only to pure diesel. The same applies in the case of Hungary that clarifies that the diesel quantity reported under Article 7a should be added to gasoil quantity and then compare to diesel quantity reported under Article 8. Another ambiguity that arose but was not clarified is in the case of Romania which claimed a switch in reporting formats that led to different computation of fuel quantities. In the case of Spain, the discrepancies are due to different sources of reporting for each Article, that is specifically different fuel suppliers.

6.2 Comparison of bio-ETBE and bioethanol volumes reported under Article 7a with different sources

A comparison of energy quantities of bio-ETBE and bioethanol reported by Member States under Article 7a and the EurObserv'ER Biofuel Barometer reports ([20]), for the years 2017, 2018 and 2019, is presented in Table 6.2.

([20]) https://www.eurobserv-er.org/biofuels-barometer-2019/
https://www.eurobserv-er.org/biofuels-barometer-2020/

Table 6.2 Energy quantities of bio-ETBE and bioethanol for the years 2017, 2018 and 2019 from EEA and Biofuel Barometer.

	Bio-ETBE and bioethanol supply (PJ) Source: EEA			Bioethanol consumption (PJ) Source: Biofuel Barometer			Difference		
Member State	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**	**2017**	**2018**	**2019**
Austria	2.31	2.42	2.37	2.34	2.42	2.37	-1.7%	-0.2%	0.1%
Belgium	3.52	4.17	4.92	3.63	3.92	4.45	-3.3%	6.0%	9.6%
Bulgaria	0.73	1.04	0.96	1.12	1.20	1.33	-52.3%	-15.0%	-39.2%
Croatia	0.02	0.01	0.08	0.01	0.02	0.02	51.9%	-78.7%	78.2%
Cyprus	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
Czechia	2.05	2.18	2.50	3.14	2.57	3.05	-53.5%	-17.6%	-21.9%
Denmark	1.82	1.83	1.80	0.00	1.80	2.31	100.0%	2.0%	-28.7%
Estonia	-	0.20	0.29	0.04	0.21	0.21	-	-0.4%	30.0%
Finland	3.14	3.39	3.51	3.38	3.53	3.70	-7.5%	-4.4%	-5.6%
France	4.40	16.93	27.13	22.57	24.53	27.35	-413.2%	-44.9%	-0.8%
Germany	29.99	30.79	30.81	30.69	32.03	31.36	-2.3%	-4.0%	-1.8%
Greece	0.00	0.00	1.02	0.00	0.00	1.00	0.0%	0.0%	1.6%
Hungary	1.48	2.06	2.13	1.67	2.10	2.10	-13.2%	-2.2%	1.2%
Ireland	1.23	1.15	1.10	1.24	1.14	1.10	-0.9%	0.4%	0.4%
Italy	1.78	1.75	1.64	1.39	1.36	1.27	22.2%	21.9%	22.4%
Latvia	0.24	0.19	0.22	0.33	0.36	0.41	-40.5%	-85.1%	-80.7%
Lithuania	-	0.30	0.36	0.34	0.33	0.41	-	-13.0%	-13.3%
Luxembourg	0.28	0.42	0.72	0.28	0.42	0.72	-1.5%	1.1%	1.1%
Malta	0.00	0.00	0.00	0.00	0.00	0.00	0.0%	0.0%	0.0%
Netherlands	5.95	6.34	6.92	5.40	7.15	8.32	9.2%	-12.7%	-20.3%
Poland	-	7.10	7.62	7.38	7.23	7.67	-	-1.9%	-0.7%
Portugal	-	0.33	0.31	0.12	0.32	0.18	-	3.8%	43.8%
Romania	-	2.30	3.08	3.81	3.78	3.83	-	-64.8%	-24.4%
Slovakia	0.97	1.02	1.08	0.82	0.74	0.74	15.5%	27.6%	31.9%
Slovenia	0.16	0.14	0.35	0.36	0.28	0.28	-129.8%	-106.2%	-19.2%
Spain	-	12.37	3.98	5.90	6.64	5.42	-	46.3%	-36.0%
Sweden	4.20	4.93	4.12	4.14	5.51	6.06	1.2%	-11.6%	-47.1%
United Kingdom	15.74	16.20	15.88	16.89	16.63	18.62	-7.3%	-2.7%	-17.3%
EU28	**79.98**	**119.55**	**124.90**	**117.00**	**126.22**	**134.26**	**-46.3%**	**-5.6%**	**-7.5%**

Note: For 2017, 22 Member States provided data to EEA under the FQD, for 2018 and 2019, 28 Member States have provided data.
Bioethanol consumption for 2019 for 12 Member States (Bulgaria, Croatia, Cyprus, Estonia, Finland, Hungary, Latvia, Poland, Romania, Slovenia, Slovakia and Sweden) was not available during the survey, EurObserv'ER made estimates taking into consideration the Eurostat «Energy Balance - early estimates» published in June 2020. Source: EurObserv'ER 2020.

With the exception of 2017, differences at EU28 level for 2018 and 2019 are well below 10 %.

For the year 2017, Sustainable Fuels ([21]), the association representing European producers of fuel ethers, provided data to EEA ([22]) with the supply of bio-ETBE and bioethanol to EU market. The figures are significantly higher compared to the volumes reported by the EEA based on Member States submissions. The numbers provided by Sustainable Fuels for ETBE and for bio-ethanol amount to 26.7 PJ and 90.3 PJ respectively.

The reasons for this discrepancy are, firstly, the incomplete reporting from Member States as 2017 was the first year of submission and only 21 ([23]) Member States provided complete information. Secondly, some Member States do not report ETBE separately from bioethanol as this information is not provided by their fuel suppliers. Hence, it is likely that the actual number of ETBE sales is much higher in reality, possibly close to the figures reported by Sustainable Fuels in 2017.

Additional reasons stated by the MS for the differences also occurring in 2018 and 2019 were that quantities of fuel are reported at the time of excise duty by suppliers and may be placed on the market in the following year as mentioned by Slovenia. Also that some quantities of biofuel were not reported as they did not meet the required sustainability criteria (as is the case for Latvia).

([21]) https://www.sustainablefuels.eu/
([22]) Letter sent via e-mail from the General Secretary of Sustainable Fuels to EEA and EMISIA S.A., on 2 December of 2020.
([23]) The French submission only covered two months in 2017.

Abbreviations, symbols and units

CHP	Combined heat and power
CNG	Compressed natural gas
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DLUC	Direct land use change
EEA	European Environment Agency
EFB	Empty fruit bunch
Eionet	European Environment Information and Observation Network
ETBE	Ethyl tert-butyl ether
ETC/ACM	European Topic Centre for Air Pollution and Climate Change Mitigation
EU	European Union
FAEE	Fatty acid ethyl esters
FAME	Fatty acid methyl esters
FFBS	Fresh fruit brunches
FQD	Fuel Quality Directive
GHG	Greenhouse gas
GJ	Gigajoule
HVO	Hydrotreated vegetable oil
ILUC	Indirect land use change
JRC	Joint Research Centre
LBG	Liquefied biogas
LNG	Liquified natural gas
LPG	Liquid petroleum gas
MJ	Megajoule
MTBE	Methyl tert-butyl ether
PFAD	Palm fatty acid distillate (PFAD)
PJ	Petajoule
POME	Palm oil mill effluent
QA/QC	Quality assurance/quality control
RUCO	Repurpose used cooking oil
SBE	Spent bleaching earth
TAEE	Tert-amyl ethyl ether
TJ	Terajoule
UER	Upstream emission reductions

Annex

Table A1.1 Greenhouse gas (GHG) intensity per fossil fuel type

Fuel or energy type	GHG intensity ($g\ CO_2e/MJ$)
Liquified petroleum gas	73.6
Compressed natural gas	69.3
Diesel	95.1
Petrol	93.3
Gas oil	95.1
Liquified natural gas	74.5
Other	93.3

Table A1.2 Average reported greenhouse gas (GHG) intensity per biofuel type (excluding ILUC)

Fuel or energy type	GHG intensity ($g\ CO_2e/MJ$)
Biodiesel	24.6
Bioethanol	22.6
Hydrotreated vegetable oil HVO	14.0
Bio-ETBE	28.5
Biogas	17.9
Biobutanol	30.7
Biomethanol	34.1
Bio-MTBE	36.5
Bio-TAEE	40.0
Other (Bioethanol diesel)	12.1
Other (Biofuel oil)	6.6
Other (Bio-gasoline)	7.4
Other (Bio-kerosine)	7.9
Other (Bio-LPG)	24.9
Other (Bio-Naphtha)	7.4
Other (Bio-petrol)	8.0
Other (Bio-propane)	7.6
Other (cracked HVO to petrol)	26.3
Other (Diesel (origin Bio))	8.9
Other (FAEE)	9.7
Other (LBG)	17.9
Other (Methanol (non-bio, renewable))	13.0
Other (Naphtha)	17.9
Other (Off road biodiesel)	12.1
Other (Synthetic hydrocarbons)	33.5
Pure vegetable oil	27.4

Table A1.3 Feedstocks used for biofuels

- Acid oil from used cooking oil,
- Animal fats classified as categories 1 and 2,
- Animal manure and sewage sludge,
- Barley,
- Biomass fraction of industrial waste,
- Biomass fraction of mixed municipal waste,
- Biomass fraction of wastes and residues from forestry and forest-based industries,
- Bio-waste,
- Brown grease,
- Cobs cleaned of kernels of corn,
- Corn (maize),
- Crude glycerine,
- Grape marcs and wine lees,
- Husks,
- N/A,
- Nut shells,
- Other (Agri-food waste),
- Other (Animal fats classified as category 3),
- Other (Animal manure),
- Other (Animal manure, triticale, sorghum, corn stalks, straw, chaff of rice),
- Other (Biogas from roadside grass cuttings),
- Other (Biomass fraction of industrial waste and residues),
- Other (Biomass fraction of mixed industrial and municipal solid waste and sewage sludge),
- Other (Cottonseed),
- Other (Ethiopian Mustard Seed (Brassica Carinata)),
- Other (FAEE from fish oil ethyl ester),
- Other (Fatty acids),
- Other (FFBS),
- Other (Fish oil),
- Other (Food waste),
- Other (Garden waste),
- Other (Grape marcs and wine lees, agri-food waste),
- Other (Grass silage residues),
- Other (Grass silage),
- Other (Landfill gas),
- Other (Molasses),
- Other (Non-food cellulosic material),
- Other (Oils from Brassica Carinata),
- Other (PFAD),
- Other (Sewage sludge),
- Other (Shea olein),
- Other (Tall oil),
- Other (Technical corn oil),
- Other (Triticale),
- Other (Vegetable lubricating oils from fatty acids),
- Other (Waste from biodiesel production),
- Other (Waste from ethanol production),
- Other (Wastes and residues),
- Other (Wetland grass),
- Other (Whey permeate),
- Other cereals,
- Other oil crops,
- Other sugar crops,
- Palm oil,
- Palm oil mill effluent,
- Palm oil mill effluent and empty palm fruit bunches,
- Rapeseed,
- Soap stock acid oil contaminated with sulphur,
- Soybeans,
- Spent bleached earth,
- Starch slurry,
- Straw,
- Sugar beet,
- Sugar cane,
- Sunflower seed,
- Tall oil pitch,
- Tallow - category 3 or unknown,
- Used cooking oil,
- Waste pressings from production of vegetable oils,
- Waste vegetable or animal oils,
- Waste wood,
- Wheat.

Table A1.4 Biofuel production pathways

- Biogas from dry manure as compressed natural gas,
- Biogas from municipal organic waste as compressed natural gas,
- Biogas from wet manure as compressed natural gas,
- Farmed wood ethanol,
- Hydrotreated vegetable oil from palm oil (process not specified),
- Hydrotreated vegetable oil from palm oil (process with methane capture at oil mill),
- Hydrotreated vegetable oil from rapeseed,
- N/A,
- Other (Biodiesel from brown grease),
- Other (Biodiesel from cat. 1 and 2 animal fats),
- Other (Biodiesel from CHP plant fuelled by natural gas),
- Other (Biodiesel from corn oil),
- Other (Biodiesel from corn),
- Other (Biodiesel from crude glycerine),
- Other (Biodiesel from esterification and distillation),
- Other (Biodiesel from esterification and transesterification of POME),
- Other (Biodiesel from esterification and transesterification of vegetables fatty acids),
- Other (Biodiesel from esterification and transesterification),
- Other (Biodiesel from esterification with methanol),
- Other (Biodiesel from esterification),
- Other (Biodiesel from food waste),
- Other (Biodiesel from hydrotreating),
- Other (Biodiesel from palm oil mill effluent and empty palm fruit bunches),
- Other (Biodiesel from palm oil mill effluent),
- Other (Biodiesel from PFAD),
- Other (Biodiesel from sewage system FOG),
- Other (Biodiesel from soap stock contaminated with sulphur),
- Other (Biodiesel from soap stocks splitting from sunflower oil),
- Other (Biodiesel from soy seed),
- Other (Biodiesel from spent bleached earth),
- Other (Biodiesel from tallow category 1),
- Other (Biodiesel from tallow category 2),
- Other (Biodiesel from transesterification and distillation),
- Other (Biodiesel from transesterification of animal fat and distillation to obtain biodiesel as main product and glycerine and bioheating oil as a by-product),
- Other (Biodiesel from transesterification of animal fat and distillation),
- Other (Biodiesel from transesterification of animal fat with methanol),
- Other (Biodiesel from transesterification with methanol),
- Other (Biodiesel from transesterification),
- Other (Biodiesel from transesterification of UCO),
- Other (Biodiesel from used cooking oil),
- Other (Biodiesel from waste pressings from production of vegetable oils),
- Other (Biodiesel from waste vegetable or animal oil),
- Other (Bio-ETBE from barley),
- Other (Bio-ETBE from corn, maize),
- Other (Bio-ETBE from esterification),
- Other (Bio-ETBE from rye),
- Other (Bio-ETBE from sugar beet),
- Other (Bio-ETBE from triticale),
- Other (Bio-ETBE from wheat),
- Other (Bioethanol from barley),
- Other (Bioethanol from biomass fraction of industrial waste),
- Other (Bioethanol from cereals),
- Other (Bioethanol from CHP plant fuelled by natural gas),
- Other (Bioethanol from corn),
- Other (Bioethanol from ethanol from cleaning/extraction of blood plasma),
- Other (Bioethanol from fermentation),
- Other (Bioethanol from food waste),
- Other (Bioethanol from molasses),
- Other (Bioethanol from rye),
- Other (Bioethanol from starch slurry (waste)),
- Other (Bioethanol from triticale),
- Other (Bioethanol from wheat),
- Other (Biofuel oil from PFAD),
- Other (Biofuel oil from waste vegetable oil or animal fat),
- Other (Biogas from agri-food waste as compressed natural gas),
- Other (Biogas from animal manure and sewage sludge),
- Other (Biogas from biomass fraction of industrial waste),
- Other (Biogas from biomass fraction of mixed municipal waste),
- Other (Biogas from brown grease),
- Other (Biogas from crude glycerine),
- Other (Biogas from grass silage as compressed natural gas),
- Other (Biogas from green waste as compressed biomethane),
- Other (Biogas from industrial waste),
- Other (Biogas from manure and agri-food waste as compressed natural gas),
- Other (Biogas from manure as liquified natural gas),
- Other (Biogas from municipal organic waste as compressed natural gas),
- Other (Biogas from municipal organic waste as liquified natural gas),
- Other (Biogas from nut shells),
- Other (Biogas from roadside grass cuttings),
- Other (Biogas from sewage sludge as compressed natural gas),
- Other (Biogas from used cooking oil),

- Other (Biogas from waste vegetable oils or animal fats),
- Other (Biogas from waste),
- Other (Biogasoline from animal fat),
- Other (Bio-kerosine from used cooking oil),
- Other (Bio-LPG from biomass fraction of industrial waste),
- Other (Bio-LPG from hydrotreating of Brassica Carinata),
- Other (Bio-LPG from hydrotreating of cat 3 animal fats),
- Other (Bio-LPG from hydrotreating of palm oil),
- Other (Bio-LPG from hydrotreating of POME),
- Other (Bio-LPG from hydrotreating of RUCO),
- Other (Bio-LPG from hydrotreating of shea olein),
- Other (Bio-LPG from hydrotreating of soybean),
- Other (Bio-LPG from palm oil mill effluent and empty palm fruit bunches),
- Other (Biomass ethanol (process fuel not specified)),
- Other (Biomethane from animal manure and sewage sludge),
- Other (Biomethane from food waste),
- Other (Biomethane from husks),
- Other (Biomethane from municipal organic waste),
- Other (Biomethane from roadside grass),
- Other (Biomethane from sewage sludge),
- Other (Biomethane from sugar beet tops, tails, chips and process water),
- Other (Biomethanol from animal manure and sewage sludge),
- Other (Biomethanol from food waste),
- Other (Biomethanol from municipal organic waste),
- Other (Biomethanol from other bio-waste),
- Other (Biomethanol from sewage sludge),
- Other (Biomethanol from waste pressings from production of vegetable oils),
- Other (Biomethanol produced from sugar beet)
- Other (Bio-MTBE from food waste),
- Other (Bio-MTBE from municipal organic waste),
- Other (Bio-MTBE from sewage sludge),
- Other (Bionaphta from palm oil mill effluent),
- Other (Bionaphta from used cooking oil),
- Other (Biopetrol from PFAD),
- Other (Biopetrol from tall oil),
- Other (Biopetrol from used cooking oil),
- Other (Biopetrol from waste vegetable oil or animal fat),
- Other (Biopropane from palm oil),
- Other (Biopropane from PFAD),
- Other (Biopropane from used cooking oil),
- Other (By-product in HVO production),
- Other (Corn ethanol, natural gas as process fuel in CHP plant),
- Other (Corn ethanol, natural gas as process fuel in conventional boiler),
- Other (Corn ethanol, process fuel not specified),
- Other (Cottonseed biodiesel),
- Other (Diesel (origin bio) from used cooking oil),
- Other (EFB),
- Other (ETBE renewable component),
- Other (Ethanol diesel from biomass fraction of industrial waste and residues),
- Other (Ethanol from barley),
- Other (Ethanol from biomass fraction of industrial waste and residues),
- Other (Ethanol from biomass fraction of wastes and residues from forestry and forest-based industries),
- Other (Ethanol from food waste),
- Other (Ethanol from molasses),
- Other (Ethanol from starch slurry),
- Other (Ethanol from waste in the food industry),
- Other (Ethanol from waste starch slurry),
- Other (FAEE from fish oil ethyl ester),
- Other (Fatty acid biodiesel),
- Other (FFBS),
- Other (Grape marcs and lees ethanol),
- Other (Hop ethanol),
- Other (HVO from animal fat),
- Other (HVO from animal manure and sewage sludge),
- Other (HVO from biomass fraction of industrial waste),
- Other (HVO from Brassica Carinata),
- Other (HVO from cat 3 animal fats),
- Other (HVO from co-processing - desulphurization of diesel fuel),
- Other (HVO from fish oil),
- Other (HVO from palm oil mill effluent and empty palm fruit bunches),
- Other (HVO from palm oil mill effluent),
- Other (HVO from PFAD),
- Other (HVO from POME),
- Other (HVO from RUCO),
- Other (HVO from Shea olein),
- Other (HVO from Soybean),
- Other (HVO from tall oil),
- Other (HVO from technical corn oil),
- Other (HVO from Thermochemical treatment with Hydrogen),
- Other (HVO from used cooking oil),
- Other (HVO from waste vegetable oil or animal fat),
- Other (Hydrotreated animal fat),
- Other (Hydrotreated vegetable oil from used cooking oil),
- Other (Hydrotreated vegetable oil and/or animal fats),
- Other (Hydrotreated vegetable oil from biomass fraction of wastes and residues from forestry and forest-based industries),
- Other (Liquid biogas from biomass fraction of industrial waste),
- Other (Methanisation),
- Other (Methanol (non-bio, renewable) from geothermal energy),
- Other (Mixed origin),
- Other (MTBE renewable component),
- Other (Natural gas as process fuel in CHP plant),
- Other (Non-sustainable bioethanol),
- Other (Non-sustainable biofuel oil),
- Other (Non-sustainable biopetrol),

- Other (Non-sustainable ETBE renewable component),
- Other (Non-sustainable HVO),
- Other (Off road biodiesel from brown grease),
- Other (Off road biodiesel from crude glycerine),
- Other (Off road biodiesel from food waste),
- Other (Off road biodiesel from oilseed rape),
- Other (Off road biodiesel from palm oil mill effluent),
- Other (Off road biodiesel from palm oil),
- Other (Off road biodiesel from soap stock acid oil contaminated with sulphur),
- Other (Off road biodiesel from soy),
- Other (Off road biodiesel from spent bleached earth),
- Other (Off road biodiesel from sunflower seed),
- Other (Off road biodiesel from tallow category 1),
- Other (Off road biodiesel from used cooking oil),
- Other (Off road biodiesel from waste pressings from production of vegetable oils),
- Other (oil crops biodiesel),
- Other (Other cereals ethanol, process fuel not specified),
- Other (Palmolein biodiesel),
- Other (Pure vegetable oil from used cooking oil),
- Other (SBE),
- Other (TAEE renewable component),
- Other (Triticale ethanol),
- Other (Used cooking fats and vegetable oils as fuel),
- Other (Vegetable fatty acid biodiesel),
- Other (Vegetable origin),
- Other (Waste animal fats from slaughterhouses),
- Other (Waste classified wetland grass),
- Other (Waste from the cereal industry),
- Other (Waste of processing vegetable fats, lubricants and soaps),
- Other (Waste vegetable oil),
- Other (Waste vegetable oil, lubricating oil, soap),
- Other (Biodiesel from tallow - category 3 or unknown),
- Palm oil biodiesel,
- Palm oil biodiesel (process not specified),
- Palm oil biodiesel (process with methane capture at oil mill),
- Pure vegetable oil from rapeseed,
- Rapeseed biodiesel
- Soybean biodiesel,
- Sugar beet ethanol,
- Sugar cane ethanol,
- Sunflower biodiesel,
- Used cooking oil - origin animal fat,
- Waste vegetable oil or animal fat biodiesel
- Waste wood ethanol,
- Wheat ethanol (bran as process fuel in CHP plant),
- Wheat ethanol (lignite as process fuel in CHP plant),
- Wheat ethanol (natural gas as process fuel in CHP plant),
- Wheat ethanol (natural gas as process fuel in conventional boiler),
- Wheat ethanol (process fuel not specified).

European Topic Centre on Climate change
mitigation and energy
Boeretang 200
B-2400 Mol, Belgium
Tel.: +32 14 33 59 77
Web: www.eionet.europa.eu/etcs/etc-cme
Email: etccme@vito.be

The European Topic Centre on Climate change mitigation and energy (ETC/CME) is a consortium of European institutes under contract of the European Environment Agency.

European Environment Agency
European Topic Centre on Climate change
mitigation and energy