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EU renewable energy targets in 2020:

2015 Legislative update

JEC Biofuels Programme

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This report updates and revises: the 2011 JEC Biofuels Study (EUR 24770 EN) and its 2014 revision (EUR 26581 EN) released by the JEC partner organisations. This report is available for downloading at:

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Executive Summary

Introduction

The on-going research collaboration between the Joint Research Centre of the European Commission, EUCAR and Concawe has reviewed the work done for the JEC Biofuels Study 2014 (JEC-Bio, 2014), which was itself an update of the JEC Biofuels Study 2011 (JEC, 2011) in order to update the report with the latest relevant implemented legislation – the so-called "ILUC Directive" (EU Directive 2015/1513 of 9 September 2015) and EU Directive 2015/652 of 20 April 2015 prescribing the methodology to be used for calculating upstream CO_2 emission reductions in the context of the FQD target. The results from this update are compared to those from the 2014 study for the Council compromise text of December 2013[1] given that this was the RED and FQD amendment proposal closest to the relevant implemented legislation.

This update does not aim to review assumptions regarding the definition of the baseline and alternative scenarios, such as for example vehicle fleet, energy demand, supply outlook, used in the 2014 study, but only clarifications coming from the final legislation (more information on these assumptions can be found in the JEC Biofuels study 2014 report and respective annexes). Other changes, it is expected, will be part of the next major update planned for 2H 2017.

Associated calculations of the Greenhouse Gas (GHG) reductions as mandated in Article 7a of the 2009 Fuel Quality Directive (FQD)[2] have been reviewed for the same four different fuel demand scenarios as in the 2014 study which provides a robust scientific assessment of the different fuel demand scenarios and their associated impacts on the RED 10% renewable energy and FQD 6% GHG reduction target for transport. The primary focus is on road transport demand although all other transport modes (aviation, rail, inland navigation and off-road) have also been considered as they are important contributors towards reaching the renewable energy and GHG reduction targets.

An analytical tool, called the Fleet and Fuels model (F&F) that was developed and used in the 2011 and 2013 JEC Biofuels Studies has been used for this update. The model is based upon historical road fleet data (both passenger and freight) in 29 European countries (EU27 plus Norway and Switzerland) and it projects forward the composition of the vehicle fleet to 2020 based on assumptions including the impact of regulatory measures. Additional information on the Fleet and Fuels model can be found in the 2014 study report (JEC-Bio, 2014).

Key Messages

The results from the update of the regulatory framework for each of the fuel blending scenarios were compiled to compare the potential contributions of renewable energy in transport from each scenario.

The reference scenario in this 2016 update is based on biofuel blends (B7, E5 and E10)[3] that are currently standardized as market road fuels in Europe.

- As was also the case for the reference scenario in the 2013 JEC Biofuels Study, the new reference scenario falls short of the RED 10% renewable energy target at 9.5%, when the renewable energy contribution from road transport is combined with an approximately 1.7% additional contribution from non-road transport modes.

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[1] The Council of the European Union approved a compromise text in the context of Interinsitutional File 2012/0288 (COD), 16546/13 of 3 December 2013 on the 'Proposal for a Directive of the European Parliament and of the Council amending Directive 98/70/EC relating to the quality of petrol and diese. This reference is provided as CEU, 2013.

[2] FQD: EU Fuel Quality Directive (Dir 2009/30/EC) of 23 April 2009. Reference provided as EC, 2009b.

[3] In this report, biofuel contents are expressed as the percentage of bio-component in fossil fuel on a volume basis. For example, B7 stands for 7% v/v Fatty Acid Methyl Ester (FAME) in diesel fuel while E5 stands for 5% v/v ethanol (or 2.7wt% oxygen) in gasoline.

The other three market fuel demand scenarios from the 2014 study have also been analysed, based on higher biofuel contents and multiple blend grades.

- Evaluation of these three scenarios has shown that the 10% RED target is theoretically reached for two of these scenarios in which an E20 blend is introduced in the market in 2019 and E5 is substituted by E10, which then makes up 98.6% of total gasoline sales in 2020. E10 is assumed to replace E5 at the same time as E20 replaces E10. As a result it is the substitution of the E5 by E10 that drives the apparent progress towards RED and the uptake of E20 has only a minor effect on the attainment level towards the RED target, as it only represents 1.4% of gasoline demand in 2020.
- The main reason for reaching the RED target for these particular scenarios compared to the 2013 Study is a different understanding of how the counting factors for advanced biofuels and renewable electricity in Rail and Road should be applied towards calculating the %RED.
- None of the considered scenarios achieves the minimum 6% GHG reduction target mandated in FQD Article 7a with the assumptions made for the FQD calculations.
- Instead, 4.0% savings are achieved when all relevant transport modes are included. This saving is smaller than the one in the previous study (4.3%) due to the update of the 2010 fuel baseline and the removal of the power train efficiency factor for electric vehicles to avoid possible duplication of considering the GHG intensity of electricity used in battery electric vehicles in the FQD 7a7a (see section 3.2).

As in the 2011 and 2014 JEC Biofuels Studies, this update does not assess the viability, costs, logistics, or impact on the supply chain and vehicle industry of the different demand scenarios. Additional work would be needed before determining the commercial readiness of any one scenario.

Overall, the RED fuel demand scenario results depend on the underlying assumptions and should be considered as “theoretical”. Implementation of any scenarios would depend on a combination of factors, the associated costs and the timeliness of decisions.

Additional considerations

Consumer acceptance of biofuels, the respective market blends and a flawless market introduction of such market blends are critical elements of the fuel demand scenarios.

On the supply side, the pace of introduction of renewable fuels presented in the scenarios depends not only on the availability of the feedstock and fuels but also on the compatibility of the supply and distribution system for all fuel products (including proliferation of blending options). It also depends on the contribution of non-road transport modes towards approaching the RED 10% target.

The reference scenario is based on biofuel blends (B7, E5 and E10) that are currently standardized as market road fuels in Europe while the three market fuel demand scenarios include fuel blends that are neither mandated, not standardized as market road fuels.

Realisation of scenarios requires policy measures to enable a smooth transition from today’s situation. It is therefore important that fuel standardisation proceeds in a co-ordinated way to reduce market fragmentation for fuels and their supply. Market fragmentation would also negatively impact vehicle manufacturing and customer confidence. Compatibility between different fuel blends and vehicles is critical in determining the pace and uniformity of introduction of alternatives in a single European market, and avoiding a proliferation of nationally-preferred and nationally-adapted solutions. Multi-stakeholder coordination and timely decisions will be essential in order to approach the RED and FQD targets.

The 2014 JEC Biofuels study acknowledged among its findings that much more technical work will be needed to ensure the feasibility of any of the fuel demand scenarios considered. This conclusion still holds for the 2016 study update. The compatibility between the proposed market fuels having higher renewable fuel contents with road transport vehicles and those in other transport modes is not proven and the evaluation process to ensure compatibility will require time, testing and investment.

Report Outline

In this report, the potential for renewable fuels to achieve mandatory targets for renewable energy and GHG intensity reduction in EU transport by 2020, in light of 2015 "ILUC Directive" and Council Directive EU 2015/652 implemented legislation has been re-assessed.

Following a review of the EU regulatory framework in Chapter 2, Chapter 3 describes the outcomes of the study including the reference case, comparison with the Council Compromise text included in the JEC Biofuels Study 2014 and different market fuel demand scenarios. Conclusions from the study are presented in Chapter 4.

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Abstract

This report details the 2016 minor update of the five-year JEC Biofuels Programme which was first published in 2011 and updated in 2014. The research collaboration between the **J**oint Research Centre of the European Commission, **E**UCAR and **C**oncawe has investigated the potential role of biofuels and other renewable and alternative energy sources in achieving the mandatory 10% renewable energy target in the transport sector by 2020 with an associated calculation of the impact of renewable fuels on the Fuel Quality directive target.

The focus of the analysis was on road transport although all other transport modes have been considered.

A dedicated analytical tool, the so-called Fleet and Fuels (F&F) model, has been developed and used. The modelled fleet development leads to a transport fuel demand and constitutes the basis on which penetration and distribution of alternative motor fuels – and availability thereof – are analysed. The impacts of key parameters on the achievement of the RED and FQD targets are analysed in sensitivity cases.

1. Introduction

1.1 What is JEC?

The JEC research collaboration between the Joint Research Centre of the European Commission, EUCAR (the European Council for Automotive Research and Development) and Concawe (the oil companies' European association for environment, health and safety in refining and distribution) began in 2000. The three organisations have collaborated in fields related to the sustainability of the European vehicle and oil industries, providing information relating to energy use, efficiency and emissions from a broad range of road vehicle powertrain and fuel options. The JEC Well-to-Wheels (WTW) reports (JEC, 2014) and methodology have become a scientific reference in the European energy research landscape.

1.2 The JEC Biofuels Programme

The first JEC Biofuels Study was released in 2011 (JEC, 2011b) providing a robust scientific basis for decision making and a sound outlook on the implementation of EU regulation, including the Fuel Quality Directive (FQD) (EC, 2009b).

In 2013 JEC partner organisations agreed to resume their Biofuels Programme based on the perceived need and the opportunity to revise their 2011 report acknowledging that it had become outdated. The need to update was related to two sets of considerations:

- Proposals to revise the 2009 Directives at the EU level were introduced by the European Commission in October 2012 (EC, 2012), amended by the European Parliament in September 2013 (EP, 2013) and by the Environment Council in December 2013 (CEU, 2013). These legislative concepts for RED and FQD implementation bore significant differences and – therefore – impacts on the feasibility, the efficiency and the ambition level required to achieve them.
- Market development factors (such as road fleet renewal, availability of market blends (E10), consumers' preferences determining the uptake of fuel alternatives, and the availability of advanced renewable fuels differed considerably from projections in the 2011 report.

In the JEC Biofuels Study 2014, a revised reference scenario and three fuel demand scenarios were developed and tested on the legislative concepts proposed by EU institutions to modify the RED and FQD regulation with a view to include ILUC concerns. The revised reference scenario was then compared to the outcomes of the JEC Biofuels Study in 2011 to identify and characterise the main drivers behind different results on the capacity to attain the RED and FQD targets.

The main results from the 2014 study are summarized in the table below:

For Reference Scenario		RED	FQD [w/o ILUC]	FQD [w/ ILUC]
TARGET		10%	6%	NA
2011 JEC Biofuel Study	2009 RED & FQD	9.7%	4.4%	NA
2013 JEC Biofuel Study	2009 RED & FQD	8.7%	4.3%	NA
	2012 EC Proposal	7.8%	4.3%	1.0%[4]
	2013 EP 1st Reading	8.2%	NA	1.0%
	2013 Council Text	8.7%	4.3%	1.0%[4]

Table 1-1 Results from JEC Biofuels Study 2014

In 2015 two directives amending FQD and RED came into force: Directive 2015/652 (EU, 2015a), laying down calculation methods and reporting requirements pursuant to Directive 98/70/EC relating to the quality of petrol and diesel fuels and the "ILUC Directive" (Directive 2015/1513) (EU, 2015b).

Given these developments, the JEC Consortium agreed to undertake a short update of the 2014 JEC Biofuels study reflecting the approved legislative framework regarding the update of RED and FQD.

1.3 Objective of the 2016 update

The objective of this update is to review the work done for the JEC Biofuels study 2014 and to update the report with the latest implemented legislation – the "ILUC Directive" and Council Directive EU 2015/652 (EU, 2015a).

The results from the current study will be compared to those from the 2014 study for the Council Compromise run given that this was the RED and FQD amendment proposal closest to the implemented legislation.

This update does not aim to review assumptions regarding vehicle fleet, energy demand, and supply outlook etc., used in the 2014 study. More information on these assumptions can be found in the JEC Biofuels study 2014 report and respective annexes.

[4] For reporting only

1.4 Comparison between 2014 JEC Biofuels Study and 2016 study update

Given that the "ILUC directive" is, in its essence, the text proposed by the Environment Council to revise the 2009 Directives, the results of the current update are compared with those from the 2014 JEC Biofuels study Council Compromise scenario.

The 2016 study reflects the latest legislative updates and the interpretation of regulatory text regarding how multiple counting for advanced biofuels and renewable electricity should be applied towards calculating the progress towards the RED target. A detailed description of the differences between the outcomes of the JEC Biofuels study in 2014 and its 2016 revision is presented in section 3.2. These differences are summarised in table 1.3 and the main causes briefly described.

Update	JEC Biofuels Study 2014	JEC Biofuels Study update 2016
2010 Fuel baseline Standard	88.3gCO_2e/MJ	94.1gCO_2e/MJ
Electricity in transport – Efficiency factor	For electricity in Transport, GHG intensities were adopted from JEC WTW v4. For 2010 the EU-Mix value of 150.1gCO_2e/MJ (low voltage supply) was multiplied by the power train efficiency factor of 0.4. For 2020, a similar approach was taken except the EU-Mix value used was 145gCO_2e/MJ (based on "EU energy trends to 2030" (EC, 2010)).	After reviewing the model the JEC consortium decided to remove the efficiency factor as it was considered that this factor was already taken into account in the consideration of CO_2 emission of electricity used in electric vehicles in the model, . The EU-Mix CO_2 intensities for electricity production were kept at 150gCO_2e/MJ and 145gCO_2e/MJ for 2010 and 2020 respectively.
Renewable Energy Sources (RES) Electricity in Rail – Counting factors	For the calculation of the renewable electricity consumed by electrified rail, a multiple factor was not considered.	The model was updated in order to consider the 2.5 times factor for RES electricity in rail.
Advanced Biofuels and RES Electricity in Road – %RED Counting factors usage	Advanced biofuels: 2x in the RED numerator[6]; RES electricity in ROAD: 5x in the RED numerator and denominator.	Advanced biofuels: 2x in the RED numerator and denominator[7]; RES electricity in ROAD: 5x in the RED numerator

Table 1-2 **Differences between the JEC Biofuels Study 2014 and 2016 update**

Table 1.3 shows the main results of the two studies for the reference scenario:

For Reference Scenario		RED	FQD
TARGET		**10%**	**6%**
2014 JEC Biofuels Study	2013 Council Compromise	8.8%	4.3%
2016 JEC Biofuel Study legislative update	2015 Adopted directives	9.5%	4.0%

Table 1-3 Overview of RED and FQD results v2014 vs v2016

In the current study, the RED target of 10% renewable energy in transport by 2020 is not met, but significant progress towards the target has been made compared with the 2014 study (from a figure of 8.8% for the Council compromise run to 9.5% in the current study). This is mainly due to the inclusion of the 2.5x the energy input credit given to renewable electricity in rail.

The FQD target of 6% GHG emissions reduction is also not met, instead 4.0% savings are achieved when all relevant transport modes are included. This saving is smaller than the one in the previous study (4.3%) due to the update of the 2010 fuel baseline standard and the removal of the power train efficiency factor for electric vehicles to avoid possible duplication of considering the GHG intensity of electricity used in battery electric vehicles in the FQD 7aas explained in table 1-2.

[5] See Art. 21.2 of the RED "biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material"

[6] Biofuels according to Art. 21.2 are counted twice in the numerator of the RED calculation – not in the denominator

[7] See Art. 3.4 of the RED; the factor of 2.5 is used in the numerator and the denominator

2. EU Regulatory Framework

The reference regulatory framework within which the JEC Biofuels Programme was defined is the so-called "EU Energy Package", and more specifically the Renewable Energy Directive (RED) (EC, 2009a) and Fuels Quality Directive (RED) (EC, 2009b).

2.1 The Renewable Energy Directive

The RED obliges Member States to achieve a general target of 20% renewables in all energy used by 2020 and a sub-target of 10% renewables in the transport sector.

EU Member States are required to meet a minimum binding target of 10% renewable energy share in the transport sector by 2020. All types of renewable energy used in all transport modes are included in the target setting.

Some renewable energy sources are counted differently. For example, the contribution of advanced biofuels[5] towards achieving the 10% target is counted twice[6] whereas electricity from renewable energy sources for road transport counts 5 times[7].These are the original factors which have been updated as discussed later in the report.

According to the RED, biofuels must meet minimum sustainability criteria as well as minimum GHG savings per energy unit.

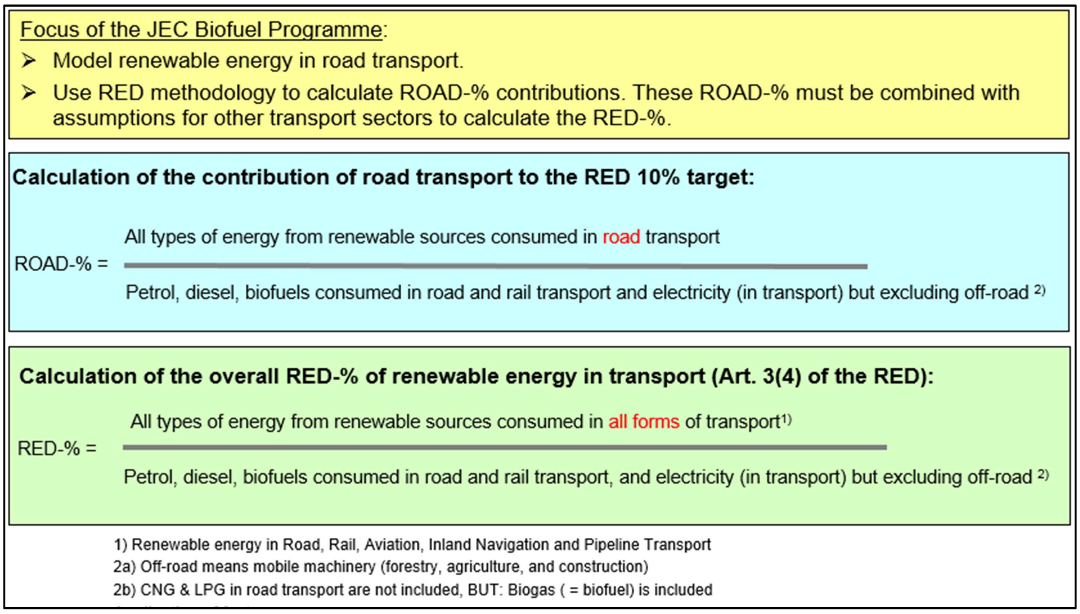

Figure 2-1 Renewable Energy calculations in RED

[5] See Art. 21.2 of the RED "biofuels produced from wastes, residues, non-food cellulosic material, and ligno-cellulosic material"

[6] Biofuels according to Art. 21.2 are counted twice in the numerator of the RED calculation – not in the denominator

[7] See Art. 3.4 of the RED; the factor of 2.5 is used in the numerator and the denominator

2.2 The Fuel Quality Directive

The FQD sets environmental requirements for gasoline and diesel fuel in order to reduce their GHG intensity. These requirements consist of technical specifications for fuel quality parameters and binding targets to reduce the fuels' life cycle GHG emissions.

By 2020, based on a 2010 baseline, the FQD requires:

- 6% reduction in the GHG intensity of fuels traded in the EU by 2020 (2% indicative reduction by 2014 and 4% by 2017);
- 2% reduction in the GHG intensity of fuels traded in the EU by 2020 from developments in new technologies, such as Carbon Capture and Storage (CCS);
- 2% reduction in the GHG intensity of fuels traded in the EU by 2020 from the purchase of Clean Development Mechanism (CDM) credits under the Kyoto Protocol[8].

The last two targets are subject to review.

The FQD places the responsibility for reducing life cycle GHG emissions of fuels traded in the EU on fuel suppliers.

The FQD Article 7a target takes into account the impact of renewable fuels on life cycle GHG emission savings of fuels supplied for road vehicles, non-road mobile machinery (including rail and inland marine), agricultural and forestry tractors, and recreational craft. The main distinction compared to the RED as regards the scope of transport activities was that the FQD excluded air transport fuel consumption whereas the RED included it. Directive 2015/1513 amends FQD Article 7a as follows – it allows Member States to permit suppliers of biofuels for use in aviation to choose to be contributors to the reduction obligation laid down in paragraph 2 of Article 7a provided that those biofuels comply with the sustainability criteria set out in Article 7b.. The FQD calculation also includes off-road fuel consumption while it is excluded from the RED calculation.

Additionally, the FQD requires a 2010 reference value for life cycle GHG emissions per unit of energy from fossil fuels to enable the calculation of GHG savings from biofuels and alternative fuels.

From 2011 fuel suppliers must report annually to Member States on the life cycle GHG emissions per unit of fuel supplied.

Other regulatory acts at EU level are also relevant because they contribute to the setting of the boundaries of the projected development of both fleet and fuels demand in Europe. These are briefly outlined in Section 2.3.

GHG savings are calculated according to the FQD Annex IV C. Methodology Sub. 4 (EC, 2009b):

Calculation of the overall FQD-% GHG emissions saving in transport (Art. 7a of the FQD):

$$\text{FQD-\%} = \frac{\text{Fossil transport fuels GHG intensity 2010}^{2)} - \text{All transport fuels GHG intensity in 2020}^{1)}}{\text{Fossil transport fuels GHG intensity 2010}^{2)}}$$

Figure 2-2 FQD calculations defined by the European Commission

The footnotes in above figure are explained below:

[8] http://cdm.unfccc.int/index.html

1) "All transport fuels GHG intensity in 2020" GHG intensity includes fuels used in road vehicles, non-road mobile machinery, rail, agricultural and forestry tractors and recreational craft, but excludes:

- Electricity used in rail
- Aviation fuels (although this was amended by Directive 2015/1513 as described above)
- Inland Navigation fuels

2) The "Fossil transport fuels GHG intensity 2010" is calculated according to the following formula and more detail on the calculation methodology can be found in JEC, 2013:

$$\text{Baseline GHG intensity} = \frac{\sum_{a\ to\ z} (GHGi_{fuel\ x} * MJ_{fuel\ x})}{\sum MJ_{a\ to\ z}}$$

2.3 2015 European legislative amendments

The FQD Implementing Directive (Directive EU 2015/652) (EU, 2015a) prescribing the methodology to be used for calculating upstream emission reductions in the context of the FQD target was adopted on 20 April 2015. This directive sets out the average life cycle greenhouse gas intensity default values for fuels other than biofuels and electricity and the 2010 fuel baseline standard.

On 9 September 2015, Directive EU 2015/1513 (so-called "ILUC Directive") was adopted (EU, 2015b). The "ILUC Directive" is in its essence the compromise text resulting from co-decision procedure (2012/0288 COD) to complete and revise the 2009 RED and FQD Directives. Main key elements of the ILUC Directive are:

- Tackles indirect land-use change emissions through a 7% cap on conventional biofuels, including biofuels produced from energy crops, to count towards the renewable energy directive targets regarding final consumption of energy in transport in 2020. Member States have the possibility to set a lower cap.
- Sets an indicative 0.5% target for advanced biofuels as a reference for national targets which will be set by EU countries in 2017
- Harmonizes the list of feedstocks for biofuels across the EU whose contribution would count double towards the 2020 target of 10% for renewable energy in transport (Annex IX)
- Requires that biofuels produced in new installations emit at least 60% fewer greenhouse gases than fossil fuels
- Introduces stronger incentives for the use of renewable electricity in transport (by counting it more towards the 2020 target of 10% for renewable energy use in transport. 5x for renewable electricity in road transport and 2.5x for renewable electricity in rail)
- Includes a number of additional reporting obligations for the fuel providers, EU countries and the European Commission.
- Member States must enact the legislation by 2017.

3. Outcome of the study

This chapter presents the results of the study. Details related to energy demand in Road and non-Road modes of transport is not presented, given that these are not affected by the changes made to the model in the 2016 study review. For more details on energy demand for each mode of transport, please refer to the 2013 JEC Biofuels study. However, the updates made to the model do affect both the attainment levels towards RED and FQD targets. The following sections present the effects of the model update in the reference scenario and in the different energy demand scenarios assuming the introduction of higher blending grades on the market.

3.1 Reference Scenario Analysis

The reference scenario includes E5, E10 and B7 as main fuel grades for road vehicles. Furthermore, a variety of alternative powertrain and fuelling options are available across all vehicle classes. All assumptions are described in detail in the 2014 JEC Biofuels Study, Chapter 3, "Description of model and Methodology"

Fossil energy demand changes compared to baseline year 2010

- Bio gasoline demand in all sectors increases by 29% from 2010 to 2020. Ethanol remains the main biogasoline component with 3.7Mtoe in 2020 with 19% of this demand assumed to be met by non-food energy sources.
- Bio diesel demand increases by 56% from 2010 to 2020 to 17.6 Mtoe. Large biofuel volumes are needed with FAME remaining the dominant biodiesel. FAME demand shows an increase of 14% from 2015 to 2020. The supply of non-food biodiesel by 2020 is 1.9Mtoe.

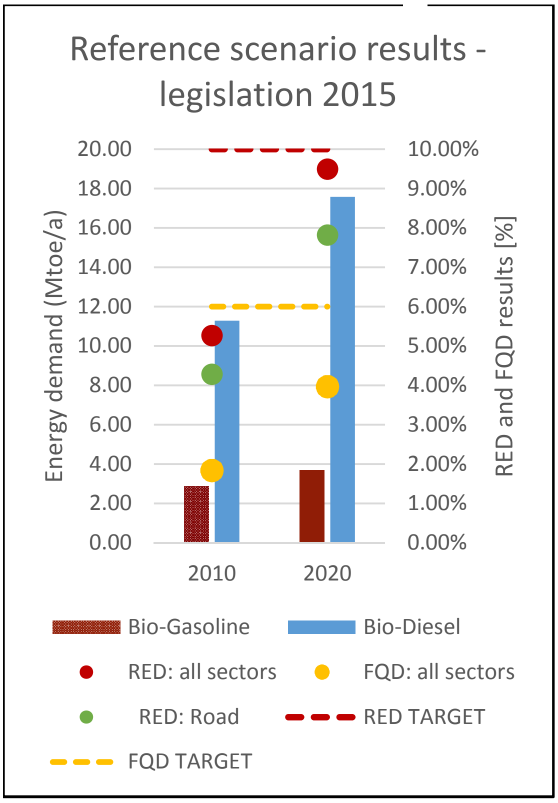

Figure 3-1 Reference scenario results

The RED target of 10% renewable energy in transport by 2020 is not met, but there is an increase in progress towards this target from the 2013 study (from a figure of 8.8% for the Council compromise run to 9.5% in the current study). This is mainly due to the inclusion of the 2.5x the energy input credit assumed to now be given to renewable electricity in Rail. Rail transport is the biggest consumer of electricity within all modes with a demand of 1.76Mtoe in 2020. Non-road contribution in this study is 1.7% of the total %RED hence the share of renewable electricity in total transport electricity demand is of great importance.

The FQD target of 6% GHG emissions reduction is also not met, instead 4.0% savings are achieved when all relevant transport modes are included. This number is smaller than the one in the previous study (4.3%) due to the update of the 2010 fuel baseline standard and the removal of the power train efficiency factor for electric vehicles to avoid possible duplication of considering the GHG intensity of electricity used in battery electric vehicles as it had been previously been taken account of in the model (see section 3.2).

The 7% accounting cap on conventional biofuels imposed by the "ILUC Directive" (proposed on the 2013 Council Compromise) is not a constraining factor. In other words, the biofuels demand as determined by the F&F model given the grades E5, E10 and B7 is fulfilled through the use of conventional biofuels.

Introducing a more restrictive accounting cap on biofuels from food type feedstocks (as originally proposed by the European Commission and Parliament for the review of the RED and FQD Directives) would make it more difficult to attain the RED renewable energy target by 2020. Fuel suppliers are incentivised to use renewable energy from advanced feedstock by the introduction of multiple counting factors. However, the supply outlook shows that advanced biofuels production is limited towards 2020.

3.2 Reference scenario comparison between 2013 JEC Biofuels Study and 2016 study update

Updating the JEC Biofuels Study results in a revised estimate of the renewable content and GHG savings achievable in 2020. The 2013 JEC Biofuels study reference scenario indicated a level of attainment of 8.8% renewable energy content compared with 9.5% in this 2016 revision. On the other hand the GHG savings (against the FQD 6% target) in the 2014 study were 4.3% in 2020, whereas in the current study they have decreased to 4.0%. It is important to outline the main causes of these differences.

Figures 3.3 and 3.4 display the main factors contributing to the differences.

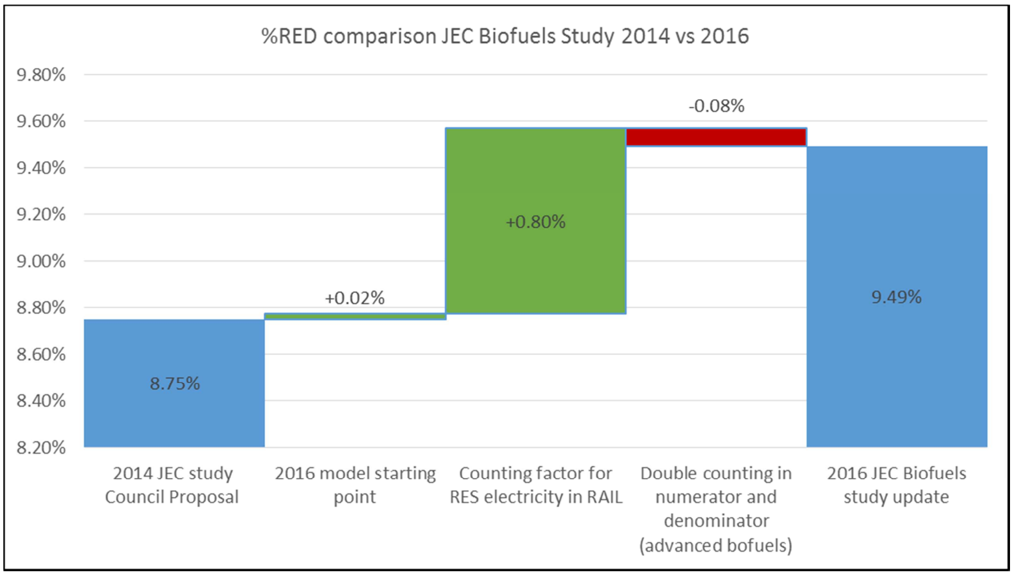

Figure 3-2 Impact of the different updates in %RED

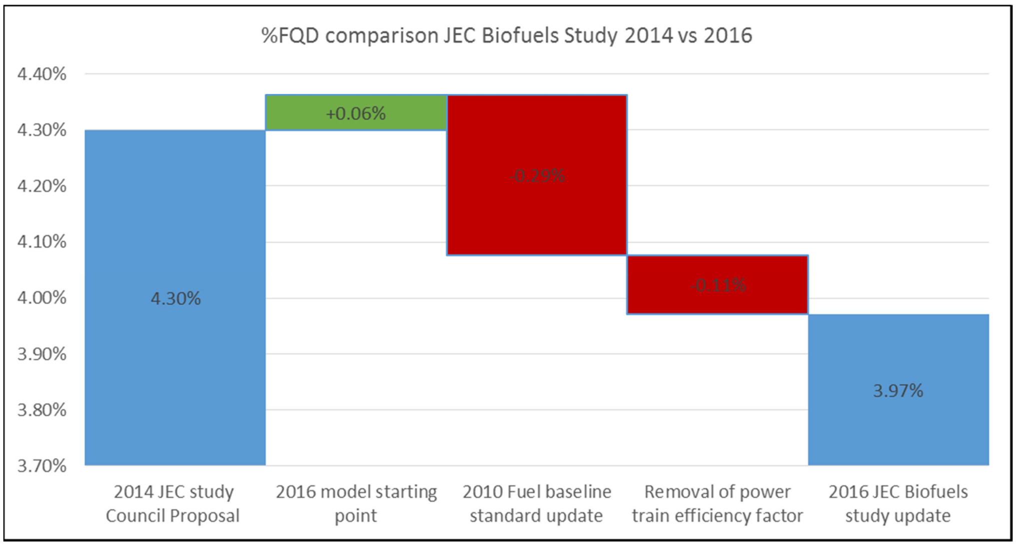

Figure 3-3. Impact of the different updates in %FQD

The starting point of both models already leads to some small differences (%RED=+0.02% and %FQD=+0.06%). This is due to minor improvements in some of the calculations from the previous study to the current update.

Comparing the results from both studies for the % RED calculation, the major impact comes from the contribution from renewable electricity consumed by electrified Rail (+0.8% in the current study). That consumption is now been considered to be 2.5 times the energy content of the input electricity from renewable energy sources consumed by Rail, which was not considered in the 2014 study.

Directive EU 2015/1513 (EU, 2015b) revises the counting factors for advanced biofuels and renewable electricity in Rail and Road towards calculating the %RED. This resulted in a 0.08% decrease in the achieved %RED. This decrease is essentially due to the fact that the double counting for advanced biofuels is now accounted for both in the numerator and denominator where before was only considered in the numerator. Regarding the %FQD the biggest impact comes from changing the 2010 Fuel baseline standard (=-0.29%). The fuel baseline standard is calculated based on the European Union average fossil fuel consumption of petrol, diesel, gasoil, LPG and CNG for 2010 and it is used to calculate the % GHG savings by 2020 (%FQD). The EU Council Directive 2015/652 (EU, 2015a) sets out in Annex II an updated figure of 94.1gCO_2e/MJ.

As this figure increases from the one used in the previous study (88.3gCO_2e/MJ) the result is a reduction in the %FQD achievement.

In the same way, the removal of the power train efficiency factor (0.4 factor multiplied by the EU-Mix electricity intensity) impacts the GHG savings in 2020 by -0.11%. This was done for the 2016 update as it was considered that this was already taken account of in the CO_2 efficiencies of the electricity used in electric vehicles and would result in a duplication of consideration.

3.3 Fuel demand scenarios

Besides the reference scenario, there were three additional scenarios analysed in the 2014 study. These scenarios assume different fuel demand compositions due to the introduction of different fuel grades. A summary of all of the analysed scenarios can be found in Figure 3-4.

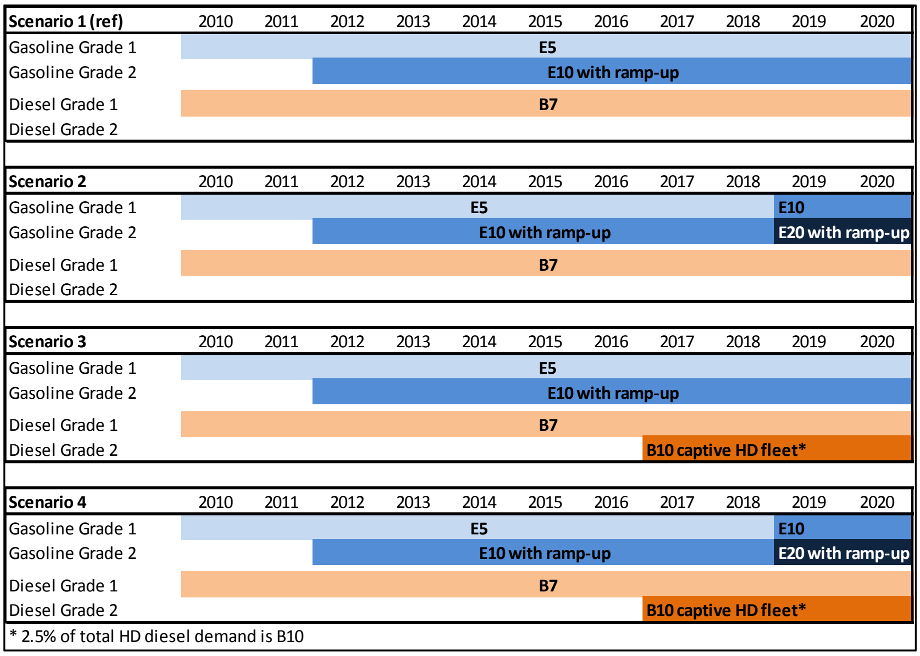

Figure 3-4 Fuel blending scenarios

There are two main differences between the reference scenario and the three fuel demand scenarios: (1) the market introduction of E20 gasoline blend and (2) the market introduction of B10 diesel blend for captive fleets representing 2.5% of total heavy duty diesel demand, which was an assumption based on experts opinion from EUCAR for the 2014 Study. It should be noted that the reference scenario is based on biofuel blends (B7, E5 and E10) that are currently standardized as market road fuels in Europe whilst two out of the three market fuel demand scenarios include fuel blends that are neither mandated, not standardized as market road fuels.

Identical to the 2014 Study, this study assumes in scenario 2 that E20 blend will be introduced in the market in 2019. The assumptions for the 2014 study have been used again but should be considered to be even more unlikely for the 2016 update, particularly when it comes to the assumption that all gasoline vehicles sold in 2019 are assumed to be E20-compatible and from 2019 onwards all gasoline vehicles from 2018 and older are E10 compatible. The same ramp-up function is used as for the introduction of E10.

Scenario 3 assumes that the diesel grade B10 is introduced for captive fleets only, representing 2.5% of the heavy duty diesel demand.

Scenario 4 is the combination of scenarios 2 and 3, introducing E20 - and B10 for captive fleet.

All assumptions are kept the same in all scenarios, with the exception of the revised regulatory framework including any changes in accounting assumptions.

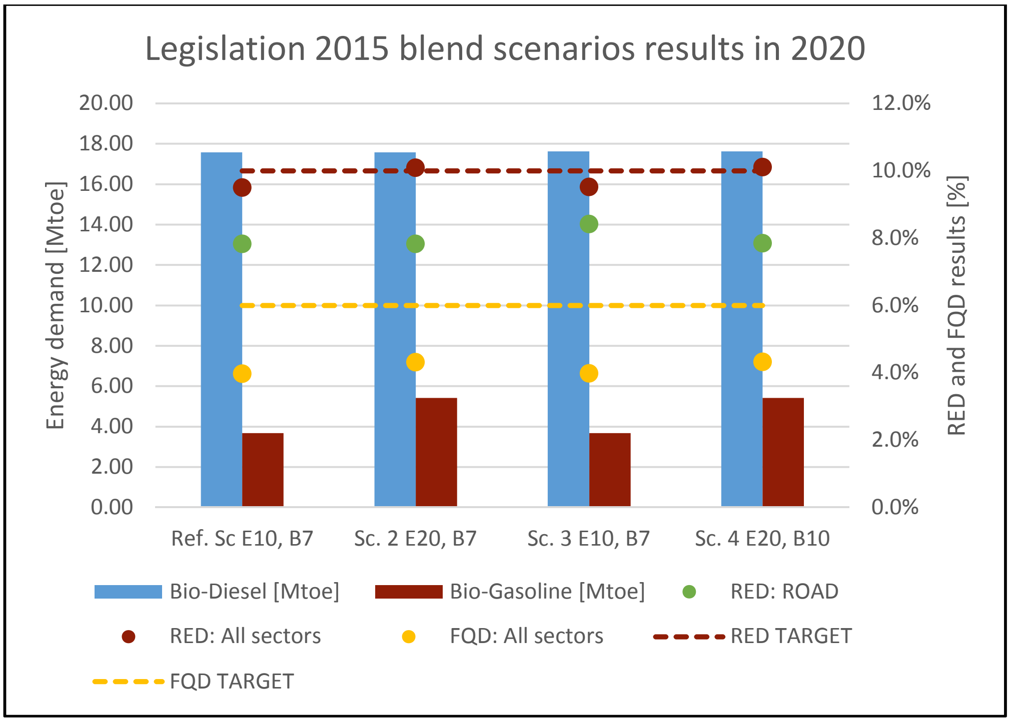

Figure 3-5 Fuel blending scenarios results

It is evident that the road transport mode, with the given assumptions, is still expected to deliver the lion's share of progress towards the 10% RED target and 6% FQD GHG savings target. At the same time, the role of non-road transport modes continues to be essential to approach the regulatory targets.

	Ref. Scenario	Scenario 2 [E10,E20,B7]	Scenario 3 [E5,E10,B7,B10]	Scenario 4 [E10,E20,B7,B10]
Bio-gasoline [Mtoe]	3.68	5.42	3.68	5.42
Bio-diesel [Mtoe]	17.57	17.57	17.63	17.63
RED%	9.5%	10.1%	9.5%	10.1%
FQD%	4.0%	4.3%	4.0%	4.3%

Table 3-1 Fuel blending scenarios results

With respect to the introduction of higher blend grades, the current outlook suggests that, although the contribution is small it is enough to meet the RED 10% target for the case of scenarios 2 and 4. Introducing new fuel blends to Scenarios 2 and 4 makes the assumption that when E20 is introduced E10 becomes the main gasoline grade, which implies maximum possible uptake of E10 at the same time as E20 replaces E10.This results in a steep increase of bio-gasoline demand rather than the introduction of E20 itself which has minimal impact on the ability to meet the targets. The resulting E10 uptake in 2020 is 98.6% and E20 is 1.4% of total gasoline sales in 2020.

4. Conclusions

The main conclusions from the 2014 JEC Biofuel study still hold for the 2016 study update:

The outlook towards 2020 for European road transport is expected to be characterised by the implementation of legislative targets that will impact car manufacturers (vehicle technology), refiners (refinery technologies, fossil fuels and final market fuels), fuel distributors and renewable energy producers. The outcomes of the JEC Biofuels Study and its Fleet &Fuels model can be evaluated by focussing on these four aspects of the impact of EU policy.

– ***Vehicle technology.*** In the current decade vehicle manufacturers will be faced with tighter regulations on emissions of CO_2 and air pollutants (PM, NOx, etc.). Hence, vehicles can be expected to be equipped with more advanced powertrain and after-treatment systems, while at the same time we will see further diversification in powertrain technology (conventional, hybrid, battery electric, etc.) and fuel types.

  Total fuel consumption of the entire fleet is expected to fall towards 2020 whereas the total diesel demand volume is likely to show slight growth until 2014-2016 but can be expected to fall or stabilize towards 2020. Continued efficiency improvements and dieselization of the passenger car fleet will trigger a continued decline in gasoline demand.

  Current vehicles are already compatible with E10 (in the F&F model assumed from model year 2000 onwards) and B7. Compatibility with higher biofuel blends is still to be proven and this will require time, testing effort and investment.

  Increasing pressure from the EU and national regulators on limiting emissions is expected to lead to higher associated costs. Customer preferences may potentially be in conflict with transport and energy policies.

– ***Refinery technology.*** Fuel production at refineries is expected to be confronted with an increasing diesel/gasoline demand ratio. This trend leads to higher CO_2 emissions due to more energy-intensive processing to satisfy the increasing diesel demand and the more severe product specifications. EU regulations may further limit CO_2 emissions which will likely increase associated costs, as outlined above under vehicle technology.

– ***The supply and distribution system***. It is uncertain whether existing logistics infrastructure will be compatible with higher biofuel blending grades. A coordinated development of CEN specifications is needed for higher grades to match the needs and/or payback investments needed to adapt the infrastructure.

  The scenario and sensitivity analyses show that higher blends need to be fully utilised in order to approach the EU targets mandated by the RED and FQD and to avoid market fragmentation.

– ***Biofuels and other renewable energy sources for transport.*** In the first place, the RED's 10% (energy basis) mandatory target by 2020 is a fixed goal. Conventional biofuels are widely available but are accompanied by sustainability concerns. The 7% cap on conventional, food-competing biofuels towards contributing to the 10% of renewable transportation fuels in the RED target in the year 2020 (while grandfathering existing investments in Europe) could potentially result in slower development and availability of advanced biofuels in the European market.

  The different pace of development and varying priorities across EU Member States might lead to a proliferation of fuel varieties and specifications. For that reason, the attractiveness of implementing different fuel demand scenarios of this study is likely to vary by Member State.

On the other hand, the standardisation process (e.g. CEN specifications) is striving to keep pace with the regulatory targets, which are more quickly adopted. Therefore robust and reliable standardisation processes are necessary to enable the implementation and success of future fuel roadmaps to achieve the RED and FQD targets.

Customer confidence in the fuel and in the renewable fuel strategy has been identified as a critical factor, particularly in view of a multiplicity of fuel blend grades available to the consumer.

Open questions remain concerning both the pace of development of advanced biofuels and the likelihood of availability of supply volumes to all transport modes at any given premium prices.

4.1 Key messages

The baseline and alternative scenarios used in the JEC Biofuels Study in 2014 have been reviewed to account for regulatory revisions of the RED and the FQD in the course of 2015. The revised reference scenario has been compared to the outcomes of the Council compromise text of December 2013 which has proven to be the legislative concept coming closest to the regulatory text which was eventually adopted. The main conclusions to be drawn from the analysis performed in this revised version of the JEC Biofuels study using the F&F model are:

- With an updated understanding for the accounting factors, the multiplication factor for renewable electricity in rail (2.5 times the energy input) has the most significant impact towards the calculation of the %RED at 0.8%.
- Together with this change, fuels blending scenarios 2 and 4 (where E20 blend is introduced in the market in 2019 and the E10 blend uptake is 98.6% of total gasoline sales in 2020) meet the RED. It should be noted that the main effect is the substitution of E5 by E10 as main gasoline grade, and the effect of the E20 itself at 1.4% of the total gasoline sales is minimal.
- None of the analysed scenarios achieve the FQD target. In fact the update of the 2010 fuel baseline standard as set out in Directive 2015/652 decreases the capacity to achieve the mandatory FQD % target, when compared with the 2014 study, by 0.3% from 4.3% to 4.0. Removing the power train efficiency factor for electric vehicles reduces the %FQD by 0.11%.
- The 7% accounting cap on conventional biofuels imposed by the “ILUC Directive” (originally proposed in the 2013 Council Compromise) is not a constraining factor. In other words, the biofuels demand as determined by the F&F model given the grades E5, E10 and B7 is fulfilled using conventional biofuels.

The following considerations complement the key messages above:

Considerations on the policy and regulatory context:

- Harmonized market actions, e.g. for the E10 introduction to all markets should have priority over isolated national actions.
- While the JEC Biofuels Study is focused on EU legislation, the impacts from other areas, like Member State initiatives, could also prove to be important. At the same time, initiatives at the national level must not increase fuel disparity among Member States which would further complicate vehicle and fuel developments and potentially lead to customer frustration;
- The results of the 2014 JEC Biofuels Study are not intended to suggest a direct link between lower policy ambition levels and the smoother achievement of the targets mandated by RED and FQD. Any decision on future transport fuels policy measures must be based on sound and detailed impact analysis, covering all vehicle, powertrain and infrastructure challenges as well as global sustainable renewable fuel, feedstock supply situation.

Considerations on the limitations and uncertainty of the analysis performed:

- Costs and investments could be significant and have not been evaluated in this study;

- Uncertainty remains with respect to assumptions made about input parameters, modelling approaches and with projecting market development into the future;
- Customer choice and the attractiveness of specific market blends (E10 introduction) impact the attainment of the RED and FQD targets;
- The share of renewables in electricity is an important factor given the continuing electrification of both the road and the rail transport modes;
- The availability of non-conventional biofuels is identified to be of major importance to achieve the RED and FQD targets; the pace of renewal in the European vehicle fleet is one of the parameters exerting a major impact on the capacity to reach the RED and FQD targets. There are two main reasons for this: in general, new vehicles are expected to be more fuel-efficient compared to the vehicles they replace and, more specifically, fleet renewal implies market uptake of fuel alternatives, including higher biofuel blends;
- Alternative vehicles and fuels can contribute to reaching the RED and FQD targets, subject to the availability and quality of renewable fuels.

Considerations on non-road transport modes:

- Potential exists for higher bio-diesel blends to be used in non-road transport modes to meet the regulatory targets but this will require time, testing and investment;
- Questions remain about the uptake of HVO/BTL by the aviation sector and the potential role of the "European Advanced Biofuels Flightpath" initiative in incentivising the production of additional volumes of advanced biofuels;
- The contribution of non-road transport modes to achieving the RED and FQD target is important, although the current JEC estimate for this contribution is 1.7%: the greatest contribution towards achieving the target is expected to come from road transport. However, the share of renewables in electricity is an important factor given the continuing electrification of the rail transport.

Given the evolving state of the policy considerations[9] and the market features impacting on the analysis carried out in the JEC Biofuels Programme, JEC partner organisations will continue revising and updating projections aimed at assessing the attainment of the EU renewable energy targets at and beyond 2020.

[9] "A policy framework for climate and energy in the period from 2020 to 2030", COM (2014) 15 final of 22 January 2014.

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Appendix A. Biofuel pathways information

Biofuels pathways used			Directive EU 2015/1513	
	GHG intensity in 2020	iLUC factor	Cap applied	Counting factor
Pathways gasoline pool	[gCO_2eq/MJ]	[gCO_2eq/MJ]		
Ethanol from Wheat	44.2	12	7%	1
Ethanol from Maize	43.0	12	7%	1
Ethanol from Barley	43.0	12	7%	1
Ethanol from Rye	43.0	12	7%	1
Ethanol from Triticale	43.0	12	7%	1
Ethanol from Sugar beet	40.0	13	7%	1
Ethanol from Sugar cane	24.0	13	7%	1
Ethanol from other conventionals	43.0	12	7%	1
Ethanol from Wine	15.0	0	No	2
Ethanol from Farmed wood	25.0	0	No	2
Ethanol from Waste wood	22.0	0	No	2
Ethanol from Wheat straw	13.0	0	No	2
Ethanol from advanced	35.3	0	No	2
Butanol from advanced	35.3	0	No	2
Butanol from conventionals	35.3	0	7%	1
Methanol from waste wood	5.0	0	No	2
Pathways diesel pool				
FAME from Rapeseed	52.0	55	7%	1
FAME from Soybean	58.0	55	7%	1
FAME from Palm Oil	52.5	55	7%	1
FAME from Sunflower seed	41.0	55	7%	1
FAME from conventionals	47.3	55	7%	1
Diesel from Farmed wood FT	6.0	0	No	2
Diesel from Waste oil	14.0	0	No	2
Diesel from Waste wood FT	4.0	0	No	2
Diesel from advanced	35.3	0	No	2
HVO/co-processing from Waste oil	20.5	0	No	2
HVO/co-processing from Rapeseed oil	42.8	55	7%	1
HVO/co-processing from Palm Oil	44.2	55	7%	1
Pathway DME pool				
DME from Waste wood	5.0	0	No	2

Appendix B. Glossary

ANFAC	Asociación Española de Fabricantes de Automóviles y camiones
BEV	Battery Electric Vehicle
BTL	Biomass-to-Liquids
CCS	Carbon Capture and Storage
CDM	Clean Development Mechanism
CEN	European Committee for Standardisation
CNG/CNGV	Compressed Natural Gas/CNG Vehicle
DLUC	Direct Land Use Change
DME/DMEV	Dimethyl ether/DME vehicles
E95/E95V	E95 fuel, 95%vol Ethanol, remainder mainly ignition enhancer/E95 Vehicle
E-REV	(Battery) Electric vehicle with Range Extender
ETBE	Ethyl Tertiary Butyl Ether
EU	European Union
EU27+2	EU 27 Member States plus Norway and Switzerland
F&F Model	Fleet and Fuels Model
FAME	Fatty Acid Methyl Ester
FCEV	Fuel Cell Electric Vehicle
FFV	Flexible Fuel Vehicle (Vehicle able to run with ethanol blends up to E85)
FQD	Fuel Quality Directive
GHG	Greenhouse Gas(es)
HD/HDV	Heavy Duty/Heavy Duty Vehicle
HVO	Hydrogenated Vegetable Oil
ILUC	Indirect Land Use Change
JEC	European Commission's Joint Research Centre (JRC), EUCAR and CONCAWE
LCV	Light Commercial Vehicle
LD/LDV	Light Duty/Light Duty Vehicle
LPG/LPGV	Liquefied Petroleum Gas/LPG Vehicle
Mtoe	Million tonnes oil equivalent
MY	Model Year
PHEV	Plug-In Hybrid Vehicle
pkm	Passenger kilometres (used for buses and coaches instead of annual mileage) transport of one passenger over a distance of one kilometre

RED	Renewable Energy Directive
RES	Renewable Energy Sources
tkm	Tonne kilometres (used for HD instead of annual mileages) transport of one tonne over a distance of one kilometre
TREMOVE	Policy assessment model to study the effects of different transport and environment policies on the transport sector for all European countries more information: www.tremove.com
TTW	Tank-to-Wheels
vkm	vehicle kilometres
WTT	Well-to-Tank
WTW	Well-to-Wheels

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