

Practical guidance on biodiesel and renewable diesel

Key decision-making criteria to assess and
deploy biodiesel and renewable diesel

October 2022



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About Smart Freight Centre

Smart Freight Centre is an international non-profit organization focused on reducing greenhouse gas emissions from freight transportation. Smart Freight Centre's vision is an efficient and zero emission global logistics sector. Smart Freight Centre's mission is to collaborate with the organization's global partners to quantify impacts, identify solutions, and propagate logistics decarbonization strategies. Smart Freight Centre's goal is to guide the global logistics industry in tracking and reducing the industry's greenhouse gas emissions by one billion tonnes by 2030 and to reach zero emissions by 2050 or earlier, consistent with a 1.5°C future.

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Contents

1	Introduction	6
1.1	Scope and motivation	6
1.2	Document structure	7
2	Applicability of biodiesel and renewable diesel	8
3	Availability of biofuel based on feedstock and geographical distribution	9
4	Fuel supply and distribution	11
5	Lifecycle greenhouse gas emission factors	12
5.1	Emission factors at the sector and regional level	12
5.2	Emission factors for biofuels and their blends	13
6	Sustainability issues	14
7	Prices and trends	15
8	Conclusion	17
9	References	18

Tables

Table 1	Fuel emission factors for biodiesel, renewable diesel and their blends	13
Table 2	Emission intensity values for biodiesel, renewable diesel and their blends	13
Table 3	Lifecycle stage for sustainability issue for biofuels.....	14

Figures

Figure 1	Illustration of actual and reporting well-to-tank emissions of biofuels	6
Figure 2	Structure of guidance document	7
Figure 3	Amount of biofuel per feedstock used by Germany, the Netherlands and France. (Source: Own illustration based on EEA 2022; Dutch Emissions Authority 2021; Ministère de la Transition écologique 2021)	9
Figure 4	Estimated and reported emission factors for the EU, the Netherlands, Germany, France and Belgium (Source: Own illustration, based on feedstock mix presented in Figure 3, Mellios and Gouliarou (2021) and RED II typical emission factors.)	12
Figure 5	Monthly average prices for diesel in Belgium (Source: own illustration, data: (Algemene Directie Energie - FOD Economie, 2022)).....	15

Executive Summary

The 'Practical Guidance on Biodiesel and Renewable Diesel' report is part of Smart Freight Centre's series on biofuels, where we address different perspectives on impact, greenhouse gas emissions and implementation challenges of biofuels as a decarbonization solution. The full series is available [here](#).

Introduction

Biofuels can be a short-term solution to decarbonize road freight. They can be used to blend or replace fossil based fuels and provide a solution for operations where zero emission technology is not yet readily available. The lifecycle greenhouse gas emission factors attributed to biofuels are much lower than petroleum diesel because the carbon dioxide emissions from fuel combustion in the tank-to-wheel stage are considered zero. The reason behind this is that it is assumed that the carbon dioxide emitted during combustion is equal to the carbon dioxide sequestered from the atmosphere during the cultivation of the biomass. Biofuels can also often be directly used in existing fleets – whether in a blend or pure, thus reducing fleet replacement costs.

This document presents a short overview of what shippers and carriers should consider when integrating higher blends of biofuel-substitutes for petroleum diesel, namely biodiesel and renewable diesel. Diesel used in road transport already includes up to 7% by volume of biodiesel. However, integrating higher blends of biodiesel and renewable diesel, which is often supplied neat, will require additional planning. This document discusses three key questions modelled after Smart Freight Centre's decision-making guide for low emission fuels and vehicles:

Applicability: Is the solution applicable to your use case?

Availability: Is the solution, whether vehicle or fuel, available to be procured or supplied in location of your operations?

Feasibility: Does the solution meet your requirement in terms of emission reduction and financial budgetary constraints?

Applicability

While low blends of biodiesel can be used in most diesel engines, precautions must be taken to ensure the compatibility of engine with higher biodiesel blends. Otherwise, special filters must be fitted, and the vehicles must be more frequently maintained. Renewable diesel, in contrast, can be used as a drop-in fuel in existing diesel vehicles. Although both fuels may provide lifecycle emission reductions, the use of these fuels, by themselves, do not provide exemption from low emission zones (or similar environmental or air quality traffic policy). Both biofuels, thus are good options, to reduce emissions without replacing the existing diesel fleet. If there is an option for replacing the fleet, in keeping with the broader industry's decarbonization strategy, electric vehicles should be preferred.

Availability

Availability of sustainable biofuels, with sufficiently high emission reduction potential and low impact over a wider range of sustainability criteria, depends on availability of biofuels produced from certain feedstocks. There are strong regional differences impacting availability of biofuels made from these feedstocks. Both Germany and France use biodiesel and renewable diesel made predominantly using oil crops (i.e., rapeseed and palm oil), which replaces in total between 8 to 9 % of the respective countries' diesel use. The Netherlands uses waste and residue products as its main feedstocks to produce these fuels. While its biodiesel replaces up to 17 % of total diesel use, its renewable diesel only replaces about 2 %.

Another aspect of sustainable biofuels is the origin country of the feedstock. Of the main feedstocks, such as palm oil, used cooking oil, soy and rapeseed, only rapeseed is predominantly

produced domestically within the EU. Palm oil, which is linked to high indirect land use change (iLUC) emissions, and used cooking oil are imported from Asia. Due to the pressure of legislation, both at the EU level through the Renewable Energy Directive (recast) (RED II) and through Member State legislation, palm oil will gradually be phased out. It is uncertain whether sufficient feedstock will remain to meet the demand in the future.

The market at the supply and distribution level is diverse and dynamic. In most cases, high-blend biodiesel and renewable diesel is distributed via on-site tankers to the transport operators. In the Netherlands and Belgium, renewable diesel is available neat at many truck fuel stations. Many fuel refineries are expected to be built in the coming years to meet the demand for both biofuels.

Feasibility

Biodiesel and renewable diesel emission factors depend primarily on feedstock and blending level. Average emission factors of biodiesel and renewable diesel used in the EU, the Netherlands, Germany and France can show, in some situations, a wide range of values depending on the source of emission factors. Fuel suppliers are required to submit the GHG emission factor of the biofuel supplied. Where a certification scheme has been applied these are frequently much lower than typical emission factors provided in the RED II and have a smaller range. In case iLUC emissions are included, the emission reduction potential of biofuel used in Germany and France, which rely predominantly on crop-based biofuels, can be significantly reduced, or even completely negated. Emission factors from blends must consider the differing energy density of the fuels (in Megajoule per liter) in the final calculation.

Users of biofuels, particularly those made of crop-based feedstock, must be aware of the potential sustainability issues arising along the fuel value chain. To a certain extent, these issues are mitigated through required compliance to biofuel legislation, which includes sustainability criteria, such as the RED II, (sometimes) voluntary compliance to certification schemes, such as provided by the International Sustainability & Carbon Certification (ISCC) and Roundtable on Sustainable Biomaterial (RSB). Nevertheless, it is up to freight actors to make decisions, particularly where specific sustainability issues do not align well with their corporate sustainability commitments (e.g. ecolabels).

The prices of biodiesel and renewable diesel depend on the legislations applicable in each country. In the Netherlands, the prices are expected to be at least 10% more expensive than diesel. In Belgium, the price is estimated to vary from month to month and can range from 50 to 92% more expensive than diesel. In France, the price of B100 and B7 is approximately the same because of the effective carbon tax.

The prices in the future may change depending on a number of reasons, due to the price of diesel, impacts of legislation on feedstock, global supply chain of feedstock, and the insufficient supply of biofuels to meet RED II national targets.

Conclusion

The extent of the climate change urgency means that companies should support their and the broader industry's transitions to road freight electrification as much as possible. If fleets need to be replaced, companies should consider that battery electric trucks are set to ramp up in model and volume availability, at least for short to medium duty cycles, in the coming five years. For diesel fleets that do not need to be replaced yet, the use of higher blends of biodiesel and renewable diesel produced from certified low-carbon, sustainable feedstocks are a reasonable and effective step to maximize the GHG benefit of the existing assets.

1 Introduction

The 'Practical Guidance on Biodiesel and Renewable Diesel' report is part of Smart Freight Centre's series on biofuels, where we address different perspectives on impact, greenhouse gas emissions and implementation challenges of biofuels as a decarbonization solution. The full series is available [here](#).

The Smart Freight Centre (SFC) and members of the Working Group on Low Emission Fuels and Vehicles (LEFV) project have worked on understanding the role of biofuels in decarbonizing the freight transport sector over the past 2 years. This guidance attempts to present our viewpoint on how transport operators may evaluate, decide and incorporate biodiesel and renewable diesel in their fuel mix. The report builds upon work done in the [Low Emission Fuels and Vehicles for Road Freight: Introductory guide to support the transition to zero emissions](#), [Desktop Review of GHG Emission Factors for Road Freight](#), and [The potential of bio-LNG in decarbonizing logistics](#).

1.1 Scope and motivation

The study focuses on biodiesel and renewable diesel, primarily in the western Europe setting. Biofuels, in general, receive attention as a carbon abatement solution because of two reasons:

- Biofuels, whether in a blend or pure form, can be used in existing vehicles, thus reducing the need for potentially high investment costs.
- Biofuels have a potentially lower fuel lifecycle greenhouse gas (GHG) emissions factor than fossil diesel (see Figure 1). Carbon sequestration happens during the cultivation of biomass, whether from agriculture or natural growth in forests. This sequestration is assumed to effectively cancel out carbon emitted from fuel combustion according to the current GHG accounting frameworks. Thus, fuel lifecycle emissions are only produced from non-carbon emissions during combustion and emissions from other agricultural and industrial activity along the value chain.

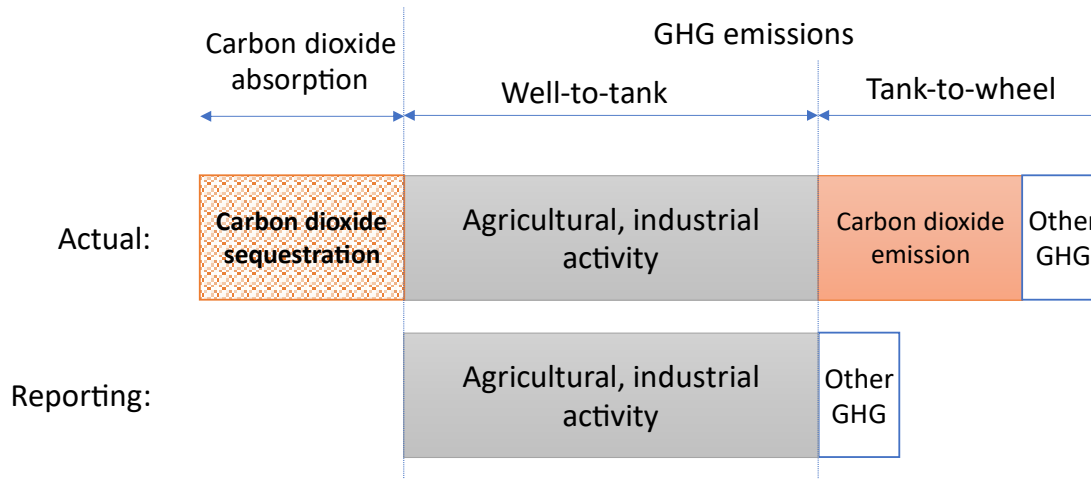


Figure 1 Illustration of actual and reporting well-to-tank emissions of biofuels

It is clear that biofuels play an important role in reducing the GHG intensity of the road freight sector, especially while the medium to heavy duty electric vehicle market is still in its nascent stage and the energy sector still strongly depends on fossil fuel for its power generation.

The two biofuels discussed in this guidance is biodiesel and renewable diesel. Both are primarily produced from the same feedstock: oil-crops (e.g., palm oil, rapeseed, sunflower and soybean) or waste-products (e.g. animal fats, used cooking oil).

- Biodiesel is produced through a transesterification process (ETIP Bioenergy, 2020b) and results in fatty acid methyl esters (FAME). Biodiesel blends are designated with “B” followed by the volume percentage in the blend. For instance, the diesel B7 refers to a blend with conventional diesel of up to 7% by volume. B100 is pure biodiesel.
- Renewable diesel is produced primarily through a hydrogenation process and is commonly known in Europe as hydrogenated vegetable oil (HVO) or more broadly, hydroprocessed esters and fatty acids (HEFA) to include other feedstock types. In the US, it is known as hydrogenation-derived renewable diesel (HDRD) to include the use of non-vegetable oil feedstock, such as animal fats. This document will use the term HEFA as a shorthand for renewable diesel.

1.2 Document structure

The guidance is structured according to the principles defined by the steps developed in SFC’s decision making guide for LEFV (Smart Freight Centre, 2021). The steps are based on a sequential evaluation of the following questions:

- **Applicability:** Is the solution applicable to your use case?
- **Availability:** Is the solution, whether vehicle or fuel, available to be procured or supplied in location of your operations?
- **Feasibility:** Does the solution meet your requirement in terms of emissions reduction and financial budgetary constraints?

Based on these questions, seven topics most critical to the issue of biofuels have been identified (Figure 2). The guidance addresses each topic in individual chapters.

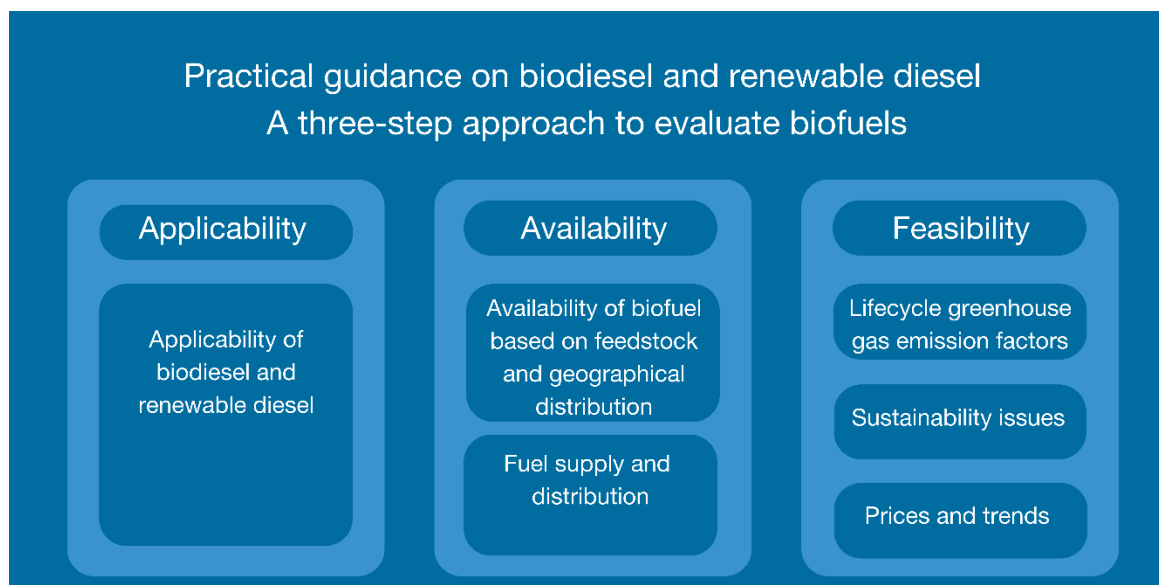


Figure 2 Structure of guidance document

2 Applicability of biodiesel and renewable diesel

While both biodiesel and renewable diesel are meant to replace fossil diesel, especially in cases where electric vehicles are unsuitable, their different chemical composition dictates how they may be used in existing fleets and their applicability in transport operations. Three topics of applicability are relevant to be introduced: compatibility with existing vehicles, use during cold weather, and effect of road traffic management.

Compatibility with existing diesel engine types:

- Biodiesel, a methyl ester, can damage conventional diesel engines at higher blends. Hence, only vehicles using certain engines (AGQM, 2022) are approved to safely use higher biodiesel blends B10, B20, B30 or B100. Otherwise, they should be fitted with special filters and maintenance cycles should be more frequent (Parker, n.d.).
- Renewable diesel, in contrast, can be used as a drop-in fuel in existing diesel vehicles (ETIP Bioenergy, 2020a). This major difference leads to renewable diesel more often supplied neat or at higher blends¹, while biodiesel is provided at lower blends with diesel.
- Both biofuels, thus are good options, to reduce emissions without replacing the existing diesel fleet. If there is an option for replacing the fleet, in keeping with the broader industry's decarbonization strategy, electric vehicles should be preferred.

Use during cold weather

- Some higher biodiesel blends are less resistant to the cold due to the fuel's higher cloud point and cold filter plugging point². This depends in some part on the feedstock used to produce it. Fuel additives can be used to change their cold resistance.
- In contrast, renewable diesel has better contrast resistance than biodiesel, and even that of conventional diesel, which reduces the problems that the diesel engine might face during the cold season.

Road traffic access

- Neither biodiesel nor renewable diesel are exempted from restrictions in low emission zones (or similar environmental or air quality traffic policy). Restrictions or exemptions are more likely to depend on tailpipe emissions, that is on whether the vehicle has a particular powertrain (e.g. electric vehicle) or emissions standard (e.g. EURO 6), rather than the use of a specific fuel (Urban Access Regulations in Europe, 2022).

¹ Other blends at 20, 30 or 50% are also used in the market, sometimes marketed under the name Blue Diesel, blue coloring is added to HEFA blends to differentiate from conventional diesel. (<https://www.esso.nl/nl-nl/dieselblue>)

² The cloud point is the temperature of the fuel at which small, solid crystals can be observed as the fuel cools. The cold filter plugging point is the temperature at which a fuel filter plugs due to fuel components that have crystallized or gelled. (<https://farm-energy.extension.org/biodiesel-cloud-point-and-cold-weather-issues/>)

3 Availability of biofuel based on feedstock and geographical distribution

The availability of biodiesel and renewable diesel should take into account the feedstock used to produce the fuels, as it is a determining factor in lifecycle GHG emissions and other impacts. This will be discussed further in Section 5 on the lifecycle emission factors and Section 6 on sustainability issues.

Current feedstock mix

Biofuel feedstock are usually categorized according to three main categories (ETC, 2021).

- Feedstock grown on dedicated land: energy crops, food crops or forest material.
- Feedstock sourced from waste and residue: forest and agriculture production waste or municipal and industrial waste.
- Feedstock from aquatic sources, i.e., algae.

Looking at the overall feedstock mix of a geographical area helps to understand the general availability of biofuels, although it is not a substitute for identifying actual fuel suppliers and their supply capacity in the region of operation. Figure 3 compares the availability of biodiesel and renewable diesel in Germany, the Netherlands and France, in terms of aggregated feedstock mix and volume of fuel.

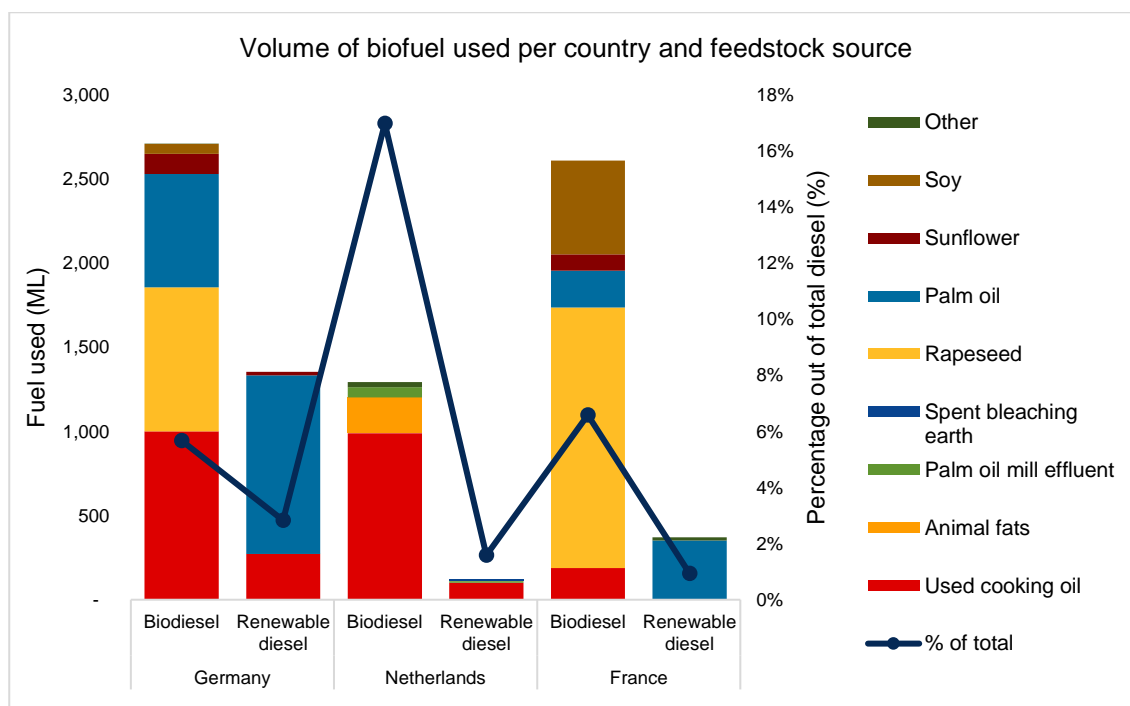


Figure 3 Amount of biofuel per feedstock used by Germany, the Netherlands and France. (Source: Own illustration based on EEA 2022; Dutch Emissions Authority 2021; Ministère de la Transition écologique 2021)

Some observations can be made:

- It is striking that compared to Germany and France that rely predominantly on oil crops (i.e., rapeseed and palm oil), the Netherlands relies almost completely on waste products, such as used cooking oil and animal fats.
- The total amount of biofuels in the Netherlands is half of that used in Germany and France, but represents a higher percentage of the country's total diesel supply.

Feedstock origin

Where feedstock is sourced from has an impact on supply availability, the overall GHG emissions attributes and risks of indirect land use change (iLUC) impacts, and wider sustainability issues. Hence, it is necessary that the biofuel supply is accompanied by credible sustainability certification schemes that provide visibility into the lifecycle of the fuels. This is especially the case as much of the feedstock are imported into the EU (Transport & Environment, 2021), which becomes a bigger challenge for fuel distributors and eventually end-users to monitor by themselves. For instance, in 2020, almost 82% of palm oil demand was sourced from Southeast Asian countries. This is an important reason why iLUC is strongly associated with palm oil. Notably, 73% of the UCO feedstock is imported, primarily coming from Asia. Also, it is estimated that about half of the soy feedstock is imported into the EU, mostly from the non-EU European countries. While rapeseed is also imported, such as from Australia and non-EU European countries, most rapeseed is produced domestically (Flach et al., 2021).

Legislation on feedstock

The mix of feedstock is likely to shift away from oil crops in the EU, especially palm oil, as per the RED II. In RED II, palm oil has been classified as a feedstock with high-iLUC risk and will be phased out gradually from 2023 to 2030. Several biofuel producers, such as Shell, Neste, Total Energies and Eni, have already committed to eliminate the use of palm oil as feedstock by 2023. RED II also encourages the use of waste-based feedstock, such as used cooking oil (UCO), animal fats, and other types of industrial, municipal and agricultural waste and residue (i.e., list of feedstocks mentioned in Annex IX Part B), by allowing double counting of such fuels towards the Member States minimum biofuel target. Nevertheless, it is unclear whether the supply of these feedstocks will be sufficient to fulfill the demand in the medium term.

4 Fuel supply and distribution

Based on our review of public information on fuel supplier and distributors in the Netherlands, Germany, France and Belgium, as well as a few interviews with several of them, it is clear that the market is diverse and dynamic.

Below are several of our key findings:

- High-blend biodiesel and renewable diesel are most often distributed via on-site fuel tankers in a contractual arrangement between the transport company and fuel distributor.
- Renewable diesel, since it is a drop-in fuel compatible with current engines, is also distributed via both car and truck fuel stations, notably in the Netherlands. Neste, for example, exclusively uses fuel retailers³, such as Texaco, Q8, BSP, Esso, GP Groot, Tamoil, for distribution. Out of the 126 locations, approximately 40% serve exclusively trucks. Shell and Total Energies distribute via their own fuel stations⁴. Nevertheless, it is important to note that renewable diesel is not permitted to be used for road applications in Germany.
- Much of the fuel consumed in Europe is produced in Europe. The size and capacity of biodiesel producers range from relatively small capacity of 2.3 million liters per annum owned by a farmer collective to 680 million liters per annum owned by large multi-national companies (Flach et al., 2021).
- The number of biodiesel producers are many times larger than renewable diesel producers. However, most biodiesel producers, such as Estener, Delix, Saipoll, Dyneff, Avril and Cargill, simply contribute to the diesel pool, rather than provide a standalone high blend. Targray distributes B20, B99 and B100 from their tanker in Antwerp. The Renewable Energy Group, a large producer based in the US, produces B100 in Germany, but imports renewable diesel to Europe from their plant in the US.
- From the list of renewable diesel suppliers we reviewed, most use waste and residue as their primary feedstock. Only Total Energies still relies on oil crops – palm oil, rapeseed, and sunflower – as the major (94%) feedstock.
- Many of the smaller biodiesel producers use rapeseed and sunflower as the main feedstock. Delix, Targray, Estener and Nord Ester rely fully or include a significant amount of waste-based feedstock.
- The availability of both fuels is expected to increase in the coming years, with several announcements of expansion. Shell have announced plans to build biofuel refineries to meet the demand for diesel-replacements (Royal Dutch Shell, 2021). Eni is building towards doubling their production by 2025 to 2 million tonnes per year, and to 6 million tonnes per year by 2035 (Porter, 2022). At the EU level, the International Energy Agency expects that production of renewable diesel will increase by 50% in 2025 from 3.5 billion liters per year in 2020 (IEA, 2021). Biodiesel is expected to increase by 10% in the same period from 13.5 billion liters per year.

³ Neste provides a list of distributors (<https://www.neste.nl/neste-my-renewable-diesel/distributeurs>). In the Netherlands and Belgium there are 126 locations, with approximately 40% serving trucks, operated by the fuel retailers, such as Texaco, Q8, BSP, Esso, GP Groot, Tamoil.

⁴ In the Netherlands, 83 Total stations are reported to supply HEFA100 (<https://www.bestelauto.nl/nieuws/waarom-geen-hvo100-in-de-tank/19757/>)

5 Lifecycle greenhouse gas emission factors

In this section, emission factors for several categories of biodiesel and renewable diesel are presented both at an aggregated level and at the fuel-blend level.

5.1 Emission factors at the sector and regional level

Figure 4 illustrates the range of aggregated emission factors of biofuels in the EU, the Netherlands (NL), Germany (DE), and France (FR). Estimated values are calculated based on feedstock mix and typical emission factors provided in Annex V of RED II. Reported values are based on certified GHG emission factors that are submitted by fuel suppliers, and are only available for the EU, the Netherlands and Germany.

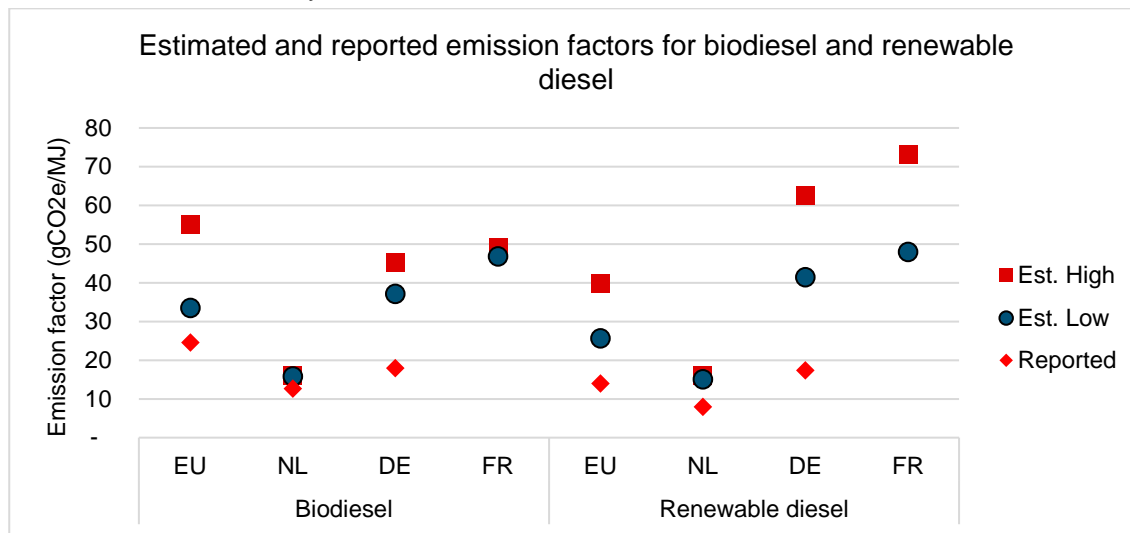


Figure 4 Estimated and reported emission factors for the EU, the Netherlands, Germany, France and Belgium (Source: Own illustration, based on feedstock mix presented in Figure 3, Mellios and Gouliarou (2021) and RED II typical emission factors).

Several conclusions can be derived from the figure, bearing in mind the feedstock mix presented in Figure 3.

- First, the Netherlands, which relies primarily on biofuels produced from waste and residue, has the lowest average emission factor. Also, the reported values for the Netherlands are quite close to the estimates.
- Second, the reported certified emission factor values are relatively close together (i.e. ranging from 8 to 25 gCO₂e/MJ) in comparison to the estimated values (i.e. ranging from 16 to 73 gCO₂e/MJ). This gives a better emission factor value to the EU and Germany, since even the low estimates do not meet 65% threshold required by RED II for biofuels from new installations, that is 33 gCO₂e/MJ. Hence, it is recommended that companies use certified emission factors in their disclosure activities.
- Third, including iLUC emissions (i.e., 55 gCO₂e/MJ) could significantly reduce the emissions reduction potential of biofuels in Germany and France, which rely on crop-based biofuels.

5.2 Emission factors for biofuels and their blends

For the following analysis, we use the REDII default emission factors to provide indicative values for different blends using both rapeseed oil and UCO as the main feedstock. A blend of v % indicates a volumetric content of v % in the final fuel mix. Since the specific energy and density of the conventional diesel, biodiesel and renewable diesel differs, it must be considered when calculating the emissions factor of the blend.

The calculation for a blend of B % can be performed using the following equation:

$$EF_b = \frac{B * (EF_n * d_n * E_n) + (1 - B) * (EF_d * d_d * E_d)}{B * (d_n * E_n) + (1 - B) * (d_d * E_d)}$$

where subscript b , n and d represent the final blend, pure biofuel, and diesel respectively, and EF , d and E are the emissions factor in g CO₂e/MJ, the density in kg/L and specific energy in MJ/kg of the fuels, respectively.

The results (Table 1) show the RED II default value for the rapeseed oil-based fuels provide only a reduction of 47% for 100% biofuels, and so do not meet the RED II threshold value of 65% reduction (for installations starting operations after 1 January 2021). Nevertheless, bear in mind that the reported values are up to 50% lower than the defaults (Figure 4). In comparison, UCO-based fuels can provide a reduction of up to 85%, when used in pure form, and up to 16% reduction for 20% blends.

Table 1 Fuel emission factors for biodiesel, renewable diesel and their blends

Blends	Specific energy in MJ/kg	Density in kg/L	WTW Emission factor in g CO ₂ e/MJ		
			Rapeseed	UCO	RED II threshold
Reference point: Diesel	43.1	0.83	94		
RED II threshold value (65%)			32.9		
B100	37.2	0.89	50.1	14.9	32.9
B50	40.1	0.86	72.9	56.0	64.7
B20	41.9	0.84	85.8	79.2	82.5
HEFA100	44.0	0.78	50.1	16.0	32.9
HEFA50	43.5	0.81	72.5	55.1	64.1
HEFA20	43.3	0.82	85.5	78.6	82.2

The emission intensity for the various blends are easily obtained by multiplying with the energy intensity factor of 0.89 MJ/tkm for the 40t articulated truck. The results are presented in Table 2.

Table 2 Emission intensity values for biodiesel, renewable diesel and their blends

Blends	WTW emission factor per unit volume in kg CO ₂ e/L		WTW Emission intensity in kg CO ₂ e/tkm	
	Rapeseed	UCO	Rapeseed	UCO
Reference point: Diesel	3.37		84	
B100	1.66	0.49	45	13
B50	2.51	1.93	65	50
B20	3.03	2.80	76	70
HEFA100	1.72	0.55	45	14
HEFA50	2.55	1.96	65	50
HEFA20	3.04	2.81	76	70

6 Sustainability issues

The production of biofuels, especially those dependent on crop-based feedstock, are associated with other sustainability issues besides the impact of climate change. Table 3 depicts how sustainability issues might arise in the lifecycle of the biofuel. Most of the issues identified affect the feedstock cultivation stage. Hence, it is important to be mindful of these issues. Smart Freight Centre has published a report [Sustainability criteria for biofuels](#), which describes these issues and presents how legislation and certification currently deal with ensuring sustainability of biofuels.

Table 3 Lifecycle stage for sustainability issue for biofuels

SUSTAINABILITY ISSUE	FEEDSTOCK CULTIVATION	FUEL PRODUCTION	FUEL USE
Greenhouse gas emissions	xx	x	xx
Short-lived climate forcers			xx
Air quality	xx	x	xx
Carbon source	xx		
Electricity/energy source		xx	x
Water	xx	x	
Sustainable resource use	xx	x	
Soil health	xx		
Ecological impacts	xx		
Social equity	xx	x	
Social, labor and human rights	xx	xx	
Food security	xx		
Health, safety, and security	x	xx	
Economic well-being	xx	xx	
Continuous improvement	xx	x	xx

* x is important; xx is very important, <blank> not important

Nevertheless, legislation and sustainability certification schemes help to mitigate the risk of these issues. RED II compliant biofuels are required to comply with a set of sustainability requirements outlined in Article 29. Voluntary schemes are also permitted to support the verification of compliance with sustainability and GHG savings criteria. National legislation may also impose certain specifications. In France, biofuel suppliers are required to comply with the International Sustainability & Carbon Certification scheme. Furthermore, countries may ban the use of different feedstock, such as palm oil, due to sustainability concerns.

These sustainability issues could in some cases also come in conflict with other sustainability commitments that a shipper might have, such as those related to agriculture or water. Shippers should be mindful of fuel procurement that does not align with the sustainability commitments made for their supply chain (e.g. ecolabels), especially if promoted for *sustainability* purposes. On the other hand, shippers may use their influence and purchasing power to push the transport and fuel industry to higher levels of accountability, by integrating sustainable fuel procurement with their own CSR promotion and activity. For instance, Nestlé (2013) commits to avoiding the use of first-generation liquid crop-based biofuels, as well as raise awareness and advocate for sustainability of biofuels.

7 Prices and trends

The main impact of the use of biodiesel and renewable diesel on the costs of the transport operation arises from the higher fuel prices (assuming a new vehicle is not purchased simply to enable the use of B100). The recommended price of HEFA (as of 19 May 2022) is more expensive than conventional diesel (B7) by about 10% in the Netherlands, at € 1.95 per liter without value-added tax (DCB Energy, 2022). Each fuel station operator sets the prices themselves to compete for the market. The price of on-site tankers are not publicly disclosed and may likely be cheaper, especially if long term contractual arrangements are made between fuel supplier and fleet operator.

In Germany and France there is a high effective carbon tax for road transport (including fuel excise duties) of approximately € 240 per tonne CO₂. In France, the price of B100 and B7 is approximately the same, currently at €2.07 per liter because of the effective carbon tax.

The official prices for the fuels in Belgium are published by the Federal Public Service Economy and are presented in Figure 5. The figure shows the average price including VAT per month for the past 25 months for various blends, including the Diesel XTL, which should be taken as an indicative of B100 or HEFA100. The prices between the conventional diesel B7 and the different blends are quite comparable. Strangely, B10 is 1 or 2 cents cheaper than B7 on average. The Diesel XTL prices have become in recent months comparatively more expensive than B7. The prices range from approximately 50 to 92% more expensive than B7 in the same month, which leads to an increase of € 1.02 on average.

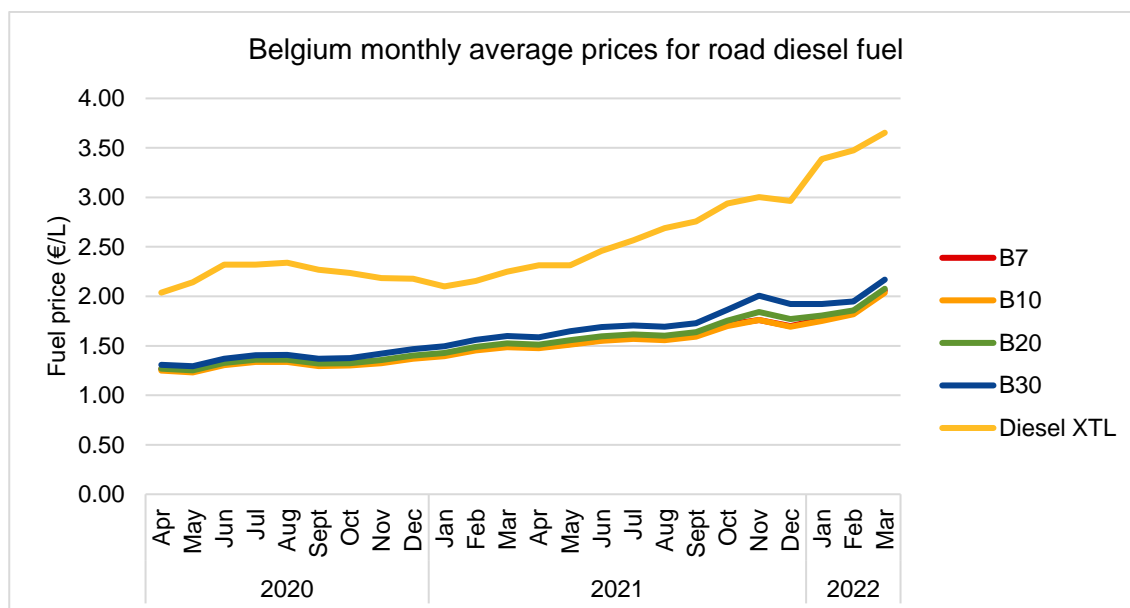


Figure 5 Monthly average prices for diesel in Belgium (Source: own illustration, data: (Algemene Directie Energie - FOD Economie, 2022))

There are short- and long-term factors that might lead to a change in fuel prices, especially with respect to the feedstock supply.

- Global diesel prices are linked to biofuel prices for two main reasons. (1) Diesel is still primarily used in agricultural, industrial and transport activity in the value chain of the fuel. (2) The price of biofuel can rise, when the price of its main competitor, diesel, rises for commercial reasons.

- Palm oil, which is a significant feedstock in Europe, will be phased out by 2030, which will increase demand for other feedstock sources, such as used cooking oil.
- There is strong pressure to reduce the share of crop-based biofuels. Share of crop-based biofuels in Europe is 60.1% in 2018, but national mandatory targets (crop cap), introduced at least by 2020, range from 4 to 7% and are reduced gradually year by year.
- The administrative burden and cost to ensure traceability and sustainability certification will increase to avoid fraud in waste feedstock, such as used cooking oil. Cases of fraud, where UCO was combined with virgin cooking oil in the Netherlands, have been investigated.
- Effects on global supply chains will reduce availability and increase prices of some feedstock (Gratton, 2021). For instance, Ukraine supplies 50% of rapeseed (UFOP, 2022b) and 86% of sunflower seed (UFOP, 2022a) imports to the EU-27 in 2021.
- Supply for biofuel is not expected to meet the RED II national targets in the short term.
- Biofuels are considered essential in the decarbonization of other modes of transport, namely the maritime and aviation sector.

8 Conclusion

This guidance document aims to support a company in making a decision whether to use biodiesel and renewable diesel as a short to medium term component of their fleet decarbonization strategy. It presents six topics covering different aspects of applicability, availability and feasibility that guide the selection of LEFV solutions according to the approach the SFC recommends. The information is intended to be used in comparison with other solutions, such as the use of electric or hydrogen fuel cell vehicles.

These questions are summarized here.

- **Applicability:**
 - In which road transport operations, are the fuels to be used considering its technical and legal context?
- **Availability:**
 - What is the availability of sustainable biodiesel and renewable diesel based on its feedstock source and how can it be expected to change in the short to medium term?
 - What is the immediate supply of sustainable biodiesel and renewable diesel in the location of operations and how can fleet operators gain access to them?
- **Feasibility:**
 - What emissions reduction potential do the biofuels have, especially considering the type based on feedstock, legislation that limit the associated lifecycle emissions, and the blend that is available?
 - What wider sustainability issues should users be aware of and how can these risks be mitigated?
 - How will the use of the biofuels affect the cost of transport operations and thus the price of freight services?

The extent of the climate change urgency means that companies should support their and the broader industry's transitions to road freight electrification as much as possible.

- For diesel fleets that do not need to be replaced yet, the use of higher blends of biodiesel and renewable diesel produced from certified low-carbon, sustainable feedstocks are a reasonable and effective step to maximize the GHG benefit of the existing assets.
- If fleets need to be replaced, companies should consider that battery electric trucks are set to ramp up in model and volume availability, at least for short to medium duty cycles, in the coming five years. Many governments make financial incentives available for electric truck purchases.
- In order to accurately account for GHG emissions from operations using biodiesel and renewable diesel, users should ensure they have a verified emission factor that is representative of the specific fuel supplied to them.

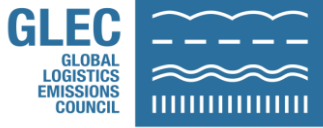
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