

## Availability and sustainable provision of biofuels under Annex IX Part B (biodiesel from used cooking oil and animal fat)

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8.1 UCO Market composition in the Netherlands
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# 1 Starting point and objective

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The Federal Republic of Germany views climate change as a key challenge of the 21<sup>st</sup> century. By ratifying both, the Kyoto Protocol as well as the Paris Climate Convention, Germany committed to a profound and comprehensive decarbonisation of its economy and society. Compared with the reference year 1990, the past 30 years have seen some progress. Especially in the electricity sector, which has successfully reduced its emissions per kilowatt-hour by 32% compared to 1990, the “Energiewende” (Germany’s transition to a sustainable energy sector) is showing first results (Icha & Kuhs, 2019). Both the relative share of renewables has risen from 3.4% in 1990 to around 42% today (2019), and the associated emissions from the electricity sector have fallen by 93 million tons (Umweltbundesamt, 2020) (Icha & Kuhs, 2019).

In contrast, the transport sector is stagnating at a similar level to 1990. Technological advances, especially in the area of drivetrain efficiency, have been offset by an increased demand for transport, which is increasingly concentrated on roads. The renewable share of final energy consumption in the transport sector is also stagnating at around 5.5%. According to the second iteration of the Renewable Energies Directive (EU 2018/2001, hereinafter RED II), this share is to rise to 14% by 2030. While the majority of renewables in the transport sector constituted of conventional biofuels, their share will be heavily regulated in future and limited to a maximum of the share in 2020 plus 1 percentage point, but not more than 7% in total. RED II thus follows the EU’s iLUC Directive (Directive (EU) 2015/1513), which, for the first time, takes into account the concerns of conventional biofuels with regard to indirect land use changes and associated environmental problems.

The fuels listed in Annex IX, Part B, have a special role to play in meeting RED II targets in the transport sector. These include biofuels based on used cooking oil (hereinafter referred to as UCO) and biofuels based on animal fats of categories 1 and 2 of Regulation (EC) No 1069/2009<sup>1</sup>. Due to their classification as residues or wastes, biofuels based on UCO or animal fats achieve very high specific greenhouse gas (GHG) savings. Furthermore, both are considered to be raw materials with a low iLUC risk. Nevertheless, RED II also provides for a 1.7% cap on the fuels listed in Annex IX Part B. However, RED II further states that, at the request of a Member State and with appropriate justification, higher shares are possible.

However, unlike conventional biofuels, the cap is not based on environmental concerns. On the contrary, the aim is to prevent these coveted residues from third countries from being siphoned off. Currently, less than 20% of the raw materials listed in Annex IX Part B come from domestic European collection. A large proportion is increasingly being imported from South-East Asian countries, which have their own climate targets to meet. Competition for use cannot therefore be ruled out. In addition, the traceability of the origin and thus sustainability of the derived fuel in global supply chains represents a challenge.

<sup>1</sup> According to EC 1069 / 2009, there are, in total, three categories of animal fats. Category 3 animal fats are of higher quality and are therefore preferred for other uses.

This study will therefore examine the following aspects:

- 1) What is the relevance of biofuels under Annex IX Part B for Germany?
- 2) How are the quantities and utilization of UCO in Germany, Europe and the main non-European export countries structured?
- 3) What is the availability of UCO in the main non-European export markets China, USA, Malaysia and Indonesia? Will / Do imports from these markets lead to competition of use?
- 4) Is there potential for an increase of UCO collection in Germany?
- 5) What significance can biofuels based on animal fats of categories 1 and 2 have for Germany? What is their emergence and whereabouts in Europe to this date? How are the consequences of implementing an eligibility of these biofuels to the GHG quota?

## 2 Relevance of biofuels under Annex IX Part B of RED II for Germany

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This chapter analyses the role and relevance of biofuels under Annex IX Part B for Germany. In the pan-European context, Germany is the largest consumer of fuels in the transport sector. Around 1/6 of total energy consumption in the transport sector in the European Union was consumed in Germany (EUROSTAT, 2020) (see Figure 1 below, for reference). With the United Kingdom's withdrawal from the EU, Germany's market share in the EU 27 is projected to increase to almost 20 %. German (bio)fuel policy thus has a decisive influence on the European market.

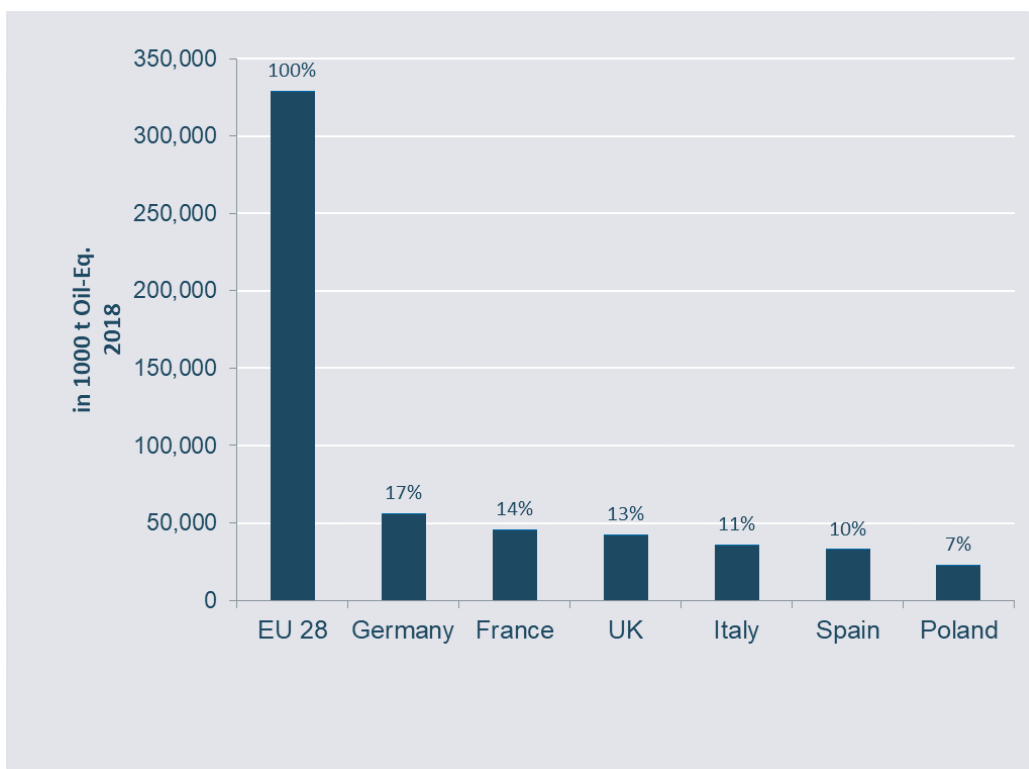
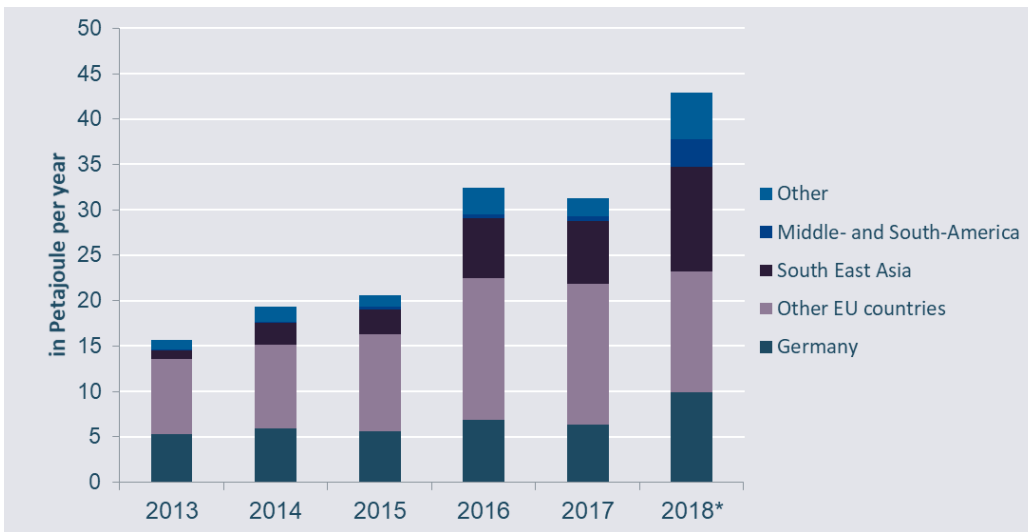


Figure 1: Fuel consumption in transport of selected EU Member States. Own presentation according to (EUROSTAT, 2020)

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The German market share is even larger in the biodiesel and especially UCO-ME sector. Germany's share of the UCO-ME market in 2018 was around 43 PJ, with 97 PJ in the EU as a whole, or 44% (BLE, 2020) (Flach, Lieberz, & Bolla, 2019). However, it should be noted that the demand for UCO-ME in 2018 has risen sharply, compared to previous years. In 2017, there was demand for around 32 PJ UCO-ME. The exact development can be seen in Figure 2 below.



\* Adjusted import mix (cf. chapter 3.3)

Figure 2: UCO Biodiesel demand in Germany from 2013 to 2018. Own presentation according to (BLE, 2019) and (BLE, personal communication, 2020)

Although various scenarios on the development of final energy consumption in Germany's transport sector forecast a decline in the period from 2020 to 2030 across all scenarios (a comparison of six common scenarios can be seen in Figure 3). However, it can be assumed that Germany will remain the largest and therefore most important fuel market in the EU in 2030.

Moreover, the assumption of a decreasing final energy consumption in Germany has further implications with regard to the fulfilment of RED II. If the UCO-ME volume reported in 2018 is taken as the status quo, the relative share of UCO-ME in final energy consumption in road and rail transport increases from 1.8% in 2020 to 2% in 2026 and finally to around 2.2 % in 2030. This would require a corresponding approval by the European Commission. Figure 3 summarises the developments described above.



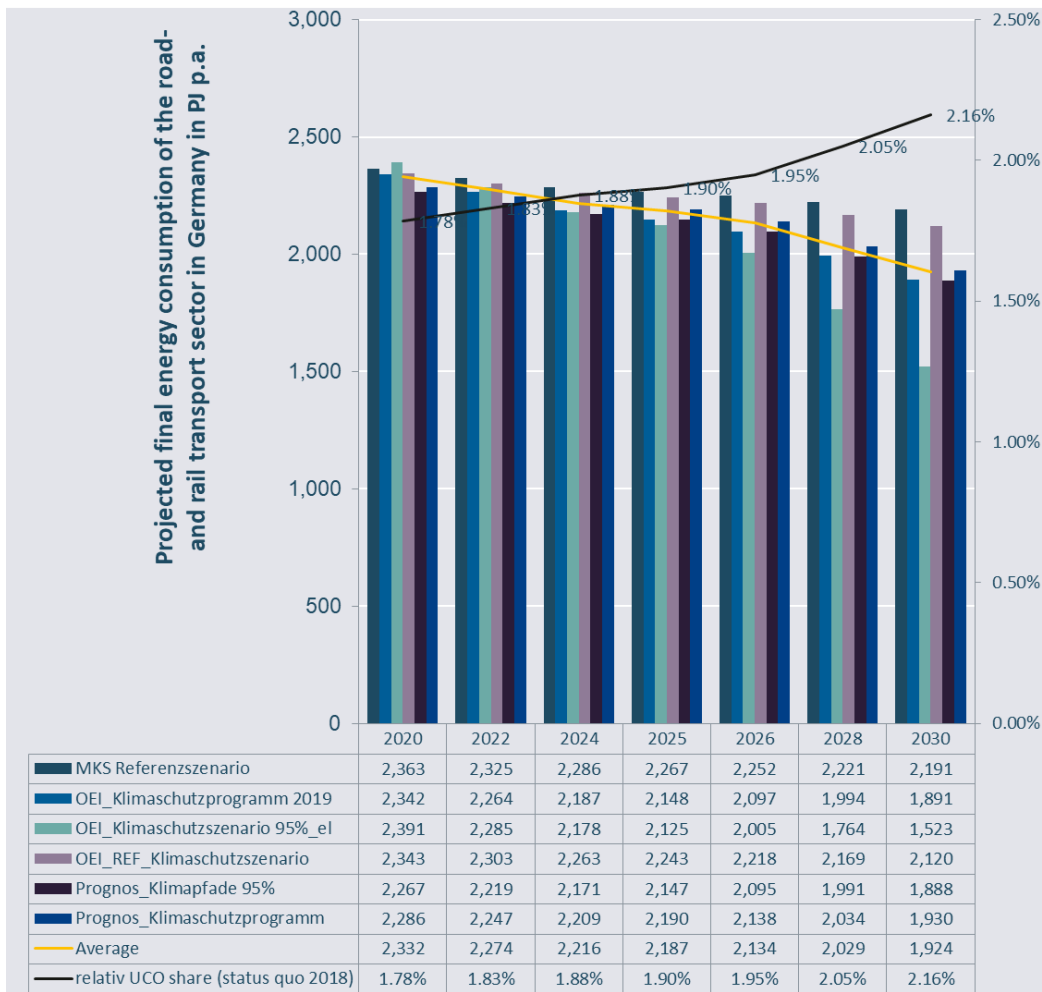


Figure 3: Development of final energy consumption of German road and rail transport 2020 – 2030 according to a selection of scenarios; Own presentation.

If Germany complies with the 1.7 % cap for UCO based fuels according to RED II, the quantity of these fuels placed on the market would have to fall from the current level of around 42 PJ to 33 PJ (see Figure 4). This would entail a decrease of about 25 %, with corresponding effects on the UCO-ME economy in Germany and, to a lesser extent, Europe.

#### In short:

Germany is the largest fuel market in the EU and, with regard to the utilization of UCO as a fuel, is of far above average significance.

With today's quantities of UCO-based biofuels, Germany would already exceed the limit of 1.7 % of RED II for biofuels according to Annex IX Part B and even with constant quantities, the excess would continue to increase. Therefore, there is a need for action.

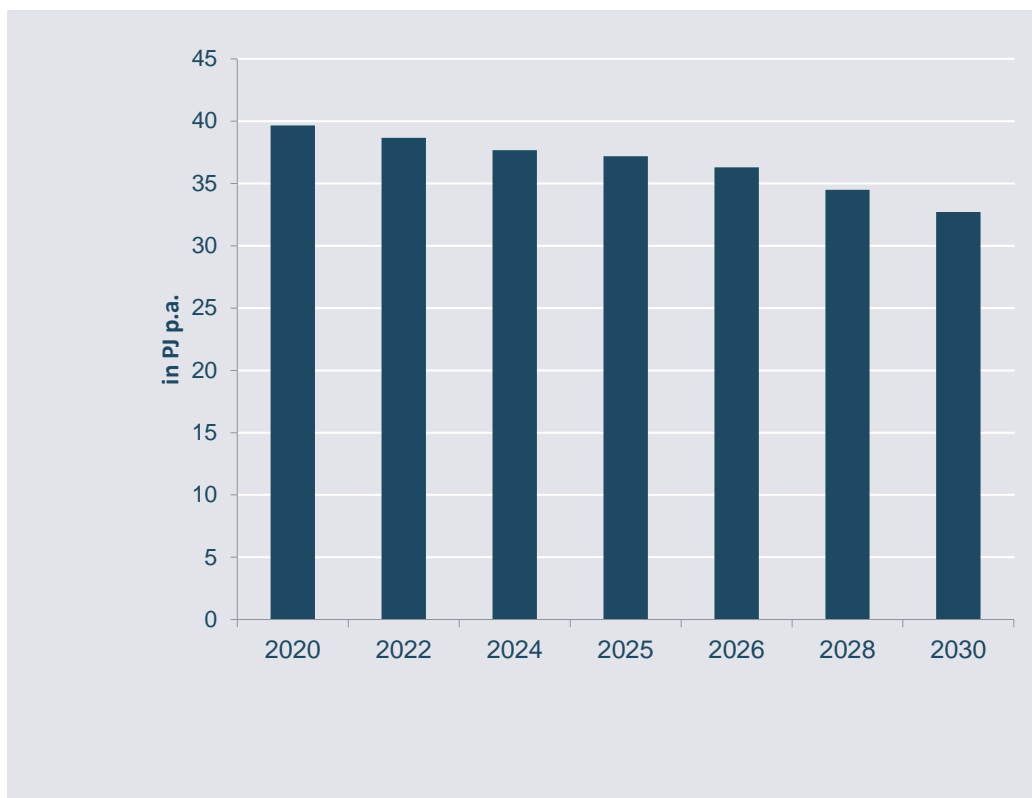


Figure 4: Development of absolute UCO-ME quantities for quota fulfilment according to RED II in Germany.

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# 3 Quantities and utilization of UCO in Germany, Europe and non-European export countries

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## 3.1 UCO Collection

The quantities and utilization of UCO varies considerably from country to country within the EU. While the eating and nutritional habits of the respective country are the main factors for the former (a high proportion of fried foods or a high proportion of processed "ready-made" meals result in a high specific UCO potential, whereas a healthier lifestyle produces correspondingly low UCO quantities), the framework conditions of the countries' waste management are decisive for the latter (Greenea, 2016).

A comprehensive collection of UCO from "professional" sectors, i.e. from the food industry, restaurants, caterers, hotels, refectories and the like, is well established in almost all European countries. However, there are significant differences in the collection of UCO in households<sup>1</sup>. There are currently only three countries, where the collection of UCO from households is organized at national level: Belgium, the Netherlands and Austria (Greenea, 2016).

In addition, Sweden has a household collection, which, unlike in the countries mentioned above, is organized at local level without any coordination or cooperation between the different actors. All other countries have either no UCO collection from households at all, or a strongly regionalized collection scheme while other countries rely on isolated regional initiatives or commenced first pilot projects (Greenea, 2016). Figure 5 gives an overview of the handling of Near-Home UCO in the EU in 2016.

<sup>1</sup> UCO generated in private households by e.g. frying processes or food preparation.

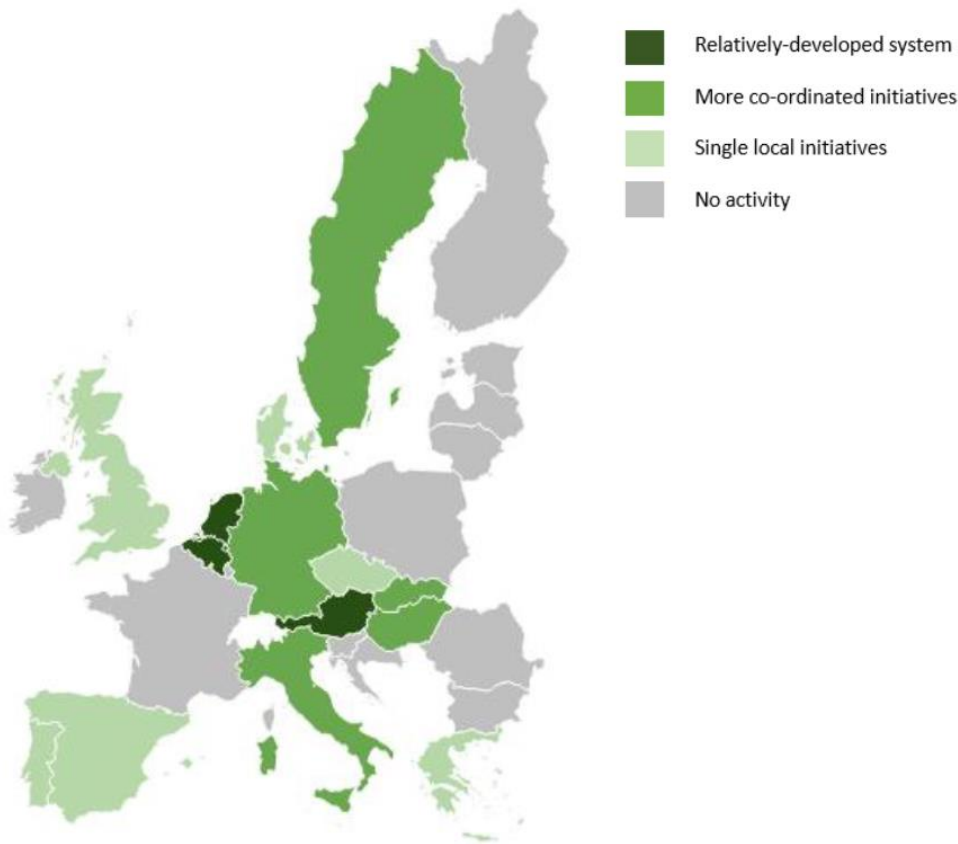


Figure 5: Differences in household UCO collection within the EU (Greenea, 2016)

## 3.2 UCO quantities in Germany

### 3.2.1 Domestic origin

The collection of UCO in the professional sector in Germany is very advanced. Of a total estimated volume of about 161,000 t per year, 140,000 t (corresponding to about 87.5 %) were collected in 2015 (Greenea, 2016). In comparison, the UCO margins collected in private households are extremely low. Of an estimated potential of 65,000 t per year, only 1,209 t were collected. It is to be assumed that the uncollected quantities in households are either disposed of via household waste or drains, which increasingly represents a challenge for water management. This results in an overall collection rate in Germany of 62 % (see Figure 6).

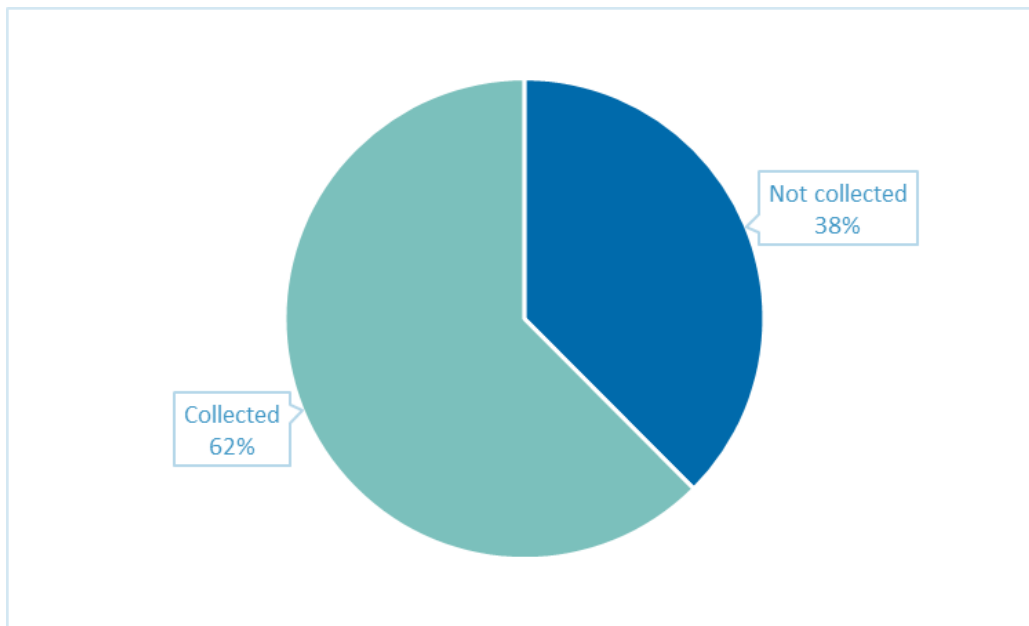


Figure 6: Collection rate of UCO in Germany 2015. Own presentation according to (Greenea, 2016)

Converted to energy, the 142,000 t estimated by (Greenea, 2016) correspond to 5.3 PJ<sup>1</sup> from UCO sourced in Germany.

The *Mittelstandverband abfallbasierter Kraftstoffe* (MVaK) estimates that the amount of UCO available for the period 2021 - 2030 will be higher. In addition to a potential of around 250,000 t (or 9.3 PJ) per year in the period 2021 to 2030 from the professional sector, the association estimates that a UCO household collection could add another 100,000 t per year (see Table 1).

While these figures represent an estimate of the UCO volumes in Germany, the evaluation reports of the Federal Agency for Agriculture and Food (in the following BLE) provide information on the quantities of biofuels placed on the market and their raw material base. These quantities, recorded via *NaBiSy*, correspond to the biofuel quantities counted towards the greenhouse gas quota. Accordingly, the quantity of residue-based biodiesel or UCO could be increased from 6.8 PJ to 8.2 PJ during the period between 2016 to 2018. This corresponds to a quantity of 183,000 t in 2016 and 220,000 t in 2018 (BLE, Evaluation and Experience Report for 2018, 2019).

Thus, the UCO-ME of German origin currently placed on the market already corresponds to 88 % of the potential from professional UCO collection identified by the MVaK. If the potential for a UCO household collection is added (100,000 t per year according to MVaK), 63 % of the total potential is currently utilized.

<sup>1</sup> Assuming a lower heating value of 37 MJ/kg

Table 1: UCO potentials from Germany to meet quotas under RED II

	2015 (Greenea)	2016 (BLE)	2017 (BLE)	2018 (BLE)	2021 – 2030 (MVaK)
<b>Professional collection</b>	140.000 t	183.000 t	170.000 t	220.000 t	250.000 t
<b>Corresponding share of final energy consumption in transport</b>	0.22%	0.29%	0.26%	0.34%	0.43%
<b>Household collection (potential)</b>	65.000 t	k.A.	k.A.	k.A.	100.000 t
<b>Corresponding share of final energy consumption in transport</b>	0.1%	-	-	-	0.17%

### 3.2.2 Imports of UCO

The figures above show that UCO from Germany plays only a minor role. According to (BLE, 2019), even in the record year 2018, only around 20 % (8.2 PJ of 41.1 PJ) of the UCOs processed into biodiesel came from Germany itself. The rest was imported. As shown in Figure 7 and Figure 8, the following importing countries are the most important besides the EU states (with 17.2 PJ or 42 %) (BLE, 2019), (BLE, 2020):

- the People's Republic of China (7.2 PJ, 17.5%),
- the USA (2.5 PJ, 6.1%),
- Indonesia (1.7 PJ, 4.1%)
- and Malaysia (1.3 PJ, 3.2%)

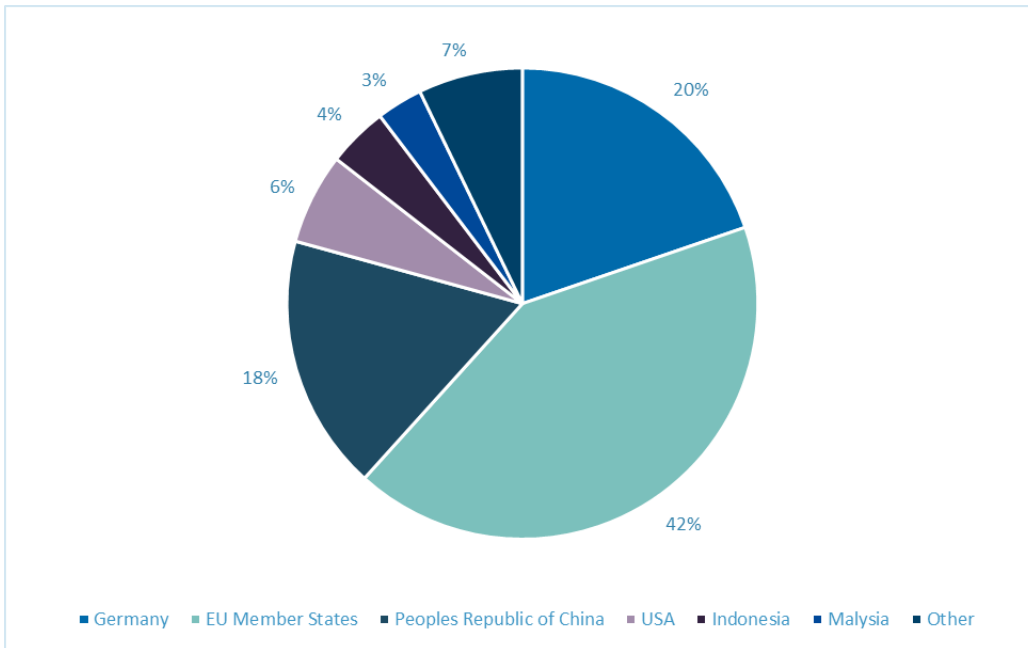


Figure 7: UCO by origin in the German transport sector 2018. Own presentation according to (BLE, 2019)

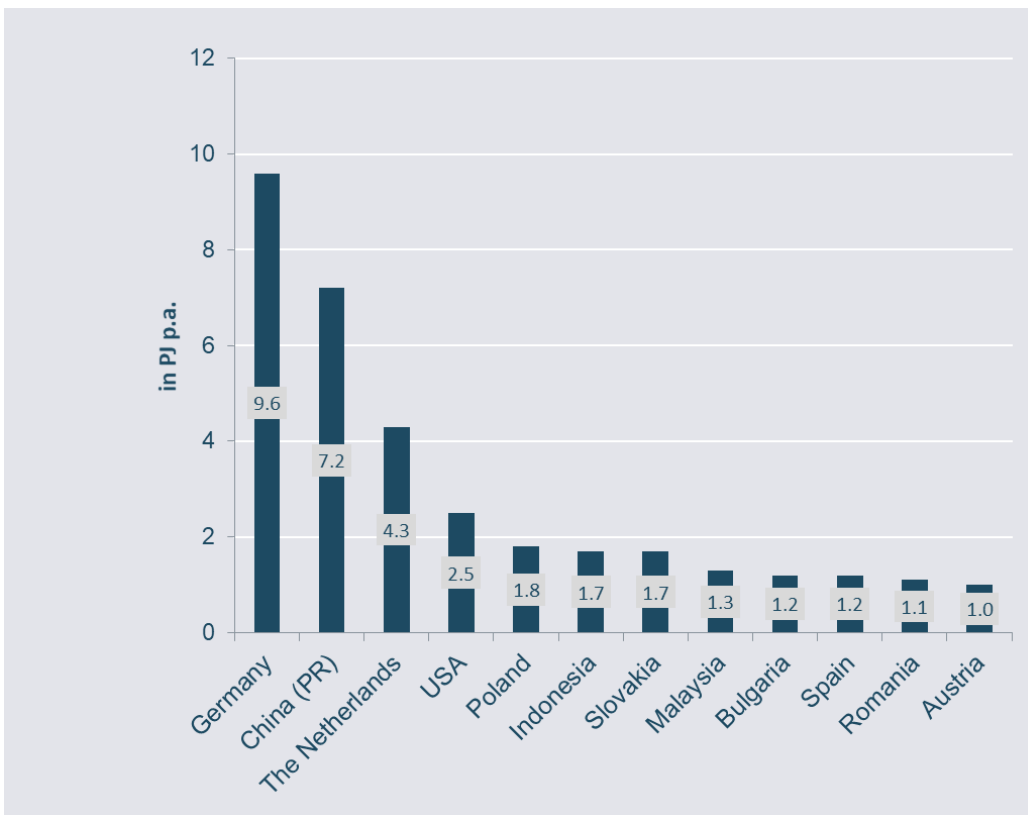


Figure 8: Origin of the UCO for the German market, 2018. Own presentation according to (BLE, personal communication, 2020)

The following chapters cover the emergence and possible potentials of the import countries that are important for Germany in the UCO sector.

### 3.3 UCO quantities in EU countries

As shown in Figure 7, the majority of the UCO utilized in Germany comes from other EU countries. The relevant import countries and their respective shares in 2018 are shown in the following Table 2.

Table 2: Major European export countries for the German UCO market

	The Netherlands	Poland	Slovakia	Bulgaria	Spain
Quantity 2018 [PJ]	4.3	1.8	1.7	1.2	1.2
Share (relativ) (1)	25%	10%	9.7%	6.8%	6.8%

(1) Share of other EU countries: 17.2 PJ

The five largest export countries for Germany therefore only cover slightly more than 50 % of the EU market in total. According to the BLE (BLE, 2020), UCO was imported from a total of 26 EU countries, which underlines a robust market integration and the demand of this coveted resource.

#### Special case: UCO from the Netherlands

Within the countries of Europe, the Netherlands is the most important and internationally second most important trading partner for Germany in terms of UCO. Only the People's Republic of China supplied Germany with more UCO in 2018.

Waste-based fuels play a significant role in the transport sector in the Netherlands. Between 2017 and 2019, the share of UCO in total biofuels was 56% in 2018 and 63% in 2019, respectively (Emissieautoriteit, 2020). It should be noted, however, that the Netherlands also covers only a fraction of its national biodiesel demand from domestic sources. Even though there is an exemplary organized and established UCO collection system, both in the professional and the household sector (Greenea, 2016). Nevertheless, the Netherlands' contribution to UCO consumption in the above period varied between 10% - 20% (Emissieautoriteit, 2020)<sup>1</sup>. For the Netherlands, the People's Republic of China and the USA are also the main sources of UCO. The Netherlands also imports UCO from Germany (8%, as shown in Annex 8.1).

For Germany, this means that the quantities officially sourced from the Netherlands or declared in this way are only imported via the Netherlands, but, for the most part, have not physically originated in the Netherlands. Consequently, in order to evaluate the real origin

<sup>1</sup> Furthermore, the 4.3 PJ exported to Germany exceed the total amount of UCO collected domestically in the Netherlands by several orders of magnitude.



of the UCOs imported in Germany, the Dutch import share would have to be allocated according to its market composition. The market composition of Germany adjusted for the Dutch import share is shown in Figure 9 and Figure 10. Both underline the importance of the source markets People's Republic of China and USA for Germany<sup>1</sup>. The market composition of the Netherlands can be seen in Appendix 8.1.

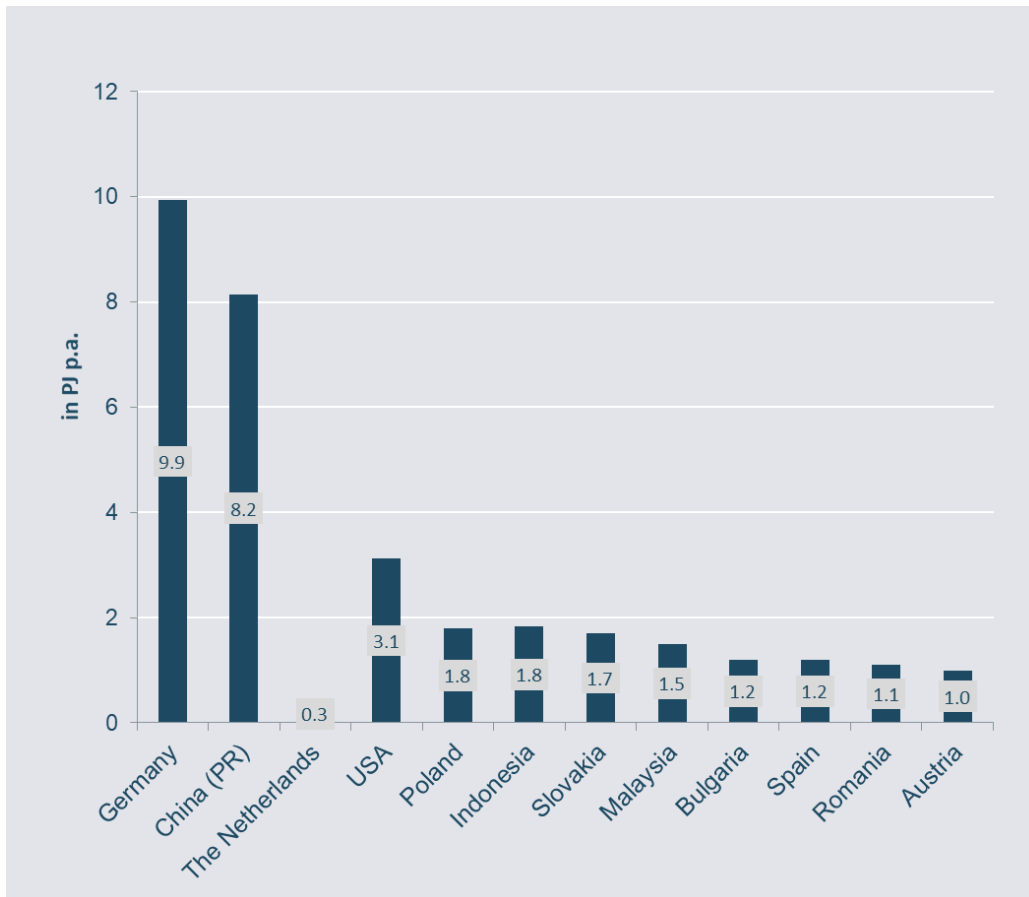


Figure 9: Adjusted origin of UCOs for the German market, 2018. Own presentation according to (BLE, 2019) and (Emissieautoriteit, 2020)<sup>2</sup>

<sup>1</sup> The specific shares from Indonesia and Malaysia are also increasing slightly. However, to a lesser extent compared to the US and China.

<sup>2</sup> Note: The market composition of the Netherlands in 2019 was assumed to be constant.

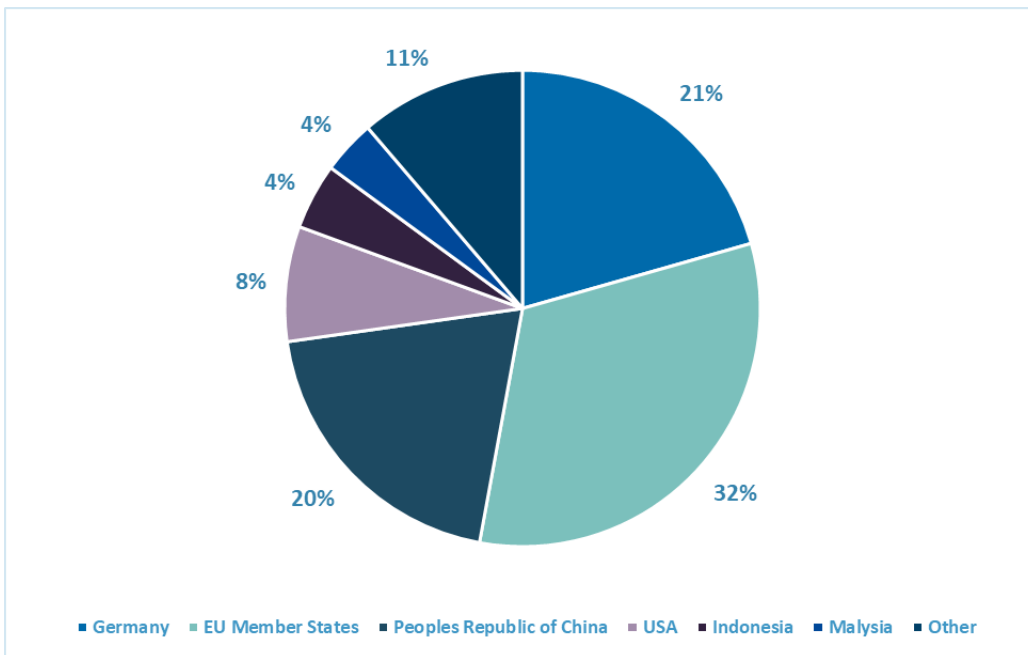


Figure 10: Adjusted UCO by origin in the German transport sector 2018. Own presentation according to (Emissionautoriteit, 2020)<sup>1</sup> and (BLE, 2019)

### Eastern Europe

Besides the Netherlands, Eastern European countries – mainly Poland and Slovakia – stand out in the German UCO import statistics. Both countries cover their renewable share in transport primarily with first generation biofuels, mainly rapeseed oil-based fuels. Second generation biofuels currently have a small share, but are expected to play a greater role in the future (Flach, Lieberz, & Bolla, 2019).

UCO-based fuels are currently not utilized in either country, and it can be assumed that UCO is intended for export purposes only, accordingly. (Greenea, 2016) states that a professional collection is established in both countries. A collection close to households is not yet available in Poland. In Slovakia, there are first approaches to this, so that for both countries, in contrast to the Netherlands, there are moderate growth opportunities.

## 3.4 Quantities in the main non-European export markets

Chapter 3.2 discussed the main importing countries. Overall, EU countries together make up Germany's most important trading block. European third party countries only play a marginal role. Besides the EU, China (20%), the USA (8%), Indonesia and Malaysia (4% each) have been identified as Germany's main trading partners. As Figure 2 shows, the Southeast Asian market share grew rapidly in 2018 by almost 100%<sup>2</sup>. However, there are still concerns

<sup>1</sup> Note: The market composition of the Netherlands in 2019 was assumed to be constant.

<sup>2</sup> It should be noted, however, that the import mix was adjusted for the Netherlands only for 2018 (see Chapter 3.2).

about the sustainability of the UCO from South East Asia (Phillips, 2019). The following chapter therefore focuses separately on the biofuel and UCO markets of these countries.

### 3.4.1 People's Republic of China / South East Asia

The People's Republic of China is by far Germany's largest trading partner for UCO. In 2018, around the same amount of UCO was imported from China as was collected in Germany itself (BLE, 2020). In addition, the Southeast Asian market share from 2013 (6%) grew strongly in recent years until 2018 (27%) (see Figure 2).

China's biofuel policy focuses more strongly on bioethanol. Biodiesel has played virtually no role so far. Furthermore, the Chinese blending target of 10% (E10) only applies to petrol. Consequently, there are no incentives for the use of biodiesel here, either. If China's transport policies remain constant, a competition for use within the transport sector can be ruled out (Kim, 2019).

In the PRC, UCO is mainly used in animal feed / fattening. Here, it serves as a cheaply available energy supplier to meet the growing demand for (especially pork) meat<sup>1</sup> (Phillips, 2019). Although the use of food waste in animal fattening is officially prohibited or a legal grey area, this ban is only enforced in exceptional cases, such as the outbreak of swine flu in 2019, in affected companies (Argus Media Group, 2020).

Another way in which used cooking oil is recycled in the People's Republic of China is to turn it into new cooking oil (Lu & Wu, 2014). This so-called "Gutter Oil" is marketed in China as a cheaper alternative to fresh vegetable oils. However, according to (Lu & Wu, 2014), Gutter Oil is a mixture of used cooking oils and other fats based on residual materials, e.g. low-grade residues from meat production or reused frying fat. This has given rise to controversy in the past about the potential harmful effects on health of consuming Gutter Oil. In response, the PRC government has successfully initiated a series of measures<sup>2</sup> and reforms<sup>3</sup> since the beginning of the 2010s to ensure the safety of edible oils in China (Lu & Wu, 2014).

As mentioned above, imports of UCO to the EU have grown significantly in recent years, accompanied by Chinese export growth. Total imports already reached 500,000 t in 2018, of which about 200,000 t of Chinese UCO alone went to Germany (Phillips, 2019). This again shows the importance of Germany for the international market, but especially also for the Chinese market.

However, there are numerous concerns regarding the sustainability and origin of UCO from China. As Chinese exports of UCO grew, palm oil, a highly controversial resource, was increasingly imported to the same extent, in order to compensate for the lack of capacities in animal fattening (Phillips, 2019) (T&E, 2020). This is particularly true for used cooking oils that have not previously been produced in the food or meat industry, but are only slightly contaminated. Between 2016 and 2018, imports of palm oil grew by 20%. Those of soybean and rapeseed oil also grew, but more moderately (Phillips, 2019). Both the demand for UCO and the profit margin on palm oil have risen sharply in Southeast Asia in recent years: the former already exceeds supply in Asia. The latter doubled between 2016 and 2018 to 10 % - 15 % compared to palm oil (Chow, 2018). Furthermore, there is a price fixing between UCO

<sup>1</sup> This was also the main use of UCO in Europe until 2003 pre the BSE problem.

<sup>2</sup> Among other things, a reward system has been developed for the notification of infringements or illegitimate use.

<sup>3</sup> In the event of a conviction, the death penalty is not excluded.

and palm oil, whereby the profit margin described above is solely because UCO is a more environmentally friendly fuel alternative with correspondingly increased demand (Chow, 2018). (Phillips, 2019) therefore suggests that this resulting iLUC risk should be taken into account in the ecological assessment of UCO-based biodiesel from China<sup>1</sup> and that these fuels should be labelled accordingly.

The situation is further complicated by concerns about the origin of Chinese UCO. Since the increased UCO imports to Europe in recent years, the UCO market price has been constantly above the price of palm oil (CPO, Crude Palm Oil) (Phillips, 2019).<sup>2</sup> This difference represents a potential profit margin from the sham use of (previously imported) palm oil or a direct misdeclaration of fresh vegetable oils as UCO (Phillips, 2019) (Michalopoulos, 2020). Moreover, existing protection mechanisms are often inadequate and are based only on the completion of self-declarations, which moreover only have to be fulfilled by major suppliers of 120 tons per year or more (Phillips, 2019) (Meyer, 2020). These relatively weak anti-fraud measures in combination with an attractive profit margin of up to 25 % per ton (corresponding to the price difference between UCO and CPO) make the system vulnerable to potential exploitation (Phillips, 2019) (T&E, 2020) (Meyer, 2020).

In addition, there are also concerns about the sustainability and robustness of the UCO supply chain in the other Southeast Asian countries of origin, especially Indonesia and Malaysia (Phillips, 2019) (Kharina, Searle, Rachmadini, Kurniawan, & Prionggo, 2018) (T&E, 2020) (Meyer, 2020). Even though both countries share a large-scale palm oil industry and corresponding economic markets, the price difference between UCO and palm oil is an incentive for increased exports – but also fraud by blending fresh vegetable oil (Phillips, 2019) (Kharina, Searle, Rachmadini, Kurniawan, & Prionggo, 2018) (T&E, 2020). Possible fraud cases are currently being investigated in several cases in the Netherlands and UK (T&E, 2020) (Meyer, 2020) (Phillips, 2019). A further complicating factor for Indonesia is that – despite a high per capita volume, which is only utilized / collected in the professional sector – UCO cannot be counted towards the national biodiesel quota of 30 % (20 % in Malaysia) (Kharina, Searle, Rachmadini, Kurniawan, & Prionggo, 2018). This quota is met exclusively by palm oil-based biofuels. The UCO, which is thus available in surplus for export, could be used alternatively as feedstock to meet quotas in Indonesia or Malaysia and substitute palm oil.

In summary, an iLUC risk of UCO from China, Indonesia and Malaysia cannot be ruled out due to displacement effects and/or potential fraud/false declaration (T&E, 2020) (Phillips, 2019) (Michalopoulos, 2020).

### 3.4.2 USA

After China, the USA follows as the second most important supplier of UCO exported to Germany (BLE, 2020). In the USA, too, there are legal requirements to meet the challenge of decarbonising the transport sector, which are summarised under the "Renewable Fuel Standard" (EPA, 2020). This standard distinguishes four different sustainable fuel categories, each of which has to meet annual volume targets. Analogous to the regulation under RED II (and FQD), conventional biodiesel has been capped since 2015.<sup>3</sup> The key raw material for

<sup>1</sup> The same applies to any UCO imports from abroad which are domestically substituted with high-iLUC vegetable oils.

<sup>2</sup> The price development for UCO can be followed at: <https://www.greenea.com/en/market-analysis/>, that of palm oil at: <https://www.rea.co.uk/websites/reaholdingsplc/English/2450/cpo-price.html>

<sup>3</sup> It should be noted that there is no explicit cap, but it is based on the overall quantity target minus advanced biofuels.

the production of biodiesel in the USA is soybean oil (approx. 70%) (EPA, 2020) (US Energy Information Administration, 2020).

Used cooking fats, known in the USA as "yellow grease", had a share of around 13 % and 12 % in 2018 and 2019, respectively (US Energy Information Administration, 2020). This makes Yellow Grease the third largest biodiesel feedstock in the USA (Zhou, Baldino, & Searle, 2020). In total, about 65% of the Yellow Grease collected in the USA was used for the production of biodiesel. In the future, even more biodiesel will be produced in the US from Yellow Grease. By 2032, its contribution is expected to grow by 50%, compared to 2018 (Zhou, Baldino, & Searle, 2020), while use in other sectors is largely predicted to remain constant or increase slightly.

Thus, the US UCO market is dominated by the production of biodiesel, with a further increasing trend (Zhou, Baldino, & Searle, 2020). According to (Zhou, Baldino, & Searle, 2020), however, the increase in production or growth in the UCO-based biofuel industry will not be at the expense of other sectors, but can be met by expanding collection. Furthermore, it is not clear to what extent exports or an increase in exports of UCO would lead to increased use of conventional biofuels in the USA.

In summary, UCO imports from the USA can be considered uncritical with respect to iLUC risk.

# 4 Potentials to increase UCO collection in Germany

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Chapter 3.2 presented the UCO potentials available in Germany. While only limited growth potential is forecast for the professional sector, the greatest growth potential is in the area of household collection, which is currently limited to isolated regional initiatives (Greenea, 2016). This chapter describes the possibilities of implementing nationwide UCO collection from private households, provided that appropriate quantities are available in households. The eating and cooking habits of the population of the respective country play a decisive role. Assuming the forecast of MVaK of 100,000 t per year for Germany, this results in a per capita collection volume of 1.20 kg per year. This means that Germany is well above the quantities actually collected in other European countries. For comparison: Belgium, a country with a well-established private collection system, collects about 0.73 kg per year. A possible implementation in Germany is mainly based on the experiences of the UCO household collection in the neighboring countries Netherlands, Belgium and Austria.

## 4.1 Value chain of a household UCO collection

How can the collection of UCO from private households be designed? In general, there are two options. A collection obligation (see e.g. Belgium) or a voluntary collection scheme (see e.g. the Netherlands). Regardless of these options, a possible UCO collection from households always starts with the use of a vegetable oil in households, for example, for the preparation of food. If, at the end of the use of the oil (e.g. after frying something), residual (used) oil remains, it should be collected in a container / bottle / receptacle specially designed for this purpose instead of being disposed of via the residual waste bin or flushed down the drain. The UCO containers can then either be handed in at (de)central points<sup>1</sup> or collected by third parties in the households<sup>2</sup>, whereby experiences from other countries proved that collection at central points is clearly advantageous (Greenea, 2016).

As a next step, the collected UCO is transported to a treatment plant and prepared for further recovery/treatment before being transported to a biodiesel producer. Here, the transesterification process (from UCO to UCO-ME) takes place to condition the UCO for optimal combustion in diesel engines. Glycerin is produced as a co-product, which has further technical applications. The UCO-ME can then either be used directly or blended with conventional diesel (Greenea, 2016). Figure 11 provides an overview of the value chain of a household UCO collection.

<sup>1</sup> Analogous, e.g., to the collection of used batteries in businesses or at other central collection points like schools.

<sup>2</sup> Similar to conventional household waste collection by waste disposal companies.

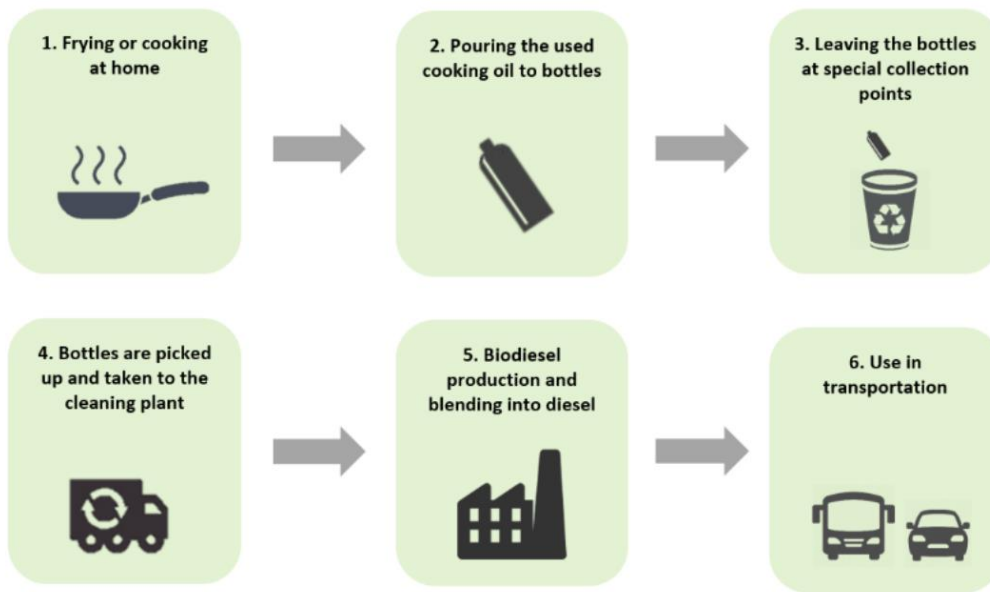


Figure 11: Presentation of a value chain of household UCO collection (Greenea, 2016)

## 4.2 Household UCO collection – Examples of Best Practice

The aim of this chapter is to briefly outline the different approaches to household UCO collection in the European countries Belgium, the Netherlands and Austria.

### 4.2.1 Belgium

According to (Greenea, 2016), Belgium is - by far - the country in Europe with the highest percentage of UCO collected in households<sup>1</sup>. The total potential in Belgian households is estimated at 13,000 tons per year (corresponding to a per-capita volume of 1.16 kg per year). Currently, already 8,300 t per year (corresponding to a per capita collection of 0.73 kg per year) are collected (Greenea, 2016). For comparison: The second most successful country, Sweden, achieves a collection rate of 47%. For the EU as a whole, (Greenea, 2016) estimate a collection rate of only 5.6% or 47,700 tons per year from European households, with a total UCO potential of 850,000 tons per year.

In Belgium, household UCO collection is organised in the so-called *Valorfrit system*. The initiative dates back to 2004 and is the result of the merger of eleven companies active in the sector. The *Valorfrit system* was created following the introduction of a law on the recycling of edible oils. Producers, importers and distributors in general are obliged to report both the quantity of edible oils placed on the market as well as the quantity of recycled UCO. *Valorfrit* as the umbrella organisation coordinates the exchange of information on the one

<sup>1</sup> Belgian eating and cooking habits, with its' high proportion of frying and correspondingly large amounts of UCO constitute a major influencing factor.

hand and the collection itself on the other. The collection companies licensed in the system are paid by *Valorfrit*.

The Belgian *Valorfrit system* constitutes a form of central collection<sup>1</sup>. The total of around 700 collection points are distributed to central and easily accessible locations, such as a shopping centers, malls, and the like. Each collection point collected an average of around 12 tons of UCO in 2014.

The cooperation of households in collection is an integral part of the success of the household collection in Belgium. In order to ensure this, a continuous PR campaign is indispensable to highlight the necessity of household collection. At the same time, however, this PR campaign is a major cost factor, amounting to around €1 million per year.

However, other factors contribute to the success of the collection system. Firstly, the culinary environment in Belgium means a relatively high per capita UCO potential. In addition to the culinary habits of the Belgian population, the attitude towards recycling is generally decisive. The willingness to recycle waste is traditionally high among the population of the Benelux countries, which is also reflected in the considerable collection rate of almost 2/3.

#### 4.2.2 The Netherlands

Following Belgium, the Netherlands have also introduced a nationwide household UCO collection in 2011. In contrast to Belgium, however, this is based on a voluntary approach. There is no collection obligation by the state. The Dutch system is also centrally organised. However, with around 2,000 collection points, it comprises around three times as many contact points, resulting in comparatively low quantities collected per collection point of only 1.8 tons.

Similar to the successful *Valorfrit system* in Belgium, the Dutch household UCO collection system was also developed from a merger of various actors - including wastewater treatment companies - in the UCO economy.

In addition to the central collection infrastructure, the Dutch system has produced a number of other innovations. Firstly, an application for simplified UCO collection for conventional (drinking) bottles, the so-called "*EKOFUNNEL*", has been developed. This attachment encourages UCO to be collected in standard *PET* or other plastic bottles rather than in specially designed containers. Figure 12 shows a UCO collection from a pan using the *EKOFUNNEL* design and *PET* bottle.

<sup>1</sup> There are individual municipal collections in the households themselves, similar to conventional waste disposal.





Figure 12: EKOFUNNEL - Design for simplified UCO collection in private households (EKOFUNNEL, 2020)

Secondly, the Dutch collection system is strongly involved in schools, sports clubs and other youth organisations. These young people are encouraged to collect UCO and in return receive a grant or funding. This targeting of young people and children has the advantage of establishing habits at an early age. Furthermore, it sensitises young people and children in general to the subject of recycling and environmental protection, which is hoped to have an effect beyond UCO collection. Furthermore, cooperation with these institutions makes it easier to choose the location for UCO collection, as cooperating institutions are encouraged to set up collection containers on their premises.

Nevertheless, compared to the mandatory system in neighboring Belgium, households in the Netherlands collect comparatively little UCO: per capita, the collection rate in 2014 was 0.21 kg per year with a potential of 0.7 kg per capita and year, or 30% (Greenea, 2016). Apart from the voluntary nature of the collection, a major reason for this may be the relatively low per capita consumption of edible oils, which is due to Dutch dietary habits. Furthermore, the Belgian collection system has existed around twice as long as that in the Netherlands (introduction 2004 vs. 2011) and is therefore more mature.

#### 4.2.3 Austria

Starting in 1990, private households in Austria have been collecting UCO (Greenea, 2016). In contrast to the Netherlands and Belgium, however, the UCO collection originated as a regional or municipal initiative of the city of Graz. In addition, there is no uniform, area-wide system, but the *Ökodrive* System of the City of Graz and the *Öli* System for other regions. The *Öli* System was created in 1999 and, too, covers parts of southern Germany, among other things.

The Austrian systems are also centrally organised with publicly accessible delivery points. In contrast to Belgium and the Netherlands, however, *Öli* uses a specially designed 3l container, which is exchanged for an empty one when the oil is submitted (Figure 13).



Figure 13: Demonstration of the Öli design, Austria (Fritzens, 2020)

The *Öli* system collects up to 1 kg per capita and year. However, the UCO collection schemes in Austria do not cover the entire national territory, but only about 27 % so far.

Culinary factors are also decisive here. Austrian cuisine, for example, produces a disproportionately high amount of UCO. This is not easily transferable to other countries, such as Germany. Furthermore, the UCO collected with the *Öli* System is not processed into biofuels, but is used for energetic use directly or after fermentation to biogas.

#### Summary:

The analysis of the experiences of the European neighbouring countries Belgium, the Netherlands and Austria has revealed a number of key factors, which are decisive for the success of a household UCO collection:

The main factor determining the UCO potential from private households is primarily the quantities used, which in turn are mainly determined by culinary factors. Furthermore, the comparison of the Netherlands and Belgium shows that a political / governmental collection obligation has a positive effect on recovered margins<sup>1</sup>.

Another significant factor are general recycling habits of the population of the respective country. If these are generally well established and well anchored, it can be assumed that they can also be transferred to a further collection of a special waste material, UCO. However, the example of Belgium shows that a continuous PR campaign - at least when a separate UCO collection is first introduced - is essential to promote motivation and participation

<sup>1</sup> As already mentioned in 4.2.2, the per-capita differences are not solely due to the collection obligation. However, it can be assumed that it plays a decisive role.

of the population. In order to facilitate the creation of new habits, the approach and targeted sensitisation of young people and children via schools and recreational facilities proved to be particularly successful.

As regards the form of organisation (uniform across the board vs. regionally different structures/associations/collaborations) or collection technology (specially developed collection container vs. collection in plastic bottles with an application), no clear trends could be derived. Various concepts have proven successful in practice. Common to all systems investigated is that collection is organised centrally and UCO is not collected decentrally in the households of waste management companies.

Nor is the influence of possible incentives or remuneration for the collection and delivery of the privately collected UCO clear. Whether or to what extent a possible (financial) remuneration has a decisive influence on collection behaviour is not the subject of this study. If, however, UCO household collection is to be introduced in Germany or other countries, this question should be given greater consideration.

# 5 Significance of biofuels based on category 1 and 2 animal fats

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## 5.1 Problem definition

The raw materials and RED II Annex IX Part B include animal fats classified in categories 1 and 2 of Regulation (EC) No 1069/2009. These categories are defined as follows:

- Category 1: Raw material presenting a high risk, such as animals suspected of being infected by a TSE or specified risk material
- Category 2: Medium risk material, e.g. carcasses of animals which have died by means other than slaughter or killing for human consumption, including animals killed for disease control purposes

These materials must be disposed of as waste by incineration. Category 2 animal fats can also be utilized for the production of biogas.

Category 3 animal fats may also be used for the production of feed for other farmed animals. For this reason, they are not eligible for double counting towards the quota under RED II (minimum percentage under RED II Article 25 (1)).

Germany constitutes the only EU country to have excluded the production of biofuels based on animal fats (hereinafter referred to as TME, an abbreviation of tallow methyl ester or animal fat methyl ester) from the scope of eligibility (BlmSchG, § 37b (8) No. 3). Among other EU Member States, so far, only Denmark, Finland, France and the Netherlands<sup>1</sup> allow a double counting of TME.

The reason for the exclusion in Germany is the competition for use that would be created by the promotion of TME in comparison with other industries that already use animal fats as raw materials.<sup>2</sup> A further (informal) argument was that the promotion of TME would create a contribution to limiting the costs of rendering, which could lead to a reduction in the price of meat and, thus, also further stimulate meat consumption.

<sup>1</sup> The UK, too, allows for a double counting, when assessing the EU-28.

<sup>2</sup> See Bundesrat Drucksache 360/14 of 08.08.2014 (p. 19, explanatory memorandum to number 5 (§37b, paragraph 8)); [https://www.bundesrat.de/SharedDocs/drucksachen/2014/0301-0400/360-14.pdf?\\_\\_blob=publicationFile&v=1](https://www.bundesrat.de/SharedDocs/drucksachen/2014/0301-0400/360-14.pdf?__blob=publicationFile&v=1)

The focus of this chapter is the question of what role can a possible future eligibility of biofuels based on animal fats of categories 1 and 2 play towards the for the fulfilment of quotas for Germany. Which arguments speak in favour, which against? The following additional questions need to be further clarified:

- What are the quantities and destinations of animal fats in Germany and in the EU?
- How important are biofuels based on animal fats of categories 1 and 2 in the EU?
- What are the possible consequences of an additional GHG quota eligibility?

## 5.2 Quantities and destinations of animal fats in Germany and the EU

### 5.2.1 Germany

Quantities of animal fats in Germany were investigated in the so-called *BioRest study* (Fehrenbach, 2019), among others. The figures in Table 3 (reference year 2016) are taken from this study. The background data is based primarily on data from the *Servicegesellschaft Tierische Nebenprodukte* (STN) in the *Verband der Verarbeitungsbetriebe Tierischer Nebenprodukte e. V.* (VVTN). According to these data, Germany produces about 130,000 tons of category 1 and 2 animal fats per year, 86 % of which fall under category 1. Roughly, 96 % of them are processed into bio-diesel, which corresponds to about 4.8 PJ. Assuming that this quantity is constant, this would amount to about 12 % of UCO in Germany (about 42 PJ in 2018, see above).

Table 3: Collection and use of animal fats in Germany; source: (Fehrenbach, 2019)

2016 in [t/a]	Animal feed	Techn. Applications	Biodiesel	Thermal utilization	Own consumption
Cat. 1 animal fats	-	3,864	105,779	625	456
Cat. 2 animal fats	-	-	18,003	-	-
Cat. 3 animal fats	63,962	151,624	103,861	71	-
Sum	63,962	155,488	227,643	696	456
Total	448,245				

It is also worth noting that of the 320,000 tonnes of category 3 animal fat, a third is also processed into biodiesel, which corresponds to a further 3.8 PJ. Only 20% are being used as animal feed, while 47 % go to technical applications (mainly oleochemistry).

The TME produced in Germany from animal fats is exported in its entirety to neighbouring European countries because it is not eligible towards the GHG quota. However, (Flach, Lieberz, & Bolla, 2019) show that Germany also uses TME.

### 5.2.2 Europe

According to data from the *European Fat Processors and Renderers Association* (EFRA), approximately 6 million tons of Category 1 and 2 material are recycled in Europe. Approximately 12 % of this is animal fat. Figure 14 shows the volume development of animal fats until 2014. More current figures are not published.

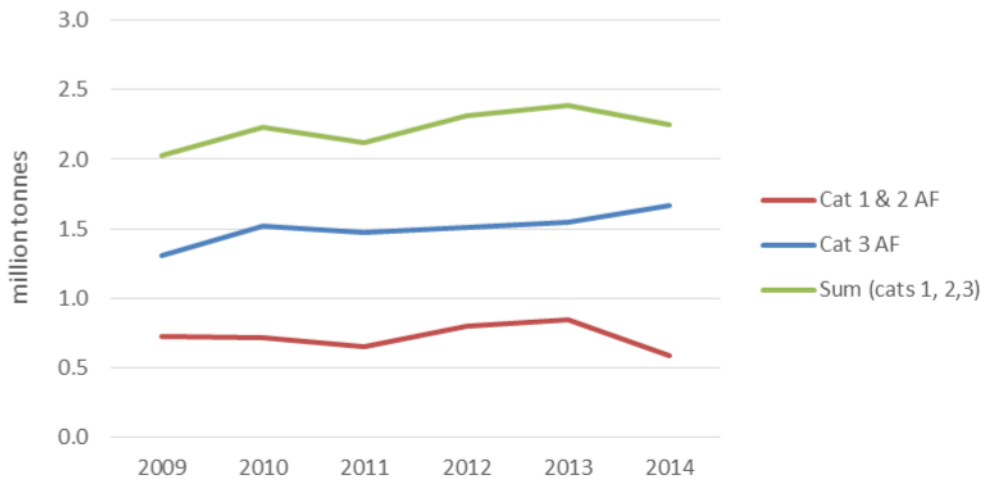


Figure 14: Volume of category 1+2 and 3 animal fats in Europe; source: (Chudziak & Haye, 2016), based on data from EFRA

## 5.3 Importance of biofuels based on category 1 and category 2 animal fats in the EU

### 5.3.1 Produced volumes

According to the GAIN report by (Flach, Lieberz, & Bolla, 2019), about 1 million tons TME have been used as fuels in Europe in recent years. At 37 PJ, this corresponds to more than a third of UCO. Until 2013, quantities ranged from 0.3 to 0.4 million t and then increased sharply, collapsed again sharply in 2016 and have been rising continuously ever since. This development of the TME in the EU shown in Figure 15 does not quite fit in with the picture in Figure 14, according to which, following EFRA data, only just under 600,000 tons of Category 1 and 2 animal fat were available in 2014, but 900,000 tons of TME had already been used. There is no doubt, however, that the use in the last five years is significantly higher than before.

The authors of the GAIN report attribute the increasing use of animal fats predominantly to the installation of new plants or capacity increases in already existing plants, then as a function of raw material prices, as the use of animal fat requires changes in technical equipment.

Figure 16 therefore does not show the current situation, but shows the distribution of TME (and UCO) production and pro-capacity in Europe.

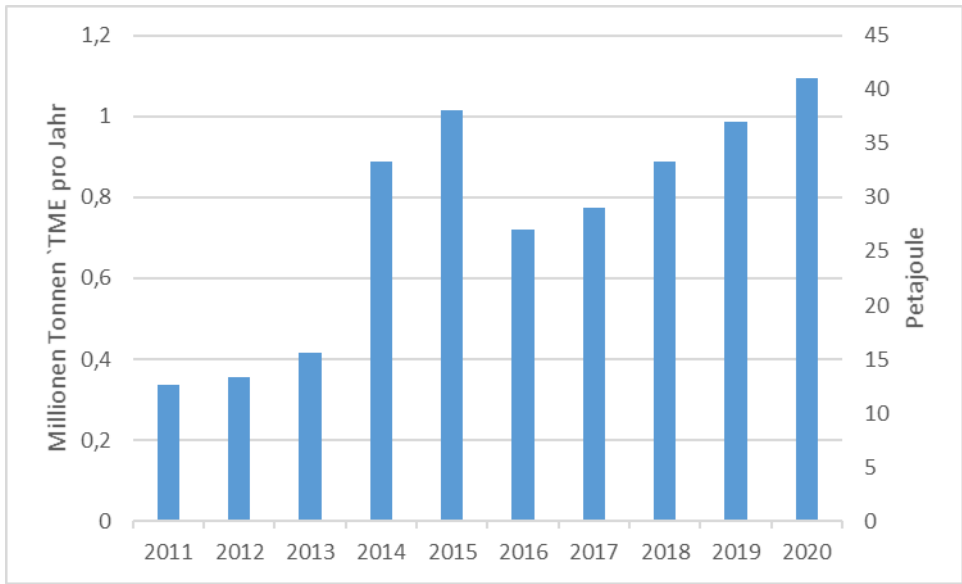


Figure 15: Utilization of TME in the EU; Source: (Flach, Lieberz, & Bolla, 2019)

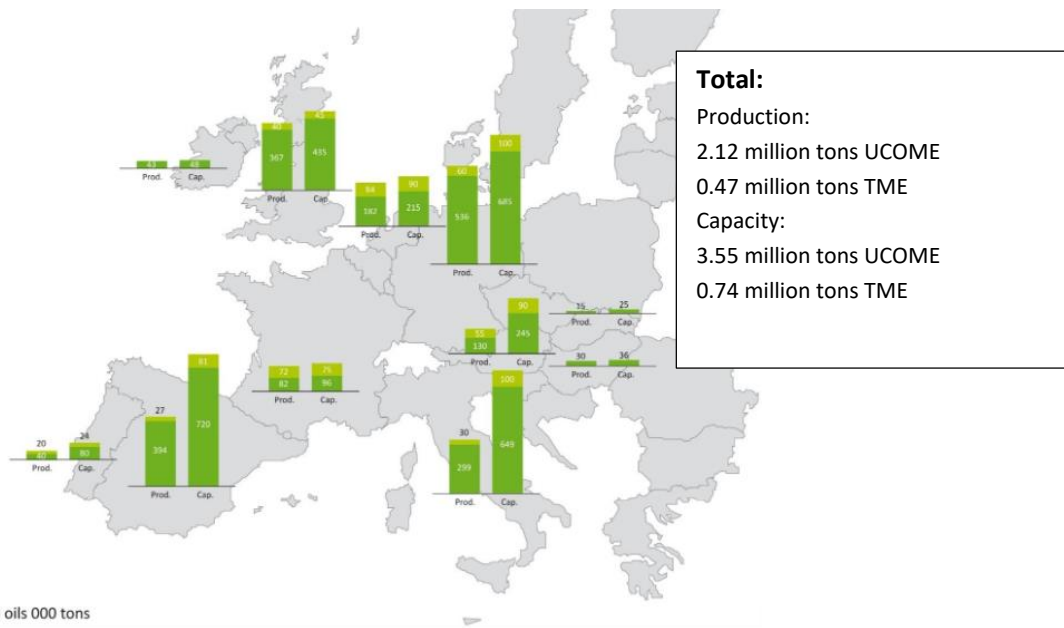


Figure 16: Waste based biodiesel production and capacities in Europe, 2016; Source: (greenea, 2016)

The main countries using TME as a biofuel are Italy, the Netherlands and France. Significantly smaller shares are found in Finland, UK, Denmark, Spain, Austria, Ireland, Hungary, Poland and the UK. As mentioned above, Germany (Flach, Lieberz, & Bolla, 2019), too, utilizes TME, but with comparatively low margins, only.

Denmark and Italy recognise animal fats (and UCO) as a feedstock for advanced biofuels. There, as well as in the Netherlands, France and Finland, they are processed together with other wastes (also Annex IX, Part A) in plants using the hydrotreatment process.

### 5.3.2 Price relations

According to Greenea, the animal fat market is relatively stable due to the dominance of a few top buyers. According to (Chudziak & Haye, 2016), the price of animal fat follows the developments of vegetable oils (see Figure 17) and is always slightly below them. In most cases, the price is close to crude palm oil (CPO), but always below UCO.

This suggests that TME is more competitive compared with UCOME.<sup>1</sup>



Figure 17: Development of prices of animal fats compared to several vegetable oils and UCO; Source: (Chudziak & Haye, 2016), based on data from O. Licht, Oil World

## 5.4 Possible consequences of an eligibility towards the GHG quota in Germany

The starting position for this question can be outlined as follows:

- The potential of animal fat is limited and exhausted by the status quo in Germany as is; the quantities produced in Category 1 and 2 rendering plants cannot be significantly increased in view of the technology already installed in the plants.<sup>2</sup>

<sup>1</sup> NOTE: The large price advantage of animal fat over UCO is not easy to explain because the quality of the output from the fat melting plant is comparatively high and can be used directly in biodiesel production (transesterification).

<sup>2</sup> According to the self-presentation of the companies that process category 1 and 2 in Germany (websites).



- In Germany, the available animal fats of categories 1 and 2 are already almost completely processed into biodiesel (TME); due to legal requirements, these quantities do not compete with alternative material uses (e.g. animal feed or oleochemistry).
- Category 3 animal fats, which more than doubles the other categories in terms of volumes, is mainly used materially. Nevertheless, high proportions of this raw material are already being processed into TME.
- TME produced in Germany is being exported to other EU Member States in (almost) its entirety, where it's eligible towards the GHG quota.
- The quantity of TME produced in Germany from categories 1 and 2 (in 2016, this was approx. 130,000 t with an energy content of 4.8 PJ) corresponds to 12 % of the quantity of UCO currently counted as Part B biofuel towards the GHG quota; with these TME quantities, Part B biofuels would increase to approx. 48 PJ and thus account for a total of 2.0 % of final energy consumption in transport (for 2020, see Chapter 2).
- Prices for animal fats are lower than UCO prices.

If in light of the implementation of RED II, Germany would allow TME to be eligible towards the GHG reduction quota, the following consequences can be expected:

- As a result of the price advantage, market participants subject to the quota in Germany would increasingly demand TME and thus enter into competition with existing customers in other EU countries.
- Additional production of TME, i.e. additional development of category 1 and 2 animal fats, is unlikely due to the limited and already widely developed potential; To what extent further untapped volumes for biodiesel production in other EU countries can be developed, cannot be assessed at present; neither can it be assessed whether, similar to UCO, imports from non-EU countries are an option for TME.
- With a cap in place, the additional use of TME is expected to displace the use of UCO. This would probably primarily affect the UCO with the comparatively most expensive production costs, which could possibly be UCO of German origin.
- For the German GHG quota, the eligibility of TME would have a positive effect due to its' high specific savings rate; the effect would be limited, however, if it reduced the share of UCO (which also has a high savings rate).
- The overall changes from the previous situation, both positive and negative, would be limited:
  - little incentive or potential for more TME, but rather a redistribution of biofuels between current TME importing countries from German production and Germany itself.
  - GHG savings largely limited to avoided transports.

Accordingly, a future possible eligibility of TME towards the GHG reduction quota in Germany must be assessed ambivalently.

## 6 Summary

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This study focuses on the importance of biofuels on the basis of raw materials listed in Annex IX Part B of the Renewable Energy Directive II (RED II) for Germany and Europe. One of the central questions was, what role biofuels based on used cooking oil (UCO) and animal fats of categories I to III can play at present and in the future to fulfil Germany's obligations in the transport sector. On the other hand, the sustainability of the provision of these fuels was examined, particularly with regard to competition for use and the risk of inducing indirect land use changes. Against this background, the quantities and utilization of UCO in Germany, Europe and in the main non-European export markets (China, USA, Malaysia, Indonesia) of Germany were analysed. Furthermore, the potential for increasing UCO collection in Germany was investigated. For this purpose, experiences from the UCO collection in other European countries were evaluated and decisive influencing factors were derived. In addition to UCO as a raw material for biofuels, the relevance of category I and II animal fats in the biofuel sector was further investigated. In particular, quantities and utilization as well as the possibilities and effects of counting these fuels towards the GHG quota were discussed.

**Germany is a key market in Europe**, consuming around one sixth of all fuels within the EU 28. This also and in particular applies to UCO-based fuels. Their demand in Germany has increased rapidly from 15 PJ in 2013 to over 40 PJ in 2018, and thus already corresponds to the 1.7 % of final energy consumption in the transport sector which, according to RED II, is to be attributed to these biofuels by 2030. In view of a forecast slight decrease in final energy consumption in Germany's transport sector, the current situation would mean that the 1.7 % ceiling of RED II would be exceeded in absolute terms. This would then require a separate approval by the European Commission, resulting therefore in a need for action in any case.

**The German UCO market is dominated by imports.** Domestic production accounts for only around 20%. The main import destinations are other EU countries, the People's Republic of China, the USA, Malaysia and Indonesia. Within the EU, Eastern European countries in particular play an important role for Germany. The EU country with the largest share of UCO imports for Germany is the Netherlands, which on closer inspection, however, almost exclusively acts as a transit country for UCO from international sources.

**Sustainability all along the value chain is a key issue for the evaluation of UCO-based fuels.** Especially considering UCO from the South East Asian region, there have been and still are accusations regarding the origin of UCO. Thus, it cannot be ruled out with certainty that it is actually UCO and not fresh vegetable oils based on palm oil fraudulently declared as UCO. This is not only favoured by an increasing overall European demand, but also, above all, by higher market prices for UCO, compared to fresh crude palm oil. Equally relevant is the assessment of competition for use and displacement effects. The continued use of used cooking fats in food preparation, which is harmful to health and therefore prohibited in China, must be viewed critically and the alternative use of these oils should be supported. However, used edible fats are also being withdrawn from other existing areas of use, such as the use of UCO in animal fattening. It can therefore be assumed that UCO exported from China

to Germany will have to be at least partially replaced by fresh vegetable oil, including all environmental and climate impacts.

In addition to this direct competition for use, there are other, indirect effects. For example, Malaysia and Indonesia each have their own biofuel quotas. These are almost invariably met by palm oil-based biofuels, but could also be replaced by UCO-based biofuels. In this sense, imports from these countries only shift responsibilities, but, in reality, do not prevent the undesirable effects of palm oil biodiesel.

On the other hand, imports of UCO or UCO-based biofuels from the USA can be considered unproblematic. Here, the increase in production or growth in the UCO-based biofuel industry is not at the expense of other sectors, but can be covered by extending collection.

**As regards the question of increasing Germany's UCO collection**, a more differentiated view must first be taken of the UCO collection. In general, the UCO collection can be divided into two sectors: A distinction is made between UCO collection from private households and professional UCO collection from restaurants, canteen kitchens and the food industry. With regard to the latter, there are hardly any significant sources left to tap. Accordingly, only moderate growth can be expected here. In contrast, household UCO collection in Germany has so far only taken place in selected pilot regions. If one decides in favour of compulsory collection here, one can draw on the experience of the Netherlands, Belgium and Austria. These countries already have a well-established UCO collection from private households. The general recycling habits of the population, supported by an extensive information campaign, the culinary habits of the country and centralised collection structures (instead of decentralised collection) have proved to be decisive influencing factors.

**96% of animal fats, which may not be used for the production of animal feed or other material use because of high or medium risk (categories 1 and 2) are currently processed into biodiesel (TME) in Germany.** In Germany, however, this type of biofuel is not eligible to meet the GHG reduction quota. They are therefore exported to other EU countries.

Along with Italy, the Netherlands, France and Spain, Germany is one of the relevant producers of TME. The amount of animal fats is limited and it is unlikely that the amount produced today will be significantly increased. The quantity of TME produced in Germany corresponds to about 12% of the biodiesel from UCO credited in Germany or, in total, to 2% of the final energy consumption in transport.

An important aspect is that the raw material prices for animal fat are significantly lower than for UCO. This should provide a major incentive for those in Germany who are obliged to take on a quota in the event that TME can be counted towards the GHG reduction quota in the future. They would therefore compete with existing customers in other EU countries. Considering the RED II cap, it can therefore be expected that the additional use of TME in Germany would displace the use of (more expensive) UCO biodiesel. However, the impact on environmental aspects as well as on the fulfilment of the GHG quota would be limited, as TME as well as UCO biodiesel each achieve high savings rates.

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# 8 Appendix

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## 8.1 UCO Market composition in the Netherlands

In the current reporting year 2019, the Dutch UCO market is composed as follows:

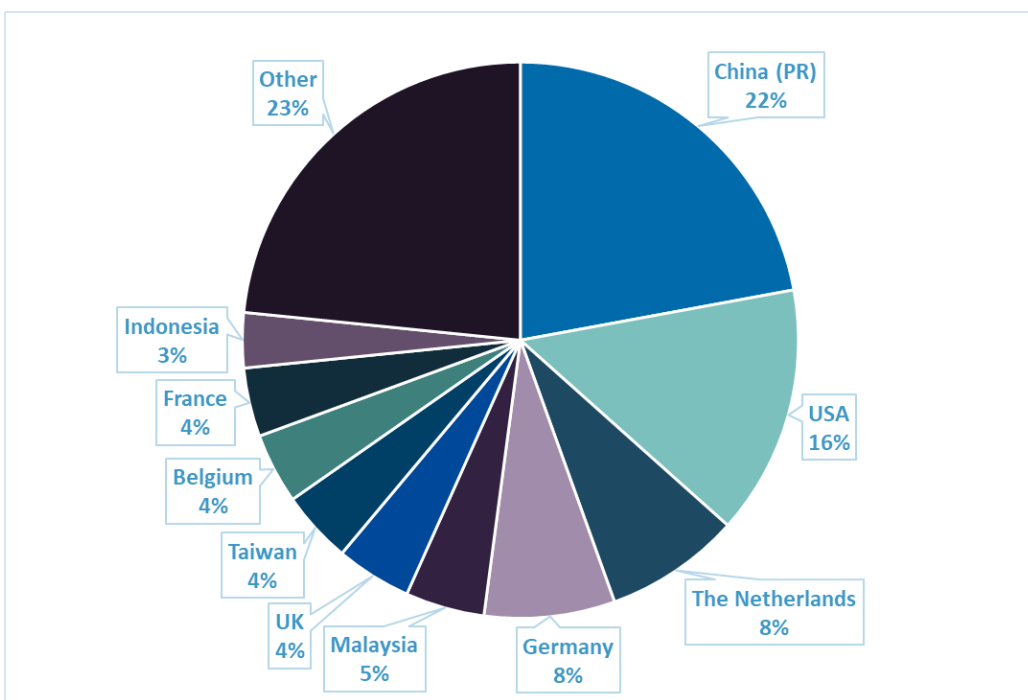


Figure 18 UCO market composition of the Netherlands in 2019; Source: (Emissieautoriteit, 2020)

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