Netherlands Enterprise Agency

Sustainable biomass and bioenergy in the Netherlands

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Sustainable biomass and bioenergy in the Netherlands:

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Colophon

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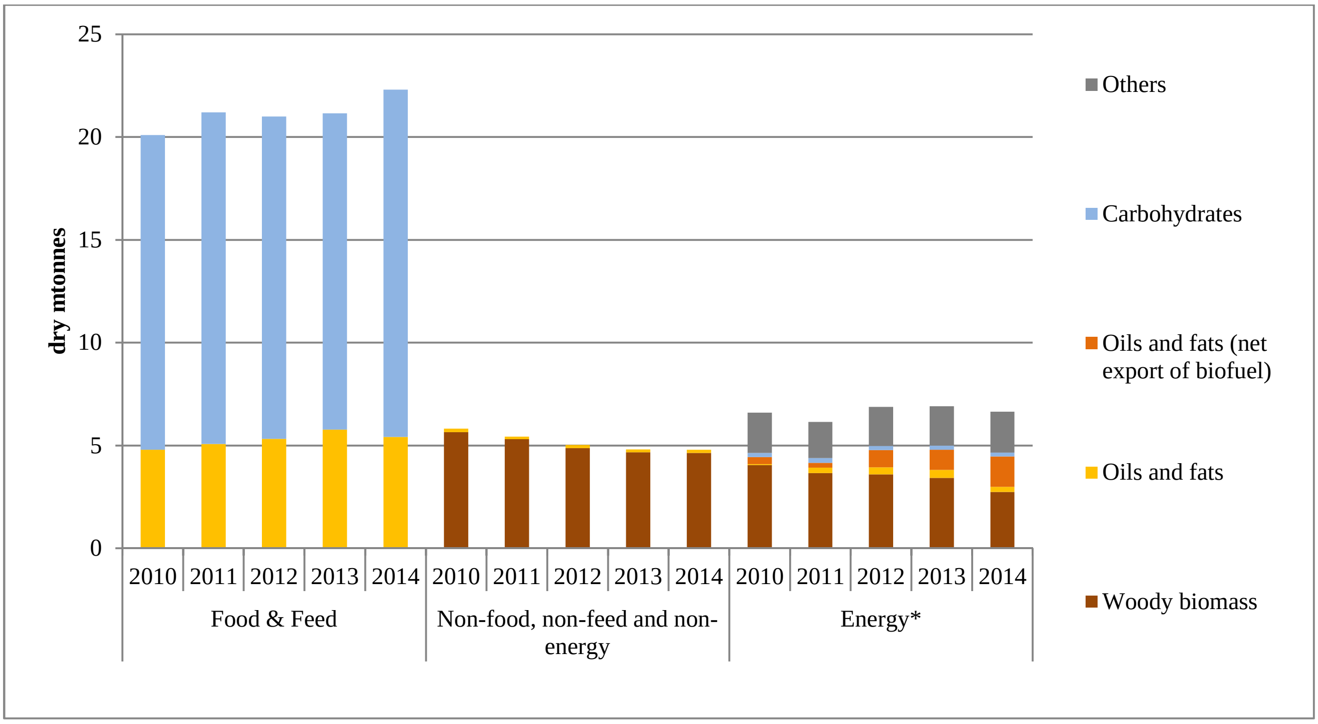
Abbreviations

AVI	Afvalverbrandingsinstallatie (waste incineration plant)
BEC	Bio Energie Centrale
CBS	Centraal Bureau voor de Statistiek (Statistics Netherlands)
CN	Combined nomenclature
COMTRADE	United Nations Commodity Trade Statistics Database
DBI	The Sustainable Biomass Import programme
DBM	The Global Sustainable Biomass programme
EBB	European Biodiesel Board
EEC	European Economic Community
EUROSTAT	The Statistical Directorate-General of the EC
FAME	Fatty Acid Methyl Ester
FAOSTAT	The Statistics Division of the FAO
GGL	Green Gold Label
GHG	Greenhouse Gas
GSP	Generalized System of Preferences
HVO	Hydro-treated Vegetable Oils
ISCC	International Sustainability & Carbon Certification
IDH	Initiatief Duurzame Handel (Sustainable Trade Initiative)
MVO	The Product Board for Margarine, Fats and Oils
MT	million tonnes
NEa	Dutch Emission Authority
NCV	Net calorific value
PME	Palm Methyl Esters
RED	Renewable Energy Directive
RSPO	Roundtable on Sustainable Palm Oil
RTRS	Round Table on Responsible Soy
RWS	Rijkswaterstaat
SME	Soy Methyl Esters
UAE	United Arab Emirates
UCO	Used cooking oil
USDA	United States Department of Agriculture
VVAK	Voedsel- en Voederveiligheid Akkerbouw
WTO	World Trade Organization

1. Summary

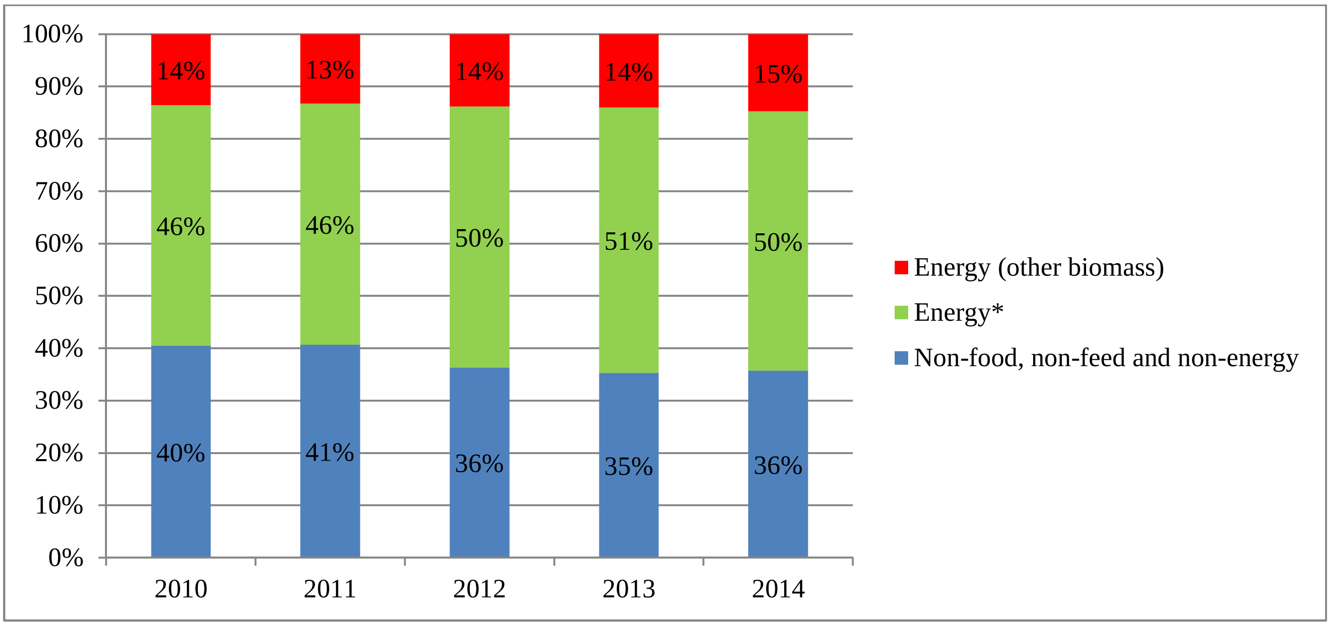
Since 2012, the report "Sustainable Biomass Flows in the Netherlands" has been compiled to provide a quantitative and qualitative overview of past and current solid and liquid biomass import flows, and assess (as far as possible) to what extent this biomass was produced sustainably. In 2014, the report adapts the 'Protocol For Monitoring Of Material Streams In The Biobased Economy (BBE)' to account for the size of bio-based economy (limited to three major biomass groups) in the Netherlands (Kwant et al. 2015, Meesters et al. 2014).

Figure 1-1 shows the overview of biomass from the three major categories, i.e. woody biomass, oils and fats and carbohydrates used in different sectors in the Netherlands. The use of woody biomass for non-food, non-feed and non-energy sectors is the largest, but it has been decreasing since 2010 but remain stagnant for 2013-2014. The use of oils and fats for these sectors are small, mainly in the chemical sector. In the energy sector, the quantity of woody biomass consumed has also declined (due to the smaller amount of co-fired wood pellets), but the export of biofuel has grown significantly. It is uncertain about the development of bio-ethanol production in the country due to very limited information available. The other biomass is also included in the illustration within the energy sector. This mainly comprises other organic materials (e.g. agricultural residues, food wastes, textiles) combusted in BEC and waste incinerators. Figure 1-2 illustrates the share of biomass used in different sectors from the three categories as well as energy use of other biomass from 2010 to 2014. The energy use of biomass has grown from 61% in 2010 to 67% in 2013, but it remained the same in 2014.



* Carbohydrates shown for use for energy is domestic consumption of bioethanol only, export of bioethanol is not included here due to lack of reliable data.

Figure 1-1 Overview of biomass feedstock used in different sectors



* Export of bioethanol is not included here due to lack of reliable data.

Figure 1-2 Share of biomass used in different sectors.

Figure 1-3 shows the energy use of biomass in the Netherlands 2010 – 2014. This graph excludes exported energy production. The consumption of imported biomass used for renewable electricity production from co-firing in coal power plants has dropped substantially since 2013. Data for biomass co-firing is missing for 2014, but amounts have likely decreased further due to the running out of MEP subsidy scheme. The consumption of biofuels remains rather stable in since 2011. Note that a high percentage of biofuel are counted double to fulfil the obligation, however the values shown in the figure are physical amount. For company wood boilers, there are more heat produced in 2014 but data for electricity generation is missing due to confidentiality reasons.

Overall, a few key trends were observed:

- Woody biomass: While the use of woody biomass for non-energy use has remained stable between 2013 and 2014, the energy use from woody biomass has dropped substantially, particularly the reduction in the amount of wood pellets co-fired in coal power plants.
- Oils and fats: The Netherlands has continued to grow as a net exporter of biodiesel, with the net export amounted to 1.47 MT in 2014 compared to 0.99 MT in 2013. The growth in production is mainly contributed by increasing use of fatty acids as feedstock. In terms of the share of biodiesel used in the Netherlands in 2014, a large amount of double counted biodiesel was found to be made of UCO, animal fats and fatty acids from Asia and North America. Meanwhile, the use of oils and fats in non-energy markets has been stagnant.
- Carbohydrates: One prominent change in 2014 is that the production of sugar beets has increased 22% in comparison to the average of 2008-2013. In terms of ethanol trade, while ethanol import from South and Central America has reduced substantially, there are also net exports in large streams to UAE and India in 2014, which were never seen in 2010-2013.
- Trend in the chemical industry: A number of chemical companies traditionally use vegetable oils, resin and animal fats in their production and there are several companies which use biobased materials as drop-in chemicals. These materials are mainly imported due to the limited biomass resources in the Netherlands. There is currently growth in the biobased chemical sector but it is slow and uncertain as it is dependent on the end-use markets.
- Waste incineration/ waste trade: Recorded by RWS, in 2014, 60% of the total wastes delivered to the waste incinerators were biogenic. The dry organic mass amounts to about 2,700 tonnes. Biogenic wastes are burnt for electricity and heat production. Wastes delivered to incinerators include mixed municipal wastes, imported wastes and other streams. In 2013, the imported mixed municipal wastes represents 94% of the total imported wastes but there is also imported wood wastes used for bioenergy production, storage for treatment elsewhere and recycling purposes.

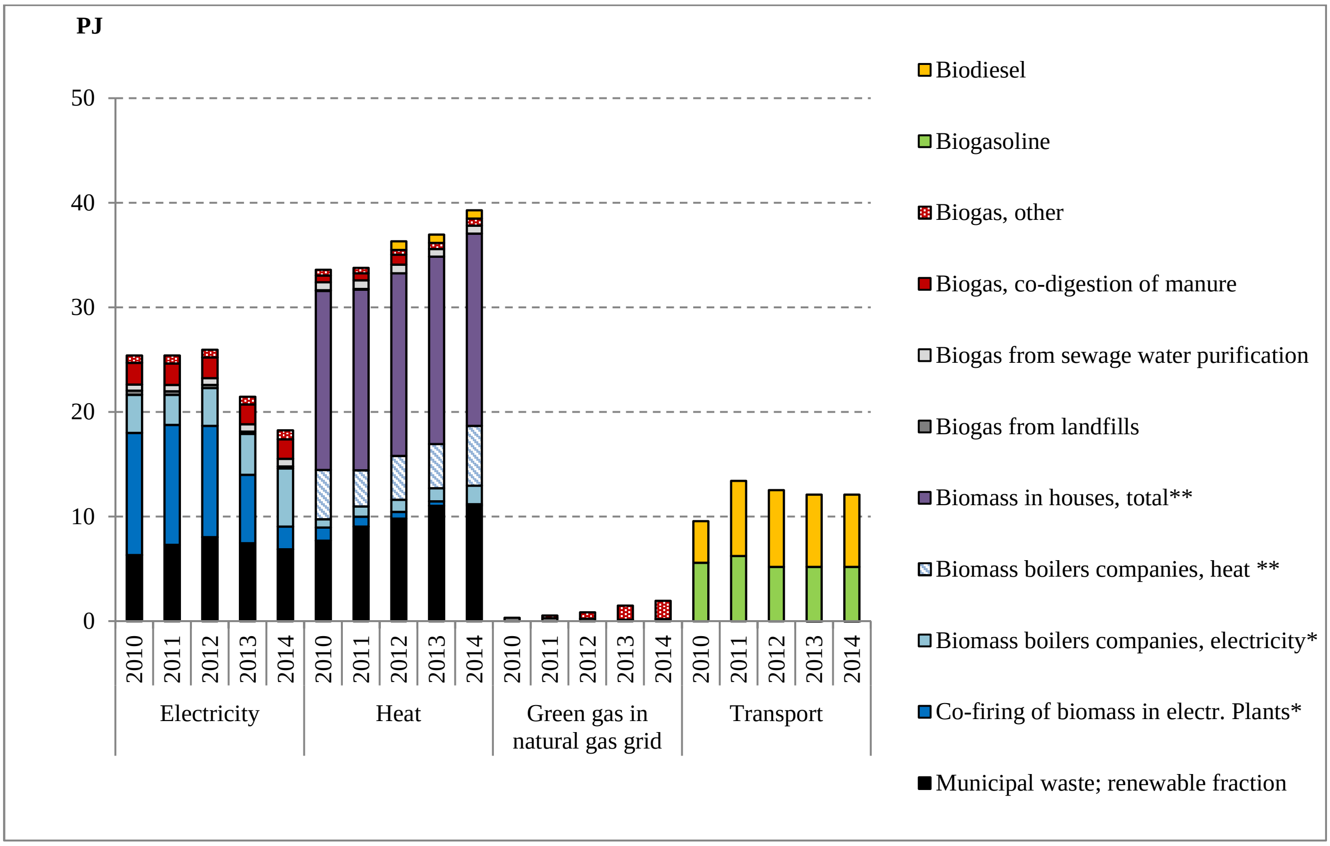


Figure 1-3 Gross final energy consumption** from bio-based materials in the Netherlands 2010 – 2014 (CBS 2015b) [accessed on 2/2/2016]

* Data is missing for 2014.

** Data is missing on CBS 2015b, but taken from CBS 2015a

*** Gross final consumption of energy is consumption of energy for energetic purposes by end-users without producing another usable energy commodity plus the use of electricity and heat for by electricity and heat producing companies plus the distribution losses for electricity and heat.

2. Introduction

2.1 Project overview and background

Between 2010–2014, Utrecht University has conducted work for the "Sustainable Biomass Import" project of RVO with the following aims:

1. To provide a quantitative and qualitative overview of past and current solid and liquid biomass import flows, and assess (as far as possible) to what extent this biomass was produced sustainably;
2. To identify trade and market barriers for sustainable biomass in the Netherlands, and identify possible solutions.

This work has resulted in a first report published in 2010 (Jonker and Junginger, 2010), and an updated report in 2011 (Jonker and Junginger, 2011). In these two reports, the first objective was achieved with the main focus on the energy use of biomass, particularly on the trade and consumption of wood pellets, biodiesel and bio-ethanol in and to the Netherlands. The studies also provide a concise overview of market development, current trade barriers and the status of sustainability certification, by conducting a number of interviews with the market actors.

A study on monitoring of (sustainable) biomass flows for various end-uses was conducted in 2012 and 2013 to gain insight into the market mechanism and trade dynamics (Goh and Junginger, 2013). This series of reports has a wider scope (covering both energy and non-energy use of biomass) and uses an extended methodology to assess quantitatively and qualitatively past and current solid and liquid biomass flows in the Netherlands, and the share of certified biomass in the market, focusing on three categories – woody biomass, oils and fats, and carbohydrates. In the 2013 report, an overview of global biomass trade flows was also presented to screen large biomass importers and examine their trade flows. Workshops was organised on 25 Oct 2012 and 22 December 2013 to discuss the preliminary results to the experts for confirmation and comments. Since 2014, the report adapts the 'Protocol For Monitoring Of Material Streams In The Biobased Economy (BBE)' to account for the size of bio-based economy (limited to three major biomass groups) in the Netherlands (Kwant et al. 2015, Meesters et al. 2014).

2.2 Aims and scope

This study limited the scope to three main categories: (i) woody biomass; (ii) oils and fats; (iii) and carbohydrates. "Woody biomass" includes timber, wood products, paper and cardboard, wood fuels, and their waste streams. "Oils and fats" includes oil seeds, vegetable oils, animal fats, and biofuels (Fatty Acid Methyl Ester (FAME) and hydro-treated vegetable oils (HVO)). "Carbohydrates" includes grains, starch, sugars and possible connection to bio-ethanol. Only biomass that falls under these three categories was investigated. This selection was based on three characteristics:

a. they are relatively large streams with clear distinction compared with other biomass groups;
b. their relevance to the bio-based economy – they are either long-chain polymers (such as starch and lignocellulose) or high-quality monomers (such as fatty acids and sugars) and have high potential to substitute fossil materials;
c. they are closely related to bioenergy carriers – wood pellets, biodiesel and bio-ethanol (and also considering their large share in waste streams that may end up in energy production).

Based on this defined scope, chapter 3 focuses on the mass flows of biobased materials including woody biomass; oils & fats; carbohydrates; and biogenic components in waste incinerators. A monitoring of bio-based materials processed in chemical industry is also included, however these materials are diversely sourced and only overview of the biobased chemical sector was investigated.

Chapter 4 discusses the sustainability of bio-based materials however sustainability of woody biomass sustainability is excluded due to unavailable data. Statistics of certified and non-certified vegetable oils and fats are reviewed and application of sustainability schemes on biodiesel is also discussed. Sustainability issues of carbohydrates are the final part of the report.

The three categories are the major streams investigated to measure the size of BBE within the 'Protocol For Monitoring Of Material Streams In The Biobased Economy' described in Meesters et al. (2013). The other biomass categories with large volumes in the Dutch economy that falls under the "Bio-economy", e.g. flowers, vegetables, fruits, meats, and processed food are not included here.

This report aims to update the previous report with the latest figures as possible and describe the market trends, and underlying reasons and drivers. In addition, it pays particular attention to two extensions: (i) biomass components in waste incineration, and (ii) production of bio-based products in chemical industry. Note that the overview of global biomass trade flows in the previous report is not updated in this report.

2.3Definition and boundaries of BBE

Development of bio-based economy (BBE) has received much attention in recent years. The tracking and monitoring of BBE is crucial for the policymakers to determine the effects of government policies. Bio-based economy is defined in illustration in Kwant et al. (2015) as shown in Figure 1-1. Meesters et al. (2014) have specifically defined BBE as "economic activity based on biomass, with the exception of human food and feed" with the condition that it is based on recently captured carbon.

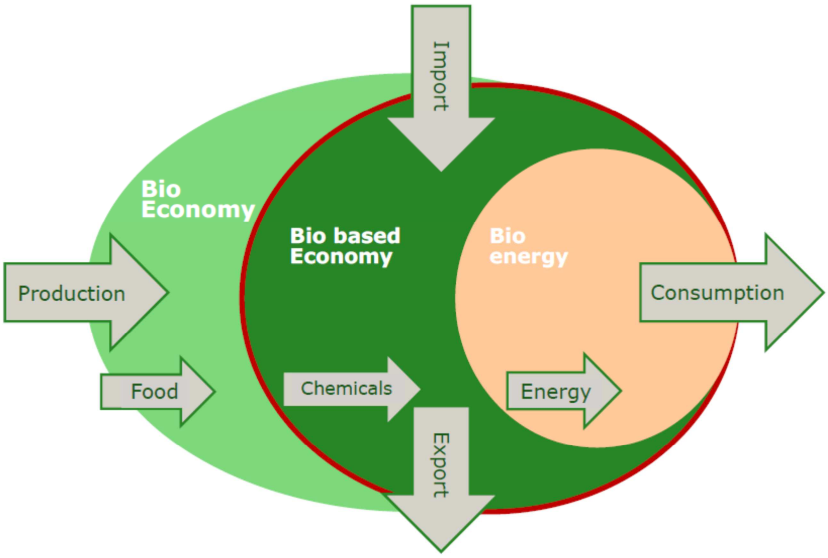


Figure 1-1. The bio-based economy embedded in the overall bio-economy (adopted from Kwant et al. 2015).

2.4Methodological approach

In this study mass-based measurement is adopted. Mass-based measurement monitors the flows of materials and products in mass units. These flows can be converted into energetic units especially when bioenergy is the key focus. It employs direct surveys, agricultural statistics, trade statistics, and other sources of information that provide actual amounts of bio-based materials produced, consumed and traded. Since 2010, this project has attempted to quantify these flows in three aspects as described below.

Processed quantity of bio-based materials: Evidence on the development of BBE can be found by the measurement of the inputs of bio-based materials, i.e. the processed quantity of bio-based materials. The idea is that the growth of bio-based economy is generally represented by the increase in processing of woody biomass and agricultural commodities for non-food purpose. Meesters et al. (2014) formulated a protocol to measure BBE by taking the input of bio-based raw materials for the production of chemical and materials as a proxy. The reason for making this choice is due to fact that it is almost impossible to track the destinations of the multitude intermediates and end-products (whether consumed domestically or exported). CEFIC (2014) took a similar approach to account for the size of BBE at the EU level. They estimated that about 9% (8.6 Mt) of the European chemistry industry's raw materials come from renewable sources in 2011. This mainly comprises of oils and fats, carbohydrates and bio-ethanol. A drawback of this approach is that intermediates imported from outside the territory are not tracked, e.g. ethylene (in principle bio-ethanol is also one form of intermediates, but it is monitored more extensively as biofuels). This report adopted the approach described in Meesters et al. (2014).

International trade of bio-based materials, intermediates and products: The past reports have illustrated the cross-border flows of bio-based materials, intermediates and products in combination with domestic production and consumption. However, they were not able to capture all the flows of intermediates made from bio-based materials due to data insufficiency. The tracing of bio-based material flows is getting more difficult with global integration of commodity markets through trade. In the third report of this series (Report 2013), the global trade of several key commodities in the categories of woody biomass, oils and fats, and carbohydrates was also illustrated. In this report, a round of small investigation was performed with several industrial informants to further clarify the picture of bio-based materials traded and used by the chemical industry.

Consumption of bio-based products: While the consumption of bio-based products for non-energy purpose is unclear, the consumption of biomass and biofuels for energy purpose is well monitored. At present, bioenergy plays the most important role in terms of quantity (and thus fossil fuel displacement).

2.5Uncertainties

Mass-based measurement leads to uncertainty from two aspects:

- **Moisture content:** For woody biomass, the calculation of dry mass content is not very reliable, because moisture content is not measured together with their mass at the same point. Assumptions made for moisture content is crude, and the default values from Probos is followed. For grains, dry mass can be accounted for due to strict storage condition that limits the moisture content. This is however not applicable for potatoes and thus measuring the dry content of this stream is also less reliable.
- **Energy content:** While the conversion of biomass and biofuels can be calculated with reliable conversion factor, it is comparatively quite difficult to calculate the mass-energy conversion of waste. The sources of uncertainties are the composition and moisture content of waste streams. It is almost impossible to precisely distinguish the energy production by a particular type of waste, e.g. waste paper, if all solid waste is incinerated together. The net calorific values and moisture contents were therefore used following RWS estimation.

3. Mass flows of bio-based materials

3.1Mass flows of woody biomass

This chapter covers (almost) all woody biomass flows in the Netherlands, including timber, processed woods, paper and cardboard, furniture and energy use of woody biomass. A key change in the results presented in this report compared to previous reports is the use of conversion factors from Probos as shown in Appendix III. Figure 3-1 and 3-2 illustrates the flows of woody biomass in the Netherlands in 2013 and 2014. The box in the middle of the diagram indicating "wood products" represents storage of woody biomass in the form of buildings, furniture, and other types of wood products that are non-consumable or not short-lived. There were no significant changes between 2013 and 2014 for non-energy use of woody biomass. The Netherlands produced considerable amounts of round wood, but about half of that was exported. On the other hand, a relatively large amount of sawn wood and wood panels was imported, mostly originated from adjacent countries (Probos, 2013).

There was also a large import of paper and cardboard into the Dutch market, but the volume has been declining since 2010, but remains rather stable in 2013-2014. The use of old paper for paper production has increased from 72% in 2013 to 80% in 2014, but it is not far from 77% in 2010. Note that about 50% of paper and cardboard was imported products which may also be produced from recycled materials.

In 2013-2014, a much smaller amount of wood pellets was consumed by the utilities compared to 1.43 dry MT in 2010, decreased to 0.73 MT dry MT in 2013, and further to 0.15 dry MT in 2014. A considerable amount of woody biomass and paper and cardboard were also incinerated to generate electricity and heat.

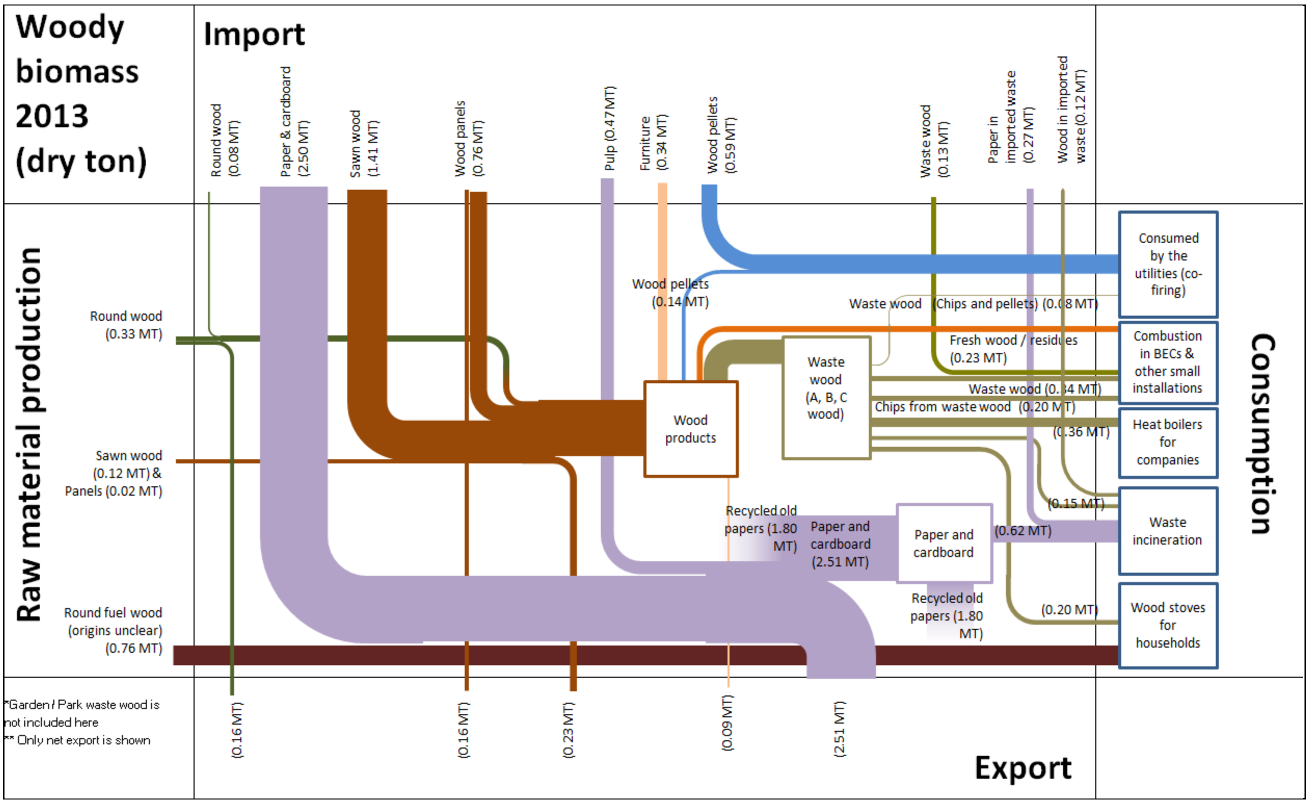


Figure 3-1 Mass balance for woody biomass flows in the Netherlands in 2013 (dry content)

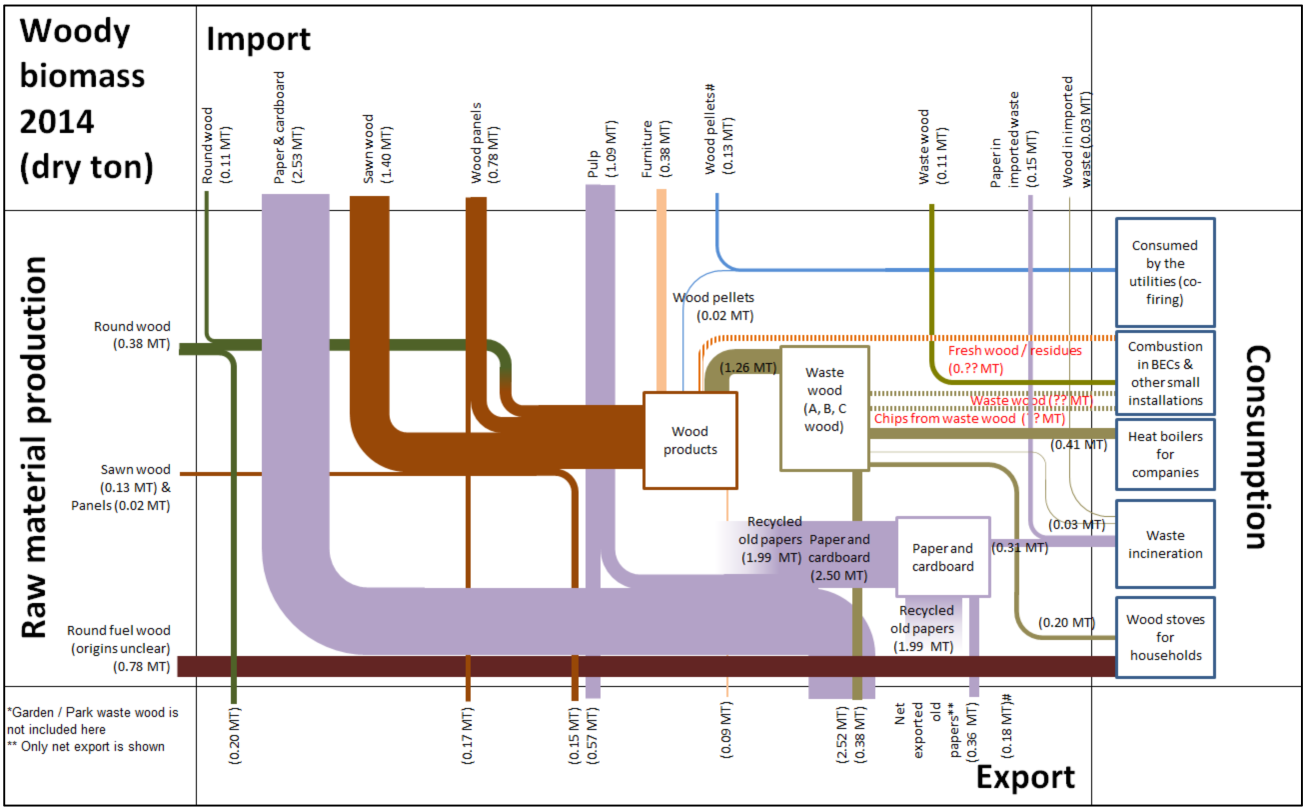


Figure 3-2 Mass balance for woody biomass flows in the Netherlands in 2014 (dry content)

3.2Mass flows of oils and fats

This section covers oils and fats in the Netherlands. It covers oil seeds, vegetable oils, animal fats and biofuels (mainly FAME and hydro-treated vegetable oils (HVO)). The mass balance is limited to only primary material flows. Figure 3-3 and 3-4 show the mass balance for oils and fats flows in the Netherlands in 2013-2014. One important note is that protein-based products (e.g. soy meal) are shown here but excluded from the calculation of input to bio-based economy because it is mainly used for feed and fodder. This is not considered part of the biobased economy, so excluded from this paragraph. However, since the biobased economy is defined on the input-side of the industry, and this distinction can only be made at the output side, an estimation should be made. Therefore the percentage of output used for material is measured (in mass percentage). The same percentage on the input is then considered to be material for the biobased economy. Palm oil (including palm kernel oil) has been the largest vegetable oil source followed by rapeseed oil, soy oil and sunflower oil. A notable development is the increase in the import of fatty acids for the use of energy production in the year 2014. Meanwhile, the import of palm oil has slightly declined, while the flows of rapeseed oil and sunflower oil have also changed from export to import. Another interesting trend is the decrease in export of soymeal since 2013 (and almost diminished in 2014). This may imply that the consumption of animal meals as feed within the Netherlands has increased. For both 2013 and 2014, some details are missing compared to the previous years due to the stop of the publication of annual statistical report by MVO.

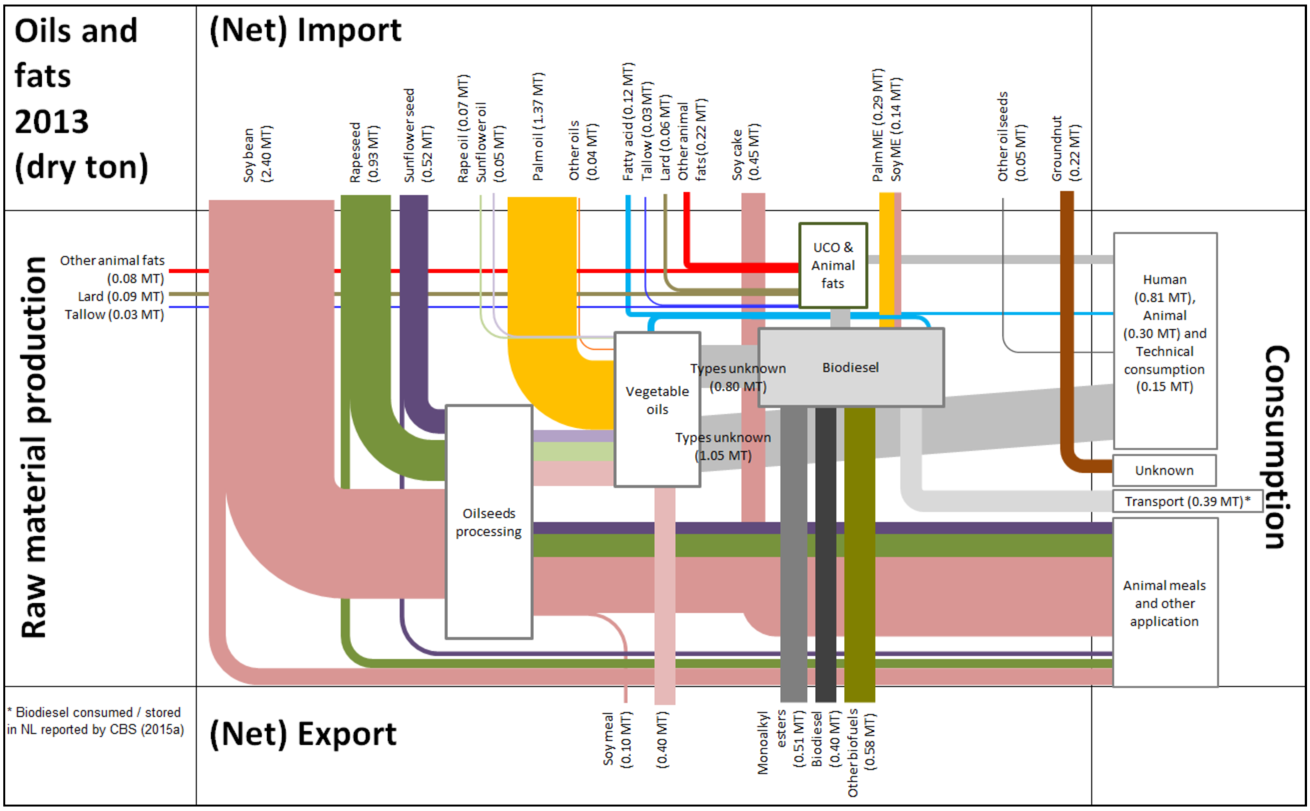


Figure 3-3 Mass balance for oils and fats flows in the Netherlands in 2013 (dry content)

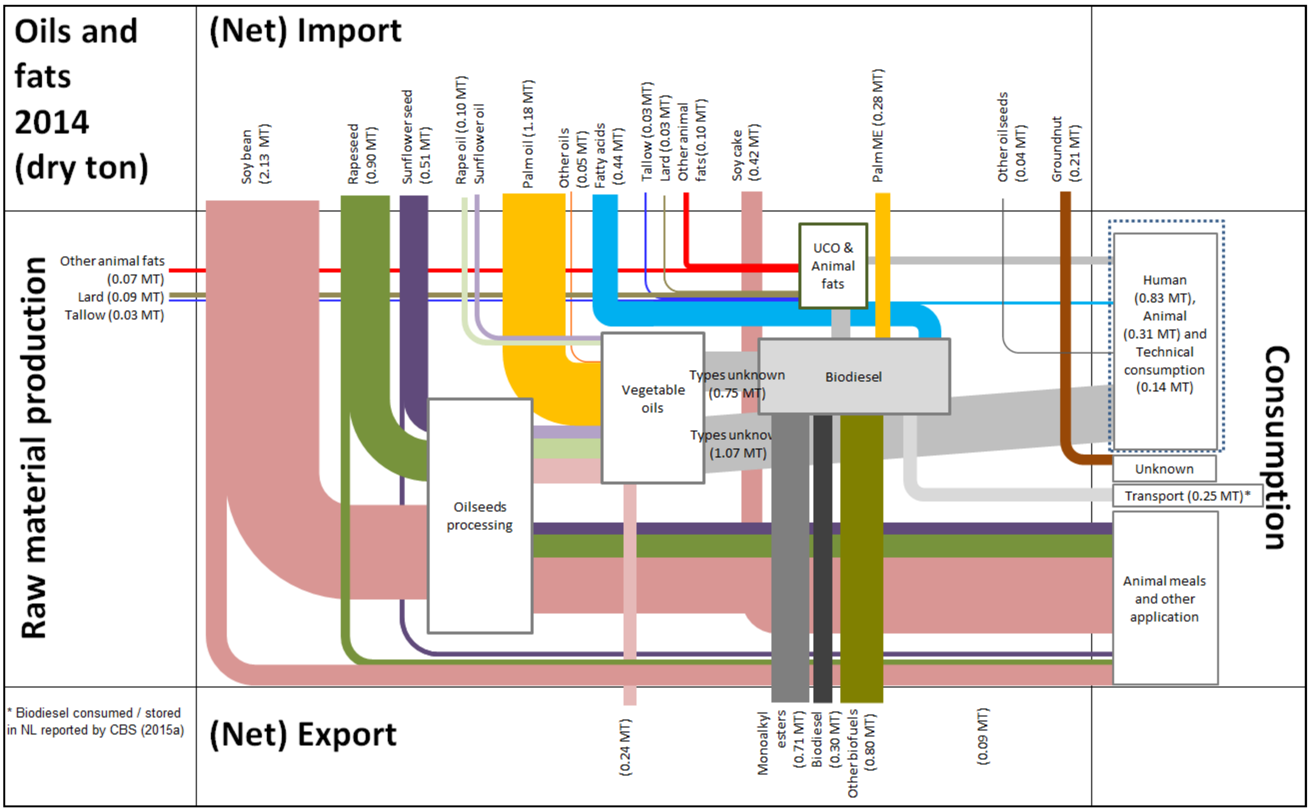
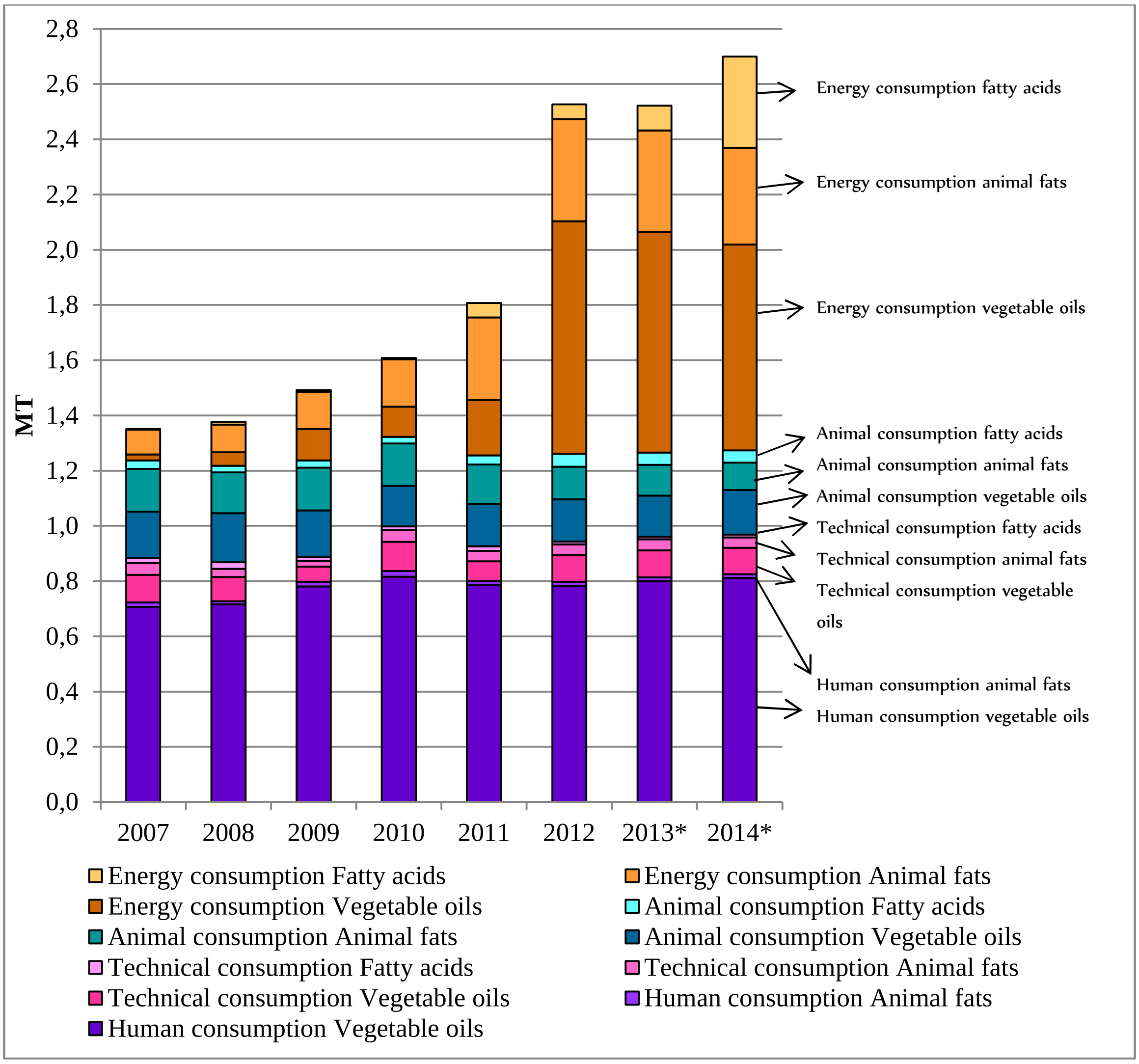


Figure 3-4 Mass balance for oils and fats flows in the Netherlands in 2014 (dry content)

Figure 3-5 summarizes the consumption trends of oils and fats for different purposes. The total consumption shows a steady increase until 2011, and an extraordinary surge in 2012. From 2011 to 2012, the Dutch (net) import has shown a remarkable increase from 0.72 MT to 1.63 MT, owing to the substantial growth of palm-oil based biofuel production. In 2012, about 0.78 MT of palm oil was processed for energy purpose (mainly to HVO), which is almost 10 times of the processed amount in 2011 (MVO 2013; Bergmans 2013). The quantity of crude palm oil converted to HVO by Neste Oil increased significantly since 2012 (globally from about 0.4 MT in 2011 to 1.4 MT) as a result of the company's increased refining capacity to a total of 2.1 MT, of which the Rotterdam plant accounted for 0.8 MT (Neste Oil, 2013). However, as NEa (2013; 2014; 2015) reported that there is only marginal consumption of palm-based HVO in the Netherlands in the past three years, most of these palm oil- based HVO is assumed to be exported. Meanwhile, there is also a substantial increase in animal fats import for energy purpose since 2011. The biofuel consumed in the Netherlands are mainly made of UCO and animal fats which are double counted (see Figure 3-6). In 2014, a substantial increase in the use of fatty acids for energy production is also observed. This is in line with the Dutch consumption trend of FAME in 2014, of which about 7% (by weight) is made of fatty acids compared to their insignificance in the previous years (NEa 2015). However, only 0.02 MT of FAME made from fatty acids is consumed within the Netherlands, compared to 0.33 MT of fatty acids processed.



(See Appendix IV for data in table)

* There are discrepancies between biodiesel production reported by CBS and oils and fats consumption for energy production reported by MVO. See Figure 3-4.

Figure 3-5 Consumption of oils and fats by end markets (Source: MVO 2015)

Figure 3-6 shows the numbers provided by CBS (2015a) on the production of biodiesel (and HVO) and MVO (2015) on the consumption of oils and fats for energy purpose (production of biofuels for transport purposes). Biofuels includes gasoline (bioethanol) and biodiesel in which annual production capacity of gasoline (bioethanol) was 503 MT (20%) in 2013 (other years were not recorded). The annual production capacity of biodiesel in the Netherlands has increased from 0.52 MT to 2.03 MT in 2011, and slightly increased again in 2014 to 2.20 MT (CBS 2015a). CBS (2015a) reported that the production of biodiesel has increased from 0.38 MT from 2010 to 1.72 MT in 2014. This means that the unused production capacity has decreased significantly compared to previous years. Neste oil is the largest producer with its Rotterdam plant which has a capacity of 0.80 MT per year. The facility is capable of using a variety of vegetable oils, by-products of vegetable oil refining (e.g. stearin), as well as waste oils and fats to produce hydro-treated vegetable oils (HVO) (Neste Oil, 2011). Since 2012, there is a large increase in the import of palm oil for biofuel production. CBS (2015a) reported that 1.47 MT (85%) of the biodiesel is exported in 2014.

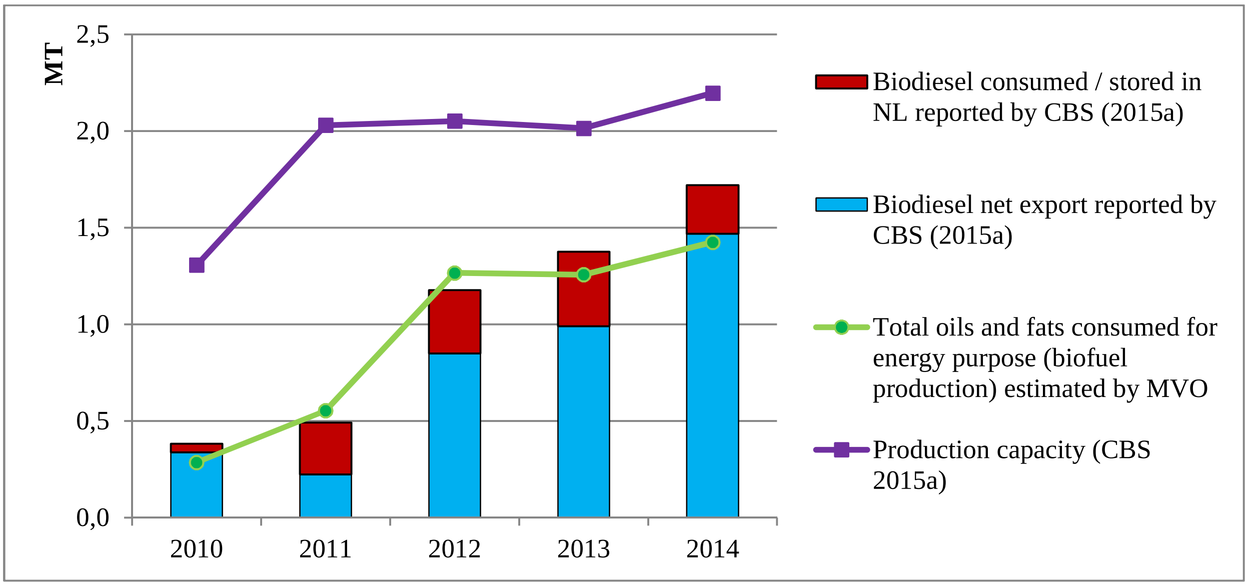


Figure 3-6 Use of oils and fats for production of transport biofuels (Source: CBS 2015a; MVO 2015)

Figure 3-7 presents the trade flow of monoalkylesters, oil seeds and oils and fats by country or region. The connection between monoalkylesters trade flows and biodiesel trade flows is not entirely clear; it is assumed in this study that monoalkylesters trade flows are the main components of biodiesel flows. A code that covers fatty-acid monoalkyl esters (FAME) with an ester content >96.5%vol was introduced in 2008 (38249091), and changed in 2012 (38260010). Interestingly, the import from Indonesia has diminished in 2014, replaced by import from Malaysia. However, this trend is not seen in the trade of vegetable oils – both countries still hold almost equal shares in Dutch import of vegetable oils. Similarly, the import of Argentinean FAME has not been seen in 2014. This is mainly because in 2013, the EU started to expand trade barriers to Argentina and Indonesia by imposing tariffs on biodiesels from these countries, for the reason that they are allegedly selling it in the EU below cost. As NEa (2013) indicates that there is no soy biodiesel reported in the country since 2012, these FAME is assumed to be re-exported. In contrast, with the replacement of Indonesian FAME import with Malaysian FAME, the consumption of palm-based biofuel has still increased substantially in 2013 (see Figure 3-6). Previously, the EU has also hit the US with a 5-year anti-dumping duties in 2009 (the large amount of import in 2008 – 2009, including the import from Canada is mainly due to the 'splash-and-dash' effect described in the previous reports).

Since 2012, a code (38260090) is also used in parallel to represent biodiesel which contains less than 70 % by weight of fossil fuels. However, other forms of biodiesel could still enter under other codes depending on the chemical composition. Diesel with a biodiesel component of less than 30% can also fall under chapter 271020 at a tariff rate of 3.5 percent (Flach et al., 2013). From the statistics there is a remarkable amount exported to the EU and even Asia (the Asian countries are unknown) from the Netherlands in 2012-2014. Meanwhile, there are no significant changes for net import of oil seeds, except for the trade with the EU. The EU has been a net importer of oil seeds from the Netherlands except for the year 2011. The net export of oil seeds to the EU has increased impressively in 2012 to about 1 MT.

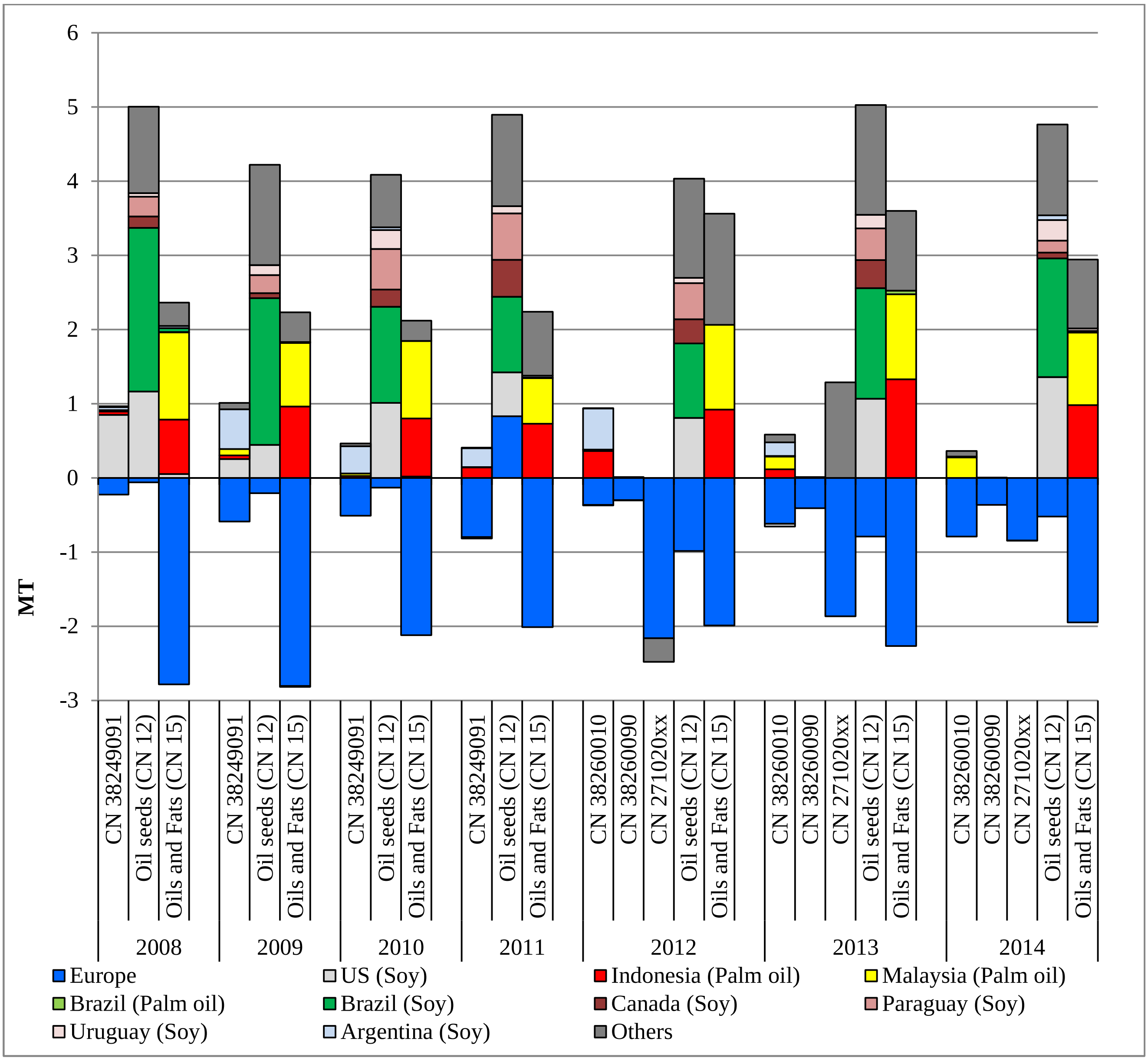


Figure 3-7 Major trade flows of monoalkylesters, oil seeds and oils & fats (net) for the Netherlands from 2008 – 2014 (MT) (Source: CBS 2015, see Appendix V for full table)

a. Countries with small net trade amount were omitted
b. CN 12xxxxxx: Oil seeds and oleaginous fruits
c. CN 15xxxxxx: Animal or vegetable fats and oils and their cleavage products; prepared animal fats; animal or vegetable waxes
d. CN 38249091: Monoalkylesters of fatty acids, with an ester content of 96.5%vol or more esters (FAMAE) (for 2008 – 2011)
e. CN 38260010: Monoalkylesters of fatty acids, with an ester content of 96.5%vol or more esters (FAMAE) (since 2012)
f. CN 38260090: Biodiesel and mixtures thereof, not containing or containing less than 70 % by weight of petroleum oils or oils obtained from bituminous minerals.
g. CN 271020xx: Diesel, fuel oil, oils, containing>= 70% weight of petroleum oils or oils obtained from bituminous minerals, containing biodiesel.
h. "Others" is derived from the balance of world total net flow

Figure 3-8 shows the estimated quantity of FAME and HVO consumed in the Netherlands in 2010-2014. The amount remains stable in the past three years at around 0.26-0.27 MT respectively in the three consecutive years. For 2014, the total amount reported by NEa almost matches the physical amount reported by CBS (2015). Until 2014, the Netherlands market still heavily relies on double counting. The double counting mechanism is generally applied for biofuels produced from wastes, residues, non-food cellulosic material and lignocellulosic material. These biofuels are counted double for the annual obligation of renewable transport fuel. Note that for the year 2011, it is unclear whether the "Unknown" category includes UCO or not, but more than 80% of this category was counted double. This double-counted "Unknown" diminished in 2012. Since 2013, the use of biofuels made of UCO has increased sharply, especially UCO with Asian origins seen in 2014. It is also noted that there some biofuels made of industrial fatty acids with Malaysian and Indonesian origins entering the market in 2014.

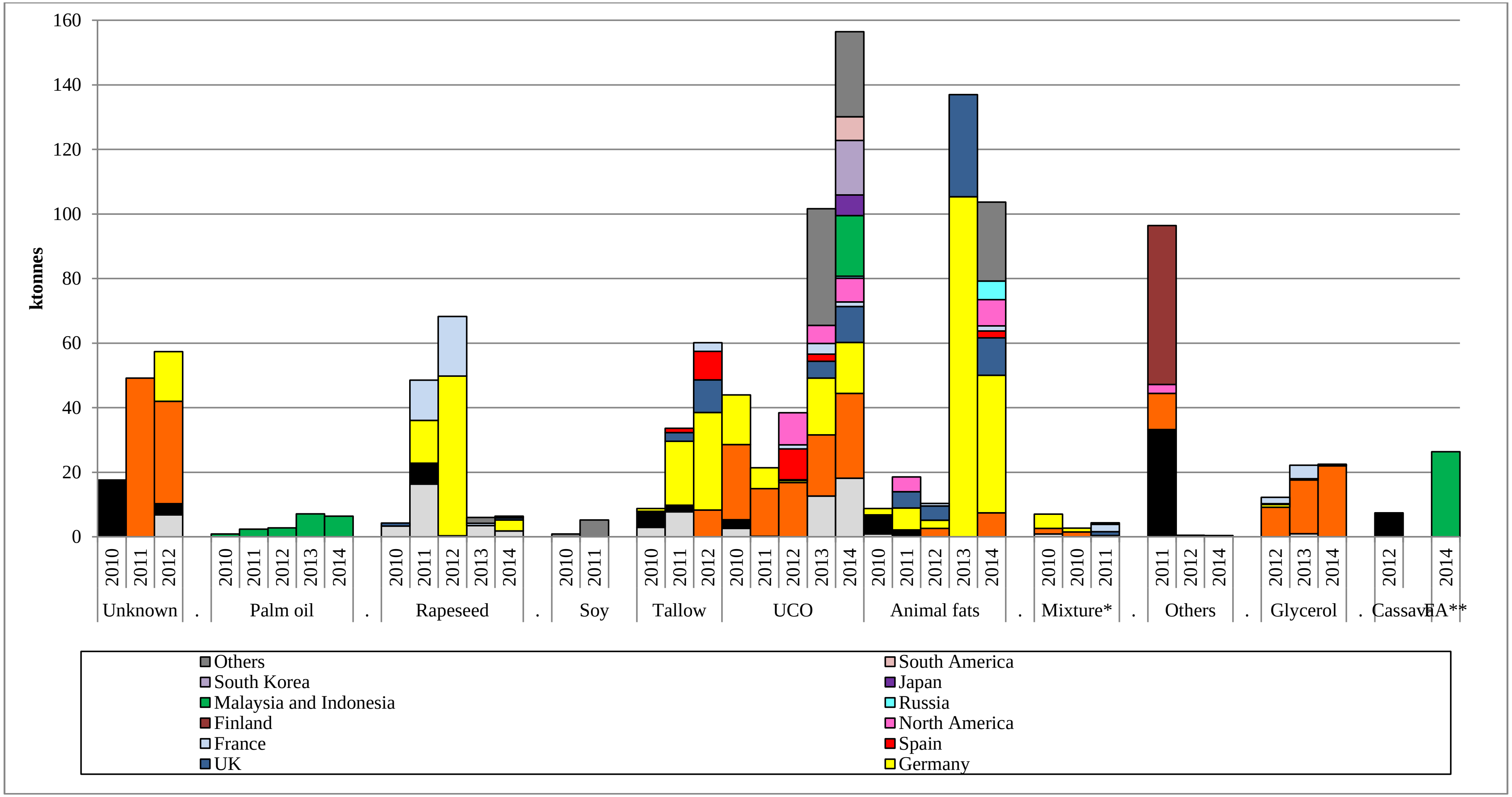


Figure 3-8 Estimations of FAME and HVO consumed in the Netherlands in 2010- 2014 by feedstock and country (Source: NEa, 2011; 2012; 2013; 2014; 2015; CBS 2015a) (See Appendix VI for the table)

Note: Tiny streams are omitted. 'Others' implies the feedstock is known to NEa but reported at aggregated level.

* UCO / Animal fats / Tall oil

** Industrial fatty acids

3.3Mass flows of carbohydrates

This section covers carbohydrate chains in the Netherlands. This includes grains and starch such as maize (maize), wheat barley, sugar beets, potatoes and etc. The mass balance is limited to only primary material flows. Carbohydrates are widely used food staples, which can be directly used for food and animal feed, or processed to make food (bread, biscuits), beverages (beers) and feed, or industrial products such as ethanol. In addition to food and feeds, carbohydrates can also be feedstock for textiles, adhesives and energy. Figure 3-9 illustrate the quantified mass flows of carbohydrates in the Netherlands in 2014 (see previous report for 2013[1]). Basically, the Netherlands was able to self-supply more than half of its total carbohydrates consumption. Maize (corn) turned out to be the largest Dutch carbohydrates source with large import volume. Although the Netherlands produced relatively large amount of maize, considerable amounts of maize were imported. Potatoes, sugar beets and barley were other important sources of carbohydrates. One prominent change in 2014 is that the production of sugar beets has increased 22% in comparison to the average of 2008-2013.

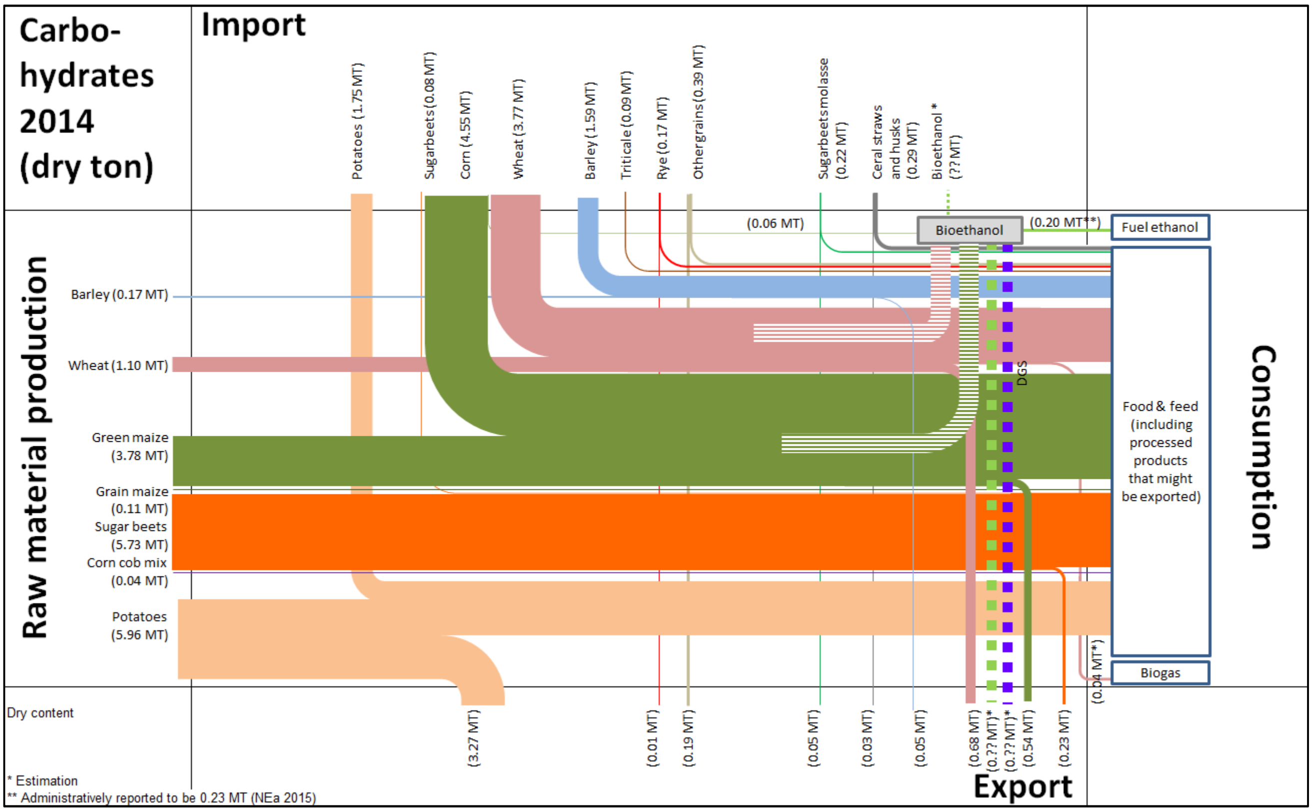


Figure 3-9 Mass balance for carbohydrates flows in the Netherlands in 2014 (dry content)

The Netherlands may continue to become a hub for ethanol blending and further distribution, as well as production since its large seaports provides easy access to feedstock. Since 2011, ethanol is produced on a large-scale in the Netherlands. However, due to the limit number of producers, all information regarding feedstock use is not published, and also other related data is difficult to obtain. CBS (2014) has reported the production of bio-gasoline is 414 ktonnes in 2013. In terms of production capacity, there are two large bioethanol plants in the Netherlands operated by Abengoa (capacity 480 ktons) and Lyondell (ETBE, 400 ktons). The Abengoa Bioenergy's bioethanol plant in Rotterdam that started in September 2010 is the largest single facility in the world. It can produce 480 million litres of bioethanol (0.38 MT) annually from 1.2 MT of maize or wheat cereal as feedstock. It also produces 0.36 MT of distilled grains and solubles (DGS) which can be used an animal feed (Abengoa Bioenergy, 2012). In 2013, in total overseas grain import used by the

1 Information of mass balance for carbohydrates flows in the Netherlands in 2014 can be found at:
http://english.rvo.nl/sites/default/files/2015/04/Sustainable%20biomass%20flows%20Netherlands%202014%20by%20UU.pdf

plant is about 462 ktons (388 dry ktons), but there is also some imports from the hinterland by barge. According to an expert, the maximal grain consumption by the Abengoa plant might be about 2.4 million tons (2.01 dry million tons) (Du Mez, 2014), but others deem this amount too high. In June 2012, Cargill has also reportedly added 380 million litres of annual starch-based ethanol production capacity to its wheat wet-mill in Bergen op Zoom. The facility can process 0.6 MT of wheat annually. Ethanol will be produced from a side stream containing starch as raw material instead of the whole wheat grain (Ethanol producer magazine, 2012). However, it is not publicly known that how much they produce (ethanol and DDGS), where they source the raw materials and where they sell the bioethanol to. Thus, the connection shown in Figure 3-9 was only for indication because the actual feedstock and destination are unknown.

Besides bioethanol, carbohydrates are also used as feedstock for biogas. About 0.36 MT of maize was fermented into biogas in 2010, but this figure dropped to 0.18 MT in 2011 and 0.03 MT in 2013 and 2014 (CBS 2012; 2014). AVEBE, a company that works on innovation use of potato starch has signed the Green Deal with Drenthe (province) that involves an investment for biogas production in "Potato Power", a large biogas project in Gasselternijveen using potato starch as feedstock. This project aims to produce 500 to 750 million m^3 of biogas by 2020 (Provincie Drenthe, 2012).

Figure 3-10 depicts the trend of ethanol trade flows in 2008-2014. The major suppliers are American countries, but shifted from individual countries to countries in the period. The Brazilian ethanol has disappeared in the Dutch market after 2009, first replaced by US ethanol in 2009-2012, and then the market is largely occupied by import from Bolivia, Costa Rica, Guatemala and Peru in 2013-2014. The import of ethanol under the groups CN 22071000 and CN 22072000 have plummeted since 2008, but shown some recovery since 2012. Between 2009 and 2011, there was a steep increase of US ethanol entering the EU under the code CN 38249707 (Vierhout 2012). These products were found to leave the US as denatured (CN 22072000) or undenatured ethanol (CN 22071000), but most of those exports enter the EU as chemical compound (CN 38249097) with lower tariff. In 2012, these bioethanol blends was reclassified to the higher tariff rate, and trade of ethanol from US to Europe has declined significantly. As shown in the figure, US ethanol has returned to the Dutch market under CN 22072000 in 2012, however, the import from US has diminished since 2013. Due to the fact that the EU domestic production is insufficient even with the anticipated capacity expansion in 2013 and 2014, non-EU ethanol has entered the EU market through the Netherlands. The re-export to the EU has increased substantially since 2013. Interestingly, there are also some exports to non-EU countries in 2014, especially in large streams to UAE and India.

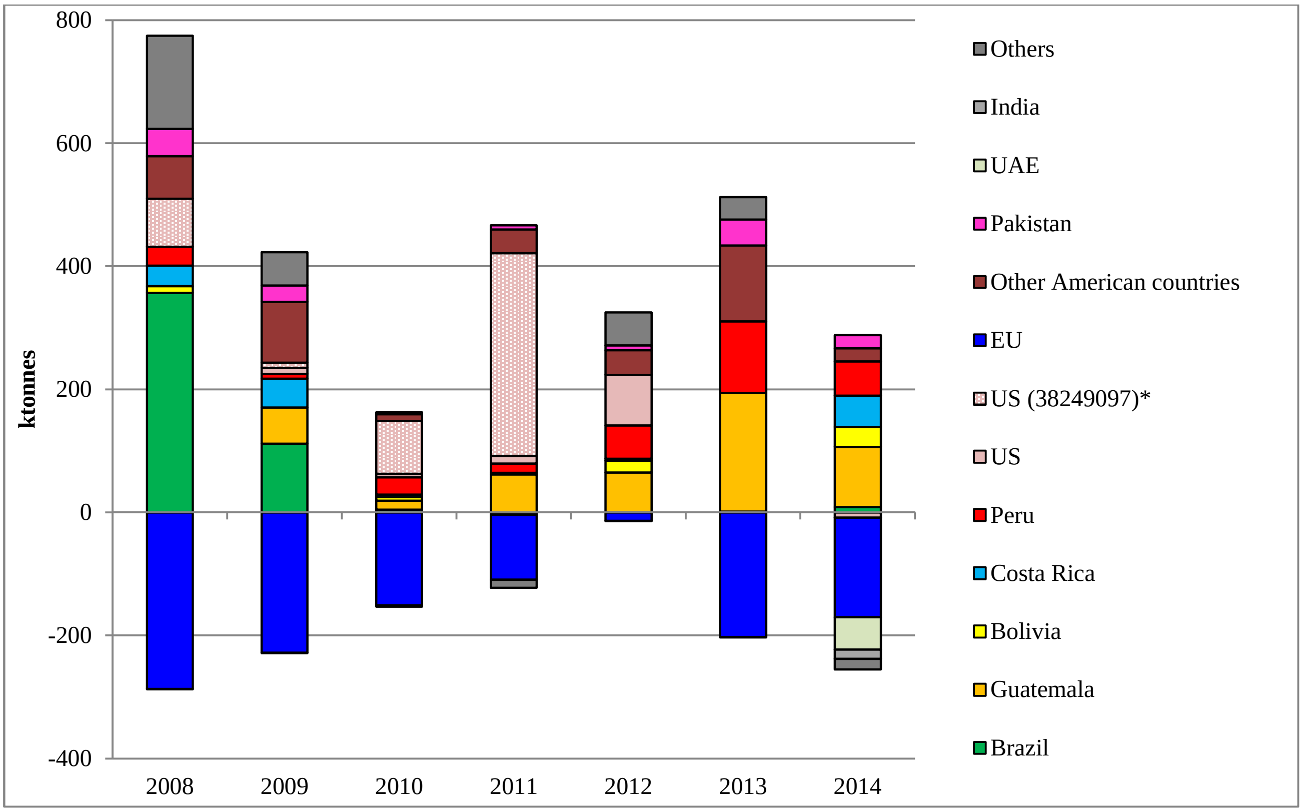


Figure 3-10 Major ethanol trade flows in and out the Netherlands for 2008 – 2014 (ktonnes). (Source: CBS, 2013) (See Appendix VII for table)

* Note on 2008-2012: Fuel ethanol from US was found registered as 38249097 upon arriving in the EU, but the number reported under this code may also contain other chemicals. (CN 38249097: Other chemical compounds)

Figure 3-11 illustrates the Dutch bioethanol estimated for consumption in the Netherlands in 2010-2014. The total physical consumption remained rather stable at 0.19-0.20 MT in 2013 and 2014 (CBS 2015a). Since 2011, the majority of the bioethanol consumed in the Netherlands originated from US maize and European wheat, but sugarcane ethanol has returned to the European market in 2013, together with the substantial increase of sugar beets ethanol. Maize ethanol dominates with 40% of market share in 2010 and even 90% in 2011, but the number dropped to 71% in 2012, and 34% in 2013. This is probably due to the reclassification of US ethanol to higher tariff rate. East Europe has emerged as the main supplier of maize for ethanol since 2013. The next important feedstock is wheat, which has plummeted drastically in 2011, but bounced back and grown steadily in 2012-2014. The decline of wheat ethanol in 2011 is probably caused by bad harvest in that year - feedstock price was high and production of bioethanol from cereal was less attractive (GAIN, 2012a; 2012c). For sugarcane ethanol, Brazil was once an important contributor, but it has experienced a large decline in 2011 and the trend continued in 2012. The reasons could be multifold: increasing domestic consumption, more attractive export to the US market where sugarcane ethanol is classified as “advanced biofuels”, and bad harvest in 2011. In 2013, Brazilian sugarcane has taken over about 21% of the market share, but it has been replaced by Costa Rica and Peru in 2014. Sugar beets have become one of the four major feedstocks for ethanol consumed in the Netherlands in 2013 and 2014. These ethanol mostly made of sugar beets come from France.

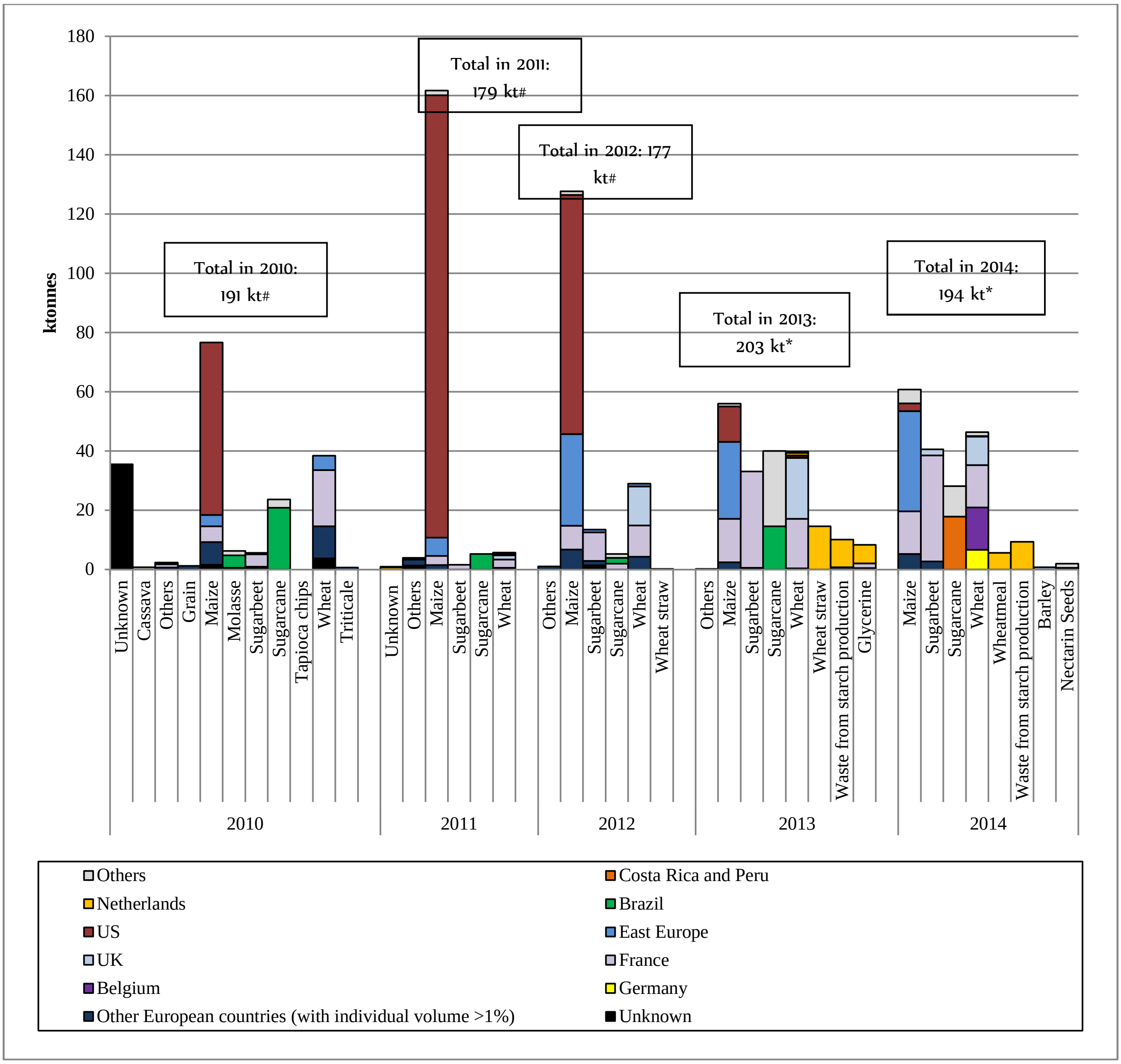


Figure 3-11 Estimations of bioethanol consumed in the Netherlands in 2010 -2014 by feedstock (Source: NEa 2011#; 2012#; 2013#; 2014; 2015; CBS 2015a*)

3.4Bio-based wastes in waste incinerators (AVIs)

In general, most of the collected waste delivered to the incinerators is burnt for electricity and heat production. The waste includes biogenic and non-biogenic parts and combustion of bio-based waste was gradually growing until 2012. The last two years there is a slight decline in bio-based waste. The data for bio-based waste in waste incineration plants is extracted from the report series "Waste processing in the Netherlands" (RWS) and "Renewable energy in the Netherlands" (CBS) which are published annually. The results are based on a questionnaire organised by the Working Group on Waste Registration which is held yearly since 1991 with nearly 100% response. The incinerated amount includes also imported waste.

Waste incineration plants

In Netherlands, there are 12 waste incinerators. These large plants contributed 17 percent to the final consumption of renewable energy in 2014 (CBS 2015). Wastes transported to the incineration plants include mixed municipal wastes, imported wastes and other waste streams. On mass basis, biogenic components are estimated at about 2,700 dry ktonnes (4,569 ktonnes as received). Details of different wastes are shown in Appendix VIII.

Import and Export of Waste

Since several years, import and export data regarding mixed municipal waste in the Netherlands are collected as part of the waste monitoring which is required for the optimal use of the incineration capacity in combination with guarantee of capacity for domestic waste. For mixed municipal waste the reason of importing was the over-capacity of waste incineration plants while a surplus of waste is available in other countries (e.g. UK and Ireland). Therefore some foreign regions and municipalities have contracts with Dutch waste incinerators. Due to the proximity to ports, it is relatively cheap to import waste from European countries where there is lack of capacity. Waste wood is used for bioenergy plants or recycling purposes. More information can be found in Appendix XI.

Regarding export, some Dutch municipalities have a contract with the German incinerator SITA Emlichheim (close to the Dutch border near Coevorden), therefore mixed municipal wastes are also exported. There are data of waste wood to be exported but the destination is not yet known.

There were more exported wastes from the Netherlands in 2012 but this trend was opposite in 2013. This can be explained by the increased capacity of waste incinerators and bioenergy plants. Waste that is transferred in transit in the Netherlands (for example from United Kingdom to Germany) is not included in Figure 3-12. More details are shown in Appendix XI.

Monitoring method

Waste incineration plants are treatment facilities which are suitable for combusting mixed waste streams. Electricity and heat from waste incineration plants is determined based on energy surveys of CBS and RWS. The time series of the amount of incinerated waste can be found until 2014 from RWS (formerly NL Agency), which establishes this in the context of the Working Group on waste registration (WAR, a partnership of RWS and the Waste Management Association) using a survey of the AVIs.

Development

The production of renewable energy from waste incineration plants has been investigated since 2009. The total amount increases annually for heat, but slightly decreases for electricity in 2013-2014. The increase was due to the commissioning of new facilities, construction of new heat pipes and increase in biomass fraction of the waste. In 2014, heat delivery increased further, but declined electricity generation. The reduction in electricity was due to technical failures at some incinerators (CBS 2015)
and increased heat production were probably due to SDE+ subsidy for renewable heat .

For the calorific value and biomass fraction, data from RWS were used each year for the IPCC monitoring. Missing data were estimated based on the basis of environmental reports and reports of AVIs to RWS for the report "Waste processing in the Netherlands" and the adoption of the so-called R1 status (useful application).

Waste category

According to the report series "Waste processing in the Netherlands" (RWS) and "Renewable energy in the Netherlands" (CBS), wastes are categorized by sources including mixed municipal waste, domestic waste, household waste, industrial waste, commercial waste, residues after separated, hazardous waste and other wastes. This category list however does not reflect the biogenic part covered in the total wastes brought to incinerators.

In this report, with the support from RWS experts, different biogenic components are presented including organic component[2], paper, diaper, plastics[3], textile and wood which are collected from mixed municipal waste, imported waste and other streams[4].

Mixed municipal waste has the highest share (about 65% in 2014) of total biogenic waste as it includes waste from various sources: municipal facilities, household waste, separated residues from mechanical treatment, and other municipal waste. Imported waste mainly covers paper and carton, wood waste and wood components in mixed municipal waste (total mixed wood is about 75% of the whole imported components). Other streams (domestic waste excluding mixed municipal waste) include various components but industrial waste shows large portions of the total number. Detail of calculated numbers is found in Appendix VIII.

Uncertainties in estimating the biogenic portion

Due to the heterogeneity of mixed municipal waste uncertainty in content is high. To a certain degree data on energy content and moisture content can be calculated out of the data collected at the incineration facility, but since only a percentage of the material is biomass, the determination of this percentages is uncertain. This determination is now based on sorting analysis for municipal waste, where about 10 years ago an analysis of the biomass percentage of each sorting fraction is made (Appendix IX). Each year this sorting analysis is investigated and combined with the sorting, an estimation of the biomass percentage is also found out for municipal solid waste and imported waste.

For the other waste streams a rough estimation of the content is made and this is combined with the biomass percentages given in Appendix X. The overall uncertainty estimated by the CBS for the energy figures is about 10%. This might be a low estimate for this monitoring since the mean uncertainty is the determination of the biomass content of the rest material (dust, small parts) which is low in energy but high in weight. Therefore it indicates a high uncertainty for the determination of the biomass on mass but low on energy.

2 Organic components include organic waste collected at sources and organic residues which are sorted and separated at incineration plant. These two organic parts have different moisture content but are incorporated in this report to avoid misinterpretation.

3 Plastics in mixed municipal waste often contain biogenic waste. About a quarter of the carbon in the sorting of plastic is biogenic carbon [17

4 Other streams include wastes from bulks, industries, agriculture, hospital (non harzadous and non dangerous), tire, construction and demolition, sanitation, residues (composting, fermentation), residues from incinerators (not dangerous, dangerous), residue (drinking water), shredder, sewage sludge, other wastes (unspecified, dangerous). These wastes do not sum up to a considerable quanity, therefore they are covered under other streams

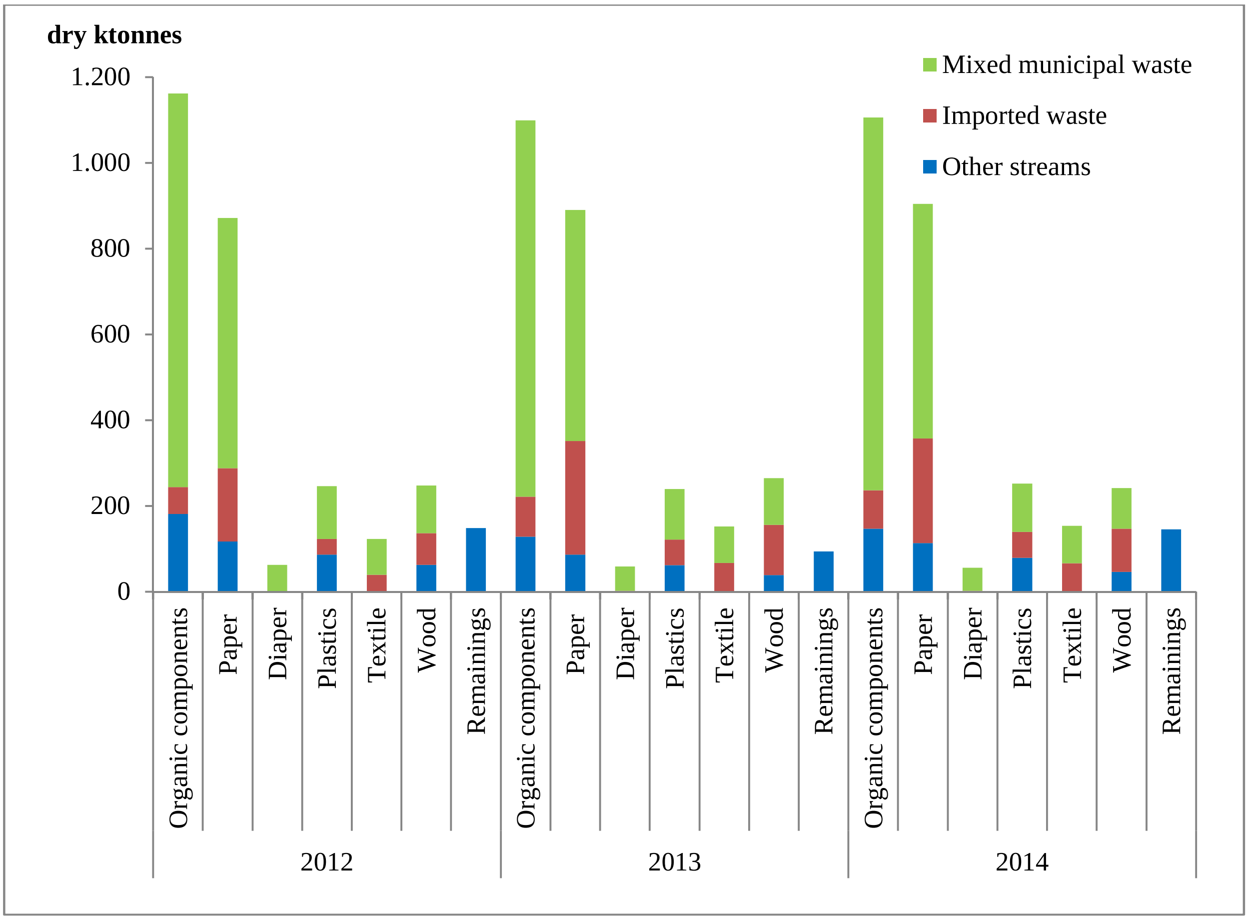


Figure 3-12 Types and origins of biogenic wastes incinerated in waste incinerators in the Netherlands (Source RWS 2015b)

Mass balance of woody biomass: production, trade, storage and incineration

Table 3-1 shows the mass balance of woody biomass in the Netherlands for 2012-2014. Regarding paper and cardboard, the country use a quantity of 0.70 million dry tonnes (waste) paper burnt in waste incinerators for bioenergy production in 2012, this number decreased to 0.62 million dry tonnes in 2013 and increased slightly to 0.66 million dry tonnes in 2014. Therefore there is no storage for this type of woody biomass. Regarding wood, it seems that the country is storing woody biomass each year, resulting in about 1.11 million dry tonnes in 2012, as only a small amount of wood ends up in incineration and energy use. This number has slightly increased in 2013 and 2014.

Table 3-1 Calculating storage quantity of woody biomass (million dry tonnes)

	Year	Input				Output			Storage
		Import (paper and cardboard)	Import (pulp)	Import (woods)*	Domestic woods*	Export	Waste incineration**	Other energy use**	
Paper and cardboard	2012	2.33	0.46			2.21	0.70		-0.12
	2013	2.50	0.47			2.51	0.62		-0.16
	2014	2.53	0.62			2.52	0.66		-0.03
Woody biomass ***	2012			2.70	0.41	0.70	0.17	1.13	1.11
	2013			2.58	0.47	0.65	0.15	1.08	1.18
	2014			2.68	0.52	0.76	0.14	1.12	1.17

* Excluding woods dedicated for energy purpose, e.g. wood pellets, but including furniture
** Excluding imported waste and woods dedicated for energy purpose, but including export
*** Including round wood, sawn wood, wood panel, furniture

3.5Monitoring of bio-based materials processed in chemical industry

To further investigate the trends in chemical industry and identify possibility to improve the monitoring efforts, questionnaire and interviews with several key industrial informants have been conducted (seven have responded: CRODA, AkzoNobel, SABIC, Forbo Flooring, Chain Craft, Cargill and Simadan out of 20 companies contacted). First, the current trends and issues are described. Then, the problems in monitoring of bio-based materials flows are discussed.

General trends

Percentage of biobased-material in the total production: In general, the amounts of biobased materials and products are small compared to the total material flow in the chemical companies. For example, Akzonobel currently has about 1% of their raw materials coming from bio-based sources. Cargill has mentioned that their biobased chemicals production in the Netherlands is too small to report to the questionnaire and their production is European-wide, therefore an investigation within the Netherlands is not relevant. Chain Craft will start their demo plant facility for food waste from 2017; therefore, the investigation is not yet possible for the company at the time being. While it was impossible to get a clear quantitative picture of the use of oils & fats, woody biomass and carbohydrates, it became clear that the vast majority of the current biomass feedstock used for biochemicals production in the Netherlands are oils and fats. Even without complete numbers, it is very likely that the total amount of woody biomass and carbohydrates used as feedstock for biobased d chemicals is far below 100 ktonnes per year, and therefore only represents a negligible amount. Thus, a larger effort to determine these amounts in more detail (which would also be hampered by issues with monitoring, see next section) is currently not deemed necessary.

Traditional use of bio-based materials: The use of vegetable oils, resin and animal fats for non-food products is not new (e.g. beauty products, floor manufacturing). The processed amount has remained rather stable in the past few years. Since the biofuel production started, the traditional industrial users are facing increased competition due to the double-counting promotion mechanism for the use of UCO and animal fats. This has caused market distortion and price fluctuation. An example of evidence is that the price of animal fats (category III) has dropped after the implementation of legislation since 2014 that excludes them from double counting mechanism. From the interviews, it is found that the traditional use of bio-based materials is not expected to experience significant growth in the near future.

New use of bio-based materials: Bio-based materials are also increasingly used as drop-in chemicals (replacing fossil-based materials). The growth in this part is steady but relatively small and slow. The interviewees do not expect that in the near future, the use of bio-based materials will increase significantly. Research on novel bio-based materials (with new chemical structures compared to drop-in replacement) and alternatives is one of the targets of several companies to achieve further market penetration in the bio-based economy; however, the development of novel chemicals still remains in an early stage.

Origin of bio-based materials: The Netherlands has relatively limited domestic biomass resources (compared to other countries with vast areas of agriculture or forestry), which are typically already in use and are comparatively expensive. Bio-based feedstocks are imported both from within the EU or from outside the EU depending on the type of industry.

Material competition: There is more competition for the feedstock to produce bio-based bulk products than for fine chemicals (derivatives, specialties, flavors and fragrances). For oleo-chemical materials, there is a trend that companies that are directly linked to raw materials production (particularly oil palm plantation companies from Asia) are taking over the role of bulk chemical production in the Netherlands. There are limited bio-based resources and sourcing regions are diverse. Using alternative feedstocks is still more expensive than traditionally produced ones, raising awareness to consumers to buy more products from renewable resources is therefore needed.

Market price and impacts to the growth: The prices of bio-based materials and products are generally higher than fossil-based commodities, and therefore, the use of bio-based materials is closely related to price of fossil fuel products. With the current low oil price, the growth of the sector is slow and highly dependent on the end markets (if there are incentives, e.g. consumer choice or government support) .

Market expansion: the EU is considered the main market of bio-based materials/ products; however, companies interviewed already have markets outside the EU e.g. North America and Asia, Brazil and Russia as potential markets. But also here, market price plays an important role.

Certification of bio-based raw materials: Asia and Russia have relatively large amount of raw materials but feedstocks in these markets are in general not easy to monitor, and are currently not sustainably certified. To avoid conflicts and legal debates especially with NGOs, companies tend to find certified sources within the EU, however this might change in the future when legislations for sustainable material uses are applied. At present, companies use audit firms to verify sustainable sources of raw materials through bilateral trade agreements.

Policies in the Netherlands: Although the Netherlands has an excellent (chemical industry) infrastructure and could attract more bio-based production facilities, the interviewees consider policies in the Netherlands as less attractive compared to supportive measures in other countries, e.g. US or Malaysia. A level playing field is also important to boost the growth of (bio)chemical sector, particularly in the context that subsidies are (or going to be) implemented for other sectors (e.g. co-firing of biomass, double counting of biofuels) but not for the biochemical industry. Currently, there are a number of chemical companies who cooperate with industry representatives to lobby for legislative changes in order to support the growth of the biochemical sector.

Monitoring problems

Quantification of bio-based materials: A number of bio-based materials have been dominant in selected applications for many decades, e.g. oleochemicals, cellulose-derivatives and their market are relatively stable. However, compared to fossil fuels, volumes of emerging applications of bio-based materials, including both novel molecules and drop-in chemicals based on biomass are still very small as these are new and have to compete with established production (which is relatively efficient and currently benefits from a decrease in fossil feedstock prices). In addition, supply - demand market will decide the expansion of these biobased materials and biobased industry accordingly. In this case, mass balance principle is applied to estimate the percentage of bio-based materials in the final products. Companies could use information provided by suppliers to estimate the percentage of materials originating from bio-based materials. From the perspective of national monitoring, to avoid double counting (i.e. when raw materials and intermediates are both counted), it is important to distinguish materials sourced from outside the Netherlands. However, multinational companies tend to monitor at company level due to their size and establishment in various countries

Definition of waste: The inclusion of some bio-based materials within the waste category instead of by-products may impede trade of these materials to biochemcial industry (in particular preparation of additional documents and paying extra fees), and ultimately cause difficulties to trace their flows in statistics. While there are incentives of double counting for biofuels, for chemical industry categorizing materials as 'waste' actually has become a trade barrier.

Willingness to reveal data: Generally, interviewees expressed their willingness to provide data if there is a standard, and data is only reported at aggregate level. However, not all bio-based intermediates can be easily distinguished from fossil-based intermediates. Also, from the viewpoints of multinational companies, reporting by country is less favored. Mass-based monitoring can only be performed if the industry is already mature, i.e. with stable quantity and trend. This is possible for traditional uses of bio-based materials, e.g. technical use of oils and fats is monitored by MVO, but more difficult for new uses, e.g. drop-in replacements and novel chemicals.

4. Sustainability of bio-based materials

4.1Woody biomass

This sub-section is not updated for 2014 because data is not available[5].

4.2Oils and fats

Figure 4-1 shows the use of certified and non-certified vegetable oils, UCO and animal fats, and fatty acids in the Netherlands in 2010-2014. To some extent the year 2011 can be regarded as the starting year for the significant use of sustainable certified vegetable oils in the Dutch market. In this year, the Dutch food and feeds industry imported the first batch of RTRS (Round Table on Responsible Soy) certified soy bean. Many Dutch food manufacturers also started to import RSPO (Roundtable on Sustainable Palm Oil) certified palm oil with ambitious target in the next few years. The share of certified vegetable oils has grown steadily. For 2014, the amount of RSPO certified palm oil and RTRS certified soy bean is known to be 205 kton and 600 kton (117 kton oil), respectively (The Dutch Taskforce Sustainable Palm Oil 2015; IDH 2015).

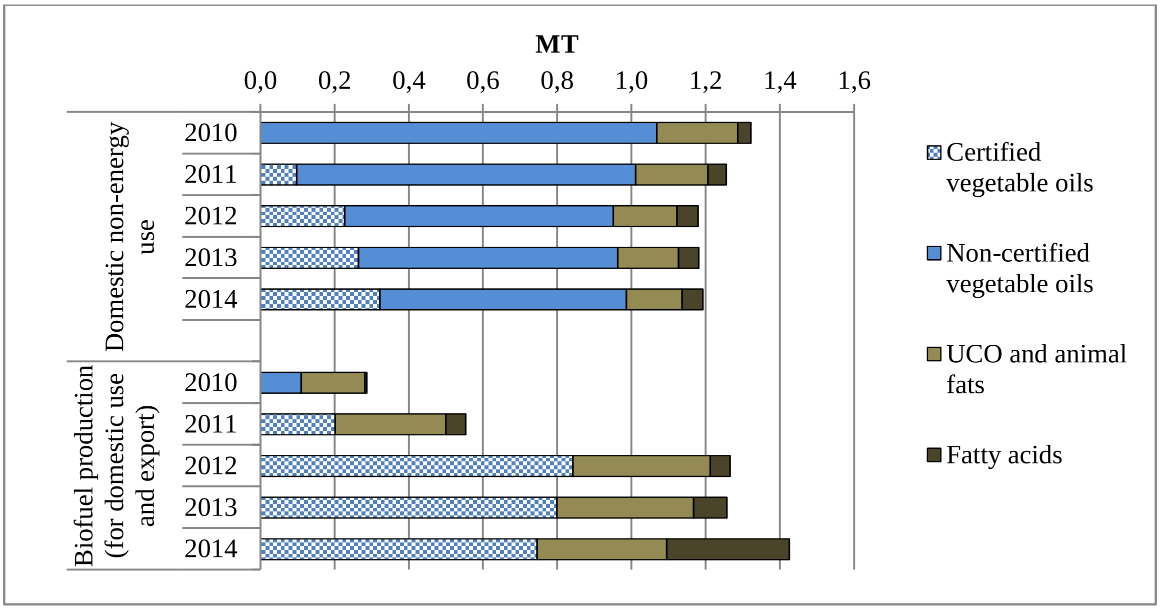


Figure 4-1 Use of certified and non-certified vegetable oils, UCO and animal fats, and fatty acids in the Netherlands.
* Assuming all biofuels produced since 2011 were certified
** UCO and AF used for biofuel was all certified since 2013
*** Administrative data is used for biofuels – about 25% maybe blended last year but administratively counted this year to fulfill the obligation.

Data for certified vegetable oils used for biodiesel production in 2010 is not available. Since there was no mandatory requirement, it is assumed all vegetable oils used for energy purpose in 2010 were not certified. In 2012, the use of palm oil for biofuel production has increased substantially, mainly by the Neste Oil plant in Rotterdam. Neste Oil has increased the use of crude palm oil certified by either or both RSPO and ISCC in all of its plants up to 91% in 2012 (Neste Oil, 2013). This number has reached 100% in 2013, and Neste Oil was the first company in the world to receive a RSPO-RED Supply Chain certificate. RSPO-RED is a new, stricter certification system that complies with the requirements of the EU's RED system.

Figure 4-2 shows the application of sustainability schemes on biodiesel reported to fulfill obligation in the Netherlands. Although the application of NTA 8080 and 2BSvs has grown remarkably in 2012, ISCC has

5 Information of woody biomass sustainablility for 2013 can be found at:
http://english.rvo.nl/sites/default/files/2015/04/Sustainable%20biomass%20flows%20Netherlands%202014%20by%20UU.pdf

nearly dominated the whole market in 2013 and 2014. As usual, a large portion of the biofuels falls under double counting in 2013, but it was not specifically indicated by the NEa report for which scheme was used (but it is quite clear since 2013 that ISCC-EU was mostly applied).

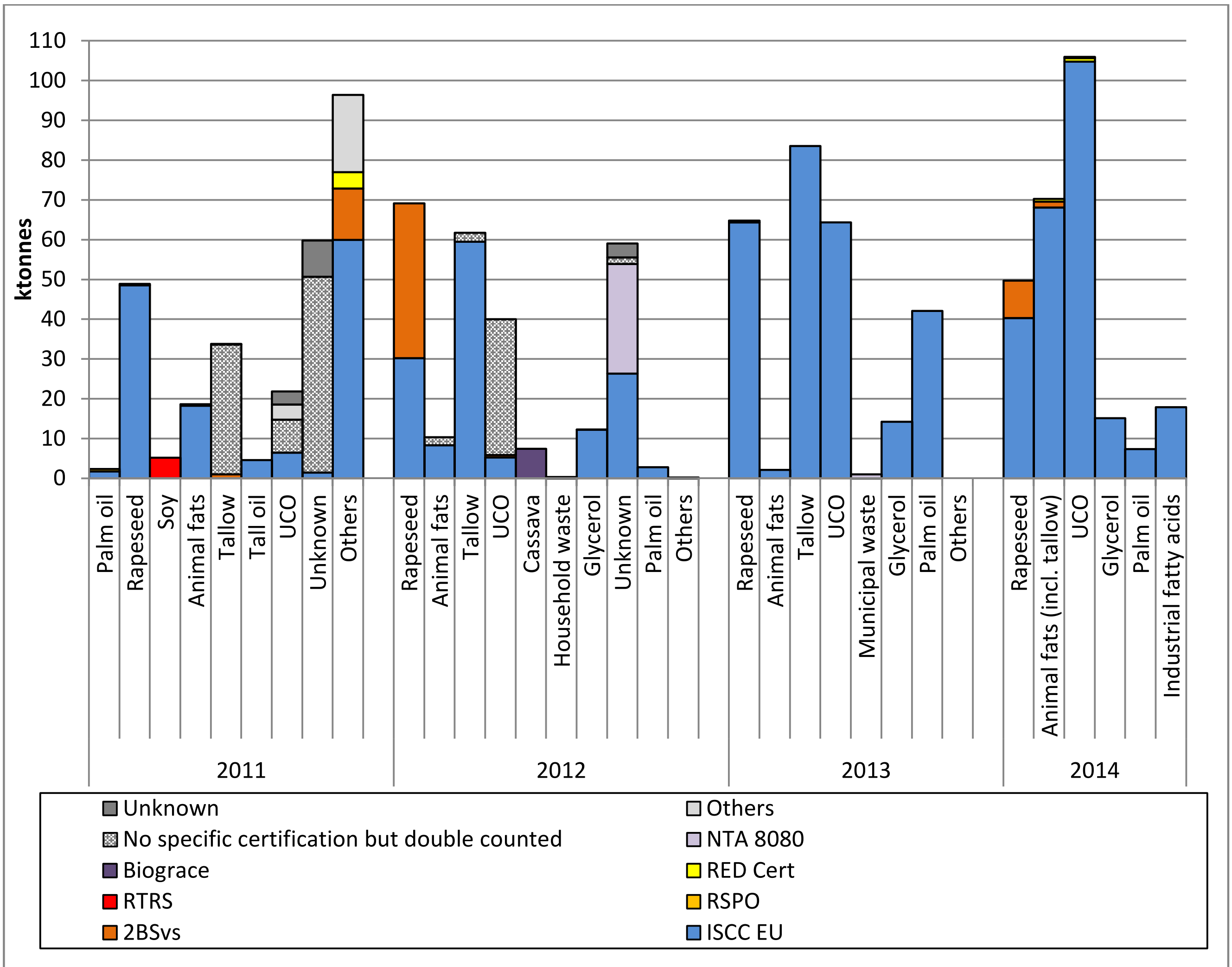


Figure 4-2 Biodiesel and HVO reported to NEa to fulfill blending obligation in 2011-2014 by raw materials and schemes (Source: NEa 2012; 2013; 2014; 2015)

4.3Carbohydrates

Majority of carbohydrates consumed in the Netherlands originated from Europe. In recent years sustainability has been an important consideration in Dutch food industry, and included in procurement policies of many food companies. However, currently it is still unclear how sustainability certifications can be applied on grains in Europe. Companies generally purchase sustainable supplies through bilateral agreements by providing the suppliers a set of rules and criteria to follow. In addition, agriculture in Europe is largely monitored by environmental laws and regulations. Conventional certifications focus more on some other issues such as organic food. Figure 4-3 shows the share of schemes for bioethanol in the Netherlands between 2011 and 2013. ISCC EU remains as the most popular scheme, with its market share increased to near 97% in 2013, but RED Cert and 2Bvs has also contributed significantly in 2014.

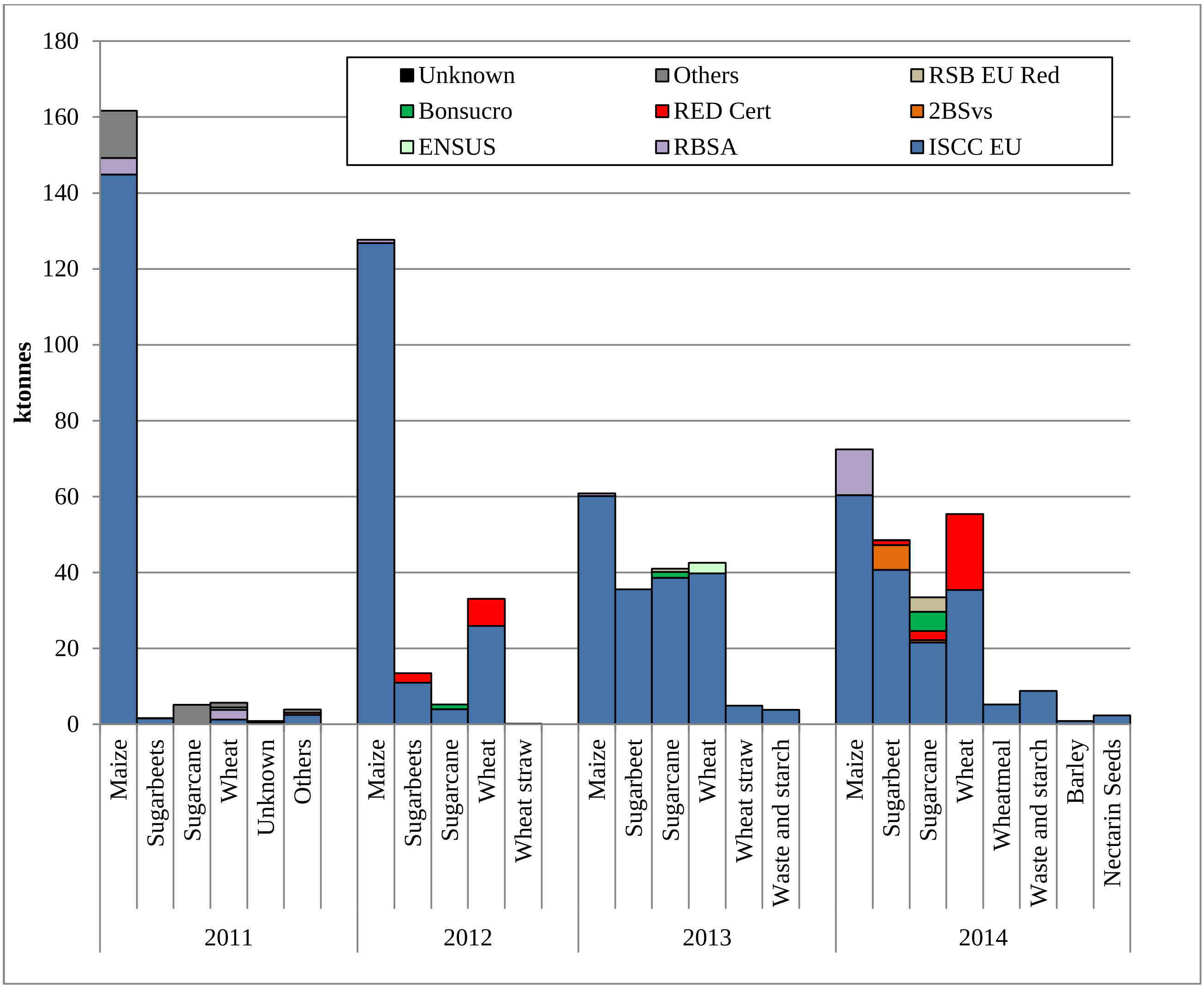


Figure 4-3 Sustainable certified bioethanol reported to NEa to fulfill blending obligation in the Netherlands in 2011-2014 by raw materials and schemes (Source: NEa 2012; 2013; 2014; 2015)

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Appendix

Appendix I Data sources

	Sources	Woody biomass	Oils and fats	Carbohydrates
i	Own data collection directly from the market actors	Wood pellet buyers (up to 2012)	-	-
ii	Monitoring bodies and general statistics portals	Probos, RVO	Product board Margarine, Fats, Oils (MVO); Task Force of Sustainable Palm Oil, Sustainable Trade Initiative (IDH); Liquid biofuels - Dutch Emission Authority	-
		Waste - Afval database van RVO; General - Central Bureau of Statistics of the Netherlands (CBS)		
iii	Trade statistics portals	Central Bureau of Statistics of the Netherlands (CBS);		
iv	Mass balance deductions	Derivations from the other sources		
v	Fragmented data, assumptions, and data aggregation	Various sources like press releases, news, reports by companies or other organizations, and scientific literature		

Appendix II CN code of biomass

CN Code	Description
Woody biomass	
CN 44xxxxxx	Wood and articles of wood; wood charcoal
CN 45xxxxxx	Cork and articles of cork
CN 47xxxxxx	Pulp of wood or of other fibrous cellulosic material; recovered (Waste and scrap) paper and paperboard
CN 48xxxxxx	Paper and paperboard; articles of paper pulp, of paper or paperboard
CN 49xxxxxx	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, type scripts and plans
CN 44013020	Sawdust and wood waste and scrap, agglomerated in pellets
Oils and fats	
From CN 1201xxxx until CN 1209xxxx	Oil seeds and oleaginous fruits
CN 230400	Oil-cake & oth. solid residues, whether or not ground/in pellets, from extraction of soyabean oil
CN 15xxxxxx CN 15200000	Animal or vegetable fats and oils and their cleavage products; prepared animal fats; animal or vegetable waxes Glycerol, crude; glycerol waters and glycerol lyes
CN 29054500	Glycerol
CN 38249055 CN 38249091 CN 38260010 (since 2012) CN 38260090 CN 271020xx	Mixtures of mono-, di- and tri-, fatty acid esters of glycerol (emulsifiers for fats) Monoalkyl esters of fatty acids, with an ester content of 96.5%vol or more esters (FAMAE) Biodiesel and mixtures thereof, not containing or containing less than 70 % by weight of petroleum oils or oils obtained from bituminous minerals. Diesel, fuel oil, oils, containing >=70% weight of petroleum oils or oils obtained from bituminous minerals, containing biodiesel
Carbohydrates	
CN 10xxxxxx	Grains / Cereals
CN 11xxxxxx	Products of the milling industry; malt; starches; inulin; wheat gluten
CN 121291xx CN 12129300 CN 1213xxxx	Sugar beets Sugar cane Cereal straw and husks, unprepared, whether or not chopped, ground, pressed or in the form of pellets
CN 17xxxxxx	Sugars and sugar confectionery
CN 19xxxxxx	Preparations of cereals, flour, starch or milk
CN 200410xx CN 200520xx	Potatoes prepared or preserved otherwise than by vinegar or acetic acid, frozen, other than products of heading 2006: Potatoes prepared or preserved otherwise than by vinegar or acetic acid, not frozen, other than products of heading 2006
CN 22071000 CN 22072000 CN 38249097	Undenatured ethyl alcohol of an alcoholic strength by volume of 80%vol or higher Ethyl alcohol and other spirits, denatured, of any strength Other chemical compounds

Appendix III Conversion factor for biomass

	Value	Unit
Woody biomass		
Density		kg/m^3
- Soft Roundwood	0.78	
- Hard Roundwood	0.90	
- Tropical round wood	1.181	
- Panels	0.65	
Lower heating value [a]		
- Wood pellet	17	MJ/kg
- Wood chips	12	
- Waste wood and other woods	12	
Economic value [b,c]	Change with time	$/kg
Moisture content		
- Wood use by households from forest, gardens, public green areas ect.	25 [a] - 50 [d] %	%
- Round wood [d]	50%	
- Sawn wood and panels [d]	15%	
- Paper and cardboard, pulps	10%	
- Wood pellet [d]	7.5%	
- Wood chips [d]	50%	
- Waste wood [d]	10%	
Oils and fats		
Density		
- FAME [e]	0.88	kg/litre
Lower heating value		
- FAME [e]	37.1	MJ/kg
Moisture content	Negligible *	%
Carbohydrates		
Density		
- Ethanol [e]	0.79	kg/litre
Lower heating value		
- Ethanol [e]	26.7	MJ/kg
Moisture content	Moisture contents for crops are usually high and vary with crops, seasons and also reporting sources. This is described together with the data. Moisture contents for other streams like sugars are considered negligible.	%

a) Personal communication with Reinoud Segers (Statistical Researcher at CBS).
b) Argus Biomass Markets (2013). http://www.argusmedia.com/Bioenergy/Argus-Biomass-Markets [accessed 5 July 2013]
c) Index Mundi. Available at: http://www.indexmundi.com/
d) Oldenburger et. Al., 2012. Nederlandse houtstromen in beeld, Wageningen, Stichting Probos. Available at: http://www.probos.nl/images/pdf/rapporten/Rap2012_Nederlandse_houtstromen_in_beeld.pdf
e) EBTP (2011). EBTP Biofuels Fact Sheets 2011. Available at: ttp://www.biofuelstp.eu/fact_sheets.html [accessed 5 July 2013]
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* UCO and animal fats are assumed to be pretreated before they were fed into biofuel production

Appendix IV Consumption of oils and fats by end markets (ktonnes)

(ktonnes)		2007	2008	2009	2010	2011	2012	2013	2014
Human consumption	Vegetable oils	706	716	781	816	786	783	800	811.0
Human consumption	Animal fats	17	11	17	20	15	15	14	14.0
Technical consumption	Vegetable oils	99	88	55	106	71	97	98	96.0
Technical consumption	Animal fats	44	30	20	43	38	38	39	37.0
Technical consumption	Fatty acids	17	24	14	13	17	10	10	11.0
Animal consumption	Vegetable oils	168	177	169	146	154	153	149	161
Animal consumption	Animal fats	154	149	155	154	143	118	111	99
Animal consumption	Fatty acids	31	24	27	23	32	47	44	45.0
Energy consumption	Vegetable oils	22	49	113	110	201	842	799	745
Energy consumption	Animal fats	89	101	134	171	299	370	368	350
Energy consumption	Fatty acids	2	10	7	5	53	54	90	330

Appendix V Major trade flows of monoalkylesters, oil seeds and oils & fats (net) for the Netherlands from 2008 – 2014 (MT)

	2008			2009			2010			2011		
	CN 38249091	Oil seeds (CN 12)	Oils and Fats (CN 15)	CN 38249091	Oil seeds (CN 12)	Oils and Fats (CN 15)	CN 38249091	Oil seeds (CN 12)	Oils and Fats (CN 15)	CN 38249091	Oil seeds (CN 12)	Oils and Fats (CN 15)
Europe	-224.3	-60.9	-2783.7	-586.6	-207.0	-2805.2	-509.7	-131.1	-2118.9	-796.6	833.3	-2011.3
US (Soy)	850.2	1163.7	52.7	253.0	444.1	-10.6		1010.6	17.3	-21.0	588.7	0.0
Indonesia (Palm oil)	44.1	0.0	735.2	51.7	0.0	961.6	26.9	0.0	783.4	142.3	0.0	729.0
Malaysia (Palm oil)	21.5	0.0	1176.2	85.4	0.0	857.9	32.7	0.0	1046.2	4.3	0.0	615.1
Brazil (Palm oil)	0.0	0.0	1.5	0.0	0.0	1.1	0.0	0.0	1.2	0.0	0.0	8.8
Brazil (Soy)	0.0	2207.0	55.0	0.0	1981.0	11.1	0.0	1296.0	0.0	0.0	1021.3	0.0
Canada (Soy)	0.0	153.6	0.0	0.0	64.9	0.0	0.0	234.6	0.0	0.0	498.8	0.0
Paraguay (Soy)	0.0	265.5	0.0	0.0	243.4	0.0	0.0	546.7	0.0	0.0	625.0	0.0
Uruguay (Soy)	0.0	49.7	0.0	0.0	135.7	0.0	0.0	254.8	0.0	0.0	97.1	0.0
Argentina (Soy)	40.0	0.0	26.6	536.9	0.0	1.0	367.8	37.3	0.0	255.5	0.0	27.0
Others	9.0	1163.8	315.6	84.4	1353.0	399.4	35.4	706.9	270.6	5.8	1231.3	861.0

	2012					2013					2014				
	CN 38260010	CN 38260090	CN 271020xx	Oil seeds (CN 12)	Oils and Fats (CN 15)	CN 38260010	CN 38260090	CN 271020xx	Oil seeds (CN 12)	Oils and Fats (CN 15)	CN 38260010	CN 38260090	CN 271020xx	Oil seeds (CN 12)	Oils and Fats (CN 15)
Europe	-364.3	-299.0	-2161.3	-985.9	-1990.5	-617.1	-408.6	-1864.5	-789.3	-2265.1	0.0	0.0	0.0	-520.6	-1948.9
US (Soy)	-6.6	0.0	0.0	809.6	0.0	-39.9	0.0	0.0	1066.4	0.0	0.0	0.0	0.0	1359.8	0.0
Indonesia (Palm oil)	363.1	6.0	0.0	0.0	920.7	116.3	6.5	0.0	0.0	1329.1	0.0	1.6	0.0	0.0	979.7
Malaysia (Palm oil)	15.2	5.0	0.0	0.0	1142.0	170.2	0.0	0.0	0.0	1146.1	275.5	0.0	0.0	0.0	980.5
Brazil (Palm oil)	2.5	0.0	0.0	0.0	0.0	9.0	0.0	0.0	0.0	50.6	12.1	0.0	0.0	0.0	19.6
Brazil (Soy)	0.0	0.0	0.0	1004.2	0.0	0.0	0.0	0.0	1491.1	0.0	0.0	0.0	0.0	1599.4	0.0
Canada (Soy)	0.0	0.0	0.0	326.2	0.0	0.0	0.0	0.0	380.1	0.0	0.0	0.0	0.0	78.1	0.0
Paraguay (Soy)	0.0	0.0	0.0	485.8	0.0	0.0	0.0	0.0	424.7	0.0	0.0	0.0	0.0	163.2	0.0
Uruguay (Soy)	0.0	0.0	0.0	71.5	0.0	0.0	0.0	0.0	186.7	0.0	0.0	0.0	0.0	276.8	35.0
Argentina (Soy)	554.9	0.0	0.0	0.0	0.0	183.6	0.4	0.0	0.0	0.0	0.0	0.0	0.0	64.4	0.0
Others	2.7	0.0	-318.7	1338.6	1498.5	105.2	0.0	1289.0	1477.8	1073.8	-714.1	-362.8	-842.7	1224.7	929.7

Appendix VI Estimations of FAME and HVO consumed in the Netherlands in 2010-2014 by feedstock and country (Source: NEa, 2011; 2012; 2013; 2014; 2015; CBS 2015a)

	Unknown			Palm oil					Rapeseed					Soy	
	2010	2011	2012	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2011
Other European countries (with individual volume >1%)	0.0	0.0	6.8	0.0	0.0	0.0	0.0	0.0	3.3	16.4	0.0	3.5	1.8	0.0	0.0
Unknown	17.6	0.0	3.5	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0
Netherlands	0.0	49.2	31.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0
Germany	0.0	0.0	15.4	0.0	0.0	0.0	0.0	0.0	0.0	13.2	49.5	0.0	3.4	0.0	0.0
UK	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.6	0.0	0.0
Spain	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
France	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	18.5	0.7	0.3	0.0	0.0
North America	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Finland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Russia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malaysia and Indonesia	0.0	0.0	0.0	0.9	2.4	2.8	7.1	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Japan	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South Korea	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
South America	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Others	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.2	0.9	5.2

Tallow			UCO					Animal fats					Mixture*			Others			Glycerol			Cassava	FA**
2010	2011	2012	2010	2011	2012	2013	2014	2010	2011	2012	2013	2014	2010	2010	2011	2011	2012	2014	2012	2013	2014	2012	2014
2.9	7.7	0.0	2.6	0.2	0.0	12.6	18.2	0.9	0.0	0.0	0.0	0.0	0.9	0.0	0.4	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0
5.0	1.6	0.0	2.6	0.0	0.0	0.0	0.0	5.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	33.2	0.1	0.0	0.0	0.0	0.0	7.4	0.0
0.0	0.5	8.3	23.3	14.7	16.8	19.0	26.3	0.0	0.0	2.6	0.0	7.4	1.8	1.5	0.0	11.3	0.3	0.0	9.2	16.7	22.0	0.0	0.0
0.9	19.8	30.3	15.4	6.5	0.6	17.6	15.8	2.0	6.8	2.5	105.4	42.6	4.4	1.2	0.0	0.0	0.0	0.0	0.9	0.4	0.0	0.0	0.0
0.0	2.7	10.1	0.0	0.0	0.2	5.2	11.1	0.0	5.0	4.5	31.6	11.6	0.0	0.0	1.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
0.0	1.3	8.8	0.0	0.0	9.6	2.2	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0
0.0	0.0	2.7	0.0	0.0	1.2	3.3	1.4	0.0	0.0	0.8	0.0	1.6	0.0	0.0	2.3	0.0	0.0	0.0	2.0	4.2	0.2	0.0	0.0
0.0	0.0	0.0	0.0	0.0	9.9	5.6	7.4	0.0	4.6	0.0	0.0	8.1	0.0	0.0	0.5	2.8	0.0	0.0	0.0	0.0	0.1	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26.4
0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	0.0	0.0	0.0	0.0	0.0	36.2	26.3	0.0	0.0	0.0	0.0	24.5	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2	0.0	0.0

Appendix VII Major ethanol trade flows in and out the Netherlands for 2008 – 2014 (ktonnes). (Source: CBS, 2013)

	2008	2009	2010	2011	2012	2013	2014
Brazil	357.2	111.8	4.7	-3.6	0.2	1.4	8.6
Guatemala	0.0	58.9	14.3	61.9	65.0	192.7	97.8
Bolivia	10.8	0.0	6.1	2.4	18.9	0.0	32.6
Costa Rica	33.3	47.1	4.0	0.0	3.3	0.0	50.6
Peru	30.8	7.7	28.2	15.5	54.2	116.3	55.9
US	0.0	10.0	5.5	12.1	82.1	0.0	-8.4
US (38249097)*	77.6	7.9	85.7	329.7	0.0	0.0	0.0
EU	-287.0	-228.0	-151.0	-105.8	-13.6	-202.3	-162.1
Other American countries	69.4	99.2	11.0	38.4	40.2	123.4	21.6
Pakistan	44.1	26.3	3.3	6.8	7.7	42.2	21.2
UAE	0.0	0.0	0.0	0.0	0.0	0.0	-52.3
India	0.0	0.0	0.0	0.0	0.0	0.0	-15.1
Others	151.5	54.0	-1.9	-12.9	53.4	36.8	-17.1

Appendix VIII (Dry) biogenic components in waste incinerators

tonnes	2012			2013			2014		
	Mixed municipal waste	*Imported waste*	*Other streams*	*Mixed municipal waste*	*Imported waste*	*Other streams*	*Mixed municipal waste*	*Imported waste*	*Other streams*
Organic components	918,095	62,796	180,923	877,381	92,926	128,263	869,161	89,199	146,919
Paper	583,996	170,844	116,683	538,414	265,053	86,244	547,012	243,946	113,532
Diaper	61,665	1,071		56,898	1,667		54,246	1,646	
Plastics	122,734	36,471	0	118,434	59,418	0	113,369	59,998	0
Textile	83,408	39,238		85,356	66,984		87,225	66,160	
Wood	111,380	73,560	62,452	109,335	116,806	38,690	94,600	100,521	46,156
Remainings			74,002			46,775			72,600
Total biogenic components			**2,699,317**			**2,688,643**			**2,706,290**

*Organic components include organic waste collected at sources and organic residues which are sorted and separated at incineration plant. These two organic parts have different moisture content but are incorporated in this report to avoid misinterpretation.

Appendix IX Net calorific value and moisture content of biogenic parts – Mixed municipal and imported wastes (RWS 2015b)

	NCV[6]	**NCV[7] biomass**	**Moisture**
	(MJ/kg)	(MJ/kg)	(Weight %)
Organic waste	5.8	5.1	50.9
Organic residues	3.8	3.4	47.9
Papier (excl. diaper)	10.2	8.9	38.8
Diaper	7.1	3.6	59.2
Plastics	23	4.6	17.7
Glass	0	0	0
Ferro	0	0	0
Non-ferro	0	0	0
Textile	15.9	7.95	18.5
Small chemical waste	0	0	0
Wood	14.2	13.2	22.8
Other, rest	7.4	0	4.5
Overig,electrical & electronic appliances	16.4	0	13.5
Overig, stone like	0	0	0

6 & 7 Net calorific value of biogenic wastes differ from other waste components

Appendix X Net calorific value and dry content of other wastes (RWS 2015b)

	NCV	Percentage of biomass	Dry content
	(MJ/kg)	(Weight %)	(Weight %)
Organic waste	3	100	60
Papier (excl. diaper)	10	100	70
Plastics	33	0	90
Wood	14	100	90
Other, rest	15	50	70

Appendix XI (Dry) biogenic quantity in imported-exported wastes

dry tonne	**2012**		**2012**	
	Import	**Export**	**Import**	**Export**
Wood waste	62,034	546,092	140,009	493,409
Mixed municipal waste	383,981	447,795	602,854	489,984
Net import		**-547,873**		**-240,531**

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