Sustainable biomass and bioenergy in the Netherlands

Report 2016

CE Delft

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Abbreviations

AVI	Waste incineration plant (Afvalverbrandingsinstallatie)
BEC	Bio Energy Plant (bioenergycentrale)
CBS	Statistics Netherlands (Centraal Bureau voor de Statistiek)
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
ETOH	Ethanol
ETBE	Ethyl tert-butyl ether
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
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

Content

1 Summary

This report provides an overview of the biomass flows in the Dutch biobased economy over the year 2015. 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 biobased economy (limited to three major biomass groups) in the Netherlands (Kwant et al. 2015, Meesters et al. 2014).
This year more attention is paid to differentiation between streams in the bio-economy and the biobased economy, the conversion of biomass in the Dutch chemical industry and comparison of the flows identified in this study with the goals set in the vision: Biomass 2030, currently part of the Nation-wide programme Circular Economy.

Figure 1 shows the overview of biomass used per type of raw material:
1. carbohydrates (used for carbohydrates based materials like starches and biogasoline);
2. oils and fats (used for oleochemistry and biodiesel);
3. woody biomass (used for the production of wood as material, for pulp and paper production and energy generation);
4. waste streams used for energy generation.

Figure 1 show both use and net export, if the net export is negative this implies a net import

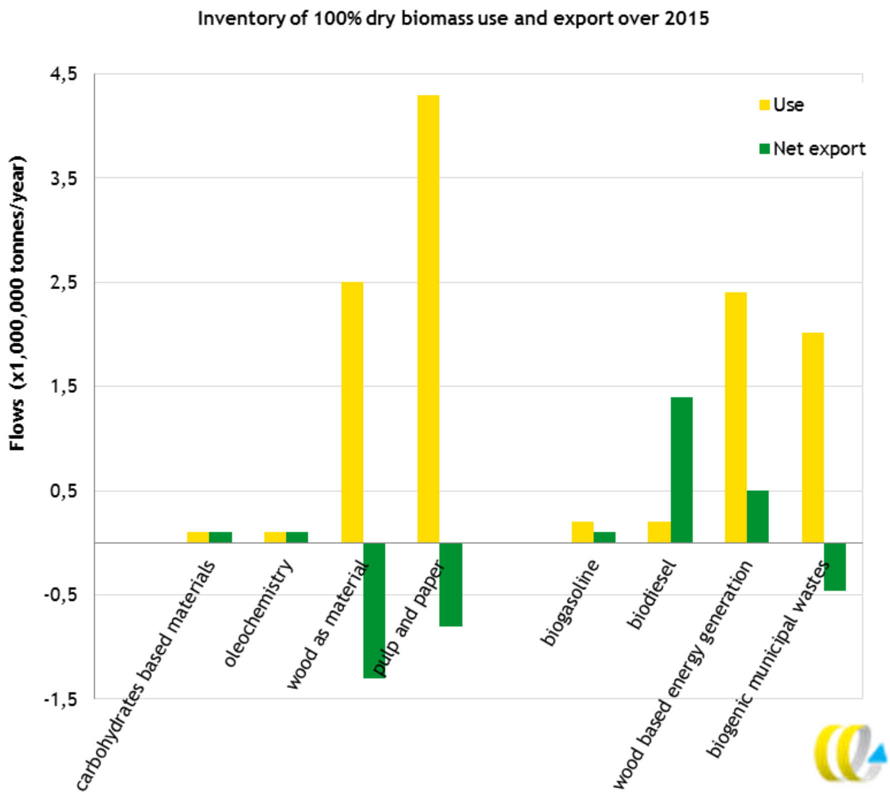
The material use and net export based on carbohydrates and oils and fats (oleochemistry) is much lower than the use of the transport fuels produced from these biomass categories (respectively biogasoline and biodiesel). This is because large biofuel producing companies are located in the Netherlands that are net exporters to mainly the rest of Europe.

In the category woody biomass the use of woody biomass for non-energy industrial production (i.e. material production) is almost three times as high as the amount of woody biomass used for energy generation. As can be expected from a small and densely populated country the import of woody biomass exceeds the export. In case of pulp and paper production, the situation differs from this expectation since a large part of paper production is based on recycled paper and board, producing high content recycle paper for a wider region than the Netherlands. Therefore, the import and export of pulp and paper are a factor 5 higher than the local use, but since the import and export are about the same amount, the net result is relatively small, this is why the net import is small compared to the production.

Currently, no material use of biogenic waste streams is reported within the biobased economy. When looking in the bio-economy there is a significant flow of materials that is re-used in the form of soil enhancers. Within this report we focus on the biobased economy and there only energy applications are recorded.

Of the total biogenic waste streams 64% of the energy yield comes from municipal wastes incinerated in energy recovery plants. This is based on 2 million tonnes of dry biogenic wastes. The other energy generation is based on mass flows of which the mass flow is not recorded, and therefore not included in this overview. In 2015 23% of the waste processed in the Dutch waste incineration plants was imported from other countries (RWS, 2016).

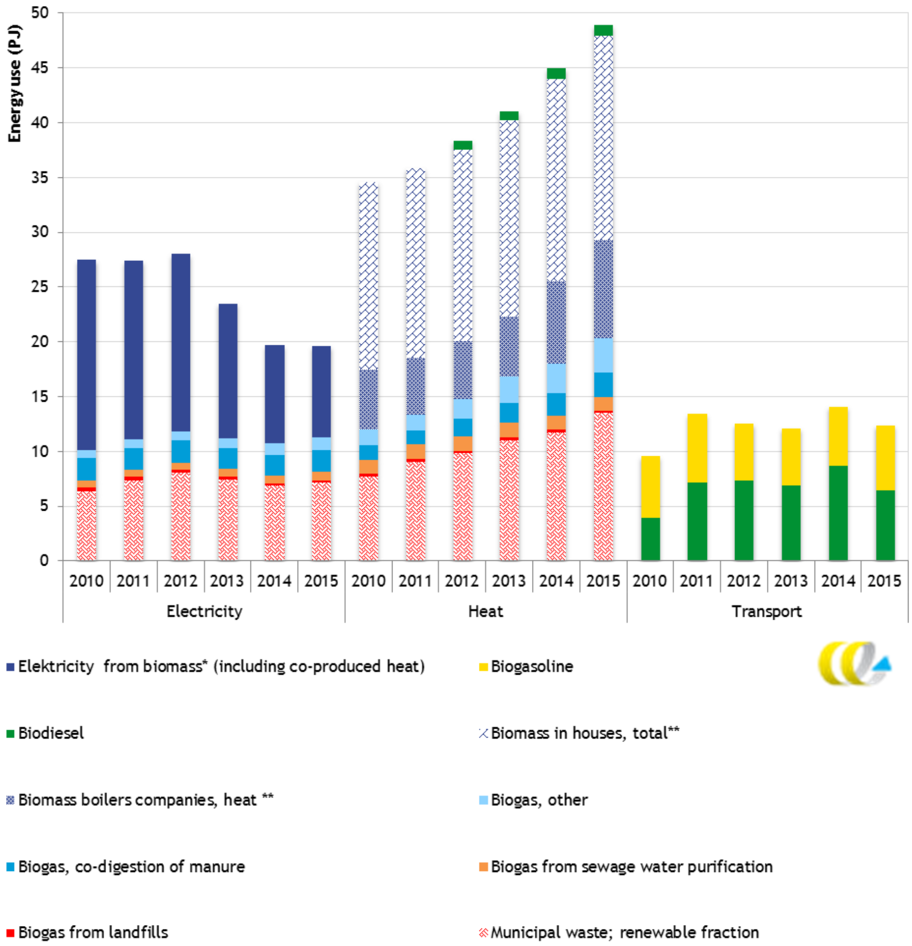
Figure 1 Overview of biobased production (use and net export) in the Netherlands (2015)



In previous reports the biobased energy produced in the Netherlands was shown in more detail. Since the electricity from wood pellets was no longer reported separately for energy plants and companies we redesigned the figure and show the numbers as reported by CBS over the period 2010–2015 per type of biomass processing method and energy type.

In recent years the use of biomass for electricity decreased. Especially the amount of biomass co-fired in energy plants and biomass used by companies to produce electricity decreased strongly since 2012 and seems to stabilize on a level slightly below the level of 2014.
The production of biomass based heat increases steadily. The amount of biomass used in houses and the increase in heat recovery from the burning of the biogenic fraction of municipal waste are the main contributors to this increase.

Figure 2 **Gross final energy consumption** from biobased materials in the Netherlands 2010-2015**



Source: (CBS 2015b; CBS 2016a; CBS 2016b). (See Annex A, Table 13.)

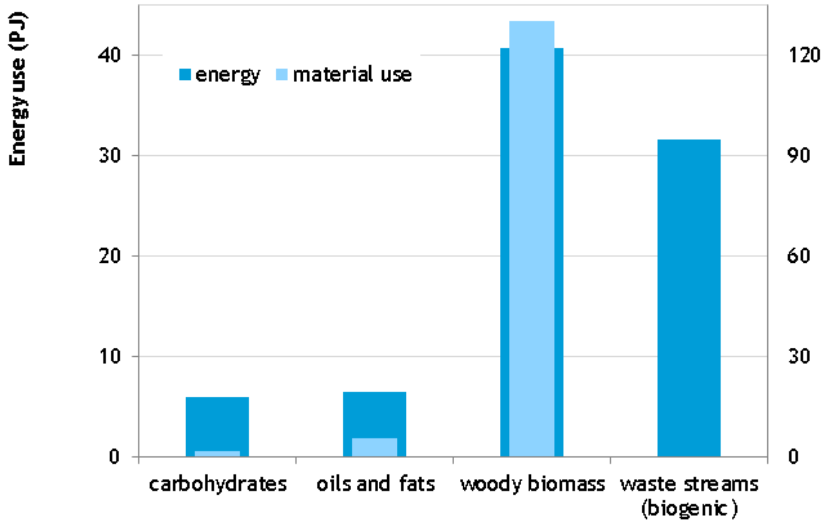
Since the SDE+ also supports feed-in of renewable gas in the gas grid the amount of renewable gas fed to the natural gas grid and used for heating, electricity and transport strongly increased (by 632% in 2015 compared to 2010). This increase was realised by an increase of waste streams fermentation by both companies and local authorities to increase their renewable energy production in a sustainable way. However, since this amount was negligible in 2010 it is 2.3 PJ in 2015 (CBS, 2016a)., which is rather small compared to the other categories, see Figure 3.

The amount of biodiesel use in the Netherlands decreased with 35% compared to 2014, only slightly compensated by an increase in biogasoline use with 10%, see Figure 2. The percentage of biofuels in transport in the Netherlands is nearly constant in recent years. This market is strongly governed by European regulations and their implementation in the Netherlands which have not changed significantly.
What has changed is that apart from the biogas (certified under NTA 8080) all streams used as a transport fuel are certified under the ISCC EU, while before there used to be more certification schemes.

In the vision Biomass 2030, goals are set for the increase in the use of biomass in three applications:
- electricity and heat;
- chemicals;
- transport fuels.

In this vision all goals are expressed in energy units (PJ). The question is how can this report help with monitoring the goals set in the vision Biomass 2030.

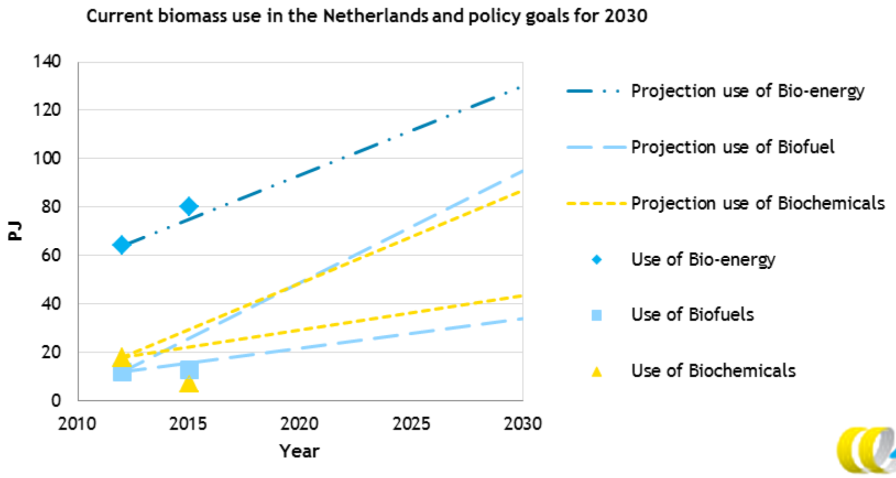
Figure 3 Overview of biobased production in four categories for material and energy use



(See Annex A, Table 14).

Therefore we summarised the results for 2015 in terms of energy units, see Figure 3. As we saw in Figure 2 the largest energy applications are of woody biomass and waste streams used for the production of energy. Nevertheless, as already shown in Figure 1, the use of woody biomass for material uses is significantly higher than the use for energy purposes (the material axis is a factor 3 higher than the energy axis).

Figure 4 Current use and goals set for biomass use in 2030



(See Annex A, Table 15.)

To compare these results to the projections in the vision Biomass 2030 we plotted the goals for 2030 as a linear increase between 2012 and 2030 and added the numbers for 2015, see figure 4. The data presented in this study should provide a complete picture of the use of biomass for the applications Bio-energy and Biofuels. This is not the case for the third category Biochemicals. We will explain this in the following paragraphs.

In Figure 4 the total for electricity and heat generated on the basis of biomass is plotted as bio-energy. The generated heat and electricity from biomass is just a little above the (linear) projection of the policy goal.
The total of all transport fuels based on biomass is presented as Biofuels. The consumption of biofuel is in line with the low scenario for biofuels projected in Figure 4.

The total industrial use of biomass as shown in Figure 1 is significantly higher than the goal set for biochemicals. Nevertheless, the use of biomass for the production of chemicals as far as identified in this report seems to be les than reported in 2012 for Biochemicals, see Figure 4.
This is explained by the following aspects:
1. Only part of the industrial use of the biomass presented in this study is relevant to the goals set in the vision Biomass 2030: application of woody biomass for traditional biomass applications like wood and paper are excluded. Therefore only the industrial use of Carbohydrates and Oils and fats within the biobased economy comply with this definition.
2. As described in Chapter 2 on Methodology the applied methodology excludes significant biobased streams in the chemical industry.

Therefore the data presented in this study provides information about a part of the biomass applied as a raw material in the chemical industry. For a complete picture all flows included in the vision Biomass 2030 should be included in the monitoring report.

2 Introduction

From 2012 to 2015, Utrecht University has conducted work for the 'Sustainable Biomass Import'.
This year CE Delft continues this work with the focus on the following aspects:
- the nature and quantity of exported and imported biomass from and to the Netherlands;
- deployment/industrial application of biomass in the Netherlands;
- country of origin of the biomass imported in the Netherlands;
- presence and type of Certification of the biomass.

The results obtained are discussed in relation with the relevant policies in the Netherlands. The basis for the methodological approach of this study is the report 'Protocol For Monitoring Of Material Streams In The Biobased Economy (BBE)' (Meesters et al., 2013).

This study limits the scope to four main categories:
1. 'Carbohydrates' including grains, starch, sugars and possible connection to bioethanol.
2. 'Oils and fats' including oil seeds, vegetable oils, animal fats, and biofuels (Fatty Acid Methyl Ester (FAME) and hydro-treated vegetable oils (HVO)).
3. 'Woody biomass' including timber, wood products, paper and cardboard, wood fuels, and their waste streams.
4. 'Biogenic components in energy generation', including wood and organic components from different types of waste streams in incineration plants and fermentation units.

These categories are a continuation of the selection used in previous studies carried out by the Copernicus Institute(Goh, Junginger (2012-2014) Mai-Moulin, Goh, Junginger (2015)). Although the fourth category is significantly wider than studied in the earlier studies. These categories are a slight deviation of the raw material categories identified within the 'Protocol For Monitoring Of Material Streams In The Biobased Economy' described in Meesters et al. (2013). We will further specify this deviation in the chapter on methodology.

This report aims to update the previous report with the latest figures as possible. In addition, it pays particular attention to the following extensions:
1. Application of these categories in the Dutch chemical industry.
2. Completeness of CBS data as a basis for the monitoring of these streams.
3. Relevance of the BBE to green growth and circular economy programs.
4. Progress realized compared to goals formulated in the Vision Biomass 2030.

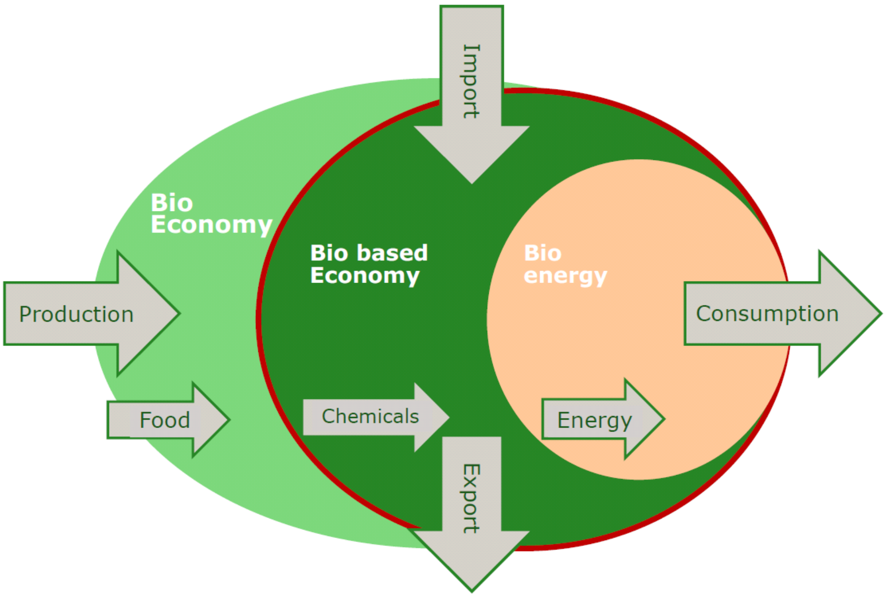
The outcomes of the monitoring are described in the following chapters. Chapter 2 describes the methodology used in general terms. Chapter 3 to 6 describe the import, export, production, conversion and certification of respectively the carbohydrates, the oils and fats, the woody biomass and the biogenic compounds in waste streams.

Chapter 7 discusses the policy context of the outcomes: completeness of CBS data as a basis for the monitoring of these streams, the relevance of the streams in the BBE to green growth and circular economy programs, and the progress realized compared to goals formulated in the Vision Biomass 2030.

2.1 Definition and boundaries of BBE

Development of biobased 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. Biobased economy is defined in illustration in Kwant et al. (2015) as shown in Figure 5. 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 5 The biobased economy embedded in the overall bio-economy



Source: Adopted from Kwant et al. 2015.

2.2 Methodological approach

The basis for the methodological approach of this study is the report ‘Protocol For Monitoring Of Material Streams In The Biobased Economy (BBE)’ (Meesters et al. 2013).

The protocol suggests some questions that could be answered by the monitor BBE.
This study limits the scope to the quantification of the mass flows that are imported, exported, locally produced, the type of certification of these streams and the local conversion to biobased materials. This is carried out for four main categories:
1. ‘Carbohydrates’ including grains, starch, sugars and possible connection to bioethanol. Only biomass that falls under these three categories was investigated.
2. ‘Oils and fats’ including oil seeds, vegetable oils, animal fats, and biofuels (Fatty Acid Methyl Ester (FAME) and hydro-treated vegetable oils (HVO)).
3. ‘Woody biomass’ including timber, wood products, paper and cardboard, wood fuels, and their waste streams.
4. Biogenic components in waste incinerators (AVIs) including organic components from different types of waste streams, paper, diapers, plastics, textile, wood and contaminated remaining of animals.

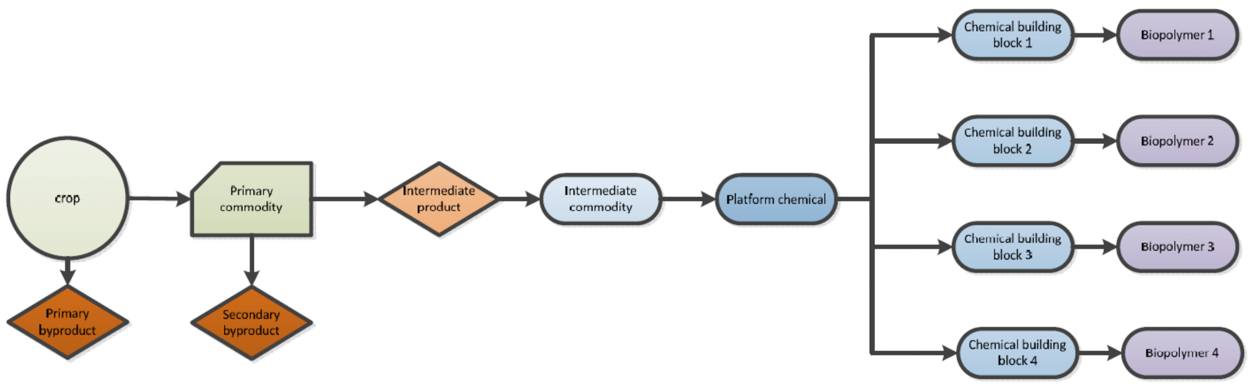
These categories are a slight deviation of the raw material categories identified within the 'Protocol For Monitoring Of Material Streams In The Biobased Economy' described in Meesters et al. (2013).

The first two categories, 'carbohydrates' and 'oils and fats' are the same as the 'carbohydrate rich commodities' and 'oil crops' mentioned in the protocol. The category 'woody biomass' is a more narrow definition of the category 'lignocellulose raw materials', which includes woody biomass and also other fibrous materials like flask, hemp, cotton and coconut fibres.
The fourth and fifth categories, respectively 'protein crops' and 'other crops (natural rubber, natural dye colours, etc.' are still relatively small when considering non-food and feed applications and are not included in this overview.

The used categories are a continuation of the selection of biomass and the data sources used in previous studies carried out by the Copernicus Institute (Goh, Junginger (2012-2014); Mai-Moulin, Goh, Junginger (20115)).

The protocol advocates an as complete monitoring as possible from primary production of the biomass to final use:
"A typical production chain for biobased products starts with cultivation of the crop (wheat, soybeans, trees). The crop is then harvested from the land and converted to a primary commodity (grain, oilseeds, logs) with a few processes that are often simple. These commodities are then transported and refined to intermediary commodities (flour, sugar, paper pulp). These intermediary commodities can then be used for the production of consumer products (biofuels, bioplastics, and paper, for instance)."

Figure 6 Typical production chain in the BBE from cultivation to product



Source: Adopted from Meesters et al., 2013.
Per category we will indicate how far we look into the production chain. Within a biomass category this may differ per type of production chain.

2.3 Uncertainties

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.
The main data source are the import and export statistics and (agricultural) production statistics kept by the Dutch central bureau for statistics (CBS) and the European bureau for statistics (Eurostat). In addition we employ the yearly reports on biobased fuel use in the Netherlands (Nea reports), statistics kept

by Probos on wood use and interviews with suppliers of the chemical industry (specifically soap and shampoo producers), starch producers, the Dutch paper and board industries VNP and the industry association for margarines, fats and oils (MVO).

Mass-based measurement leads to uncertainty from a number of aspects:

1. Availability of data on biomass for non-energy and non-food and non-feed use: The current recording of imports and exports and production of oils and fats and carbohydrates does not distinguish between food and feed applications and other applications of the same streams. If available we used default values from industry contacts and industry associations.
2. Availability of data on biobased origin of substances. For the derivates that are obviously meant for industrial use like denatured ethanol it is impossible to distinguish between fossil based ethanol and biobased ethanol.
3. Moisture content: The CBS does not correct for the moisture content of biomass. For example starch potatoes contain a moisture content of about 70-75%, the numbers on harvested potatoes does not specify the average moisture content at the specific year of harvesting. The same situation occurs with reported starch numbers, import and export numbers on starch either from grains or potatoes include approximately 20% moisture. This number is not specified in the statistics. Assumptions made for moisture content are crude. Therefore we decided to use as much as possible the data as reported by CBS and only use moisture when the amount of moisture in a certain product had to be calculated. For example statistics on potato and potato starch are not corrected for moisture content. Sow we reported them as reported by CBS. However, when calculating the local production of potato starch from potatoes we had to correct for the moisture content of starch to bring this flow in line with the, import and export of starch as reported by CBS. In such situations we used the default values from industry contacts and industry associations.
4. Size of the BBE: the basis of this study is that the size of the BBE can be found by measurement of the inputs of biobased materials, i.e. the processed quantity of biobased materials The idea is that the growth of biobased 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 biobased raw materials for the production of chemical and materials as a proxy. However, in our experience this approach underestimates the size of the biobased economy in two ways:
   a The size of the stream and the value it creates varies strongly between types of industries. For example the amount of oils and fats converted by companies like Cargill (bulk), Croda (specialties) and Givaudan (perfumes) strongly differ in added value per stream that is handled by these companies, as is the number of people that is employed in these companies per ton of oily biomass converted.
   b Most biomass streams that are applied in industry in the Netherlands are already partly processed.

The paper industry produces more on the basis of readymade pulp than on wood. The soap and cosmetic producers use Sodium Lauryl Sulfate (SLS), Sodium Laureth Sulfate (SLES) or related substances like: Ammonium Lauryl Sulfate, Sodium Myreth Sulfate, etc. these are substances that are produced by chemical conversion of natural oils in other countries (in the EU Spain and Germany have known production locations). They still are partly biobased. This study includes the pulp stream and therefore provides quite a good indication of the size of the wood converting industry in the Netherlands, but

SLS, SLES and other oil based intermediaries are not included and therefore the estimate of the size of the biobased flows in the Dutch economy as a proxy for the biobased economy is flawed.

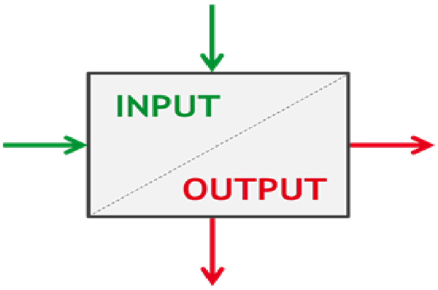
2.4 Methodology used for the drawing of the Sankey diagrams

All the numbers in the Sankey diagram are actual mass flows as reported by CBS, thus flows were not corrected for dry content since no accurate data on dry content is reported.

The flow scheme was possible by working with net import and net export streams. This greatly simplifies the complex network of in- and outgoing streams of all types of kinds. Nevertheless the Sankey diagrams still are complex due to the high number of streams represented in one figure.

To limit the complexity of the diagrams to the minimum we used the following methodology: import enters the diagram from the top the ingoing streams from import flow through the diagram. Export leafs the diagram from the bottom. Local cultivation enters the diagram from the left and local applications leaf the diagram at the right. The same reasoning is used for the boxes representing processing steps of the biomass or the biobased products: from the top or the left side biomass or biobased products enter the process and from the right side or the bottom flows of biomass or biobased products leaf the processing step.

Figure 7 **Illustration of the flow convention used in the process boxes of the Sankey diagrams**



2.5 Specifications on the biofuel flows and certification

The basis sources for the biofuel flows were the following:
1. Numbers on renewable bioenergy production in the Netherlands (CBS statline, Hernieuwbare energie; verbruik naar energiebron, techniek en toepassing, 30 juni 2016).
2. Numbers on biofuel consumption in the Netherlands (NEa, 2016).
3. Numbers on import and export of ethanol and ETBE in the Netherlands (EUROSTAT, 2016).
4. Numbers on import and export of starch and starch potatoes (EUROSTAT, 2016b).

However a difference occurs between the CBS/Eurostat numbers at one hand and the numbers reported in the NEa report on the other side, se the following text box for the explanation by Statistics Netherlands (CBS).

Statistics Netherlands (CBS) gives the following explanation for the difference between the figures from CBS and the NEA (CBS & RVO, 2015; CBS, 2016), quoted freely:

The calculation of the share of renewable energy in transport according to the Dutch act Hernieuwbare Energie Vervoer (NL HEVA, as applied by the NEA) is not exactly the same as the calculation according to the EU Renewable Energy Directive (EU RED) as applied by the CBS, resulting in different percentages.
The Dutch Emissions Authority (NEA) reports annually to the Ministry of Infrastructure and Environment on the performance of companies with an obligation to blend renewable energy. This obligation is coupled to a license for storage/supply of mineral oils under suspension of excise duty (a so-called 'Accijnsgoederenplaatsvergunning' or AGP permit). This obligation, based on the Regeling hernieuwbare energie vervoer, differs from the monitoring report for the EU RED. The calculation method differs on the following aspects:

- Carry-over: according to the NL HEVA, oil companies are allowed to blend more renewable energy in a certain year and less in the following year. The EU RED does not allow such a shift and is based on the physical supply in the reporting year. This flexibility reduces costs for the oil companies.
- Biogas: the NL HEVA allows biogas to be counted towards the requirement through physical delivery of natural gas in road transport in conjunction with a (Guarantee of Origin) certificate for biomethane fed into the gas grid elsewhere in the Netherlands. The EU RED counts only the physical delivery of biogas to transport towards the requirement. This delivery of biomethane in transport is negligible, because the share of biomethane in the gas grid is still very small. Furthermore, companies can participate voluntarily, since no obligation is in place. This explains why the share of biogas registered by the NEA was considerably higher than the 0.07% of the CBS, in recent years.
- Biofuels for mobile machinery: mobile machinery in construction and agriculture use also diesel which is blended with biodiesel. In the EU RED the use of (bio)diesel for mobile machinery does not count towards the compulsory share of renewable energy in transport. For the NL HEVA biofuels for mobile machinery do count towards the obligation. (In the EU RED only petrol and diesel for road transport are taken into account until and including 2014. The NL HEVA includes diesel for mobile machinery such as tractors and equipment for construction).
- Moment of registration: biofuels are accounted to the EU RED when they are physically on the Dutch market, according to energy statistics. This is the moment when excise duties are paid. Since 2015 biofuels can be counted for the NL HEVA when it is sold to a Dutch buyer. Any subsequent export of biofuels is irrelevant to the requirement in the act. For reporting to the NEA companies are allowed to book biofuels placed on the market after it has been blended and after the resulting blend has reached the destination "domestic market". In practice, the actual physical destination may have changed when the blended biofuel is supplied to another AGP holder. Based on additional information from the oil companies, the CBS yearly estimates and corrects for this difference (if necessary).

Furthermore, the CBS reports how much biofuel is produced in the Netherlands per year. The yearly report of RVO (NEa, 2016) does report what part of the biofuel production is based on carbohydrates and what the source of these carbohydrates was; sugar beets, sugar cane, wheat or maize. However, the information to combine stock material and production in the Netherlands lacks. This information is not gathered by RVO.

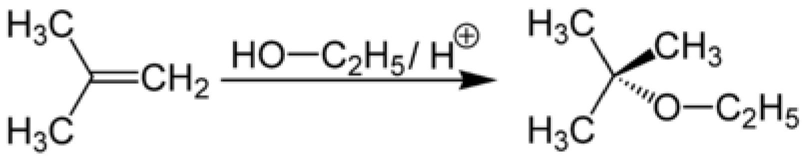
To deal with this situation we used the data by CBS as leading and for absolute numbers and used the NEa numbers to obtain an indication of the division of different types of stock material or different countries of origin of the stock material.

2.6 Specifications on the carbohydrate flows

The basis sources for the data on carbohydrate flows were the following:
1. Numbers on starch potato production in the Netherlands by CBS (CBS statline, Akkerbouwgewassen; productie naar regio, 03 October 2016).
2. Numbers on renewable bioenergy production in the Netherlands (CBS statline, Hernieuwbare energie; verbruik naar energiebron, techniek en toepassing, 30 juni 2016).
3. Numbers on biofuel consumption in the Netherlands (NEa, 2016).
4. Numbers on import in and export of starch potatoes and potato starch in the Netherlands (EUROSTAT, 2016).
5. Numbers on import in and export of ethanol and ETBE in the Netherlands (EUROSTAT, 2016).

In addition we used the following approaches.
1. The mass balance of the sugars is limited to the sugar crop, the bioethanol and the use of bioethanol as a biofuel or a base chemical.
   a We assume that in the Netherlands no ethanol is produced from sugar beets or sugar cane, only from maize and wheats.
   b at the current price difference between bioethanol and fossil ethanol no ethanol is used in the Dutch chemical industry, other than as a feedstock material for the production of biofuel (ETBE) and the feedstock for the production of bio-PET.
   c Ethyl Tertiary Butyl Ether (ETBE) is produced from bioethanol and isobutylene in 1 mol: 1 mol ratio in a catalytic reaction. This implies that for each tonne of ETBE 451 kg of bioethanol is required.

Figure 8 Synthesis reaction of ETBE



Source: Jürgen Martens – Jü, Wikipedia ETBE.

2. We considered production in the Netherlands based on carbohydrate crops and on the direct intermediates starch and ethanol. Biobased production of PLA made from lactic acid produced in a fermentation process fed on sugars was not taken into account since lactic acid production in the Netherlands is entirely focussed on the food industry.
3. All potato based starch is produced from starch potatoes. However, this leafs two questions open:
   a Conversion efficiency from tonne starch potato to tonne potato starch. We estimated this based on the following: 21 % starch per tonne starch potato, conversion efficiency 95% and 80% dry content of the starch that is being sold. The 21% is reported by Avebe (this is the measured average of potatoes processed in the Dutch factories in 2015), the 95% is an estimate by CE Delft (Avebe does not communicate a number on starch production efficiency), the 80% is an average dry content of starch in trade (Avebe, 2016).
   b Avebe indicates that of the total Dutch production 40% is used for industrial applications in the Netherlands or exported for industrial applications outside the Netherlands. They can do that since they are the only potato starch producer in the Netherlands. The net import of starch is 15% of the total starch production by Avebe. Therefore we

used the same division of industrial and non-industrial use for the imported potato starch.

4. To have an indication of the use of grain based starch consumption we assumed that the consumption of grain based starch equals the consumption of potato based starch. This assumption is based on an inquiry by the VNP within the Dutch paper industry, showing that potato and grain based starches are consumed in equal amount (VNP, 2016). We extrapolated these results to all other starch consuming industries. Since starch consumption in the paper industry is rather small compared to the total starch production this is the most disputable assumption in this chapter.

2.7 Specifications on the oils and fats flows

We used the following sources:
1. Numbers on oil seed production in the Netherlands by CBS (CBS statline, Akkerbouwgewassen; productie naar regio, 03 October 2016).
2. Numbers on biodiesel consumption in the Netherlands (NEa, 2016).
3. Numbers on import in and export of vegetable oils and animal fats in the Netherlands (EUROSTAT, 2016).

The major limitation of these sources is the limited availability of data on which part of the biomass is used for non-energy and non-food and non-feed use. The current recording of imports, exports and production of oils and fats and carbohydrates does not distinguish between food and feed applications and other applications of the same streams. Before the industry association MVO (margarines, fats and oils) had this type of detailed information, but since this task was no longer required by the ministry of economic affairs (closure of all so called 'Productschappen') this type of data gathering stopped and this information is no longer available.
As an estimate for the application of oils and fats in the traditional non-food and feed industries we used older data both from MVO and from the monitor biobased economy (CE Delft 2013; CE Delft, 2015). Examples of these applications are:
- this oil is used as a paint or a finish to protect wood against weather influences;
- it is a major ingredient in the production of linoleum;
- an ingredient in floor detergent.

In addition we only consider the streams of oils and fats that are processed in the Netherlands for use in the biobased industry while apart from biofuel production, the oleochemistry in the Netherlands is limited to producers of high quality niche products, while the bulk conversion takes place abroad. The intermediates resulting from these conversions like sulfonated oils and fats are imported and processed in detergents or paints of all kinds.

The reports on certificates for biofuels are based on NEa reports.
In addition we used the final report on 2015 by the Dutch task force sustainable palm oil (The Dutch Taskforce Sustainable Palm Oil (Taskforce Duurzame Palmolie), 2016), reporting the increase in palm oil and the Dutch food industry.

2.8 Specifications on the woody biomass flows

The data on woody biomass are based on the following publications:
1. The Core Data 2015 (Kerngegevens 2015), by Probos, which were kindly made available in preliminary form.
2. View on wood flows (Oldenburger et al. (2012) Nederlandse houtstromen in beeld, Wageningen) by Probos.
3. Statistics on pulp and paper production and consumption by the association for Dutch paper and board producers VNP.
4. Protocol monitoring renewable energy (Protocol monitoring Hernieuwbare energie, Meesters KPH, van Dam JEG, Bos HL (2013)) by the WUR.

Certification of woody biomass is not included since these numbers are classified until reported to the House of Representatives, which was due by the end of December 2016 and is postponed to February 2017.

2.9 Specifications on the biogenic waste streams

The data on biogenic waste streams are based on the following publications:
- Renewable energy in the Netherlands, 2015 (CBS, 2016a).
- Waste processing in the Netherlands. 2015 (RWS, 2016).

There are no data available on import and export of waste streams that are coherent with the above mentioned sources.

2.10 Specification on the calculation of the energy value of all material streams (Chapter 7 comparison to vision Biomass 2030)

In Section 7.3 of Chapter 7 we compare the projections of the biomass use as foreseen by the Dutch government with the actual use as registered in this monitoring study. These projections are expressed in energy units.

For energy use the biomass use is reported in energy units. We use the data on renewable energy by CBS to report on this aspect (CBS, 2016a).
In addition we have to convert the biomass streams for material use from mass units to energy units using the following sources for the caloric values per type of material:

We used three different sources for the caloric value of biomass or biobased derived products:
- Oils fats and sugar derivates: JRC conversion factors and fuel properties (JRC, 2014).
- Potato and Starch: National Nutrient Database for Standard Reference Release 28 by the United States Department of Agriculture Agricultural Research Service (NND, 2016).
- Woody biomass: Protocol monitoring renewable energy (RVO, 2015).

In case the specific material was not available we used the closest available material and corrected for dry biomass content.

3 Carbohydrates

This chapter covers flows of carbohydrates in the Netherlands, including grains, starch, sugars and bioethanol. Figure 9 summarises the flows of carbohydrates In the Dutch biobased economy. The figure shows that the main production chains of non-food and non-feed applications of carbohydrates are sugar and starch based.

Sugar based production

Sugar based production can be based on sugar beets, but also on sugars from maize, or other crops. The main (non-food and non-feed) products of sugar are bioethanol (in Figure 9 indicated with ETOH) and lactic acid each of which are also widely applied in the food industry. Production of lactic acid for non-food applications does not take place in the Netherlands. The part of the bioethanol that is not used for food applications is mainly applied as a biofuel. Furthermore, when biobased ethanol could be purchased at a lower price than fossil based ethanol some companies in the petrochemical industry (for example Shell) reported replacement of fossil based ethanol by bioethanol in specific processes. However, shale gas production in the US has significantly decreased the price of ethylene (from shale gas) and consequently the price of fossil based ethanol, since ethylene is easily converted in ethanol. As a result the price of fossil based ethanol is significantly lower than biobased ethanol. Since the differences in specification between fossil based and biobased ethanol are small, we assume this production is switched back to fossil based ethanol, apart from the stream used for the production of bio-PET.

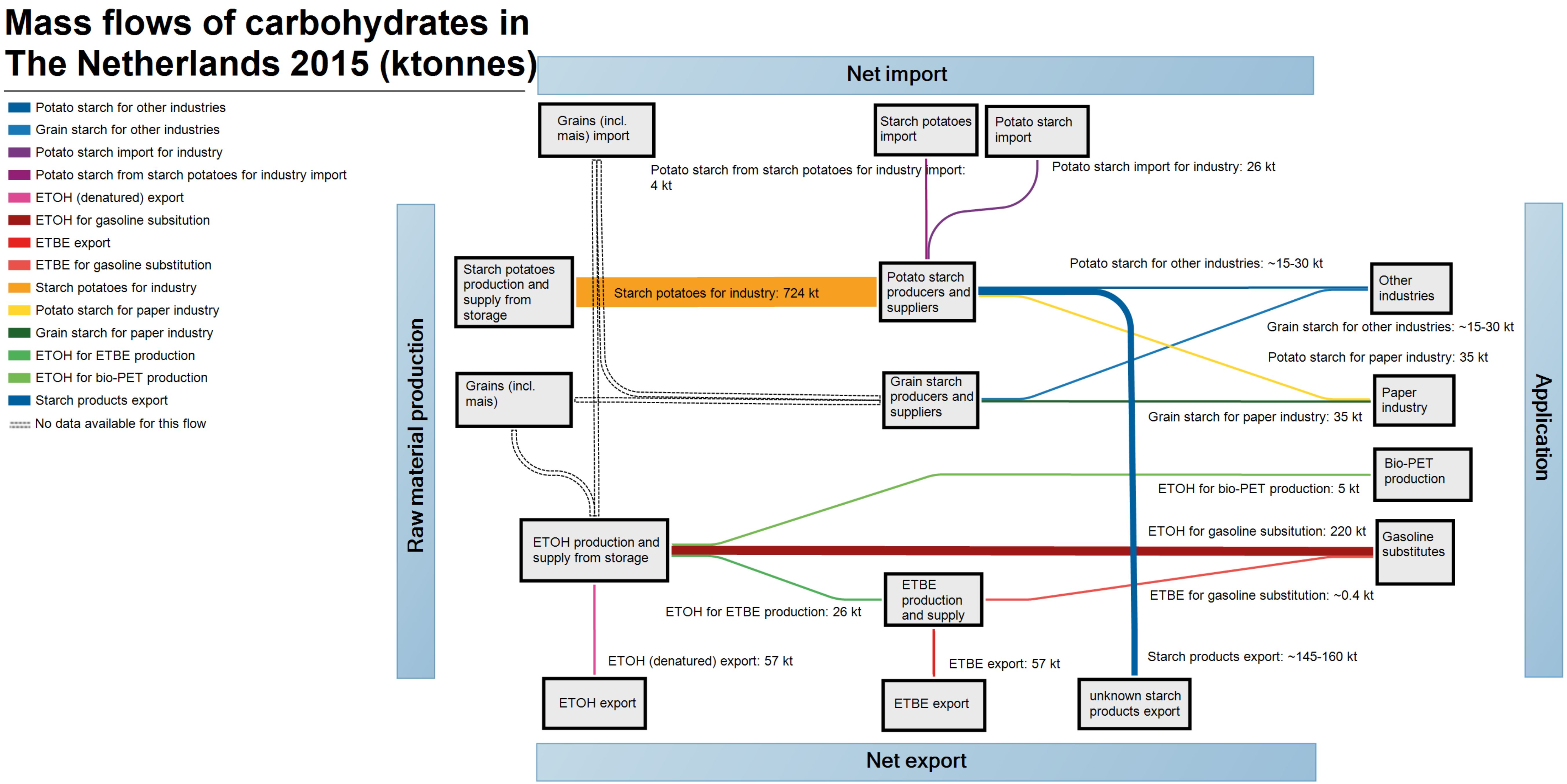
Starch based production

Starch based production in the Netherlands is heavily based on starch potatoes, but starch is also produced based on grains. Both types of starch are mainly used in the food industry, although a significant portion of all starch produced from starch potatoes ends up in industrial applications. The main applications of starches are adhesive and/or stiffener. Sectors using starches in such applications are home decoration (glue for wall paper), the paper industry and (as a temporarily stiffener of garments) the textile industry.
No significant changes have occurred in this sector compared to previous years.

Application of waste streams

Cosun, Avebe and the Northern provinces have significantly invested in fermentation of waste water streams of starch and sugar production plants to produce biogas. We will treat this production in the chapter on waste streams. Most residuals of the processing of consumer and starch potatoes are used as animal feed. However, some waste water streams are not fit for animal feed. In recent years applications have been developed for these streams. Some are cleaned by means of algae, but since the algae are sold as animal feed we do not consider those streams. A small stream of waste water from the production of consumer potatoes is converted to bioplastics and bio-latex. However this application is currently a few tonnes per year, too small to show in this figure.

Figure 9 Overview of carbohydrates flows in the Dutch biobased economy in 2015



(NEa, 2016; EUROSTAT, 2016; CBS, 2016b; assumptions made by CE Delft based on data from NVP, 2016).

Total flow of carbohydrates for non-food and non-feed applications

In 2015 the use of carbohydrates for non-food, non-feed and non-energy applications was dominated by starches for industrial applications. The total import and production of starches for industrial applications totalled 0.3 million tonnes of 100% dry biomaterial. The national use equalled 0.1 million tonnes the rest was exported. There is no indications that there has been a significant change in these numbers since 2010.

The total import and production of biogasoline totalled over 0.3 million tonnes per year. Use of biogasoline in the Netherlands equalled 0.2 million tonnes over 2015. In addition 0.1 million tonnes of biogasoline were exported as bioethanol and bio-ETBE (assuming the net export of ethanol and ETBE is bioethanol and bio-ETBE, this assumption is based on the export countries and the fact that the production capacity in the Netherlands exceeds the use).

3.1 Import, production, conversion and export of starch

The Dutch starch potato production in the Netherlands is based on the Dutch production of starch potatoes and the net import of starch potatoes.

Table 1 Starch potato production in the Netherlands (circa 25% dry content)

Years	Total gross yield of starch potatoes in the Netherlands in tonnes
2010	1,845,149
2011	2,163,374
2012	1,903,501
2013	1,695,193
2014	1,753,847
2015	1,809,329

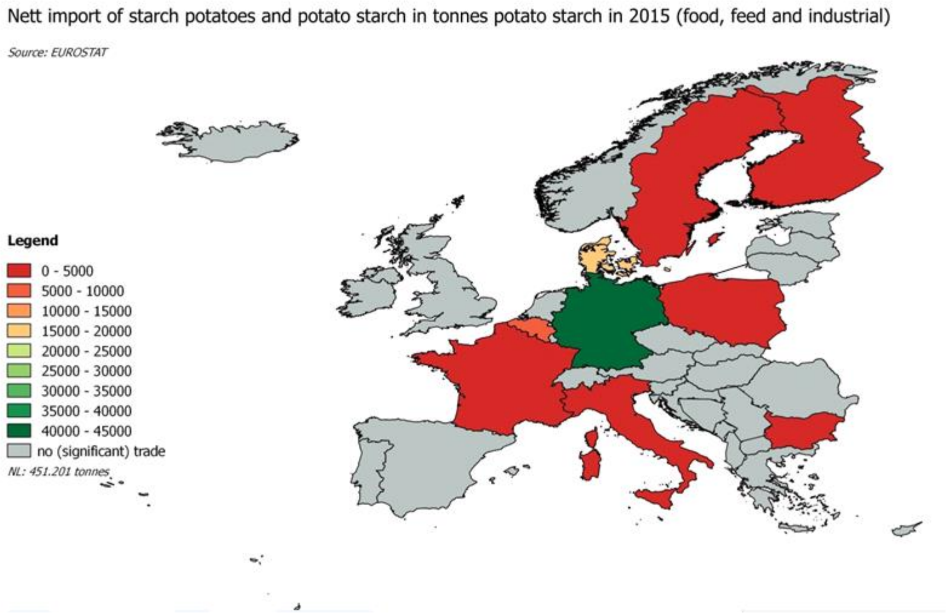
Source: (CBS, 2016c).

In 2015 the Dutch potato harvest yielded 1.81 million tonnes just below the production average over the period 2010-2015 of 1.86 million tonnes, see Table 1. In addition 39,112 tonnes were imported from other European countries, mostly from Germany (97%). From this total of 1.85 million potatoes circa 461,000 tonnes of starch were produced.

Figure 10 shows the countries from which starch potatoes and potato starch is imported (expressed in net import) in 2015. In addition another 66,000 tonnes of potato based starch was imported mainly from Germany and Denmark, see Table 2.

According to AVEBE approximately 40% of the potato starch is produced for non-food and non-feed applications in the Netherlands, and abroad, totalling 184,000 tonnes.
About 35,000 tonnes are used in paper production (paper coating and sizing) (VNP, 2016). Other technical applications are wallpaper adhesive, for textile finishing and textile sizing, and as an adhesive in paper sacks and gummed tape, the rest is exported. Since starch derivates fall under categories like adhesives including various chemicals we do not know precisely how much is exported. Unfortunately, AVEBE does not communicate on export numbers on national level. We estimate it is circa 100,000-130,000 tonnes per year.

Figure 10 A map showing the net import of starch potatoes and potato starch for the Netherlands



Source: (EUROSTAT, 2016).

Table 2 Import of potato based starch in the Netherlands (80% dry content)

Country	Net starch import (tonnes)	
DE	35,097.5	52%
DK	18,382.3	27%
BE	8,323.6	12%
FR	3,766.3	6%
PL	937.6	1%
SE	765.9	1%

Source: (EUROSTAT, 2016).

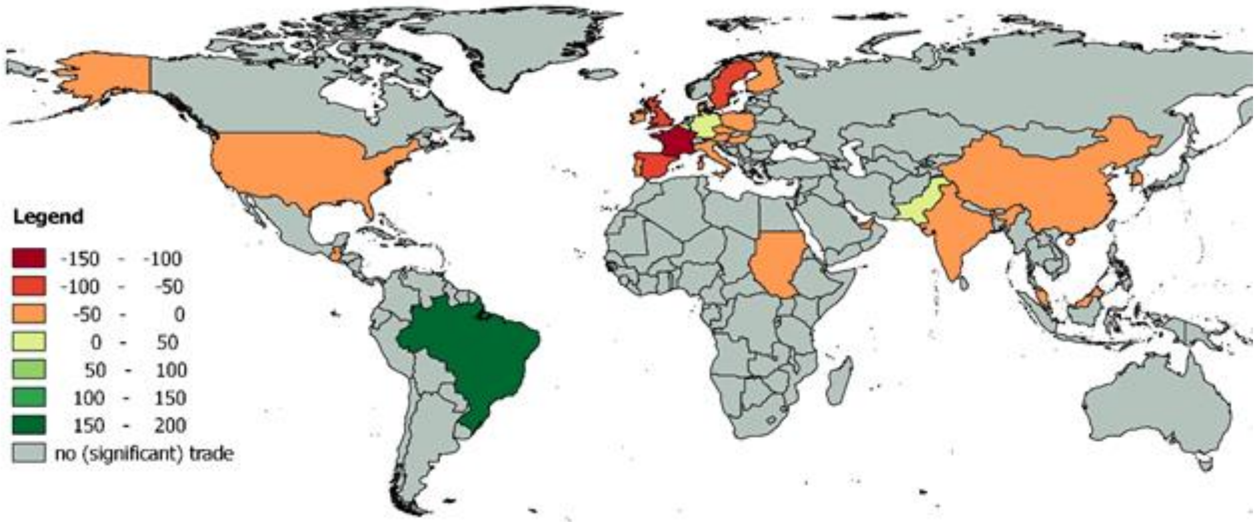
3.2 Import, production, conversion and export of sugars

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. The first large scale plant was the Abengoa Bioenergy's bioethanol plant in Rotterdam that started in September 2010 as allegedly the largest single facility in the world. It can produce 480 million litres of bioethanol (0.38 million tonnes) annually from 1.2 million tonnes of maize or wheat cereal as feedstock. It also produces 0.36 million tonnes 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 plant is about 462 ktonnes (388 dry ktonnes), 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 tonnes (2.01 dry million tonnes) (Du Mez, 2014), but others deem this amount too high. In June 2012, Cargill has also reportedly added 40 million litres of annual starch-based ethanol production capacity to its wheat wet-mill in Bergen op Zoom.
The facility can process 0.6 million tonnes 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, like in case

of Abengoa it is not publicly known how much they actually produce (ethanol and DDGS), where they source the raw materials and where they sell the bioethanol to.

Figure 11 shows the net import of denatured ethanol and ETBE to the Netherlands in 2015. Since that were the only types of bio gasoline that were consumed in 2015 in the Netherlands (NEa, 2016). The Netherland exported more denatured ethanol and ETBE than it imported, both the net export of denatured ethanol and ETBE totalled to approximately 57,000 tonnes in 2015. However, we cannot state that the net export of biofuels based on carbohydrates equalled circa 114,000 tonnes of bio-ETBE and bioethanol, because the trade statistics do not distinguish between denatured ethanol and denatured bioethanol or bio-ETBE and ETBE. Nevertheless, since the Netherlands have a far larger installed production capacity for bioethanol than used in national consumption, most of the import came from Brazil (70%) and over 99% of the export was within Europe we assume that these streams can be considered as bio-ETBe and bioethanol.

Figure 11 Net import of denatured ethanol and ETBE to the Netherlands in 2015



Source: (EUROSTAT, 2016). (See Annex A, Table 16.)

Apart from two ethanol producers Lyondell Chemie Nederland B.V. location of LyondellBasell in Botlek has a production capacity of bio-ETBE of 0.4 million tonnes per year based on isobutyl and bioethanol. This means that for each tonne ETBE at least 0.451 tonne of ethanol is consumed. Based on the yearly consumption of ETBE and the net export number of ETBE we could calculate that a little over 26.000 tonnes of bioethanol were used to produce ETBE in the Netherlands.

In addition bioethanol is used for the production of plant bottles. However before it can be used it is conversed to bio-ethylene glycol. It remains unclear whether this conversion step occurs in the Netherlands or that the bioethylene glycol is imported from elsewhere. However, since Shell Moerdijk has the facilities to produce ethylene glycol and has experience with production based on bioethanol we assumed the production took place in the Netherlands.

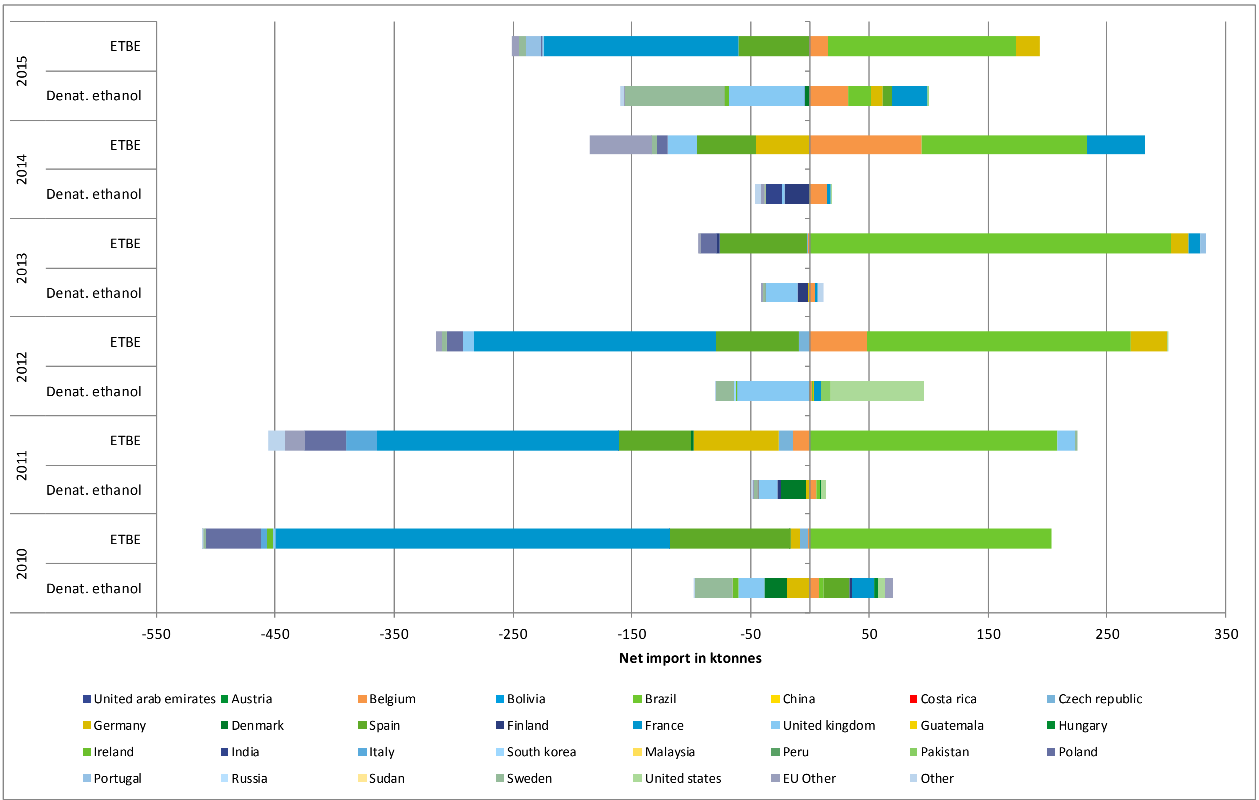
CBS (2016b) reported that 220,000 tonnes of biogasoline were consumed in the Netherlands, the amount produced in the Netherlands is not published. According to the NEa report, the yearly consumption in the Netherlands of bioethanol amounts to 226 ktonnes and the yearly consumption of bio-ETBE to 0.42 ktonnes. The difference between the total amount of bioethanol between CBS (220 ktonnes) and NEa (227 ktonnes) can be explained by a different methodology as discussed in the textbox of Section 2.5.

Figure 12 depicts the trend of ethanol and ETBE trade flows in 2010-2015. The major supplier of ETBE is Brazil, the suppliers for ethanol are more diverse. Also, denatured ethanol is a smaller trade flow than ETBE, but both show large variations in trade volumes year by year. The combined net import of denatured ethanol and ETBE is shown in Figure 12 for 2015. Denatured ethanol is not suitable for human consumption and is duty free, in contrast to natured ethanol. Therefore, natured ethanol is not expected to be used for industrial applications or biofuel production.

The Brazilian ethanol has diminished in the Dutch market after 2009, first replaced by US ethanol in 2009-2012, and then the market is largely occupied by import from (or via) Belgium and France, and Brazil again in 2015 (70%) with import from or via Belgium (19%) and Germany (12%), the amounts coming from Pakistan are negligible (0,00%), see Figure 11 and Figure 12.

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 India. In 2015 the net export of biogasoline to countries outside the EU decreased to less than 1% of the export, 99% of the export destinations laid within the EU. The main destination were France (36%), Sweden (24%) and the UK (18%), see Figure 11 and Figure 12.

Figure 12 Major ethanol and ETBE trade flows in and out the Netherlands for 2010-2015 (ktonnes)

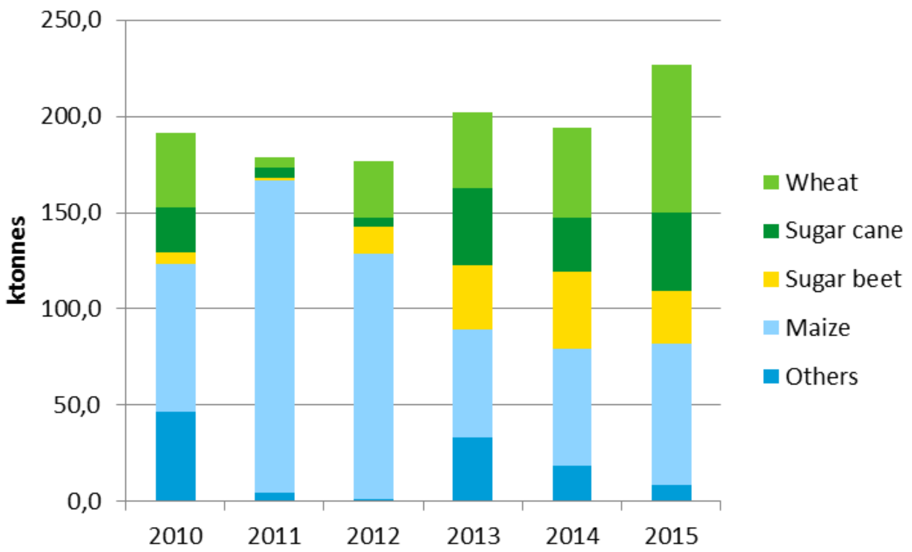


Source: (EUROSTAT, 2016). (See Annex A, Table 16.)

Figure 13 shows the bioethanol consumed in the Netherlands in 2010-2015 by feedstock (Nea, 2012-2016). Apart from regions of origin also the crop providing the sugars to produce the ethanol (and subsequently the biobased part of the ETBE) is registered (NEa, 2012-2016). Maize significantly decreased after 2012, but increased slightly since 2013. Wheat based ethanol production significantly increased. The amount of sugar beet and sugar cane based ethanol remained more or less constant between 2013 and 2015.

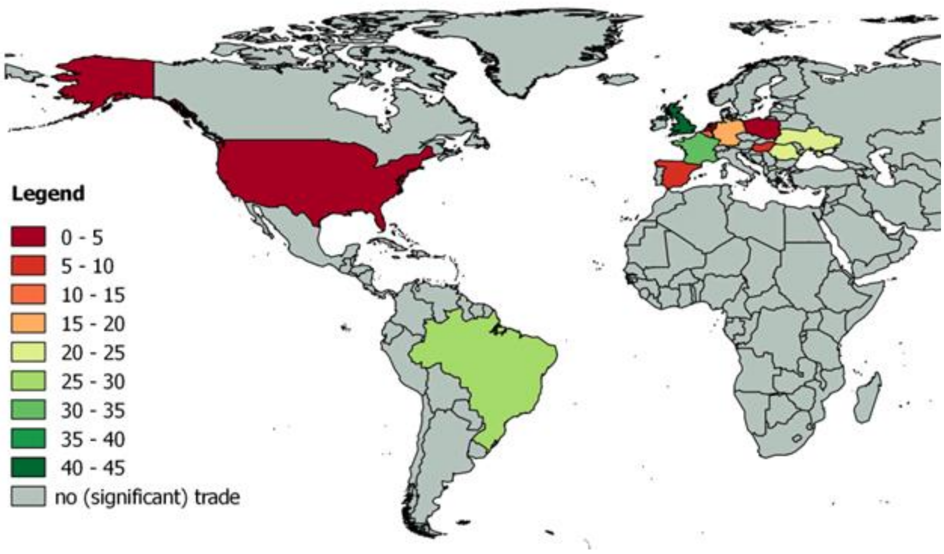
Figure 14 shows the countries the sugar supplying crops originate from. The maize used in ethanol production is another type of maize than grown on the Dutch acres for feeding purposes. Large areas are dedicated to this sweeter types of corn in Hungary, Romania, Ukraine, Spain and the United States. It remains unclear what part of this corn was converted in the Netherlands to ethanol and what part was imported as ethanol. At least part of the maize based ethanol consumption was produced in the Netherlands by Abengoa. Triticale and wheat are two types of grains that can be converted in a similar ethanol plant of Cargill. Again it remains unclear what part was imported as a grain and converted in the Cargill plant and what part was imported as a grain based ethanol. All sugar cane and sugar beet based ethanol and ETBE was imported as an ethanol and not converted to ethanol in the Netherlands. Comparison of Figure 13 and Figure 14 shows that only Brazil is both net exporter of ethanol and ETBE and also origin of the required feedstocks.

Figure 13 **Estimations of bioethanol consumed in the Netherlands in 2010-2015 by feedstock**



Source: (NEa 2012-2016; CBS 2015a*). (See Annex A, Table 17.)

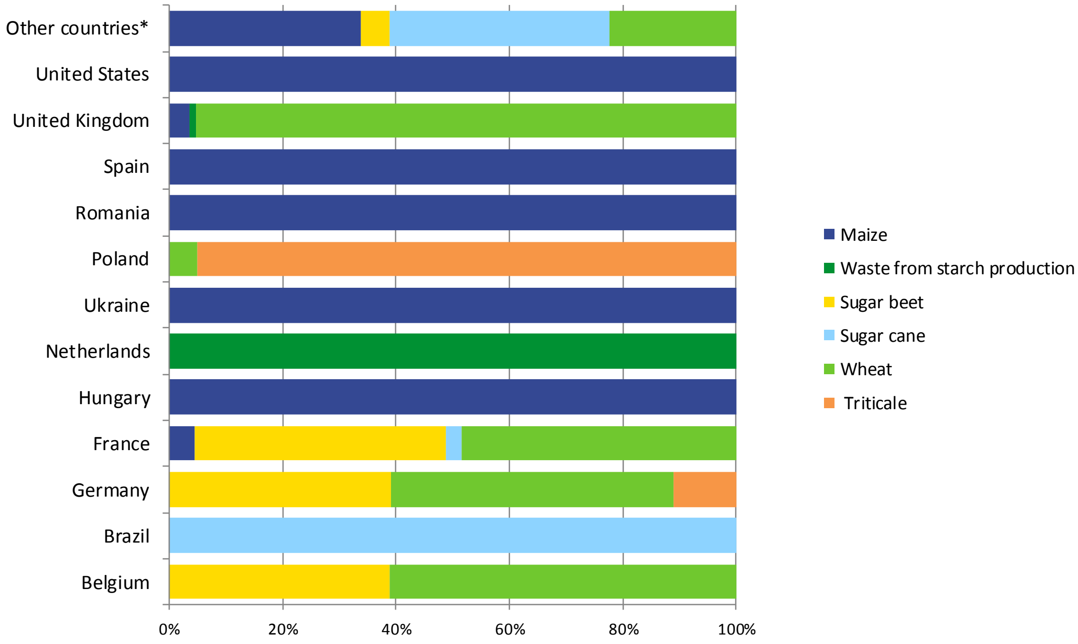
Figure 14 **Map showing the origin of the feedstocks used in the production of bioethanol (ETOH) and bio-ETBE that was consumed in the Netherlands in 2015**



Source: (NEa, 2016). (See Annex A, Table 18.)

A further specification of the type of raw material per country is provided in Figure 15. This figure indicates where the raw material of the bioethanol consumed in the Netherlands originates from. It does not say where the raw material was converted to bioethanol or bio-ETBE. Figure 15 shows for example that the raw material of 33,000 tonnes of ethanol originates from France. The picture further shows that the raw materials of this ethanol consist for circa 40% of sugar beet, 5% of sugar cane, circa 50% of wheat and circa 5% maize. Since no ethanol is produced on the basis of sugar cane or sugar beet in the Netherlands and France has a large production plant for the production of bioethanol from sugar beet it is likely that this part of the Dutch ethanol consumption was produced in France and imported in the Netherlands as ethanol. The maize and the wheat may be converted in France to ethanol but may as well be converted to ethanol in the Netherlands. Or the total of 33 ktonnes may be imported in the Netherlands as ethanol and partly be exported to France as ETBE (not included in Figure 15).

Figure 15 Feedstocks for bioethanol consumed in the Netherlands in 2015 by country of origin

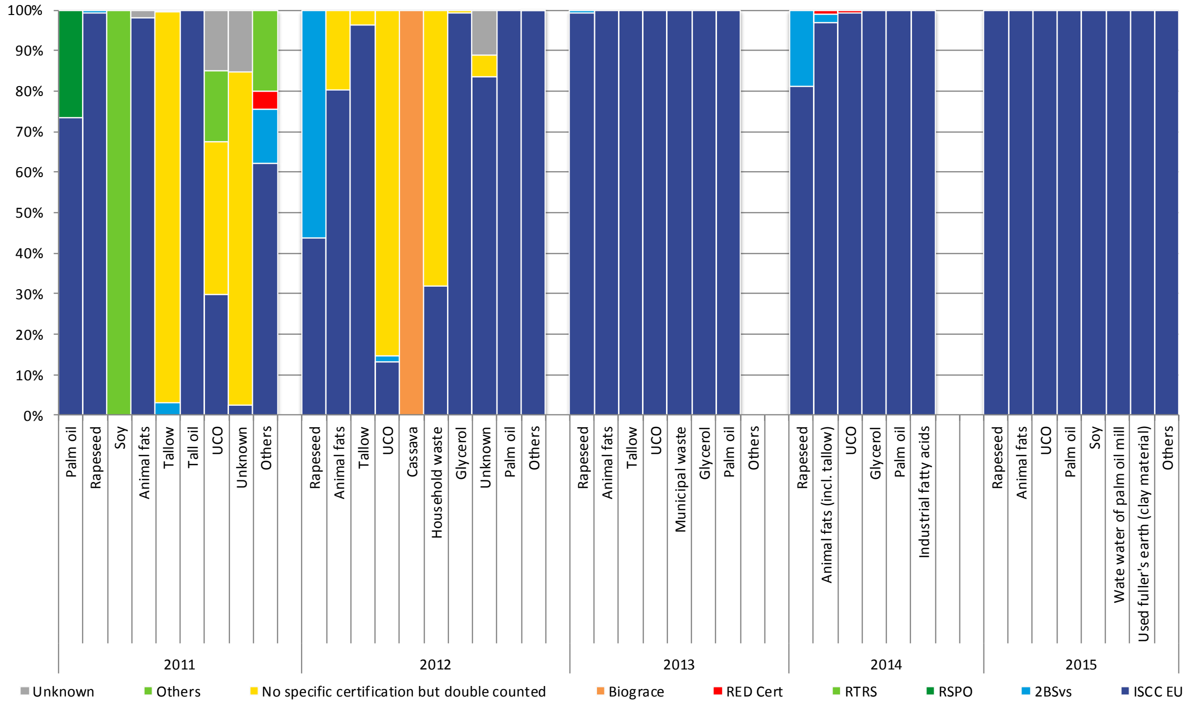


Source: (NEa; 2016; CBS, 2016). (See Annex A, Table 18.)

3.3 Certification

The majority of carbohydrates consumed in the Netherlands originate 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, conventional certifications focus more on specific food issues such as organic food.
The incentive for certification is not so high outside production of biofuels. Agriculture in Europe is largely monitored by environmental laws and regulations. In addition, companies generally purchase sustainable supplies through bilateral agreements by providing the suppliers a set of rules and criteria to follow. Furthermore potatoes and sugar beets are converted by co-ops set up by the producers of these crops. So there is a relation of trust and agreed quality tests that have been developed over the years.
Figure 16 shows the share of schemes for bioethanol in the Netherlands for use as a biofuel. Between 2011 and 2015 the scheme ISCC EU became more and more the dominant scheme, eventually being the only scheme applied in 2015.

Figure 16 Sustainable certified bioethanol reported to NEa to fulfil blending obligation in the Netherlands in 2011-2015 by raw materials and schemes



Source: (NEa, 2012-2016).

4 Oils and fats

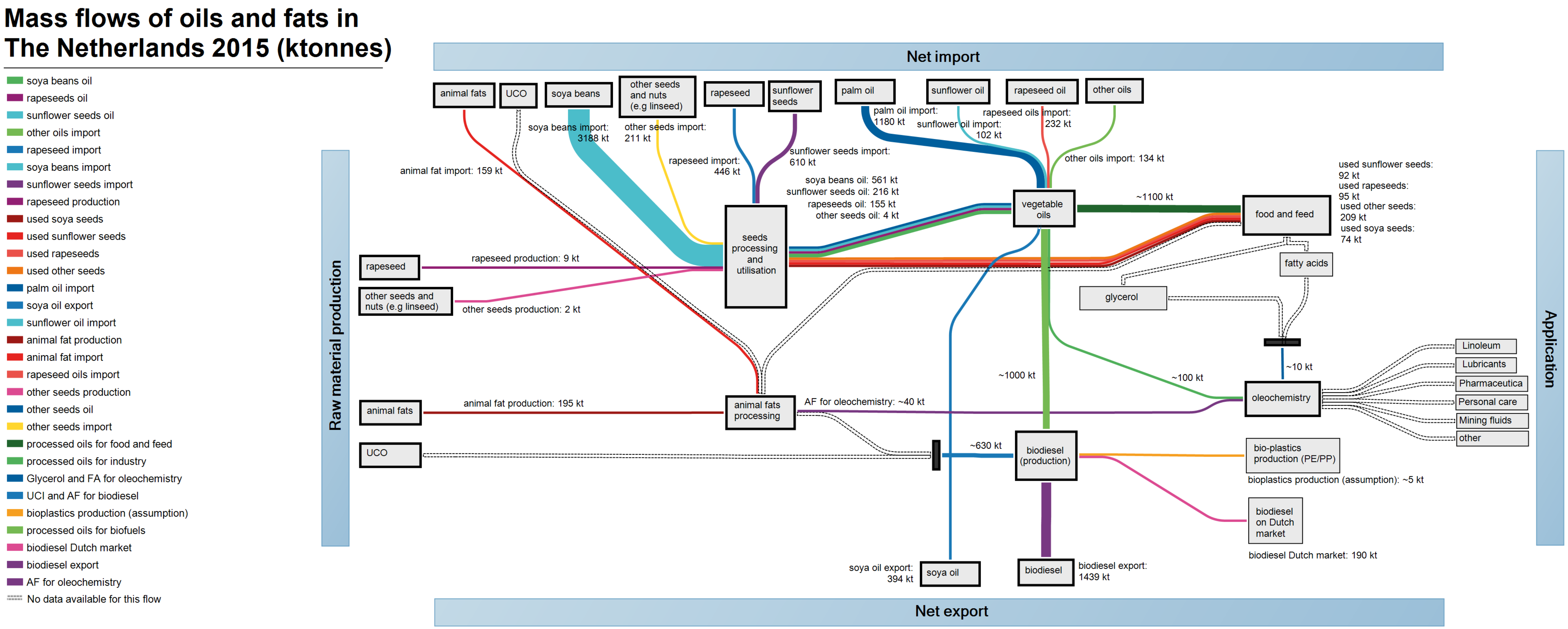
This chapter covers flows of oils and fats in the Netherlands, including oil seeds, biodiesel and industrial uses of oils and fats outside the food and feed industry. The two main categories are vegetable oils and fats and animal fats.

Figure 17 summarises the flows of oils and fats in the Dutch biobased economy.

Many rest streams of the processing of oils and fats in the food and feed industry are applied in the biobased economy as a raw material. In addition part of the oils that are used to produce biofuels were chosen for this application because the large scale availability of these oils and fats due to wide spread use in the food industry. Therefore food and feed applications could not be fully eliminated from this figure, as we did in the previous chapter.

To what extend oils and fats are used in food and feed and to what extend oils and fats are used as raw material for the biobased economy differs per type of oil or fat. For example soy beans are only a very small stream in the biobased economy (approximately 20,000 tonnes), the vast majority (about 2.740,000 tonnes) are used in the (animal) food industry or are exported (about 400,000 tonnes). In case of palm oil about two times as much oil is converted to biodiesel than processed in the food and feed industry (approximately 800,000 tonnes versus 400,000 tonnes). The use of soy- and palm oil in the Dutch biobased industry is an educated guess based on reports on feed stock for biofuels consumed in the Netherlands (NEa, 2016), the name plate capacity of the Nestle production plant and the fact that the preferred raw material of this plant is palm oil. There are no production data available explicitly indicating the industrial use of palm oil or any other types of oil in the Dutch biobased economy.
Most industrial use occurs after hydrolysis, sulfonation or transesterification of natural oils and fats. Natural oils and fats are normally triglycerides of mainly stearic acids and oleic acid. The main difference between oleic and stearic acids is that the stearic acids are saturated and oleic acids have non-saturated bonds.
To free the oleic acids and stearic acids from natural oils and fats these triglycerides are hydrolysed. In this process oleic acids and stearic acids (fatty acids) and glycerol are produced.

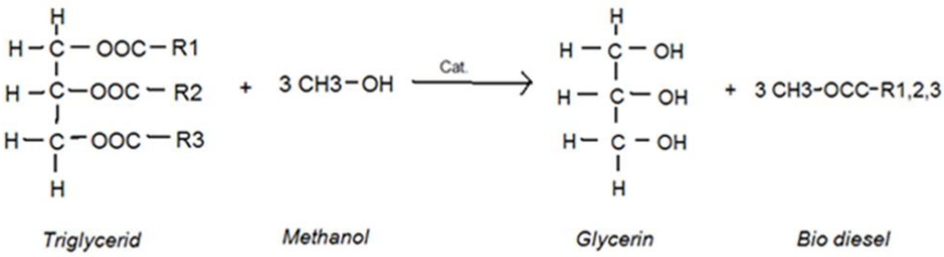
Figure 17 Overview of flows of oils and fats in the Dutch biobased economy in 2015



Data sources: NEa, 2016; MVO, 2016; CBS, 2016b; assumptions made by CE Delft based on MVO 2013, 2015.

Biodiesel

Biodiesel is produced in three grades FAME, FAEE and HVO. FAME and FAEE are produced by transesterification of natural oils and fats (triglycerids) in the presence of respectively methanol or ethanol and a catalyst:



The fatty acids can be directly applied as FAME (if ethanol was the catalyst than the resulting biodiesel is FAEE).
HVO is produced by hydrogenation and isomerization of natural oils and fats (triglycerids) in the presence of hydrogen and a catalyst.

Soaps, cosmetics, detergents

Oleic acids and stearic acids react with alkalis (merely sodium hydroxide) to soaps. There used to be a large number of factories that produced soap in this way. However, nowadays this method is only applied on a small scale in the Netherlands (soapfactory Siderius). Most soaps are replaced by detergents like Sodium Lauryl Sulfate (SLS), Sodium Laureth Sulfate (SLES) or related substances like sodium coco sulfate (SCS), Ammonium Lauryl Sulfate, Sodium Myreth Sulfate, etc. These are sulfonates of oleic and/or stearic acids.
The production of these substances occurs outside the Netherlands.

Softeners

Lithium stearate is an important component of grease. The stearate salts of zinc, calcium, cadmium, and lead are used to soften PVC. Stearic acid is used along with castor oil for preparing softeners in textile sizing. They are heated and mixed with caustic potash or caustic soda. Related salts are also commonly used as release agents, e.g. in the production of automobile tires.

Alkyd resins

Alkyd resins are ingredients for varnishes, paints and coatings. An alkyd resin is a polyester modified by the addition of fatty acids and other components. There are two types of alkyd resins, drying (including semi drying) and non-drying. For the 'drying' resins, triglycerides are derived from polyunsaturated fatty acids (often derived from plant and vegetable oils, e.g. linseed oil). These drying alkyds are cured in air. The drying speed and the nature of the coatings depends on the amount and type of drying oil employed (more polyunsaturated oil means faster reaction in air) and use of metal salts, the so-called oil drying agents. These are metal complexes that catalyse crosslinking of the unsaturated sites.

Alkyd coatings are produced in two processes; fatty acid process and the alcoholysis or mono-glyceride process. Higher quality, higher performance alkyds are produced in the fatty acid process where the composition of the resulting resin can be more precisely controlled. In this process an acid anhydride, a polyol, and an unsaturated fatty acid are combined and cooked together until the product has achieved a predetermined level of viscosity. Penta alkyds are made this way. More economical alkyd resins are produced from the alcoholysis or glyceride process where end product quality control is not as paramount. In this process raw vegetable oil, high in unsaturated component, is combined with additional polyol and heated to cause transesterification of the triglycerides into a mixture of mono- and diglyceride oils. To this resulting mixture acid anhydride is added to build the molecular weight of the resin into roughly the same product as in the fatty acid process. However, the alcoholysis process, also known as the glyceride process, produces a more randomly oriented structure.

Because the major components of an alkyd coating, i.e. fatty acids and triglyceride oils, are derived from low cost renewable resources, this has kept the cost of alkyd coatings very low despite ever increasing cost of petroleum, which is the predominant raw material source of most other coatings. Typical sources of drying oils for alkyd coatings are: linseed, tung, sunflower oil, safflower oil, walnut oil, soybean oil, fish oil, corn oil, DCO. (made by dehydrating castor oil, which creates a semi drying, conjugated, oil/fatty acid), and tall oil (resinous oil by-product from pulp and paper manufacturing).

Niche uses

Being inexpensively available and chemically benign, stearic acid finds many niche applications.

- When reacted with zinc it forms zinc stearate, which is used as a lubricant for playing cards (fanning powder) to ensure a smooth motion when fanning.
- In compressed confections, it is used as a lubricant to keep the tablet from sticking to the die.
- Stearic acid is also used as a negative plate additive in the manufacture of lead-acid batteries.
- Fatty acids are classic components of candle-making.
- In fireworks, stearic acid is often used to coat metal powders such as aluminium and iron. This prevents oxidation, allowing compositions to be stored for a longer period of time.
- Stearic acid is a common lubricant during injection molding and pressing of ceramic powders. It is also used as a mold release for foam latex that is baked in stone molds.
- Linoleum, also called Lino, is a floor covering made from materials such as solidified linseed oil (linoxyn), pine rosin, ground cork dust, wood flour, and mineral fillers such as calcium carbonate, most commonly on a burlap or canvas backing; pigments are often added to the materials for colouring.

Glycerol

Apart from a wide range of applications in the food industry glycerol is applied in pharmaceutical and personal care applications, as a chemical intermediate and as a yield booster in co-fermentation of manure.

Since the production of biodiesel has started value-added products from crude glycerol (typically containing 20% water and residual esterification catalyst) obtained from biodiesel production are developed:
- Solvay successfully developed a process to produce epichlorohydrin, a raw material for epoxy resins, from glycerol instead of the fossil based route currently used for the epichlorohydrin production in the Netherlands. Several plants are built in Thailand and China that produce based on glycerol.
- BioMCN (currently part of OCI NV) succeeded to produce biomethanol form glycerol. However, the current production of biomethanol alledgedly takes place on the basis of methane and green gas certificates (Vertogas).

Total flow of oils and fats for non-food and non-feed applications
In 2015 the use of oils and fats for non-food, non-feed and non-energy applications was dominated by traditional oleochemistry applications covering a wide range from industrial to personal care applications of biomass. In this application approximately 0.1 million tonnes of biomass were used. However, since most of the oil and fat derived detergents are imported from abroad the total amount of oil and fats based materials used in the Dutch detergent and personal care industry is significantly larger but is outside the scope of this study.

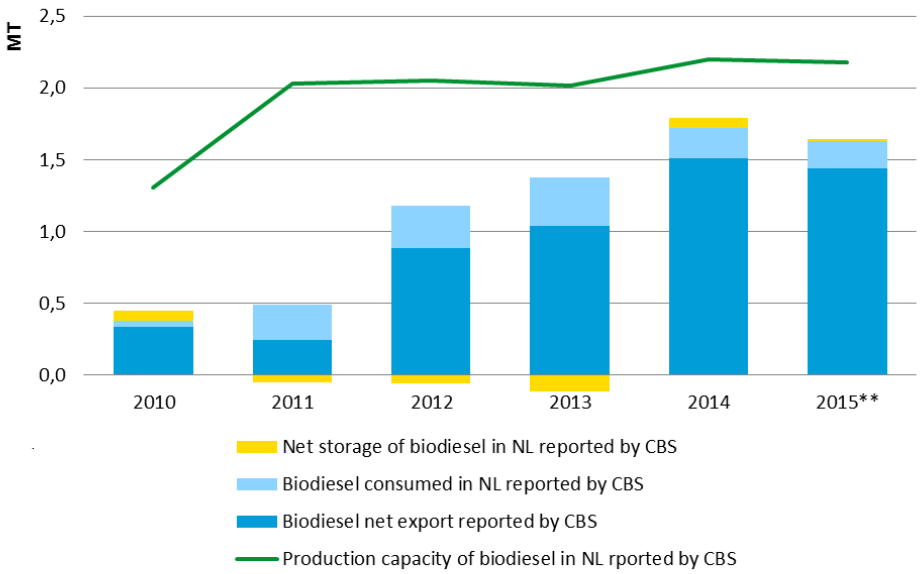
The total production of biodiesel totalled over 1.6 million tonnes in 2015. Use of biodiesel in the Netherlands equalled 0.2 million tonnes. The rest was exported. The export numbers may be an overestimation since CBS report biodiesel contents in groups up to a certain content.

4.1 Import, production, conversion and export of biodiesel

This section covers the production of biofuels based on oils and fats from vegetables or animals. The production of biodiesel from oils and fats is registered separately. The national governments reports yearly on the amount of biodiesel consumed in the Netherlands, the source of the crops or animal fats the biodiesel is produced from and the countries of origin of these crops and/or animal fats (NEa, 2016; CBS, 2016). In addition the export and import of FAME, biodiesel mixtures and oils containing biodiesel are registered per country (Eurostat, 2016). The CBS reports the amounts of biodiesel consumed/stored in the Netherlands per year and the net export of biodiesel from the Netherlands to other countries.

Based on the provisional figures for 2015 it seems that the net use of oils and fats for production of transport biodiesel has slightly decreased compared to 2014. This decrease is due to a slight decrease in export, this decrease is roughly the same amount as the net storage over 2014. The net storage in 2015 is according to this figure significantly lower than in 2014 but still there is a net storage. This in contrary to the years 2011-2013 were the net storage was negative. Although lower than in 2014 the net export of biodiesel is still significantly higher than in 2013 and earlier years. This increased can be explained from the large HVO factory realised by Neste Oils in the port of Rotterdam.

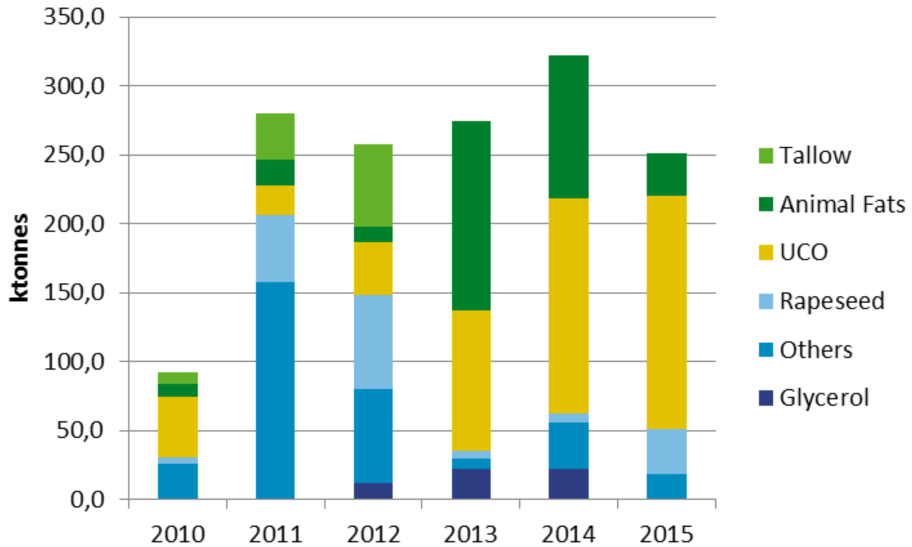
Figure 18 Use of oils and fats for production of transport biodiesel



Source: (CBS 2016b; with ** second provisional figures of the CBS). (See Annex A, Table 19.)

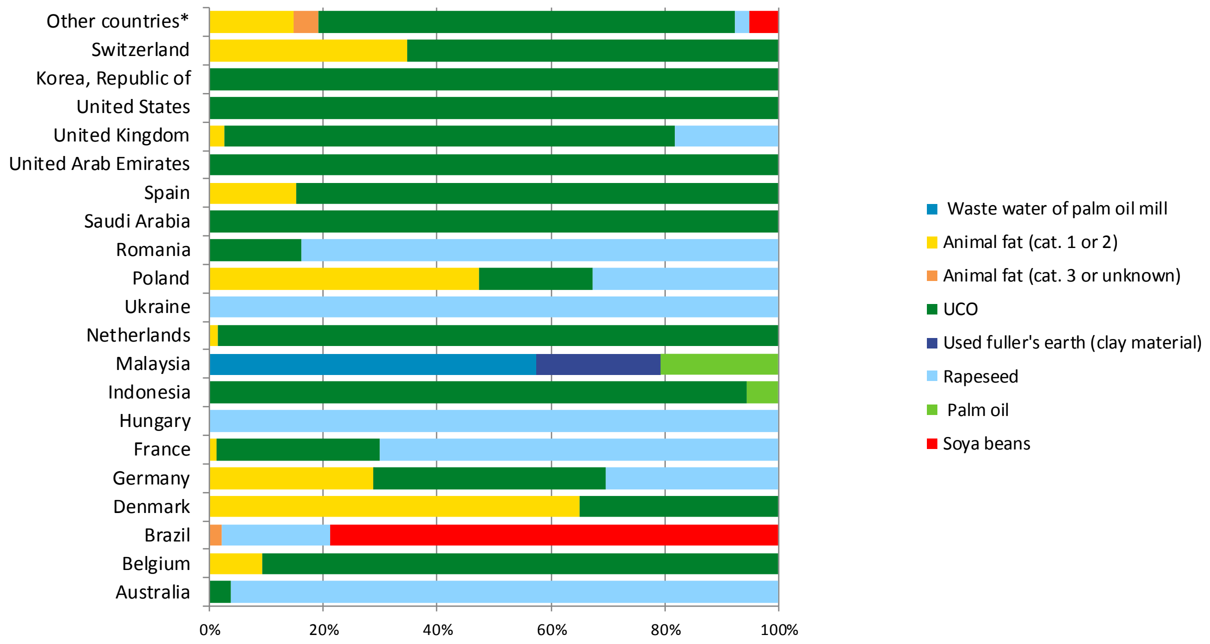
Based on the NEa report and the energy content of different types of biodiesel (mainly FAME and HVO) the mass of biodiesel consumed in the Netherlands was calculated per type of source material. Figure 19 shows the amounts of biodiesel per raw material consumed in the Netherlands over the period 2010-2015. Since 2013 the main raw material for biodiesel production in the Netherlands is UCO. Although the total consumption of biodiesel decreased from 2014-2015 the absolute amount of UCO based diesel increased. The use of rapeseed based biodiesel increased also strongly all other types of raw material decreased strongly compared to 2014.

Figure 19 Estimations of FAME and HVO consumed in the Netherlands in 2010-2015 by feedstock



Source: (NEa, 2012- 2016; CBS 2016a) (See Annex A, Table 20).
Note: 'Others' implies the feedstock is known to NEa but reported at an aggregated level.

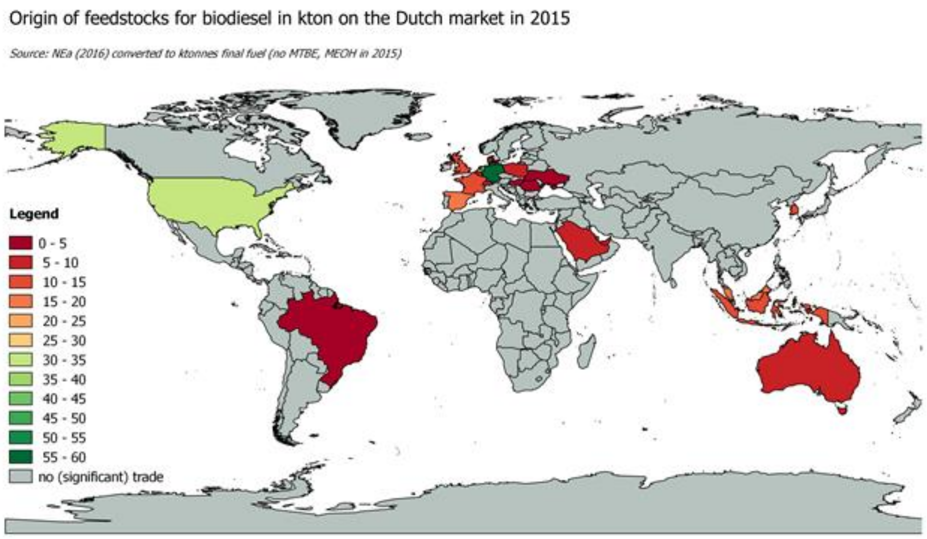
Figure 20 Feedstocks for biodiesel consumed in the Netherlands in 2015 by country of origin



Source: (NEa 2012-2016). (See Annex A, Table 21.)

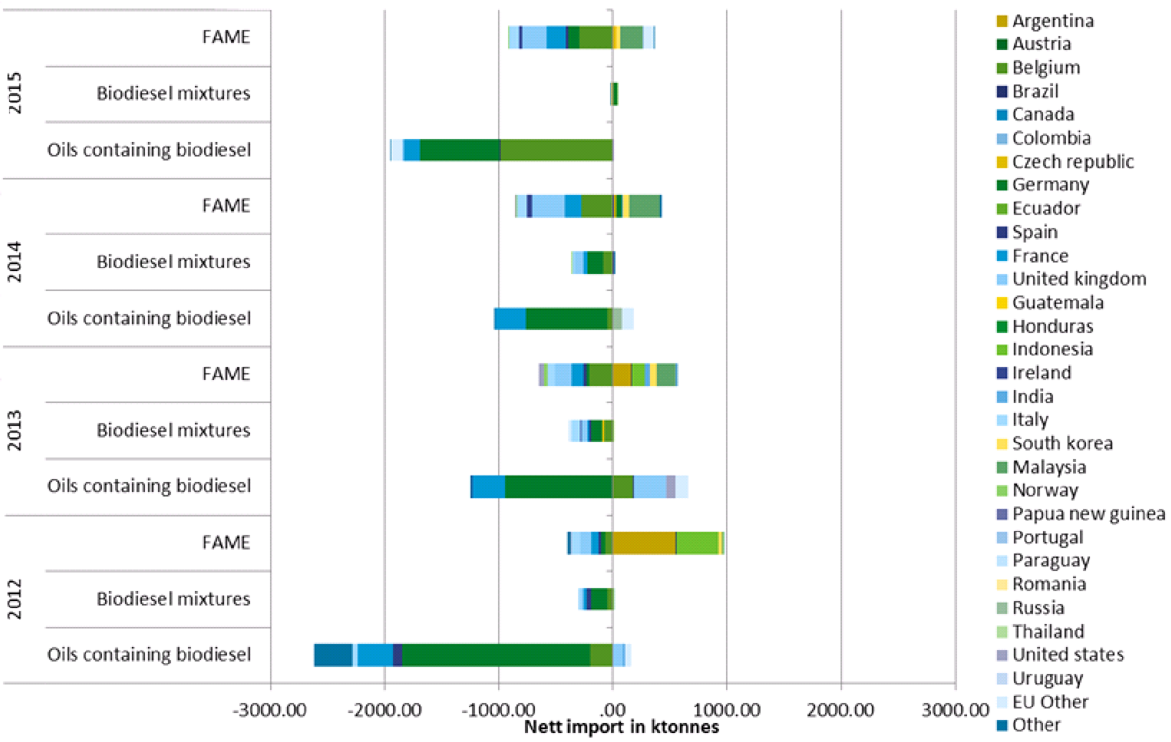
Figure 20 and Figure 21 show the countries of origin of the raw materials used. In total, 13% of the raw materials are from the Netherlands, 41% from other EU member states, 33% from non-EU countries (including Switzerland) and 13% of the raw materials has an unknown origin. UCO comes mainly from outside the EU (37%, including Switzerland) and from other EU member states (30%), the domestic UCO used for biodiesel is 19%, the remaining 14% has an unknown origin.

Figure 21 Origin of feedstocks for biodiesel on the Dutch market in 2015



Source: (EUROSTAT, 2016). (See Annex A, Table 22.)

Figure 22 **Major trade flows of FAME and biodiesel (mixtures including HVO) for the Netherlands from 2012-2015 (ktonnes)**



Source: (EUROSTAT, 2016). (See Annex A, Table 22.)

Note: 'Other' is derived from the balance of world total net flow.

Figure 22 shows the more complex picture of import and export of FAME, biodiesel mixtures and oils containing biodiesel. Apart from the stream of pure FAME (biodiesel produced by transesterification of natural oils and fats in the presence of methanol), streams of mixed biodiesel (biodiesel which contains less than 70 % by weight of fossil fuels and oils containing biofuels (biodiesel component of less than 30%). The mixtures may include both HVO and FAME as a biodiesel.

4.2 Import, production, conversion and export of oleochemistry

The oleochemistry covers all types of conversions of oils and fats for non-food, non-feed and non-energy use in the Netherlands. Unfortunately, the so-called productschappen, agencies of the ministry of economic affairs, that used to register the raw material consumption by sectors like the oleochemistry no longer exist. Therefore, this data is no longer gathered.
What we know is that there is since long a oleochemistry sector that keeps inventing new applications for oils and fats ranging from pharmaceuticals and personal care products to softeners and mining fluids. In addition there are some small paint companies producing traditional and modern paints on the basis of line oil
Since this sector did not increase significantly since 2012 we assume the production capacity is more or less the same as it was when the 'Productschappen' did gather this type of information.
Furthermore there are two petrochemical companies that produce a biobased version of their regular products, Sabic producing a few kilotonnes PE and PP

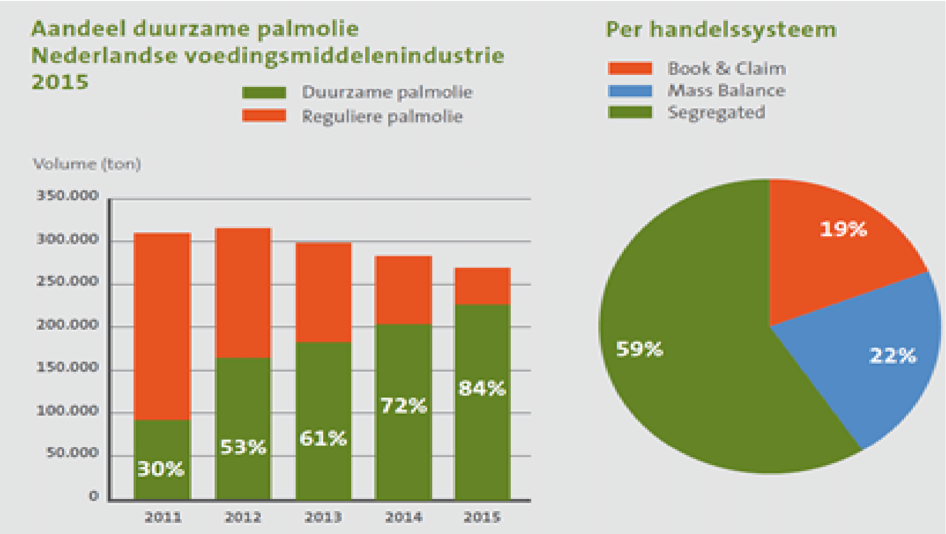
on the basis of biodiesel and BioMCN investigated the production of biomethanol from bioglycerol. However, currently they produce biomethanol on the basis of green gas certificates (Vertogas) and natural gas (fossil methane). BioMCN did not report the 2015 production of biomethanol since it was produced on contract basis for a third party. Since no consumption of MTBE is reported in the Netherlands and there is no way to distinguish between bioMTBE end MTBE or methanol and biomethanol in export data we can not give an indication of the production of biomethanol in 2015.

4.3 Certification

A large part of oils and fats consumed in the Netherlands originate from outside the European Union. Some of these streams have raised environmental concern. This is especially the case for oils and fats from soy beans and palm nuts. Therefore, companies within the European food industry cooperated to set up the Roundtable on Sustainable Palm Oil (RSPO) and the Round Table on Responsible Soy (RTRS) These organisations developed a certification scheme that is developed to be adopted by the majority of the companies in the trade.

In 2011, the Dutch food and feeds industry imported the first batch of RTRS certified soy beans. Many Dutch food manufacturers also started to import RSPO certified palm oil with ambitious target in the next few years. The share of certified vegetable oils has grown steadily.

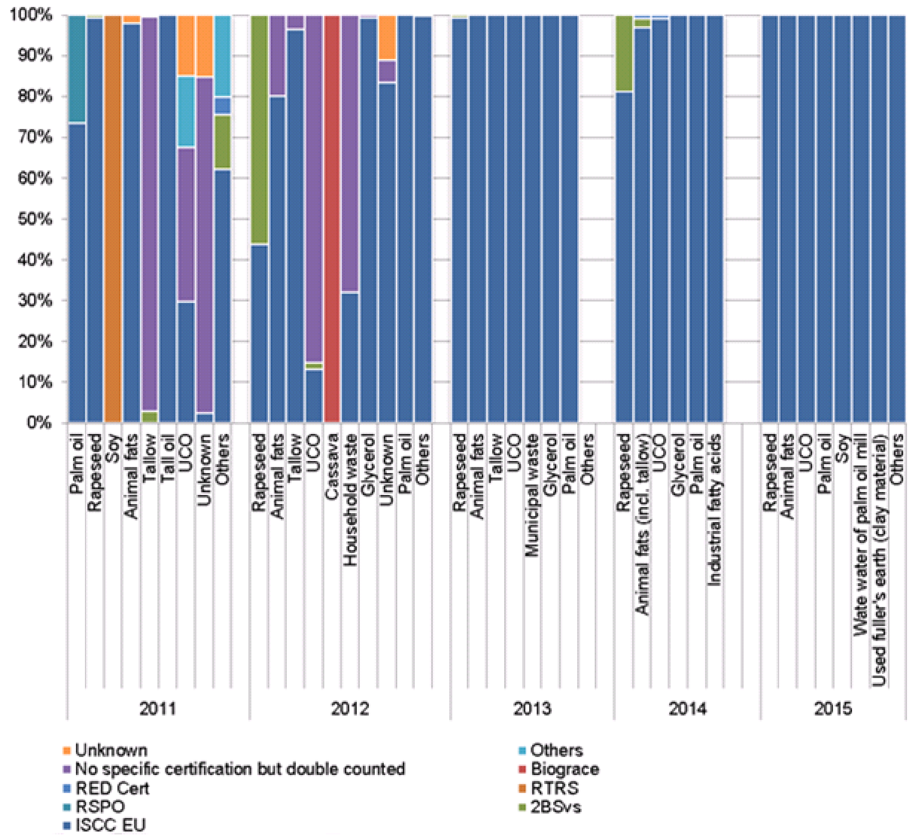
Figure 23 Use of RSPO certified and non-certified palm oil in the Dutch food industry



Source: (Taskforce Duurzame Palmolie, 2016).

Figure 23 shows the growth of RSPO-certified palm oil in the Dutch food industry between 2011-2015. In 2015 84% of all palm oil converted by the Dutch food industry was RSPO certified (234,000 tonnes) (The Dutch Taskforce Sustainable Palm Oil, 2016). Apart from the growth of the part of the palm oil consumption that was RSPO certified, also the type of certification shifted from the most indirect type of certification 'book & claim' to the most direct type of certification 'segregated'.

Figure 24 Use of sustainability schemes on biodiesel reported to fulfil obligation in the Netherlands



Source: NEa, 2012-2016.

Figure 24 shows the application of sustainability schemes on biodiesel reported to fulfil obligation in the Netherlands. ISCC nearly dominated the whole market in 2013 and 2014 and finally dominates the total market in 2015. However, apart from certificates other factors are increasing the sustainability of biofuels. As is illustrated by the raw material policy communicated by Neste (Neste, 2017). Neste reports that over 2015 80% of the raw material used was based on residues and by products of other processes:

- animal fat from food industry waste;
- fish fat from fish processing waste;
- vegetable oil processing waste and residues (e.g., palm fatty acid distillate, spent bleaching earth oil);
- used cooking oil;
- technical corn oil (a residue from ethanol production).

The aim for 2017 is to produce fully based on such residue flows. In 2015 this was proven technically possible. It remains unclear how this works out exactly for the Rotterdam location, but if the aim for 2017 is to produce fully based on such residue flows it is probable that Neste also produces in Rotterdam based on large percentages of residues and by-products of other processes.
Also because this not only influences the sustainability but also implies a cost reduction.

5 Woody biomass

This chapter covers flows of woody biomass in the Netherlands, including sawn timber, boards, wood pellets, pulp, paper and board. The two main categories are wood and wood products and pulp and paper/board. In general one can say that the lowest quality virgin wood tends to be used for the paper and board production. This changed with the increase in use of wood and woodbased streams for energy applications. For energy applications all woodstreams in this diagram can be used as long as the wood is relatively clean.

Figure 25 summarises the flows of woody biomass in the Dutch biobased economy.

The wood biomass is thanks to the continuous efforts of the industry organisations Probos and VNP one of the best documented flows, in the biobased economy. We distinguish three different types of woody biomass streams, biomass involved in the production of:
- wood products;
- paper and board production;
- energy production.

Wood for wood products

Wood for wood products including streams like round wood, sawn timber, board, semi-finished wood products and wood products. These wood products applied in the following applications:
- furniture (11%);
- carpentry (22%);
- construction and civil engineering (24%);
- packaging (26%);
- other (17%).

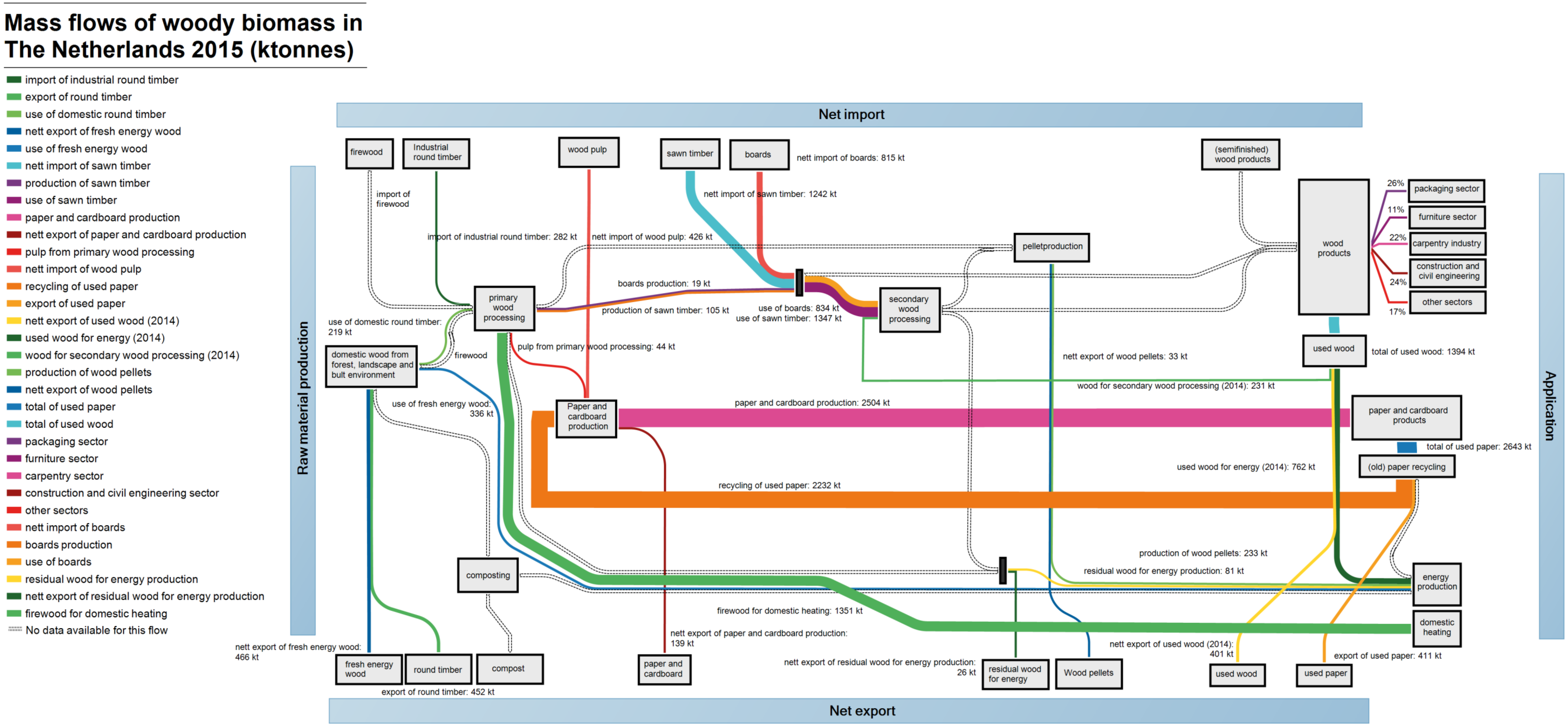
The percentage mentioned are the result of a survey by Probos from 2012 (Probos, 2012b).

From wood to finished wood products requires at least two wood processing steps. In the first wood processing step the round wood is converted to sawn timber and boards. Some of this sawn timber and boards are directly applied for example in carpentry and constructions others are further processed in a secondary wood processing step. The rest streams of the first process are used as raw materials for the production of pulp and paper. Rest streams of both the first and the secondary wood working process are applied for energy generation.

Paper and board production

Most paper in the Netherlands is either produced from pulp produced in other countries from wood (the fibres in this pulp are called virgin fibres) or from pulp made from recycled paper and board (the fibres in pulp from recycled paper and board are indicated as secondary fibres or recycle fibres).
The high percentage of recycling of paper and board and the percentage of recycle fibres in Dutch paper and board production significantly decrease the use for virgin fibres in the Netherlands, which is clearly visible from the size of the recycle stream compared to the streams of locally produced and imported

Figure 25 Overview of flows of woody biomass in the Dutch biobased economy in 2015



Source: (Probos, 2016; Probos, 2012b for shares of wood products).

virgin fibre pulp in Figure 25. Even though significant streams of newly produced and recycle paper are exported.

Energy production
Energy production takes place on rest streams of all wood and paper conversion processes. In addition a large stream of wood is converted to wood pellets for use in industrial energy and electricity plants.

Total flow of woody biomass for non-food and non-feed applications
In 2015 the use of woody biomass for wood applications in the Netherlands totalled 2.5 million dry tonnes per year, of which 1.3 million dry tonnes were imported. The total of 2.5 million dry tonnes is corrected for double use. So if round wood was converted to sawn wood in the Netherlands, that sawn wood was subtracted of the total amount of sawn wood produced and imported in the Netherlands.

In addition 4.4 million dry tonnes of pulp and paper are used in the Netherlands, compared to a net import of 0.8 million dry tonnes. The total of 4.4 million dry tonnes is corrected for double use. So if pulp was converted to paper in the Netherlands and that paper was used in the Netherlands the amount of paper, produced and used in the Netherlands was subtracted of the total amount of paper used in the Netherlands.

The consumption of wood for energy generation totalled 2.4 million dry tonnes per year. In addition 0.5 million dry tonnes of woody biomass was exported for energy generation purposes.

5.1 Import, production, conversion and export of wood and wood-products

We discriminate different types of wood streams:
- round wood;
- sawn wood;
- wood panels;
- rest wood from wood working industries (partly used for energy production);
- waste wood (categories A, B, C) ((partly used for energy production));
- wood for energy generation (excluding private home heating).

Round wood is the debarked trunk or branch of a tree. Table 3 provides an overview of the national production, import, export and use of round wood in the Netherlands (Probos, 2016) we converted the original data in 1,000 m^3 to tonnes using the densities listed in Table 3. The total national production equals 672,000 tonnes per year of which 75% (525,000 tonnes) is consumed nationally. 2.8% of the round wood use is from tropical wood (14,000 tonnes per year).

Table 3 **Production, import, export and use of round wood in the Netherlands (dry content approximately 50%)**

Round wood 2015 (no bark, excl. fire wood)	Total		Soft wood	Hard wood	Tropical hard wood
	(x1,000 tonnes)				
Density*			780 kg/m^3	900 kg/m^3	1,181 kg/m^3
Dry content	100%	50%	50%	50%	50%
Production	336	672	406	266	0
Import	142	283	94	175	14
Export	226	452	277	176	0
Use	251	502	224	265	14

Source: Probos, 2016; *Oldenburger, 2012.

Apart from round wood we import larger quantities of sawn wood, Table 4. A small part of the locally produced round wood is also converted to sawn wood (105,000 tonnes, i.e. 8% of local use).

Table 4 **Production, import, export and use of sawn wood in the Netherlands (dry content approximately 85%*)**

Sawn wood 2015	Total		Soft wood	Hard wood
	(x1,000 tonnes)			
Density*			517 kg/m^3*	680 kg/m^3*
Dry content	100%	85%	85%	85%
Production**	89	105	67	38
Import	1,337	1,573	1,263	310
Export	281	331	236	95
Use	1,145	1,301	1,094	207

Source: Source: Probos, 2016; *Oldenburger, 2012.

** Production of sawn wood based on round wood in the Netherlands.

Wood panels come in two grades: panels from triplex or multiplex or veneer and chip- or fiberboard. There is only a small board production in the Netherlands, all multiplex, triplex or veneer and the majority of the chip and fiberboard is imported.

Table 5 **Production, import, export and use of wood panels in the Netherlands (dry content approximately 85%*)**

Wood Panels 2015	Total		Plywood and veneer	Chip- and fibreboard
	(x1,000 tonnes)			
Density*			650 kg/m^3*	650 kg/m^3*
Dry content	100%	85%	85%	85%
Production	16	19	0	19
Import	866	1,019	386	634
Export	173	204	46	159
Use	709	834	340	494

Source: Probos, 2016; *Oldenburger, 2012.

The wood used in the form of sawn wood and panel wood is for 13% tropical hard wood, see Table 5 and Table 6.

Table 6 **Production, import, export and use of tropical hard wood in the Netherlands**

Tropical hard wood 2015	Total	Round wood	Sawn wood	Wood panel
	(x1,000 tonnes)			
Production	6	0	6	0
Import	333	14	216	103
Export	56	0	36	20
Use	284	14	186	83
Density* (kg/m^3)		1181	850	650

Source: Probos, 2016; *Oldenburger, 2012.

The wood working processes resulting in sawn wood, wood panels and wood products generate 503,000 tonnes of rest streams of wood. In addition a net flow of 58,000 tonnes of rest wood is imported. These rest streams are used as a raw material for wood panels, pulp and paper, and wood pellets for energy generation.

When wood products are discarded they are as much as possible retrieved from the waste stream. In 2014 the total waste wood retrieval equalled 1,394,000 tonnes. Of which 993,000 tonnes were used in the Netherlands Used wood is categorised according to cleanliness from category A: clean wood, to category C: heavily impregnated wood. For energy production in coal fired power plants only category A wood is suited, dedicated waste wood power plants can also process category B wood.

Four different types of wood described above are processed to be used for generation of energy:
- pruning wood from woods, landscapes and parks;
- rest wood of the wood industry;
- waste wood from waste streams (category A-C);
- wood pellets.

In addition CBS reported the use of fire wood by households in the yearly publication on renewable energy consumption in the Netherlands (CBS, 2016a). Pruning wood is also indicated as category A wood. It is now defined separately since it considers fresh pruning wood that generally has a high moisture content of 50%, compared to rest and waste wood with a moisture content of respectively 15% and 10%. Wood pellets have with 7.5% moisture content the lowest moisture content and thus the highest caloric value.

Table 7 **Production, import, export and use of wood for generation of energy in the Netherlands**

Wood for generation of energy	Pruning wood	Rest wood	Wood pellets	A, B, C wood*	Fire wood households
	(x1,000 tonnes)				
Dry content	50%	85%	92.5%	90%	90%
Production	802	107	266	968	
Import	0	9	147	176	
Export	466	35	180	382	
100 % Dry net export	233	22	31	185	
Use	336	81	233	762	1,351
100% Dry use	168	69	216	686	1,216

Source: Probos, 2016; *Oldenburger, 2012.

5.2 Import, production, conversion and export of pulp, paper and board

The Dutch paper and board industry is a very specialised industry. Therefore the use of paper and board in the Netherlands (2.5 million tonnes) is almost as high as the production of paper and board (2.6 million tonnes) and the import (2.6 million tonnes) and the export of paper and board (2.7 million tonnes) (Probos, 2016).

Apart from some niche applications paper mills in the Netherlands distinguish themselves by the high percentage of paper and board production based on recycle fibre. On the total production of 2.6 million tonnes of paper, 2.2 million tonnes of recycled paper were used as a raw material (84%) (VNP, 2017).

Table 8 Production, import, export and use of wood and woody biomass for the production of pulp and paper

Wood for pulp and paper	Chemical pulp	Recycle pulp	Total pulp	Paper
	(x 1000 tonnes)			
Production	44	2,643	2,687	2,643
Net Import	430		19	
100% dry net import	387		17	
Net export		411		139
100 % Dry net export		370		132
Use	474	2,232	2,706	2,504
100% Dry use	427	2,009	2,435	2,379
Dry content pulp	90%	90%	90%	95%

Source: Probos and VNP

From the above it follows that 2.7 million tonnes of pulp are used in the Netherlands (2.4 million dry tonnes). These tonnes are used to produce 2.6 millon tonnes of paper.
In total 2.5 million tonnes of paper are used in the Netherlands. However due to the specialised nature of the Dutch paper and board industry only 0.5 million tonnes of this production was produced in the Netherlands.
So when you want to correct use of woody biomass for pulp and paper for double counting we have 2.7 million tonnes of pulp (2.4 tonnes 100% dry) and an additional paper use of 2.5 million – 0.5 million (locally produced paper) = 2 million tonnes paper (1.9 million tonnes 100% dry) is in total 4.3 tonnes of 100% dry biomass in pulp and paper use in the Netherlands

In previous reports the recycle pulp stream and the difference between use and local production was overlooked and thus left out of the report. In this year that would have meant a use of 2 million tonnes dry pulp and paper.

5.3 Total overview import

An overview of the origin of the flows of wood and wood products used in the Netherlands is made for 2013, see **Figure 26**. This shows that most of the wood used in the Netherlands originates from Europe (76%), while Germany, Sweden and Belgium are the largest suppliers together supplying approximately 60%.

The main streams coming from Europe are paper and sawn wood. Other major suppliers are the USA(6%) and Brazil (7%).
The flows of wood and wood products from European countries contain for approximately 80% paper, sawn soft wood, non-tropical wood panels and pulp. The flows from the USA and Canada consist for 50% of wood pellets, 25% pulp and over 20% of paper and a small fraction of sawn softwood. The streams from Latin Americas consists of approximately 90% of (eucalyptus)pulp.

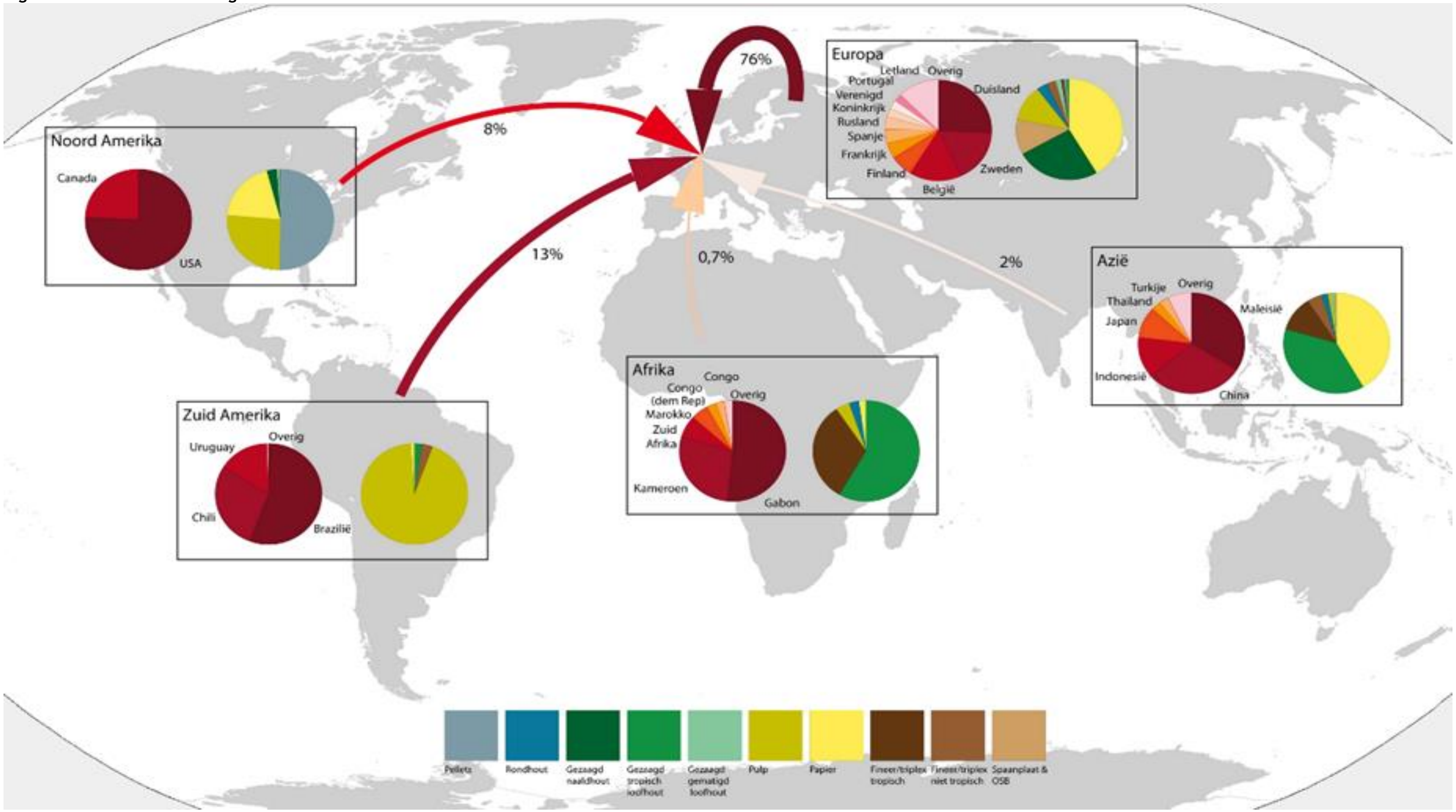
5.4 Certification

The numbers on certification of wood are registered by Probos. The last time Probos published numbers on wood certification was in 2014 and this considered the certification of wood until 2013. The publication of the data for 2015 was scheduled for December 2016, however this has not been the case yet.

The numbers on certification of wood are registered by Probos. The last time Probos published numbers on wood certification was in 2014 and this considered the certification of wood until 2013. This publication only considers the wood, pulp and paper that are certified under a FSC or PEFC scheme. The publication of the data for 2015 was scheduled for December 2016, however this has not been the case yet.

Therefore no new numbers are available other than the numbers from the publication in 2014. Thus we cannot conclude whether the slightly increasing trend in certification until 2013 has continued or not, see Figure 27 and Figure 28.

Figure 26 Overview of origin of wood flows towards the Netherlandsin 2013



Source: (Probos, 2016).

Figure 27 Certification of wood used as sawn wood or panels in the Netherlands (2005 to 2013)

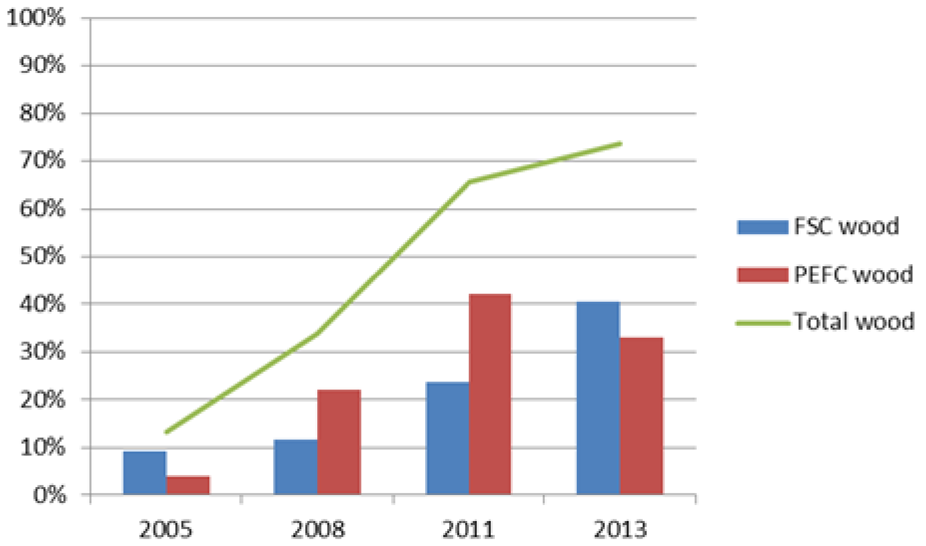
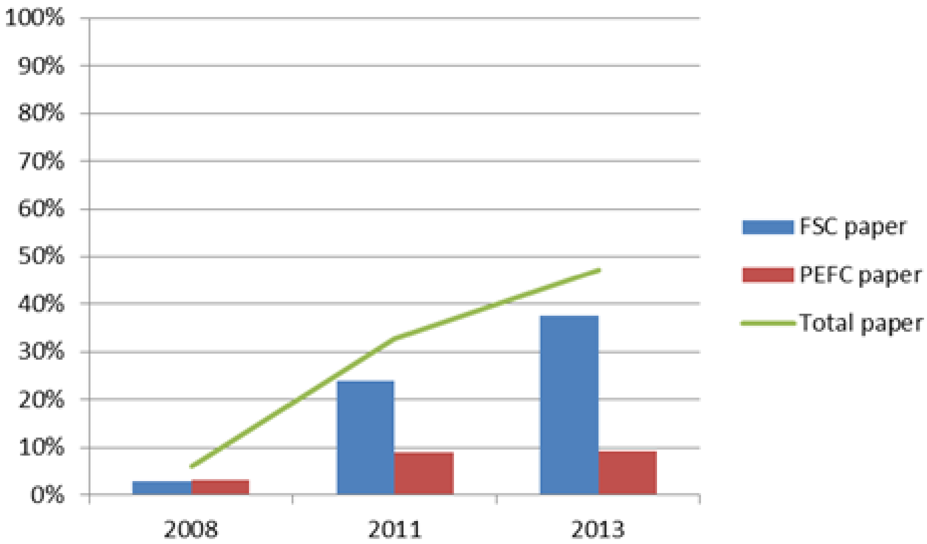


Figure 28 Certification of paper used in the Netherlands (2008 to 2013)



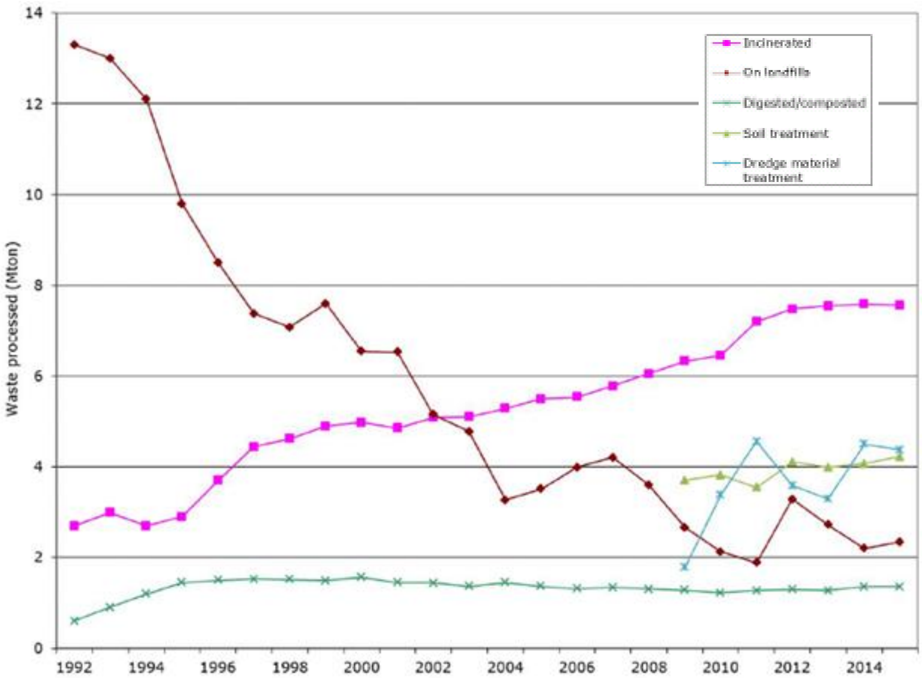
6 Biogenic wastes in waste streams

Since 1991 the Dutch government presents a survey of the annual amounts of waste processed by landfills, waste incinerators, vegetable, fruit and garden waste digestion and composting installations. Since 2009 also treatment of soils and the treatment of dredge material in the Netherlands are reported (RWS, 2016).

The resulting numbers are presented in Figure 29. This figure shows that the amount of landfilled material showed a strong decline from over 13 million tonnes per year in 1992 to less than 7 million tonnes per year in 1997.
Since then yearly variations may cause a temporarily increase in landfilling but the overall trend remains decreasing to a level below 2 Million tonnes per year in 2015.

The amount of incinerated waste shows in the same period an increase from below 3 million tonnes per year in 1995 to 7.6 million tonnes in 2015.
Digestion and composting is relative stable around 1.4 million tonnes.
Treatment of soil and dredge material seem to vary around 4 million tonnes with higher variations in the treatment of dredge material.

Figure 29 Overview of amount of waste processed in the Netherlands between 1992 and 2015*



Source: (RWS, 2016).

* Data for soil and dredge material treatment are only available since 2009.

For the Biobased economy these streams are only of interest to the extent that they are of biogenic origin and are applied in the biobased economy. At the moment the only use of these streams in the biobased economy is energy generation. Energy is generated by incineration or digestion or gasification followed by use of the produced biogas for energy applications.
This is discussed in the following paragraph.

6.1 Use of waste streams for energy production

Both electricity and heat are generated from waste streams.
Electricity is generated from the heat that is generated during incineration of the biogenic fraction of waste (54%) in waste incineration plants (CBS, 2016a). The amount of energy generated in this way is four time as high as it was in 1990. This is due to a large capacity increase in waste incineration plants since 1990. This also caused an increase in the net import of municipal wastes from other parts of Europe for incineration in the Netherlands.
In addition to electricity from waste incineration there is electricity production based on biogas produced from waste streams. There are four types of waste streams that are used for biogas production:

- Digestion of slibs from the sewage water purification plants.
- Biogas that is produced inside landfills due to anaerobe digestion of the biogenic wastes in the landfills.
- Biogas from the co-digestion of manure. Since there is an overproduction of manure in the Netherlands we categorise manure as a waste stream in this context. The other materials applied in co-digestion are by-products of other processes with very few other applications (otherwise they would be too expensive to be used for co-digestion).
- Other sources of biogas the most important are waste water streams at companies with a relatively high content of biogenic material that is suitable for digestion like the waste water of a potato starch factory (AVEBE has a large digester for biogas production) or sugar production plant (COSUN has a large digester for biogas production). But also mono-manure digester are taken into account in the ‘other sources’ category.

Table 9 Electricity production based on waste streams in the Netherlands

Electricity production (PJ)	2010	2011	2012	2013	2014	2015
Municipal waste; biogenic part	6,348	7,324	8,045	7,473	6,871	7,188
Biogas from landfills	0,392	0,349	0,282	0,222	0,202	0,181
Biogas from sewage water purification	0,59	0,623	0,664	0,699	0,725	0,743
Biogas, co-digestion of manure	2,069	2,024	1,981	1,891	1,89	1,992
Biogas, other	0,707	0,827	0,834	0,933	1,102	1,177

Source: (CBS, 2016a).

Table 9 shows that electricity production based on biomass is more or less constant since 2010 varying between 10 and 12 PJ per year.
Most of the biomass based electricity generation is generated on the biogenic part of municipal waste in waste incinerators: 6.3 PJ-8.0 PJ per year.
Electricity from biogas generated in co-digestion of manure generates 1.9-2.1 PJ per year. Electricity from biogas from the slibs of sewage water purification shows a slight increase from 0.6 tot 0.7 PJ per year. Probably due

to increased attention for digestion among water sewage authorities (www.energiefabriek.com; www.waterschapsenergie.nl). Electricity generated from biomass from landfills decreased from 0.4-0.2 PJ, probably due to decreasing biogas yields, since the ban on landfilling. Last but not least is the electricity of biogas generated from other biomass streams. This stream yielded 0.7 PJ in 2010 to increase with 40% to 1.2 PJ in 2015. The category 'Biogas, other' includes electricity generated from waste stream digesters at companies and mono-disgesters of manure. Both categories have shown an increase since 2010.

Apart from electricity waste streams are also used for heat generation, see Table 10.

Table 10 Heat production based on waste streams in the Netherlands

Heat (PJ)	2010	2011	2012	2013	2014	2015
Municipal waste; biogenic part	7,708	9,069	9,812	11,053	11,757	13,523
Biogas from landfills	0,267	0,256	0,251	0,234	0,233	0,202
Biogas from sewage water purification	1,258	1,297	1,284	1,341	1,288	1,205
Biogas, co-digestion of manure	1,333	1,31	1,682	1,798	2,014	2,300
Biogas, other	1,424	1,419	1,729	2,425	2,724	3,065

Source: (CBS, 2016a).

Table 9 shows that heat production based on biomass has shown a 25% increase from 36.6 tot 48.9 PJ per year.
Most of the heat production based on biogenic waste streams is generated on the biogenic part of municipal waste in waste incinerators from 7.7 PJ in 2010 to 13.5 PJ per year in 2015. Heat from burning biogas generated in co-digestion of manure increased from 1.3 to2.3 PJ per year. Biogas from the slibs of sewage water purification yielded 1.2 to 1.3 PJ per year.
Heat generated from biomass from landfills decreased from 0.3-0.2 PJ, probably due to decreasing biogas yields, since the ban on landfilling. Last but not least is the heat of biogas generated from other biomass streams, increasing with 54% from 1.4 PJ in 2010 to 3.1 PJ in 2015. As mentioned at Table 10, the categorie 'Biogas, other' includes electricity generated from waste stream digesters at companies and mono-digesters of manure. Both categories have shown an increase since 2010.

6.2 Incineration of waste streams in energy recovery plants

Since heat recovery in waste incineration is the largest category of waste streams yielding biobased electricity and heat we take a closer look at this stream, see Table 11.

The biogenic fraction varied between 53 and 56% but is since 2014 constant on 54%. The amount of waste that is being burned showed a steep increase from 6.5 to 7.5 million tonnes between 2010 and 2012 and remains since then more ore less constant at 7.5 million tonnes per year. The increase in waste incineration was caused by an increase of import of municipal waste from other countries.

The difference between the energy content of the burned biogenic faction and the gross final energy use is more or less constant at 22 PJ, although in 2015 it was with 19 PJ slightly lower. It is unclear whether this is caused by increased heat recovery from the waste incinerators or dryer biomass that is fed to the waste incinerators.

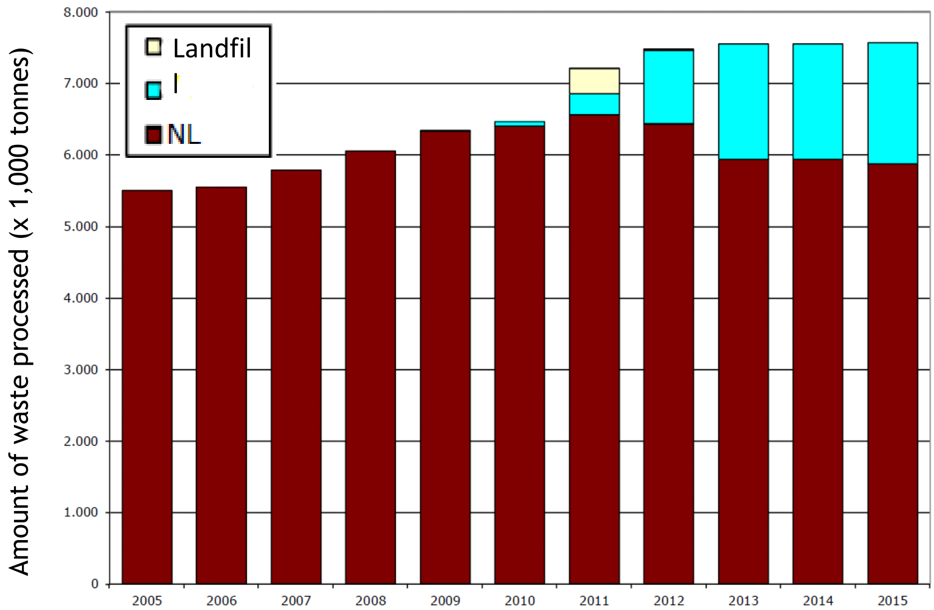
In total the energy recovered from waste incineration replaced the energy generation based on fossil energy, avoiding 1.7 million tonnes of CO_2 emission.

Table 11 Energy generation based on incineration of the biogenic fraction of municipal waste in the Netherlands

	2010	2011	2012	2013	2014	2015*
Waste						
Burned waste (1,000 tonnes)	6,586	7,207	7,480	7,549	7,601	7,459
Renewable fraction (%)	53	54	56	55	54	54
Energy content biogenic fraction (TJ)	34,208	37,361	39,794	40,689	40,265	39,512
Gross final energy use (TJ)						
Electricity	6,348	7,324	8,045	7,473	6,871	7,056
Heat	7,708	9,069	9,812	11,053	11,757	13,251
Total	14,056	16,393	17,857	18,526	18,628	20,307
Effect (1,000 tonnes)						
Avoided use of fossil energy	17,436	20,900	23,950	24,112	23,680	25,945
Avoided CO_2 emission	1,115	1,329	1,579	1,604	1,555	1,689

Figure 30 shows the amount and origin of the waste that is burned in the Dutch waste incinerators. The figure shows that since 2011 there is no significant increase in the amount of waste that is being processed in Dutch waste incinerators. It also shows that the amount that is percentage of imported waste has steadily increased from negligible in 2009 to 1.69 million tonnes in 2015 a slight increase compared to the 1.59 tonnes in 2014. This means that in 2015 23% of the waste burned in waste incineration plants was imported from other countries, compared to 21% in 2014.
This means that the burning of Dutch (biogenic) waste has decreased from 6.01 million tonnes in 2014 to 5.87 million tonnes in 2015.

Figure 30 Origin of waste burned in Dutch waste incineration plants between 2005 and 2015*



Source: (RWS, 2016).

7 Policy context

What conclusions can be drawn from this monitor for Dutch policies on BBE and adjacent policies?

7.1 National/EU statistics

National and EU statistics form the basis of this report. However, these data have a number of limitations.

First of all, apart from the yield of agriculture and forestry the national production is not measured by the national or the European Statistics offices. Until 2012 agencies of the ministry of Economic Affairs and Infrastructure and Environment, the so-called 'Productschappen' gathered additional information on national production. However, the Productschappen are shut down.
The only industry organisation still gathering and publishing data on production and raw material use is the association of Dutch paper and board producing industries VNP.

Secondly, the national consumption of biofuel consumption in the Netherlands is reported both in the CBS statistics and the yearly NEa report. There is a discrepancy between those numbers due to differences in methodology. The involved institutions are working on a solution.

Thirdly, the national and EU statistics do not discriminate in origin of application of a given material. So no difference exists between biobased ethanol and fossil based ethanol in these statistics. Similarly there is no discrimination possible between for example vegetable oils used in food and vegetable oils used to produce drilling fluids (industrial application in mining industry).

Because of the above mentioned limitations of the national and EU statistics additional research is required to get an insight in the development of the biobased part of green growth and the circular economy in general and the biobased economy in specific.

7.2 Relevance of this monitor to green growth and circular economy programs

The relevance of the flows measured in this study to green growth and or circular economy programs strongly depends on the definitions used for green growth/circular economy.

Compliance with Green Growth principles

The definition of Green Growth is all economic activity that is sustainable.
In important issue for this definition is how to define that the yield and processing of biomass is sustainable?
Biobased production has a significant potential to contribute to green growth, since the carbon involved is short cyclic carbon so the net increase of green house gas emissions over the life time of the product (when including the

growth phase of the biomass) tends to be significantly lower than in case of fossil fuels.

However, especially the growth phase of the biomass presents some significant risks for high green house gas emissions if the cultivation and harvesting of the biomass occurs in an non-sustainable way. Some examples of known risks are:
1. land degradation;
2. (over)use of water, pesticides and fertilizers;
3. carbon depletion of the soil.

The standard response to deal with this risk is to use certified biomass.
To make sure that certification of biomass actually decreases the changes on increased greenhouse gas emissions due to the use of biomass, the following changes have to occur:
1. The percentage of the biomass that is certified has to increase
2. The range of risks covered by the certification has to increase. Of the widely applied certification schemes only FSC covers fully land degradation, overuse of water, pesticides, fertilizers and carbon depletion of the soil. Most of the other widely applied certification schemes only apply land degradation to some extend.
3. The governance on the certification schemes has to drastically increase: both in terms of local control on what actually happens and on the weight of the measures that are taken when a serious breach of the rules is ascertained.

Box 1 An example of strong governance on a certification system

In 2016 one of the members of the table for sustainable palm oil would have a control of a NGO whether the land planned to be used for new plantations was suited for this purpose or should be set a side because of high conservational values and / or high risk for additional greenhouse gas release when brought into cultivation.
Before the assessment could take place, local managers in Indonesia already started the cultivation outside of the company policy.
This was reported by a local NGO. The Round table for Sustainable Palm oil responded by immediately suspending the certification of the palm oil company not only the Indonesian branch but the whole company.
This had the following effects:
- An outcry of the customers of this company because they feared to be without certified palm oil in the holiday season.
- A serious shock of the international board of this company, who before was not fully in control of the compliance of the plantations. Due to the outcry of their clients they ascertained full compliance with the certification and took measures to prevent recurrence of this breach.
- Other companies with a lesser track record voluntarily suspended their own certification in order to increase their compliance quietly before regaining certification in fear of bad publicity.

In this way a breach of the rules that was common practice in Indonesia became a stepping stone for further compliance with the certification scheme, not only in the Indonesian branch of the company where the breach was reported but in the whole sector.

In general biomass from waste streams and residues or by products of processing of certified biomass for food and feed applications is more sustainable than direct processing of (certified) biomass. However, currently the information on such streams is rather limited.

Therefore, more specific study is required to determine the type of origins of the biomass used in the Dutch biobased economy to give any conclusive answers on the contribution to the Green Growth.
Biobased production has the advantage that the carbon sequestered in the product is biogenic or short cyclic drastically decreasing the carbon footprint of a product. But large scale agricultural or forestry based production can also have significant drawbacks from an environmental point of view.

Compliance with Circular Economy principles

Whether the flows in this report comply with the principles of the Circular Economy depends on the strictness of interpretation of these principles. We distinguish four different levels of compliance.

From the lowest to the highest degree of compliance these are:
1. All production based on biomass is regarded as part of the circular economy. In this definition all the streams mentioned in this study are considered part of the circular Economy.
2. All biomass that is compliant with the principles of green growth is regarded as part of the circular economy.
3. All biomass that is compliant with the principles of green growth and of which the nutrients eventually are brought back into the natural system after use of the biomass.
4. All biomass that is compliant with the principles of green growth and of which nutrients return to the specific eco-system the biomass originates from.

If the first definition is used, all biomass streams in this report are part of the circular economy. The last two are the hardest to realise and only achievable for those applications that are composted at the end of their lifetime. From a sustainability point of view the latter two may not always be the preferred options. For example if you make drop in chemicals based on biomass these chemicals are processed into plastics that cannot be composted anymore, but they can be recycled and thus endlessly reused.

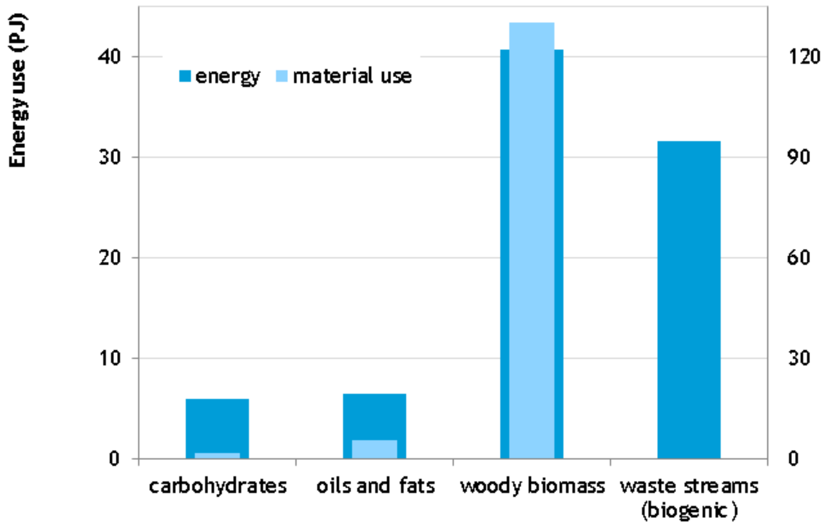
7.3 Progress compared to the Vision Biomass 2030

The Dutch government has formulated goals on the long term development of the biobased economy in the vision Biomass 2030 (Ministerie EZ, 2015).
In this vision, goals are formulated for three types of biomass applications.:
The goals are formulated in energy units instead of mass units.
1. Generation of electricity or heat: 130 PJ in 2030 compared to 64 PJ in 2012.
2. Raw material for chemical production: lower limit 34 PJ, upper limit 95 PJ in 2030, compared to 12 PJ in 2012.
3. Raw material for transport fuels: lower limit 43.5 PJ, upper limit 87 PJ in 2030, compared to 18 PJ in 2012.

These goals were taken onboard in the broader policy presentation for the development of the circular economy towards 2050 (Ministerie van I&M, 2016).

To check where we currently stand we converted the mass unites per type of biomass into energy units. So both biomass used for energy purposes and biomass for material use are expressed in energy units. The results are presented in Figure 30.

Figure 31 Overview of biobased production in four categories for material and energy use



This figure shows that woody biomass and waste streams are most applied for energy generation. Nevertheless, biomass is most applied for material use (three times higher values in material use axis than in energy use axis). The material use in this figure is higher than the total goal for biomass use in 2030 as projected in the vison Biomass 2030.

This does not mean that the goals are already met, but shows the difference in biomass considered between this studu and the vision Biomass 2030. Only part of the industrial use of the biomass presented in this study is relevant to the goals set in the vision Biomass 2030: application of woody biomass for traditional biomass applications like wood and paper were excluded in the vision.

To compare these results to the projections in the vision Biomass 2030 we plotted the goals for 2030 as a linear increase between 2012 and 2030 and added the numbers for 2015, see figure 32.

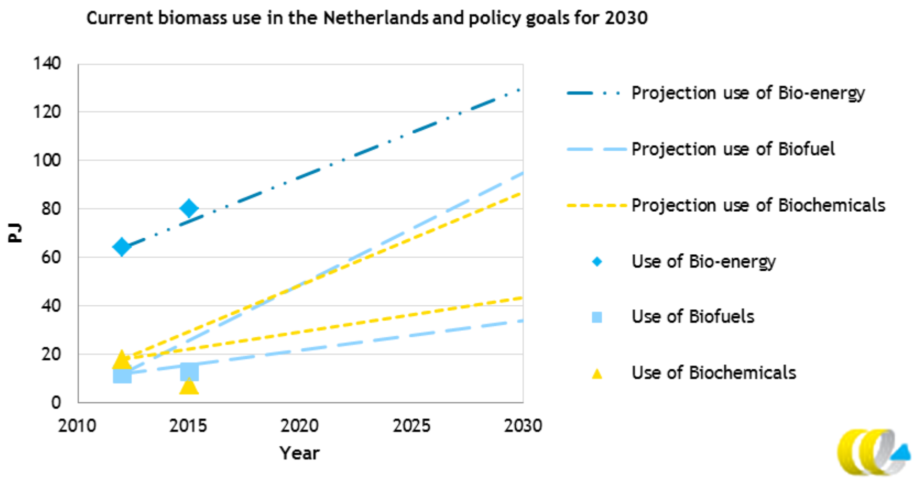
The data presented in this study should provide a complete picture of the use of biomass for the applications Bio-energy and Biofuels. This is not the case for the third category Biochemicals. We will explain this in the following paragraphs.

In Figure 32 the total for electricity and heat generated on the basis of biomass is plotted as bio-energy. The generated heat and electricity from biomass is just a little above the (linear) projection of the policy goal.
The total of all transport fuels based on biomass is presented as Biofuels. The consumption of biofuel is in line with the low scenario for biofuels projected in Figure 4.

The total industrial use of biomass as shown in Figure 1 is significantly higher than the goal set for biochemicals. Nevertheless, the use of biomass for the production of chemicals as far as identified in this report seems to be les than reported in 2012 for Biochemicals, see Figure 4.
This is explained by the following aspects:
– Only part of the industrial use of the biomass presented in this study is relevant to the goals set in the vision Biomass 2030: application of woody

biomass for traditional biomass applications like wood and paper were excluded. Therefore only the industrial use of Carbohydrates and Oils and fats within the biobased economy comply with this definition.
- As described in Chapter 2 on Methodology the applied methodology excludes significant biobased streams in the chemical industry.

Figure 32 **Biomass use in 2012 and in this report identified use in 2015 and goals set for 2030**



Therefore the data presented in this study provides information about a part of the biomass applied as a raw material in the chemical industry. For a complete picture additional research is required.

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Annex A Tables

Table 12 Overview of biobased production (use and net export) in the Netherlands (2015) in 1,000,000 tonnes dry, table corresponding to Figure 1

Biomass type	Use	Net export
Carbohydrates based materials	0,1	0,1
Oleochemistry	0,1	0,1
Wood as material	2,5	-1,3
Pulp and paper	4,3	-0,8
Biogasoline	0,2	0,1
Biodiesel	0,2	1,4
Wood based energy generation	2,4	0,5
Biogenic municipal wastes	2,0	-0,5

Table 13 **Gross final energy consumption** from biobased materials in the Netherlands 2010-2015, table corresponding to Figure 2**

Energy application	**Electricity**						**Heat**					
(PJ)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Municipal waste; renewable fraction	6,3	7,3	8,0	7,5	6,9	7,2	7,7	9,1	9,8	11,1	11,8	13,5
Electricity from biomass* (including co-produced heat)	17,4	16,2	16,2	12,3	8,9	8,3						
Biomass in houses, total**						-	17,1	17,3	17,5	17,9	18,4	18,6
Biomass boilers companies, heat **						-	5,5	5,2	5,3	5,5	7,6	9,0
Biogas from landfills	0,4	0,3	0,3	0,2	0,2	0,2	0,3	0,3	0,3	0,2	0,2	0,2
Biogas from sewage water purification	0,6	0,6	0,7	0,7	0,7	0,7	1,3	1,3	1,3	1,3	1,3	1,2
Biogas, co-digestion of manure	2,1	2,0	2,0	1,9	1,9	2,0	1,3	1,3	1,7	1,8	2,0	2,3
Biogas, other	0,7	0,8	0,8	0,9	1,1	1,2	1,4	1,4	1,7	2,4	2,7	3,1
Biogasoline	-	-	-	-	-	-	-	-	-	-	-	-
Biodiesel	-	-	-	-	-	-	0,0	0,0	0,8	0,8	1,0	0,9
Total	42,8	41,7	42,3	33,9	19,7	19,6	36,6	37,8	40,3	42,9	45,0	48,9

Energy application	**Transport**						**Green gas in natural gas grid**					
(PJ)	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Municipal waste; renewable fraction												
Electricity from biomass* (including co-produced heat)												
Biomass in houses, total**												
Biomass boilers companies, heat **												
Biogas from landfills	0,0	0,0	0,0	0,0	0,0	0,0	0,3	0,3	0,2	0,2	0,2	0,2
Biogas from sewage water purification												
Biogas, co-digestion of manure												
Biogas, other	0,0	0,0	0,0	0,0	0,0	0,0		0,2	0,6	1,3	1,7	2,3
Biogasoline	5,6	6,2	5,2	5,2	5,4	6,0						
Biodiesel	4,0	7,2	7,3	6,9	8,7	6,4						
Total	9,6	13,4	12,5	12,1	14,1	12,4	0,3	0,5	0,9	1,5	2,0	2,5

* Co-firing of biomass in electr. plants and biomass boilers companies, electricity.
Source: (CBS 2015b; CBS 2016a; CBS 2016b).

Table 14 **Overview of biobased production in four categories for industrial and energy use, table corresponding to Figure 3**

PJ	Carbohydrates	Oils and fats	Woody biomass	Waste streams (biogenic)
Energy	5,95	6,44	40,67	31,55
Industrial use	1,7	5,5	130,1	

Only domestic consumption no import/export.

Table 15 **Current use and goals set for biomass use in 2030, table corresponding to Figure 4**

	Projection use of Bio-energy	Projection use of Biofuel		Projection use of Biochemicals	
PJ	Use of Bio-energy	Biofuels low scenario	Use of Biofuels	Chemicals low	Use of Biochemicals
2012	64	12	12	18	18
2030	130	34	95	43,5	87

Table 16 Major ethanol and ETBE trade flows in and out the Netherlands for 2010-2015 (ktonnes), table corresponding to Figures 11 and 12

Nett import in kton	2010		2011		2012		2013		2014		2015	
	Denat. ethanol	ETBE	Denat. ethanol	ETBE	Denat. ethanol	ETBE	Denat. ethanol	ETBE	Denat. ethanol	ETBE	Denat. ethanol	ETBE
United Arab emirates	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Austria	-0,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	-0,1	0,0
Belgium	8,0	-1,9	5,5	-14,1	1,7	48,3	4,6	-1,5	14,7	94,2	32,1	15,9
Bolivia	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Brazil	3,7	203,6	2,6	208,6	0,7	221,5	0,0	303,5	0,0	139,5	19,5	158,0
China	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Costa Rica	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Czech republic	0,0	-6,6	0,0	-11,8	0,0	-9,9	0,0	-1,1	0,0	0,0	0,0	0,0
Germany	-18,6	-7,7	-3,8	-71,9	1,4	31,5	-1,6	15,1	-0,7	-44,9	9,7	19,6
Denmark	-19,2	0,0	-20,8	-1,9	0,0	0,0	-0,2	0,0	0,0	0,0	-4,0	0,0
Spain	21,6	-101,8	0,0	-61,1	0,0	-68,7	0,0	-73,4	0,0	-50,0	8,2	-60,6
Finland	2,4	0,0	-2,7	0,0	0,0	0,0	-9,1	-2,0	-20,5	0,0	0,0	0,0
France	18,3	-331,5	0,5	-203,3	5,5	-204,3	1,5	10,4	2,9	48,7	29,0	-163,1
United kingdom	-22,0	-2,9	-15,8	14,5	-60,9	-9,2	-25,9	-0,1	-2,1	-24,8	-63,5	-1,9
Guatemala	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Hungary	3,0	0,0	0,7	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Ireland	-4,4	-4,4	0,0	0,0	-1,1	0,0	0,0	0,0	0,0	0,0	-4,2	0,0
India	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	-13,6	0,0	0,0	0,0
Italy	0,0	-5,1	0,0	-25,8	0,0	0,0	-0,2	0,0	0,0	0,0	0,0	0,0
South Korea	0,0	0,0	-0,3	0,0	-1,9	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Malaysia	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Peru	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Pakistan	0,0	0,0	0,0	0,0	7,8	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Poland	0,0	-46,4	-1,0	-35,6	0,0	-13,6	0,0	-13,6	0,0	-8,6	0,0	-1,1
Portugal	0,0	0,0	0,0	0,0	0,0	0,0	0,0	4,9	0,0	0,0	0,0	-12,1
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
Sudan	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	-0,1	0,0	-0,1	0,0
Sweden	-31,8	-2,4	-3,2	1,9	-14,6	-4,3	-1,8	0,0	-1,3	-4,4	-83,6	-6,4

Nett import in kton	2010		2011		2012		2013		2014		2015	
	Denat. ethanol	ETBE	Denat. ethanol	ETBE	Denat. ethanol	ETBE	Denat. ethanol	ETBE	Denat. ethanol	ETBE	Denat. ethanol	ETBE
United states	5,7	0,0	3,8	0,0	79,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
EU Other	7,0	0,0	-0,1	-16,0	-0,6	-4,2	-2,5	-2,0	-3,2	-52,7	-1,2	-5,7
Other	-0,2	0,0	-0,1	-14,3	-1,1	0,0	5,7	0,0	-4,3	0,0	-2,5	0,0

Source: (EUROSTAT, 2016).

Table 17 Estimations of bioethanol consumed in the Netherlands in 2010-2015 by feedstock in ktonnes, table corresponding to Figure 13

Year	Others	Maize	Sugar beet	Sugar cane	Wheat
2010	46,9	76,6	5,6	23,7	38,4
2011	4,8	161,7	1,6	5,2	5,7
2012	1,2	127,7	13,5	5,2	29,0
2013	33,3	56,0	33,1	40,0	39,8
2014	18,2	60,7	40,5	28,1	46,4
2015	8,9	73,3	27,5	40,3	76,9

Source: (NEa 2012-2016; CBS 2015a*).

Table 18 Feedstocks for bioethanol consumed in the Netherlands in 2015 by country of origin in ktonnes bioethanol, table corresponding to Figures 14 and 15

Land	Maize	Waste from starch production	Sugar beet	Sugar cane	Wheat	Triticale
Belgium			5,82		9,16	
Brazil				27,57		
Germany			6,10		7,77	1,72
France	1,47		14,50	0,83	15,85	
Hungary	9,60					
Netherlands		3,61				
Ukraine	24,34					
Poland					0,08	1,46
Romania	20,31					
Spain	6,89					
United Kingdom	1,47	0,47			39,55	
United States	2,42					
Other countries*	6,82		1,04	7,83	4,54	

Source: (NEa; 2016; CBS, 2016).

Table 19 Use of oils and fats for production of transport biodiesel in MT, table corresponding to Figure 18

MVO balance	2010	2011	2012	2013	2014	2015**
Production capacity of biodiesel in NL reported by CBS	1,306	2,030	2,051	2,014	2,196	2,176
Biodiesel net export reported by CBS	339	249	884	1,043	1,512	1,439
Biodiesel consumed in NL reported by CBS	43	242	293	332	208	190
Net storage of biodiesel in NL reported by CBS	64	-48	-55	-112	70	12

Source: (CBS 2016b; with ** second provisional figures of the CBS).

Table 20 **Estimations of FAME and HVO consumed in the Netherlands in 2010-2015 by feedstock in ktonnes, table corresponding to Figure 19**

Year	Others	Rapeseed	UCO	Animal Fats	Tallow	Glycerol
2010	26,4	4,3	44,0	8,8	8,8	0,0
2011	157,5	48,6	21,4	18,6	33,6	0,0
2012	68,1	68,3	38,4	10,4	60,1	12,2
2013	7,1	6,0	101,7	137,0	0,0	22,2
2014	33,3	6,4	156,5	103,7	0,0	22,5
2015	18,3	32,6	169,4	30,6	0,0	0,0

Source: (NEa, 2012- 2016; CBS 2016a).

Note: 'Others' implies the feedstock is known to NEa but reported at an aggregated level.

Table 21 Feedstocks for biodiesel consumed in the Netherlands in 2015 by country of origin in ktonnes biodiesel, table corresponding to Figure 20

Country	Waste water of palm oil mill	Animal fat (cat. 1 or 2)	Animal fat (cat. 3 or unknown)	UCO	Used fuller's earth (clay material)	Rapeseed	Palm oil	Soya beans
Australia				0,21		5,55		
Belgium		0,88		8,71				
Brazil			0,03			0,25		1,02
Denmark		3,56		1,91				
Germany		15,92	0,00	22,53		16,77		
France		0,15		3,61		8,80		
Hungary						1,07		
Indonesia				10,84			0,65	
Malaysia	10,43				3,94		3,78	
Netherlands		0,62		39,32				
Ukraine						1,11		
Poland		4,00		1,70		2,75		
Romania				0,21		1,11		
Saudi Arabia				8,29				
Spain		2,35		12,97				
United Arab Emirates				7,01				
United Kingdom		0,40		11,69		2,67		
United States				33,80				
Korea, Republic of				14,24				
Switzerland		2,60		4,89				
Other countries*		6,20	1,83	30,61		1,03		2,14

Source: (NEa 2012-2016).

Table 22 Major trade flows (net import) of FAME and biodiesel (mixtures including HVO) for the Netherlands from 2012 -2015 (ktonnes), table corresponding to Figures 21 and 22

Country	2012			2013			2014			2015		
	Oils containing biodiesel	Biodiesel mixtures	FAME	Oils containing biodiesel	Biodiesel mixtures	FAME	Oils containing biodiesel	Biodiesel mixtures	FAME	Oils containing biodiesel	Biodiesel mixtures	FAME
Argentina	0	0	551,3211	0	0,3535	155,1572	0	0	0	-5,6739	-0,0041	0
Austria	3,3028	0,8273	-4,3479	0,0001	-6,5134	-2,921	0,0002	0,0017	-6,6101	0	-0,0064	1,6481
Belgium	-199,4893	-48,2513	-64,5587	178,4648	-67,5245	-200,6448	-46,7256	-80,8266	-270,3319	-985,5513	11,1414	-296,402
Brazil	0	0	2,467	0	0	9,0324	-0,0068	0	12,0549	-4,9423	0	0
Canada	0	0	0	0	0	0	0	0	0	0	-0,0001	0
Colombia	0	0	0	0	0	0	0	0	0	0	0	0
Czech Republic	-0,0008	0	0,4022	0	-15,4256	4,1528	0,0352	0	12,1974	0,0122	-0,0003	22,3432
Germany	-1651,1963	-143,5604	-35,3829	-942,9404	-102,4911	-32,0816	-711,2201	-146,6699	58,6071	-695,5595	22,3956	-95,7326
Ecuador	0	-0,0038	0	0	0	0	-0,0001	0	0	-0,0001	0	0
Spain	-76,9083	-36,8923	-27,9286	8,0282	-17,6157	-21,1699	-0,1112	7,5539	-2,0158	-0,002	2,6508	-20,505
France	-307,4748	-32,4423	-60,7913	-291,773	-14,4757	-104,8872	-273,0933	-33,9315	-142,477	-137,5495	-5,9928	-170,0726
United kingdom	81,6138	-12,8387	-92,4476	280,0272	-55,5124	-144,9076	5,8812	-71,8574	-290,4085	-17,1332	0,1773	-217,8818
Guatemala	0	0	0	0	0	0	0	0	0	0	0	0
Honduras	0	0	0	0	0	0	0	0	0	0	0	0
Indonesia	0	8,9692	364,1652	0	7,5341	109,5028	-0,0002	0	0	-0,0006	0	0
Ireland	-6,262	0,006	-1,7941	-6,9487	-4,616	-6,45	0	0	-37,6655	0	0,0022	-18,2319
India	22,3028	0	4,7532	0	0	43,0445	0	0	6,5128	0	-0,0021	7,3499
Italy	-36,795	-28,8146	-74,8426	-0,0014	-82,163	-55,7461	-0,0061	-24,0128	-89,8862	-0,0018	-4,5043	-88,1447
South Korea	-0,0005	0	30,9126	-0,0048	0	63,7293	0	0	51,4611	0	-1,25	27,9407
Malaysia	0	5,0095	15,1782	0	0	167,5434	0,0001	0	265,6286	0	0	207,5431
Norway	-0,0017	0	9,2384	-0,001	0	-38,4013	-0,0004	-0,0289	-8,1189	-0,0019	0,5165	-8,6552
Papua New Guinea	0	0	0	0	0	0	0	0	0	0	0	0
Portugal	0	0	0	7,1762	0	1,9994	-0,0007	0	4,1937	-0,0002	-0,0056	5,6998
Paraguay	0	0	0	0	0	0	0	0	0	0	0	0
Romania	-0,0094	0	-0,9873	-0,2279	0	-0,9997	-0,0895	0	-0,7906	-0,0023	-0,0012	1,5266
Russia	-0,0054	0	0	-0,0313	0	0	71,6662	0	0	0	-2,5733	0
Thailand	-0,0007	0	0	-0,0005	0	0	0	0	0	0	0	0
United States	0,0793	0,0002	-6,5908	71,0447	0	-39,9436	0,001	0	-0,0208	0,002	-0,0002	0

Country	2012			2013			2014			2015		
	Oils containing biodiesel	Biodiesel mixtures	FAME	Oils containing biodiesel	Biodiesel mixtures	FAME	Oils containing biodiesel	Biodiesel mixtures	FAME	Oils containing biodiesel	Biodiesel mixtures	FAME
Uruguay	0	0	0	0	0	0	0	0	0	0	-0,0014	0
EU Other	49,1114	2,6121	4,0316	115,5223	-18,5891	6,7319	105,7244	2,6594	1,0828	-93,6764	-0,5651	84,0217
Other	-341,0383	0	-29,9177	-0,066	0	2,6056	-6,6968	0,2586	19,1843	-0,6072	-0,1484	11,0217

Source: (EUROSTAT, 2016).

Note: ‘Other’ is derived from the balance of world total net flow.