# *IEA Bioenergy Task 40 / EUBIONETIII*
# *Country report for the Netherlands – Update for 2009*


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**Universiteit Utrecht**

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*Science, Technology and Society*

IEA Bioenergy

Task 40: Sustainable International Bioenergy trade

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# Executive Summary (not updated for 2009)

This country report was written within the frame of two projects: IEA Bioenergy Task 40 and EUBIONETIII. In summary, the aims of this country report are:

(1) To provide a concise overview of biomass policy, domestic resources, biomass users and biomass prices,

(2) To analyse bioenergy trends and reasons for change in the Netherlands and point out barriers & opportunities for trade in detail, and

(3) To identify new industries in the Netherlands where biomass is used as an energy carrier, or has the potential to be used in the future, and to describe which drivers, bottlenecks and opportunities these sectors see for the (increased) use of biomass;

### Domestic biomass use

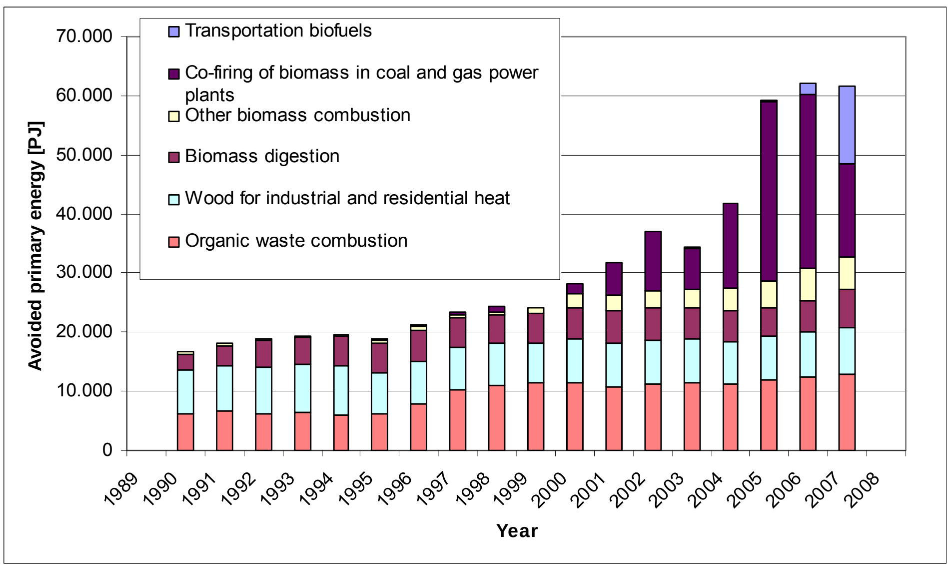



Figure ES-1 Avoided fossil primary energy consumption by production of electricity, heat and transportation fuels from biomass. Source: CBS Statline, BCS 2009d.

The consumption of biomass in the Netherlands decreased slightly from 62,1 to 61,6 PJ in the period 2006-2007 (see figure ES-1). This is mainly caused by a decrease in co-firing (from 28.5 to 15,7 PJ) as a result of an dramatic decrease in the use of liquid biomass like palm oil. The decrease is partly counteracted by a significant increase in use of liquid transport fuels. In 2007, more than 9,3 PJ of biodiesel was consumed in the Netherlands, almost tenfold the amount that was used in 2006. For biogasoline the consumption in 2007 was more than 3,6 PJ compared to approximately 1,0 PJ in 2006. Regarding the use of domestic biomass resources,

**Biomass import/export**

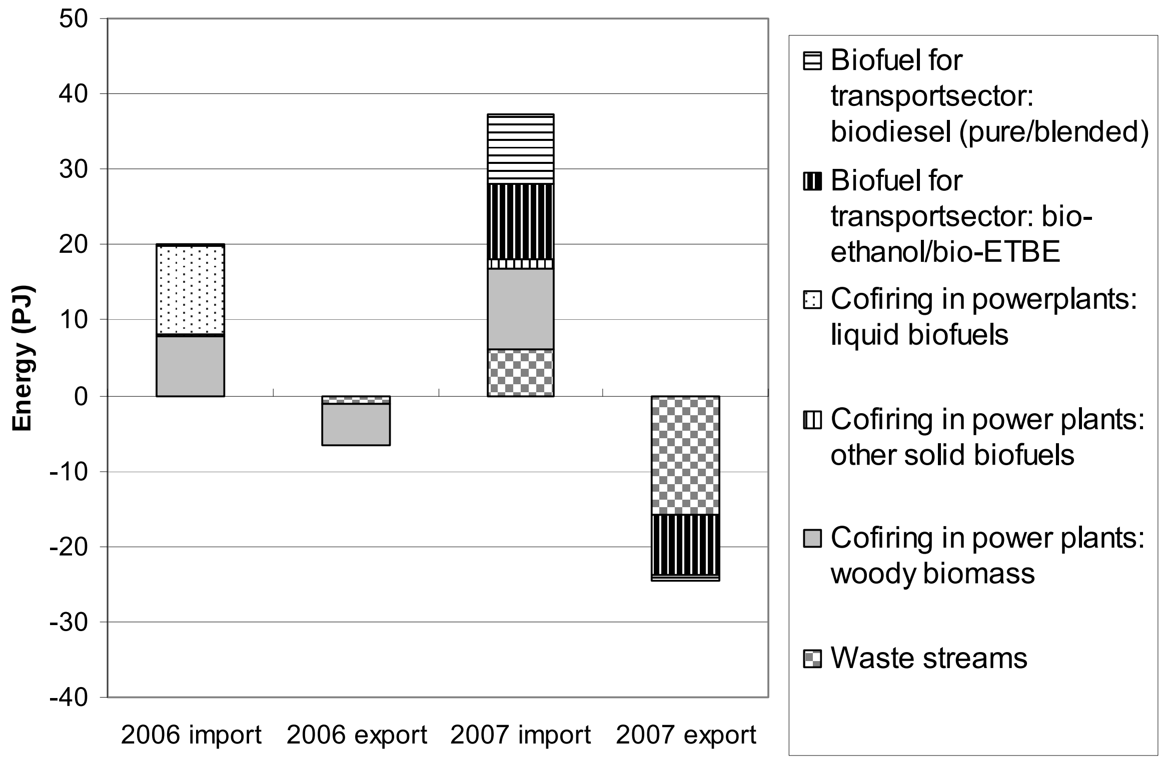



Figure ES-2: Dutch total net import and export of biomass used for energy end-uses in the year 2006 and 2007

In comparison to the total consumption of biomass for energy purposes in the Netherlands in 2007 (61,6 PJ), both the total net imports (37,2 PJ) and net exports (24,6 PJ) are substantial. They show that on the one hand, the Netherlands rely heavily on imports, especially for cofiring in power plants and for liquid transportation fuels. The consumption of biomass for co-firing amounted to 15,7 PJ in 2007, of which 11,9 PJ were imported (i.e. 75%). In case of biofuels for transport, the Netherlands basically depend almost entirely on imported ethanol and biodiesel. On the other hand, they show that still significant amounts of waste streams are available, of which large amounts were exported up to 2007. The export of used wood is however expected to decrease significantly in the future, mainly because of the development of new bio-energy installations in the Netherlands (especially stand-alone b-wood incineration), increasing domestic demand. Note that for 2006, very little data on import and export of biomass waste streams was available. Thus, the trade data for 2006 is likely incomplete and too low.

## Barriers and Opportunities for bioenergy trade and utilization

- One of the biggest barriers for increase use of biomass for electricity production is the uncertainty regarding subsidies for co-firing, i.e. commitments under the former MEP system (which still is responsible for the majority of imports) and the uncertainty whether the current SDE feed-in premium system for renewable electricity will include co-firing of wood pellets and other biomass types in the future.

- Concerns regarding the sustainable production is a barrier for the use of certain biomass streams, such as palm kernel expeller, and all liquid biomass streams in general (and especially palm oil and soy bean oil). It is a real problem that currently no label/certification system is in place. However, recently the first palm oil plantations have been RSPO –certified, and it is now investigated, whether the palm kernel expeller form these plantations are then automatically also RSPO-certified / sustainable. On the other hand, for many biomass streams used as animal feed (e.g. sunflower husk), the issue of sustainability plays a much lesser role.

- The import of heavily subsidized biodiesel from the US has been on the one hand a strong driver for increasing trade, but on the other hand has proven detrimental for the production of biodiesel in the Netherlands.  While the European Commission introduced provisional anti-dumping and countervailing measures against imported US biodiesel in March 2009 (and on July 7th 2009 extended these measures for 5 years), Dutch traders reported that this led in practice to biodiesel being exported form the US to Canada, and from there to Europe, thereby circumventing these measures.

- An opportunity for trade was created by collapsing ocean dry bulk freight rates, leading to lower transport costs. However, as many traders have often fixed transport rates significant time ahead, the effects are not as strong as could be expected.

- The weak US dollar against the Euro has especially aided the export of wood pellets from North America to Europe.

- The housing crisis in the USA has caused prices for wood to decline strongly, which enables the pellet plants in the US to use wood as feedstock for wood pellet production which are subsequently exported to Europe. On the other hand, the reduced amount of wood being processed also means reduced availability of saw dust. The resource availability is and remains a concern on the longer term.

## Utilization of biomass in new industries

For a number of industry sectors, an overview of current biomass use was made. I short, only the cement industry uses significant amount of biomass. It has been strongly increasing its use of biomass waste streams from 0% in 1996 to 44% in 2007, equaling a biomass use of 1.49 PJ. Sewage sludge is the principal biomass source, other biomass feedstocks being still significant quantities of bone meal, paper sludge and plastic-paper derived fuel. The entire agricultural sector has the target to use 200 PJ, of which the food and grocery industry has a large share: about 75 –125 PJ. This is a very ambitious target, given the current estimated use of only 0.4 PJ in 2006. Only in a few cases, biomass waste streams (e.g. spent coffee ground, rejected food products, animal fats, manure) and waste water are currently used to produce either process steam (in boilers) or biogas (through digesters). None of the other industry sectors investigated (manufacture of chemical & pharmaceutical products, basic metals coke and refined petroleum products) is currently using biomass for energy purposes.

# Acknowledgments and disclaimers

This country report was written for both IEA Bioenergy Task 40 and EUBIONETIII. The sole responsibility for the content of this report lies with the authors. It does not necessarily reflect the opinion of the European Communities. The European Commission is not responsible for any use that may be made of the information contained therein. Neither do the analyses and conclusions necessarily represent the opinion of the IEA Bioenergy Implementing Agreement, or of Dutch policy makers.

The authors of the Task 40 country report would like to thank a number of persons who have been particularly helpful:

- Ric Hoefnagels and Martin Junginger, for providing an excellent base of information sources and guiding us through the process of making the report.
- Reinoud Segers of CBS for the help he provided in interpreting the information of the StatLine database, and his insights regarding the CBS data collection methods.
- Bas van Huet and Timo Gerlagh of SenterNovem for their extensive help on the topic of biomass waste streams and providing waste statistics.
- Frank Bergmans of MVO, for his knowledge on liquid biomass.
- Hein Aberson of Solaroilsystems B.V., who provided massive information about the production and lifecycle of pure vegetable oils (PPOs).
- And all the contact persons of the power plants and waste incineration plants, for their positive attitude towards this project and all the information they so willingly provided.

Finally, Martin Junginger would like to thank Paul Alfing (FNLI), Jorrit Hachmer (Essent), Jan Theulen and Frans Erens (ENCI Maastricht), Francis van Marle (Nidera), Marleen Vermeulen (Nidera), and Gijs Voskuilen (Saralee) for their time and contributions to the EUBIONETIII country report.

**Update 2010:**

For 2010 an update is made of most sections of the detailed 2009 report. Section 2 is an overview of the energy consumption in the Netherlands and is fully updated with 2009 data. Data provided in section 4 (domestic biomass supply) is updated, including the related text, the other parts of this section are assumed to be consistent for 2009 also. Of section 5 only paragraph 5.1 till 5.3, covering a general overview of biomass use, especially waste incineration and cofiring in the Netherlands are updated. Section 6 covers the biomass prices and is fully updated. Import and export data is shown in section 7, thereof only the first two paragraphs (7.1 and 7.2) are updated.

# Table of Contents

# 1. Introduction

In the face of a growing demand for sustainable energy sources, the importance of bioenergy is increasing. This is partly reflected in the increase of bioenergy trade during the last few years. Main drivers concerning this trade are reduction of greenhouse gas emissions, a diversification of the fuel supply and the availability of low-costs biomass feedstocks in one region and demand for this feedstock (or refined bioenergy commodity) in another. However, many bioenergy markets are however immature at the moment. This is in particular true for the demand side of the market; many biomass markets, e.g. for solid fuels, rely on policy objectives and incentives, which may change over time and often have proven to be unpredictable (Faaij et al, 2006). In order to secure further investments and sustain the growth of bioenergy markets, the supply and demand side of the market needs to be balanced and distortions have to be avoided. Bioenergy markets are however poorly mapped and the available analyses, statistics and modeling exercises are limited (Faaij et al, 2006). Consequently, the knowledge and insights on the relevant market mechanisms and trade flows are relatively poor, making it difficult to manage and organize a stable and sustainable bioenergy market.

In 2004 IEA Bioenergy Task 40 was initiated an (Task 40) to assemble available information concerning the countries' experience with determining, exploiting and developing biomass resources and the development of stable bio-energy markets. Another crucial point is securing the sustainability of biomass production. Its main goal is to identify the possibilities, constraints and criteria for sustainable and global trade of biomass and energy carriers derived from biomass. One of the main products of Task 40 are country reports, in which each member state provides (amongst others) an overview of the import and export flows of biomass for a 1-2 year time frame for their country. This report is an update of the previous Dutch country report of 2008 (Junginger et al, 2008). The aim is to provide an overview regarding all biomass streams in the Netherlands for 2008 and as far as possible, also for 2009. The main focus is on providing information concerning topics that were not analyzed extensively in the former report or have changed substantially in the last few years. These topics are trade in biodiesel, bioethanol and biomass waste streams.

The European project EUBIONETIII carries out analyses of bioenergy trends and reasons for change in different countries and provide an overview of solutions to specific barriers impeding the development of international biomass trade. Moreover, it reports opportunities for further biomass trade development. Special attention is paid to those industrial sectors which to date have not been involved in bioenergy projects. These sectors are identified during the project and could, for example include metal and construction material industries. Three expert group meetings and one international trade event are organized to discuss the most important current market barriers and to formulate strategies and solutions to overcome barriers. At present, large amounts of potential raw material for biomass fuels are traded without knowledge of the bioenergy sector due to immature systems of reporting trade statistics. Development of comprehensive and detailed Combined Nomenclature for raw materials of biomass fuels will facilitate more transparent biomass fuel market, and help to identify types and amounts of raw material that could be available for bioenergy purposes. This work is carried out in cooperation with EUROSTAT and national statistics organisations.

This is the joint Dutch country report for both projects[1]. In summary, the aims of this country report are:

(1) To provide a concise overview of biomass policy, domestic resources, biomass users and biomass prices,

(2) To analyse bioenergy trends and reasons for change in the Netherlands and point out barriers & opportunities for trade in detail, and

(3) To identify new industries in the Netherlands where biomass is used as an energy carrier, or has the potential to be used in the future, and to describe which drivers, bottlenecks and opportunities these sectors see for the (increased) use of biomass;

By 'new industries' we do mean industries which are normally not directly associated with bioenergy. Examples of 'new industries are: metal (e.g. steel, silicon carbide), cement, food processing and construction (brick producing) industries. The forestry, pulp & paper and the energy sectors should be excluded –they are 'classic' bioenergy users, and are in other parts of the EUBIONETIII project. Also, the agricultural production sector (including farmers, pig & poultry producers, greenhouse cultivation, and aviculture as suggested by EUBIONETIII partners) are excluded. However, use of biomass in the food-processing industries (e.g. processing table olives, cocoa, coffee, meat) are included.

By 'energy carrier' we mean that the biomass should be used for energy purposes. e.g. to produce electricity, and/or heat/steam. Examples could be the cement industry (co-firing biomass wastes to produce heat), or a food processing industry (e.g. fermenting their biomass residues to produce heat and electricity). What we are not looking for are industries using biomass to produce biomaterials (e.g. bioplastics) – unless they (also) use biomass to meet their energy requirements. A borderline case is the production of silicon or iron using wood chips or charcoal as reducing agent. In these examples the role of biomass is twofold: it produces the necessary heat for the process (so it's an energy carrier, that's what we are looking for), but it also is actual part of the chemical reaction (getting the oxygen out of the ore, producing pure iron/silicon).

[1] Next to this joint country report, also a separate country report for EUBIONETIII only is available, in which amongst others some of the interviews conducted with traders of biomass are included.

# 2. Energy production and consumption in the Netherlands

## General characteristics

In 2009 the human population grew up to 16.5 million inhabitants (CBS 2010a) with an estimated average GDP of €28 765 in 2009 (CIA 2010). Total land area is approximately 3.39 million hectares; 22% arable land and 1% croplands (CIA 2010). The Netherlands are situated in the North-Western part of Europe, with borders to Belgium, Germany and the Northsea (CIA 2010). Natural resources often named are natural gas, petroleum, peat, limestone, salt, sand and gravel and arable land.

## Main industries

According to the World Factbook the Dutch economy has stable industrial relations, moderate unemployment and inflation rates, a sizable current account surplus and an important role as European transport hub with among others its airports and harbours. Since 2002 the Euro is the official currency, together with other EU partners. Main industrial activities are food processing, chemicals, petroleum refining and electrical machinery. Import and export commodities are machinery and (transport) equipment, chemicals, fuels and foodstuffs (CIA 2010). Agriculture employs only 2% of labour due to its highly mechanized characteristics, although it provides large surpluses for food-processing and export. The economy was hit hard in 2009 (due to the global financial crisis), resulting in declining export and a GDP contraction of 3.9%.

## $CO_2$ reduction requirement

The total emission volume in 2007 amounted to 205 million tonnes of $CO_2$ equivalents (eq.), which is 4 percent below the level of 1990, the base year of the Kyoto Protocol. This is based on calculations conducted by Statistics Netherlands and the Netherlands Environmental Assessment Agency (CBS, 2008).

The reduction by approximately 2 million tonnes of $CO_2$ eq. in 2007 is mainly due to a reduction in the emission of nitrous oxide ($N_2O$) realized by nitric acid plants. The volume of methane ($CH_4$) emissions from landfill sites also diminished (CBS, 2008).

In 2007, an increase in carbon dioxide emissions occurred in the electricity generation process (see figure 2.1). This is due to an increase in electricity consumption by 1 percent and at the same time a decline in imports by 18 percent. As a consequence, in 2007, power stations generated 5 percent more electricity to meet the domestic demand. This resulted in an increase in $CO_2$ emissions by more than 3 million tonnes (CBS, 2008).

According to the Kyoto Protocol, the Netherlands must have reduced its greenhouse gas emissions by an average of 6 percent annually over the period 2008–2012 relative to the base year (1990). Part of the reduction may be realized abroad. The Dutch government can buy emission rights in other countries or finance carbon emission mitigation projects abroad. The emission volume in the base year is set at 213 million tonnes of $CO_2$ equivalents. In 2005, the overall emission volume in the Netherlands dropped under this level for the first time. In the years that followed, the reduction continued (CBS, 2008).

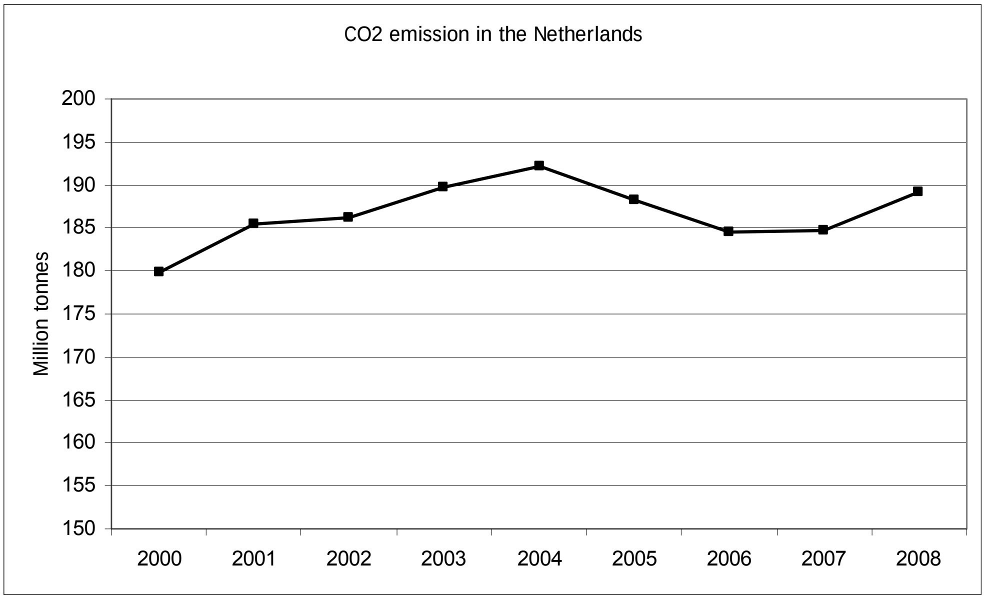



***Figure 2.1: $CO_2$ emission in the Netherlands from 2000 to 2008***

Source: CBS statline, CBS 2010p.

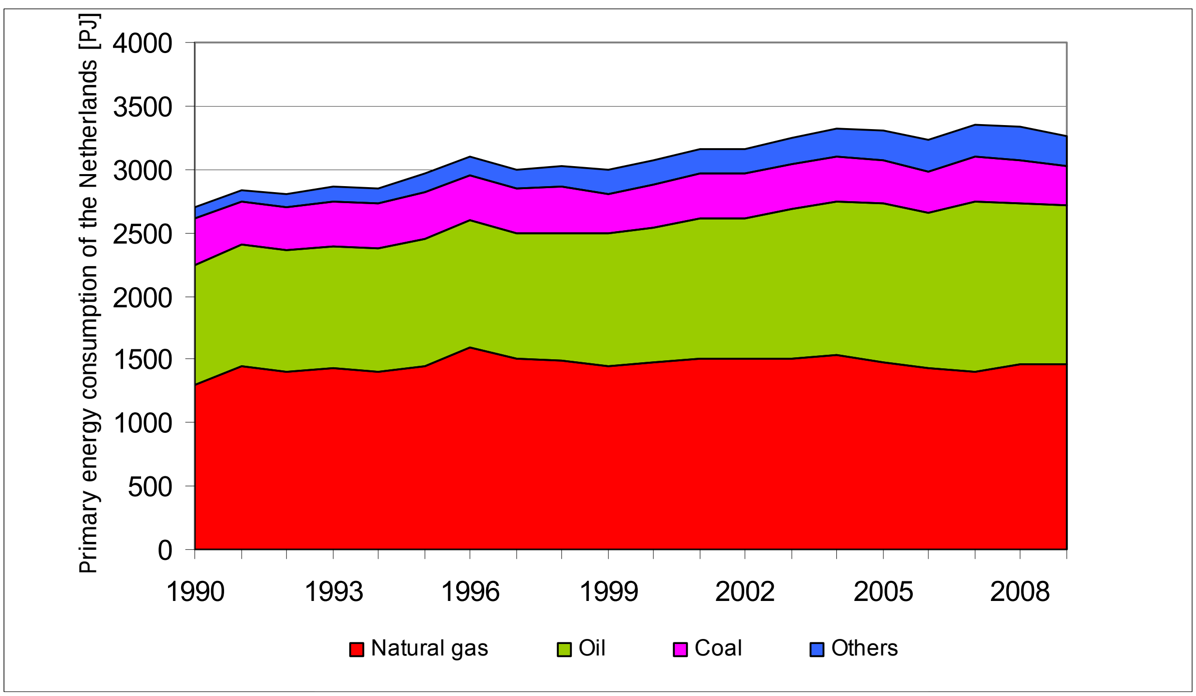



***Figure 2.2: Primary energy consumption from 1990 - 2009***

An overview of primary fossil energy consumption in the Netherlands from 1990 to 2009 by fuel source is given in Figure 2.2. Segment "Others" is mainly heat from biomass and waste. In figure 2.3 an overview of energy sources of the total primary energy supply in 2009. Fossil fuel energy is dominant in the fuel mix. Due to the industrial activities and quality of life industry and households are the most energy intensive sectors, see figure 2.4.

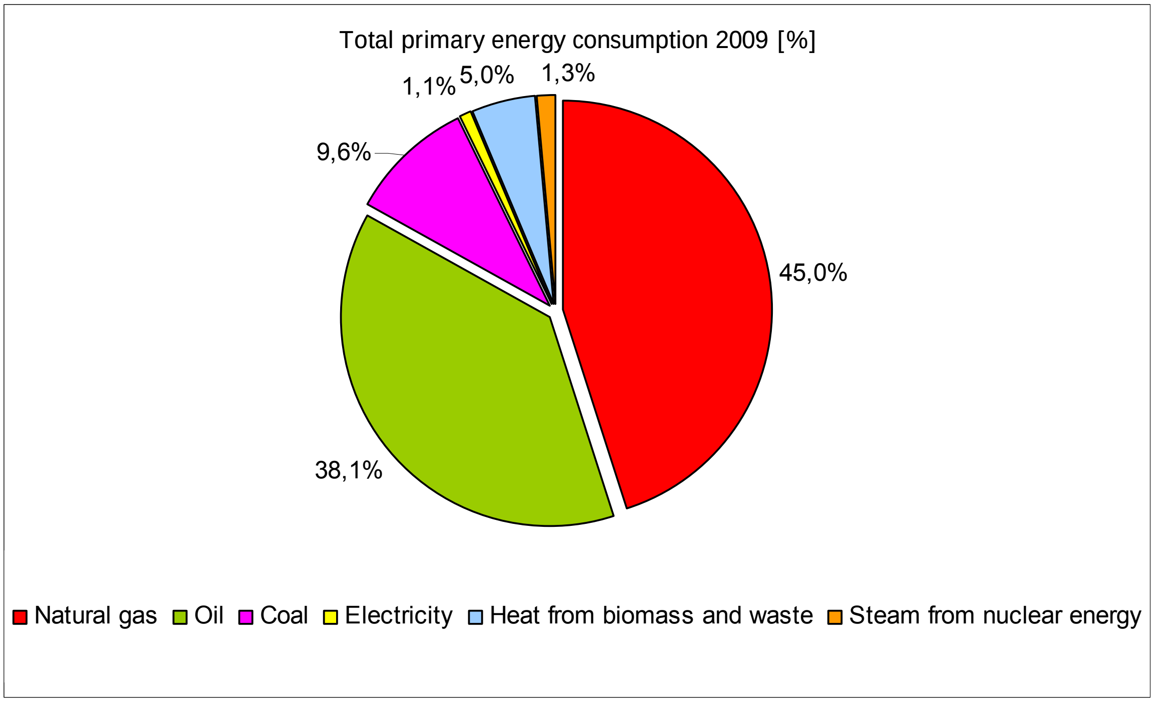



***Figure 2.3: Total primary energy consumption by source in 2009***

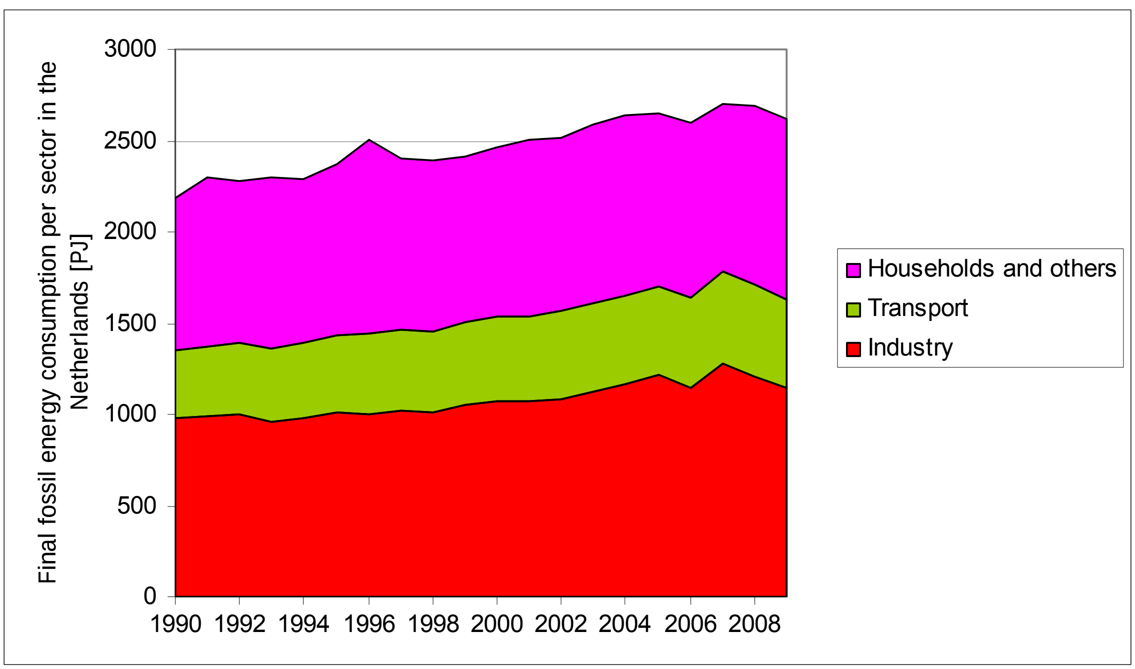



***Figure 2.4: Final fossil energy consumption per sector in the Netherlands in 1990-2009***

Source: CBS statline, CBS 2010j.

Figure 2.5 (electricity generation) and figure 2.6 (heat generation) show the importance of natural gas in the fuel mix.

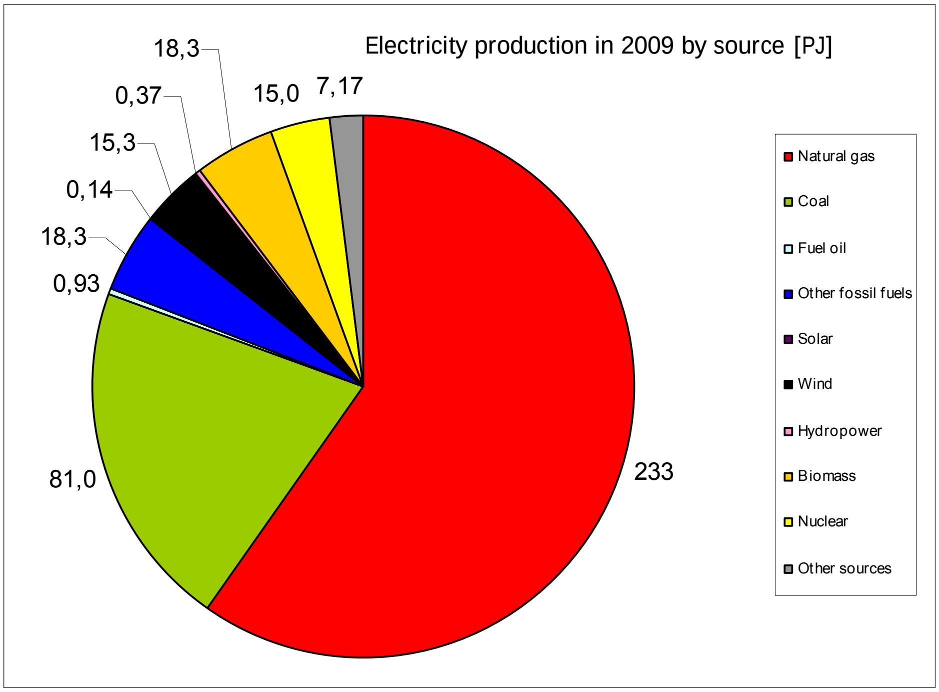



***Figure 2.5: Total electricity consumption per sector in the Netherlands in 2008***

Source: CBS statline, CBS 2009j.

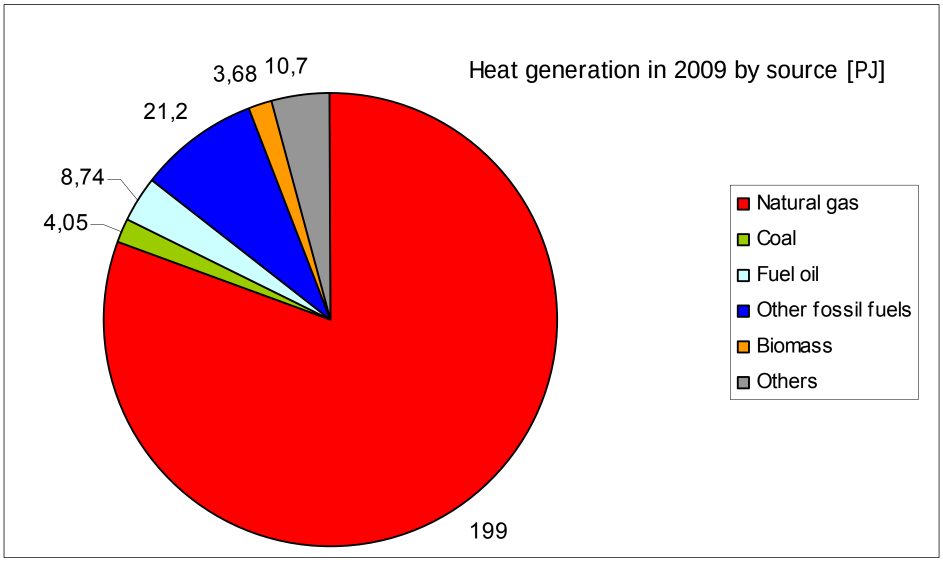



***Figure 2.6: Total heat consumption per sector in the Netherlands in 2008***

Source: CBS statline, CBS 2009j.

A total overview of renewable energy sources in the Netherlands is shown in table 2.7 below. The share of renewable energy in total energy supply is relatively small; 3.9% in 2007.

***Table 2.1: Renewable electricity, heat and fuel production in the Netherlands between 2000 and 2008*** *(CBS 2010e CBS 2010f)*

| | | **2000** | **2001** | **2002** | **2003** | **2004** | **2005** | **2006** | **2007** | **2008** |
|---|---|---|---|---|---|---|---|---|---|---|
| Wind energy | $GWh_e$ | 829 | 825 | 946 | 1318 | 1867 | 2067 | 2733 | 3438 | 4260 |
| Solar energy | $GWh_e$ | 8 | 13 | 17 | 31 | 33 | 34 | 35 | 36 | 38 |
| Hydropower | $GWh_e$ | 142 | 117 | 110 | 72 | 95 | 88 | 106 | 107 | 102 |
| Waste incineration | $GWh_e$ | 1003 | 962 | 942 | 959 | 931 | 1001 | 1029 | 1116 | 1087 |
| Cofiring | $GWh_e$ | 198 | 563 | 1082 | 757 | 1539 | 3310 | 3103 | 1711 | 2116 |
| Other biomass combustion | $GWh_e$ | 216 | 221 | 216 | 205 | 217 | 235 | 235 | 254 | 664 |
| Biogas for electricity | $GWh_E$ | 278 | 291 | 316 | 304 | 282 | 286 | 348 | 488 | 693 |
| | | | | | | | | | | |
| Waste Inceneration | $TJ_{THERMISCH}$ | 3176 | 2849 | 3295 | 3380 | 3491 | 3579 | 3930 | 3910 | 4133 |
| Cofiring | $TJ_{THERMISCH}$ | 15 | 58 | 222 | 81 | 325 | 693 | 552 | 821 | 789 |
| Woodstoves | $TJ_{THERMISCH}$ | 11916 | 11695 | 11520 | 11326 | 11282 | 11384 | 11622 | 11868 | 11994 |
| Other biomass combustion | $TJ_{THERMISCH}$ | 513 | 674 | 943 | 1184 | 1984 | 2248 | 3078 | 3262 | 3340 |
| | | | | | | | | | | |
| Biogasoline | $TJ_{FUEL}$ | - | - | - | - | - | - | 1010 | 3687 | 4524 |
| Biodiesel | $TJ_{FUEL}$ | n.k. | n.k. | n.k. | 134 | 134 | 101 | 968 | 9344 | 7524 |
| | | | | | | | | | | |
| Biogas not for conversion | TJ | 1836 | 1714 | 1469 | 1469 | 1683 | 1530 | 1438 | 1224 | 1193 |

# 3. Energy Policy

**Energy situation**

The current Dutch energy situation is characterised by a primary energy consumption of 3.3 EJ (2009). The main energy sources are natural gas (1.5 EJ), oil (1.3 EJ) and coal (0.3 EJ). Renewable energy sources currently make a contribution of 0.1 EJ (avoided primary).

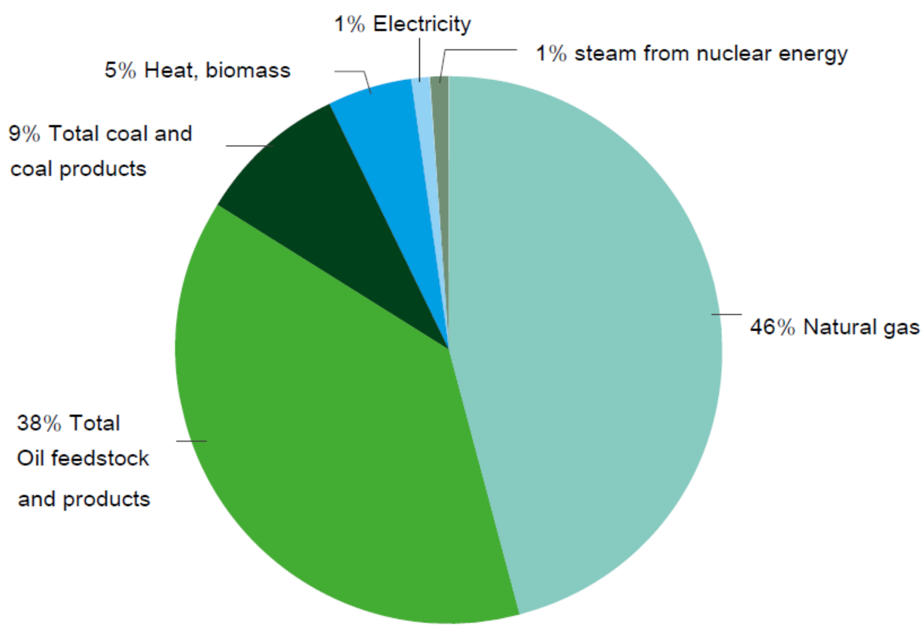



***Figure 3.1 Energy consumption in the Netherlands 2009: total 3.3 EJ (Source: CBS Statline)***

**Strategy**

In order to obtain sufficient energy from renewable sources, market players need to be provided with a stable investment climate with long-term prospects in the Netherlands. A vision, strategy and agenda for the medium-term (with long-term prospects up to 2020 and 2050) are set out in the 2008 energy report. Central policy themes in this report include economically efficient energy supply, a sustainable energy mix for the Netherlands and associated adequate infrastructure. The strategy for ensuring the creation of an energy supply in the Netherlands that can meet the demand for energy in a sustainable manner comprises the following three main elements:

- Making the supply of energy cleaner and more efficient through the encouragement of energy savings, the production of more renewable energy and the capture and storage of $CO_2$ .
- The promotion of smoothly running energy markets in which consumers of energy occupy a central position and in which there is total freedom for energy innovations at central and local level.
- Creation of a healthy and stable investment climate for all energy options by defining a clear framework and procedures, with additional incentives where necessary.

This must result in a clean, affordable and secure energy supply. The Dutch government does not set out a blueprint for sustainable energy management, but provides targets and a framework, incentives and direction.

**Less energy, more diversification**

Energy saving is also a cornerstone of the energy policy. The target for Clean and Efficient energy saving is 2% per annum. Further diversification of the fuel mix is also required in the form of coal-fired and nuclear power stations. In the case of coal-fired power stations, the capture and storage of $CO_2$ (CCS) is essential in order to achieve the $CO_2$ emission reduction target. For this reason, the cabinet is driving forward the development of CCS. Various nuclear energy scenarios are also currently under consideration. The next cabinet will decide on these options.

**Renewable energy**

Along with energy savings and diversification, there are also good reasons for investing in renewable energy. The Dutch renewable energy policy is driven by the need to help tackle the climate problem, to safeguard a secure energy supply and to maintain the long-term affordability of energy. In addition, it is also a major incentive for innovation and economic activity.

**Cabinet targets for 2020**

The cabinet targets for 2020, as set out in the Clean and Efficient Work Programme are to enable the achievement of a 30% reduction in $CO_2$ in 2020 compared with 1990, a renewable energy share of 20% in 2020 and an annual energy saving of 2% as from 2011.

**Avoided primary energy and gross final energy**

The Dutch method for calculating renewable energy and the method from the Renewable Energy Directive differ from one another. The Dutch method for calculating the renewable energy contribution is known as the substitution method. This method examines what the primary energy consumption would be in a reference situation if no use were made of renewable energy. The method from the Renewable Energy Directive is based on the gross final energy (the denominator) and focuses on the component of this energy that is derived from renewable sources. The expected 14.5% gross final energy in 2020 in this action plan corresponds to 15.5% according to the substitution method.

**Clean and Efficient strategy**

The strategy aims to achieve the Clean and Efficient objectives in three phases;  1) Make advances using technologies and policy instruments that are already available. 2) Pave the way for further advances by working on options that will come to fruition over a number of years; 3) further innovations through the implementation of an innovation agenda for the medium and long term. This strategy will be implemented by means of a broad and coherent portfolio of instruments (see 4.1).

**Government and market working together**

The government wishes to tackle these challenges together with society. By doing this, the government can build up greater momentum than it would by imposing measures on society. In the 'energy transition', the government and market work together, focusing particularly on the transition paths which offer the best opportunities for the Netherlands. Common goals and paths are defined by making covenants and agreements.

**Central instruments**

A number of instruments are central to the achievement of an increase in the renewable energy share;

- The Stimuleringsregeling Duurzame Energieproductie – SDE [Incentive Scheme for Sustainable Energy Production] is a financial instrument. Renewable energy in the electricity, heat and gas sectors is subsidised through this scheme.
- The Verplichting Biobrandstoffen [Biofuels Obligation] is an instrument which specifies a mandatory minimum share for petrol and diesel substitutes in the transport sector.
- The Rijkscoördinatieregeling - RCR [Government Coordination Scheme] facilitates the coordination of licences for major energy infrastructure projects and renewable energy projects. The aim of this scheme is to speed up the licensing process.

- The aim of the Wet algemene bepalingen omgevingsrecht - Wabo [law governing the general provisions of the Environment Act] is to speed up the licensing procedures for small-scale renewable energy installations and increase transparency.
- The aim of the 'Voorrang voor duurzaam' ['Priority for sustainable'] bill is to give priority to sustainable energy in the energy network in the event of congestion.

**Policy instruments**

The Reference Projections - Energy and Emission 2010- 2020 are based on the projections for the long-term SDE which the Minister for Economic Affairs sent to the House in her letter of 17 April. These projections contain the indicative development of renewable electricity up to 2020, in which cost effectiveness is a key condition: large-scale additional burning and combined burning of biomass in coal-fired power stations, onshore and offshore wind energy are the dominant aspects of this scenario.

**Target range**

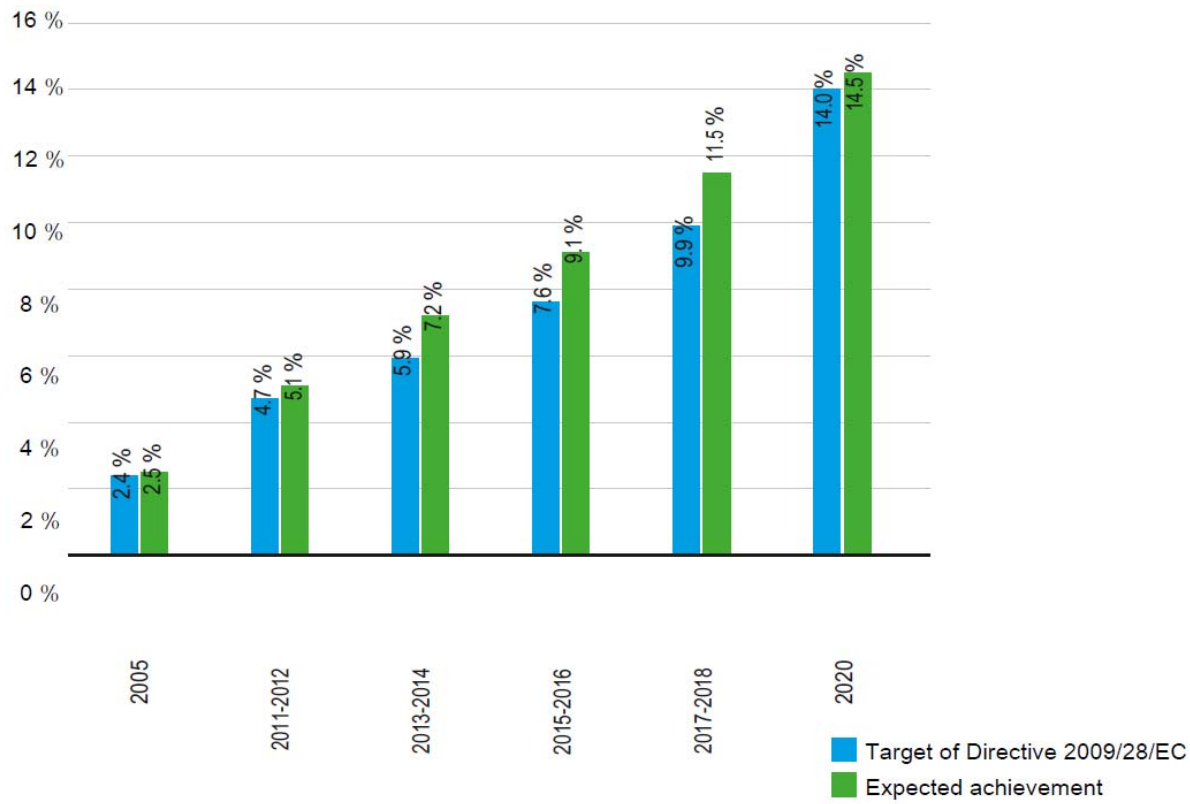



**Figure 3.2 Target of the Renewable Energy Directive and expected achievement**

Figure 3.2 shows the expected achievement and the indicative targets from the Renewable Energy Directive. Nederland expects to achieve the target from the Renewable Energy Directive for the general share of energy from renewable sources. This target from the Renewable Energy Directive for 2020 is 14.0%. The expectation is that the the renewable energy share could be 14.5% in 2020. With regard to the indicative trajectory, the Netherlands expects an achievement above this trajectory up to 2018. The indicative figure for 2011-2012 is 4.7%. The expected average achievement for the year 2011-2012 is 5.1%. The target from the Renewable Energy Directive of 10.0% within the transport sector is also expected to be achieved.

The expected achievement on the basis of the reference projections and additional assumptions regarding the share of fuels in Article 21(2) of the Renewable Energy Directive is 10.3% renewable energy within the transport sector.

**Uncertainties**

Long-term projections are notoriously uncertain. For this reason, ECN/PBL assume a range within which the renewable energy share will move. The range reflects a 95% certainty interval and amounts to 12% - 15%, whereby the projected 14.5% in this action plan lies at the upper end of this range. It should be noted here that this share is achievable, but only on condition that the construction of sustainable options is not delayed and an adequate budget is made available to finance these options.

# 4. Domestic Biomass Supply

This chapter will elaborate on the domestic supply of biomass suitable for energy purposes. First, the yields from the cultivation of dedicated energy crops, the yearly available biomass waste streams and their actual application for energy purposes will be analysed. The results will then be summarized in a comprehensive overview in the form of a table. The chapter will be concluded with a brief assessment on the future potential of domestic biomass production for the Netherlands.

## 4.1 Cultivation of dedicated energy crops

In the Netherlands, cultivation of dedicated energy crops does not take place on a significant scale. Rapeseed is being harvested in relatively small amounts. In addition a minor effort is taken on cultivation of energy wood. From 1999 an experimental forest of willow trees was planted in the province of Flevoland. Since 2002 wood has been harvested (SenterNovem, 2005). The wood is chipped and used as fuel for the stand-alone wood combustion installation near Lelystad (see chapter 4). In 2006, the yield amounted to roughly 290 tonne of fresh wood (Vonk, 2006) and was projected to be about the same in 2007. The yield corresponds to 3 TJ. This amount is negligible compared to the domestic biomass waste streams utilized for energy purposes as described in the next section.

## 4.2 Biomass waste streams

This section focuses on biomass waste streams that are currently economically attractive to use for energy purposes and already contributed substantially to renewable energy production in 2007 and 2008 .

***Table 4.1: Biomass waste stream specification***

| **Biomass waste stream** |
|---|
| ***'Green'*** |
| Fresh residue wood (woodblocks, shredded wood) |
| Clean residue wood from wood processing industry (sawdust/curls) |
| Discarded frying oil |
| Animal fats |
| Animal meal |
| ***'Orange'*** |
| Used wood (A, B, C quality) |
| Municipal solid waste (MSW) |
| Paper sludge |
| Refuse Derived Fuel (RDF) |

Table 4.1 distinguishes 'green' and 'orange' waste streams. This is done according to the categorization offered by the European Union. This is a broad categorization for the distinction of all types of waste (EVOA, 2006). The green list entails 'clean' biomass waste and the 'orange' entails biomass waste that includes hazardous substances.

Agro residues such as straw, verge grass, reed, hay and several by-products from the food and beverage industry are currently only utilized marginally for energy purposes, and will therefore be ignored. Often these resources turn out to generate more added value (or less negative value) when used for purposes other than energy generation like animal fodder or fertilization of agricultural land. Another reason for the marginal application for energy purposes is the highly dispersed harvest of feedstock causing substantial logistic difficulties for central utilization. A sizeable amount of these streams is however being used locally, especially within digestion installations for the production of biogas. The production of biogas, has increased with 23% from 2006 and corresponded to 9.4 PJ in 2008 (CBS, 2010a). The produced biogas is primarily being combusted near the source for heat and electricity generation (see chapter 5 for electricity and heat production).

### 4.2.1 'Green' Biomass Waste-Streams

In the following the quantitative as well as the qualitative characteristics of the separate streams will be described briefly.

#### Fresh residue wood

Fresh residue wood is a term to denote harvested wood like pruning waste from municipalities and tree nurseries and woodblocks from forestry. In total over 1 Mtonne of fresh residue wood is released from forests, parks, households and from the fruit and tree cultivation sector (Koppejan, 2005). Because of the highly diversified way fresh residue wood is being gained and the local character of the distribution of the streams a good estimate on the amount of being used for energy purposes is impossible at the moment. A report from the Dutch energy consultancy Ecofys states that currently about 275 kton (dry weight) is being retrieved from the Dutch forests as firewood and energy wood (Kuiper, 2008).

#### Clean residue wood from wood processing industry

Clean residue wood represents the wood that is discharged during the processing of wood to products (sawdust, curls short-wood, etc.). In the Netherlands about 351,5 ktonne dry industrial rest wood is being collected yearly, the imports sum up to 78,5 ktonne and export is negligible (Leek et al, 2009). The residue wood is being processed into various kinds of products like flooring for livestock or domestic animals boxes (litter), in particle boards but also energy pellets. The products are used in the Netherlands but exported as well. In addition, it is also being directly used for energy generation by combustion, digestion or gasification.

#### Discarded frying oil

Discarded frying oil is collected from around 44.000 catering and hotel occurrences. About 50 collectors gather 60 ktonne of discarded frying oil each year. In addition the Netherlands import 60 ktonne, primarily from Germany and Belgium (Bergmans, 2009).

#### Animal fat

Animal fat is a waste stream submitted by slaughterhouses. The total production of animal fat in the Netherlands equals 206 ktonne. Next to that substantial imports and exports take place.

#### Animal Meal

Animal meal is being produced throughout the production of animal fats from animal carcasses and slaughter waste. About 46 ktonne becomes available each year that is primarily being used for heat and electricity generation (Koppejan, 2005).

### 4.2.2 ‘Orange’ Biomass Waste-Streams

#### Used Wood

Used wood includes all wood available after usage (post-consumer wood). Depending on its former function the used wood can be contaminated. The contamination is being expressed by a simple categorization; A (clean), B (contaminated; painted, laminated), C (impregnated).

An important development in the Dutch used wood market is the realisation of three new wood burning installations that are producing renewable electricity from burning shredded B-wood and a little A-wood (see chapter 5). In 2009, they are fully operational increasing domestic demand and therefore diminishing the export of used wood. C-wood is still being exported to Germany and Sweden (Leek et al., 2009).

#### Municipal solid waste (MSW)

MSW is collected from households and industry sectors to be burned in a waste incineration plant. Dutch policy concerning the treatment of MSW is based on ‘the ladder of Lansink’ (Remco Houtkamp, AEB). This prescribes the treatment of waste so that the highest value is retained from the waste. Therefore the MSW will be preferably separated and recycled to maximize the reuse of materials. When this is economically not viable the waste should be incinerated or converted trough composting, gasification or digestion. In the end only a small fraction (2%, CBS Statline, 2009k) of the waste is land filled (including ashes from waste incineration).

An extensive part of this waste is being sorted at the source. Virtually all Dutch households separate glass, paper & cardboard and often organic waste. Still the largest part is being collected as mixed waste, some of it is still being sorted mechanically, but the bulk is incinerated directly. Mixed municipal waste consists out of all types of waste and the embedded energy is for 48 % accountable to biogenic components (Houtkamp, 2009), meaning only 48 % of the energy can be attributed to renewable/biomass.

#### Paper sludge

Paper sludge is produced out of the residue during the de-inking of old paper before recycling and sludge from wastewater purifiers in the paper industry. The yearly amount of paper sludge being produced in the Netherlands is roughly estimated around 3 Mtonne (Koppejan, 2005). Paper sludge is predominantly being processed without energy recovering at the moment. Still, a substantial amount of paper sludge is also being co-fired in cement ovens and coal fired power plants.

#### Refuse Derived Fuel (RDF)

RDF is produced by shredding and dehydrating MSW. Non combustible waste is removed by mechanical separation. The so-called ‘fluff’ resulting can be used directly but can also be further processed into pellets. All RDF produced in the Netherlands , whether it is fluff or pellets, is currently being exported (Huet, 2009).

## 4.3 Quantitative Overview

The overview indicates the domestic production of biomass for energy purposes in ktonne and the corresponding energy content. For illustrative reasons the domestic consumption of those streams has been added to the overview as well.

***Table 4.5: Domestic supply and consumption of biomass for energy purposes in 2009 (Koppejan 2009)***

| **Category** | **Domestic production (PJ LHV)** | **Availability (PJ LHV)** | **Consumption (PJ LHV)** |
|---|---|---|---|
| Agricultural residues | 51.6 | 1.3 | 0.08 |
| Clean wood residues | 48.4 | 13.9 | 10.9 |
| Energy crops | 155.4 | 0.24 | 0.24 |
| Food and food processing industry | 69.6 | 13.6 | 4.0 |
| Non agricultural biomass residues | 41.2 | 1.5 | 0.795 |
| Animal waste | 35.9 | 18.1 | 6.8 |
| Sludge, including paper sludge | 6.6 | 2.0 | 0.95 |
| Waste | 80.1 | 73.0 | 61.5 |
| Solid recovered fuels | 0.0 | 1.8 | 0 |
| **Total** | **489** | **124** | **85** |

Competition with food, animal feed, animal bedding and other application make up the difference between production and availability. Prices of biomass supply make up the difference between availability and consumption. Due to fluctuations in supply and demand costs also fluctuates.

Future supply is strongly depended on bio-energy market and policy development. Only with a strong focus on climate change mitigation options the (regional) demand for bio-energy, and consequently supply will increase (Koppejan 2009). According to Koppejan 2009 all biomass and biogenic waste streams are playing a significant role. All supply options are expected to increase in ratio, only the increase of kitchen and garden waste collection is relatively high.

As seen from the earlier fluctuation in supply and demand of bio-energy streams it is difficult to predict future biomass demand. The demand is strongly depended on policy targets and consistency and determination of policy makers.

## 4.4 Future Potential

### 4.4.1 Domestic waste streams

The domestic supply of biomass waste is not likely to change significantly on the short term. Neither is the demand for alternative uses of the 'green' streams and therefore the availability of those streams for energy purposes. The Orange streams of used wood and RDF, however, are predominantly exported at the moment but are likely to be used more in the Netherlands in the future. For used wood, this is clearly happening already now that there are three new stand-alone wood incineration plants in operation.

Still, there is a large potential in organic residues from agriculture, nature and landscape maintenance. For energy purposes the demand is mainly focused on woody biomass and already a substantial amount of fresh residue wood is being used (as can be seen from table 4.5). There is no significant demand for non-woody residue streams like verge grass, straw and reed. While these offer potential because they are already being harvested during terrain maintenance and therefore include no additional costs (except for transport). The potential of these streams is shown in table 4.5. However, in utilizing this potential some major hurdles have to be overcome. First off all, a significant problem is the lack of technology to use non-woody biomass for energy generation, the quality of the biomass is uncertain because of different composition, legal restriction on the use of grass from nature in fermentation facilities, uncertainty on return of investment, highly dispersed harvest causing logistic challenges (Spijker et al, 2008).

### 4.4.2 Domestic cultivation of Energy crops

Cultivation of energy wood is currently done on an experimental scale. There has been decided upon up scaling the experiment from roughly 40 ha to 60 ha (Vonk, 2008), increasing future yield from 290 tonne to 435 tonne of fresh wood (from approximately 3 to 4,5 TJ). No other related project of any significance is being initiated in the Netherlands.

At the moment approximately 3200 ha of arable area is used for rapeseed cultivation in the Netherlands. Several studies have focused on the total available area for rapeseed cultivation in the Netherlands with highly different results ranging from 5.000 ha to over 100.000ha. Projections are highly uncertain because the development depends on many uncertain factors like relative prices of other agricultural products and of oil, future policy like directives and tax schemes on fuels and the technological development of second generation biofuels.

# 5. The use of biomass for energy purposes in the Netherlands

This chapter analyzes the consumption of biomass for renewable energy production in the Netherlands for the year 2009. The chapter starts with a general overview of biomass use for energy purposes and the related fossil fuel avoidance. The rest of the chapter elaborates the different categories indicated in the general overview.

## 5.1 General Overview

A general overview of used biomass for 2000 – 2009 is shown in table 2.7. Figure 5.1 shows the overall effect on the avoided fossil primary energy. Due to the sustainability issues regarding palm oil the element cofiring highly fluctuates. Also the amount of biodiesel (part of transportation fuels) changes significantly, see table 2.7.

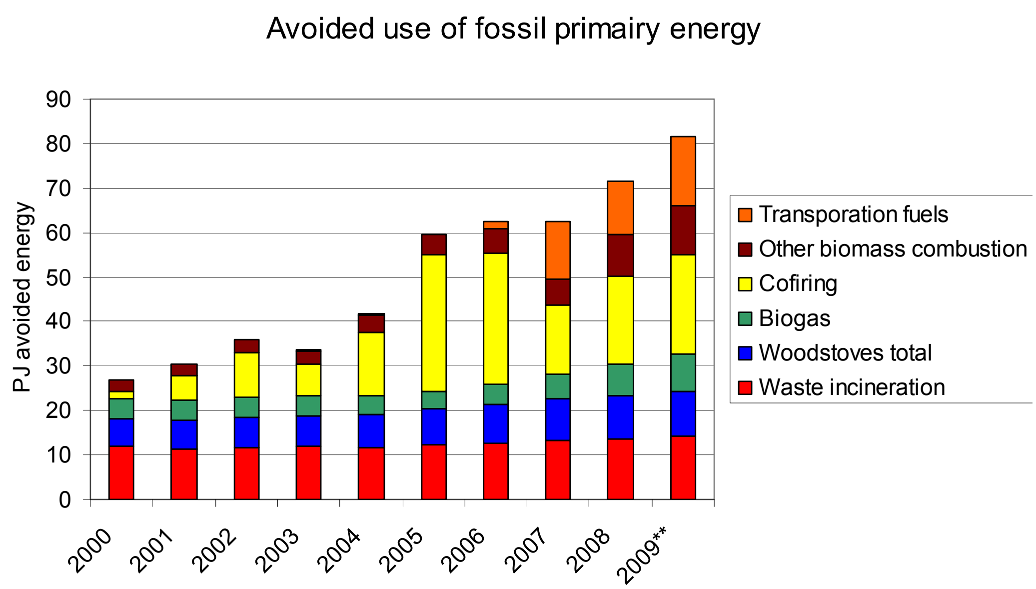



***Figure 5.1: Avoided fossil primary energy consumption by production of electricity, heat and transportation fuels from biomass***

Source: CBS Statline, BCS 2009d. Data for 2009 is preliminary.

## 5.2 Waste Incineration

In the Netherlands there are eleven large-scale waste incineration plants (AVIs) that incinerate MSW (KEMA, 2008). Some AVIs co-fire minor amounts of wood pellets or B-wood as well (these fuels are included in the statistics). AVIs produce heat and electricity. The feedstock also contains non-renewable matter therefore a correction on electricity production is applied. This reduction includes the percentage organic matter and the plants own electricity usage. The heat is usually used in a power plant, local industrial sites, or in district heating systems. Some plants do not provide heat to these systems yet, but are looking into the possibilities of delivering this additional service in the future.

***Table 5.2: The delivering of heat from AVIs to various industrial and residential sites***

| | **Delivering to:** |
|---|---|
| AEB Amsterdam | Amsterdam North, Commercial park 'Westpoort", DWR and -Nieuw West [1,3] |
| ARN Nijmegen | Sewer treatment plant 'Rivierenland' [1] |
| AVR Duiven | District heating system Duiven [1] |
| AVR Rotterdam | Plans to deliver heat to Rotterdam [2,3] |
| AVR Rozenburg | Destilled water production plant and processes of Tronox [1] |
| Essent Milieu Moerdijk | Power plant of Essent Moerdijk. This power plants delivers CHP heat to Shell Moerdijk [2,3] |
| Essent Milieu Wijster | None[4] |
| HVC Alkmaar | Industrial sites, Boekelermeer Zuid and AZ-stadion [1,3] |
| HVC Dordrecht | Researching the possibilities for district heating in Dordrecht, Zwijndrecht and Papendrecht. |
| Sita ReEnergy | Mainly horticulture [1] |
| Twence Hengelo | District heating in Enschede [5] |

1) Source: Senternovem: Energie uit Afval.
2) Source: Environmental reports MSW incinerators.
3) Source: Websites specific MSW incinerators.
4) Source: Toetsingsadvies over het milieueffectrapport Essent milieu wijster 2007.
5) Source: De Twentse courant 2006.

## 5.3 Co-firing in power plants

Co-firing of biomass almost halved from 2006 to 2007. This significant change can be attributed to a drastic decrease in the use of liquid biomass (mainly palm oil). The usage plunged from 15,9 PJ in 2006 to only 0,6 PJ in 2007, whereas the usage of solid biomass slightly increased from 13,4 PJ to 15,4 PJ in the same period. The main causes for the drop in co-firing liquid biomass is most likely the reduction of the MEP subsidy scheme in July 2006 for co-firing, and the sustainability issues rose concerning palm oil. After the initial drop in 2007, however, the co-firing of liquid biomass has been slowly increasing again to a consumption of 3 PJ in 2008. In 2009 the main feedstock for cofiring was solid biomass; its use was relatively stable. Around 650 GWh electricity was produced by cofiring power plants with combustible renewables.

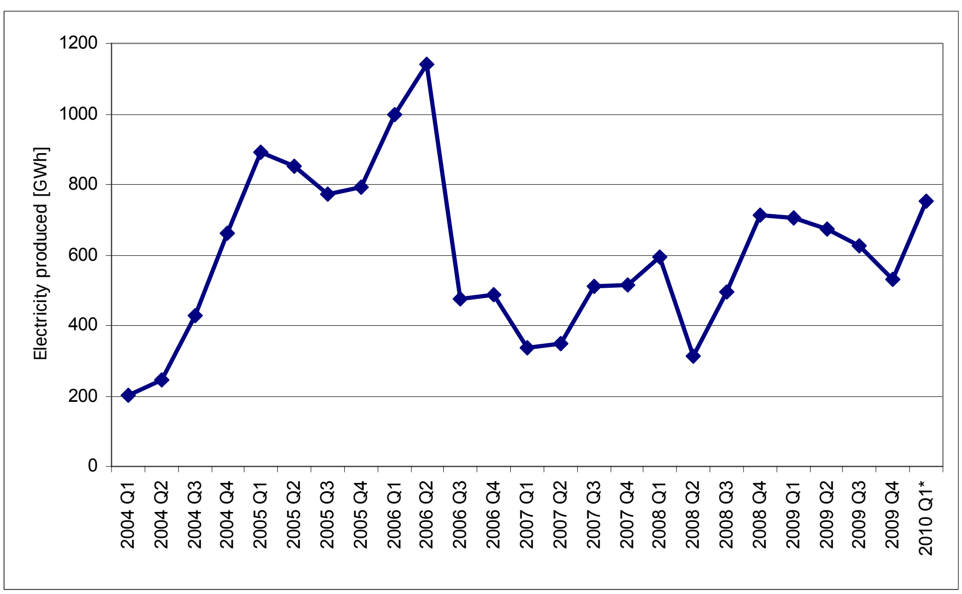



***Figure 5.2: Co-firing of biomass in power plants from 2002 to 2009, including Q1 of -2010, expressed as GWh electricity produced***

Source :CBS Statline 2010 C.
* 2010 data is only preliminary.

From 2007 onwards, the main fuel for co-firing were wood pellets. The use of wood pellets has increased from 450 ktonne in 2006 to 675 ktonne in 2007 and increased to 790 ktonne in 2008. Other important biomass fuels were waste wood, agricultural residues from cocoa processing[2] and various waste streams. For 2009 the wood pellet consumption is estimated to be around 1264 ktonne.  Other fuels were crude palm oil, waste wood[3], and agricultural residues from cocoa processing.

In order to reach the renewable energy targets set by the Dutch government and RES directive, the biomass market is expected to grow. Up to now, the market was mainly using palm oil and wood. The palm oil market is, however, heavily under debate, because of uncertainties regarding the sustainability of the production (Milieudefensie). Furthermore, all subsidy tariffs, except those of woody biomass were lowered. Therefore, it is expected that wood pellets will continue to be the most important biomass source in the near future, and that the demand will continue to increase. (European Pellets Centre, 2007)

The co-firing of palm oil will probably come to a complete stop, as the large power producing companies have stopped buying palm oil. All the palm oil that was used in 2008 was drawn from stocks. Biox is currently the only known company that still uses palm oil for energy purposes in the Netherlands. Biox has been included in the category 'other biomass burning'  (P. Romijn, Essent, 2009; Biox, 2008; Milieudefensie, 2009).  Due to an over enthusiastic

## 5.4 Woodstoves: companies

This category includes all use of waste wood and saw dust in the wood industry and other sectors like agriculture. The input has been estimated based on the heating capacity (obtained from the suppliers) and a constant estimate for the full load hours CBS (2008).

## 5.5 Woodstoves: households

This category entails the use of wood in domestic wood stoves. The number is estimated on the basis of a survey among owners of a wood stove carried out around 2002 by the suppliers of wood stoves CBS (2008). The consumption in this category has been kept stable since then. The main source is locally collected wood from tree felling. A second source of household wood is waste wood from forest maintenance (like Staatsbosbeheer). A third source concerns companies that import wood from Poland, Scandinavia, the Baltic states, Romania and other Eastern European countries. (Gelten, 2009).

## 5.6 Other biomass burning

This category includes the solid and liquid biomass that is incinerated in stand-alone plants, cement ovens, paper mills or at other sites.

During 2008, four new medium-sized installations became operational. Three waste wood combustion installations and one chicken manure incinerator. The overall capacity of these four installations amounts to approximately 90 $MW_e$ and accounted for about 5 percent of renewable electricity production (CBS,

## 5.7 Biogas

Biogas is being produced from various sources (listed in Table 5.5) and is primarily being combusted for heat and electricity generation in gas turbines near the source. A small amount is also being enhanced to natural gas quality and injected into the Dutch natural gas grid.

[2] Cocoa residues are mainly residues from the cocoa industry, and make up out of husk, crushed shells and others. Source: Cargill BV; Jan Schoenmaker BV

[3] Primarily wood dust and B-wood, but it also includes all other wood based fuels, that are not included in the wood pellets fraction.

## 5.8 Biofuels

As shown in figure 5.1, the use of liquid transportation fuels has increased strongly in recent years in the Netherlands. Two main categories can be distinguished: biodiesel (based on vegetable oils and fatty acids) and biogasoline[4].

### 5.8.1 Biogasoline

Bio-ethanol is produced in the Netherlands by the company Nedalco (eBio, 2009) who only occasionally sells ethanol to the fuel market. Bio-ETBE is produced by two companies: LyondellBasell, who has a 650 kton facility in Botlek, harbor of Rotterdam, and Sabic, who has a 155 kton[5] facility in Geleen (Milieudefensie, 2008; Ecofys&SenterNovem, 2005). LyondellBasell converted former MTBE factories into ETBE factories, which is an economically attractive option compared to building new plants. For this, a subsidy scheme was granted by SenterNovem at the end of 2005. The transition was complete by February 2007 (Ecofys & SenterNovem, 2007). As Sabic also produces MTBE in Geleen (Sabic, 2007), it is likely that the ETBE factories here are also converted MTBE factories.

Data on the production of biogasoline in the Netherlands is not transparent at the moment, especially concerning bio-ETBE. Data on the production and the use of feedstocks are considered confidential by the producing companies. Therefore these cannot be included in this report. The consumption however, is being reported by CBS.

### 5.8.2 Biodiesel and pure vegetable oil (PPO)

**Biodiesel**

In 2007 the total production capacity of biodiesel in the Netherlands was 210 ktonne.

***Table 5.7: Biodiesel producers in the Netherlands in 2007***

| Producer | Feedstock | Total capacity (ktonne) | Remarks | Source |
|---|---|---|---|---|
| BEWA | discarded frying oil | 15 | Production started in December 2007 | (1 |
| Biodiesel Kampen (Vierhouten Vet) | discarded frying oil | 50 | Production on hold from April on due to storage difficulties. Used feedstock is a collection of catering waste streams. | (1,(2 |
| Ecoson/Vion | animal fat | 5 | Produces also biogas | (1,(2,(4 |
| Sunoil Biodiesel | discarded frying oil, multiple | 60 | Production started July 2007 | (1,(2,(4 |
| Biovalue | rapeseed oil | 80 | Production started August 2007. Plant expansion projected to 240 ktonne | (1,(2,(3, (5 |
| Total | | 210 | | |

1) Source: MVO (2008).
2) Source: Bersch, F.(2008).
3) Source: Biofuel cities (2008).
4) Source: Senternovem (2005).
5) Source: http://www.biovalue.nl.

4 Biogasoline is defiend here as either bio-ethanol or Ethyl-tertiary-butyl ether (ETBE). Bio-ethanol is either used as a biofuel directly (i.e. blended with fossil gasoline), or it is used to produce ETBE (which again is blended with gasoline).

5 Output of ETBE.

Only the company *Biovalue* used rapeseed for their production of biodiesel in 2007. The amount of required rapeseed for the production of 35 ktonne of biodiesel is 105 ktonne, since approximately one third of the total mass of rapeseed can be converted into oil. It is assumed that all rapeseed (raw) needed for this amount of biodiesel has been imported (all locally produced rapeseed is allocated to the production of PPO). The quantities and origins of imported rapeseed are listed in section 8.3.4. The other companies used other sources, mainly discarded frying oil and animal fat.

In 2008, the capacity increased significantly to roughly 520 ktonne (CBS, 2009f). The main cause of this significant discrepancy will be elaborated in chapter 9. As a consequence, a major part of the planned capacity indicated in table 5.7 is now uncertain or at least delayed.

***Table 5.9: New and planned biodiesel production capacity in the Netherlands since 2007***

| Producer | Feedstock | Capacity (ktonne) | Operational status | Source |
|---|---|---|---|---|
| *New capacity since 2007* | | | | |
| BioDsl | discarded frying oil | 6-10 | start 2008 | (1,(2,(5 |
| Biofueling | multi resources, edible oils | 200 | start 2008 | (1,(2 |
| Biopetrol | rape and soya oils | 400 | start 2008 | (1,(2,(4 |
| Golden Hope /Unimills/Clean energy | multi resources | 250 | start 2008 | (1 |
| DutchBioDiesel | rape oil, edible oils | 200-250 | start 2009 | (1,(2,(4 |
| Rosendaal Energy BV | multi resources, edible oils | 250 | start 2009 | (1,(2,(3,(7 |
| *Planned Capacity* | | | | |
| Argus Oil | rapeseed | 188 | planned start 2009 | (8 |
| CleanerG | edible oils | 220 | planned start 2009 | (2 |
| Wheb Biofuels | multi resources, edible oils | 400 | planned start 2009 | (1,2,4 |
| Biovalue2 | edible oils | 180 | planned start 2010 | (2 |
| J&S Bioenergy (Mercuria Energy Group) | edible oils | 200 | planned start 2010 | (2 |
| Neste Oil | edible oils | 800 | planned start 2011 | (2 |

1) Source: MVO (2008).
2) Source: Bersch, F.(2008).
3) Source: Biofuel cities (2008).
4) Source: Port of Rotterdam (2008).
5) Source: Senternovem (2005).
6) Source: http://www.biovalue.nl.
7) Source:http://www.rosendaal-energy.nl.
8) Source: GrainStrategy (2008)

## Pure vegetable oil (PPO)

There are seven major producers of PPO in the Netherlands

***Table 5.10: PPO production in the Netherlands in 2007***

| Producer | Feedstock | Capacity (ktonne) | Sources |
|---|---|---|---|
| Biovalue | rapeseed | 80 | 1,2,3,6 |
| OPEK Nederland B.V. | rapeseed | 0,5 | 2,5 |
| Coöperatie Carnola | rapeseed | 3 | 2,5 |
| Noord-Nederlandse Oliemolen | rapeseed | 5 | 2,3,4,5 |
| Ecopark Harlingen Holding BV (Oliemolen) | rapeseed | 30 | 2,5 |
| PPO Groeneveld | discarded frying oil | 0,25 | 1,3 |
| Twentsche Oliemolen B.V. | rapeseed | 3 | 5,7,8 |
| Total | | 121 | |

1) Source: MVO (2008).
2) Source: Bersch, F.(2008).
3) Source: Biofuel cities (2008).
4) Source: http://www.solaroilsystems.nl.
5) Source: Senternovem (2005).
6) Source: http://www.biovalue.nl.
7) Source: TC Tubantia.
8) Source: Solaroilsystems (2009)

The feedstock used for production is mainly rapeseed. Most PPO producers form co-operations with rapeseed-producing farmers. Produced rapeseed is collected and crushed locally.

***Table 5.11: Overview of feedstock required for production PPO***

| Feedstock | ktonne |
|---|---|
| Total amount of PPO produced | 42,25 |
| Total amount PPO produced from rapeseed oil | 42 |
| Total amount of rapeseed required[(1] | 126 |
| Total amount of domestic rapeseed production | 11,8 |
| Amount of rapeseed imported for PPO production | 114,2 |

Source: MVO (2008).

1) For the calculation of needed amount of rapeseed: Of rapeseed 1/3 is processed into oil, 2/3 of the rapeseed is converted into rapecake.

Currently, there is no new production capacity of PPO being planned except for a plant expansion by the company Biovalue that produces also PPO next to biodiesel. Their total PPO capacity is currently around 80 ktonne but is planned to grow up to around 240 ktonne.

## 5.9 Biomass use in new industries

## 5.9.1. Developments in the food processing industry

The Dutch FNLI (Federation of the Dutch Food and Grocery Industry) is the umbrella organisation for all companies and trade associations (food and non-food) and represents the common interests of its members. The annual turnover of all members of the FNLI is approximately 50 billion Euros, and the industry sector employs more than 140.000 people in the Netherlands.

As shown in table 4, the Dutch Government and various industry sectors agreed with the agricultural sector on Energy Covenant „Clean & Efficient Agricultural sector‟

Targets for 2020 are:

- 2% energy saving per year
- 30% reduction of GHG
- 20% of energy is sustainable.

The entire agricultural sector has the target to use 200 PJ, of which the food and grocery industry has a large share: about 75 –125 PJ. This is a very ambitious target, given the current estimated use of 0.4 PJ in 2006. It is also an ambition, and not an obligation.

The expectation is that the ambitious targets can be reached by making efficient use of so-called high-risk waste streams, and waste streams which are currently not utilized. The main conversion route will likely be anaerobic digestion of these waste streams, producing biogas (and optionally subsequently electricity and heat). Another route is the production of liquid biofuels from e.g. used fats, or production of ethanol (EZ, 2008c).

However, a leading principle is and remains the use biomass for the application with the highest profit. In other words, if biomass streams can be sold more profitably for other uses (e.g. as animal feed), they not be utilized for energy purposes (Alfing, 2009).

In an explorative study, Budding and Blok (2009) investigated the financial feasibility of using more biomass from the food-processing sector for anaerobic digestion. Their main conclusions were that utilization of biomass by-products can only be feasible if:

- A subsidy is available for the renewable energy produced
- Sufficient biomass material is available within the close vicinity of the digester
- The biomass waste streams are available at negative costs (i.e. otherwise a fee has to be paid for their processing)
- There is a heat demand close to the digester, or (preferably) the biogas can be used directly in the near vicinity
- The digestate can be used as fertilizer

From the literature and an interview with a coffee –processing company in the Netherlands, it became clear that in a few cases, already biomass waste streams (e.g. spent coffee ground, rejected food products, animal fats, manure) and waste water are used to produce either process steam (in boilers) or biogas (through digesters). Some companies such as sugar producer Suikerunie (Backx, 2009) and dairy producer Campina (van Kasteren, 2008) have started to build pilot plants, which typically produce a few hundred TJ of biogas per year. However, given the limitations mentioned above, many companies in the food processing industry are reluctant to invest on a large scale in bioenergy production.

### 5.9.3 Developments in the cement industry

Within the Netherlands, ENCI Maastricht is the largest cement factory in the Netherlands, and the only one utilizing biomass. In 2007, ENCI Maastricht produced almost 1.4 million tonnes of cement, and about 900,000 tonnes clinker (which are largely used internally for cement production). Producing cement is a very energy-intensive process, and ENCI Maastricht alone consumes annually about 3.1 PJ primary energy, which is a little less than 1% of the total primary energy demand of the Netherlands. It has been strongly increasing its use of biomass waste streams from 0% in 1996 to 44% in 2007, equalling a biomass use of 1.49 PJ (compared to 1.3 PJ in 2006), and leading to an overall GHG emission reduction of 28% compared to 1990. Sewage sludge is the principal biomass source, other biomass feedstocks being still significant quantities of bone meal, paper sludge and plastic-paper derived fuel.

For more information on the use of biomass in the Dutch cement industry, we refer to the Dutch case study on the cement industry, available at the EUBIONETIII website (Junginger, 2009).

# 6. Biomass Prices

Prices of liquid biofuels have been fluctuating significantly between 2007-2009, as shown in Figure 6-1 for ethanol (in comparison with gasoline and the crude oil price), and Figure 6-2 for rapeseed methylester (RME, one of the main types of biodiesel) and rapeseed oil (in comparison with diesel). As a reference, in the graphs, the prices of gasoline and diesel have been included. However, these prices are at the pump, whereas ethanol and biodiesel prices are measures free on board (FOB) in the Rotterdam harbor, and thus do not include distribution costs to the pump. Also, the fossil fuels are given including value added tax and fuel tax of about 12.1 €/GJ for gasoline, and about 8 €/GJ for diesel.

As can be seen in figure 6-1, the price of ethanol seems to be strongly correlated with the price of crude oil. When neglecting the fuel tax on ethanol (i.e. when one would assume that ethanol would receive a tax exemption), ethanol could clearly compete competitively with gasoline seems (although the cost of distribution to the pump still would needs to be included to allow a direct comparison).

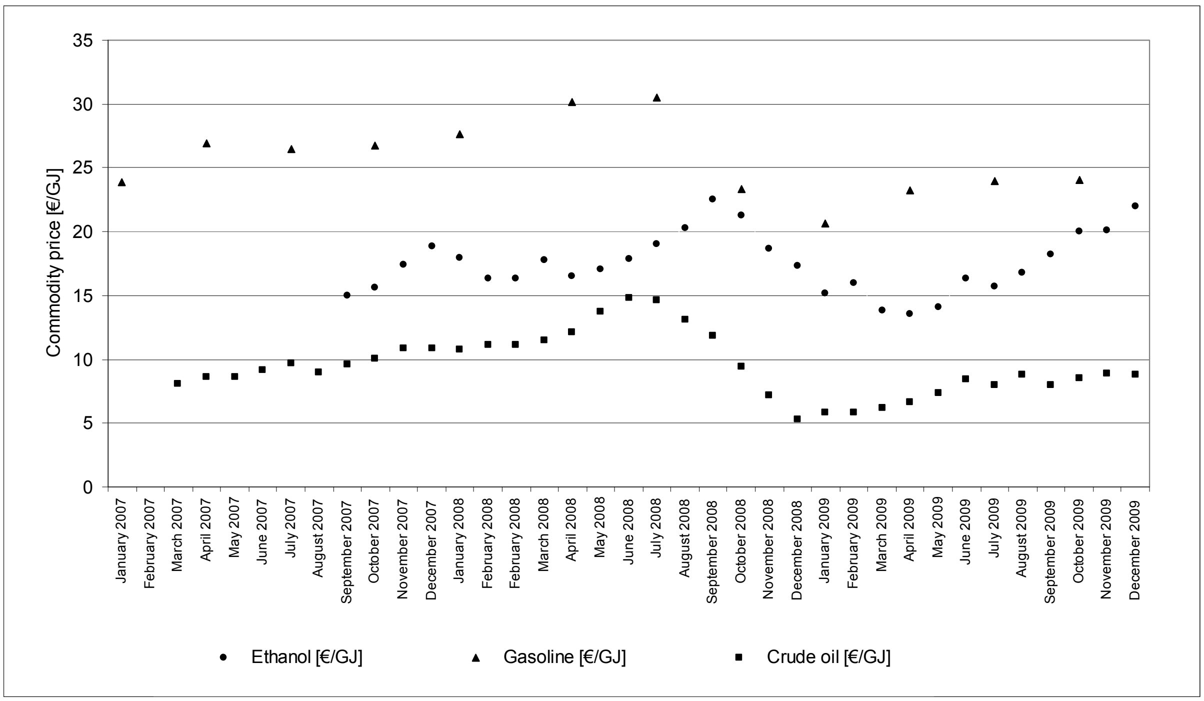



Figure 6-1 Price development of Ethanol (delivered FOB to Rotterdam) in comparison to gasoline prices (at the pump, including VAT and fuel taxes (about 12.1 €/GJ) over the period March 2007- June 2009. For comparison, also the crude oil price is shown. Data sources: ethanol (Nidera, 2009) gasoline prices (CBS, 2009q), crude oil price (Indexmundi, 2009).

When comparing the prices of biodiesel and the feedstock used for biodiesel, it is remarkable that both prices are almost identical, and in a few cases, rapeseed oil is even more expensive than RME (see Figure 6-2). This is likely caused by the US splash and –dash subsidy (see section 8.3.2). Compared to fossil diesel, biodiesel is not competitive, especially as biodiesel (opposed to PPO, which is exempted from the tax) is taxed about 8 €/GJ (on top of the prices shown in figure 6.2).Even with the fuel tax included, fossil diesel was always cheaper than RME over the period 2007-2009.

Note also, that between the different kind of imported monoalkylesters, there are quite significant differences in prices. For example, the average price of monoalkylesters from Germany (very likely almost 100% RME) over 2008 was 23,69 €/liter, while monoalkylesters from the US (most likely soy-bean oil based) cost on average 18,73 €/liter. An overview of the average annual costs of monoalkylesters differentiated by country is given in Appendix 3. For a comparison of various prices of biodiesel, fossil diesel and PPO, see Table 6.1.

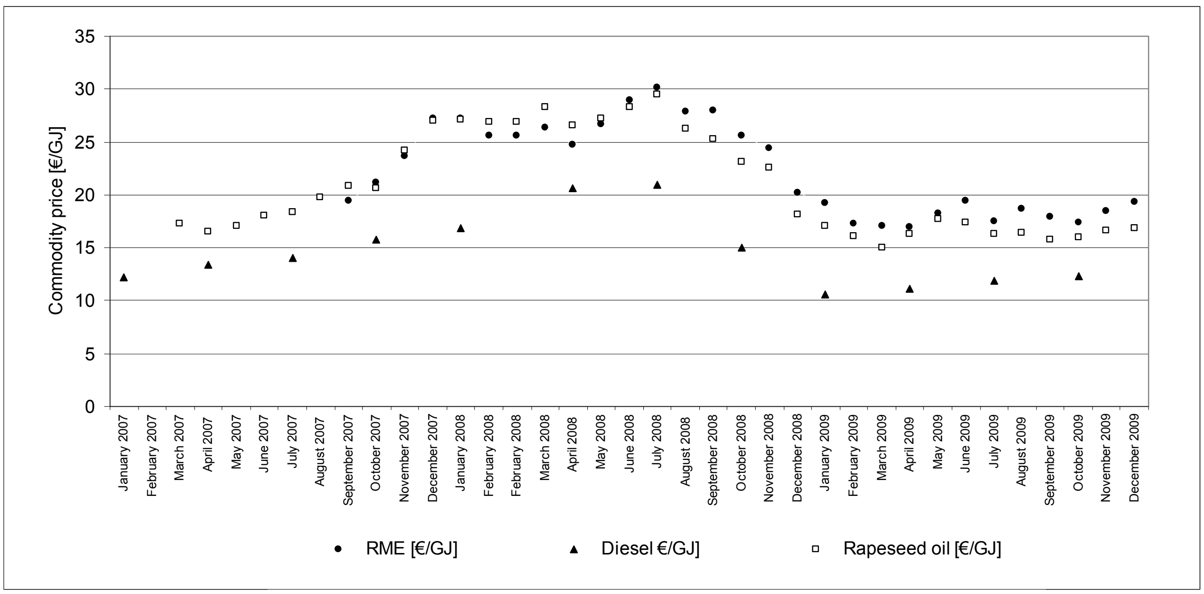



Figure 6-2 Price development of RME (Rapeseed methyl ester) and rapeseed oil, both delivered FOB Rotterdam, in comparison with diesel (at the pump, including VAT, fuel taxes of about 8 €/GJ) over the period March 2007- June 2009. Data sources: rapeseed oil and RME (Nidera, 2009), diesel prices (CBS, 2009q), crude oil price (Indexmundi, 2009).

***Table 6.1: Prices and characteristics of (bio)diesel and biodiesel feedstocks****

| | **Energy content (MJ/kg)** | **Density (kg/l)** | **Energy content (MJ/l)** | **Price (€/l)[3,4,5]** | **Price (€/GJ)[2,4]** |
|---|---|---|---|---|---|
| *Feedstock* | | | | | |
| Rapeseed | NA | NA | NA | 0,31 | NA |
| Discarded frying oil[6] | 36,00 | 0,93 | 33,48 | 0,2 | 5,97 |
| *End product* | | | | | |
| Monoalkylesters (imported)[7] | 36,93 | 0,89 | 32,69 | 0,64 | 19,58 |
| Biodiesel (selling price)[1] | 36,93 | 0,89 | 32,69 | 1,03 | 31,51 |
| Pure vegetable oil (PPO)[2] | 36,00 | 0,93 | 33,48 | 0,72 | 21,51 |
| Fossil Diesel (selling price)[3] | 45,40 | 0,85 | 38,60 | 1,03 | 26,68 |

* Prices fluctuate throughout the year, as shown in figure 6-1. This table provides indicative prices.
1) Source: CBS - Biobrandstoffen - overzicht 2008
2) Source: Solaroilsystems
3) Source: BOVAG
4) Source: Fuelswitch, http://www.fuelswitch.nl/index.php?mod=pages&item=28. Biodiesel prices can range from 1,03 to 1,50 €/l
5) Source: MVO (2008)
6) Source: Rabou (2006). In this article discarded frying oil has an energy content of 38 MJ/kg, similar to the energy content of vegetable oil. However, as we use a LHV for PPO of 36 MJ/kg we use the same numbers for discarded frying oil here as well.
7) Source: CBS import & export of products(2009). The main share of imported monoalkylesters is biodiesel, therefore the energy content of monoalkylesters is assumed to be identical to the energy density of biodiesel

In comparison to liquid biofuels, prices for wood pellets have remained more stable (see Figure 6-3). In direct comparison with coal, wood pellets are far from competitive. However, in mid-2008, coal prices reached up to 4,5 €/GJ. Combined with an added value of avoided $CO_2$-emissions, this brought wood pellets on the edge of direct competitiveness for electricity production. Since then, coal prices have declined again to lower levels, and thus wood pellets still require policy incentives to make their use as fuel for electricity production economically viable.

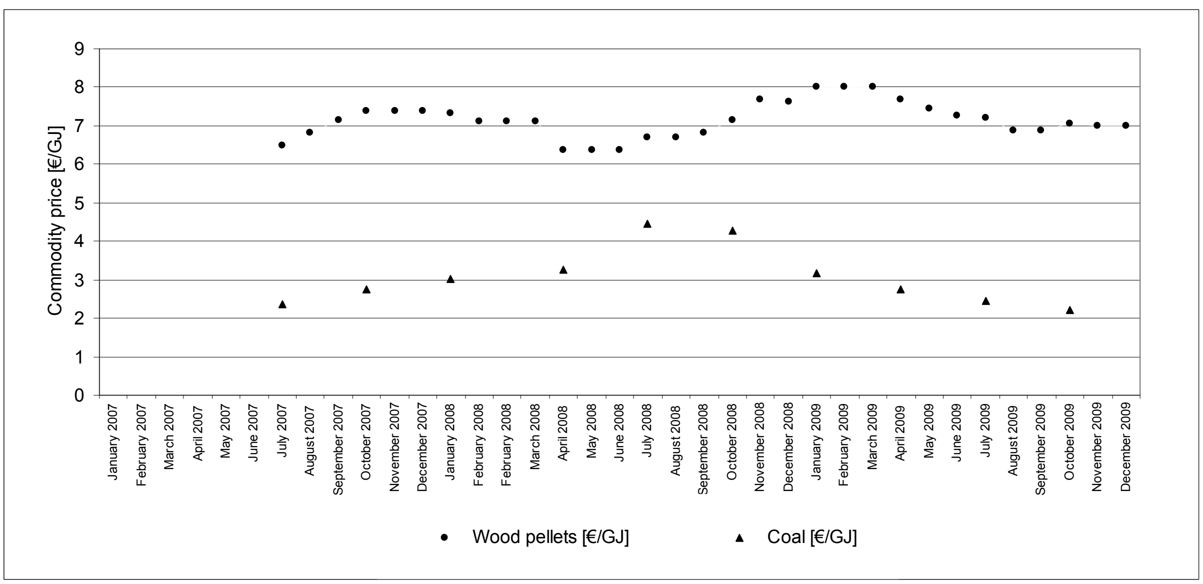



Figure 6-3 Price development of wood pellets delivered CIF Rotterdam, including VAT for bulk delivery of 5000 tonnes wood pellets by ocean vessel between 2007-2009 (Source: Pellets@las, 2009), compared to imported coal from non-EU countries (Source: CBS, 2009r)

# 7. Biomass Import and Export

## 7.1 Waste streams (not updated for 2009)

### 7.1.1 General import and export of biomass waste streams

A general overview regarding 'green' biomass waste flows that come in and go out of the Netherlands is currently lacking. This is mainly because no permit or allowance is required for exporting or importing 'green' biomass. Nevertheless, one can assume import and export of agro residues, the main 'green' biomass waste flows, to be negligible because of the high moisture content of the streams and the wide diffusion of feedstock causing significant logistic difficulties. In addition, specific 'green' flows that are being imported and exported are reported by Dutch sectoral organisations like 'Probos' (clean residue wood) and 'MVO' (discarded frying oil and animal fat). Therefore, it is reasonably possible to compile a viable overview of imported and exported 'green' biomass waste suitable for energy purposes. This overview is presented in table 7.1.

***Table 7.1: Domestic production, import and export of biomass waste streams, which are suitable for energy purposes in 2007***

| Biomass waste stream | LHV biogenic(1 | Domestic production | | Import | | Export | |
|---|---|---|---|---|---|---|---|
| | *TJ/ktonne* | *ktonne* | *PJ* | *ktonne* | *PJ* | *ktonne* | *PJ* |
| ***Green'*** | | | | | | | |
| Fresh residue wood | 10,2 | 1000 | 10,2 | - | - | - | - |
| Residue wood from wood processing industry | 15,6 | 351,5 | 5,5 | 78,5 | 1,2 | (2 | - |
| Discarded frying oil | 38 | 60 | 2,3 | 60 | 2,3 | - | - |
| Animal fats | 25 | 206 | 5,1 | 352(6 | 8,8(6 | 305 | 7,6 |
| Animal meal | 22 | 46 | 1 | - | - | - | - |
| ***Orange'*** | | | | | | | |
| Used wood (A, B, C quality) | 15,4 | 1485 | 22,9 | - | - | 1.160 | 17,9 |
| Municipal solid waste (MSW) | 3,9 – 4,4(3 | 10.551 | 41,1 | - | - | 182 | 0,8 |
| Papers sludge | 1,6 | 3.000(4 | 4,8 | - | - | 39,5 | 0,1 |
| Refuse Derived Fuel (RDF) | 4,0 – 4,9(6 | 197,5 | 0,8 | 27.5 | 0.1 | 203 | 0,8 |
| **Total** | | | **93,7** | | **12,4** | | **27,2** |

1) the lower heating value that can be attributed to the biogenic fraction in the waste stream. Values, if not indicated otherwise, are taken from Rabou et al (2006). These are based on wet tonnes. The biogenic energy content for mixed municipal waste and RDF differs depending on the composition of the waste stream.
2) Residue wood from wood processing industry was not exported as raw material, only in the form of end-use energy carriers like pellets after processing. These end-use energy carriers represent 87 ktonne existing for 85% out of energy pellets, 8% firewood, and 7% others (Leek et. al, 2009)
3) MSW Rabou et al (2006) propose an energy content of 8.4 TJ/ktonne for MSW. Other sources report 10 MJ/kg (Duurzame energie in Nederland, 2007), but in this study, we do use the more conservative value of 8.4. The biogenic fraction of the waste is assumed to be 47% following SenterNovem's protocol for the monitoring of sustainable energy (2006) the LHV for the biogenic fraction will be => 8.4 TJ/ ktonne * 0.47 = 3.9 TJ/ktonne. After mechanical treatment of MSW a part of the residual fraction is being exported the average LHV for the biogenic fraction of this stream is 4.4 TJ/ktonne **(**see appendix 5 for the calculation of the LHV**)**
4) rough estimate taken from Koppejan et al (2005)
5) While the RDF produced in the Netherlands is exported the RDF being consumed in the Netherlands is imported. The streams have different (average) LHV's of the biogenic fractions, respectively 4.0 and 4.9 (see appendix 5 for calculation of LHVs).
6) Only about 30% of this amount is actually used for energy purposes (Bergmans, 2009)

In 2007, the imports of green and orange amounted to a total of 12,4 PJ. Primary imported streams were animal fat and discarded frying oil. The animal fat, however is only partly being used for energy purposes (approximately 30% (Bergmans, 2009)). Regarding import and export of 'orange' waste, one needs to have a permit. In the Netherlands these permits are handed out by the Dutch ministry of environment (VROM). They include a detailed description of the type/composition of the waste, the permitted amount of waste, the amount of transports a year, and the end-use(s) of the transported waste. Parties that own a permit are obliged to report every transport through a transport form. This form includes the date of transport and the amount of transported waste. While the permits are handed out by VROM, SenterNovem is the party who safeguards the database of existing permits and who registers the transport forms. In that way, SenterNovem has a clear image on the amount of imported and exported 'orange' biomass waste streams. The SenterNovem database is used to determine import and export quantities of 'orange' biomass waste flows and defining the average Lower heating value (LHV) that can be attributed to the biogenic fraction in the imported and/or exported MSW and RDF waste-streams (based on their composition, for calculation see appendix 5). The SenterNovem database will be referred to as the EVOA database (2009).

### 7.1.2 Specific export of waste used for energy purposes

Export in 2007 was quite substantial (15.7 PJ, of which 11,7 used wood) and accounted for roughly 30% of domestic production. Table 7.2 shows the actual use for energy purposes of exported biomass waste streams.

***Table 7.2: Actual use of exported biomass waste streams for energy purposes***

| **Biomass waste stream** | **LHV biogenic**[1] | **Export** | | **use of exported biomass for energy purposes** | |
|---|---|---|---|---|---|
| | *TJ/ktonne* | *ktonne* | *PJ* | *ktonne* | *PJ* |
| ***Green'*** | | | | | |
| Fresh residue wood | - | - | - | - | - |
| Residue wood from wood processing industry | - | [2] | - | [2] | - |
| Discarded frying oil | - | - | - | - | - |
| Animal fats | 25 | 305 | 7,6 | 100[3] | 2,5 |
| Animal meal | - | - | - | - | - |
| ***Orange'*** | | | | | |
| Used wood (A, B, C quality) | 15,4 | 1.160 | 17,9 | 760 | 11,7 |
| Municipal solid waste (MSW) | 4,4[4] | 182 | 0,8 | 137 | 0,6 |
| Papers sludge | 1,6 | 39,5 | 0,1 | 36 | 0,1 |
| Refuse Derived Fuel (RDF) | 4,0[4] | 203 | 0,8 | 203 | 0,8 |
| **Total** | | | **27,2** | | **15,7** |

1) the lower heating value that can be attributed to the biogenic fraction in the waste stream. Values, if not indicated otherwise, are taken from Rabou et al (2006). These are based on wet tonnes. The biogenic energy content for MSW and RDF differs depending on the composition of the waste stream.
2) Residue wood from wood processing industry was not exported as raw material only in the form of end-use energy carriers like pellets after processing. These end-use energy carriers represent 87 ktonne existing for 85% out of energy pellets, 8% firewood, and 7% others (Leek et. al, 2009).
3) This figure is based on the crude assumption that the application of exported animal fat is comparable to the Netherlands, meaning 34% is used for energy purposes => 0,34 * 305 ktonne = 100 ktonne.
4) See appendix 5 for the calculation of the LHV.

## 7.2 Electricity: Co-firing[6]

### 7.2.1 Import countries of biomass used for co-firing

Biomass for co-firing is mainly imported: in recent years the use of domestic biomass is between 22 and 24 percent. Important import countries for 2009 are Canada, the United States and Western Europe, mainly Portugal. Especially the United States gained its share in recent years by increasing wood pellet production.

### 7.2.2 Import countries of specific biomass

**Woody biomass**

The largest part of the biomass used in co-firing concerned wood pellets. Other forms of woody biomass were residue wood, wood dust and B-wood. In 2009 main international trading routes  were Canada and the USA, next to inland production.

**Other solid biomass**

The fraction of other solid biomass streams was in 2009 very low. In total around 150 ktonne other solid biomass was consumed, mainly domestically sourced. In the Netherlands the use of solid biomass, apart from wood pellets, wood chips and wood waste decreased in recent years to the level of 2009.

**Liquid biomass**

As revealed in earlier chapters, no liquid biomass is imported in 2007 or 2008, due to uncertainty about the sustainability of the fuel and the withdrawal of MEP subsidy. In earlier years, palm oil, which was the major liquid biomass type, was mainly imported from Southern Asia. According to Milieudefensie (Organisation for Environmental protection) the main countries were Malaysia and Indonesia.

[6] The data is this paragraph is based on interviews, annual reports and environmental reports. Due to estimation of both volumes of biomass (to bridge missing data points) and heating values, the data in this paragraph can differ somewhat from the aggregated data published by the Dutch statistical office CBS.

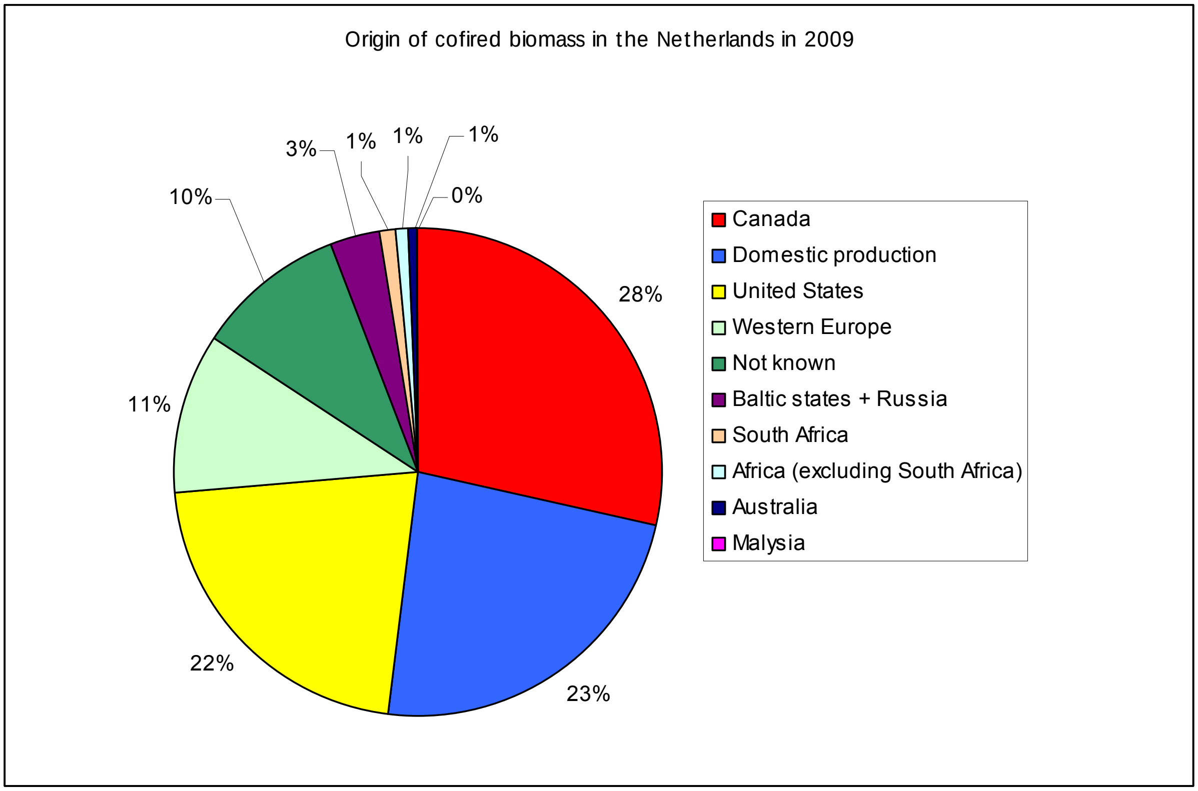



***Figure 7.1: Origin of the biomass used for co-firing in Dutch power plants in 2009***

Source: environmental reports, annual reports, interviews.

| | 2009 | |
|---|---|---|
| | **Total consumption (TJ)** | **Domestic production (TJ)** |
| Wood pellets | 22124 | 1575 |
| Wood chips | 3759 | 3759 |
| Waste wood | 100 | 100 |
| Non-wood biomass (agricultural) | 1049 | 937 |
| Other solids | 160 | 160 |

Source: environmental reports, annual reports, interviews.

## 7.3 Biodiesel

### 7.3.1 General domestic flows of biodiesel and biogasoline

The arable crop area in the Netherlands is too small to produce sufficient amounts of biofuels to meet the Dutch biofuels policy targets (see chapter 2). Therefore, the Netherlands have been relying on imports of biodiesel (and ethanol, see section 7.3.2). Also feedstock needed to produce biodiesel has been imported.

In table 7.5 and figure 7.5 the main characteristics of the biodiesel and gasoline flows in the Netherlands are given for 2008 and 2009.

***Table 7.5: Domestic level flows of biodiesel and biogasoline in 2008 and 2009***

| ***Biodiesel*** | Pure biodiesel 2008 | Blended biodiesel 2008 | Pure biodiesel 2009 | Blended biodiesel 2009 |
|---|---|---|---|---|
| Net Import (Import - Export) | 319 | -84 | 57 | -69 |
| Stock change | -115 | 0 | -3 | 0 |
| Total production | 83 | - | 274 | - |
| Domestic consumption | 0 | 203 | 0 | 259 |
| Production capacity | 520 | - | 1323 | - |
| **Biogasoline** | Pure biogasoline 2008 | Blended biogasoline 2008 | Pure biogasoline 2009 | Blended biogasoline 2009 |
| Net Import (Import - Export) | 180 | -27 | 214 | 14 |
| Stock change | 4 | - | -13 | - |
| Total production | 7 | - | 0 | - |
| Domestic consumption | - | 163 | - | 215 |
| Production capacity | 11 | - | 0 | - |

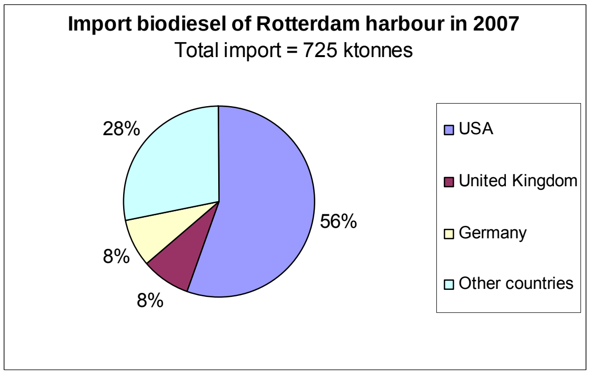
Source: CBS Statline, CBS 2009f

Due toe the increasing domestic production of biodiesel net import decreased in 2009. The production capacity for biodiesel more than doubled; large installations have been built in recent years. For biogasoline the net import is close to the total domestic consumption of pure biogasoline and blended gasoline.

### 7.3.2 Import of biodiesel (not updated for 2009)

A large share of the import of pure and blended biodiesel goes through the large sea ports. Due to this reason, most biofuel plants are located near these locations. The largest transportation hub in the Netherlands is Rotterdam harbor, but also the Amsterdam port and the Eemshaven (in the North of the Netherlands) can function as a centre for biofuel import, export and production.

In figure 7.6, an overview of imported and exported quantities of biodiesel in 2007 of the Rotterdam harbour is given. It must be noted that total import and export amounts given are larger than the amounts of imported and exported biodiesel used in the Netherlands. This is due to the fact that the Rotterdam harbour functions not only as an important centre for biodiesel distribution in the Netherlands, but is also one of the crucial transportation hubs of Europe. A large share of imported biodiesel is exported directly to other European countries, and does therefore not enter the domestic biodiesel flows.



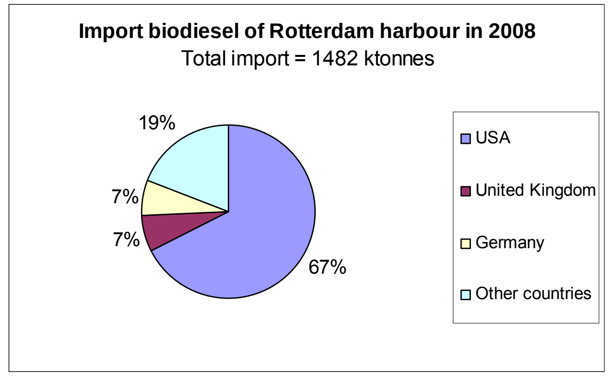




***Figure 7.6: Import of biodiesel in the Netherlands in 2007 and 2008***

Source: Port of Rotterdam (2008, 2009)

The largest contributor to biodiesel imports through the Rotterdam harbor in 2007 is the USA, with a share of 56%. This share even increased for the year 2008 to a share of 67% of the total import of biodiesel. The absolute import from the USA grew with approximately 600.000 tonnes, more than twice the amount that was imported from the USA in 2007 (Port of Rotterdam, 2009). This is mainly due to large stimulations of the production of energy crops and distribution of biofuels provided by the US government. This is discussed in more detail in chapter 9.

The total import of biodiesel in 2008 has more than doubled compared to the import of biodiesel in 2007. The absolute import has grown from around 725 ktonne to almost 1.500 ktonne in 2008.

### 7.3.3 Export of biodiesel (not updated for 2009)

The large sea ports also play a central role in the export of biodiesel. In figure 7.7, an overview of exported quantities of biodiesel in 2007 and 2008 of the Rotterdam harbour is provided. As mentioned above, large sums of biodiesel imported in the Rotterdam harbour, mainly from the USA, are directly exported to other European Countries and are not processed in the Netherlands.

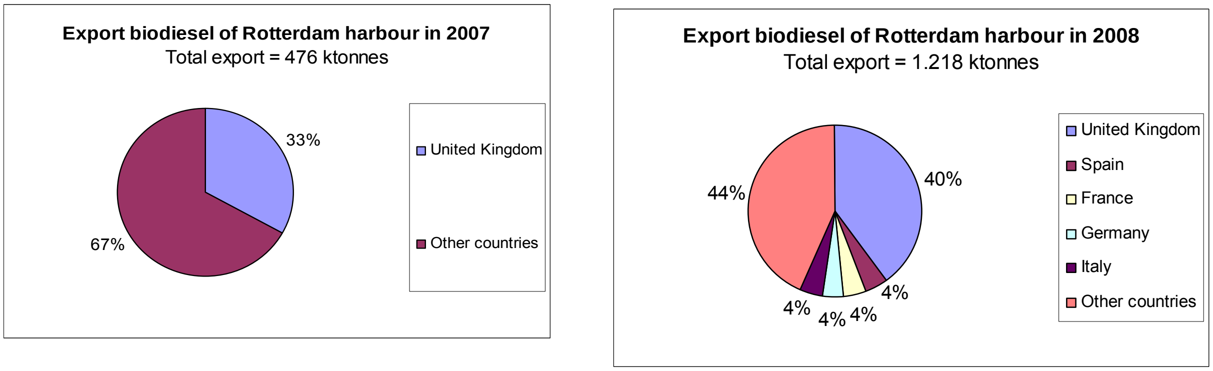



***Figure 7.7: Export of biodiesel in the Netherlands in 2007 and 2008***

Source: Port of Rotterdam (2008, 2009).

In total ,the export of biodiesel of the Rotterdam harbor grew from 476 ktonne in 2007 to 1.218 ktonne in 2008. The United Kingdom is the largest importing country of biodiesel exported by Rotterdam harbor. In 2007, approximately 160 ktonne of biodiesel were exported to the United Kingdom. This amount increased In 2008 to a total of almost 490 ktonne. Next to the United Kingdom the remaining biodiesel is exported to a number of other, mainly European, countries. In 2008, quantities of around 50 ktonne were exported to Spain, France, Germany and Italy.

### 7.3.4 Monoalkylesters

#### General

Biodiesel is the synthesis and treatment of non-fossil fatty acids into monoalkylesters (Douane, 2009), but not all monoalkylesters are necessarily used as biodiesel. These trade numbers might therefore present a good indication of the potential maximum import of biodiesel. The CBS started collecting data on the import and export of these monoalkylesters in 2008, in the framework of the Eurostat statistics on international trade. However, monoalkylesters are classified at the lowest level (8 digit). At this detailed level CBS does not perform any checks or corrections for non-response.

#### Import and export of monoalkylesters

In figure 7.8, an overview of countries exporting monoalkylesters to the Netherlands and the countries to which the Netherlands exports monoalkylesters is shown. The total volume of monoalkylesters does not reflect the import and export of biodiesel of the Netherlands, due to the above-mentioned issues. Figure 7.8 does give an indication of the most important trading countries.

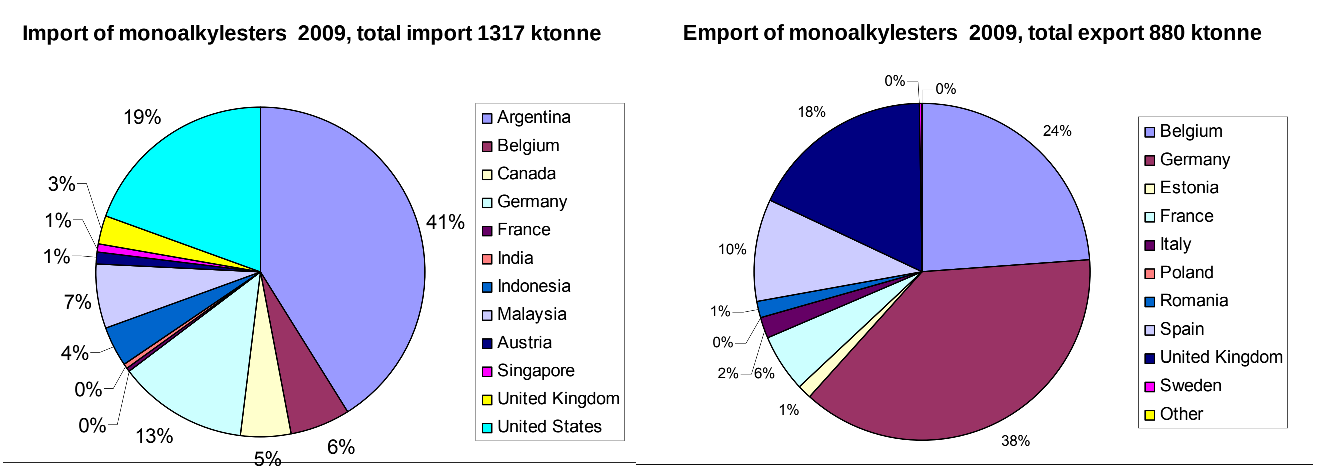



***Figure 7.8: Import and export of monoalkylesters in 2009.*** ***Source: CBS Statline, CBS 2009f***

## 7.3.5 Feedstock for biodiesel and PPO production (not updated for 2009)

### General

As mentioned before, the amount of arable land available in the Netherlands is not sufficient enough to provide enough feedstock for the production of these amounts of biodiesel. Therefore, next to the import of large amounts biodiesel, large quantities of feedstock are imported into the Netherlands for the production of biodiesel and PPO. In 2007 rapeseed was the only edible feedstock used for the production of biodiesel and PPO. Palm oil and soy oil were not used for the production of biodiesel. In 2007, a total of 648 ktonne of rapeseed oil was imported in the Netherlands (MVO, 2008). Approximately 220 ktonne (34%) of this amount was used for the production of biofuel.

### Biodiesel

For biodiesel a total of 105 ktonne of rapeseed was imported into the Netherlands. In this study all rapeseed grown in the Netherlands in 2007 was assumed to be used for the production of PPO. This might not be entirely true, since certain amounts of locally produced rapeseed might also be stored or used in the food industry. An overview of countries exporting rapeseed to the Netherlands is given in figure 7.9.

### PPO

For the Dutch PPO production, a total of 126 ktonne of rapeseed was required in 2007. A total of 11,8 ktonne of rapeseed was produced in the Netherlands in 2007 (MVO, 2008). If we assume that all domestic grown rapeseed was used for the production of PPO the remaining amount must have been imported. This means that a total of 114,2 ktonne of rapeseed was imported from abroad.

The assumption that most of the locally grown rapeseed was used for PPO production is quite likely, since most farmers that grow rapeseed often operate in a cooperative structure. In such a structure all joined farmers deliver their feedstock to one production facility of biodiesel or PPO.

### Sunflower seed

In 2007, PPO was only made from rapeseed. PPO producing company Twentsche Oliemolen stopped production of PPO in 2008 due to financial reasons. In contrast to Coöperatie Carnola, OPEK Nederland and Noord-Nederlandse Oliemolen, the Twentsche Oliemolen did not receive relief from tax excise of the produced PPO, resulting in a difficult market position. However after the company was sold to a different owner operation has restarted. Initially, the Twentsche Oliemolen used rapeseed as feedstock, but since its restart the company has switched to producing PPO using sunflower seeds as feedstock.

As the amounts of import and export of vegetable oil and feedstock for production of biodiesel and PPO for 2008 will be published around August 2009, figure 7.9 only shows imports for 2007.

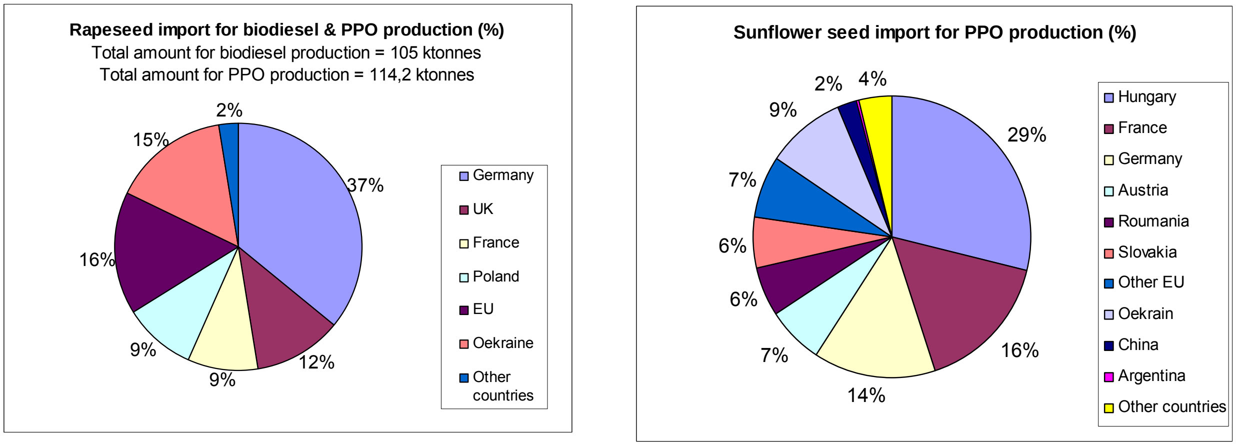



***Figure 7.9: Import of rapeseed and sunflower seeds in 2007. Source: MVO (2008).***

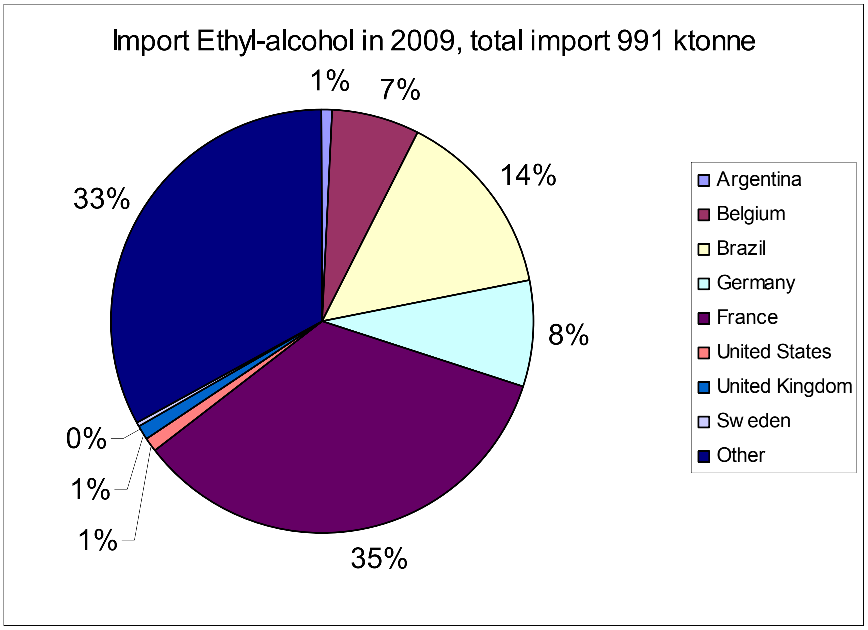
## 7.4 Bio-ethanol

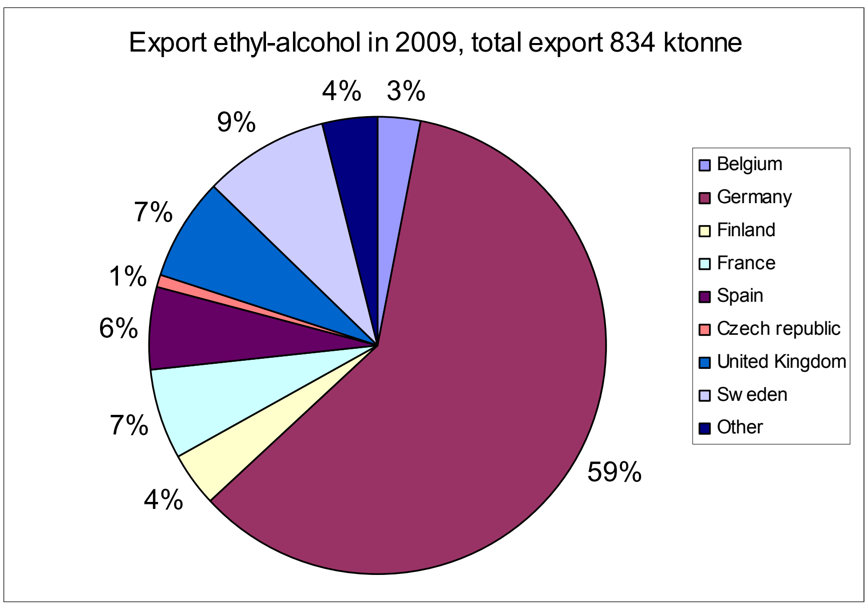
### 7.4.1 National flows

The data on import/export of bio-ethanol and bio-ETBE are solely from tables in the CBS database. Please note that CBS only gives numbers on biogasoline, which is an artificial aggregate of bio-ethanol and the biogenic fraction of bio-ETBE, because specific numbers on production, consumption and storage of bio-ETBE and bio-ethanol are classified.

### 7.4.2 The origin and destinations of bio-ethanol trade for fuel purposes

After 2004 the net import of ethyl-alcohol increased up to 350 ktonne in 2007. In the years 2008 and 2009 the net import decreased due the high increase in export compared to import. The main trading countries for import and export are shown below. For import of biodiesel a large number of countries covers the "other" segment, all trading volumes of these countries are less than 10 ktonne.


Import Ethyl-alcohol in 2009, total import 991 ktonne
1%
7%
14%
8%
35%
1%
1%
0%
33%
Argentina
Belgium
Brazil
Germany
France
United States
United Kingdom
Sw eden
Other


Export ethyl-alcohol in 2009, total export 834 ktonne
4%
3%
9%
7%
1%
6%
7%
4%
59%
Belgium
Germany
Finland
France
Spain
Czech republic
United Kingdom
Sw eden
Other

# 8. Barriers and Opportunities

In this final chapter, a description is given on the most important barriers and opportunities that were encountered during the analysis of the biomass markets. This section is not meant to be comprehensive, but merely to point out several developments and prospects in the biomass field of interest.

## 8.1 Barriers

### Barriers for further utilization of residue- and waste streams

There is no significant demand for non-woody residue streams like verge grass, straw and reed. This could be an opportunity, as these materials offer a large potential. However, before this potential can be utilized, some large hurdles have to be overcome. First off all, a significant problem is the lack of technology to use non-woody biomass for energy generation. Secondly, the quality of the biomass is difficult to guarantee, because of different composition. Furthermore, there is a legal restriction on the use of grass from nature in fermentation facilities. Finally, the feedstock is often highly dispersed, causing logistic challenges, high collection costs and thus an uncertain return of investment (Spijker et al, 2008).

#### Barriers for increasing electricity and heat production

Two main barriers are currently hampering the increased use of biomass for co-firing:

- One of the biggest barriers is the uncertainty regarding subsidies for co-firing, i.e. commitments under the former MEP system (which still is responsible for the majority of imports) and the uncertainty whether the current SDE feed-in premium system for renewable electricity will include co-firing of wood pellets and other biomass types in the future.

- Concerns regarding the sustainable production is a barrier for the use of certain biomass streams, such as palm kernel expeller, and all liquid biomass streams in general (and especially palm oil and soy bean oil). It is a real problem that currently no label/certification system is in place. However, recently the first palm oil plantations have been RSPO –certified, and it is now investigated, whether the palm kernel expeller form these plantations are then automatically also RSPO-certified / sustainable. On the other hand, for many biomass streams used as animal feed (e.g. sunflower husk), the issue of sustainability plays a much lesser role.

#### Barriers for biofuels production and utilization

Today, biodiesel plant constructions are being delayed or biodiesel production of finished factories is being postponed due to unfavourable market conditions (Strategygrains, 2009). These unfavourable market conditions are mainly caused by two factors:

1. The main reason is the import of large amounts of biodiesel produced in the USA. In 2005, the first renewable fuels standard was established which called for an annual production of 7,5 billion gallons of biofuels to be used annually by 2012 (EPA, 2005). In order to reach these goals, instruments were developed in order to stimulate the biofuel market. One of these instruments is a blending credit in place in the US. Blenders receive of $1 per gallon of blended biodiesel, which has led to the situation that biodiesel exported from the US could benefit form a subsidy of over 200 Euro per tonne (EBB, 2007), which led to the situation that in some cases, feedstock costs in Rotterdam were higher than biodiesel costs. This mechanism leads to distorted market competition in Europe. So far several unsuccessful attempts have been carried out in order to control the import of this inexpensive biodiesel from USA. While the European Commission introduced provisional anti-dumping and countervailing measures against imported US biodiesel in March 2009 (and on July 7$^{th}$ 2009 extended these measures for 5 years), Dutch traders reported

that this led in practice to biodiesel being exported form the US to Canada, and from there to Europe, thereby circumventing these measures.

2. Another important aspect of the downfall of current Dutch biodiesel production is the adjustment of the Dutch national target for biofuel incorporation, which was lowered from 5,75 to 4% in 2010. The main reason for this adjustment were questions regarding the sustainable character of biodiesel production.

### General barriers for bioenergy trade

The current economic crisis has had several effects influencing the competitive position of wood pellet use. Various traders reported different effects:

- On the supply side, especially in the USA, the housing market has collapsed, which means less timber is sawn and thus less sawdust is produced, leading to less availability of cheap feedstock. On the other hand, it has enabled the use of plantation wood in amongst others Alabama, so the crisis has also opened up new feedstock sources.

- Ocean dry bulk freight rates have collapsed, leading to lower transport costs. However, as many traders has often fixed transport rates significant time ahead, the effects are not as strong as could be expected.

- On the end-use side, the prices for coal have more than halved, the prices for CO2 have about halved, and the price for electricity has been decreasing.

Overall, the economic crisis has probably led to a worse competitive position for wood pellets co-firing then e.g. in the beginning of 2008.

## 8.2 Opportunities

### Opportunities for utilization of residue- and waste streams

The energy-related demand for waste materials is mainly focused on woody biomass. As shown in table 4.5, some amounts of fresh residue wood are already used for energy purposes. In contrast, there is almost no demand for non-woody residue streams like verge grass, straw and reed. If financial incentives were developed to support the utilization of this feedstock, they could contribute significantly to the domestic biomass supply.

### Opportunities for biofuels production and trade

In theory, the Netherlands could produce more liquid biofuels domestically. For example, in 2007, 11.840 tonnes of rapeseed was grown in than Netherlands (MVO, 2008). This corresponds to around 3200 ha of area used for rapeseed, while the total arable area in the Netherlands in 2007 was 997.445 ha. Thus, in principle, there is certainly technical potential for production of feedstocks for biofuels. However, given the generally high prices for labour and land, and the competition with imported biofuels, it is highly questionable whether this will occur in the future.

Regarding biomass trade however, it is quite likely that the Netherlands will increasingly become a trade hub for liquid biofuels, given the available refining and blending infrastructure. Already, several harbours have announced the ambition to increase the amount of traded biomass.

## General opportunities for biomass trade

- Freight rates have dropped dramatically in the past 12 month , especially for large scale (Panamax) type vessel, but also (thought o a lesser extent) for smaller coaster/handy vessels. As freight costs are usually a substantial part of the overall costs of wood pellets, this has caused traded volumes to clearly increase.
- The weak US dollar against the Euro has especially aided the export of wood pellets from North America to Europe.
- The housing crisis in the USA has caused prices for wood to decline strongly, which enables the pellet plants in the US to use wood as feedstock for wood pellet production which are subsequently exported to Europe. On the other hand, the reduced amount of wood being processed also means reduced availability of saw dust. The resource availability is and remains a concern on the longer term.
- It is the expectation that torrefied pellets – once they are produced commercially on a large scale – may reduce transport, storage and other costs for co-firing, and may provide opportunities to further increase traded solid biomass volumes.

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# Appendix 1: Overview of biodiesel related projects

This appendix gives an overview of all Biodiesel related projects. A short description of each project is given to place it into a framework.

***Table 1: Overview of biodiesel related projects***

| Project title | Organisation | Location | Status | Phase | subject | # | Fuel | Short description |
|---|---|---|---|---|---|---|---|---|
| Cars and tractors on biodiesel | Staatsbosbeheer Salland-Twente | Salland | Operational | End use | Cars | 8 | Biodiesel | Since Nov. 2007 various vehicles use biodiesel (b100) as an experiment for other regions of staatsbosbeheer |
| | | | | | Delivery vans | 2 | Biodiesel | |
| | | | | | Tractor | 6 | Biodiesel | |
| Biodiesel in delivery vans | TPG Post delivery service | Amsterdam | Operational | End use | Delivery | 56 | B100 | 56 delivery vans that annually use approximately 120.000 litre of biodiesel |
| Garbage trucks on biodiesel | Area sweeping | Coevorden, Emmen and Hoogeveen | Operational | End use | Garbage trucks | ? | Biodiesel | It is unknown how many garbage trucks currently use biodiesel. |
| Use of biodiesel in delivery vans of the municipality of Breda | Municipality of Breda | Breda | Operational | End use | Delivery vans | 3 | B20 | Since last year the municipality of Breda has been testing biodiesel from frying oil and slaughter waste. In 2009 this experiment is expanded, to make it possible to tank locally made biodiesel in the province of Brabrant. |
| | | | | End use | Trucks | 1 | B20 | |
| Pure biodiesel in busses | Connexxion | Province of Friesland | Operational | End use | Busses | 27 | Biodiesel | From April 2007 North- and Southwest Friesland uses 27 Connexxion regional busses use biodiesel. |
| Tourist boats biodiesel | Rederij P. Kooij | Amsterdam | Operational | End use | Boats | 16 | Biodiesel | At the moment 16 boats use biodiesel. |
| Fuelling station on biodiesel | CZAV | Wissenkerke | Operational | Distribution | | 0 | B20 | |
| Use of PPO and biodiesel on garbage trucks. | Afvalcombinatie De Vallei | Ede and surroundings | Operational | End use | Garbage trucks | 2 | Biodiesel | In February 2006 'Afvalcombinatie de Vallei (ACV)' has started an experiment to fuel two garbage trucks with biodiesel, and two others with PPO |
| Boats and tractors on biodiesel | Province of Fryslân | Province of Fryslân | Operational | End use | Boats | 14 | Biodiesel | The province of Fryslân uses 14 inspection vessels which are |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| and PPO. | | | | | | | | fuelled by biodiesel. Staatsbosbeheer uses biodiesel en bio lubricants in machines and terrain vehicles. |
| Sweeping vehicles on biodiesel | Stadsdeel Amsterdam-Noord | Amsterdam | Operational | End use | Sweeping vehicles. | 3 | Biodiesel | |
| | | | | | Cars | 7 | B100 | |
| Cars on biodiesel | Amsterdam Airport Schiphol | Schiphol | Starting phase | End use | Cars | 14 | Biodiesel | Fourteen cats and a tractor use Biodiesel in a pilot project. |
| | | | | | Tractor | 1 | Biodiesel | |
| Sustainable fuelling station | Green Planet | Pesse | Starting phase | Distribution | | | Biodiesel | Energy Valley, BOVAG and technology centre North-Netherlands TechnologieCentrum have cooperated in this project. |
| Busses on natural gas and biodiesel | Arriva | Assen en Groningen | Starting phase | End use | Busses | 4 | Biodiesel | Arriva is starting an experiment to use 4 biodiesel fuelled busses, and 8 busses that use natural gas. The public transport centre Groningen - Drenthe uses the experiment to gain insides for the replacement of current vehicles in 2010. |
| Fuelling station on biodiesel and bio-ethanol | Zero-e | Diemen | Starting phase | Distribution | | | Biodiesel | Zero-e is bringing parties together from the commercial sector, the government, technical sector, the car sector and the fuelling sector in the project "Samen Schoon op Weg" to stimulate the use of biofuels. |
| | | | | | Cars | 2000 | Biodiesel | |
| Fuelling station and personal cars on biodiesel | Municipality of Deventer | Deventer | Idea phase | Distribution | | | Biodiesel | Fuelling station on. The municipality is participating in the project. |
| | | | | End use | Cars | ? | Biodiesel | Some municipal departments, as the fire brigade and city control unit make the switch to biodiesel, as do Sallcon and Circulus. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cleaner busses in Leeuwarden | Munici-pality of Leeuw-arden | Leeuw-arden | Idea phase | End use | Buses | 25 | Biodies el | 5 of the 25 local busses should become hybrid; They should partially use electrical engines. The other busses preferably Biodiesel, biogas or natural gas. |

Source: SenterNovem, 2009b

## Appendix 2: Overview of PPO related projects

This appendix gives an overview of all PPO related projects. A short description of each project is given to place it into a framework.

***Table 2: Current projects based on consumption PPO***

| Project title | Organisation | Location | Status | Phase | subject | # | Fuel | Short description |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| Garbage trucks on PPO | SITA - McDonalds | Arnhem and surround-dings | Operational | End use | Trucks | 2 | PPO | 2 trucks on PPO |
| Busses on PPO | BBA | Eindhoven and surround-dings | Operational | End use | Busses | 2 | PPO | Since 2005 2 regional busses use PPO. |
| Rapeseed on the road. | Arvalis | Limburg | Operational | End use | | | PPO | Arvalis, a consultancy agency for the agricultural sector, is coordinating the project "Koolzaad op de weg". In this project (trans-portation) companies from Limurg, governments and civilians can apply for a subsidy for adapting engines to the use of rapeseed or for making an appropriate fuelling point. |
| Rapeseed oil in municipal vehicles | Munici-pality of Haarlemmer-meer | Haarlemmermeer | Operational | End use | Cars | 2 | PPO | Since November 2007, two cars use rapeseed oil, in a 1-year experiment. |
| PPO Use | Omrin | Leeuwarden and surround-dings | Operational | End use | Sweeping trucks | 4 | PPO | 4 sweeping trucks and 12 collection trucks are fuelled with PPO. 3 garbage vans are waiting to be adjusted. |
| | | | | End use | Garbage truck | 12 | PPO | |
| | | | | | | 2 | PPO | |
| Boats op PPO | Province of Zeeland | Middelburg and surround-dings | Operational | End use | Boats | 1 | PPO | The province of Zeeland has bought a vessel for the inspection of the Ooster-schelde. The inspection vessel has been bought from Rijkswaterstaat. |
| Sweeping vehicle and municipality of Noord-Beveland | Munici-pality Noord-Beveland | Noord-Beveland | Operational | End use | Delivery van | 2 | PPO | Two municipal vans are fuelled with PPO. 7 others will drive on a mixture of Biodiesel and fossil diesel. |
| Sweeping vehicle on | Flour market | Aalsmeer | Operational | End use | Sweeping van | 1 | PPO | Since September 2004 a sweeping van at Aalsmeer |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| PPO | Aals-meer | | | | | | | uses PPO. |
| Sweeping vehicles on PPO | Munici-pality of venlo | Venlo | Operational | End-use | Sweeping van | 5 | PPO | Three sweeping vans have been adjusted to use PPO. Venlo has plans to replace two sweeping vans and adjust them to use PPO. |
| Cars municipality on PPO | Munici-pality of Meppel | Meppel | Operational | End-use | Sweeping van | 1 | PPO | 1sweeping van on PPO since the end of 2006 |
| Using PPO in Noord-Holland (rijschoon.nu) | Team-work Techno-logy | Noord-Holland | Starting phase | End use | Cars | 500 | PPO | The Rijschoon.nu project wants to have 500 cars in Noord-Holland adjusted to use PPO within 3 years. It is expected that 200 cars will use PPO at the end of 2007. |

Source: Senternovem 2009, Uitdraai met initiatieven van en met (locale) overheden –PPO en biodiesel.

# Appendix 3. Monoalkylesters prices

Biodiesel is the synthesis and treatment of non-fossil fatty acids into monoalkylesters (Douane, 2009). In table 3 an overview of the data concerning the import of monoalkylesters to the Netherlands is given. After the United States delivering three quarters of the total volume in 2008), Germany is the largest source of monoalkylesters. The prices shown are average prices over 2008. As shown in figure 7-2, these have strongly fluctuated over the year.

***Table 3: Overview of import prices of monoalkylesters (CN code* 38249091)**

| Countries | Import (tonne) | Share of total import % | Value (1000 euro) | €/kg | €/l | €/GJ |
|---|---|---|---|---|---|---|
| Argentina | 31.403 | 3,64% | 27.976 | 0,89 | 0,79 | 24,12 |
| Belgium | 11.962 | 1,39% | 12.775 | 1,07 | 0,95 | 28,92 |
| Germany | 81.797 | 9,48% | 71.553 | 0,87 | 0,77 | 23,69 |
| India | 7.816 | 0,91% | 6.003 | 0,77 | 0,68 | 20,80 |
| Indonesia | 35.913 | 4,16% | 19.814 | 0,55 | 0,49 | 14,94 |
| Malaysia | 18.120 | 2,10% | 10.877 | 0,60 | 0,53 | 16,25 |
| Norway | 950 | 0,11% | 237 | 0,25 | 0,22 | 6,76 |
| Austria | 204 | 0,02% | 262 | 1,29 | 1,14 | 34,84 |
| Romania | 3.043 | 0,35% | 2.900 | 0,95 | 0,84 | 25,80 |
| United Kingdom | 23.071 | 2,67% | 19.181 | 0,83 | 0,74 | 22,51 |
| United Arabic Emirates | 3.204 | 0,37% | 2.573 | 0,80 | 0,71 | 21,75 |
| United States of America | 643.100 | 74,56% | 444.781 | 0,69 | 0,61 | 18,73 |
| Sweden | 1.990 | 0,23% | 1.923 | 0,97 | 0,86 | 26,17 |
| other countries | 11 | 0,00% | 70 | 6,10 | 5,40 | 165,07 |
| Total | 862.584 | 100,00% | 620.925 | 0,72 | 0,64 | 19,49 |

Source: CBS statline, CBS 2009l

# Appendix 4. New project overview

***Table 4: List of new projects and plants that are planning to use biomass for energy production, divided in categories***

| | **Power production ($MW_e$)** | **Heat Production ($TJ_{th}$)** | **Input renewables (tonnes)** | **Input renewables (TJ)** | **Biomass resources:** |
|---|---|---|---|---|---|
| **waste incineration** | | | | | |
| Twensche Hengelo (planning to start 2009/2010)[*1,*8] | | | 140.000 | 650 | Waste wood, digesters residue, green waste households (GFT) |
| HVC Alkmaar[*1] | | | 170.000 | 750 | Waste wood, digesters residues |
| HVC Dordrecht/Alkmaar (planning to start in 2013)[*2] | | | | | Municipal solid waste |
| AVR Rijnmond<br>(started in 2008)[*1] | | | 150.000 | 700 | Waste wood, prunnings |
| Sita ReEnergy [*7]<br>(planning to start in 2011) | 32 | Yes, figure unknown | 291.000 | | Only office waste. |
| **power plants** | | | | | |
| Delta Moerdijk<br>(started in 2008)[*1] | 35 | 400.000 | 4.300 | | Chicken manure |
| Evelop Delfzijl<br>(Start construction on the first of two plants mid 2009)[*3] | 49 | - | 350.000 - 400.000 | 5.100 | Waste wood and residues |
| NUON Delfzijl Eemshaven (magnum plant becomes operational in 2011)[*1,*4] | 1.200 | Possibly | p.m. | p.m. | Various biomass sources |
| **Other biomass burning** | | | | | |
| Biox, 3 locations for the use of liquid biofuels [*1*5] | 50 | unknown | 80.000 | 2.900 | Palm oil |
| **Biodiesel)[*9]** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Nedalco, Sas van Gent (Project status is unknown. The project is currently parked)[*1, *6] | - | | n.a. | 200 million litres of ethanol | Cellulose raw material |
| Biovalue2 | NA | NA | 180.000 | 6.480 | Edible oils |
| Greenmills | NA | NA | 135.000-200.000 | 4.860 – 7.200 | Discarded frying oil |
| J&S Bioenergy (Mercuria Energy Group) | NA | NA | 200.000 | 7.200 | Edible oils |
| Neste Oil | NA | NA | 800.000 | 28.800 | Edible oils |
| Rosendaal Energy BV | NA | NA | 250.000 | 9.000 | multi resources, edible oils |
| Wheb Biofuels | NA | NA | 400.000 | 14.400 | multi resources, edible oils |

*1: IEA Bioenergy Task 40 - Country report for the Netherlands, 2007
*2: MVO report HVC, 2008
*3: www.evelop.com 2009
*4: http://www.eemsdelta.nl/nieuws.htm, 2008
*5: www.biox.nl, PZC, Zeeuwse stroom uit Indonesische palmolie
*6: PZC regionieuws Zeeland, 2008
*7: www.baviro.nl
*8: Milieujaarverslag Sita ReEnergy, 2008
*9: Sources for data of biodiesel production and capacity are given in table 4.3. For the energetic input of renewable the energy content of PPO is chosen: 36,0 MJ/kg.

# Appendix 5. Calculation of biogenic LHVs for RDF and MSW

## Residual fraction from mechanical waste separation of MSW

***Table 5: Composition of exported Residual fraction from mechanical waste separation of MSW used for energy purposes in 2007***

| Waste fraction | Biogenic fraction of specific waste | Energy content of specific waste | Mass percentage of specific waste in RDF | Amount biogenic energy content | |
|---|---|---|---|---|---|
| | *%* | *GJ/tonne* | *%* | *ktonne* | *TJ* |
| paper & cardboard | 100 | 10 | 31 | 42,7 | 427 |
| wood | 100 | 14 | 6 | 7,6 | 106 |
| organic | 100 | 3 | 13 | 17,3 | 52 |
| plastics | 0 | 33 | 41 | 56 | 0 |
| others combustible | 50 | 15 | 2 | 2,6 | 19 |
| Others non-combustible | 0 | 0 | 8 | 10,8 | 0 |
| **Total** | | | | **137** | **604** |

Source; EVOA database (2009)

The average LHV of the biogenic fraction is determined by dividing the total energy embedded in the biogenic fraction being exported (TJ) with the total mass being exported (ktonne) => 604 TJ / 137 ktonne **= 4.4 TJ/ktonne**. The biogenic fraction in the exported residual fraction from mechanical waste treatment corresponds to 0.6 PJ, this is 24.5% of the total energy content of the exported residual waste for 2007

## Exported RDF

***Table 6: Composition of exported RDF in 2007***

| Waste fraction | Biogenic fraction of specific waste | Energy content of specific waste | Mass percentage of total | Amount biogenic energy content | |
|---|---|---|---|---|---|
| | *%* | *GJ/tonne* | *%* | *ktonn* | *TJ* |
| paper & cardboard | 100 | 10 | 30 | 60,8 | 608 |
| wood | 100 | 14 | 4 | 7,5 | 105 |
| organic | 100 | 3 | 6 | 11,2 | 33,6 |
| plastics | 0 | 33 | 51 | 103,2 | 0 |
| others combustible | 50 | 15 | 4 | 7,2 | 54 |
| others non-combustible | 0 | 0 | 6 | 12,9 | 0 |
| **Total** | | | | **202,8** | **800,6** |

Source; EVOA database (2009)

The average LHV of the biogenic fraction is determined by dividing the total energy embedded in the biogenic fraction being exported (TJ) with the total mass being exported (ktonne) => 800.6 TJ / 202.8 ktonne = **3.9 TJ/ktonne**. The biogenic fraction in the exported RDF corresponds to 0.8 PJ, this is 19% of the total energy content of the exported RDF for 2007.

## Imported RDF

All imported RDF is being co-fired in the Maastricht cement oven. It consists out of two streams that have different compositions

***Table 7: Composition of imported RDF (stream 1) co-fired in Dutch cement ovens in 2007***

| Waste fraction | Biogenic fraction | Energy content | Part of composition | Amount biogenic energy content | |
|---|---|---|---|---|---|
| | % | GJ/tonne | | ktonne | TJ |
| paper & cardboard | 100 | 10 | 9 | 0,288 | 2,88 |
| wood | 100 | 14 | 80 | 2,56 | 35,84 |
| Textile | 100 | 15 | 0 | 0 | 0 |
| plastics | 0 | 33 | 9 | 0,288 | 0 |
| others combustible | 50 | 15 | 2 | 0,064 | 0,48 |
| **Total** | | | | **3,2** | **39,2** |

Source; EVOA database (2009)

The average LHV of the biogenic fraction is determined by dividing the total energy embedded in the biogenic fraction being imported (TJ) with the total mass being exported (ktonne) => 39.2 TJ / 3.2 ktonne = 12.2 TJ/ktonne.

***Table 8: Composition of imported RDF (stream 2) co-fired in Dutch cement ovens in 2007***

| Waste fraction | Biogenic fraction | Energy content | Part of composition | Amount biogenic energy content | |
|---|---|---|---|---|---|
| | % | GJ/tonne | | ktonne | TJ |
| paper & cardboard | 100 | 10 | 30 | 5,64 | 56,4 |
| wood | 100 | 14 | 1 | 0,188 | 2,63 |
| Textile | 100 | 15 | 3 | 0,564 | 8,46 |
| plastics | 0 | 33 | 65 | 12,22 | 0 |
| others combustible | 50 | 15 | 1 | 0,188 | 1,41 |
| **Total** | | | | **18,8** | **68,9** |

Source; EVOA database (2009)

The average LHV of the biogenic fraction is determined by dividing the total energy embedded in the biogenic fraction being imported (TJ) with the total mass being exported (ktonne) => 68,9 TJ / 18,8 ktonne = 3.7 TJ/ktonne.

Given the two LHVs the average for all imported RDF can be determined => (39,2 + 68,9) / (3,2 + 18,8) = **4,9 TJ/ktonne**.

# Appendix 6. Definitions

- **Quantitative characteristics**: amount of the flows (biomass, biofuel, organic waste, etc.) specified by a certain unit (TJ, $m^3$, tonne, etc.).
- **Qualitative characteristics**: the context in which the import and export of biomass takes place (country characteristics, policies, barriers & opportunities, potentials, etc.).
- **Dutch import**: gross import.
- **Dutch export**: gross export.
- **Biomass**: biodegradable fraction of products, waste and residues from agriculture (including forestry, vegetable and animal matter) and related sectors, and the biodegradable fraction of industrial and domestic waste (NTA, 2009).
- **Biomass for energy purposes**: only biomass for energy end-use. For example not all vegetable oil imported to the Netherlands is for biodiesel but it can also be for food and cosmetics. Not all waste wood exported is for combustion in power plants but can for instance also be for particle board or be land filled.
- **Biofuels**: energy carriers derived from biomass like for instance biodiesel, bio-ethanol and biogas but also solid fuels such as wood pellets.
- **Bioenergy**: In this case this term is used as a comprehensive term to account for both biomass and biofuels.
- **Major domestic biomass resources**: >10% of the total domestic biomass resources.
- **<u>Direct/Indirect imports</u>**: Direct imports are imports of biomass that are primarily used for energy purposes. If goods have side products that are used for energy purposes, that is regarded as an indirect import. An example of this is the import of food, where only a small part is used as biomass for energy purposes.
- **<u>Domestic production</u>**: There are two definitions of domestic production;
  - If a good is produced in a country, it is counted as domestic production. For example if biodiesel in the Netherlands is produced out of Malaysian vegetable oils it is counted as Dutch domestic production.
  - The country in which the carbon from the biomass is fixed, is the country of domestic production. In the example above that would be Malaysia.

  The emphasis will be on the upper definition. Wherever possible the second definition will be added to support results.

- **<u>Gross imports</u>**: Gross imports is all biomass that enters the Netherlands. Net imports are the gross imports minus the exports.
- **Biogasoline**: An artificial aggregate of bio-ethanol and the biogenic fraction of bio-ETBE. The biogenic fraction is 47 weight-% of total bio-ETBE mass, which is practically the same as the weight of an ethanol molecule. To be precise: the ethanol in bounded form in ETBE has one less hydrogen atom. The weight of this missing hydrogen atom is so small, that the bio-ethanol in its pure form and the bio-ethanol as component of bio-ETBE can be summed as if they weighted the same, assuming that no ethanol is lost in its conversion to bio-ETBE.
- **Bio-ETBE**: ethyl-tert-butyl-ether (ETBE) is an oxygenated gasoline fuel component that is used instead of for example lead or MTBE as octane booster. It also decreases the negative effects on air quality by fuel combustion. ETBE is made from ethanol and isobutylene. When made from bio-ethanol, the ETBE contains 47% (mass/volume/energy) biofuel, thus both boosting fuel properties as increasing biofuel consumption. This makes bio-ETBE an attractive fuel additive for refiners (EFOA, 2006).
- **MTBE**: methyl-tert-butyl-ether is the predecessor of ETBE as a fuel enhancer. It has less favorable properties and therefore ETBE is now the preferred compound.