IEA Bioenergy Task 40 / EUBIONETIII
Country report for the Netherlands 2008

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Task 40: Sustainable International Bioenergy trade

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Intelligent Energy Europe

Executive Summary

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

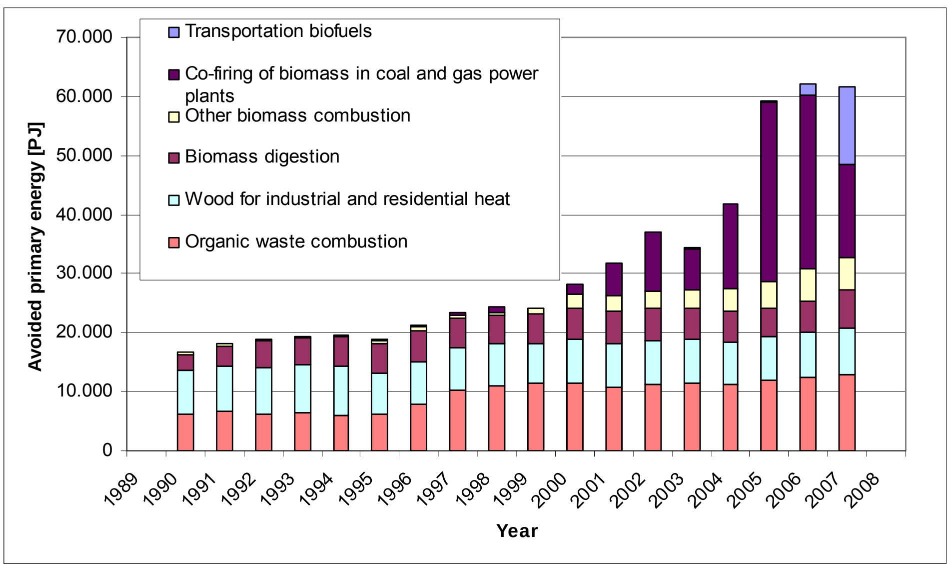

Figure ES-1 Avoided fossil primary energy consumption by production of electricity, heat and transportation fuels from biomass. Source: CBS Statline, BCS 2009d.

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

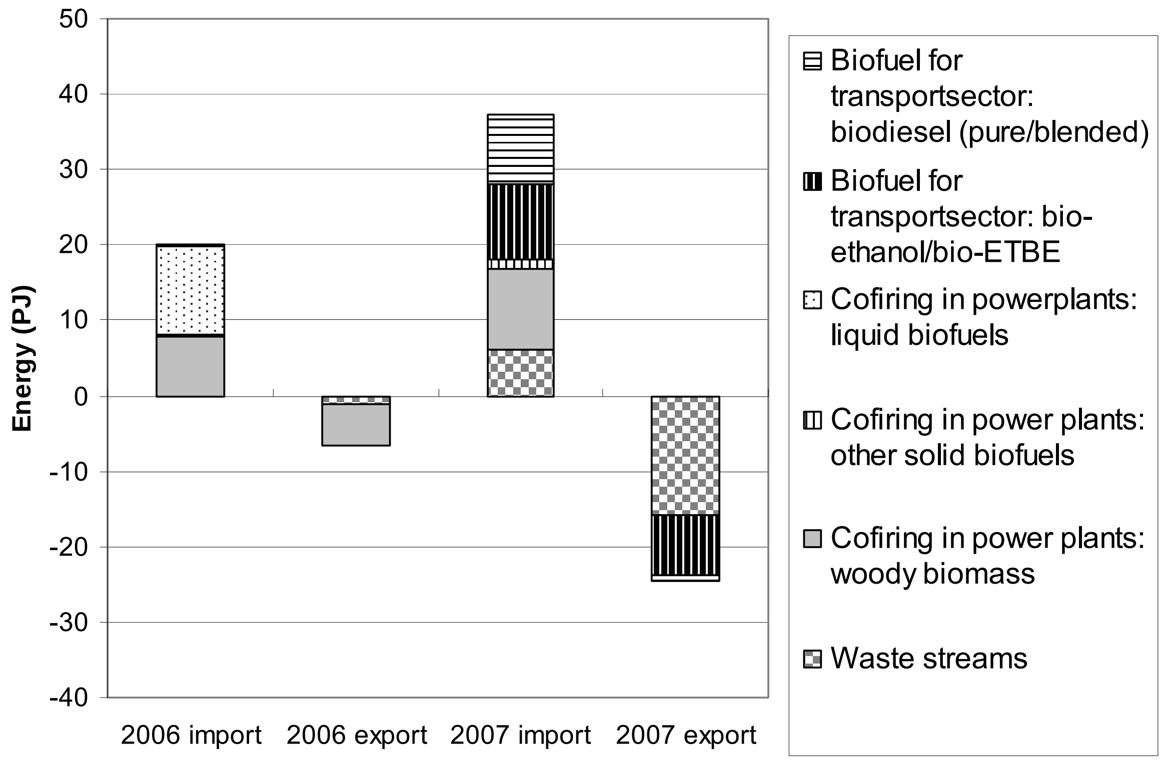

Figure ES-2: Dutch total net import and export of biomass used for energy end-uses in the year 2006 and 2007

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.

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- 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.

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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 need 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 extensive update of the previous Dutch country report of 2007 (Junginger et al, 2007). The aim is to provide a comprehensive overview regarding all biomass streams in the Netherlands for 2007 and as far as possible, also for 2008. 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

The Netherlands had about 16,5 million inhabitants (CBS, 2009) and an average GDP of €31.725 (approximately US$ 40.000) per capita in May 2009 (CIA, 2009). The land area is about 3,39 million hectares, of which 22% consisted of arable land and another 1% of croplands (CIA, 2009). The forest area is about 330.000 ha. The Netherlands are situated in the North Western part of Europe.

Main industries

According to the World Factbook (CIA, 2009) the Netherlands has a prosperous and open economy, which depends heavily on foreign trade. The economy is noted for stable industrial relations, moderate unemployment and inflation, a sizable current account surplus, and an important role as a European transportation hub. Industrial activity is predominantly in food processing, chemicals, petroleum refining, and electrical machinery. A highly mechanized agricultural sector employs no more than 3% of the labor force but provides large surpluses for the food-processing industry and for exports. The Netherlands, along with 11 of its EU partners, began circulating the euro currency on 1 January 2002. The country has been one of the leading European nations for attracting foreign direct investment and is one of the four largest investors in the US. The pace of job growth reached a 10-year high in 2007, but economic growth fell sharply in 2008 as a consequence of the world financial crisis. This constricted demand and raised the specter of a recession in 2009.

CO_2 reduction requirement

In 2007, greenhouse gas emissions in the Netherlands were reduced for the third consecutive year. The total emission volume 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).

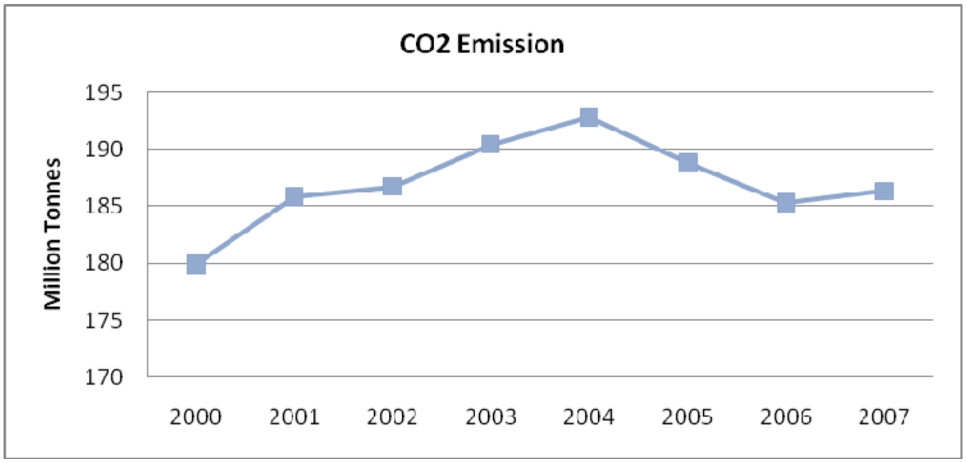


Figure 2.1: CO_2 emission in the Netherlands from 2000 to 2007

Source: CBS statline, CBS 2009p.

Primary fossil energy consumption

An overview of primary fossil energy consumption in the Netherlands between of the years between 1975-2007 by fuel source is given in Figure 2.2. In figure 2.3 an overview of produced and imported electricity in the Netherlands for the last 10 years is given.

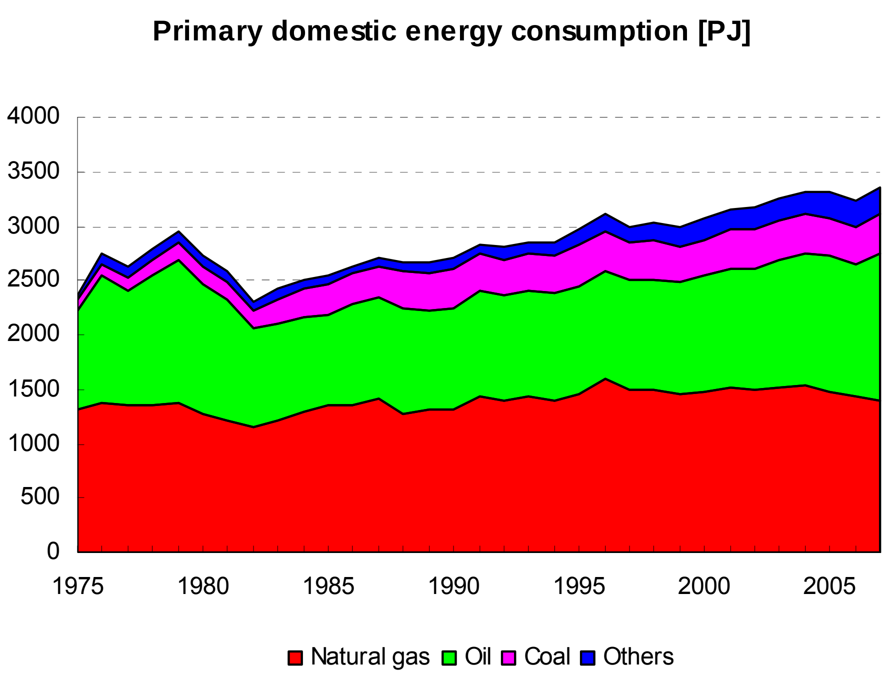


Figure 2.2: Final fossil energy consumption per sector in the Netherlands in 2006-2007

Source: CBS statline, CBS 2009j.

Figure 2.2 shows that the petrol industry and the transport are the two most energy intensive sectors. In general the energy consumption of the various sectors did not change significantly. The only sector with a noteworthy increase is the 'other sector' (agriculture, services and construction).

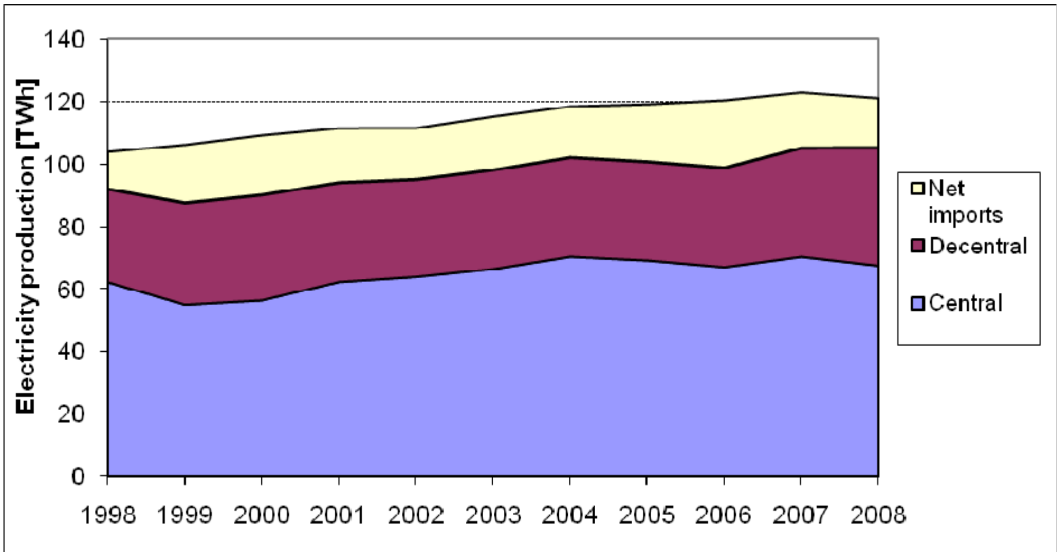


Figure 2.3: Total electricity production in the Netherlands and imports from 1998 to 2008

Source: CBS statline, CBS 2009o.
* 2008 is based on estimations by CBS.

The next graph (figure 2.4) shows fuel use for production of both heat and electricity. Natural gas is the largest source. Most of the gas is of Dutch origin, although the Netherlands also import natural gas from the UK, Norway, Russia and other countries. The consumption of biomass and waste is still small, but the share has increased strongly in the last few years.

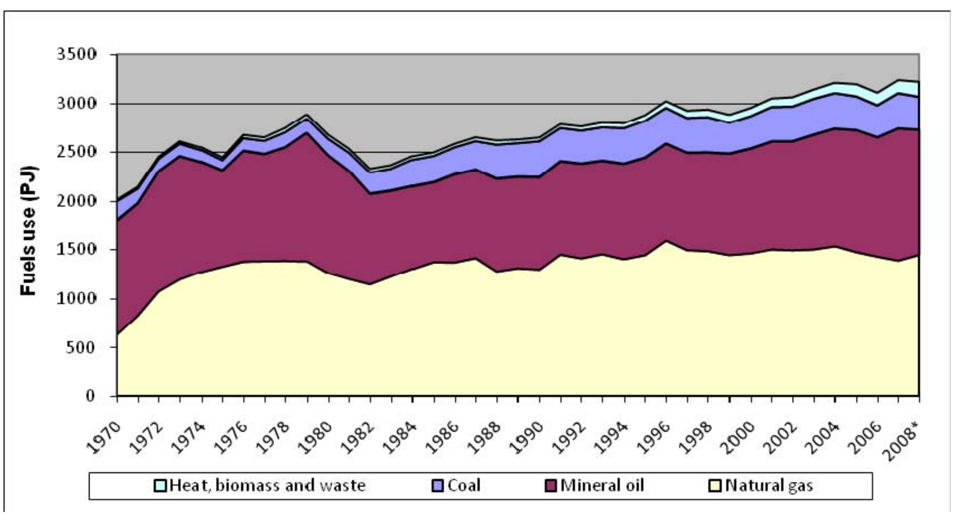


Figure 2.4: Overall use of fuel for heat and electricity in the Netherlands from 1970 to 2008

Source: CBS statline, CBS 2009j.*2008 data is based on CBS estimations).

Regarding the consumption of electricity per sector, the most electricity-intensive sector in the period 2006-2007 is the industry sector with about 145 PJ of electricity used each year. However few changes occurred from 2006 to 2007.

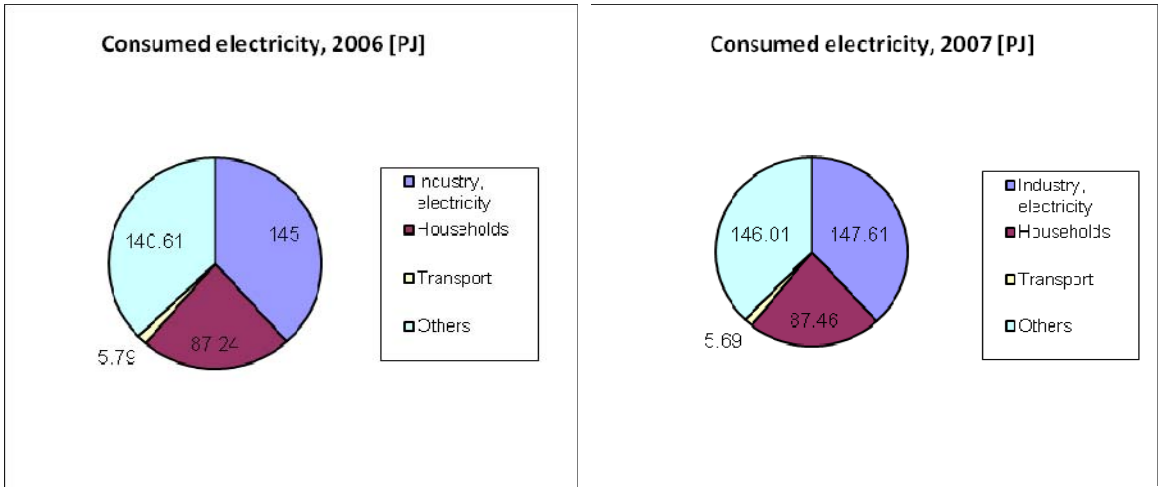


Figure 2.5: Total electricity consumption per sector in the Netherlands in 2006-2007

Source: CBS statline, CBS 2009j.

Renewable Electricity Production & Consumption

Table 2.1 shows that the renewable electricity production in the Netherlands has risen from 6 percent of domestic electricity consumption in 2007 to 7 percent in 2008 , due to an increase in electricity produced from wind energy and biomass. This increase is mainly due policy support schemes (see section 3.3). The new installations were probably all based on the old subsidy scheme (MEP), which was stopped in August 2006 for new projects.

Table 2.1: Renewable electricity production in the Netherlands from 2004 to 2008

	Net domestic production of renewable energy (GWh)				
	2004	2005	2006	2007	2008*
Total electricity production	102.145	100.769	98.835	105.164	105.277
Total net electricity consumption	114.625	114.471	116.085	118.463	119.226
Renewable electricity production	4.963	7.021	7.589	7.150	8.988
Renewable electricity production (in %)	4,3%	6,1%	6,5%	6,0%	7,5%
- Wind turbines	1,6%	1,8%	2,4%	2,9%	3,6%
- Co-firing of biomass in power plants	1,3%	2,9%	2,7%	1,4%	1,8%
- Waste incineration	0,8%	0,9%	0,9%	0,9%	0,9%
- Other sources	0,5%	0,6%	0,6%	0,7%	1,3%

Source: CBS statline, CBS 2009n.

Excluding energy saving through seasonal thermal storage.

Including losses in the electricity network, but excluding the use for power generation

* 2008 is based on estimations by CBS.

Besides biomass, various other renewable energy technologies were used. An over view is presented in figure 2.6

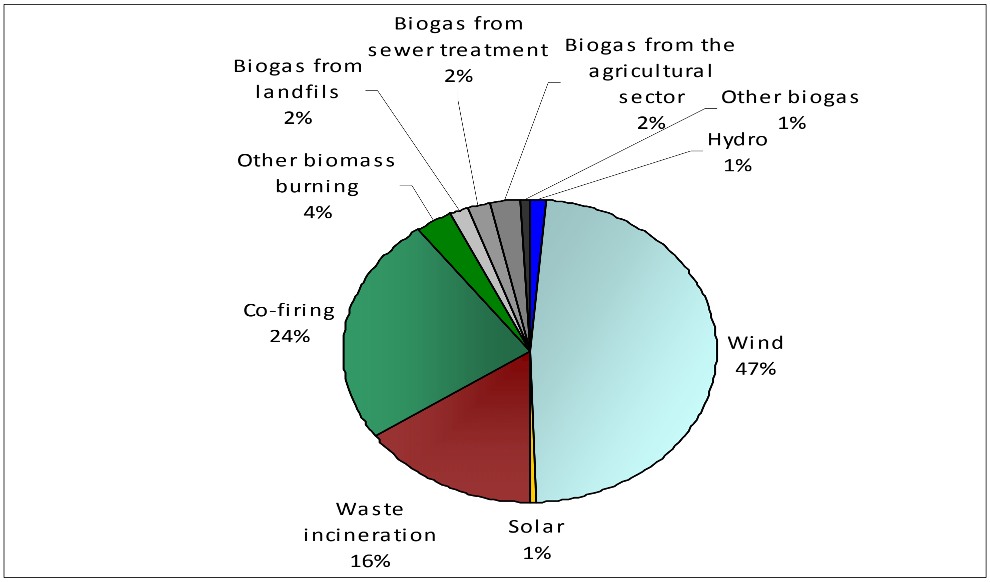


Figure 2.6: Dutch renewable electricity production in 2007.

Source CBS Statline, CBS 2009a.

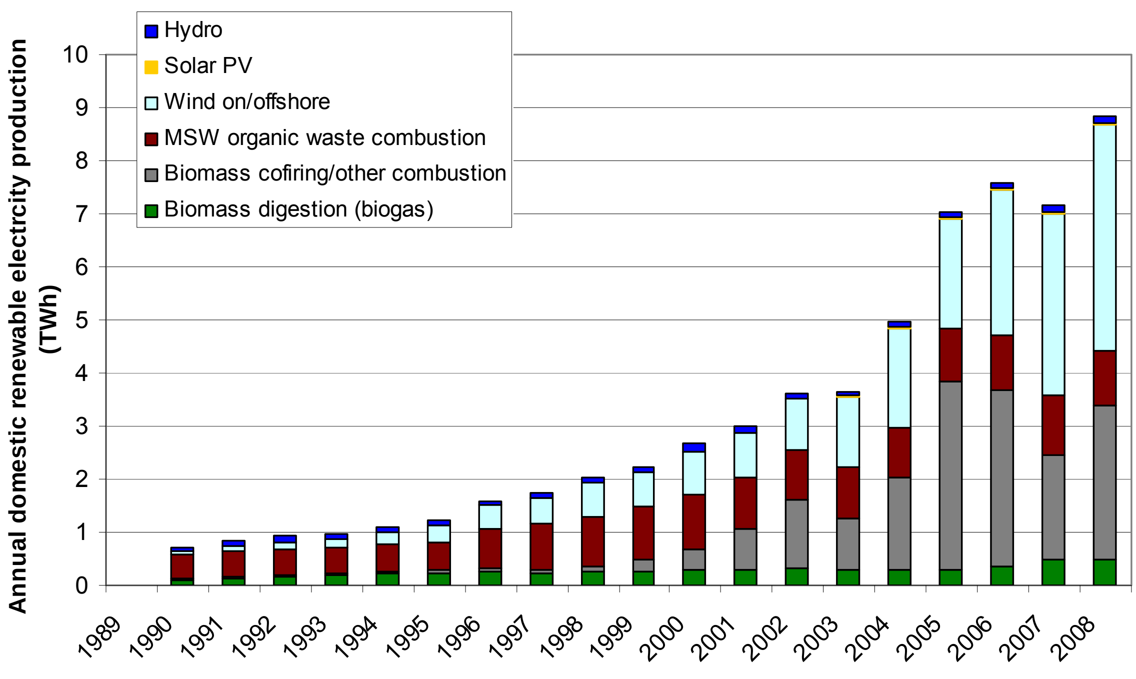


Figure 2.7: Annual renewable electricity production in the Netherlands and contribution per technology from 1990 to 2008

Source: CBS statline, 2009a.

*2008 biomass data is based on estimations, data for biogas and solar PV is assumed equal of 2007.

In 2007, the production of wind powered electricity increased considerably, compared to 2006. Where in 2006, the share was still 26%, the share in 2007 was over 48%. This increase can be partially explained by a 12% increase of the installed capacity (to 1.748 MW_e), and a 2% increase in the production factor (to 24,1%). This implies that the average monthly wind speeds in 2007 were higher than in 2006 (CBS Statline, 2009b).

Renewable electricity generated in the Netherlands is used to supply Dutch consumers with green electricity. As the domestic demand for green electricity by far exceeds the supply, the net imports of green electricity certificates is considerable, accounting for almost 15 percent of total electricity consumption in the Netherlands in 2008. These imports do not contribute to the objective of the Dutch government to cover 9 percent of total domestic electricity consumption (see section 3.2) by electricity generated from renewable sources in 2010 (CBS, 2008).

Fuel consumption by road transportation sector

There has been a significant growth in biofuel consumption by the road transport sector in the Netherlands. Since 2003 there has been a large increase in total energy consumption of biofuels. In 2006 biofuel consumption exploded from 101 TJ in 2005 to 1.979 TJ in 2006. In 2007 biodiesel consumption amplified almost tenfold in relation to 2006. Biogasoline consumption increased steadily from 2005 onwards, and is now around 5.500 TJ.

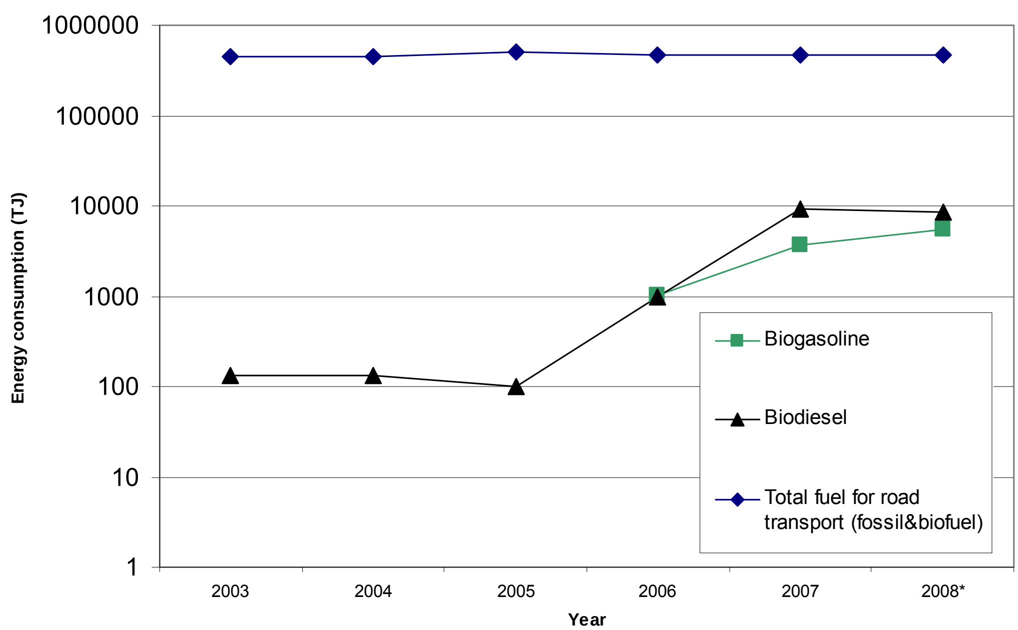


Figure 2.8: Domestic biofuels consumption by the road transport sector between 2003-2008.

Source: CBS Biofuel consumption by road transport.
*2008 data is preliminary.

In relation to the total consumption of fuels by the road transport sector the share biofuels is limited. However there has been an increase in share from 0,03% in 2003 to 2,98% in 2008. The total diesel and gasoline consumption by the road transport sector has slowly increased from 438 PJ in 2003 to 471 PJ in 2008.

Table 2.2: Biofuels and total fuel consumption by the road transport sector in the period 2003-2008

Year	2003	2004	2005	2006	2007	2008*
Biogasoline (TJ)	-	-	-	1.010	3.687	5.461
Biodiesel (TJ)	134	134	101	968	9.344	8.571
Total Biofuel consumption by road transport sector (TJ)	134	134	101	1.979	13.031	14.032
Share total biofuels in total fuel consumption by road transport sector (%)	0,03	0,03	0,02	0,43	2,78	2,98
Total fuel consumption by road transport sector (PJ)	438	446	447	463	469	471

Source: CBS Biofuel consumption by road transport. *

*2008 data is only preliminary.

In table 2.3 overview of the total biodiesel and fuel supply and consumption of 2007 and 2008 is provided. Also the avoided fossil energy use and avoided CO_2 emission is given.

Table 2.3: Overview biodiesel and total fuel consumption in the Netherlands

Total supply / Consumption Biodiesel	2007	2008
Biodiesel (kton)	253	232
Biodiesel (TJ)	9.344	8.571
All diesel fuels (fossil- & bio-diesel) (PJ)	285	288
Share biodiesel (%)	3,28%	2,98%
Required minimum (%)	2,00	3,25
Avoided fossil energy use (TJ)	9.344	8.571
Avoided CO_2 emission (kton)	694	637

Source: CBS statline, 2009f.

3. Energy Policy

The energy policy of the Netherlands is strongly embedded in international and especially European policy. Initiatives taken at International and European level substantially influence the national targets and the national subsidies. Therefore, first international and specific European policies are discussed followed by sections on Dutch policy targets and related subsidies. The chapter will round up with a discussion on the possible future development of bioenergy policies in the Netherlands.

3.1 International policy

In order to reach a sustainable society for future generations, it is essential that activities concerning energy are guided in the right direction. The global character of energy production and consumption needs to be regulated on as well national as international level. On an international level, there are several bodies involved in regulation of energy production and use of energy containers, including biomass. The United Nations Framework Convention on Climate Change (UNFCCC) was founded in order to consider which actions should be considered in reducing global warming. Under the UNFCCC the Kyoto protocol was agreed on. This protocol is a legal powerful treaty in which joined countries have to report and restrict CO_2 emissions, including those that originate from biomass. Another body is the Johannes Renewable Energy Coalition (JREC), a coalition of Governments that are committed to achieve the commitments on renewable energy made at the World Summit for Sustainable Development (WSSD) at Johannesburg in 2002. For policy development the JREC works in close partnership with the International Energy Agency (IEA), an intergovernmental organization which acts as energy policy advisor to 28 member countries in their effort to ensure reliable, affordable and clean energy for their citizens. The IEA provides support for over 40 international co-operation and collaboration agreements regarding bioenergy in energy technology R&D, deployment and information dissemination.

3.2 European policy

On the European level the European Union (EU) has made some policy changes for the use of biofuels over the last years. One example, in 2003 the European Commission (EC) set the indicative non-binding goal of 5,75 percent of biofuels use for transportation that have to be reached within 2010. However due to high food prices in the summer of 2007, debate arose regarding the sustainability of use of biomass for energy purposes. Several criteria, such as the achieved greenhouse gas savings and the effect on natural habitats were needed in order to assess the contribution of biomass on reaching national and international set sustainable goals. On 23 January 2008, the EC put forth a proposal for Climate Action, including a directive that sets an overall binding target of 20 percent renewable energy by 2020 and a 10 percent minimum target for the market share of biofuels by 2020. Furthermore a proposition was made to transform the voluntary targets previously laid down in Directive 2003/30 to binding ones (for the Netherlands this directive has been changed in 2008: see the biofuels section). Regarding production and consumption of biofuels there are two important regulations. One is the Directive 2001/77/EC, which set the conditions for regulating taxes on biofuels for as well electricity generation as transportation fuel. The other one is the Renewable Energy Directive (RED).

The RED states that (in 2020) 10% of the transport fuels sold must be derived from renewable sources, including biofuels (such as biodiesel and bioethanol), but also renewable electricity and hydrogen. The RED directive incorporates sustainable criteria regarding the production of biofuels. These criteria stated that the production of biofuels may not have any negative effects on biodiversity and the reduction in greenhouse gas emissions must be at least 35%, measured over the entire chain (from production of raw materials through to end-use) and compared to fossil fuels. In 2017 these minimum criteria will be increased to at least 50%.

3.3 National Targets

3.3.1 General Policy Target

The actual government has established an important energy policy framework addressing key challenges: to secure energy supply, develop a sustainable energy future and maintain economic competitiveness. The government is actively engaged in evaluating its medium- and long-term energy future, and has adopted a set of very ambitious sustainability targets. Moreover, the government pays particular attention to the cost-effectiveness of its policies and regularly evaluates the implemented measures (N. Tanaka, 2009).

Another important point is that the government is intensifying its support for research and development of energy technologies (on both the supply and demand sides). It has increased its R&D budget, planning to spend EUR 900 million in 2008-2011 on innovation. The Netherlands is actively participating in international energy R&D networks and activities (N. Tanaka, 2009).

In a letter to the Lower House of Parliament, Ministers Cramer and Koenders (from the Ministries of Environment and Development Cooperation respectively) indicated how they plan to implement the sustainability policy during the period 2008-2011 (SenterNovem, 2008).

The targets for the period 2008-2011

The policy should achieve the following results over the next few years (SenterNovem, 2008):

- Implementation of trial projects to produce biomass more sustainably, in cooperation with producing countries.
- A political agreement needs to be reached concerning the EU's Renewable Energy Directive, and the first certified biomass should be sold in the Netherlands.
- The European Energy and Climate Measures, including sustainability criteria for biofuels and certification, should be approved and implemented.
- Innovation focuses on 2nd and 3rd-generation biofuels, as well as new energy crops and techniques that are less competitive with agriculture and vulnerable nature areas (e.g. cultivation in salty areas or poor soils).
- An international monitoring system is set up for macro-monitoring of both direct and indirect effects of biomass production and consumption, thus providing an overview, as well as following the application of sustainability criteria.
- The EU legislation is implemented in the Netherlands.
- Sustainable biomass production is encouraged in developing countries, and the goal is to actually achieve sustainable production in at least two developing countries.

The plan also calls for an annual overview to be sent to the Lower House of Parliament (after the Sustainability Monitor has been published), which describes the progress made in relation to the aforementioned approach, and the conclusions that can be drawn from the Sustainability Monitor (SenterNovem, 2008).

3.3.2 Specific Policy Target

Dutch policy for renewable energy from biomass sources are based on the Dutch Biomass Action Plan and the EU directive for biofuels. Also important are the targets in renewable electricity production.

Biomass action plan

The Dutch government is aiming for 10% renewable energy use in 2020 (Biomass Action Plan). All Biomass action plan figures have been derived from the so called "Statusdocumenten" of Senternovem 2007. These documents are used as input for the evaluation of policy goals of the Ministry of Economic Affairs (EZ). The following table shows the objectives of the biomass action plan.

Table 3.1: Biomass action plan target for 2010

Type of plant	ACTION PLAN 2010 (PJ)
Large scale	
Co-firing (power plants)	34
Waste incineration	20
Cement kilns	-
Small scale	
Cogeneration of heat and power (CHP)	8-18
Wood-burning stoves (industrial)	7
Landfill sites	2
Wastewater purification plants	4-6
Total	75-87

Source: 'Statusdocumenten' 2007.

Biofuels

The Ministry for Environment hopes that the measures concerning biofuels will bring about important steps towards achieving a sustainable energy supply. In 2007 some 2% of the petrol and diesel sold in the Netherlands had to consist of biofuels. The objective was to increase this target according to European Guideline 2003/30EG, to 5,75% in 2010. However, in October 2008 the Dutch government modified biofuels targets for 2009 and 2010. The biofuels target for 2009 is now reduced from 4,5% to 3,75%, and the target for 2010 is reduced from 5,75% to 4%. For 2008 the target was 3,25%. The most important reason behind this adjustment is the concern regarding the effectiveness and sustainability of biofuels (SenterNovem, 2008).

Moreover, with effect from 1 January 2007, the parties selling petrol and diesel in the Netherlands are obliged to achieve a certain percentage of their turnover (on an energy basis) from sales of biofuels. For 2008 this percentage is set at 3,25%. The Transport Biofuels Act 2007, which legislates this, has been published in the Government Gazette (SenterNovem, 2008).

The companies that are not fulfilling the mandatory targets can face a penalty (Strategy grains, 2009). The exact fine will be set by a judge, but can reach 450 000 €. Like with the CO_2 trading emission system there is a system through certificates for trading biofuels as well, which makes it possible for each company to reach the global and minimum obligatory targets set for biofuels for a certain period in time.

Renewable electricity

Dutch policy on renewable electricity production important aim: 9% of the net domestic consumption in 2010 should be based on renewable sources. In 2007 this percentage was 6% and in 2008 is estimated to be 7% (see also table 2.1).

As indicated in chapter 2 (figure 2.4) in 2007 there was a substantial decrease of the biomass co-fired due to the cut of the MEP subsidies in 2006 (see the MEP paragraph, section 3.3). As a consequence the overall renewable electricity production decreased in 2007.

3.3.3 Specific national targets overview

In table 3.2 an overview of the different national targets is given.

Table 3.2: Dutch targets for 2010 and 2020

EFFECT	2006	2007	2010	2020
Renewable energy (from 20% EU target)			10%	14,0%
Renewable energy (national government)	2,8%	2,6%	10%	20,0%
Renewable energy in electricity portfolio	6,5%	5,8%	9,0%	
Renewable energy in transport (biofuels)	0,4%	2,0%	4,0%	
CO_2 reduction (national government)	3,0%			30,0%

Source: ECN 'Country report the Netherlands'.

3.4 National Subsidies

The Netherlands implemented several instruments to stimulate renewable energy production. The following paragraphs describe the major subsidies and other policy support schemes that influence the biomass use in the Netherlands.

Subsidy on renewable energy production (MEP)

In July 2003, the Dutch government introduced the support for renewable energy through subsidies of renewable electricity production during a period of 10 years. These subsidies have been cut on the 18th of August 2006. Only approved projects before this date still obtain these subsidies until the end of a 10-year period (Vereniging Afvalbedrijven, 2007).

SDE 2009

The SDE (stimulering duurzame energie) can be seen as a successor to the MEP, and also aims stimulate the production of amongst others renewable electricity. The SDE is a grant which compensates for non-top projects in the field of renewable energy and it is wider (more categories included) than the MEP. The SDE is an important tool in the work Program "Clean and efficient, new energy for the climate", in which the government explains how the Netherlands is going to reach the target of 20% of renewable energy by 2020.

On April 6 2009, a new round of granting SDE subsidies started. SDE is not an investment subsidy, it is a feed-in (tariff) premium subsidy scheme. This means that government pays a subsidy for each MWh of renewable electricity. Therefore, the SDE provides to the investors in renewable energy a long-term security. The scheme covers up to 1000MW_e, which is equal to an investment of approximately EUR 1.5 billion. This is a system that compensates the difference between the cost of the regular energy and sustainable energy. This subsidy scheme lasts for a period of fifteen years (for hydro, waste incineration, solar-PV and wind on land) or twelve years (for biomass, other green categories and gas). The scheme closes on October 30, 2009.

The scheme provides support for bioenergy in the following categories:

Table 3.3: SDE scheme with categories supported

TYPE OF BIOMASS USED	SUBSIDIES
Electricity generation using WWTP / Landfill Gas	4,4 €ct per kWh
Green Gas production by WWTP / Landfill Gas	14,7 €ct per Nm^3
Green Gas production by co-fermentation of animal manure fermentation and vegetable waste	14,7 €ct per Nm^3
Burning of solid biomass, fermentation of vegetable waste and co-fermentation of manure	4,4 €ct per kWh
Waste incineration plant with an energy efficiency higher than 22%	9,2 €ct per kWh*

WWTP: waste water treatment plant.
Source: SenterNovem, 2009.
*ascending to higher returns.

3.4.2 R&D subsidies and tax exemption schemes

EOS

The Energy Research Grant Program (EOS) encourages the quality of the research and knowledge in the Netherlands by developing new technology to promote, with the aim of realizing a sustainable energy supply. EOS offers financial aid to companies and research institutes. Cooperation projects, demonstration projects and research projects in the field of renewable energy are included in this grant scheme (SenterNovem, 2008).

EIA 2009 and 'regeling groen beleggen'

The EIA tax scheme, aims to stimulate investment in energy efficient assets and renewable energy technologies. It allows investment in certain technologies (including wind) to be deducted from taxable profit up to a percentage of investment costs. In 2009, this percentage is 44%. In order to be eligible for EIA support the costs of a corporate asset must be at least € 450, and the total amount of the energy investments per calendar year must be at least € 2.200. The maximum deduction is € 113 million per year per fiscal entity (SenterNovem, 2008). Another scheme, called 'regeling groen beleggen' allows private investors to invest in e.g. renewable energy projects, and to receive a tax break for this investment.

3.4.3 Fuel Subsidies

Rural stations cover alternative fuels (TAB)

The Ministry of Transport provides a grant for the realization of alternative fuel stations for natural gas and ethanol. The purpose of the grant program is a nationwide network of service stations realized with the aim of making alternative fuels available for everyone. In combination with local and provincial initiatives this nationwide network will be feasible for 2010. On May 21 in 2008, this subsidy was published. At present the scheme is closed (SenterNovem, 2008).

CO_2 reduction Innovative Biofuels for Transport (IBB)

Beginning in 2007, the CO_2 reduction Innovative Biofuels for Transport (IBB Program) carried out with a budget of € 12 million for the promotion of second generation biofuels (SenterNovem, 2008).

Tax reduction

In the beginning of the 21st century a new tax system for biofuels was set up. A tax reduction of 0,061 €/l for biodiesel (FAME) and 0,101 €/l for bioethanol was made if the fuel mix contained at least the minimum amount of biodiesel or bioethanol set by the national targets (Stratgrain, 2009). If less biodiesel was added, the reduction was lowered proportionally. However, policy changed, and since January 2007 no de-taxation has been granted. Nevertheless a number of companies have been granted relief from excise duty (0.365 €/l) on a more limited scale. This relief mainly concerns a small numbers of projects involving pure vegetable oil production. PPO producers Carnola, OPEK and Solaroilsystems have been granted relief from excise duty for the period 21 June 2003 until 31 December 2010 for alimited amount of PPO (Solaroilsystems, 2009).

3.4.4 Other Subsidies

ROB Agriculture (Reductie Overige Broeikasgassen)

Translated ROB means Reduction Other Greenhouse gasses. The Dutch agricultural sector contributes about ten percent to the emissions of all greenhouse gases in the Netherlands. These are the greenhouse gases carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). CO_2 emissions are mainly due to consumption of fossil energy (gas, coal, oil). Cattle and stored manure are the main sources of methane. Nitrous oxide is mainly released from the soil induced by N-fertilizer application and manure. This subsidy scheme stimulates the emission reductions of methane, nitrous oxide and fluorine compounds (SenterNovem, 2008).

3.5 Future Prospects

The target for renewable to make up 20% of total energy supply by 2020 is probably the most challenging, given that renewable currently accounts for just over 2,8% of the total energy supply. Compared to the 28 IEA member countries, the Netherlands has the sixth-lowest share of renewable in its TPES (total primary energy supply), partly explained by the lack of large-scale hydro in the country. To achieve its objective, the government has recently revised its primary renewable promotion scheme for renewable energy (N. Tanaka, 2009).

The Netherlands' energy and climate agenda calls also for a 30% reduction in greenhouse gas emissions by 2020 from 1990 levels and an annual energy efficiency improvement of 2% by 2020. Very important is also the implementation of the sustainability criteria as described at the end of this section.

CO_2 reduction

Nuclear power currently provides 4% of the country's electricity, but the future of nuclear in the Netherlands is not clear: the coalition agreement of the current government rules out the construction of new nuclear power plants before 2011. On the other hand, government forecasts show that the share of coal in the energy mix is expected to grow in the coming decades. The sharp increase in coal use could be counter-productive given the country's ambitious climate change agenda. However, the government is working actively on carbon capture and storage. Nevertheless this technology is still under development and the ability to deploy it widely and successfully is not assured (N. Tanaka, 2009).

Efficiency

Another important target is to improve the country's energy efficiency by 2% per year in the Netherlands. At present, energy intensity is nearly 10% higher in the Netherlands than the average for IEA Europe. This is mainly due to the higher concentration of energy-intensive industry in the Netherlands, including the refinery and chemicals industries. Energy intensity has been declining over the past decades, although this decline has somewhat slowed down in recent years. The current rate of energy efficiency improvement is less than 1% per year. The Netherlands' energy efficiency policy is increasingly guided by EU-level requirements. The country generally complies with these requirements, and has put in place a number of policies to stimulate energy efficiency in different sectors (N. Tanaka, 2009).

Sustainability Criteria

In order to responsibly integrate financial support into (new) bio-energy plants, new requirements for sustainable biomass resources are necessary. The Commission Cramer developed an overall (meta) sustainability framework for biomass production (Commission Cramer, 2007). The framework is based on six themes. Themes i, ii and iii are biomass specific themes, whereas themes iv, v and vi are more general. The latter rely on the triple P approach (people, planet, profit), which is considered the guiding principle for corporate social responsibility in general. These are the following themes:

- Greenhouse gas emissions
- Competition with food and other local applications of biomass
- Biodiversity
- Environment
- Prosperity
- Social well-being.

As mentioned in section 3.1 also the RED directive incorporate sustainable criteria regarding the production of biofuels. These criteria state that the production of biofuels may not have any negative effects on biodiversity, and the reduction in greenhouse gas emissions must be at least 35%, measured over the entire chain (from production of raw materials through to end-use) and compared to fossil fuels. In 2017, these minimum criteria will be increased to at least 50%. The sustainability criteria in the Directive are not as strict as the Cramer criteria, which, for example, also include social aspects. The first evaluation will be conducted in 2014 (SenterNovem, 2008).

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. According to MVO (2007), 11.8 ktonne of rapeseed was produced in the Netherlands in 2007. By rule of thumb 1/3 of the mass is represented by rapeseed oil and 2/3 by rape cake (Solaroilsystems, 2009). The rape cake is virtually all being processed into animal fodder the rapeseed oil is primarily being used as PPO in the Netherlands. Given an energy density of rapeseed oil (PPO) of 36 MJ/kg the total resulting energy amounts to 142 TJ[2]. 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)

[2] 142 TJ = 1/3 * 11.8 ktonne * 36.0 TJ/ktonne

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 7.3 PJ in 2007 (CBS, 2009a). 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.

Table 4.2: Destination of end-products from clean residue wood in 2007

Product[2]	Domestic use (ktonne)	Export (ktonne)	Total (ktonne)
Litter	145,5	71	216,5
Energy	130	87	217
Particle board	-	28	28
Total	275,5	186	461,5[1]

Source: Leek et. Al, 2009.
1) The difference between the tonnes of end-product (461.5) and the tonnes of available clean residue wood (351.5+78.5 = 430) is due to the fact that some companies were not able to indicate the exact amount of clean residue wood used for production.
2) Approximately 85% of the end-products used for energy is represented by energy pellets, 8% firewood, and 7% others (Leek et. al, 2009).

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. In 2007, 352 ktonne was being imported, whereas 305 ktonne was being exported (Bergmans, 2009). The available animal fat in the Netherlands in 2007 therefore was about 258 ktonne.

Table 4.3: Specific use of available animal fat in the Netherlands in 2007

Specific use	Amount (ktonne)	Part of total
Human consumption	16	6%
Animal Fodder	110	43%
Technical applications (incl. energy)	132	51%
Total	258	

Source: Bergmans , 2009.

From the 132 ktonne animal fat for technical applications approximately 65% (88 ktonne) is being used for energy purposes (Bergmans, 2009). This is 34% of the total available animal fat in the Netherlands for the year 2007.

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). The total amount of domestically available used wood was 1.485 ktonne for the year 2007 (Leek et al., 2009). 130 ktonne was being used for energy purposes in the Netherlands, 175 for energy pellet production (indirect energy purposes) and 20 ktonne for other products. A large share, 1.160 ktonne, was being exported (mainly to Belgium and Germany).

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. In 2007 the total of municipal solid waste summed up to 10.551 ktonne according to CBS (Statline, 2009). 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. In 2007, 5.788 ktonne of mixed waste was burned in 12 incineration plants in the Netherlands (excluding the combustion of sewage and paper sludge) (SenterNovem, 2008). This was 4% more than in 2006. 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.

Table 4.4: Quantity of incinerated waste in 2007

Category	ktonne
Households	2.867
Industrial waste (office-, shop-, and services)	1.846
residual fraction after mechanical separation of household and industrial waste	919
others/ non specified	98
Hazardous waste	57
Total	**5.788**

Source: SenterNovem, 2008.

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. According to CBS (Statline Databank, 2009), 580 ktonne of paper sludge was used for domestic energy purposes in 2007.

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). The total amount of exported combustible waste (RDF) was 203 ktonne for the year 2007 (Huet, 2009). At the same time a smaller amount is being imported (27,5 ktonne) whereof 80% (22 ktonne) is being combusted in the Dutch Cement ovens (ENCI) near Maastricht, the other 20% (5,5 ktonne) is being processed to RDF with a higher heating value and is exported again.

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 2007

Biomass resources	**LHV biogenic**[1]	**Domestic supply**		**Domestic consumption for energy purposes**[2]	
	TJ/ktonne	*ktonne*	*PJ*	*ktonne*	*PJ*
Dedicated energy crops					
rapeseed oil	36[3]	3,9	0,1	3,9	0,1
chipped energy wood	10,2	0,3	0	0,3	0
Total energy crops			**0,1**		**0,1**
Biomass Waste streams					
Biogas from residues	-	-	**7,3**	**-**	**7,3**
'Green'					
Fresh residue wood	10,2	1.000	10,2	275	2,8
Residue wood from wood processing industry	15,6	351,5	5,5	130	2
Discarded frying oil	38	60	2,3	120	4,6
Animal fats	25	206	5,1	88	2,2
Animal meal	22	46	1	46	1
'Orange'					
Used wood (A, B, C quality)	15,4	1.485	22,9	305	4,7
Mixed municipal waste	3.9[4]	10.551	41,1	5.778	22,5
Papers sludge	1,6	3.000[5]	4,8	580	0,9
Combustible waste (RDF)	4.0 - 4.9[6]	197,5	0,8	22	0,1
Total biomass waste streams			**93,7**		**40,8**
Total			**101,1**		**48,2**

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) Including imports.
3) Source: Solaroilsystems (2009)
4) Source: Rabou et al (2006) propose an energy content of 8.4 TJ/ktonne of mixed municipal waste. Another literature source (Duurzame Energie in Nederland, 2007) states that municipal waste that is combusted in incineration plants has energy content of 10,0 TJ/kton . Here, we take the more conservative value of 8.5 TJ/tonne. The biogenic fraction of the waste is assumed to be 47% following SenterNovem's protocol for the monitoring of sustainable energy (2006) => 8.4 TJ/ ktonne * 0.48 = 3.9 TJ/ktonne.
5) Rough estimate taken from Koppejan et al (2005).
6) 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.

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 add up to approximately 8 PJ (Spijker et al, 2008). 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 2007. 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

Table 5.1 shows the use of biomass in 2007 compared to 2006.

Table 5.1: The use of biomass for renewable energy in the Netherlands

	Biomass (PJ)		Electricity production (TWh)		Heat production (PJ_{th})		Replaced fossil fuels (PJ prim/yr)	
	2006 (1	2007 (2	2006(1	2007 (2	2006(1	2007 (2	2006(1	2007 (2
Total biomass	**73,2**	**69,8**	**4,7**	**3,6**	**15,5**	**16,3**	**62,1**	**61,6**
Waste incineration	27,1	27,9	1,0	1,1	3,9	3,9	12.4	13,0
Co-firing in power plants	28,5	15,7	3,1	1,7	0,6	0,8	29,4	15,7
- Solid biomass	47%	98%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
- Liquid biomass	53%	2%	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Woodstoves: industry	2,2	2,6	0	0	1,9	2,1	2,1	2,4
Woodstoves: households	9,3	9,3	0	0	5,2	5,2	5,5	5,5
Other biomass burning	6,1	7,1	0,2	0,3	3,1	3,3	5,3	5,6
- Solid biomass	97%		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
- Liquid biomass	3%		n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Biogas	5,9 (1	7,3	0,3	0,5	0,9	0,9	5,4	6,4
Biofuels for transport	2,0	13,0	0	0	0	0	2,0	3,7
- Biogasoline*3	1,0	3,7	0	0	0	0	1,0	9,3
- Biodiesel*3	1,0	9,3	0	0	0	0	1,0	13,0

1) Source: IEA Bioenergy Task 40 - Country report for the Netherlands 2007, also based on CBS data.
2) Source: CBS Statline 2009, CBSa, CBSd, CBSe, CBSi.
3) Source: CBS 2009, CBSf.
4) Renewable fraction only
n.a: Not applicable.

The biomass consumption for co-firing almost halved from 2006 till 2007. The production of electricity from biomass, therefore, decreased with 25%. The decrease in consumption for co-firing was largely counteracted by a significant increase in the consumption of biofuel. It has increased from 2 PJ in 2006 to 13 PJ in 2007. Figure 5.1 shows the overall effect on the avoided fossil primary energy.

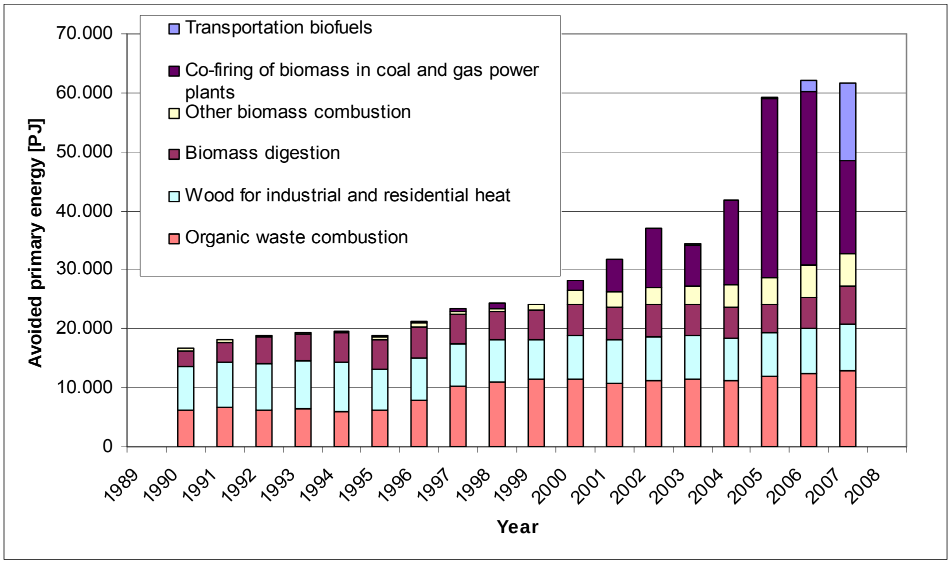


Figure 5.1: Avoided fossil primary energy consumption by production of electricity, heat and transportation fuels from biomass

Source: CBS Statline, BCS 2009d.

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). In 2007, the AVIs produced roughly 3.000 GWh of electricity. After a correction for the organic fraction and a deduction of the plants own electricity usage, 1.116 GWh net renewable electricity from biomass was produced. Next to electricity, the AVIs also produced 8146 TJ of heat. (CBS, Statline 2009e) This 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

The 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 raised 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.

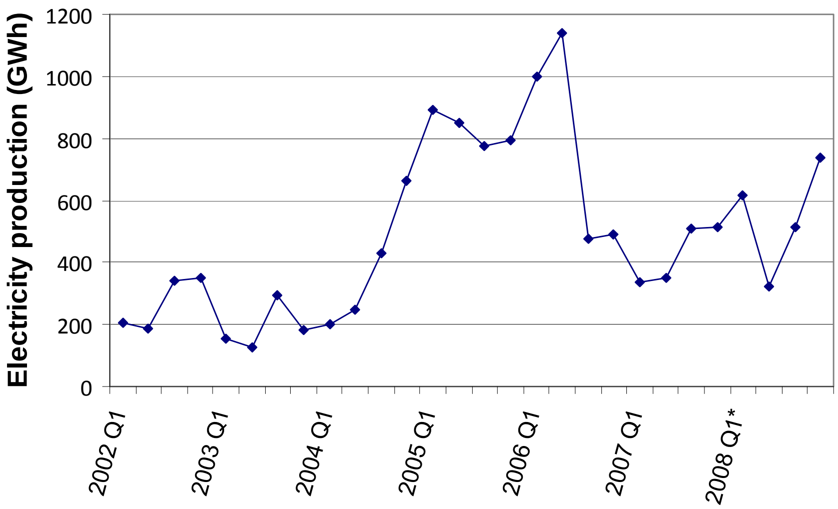


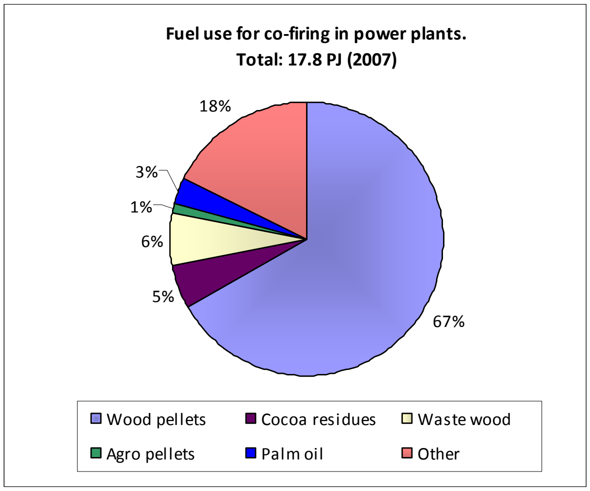
Figure 5.2: Co-firing of biomass in power plants between 2002-2008

Source :CBS Statline 2009 C.
* 2008 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 (7,9 TJ to 11,9 TJ) although its overall share decreased from 67% to 58%. Other important biomass fuels were waste wood, agricultural residues from cocoa processing[3] and various waste streams. In 2008, the main fuel for co-firing was again the use of wood pellets. In total, 790 ktonne of wood pellets have been co-fired (14 TJ). Other fuels were crude palm oil, waste wood[4], and agricultural residues from cocoa processing.

[3] 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

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



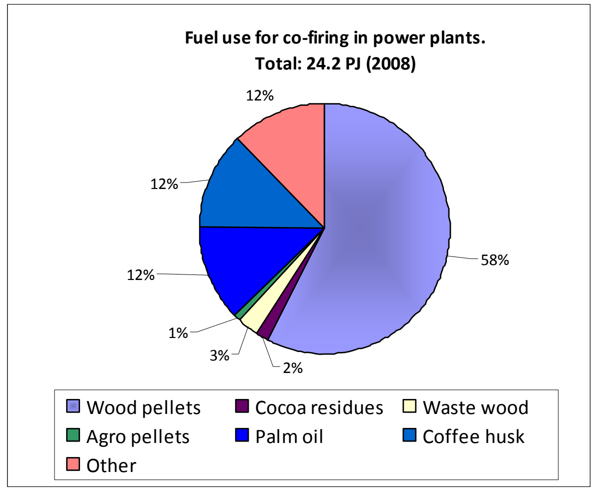


Figure 5.3: Used fuel mix for co-firing in power plants in 2007 and 2008, based on the input of tonnes of biomass

Sources: Pelletatlas 2007-2008, telephone interviews, annual reports + environmental reports of power plants and MSW incineration plants.

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).

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). In 2007 there has been an increase in the use of residue wood in industrial woodstoves of 16%, to 2,6 PJ, i.e. about 174 ktonne if the same heating value is assumed.

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, and amounts to 9,3 PJ. 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.

Table 5.3: Overview important stand-alone biomass burning installations operating in 2007

Facility	Fuel	Biomass	Electricity
		Ktonne	*GWh / year*
Cuijk	A-wood (fresh residues)	270	190
Lelystad	A-wood (fresh residues)	25	10
Schijndel	A-wood (fresh residues)	14	8,4

Source: SenterNovem (2005) "Bio-energie van eigen bodem- voorbeelden van en ervaringen met kleinschalige installaties voor opwekking van elektriciteit uit biomassa" Publication SenterNovem, Utrecht.

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, 2009).

Table 5.4: Overview new biomass burning installations operational in 2008

Facility	Fuel	Biomass	Electricity
		Ktonne / year	*GWh / year*
HVC Alkmaar	B-wood from construction and sorted wood from compost	170	205
AVR Rozenburg	B-wood and A-wood (prunings)	150	192
Twence Hengelo	B-wood, organic waste and sorted wood from compost	140	185
BMC Moerdijk	Chicken manure	440	36,5

Source: Vereniging afvalbedrijven (2007), BMC Moerdijk (2008) press release "Van mest naar stroom".

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.

Table 5.5: Renewable energy generation from biogas in 2007

Biogas Source	Feedstoc k	Renewable electricity production	Renewable CHP heat production[3)]	Biogas production
		GWh	TJ	10^6 m^3 natural gas
Biogas from agriculture	Manure[(1]	173	20	
Biogas from sewage sludge	Sewage	139	683	6
Biogas from landfill	Landfill	111	72	13
Biogas from other sources[(2]	Various	65	171	21
Total		**488**	**946**	**40**

Source: CBS statline database.
1) Plus a considerable vegetable part for co-digestion.
2) Predominantly biogas from digestion of vegetable waste streams from industry.

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[5].

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[6] 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. The use of pure biogasoline (either 100% bio-ethanol, 100% bio-ETBE or a mixture of both) as transport fuel in the Netherlands was practically zero in both 2007 and 2008. This is most likely because the conventional gasoline infrastructure and combustion engines are not equipped for pure ethanol. Instead they are blended with fossil gasoline.

Table 5.6: Production and consumption of biogasoline in 2007 and 2008

	2007		2008(1	
	ktonne	PJ(2	Ktonne	PJ(2
domestic bio-ethanol production	11(3	0,3	7(3	0,2
biogasoline consumption	132(4,5	3,7(4	197(4,5	5,5(4

1) The numbers for 2008 are preliminary.
2) Unless stated otherwise, these numbers are calculated using energy densities: 26,9 MJ/kg for ethanol and 36,3 MJ/kg for ETBE (IES, 2007).
3)Source: eBio.org. Using the EFOA (2006) energy density of 26,9 MJ/kg for ethanol, this is 300 [TJ] for 2007/200 [TJ] for 2008.
4) Source: CBS (2009f). Numbers for 2008 are last updated in 27th of April, 2009. Next update will be in June 2009.
5)Although the separate consumption of bio-ethanol and bio-ETBE is not given by CBS (they are classified), comparison of the biogasoline densities that can be derived from CBS (2009f) and the densities of ethanol and ETBE as given by IES (2007) shows that most biogasoline is consumed in the form of bio-ETBE.

In 2007 and 2008, most of the bio-ethanol required for direct consumption or production of bio-ETBE was imported. However, there are reports of three companies starting up bio-ethanol factories and 2 bio-ethanol projects that are on hold (GAVE, 2009), so in the near future this picture might change.

[5] 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).
[6] Output of ETBE.

5.8.2 Biodiesel and pure vegetable oil (PPO)

Biodiesel

In 2007 the total production capacity of biodiesel in the Netherlands was 210 ktonne, the actual produced biodiesel amounted to 85 ktonne(CBS, 2009f).

Table 5.7: Biodiesel producers in the Netherlands in 2007

Producer	Feedstock	Total capacity (ktonne)	Total production (ktonne)*	Remarks	Source
BEWA	discarded frying oil	15	2	Production started in December 2007	(1
Biodiesel Kampen (Vierhouten Vet)	discarded frying oil	50	13	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	5	Produces also biogas	(1,(2,(4
Sunoil Biodiesel	discarded frying oil, multiple	60	30	Production started July 2007	(1,(2,(4
Biovalue	rapeseed oil	80	35	Production started August 2007. Plant expansion projected to 240 ktonne	(1,(2,(3, (5
Total		210	85		

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

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.

Table 5.8: Overview of feedstock required for production biodiesel in 2007

Feedstock	ktonne
Discarded frying oil (+other resources)	75
Animal fat	5
Rapeseed for energy purposes[1	105

Source: MVO (2008).
1) About one third of the total mass of rapeseed is converted into oil and two third into rape cake.

In 2008, the capacity increased significantly to roughly 520 ktonne (CBS, 2009f). However, the actual produced biodiesel was less than that produced during 2007 and amounted to 83 ktonne (3,1 PJ) (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. In 2007 the total production of PPO in the Netherlands amounted to roughly 42 ktonne.

Table 5.10: PPO production in the Netherlands in 2007

Producer	Feedstock	Capacity (ktonne)	Production (tonnes)*	Sources
Biovalue	rapeseed	80	3	1,2,3,6
OPEK Nederland B.V.	rapeseed	0,5	0,5	2,5
Coöperatie Carnola	rapeseed	3	2	2,5
Noord-Nederlandse Oliemolen	rapeseed	5	4	2,3,4,5
Ecopark Harlingen Holding BV (Oliemolen)	rapeseed	30	30	2,5
PPO Groeneveld	discarded frying oil	0,25	0,25	1,3
Twentsche Oliemolen B.V.	rapeseed	3	3	5,7,8
Total		121	42	

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. The amount of feedstock used for PPO production is indicated in table 5.11. In this calculation, all produced rapeseed in the Netherlands is allocated to the production of PPO. The additional amounts needed for the total amount of PPO is imported. As can be observed from the provided data, less than 10% of the required amount of rapeseed is produced in the Netherlands, the remainder needs to be imported.

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 General overview

As described in the introduction, one of the goals of the EUBIONETIII project is to investigate the use of biomass in a number of different industry sectors. In Table 5.12, an overview is listed of the industries categories investigated in EUBIONETIII and their presence in the Netherlands. In table 5.13, the total primary energy use (in PJ) of primary energy in 2006 for each of the categories listed above is specified. In addition, also an estimate is provided how much biomass is used (in PJ) for energy use. As can be seen, the only two sectors in which biomass is currently used for energy purposes are the food processing and the cement industry. Thus these two sectors are further investigated in sections 5.9.2 and 5.9.3.

Table 5.12. Selected industries and description of companies present in the Netherlands.

NACE Industry	Description
C10 Manufacture of food products	Several large companies are producing in the Netherlands, such as ADM, Unilever, Friesland Foods, McCain, Friesland Campina, Royal Cosun and Lamb Weston Meijer. Next to this, there are numerous smaller companies processing food products.
C11 Manufacture of beverages	A number of major international beer breweries have production plants in the Netherlands, e.g. Heineken and Inbev. Also, there several production plants of soda's liquid dairy products etc.
C19 Manufacture of coke and refined petroleum products	There is significant refining capacity in the larger Rotterdam area, a.o. plants of Shell, Total, BP, Kuwait Petroleum and Esso.
C20 Manufacture of chemicals and chemical products	In the especially in the area surrounding the Rotterdam harbour. Typical companies producing in the Netherlands are Akzo Nobel, Dow Chemicals, DSM and Lyondell
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	More than 100 pharmaceutical companies are registered in the Netherlands, amongst other Bayer, DSM, Organon, Pfizer and Solvay
C23.5.1 + C23.5.2 Manufacture of cement, lime and plaster	There is only one major cement producers in the Netherlands: ENCI, with three production plants in Maastricht, IJmuiden and Rotterdam
C24 Manufacture of basic metals	There is only one major steel-producing company in the Netherlands, Corus (part of the Tata group).

Table 5.13. Primary energy use in selected industrial sectors in 2006.

Industry	Primary Energy use (PJ) in 2006	Of which biomass (PJ)
C10 Manufacture of food products	66	0.42[a]
C11 Manufacture of beverages	Included in previous row	Included in previous row
C19 Manufacture of coke and refined petroleum products	132	0
C20 Manufacture of chemicals and chemical products	48	0
C21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	Included in previous row	0
C23 Manufacture of other non-metallic mineral products	4	0
C23.5.1+23.5.2) Manufacture of cement, lime and plaster	26	1.3
C23.6 Manufacture of articles of concrete, cement and plaster	0	0
C24 Manufacture of basic metals	93	0

a This is based on annual average based on multi-year cumulative biomass use (typically between 2001-2007) in various sub-industries (e.g. potato, coffee, meat-processing etc.). Source of information: van der Sterren (2009), Alfing (2009)

5.9.2. 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. Current large biomass users

This chapter provides qualitative information on the actors within the field of bioenergy in the Netherlands. It offers a background for the quantitative data presented in this report. Table 6.1 shows a general overview of the main bioenergy installations in the Netherlands in 2007.

Table 6.1: Overview of main bioenergy installations in the Netherlands in 2007

Number of installations	Description	Main kinds of feedstock	Domestic suppliers	Foreign suppliers
Waste incineration plants				
11	large scale waste incineration plants	Municipal solid waste, with an average organic fraction of 48%(2	3 waste collecting companies: Sita, van Gansewinkel and ASW(2	1 foreign supplier. Possibly an exchange program with Remondis (Germany) (2
Co-firing in power plants				
7	7 out of 7 co-fire wood pellets and used wood	69% Of all co-fired biomass was wood pellets. 6% was used wood,	Various wood pellet producers.	Mainly Canada and the USA, Germany, Scandinavia and Baltic states. (3
	2 out of 7 also co-fire cocoa based fuels	5% Of all co-fired biomass were Cocoa based fuels	Cocoa delivered via Cargill BV and Jan Schoenmaker BV.(3)	Mainly Brasil, Ghana, Cameroon, Ivory coast, Indonesia, and Vietnam.
	3 out of 7 co-fire other fuels as well	20% Of all co-fired biomass were other fuels, like grape pits, industrial waste, palm oil and agricultural residues.(3)	Dutch industry and agriculture.	Malaysia, Indonesia, Spain, Belgium, other countries in Western Europe.
Other biomass burning				
3 (3 more planned)	Stand-alone wood incineration	A-wood (new plants mainly on B-wood) – see table 5.4.	-	None
1	Co-fire in cement oven Maastricht (ENCI)	Sewage & paper sludge, PPDF, animal meal,	None	Germany (PPDF)
1	Zavin, specialised hospital waste incineration	Hospital waste	Hospitals	Unknown
Biogas				
± 70	Fermentation facilities (agricultural, sewage water purification, landfill and others)	Agro-residues, sewage sludge, landfill gas	Many	n.a.

Biofuel				
2	Production of Bio-ETBE	-	-	Most likely Brazil and Western-Europe (see chapter 8).
1	Production of Bio-ethanol	-	-	-
5	Production of Biodiesel	Discarded frying oil, animal fat, rapeseed oil	Wastecollecting companies (discarded frying oil/animal fat)	Traders
7	Production of PPO	Rapeseed, sunflower seeds, discarded frying oil	Rapeseed farmers	Import countries of rapeseed are listed in chapter 8.4

n.a. = not available; - = not investigated further
(1) To make the distinction between co-firing and other biomass burning, the approach of Senternovem and CBS is followed, rather than the approach of Vereniging Afvalbedrijven. Therefore waste incinerators like ZAVIN are counted amongst ´other biomass burning´. (Vereniging afvalbedrijven; CBS Statline; statusdocumenten Senternovem).
(2) Source: Interviews of various contacts at the AVI; environmental reports; annual reports.
(3) Source: Interviews of various contacts at the power plants; environmental reports; annual reports.

6.1 Waste incineration and co-firing

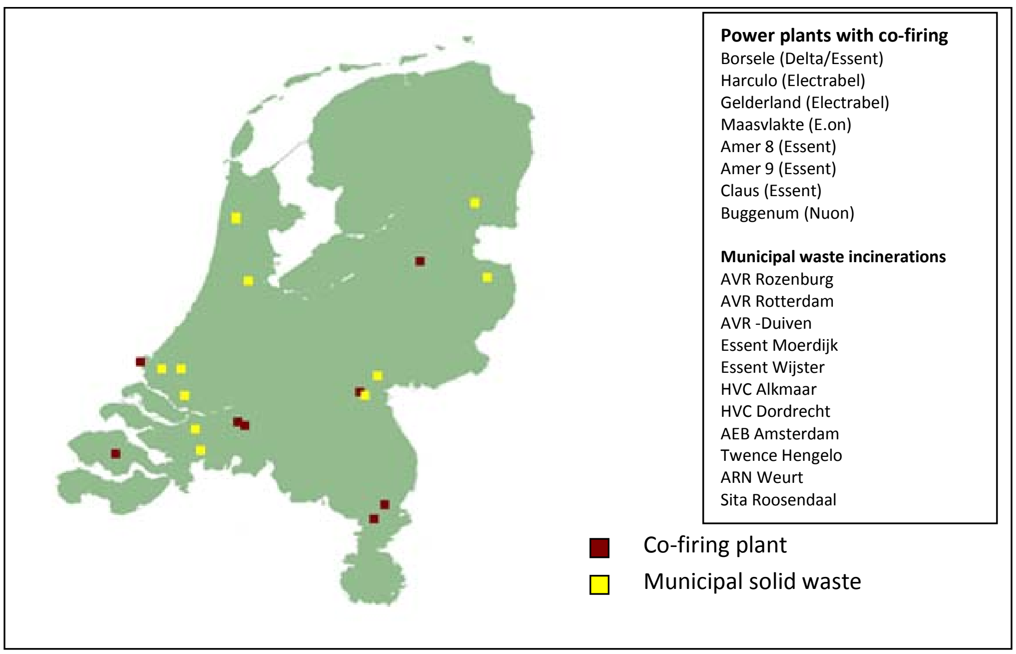


Figure 6.1: Co-firing plants and municipal waste incineration plants in 2007 and 2008, including the Harculo plant.

The plants that are counted amongst the waste incineration plants, are only the municipal solid waste incineration plants. Other waste incineration plants, such as ZAVIN (hospital waste) and SNB Moerdijk (sewer sludge) are counted amongst 'other biomass burning'. Apart from the seven indicated co-firing plants also the Harculo plant of Nuon has capacity for the co-firing of wood pellets. This is however not done in practice (Pellet@las 2007/2008).

Apart from waste incineration plants numerous actors are active in the collection and distribution of the different waste streams, they are summarized in table 6.2.

Table 6.2: Main actors involved in collection and distribution of waste

Biomass waste stream	**actors**
Clean Residue Wood	The market for residue wood exists out of about twenty companies specialized in the collection and the retail of special products made from sawdust and curls. The available clean residue wood is exclusively being collected by these companies (Leek et al, 2009).
Used wood	Numerous market actors are active on the used wood market they can be divided into collectors, processers, traders and end-users. Collecting and processing companies tend to integrate, align or even fuse. (Leek et al, 2009)
Discarded frying oil	Discarded frying oil is collected from around 44.000 catering and hotel occurrences. About 50 companies are collecting the used oil. (Bergmans, 2009)
Animal fat	Currently there are 3 big and 3 small companies in the Netherlands that are processing animal fat to products for human consumption, animal fodder and technical applications (including energy purposes). (Bergmans, 2009)

7. Biomass Prices

Prices of liquid biofuels have been fluctuating significantly between 2007-2009, as shown in Figure 7-1 for ethanol (in comparison with gasoline and the crude oil price), and Figure 7-2 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 excluding value added tax, but including a fuel tax of about 12.1 €/GJ for gasoline, and about 8 €/GJ for diesel.

As can be seen in figure 7-1, 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).

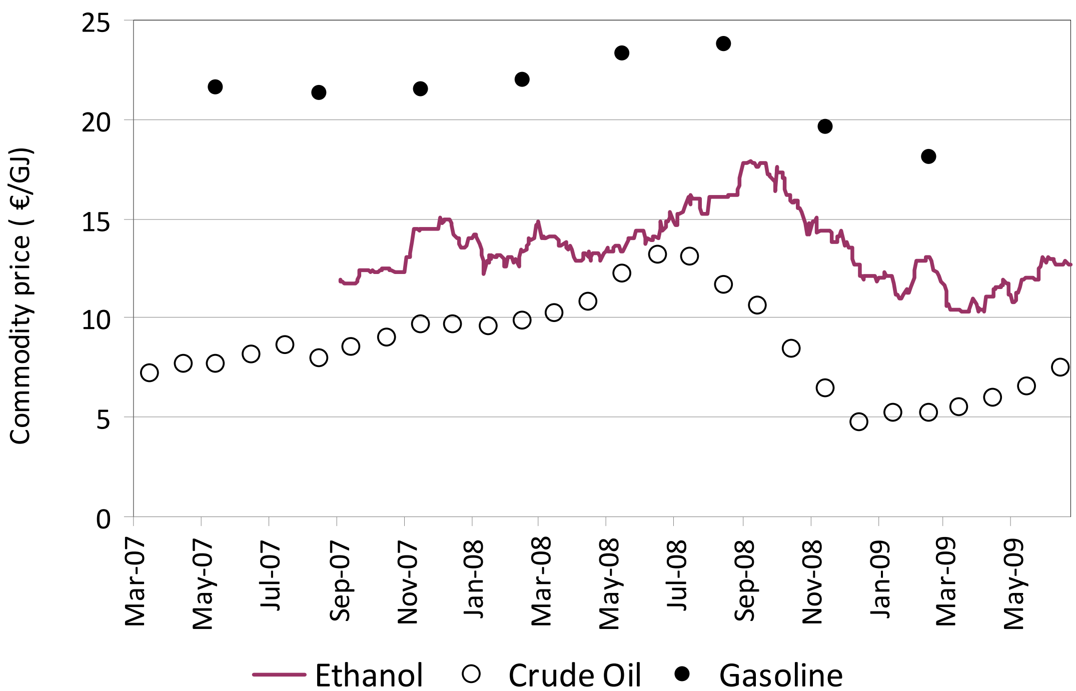


Figure 7-1 Price development of Ethanol (delivered FOB to Rotterdam, no taxes) in comparison to gasoline prices (at the pump, ex VAT, but including fuel taxes (about 12.1 €/GJ) over the period March 2007- June 2009. For comparison, also the crude oil price is shown. Data sources: ethanol (Nidera, 2009) 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 7-2). 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 7.2).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 7.1.

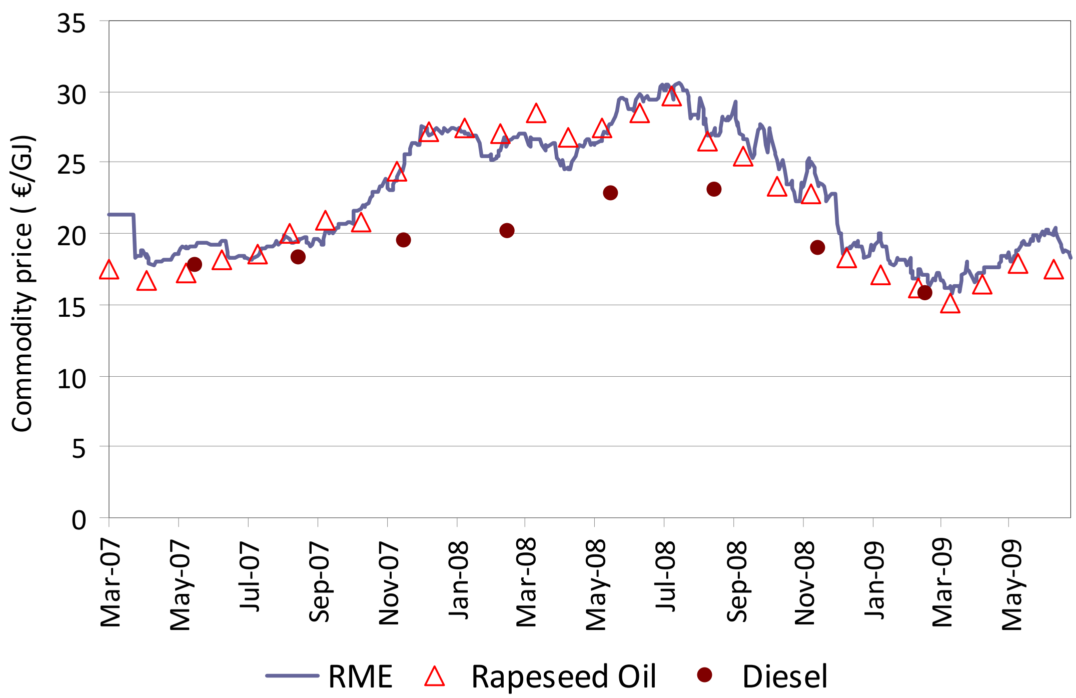


Figure 7-2 Price development of RME (Rapeseed methyl ester) and rapeseed oil, both delivered FOB Rotterdam, in comparison with diesel (at the pump, ex VAT, but including fuel taxes of about 8 €/GJ) over the period March 2007- June 2009. Data sources: rapeseed oil and RME (Nidera, 2009), diesel prices (CBS, 2009q), crude oil price (Indexmundi, 2009).

*Table 7.1: 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 7-1. 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 7-3). 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.

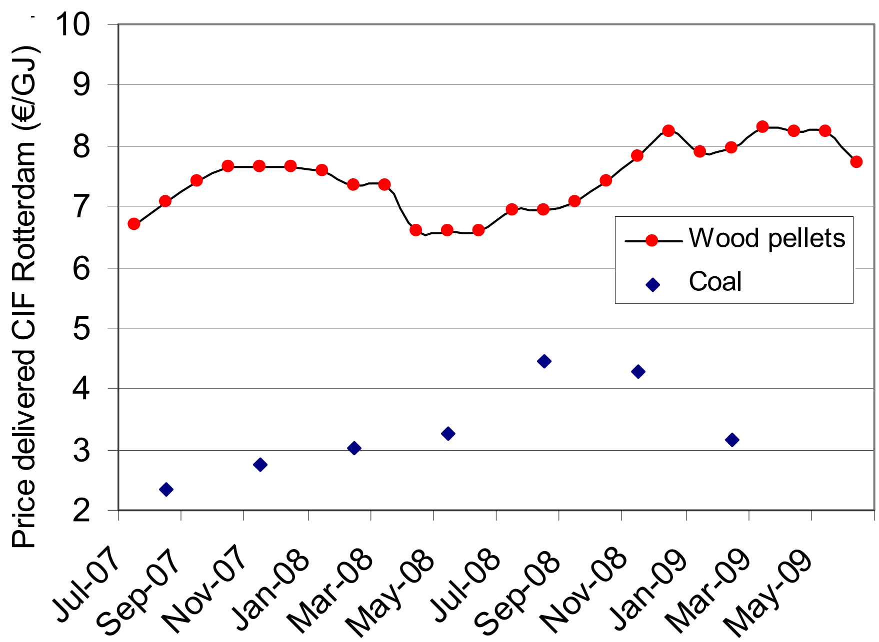


Figure 7-3 Price development of wood pellets delivered CIF Rotterdam, excl. VAT for bulk delivery of 5000 tonnes wood pellets by ocean vessel between 2007-2009 (Source: Pellets@las, 2009), compared to imported coal from non-EU countries (Source: CBS, 2009r)

8. Biomass Import and Export

8.1 Waste streams

8.1.1 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 8.1.

Table 8.1: 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).

8.1.2 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 8.2 shows the actual use for energy purposes of exported biomass waste streams.

Table 8.2: 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.

8.2 Electricity: Co-firing[7]

8.2.1 Import countries of biomass used for co-firing

Biomass for co-firing is mainly imported: in 2007, only 24% (in 2008 this was 22%) of all biomass was sourced domestically (see Figures 8.1 and 8.2). The main countries of origin were Canada and the United States. Also Germany, the Baltic States and Scandinavia played a large role (in Figure 8.2, these are aggregated as 'Europe').

8.2.2 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 2007, approximately one third was sourced within the Netherlands, which was thus the most dominant source of woody biomass. The second largest source was North America. In 2008, North America (i.e. Canada and the USA) became the major supplier of biomass. Also Russia has entered the co-firing market (Wood pellets, 69 PJ).

In figure 8.3 and table 8.3 an overview of the origin of woody biomass used for co-firing in Dutch power plants in 2007 and 2008 is given.

Other solid biomass

Next to woody biomass, there were also other types of solid biomass, like agro pellets, crushed grapes, cocoa residues and other industrial residues. Most of this biomass came from The Netherlands and Belgium, but also Brazil, Southern Asia and Western Africa were important countries of origin.

In 2008, the total import of other solid biomass decreased by 8,5%. This can primarily be attributed to the decrease in import from countries in South Asia and West Africa. Imports from Denmark have increased since 2007.

In figure 8.4 and table 8.4 an overview of the origin of biomass that was used for co-firing in Dutch power plants in 2007 and 2008 is given.

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. 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.

[7] 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.

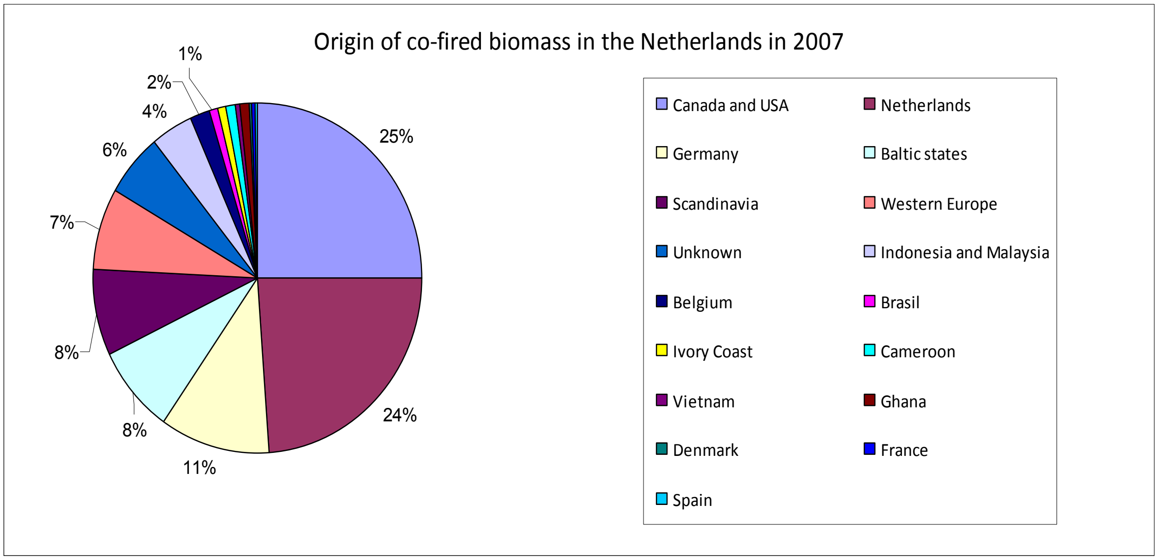


Figure 8.1: Origin of the biomass used for co-firing in Dutch power plants in 2007

Source: environmental reports, annual reports, interviews.

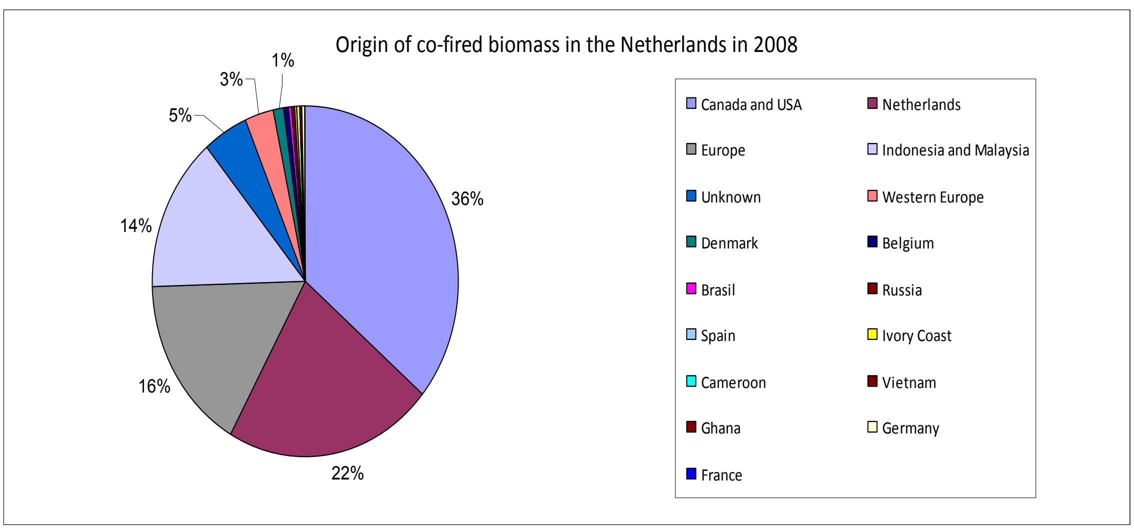


Figure 8.2: Origin of biomass used for co-firing in Dutch power plants in 2008

Source: environmental reports, annual reports, interviews.

Table 8.3: Origin of woody biomass used for co-firing in 2007 and 2008

	2007		2008	
	Energy (TJ)	**Share of total import (%)**	**Energy (TJ)**	**Share of total import (%)**
Netherlands	4.934	31,8%	2.293	15,5%
Germany	1.918	12,4%	29	0,2%
France	62	0,4%	23	0,2%
Baltic States	1.439	9,3%		
Scandinavia	1.439	9,3%		
Belgium	3,8	0,0%	125	1%
Spain	-	-	33	0,2%
Russia			69	0,5%
W. Europe	1.231	7,9%		
Europe			3.481	23,5%
Canada/USA	4.471	28,9%	7.695	52,0%
Unknown			1.056	7,1%
Total	15.497	100,0%	14.805	100%
Imported	10.564	68,2%	12.512	85%

Source: environmental reports, annual reports, interviews.

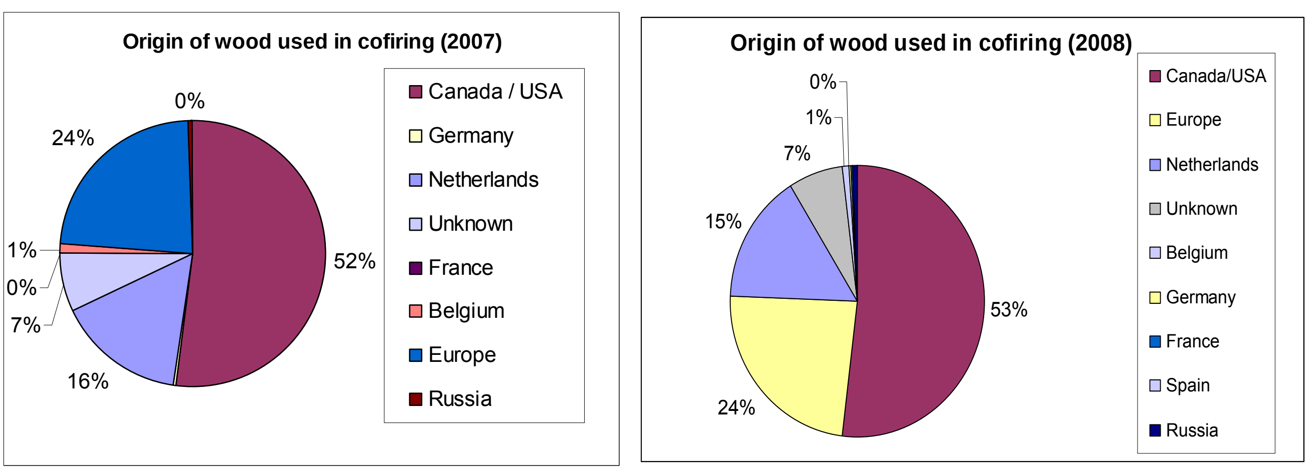


Figure 8.3: Origin of wood used in co-firing in 2007 and 2008

Source: environmental reports, annual reports, interviews.

Table 8.4: Origin of other solids used in co-firing in 2007 and 2008

Other solid biomass	2007		2008	
	Energy (TJ)	**Share (%)**	**TJ**	**Share (%)**
Netherlands	2.380	64,8%	2380	66,8%
Belgium	347	9,5%	-	
Denmark	75	2,0%	209	5,9%
Spain	29,8	0,8%	-	
Western Europe	-		620	17,4%
Brasil	168	4,6%	97	2,7%
Indonesia	168	4,6%	-	
Ivory Coast	126	3,4%	31	0,9%
Cameroon	126	3,4%	31	0,9%
Vietnam	126	3,4%	31	0,9%
Ghana	126	3,4%	31	0,9%
Indonesia and Malaysia	-		133	3,7%
Total	3.674	100,0%	3.564	100,0%
Import	1.294	35,2%	1.184	33,2%

Source: environmental reports, annual reports, interviews.

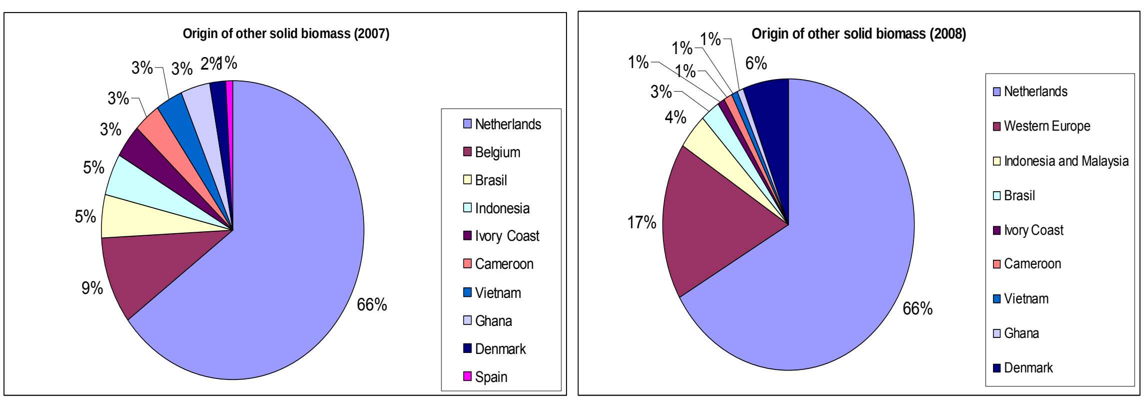


Figure 8.4: Origin of other solids used in co-firing in 2007 and 2008

Source: environmental reports, annual reports, interviews.

8.3 Biodiesel

8.3.1 General domestic flows of biodiesel

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 8.3.2). Also feedstock needed to produce biodiesel has been imported.

In table 8.5 and figure 8.5 the main characteristics of the biodiesel flow in the Netherlands are given for 2007 and 2008. In figure 1, these flows are graphically illustrated.

Table 8.5: Domestic level flows of biodiesel in 2007 and 2008

Pure biodiesel	2007 (kton)	2007 (TJ)	2008 (kton)	2008 (TJ)
Net Import (Import - Export)	249	9.196	322	11.892
Stock change	-60	-2.216	-115	-4.247
Consumption on domestic market (total supply)	3	111	3	111
Total production	85	3.139	83	3.065
Production capacity	189	6.980	520	19.205
Blended biodiesel				
production from blending	271	10.009	287	10.600
import	0	0	0	0
export	22	813	59	2.179
Stock change	0	0	0	0
Consumption on domestic market (total supply)	250	9.233	229	8.458
Total biodiesel				
Consumption on domestic market (total supply)	253	9.344	232	8.568

Source: CBS Statline, CBS 2009f

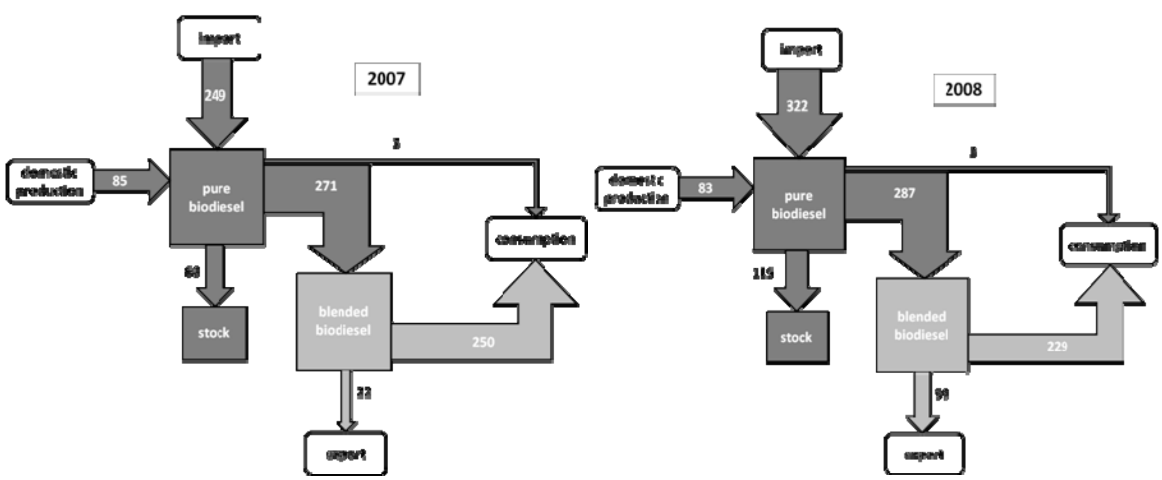


Figure 8.5: Overview of flows of biodiesel in the Netherlands in 2007 and 2008

Amounts are in ktonne. Dark grey is pure biodiesel, light grey is biodiesel blended with fossil diesel.
Source: CBS Statline, CBS 2009f

The import of pure biodiesel has increased from 249 ktonne in 2007 to 322 ktonne in 2008. However, the total consumption of biodiesel declined in 2008. Also the domestic production decreased, although the total capacity of biodiesel production increased from 189 ktonne in 2007 to 520 ktonne in 2008. There was also a small increase in export of blended biodiesel which showed a growth of 37 ktonne to a total of 59 ktonne in 2008.

8.3.2 Import of biodiesel

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 8.6, 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.

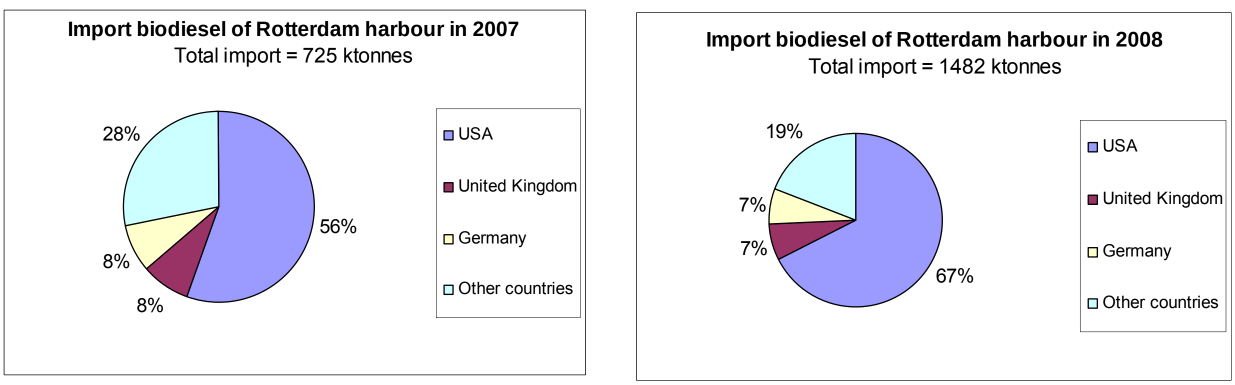


Figure 8.6: Import of biodiesel in the Netherlands in 2007 and 2008

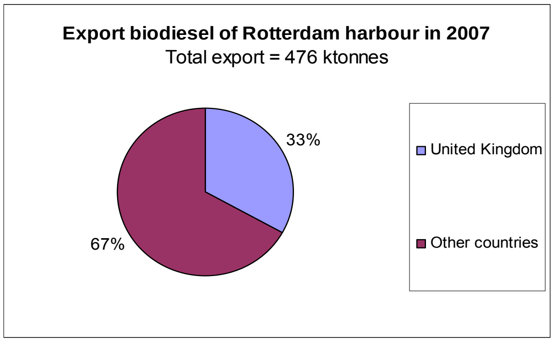
Source: Port of Rotterdam (2008, 2009)

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.

8.3.3 Export of biodiesel

The large sea ports also play a central role in the export of biodiesel. In figure 8.7, 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.



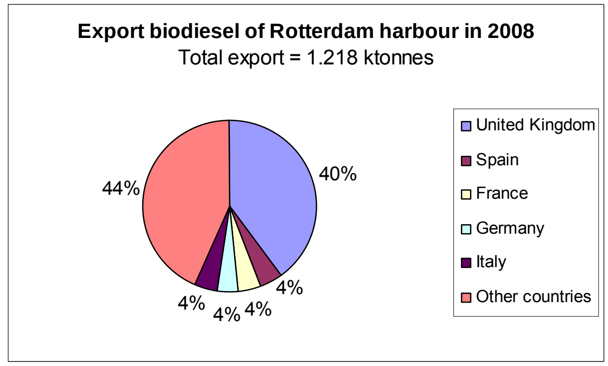


Figure 8.7: Export of biodiesel in the Netherlands in 2007 and 2008

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.

8.3.4 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.

Gross import of monoalkylesters

In figure 8.8, an overview of countries exporting monoalkylesters to the Netherlands is given. The total gross import of monoalkylesters of the Netherlands in 2008 was approximately 863 ktonnes. The United States of America is the largest provider for monoalkylesters in the Netherlands. The share of USA in the total biodiesel import of the Netherlands was already indicated in the previous section. More than three quarters of the total import of monoalkylesters arrive from the USA, a total of approximately 643 ktonnes. The remaining 24 % of imported monoalkylesters is divided among a number of various countries. Most of these countries are European, although some amounts are also imported from Asia.

Export of monoalkylesters

Next to the import of monoalkylesters an overview of exporting countries of monoalkylesters into the Netherlands is also provided in figure 8.8. The shares of exporting countries are indicated.

The total amount of exported monoalkylesters from the Netherlands in 2008 was approximately 310 ktonnes. Germany has the largest share (60%) followed by the United Kingdom (23%). The export of monoalkylesters is mainly to European countries, although some small amounts are exported to non-European countries. These amounts however contribute to less than 1% of the total export of monoalkylesters of the Netherlands.

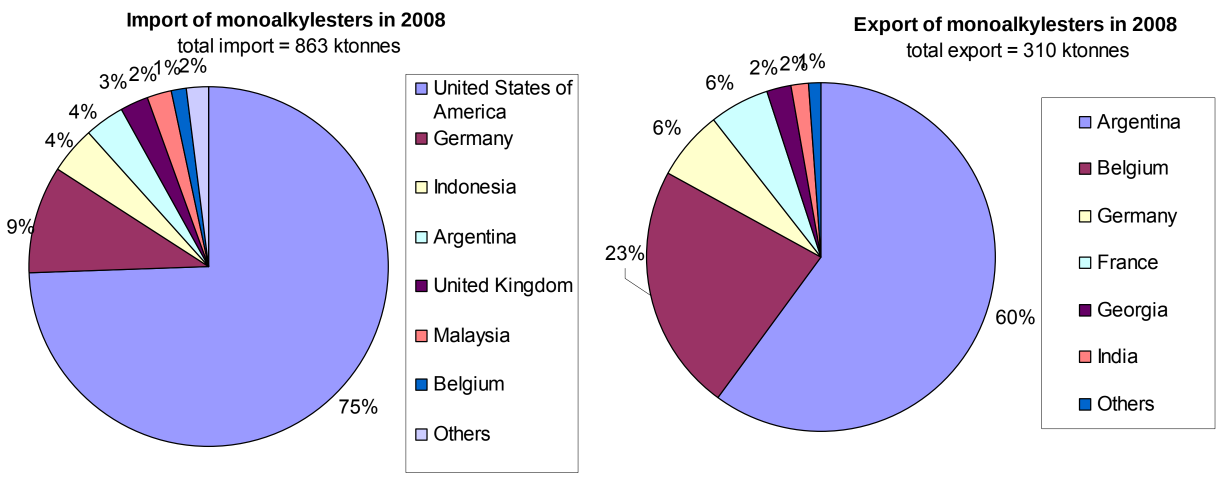


Figure 8.8: Import and export of monoalkylesters in 2008. ***Source: CBS Statline, CBS 2009f***

8.3.5 Feedstock for biodiesel and PPO production

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 8.9.

PPO

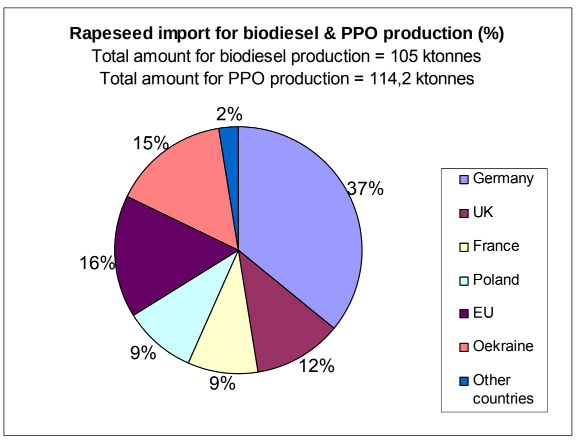
For the Dutch PPO production, a total of 126 ktonne of rapeseed was required in 2007. A total of 11,8 ktonne of rapeseed was produced in the Netherlands in 2007 (MVO, 2008). If we assume that all domestic grown rapeseed was used for the production of PPO the remaining amount must have been imported. 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 8.9 only shows imports for 2007.



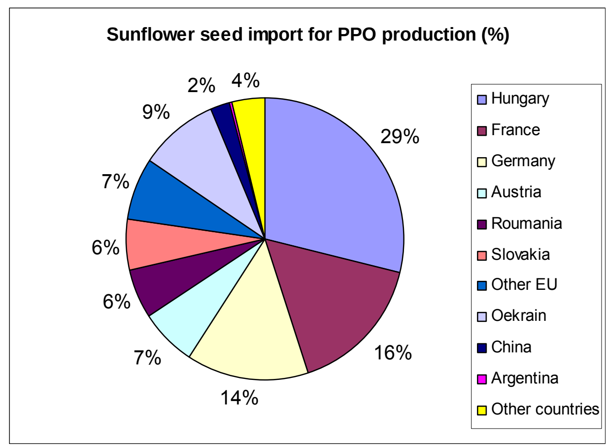


Figure 8.9: Import of rapeseed and sunflower seeds in 2007. Source: MVO (2008).

8.4 Bio-ethanol

8.4.1 National flows

In table 8.6 the rapid growth of bio-ethanol imports can be seen. The moderate growth in 2005 could possibly be explained by the early first steps of the shift from MTBE to bio-ETBE by Lyondell. In 2006 the production of ethanol by Lyondell and Sabic ethanol plants increased. This expansion continued in 2007, mainly caused by increasing production rates by the Lyondell factory . Figure 8.10 gives an indication where large bio-ethanol imports are coming from.

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.

In table 8.6 the trade flows of bio-ethanol are represented. In figure 8.10 these flows are represented graphically.

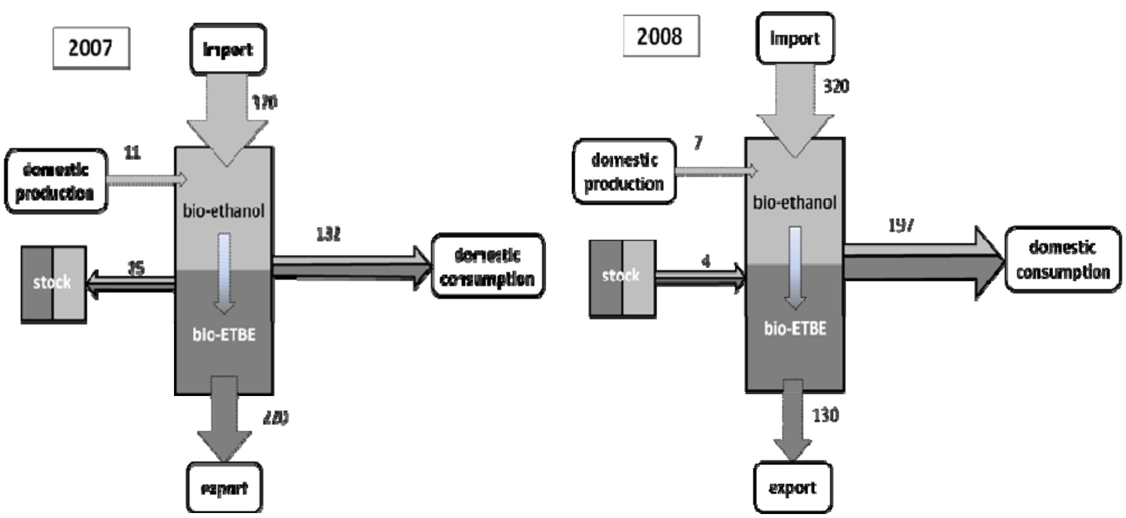


Figure 8.10: Diagram of import and export flows of bio-ethanol in the Netherlands

All data in the above figure is depicted in ktonne ethanol and taken from table 8.6. The 2008 numbers are preliminary. The light grey objects denominate bio-ethanol flows, dark grey objects denominate flows of bio-ethanol that is bound in bio-ETBE (see definition of 'biogasoline' for more information). For both years, there is a mismatch of 4 ktonnes. Given assumptions made and the preliminary character of the data, this is deemed a relatively small discrepancy.

Table 8.6: Mass balance of the biogasoline stock in the Netherland

	2007 Mass [ktonne]	2007 Energy [TJ]	2008* Mass [ktonne]	2008* Energy [TJ]
domestic bio-ethanol production	11(1)	300	7(1)	200
net ethanol imports	370(2)(3)	9.900	320(2)(6)	8.600
biogasoline consumption	-132(7)(9)	3.700(9)	-197 (7)(9)	5.500(9)
added to stock	-25(9)	700(8)	4(9)	-110(8)
net bio-ETBE exports	-220(4)	-8.100	-130(5)	-4.900

'Biogasoline' is the name that is used in this document to jointly describe artificial streams of bio-ethanol and bio-ETBE. ETBE flows are expressed as bio-ethanol content only. It is assumed that no ethanol is lost during production of ETBE. The total of this mass balance is per definition zero, as the bio-ethanol transporters, the bio-ETBE producers and the blenders do not add biomass to the flows. This should also apply to the energy balance, but it does not because the CBS uses different, classified, energy densities for ethanol and ETBE than are used in this report.

*The numbers for 2008 are preliminary.
Unless stated otherwise, these numbers are calculated using energy densities: 26,9 MJ/kg for ethanol and 36,3 MJ/kg for ETBE (IES, 2007).

(1) Source: eBio.org. Using the EFOA (2006) energy density of 26,9 MJ/kg for ethanol, this is 300 [TJ] for 2007/200 [TJ] for 2008.
(2) Source: CBS (2009f). Numbers for 2008 are last updated in 27th of April, 2009. Next update will be in June 2009.
(3) Source: CBS (2009l). import – export = 615 – 248 = 367 ktonnes, rounded to 370 ktonne. This number excludes bio-ethanol-for-food flows.
(4) Using the mass balance, net bio-ETBE imports should be: $ethanol_{ETBE}$ = 132 (cons.) + 25 (flow to stock) – 11 (domestic production – 370 (ethanol net imports). The actual mass of ETBE net exports import is -220 [kg_{EtOH}]/ 0,47 [kg_{EtOH} / kg_{EtBE}] = -470 [ktonne]. This number is probably a bit smaller in reality, as bioethanol imports for food are not accounted for (see explanation of net ethanol imports).
(5) Using the mass balance, net bio-ETBE imports should be: ethanol, ETBE = 198 (cons.) – 4 (draw from stock) – 7 (domestic production) – 320 (ethanol net imports). This gives a negative number, meaning positive net exports. The actual weight of ETBE net imports is: - 130 [$ktonne_{EtOH}$] / 0,47 [kg_{EtOH}/kg_{ETBE}] = -280 [ktonne]. Again, this number is probably smaller in reality, see (4).
(6) import –export = 980 – 660 = 320 [ktonne]. This number excludes bio-ethanol-for-food flows..
(7) Although the separate consumption of bio-ethanol and bio-ETBE is not given by CBS (they are classified), comparison of the biogasoline densities that can be derived from CBS (2009f) and the densities of ethanol and ETBE as given by IES (2007) shows that most biogasoline is consumed in the form of bio-ETBE.
(8) Estimates using CBS biogasoline energy density of 28 MJ/kg (R. Segers, personal communication).
(9) Source: CBS (2009f). Numbers for 2008 are last updated in 27th of April, 2009. Next update will be in June 2009.

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

As can be seen in figure 8.11, the net import (gross imports – exports) was close to 0 ktonens between 1996-2004). We therefore assume net import for food purposes in this periods was close or equal to zero, and has remained so until 2008. Thus, it is assumed that all net import form 2005 onwards was for domestic biofuel consumption. Under this assumption, the contribution of the net import per region can be estimated. As expected, Brazil (the world's largest exporter of ethanol) covers the largest part of bio-ethanol net import, providing about 50% of the total net import of the Netherlands in 2007. The contribution of Western Europe is approximately 20% of the total net import. The most important countries regarding the import of Ethyl-Alcohol are listed in table 8.8.

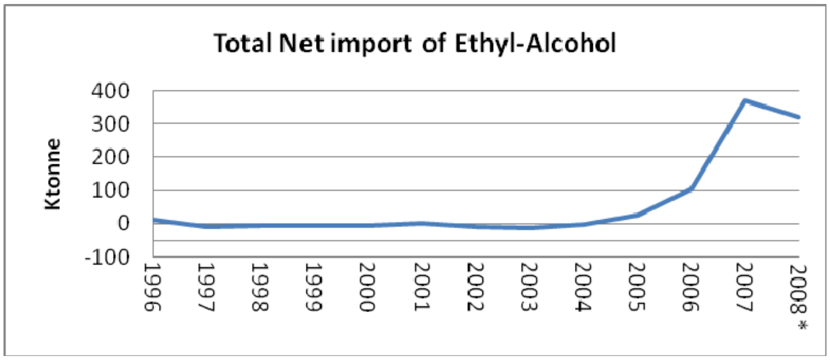


Figure 8.11: Total net import of Ethyl-Alcohol from 1996 to 2008 in the Netherlands

Source CBS statline: CBS 2009l.
*2008 is based on CBS estimations.

Table 8.7: Net import of Bio-ethanol per region in 2007 and 2008

Regions	Net Import of Bio-ethanol for Transportation	
	2007 Ktonne	2008 Ktonne
East Europe	1,74	-
West Europe	70,71	-266,17
Total Africa	18,86	22,12
Brazil	189,58	346,20
Rest of America	83,04	188,26
Total Asia	3,99	43,60

Source CBS statline: CBS 2009l
Figure for 2008 is not available because of data missing

Table 8.8: Gross Import and Export from Brazil, France and Germany in 2007 and 2008

Regions	Gross Import of Bio-ethanol for Transportation		Gross Export of Bio-ethanol for Transportation	
	2007 Ktonne	*2008 Ktonne	2007 Ktonne	*2008 Ktonne
Brazil	189,58	346,20	-	-
France	125,98	209,45	-	53,09
Germany	112,72	66,35	177,51	419,64
Total all country	615,43	982,01	247,57	662,42

Source CBS statline: CBS 2009l
*2008 : based on CBS estimations

8.5 Overview of total import & export

A general overview of the total import and biomass used for energy purposes is given in table 8.9. It must be noted that the table is not entirely complete, since some of the data is not (yet) available. Also, some numbers are based on (rough) assumptions, and should be used with care. A graphical representation of this data is illustrated in figure 8.12.

Table 8.9: Total net import and export of biomass for energy purposes used in the Netherlands from 2006 to 2008

Net Import		2006[1]		2007		2008	
		mass	energy	mass	energy	mass	energy
		ktonne	PJ	ktonne	PJ	ktonne	PJ
Waste intended for energy purposes		0**	0,0**	272	6,2	*	*
Co-firing in power plants	total	895	19,9	675[2]	11,9	771[2]	13,7
	wood	455	7,8	592[2]	10,6	649[2]	12,5
	other solid biofuels	90	0,4	83[2]	1,3	122[2]	1,2
	liquid biofuels	350	11,7	0	0	0	0
Biofuel for transport sector	total	*	*	619	19,1	642	20,5
	bio-ethanol	*	*	370	9,9	320	8,6
	biodiesel (pure)	7	0,3	249	9,2	322	11,9
Total		**902**	**20,2**	**1.812**	**37,2**	**1.413**	**34,2**
* Not available							

Net Export		2006[1]		2007		2008	
		mass	energy	mass	energy	mass	energy
		ktonne	PJ	ktonne	PJ	Ktonne	PJ
Waste intended for energy purposes		225**	1,1**		15,7	*	*
Co-firing in power plants	total	0	0	*	*	*	*
	wood	0	0	*	*	*	*
	other solid biofuels	0	0,0	*	*	*	*
	liquid biofuels	0	0,0	*	*	*	*
Biofuel for transport sector	total	*	*	242	8,9	189	7,1
	bio-ETBE	*	*	220	8,1	130	4,9
	biodiesel (blended)	*	*	22	0,8	59	2,2
Total**		**540**	**6,6**	**827**	**24,6**	**689**	**7,1**

* Not available   ** Not complete, due to a lack of sufficient data.

1) Source 2006 data: Junginger Et al. (2007)

2) Source: Estimated on information from utilities (2009), environmental report (2007 & 2008) and interviews (2009), excluding used wood from Electrabel.

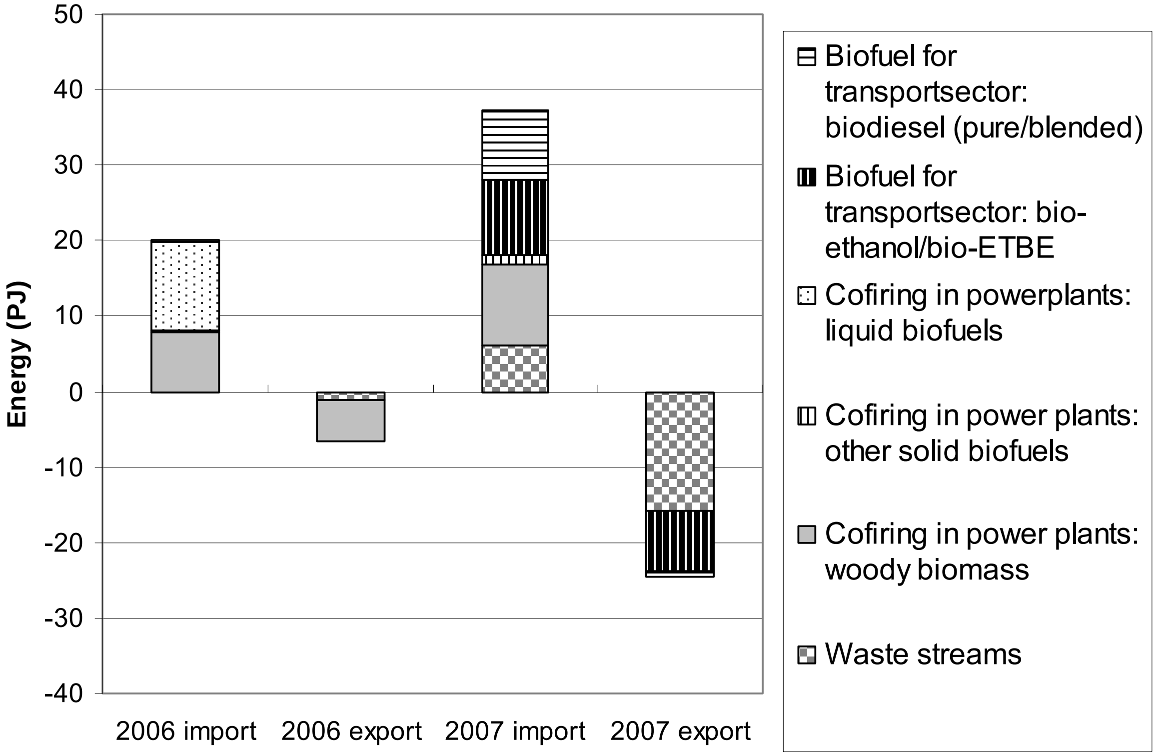


Figure 8.12: Dutch total net import and export of biomass used for energy end-uses in the year 2006 and 2007

In comparison to the total consumption of biomass for energy purposes in the Netherlands in 2007 (69,8 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.

9. 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.

9.1 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 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.

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.

9.2 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	Province of Fryslân	Province of Fryslân	Operational	End use	Boats	14	Biodiesel	The province of Fryslân uses 14 inspection

biodiesel and PPO.								vessels which are fuelled by biodiesel. Staatsbosbeheer uses biodiesel en bio lubricants in machines and terrain vehicles.
Sweeping vehicles on biodiesel	Stadsdeel Amster-dam-Noord	Amsterdam	Operational	End use	Sweeping vehicles.	3	Biodiesel	
					Cars	7	B100	
Cars on biodiesel	Amster-dam 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	Munici-pality 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 surroundings	Operational	End use	Trucks	2	PPO	2 trucks on PPO
Busses on PPO	BBA	Eindhoven and surroundings	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 (transportation) 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	Municipality of Haarlemmermeer	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 surroundings	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 surroundings	Operational	End use	Boats	1	PPO	The province of Zeeland has bought a vessel for the inspection of the Oosterschelde. The inspection vessel has been bought from Rijkswaterstaat.
Sweeping vehicle and municipality of Noord-Beveland	Municipality 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 PPO	Flour market Aals-meer	Aalsmeer	Operational	End use	Sweeping van	1	PPO	Since September 2004 a sweeping van at Aalsmeer 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 (started in 2008)[*1]			150.000	700	Waste wood, prunnings
Sita ReEnergy [*7] (planning to start in 2011)	32	Yes, figure unknown	291.000		Only office waste.
power plants					
Delta Moerdijk (started in 2008)[*1]	35	400.000	4.300		Chicken manure
Evelop Delfzijl (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.
- **Direct/Indirect imports**: 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.
- **Domestic production**: 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.

- **Gross imports**: 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.