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IEA Bioenergy Task 40
Country report

THE NETHERLANDS

2011

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Executive Summary

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

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

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

Current biomass user (energy use)

Table ES-1 shows the energy use of biomass in the Netherlands in 2010. The largest part of the bioenergy comes from incineration of biogenic portion from municipal waste. The other main biomass users are utilities and households (wood stoves). Apart from that, biomass waste was also fermented into biogas, which amount to primary energy of 12,1 PJ.

Table ES-1: Use of biomass for energy purpose in the Netherlands in 2010

Energy use of biomass	***Total use, PJ***
Co-firing of biomass in central electricity plants	
Wood pellets	27,1
Wood chips	2,5
Waste wood	1,0
Other woody biomass	0,5
Non-wood solid biomass (direct from primary agriculture)	0,2
Non-wood solid biomass (coming from agro-processing industry)	2,1
Other non-woody solid biomass	0,3
Liquid biomass (direct from primary agriculture)	0,4
Other biomass combustion	
Wood chips	1,0
Waste wood	6,1
Non-wood solid biomass (direct from primary agriculture)	3,2
Other non-woody solid biomass	2,0
Liquid biomass (direct from coming from agro-processing industry)	1,1
Municipal waste incineration, renewable fraction	33,0
Wood boilers for heat in companies	2,8
Wood stoves in houses	12,2
Biogas	12,1
Transportation	
Biodiesel	4,0
Biogasoline	5,6
Total	**107,6**

Bioenergy trade

Biomass for co-firing is mainly imported: in recent years, the share of domestic biomass was between 22 and 30%. Important import countries for 2010 are Canada and the United States. Especially the United States gained a large share in recent years. Figure ES-1 show the origin and types of biomass used in Dutch power plants in 2010. 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 2011 main international trading routes were Canada and the USA, next to inland production. The other important sources of wood pellets are Baltic states and Russia and Western Europe. There is no significant import of other woody biomass other than pellets.

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 vegetable oils and biodiesel (and ethanol). A large portion of biodiesel production in the Netherlands uses imported feedstock. Figure ES-2 shows the flow of oil and fats in the Netherlands. Large number of oil seeds was imported for the production of vegetable oils in the Netherlands. It is difficult to track the origin of feedstock due to extensive and complicated trade flows of oils and fats in the Netherlands (see section 7.2.3). The amount of oils and fats used for energy purposes is approximately 1/3 of the non-energetic use (food and technical use). Of almost half of the biodiesel, the feedstock is unknown. It is possible that this biodiesel is imported as monoalkyl esters, but there are no clear data of how much monoalkyl esters are being blended as biodiesel.

Barrier and opportunities

There are two major barriers in the Netherlands:

1) *Barriers for increasing electricity and heat production*

First, some co-firing projects will be financed with MEP funding only until 2015. However, this is largely resolved with "Green deal" of minister Verhagen. Second, the lack of standardization is seen as a trade barrier. This includes the lack of uniform technical specification, legal standardization (trade contracts) and foremost the lack of sustainability standards.

2) *Barriers for biofuels production and utilization*

With the implementation of mandatory sustainability certification for biofuels in the EU, sustainable certifications, different systems among countries and their side-effects is seen as potential trade barrier by market actors. Possible implementation of iLUC is also seen as important future barrier.

The positive signals for increasing bioenergy consumption in the Netherlands and the EU as a whole, as described above may also led to new opportunities for biomass trade. Furthermore, with its large harbours and connection to the European mainland, the Netherlands will increasingly become a trade hub for liquid (and solid) biomass. The other opportunities include the decrease of transportation costs, declining markets for conventional biomass use and expectation of torrefied pellets.

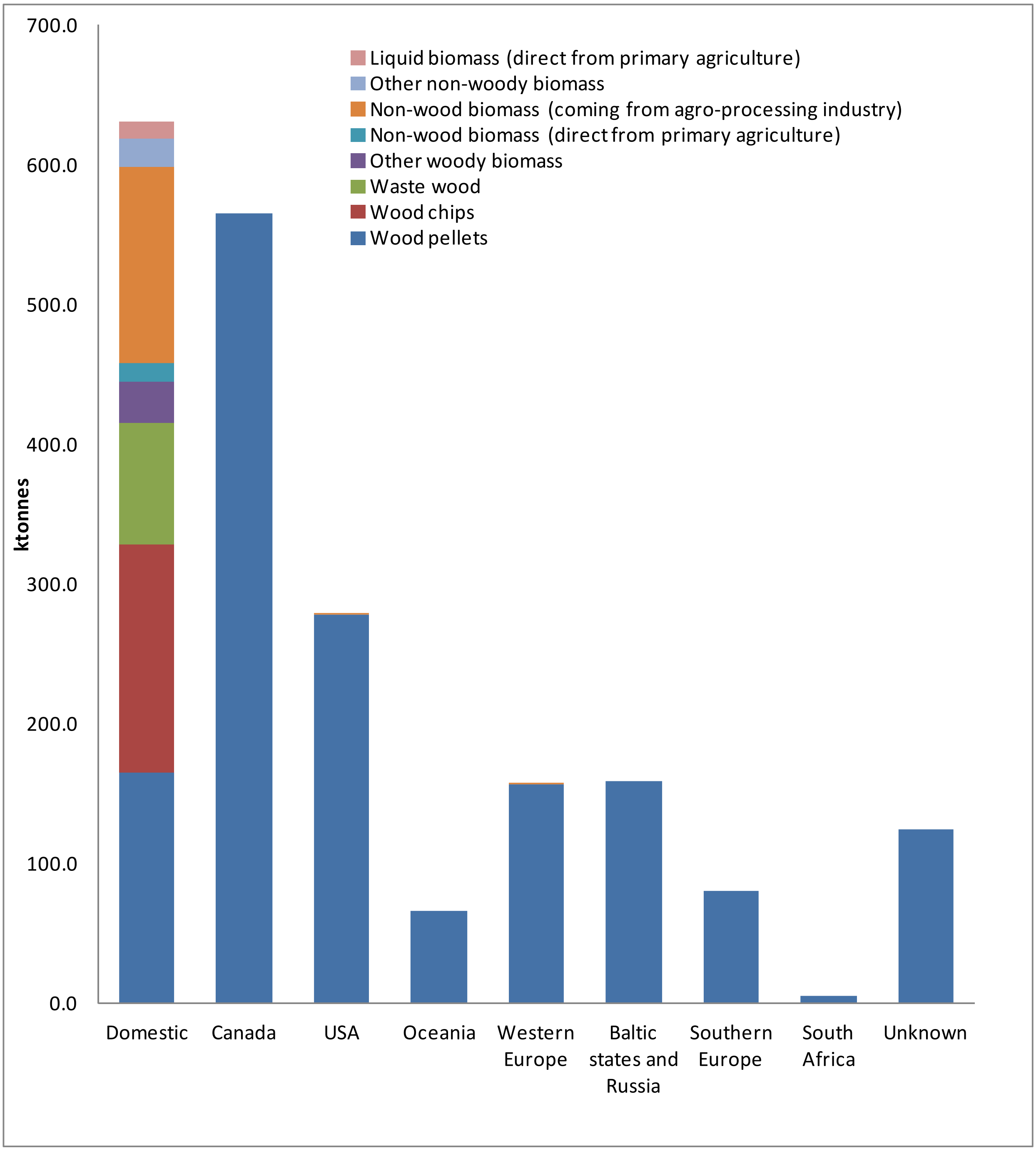

Figure ES-1 Origin and types of the biomass used in Dutch power plants in 2010
Source: Interviews with utilities.

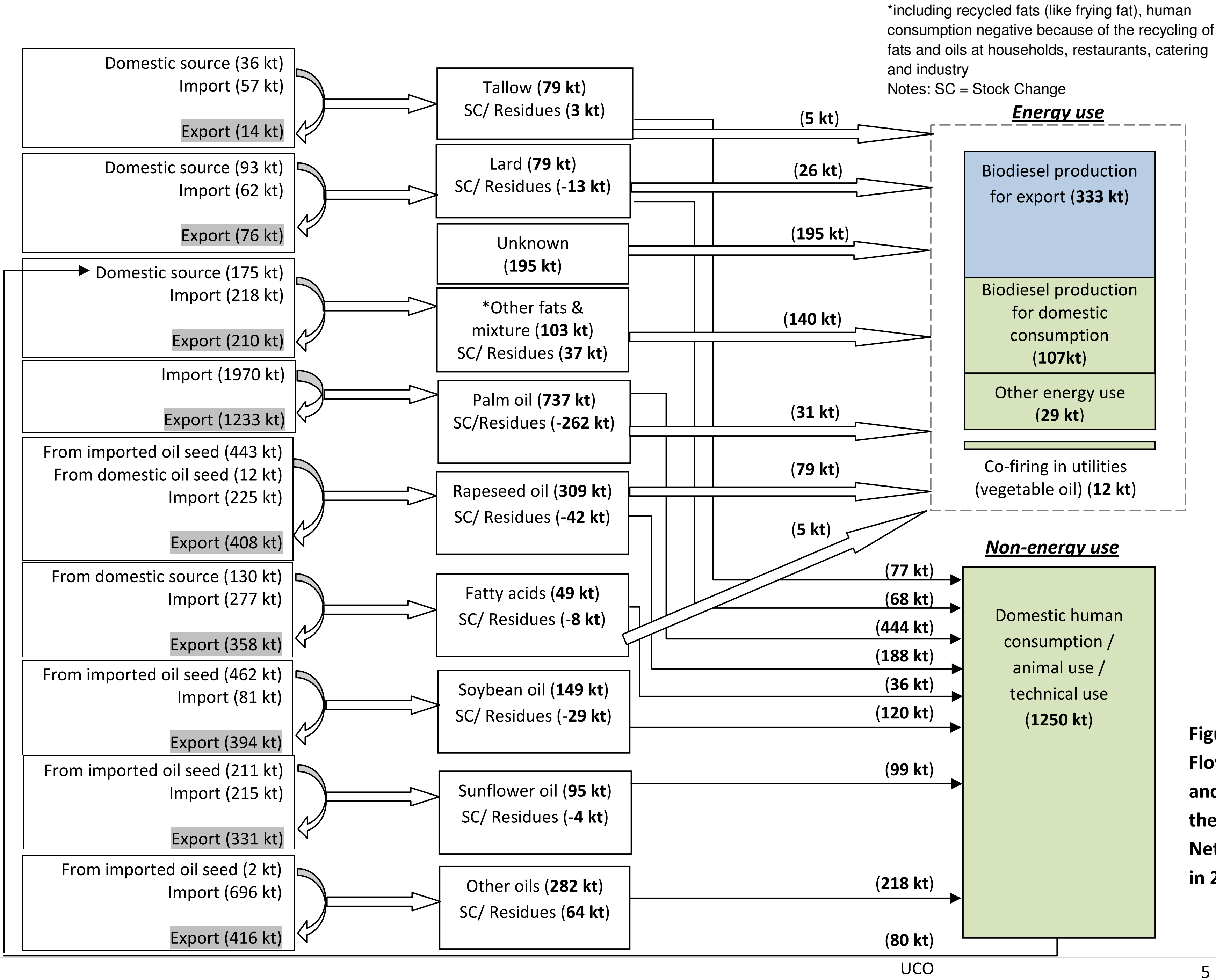

Figure ES-2 Flow of oil and fats in the Netherlands in 2010

Acknowledgments and disclaimers

This country report was written for IEA Bioenergy Task 40. The sole responsibility for the content of this report lies with the authors. The analyses and conclusions do not necessarily represent the opinion of the IEA Bioenergy Implementing Agreement, or of Dutch policy makers.

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- Frank Bergmans and Jos van Leeuwen of MVO, for their knowledge on vegetable oil and fats.
- 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

1.1 General overview

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 feedstock in one region and demand for this feedstock (or refined bioenergy commodity) in another. However, many bioenergy markets are however immature at the moment. This is in particular true for the demand side of the market; many biomass markets, e.g. for solid fuels, rely on policy objectives and incentives, which may change over time and often have proven to be unpredictable (Faaij et al., 2006). In order to secure further investments and sustain the growth of bioenergy markets, the supply and demand side of the market needs to be balanced and distortions have to be avoided. Bioenergy markets are however poorly mapped and the available analyses, statistics and modelling 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 was written based on Dutch country report of 2009 (Junginger et al., 2010) with new structure and content. The aim is to provide an overview regarding all biomass streams in the Netherlands for 2010 and as far as possible. 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.

In summary, the aims of this country report are:

(1) To provide a concise overview of biomass policy, domestic resources, biomass users, biomass prices and biomass trade, and
(2) To analyse bioenergy trends and reasons for change in the Netherlands and point out barriers & opportunities for trade in detail

1.2 Energy production and consumption in the Netherlands

General characteristics

In 2010 the human population grew up to 16,8 million inhabitants with an estimated average GDP of €29 645 in 2010 (CIA, 2011). Total land area is approximately 3,39 million hectares; 22% arable land and 1% croplands (CIA, 2011). The Netherlands are situated in the North-Western part of Europe, with borders to Belgium, Germany and the North sea. Natural resources often named are natural gas, petroleum, peat, limestone, salt, sand and gravel and arable land.

Main industries

CIA (2011) reported that the Dutch economy has stable industrial relations, moderate unemployment and inflation rates, a sizable current account surplus and an important role as European transport hub with among others its airports and harbours. Since 2002 the Euro is the official currency, together with other EU partners. Main industrial activities are food processing, chemicals, petroleum refining and electrical machinery. Import and export commodities are machinery and (transport) equipment, chemicals, fuels and foodstuffs (CIA, 2011). Agriculture employs only 2% of labour due to its highly mechanized characteristics, although it provides large surpluses for food-processing and export. The economy was hit hard in 2009 (due to the global financial crisis), resulting in declining export and a GDP contraction of 3,9%.

CO_2 reduction requirement

Figure 1.1 represents the emission in the Netherlands from 2000 to 2010. According to CBS, the effect of the various greenhouse gases is measured by converting them into so-called CO_2 equivalents. One CO_2 equivalent equals the effect of the emission of 1 kilogram of CO_2. The emission of 1 kilogram of N_2O equals 310 CO_2 equivalents and emission of 1 kilogram of CH_4 equals 21 CO_2 equivalents. All (chloro)fluorocarbon (CFC) gases have a high CO_2 equivalent, but because CFC emissions are relatively small, their contribution to the nationwide total is marginal.

According to the Kyoto Protocol, the Netherlands must have reduced its greenhouse gas emissions by an average of 6 % 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 (CBS, 2008). In the years that followed, the reduction continued.

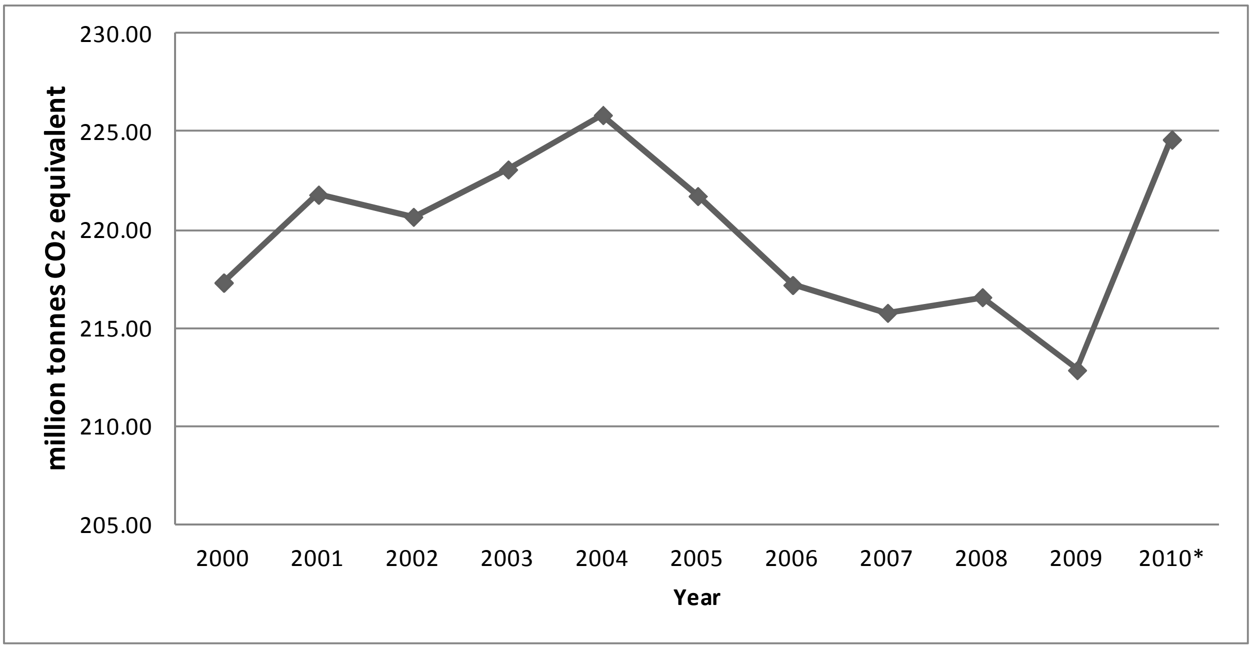


Figure 1.1: Emission in the Netherlands from 2000 to 2010 (*estimation)
Source: CBS Statline, 2011b.

Domestic energy production in the Netherlands increased from 2611 PJ in 2009 to 2944 PJ in 2010. The total primary energy and electricity produced from domestic sources are depicted in Figure 1.2 and Figure 1.3, respectively, by source of energy. Natural gas dominates the domestic energy production in the Netherlands (88,5%) as well as electricity production (60,4%). However, the Netherlands also imports coals to produce electricity.

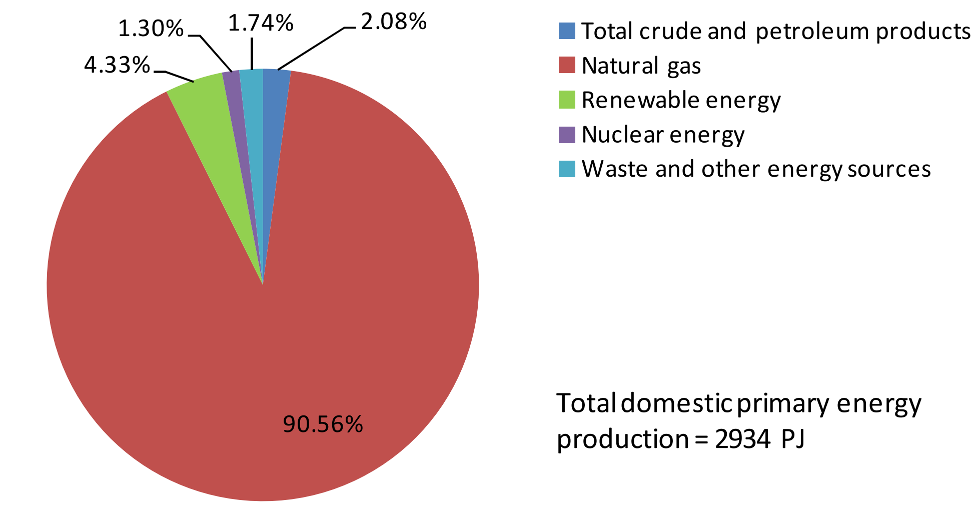


Figure 1.2: Total domestic energy production (by source) in 2010
Source: CBS Statline, 2011c.

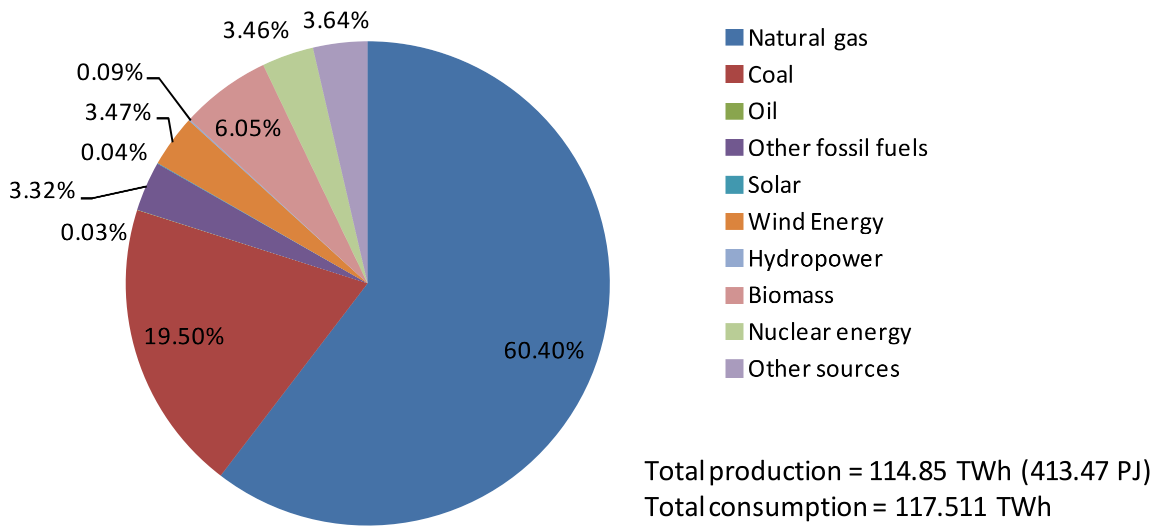
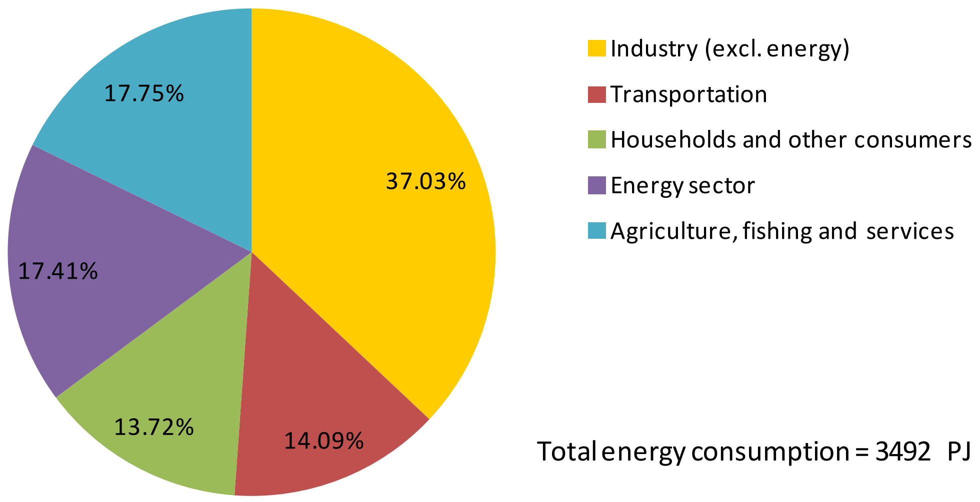
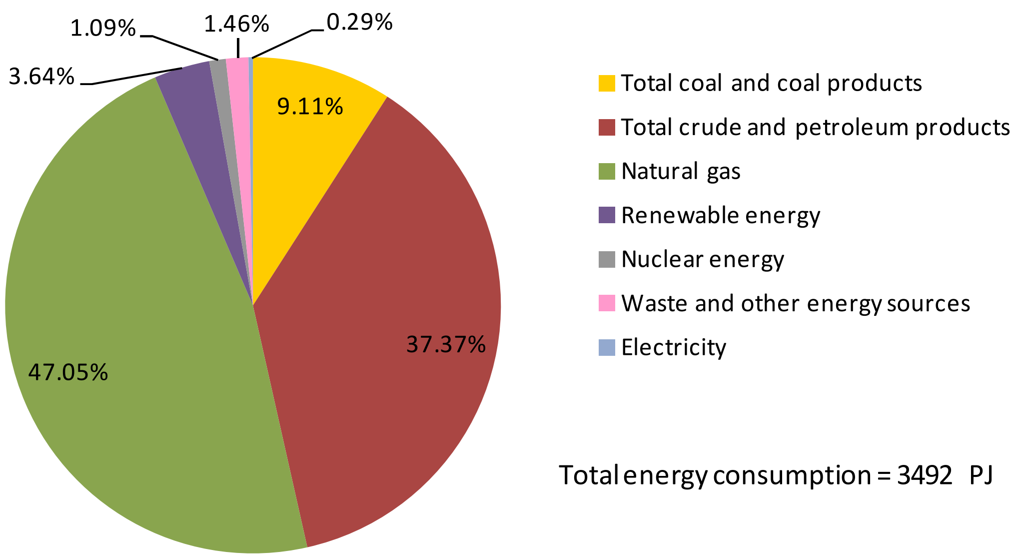


Figure 1.3: Total domestic electricity production (by source) in 2010
Source: CBS Statline, 2011c.

Figure 1.4 shows the total energy consumption in the Netherlands (a) by sectors and also (b) by source. In 2010, 2822 PJ was consumed in the Netherlands. The largest consuming sector is manufacturing sector (44,4%), followed by households and other consumers (38,4%) and transportation (17,3%). An overview of primary fossil energy consumption in the Netherlands from 1990 to 2010 by fuel source is given in Figure 1.5. Basically, fossil fuel energy is dominant in the fuel mix, but the use of coal is slowly reduced, and in the same time more heat, biomass and waste are employed for energy purposes.



(a)



(b)

Figure 1.4: Total energy consumption (a) by sector; (b) by source
Source: CBS Statline, 2011c.

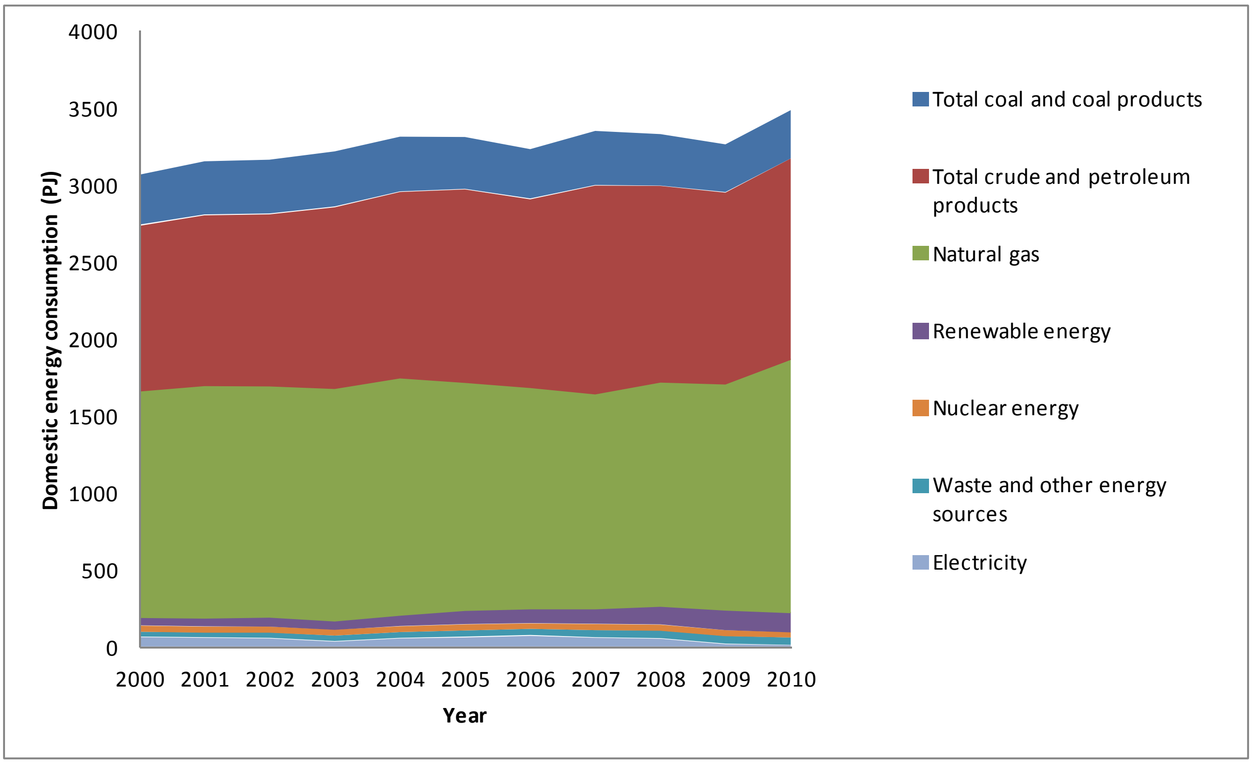


Figure 1.5: Domestic energy consumption from 1990 – 2010 (*estimation)
Source: CBS Statline, 2011c.

Figure 1.6 shows the total heat production / consumption in the Netherlands in 2010. It is assumed that all heat produced is consumed directly in the country. Similar to electricity production, natural gas is still the largest source of heat. Furthermore, the second largest heat source is other fossil fuels. These made up a total of 89% of heat source that comes from fossil fuel.

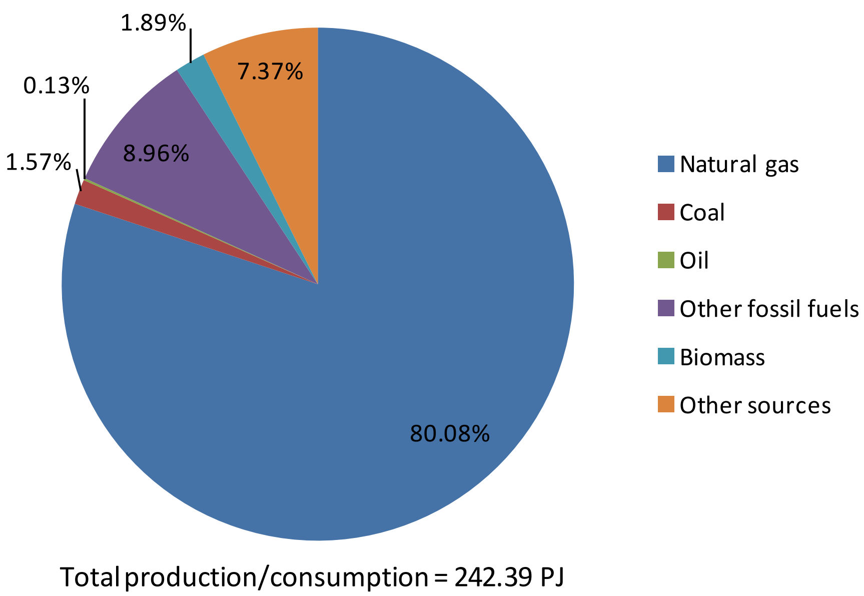


Figure 1.6: Total heat production/consumption by source in 2010
Source: CBS Statline, 2011b.

Figure 1.7 provides an overview of energy consumption from 2000 to 2010 by sector and also by source (fossil and non-fossil). Due to the industrial activities and quality of life, industry and households are the most energy intensive sectors. Both sectors also show significant use of other energy sources (mainly heat, biomass and waste) over the years. Transportation used least alternative source of energy.

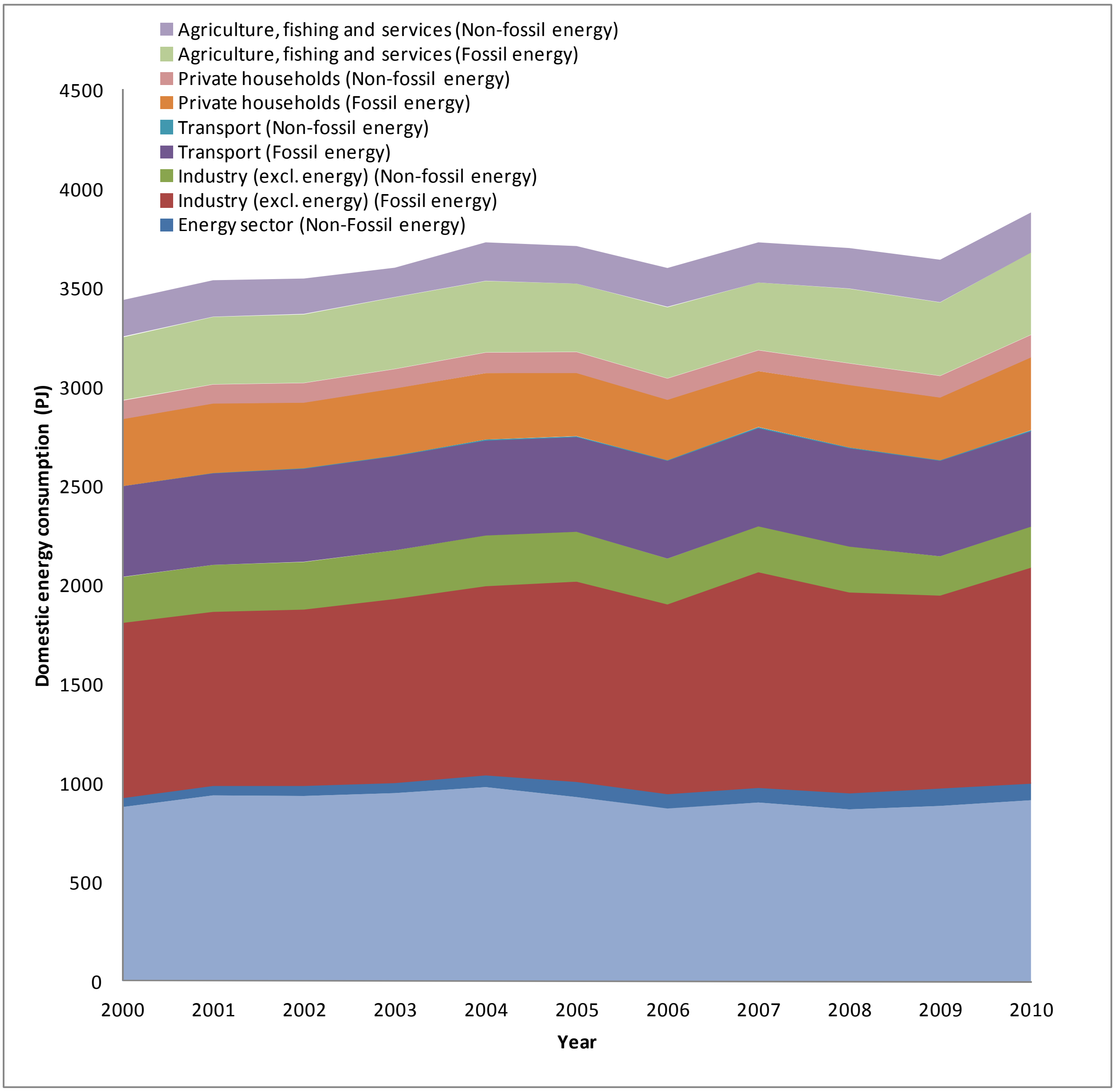


Figure 1.7: Domestic energy consumption from 1990 – 2010 by sector and by source (*estimation)
Source: CBS Statline, 2011b.

A total overview of renewable energy sources in the Netherlands is shown in Table 1.1 below. The share of renewable energy in total energy supply is relatively small but it is increasing; from 2,9% in 2007 to more than 3,6% in 2010.

Table 1.1: Renewable electricity, heat and fuel production in the Netherlands between 2000 and 2010
Source: CBS Statline, 2011d; 2011e
MW: Municipal Waste

		2000	*2001*	*2002*	*2003*	*2004*	*2005*	*2006*	*2007*	*2008*	*2009*	*2010*
Wind energy	GWh_e	829	825	946	1318	1867	2067	2733	3438	4260	4581	3981
Solar energy	GWh_e	8	13	17	31	33	34	35	36	38	46	60
Hydropower	GWh_e	142	117	110	72	95	88	106	107	102	98	105
MW (renewable fraction) incineration	GWh_e	987	945	933	946	915	984	1013	1095	1070	1207	1349
Co-firing	GWh_e	198	563	1082	757	1539	3310	3103	1711	2116	2472	3043
Other biomass combustion	GWh_e	216	221	216	205	217	235	236	254	664	895	892
Biogas for electricity	GWh_E	270	294	316	310	276	278	339	477	681	848	924
Solar energy	TJ_{TH}	446	515	590	652	718	764	793	823	858	932	990
Geothermal	TJ_{TH}	157	188	244	309	447	622	835	1123	1555	1946	2442
Aerothermal	TJ_{TH}	91	113	142	208	308	418	613	875	1244	1586	1921
MW (renewable fraction) incineration	TJ_{TH}	3126	2800	3261	3332	3432	3520	3868	3839	4066	5007	5401
Co-firing	TJ_{TH}	15	58	222	81	325	693	552	821	789	939	1267
Wood boilers (companies)	TJ_{TH}	2150	2102	2054	2010	1966	2068	2306	2552	2686	2792	2766
Woodstoves (household)	TJ_{TH}	11916	11695	11520	11326	11282	11384	11622	12056	12174	12232	12232
Other biomass combustion	TJ_{TH}	513	674	943	1184	1984	2248	3078	3262	3340	3238	2369
Charcoal used by household	TJ_{TH}	270	270	270	270	270	270	270	270	270	270	270
Biogas	TJ_{TH}	2720	2735	2659	2616	2831	2661	2857	3035	3697	4311	4681
Biogasoline	TJ_{FUEL}	-	-	-	-	-	-	798	3687	4524	5771	5616
Biodiesel	TJ_{FUEL}	n.k.	n.k.	n.k.	134	134	101	968	9344	7524	9835	3959

2. Energy Policy

Energy situation

The current Dutch energy situation is characterised by a primary energy consumption of 3495 PJ (2010). The main energy sources are natural gas (1643 PJ), oil (1299 PJ) and coal (318 PJ). Renewable energy sources currently make a contribution of 94 PJ (avoided primary). Approximately three-quarters of the renewable energy produced in 2010 came from biomass. The remainder of renewable energy was produced from sources such as hydropower and wind and solar energy. Renewable energy from biomass is for a large part produced by waste incineration plants, co-firing in energy plants, the use of wood-burning stoves and the use of biofuels in the transport sector (CBS Statline, 2011c).

National targets for 2020

The Netherlands targets for 2020, as set out in the Clean and Efficient Work Programme are (a) to enable the achievement of a 30% reduction in CO_2 in 2020 compared with 1990, (b) a renewable energy share of 20% in 2020 and (c) an annual energy saving of 2% as from 2011. In September 2007, Dutch minister for the Environment Cramer presented the working programme 'New energy for the climate'. Energy efficiency should increase to a yearly improvement of 2 to 2,3 % after 2011. Mandatory targets set by the Directive on the Promotion of the use of energy from renewable sources are (1) 14% share of RES on the final consumption of energy in 2020, and (2) at least 10% share of renewable energy in final consumption of energy in transport by 2020. The RES-E share of the Netherlands should reach 9% of the gross electricity consumption in 2010. The biofuel target for 2005 was not met, since the biofuel share by energy content in that year was 0,02%. The targets set for 2006 and 2007 are the same as the one set for 2005 (2%). Subsequently, the target was lowered from 5,8% to 4% in 2010. The main reason for this adjustment was questions regarding the sustainable character of biodiesel production (EREC, 2009).

Avoided primary energy and gross final energy

The Dutch method for calculating renewable energy and the method from the Renewable Energy Directive differ from one another. The Dutch method for calculating the renewable energy contribution is known as the substitution method. This method examines what the primary energy consumption would be in a reference situation if no use were made of renewable energy. The method from the Renewable Energy Directive is based on the gross final energy (the denominator) and focuses on the component of this energy that is derived from renewable sources. The expected 14.5% gross final energy in 2020 in this action plan corresponds to 15,5% according to the substitution method (CBS, 2011b).

Strategy – Green deals (2011)

In 2011, the Netherlands took concrete steps towards a sustainable economy by signing 59 green deals between government and business. These green deals are about concrete projects in the areas of energy saving, renewable energy, sustainable mobility and sustainable use of raw materials and water. There are a number of projects that will have effects on bioenergy industry: Green Gas Green Deal, Zeafuels biogas, Vogelaar: biobased economy, Jaap Eden Ice Rink: biomass and waste heat, higher success rate local energy companies, Bio Energy plant Cuijk, liquefied biogas, Limburg: two renewable energy plants, biogasnet and solar knowledge cluster, Flevoland energy neutral by 2020, Shell: Cogeneration, KLM Deal closes Green Biofuels, and etc (Rijksoverheid, 2011).

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

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

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

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

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

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

Central instruments

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

- The Stimuleringsregeling Duurzame Energieproductie – SDE+ [Incentive Scheme for Sustainable Energy Production] is a financial instrument. Renewable energy in the electricity, heat and gas sectors is subsidised through this scheme.
- The Nederlands Beleid Biobrandstoffen [Dutch Biofuels Policy] is an instrument which specifies a mandatory minimum share for petrol and diesel substitutes in the transport sector.
- The Rijkscoördinatieregeling - RCR [Government Coordination Scheme] facilitates the coordination of licences for major energy infrastructure projects and renewable energy projects. The aim of this scheme is to speed up the licensing process.
- The aim of the Wet algemene bepalingen omgevingsrecht - Wabo [law governing the general provisions of the Environment Act] is to speed up the licensing procedures for small-scale renewable energy installations and increase transparency.
- The aim of the 'Voorrang voor duurzaam' ['Priority for sustainable'] bill is to give priority to sustainable energy in the energy network in the event of congestion.

Policy instruments

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

Target range

Figure 2.1 shows the expected achievement and the indicative targets from the Renewable Energy Directive. Nederland expects to achieve the target from the Renewable Energy Directive for the general share of energy from renewable sources. This target from the Renewable Energy Directive for 2020 is 14%. The expectation is that the renewable energy share could be 14,5% in 2020. With regard to the indicative trajectory, the Netherlands expects an achievement above this trajectory up to 2018. The indicative figure for 2011-2012 is 4,7%. The expected average achievement for the year 2011-2012 is 5,1%. The target from the Renewable Energy Directive of 10.0% within the transport sector is also expected to be achieved. Objectives for the coming years are 4,25% in 2011, 4,5% in 2012, 5,0 % in 2013 and 5,5% in 2014.

Long-term projections are notoriously uncertain. For this reason, ECN/PBL assume a range within which the renewable energy share will move. The range reflects a 95% certainty interval and amounts to 12% - 15%, whereby the projected 14,5% in this action plan lies at the upper end of this range. It should be noted here that this share is achievable, but only on condition that the construction of sustainable options is not delayed and an adequate budget is made available to finance these options.

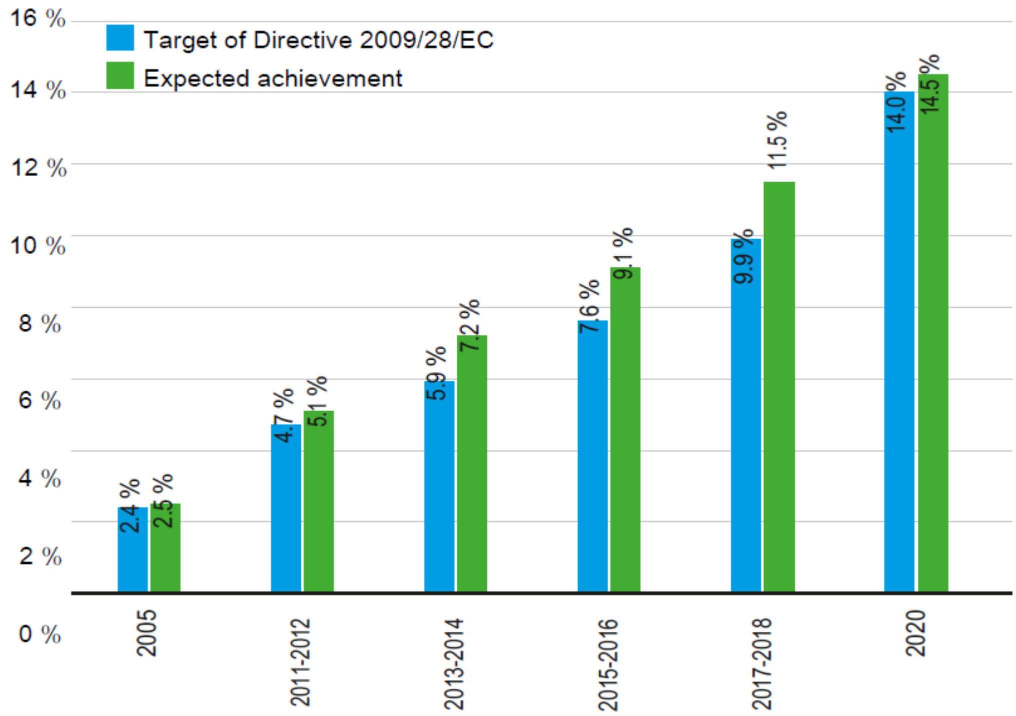


Figure 2.1: Target of the Renewable Energy Directive and expected achievement (Source: ECN, 2011)

Legislation

(Source: NL Agency 2011, CMS, 2011)

On 22 March 2011, the Dutch Senate passed the Bill implementing the Renewable Energy Directive (2009/28/EC) in relation to liquid biomass and biofuels, the Fuel Quality Directive (2009/30/EC) and the Clean Vehicles Directive (2009/33/EC).

The Bill implements the directives by amending the Environmental Management Act (*Wet Milieubeheer*), the Economic Offences Act (*Wet op de economische delicten*) and the Electricity Act 1998 (*Elektriciteitswet 1998*). The Bill features the outline of the implementation; the regulations have to be further substantiated in secondary legislation. The Bill provides the government the authority to issue governmental decrees and ministerial regulations for this purpose. These secondary regulations are not yet public but are expected to be published as soon as the Bill enters into force. The Bill will enter into force the day after publication in the Dutch State Gazette (*Staatsblad*). The provisions in respect of the sustainability criteria, the information obligations and the registration of biofuels will apply with retroactive effect as of 1 January 2011.

Renewable Energy Directive and Fuel Quality Directive: The Renewable Energy Directive provides for mandatory targets: in 2020 the share of energy from renewable sources in the European Union must be at least 20% (for the Netherlands 14%) and 10% of all transport fuels must be derived from renewable sources. The Fuel Quality Directive provides that fuel suppliers must gradually reduce the greenhouse gas emissions of the fuels they supply, towards an eventual target of 6% reduction in 2020. Biofuels and liquid biomass may only count towards the realisation of these targets if they meet the sustainability criteria as set out in the Renewable Energy Directive and the Fuel Quality Directive. 'Second generation biofuels' (biofuels produced from wastes, residues, non-food cellulosic material and lingo-cellulosic material) may be counted double.

Clean Vehicles Directive: The Clean Vehicles Directive on the promotion of clean and energy efficient road transport vehicles aims at a broad market introduction of environmentally-friendly vehicles. It requires that energy and environmental impacts linked to the operation of vehicles are taken into account in all purchases of road vehicles, as covered by the public procurement directives and the public service regulation.

Dutch Biofuels regulation: The Environmental Management Act will be amended to include a provision that provides for the adoption of a decree that (i) stipulates sustainability criteria for biofuels and (ii) prescribes rules in relation to the information that should be submitted in order to prove that these sustainability criteria are met. Furthermore the Environmental Management Act provides for a special register for fuel suppliers to register their information about supplied biofuels. The Netherlands Emission Authority (NEA) is assigned the task to control this register and the administrative enforcement of the biofuels obligations. Further substantiation regarding the organisation of the register will be set out in a ministerial regulation.
According to the explanatory memorandum to the Bill - amongst others - the following decrees will be amended: the Dutch 2007 Biofuels Road Transport Decree (*Besluit biobrandstoffen wegverkeer 2007*), the Regulations on Double Counting of Better Biofuels (*Regeling dubbeltelling betere brandstoffen*) and the Biofuels Road Transport Administration Regulations (*Regeling administratie biobrandstoffen wegverkeer*). In addition a new governmental decree and ministerial regulation will be issued: the Decree and the Regulation renewable energy for transport (*Besluit / Regeling hernieuwbare energie vervoer*).

Subsidies for liquid biomass: The explanatory memorandum to the Bill provides that in relation to liquid biomass the application of the sustainability criteria as included in the Renewable Energy Directive will be stimulated through subsidies. Such subsidies can only be obtained for liquid biomass that meets the sustainability criteria.

Although the implementation of the directives seems to be completed, much of the actual implementation still has to be filled in by secondary legislation. As soon as the necessary decrees and regulations have been published more information will be available on the actual implementation of the directives in the Netherlands.

Future

With the so-called “green deal” of minister Verhagen, co-firing is seen as essential element in the renewable energy portfolio of the Netherlands. Therefore, the minister indicated in the “Green deal” that a mandatory share of renewable sources for electricity suppliers will most likely be implemented in the future, to reach the 2020 renewable energy targets. To avoid decreasing levels of co-firing as financial support decreases, the green deal specifies that until 2015, coal- fired power plants should realize a share of 10% co-firing. With the green deal, and potential suppliers obligation the potential future role of biomass co-firing in the Netherlands has been described.

3. Domestic biomass resources

This chapter will elaborate on the domestic supply of biomass suitable for energy purposes. First, the yields from domestic vegetable oil production, cultivation of dedicated energy crops, yearly available biomass waste streams and their actual application for energy purposes will be examined. The results will then be summarized in an 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.

3.1 Domestic crops cultivation

Vegetable oil

In 2010, the production of rapeseed oil from primary agricultural sector was 11,5 ktonnes. There was no net import of vegetable oils. However, the Netherlands imported 3,95 Mtonnes of oilseeds. More than half of this was soybeans, which have an oil content of 20% , the remaining improts were was rapeseeds and sunflower seeds, which have an oil content of 40% .

Dedicated energy crops

In the Netherlands, cultivation of dedicated energy crops does not take place on a significant scale. Rapeseed is produced in relatively small amounts. In addition, a minor effort is taken on cultivation of energy wood. One example is miscanthus and willow at the experimental farm Dorschkamp North Holland, where energy production is combined with cleaning sludge. A second example is the production of cane with clean water at the Lankheet property (3 acres). Third example is the short rotation willow in Flevoland (60 ha) (SenterNovem, 2009). From 1999 an experimental forest of willow trees was planted in the province of Flevoland. Since 2002, wood has been harvested, chipped and used as fuel for the stand-alone wood combustion installation near Lelystad. In 2006, the yield amounted to roughly 290 tonnes of fresh wood 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 (Junginger et al., 2010).

At the moment, there are a few types of crops in the Netherlands which have potential for energy use. Table 3.1 shows the land area and yield of four crops. The development of crops cultivations 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.

Table 3.1: Land area and yield of four types of crops cultivation in the Netherlands

Crop	Winter wheat	Sugar beet	Rapeseed	Grain maize
Acreage (ha)	109,114	49,746	1,389	3,722
Yield (kg/ha)	8,909	89,855	4,145	12,620
Yield by-product (kg/ha)	4,472	40,000	2,500	18,600

Source: Smit et al., 2010

3.2 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 3.2 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. The green list entails 'clean' biomass waste and the 'orange' entails biomass waste that includes hazardous substances (Junginger et al., 2010).

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, as 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. There is no significant demand for non-woody residue streams like verge grass, straw and reed. 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. Some of these streams offer potential because they are already being harvested during terrain maintenance and therefore include no additional costs (except for transport). 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 (Junginger et al., 2010). 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 more than doubled since 2006, corresponded to 12,1 PJ in 2010 (CBS, 2011d). The produced biogas is primarily being combusted near the source for heat and electricity generation.

Table 3.2: Biomass waste stream specification

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

3.2.1 '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. 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.

Clean residue wood from wood processing industry

Clean residue wood is 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.

Animal fats and mixture

Animal fat is a waste stream submitted by slaughterhouses. According to statistics from MVO, the total amount of animal fats and mixture (including recycled fats (like frying fat), human consumption negative because of the recycling of fats and oils at households, restaurants, catering and industry) in the Netherlands equals 228 ktonne in 2010 (MVO, 2010). The flow of oil and fats were illustrated in section 7.2.3.

3.2.2 'Orange' Biomass Waste-Streams

Used Wood

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

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

Municipal solid waste (MSW)

MSW is collected from households and industry sectors to be burned in a waste incineration plant. Dutch policy concerning the treatment of MSW is based on 'the ladder of Lansink' (Houtkamp, 2009). 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 (1%, CBS Statline, 2011f) of the waste is land filled (including ashes from waste incineration).

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

Paper sludge

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

Refuse Derived Fuel (RDF)

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

3.3 Quantitative overview and future potential

The overview indicates the domestic production of biomass for energy purposes in ktonne and the corresponding energy content. Table 3.3 shows the estimated biomass availability in the Netherlands in 2010. Competition with food, animal feed, animal bedding and other application, as well as price of biomass supply make up the difference between availability and consumption.

Table 3.3: Estimated biomass availability and their energetic consumption in the Netherlands in 2010

Biomass source	*Availability PJ/year*	*Consumption PJ/year*	*Biomass source*	*Availability PJ/year*	*Consumption PJ/year*
Logs	5,1	N/A	Bio-Oil, Frying	2,3	5,2 [6]
Fresh Wood Chips	5,5	3,5 [1]	Bio-Oil Fatty Acids	2,3	
Energy Production (Wood)	0	N/A	Dry Food Reprod.	1,8	N/A
Sawdust	4,2	N/A	Animal Meal	1,1	1,1 [7]
Wood Pellets	1,8	2,8 [2]	Animal Fats	5	
Residues from wood processing industry	3,9	N/A	Chicken manure	6,6	N/A [8]
Wood Chips, A-Wood	7,7	3,5 [3]	Total	14,6	6,3
B-Wood	10,8		Waste	27,5	N/A
C-Wood	0,8		Vegetable, fruit and garden waste	7,8	
Verge grass	2,4	7,8 [4]	Composteeroverloop (?)	0,5	
Grass Hay	1,8		Separated Wood	7,7	
Peel	1,7		Paper Sludge	1,6	
Scrap / Flakes	1,5		Paper / Plastic Pellets	18,9	
			STP / WWTP Sludge	2,1	
Woodstoves (households/companies)	-	15,0 [5]	Municipal waste incineration	-	32,9 [9]
Total	47,2	35,7	Total	30,8	32,9

Source (for availability): Koppejan, 2005
[1-5, 9] Data estimated from Table 7.1 (domestic source)
[1] Wood chips co-fired in power plants + other combustion
[2] Wood pellets co-fired in power plants
[3] Waste wood co-fired in power plants + other combustion
[4] All non-woody biomass co-fired in power plants + other combustion
[6-7] Data estimated from Figure 7.3 (aggregated data, origin is unknown)
[6] Other fats and mixture
[7] Tallow and lard
[8] May be related to biogas production

Future supply is strongly dependent on bioenergy market and policy development. Only with a strong focus on climate change mitigation options the (regional) demand for bio-energy, and consequently supply will increase (Koppejan 2009). According to Koppejan 2009 all biomass and biogenic waste streams are playing a significant role. All supply options are expected to increase in ratio, only the increase of kitchen and garden waste collection is relatively high. As seen from the earlier fluctuation in supply and demand of bio-energy streams it is difficult to predict future biomass demand. The demand is strongly depended on policy targets and consistency and determination of policy makers.

4. Current and expected future energy use of biomass

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

4.1 General overview

A general overview of used biomass in 2010 is shown in Table 4.1. Figure 4.1 shows the overall effect on the avoided fossil primary energy. In 2010, although there are 21 wood boiler heating systems for companies were decommissioned, there were 177 systems installed in the same year. Figure 4.2 and Figure 4.3 shows the net electricity production and heat production with bioenergy in the Netherlands in 2010, respectively.

Table 4.1: A general overview of energy use of biomass in 2010 (CBS Statline, 2011d)

	Capacity			*Net production of energy*				*Energetic use of biomass*
	Number of systems	**Electrical power**	**Thermal power**	**Electrical in kWh**	**Electrical in % total electricity consumption**	**Thermal**	**Useful gas**	
Energy sources/techniques		**MWe**	**MWth**	**mln kWh**		**TJth**	**TJ**	**TJ**
Municipal waste; renewable fraction	.	563	.	1349	1,19	5401		32927
Co-firing of biomass in electr. plants	.	.	.	3043	2,68	1267		28357
Wood boilers for heat in companies	2135		435			2351		2766
Wood stoves in houses, total	939911		.			6851		12232
Wood stoves, houses, open fireplaces	391346		.			246		2457
Wood stoves, households, put in	187601		.			1192		2211
Wood stoves, houses, free standing	360964		.			5413		7565
Other biomass comb., with electr. prod.	18	.	.	892	0,79	775		12696
Other biomass comb., without elec. prod.	8		.			1594		1979
Biogas from landfills	.	28	.	82	0,07	66	387	1447
Biogas from sewage water purification	.	.	.	154	0,14	99	84	2101
Biogas, co-digestion of manure	93	101		553	0,49	293	-	6028
Biogas, other	.	.	.	135	0,12	284	618	2493
Biogasoline								5616
Biodiesel								3959

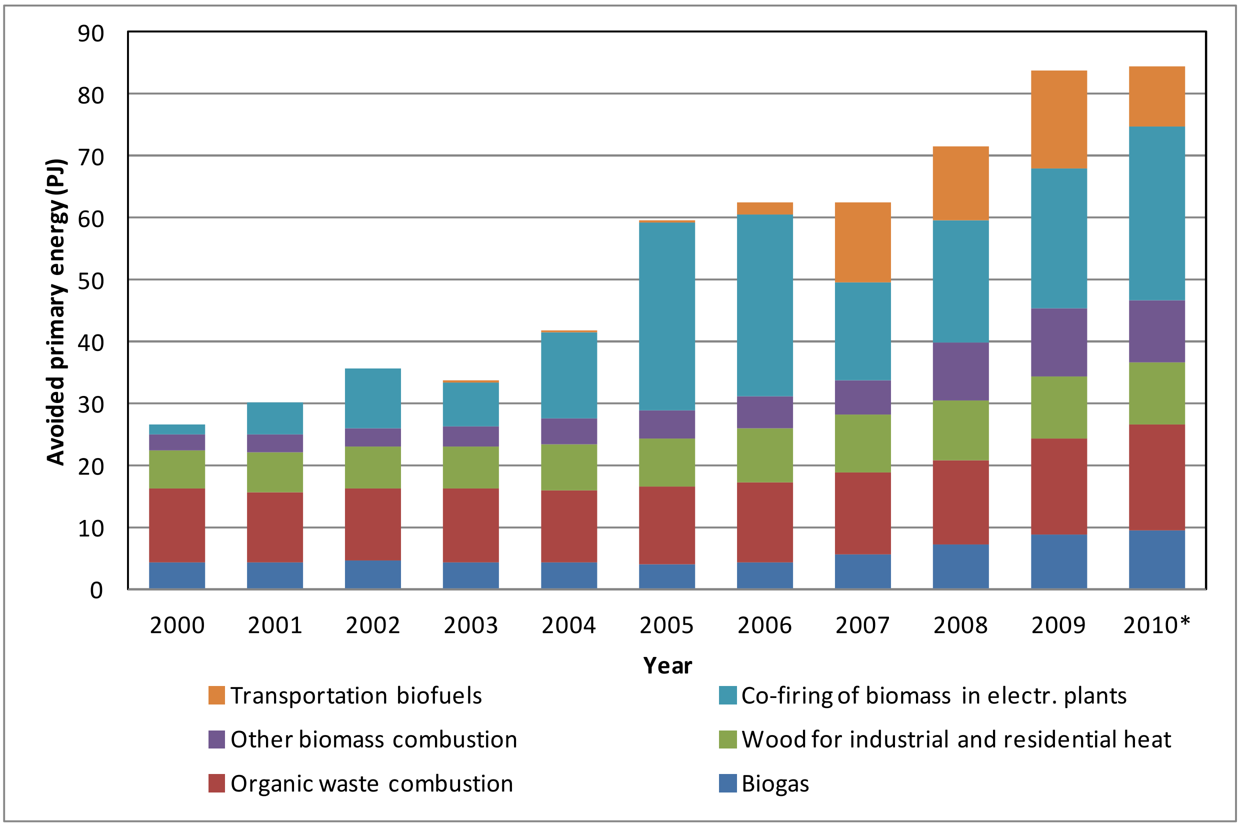


Figure 4.1: Avoided fossil primary energy consumption by production of electricity, heat and transportation fuels from biomass
Source: CBS Statline, 2011d
* Preliminary data

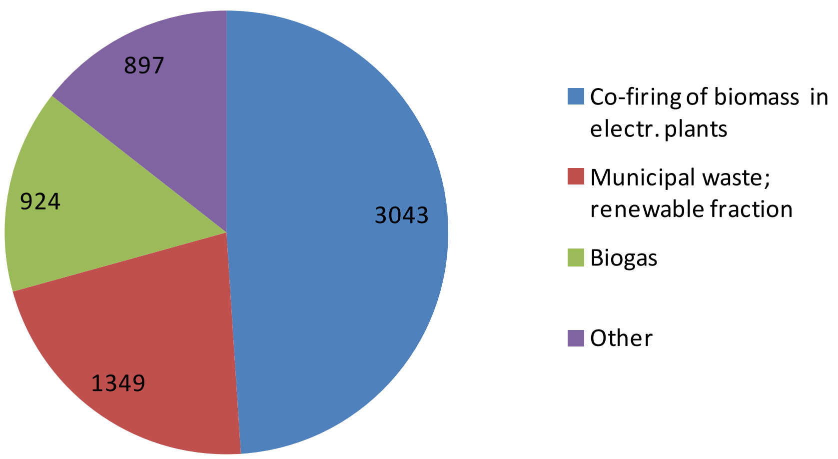


Figure 4.2: Net electricity production with bioenergy in the Netherlands in 2010 (GWh)
Source: CBS Statline, 2011d

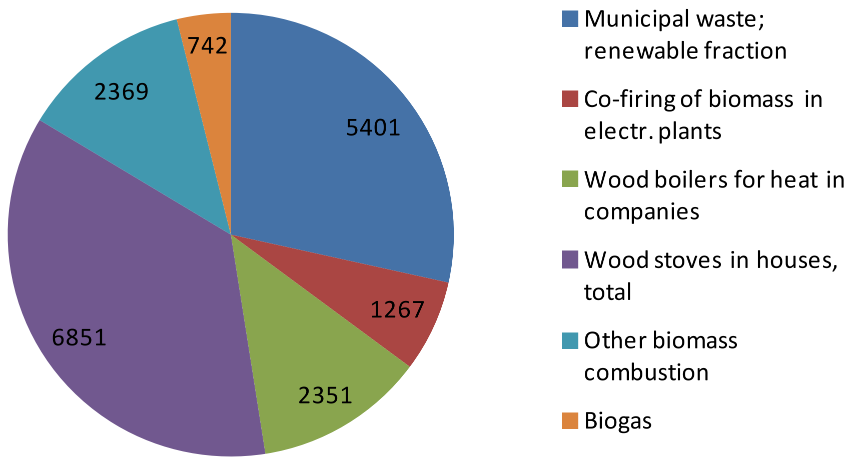


Figure 4.3: Heat generated from biomass in the Netherlands in 2010 (TJ_{th})
Source: CBS Statline, 2011d

4.2 Waste incineration

In the Netherlands, there are twelve large-scale waste incineration plants (AVIs) that incinerate MSW, as shown in Table 4.2. Some AVIs co-fire minor amounts of wood pellets or B-wood as well (these fuels are included in the statistics). AVIs produce heat and electricity. The feedstock also contains non-renewable matter therefore a correction on electricity production is applied. This reduction includes the percentage organic matter and the plants own electricity usage. The heat is usually used in a power plant, local industrial sites, or in district heating systems. Some plants do not provide heat to these systems yet, but are looking into the possibilities of delivering this additional service in the future. Table 4.2 shows the delivering of electricity and heat from AVIs to various industrial and residential sites.

Table 4.2 State of affairs of waste incineration plants 2009

Plant	Total waste used (ktonnes)	Renewable electricity (PJ)	Renewable heat (PJ)
Attero Noord BV GAVI Wijster	609,0	0,66	0
Twence Afval en energie	493,2	0,51	0
ARN B.V.	267,6	0,36	0,35
AVR Afvalverwerking BV	360,6	0,27	0,30
Afval Energie Bedrijf	1284,2	0,77	0,02
HVC Afvalcentrale locatie Alkmaar	682,1	1,63	0,13
AVR Afvalverwerking Rijnmond	1167,9	1,02	0,97
AVR Afvalverwerking Rotterdam	355,1	0,30	0
HVC Afvalcentrale locatie Dordrecht	189,4	0,13	0
ZAVIN CV	7,6	0	0
AZN	858,6	0,08	3,38
SITA ReEnergy	57,3	0	0,05
Total	6333,0	5,73	5,19

Source: Agentschap NL, 2010; NL Energy and Climate change, 2011

At the end of 2009, due to an imminent overcapacity, an agreement was signed between the waste sector and the government. It has been agreed therein not to undertake new initiatives aimed at expanding incineration capacity. The estimated production of renewable electricity has risen to 6,29 PJ of final end use (1748 GWh) in 2010, with renewal heat production standing at 4,80 PJ.

There will be no expansion of the Netherlands' capacity for waste incineration until 1 January 2020. Some waste incineration plants will be fast-tracked to so-called 'R1 status', i.e. they will become waste recovery plants, which will make it easier for them to source waste for incineration from other countries. These agreements have been made between Minister Jacqueline Cramer of the Environment and Spatial Planning, and the waste incineration plants (partly represented by the Association of Waste Processors. The agreements have been set out in the Waste Incineration Capacity Regulation Agreement (Convenant capaciteitsregulering afvalverbranding), which was signed in 2009 by Minister Cramer and the Chairman of the Association of Waste Processors, Pieter Hofstra. The waste incineration plants currently in existence or currently being built in the Netherlands provide sufficient capacity. For a number of reasons – including the financial crisis – the supply of waste has dropped, which is why the government and the waste disposal sector are now agreeing not to expand existing waste incineration plants or build new ones (NL Energy and Climate change, 2011).

The Minister of Housing, Spatial Planning and the Environment (VROM) will also grant accelerated R1 status to a number of incineration plants in the Netherlands that meet the relevant standards. In doing so, the minister is acting in advance of a European directive that is to take effect in the EU Member States towards the end of 2010. R1 status makes it easier for waste incineration plants to import waste.

The existing incineration plants that meet the standards for R1 status are Afval Energie Bedrijf (AEB) in Amsterdam, ARN in Weurt, AVR in Rozenburg, AZN in Moerdijk and a section of the Twence plant in Hengelo (Overijssel). There are several plants still being built or overhauled that also meet the standard.

Allocation of R1 status must also be included via a consultation procedure in the national waste management plan, which is a change to the plan that will need EU approval.

4.3 Co-firing in power plants

Figure 4.4 presents the co-firing of biomass in power plants from 2000 to 2010, expressed as GWh electricity produced. 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 that rose concerning the use of palm oil. After the initial drop in 2007, however, the co-firing of liquid biomass has been slowly increasing again to a consumption of 3 PJ in 2008. In 2009 the main feedstock for co-firing was solid biomass; its use was relatively stable. Around 650 GWh electricity was produced by co-firing power plants with combustible renewables.

From 2007 onwards, the main fuel for co-firing was wood pellets. The use of wood pellets has increased from 450 ktonne in 2006 to 675 ktonne in 2007 and increased to 790 ktonne in 2008. Other important biomass fuels were waste wood, agricultural residues from cocoa processing[1] and various waste streams. For 2009 the wood pellet consumption is estimated to be around 1264 ktonne. Other fuels were crude

[1] 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

palm oil, waste wood[2], and agricultural residues from cocoa processing. The consumption increased again in 2010 to 1597 ktonne.

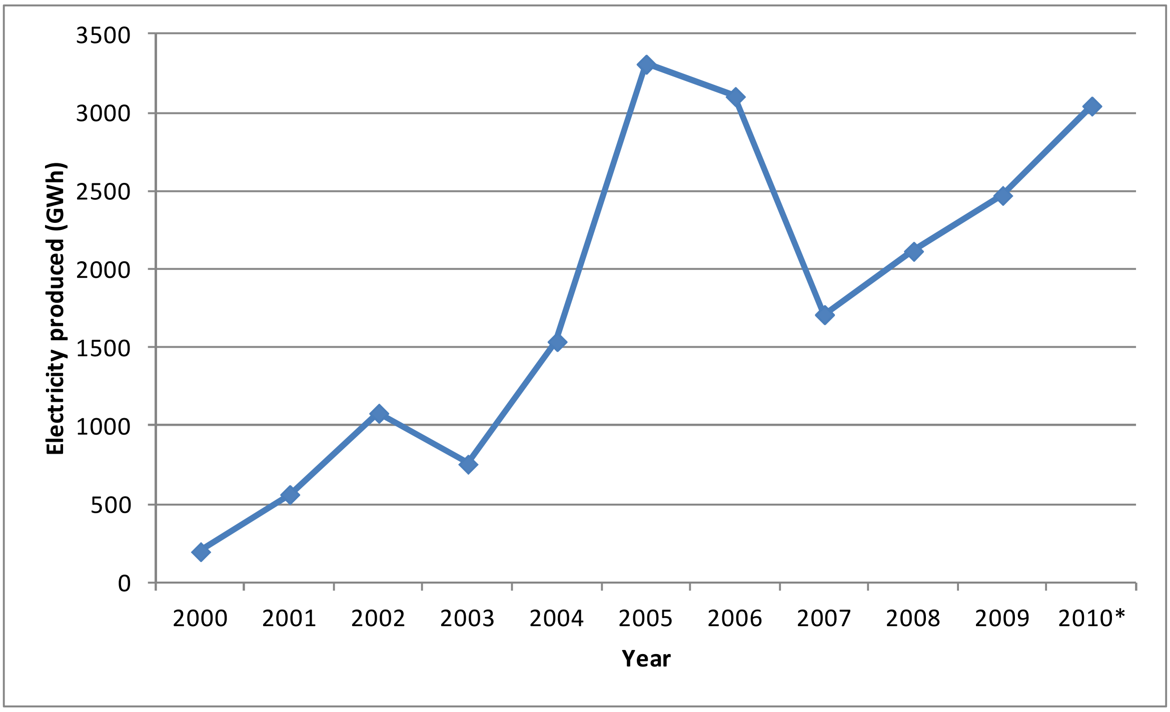


Figure 4.4: Co-firing of biomass in power plants from 2000 to 2010, expressed as GWh electricity produced
Source :CBS Statline, 2011d.
*2010 data is only preliminary.

To reach the renewable energy targets set by the Dutch government and RES directive, the biomass market is expected to grow. In 2010, electricity production by co-firing biomass rose slightly to 3,043 GWh. Due to the Environmental Quality of Electricity Production (MEP) scheme being phased out, MEP-subsidised production will be gradually reduced to zero in 2015. Electricity companies indicate that with the discontinuation of the MEP subsidy, co-firing will possibly be discontinued as well, if no additional policies are implemented. To avoid decreasing levels of co-firing as financial support decreases, the green deal (refer to Chapter 2 and Chapter 8) specifies that until 2015, coal-fired power plants should realize a share of 10% co-firing. With the green deal, and potential suppliers obligation the potential future role of biomass co-firing in the Netherlands has been described.

4.4 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). The number of newly installed stoves at companies has been decreasing in the last few years.

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

4.5 Woodstoves: households

This category entails the use of wood in domestic wood stoves. During the last years, wood-burning stoves in private households are used more and more as a sustainable heat source rather than an atmospheric element. Expectations are that wood consumption in private wood-burning stoves will remain stable in the years to come (Ministry of Economic Affairs, Agriculture and Innovation, 2010) (NL Energy and Climate Change, 2011). 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).

4.6 Other biomass burning

This category includes the solid and liquid biomass that is incinerated in stand-alone plants, cement ovens, paper mills or at other sites. During 2008, four new medium-sized installations became operational. Three waste wood combustion installations and one chicken manure incinerator. The overall capacity of these four installations amounts to approximately 90 MWe and accounted for about 5 percent of renewable electricity production (CBS, 2009).

4.7 Biofuels

As shown in Figure 4.1, the use of liquid transportation fuels has contributed significantly in bioenergy in recent years in the Netherlands. Two main categories can be distinguished: biodiesel (based on vegetable oils and fatty acids) and biogasoline[3]. After 2007, as a result of the Biofuels (Road Traffic) Decree, the consumption of bioethanol, bio-ETBE and biodiesel increased substantially. Suppliers of road transport fuels are obliged to deliver a certain share of biofuels from 2007 onwards. In practice, the obligation mainly involves blending biofuels in ordinary petrol and diesel. This is referred to as the “blending obligation”. The obligatory share of biofuels in petrol and diesel for road transport increased from 2 percent in 2007, 3,25 % in 2008, 3,75 % in 2009 to 4 % in 2010. In 2010, the compulsory shares of renewable energy in fuel (at least 4 percent of renewable fuels in 2010) ruled the development in the Dutch fuel market (Ministry of Economic Affairs, Agriculture and Innovation, 2010).

Physical delivery of biofuels to the Dutch market equalled 2 percent of all petrol and diesel for road transport in 2010. This is substantially below the target of the obligation. This does not mean that suppliers did not fulfil their obligation, because suppliers are also allowed to use additional deliveries from preceding years. This happened to a large extent in 2010.

In addition, environmental-technically good biofuels count double from 2009 on. When suppliers use such biofuels, they need to deliver less biofuels to fulfil their obligation. In biodiesel this double counting was much used, explaining why biodiesel consumption decreased in 2010. Biopetrol consumption remained constant.

4.7.1 Biogasoline

Bio-ethanol is produced in the Netherlands by the company Nedalco (eBio, 2009) who only occasionally sells ethanol to the fuel market. On the other hand, SABIC has an ETBE production plant in Geleen (SABIC, 2011).

[3] Biogasoline is defined 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).

Data on the production of biogasoline in the Netherlands is not transparent at the moment, especially concerning bio-ETBE. However, NEA (2011) has reported the Liquid biofuels consumed for energy purpose in the Netherlands, by raw materials. This was discussed in detail in section 7.4.

4.7.2 Biodiesel

Table 4.3 shows the biofuel production capacity in the Netherlands. Although the Netherlands produced about 11,500 tons of rapeseed in 2010, it is assumed that all rapeseed oil used for biodiesel has been imported or produced from imported oil seeds (Bergman, 2011).

Table 4.3: Expected biofuel production capacity in the Netherlands (Bioref-Integ, 2009)

	Project	*Location*	*Feedstock*	*Capacity*
1.	**Dutch BioDiesel (Start: 2009)**	Harbour of Rotterdam	Rapeseed oil	250 ktonnes (2011)
2.	**Biovalue2 (Start: 2010)**	Province Zeeland	Rapeseed	180 ktonnes (2011)
3.	**Biofueling (Start: 2010)**	Province Zeeland	Rapeseed oil (60%), palm oil, soy oil, jatropha oil	200 ktonnes (2012); 600 ktonnes (2014)
4.	**Biovalue (Start: 2007)**	Energy Valley	Rapeseed	80 ktonnes (Pure Vegetable oil)
5.	**Biopetrol (Start: 2008)**	Harbour of Rotterdam	Rapeseed oil	400 ktonnes (2011)
6.	**Rosendaal (Start: 2008)**	Province Zeeland	Rapeseed iuk	250 ktonnes (2011)
7.	**Wheb Biofuels (Start: 2010)**	Harbour of Rotterdam	Rapeseed oil	400 ktonnes (2011)
8.	**J & S Bio Energy (Start: 2010)**	Harbour of Amsterdam	Rapeseed oil	200 ktonnes (2011)
9.	**Neste Oil (Start: 2011)**	Harbour of Rotterdam	Palm oil	800 ktonnes (2011)
10.	**CleanerG (Start: 2009)**	Zwijndrecht	Rapeseed, Palm and soy-bean oil	220 ktonnes (2011)
11.	**Ecoson (Start: 2007)**	Son	Animal fats residue / waste	5 ktonnes (2011)
12.	**Greenmills (Start: 2009)**	Harbour of Amsterdam	Oil residue / waste	135 ktonnes (2011)
13.	**Biodiesel Kampen (Start: 2007)**	Kampen	Oil residue / waste	50 ktonnes (2011)
14.	**BioDSL (Start: 2008)**	Breda	Oil residue / waste	10 ktonnes (2011)
15.	**SunOil (Start: 2006)**	Energy Valley	Oil residue / waste	70 ktonnes (2011)
16.	**BioMCN (Start: 2009)**	Energy Valley, Delfzijl	Glycerol (by-product from biodiesel)	Biomethanol: 200 ktonnes (2011)
17.	**Noord Nederland Oliemolen (Start: 2005)**	Energy Valley	Rapeseed	PPO: 5 ktonnes (2011)
18.	**OPEK (Start: <2008)**	Province Flevoland	Rapeseed	PPO: 0.45 ktonnes (2011)
19.	**Ecopark (Start: 2007)**	Energy Valley	Rapeseend	PPO: 25 ktonnes (2011)
20.	**Cooperatie Carnola (Start: 2006)**	Province Limburg	Rapeseed	PPO: 2.5 ktonnes (2011)

4.8 Biogas

Biogas is being produced from various sources and is primarily being combusted for heat and electricity generation in gas turbines near the source. During the past few years, (co-)digestion plants in combination with water treatment / agriculture / organic waste (GFT) or the food processing industry (VGI) have become increasingly popular. In 2010, a shared capacity of approximately 13 MWe was taken into service, which includes the co-production of heat The number of fertiliser fermenters which, in addition to fertiliser, also ferment co-products, showed a particular increase (Ministry of Economic Affairs, Agriculture and Innovation, 2010).

A recent development is the production of green gas whereby (raw) biogas from fermenting biomass is reprocessed into natural gas quality and fed in the natural gas grid. In 2010, 4 projects were realised with a combined capacity of 16 million Nm^3 /year. Green gas is (physically or administratively) deployed for the production of electricity, heat or transport fuel (Ministry of Economic Affairs, Agriculture and Innovation, 2010). Table 4.4 shows the actual green gas production in the Netherlands.

Table 4.4: Actual green gas production

Municipality	*Company*	*Used biomass*	*Installed E-power (MW)*	*Green gas production [Nm3/h]*
Tilburg	Attero locatie Tilburg	Landfill	-	300
Wijster	Attero locatie Wijster	Landfill	-	500
	Stortplaats Slagenweg	Landfill	-	25
Groningen	Attero locatie Groningen	Organic waste	-	700
Witteveen	Bouwhuis Biovergisting B.V.	Co-digestion	1,59	200
Zwolle	Natuurgas Overijssel (ROVA)	Organic waste	-	420
Mijdrecht	BioGast Sustainable Energy BV-RWZI Mijdrecht	Sewage sludge	-	40
Beverwijk	BioGast Sustainable Energy BV-RWZI Beverwijk	Sewage sludge	-	80
Nuenen	Carbiogas BV-Gulberg Nuenen	Landfill	0,31	750
Bunschoten-Spakenburg	A v/d Groep en Zonen BV	Fish residues	0,63	690
			Total	3705

Source: Ministry of Economic Affairs, Agriculture and Innovation, 2010

4.9 Trend analysis of domestic production/consumption

Figure 4.5 shows an overview of projected bioenergy use in the Netherlands from 2005 to 2020. The data was taken from NREAP data published by ECN. This prediction is based on “aditional energy efficiency” scenario ENEFF. According to the Commission Decision of 30 June 2009 establishing a template for NREAPs, the reference scenarios and additional energy efficiency scenario are defined as follows: “Under the heading reference scenario, a scenario has to be presented taking into account only the energy efficiency and savings measures adopted before 2009. Under the heading additional energy efficiency scenario a scenario has to be presented taking into account all measures to be adopted from 2009. The elaboration of the other parts of the NREAP is based on this additional energy efficiency scenario”. This means that the ENEFF scenario in the NREAP would be the latest statement of the national ambition on energy efficiency. Solid biomass was predicted to continue as the largest source of bioenergy, mainly used in heating, but there is also a significant increase in the use for electricity. As discussed in Chapter 2 and 8, a mandatory share of renewable sources for electricity suppliers will most likely be implemented in the future, to reach the 2020 renewable energy targets. Therefore, the use of biomass in electricity could be higher in the future. The report also predicts significant increase of biofuels use in the Netherlands, from relatively small or insignificant to more than one third in the total bioenergy use.

Figure 4.6 shows the electricity production from renewables in the Netherlands projected to 2020 according to different scenarios. Three scenarios were presented: without new national and European policy (RR2010-0); under fixed national and European policy (RR2010-V); and upon implementation of intended national and European policy (RR2010-VV). The trends are very different in different scenarios for direct and indirect co-combustion. For electricity production, based on the lowest cost options, the production will gradually increase to 15,2% in 2015 under fixed policy. After that the growth stagnates and the share of renewable electricity even decreases slightly to 13,8% in 2020. The SDE budgets reserved for 2010 to 2020, including the phase out of the MEP r, are insufficient to realise the long term targets of the

Dutch cabinet. In the projection, it is assumed that the available financial means will first be dedicated to technologies with a specific objective, i.e. onshore wind and offshore wind. Onshore wind can grow to 4000 MW and offshore wind can increase to 1750 MW in 2020.

Under the intended policy, nearly all categories grow more rapidly due to the larger subsidies from the SDE scheme. Especially onshore wind grows faster and the SDE is also opened up for biomass co-firing. The amount of green gas from digestion amounts to about 1 PJ in 2020 under fixed policy and 24 PJ under intended policy, excluding the deployment of locally produced green gas in electricity production. Owners of digestion plants can either upgrade the biogas to natural gas quality or use it in a gas engine for electricity production. A broader and more robust SDE scheme will basically reimburse the unprofitable gap of both options. In the projection it is assumed that the routes will be stimulated to the same extent, resulting in an approximately equal distribution between electricity production and green gas production of natural gas quality.

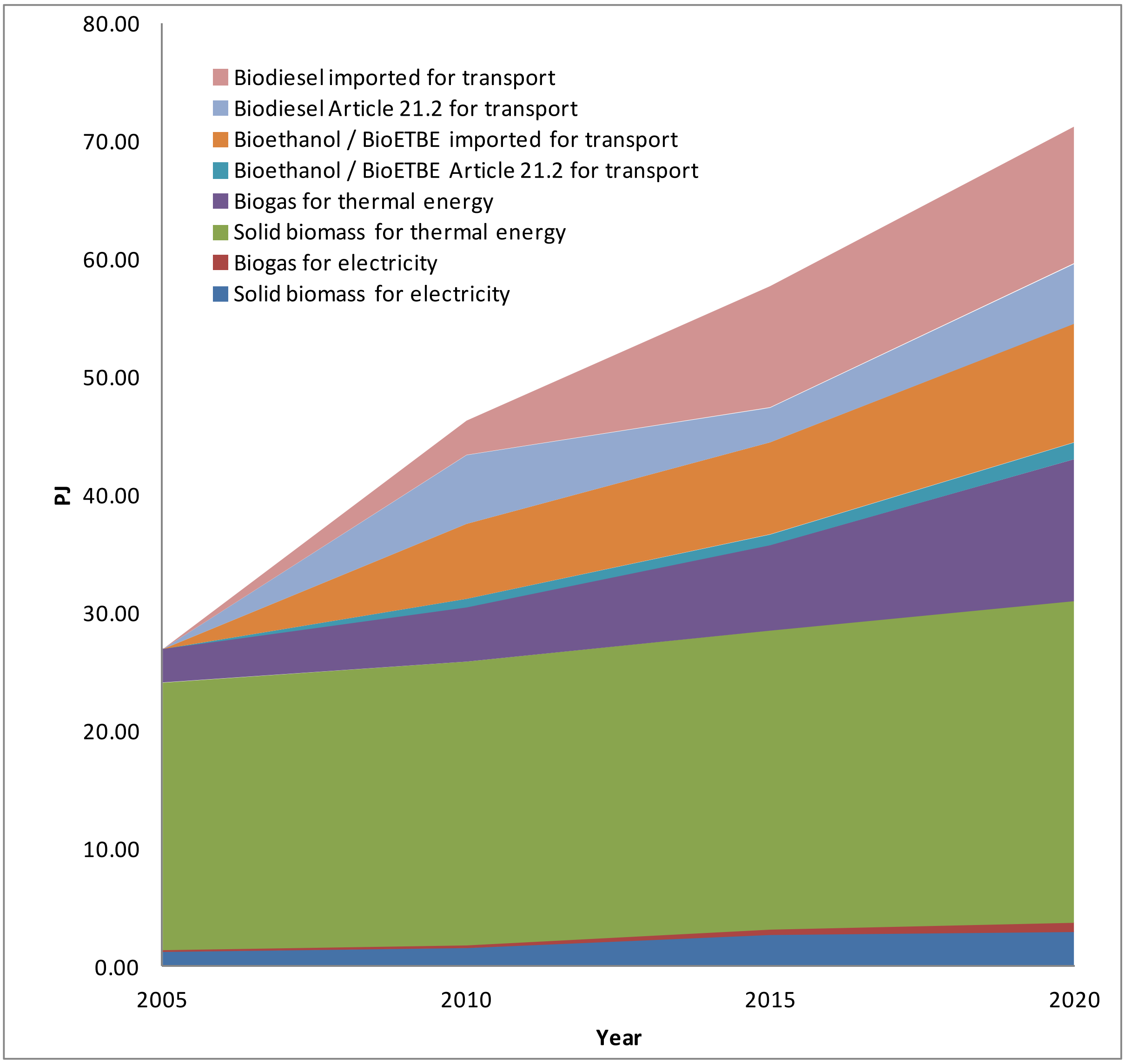


Figure 4.5: Projection of domestic bioenergy use in the Netherlands 2005-2020 based on "aditional energy efficiency" scenario ENEFF
Source: ECN 2011

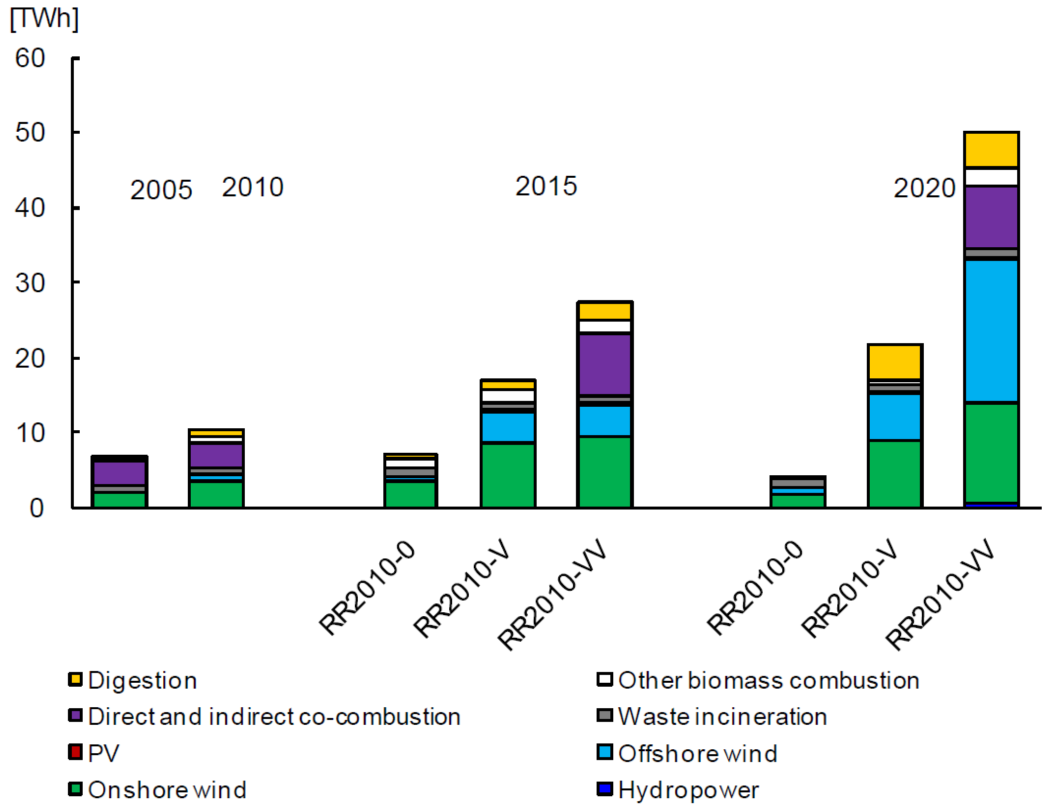


Figure 4.6: Electricity production from renewables in the Netherlands: Projection 2005 - 2020.
Source: ECN, 2010
RR2010-0: without new national and European policy
RR2010-V: under fixed national and European policy
RR2010-VV: upon implementation of intended national and European policy

Figure 4.7 shows the heat production from renewables in the Netherlands projected to 2020 according to different scenarios. Renewable heating and cooling will make a substantial contribution to the renewable energy target in 2020. The total of 510 PJ avoided primary energy in the intended policy variant can be distributed into 5400 PJ renewable electricity, 35 PJ biofuels and about 75 PJ renewable heating and green gas. Renewable heating is supported to a limited extent through the useful heat calculation in the SDE scheme. Green gas from manure digestion is also coveredby the SDE scheme.

Figure 4.8 shows the biofuel consumption in the Netherlands projected to 2020 according to different scenarios. The projection of the share of biofuels in transport fuels of both fixed and intended policy are based on the starting point that the European target of 10% renewable energy is realised. Without Clean and Efficient policy the old obligation of a share of 5,75% applies. Second generation biofuels (including biofuels from biomass residual flows) count double for the European target. Projections for 2020 indicate that the required 10% consists of 7%-point first generation biofuels and 1,5%-point second generation biofuels. Biodiesel will take up about two third of the biomass market (in energy content) and bio-ethanol about one third. Under intended policy there is a slight decrease in biofuels in the transport sector because the total energy demand is lower here. Although electricity and green gas can also contribute to the target, their contribution is assumed minimal in the projection.

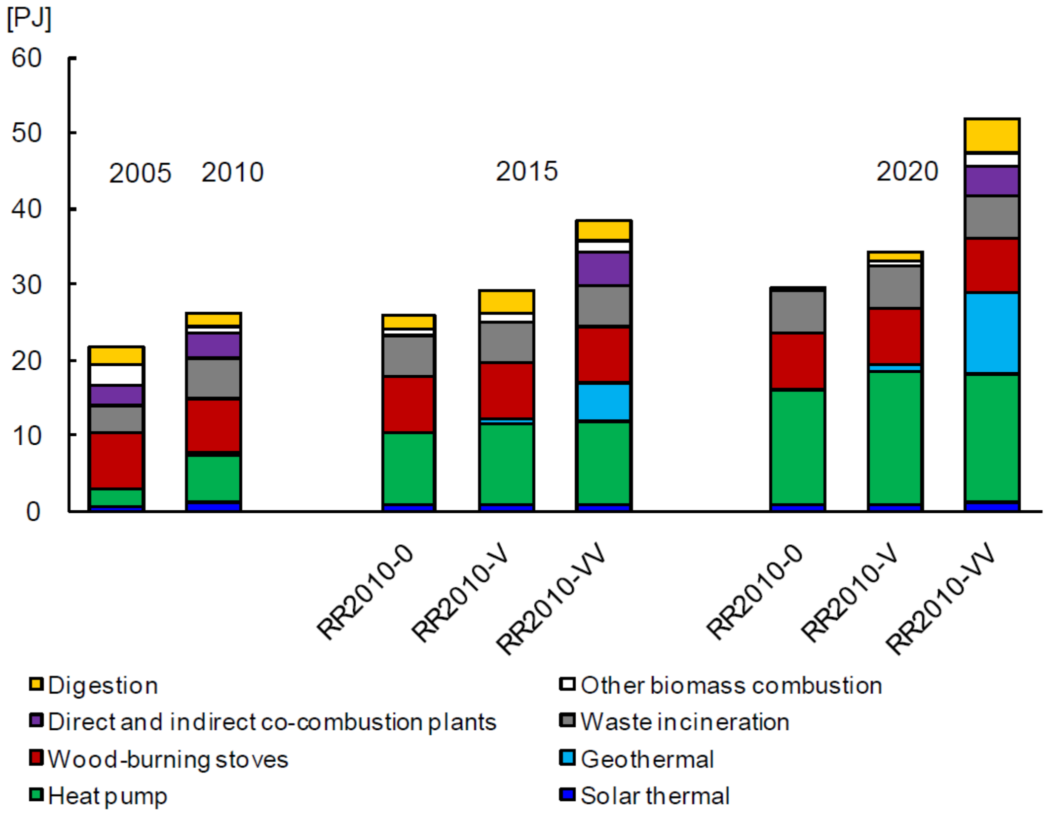


Figure 4.7: Heat production from renewables in the Netherlands: Projection 2005 - 2020.
Sources: ECN, 2010
RR2010-0: without new national and European policy
RR2010-V: under fixed national and European policy
RR2010-VV: upon implementation of intended national and European policy

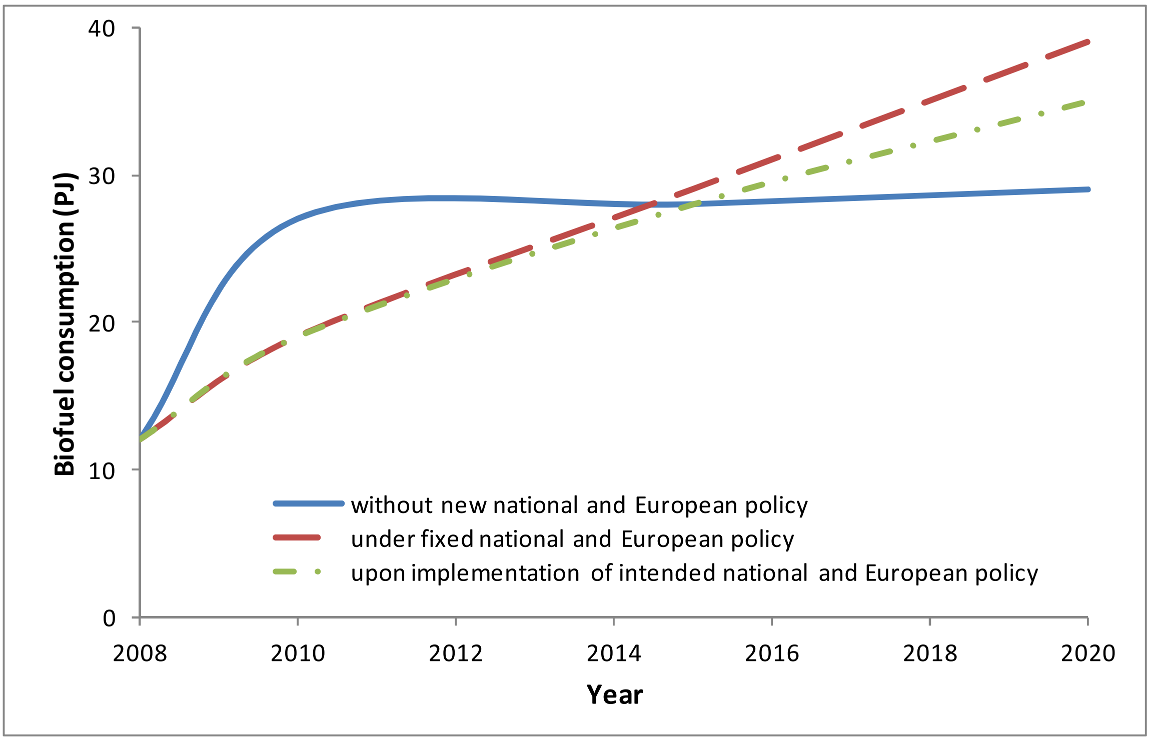


Figure 4.8: Biofuel consumption (PJ) in the Netherlands: Projection 2008 - 2020.
sources: ECN, 2010

5. Current biomass users

Table 5.1 shows the energy use of biomass in the Netherlands in 2010. Largest part of the bioenergy comes from incineration of biogenic portion from municipal waste. On the other hand, wood pellet is the largest group of solid biofuel used in co-firing. 27,1 PJ of primary energy from wood pellets were consumed in 2010 in power plants. The other main biomass users are utilities and household (wood stoves), amounted to 12,2 PJ. Apart from that, biomass waste was also fermented into biogas, which amount to primary energy of 12,1 PJ.

Table 5.1: Use of biomass for energy purpose in the Netherlands in 2010

Energy use of biomass	***Total use, PJ***
Co-firing of biomass in central electricity plants	
Wood pellets	27,1
Wood chips	2,5
Waste wood	1,0
Other woody biomass	0,5
Non-wood solid biomass (direct from primary agriculture)	0,2
Non-wood solid biomass (coming from agro-processing industry)	2,1
Other non-woody solid biomass	0,3
Liquid biomass (direct from primary agriculture)	0,4
Other biomass combustion	
Wood chips	1,0
Waste wood	6,1
Non-wood solid biomass (direct from primary agriculture)	3,2
Other non-woody solid biomass	2,0
Liquid biomass (direct from coming from agro-processing industry)	1,1
Municipal waste incineration, renewable fraction	33,0
Wood boilers for heat in companies	2,8
Wood stoves in houses	12,2
Biogas	12,1
Transportation	
Biodiesel	4,0
Biogasoline	5,6
Total	**107,6**

Co-firing power plants

The Netherlands is a leader in co-firing in Europe. It has been popular for a number of reasons, such as co-combustion being relatively cheap, is environmentally sound, and lowers greenhouse gases, efficient conversion of biomass to energy, realization can be accomplished in a short period. Main issues from Dutch experiences: the grindability of the biomass/coal blend, the capacity of existing unit components, and the risk of severe slagging, fouling, corrosion and erosion. In order to meet the challenging objectives set by the Dutch government with respect to the contribution of renewable energy, and the severe regulations concerning for example emissions and the use of by-products, many technical problems still have to be solved. These problems include technical boundaries of increasing direct co-combustion, and exploring different (in)direct co-combustion concepts, such as upstream gasification, pyrolysis and combustion with steam-side integration, in order to: 1) handle less cleaner fuels and 2) to co-fire larger fractions of biomass/waste fuels, while maintaining to fulfill all the requirements (EUBIA, 2011).

In the Netherlands, the capacity of coal-fired installations amounts to 4,000 MWe, divided over 8 units (total generating capacity of the power sector is 17,700 MWe).

Table 5.2: List of Biomass Co-firing Plants in the Netherlands

Power Station	*Type of Combustion*
Gelderland 13	Direct co-combustion with separate milling, injection of pulverised wood in the pf-lines and simultaneous combustion
Amer 8	Direct co-combustion: separate dedicated milling and combustion in dedicated biomass burners
Amer 9	Direct co-firing: biomass is milled separately in dedicated mills; combusted in separate burners
Amer 9	Indirect co-firing : gasification in an atmospheric circulating bed gasifier and co-firing of the fuel gas in the coal-fired boiler
Borssele 12	Practice 1: direct co-firing by separate milling and combustion Practice 2: direct co-firing by mixing with the raw coal before the mills
Maasvlakte 1 & 2	Practice 1: direct co-firing of biomass, pulverised in a separate hammer mill, injection into the pf-lines and simultaneous combustion Practice 2: liquid organics fired in separate oil burners
Willem Alexander	Direct co-gasification

Source: EUBIA (2011)

From the results of these unique co-firing trials it was concluded that co-firing of waste wood up to about 25%, chicken manure up to a few percent and RDF (refused derived fuel) up to about 15% (on an energy basis) is possible without for instance significant influence on the properties of the fly ash. Therefore the ash can be sold to cement industries.

Co-firing units in the Netherlands range from 420 to 650 MWe capacity. Co-firing fuel experience 1996-2000 include: Pet cokes (dried), sewage sludge, paper sludge, (waste) wood, hydrocarbon gas, biomass pellets, citrus pellets, municipal waste, coffee grounds, cacao shells, animal fat, meat and bone meal (EUBIA, 2011).

Example: Gelderland power station and Maasvlakte plant

Source: EUBIA (2011)

In the Gelderland power station, waste and demolition wood is collected in the Netherlands from 3 locations. It is chipped and metal, plastics or textiles are removed manually. Small pieces of plastic are removed by wind sifting and stone, sand and glass particles are sieved out. Wood chips are then transported in containers to the power plant. The chips are then unloaded to a reception area at the plant onto a hopper and conveyed to the grinder area. After further cleaning from magnets, wind-sifting the rest of the dirt is removed. The material is then delivered to the hammer mill (15 tonne/hr) which beats it up into particles of no more than 4mm. This stream material is sieved and divided further before being transported to the dust collector. The static classifier removes about 10% of the material <800um. Drying using pre-heated air is used to dry the material in the mill stage.

Each mill operates at about 1,8 tonnes per hour, with a final product density of 200 to 240 kg/m^3. A metering system fed the powder into four separate burner injection lines, each capable of conveying 1.1 to 3,5 tonnes per hour. Four special wood burners with a capacity of 20MWth each were mounted in the side of the boiler (two on each side) below the lowest rows of the existing 36 coal burners. At present, Electrabel is feeding the pulverized wood directly into the pulverized coal transport lines. There is a reduction of fly ash as wood produces a lot less than coal.

There is some mixed biomass pellets used in co-firing for the Maasvlakte plant. The pellets are made from sewage sludge, waste wood and paper sludge available in the vicinity of the plant. The pellets are blended with raw coal on the conveyor belts. BioMass Nederland started in the beginning of 1998 with the production of pellets consisting of biomass (pruning), sewage sludge and paper sludge. The yearly production is estimated to be 150 ktonnes of material with a higher heating value of about 16 MJ/kg. This amount of fuel will replace 30 ktonnes of coal and thereby leading to an equivalent reduction in CO_2 emissions.

6. Biomass prices

Prices of liquid biofuels have been fluctuating significantly between 2007-2009, as shown in Figure 6.1 for ethanol (in comparison with gasoline and the crude oil price), and Figure 6.2 for rapeseed methylester (RME, one of the main types of biodiesel) and rapeseed oil (in comparison with diesel)[4]. 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 harbour, and thus do not include distribution costs to the pump. Also, the fossil fuels are given including value added tax and fuel tax of about 12,1 €/GJ for gasoline, and about 8 €/GJ for diesel.

As can be seen in Figure 6.1, the price of ethanol seems to be strongly correlated with the price of crude oil. When neglecting the fuel tax on ethanol (i.e. when one would assume that ethanol would receive a tax exemption), ethanol could clearly compete competitively with gasoline seems (although the cost of distribution to the pump still would needs to be included to allow a direct comparison).

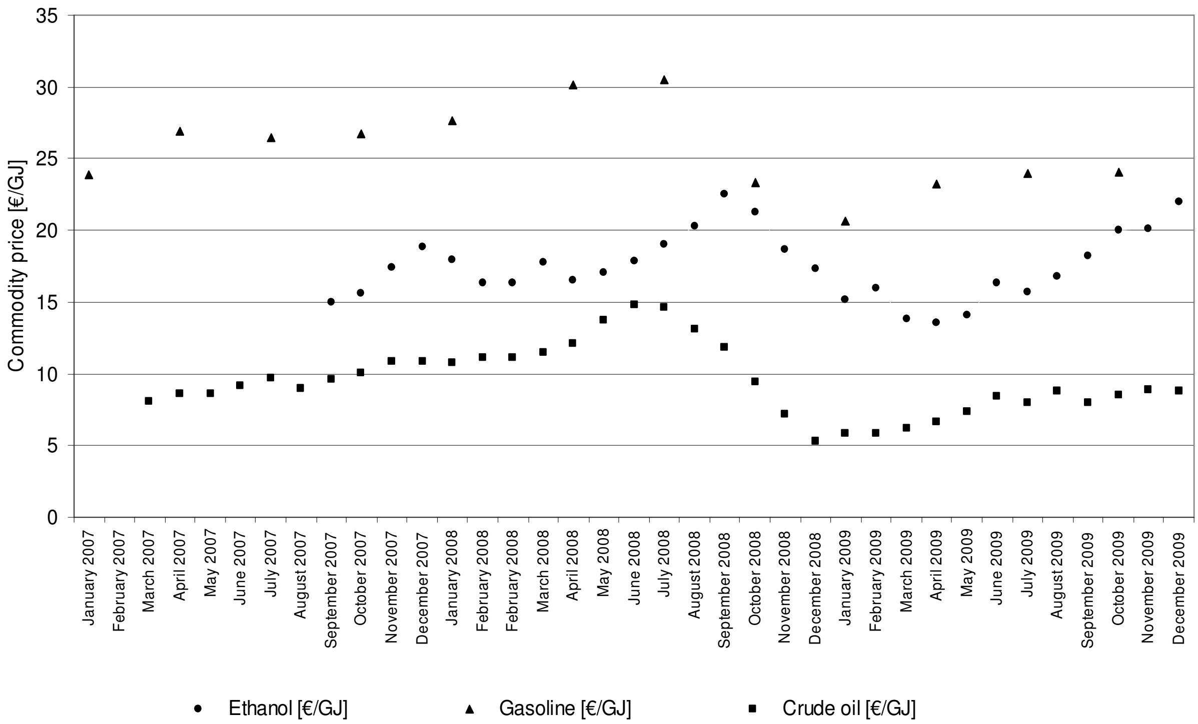


Figure 6.1: Price development of Ethanol (delivered FOB to Rotterdam) in comparison to gasoline prices (at the pump, including VAT and fuel taxes (about 12.1 €/GJ) over the period March 2007- June 2009. For comparison, also the crude oil price is shown.
Sources: ethanol (Nidera, 2009) gasoline prices (CBS Statline, 2011j), crude oil price (Indexmundi, 2009).

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

Note also, that between the different kind of imported monoalkylesters, there are quite significant differences in prices. For example, the average price of monoalkylesters from Germany (very likely almost

[4] Unfortunately, no public data was available for liquid biofuel prices for the years 2010 and 2011.

100% RME) over 2008 was 23,69 €/liter, while monoalkylesters from the US (most likely soy-bean oil based) cost on average 18,73 €/liter. An overview of the average annual costs of monoalkylesters differentiated by country is given in Appendix 3. For a comparison of various prices of biodiesel, fossil diesel and PPO, see Table 6.1.

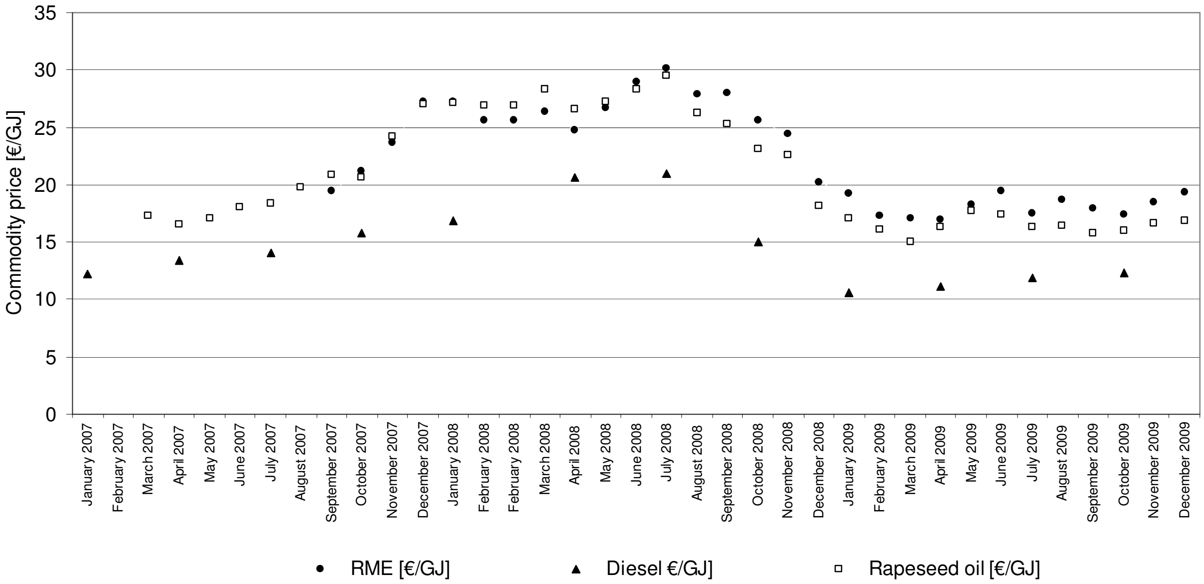


Figure 6.2: Price development of RME (Rapeseed methyl ester) and rapeseed oil, both delivered FOB Rotterdam, in comparison with diesel (at the pump, including VAT, fuel taxes of about 8 €/GJ) over the period March 2007- June 2009.

Sources: rapeseed oil and RME (Nidera, 2009), diesel prices (CBS Statline, 2011j), crude oil price (Indexmundi, 2009).

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

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

Source: Junginger et al. (2010)

In comparison to liquid biofuels, prices for wood pellets have remained more stable (see Figure 6.3). In direct comparison with coal, wood pellets are far from competitive. In mid-2008, coal prices reached up to 4,5 €/GJ. However, coal prices stayed at a stable level around 3 €/GJ until 2011, and wood pellets prices increased to 8 €/GJ in 2011 compared to 2010. Combined with an added value of avoided CO_2-emissions, this brought wood pellets on the edge of direct competitiveness for electricity production. Since then, coal prices have declined again to lower levels, and thus wood pellets still require policy incentives to make their use as fuel for electricity production economically viable.

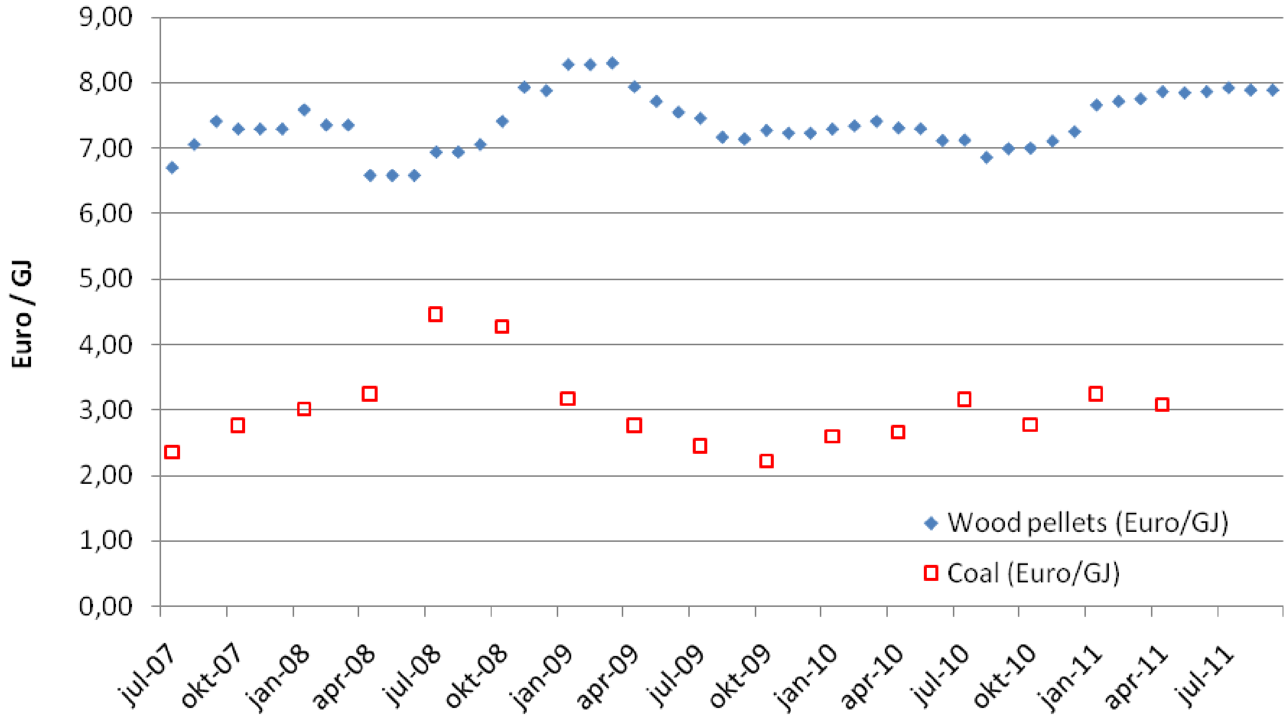


Figure 6.3: Price development of wood pellets delivered CIF Rotterdam, including VAT for bulk delivery of 5000 tonnes wood pellets by ocean vessel between 2007-2009 (Source: Pellets@las, 2011), compared to imported coal from non-EU countries (Source: CBS Statline, 2011j)

7. Biomass import and export

7.1 Electricity: co-firing

Biomass for co-firing is mainly imported: in recent years the share of domestic biomass is between 22 and 30%. Important import countries for 2010 are Canada and the United States. Especially the United States see comments ecex sum gained its share in recent years by increasing wood pellet production. Table 7.1 and Figure 7.1 show the origin and types of biomass used in Dutch power plants in 2010.

Woody biomass

The largest part of the biomass used in co-firing concerned wood pellets. Other forms of woody biomass were wood chips and waste woods. In 2011, main international trading routes were Canada and the USA, next to inland production. Other important countires of origin of imported wood pellets are the Baltic states, Russia and a few Western European countries. There is no significant import of woody biomass other than pellets.

Non-woody biomass

The fraction of other solid biomass streams in 2010 was low. However, it contributes to more than quarter of total domestic biomass energy use. In total around 174 ktonne other solid biomass was consumed, mainly domestically sourced.

Liquid biomass

No liquid biomass was imported in 2011 for co-firing due to sustainability issue of energy use of vegetable oils. Only domestic liquid biomass (direct from primary agriculture) was co-fired.

Table 7.1: Origin and types of biomass used in Dutch power plants in 2010 (ktonnes).

	Domestic	*Canada*	*USA*	*Oceania*	*Western Europe*	*Baltic states and Russia*	*Southern Europe*	*South Africa*	*Un-known*	*Total*
Wood pellets	164,4	564,6	278,3	66,1	156,0	158,5	79,7	5,0	124,0	1596,6
Wood chips	163,9	0	0	0	0	0	0	0	0	163,9
Waste wood	86,3	0	0	0	0	0	0	0	0	86,3
Other woody biomass	29,7	0	0	0	0	0	0	0	0	29,7
Non-wood biomass (direct from primary agriculture)	14,0	0	0	0	0	0	0	0	0	14,0
Non-wood biomass (coming from agro-processing industry)	140,0	0	0,3	0	1,7	0	0	0	0	142,0
Other non-woody biomass	20,0	0	0	0	0	0	0	0	0	20,0
Liquid biomass (direct from primary agriculture)	12,0	0	0	0	0	0	0	0	0	12,0
Total	630,3	564,6	278,6	66,1	157,7	158,5	79,7	5,0	124,0	2064,5

Source: Interviews with utilities.

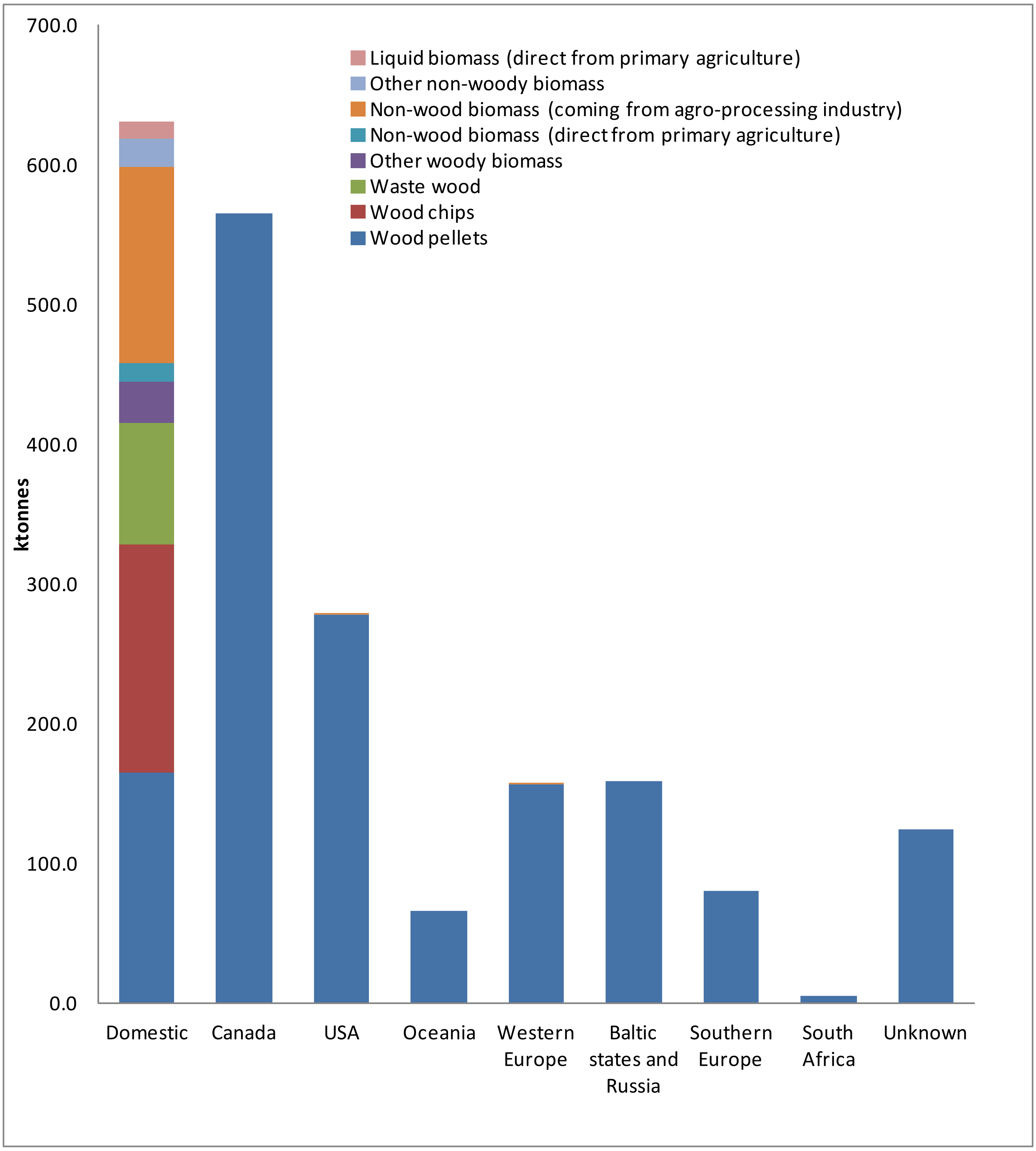


Figure 7.1 Origin and types of the biomass used in Dutch power plants in 2010
Source: Interviews with utilities.

7.2 Biodiesel and biogasoline

7.2.1 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 vegetable oils and biodiesel (and ethanol). There is a large portion of biodiesel production use imported feedstock. It is difficult to track the origin of feedstock due to extensive and complicated trade flows of oils and fats in the Netherlands (see section 7.2.3).

In Table 7.2 the main characteristics of the biodiesel and gasoline flows in the Netherlands are given for 2010. Please note that the Dutch statistical office 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.

Table 7.2: Domestic level flows of biodiesel and biogasoline in 2008 and 2009 (kton)

	2008		2009		2010*	
Biodiesel	Pure biodiesel	Blended biodiesel	Pure biodiesel	Blended biodiesel	Pure biodiesel	Blended biodiesel
Net Import (Import - Export)	319	-84	57	-69	-333	-6
Stock change	-115	0	-3	0	64	0
Total production	83	-	274	-	382	-
Domestic consumption	0	203	0	259	0	107
Production capacity	520	-	1323	-	1306	
Biogasoline	Pure biogasoline	Blended biogasoline	Pure biogasoline	Blended biogasoline	Pure biogasoline	Blended biogasoline
Net Import (Import - Export)	180	-27	214	14	x	x
Stock change	4	-	-13	-	7	-
Total production	7	-	0	-	x	-
Domestic consumption	-	163	-	215	-	208
Production capacity	11	-	0	-	x	x

Source: CBS Statline, 2011g
* estimation

Due to the increasing domestic production of biodiesel[5], net import decreased in 2009. The production capacity for biodiesel more than doubled; large installations have been built in recent years. For biogasoline, the net import is close to the total domestic consumption of pure biogasoline and blended gasoline.

7.2.2 Monoalkylesters

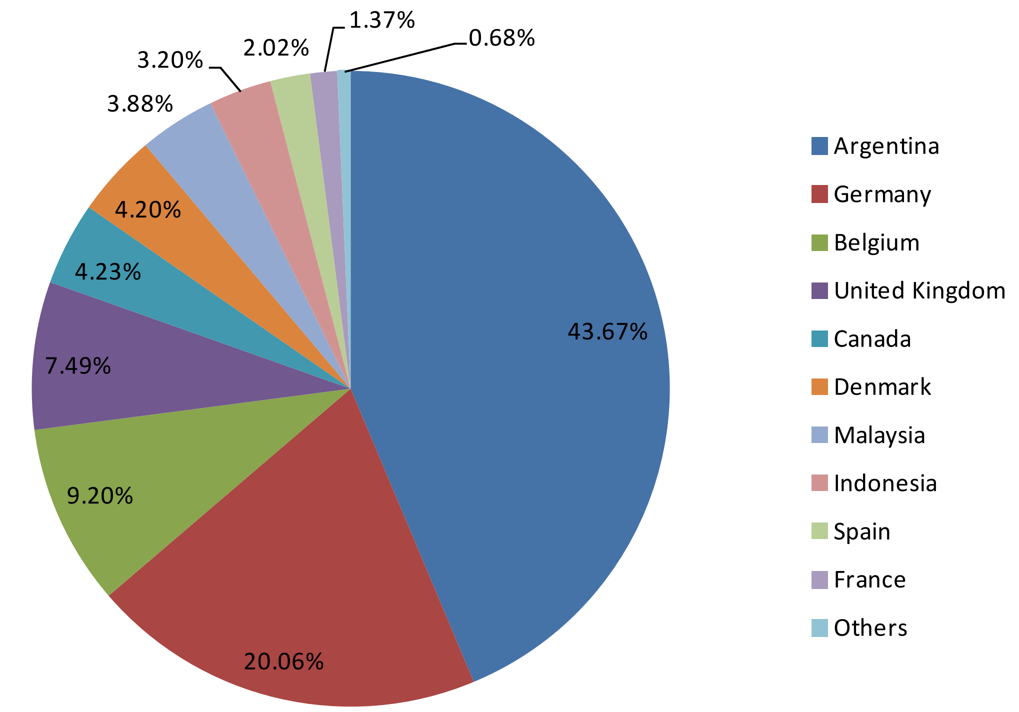
General

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

Import and export of monoalkylesters

In Figure 7.2, an overview of countries exporting monoalkylesters to the Netherlands and the countries to which the Netherlands exports monoalkylesters is shown. The total volume of monoalkylesters does not reflect the import and export of biodiesel of the Netherlands, due to the above-mentioned issues. Figure 7.2 does give an indication of the most important trading countries.

[5] Which however heavily relies on imported feedstock such as vegetable oil or oil seeds



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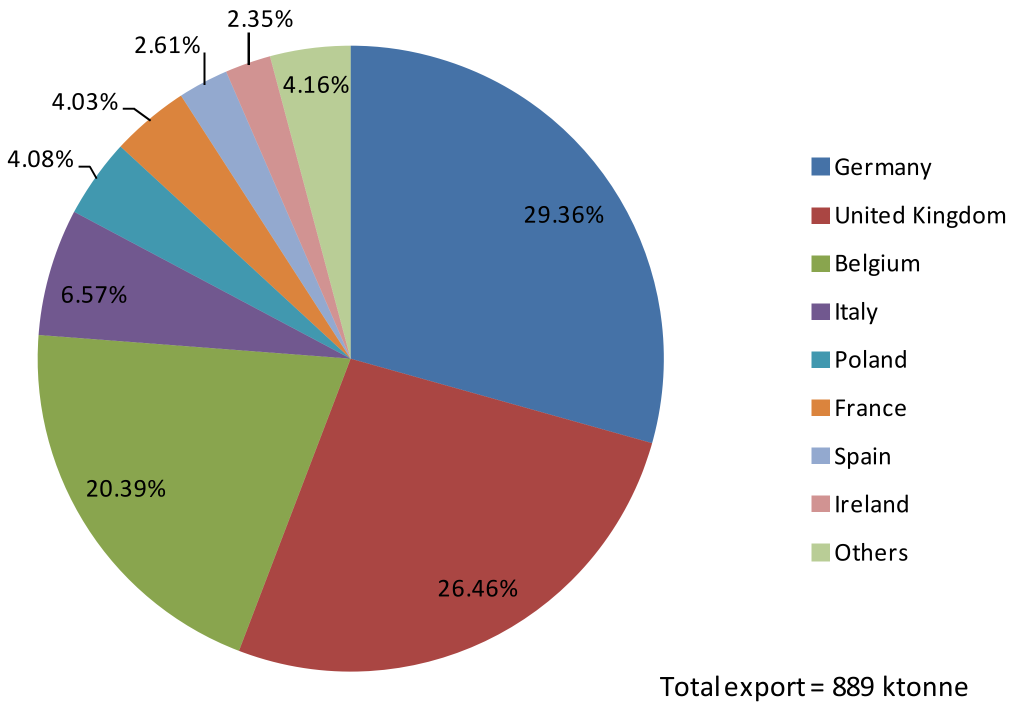


(b)

Figure 7.2: Import and export of monoalkylesters in 2010.
Source: CBS Statline, 2011g

7.2.3 Feedstock for biodiesel production

The amount of arable land available in the Netherlands is insufficient 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 food and biodiesel. Figure 7.3 shows the flow of oil and fats in the Netherlands in 2010.

A large quantity of oil seeds was imported for the production of vegetable oils in the Netherlands. Rapeseed was the only domestic oil crop with 12 ktonnes of oil seeds produced in 2010. Animal fats such as tallow and lard, palm oil, rapeseed oil, fatty acids and other fats and oil mixture (including recycled fats (like frying fat), human consumption negative because of the recycling of fats and oils at households, restaurants, catering and industry) were channelled to biodiesel production. Large portion of biodiesel (140 kt) were produced from fats and oil mixture which can be regarded as waste and inedible. Up to date, when oil is used for the production of biodiesel (like rapeseed oil), it is not possible to determine whether the oil was obtained from domestic production (crush) or was imported. .

The amount of oils and fats used for energy purposes is approximately 1/3 of the non-energetic use (food and technical use). Of almost half of the biodiesel, the feedstock is unknown. It is possible that this biodiesel is imported as monoalkyl esters, but there are no clear data of how much monoalkyl esters are being blended as biodiesel. The data of import and export of monoalkyl esters can be found on section 7.2.2.

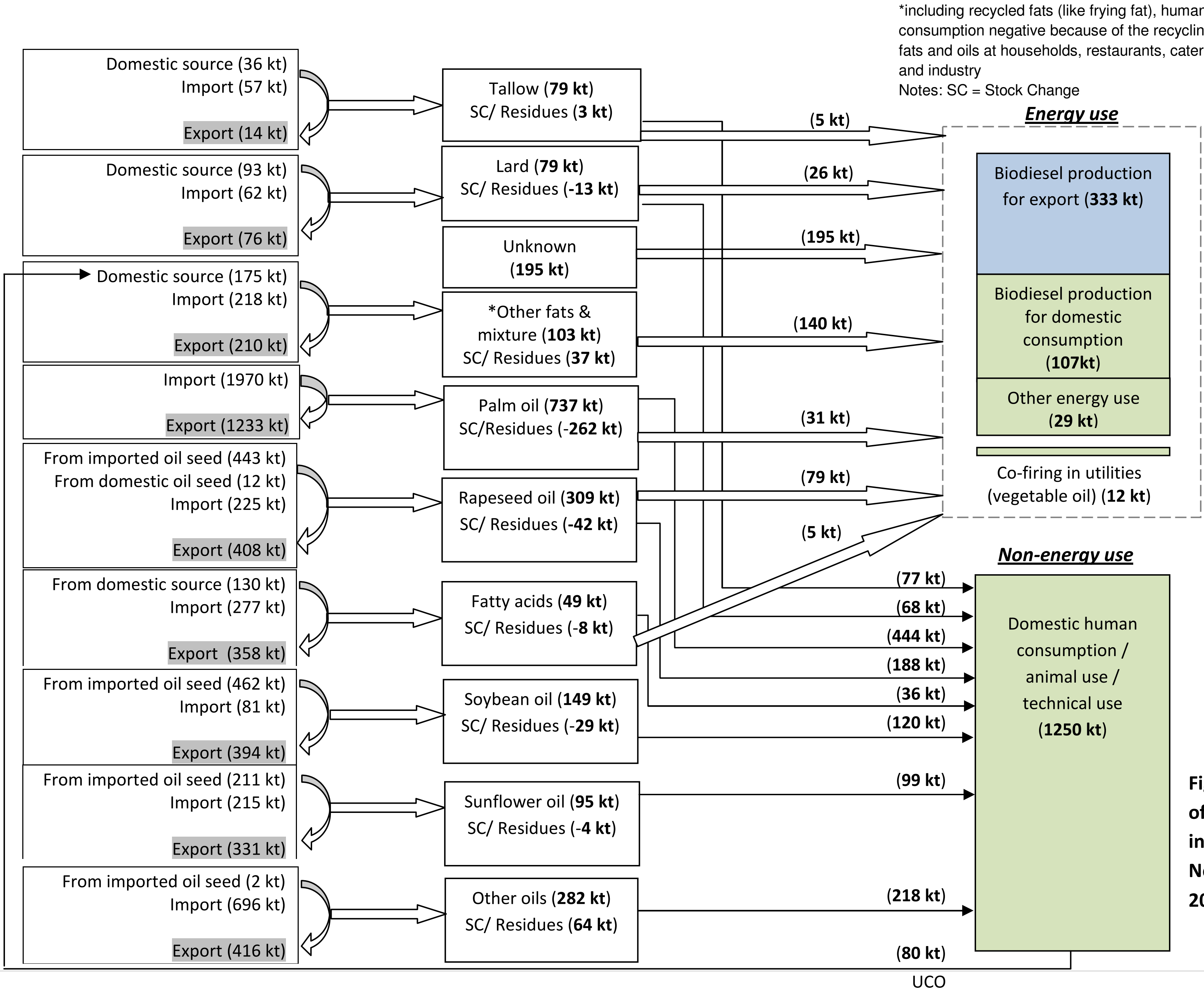
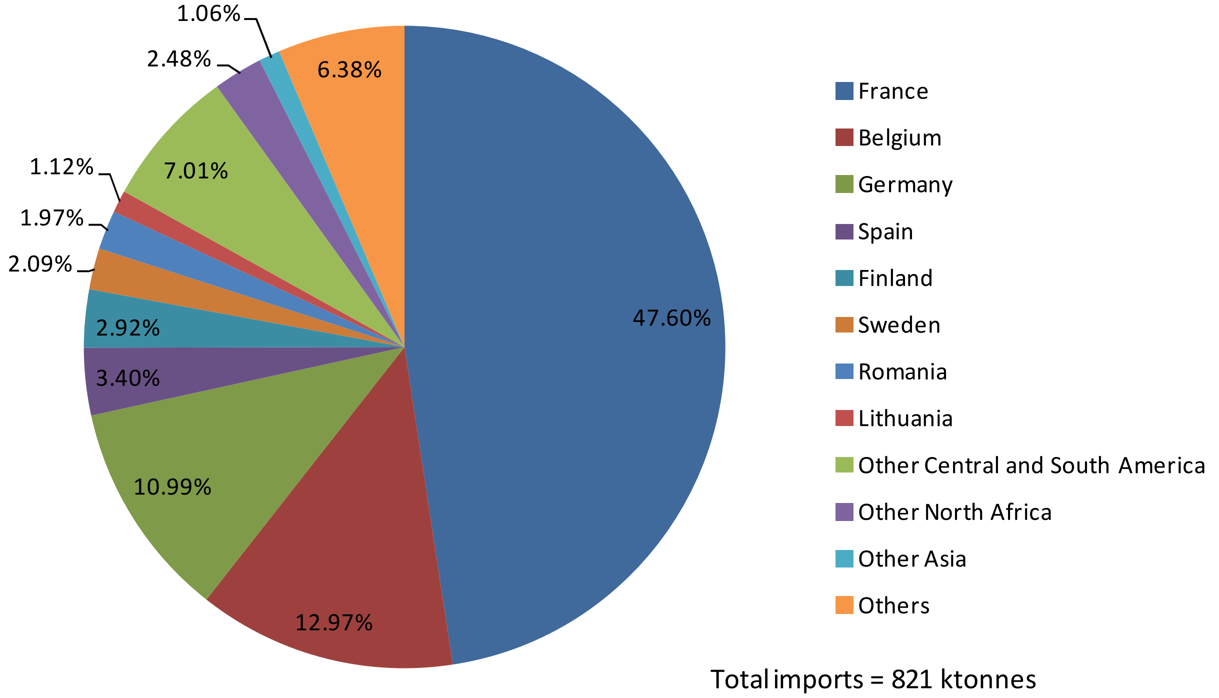


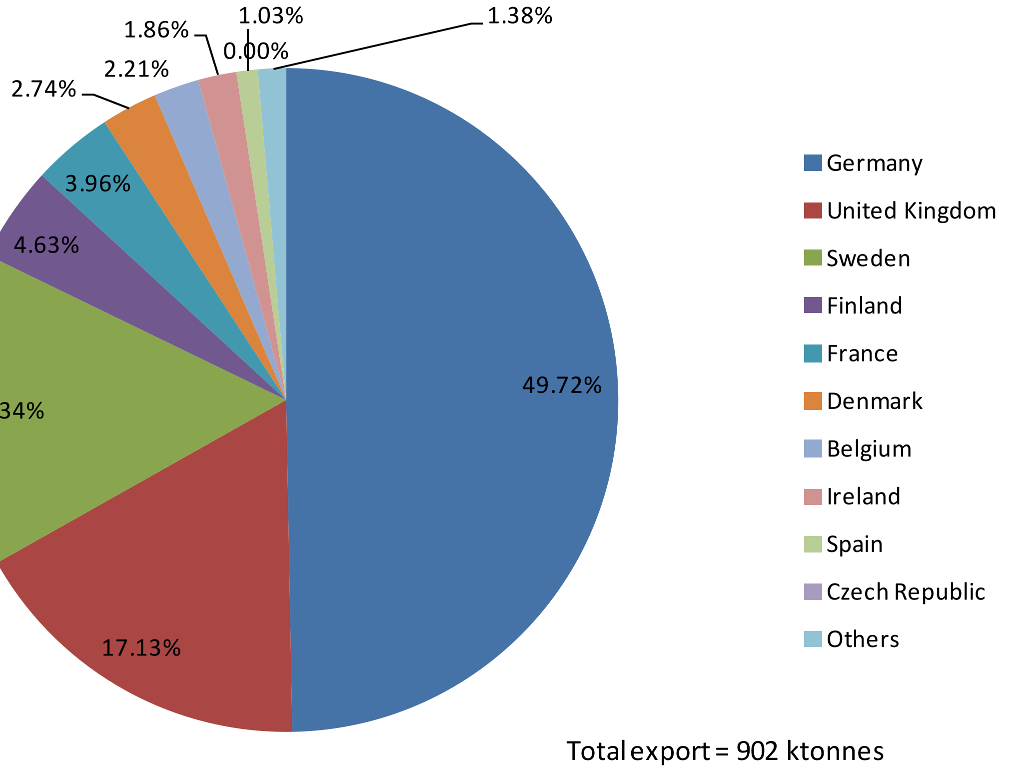
Figure 7.3 Flow of oil and fats in the Netherlands in 2010

7.3 Bioethanol

Data on the production of biogasoline in the Netherlands is not transparent at the moment. Data on import and export (by source) are considered confidential by the producing companies. However, the import and export of ethanol were reported by CBS. Although not all of this ethanol is used for energy, but it illustrates the flow of ethanol through the Netherlands. Figure 7.4 shows the (a) Import and (b) export of ethyl-alcohol in 2010. The net export in 2010 is 81 ktonnes.



(a)



(b)

Figure 7.4 (a) Import and (b) export of ethyl-alcohol in 2010.
Source: CBS Statline, 2011h

NEA (2011) has reported the liquid biofuels consumed for energy purpose in the Netherlands, by raw materials, as shown in Figure7.5. Bioethanol made from corn was most consumed in the Netherlands in 2010, amounted to approximately 100 million litres. In 2010, 85 ktonnes was produced in the country and 0,2 ktonnes of corn was imported to the Netherlands. Whether the bioethanol was made in the Netherlands or imported from other countries was remained unknown. However, due to relatively not high domestic production (85 ktonnes, considering part of that was served as food and used as animal feed) and insignificant import, the authors consider the possibility of bioethanol production from domestic corn is low.

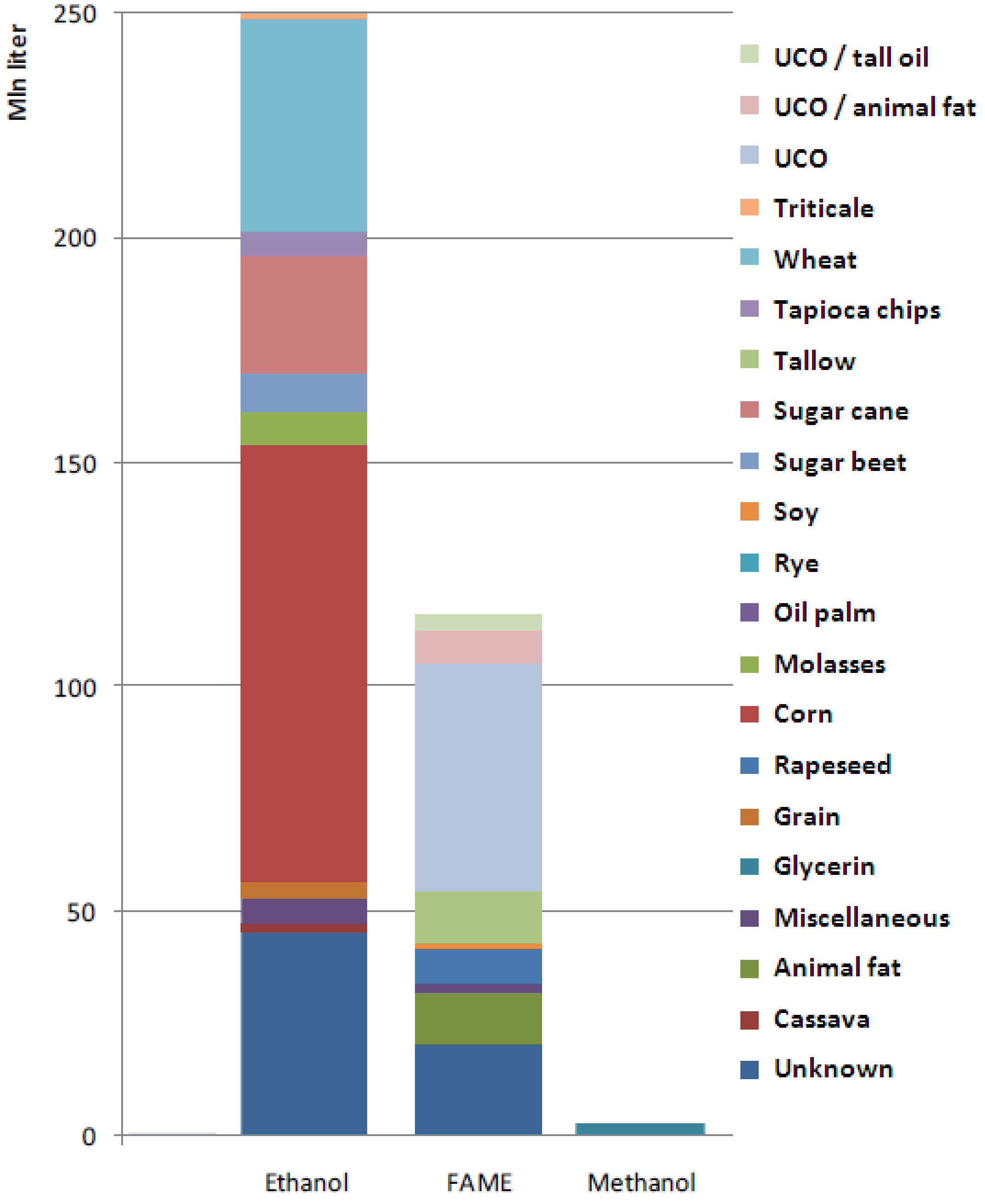


Figure 7.5: Liquid biofuels consumed for energy purpose in the Netherlands, by raw materials
Source: NEA (2011)

The second largest portion of bioethanol consumed in the Netherlands comes from wheat (about 45 million litres). In the same year, the Netherlands has imported 5464 ktonnes and exported 6152 ktonnes of wheat and meslin. 1370 ktonnes was produced in the country. Due to active trading of raw materials, the origin of wheat-based bioethanol is therefore unclear.

The third source is sugar canes (about 25 million litres). Due to the fact that the Netherlands does not produce sugar cane and has relatively low trading volume of sugarcane, the authors deduced that sugar cane-based bioethanol may have international sources.

The forth source is sugar beets (about 8 million litres). In 2010, 5280 ktonnes was produced in the country. The trading volume is comparatively low, as 18 ktonnes of sugar beets was imported, 26 ktonnes was exported. Also, net 425 ktonnes of beet pulps with molasses was imported. However, the Netherlans is a net exporter of sugars, amounted to 110 ktonnes of net export in 2010. The fifth source is molasses (about 8 million litre). It is worth noting that the Netherlands has a net import of 177 ktonnes of sugar cane molasses. On the other hand, the Netherlands has exported net 33 ktonnes of sugar beets molasses. Due to relatively much larger amount of raw materials were traded, it is difficult to track the source of sugar beets and molasses-based bioethanol from only these data.

The sixth source is tapioca chips (about 5 million litres). The Netherlands does not produce tapioca but has a net import of 0,5 ktonnes. Considering its low amount and has other uses, it is least possible that the bioethanol was produced in the Netherlands. The rest of the sources has small amount and therefore are not investigated.

Source: NEA (2011); CBS Statline (2011k, 2011l)

7.4 Possible indirect import/export of biomass

In the previous sections, we discussed direct bioenergy trade, i.e. biomass products that are traded with the direct aim to utilise it as an energy source in the country of destination. However, significant amounts of products containing organic carbon are also traded for other primary purposes (e.g. roundwood for construction, wood chips for pulp and paper, fruit and vegetables for human consumption), but parts of these streams are used for bioenergy fuel after all: examples are black liquor or sawdust, or packaging material and organic waste in MSW, which can all be used to produce heat and electricity. Table 7.6 shows import/export of biomass products in the Netherlands in 2010. Even though wood consumption tends to be mainly local, about 3,40 Mtonnes of woods and wood products were traded internationally in 2010 in the Netherlands (2,30 Mtonnes imported and 1,10 Mtonnes exported) - equivalent to about 59,40 PJ of indirect trade. On the other hand, 4,35 GL vegetable oils were imported and 4,35 GL were exported in various forms. This is equivalent to more than 320 PJ. Oil seeds were also traded in the Netherlands: 6,42 Mtonnes were imported and 2,47 Mtonnes were exported. Considering large amount of paper products will be incinerated as biogenic portion in MSW, trading of paper products (and also waste papers) may play a significant role in indirect import/export of biomass. In 2010, 11,46 Mtonnes of paper products were imported and 9,51 Mtonnes were exported.

On the other hand the flow of waste stream biomass in the Netherlands is difficult to be determined. Therefore it is not included in this report, but data of 2007 from previous country report (Junginger et al., 2010) is attached in the appendix.

Table 7.6: Import/export of biomass products in the Netherlands in 2010

	Import	*Export*	*Net Import*
Wood products (Mtonnes)	2,30	1,10	1,20
Vegetable oils (GLitre)	4,35	4,35	0
Oil seeds (Mtonnes)	6,42	2,47	3,95
Paper products (Mtonnes)	11,46	9,51	1,95

Source: CBS Statline, 2011i

7.5 Importance and impact of international bioenergy trade

A thorough analysis of the Dutch technical biomass potential was carried out by Koppejan 2009 [4] and showed a domestic production of 489 PJ, of which 124 PJ is available for bioenergy production. In comparison, about 64 PJ bioenergy from biomass was domestically consumed in 2010, but this also includes large amounts of imported biomass. The Netherlands import an increasing amount of wood pellets for co-firing in power plants. Import volumes have more or less increased steadily from less than 100 ktonnes in 2003 to more than (an estimated) 1.5 million tonnes in 2010. Domestic production of wood pellet amounted about 165 ktonnes in 2010, so to meet the demand, wood pellets have been imported from Canada (e.g. British Columbia), the Baltics, Germany, Portugal, and since 2008 increasingly also from the south-east of the USA. The consumption of biomass for co-firing amounted to more than 34 PJ in 2010, of which approximately 24 PJ were imported (i.e. >70%). The largest Dutch user is utility Essent, but also other utilities like E.On and Electrabel use wood pellets in their Dutch coal power plants. To a certain extent, the Netherlands also act as a hub, and there are minor amounts of pellet re-exports to other European countries. The main driver for the wood pellet imports is the so-called MEP feed-in tariff scheme, which provides a feed-in premium for electricity from woody biomass of 6.1 €ct/kWh.

The Netherlands are a major hub for liquid biomass, and import and re-export huge amounts of vegetable oils, biodiesel and ethanol. Due to the presence of Europe's largest harbour Rotterdam, large amounts of biofuels or biofuel feedstock are traded, partially for own consumption, but largely also for re-export to e.g. Germany or other countries. Especially during 2006-2008, 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 from the US to Canada, and from there to Europe, thereby circumventing these measures. With regard to the use of vegetable oils for electricity production, the Netherlands imported substantial quantities of palm oil for co-firing up until 2006. In August 2006, the Dutch government abruptly cancelled the feed-in tariff for electricity from liquid biomass, effectively terminating the use of palm oil for electricity production from 2007 onwards.

8. Barriers and opportunities

In this final chapter, a description is given on the most important barriers and opportunities that were encountered during the analysis of the biomass markets. This section is not meant to be comprehensive, but merely to point out several developments and prospects in solid and liquid biomass trade. Seen the limited (economic attractive) domestic potential of biomass, a large fraction of bio-energy consumed in power plants and the transport sector in the Netherlands is imported.

8.1 Barriers

Barriers for increasing electricity and heat production[6]

The MEP system (subsidy to promote biomass co-firing in power plants) is still responsible for the majority of biomass (mainly wood pellet) co-firing consumption in the Netherlands. Some co-firing projects will be financed with MEP funding until 2015. In past years, uncertainty on future market development was a major barrier for increasing electricity and heat production, but this has been largely resolved with so-called "green deal" of minister Verhagen, see policy section.

As liquid biomass has mainly been used for biofuel production, the use of liquid biomass for electricity and heat production has been negligible after 2007. The demand for biomass co-firing has almost exclusively been met with wood pellets, mainly from Canada and the United States.

With a diminishing uncertainty regarding market development for biomass co-firing, the lack of standardization is seen as trade barrier. This includes the lack of uniform technical specification, legal standardization (trade contracts) and foremost the lack of sustainability standards. Different national (and international) market actors are involved in a working panel to solve the lack of standardization.

Barriers for biofuels production and utilization

The biofuel blending obligation is the main driver for liquid biofuel (biogasonline and biodiesel) in the Netherlands since 2007. The total blending obligation increases annually, thereby creating a biofuel market. As biofuels from waste- and residue streams (like used cooking oil) are allowed to be "double counted" for the blending obligation, causing a difference between physical and administrative supply of biofuels to the Dutch biofuel market.

With the implementation of mandatory sustainability certification for biofuels in the EU, sustainable certification and its side-effects is seen as potential trade barrier by market actors. The difference in certification systems approved throughout the EU is seen as trade barrier. With the implementation as of January 2011, the biofuel industry is still in the learning and adjustment phase. Therefore the effect of this trade barrier is currently unclear.

For market actors, the possible implementation of iLUC legislation is seen as important future barrier, if implemented. Market actors do stress a possible conflict of iLUC legislation with current WTO rules. It is unclear what the time planning for potential implementation of iLUC legislation is.

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 decreased, leading to

[6] The insights in this section are also based on an ongoing project of market and trade barriers for sustainable biomass in the Netherlands, funded by AgentschapNL.

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.

8.2 Opportunities

General opportunities for biomass trade

The positive signals for increasing bioenergy consumption in the Netherlands and the EU as a whole, as described above may also led to new opportunities for biomass trade. Increasing bioenergy consumption may lead to economy of scale advantages. Furthermore, with its large harbours and connection to the European mainland, the Netherlands will increasingly become a trade hub for liquid (and solid) biomass. Already, several harbours have announced the ambition to increase the amount of traded biomass, or even become an important EU biomass port.

The decrease of transportation costs, transport costs are usually a substantial part of overall costs of wood pellets, could improve the international trade for overseas biomass. Declining markets for conventional biomass use could enable the use of biomass for energy purposes.

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 (not updated for 2010)

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	Organi-sation	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	Munici-pality 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	Distribut-ion		0	B20	
Use of PPO and biodiesel on garbage trucks.	Afvalcom-binatie De Vallei	Ede and surround-dings	Operational	End use	Garbage trucks	2	Biodiesel	In February 2006 'Afvalcombinatie de Vallei (ACV)' has started an experiment to fuel two garbage trucks with biodiesel, and two others with PPO
Boats and tractors on biodiesel and PPO.	Province of Fryslân	Province of Fryslân	Operational	End use	Boats	14	Biodiesel	The province of Fryslân uses 14 inspection 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	Start-ing 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	Start-ing phase	Distribut-ion			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	Start-ing 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	Start-ing phase	Distribut-ion			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	Distribut-ion			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	Biodiesel	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, 2009

Appendix 2. New project overview (not updated for 2010)

Table 2: 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 3. Calculation of biogenic LHVs for RDF and MSW (not updated for 2010)

Residual fraction from mechanical waste separation of MSW

Table 3: 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 4: 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 5: 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 4. Waste streams (not updated for 2010)

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 9.

Table 9: 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. 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).

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

Table 10: 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.

Appendix 5. Definitions (not updated for 2010)

- **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.