Market analysis for the start of a biomass commodities exchange

Public version

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1. Introduction

The Market Analysis

This market analysis describes the possibilities for the development of a biomass commodities exchange. A biomass commodities exchange should support and reinforce the international trade in biomass and strengthen the position of the Port of Rotterdam as the biomass main port for North West Europe. In this report biomass includes solid and liquid biomass and biofuels for energy purposes. Solid biomass is mostly used as primary energy source for heat and electricity production, either in dedicated biomass facilities and household stoves or by co-firing in coal power plants. This includes e.g. wood pellets and wood chips. Liquid biomass, like vegetable oils from rapeseed or soy bean, is primarily used as raw material for the production of biofuels that are a substitute for fossil transport fuels.

The market analysis is developed under the authority of Rotterdam Climate Initiative (RCI) to support a decision on the development of a biomass commodities exchange and to optimize the position of Rotterdam. This public version of the market analysis includes the following chapters:

- Analysis of present biomass supply and demand and future volumes and liquidity of biomass trade flows (Chapter 3);
- Inventory of views and positions of relevant market parties (Chapter 4);
- Assessment of other relevant developments (Chapter 5).

Chapter 2 presents the main findings and conclusions.

Collaboration between Port of Rotterdam and APX-ENDEX

With the development of this market analysis contacts were made with APX-ENDEX, a Dutch energy derivatives exchange. APX-ENDEX has the expertise to develop and execute exchange trading platforms and offers clearing and settlement services, while Port of Rotterdam is specialized in the physical handling and throughput of biomass. These complementary skills have been confirmed in a Letter of Intent between Port of Rotterdam Authority and APX-ENDEX to collaborate on the development of a biomass exchange with physical delivery in Rotterdam. Under the Letter of Intent a business case is developed based on the present market analysis and an analysis of the trading platform possibilities by APX-ENDEX. These products will identify the critical elements for a plan of action to prepare for the start of a biomass commodities exchange.

Background

Rotterdam takes a lead position in fighting climate change and promoting sustainable economic development. In 2007 Rotterdam launched the climate programme Rotterdam Climate Initiative (RCI). The RCI objectives are to achieve a fifty per cent reduction of CO_2 emissions, to adapt to climate change and to promote the economy in the Rotterdam region.

The use of biomass for the production of renewable energy, biofuels and biobased products takes a central position in meeting the RCI objectives. It should result in a reduction of 4.5 Mton of CO_2 emissions. This figure compares to 13% of the total CO_2-reduction target of 34 Mton and accounts for the largest non-CCS (short for carbon capture storage) contribution[1].

Biomass is an increasingly important bulk commodity for the Port of Rotterdam with great economic potential. Port of Rotterdam offers the necessary logistic conditions and infrastructure for the import, storage, transhipment and processing of biomass. Existing industries have an interest in bio-energy production and biobased chemicals and other products, while new businesses in the biobased economy are settling in Port of Rotterdam. From a historic perspective Rotterdam has an important advantage because of its leading position in agri-bulk commodity handling and its petro-chemical industry. Both industries are crucial elements in the converging agri- and energy markets which together shape the biomass commodities market.

The ambitious EU renewable energy targets boost the interest in biomass as a major renewable energy source. The use of biomass is likely to show a multi-fold increase and will in large part be dependent on imports. Rotterdam has the ambition to take advantage of these developments by positioning itself as the biomass main port for North West Europe.

In 2009, RCI commissioned a survey of the possibilities for a biomass commodities exchange in Rotterdam. The survey confirmed the need among market parties for a biomass exchange. In particular, a biomass exchange is considered to support the procuring of biomass and would provide important hedging possibilities. Hedging is an essential tool to mitigate financial risks connected to the procurement and trading of biomass. This in turn will enable and accelerate investments in bio-energy projects as the financial risks involved can be managed in a more secure way. The survey also revealed that market parties consider liquidity a key factor for a biomass exchange to be successful. This requires a critical volume of exchange traded biomass and exchange trading parties, as well as product standardization reflected in standard trading contracts[2]. The present market analysis builds upon these results providing an extension of the market views and a detailed biomass supply and demand analysis.

[1] The Roadmap to 2025 ("De weg naar 2025"), Rotterdam Climate Initiative (December 2009).
[2] Exploration of the possibilities for a biomass commodities exchange and the development of a biomass sustainability policy ("Verkenning naar de mogelijkheden voor een biomassa goederentermijnmarkt en de ontwikkeling van een duurzaam biomassa beleid"), CKade (Maart 2009).

2. EXECUTIVE SUMMARY

This market analysis describes the biomass market and the opportunities for starting a biomass commodities exchange as of today. The global biomass market has shown rapid growth in recent years, as well as the dynamics and uncertainties of a new commodity market. This requires a continued monitoring of market developments to stay well-informed for further decision-making in the development and execution of a successful a biomass commodities exchange.

One important spinoff from this project is the establishment of a formal collaboration between Port of Rotterdam Authority and APX-ENDEX, a Dutch energy derivatives exchange, to work together on the development of a biomass exchange with physical delivery in Rotterdam. The present market analysis thus provides essential input for the plan of action that is developed under this cooperation. In this Chapter, the most important findings and conclusions are presented.

Main findings and conclusions

- **Strong growth in supply and demand merit the development of a biomass exchange**

Wood pellets production is quickly responding to the renewable energy targets implemented in the EU and elsewhere. Large scale wood pellet production facilities are being developed, rapidly increasing the present 12 - 16 Mtons world wood pellet production. Demand in The Netherlands and Belgium for industrial wood pellets is expected to grow from the present 2.5 Mtons to 8 Mtons in 2020. The United Kingdom has planned for the large scale use of 30 Mtons biomass, of which some 90% will have to come from imports. Already in the EU alone the use of biomass will increase from 102 Mtoe in 2008 to 165 – 195 Mtoe in 2020. This growth correlates with 155 to 229 million ton wood pellets equivalents.
Production of biofuels has grown double digit percentages and the blending mandates still require another threefold growth in the next decade. EU biofuels use raised from 5.9 (2005) to 10.3 Mtoe in 2009. The 10% mandatory use of renewable transport fuels implies the use of 36 Mtoe in 2020, a 3.5 fold increase in the next 10 years. EU biodiesel production grew from 3.2 Mtoe to more than 8 Mtoe in 2009. Production of ethanol also doubled in that same period. Outside the EU biofuel production showed equally strong figures, with the USA topping the list with a 6-fold increase in ethanol production since 2001 reaching more than 40 billion liters in 2009.
The developments in biomass supply and demand merit the development of a biomass exchange. International trade in biomass and biofuels is growing. The EU is largely dependent on imports from third countries and Rotterdam is an important entry point for both biofuels and wood pellets.

- **A biomass commodities exchange meets the demand of market parties for better trading instruments**

Most market parties explicitly support the development of a biomass exchange. From interviews with market parties biomass suppliers, biofuels producers, power utilities, traders and financial

institutions all confirmed a positive standpoint. A biomass exchange will help these parties especially in their financial risk management. It was generally acknowledged that a biomass exchange would need active trading from day one to promote its development into a reliable and effective trading instrument. Market parties therefore emphasized the importance of ensuring market makers' commitment to generate trading volumes. Large vertically integrated multinationals with vested interests within the different parts of the biomass supply chain showed more reluctance.
Based on discussions with market parties and taking into account existing commodity exchanges in the agri-commodity sector, a successful biomass commodity exchange should provide or facilitate the following elements:

- The exchange should provide a specific trading portal for the biomass commodities sector.
- From the start market parties should be able to trade futures with different delivery times, preferably as far as 1 year in the future.
- The biomass commodities exchange should have a back office to handle and execute the contracts that require physical delivery as this involves the exchange in regular commodity contract execution. Preferably this office is close to the action, located in Rotterdam with experts from the biomass commodity trade taking care of all contractual provisions and communications. The establishment of such a back office in Rotterdam strengthens the ties between the location, the commodity contract and the market.
- The following contracts would qualify for quotation at the start of the biomass commodities exchange:
  - wood pellet futures;
  - (non edible) rapeseed oil futures;
  - Wood chips futures;
  - Biodiesel / bio-ethanol futures.

  Other contracts that that may be considered in one to three years time are bio-coal futures or a generic biomass futures contract based on key biomass elements.

Biomass commodities exchange back office in Rotterdam
In this document the reference to a back office means the executing agency or department that carries out the procedures and formalities that are involved with the transactions of physically delivered goods traded over a biomass commodities exchange. It ensures that the delivery is according to the terms of delivery and other provisions included in the contract. A back office is needed in Rotterdam as Rotterdam will be the place of delivery in contracts traded over the biomass commodities exchange. It will greatly improve the efficiency and authority of the biomass exchange. Furthermore, it enhances the view of Rotterdam as biomass main port, concentrate knowledge on biomass handling and logistics in Rotterdam and hence further contribute to the building of Rotterdam as Biomass Expertise Centre.
Futures traded through the exchange will need to be settled ('closed') at a certain point in time. The long and short positions that exist between the buyers and sellers on an exchange, which are governed and controlled by a clearing house, will have to be reconciled before expiry of the relevant futures. The finalization of these positions between parties is taken care by a clearing house. Most of the time the contracts are settled against the price difference that arises between opening and closing a position (i.e. open short sell and close buy or open buy and close sell). In those instances no physical delivery of the relevant commodity takes place and there is no transfer of ownership between parties. Contracts are financially settled after which the contracts are fulfilled (positions closed).
On the other hand a seller may prefer physical delivery of the relevant commodity. In that case the contracts cannot be financially settled and the clearing house is required to act as a principal trader between its peer sellers and buyers. At that moment the futures contract requires to be handled and executed as a physical commodity contract and forces the clearing house to perform all contract obligations connected to the delivery of a physical commodity. In order to be able to effectively comply with these physical commodity execution affairs, the establishment of a back office with skilled and experienced personnel is essential.

- **Economic factors have impeded a full blown development of the biomass market**

While the arguments for developing renewable energy as an alternative for fossil fuels are convincing, several economic factors were identified in interviews with market parties that have slowed down the development of a biomass market. First, with the present price ratios fossil fuels and coal outcompete biomass and its derived energy carriers. The cost price of biomass use is made up of several factors that make it difficult to make reliable projections on future price developments. Apart from volatility in the price of the raw material, price-determining factors include supply and demand, shipping costs, costs for storage, changes in currency exchange ratios and the price for CO_2 emission rights or greenhouse gas emission reduction credits. Still, as biomass use is a substitute for fossil fuels, the ultimate economic performance of biomass will depend on price developments in the transport fuel and coal markets. Mandatory targets for the production or use of renewable energy will allow the passing on of additional costs to the customers. However, customers are likely to resist significant and sudden price increases.

Second, the conditions for long term investments have been unfavorable. This is largely due to uncertainty about government policies and rapid changes in the biofuels and solid biomass landscapes. A fierce debate developed on the possible impact of biofuels, in particular on deforestation and food security. This switched public opinion from a generally positive standpoint to more critical views, slowing enthusiasm with governments and investors. Also, strong industrial developments and policy measures in third countries put pressure on the viability of a bioenergy industry in the EU. For instance, the differential export tariffs in Argentina or the corn ethanol support programmes and biodiesel tax credits in the US have seriously affected the European biofuels industry. Finally, sudden changes in the execution of subsidy schemes have undermined the financial security of renewable energy projects.

Food prices and biofuels
The 2008 food price spikes and rise in biofuels use have often been discussed as an isolated correlation. This has had a serious impact on the perception of biofuels with the public and private investors. The World Bank published a commanding paper taking into account the complexity of the world food, fuel and financial markets to explain one of the most significant price booms in the past 70 years. This document thus introduces a necessary nuance in understanding the effects of biofuels on existing markets.
(*Placing the 2006/08 Commodity Price Boom into Perspective – World Bank, 2010*)

- **Further political decisions will impact on the development of the biomass market**

The development of a renewable energy sector is largely driven by a political agenda to reduce dependency on the import and use of fossil fuels, to lower greenhouse gas emissions and to create new jobs. At the same time, fossil fuels have outcompeted renewable sources in price, requiring intensive government support for the renewable energy sector. In addition, governments attach great value to the sustainable sourcing of biomass feedstock. These two factors have so far prevented governments from taking a clear position on its long term renewable energy policy. From the interviews with market parties it became clear that this is considered a major hurdle for future investments and business development and leads to a skeptical view among market parties.

Uncertainties remain over the implementation of the EU target for a minimum of 20% renewable energy use by 2020. The responsibility for taking the appropriate measures is at the national level of the EU Member States. Only part of the national policy decisions have yet been published and are likely to lead to differences in obligations and support schemes between countries. This threatens the uniformity of a policy framework that is important to maximize liquidity in the biomass market. Also, a decision on possible communautary sustainability requirements for the use of solid biomass has been postponed and will be revisited in 2012. In the mean time EU Member States are allowed to develop their national policy measures. This is likely to further add to a fragmented market. A first report by the European Commission on progress in reaching the 20% target and possible proposals for further improvement of the EU legislative framework will be published in 2012.

3. Biomass supply and demand

This Chapter describes the present and future supply and demand of solid and liquid biomass and biofuels for energy purposes. It concentrates on those biomass products that are internationally traded and have a significant production volume. These products are of most significant interest to be considered for a decision on the start of a biomass exchange. Solid biomass is mostly used as primary energy source for heat and electricity production, either in dedicated biomass facilities and household stoves or by co-firing in coal power plants. Liquid biomass is primarily used as raw material for the production of biofuels that are a substitute for fossil transport fuels. For biodiesel, vegetable oils are the most important feedstock, while bioethanol, that is blended with gasoline, is mostly made from grains, maize, sugar cane and sugar beet.

3.1 Solid biomass

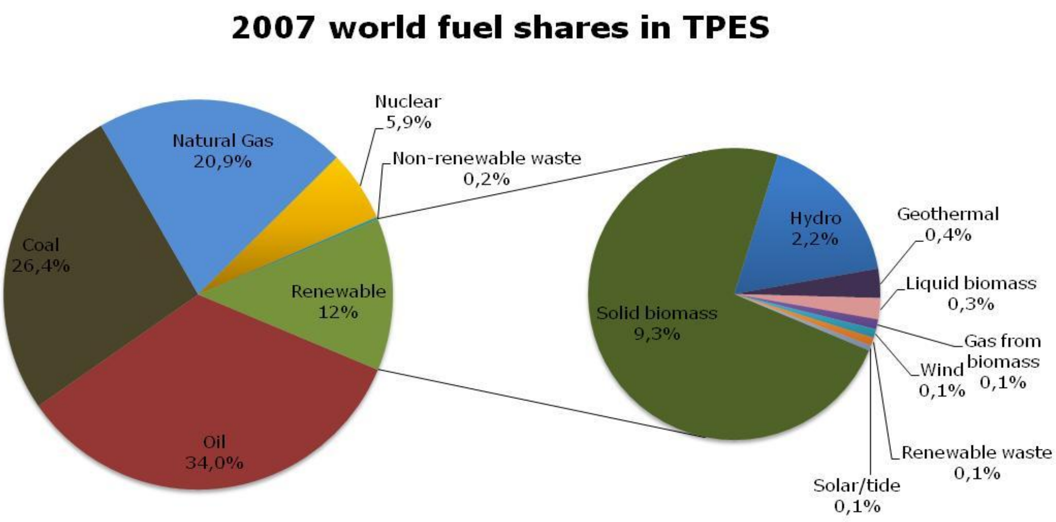
Mtwpe (million tons wood pellets equivalent)

For the purpose of illustrating physical biomass volumes and allowing swift comparison between different solid biomass commodities, an additional factor is introduced: the million tons wood pellets equivalent (Mtwpe). 1 Mtwpe represents a value of 17000 TJ (17 MJ/kg) or 4723 GWh. This value is the energy content of industrial wood pellets generally used in product specifications for industrial wood pellets. The Mtwpe unit is of particular interest for traders who are used to work with tonnages. The conversion factors used in this document are in accordance with the conversion and mathematical equations used by the International Energy Agency (IEA). These have been reproduced in Annex 1.

3.1.1 The international biomass market[3]

- World Total Primary Energy Supply (TPES) in 2007 was 12,026 Mtoe (29,624 Mtwpe or 504 EJ). Fossil fuels account for more than 80%, renewable energy sources represent 12%.
- Solid biomass is by far the largest renewable energy source. Solid biomass represented 9.3% of the World TPES amounting to 1,118 Mtoe (2,755 Mtwpe or 47 EJ).

[3] IEA World Energy Outlook 2009.
RISI International Biomass Reports.



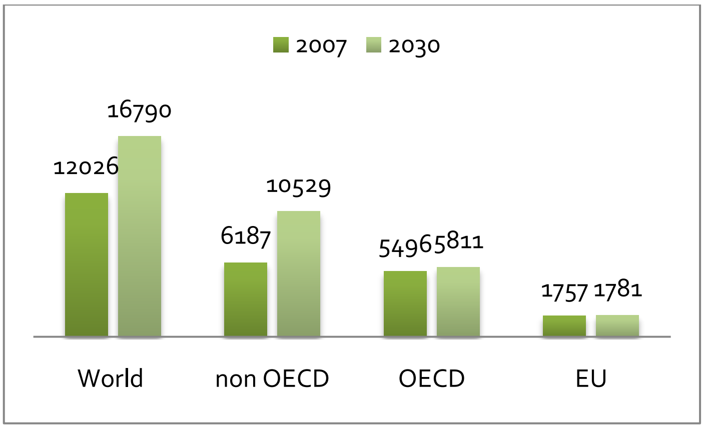
- Non-OECD countries are the main users of biomass for energy due to the widespread household use as charcoal or plain fuel wood. Africa and Asia use 1,558 Mtwpe or 56% of the total biomass use. OECD countries use almost 500 Mtwpe (or 18%).

World biomass use 2007[4]			
	Mtoe	Mtwpe	PJ
Middle East	1.2	2.97	50.42
Non-OECD Europe	6.2	15.20	258.42
Former Soviet Union	9.0	22.08	375.39
Latin America	108.0	266.16	4524.65
China	194.5	479.08	8144.39
OECD	202.6	498.99	8482.90
Africa	295.5	727.81	12372.80
Asia	336.9	829.96	14109.30

- A significant growth in world primary energy demand (40%) is expected for the next 20 years: from 12,026 Mtoe (2007) to 16,790 Mtoe in 2030. 90% of demand growth comes from non-OECD countries. Demand from OECD countries will grow 6% from 5,496 Mtoe to 5,811 Mtoe. When a cleaner and more efficient energy sector develops, IEA predicts that the growth in world primary energy demand may rise to only 14,389 Mtoe instead of 16,790 Mtoe.
- Biomass is the major source of renewable energy. The use of biomass in non-OECD countries will add to meeting the major growth in energy demand, while the use of biomass in the EU will be a replacement of fossil fuels that consolidates its energy demand.

[4] IEA Statistics Renewable Information 2009.
FAO wood report 2009.

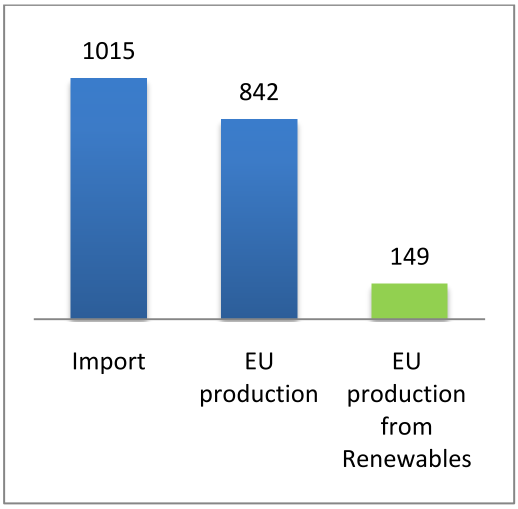
World primary energy demand (Mtoe)[5]



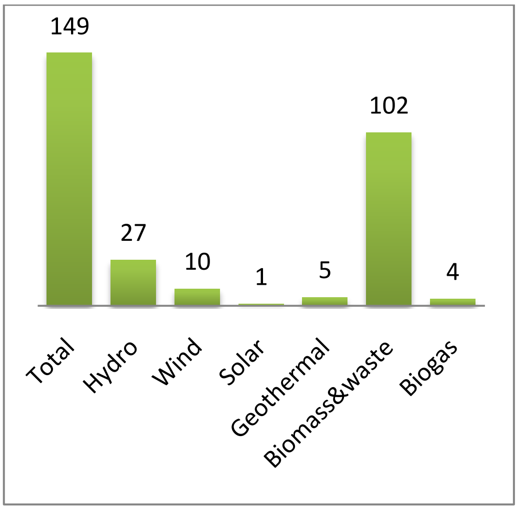
3.1.2 EU biomass supply

- The EU produced 842 Mtoe of primary energy in 2008. Imports exceeded this number with 1,015 Mtoe. The EU dependency on energy imports thus equals ~ 55%, while this was less than 40% in the 1980s. 17% of the EU primary energy production is from renewable energy sources.
- Biomass and waste accounts for 102 Mtoe (or 251 Mtwpe) or 70% of the total renewable energy production. This represents ~ 5% of the final energy consumption. Biomass is used mostly in the form of pellets, wood chips and agricultural residues.

EU primary energy production (2008; Mtoe)[6]



EU renewable energy production (2008; Mtoe)[7]



[5] IEA World Energy Outlook 2009.
[6] Eurostat. Energy production and imports, 2008.
[7] Id.

3.1.3 EU biomass demand

- The European Commission developed a model to calculate projections on biomass demand[8]. Starting from the 20% renewable energy production target in 2020, it is estimated that the EU will use 165 – 195 Mtoe of biomass. These numbers equal a biomass demand of 406 – 480 Mtwpe. This is a 60 to 90% increase in the use of biomass and waste compared to 2008.

3.1.3.1 Residential wood pellets use

- EU demand for wood pellets was an estimated 8 Mtons in 2008[9]. Residential wood pellet consumption in Europe amounted to 4.4 Mtons. Austria, Denmark, Germany, Italy and Sweden are the lead countries.
- Residential use of wood pellets comprises the burning of wood pellets in household stoves and heating boilers. These pellets are mostly produced domestically or in neighboring countries. It is sold in bags of up to 25 kg or as loose pellets. The price ranges between 200 and 250 €/ton and is further influenced by local currency rates, transport costs and VAT. Its price is significantly higher than the industrial wood pellet price (~ 115-120 €/ton CIF Rotterdam).
- Residential use requires specific qualifications that make wood pellets for residential use a premium product. These include ash content, additives, sulphur and nitrogen concentrations. Multiple certification standards do exist in the different EU Member States for premium wood pellets (e.g. ŐNORM M 7135 and Umweltzeichen 38 (Austria), SS 187120 (Sweden), DINplus (Germany)). The German DEPV and Austrian ProPellets organizations have recently developed a new harmonized standard (ENplus) to secure the supply for end consumers of standardized high-quality wood pellets.
- Residential use of wood pellets has seen a rapid growth in e.g. Italy and Austria over the past 10 years. Italy now sells 250,000 wood pellet stoves per year and in Austria the sale of wood pellet boilers has grown to 12% of the total[10]. But also in the USA domestic wood pellet use is growing and current demand is now approximately 1 Mtons[11].
- The market for residential wood pellet use will show further growth over the coming years. Although the residential wood pellet market is expected to be substantial in a number of countries, with respect to international trading the effects on the supply and demand figures are limited to the respective domestic markets.
- The reasons for the above are that residential wood pellets have a significantly more rigorous quality specification so that only certain premium wood residues can be used. This prevents interchangeability with industrial wood pellets on specifications. Moreover residential wood pellets are bagged and marketed as a brand shifting from a commodity to a consumer product. Thus the domestic biomass for residential wood pellets quickly changes from commodity to wholesale and retail product at a very early stage leading to early domestic disappearance on the supply and demand balances and therefore of the scope of the traders arena and biomass commodity markets.

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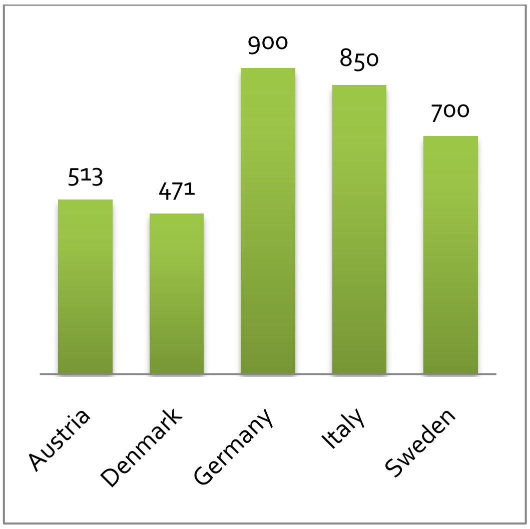
[8] European Commission-DG Agriculture. GreenX/PRIMES model, 2010.
[9] Pellet@tlas database.
[10] Aebiom – A pellet road map for Europe (2008)
[11] USDA - North America's Wood Pellet Sector (2009)

- However when residential wood pellets consumption reaches a certain volume or local biomass supply hampers, it may lead to increased imports of woody biomass or wood pellets to compensate for domestic shortages for both the industrial and residential wood pellet consumers. In this case the increased import requirements will have to be matched on the international biomass market. It is expected that these situations may occur incidentally, but will be very limited.

EU residential wood pellets use (2008; kton)[12]



3.1.3.2 Industrial wood pellets use[13]

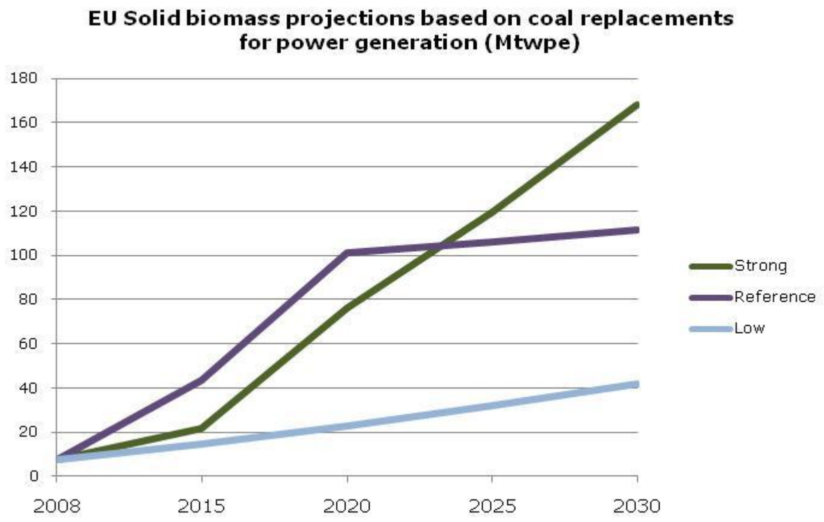
- For large scale heat and power production the EU used at least 3.2 Mtons of wood pellets in 2008. Reliable statistics on these numbers are not readily available and the data published in the Pellet@tlas database are likely to be an underestimate. While Pellet@tlas estimates the industrial wood pellet use at almost 900 kton in 2008, CBS (the national statistics office) reported the use of more than 1.1 Mtons[14].
- Belgium and The Netherlands utilise wood pellets in power plant co-firing. Sweden mainly uses bulk wood pellets for district heating. The number of utilities in each country ranges from 2 to 5.

[12] Pellet@tlas 2009.
[13] Pellet@tlas database.
Aebiom – A pellet road map for Europe (2008)
[14] CBS. Duurzame energie in Nederland 2008.

Country	Industrial wood pellet use (2008; in kton)[15]	Number of utilities
Belgium	800	2
Denmark	355	2
Netherlands	876	5
Poland	not known	5
Sweden	800	2
United Kingdom	166	5

- Coal is the main source of fuel for power generation in the EU. In 2007 it accounted for 1,024 TWh (217 Mtwpe or 126 Mtce). This is 31% of the total power production.
- Coal replacement by wood pellets is an effective way of generating renewable energy. To project for possible future wood pellets demand for co-firing in coal fired power plants a calculation has been made based on replacement of coal using existing infrastructure for the power generation industry. It is assumed 3 different scenarios may develop:

  a. **Low**; coal replacement growing from 2% in 2015 to 5% in 2030.
  b. **EU Reference**; based on the EU Renewable Energy Directive 20% renewable energy by 2020; assuming biomass will consist of 2/3 of the 20% renewables share (coal replacement 13.3% by 2020).
  c. **Strong**; coal replacement growing from 3% in 2015 to 20% in 2030.
- The outcomes from the three different scenarios for wood pellets demand based on replacement of coal show a potential increase in demand from 7.8 Mtwpe (2008) to 42 – 168 Mtwpe in 2030.



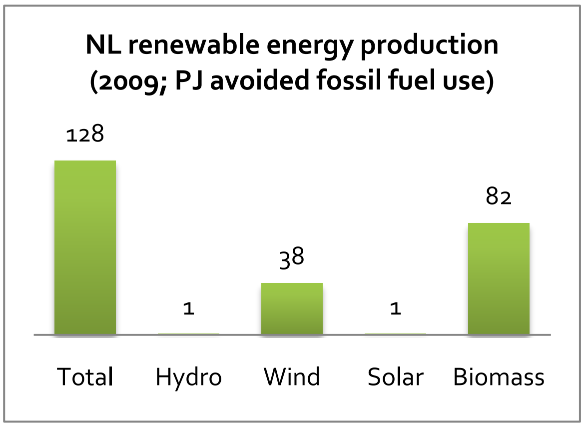
[15] Pellet@tlas database.

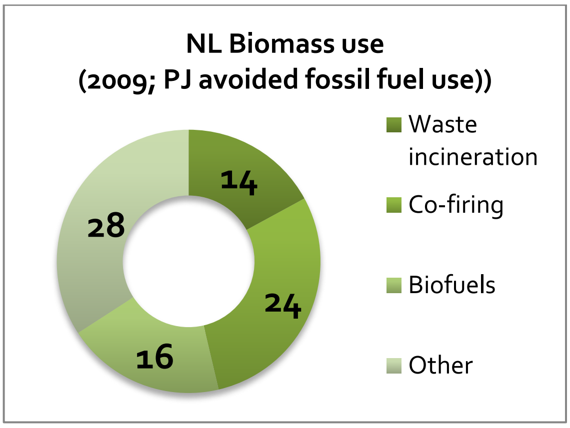
3.1.4 NL biomass supply[16]

- In The Netherlands, 48 Mtons of biomass dry matter is present, of which 10.5 Mtons is available for electricity and heat production. Some 40% of the available biomass is actually used, which corresponds to a net caloric value of some 50 PJ.
- The availability of biomass dry matter could grow to 16.4 Mtons in 2020 and replace a maximum of 150 PJ of energy produced by fossil fuels.

3.1.5 NL biomass demand[17]

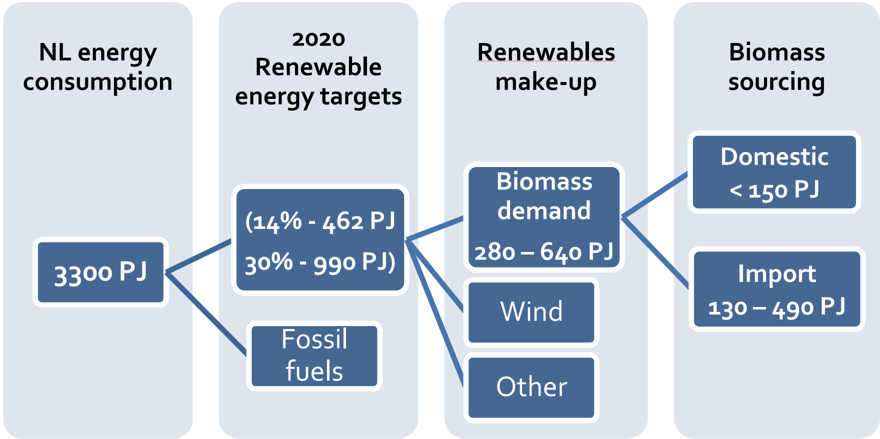
- The Netherlands produced 4% renewable energy in 2009. Biomass represented the most significant resource (65%). Biomass co-firing totalled 24 PJ of avoided fossil fuel use. This corresponds with the use of 1.4 Mtwpe.



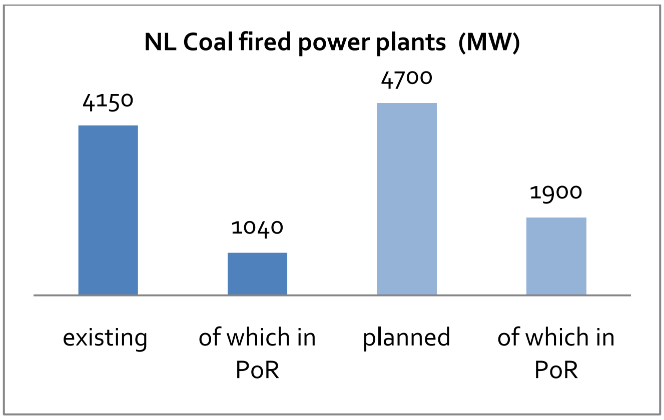


- Demand for biomass in The Netherlands will grow significantly to meet the 2020 renewable energy targets. The EU Renewable Energy Directive (14%) and national 'Schoon en Zuinig' (30%) targets translate into an annual renewable energy demand of 280 to 640 PJ. This estimate assumes that the relative contribution of biomass to renewable energy production would remain constant (60%). With the 150PJ being a theoretical maximum of domestic biomass supply, a minimum of 130 to 490 PJ of biomass should be obtained through imports. These numbers correspond with 7.5 to 28.4 Mtwpe.

[16] SenterNovem, 2009. Beschikbaarheid van nederlandse biomassa voor electriciteit en warmte in 2020.
[17] CBS Duurzame Energie in Nederland 2009.



- The present capacity of coal-fired power utilities in The Netherlands is 4,150 MW. Another 4,700 MW capacity is under construction. This would bring the total capacity to 9,000 MW. 3,000 MW will be installed in the Port of Rotterdam area. Wood pellet use amounted to an estimated 1.4 Mtons in 2009. Essent and Electrabel almost exclusively co-fire wood pellets. The Nuon facility in Buggenum uses mostly waste product and redundant biomass materials.



- For the existing power utilities, as well as for the utilities that come on line in the near future ambitious co-firing targets have been announced. From 20% coal replacement in the E.ON Maasvlakte and Essent Eemshaven to 60% for the Electrabel Maasvlakte utility. Based on these figures it is estimated that large scale biomass co-firing in these utilities could reach a total of 5.5 Mtwpe (or 94 PJ).

Overview of biomass potential co-firing percentages in Dutch coal-fired power utilities[18]

Company	Present sites	Total capacity (in MW)	Future biomass co-firing (in %)	Future sites	Total capacity (in MW)	Future biomass co-firing (in %)
RWE/Essent	AMER 8	630	50	EEMSHAVEN	1600	20
	AMER 9	600	50			
Electrabel	GELDERLAND	600	25	MAASVLAKTE	800	30-60[19]
Vattenfall/Nuon	BUGGENUM	235	30	EEMSHAVEN	1200	not known
Nuon	HEMWEG	630	not known			
EPZ	BORSSELE	400	15-20			
E.ON	MAASVLAKTE	1040	30	MAASVLAKTE	1070	20

3.1.6 Belgium biomass supply and demand

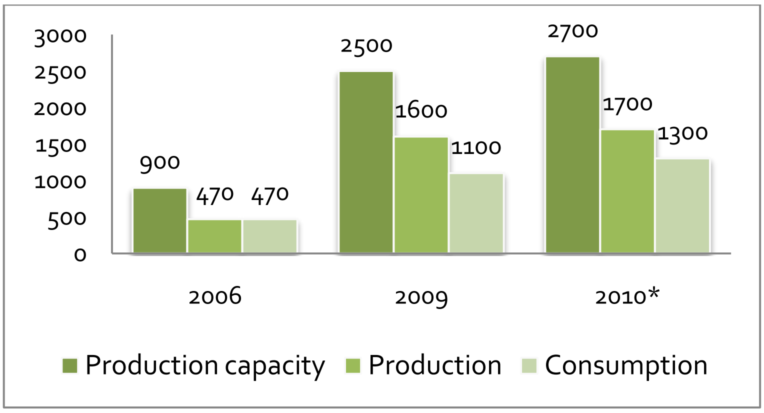
- Electrabel is the only large scale user of industrial wood pellets in Belgium. It used 1.1 Mtons biomass in 2009 for the production of bio-energy[20]. This included at least 350 kton wood pellets for co-firing in its Rodenhuize site and 350 kton wood pellets for fuelling its dedicated biomass power plant in Les Awirs. The industrial wood pellets are sourced from North America, Germany and Eastern Europe. The demand from Electrabel for wood pellets may rise to 3 million tons in 2014[21].
- The use of biomass for renewable electricity production is stimulated by the Green Certificate and Quota Systems. Suppliers of electricity are obliged to deliver a minimum percentage of renewable electricity per year (6% in 2010). They also have to present certificates for the sustainability of the biomass used[22]. The certificates are issued by the authorities and freely exchangeable. The government guarantees a minimum price. Upon the failure to deliver the required number of certificates, a fine will be imposed.
- Residential wood pellets use is a very young market and has grown since 2004 to an estimated at 120,000 tons in 2008[23]. Production of these pellets takes place in the Wallonia area with a total production of 300,000 tons in 2008. The installed capacity has reached 500,000 tons.

[18] http://www.ieabcc.nl/database/cofiring.php
[19] Electrabel meldt op de website dat het tot 30% biomassa kan bijstoken. De vergunning maakt melding van een bijstook tot 60% (http://www.electrabel.be/sustainable_development_corp/act_today_whatwedo_produce.aspx).
[20] http://electrabel.arofex.be/sd/pdf/PacBio_Belgium_NL.pdf
[21] Willemse, Industrieforum Pellets Stuttgart, 2008.
[22] Van Stappen. Green certificates mechanisms in Belgium: a useful instrument to mitigate GHG emissions, 2007.
[23] Pellets@tlas Belgium country report., October 2009.

3.1.7 German biomass supply and demand

- Germany is one of the largest pellet producers in the EU. With a total installed capacity of 2.7 Mtons, it produced 1.7 Mtons in 2009. Feedstock for pellet production is mainly saw dust and wood chips. But with increasing shortages of these raw materials, in particular saw dust, the industry is shifting more towards round wood use. Germany houses three large scale producers (> 100,000 tons) that hold 60% of the production capacity[24].
- The German market for wood pellets is exclusively for residential heating. Almost all pellets sold in Germany are therefore of the premium DINplus grade. In 2009 a total of 1.1 Mtons was used. The use of pellet stoves and boilers was introduced some 10 years ago. This market grew very strongly until 2007 when supply shortages discouraged people from installing further pellet appliances. The use of pellets for residential heating is promoted by a federal law that targets 14% of the residential heating to come from renewable sources in 2020. At present, this figure is 7%. Thus, a doubling of the residential pellet market is foreseen in the next decade.
- Germany may become a future player in the industrial wood pellets market too. It is building more than 20 coal fired power plants that may take a significant amount of biomass. However, the plans meet increasing concerns about the environmental impacts and legal challenges have delayed or halted several of the constructions. It makes the commissioning of these power plants uncertain.
- Germany is a net exporter of wood pellets of 400-500 kton per annum. This is almost completely directed towards Scandinavia, Belgium and The Netherlands and concerns lower quality industrial pellets.

German pellets market (in kton)[25]



3.1.8 UK biomass supply and demand

- In the UK an ambitious programme was launched to ensure a 15% renewable energy production by 2020[26]. Over 4,000 MW of biomass capacity is expected to be installed in 2014 with a total

[24] Pellets@tlas Germany country report., September 2009.
[25] www.depv.de
[26] DEFRA. UK Biomass Strategy, 2007.

biomass demand of 30 Mtons. 90% will be obtained by imports. Of the total biomass feedstock, 85-90% is expected to consist of wood pellets and wood chips. Projects include large scale co-firing, but also large 100 to 300 MW dedicated biomass power plants. Together, these would account for a capacity of 1,800 MW[27].

- Like in Belgium, the UK government promotes the consumption of renewable electricity by imposing an obligation on the suppliers to deliver a minimum percentage of renewable electricity per year (10.4% in 2010). The obligation is subsidized by providing so called Renewable Obligation Certificates (or ROCs) per MWh. This subsidy system is differentiated along the type of renewable electricity production: for biomass co-firing 0,5 ROCs per MWh are paid for, while dedicated biomass yields 1.5 ROCs per MWh[28].
- At present, the UK has a very modest biomass market. Wood pellets use is estimated at 176 kton in 2008, mostly in large scale applications. This is due to a recent change in the ROCs system in 2009 that halved the ROC subsidy for biomass co-firing, making it a non-profitable business.

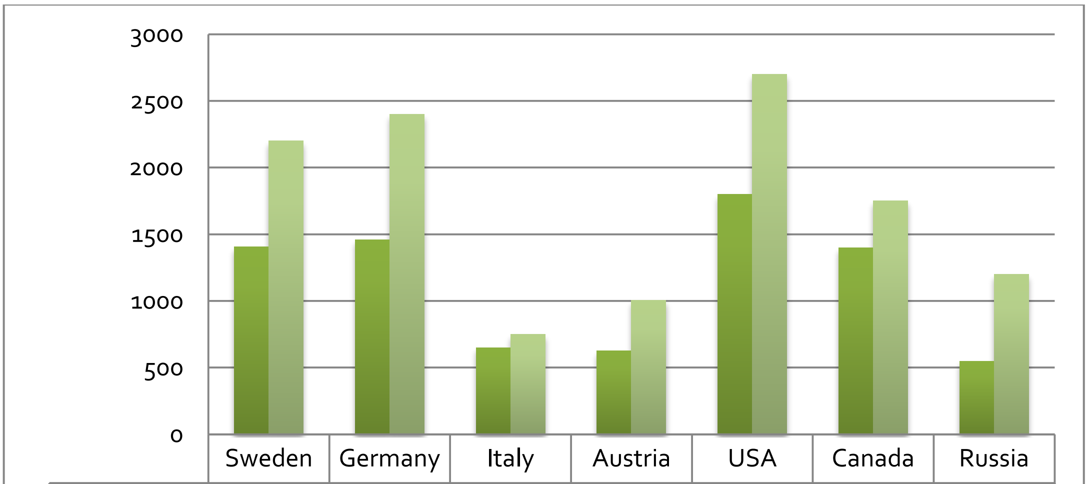
3.1.9 Wood pellets supply

- The main wood pellets producing countries are the US, Canada, Sweden and Germany. These countries together produced 7.8 Mtons in 2008. Total world production totaled an estimated 14-16 Mtons. The total EU production was 8.2 Mtons in 2008.
- The majority of wood pellet production facilities in both the EU and the USA have a smaller than 100,000 tons/year production capacity. This has its bearings on the logistics and complicates sourcing for large scale applications. A significant overcapacity does exist. In the EU e.g. the utilization rate is only 54%. In the USA this figure was 66% in 2008. A trend towards larger scale production facilities is emerging with recent announcements of 750,000 and 900,000 tons production facilities in Georgia, USA and Vyborg, Russia, respectively. Both facilities have a focus on production for export.

US wood pellet producers eye exports to the EU
According to American Biomass Magazine " conditions are ripe for a massive increase in the production of wood pellets in the U.S. due to demand from European countries". One example is Indeck Energy Services Inc. that has built a 90,000-ton-per-year wood pellet plant with a focus on exports to Europe.

[27] Brody Govan. Argus Biomass Trade Conference (Brussels, 2010)
[28] http://www.decc.gov.uk/

Wood pellets supply (2008; kton) [29]

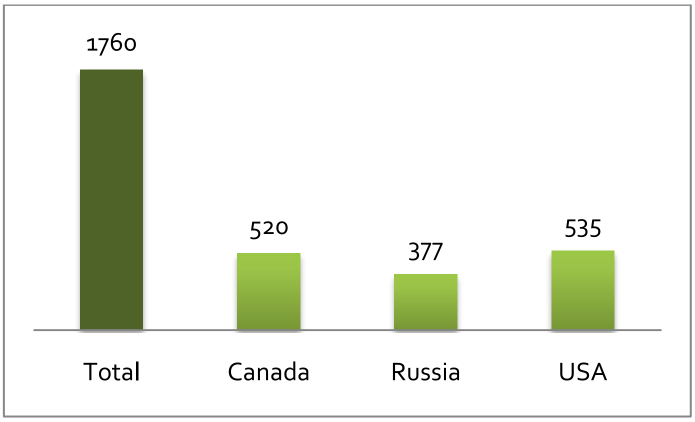


	Sweden	Germany	Italy	Austria	USA	Canada	Russia
Production	1405	1460	650	626	1800	1400	550
Capacity	2200	2400	750	1006	2700	1750	1200

3.1.10 International trade in wood pellets

- The World Customs Organization recently designated a separate HS-code for the trade of "sawdust and wood waste and scrap, agglomerated in pellets" (HS 4401.3020). Statistics on wood pellet trade from January 2009 can now be accessed through the Eurostat database, but are likely to give an underestimate as the market still has to improve on using this new HS-code.
- Wood pellets imports into the EU-27 region amounted to 1.76 Mtons in 2009. The main suppliers are the US, Canada and the Russian Federation. EU-27 intratrade (trade between the EU-27 Member States) is an estimated 2 – 2.5 Mtons.

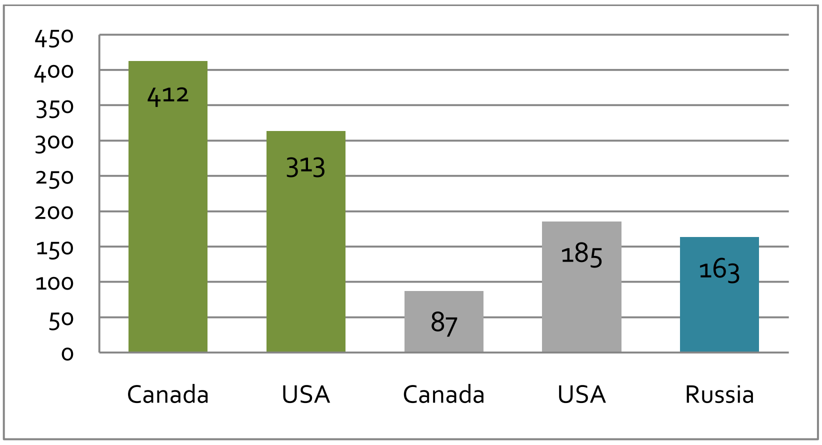
EU-27 wood pellets imports (2009; kton) [30]



[29] Pellet@tlas, 2009. Final report on producers, traders and consumers of wood pellets.
Bioenergy PelletsMap, 2009.
[30] Eurostat database.
Pellet@tlas, 2009. Final report on producers, traders and consumers of wood pellets.

- In 2009 The Netherlands (green bars) and Belgium (grey bars) were the main importers of wood pellets. Canada and USA were the main suppliers. Sweden (blue bar), and to a lesser extent Denmark and Finland, were the main importers of wood pellets from the Russian Federation.

Wood pellets imports by country (2009; kton) [31]



- The USA has an existing domestic market for wood pellets where they are used in residential applications and also in dedicated biomass power plants. 80% of the production was traded on the domestic market in 2008 and 20% was exported to Europe. The Canadian production found its way to the European continent almost in its entirety (90% of the total production). The North American wood pellets industry expects to see the majority of the growth in demand coming from European destinations.
- Russia only recently recognized the wood pellets market as a potentially interesting revenue source. The country has a massive biomass production potential that may be quickly accessed with continued EU demand. Other upcoming production countries are the Baltic States, Australia, South America and South Africa.
- The demand from OECD countries, especially European, for wood pellets will be a strong driver for growing international trade in wood pellets.

3.1.11 Other solid biomass products

Apart from wood pellets, many other types of solid biomass are being explored for its use as renewable energy resource. These include amongst others rice and sunflower husks, coffee bean and palm kernel shells, different types of agricultural residues, poplar trees and elephant grass. Many of these are still at an experimental phase improving processing technologies or solving logistic or agricultural challenges. For the purpose of this market analysis, the focus in this section is on wood

Opportunities in the paper industry?
The world newsprint and magazine paper market is ~ 60 Mtons. Wood cellulose and scrap paper are important resources for paper production. The possibilities for the exchange trading of these products is investigated with the Dutch paper industry.

[31] Eurostat database.
Pellet@tlas, 2009. Final report on producers, traders and consumers of wood pellets.

chips and bio-coal. Wood chips is an existing product, used in local heating and power utilities and has an interest from dedicated biomass power plants especially in the UK. Bio-coal may quickly develop into a new commodity. Both products therefore have a relevance for a decision on the start of a biomass commodities exchange.

3.1.11.1 Wood chips

- Wood chips are the product of a wood chipper that fragments woody materials. It is mainly used as raw material for paper and pulp production, MDF and particle board production. It is also used as renewable energy fuel. However, it has a lower energy content compared to wood pellets (10 versus 17 GJ/ton respectively), has a much higher moisture percentage (40-50 versus 10-15), contains more dirt and bark and is expensive in transport due to its low density (290 versus 650 kg/m^3). Thus, wood chips tend to be used as fuel only when harvested at short distances from the power generator. However, wood chips are considered a major feedstock for the dedicated biomass power plant projects in the UK and would include transoceanic shipping.
- Conflicting views exist over the economic feasibility. Transport costs per GJ for wood chips may be as much as 4-fold higher. However, CO_2 emissions per GJ delivered may be some 40% lower due to the absence of the energy consuming pelletizing process. This would also significantly reduce processing costs per GJ[32]. At the same time, wood chips are a less standardized product compared to wood pellets and are more difficult to use.
- In the UK over 4,000 MW of biomass power plant capacity has been planned. A total of 30 Mtons of wood would be required per annum and wood chips would be a main feedstock for these utilities[33]. The UK market would therefore be a main target when developing an exchange traded product for wood chips.

3.1.11.2 Torrefaction (bio-coal)

- Torrefaction is a thermolytic treatment of biomass at 200 to 320 °C under limited oxygen conditions. During the process the water contained in the biomass as well as other volatiles are removed and the biomass on average loses 20% of its mass (bone dry basis condition).The final product is the remaining solid, dry, blackened material which is referred to as "torrefied biomass" or "bio-coal".
- Torrefied biomass can be compressed, usually into briquettes or pellets, using conventional densification equipment to further increase the density of the material and to improve its hydrophobic properties. The main advantages of torrefied biomass are:
  1) Energy density increases to 20-25 GJ/ton.
  2) The resulting torrefied biomass demonstrates a more homogeneous composition regardless of the origin of the primary biomass used.
  3) The material becomes hydrophobic, water resistant, making it possible to store the material in open air whereas other types of solid biomass require special storage conditions.
  4) The end product closer resembles the characteristics of coal making it easier to fit bio-coal in the existing coal infrastructure, especially when looking at grindability.

[32] Argus Biomass Trade Conference (Brussels, 2010)
[33] Brody Govan. Argus Biomass Trade Conference (Brussels, 2010)

- The volumes of bio-coal will correlate with wood pellets supply and demand figures whereas the decision to convert primary biomass in bio-coal will be a strategic and financial decision based on the origin of the biomass and the final destinations, applications and requirements of end consumers.
- In The Netherlands Topell is starting production of 60,000 tons of bio-coal produced from locally available forestry residues. The construction of the plant required 17 million Euros.[34]
- It is expected that bio-coal volumes will grow at the expense of woody biomass pellet volumes when technical innovations find their way to the market, resulting in improved energy and cost-ratio efficiencies. Bio-coal may enter the market within one to three years. These bio-coal volumes will significantly improve solid biomass commodity trading strategies, lead to increased solid biomass volumes and contribute to a mature solid biomass commodity market.

3.2 Liquid biomass and biofuels

Liquid biomass and biofuels are often considered to denote a similar classification: pure plant oil, biodiesel or bio-ethanol used as alternative for petrol based transport fuels. In this document we use a more strict definition of the different terms to be able to better classify the applications and origins of the natural resources.

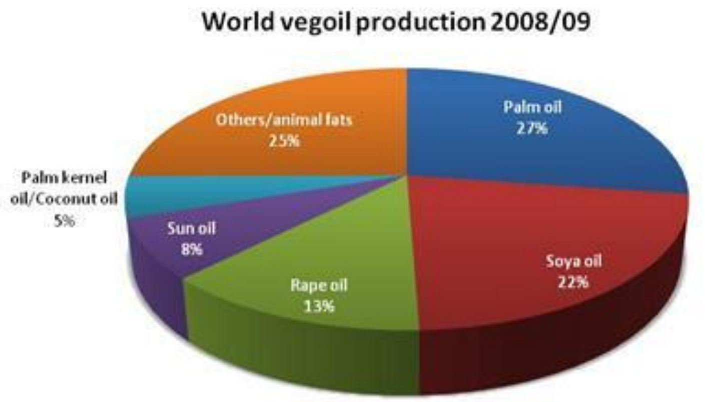
Liquid biomass is the liquid faction, semi finished product or end product that is left or derived from primary biomass after processing or liquid organic residue streams. Liquid factions can be obtained by means of extraction, pressure, fermentation etc. Liquid biomass are amongst others vegetable oils, used cooking oils, bio-ethanol etc.

Biofuels are the end product, or secondary energy carriers, fabricated from liquid and solid biomass. For the purpose of this study the term biofuels is solely used to denote liquid fuels made from biomass that can be used in specifically designed or adapted engines or blended with conventional transport fuels for use in traditional engines.

3.2.1 Liquid biomass

- Liquid biomass for energy is primarily used to produce biofuels replacing traditional transport fuels. This demand is driven by compulsory biofuel blending mandates with fossil transport fuels as stipulated by the European Union and other countries. The majority of the liquid biomass comes from vegetable oils produced from oilseeds. World consumption of vegetable oils increased from 81 Mtons in 1990/91 season to 163 Mtons in the 2008/09 season.
- Production of oilseeds grew from 218 Mtons in 1990/91 and has almost doubled in less than 20 years time totalling 392Mtons in the 2008/09 season. Palm and soybean oil are the major vegetable oils, together they contribute to almost 50% of the global vegetable oil production.

[34] http://www.topell.nl; http://www.deweekkrant.nl/artikel/2010/april/20/biomassafabriek_verrijst_in_duiven



World vegoil production (× Mtons)	
Palm oil	44.4
Soya oil	35.9
Rape oil	21.1
Sun oil	12.0
Palm kernel oil/Coconut oil	8.3
Others/animal fats	40.8

- The increase in vegetable oils consumption is essentially driven by upward demand from the food market. Increasing biofuel consumption does have an additional effect on vegetable oil demand. However more than 80% of all vegetable oils are used in the food sector whereas less than 10% is used for the fabrication of biofuels[35].

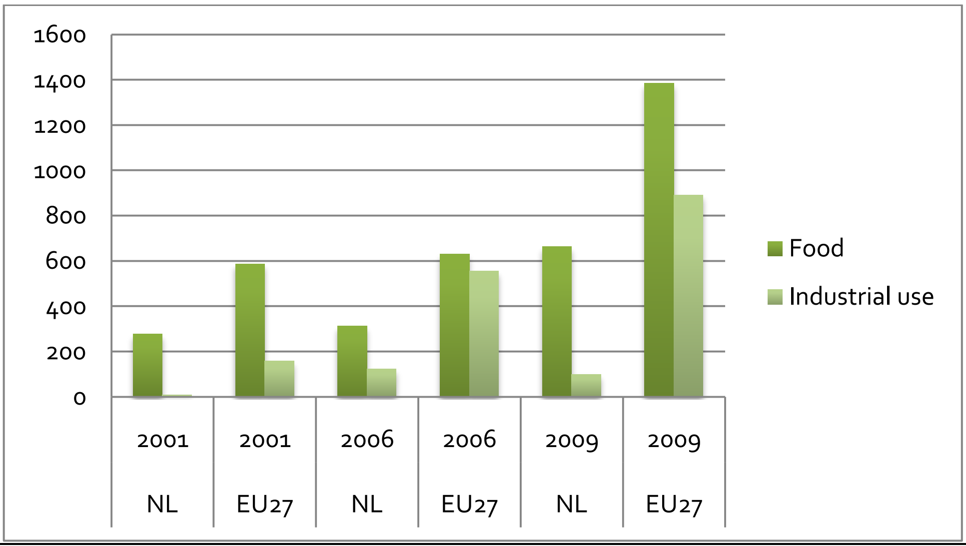
3.2.1.1 Palm oil

- Crude palm oil production (CPO) grew excessively since commercial scale plantations were first introduced. Global production in 1990/91 was 11.3 Mtons now totaling 44.4 Mtons, growing nearly a fourfold in less than 20 years time. As oil palms are perennial crops, palm oil production capacity cannot be increased in a relatively short period. Therefore it is not expected that amplified future vegetable oil demand will be satisfied with additional palm oil production.
- Malaysia and Indonesia account for the majority of the palm oil production. Indonesia produced 19.2 Mtons in 2008 and Malaysia 17.7 Mtons. Together they produce more than 80% of the world production. Other regions that have palm oil production are West Coast Africa and Central America.
- Malaysia and Indonesia both export around 15 Mtons. India, China and the EU-27 are the largest offtakers. EU-27 imports from Indonesia increased dramatically from 688 ktons in 2006 to 2.3 Mtons in 2009. The increase was both for food and industrial purposes[36]. Malaysian imports stabilized in the 1.2 (2006) to 0.9 Mtons (2009) range. The Netherlands accounted for 82% of EU-27 imports from Malaysia (2009), while it was responsible for 48% of the Indonesian imports for food and 11% for industrial use.
- Palm oil is the main feedstock for biodiesel production in South East Asia, while it is used only in minor shares in EU-27 biodiesel.

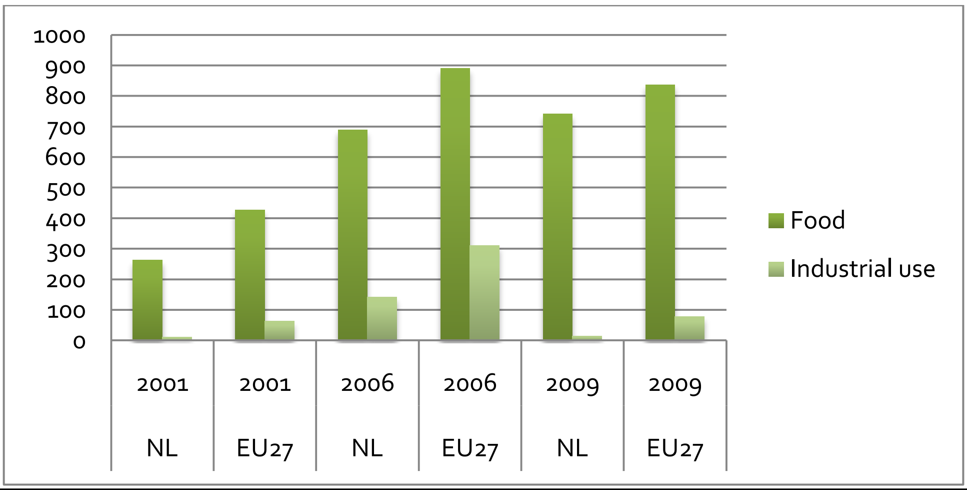
[35] Oilworld Annual 2007/08.
[36] Eurostat database.

Crude palm oil 2008 season (in kton)[37]			
Top palm oil importers		Top palm oil exporters	
India	5,753	Malaysia	15,413
China	5,593	Indonesia	14,612
EU-27	5,338		
Netherlands	*2,051*		

CPO imports from Indonesia (in ktons)[38]



CPO imports from Malaysia (in ktons)[39]



[37] Oilworld Annual 2007/08.
[38] Eurostat database.
[39] Id.

3.2.1.2 Soybean oil

- Largest producers of soybean oil are the USA, Argentina, Brazil and China. The USA alone produced almost 25% of the global soybean oil supply in 2008 totaling 9 Mtons.
- Soybean oil exports from Brazil and Argentina have been declining since 2008 as both countries are increasing production of biodiesel. Especially the sturdy biofuel ambitions of Brazil will result in significantly lower Brazilian soybean oil exports. As a matter of fact Brazil recently imported soybean oil from Argentina.
- The Netherlands is the largest importer in Europe of soybeans and together with Germany the largest crushers of soybeans.
- Soybean oil is the main feedstock for biodiesel production in Latin America and the USA. US biodiesel production is based for 50% on soybean oil.

Soybean oil 2008 season (in kton)[40]			
Top soybean oil importers		Top soybean oil exporters	
China	2,586	Argentina	5,089
EU-27	1,118	Brazil	2,316
India	835	USA	1,156

3.2.1.3 Rapeseed oil

- Rapeseed production is rapidly growing thanks to the increasing demand for vegoils that cannot be met by palm and soybean oil alone. In the 2008/2009 season global rapeseed production grew from 49 to 58 Mtons (+20%). The EU-27 has been the largest producer since the 2004/5 season, reaching 21 Mtons last year[41]. China, Canada and India are the other main producers.
- The EU is the largest producer of rapeseed oil in 2008 totaling 8 Mtons immediately followed by China and India. Rapeseed production is flexible enough to sustain additional demand. The EU is strategically looking at rapeseeds and rapeseed oil for the production of biodiesel.
- Rapeseed and rapeseed oil production is expected to increase considerably mainly driven by future biofuel demand. The Russian Federation and Ukraine are projected to considerably expand its planted rapeseed area.

Rapeseed oil 2008 season (in kton)[42]			
Top rapeseed oil importers		Top rapeseed oil exporters	
USA	1,060	Canada	1,302
EU-27	420		
China	270		

[40] Oilworld Annual 2007/08.
[41] MVO Market Analysis Oils and Fats for Fuel, 2009.
[42] Oilworld Annual 2007/08.

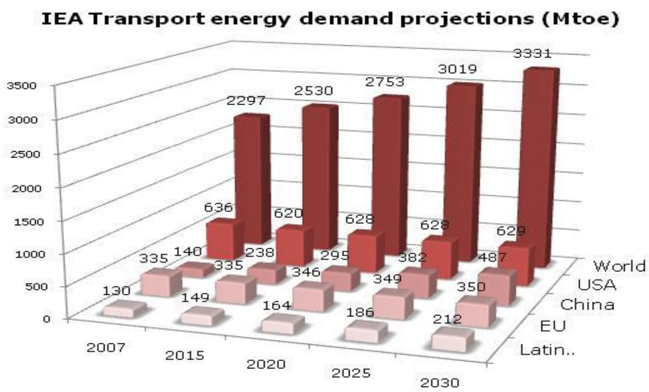
3.2.1.4 Energy crops

- It is expected that new crops specifically cultivated as feedstock for renewable energy production will find its way to the market. Large scale introduction to the market will depend on present efforts to improve crop development, agronomic practices, supply chain development and oil extraction and biofuel production and may take another 5 to 10 years.
- Jatropha oil is currently under development. First pilots and early demonstration projects failed to deliver the anticipated high yields. As new projects and further studies evolve, there are still chances that Jatropha oil may live up to its expectations.
- Camelina is a flax like plant that can sustain cold weather and therefore can be grown in more temperate climates. The crop can be easily rotated with grains to improve soils and yields. The Camelina oil that can be derived from the seeds has very good characteristics for biodiesel and bio-kerosine production. The aviation industry is actively researching the use and cultivation of Camelina oil in order to potentially replace fossil kerosene.

3.2.2 Biofuels

3.2.2.1 The international biofuels market[43]

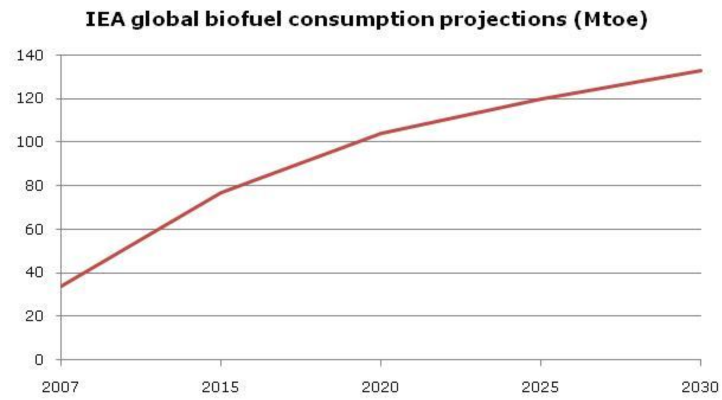
- Global consumption of transport fuels is projected to increase considerably coming decades. While consumption in the EU and US remains unchanged at 335-350 and 630 Mtoe, respectively, the growth in fuel consumption will be particularly strong in non-OECD countries like China.



- Global supply of biofuels grew excessively last decade with a 37% increase in 2007 totalling 34.1 Mtoe. Most of the increase was realised in the USA and Europe whilst Brazil and the USA will remain the dominant suppliers of biofuels. IEA prognoses predict a modest 5% global biofuel share of the transport fuel consumption by 2030 totalling 133 Mtoe.

[43] IEA World Energy Outlook 2009.
BP Statistical review of world energy. Full Report 2009.
FAO Biofuels:prospects, risks and opportunities 2008.
IEF Biofuels potential and limitations 2010.

- Blending mandates are implemented globally and will boost biofuel demand coming decades. Hart/GBC calculated when all blending mandates and targets are met, global biofuel consumption would reach 96.4 Mtoe in 2010 and 156.5 Mtoe by 2015. Aviation industry is predicted to play a growingly significant role in the biofuels consumption pattern.
- The EU 10% mandatory blending mandate translates into the use of 36 Mtoe biofuels in 2020 (compared to 10.3 Mtons used in 2009)[44]. The US Renewable Fuel Standard 2 (RFS2) introduced a renewable fuel requirement of at least 36 billion gallons in 2022 (compared to 10.9 billion gallons ethanol and 0.42 billion gallons, or 1.6 Mtons, biodiesel in 2009)[45]. Second generation biofuels are expected to contribute up to 25% of the total supply by 2030.

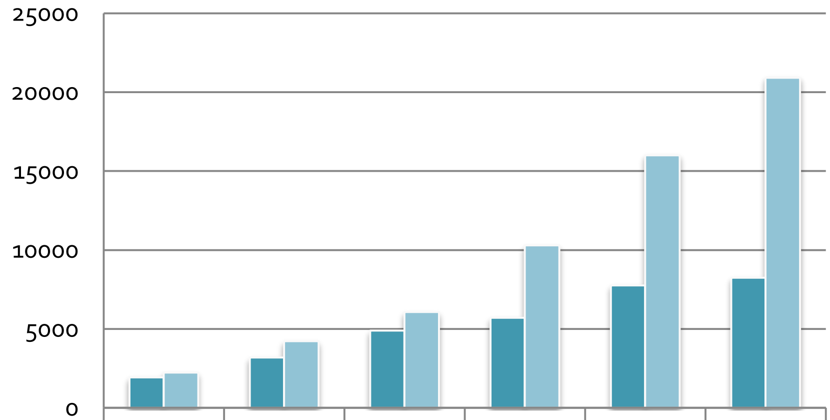


3.2.2.2 EU biodiesel supply

- EU-27 biodiesel production raised from 2.25 Mtons in 2005 to more than 8 Mtons in 2009. The largest producers have been France and Germany.
- There is a structural overcapacity that increased to more than 10 Mtons last year. The EU industry has not been competitive with production in third countries, due to a combination of feedstock prices and government support regimes.

[44] MVO Market Analysis Oils and Fats for Fuel, 2009.
[45] FO Licht.
Clayton McMartin. The Advanced Renewable Fuel Standard / RFS2, 2010.

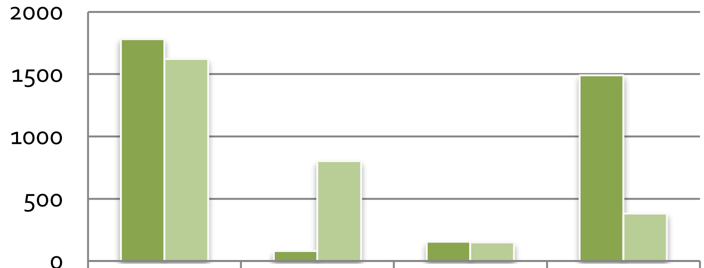
EU-27 biodiesel production (in ktoe) [46]



	2004	2005	2006	2007	2008	2009
production	1933	3184	4890	5713	7755	8250
capacity	2246	4228	6069	10289	16000	20909

- EU-27 biodiesel imports shifted sharply from the USA to Argentina in 2009. This is caused by the introduction of countervailing duties on US biodiesel imports in response to the US 1$/gallon tax credit. The Netherlands imported 80% of the total EU-27 imports.

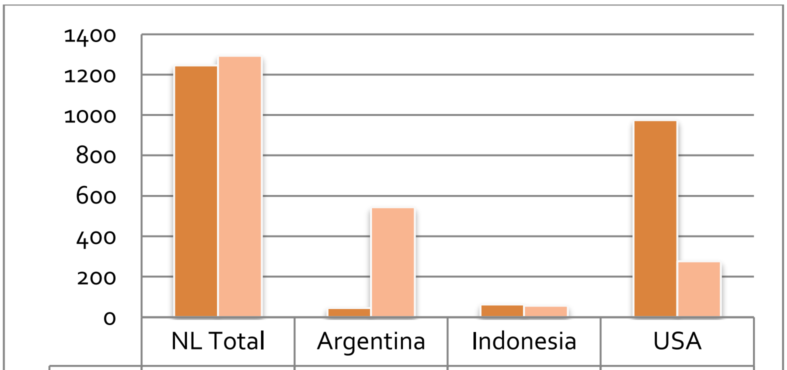
EU biodiesel imports (kton) [47]



	EU Total	Argentina	Indonesia	USA
2008	1780	80	155	1490
2009	1620	802	150	381

[46] European Biodiesel Board.
[47] FO Licht

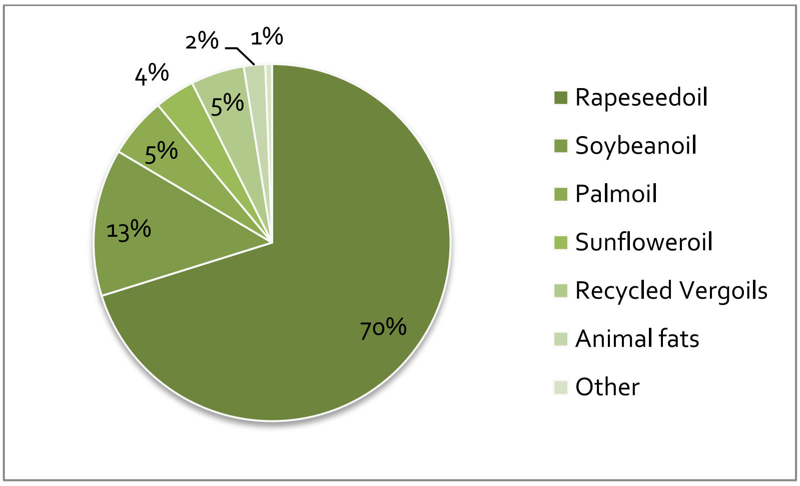
NL biodiesel imports (ktons) [48]



	NL Total	Argentina	Indonesia	USA
2008	1246	46	62	975
2009	1293	544	57	276

- Information on the feedstocks used for biofuels production is not yet recorded publicly. USDA estimated that rapeseed oil accounts for 70% of the total biodiesel production in the EU-27. This equalled to 3.4 Mtons in 2006 and 5.8 Mtons in 2009. Soybean oil (13%) an palm oil (5%) were the other main resources in 2009.

EU biodiesel feedstock (2009; in % of total)[49]



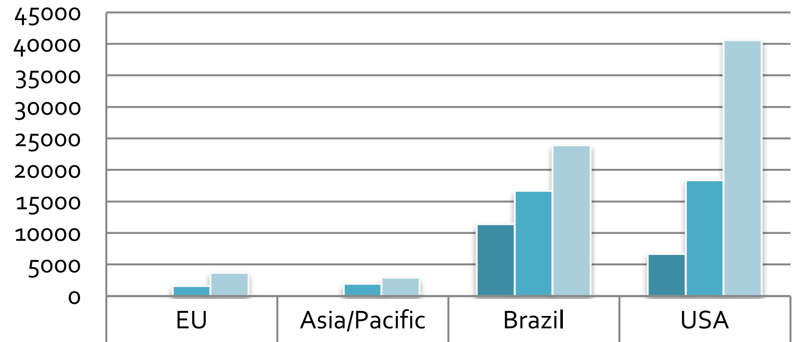
3.2.2.3 EU bioethanol supply

- World ethanol fuel production reached 73 billion liters in 2009 and is likely to grow another 14% this year to 83 billion liters. Brazil and USA accounted 88% of the total world production.
- The EU produced a moderate 3.7 billion liters in 2009, but production has more than doubled in 4 years time. Installed production capacity in the EU is 6.8 billion liters, while another 1.75 billion liter capacity is under construction[50].

[48] FO Licht
[49] USDA EU27 Biofuels Annual, 2009.

- Feedstock use for Brazil is sugar cane, while the USA relies on corn and the EU on grains and sugarbeet.

Fuel Ethanol Production (mln liters)[51]



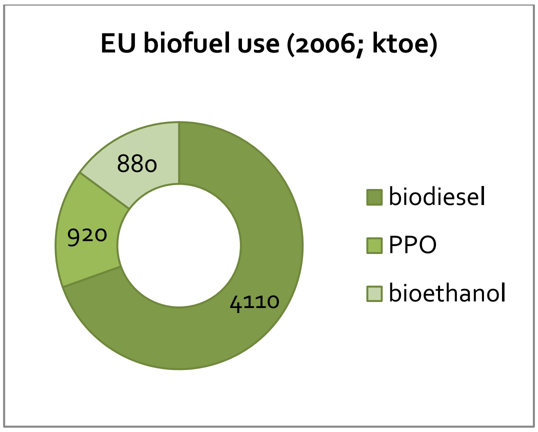
	EU	Asia/Pacific	Brazil	USA
2001			11434	6697
2006	1627	1986	16700	18381
2009	3694	2918	23920	40600

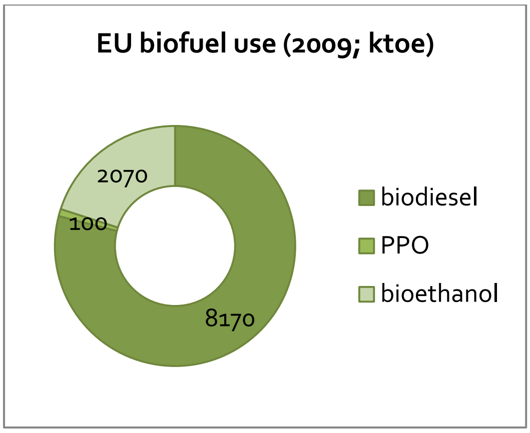
- Alcohol has multiple uses, including food, fuel and industrial and medical applications. In addition, alcohol for fuel use may be traded in pure form, as gasoline blend or as ETBE (a gasoline additive). This complicates the identification of reliable trade figures.
- Total world ethanol exports reached 9.1 billion liters in 2009, a 20% reduction compared to 2008 (11.4). Brazil is by far the largest exporter with 3.3 billion liters in 2009. The USA is a net importer. EU exports (3.1 billion liters) are almost completely between EU Member States.

3.2.2.4 EU biofuels demand

- EU biofuels use rose from 5.9 Mtoe in 2006 to 10.3 in 2009[52]. With gasoline use stable at 105 Mtoe and diesel rising slightly from 184 to 195 Mtoe, the biofuel blends reached 2% in 2006 and 3.3% in 2009.
- The bioethanol share rose from 15 to 20% and biodiesel went up from 72 to 80%, both at the cost of PPO use. The EU 10% mandatory blending target will raise demand to 36 Mtoe in 2020.

[50] European Bioethanol Fuel Association
[51] FO Licht
[52] USDA EU27 Biofuels Annual, 2009.





3.2.2.5 Advanced biofuels

- Advanced biofuels have a very loose definition, but are generally considered biofuels that have a better greenhouse gas (GHG) performance compared to the currently used vegoils and fermentation derived biofuels. Feedstocks for these biofuels include residue streams and woody forestry biomass, shifting away from the so-called first generation feedstocks, like vegoils and corn and sugar cane sugars.
- The most promising advanced biofuel appears to be ethanol produced from cellulosic material through chemical or enzymatic breakdown. The US Renewable Fuel Standard 2 (RFS2) distinguishes cellulosic ethanol and biomass-based diesel. Also, a non-defined subcategory is defined to score at least a 50% GHG reduction. RFS2 imposes a mandate for cellulosic ethanol use of at least 16 billion gallons in 2022.
- Several announcements for the building of demonstration plants or collaborations were published recently. Still, it will take another decade before advanced biofuels technologies are economically viable and ready for up scaling.

Overview of cellulosic ethanol production initiatives

Companies	Location	Production	Remarks
Zeachem	Oregon, USA	250,000 gallons	Production unit. Construction started in 2010-1.
Total + Coskata	Madison PA, USA	not known	Total took an interest in the building of demonstration plant
Novozyme + Cofco + Sinopec	not known	11 million liters	MoU signed June 2010
Shell + Iogen	Ottawa, Canada	170,000 gallons	Demonstration plant, operational.
Chempolis	Finland	25,000 tons woody feedstock p.a.	Construction started in 2010-1
Enerkem	Edmonton, Canada	36 million liters	Construction starts 2010-2
Novozyme + Royal Nedalco	not known	not known	Collaboration announced May 2010

4 Views and Positions of Relevant Market Parties

4.1 Description of relevant market parties

This paragraph provides an overview of the most relevant market parties for the different parts in the biomass supply chain and their respective interests in a biomass commodities exchange.

- **Producers**
  Positioned at the origin of the supply chain. They are often local companies in the country of origin with specific knowledge of the domestic market. This category includes biomass and feedstock suppliers as well as plants that convert biomass to secondary energy carriers like wood pellets or vegoils. Producers are mainly interested to export their product to the international trading market at the highest price. They will look for hedging strategies on a biomass exchange to mitigate price risks on future demand and to enable them to attract finance from investors.

- **Traders**
  Fill in the position between the producers and the end-consumers. Traders utilize the mismatch in supply and demand and with their expert knowledge of the market take positions to match supply and demand. They also benefit from the parity mismatch (FOB vs CIF contracts) rendering the majority of the traders also the main contractor for biomass movements. In existing commodity markets most traders take long and short positions anticipating price movements. In this very young biomass market traders prefer to trade back-to-back. Traders will use a biomass exchange to fix price risks in case of defaults and to seek for liquidity but will shift to long and short trading strategies when the biomass commodity market matures and gains liquidity.

- **End-consumers**
  Positioned at the end of the supply chain and are responsible for the conversion of the commodity to the final end-product that subsequently finds its way to the retail market. End-consumers are interested to procure the biomass at the lowest price at the best conditions. Main interest for them to utilize a biomass exchange is to mitigate price risks on their procurement using hedging strategies and to implement pricing mechanisms into long term biomass off take contracts.

- **Large vertically integrated enterprises**
  A few companies play a significant role in the entire biomass supply chain. By their sheer magnitude they were able to vertically integrate from production all the way downstream to delivery to the retail market. These enterprises still need the international biomass market to compensate mismatches within their inner supply chain as well as a liquid biomass exchange in order to optimize revenues within their internal trading strategies.

- **Speculators**
  Have no direct interest in the physical biomass but are merely interested in the price differences.

Have positive effect on liquidity as they will counter act on strategies of the other market participants leading to more liquidity.

4.2 Main findings and observations from interviews

An extensive inventory of market parties' views and positions was developed by frequent contacts with market parties. Formal interviews were performed with 17 companies and institutions and further informal discussions were held with industry representatives at international conferences and RBCN meetings. The main findings and observation have been summarized below. A list of parties that have been interviewed is included in Annex 2.

1. *Market parties are supportive of a biomass commodities exchange*

Most market parties agree with the objectives and recognize the interest for their business. These include biomass suppliers, biofuels producers, power utilities, traders and financial institutions. They attach greatest value to a financial trading market for financial risk management purposes. To reach this, a physical trade market needs to establish first.

Exchange objectives
Market parties identify three objectives:
1. Improved market transparency
2. Security of supply
3. Financial risk management

A biomass commodities exchange is considered the appropriate instrument for a future biomass market. The startup phase is considered most challenging and may have a certain lag time with the current market situation.

2. *Market makers are critical for its success*

Parties strongly voice the need to work with 'market makers' to help kick-start the exchange trading. This will mitigate possible side effects from a slow market in the startup phase. Market makers should preferably be lead parties in the market and should be committed to trade a guaranteed volume over the exchange. To obtain commitment from market makers it is essential to negotiate this with the decision makers from the respective parties that are responsible for finance and general management.

3. *Build a team of complementary expertise to develop the exchange*

In order to succeed, parties recommended to partner with third parties that introduce complementary financial and exchange trading expertise. The formal collaboration with APX-ENDEX is a first result in line with this recommendation. Banks, power utilities, storage facilities and certification institutions have also expressed their explicit interest to participate in the development and execution of a biomass exchange.

4. Make it a European biomass exchange

To maximize liquidity of a biomass exchange, it should be attractive to all players in the international biomass market. This will attract more market parties and more physical and traded volumes. The suggestion has therefore been made to give an international or European identity to the biomass exchange. An additional argument is that the renewable energy market is governed by European legislation and is to converge more and more into a single market. Adequate action is thus required to present the exchange as a recognized initiative for all market parties in Europe. One suggestion was to launch a Biomass Trade Association. Such Association could develop organizational aspects of an exchange (e.g. drawing up contracts and codes of practice, sharing of information). It would also function as a vehicle to connect market parties with the exchange.

Biomass Trade Association
In analogy with other trade associations like Fosfa and Gafta, the foundation of a Biomass Trade Association would be very helpful in supporting the biomass exchange.

5. Low liquidity is a negative factor

At present, liquidity is very low in the market due to little active trading. Liquidity is put under pressure by the limited number of end-users, the biomass cost price and uncertainty about political decision-making regarding renewable energy policies. This holds for both the solid and liquid biomass markets. Additional factors are the lack of uniform product standards and differences in sustainability requirements. In the longer term (from 2013-2014), it is expected that the renewable energy market will fully develop as further decision-making (regarding producer/supplier obligations, CO_2-tax, subsidy regimes, sustainability requirements) will provide the necessary conditions.

End users
Industrial wood pellets end users are the owners of coal fired power utilities. With the recent consolidations in the EU market, a selective group of multinational companies remain. These include RWE, E.ON, Dong, EDF, Vattenfall and Scottish Power.

6. Secure sufficient storage capacity

Storage capacity is a possible future bottleneck in the biomass supply chain. The storage capacity that is required today in Rotterdam is an estimated 8,000 tons. With the supply and demand projections this number may rise to 20,000 tons. The transatlantic supply also needs to incorporate additional stock storage to absorb possible delays in ship arrivals. Sufficient storage capacity is required for the functioning of a biomass exchange. Preferably, it will have dedicated storage facilities.

7. A single industry standard for biomass products is required

Parties recognize the need to develop a standardized product specification to facilitate trade. Electricity producers indicated they are starting an initiative to develop such a standard for industrial wood pellets. This would provide a valuable blueprint for a biomass exchange wood pellet contract. A single standard may centre around energy content per unit biomass as the critical parameter for E-producers.

8. Sustainability requirements need to be clarified and harmonized

The diversity in sustainability requirements and uncertainty about the implementation of planned policies prevent the interchangeability of biomass flows. Electricity producers are elaborating on a common set of requirements in response to the decision of the European Commission to not develop a communal framework.

The need for harmonization of sustainability requirements
Long term supply contracts are too risky with no clarity on long term requirements.

Buying on a spot market leaves too many questions about the sustainability performance.

9. Quotation possibilities extend beyond wood pellets

Market parties agree that industrial wood pellets do qualify due to its present market share and projections for future use. Wood chips are already used in Sweden at large scale (mostly domestic production) and is expected to take off in large volumes in other EU countries (UK e.g.). Similarly, bio-coal use may grow quickly once ready for large scale use. Other solid biomass products are not expected to develop into a commodity any time soon.

A quotation for fuel alcohol is considered a possible opportunity. The present alcohol quotations (e.g. CBOT ethanol futures) serve the EU market insufficiently. DDGS, produced in large quantities as a by-product in the production of alcohol from grain and used in feed, would also qualify.

Alcohol also serves as the raw material for the production of bio-ethylene. Ethylene is one of the bulk commodities in the chemical industry, used for the production of e.g. plastics. The potential for bio-ethylene and other biobased chemicals like PLA (polylactic acid) merit further investigation into the possibilities of these products for a biomass exchange.

Market parties feel that products quoted at the biomass exchange should not have a food application or strong interference with that market. It has also been suggested to look for the quotation of linked products, e.g. CO_2 emission rights.

10. Market developments

Vertical integration (e.g. electricity producers RWE and EDF taking a stake in biomass production) is a trend that is likely to continue. Equally, for liquid biomass horizontal integration (oil companies taking a stake in biofuel production) carries through. Oil

Pooling for success
International trading company Nidera is extending its activities into the pooling of biomass resources and biomass production project development. Vertical integration is considered a key to secure a market lead position.

company Shell and world's largest sugar cane processor Cosan signed a joint venture on the production and distribution of bioethanol. These kinds of collaborations provide end-users with security of supply. A biomass exchange would provide a good instrument for financial risk management and physical settling of production surplus and shortages.

Biocoal (torrefied biomass) is still in a development phase. If it meets the expectations (a homogenous, high GJ/ton product that can be mixed with coal at the power utility entry) it may develop in a true commodity in one to three years from now.

Supply. The US and Canada are likely to remain the main suppliers of woody biomass. Production forests are planted at rapid pace that come with strong logistic advantages. A possible change in availability of biomass from these countries can be caused by the future introduction of domestic renewable energy policies. Other upcoming producing regions are the Baltic states, Australia, South Africa and South America. The US and Brazil will remain the largest alcohol producers, with China recently becoming the third largest producer. In the long term solid biomass may become competitive with biofuels due to the large scale introduction of electric vehicles (10 years).

Biojet fuels are yet in an experimental phase. No commercial introduction is expected in the next 5 years. This could change quickly once investors are ready to finance biojet fuel production facilities. Another determining factor is the economics with respect to conventional kerosene cost price.

5 Other relevant developments

5.1 Government policies

The development of a renewable energy sector is largely driven by a political agenda to reduce dependency on the import and use of fossil fuels, to lower greenhouse gas emissions and to create new jobs. At the same time, fossil fuels outcompete renewable sources in price, requiring intensive financial support for the renewable energy sector. In addition, governments attach great value to the sustainable sourcing of biomass feedstock. These two factors have so far prevented governments from taking a clear position on its long term renewable energy policy, which is of crucial importance for future investments and business development.

5.1.1 Renewable energy targets

The EU the Renewable Energy Directive (or RED) lays down clear targets for the use of renewable energy[53]. In 2020 at least 20% of the final energy consumption should be from renewable sources. The 20% target includes a mandatory blending of at least 10% biofuels in transport fuels. For each EU Member State national targets have been defined. For The Netherlands e.g. this figure is 14%. The responsibility for implementation and control is left to the EU Member States. Each country has to draft a national action plan that will include targets for its share in renewable energy production in electricity, heating and cooling and transport and measures for achieving these targets. The RED framework thus provides clarity to the industry as regards the EU policy objective. Uncertainty however, remains about the implementation. Important aspects regarding implementation will be laid down in national action plans. These are likely to differ between individual EU Member States which will complicate the realization of a single market in the EU.

National renewable energy action plans - NREAPs
Under the EU RED Member States are obliged to develop NREAPs describing the actions and measures to reach its respective national renewable energy targets. The the necessary provisions need to be transposed into national law by 5 December 2010.

5.1.2 Financial support

Financial support to the renewable energy sector is largely regulated at national level. Every country is eligible to apply its favourite means, whether this is subsidies, feed-in tariffs, tax exemptions or otherwise. While these measures were already under constant scrutiny, due to the present budgetary constraints governments have an additional argument to reconsider their present policies.

Apart from national support systems, the trading in allowances for greenhouse gas emissions provides an alternative means for financing the production of renewable energy. Large scale power

[53] Directive 2009/28/EC of the European parliament and of the Council on the promotion of the use of energy from renewable sources.

plants e.g. fall under the EU Emission Trading System (ETS). The co-firing of biomass reduces the total greenhouse gas emissions , thus allowing power companies to sell allowances. With the present price of € 14-16/ton CO_2 this is insufficient to make up for the price difference between the use of coal versus wood pellets.

5.1.3 Sustainability

The RED includes a set of sustainability criteria that apply to biofuels and bioliquids. They cover environmental criteria and individual Member States are not allowed to take into account other criteria. This promotes a level playing field for the international trade in this set of biomass products. For solid biomass however, no mandatory sustainability requirements have been established[54]. The European Commission is of the opinion that the wide variety of biomass feedstocks complicates the development of a harmonized scheme. Also, sustainability risks are generally considered low. Member States are advised to apply the criteria as developed for biofuels and bioliquids where appropriate. This situation creates a large degree of uncertainty about the impact of sustainability regimes on the use of solid biomass in renewable energy production and the development of an open market for international trade.

5.2 Product standardization

Uniform product standards promote a single market for biomass products and thus improve market liquidity. For biofuels uniform technical product specifications are more advance compared to solid biomass. Demands with respect to the sustainability of biomass products add another layer to the definition of a product standard.
The EU Fuel Quality Directive allows for the blending of a maximum of 10 and 7 % v/v respectively, of bioethanol and biodiesel in gasoline and diesel. The biodiesel has to comply with the EN 14214 biodiesel product standard that has been developed by the European Committee for Standardization (CEN). For industrial wood pellets energy producers developed product standards based on technical specifications of its coal-fired power utility and conditions set by local and national authorities on emission standards and other environmental and spatial planning issues. As a consequence end-users make use of product standards that will have an overlap on a great number of elements, but may still differ in other aspects that prevent them from mutual use of the respective biomass products. Recently, seven of the biggest EU-based energy companies have taken the initiative to do the same exercise for industrial grade wood pellets. The outcomes of this initiative will have the support from an important set of market players and should therefore be used as the blueprint for a standard industrial wood pellets trading contract for the biomass commodities exchange.

Concerning sustainability criteria a plethora of different schemes presently exist: individual companies have e.g. developed their own sustainability criteria (e.g. Essent and its Green Gold Label, E.On's Responsible Procurement Policy), sustainability schemes do exist for specific biomass products or feedstocks (e.g. FSC or PEFC for virgin wood, RSPO for palm oil, ISCC for rape seed) and

[54] Report from the Commission to the Council and the European Parliament on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling (27 February 2010)

sustainability frameworks are developed by governments (e.g. Cramer Criteria in The Netherlands, Green Certificate Systems in Belgium and the UK). The sustainability schemes are at different stages of implementation and the feasibility and control of these schemes in most cases have still to be proven. Furthermore, under the RED legislation the EU has postponed a decision on a communautary sustainability framework for solid biomass. To promote standardization of the use of sustainability criteria energy companies are now taking the initiative to draft a communal scheme that will be submitted to the European Commission for approval still this year. This initiative is an important contribution to promoting product standardization and improving market liquidity.

5.3 Other biomass trading initiatives

5.3.1 Price indexes

- APX-ENDEX launched an industrial wood pellets price index in November 2008.
- FOEX publishes an industrial wood pellets price index since September 2009. The Pelletbio index distinguishes four markets: the Baltic and Scandinavian countries, Germany and Austria, Belgium, Great Britain and The Netherlands and exports from North America to Europe.
- The Argus Biomass Index is a price index for industrial grade wood pellets that is published since May 2009.

5.3.2 Trading platforms

- E-EnergyMarket provides an online auction for solid and liquid biomass products (www.e-energymarket.com).
- The Minneapolis Biomass Exchange is another online trading platform for a variety of products: corn cobs/stover, dedicated energy crops (e.g. cottonwood plantations, miscanthus, etc.), hays/alfalfa, wheat straw, and wood chips/residues (www.mbioex.com).

5.3.3 Futures trading

- CME Group offers several products related to the biofuels market.
- It has listed an ethanol futures since 2005. CME has now also listed a dried distiller's grain (DDG) futures contract. DDG is a by-product in ethanol production from corn and grain. This contracts improve hedging on production margins.
- Ren-X is an initiative first presented in March 2010 that intends to provide biofuels futures trading with physical settlement. The first products would be rape methylester (RME) and fatty acid methylester (FAME0) contracts.

ANNEX 1. CONVERSION FACTORS AND MEASUREMENTS

Energy conversion factors

To:	TJ	Gcal	Mtoe	Mbtu	GWh	Mtce	Mtwpe	Mbboe
From:	*Multiply by:*							
TJ	1	238.8	0.00002388	947.8	0.2778	0.00003412	0.000058824	0.00017511
Gcal	0.0041868	1	0.0000001	3.968	0.001163	1.4285×10^{-7}	2.46×10^{-7}	7.33×10^{-7}
Mtoe	41868	10000000	1	39680000	11630	1.42857	2.4633	7.3314
Mbtu	0.0010551	0.252	2.52×10^{-8}	1	0.0002931	0.000000036	6.21×10^{-8}	1.85×10^{-7}
GWh	3.6	860	0.000086	3412	1	0.00012283	0.000211748	0.00063039
Mtce	29307.6	7000000	0.7	27776000	8141	1	1.72402	5.132
Mtwpe	17000	4059600	0,40596	16112600	4722,6	0.58004	1	2,97687
Mbboe	5710.7952	1364000	0.1364	5412352	1586.332	0.194856948	0.335923302	1

Other conversion factors[55]

1 metric ton of diesel	=	42.8 GJ
1 metric ton of biodiesel	=	37.8 GJ
1 metric ton of gasoline	=	43.1 GJ
1 metric ton of bio-ethanol	=	26.4 GJ
1 metric ton of pure vegetable oil	=	34.6 GJ
1 metric ton oil equivalent	=	41.89 GJ
	=	1,1082 metric tons of biodiesel
Bio-diesel average density	=	0.88 metric tons per cubic meter
Ethanol average density	=	0.79 metric tons per cubic meter
1 barrel oil equivalent (bboe)	=	0.1364 metric tons oil equivalent
1 barrel oil equivalent	=	5.73 GJ
1 metric ton oil equivalent (toe)	=	7.33 barrels oil equivalent
1 cubic meter	=	6.289 barrels
1 barrel	=	159 liters
1 barrel	=	42 US gallons
1 U.S. gallon	=	3.785 liters
1 U.S. gallon	=	.0238 barrels
1 liter	=	.2642 U.S. gallons
1 liter	=	.00629 barrels

[55] Liquid Fuel Measurements and Conversions, Iowa State University, http://www.extension.iastate.edu/agdm

Units

Unit

Ha	Hectare
Gha	Giga hectare (1 hectare x 10^9) = 1 billion hectares
Mtce	Million tons of coal equivalent
toe	Ton of oil equivalent
Mtoe	Million tons of oil equivalent
Mtwpe	Million tons of wood pellets equivalent
Mbboe	Million barrels of oil equivalent
Mtons	Million metric tons
GJ	Gigajoule (1 joule x 10^9)
TJ	Terajoule (1 joule x 10^{12})
PJ	Petajoule (1 joule x 10^{15})
EJ	Exajoule (1 joule x 10^{18})
MBtu	Million British thermal units
kWh	Kilowatt-hour
MWh	Megawatt-hour
GWh	Gigawatt-hour
TWh	Terawatt-hour
kt	Kilotons (1,000 metric tons)
Mt	Million metric tons
Gt	Giga tons = 1 billion metric tons
b/d	Barrels per day
kb/d	1,000 barrels per day
Mb/d	Million barrels per day
W	Watt (1 joule per second)
cal	Calorie (1 cal_{th} = 4.184 J)
kcal	Kilo calorie = 1,000 calories or 4184 J
Gcal	Giga calorie (1 cal x 10^9 = 1 billion calories)

10^1	deca (da)
10^2	hecto (h)
10^3	kilo (k)
10^6	mega (M)
10^9	giga (G)
10^{12}	tera (T)
10^{15}	peta (P)
10^{18}	exa (E)

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