D2.2: Biofuel sector handbooks

– Explanation of intention and draft structure –
I. General remarks:

The main commercially available biofuels are bioethanol and biodiesel, mostly used as low-grade blend. A few EU-27 nations have a high-grade blending alternative (i.e. E85, ED95 or B100).

This sector handbook is focused on available and commercially viable biofuel technology on the European market, but also provides information for stakeholders interested in establishment of new techniques. The main focus of the handbook is places on bio-ethanol and biodiesel. Both biofuels can be used in heavy and light vehicles. The fuels can used as a low-blend in gasoline or diesel but there are also available engines that can be run on high blends (E85;ED95) and as pure fuels (B100;E100). This makes both fuels very versatile and attractive as their market potential is not as limited as other biofuels. Both fuels can also be produced by various production methods and various feed-stocks, both in large-scale and smale-scale plants. The versatility makes the fuels attractive for an export market as production can adjusted according to region conditions and market structure.

According to EU 20:20:20 targets this sector will grow rapidly. New feed-stock and production methods based on more cellulosic biomass are on the verge of commercialization, so called “second generation” biofuels. Todays market and the market on a foreseeable future will be based on 1 generation sugar and starch rich feed-stock. The market will be affected by the development of domestic biofuel production, global trade patterns as well as the phase of the commercialization of new fuels and production methods.

Discussions on the climate and environmental effect combined with an un-clear legal and policy situation is reducing the investments in the sector. Low-grade blending is the easiest way forward for the sales of large quantities but high-grade is needed for vehicle and market innovations.

The sector handbook provides information mainly for biofuel producers, consultants and providers of production plants. But also provides information to other interested stakeholders in the development of the biofuel market segment in EU27.

1.1 Biofuel technologies

Today the development in the biofuel market is very interesting with quick improvements in production techniques and available feed-stocks. There is also a multitude of available turn-key productions on the market and both light and heavy trucks that can be run on both high-blends and low blends. The majority of production is today based on agricultural products providing farmers with an increased
market for their products and bi-products from the food industry thereby sustaining a active and profitable agricultural sector. This handbook is focused on biodiesel and bioethanol production.

1.1.1 Bioethanol

Ethanol is a colorless liquid that is a volatile, flammable. The most commonly known type of alcohol found in alcoholic beverages. But it is also used in thermometers, as a solvent, and as a fuel.

Ethanol is a straight-chain alcohol, and its molecular formula is C2H5OH. Ethanol is often abbreviated as EtOH. The use focused on in this report is as a motor fuel, mainly as a biofuel additive for gasoline.

1.1.1.1 Feed-stock

Ethanol is produced via fermentation of sugar rich or starch rich crops. The major crops are sugar beets, sugar cane, corn, potatoes or cereal crops, mostly wheat in Europe.

The use of different feed-stock requires different production processes leading to that production plants cannot easily substitute its feed-stock. The chose of production- processing-method is therefore dependent of the feed-stock suitable for the specific production site. Feed-stock analyses on availability and price range is therefore crucial in the establishment of bioethanol production site.

1.1.1.2 Main production methods

Ethanol production can be achieved through a multitude of path-ways, the below is a very general generic description of the process. The production normally begins with drying and milling of the feedstock. After this the sugar is either dissolved out of the material, or the starch is converted into sugar. The sugar is then fed to yeast in a closed, anaerobic chamber. The yeast secretes enzymes that digest the sugar (C6H12O6), yielding several products, including lactic acid, hydrogen, carbon dioxide (CO2), and ethanol (C2H5OH). The main focus on development of improved ethanol production both with regards to; cost, increased yields, and use of more cellulosic feed-stock is on enzyme improvements.

1.1.2 Biodiesel

Biodiesel is a vegetable oil- or animal fat-based diesel fuel consisting of long-chain alkyl (methyl, propyl or ethyl) esters. Biodiesel is a liquid that varies in color depending on the feedstock used to produce it. It is incapable of mixing with water, has a high boiling point and low vapor pressure. Biodiesel can be used alone, or blended with petrodiesel. Biodiesel can also be used as a low carbon alternative to heating oil.

1.1.2.1 Feed-stock

Most vegetable or animal oils can be used to produce biodiesel. The feed-stock can be subdivided into three categories:

Primary oils – pure vegetable oils collected from oil-rich agricultural crops that are crushed
Residual oils – oils that are produced as by-products by other refining processes of the feed-stock.

Waste oils – oils that are collected as waste

The feed-stocks chemical properties will affect the chemical properties of the biodiesel, particularly in regards for temperature tolerance and corrosion. The choice of feed-stock is therefore very important when choosing the market for your product.

1.1.2.2 Main production methods

Biodiesel is produced, through either transesterification or alcoholysis. Biodiesel is typically made by chemically reacting lipids (e.g., vegetable oil, animal fat (tallow)) with an alcohol.

The production varies depending on scale of production and feed-stock but can generically be described as: The feed-stock is pre-treated, i.e. seeds are crushed, water is removed and the material and filtered to produce a suitable material for biodiesel production. The oil is then chemically changed trough esterification into biodiesel. The production also generates by-products such as, soap, glycerin, excess alcohol, and trace amounts of water. All of these byproducts must be removed, though the order of removal is process-dependent, to purify the end product.

1.2 Biofuel policy, incentives and targets

Within EU 27 there is two directives that have an imminent effect on the development of renewable energy. The RED directive with its target of 10 percent renewable energy in the transport sector 2020 is the front driver of development in many EU 27 countries. The fuel quality directive also has an potential of becoming an additional driver for the development, with a market development of more and more energy and climate efficient biofuels used to reduce the GHG impact of fossil fuels. Mostly by blending but also through the sales of pure biofuels by oil companies.

The full implementations of the two directives are not in place within EU 27 leading to that the markets are affected differently dependent of country specific implementations. However there is an active process to harmonize the sustainability demands within the EU 27. So the main drivers will most probably the political ambitions within each country on how fast the development shall be and if the 2020 targets should be exeeded.

1.3 Biodiesel markets

Biodiesel can be used as a low-blend in diesel but there are also available engines that can be run on pure diesel (B100). This makes the fuel versatile and attractive, as the market potential is not as limited as other biofuels. Biodiesel (FAME) can also be produced by various production methods and various feedstocks, both in large-scale and smale-scale plants. The versatility makes it attractive for an export market as production can be adjusted according to region conditions and market structure.
According to EU 20:20:20 targets in combination with the targets of increased energy efficiency in vehicles this fuel will grow rapidly. New feed-stock and production methods are on the verge of commercialization, so called “second generation” biofuels. The market will be affected by the development of domestic biofuel production, global trade patterns as well as the phase of the commercialization of new fuels and production methods.

1.3.1 Biodiesel low blend

In most EU 27 countries they're a discussions regarding implementation of a low blending of biodiesel (FAME) into gasoline or there is already a practice of blending in FAME in the diesel. With the implementation of the fuel quality directive it is now allowed to sell B7 (Diesel with a 7 percent blending of FAME).

Within the EU 27 countries there are two major strategies for implementation of B7:

Quote system, where fossil fuel providers are forced to blend in biofuel in their products otherwise a fine is placed on the economic operator.

Tax subsidies, biofuels are subsidized and fuel tax is not placed upon renewable fuels.

1.3.2 Biodiesel high blend

The market for B100 has risen and fallen over the years due to unstable targets and incentives, this has lead to that the production capacity of biodiesel in Europe exceeds the market. There are however a few regional B100 markets left within EU 27.

1.4 Bioethanol markets

Bioethanol can be used in both heavy and light vehicles. The fuel can used as a low-blend in gasoline but there are also available engines that can be run on high blends (E85;ED95). This makes Ethanol very versatile and attractive as its market potential is not as limited as other biofuels i.e. biogas or DME. The fuel can also be produced by various production methods and various feed-stocks, both in large-scale and smale-scale plants. This versatility makes the fuel attractive for an export market as production can adjusted according to region conditions and market structure.

According to EU 20:20:20 targets this sector will grow rapidly. New feed-stock and production methods based on more cellulosic biomass are on the verge of commercialization, so called “second generation” biofuels. Todays market and the market on a foreseeable future will be based on 1 generation sugar and starch rich feed-stock. The market will be affected by the development of domestic biofuel production, global trade patterns as well as the phase of the commercialization of new fuels and production methods.

1.4.1 Bioethanol low blend

In most EU 27 countries they're a discussions regarding implementation of a low blending of ethanol into gasoline or there is already a practice of blending in ethanol in the gasoline. With the
implementation of the fuel quality directive it is now allowed to sell E10 (Gasoline with a 10 percent blending of Ethanol or up to 3 percent of Methanol and 7 percent Ethanol). However the companies still need to provide a protective grade for older cars (E5).

Within the EU 27 countries there are two major strategies for implementation of E5 and E10:
Quote system, where fossil fuel providers are forced to blend in biofuel alcohol in their products otherwise a fine is placed on the economic operator.
Tax subsidies, biofuels are subsidized and fuel tax is not placed upon renewable fuels.

1.4.2 Bioethanol high blend

There are two commercially available high-blends today that have vehicles that are available on the open market. However, the fueling system and pump logistics are not available on a large scale. ED95 is mostly sold to vehicle fleets with a fixed distribution system i.e. for collective transport or regional product delivery services.

In a few countries there is a developed E85 pump system for private vehicles but in most countries the introduction of E85 is still on a trial bases.

1.5 Trade patterns

Global trade of biofuels is still under a rapid development and the number of exporting countries is increasing steadily. The trade is believed to continue its development however the patterns of trade will change over time as new producing countries enters the arena.

1.5.1 Bioethanol

The percentage of traded Bioethanol is relatively small, compared to its production, only 13 percent (FO Licht 2010). The main reason for this is ethanol is a global commodity that can be produced almost any where in the world and most installation are targeted on the domestic market. The trade of bioethanol is also restricted by trade barriers such as customs for imported ethanol and incentives for domestic production and farming of feed-stock.

The bioethanol production is relatively smaller compared to the EU 27 biodiesel production, 2009 the domestic bioethanol production was 3599 000 m3 compared to the domestic biodiesel production of 10016 000 m3. The usage of bioethanol 2009 was 4480 000 m3, given that approximately 20 percent of the bioethanol use was from non-EU27 sources. EU27 consumed in 2009 6 percent of the global consumption and produced 5 percent of the production.

On the global markets USA and Brazil produced almost 90 percent of the global production, other major producers are China, Canada, Germany and France. The global production has increased steadily and doubled between 2005-2009.
1.5.2 Biodiesel

The biodiesel production is larger compared to the EU 27 bioethanol production. 2009 the domestic biodiesel production was 10016 000 m3 compared to the domestic bioethanol production of 3599 000 m3. The usage of biodiesel 2009 was 10016 000 m3, given that approximately 18 percent of the bioethanol use was from non-EU27 sources. EU27 consumed in 2009 70 percent of the global consumption and produced 60 percent of the production. The European biodiesel market is there for of higher global relevance relative to the bioethanol market.

1.6 Vehicle development

There are several dedicated vehicles on the market for Ethanol and pure Biodiesel. The dedicated private small cars are mostly Ethanol-Gasoline Flexi-fuel cars. On the other side the B100 cars are heavy-duty vehicles for the regional distribution markets.

1.7 Criteria and indicators

1. Country risk

   a. Political framework conditions are reliable
      i. Long-term (exceeding 5 years) relevant support scheme in place or announced in NREAP
      ii. Broad political consensus for such support schemes
      iii. Political interest in renewable energy/climate change is high

2. Institutional environment

   a. Local quality requirements affects Biofuel technology
      i. Implementation of voluntary standardization and certification schemes for Sustainability
      ii. Implementation of national fuel standardization allows for low blends (E10:B7)
      iii. Implementation of national fuel standardization allows for pure blends (E85:B100)

   b. Finance is available for new business development
      i. Investment subsidies sin new production capacity/plants are available
      ii. Investment subsidies for investments in logistic/Infrastructure for high blend / pure biofuels are in place
      iii. Duty for non-EU biofuels are in place
      iv. Governmental guarantees for loans for biofuel investment

   c. Incentives for biofuels makes biofuels favourable in end market
      i. Tax is reduced for biofuels in pure blends (E85:B100)
      ii. Tax is reduced for biofuels in low blends (E5,E10:B5,B7)
      iii. Quotas for low-blend mix is in place
      iv. Investment subsidies for green vehicles procurements are in place
3. Feedstock market  
   a. Feedstock prices are easily monitored  
      i. Amount of cellulosic feed-stock in GJ primary energy/capita  
      ii. Amount of seed-crops in GJ primary energy/capita (i.e. corn or wheat)  
      iii. Amount of oil-crops in GJ primary energy/capita  
      iv. Amount of usable waste products GJ/capita  
   b. Feedstock price trends doesn’t threaten market development  
      i. Agricultural support schemes are open to energy crops  
      ii. Areas of fallow land available for agricultural expansion  
      iii. Average Cereal yield kg / hectare yield on active agricultural land (according to national statistics)  

4. Process energy  
   a. Availability of energy is foreseeable  
      i. Energy supply is dependable  
      ii. Green energy is possible to procure  
      iii. Distribution networks for electricity are prepared for increase energy production and usage  
      iv. Distribution networks for district-heating are prepared for increase energy production and usage  

5. Overall Economic framework - General business environment  
   a. There is a transparency in the market place  
      i. Market prices are published  
      ii. Trends in price development are available  
      iii. A consumer price index is published regularly  
   b. Efficient logistical solutions available  
      i. Roads are in good condition  
      ii. Rural areas are easily accessible  

6. Production/Operating Environment  
   a. Service and maintenance is available or can be established  
      i. Training programmes for service persons implemented  
      ii. Label for service staff established  
   b. Approval/permitting procedures in target country are adequate and clear  
      i. Average time to get approval is acceptable  
      ii. Small number of involved authorities  
      iii. Acceptable operative administrative burden for biofuel producers  

7. Market saturation level - end market  
   a. The Biofuel market offers good growth perspective  
      i. There is an established biofuel market  
      ii. National targets set for Biofuel is the transport sector  
   b. Biofuel has access to competitive downstream flow  
      i. Laws regulating blending of biofuels implemented  
      ii. Logistic available for high blend / pure biofuels (e.g. B100 or E85 filling stations)?
iii. Depot structure available for biofuels
iv. Local receivers/customers of biofuels exist

8. Public acceptance / knowledge of technology
a. There is a price elasticity for renewable energy
   i. Consumers are prepared to pay additional cost for green vehicles
   ii. Consumers are willing to pay additional costs for renewable fuels with low climate impact
b. Bioenergy is well-known and seen as attractive form of energy
   i. Considerable number of initiatives moving towards bioenergy are known
   ii. Number of articles in press for and against biofuels - good media climate
   iii. Interest group against/favourable to biofuels (measures through position papers)
   iv. Political parties positions on biofuel development are well known