Final report

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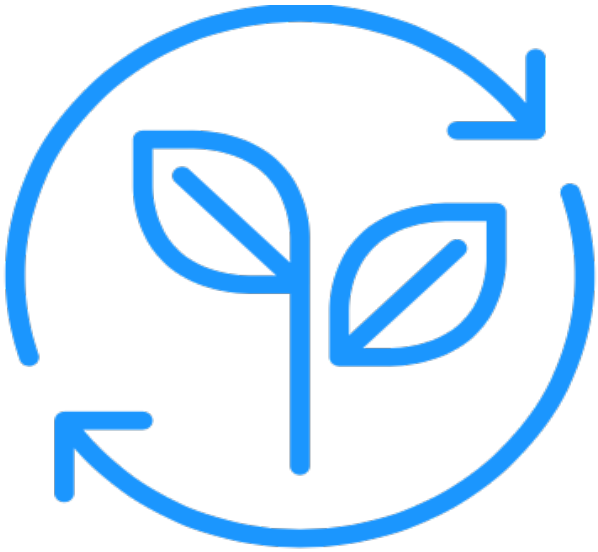
Avans Hogeschool - 22/12/16



trias energetica

Colophon

- Lay out: Borja Cusy
- Introduction: Adrián Sales
- Theoretical background: Maarten Harijgens
- Additional theoretical background: Maarten Harijgens
- Financial analysis: Maarten Harijgens and Adrián Sales
- Marketing analysis: Borja Cusy
- Conclusion: Borja Cusy
- Advice: Maarten Harijgens
- Bibliography: all the members of the group
- Appendix: Borja Cusy
- Review of the text: all the members of the group

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Introduction

General background

The climate is changing, fossil fuels reserves are running dry, and the world is consuming a lot more because of the growing population. With that in mind there is much work to do and a lot to be changed. But the world is not changed in a single day, month or year. It is changed by small steps over the course of years and years, utilizing revolutionary ideas and innovative technologies.

Taking this in mind, the NGO Blauwzaam has asked a consultation of the minor Biobased technologies & business creations/sustainable entrepreneurship given at Avans University of Applied Sciences. Blauwzaam is operating in the Dutch regions of Alblasserwaard and Vijfheerenlanden. Their focus is to achieve a sustainable economy by reaching energy neutrality and creating sustainable industries at the end of 2030.

In the region where Blauwzaam is operating there is not a large scale method used for energy production which uses renewable resources. The situation as it is now in the Netherlands is not much better. There are only 7 biomass power plants, a tidal power plant, a few large offshore wind farms and 4 coal power plants which are able to produce electricity with biomass as an alternative. So on terms of renewable energy resources there is much to improve, not only in the region but also in the whole country.

As a NGO they are in contact with many entrepreneurs in the region who are willing to invest in sustainable industries and tackle the problems of depleting resources. Blauwzaam acts as the connecting element between these entrepreneurs. Some entrepreneurs have the knowledge and others has the financial resources but not the technology at hand. This project of the minor focus on the consulting element from technological ideas which will be checked if it is financially possible or even better, profitable.

Furthermore, a stakeholders analysis of Blauwzaam has been done for this report and can be found in the *Appendix I*.

Project goal

The main goal set by Blauwzaam is that the project group comes with technological solutions, which are tested on their economical and legally achievability, for the countryside, factories and inhabitants of the regions Alblasserwaard and Vijfheerenlanden to aid in their strive to have an energy neutral region by 2030.
Both regions have a lot of farming area which is utilized by the dairy industries. This type of industry produces a lot of waste products. The side goal of this project is to look at the waste streams and the domestic waste of the area and determine if these can have an upgrade in economic value.

Boundaries

In this project there will be no production of revolutionary technologies nor will there be scientific research to be conducted. The project will solely focus on consulting the client on which and how to use certain technologies to achieve the goal set by Blauwzaam. Blauwzaam already did research or had an business case in the area of solar energy, wind energy, hydro energy, geothermal energy and improvements of uses of fossil fuels. Because of that, Blauwzaam asked for a consult in the area of renewable resources/industries.

Reading guide

First of all we are going to discuss the project activities and the technological part, analyzing the theoretical background and the processes that are going to be implemented for the resolution of the case. Then we will focus on the financial analysis to know if the project is profitable and economically viable. Later we will discuss the marketing activities that we are going to implement to try to make our project known and to people get involved on it. After it there is a review of the laws and regulations regarding to the project and the activities that we are going to realize. In order to sum up the report there are conclusion and advice.

Theoretical background

Technical aspects

Domestic waste introduction

We live in a world where the population is growing. The third and second world countries are becoming more and more prosperous. With this growing wealth in all kind of countries the consumption of various goods is also becoming more. But the world limited resources and because of that we need to improve on the recycling and bio based production aspects. As the introduction stated, we will focus on the regions Alblasserwaard and Vijfheerenlanden in the Netherlands so the introduction and the other subchapters will be focused to those two regions if possible or otherwise, the Netherlands .

In the Netherlands is an highly developed country with many waste streams. For example industrial waste, agricultural waste and in our case, domestic waste. Domestic waste is all the waste generated from the households[1]. Because this domestic waste is made up different kinds of products and materials it was normally brought to the landfills were only the organic waste and paper were somewhat sorted out at the homes. But in the last decade the recycle movement has made progress, now the plastic is sorted out of the waste and some municipalities went even further. They ask their citizens to even sort out their milk cans, aluminum packages and glass. There is also a so called “milieustraat” present in almost every municipality. Here you can bring all sorts of waste which cannot be thrown away with the regular domestic waste or simply to large quantities, some examples are car tires or electrical devices[2].

Like stated earlier, domestic waste has multiple kinds of products and materials. The most notable are organic waste, plastic, paper and glass. Fortunately these five are recyclable but still, after all the efforts by the government and municipalities, end up on landfills or incinerators with all the other waste. The most recent campaign from the government is the orange plastic hero (figure 1) was to stimulate the recycling movement of plastic in the country.

For this project we will focus on the organic waste which is already being recycled, but in our opinion there is much to improve because in the current situation, the organic waste is being composed to fertilizer. Which is of course a good cause because you can use the waste to grow more biomass. Due to the increase in possible uses trough moving the biomass to an higher cascade, the market will increase from the Dutch government the revenue of this sector which will give more new possibilities.

Figure 1: Plastic hero campaign from the Dutch government

Organic waste contents and quantities

The category organic waste includes everything what is of organic origin and biodegradable. Think about garden waste, left over food, fish, fruits, tea/coffee and even manure from small pets like

[1] Web reference: http://www.imog.be/diensten-en-educatie/voor-bedrijven/ondersteuning-voor-bedrijven/vlarema/

[2] Web reference: https://www.breda.nl/wonen-wijken-vervoer/afval/afval-inwoners-0/soorten-afval/milieustation/afval-voor-het-milieustation

hamsters and bunnies. In the Netherlands, this waste stream is called Groente, Fruit en Tuin (GFT) afval, which means vegetables, fruits and garden waste.[3]
The organic waste is being separated by the inhabitants and collected by the municipalities or outsourced to companies specialized in waste and recycling. What the most interesting part is of the GFT waste, is that it is rich in carbohydrates. Those can be used a different ways, more on that in the next subchapter.
On average, a Dutch inhabitant produces over 500 kilo of waste per year. From this 500 kilo there is 154 kilo GFT waste where 75 kilo is properly separated.[4] This is an astonishing 1275 kiloton per year if you multiply this with the 16,8~17 million of inhabitants. If the separation will improve, these numbers will be even higher. These are the national statistics of the Netherlands and the project group is only focussing on the regions Alblasserwaard and Vijfheerenlanden. These two regions have the following municipalities:

- Municipality of Giessenlanden
- Municipality of Gorichem
- Municipality of Hardinxveld-Giessendam
- Municipality of Leerdam
- Municipality of Molenwaard
- Municipality of Zederik

With the values given for this region, which are from the company HVC which are a bio-energy company specialized in incineration, we can calculate the total amount of GFT waste for both regions. they have an average waste production per year per person of 102 kilo.[5] With an inhabitants number around 205000, there is 10,5 kiloton of GFT waste available if the efficiency is the same as on the national level.

Possible techniques

GFT waste is a carbohydrate rich waste stream and relatively easy to break down as stated in the previous subchapter. Because of this rich composition there are many options available. Before choosing a technique to use to process the GFT waste to another useful product besides fertilizer we need to look at what we want to achieve and produce. Another important factor is the maturity

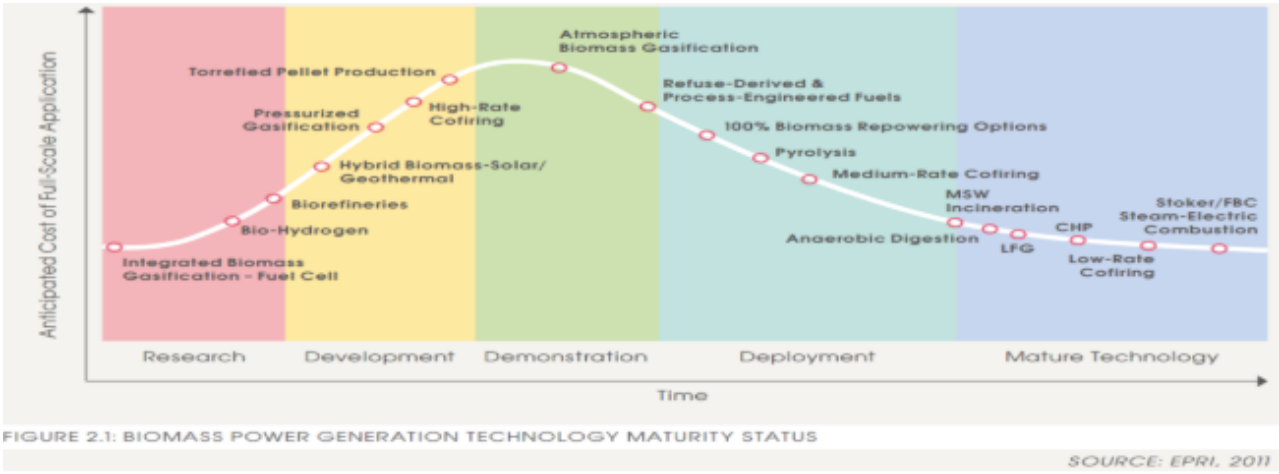


Figure 2: Biomass power generation technology maturity graph

[3] Web reference: https://www.milieucentraal.nl/minder-afval/afval-scheiden-en-recyclen/welk-afval-waar/groente-fruit-en-tuinafval-gft/

[4] Web reference: https://www.milieucentraal.nl/minder-afval/afval-scheiden-en-recyclen/cijfers-over-afvalscheiding/

[5] Web reference: https://www.hvcgroep.nl/sites/default/files/160412_hvc_jaarverslag_2015.pdf

of the technology used. The more the technology in question is mature, the lesser the operation cost will be. This will be an important factor for the investor/company to choose for this technology. in figure 2 the maturity of technologies can be seen in a graph set out to the estimated operation cost if it was applied on full scale versus the time (and by that the maturity). A short summary of applicable technologies for the GFT waste stream will be given after the figure.

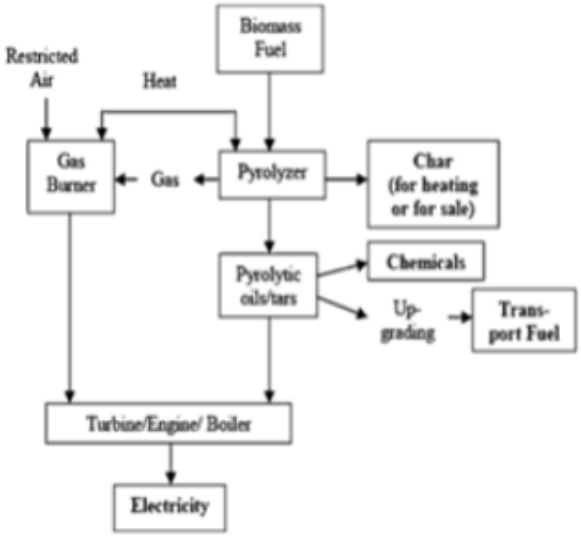
A short summary per technology starting from the most mature to the least. Also the possible usage will be discussed

- Low-rate cofiring: This technology is the most simple but also one of the least sustainable. This is simply burning a fossil fuel simultaneously with a biomass source. The problem with this technology is that it still use a fossil fuel and produces a lot of ash from the biomass because they relatively do not pre-treat the biomass, which will put a greater strain on the furnaces/ generator. The positive side of this technology is that it doesn't need to change much on the machines in the power plant, which mean that it is a cheap and fast applicable technology.
- Anaerobic Digestion: Produces methane which can be made clean to green gas. This process has the side effect to also produce some hydrogen sulphide, nitrates and sulphur oxides which are harmful for the environment if it is in high doses. The strong point of this technology is that it produces methane in a renewable way. So the costs are mostly in the production of the bio-reactor and maintenance.
- Medium-rate cofiring: the same principal as the low-rate, but the furnace is optimized so that it can handle more biomass and can better cope with the ash and other waste of the biomass after burning it. The strong point is that it is more ecological beneficial compared to the low-rate. The weak point is that it still use fossil fuels and this technology needs some changes in the power plant which cost money.
- Pyrolysis: This technology is very flexible, it uses the principle of degrading the carbohydrates to gas, bio-oils and charcoal as solid residue through intense heating (from 200 0C till 800 0C). The strong points are the different setups it can use, if the machine is used on relatively low temperatures and for 24-48 hours per batch you stimulate the charcoal production (torrefaction). If the machine is put on a temperature even higher and the batch time shorter, this will stimulate an evenly divided production of solid, liquid and gas and many more setups. This diversity also economically interesting, as the charcoal can sold as a fuel, the bio-oil can be transformed into a biofuel or even chemical compounds, the gas is used to heat the pyrolysis system. The weak point is, it is still in the deployment stage and has a fairly high operating cost.

For this project we have chosen for the technology of pyrolysis, the diversity is a strong asset. The apparatus can have the desired setup for the most efficient production of the favored product. Our client Blauwzaam has asked us to look for an opportunity for production of products in a higher cascade of the biobased economy. With this technology we think to have the desired mixture of energy production and the possible up-cycling.[6]

Pyrolysis

Pyrolysis can use a diverse selection of sources to degrade. The most common are: plant materials like our chosen organic waste, the most of the agricultural waste, domestic waste to reduce its volume and some industrial waste(for example distiller grain). [7] As stated a few times before, the possibilities are numerous. To give a good overview, we need to look at figure 3 and figure 4



[6] RENEWABLE ENERGY TECHNOLOGIES: COST ANALYSIS SER International Renewable Energy Agency. Link to pdf: https://www. RE_Technologies_Cost_Analysis-BIOMASS.pdf

for a schematic overview of the pyrolysis process. The input is Biomass and heat, which enter the pyrolyzer. In here the main heating is done and the carbohydrates are broken down from long polymeric chains like cellulose or starch to a repeating unit around 10 chains (with this degree of polymerization it is called an oligomer) which will make able to evaporate. When the biomass reach the stage of evaporation, it will stop decreasing in chain length.

The vapor will then go to the cooling tank as seen in figure 4, where the will the oligomers will transition from the gas phase to the liquid phase. The smaller molecules whom where created at the pyrolyzer will go further ahead to a gas tank, this can be used as fuel for the pyrolysis or can be burned for energy production. In theory the bio-oils could be used for heating the internal system, but that choice depends on the desired product. But the bio-oil have the most opportunity to create a greater revenue because of the upgrading of the product.[7]

Figure 3: Schematic overview pyrolysis

As seen in figure 3, there are three products which are being made during the process. But the setup determines the most abundant product. In table 1[8] is a brief summary of setups with their respectively products .

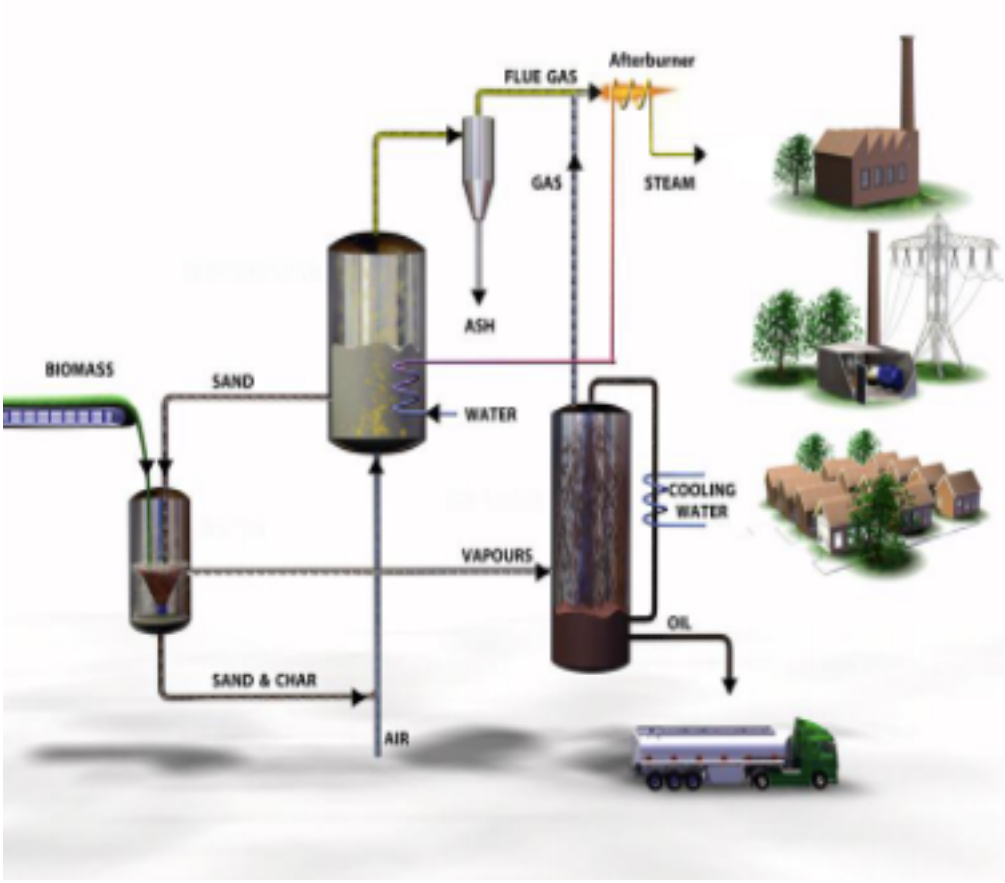


Figure 4: Visualized general setup pyrolysis

Table 1: Overview of setups for pyrolysis

Pyrolysis type	Time	Heating rate	Final temp (°C)	Products
Carbonization /torrefaction	Couple days	Very low	400	Charcoal
Conventional	5-30 min	Low	600	Charcoal, bio-oil, gas
Fast	2 sec	Very high	500	bio-oil
Flash	1 sec	High	650	bio-oil , gas , chemicals
Ultra-rapid	0,5 sec	Very high	1000	Chemicals, gas
Vacuum	2-30 sec	Medium	400	bio-oil
Hydropyrolysis	10 sec	High	500	bio-oil
Methanopyrolysis	10 sec	High	700	chemicals

The conformation , materials and specifications of the pyrolyzer will also influence the end product. Also the type of reactor has an impact on the product and quantities of the input. [7][9] in table 2 an overview of possible reactors with the yield, strong and weak points if we use fast pyrolysis for example:

Table 2: overview of fast pyrolysis reactor types with possible yield and also included with pro's and con's

Kind of reactor	Possible yields	Strong and weak points
Bubbling fluid bed reactor	70-75 % liquid	• High heat transfer rates • Heat supply to fluidising gas or to bed directly • Very good solids mixing • Particle size limit <2 mm in smallest • Simple setup
Circulating fluid bed and transported bed reactor	70-75% liquid	• Heat transfer rates are high • leading to more char in liquid product • Solids recycle required; Increased complexity of system • Maximum particle sizes up to 6 mm which is bigger thus easier • Possible liquids cracking and catalytic activity by hot solids which can be a bad thing
Ablative fast pyrolysis reactor	70-75 % liquid	• Accepts large size feedstocks thus less treatment is needed • Very high mechanical char abrasion from biomass • Compact design • Heat supply problematical • Heat transfer gas not required • Particulate transport gas not always required
Entrained flow reactor system	50-60 % liquid	• Heat transfer rates is low • Simple setup • Particle size limit <2 mm • Limited gas/solid mixing
Rotating cone reactor system	60-70 % liquid	• Recent development so operation costs are still somewhat high, which is not desirable • Less carrier gas is required than Bubbling fluid bed system • Complex setup which is more maintenance heavy

As seen in table 2[9], the type of reactor depends on the client/customer needs and biomass resource. The setup will be different because of future demands of the client.

Improvement research of pyrolysis

As seen in figure 2, the pyrolysis technology is in the deployment stage. This means that there is already enough knowledge available to implement the technology and have a reasonable

[9] Reference: An overview of fast pyrolysis, T. Bridgewater and D. Meier, Organic Geochemistry 30(12):1479-1493, December 1999

operating cost. But there is still enough to improve, for example on efficiency. In the article of "experimental studies on enhancement of bio-oil production using agro waste materials pre-treated with alkaline solutions" by S.P. Singh and A.P. Chouhan, they use a solution of Sodium hydroxide(NaOH) to reduce crystallinity of the biomass, which make the resource easier to pyrolyse. They have achieved an astonishing increase in bio-oil production in the range of 35% to 270%, depending on the type of biomass pre-treated with a 50g/L NaOH. In the experiment, they compared the result of pre-treated biomass with the results of the untreated biomass. Unfortunately, the test was performed on a lab size and homemade pyrolyzer. For this reason we can't blindly implement this for this advice report but it is a good suggestion on which can be experimented further on when implemented on a fully operational pyrolysis setup.[10]
The most improvements are researched are mostly for fast pyrolysis. The scientific article " Fast Pyrolysis Oil Stabilization: An Integrated Catalytic and Membrane Approach for Improved Bio-oils" by G. W. Huber is analyzing these improvements. The most noting parts of the research are the addition of membranes to separate chars and acids from the bio-oil to increase purity and stability.[11]
With this kind of additions to the whole picture of pyrolysis, it is possible to decrease the operating costs or increase yields for higher profits. Unfortunately, the most of these research is done on lab scale or pilot scale and not on a full implemented scale. If these new findings are going to be implemented in the future, the technology as a whole becomes cheaper to implement thus becoming a more mature technology on the scale of figure 2.

Promising biobased chains

Because of the flexibility from pyrolysis, it is possible to facilitate some bio-based chains per chosen setup. The only limitation is the quantity of products delivered by the chosen setup as discussed in the previous chapter called *Pyrolysis*. The most simple chain is the torrefaction chain, which produces charcoal with a majority share as product. This charcoal can be sold to power companies who are using cofiring as electricity generation method.
The bio-based chain of the conventional pyrolysis setup is more diverse (almost a 1/3 divide for all products). The charcoal can be sold to energy companies or if the yield has a low quantity it can be sold to inhabitants or private parties. The bio-oil which also will produced can be sold to bio refineries to transform it to a bio-fuel or chemicals. The gas is used internally for heating the system or sold if there is an overproduction.
The bio-based chain becomes even more complex when the company uses Fast or Flash pyrolysis. These two setups focus on producing bio-oils and chemicals. In figure 5 is an example of a possible setup for the pyrolysis. From all possible end products a bio-fuel seems the most easy step if you count in the vast number of possible chemicals to be produced. To give an impression, the chemicals shown in the figure are(from left to right):

- Benzene: the most basic aromatic compound, mostly used to produce aromatics, pharmaceuticals and colorants
- Toluene: in the same category as benzene
- Styrene: used for polymerization
- Benzo nitrile: in laboratories used as solute for organic chemicals.

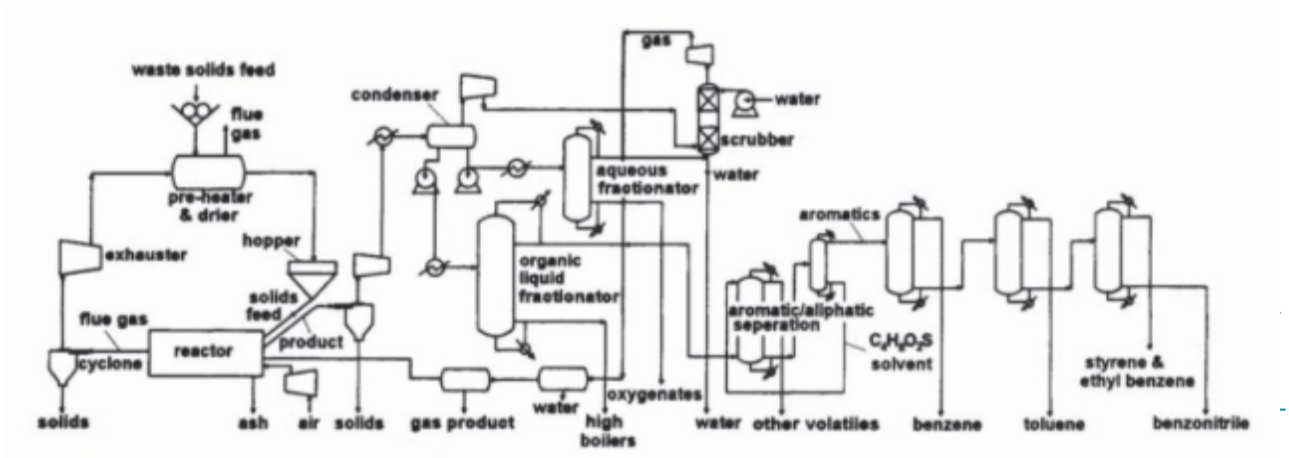


Figure 5: Possible setup for chemicals from the produced bio-oil

The only downside to the complexity of the bio-based chain is: that the more components needed to make the desired product, the cost will increase as will the product. This will certainty affect the attractiveness of this technology/setup to implement.

Additional theoretical background

Syngas

In the case we set, we make biodiesel. Because we will produce biodiesel there are two additional steps needed after the pyrolysis phase. These two steps are gasification of the bio-oil to syngas and then a chemical reaction to make DiMethylEther through a Fischer-tropsch synthesis.
First of all syngas is an abbreviation of synthetic gas. This synthetic gas a mixture which contains hydrogen and carbon monoxide, and with this mixture is it possible to make every carbon hydrate including all oil-based fuels we know off. The chemical reaction will be explained in the following sub-chapter.
To make syngas, we need to apply gasification which can be seen in figure 6. Gasification is normally applied on fossil-fuels, regularly coal as even figure 6 implies with their input. We will call it, for the explanation of the process, fuel. The fuel is putted in the machine and is mixed with some water and air. This mixture of fuel, water and air is heated to a temperature higher than 800 0C.[12] All the carbon molecules are going to react with immensely hot air and water vapor, which results in CO2 and reacts further to CO and H2. In the end there is always a residue of the fuel in the form of ash or slugs depending on the type of fuel.
In our case we plan to use the produced bio-oil as fuel for gasification. Because bio-oil is a much cleaner alternative as the normally used coal or other fossil-fuel, there is less residue because this has already been treated in the pyrolysis phase. We suppose that the residue will almost solely contain ash.

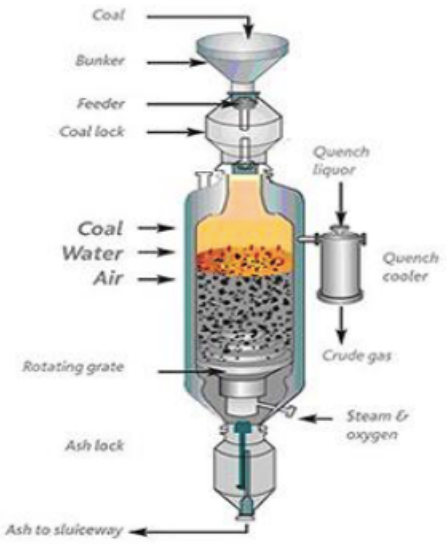


Figure 6: Conventional gasification setup

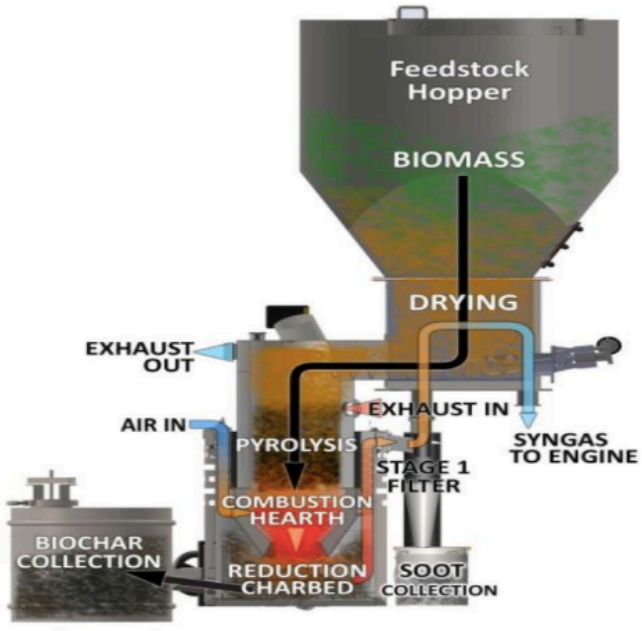


Figure 7: The combination of pyrolysis and gasification

With
the addition in mind of the gasification, the following machine setup can be seen in figure 7. This setup is a combination of the pyrolysis machine and the gasification machine. The only difference will be, that the syngas is not leaded to an engine but to a chemical plant where the Fischer-Tropsch reaction is conducted to get the DiMethylEther. Of course this will not be the final setup, this figure is only meant to visualize the process.

[12] s Reference: Fast Pyrolysis Oil Stabilization: An Integrated Catalytic and Membrane Approach for Improved Bio-oils, G. W. Huber, 2011, a report for the United States Department of Energy

Fischer-Tropsch Synthesis

A brief introduction to the process of Fischer-Tropsch, This process is a well-established technology that is almost 100 years. This process was used to make synthetic carbohydrates from a mixture of CO and H2 , which is better known as syngas now. The first big company which utilized this knowledge was SASOL in South-Africa in the 1950's, because they have large coal-reserves and few oil-fields, so through this they were less depended on other countries in terms of resources. Around 2000 some countries began experimenting and setting up pilots to make fuels through this process. They found out that because of the chemical produced fuels are made of CO and H2 , they almost contain no sulfur which is partially responsible for acid rain.

So on terms of sustainability, these fuels which we are producing are still burning fuels, but are much purer which results in a lesser impact to the environment compared to fossil-fuels. For our project we choose to make DiMethylEther(DME) because this molecule (figure 8) has equal capabilities as the fossil derived diesel, sometimes even better depending on the mixture of diesel. This makes it to a good alternative for bio-diesels from transesterification origin.

What the most counting strong point is, is that it is a well-established technology which is already used in the Willem-Alexander power plant in Buggenum (Limburg) which use coal and of course Royal Dutch Shell has some projects too. So this part of the process we are planning is not a big risk because it is already well-known.

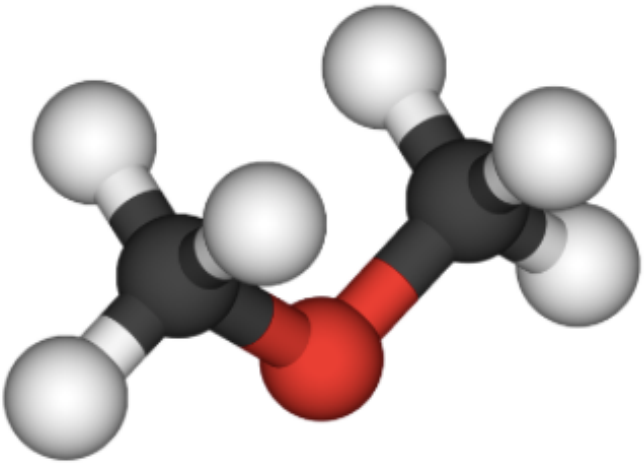


Figure 8: Molecule DiMethylEther(DME)

Financial analysis

Operational costs

For the operational costs we have divided in to 2 segments, the operational costs of pyrolysis/ gasification for the Dimethyl Ether(DME) production and the costs of the Fischer-Tropsch.
To start with pyrolysis/gasification costs, we need to know how much DME is produced a year. If we use fast pyrolysis and gasification combined, the part that we will use is bio-oil, which is produced at a rate of 80 % from all products. Because we lack real industrial data of the Fischer-Tropsch reaction, we assume that these well stablished techniques are at least on a 80% efficiency. So the rough calculation will be:

- 10,5 kilotons of available organic waste * all the efficiencies = 5,376 kilotons of DME produced. If you divide this with the density of DME you get, 5.376.000 kg/0,735 kg/l=7.314285 L of DME

Now we add up all the labor costs, energy costs and maintenance and will divide that with the amount of liters produced to get the cost per liter for pyrolysis. For this scale of production we think 5 workers for the whole pyrolysis/gasification plant. With a starting salary of 2200 euro the month we have employment costs of 136.017,46 a year. The maintenance budget will be 200.000 which will suffice if the machines are handled properly. And from our technical source we got an energy cost of 2600kJ/kg if we should use electrical heating. The energy costs will be around 151666,- euro a year. This add up together results in 487.683,60 per year. Divide this with the total amount of produced liters and the operational costs will be 0,06 eurocents for this combined machine.
The Fischer Tropsch operational costs are a bit more abstract because we lack knowledge on industrial separation. This is heavy depended on the real scale and process of the chemical reaction. Normally separation of chemicals has a share of 40 to 90% of the total costs of operations.[13]
The reaction itself is exothermic so the reaction mixture needs to be cooled to get the most efficiency, this will be a big energy cost. The reaction also use a couple of catalysts which needs to be replaced now and then for an optimal efficiency. With this we can make an estimate of the costs. If in the costs can be limited to under 1 euro, there will be a better chance on profitability.

Investment costs

The investment costs will also be a bit abstract made a rough assumption for about 5,5 million euro's for the total investment. This includes the buying of machines, building of the plant, buying of the land and many more things. For a better picture we recommend to take a broader look at the pilot plant which make bio-fuels through the same gasification and Fischer-Tropsch as we do, but not with pyrolysis. This plant is on a commercial scale and is in Piteå, Sweden. They use waste from the wood industry in Sweden. This is the link to their site from the main company/ governmental institute: http://www.biofuelstp.eu/ . We have failed to contact them yet for more information.

Financial comparison of cases

In this part we are going to talk about the profitability and if it is economically worth to carry the project. To measure this, we are going to compare two cases: The base case, which is the financial aspects on the way that they are treating the domestic waste nowadays. The pyrolysis case, are the financial aspects derived of the implementation of our project.

[13] Bosch, André B. de Haan, Hans (2013). Industrial separation processes: fundamentals. Berlin: De Gruyter. ISBN 978-3-11-030669-9.

Base case

Nowadays, all the municipalities of the region Alblasserwaard Vijfheerenlanden have delegated their responsibilities of collection and treatment of the domestic waste to a company named Waarlanden. These municipalities have an expense of XXXXX[14] / year in relation of the processing the waste.

Pyrolysis case

Taking care of the collection and treatment of the domestic waste of the region, have to take a lot of things into account:

- We have to invest in the collection of the waste. As we said before on the technical aspects, in the region we have 10,5 kilotons of waste per year that is around 30.000 kilos per day. With 3 trucks of 89.000€ each one (check the bibliography for the reference), we have enough. The trucks will be straight line depreciated in 5 years. We also have to take into account the employees, we will hire 9 workers, 3 for each truck. The salary of a trucker will be 24.000 per year. This is 216.000€ in salaries per year.
- We have to invest in the treatment of the waste. After a meeting with a researcher of pyrolysis, we have reached the conclusion that to treat all the domestic waste of the region, the investment of a pyrolysis plant according to our needs would be around 5,500,000 euros. This estimation includes rent, insurance and energy consumption of the plant. This investment will be depreciated in 5 years with the straight line method.
- Also we have to take into account the operational costs of the process. Like we calculated before on the technical aspects, we are assuming the salaries of 5 employees, 3 operators and 2 mechanics and maintenance costs. We estimate that the operational costs will be around 1€. With a production of 7.314.285 liters multiplied by the operational costs will be around 7.314.285€.
- With the previous named 10,5 kilotons of domestic waste we know that we can produce 7.314.285 liters of biodiesel, this biodiesel will be self-consumed by the municipalities. Multiplying the liters of biodiesel with the actual price of diesel that is approximately 1.21€ per liter (because is the fuel that they are buying and using at this moment for the collection) we have an astonishing savings of 8.850.285€ per year. We also want to remark that the diesel prices are on the rise, this will make better savings in the future.

C9 =C8-C7-C6-C5-C4

	A	B	C	D	E	F	G	H	I
1									
2									
3		year	1	2	3	4	5	6	7
4	investment	trucks (5 year depreciation)	53.400,00 €	53.400,00 €	53.400,00 €	53.400,00 €	53.400,00 €		
5		salaries of truckers	216.000,00 €	216.000,00 €	216.000,00 €	216.000,00 €	216.000,00 €	216.000,00 €	216.000,00 €
6		pyro plant (5 year depreciation)	1.100.000,00 €	1.100.000,00 €	1.100.000,00 €	1.100.000,00 €	1.100.000,00 €		
7		operational costs	7.314.285,00 €	7.314.285,00 €	7.314.285,00 €	7.314.285,00 €	7.314.285,00 €	7.314.285,00 €	7.314.285,00 €
8	savings	biodiesel	8.850.285,00 €	8.850.285,00 €	8.850.285,00 €	8.850.285,00 €	8.850.285,00 €	8.850.285,00 €	8.850.285,00 €
9	result		166.600,00 €	166.600,00 €	166.600,00 €	166.600,00 €	166.600,00 €	1.320.000,00 €	1.320.000,00 €

Figure 9: Cash flow of the project for the first 7 years

As we can see, the first 5 years we have a revenue of 166.600€ due to the 5 year depreciation of the pyrolysis plant and the trucks. After the 5th year we can see that we improve our revenues until 1.320.000€ because of the liberation of the payments. The salaries and the operational costs are fixed every year. The savings in biodiesel are estimated with a price of 1,20€ per liter but as we said before this price is on the rise so that mean that with the pass of the years this savings will be increased.

[14] Definition of "XXXXX": Total expense of municipalities regarding the processing of the waste not found.

Marketing analysis

SWOT Analysis

By doing a SWOT analysis (Strengths Weaknesses Opportunities and Threats) the group wants to analyses the market, the competition and the risks of producing biofuels from domestic waste by pyrolysis and gasification in Alblasserwaard and Vijfheerenlanden. This analysis will give a broad vision of the project market itself and its environment.

Strengths:

- Pyrolysis is a low-cost technology capable of processing a broad mixture of feedstocks, such as bio-oil, gases, bio-chemicals and charcoal.
- Reduction of environmental impacts (odors, pathogens, greenhouse gases).
- Renewable Energy Certificates[15] (REC's).
- Creation of value-added products (charcoal, methanol, syngas, bio-oil).
- Biobased, blue and circular economy friendly; huge support to become a more sustainable society; increase in the rate of recycling.
- Good paying green jobs, as a result of the previous strength.
- Decrease in landfill use.
- Reduction of carbon dioxide (CO2).
- Creation of new local jobs.
- Electricity generation.
- Reduce reliance on fossil fuels.
- According to Ecofys (2011) the Netherlands has the broadest biofuel distribution sector in Europe. Thanks mainly to the significant role of the ports of Rotterdam and Amsterdam.
- The European Union is the region of the world with the largest biofuels production volume and growth in the period of 2000-2010. [16]

Weaknesses:

- Economic feasibility not checked yet, due to the small number and limited scale of existing pyrolysis oil production units, the economics of a commercial scale unit can only be estimated.
- Pyrolysis technologies require high operational and investment costs.
- An air purification installation is needed in order to eliminate the gases that pyrolysis creates.
- Pyrolysis produces ashes that contain high metal compounds and are classified as a dangerous waste, which needs to be disposed of.
- Relatively expensive compared to fossil-based energy.
- The Dutch market of biofuels is producing below its whole capacity and its exporting most of their production. Furthermore, in this market blended biofuels have bigger numbers than pure biofuels.

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[15] Wikipedia: *"The Renewable Energy Certificate System (RECS) is a voluntary system for international trade in renewable energy certificates that was created by RECS International to stimulate international development of renewable energy. It advocates the use of a standard energy certificate to provide evidence of the production of a quantity of renewable energy, and provides a methodology which enables renewable energy trade, enabling the creation of a market for renewable energy and so promoting the development of new renewable energy capacity in Europe."*

[16] Source: International biodiesel markets: Developments in production and trade – Patrick Lamers (UFOP & ECOFYS)

Import, export and production of biofuels in the Netherlands (2012-2013)

Units: kton	Bioethanol, etc.		Biodiesel	
	2012	2013	2012	2013
Production capacity	Confidential	503	2051	2014
Production volume	Confidential	414	1177	1375
Net import pure biofuels	Confidential	-215	-849	-989
Net import blended biofuels	54	-9	-35	-54
Net export pure biofuels	Confidential	215	849	989
Net export blended biofuels	-54	9	35	54
Consumption blended biofuels	193	194	238	220

17

Opportunities:

- Buoyant energy prices.
- Contraction in waste and disposal costs.
- Stricter environment laws.
- Competitive lead.
- Inflation in raw material costs.
- Variation in waste and resource legislation.
- Switch in customer (for all companies) demands and expectation (a customer more aware of the environment).
- International agreements.
- Creation of high-skill jobs.
- Developing high-cascade products.
- A whole new market to dig into.
- Tendency in customers, companies and governments to be more concerned about their environment.
- The production of biofuels in the Netherlands mainly depends on the import of vegetable materials like palm oil originated from Indonesia and Malaysia.[18]
- The role of biofuels from waste and residues is increasing year by year.[19]
- The market of biofuels in the European Union has grown from 0,7 MTonnes in 2000 to 12,1 in 2010.[20]
- Biofuels are easy to source as they are made up from domestic waste, which is a renewable source of raw materials.
- Reduce dependence on foreign oil.

[17] Table reference: CBS (2014) Table “Biobrandstoffen voor het wegverkeer; aanbod, verbruik en bijmenging”

[18] Reference: Report “Biofuels on the Dutch Market” Anouk van Grinsven, Bettina Kampman, Thijs Scholten

[19] Reference: Report “Biofuels on the Dutch Market” Anouk van Grinsven, Bettina Kampman, Thijs Scholten

[20] Reference: International biodiesel markets: Developments in production and trade – Patrick Lamers (UFOP & ECOFYS)

Threats:

- Maintenance of low fossil fuel prices.
- Short-term vision of some companies.
- Risk of settle on what companies and individuals can do for the environment.
- Lack of information in the production of biofuels in the Netherlands, allowed by the Government.[21]
- Technical issue in engines: once an engine has been fueled by biodiesel it cannot be fueled ever again by normal diesel as the engine would stroke.
- High cost of production.
- Increasing development of electric cars.

Marketing mix[22]

Regarding the strategies and tactics this group has decided to implement, the marketing mix made for the final report will be used in this part too, as it may be the most useful way of explaining the choices concerning the strategic process of this project.

Product(ion)

Nowadays, domestic waste in the region Alblasserwaard and Vijfheerenlanden is being outsourced to be collected and to be treated. Governments of Alblasserwaard and Vijfheerenlanden have the need to deal with the domestic waste of their inhabitants, but they also have the need of becoming more and more sustainable, as the European Union is trying to with their policies regarding sustainability in the countries of the Eurozone. This report has come up with a solution that fits between these two needs, a pyrolysis plant to produce biodiesel out of domestic waste. Furthermore, this plant would also satisfy the needs for fuel of the machinery (machines, vehicles, heating, etc.) of these governments, as the biodiesel produced would be used to fuel them.

Our customer segment are the governments of this zone. This is our customer segment as they are the ones that are in charge of the domestic waste, a waste stream that can be much more valuable than it is right now by applying our solution.

The sustainability of the product and the process is already proven, but furthermore this biofuel could be used by our customer segment to fuel their own machinery, such as trucks, machines, public transport, heat, etc. Reaching this would make a sustainable circle that would benefit our customer segment. They would make a huge step towards sustainability, and could preach with their actions when they try to make new policies regarding sustainability. Besides, the externalities of this plant are minimum and the energy consumption too, as it produces by itself almost all the energy that requires to be working.

The competitors of this plant are the actual companies which are hired by the municipalities, Waarlanden and HVC. This plant is different from them, as it has a more sustainable process such as pyrolysis and a high value product such as biodiesel, which besides could be used by the customer for their own consumption by their machinery.

Regarding the positioning of this solution, the group would like to appear on the mind of the customer segment as a great approach towards sustainability and a way to show their own stakeholders that they are committing with the Earth's health by taking direct action.

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[21] Reference: Report "Biofuels on the Dutch Market" Anouk van Grinsven, Bettina Kampman, Thijs Scholten

[22] Definition of Marketing Mix: *"The marketing mix refers to the set of actions, or tactics, that a company uses to promote its brand or product in the market. The 4Ps make up a typical marketing mix - Price, Product, Promotion and Place. However, nowadays, the marketing mix increasingly includes several other Ps like Packaging, Positioning, People and even Politics as vital mix elements."* - The Economic Times

Place

As this new plant would be to be built from nothing and the group believes that this building should be as sustainable as possible, some characteristics are described in order to achieve that goal. A proper approach of these features would be the ones mentioned on "The sustainable business – Jonathan T. Scott", that is the reason why paraphrase it now:

"[…] This includes placing the building close to major transportation routes, locating next to hills or trees for protection from wind and sun, aligning the building with the sun's trajectory to maximize or minimize solar heat gain, and using the structural mass and shape of the building to the utmost benefit. […]"

There are many other characteristics mentioned in this book, but this one has been the most important one for the group.

It has taken into consideration implementing some sustainable characteristics of a new building as this report has focused on the development of a technique and a product, not the construction of the plan itself. Assuming these implications, the place to be built the plant should be inside the region of Alblasserwaard and Vijfheerenlanden and exactly in the place that matches the most recommendations and features previously paraphrased.

The reason of this building for being sustainable relies on the 2030 energetic goal. It would be a mistake to focus only in processes and products and not paying attention to the fact that the way the plant is built may also contribute to the achieving of this goal, which is the main reason for the writing of this report.

Price

The group still has not found an exact price because of the lack of information. Nevertheless, an estimated price will be provided for the customer in the final report. Right now, the calculations don't show a reliability enough to put them in this assignment, but as it has been learnt in this subject, the price may be higher than normal diesel, but the efforts will go on shortening the gap between the estimated price of this group's biodiesel and common diesel.

Promotion

Promoting the plant requires a good approach of communication towards the customer segment, its main purpose is to let the customer know why this group believes this plant may be the best solution for its needs.

To do so, the approach and the message are going to be based on a way of communicating inspired by the book *Start with why* by Simon Sinek, which gives a different approach than the commonly used in marketing nowadays. This kind of approach is based in a concept called *the golden circle* and it's briefly explained in a TED Talk made by Simon Sinek[23], in addition of his book. That's the reason for the message towards the customer segment it is going to focus on the *why* of the report, *why* doing what the content of the report wants to do.

The 2030 energetic goal and the sustainability beliefs behind it are the main reason to get this plant done. Governments and municipalities need to take an important role towards the achievement of this goal, not only for them and their actual inhabitants, but for the future generations that may come too. This role has been mainly regulatory and political, but this group thinks it is the time for the administration to star preaching with their actions. Trias Energetica thinks that because it could make a huge difference in the concerns of the society of the region, from inhabitants until companies. Starting acting towards sustainability may be the beginning of the concern of the population to achieve the 2030 energetic goal and being a land that has

[23] Explanation of this approach: TED – https://www.ted.com/talks/simon_sinek_how_great_leaders_inspire_action?utm_source=tedcomshare&utm_medium=referral&utm_campaign=tedspread

sustainability as one of their principles. The time for acting has come and the customer segment has a good opportunity to make a giant step towards sustainability.

Canvas business model

In order to give a broader vision about the business model of this plant here is disguised a Business Canvas Model board[24], it is a very useful and dynamic tool to get to know the business model of a new idea:

Business Canvas Model board of this project

Key Partners:	**Key Activities:**	**Value Propositions:**	**Customer Relationships:**
The main suppliers of our plant are the citizens of the zone, as the plant will treat their domestic waste.	• Collect the domestic waste. • Produce biodiesel by pyrolysis and gasification. • Fuel the machinery of the customer segment.	This plant will solve the problem of the customer segment of becoming more sustainable, by dealing with the domestic waste with a very innovative technique and producing a high value product such as biodiesel. This product will also solve the need of the customer segment of buying diesel to run their utilities. This plant is creating a highly sustainable process from which the customer segment will get a renewable source of energy.	The customer relationship must be very close and trustworthy, as this whole plant needs of the legal allowance to start working and to keep it running.
Cost Structure:	**Key Resources:**	**Revenue Streams:**	**Channels:**
The most expensive cost are the fixed costs related to the building of the plant and the buying of the pyrolysis and gasification machines, also related to the buying of the trucks to collect the waste.	Domestic waste from the citizens is the main raw material the plant needs. Allowance from the customer segment to do the key activities of the plant.	The customer segment would be in charge of financing this business, as they are the ones in charge to deal with the domestic waste of their citizens. The main revenue will come from the long-term savings of having a renewable resource of fuel.	The collection of the domestic waste will be made by trucks owned by the plant and the fuel of the utilities of our customer will be made in the plant.
			Customer Segment:
			The customer segment this business will directly create value are the municipalities of the region and, indirectly, their inhabitants.

[24] Reference: Strategyzer – https://strategyzer.com/

Laws and regulations

As we are operating in the Netherlands, our main sources of information about applicable laws, regulations and possible subsidies are the European Union and the Government of the Netherlands (including the governments underlying the principal one of the country, such as provinces). The full content of the legislation concerning sustainability can be seen in Appendix II.
It has been also found that almost all national legislation on the environment is incorporated in the Environmental Management Act, see Appendix III.
It's also useful to know that the main minister responsible for environment is the Ministry of Infrastructure and the Environment, which will be a crucial source of information if needed.
Regarding subsidies there has been found an interesting article, which contains information about subsidies for environmental projects, which can be consulted in Appendix IV. These subsidies can be determinant for any company to invest in a project of the characteristics of the one explained in this report. This report focuses on governments as customer segment but they also can give subsidies to private partners to develop this project, instead of investing directly.
Regarding biofuels, there has been some research in the European and Dutch policies, which can be found in Appendix V.
The main purpose for checking the legal frame is to find any legal inconvenient which could interfere in the development of the plant and after doing research regarding this legal framework the group has not found any reason to worry about legal impediments.

Conclusions and advice

Conclusions

The conclusions of the report are made from different points of views, regarding finance and marketing.
For the operational costs, the amount that pyrolysis by itself adds is 0,06 cents per litre. for the case we made to produce bio-diesel, specific Dimeth-ylether, the costs will rise significantly. as stated in the theoretical background we need to add gasification and a chemical reaction of Fischer-Tropsch to the process chain. the gasification process requires much energy to run and the chemical process even more because of the exothermic reaction needs to be cooled to run and this will result in a mixture of carbohydrates. This mixture needs to be separated to get proper Dimeth-ylether for own or commercial use. this last step the most resource heavy of the whole process and will contribute around 40 to 90% of costs. we suppose for the whole process, an estimate of 1 euro will suffice.
From the marketing point of view, this project has a proper market to be accomplished and enough strengths and opportunities to invest in it.

Advice

In our advice report, we tackled the production of bio-diesel(DME specific) as a case. We heavily advice to do a further study on all possible products which can be made through pyrolysis. As seen in our calculation for the operational costs, it only add 0,06 cents if you process all the organic waste in the region.

Appendix

- **Appendix I:** stakeholders analysis of the client, Blauwzaam.

This stakeholder analysis will be made from the position of our client, Blauwzaam, since it's a very useful way of making this analysis. Mainly because doing it from the point of view of the group would be a mistake, as has been explained in class.

First of all, the concept "stakeholder" will be defined: the ones who are affected or may be affected by the activities of a company. With this vital concept defined, we proceed to list and briefly explain Blauwzaam's stakeholders, which are the following:

- Municipalities: classified as government and potential customers, they are the ones who establish the rules of the game and the ones capable of conceding subsidies to certain vital activities of the economy.
- Entrepreneurs: customers, they are the chain link in charge of starting up companies, which will contribute to the 2030 energy neutral goal. Also included already working companies willing to contribute to the goal.
- Banks: investor's classification, they have the power to make the difference between an idea and a company with the credits they can give to entrepreneurs and farmers.
- Farmers: classified as investors and customers, their farms can become more sustainable and also contribute to the goal by producing biobased energies.
- Inhabitants: potential customers and investors, also they are part of the link chain known as society.
- Finance partners: investors from Blauwzaam, which financially contribute to the NGO to keep it running. Besides donations, these partners also have signed the 2030 energy neutral goal commitment.
- Participants: potential investors that also are part of Blauwzaam, but they have only signed the 2030 energy neutral goal commitment.

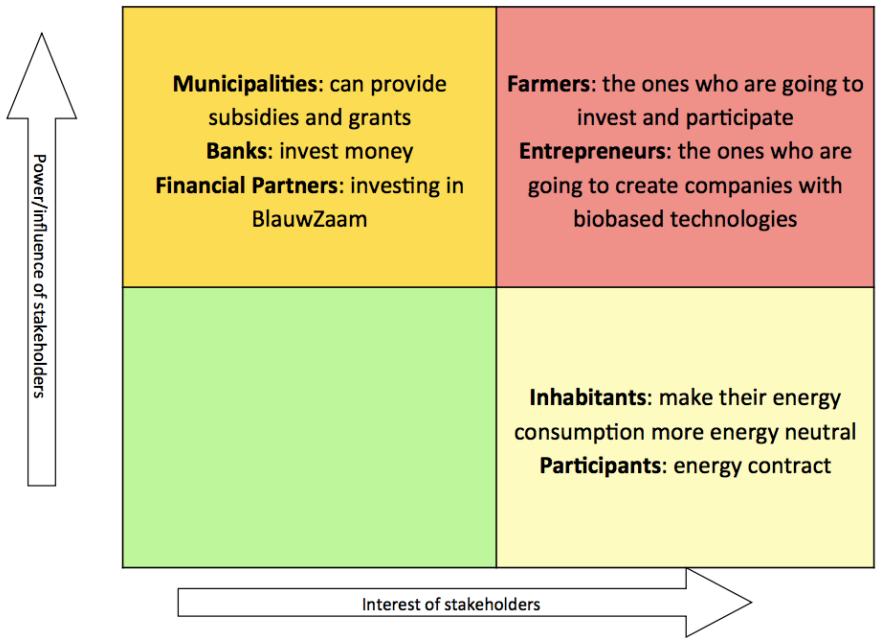
Secondly, the different interests of the stakeholders will be discussed, as they are not the same and have various pursuits among them.

- Municipalities:
    - Finance: on one hand, they are the ones in charge to distribute subsidies to companies. On the other hand, they collect taxes from the companies, and the better companies go more taxes they will collect.
    - Environment: every government has to take care of the environment of the region they administer, they are concerned about their sustainability too.
    - Legislation: they do the laws, and laws can help to achieve the 2030 energy neutral goal.
    - Reputation: as people elect their government, the reputation of the municipalities is crucial to be elected, and environment has something to say in it.
- Entrepreneurs:
    - Finance: they need funding to raise their biobased start-ups.
    - Environment: as their companies will be biobased, environment will benefit from them.
    - Legislation: they may need subsidies to run their activities and they also may need a favorable legal framework.
    - Sustainable: these new companies will have sustainability as one of their hallmarks.

- Banks:
    - Finance: key players to give credit to the stakeholders interested on investing in biobased technologies, from entrepreneurs to inhabitants.
    - Reputation: there is a tendency in banks to care about social responsibility, the 2030 energy neutral goal is one way for them to show their concern about environment.
- Farmers:
    - Finance: in order to decrease their costs and optimize their waste streams, biobased technologies are a good investment to dig in.
    - Environment: their concern in environment directly follows the pollution and waste limits that legislation draws.
    - Legislation: they need to obey the law, just like everybody, and they are also concerned about the subsidies they can receive if they invest in certain biobased technologies.
- Inhabitants:
    - Finance: renewable and biobased energies need an initial investment, but they would have a return on that investment by the sustainability of the energies they are using, as they are cheaper in long term.
    - Environment: some of the inhabitants show concern about the environment and the ones who don't at least obey the laws about it.
- Finance partners:
    - Finance: as they contribute to Blauwzaam with donations, they are interested in the same goal as the NGO.
    - Environment: they are concerned about it by being a supporter of Blauwzaam.
    - Reputation: taking care of the environment raises the reputation of companies.
    - Sustainable: sustainability is one major characteristic in the success of a company.
- Participants:
    - Environment: they show care about the environment by signing Blauwzaam's commitment.

Thirdly, as stakeholders they have influence in the company and relate between them and the company. These relations and influences will be explained here:

Influence and relations



Lastly, every company needs to have a good relationship with their stakeholders in order to achieve their goals, prioritizing their importance. For this reason, we will describe here these relations and stakeholders' value (stakeholders' importance will be graded with this scale from more important to less important: key players, meet their needs, show consideration, least important):

- Municipalities: meet their needs; appointments and meetings would be arranged in order to explain the goal and the need involving a public figure like the government.
- Entrepreneurs: key players; explaining them how they can optimize their procedures and the way they can be more sustainable.
- Banks: meet their needs; show them some of the benefits of investing money in projects like this one.
- Farmers: key players; interviews and meetings in order to know their needs and their position with the project.
- Inhabitants: show consideration; the client can provide us the ways of communication of the most important inhabitants and participants. The benefits of energy neutral. Interviews and inquiries will also be arranged.
- Finance partners: meet their needs; they may gain good reputation by investing on projects, which solve people's problems and support a more sustainable planet.
- Participants: show consideration; the client can provide us the ways of communication of the most important inhabitants and participants. The benefits of energy neutral. Interviews and inquiries will also be arranged.
- **Appendix II:** Laws regarding environment in the Netherlands found in the website of the Dutch Government.

  "Some 80 % of Dutch legislation on the environment is derived from EU legislation. The national Environmental Management Act, which sets out how the environment is to be protected, is based on EU legislation and regulations.
  The Netherlands contributes to the development of EU policies on the environment and to other policy areas with either direct or indirect bearing on creating a sustainable living

environment in Europe and the Netherlands.
The main political driving force for improving the quality of the environment and human health is the EU Treaty and the body of legislation to be adopted by the Member States. This covers aspects ranging from protecting ecosystems and biodiversity, improving water supply, to reducing noise pollution.
EU environmental regulations have a major impact on national policy, for instance:
Climate change: The EU has an agreement to reduce emissions of greenhouse gases in 2020 by 20 % on 1990 levels.
Sustainable Consumption and Production: The EU is implementing an ambitious Action Plan to stimulate sustainable production and consumption in key economic sectors such as food, transport, and energy. This is a crucial stepping stone to making the economies of the EU Member States sustainable and resource efficient."

- **Appendix III:** partial content of the Environmental Management Act from the Netherlands.

"This act sets out an integrated approach to environmental management in the Netherlands and provides the legal framework by defining the roles of national, provincial or regional, and municipal government.
The Act stipulates the tools to be used in environmental management including:
Environmental plans, for instance, the national waste management plan that regulates municipal waste collection, disposal of discarded equipment such as refrigerators and TVs, and permits for hazardous waste shipment.
Environmental quality criteria for emissions and discharges of harmful substances such as greenhouse gases and heavy metals to air water and soil.
Environmental impact assessment is a prerequisite for the construction of major infrastructure such as oil refineries, nuclear power plants, chemical plants, roads, railways, and oil and gas pipelines.
Environmental permits: In addition to regulations for the emission of substances harmful to the environment, large companies, such as chemical plants, are required to obtain environmental permits that stipulate limits for the discharge of substances harmful to the environment.
Environmental reporting is directed to stimulating companies to make production cleaner and more environmentally friendly. Many companies such as those involved in metal processing and chemical production are required to publish an annual environmental report. The Ministry is responsible for ensuring that the reporting requirement of the EU Pollutant Release and Transfer Register (PRTR) are met. Those companies and organizations required to prepare an Integrated PRTR report on waste, air emissions (greenhouse gases), and discharges into water sources are listed in the Publicatieblad van de Europese Unie Bijlage II van de EG-verordening PRTR.
Enforcement: the Human Environment and Transport Inspectorate is largely responsible for ensuring the provisions of the Environmental Management Act are enforced. Enforcement is also a task of the municipalities, the police and the justice system."
There has been also found regulations about biofuels:
"Use of biofuels –liquid or gaseous fuel for use in transport and produced from biomass can make a significant contribution to reducing greenhouse gas emissions. The EU Directive on Renewable Energy sets targets to stimulate the use of sustainably produced biofuels and the Netherlands Parliament has implemented these in national legislation.
As biofuels are produced and traded on a global scale, international agreements are essential to ensure sustainability. The Ministry of Infrastructure and the Environment represent the Netherlands in the Global Bio-Energy Partnership.
EU Directive on Renewable Energy
In 2011, the Dutch parliament incorporated the provisions of the EU Directive on Renewable Energy into national legislation. The EU Directive sets ambitious targets for all Member States to increase the proportion of energy from renewable sources including biofuels to 20 % by 2020, and in the transport sector to 10 % by the same year.
Target
The Netherlands will implement the EU Directive by gradually increasing the proportion of energy from renewable sources such as biofuels, biogas and electricity for road transport. The aim is to build confidence that biofuels are a viable energy source and to move

gradually towards the EU target of 10 % share of biofuels by 2020 in the transport sector. The Netherlands is continuing to implement policy to meet the EU targets in increase the proportion of renewable energy to 4,25 % in 2011, to 4.5 % in 2012, to 5 % in 2013 and 5.5 % in 2014. Biofuels produced from waste, residues, non-food cellulose material and ligno-cellulose material may be double-counted.

Sustainability criteria

Biofuels to be included in meeting the renewable energy targets have to meet the sustainability criteria under the EU Directive for the production of biofuels and liquid biomass. Sustainable means that production of biofuels respects biodiversity rich areas, primary forests, peat lands and contributes to reducing greenhouse gas emissions.

Indirect change in land use

The Directive incorporates sustainability aspects for which as yet there are no strict requirements. One such aspect is reducing the negative consequences of indirect change in land use. The Netherlands is proactive in the EU in developing measures to reduce these negative impacts.

Global agreements

Much biomass is produced and used in countries outside the Netherlands, and international agreements need to be made on sustainable production. The Netherlands is working with other countries on developing policy for sustainable production of biofuels and liquid biomass. Ministry of Infrastructure and the Environment is member of the Global Bio-Energy Partnership (GBEP). GBEP is a global cooperation of governments, international organizations, and companies to advance sustainable use of bio-energy.

In The Gleneagles Plan of Action (July 2005), the G8 +5 (Brazil, China, India, Mexico and South Africa) included the launch of the GBEP to support wider, cost-effective biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent. GBEP has since been expanded with other countries including the Netherlands. GBEP has developed sustainability indicators for bio energy for national voluntary use. Currently these indicators are being tested by several GBEP partners and their use promoted in other countries around." [13]

- **Appendix IV:** information regarding grants and subsidies in the Netherlands regarding renewable energies.

"In times of economic recession, it is still important to work on protecting and improving the state of the environment. If a company does not have the budget for environmental measures, it could consider applying for an environmental subsidy or tax benefit. In the Netherlands there are several subsidies and tax benefits available, discussed below in this article. However, companies may want to act fast, as the Budget Memorandum (Miljoenennota) of 2011 points out that the Dutch government intends to cut spending. This may result in a reduced budget for the subsidies and tax benefits discussed below.

Environmentally friendly products

The Indicative Rule random writing-off and investment deduction environmental investments (Meldingsregeling milieu-investeringsaftrek 2001) consist of two lists: the Environment List Indicative Random Writing-Off Environmental Investments (VAMIL-list) and the Environmental Investment Deduction (MIA List). MIA and VAMIL both have the goal of stimulating investment in environmentally friendly products.

The MIA and VAMIL lists have a great deal of crossover and are virtually identical, but are two separate fiscal incentives. As a result, most environmentally friendly products and processes are eligible for fiscal incentives under both schemes.

VAMIL provides liquidity (cash flow) and interest advantages to companies by allowing delays in payments of tax through the random writing-off of certain environmentally friendly investments. MIA is a fiscal-deduction rule, under which 15%, 30% or 40% of certain environmental investments are deductible from pre-tax profits.

In order to qualify for the list, products must be new, must offer significant improvements in environmental efficiency and must have a broad application potential. This means that the tax benefits only apply to industrial equipment that can make a substantial improvement to the environment.

The capital equipment to which the lists apply, include superior technology in the following fields:

- *Sustainable means of production;*
- *Climate change;*
- *Air pollution;*
- *Nuisance and health;*
- *Mobile tools and means of transport;*
- *External safety and preventive provisions;*
- *Bio-diversity and natural surroundings;*
- *Saving on raw materials and re-use; and*
- *Waste flows.*

Subsidies for environmental technology

The Rule on Subsidies for Environmental Technology (Subsidieregeling milieugerichte technologie) has the overriding goal of developing more environmentally friendly technology through the provision of subsidies. Projects for which subsidies are available must involve at least one party based in the Netherlands and have to meet the objectives of the Program Environment and Technology (Programma Milieu en Technologie). These objectives are aimed at Small and Medium Enterprises (SMEs) in the Netherlands and involve environmentally targeted innovations initiated by the industry or innovations within the industry. Applications for this subsidy need to be submitted to Agency NL (Agentschap NL).

Green Projects

The Rule Green Projects 2010 (Regeling groenprojecten 2010) is a tax legislation measure, and is intended to encourage the public to accumulate savings by granting a tax benefit to savers who invest money in green funds. The Rule Green Projects 2010 applies to, amongst others, the following investment projects based in the Netherlands:

- *Nature. This includes investment projects focusing on the development and maintenance of forests and projects focusing on the development and maintenance of new nature and landscape values.*
- *Agriculture. Includes projects focusing on sustainable dairy farming; greenhouses with low energy consumption and low environmental impact for cultivating horticultural crops on a commercial basis; and sustainable breeding of fish and shellfish.*
- *Recovery and reuse. Includes other projects focusing on CO2 capture, transport and storage, detoxification and dismantling of ships, recovery and reuse of certain materials.*
- *Sustainable energy. Includes projects focusing on generating renewable energy from wind and solar energy, hydropower.*
- *Energy saving. Includes projects focusing on energy saving by means of heat pumps, heat/cold storage, low energy exterior lightning, useful application of residual heat, etc.*
- *Sustainable construction. Includes projects focusing on building or renovating houses and non-residential buildings that meet specific criteria concerning material use, insulation, indoor climate and energy/water conservation.*

A project can receive a low-interest grant if it is necessary to protect the environment, including nature and forests.

Sustainable energy production (SDE)

The Decision stimulation of sustainable energy production (Besluit stimulering duurzame energieproductie - SDE) aims to promote the generation of energy from sustainable sources. Anyone who produces energy in a sustainable manner is eligible for subsidies. However, private individuals can only claim subsidies for solar panels. Applications can be submitted for solar panels, wind energy on land, biomass, waste incineration, landfill gas or biogas from waste water or sewer water purification installations, water power and combined heat and power sources. Under the Rule on subsidies for wind energy at sea

2009 (Regeling windenergie op zee 2009), applications can be submitted for generation installations that produce renewable electricity using wind energy at sea. Applications for the aforementioned subsidies need to be submitted to Agency NL.

Energy investment deduction (EID)

The Energy Investment Deduction (EID) was introduced by the Implementation Rule Energy-Investment Tax Deduction 2001 (Uitvoeringsregeling energie-investeringsaftrek 2001) and is designed for businesses that want to invest in energy-saving techniques and the application of renewable energy in their company. Under the EID such investments can double as a business advantage. Not only do businesses save on energy costs, but they will also pay less income or corporation tax. Applications for EID need to be submitted to Bureau Investment Rule and random writing-off (Bureau investeringsregeling en willekeurige afschrijving (IRWA)).

Subsidies for energy and innovation

Under the Subsidy Rule Energy and Innovation (Subsidieregeling energie en innovatie) subsidies can be given to projects/research on energy saving, sustainable heath for existing houses, sustainable biomass import, investments for reduction electricity connection of heat pump holders, covering risks of geothermal heat, biomass gasification, gasification and wind energy on the sea. Subsidy applications need to be submitted to Agency NL.

Subsidies for vehicles

Under the Subsidy Rule for motor vehicles with diesel motors and right to return on BPM, a subsidy of EUR 400 is available for vehicle owners of motor vehicles with diesel motors that emit less-polluting gases (for example NOx).

These environmental subsidies and tax benefits provide companies in the Netherlands with opportunities to protect or even improve the environment. In many cases, adopting these measures will result in multiple benefits – reduced business costs through improved efficiency as well as environmental benefits." [14]

- **Appendix V**: law and policies regarding biofuels in the European Union and in the Netherlands explained in the report *The biofuel market in the Netherlands in perspective* by Marie-Louise van Hasselt.

[…]

"3. Biofuel policy development

In order to determine who the decision makers are of EU and Dutch biofuel policy, an understanding of the political process behind biofuel policy is required. This chapter will answer the question: How are choices made concerning biofuel policy? In section 3.1 the political process and the developments of the biofuel policy will be described. In section 3.2 the EU policy measures will be explained. Section 3.3 will describe Dutch biofuel policy.

3.1 The political process

According to public choice theory, political processes are dominated by self-interest. Decision makers, just as all other people are predominantly self-interested creatures (Heckelman, 2004). Who are the decision makers with respect to biofuel policy? In the European Union's political system the main decision makers are: The European Commission, the Council and the European Parliament. The Commission consists of a president and commissioners; one from each Member State. The Commission makes proposals for new legislation, which the Parliament may accept, reject or amend by a simple majority vote. If accepted by the Parliament, the proposal goes to the Council. If the Council accepts the proposal it becomes law (Meuller, 2003). The power of the Parliament has increased in recent decades. The power of the Parliament increased in recent decades. Parliament has legislative power over various domains; It is responsible for the EU budget and co-decides concerning Common Agricultural Policy (CAP). Parliament can exert influence by putting pressure on Commission and Council to take measures on certain subjects (Hix, 2007). The European Parliament has representatives elected by the people of each Member State. As the number of seats in the European Parliament depends on the size of the population of each country, Germany, France and

the United Kingdom have the greatest representation in the European Parliament (Mueller, 2003; European Parliament Resolution, 2013).

Biofuel policy development

When were biofuels first included in EU policy and why? In table 3.1 it is shown how policy on biofuels has developed over the last years up till now. The reasons for the introduction or change of biofuel legislation, the legislation and the concerning target are schematically shown.

Table 3.1 EU biofuel policy developments, 2003 - 2013 Year	*Reason*	*Rule/law*	*Target*
2003	*To improve energy security, support agriculture and reduce greenhouse gas emissions*	*Biofuel Directive*	*To mix 2% of the energy content of fossil fuels with biofuels in 2005*
2009	*To reduce the most important emissions during biofuel production*	*The Renewable Energy Directive and the Fuel Quality Directive*	*Reach a 10% share of renewable energy in the transport sector and reduce CO_2-intensity by 10% in 2020*
2013	*To limit global land conversion for biofuel production*	*The Renewable Energy Directive and the Fuel Quality Directive (Amendment)*	*To produce biofuels that doesn't originate from land with a high biodiversity value or with high carbon*

2003: In 2003 biofuels were first mentioned in EU policy, namely in the Biofuel Directive created by the European Parliament and Council. The reasons for introductions were: to improve energy security, support agriculture and reduce greenhouse gas emissions. Member States were not obligated to incorporate the Directive in their national legislation. The target was to mix 2% of the energy-content of fossil fuels with biofuels in 2005 (Biofuel Directive (2003/30/EG). The next initiative with respect to the use of biofuels was the Biomass Action Plan. The plan set out a series of Community actions and responded to a threefold objective: further promotion of biofuels in the EU and in developing countries, preparation for the large-scale use of biofuels and increased cooperation with developing countries in the sustainable production of biofuels (Biofuel Action Plan, 2005). As a follow up, the next year the European Commission introduced "An EU strategy for Biofuels" in which the Commission brought forward a report on the implementation of the Biofuels Directive and the possible revision of the Directive.

2009: Three years later, in 2009, the European Commission incorporated measures with respect to biofuels in two mandatory Directives: The Renewable Energy Directive (RED) and the Fuel Quality Directive (FQD). At the same moment the Biofuel Directive (2003/30/EG) was withdrawn. The Renewable Energy Directive set a compulsory goal: Reaching a 10% share of renewable energy in the transport sector in every Member State by 2020. The Fuel Quality Directive (2009/30/EC) introduced the mandatory target of achieving a 6% reduction in the greenhouse gas intensity of fuels used in road transport by 2020.

2013: Currently there are two proposals of the European Commission published respectively in October 2012 and January 2013. The aim of the proposals is to reduce greenhouse gas emissions associated with biofuel production and further stimulate advanced biofuels while protecting existing investments (2012/0288 (COD)). Under

current legislation sustainability criteria to minimize greenhouse gas emissions are taken into account. However, the greenhouse gas emissions associated with land conversion and deforestation due to indirect land use changes are not yet taken into account. The proposals advocate for limiting the amount of food food-based biofuels to a maximum of 5% without modifying the 10% renewable energy target in 2020. In the next section the proposed measures are further elaborated on (2012/0288 (COD)).

3.2 EU policy measures

As mentioned before, the Renewable Energy Directive and the Fuel Quality Directive are the directives that cover the biofuel targets. A directive is a legislative act of the European Union, which requires Member States to achieve a particular result without dictating the means of achieving that result (Folsom et al., 1996) The two directives cover two main targets with respect to the use of biofuels: reduction of greenhouse gas-emissions (GHG-emissions) and a sustainable use of biofuels. In this section the targets and the measures to reach the targets will be described.

Blending mandates As mentioned before, according to the RED 10% of the transport fuels should consist of renewable energy. Renewable energy for transport includes biofuels such as biodiesel and bioethanol, renewable electricity, wind- and water energy and hydrogen. The EU uses a score system to count the quantity of biofuels and other renewable energies used by Member States. With respect to the use of biofuels there are three blending options: Mix the fuel with biofuel (low blends), use bioethanol (high blends) or use pure bioethanol (RED).

Greenhouse gas-intensity

In 2020 the greenhouse gas-intensity (also CO_2-intensity) should be reduced by 10%. CO_2-intensity is defined by the quantity of CO_2-emissions throughout the complete lifecycle of the biofuel, per energy-unit. The greenhouse gas-intensity is calculated on a life-cycle basis. This includes all relevant stages from extraction or cultivation, including land-use changes, transport and distribution, processing and combustion. According to the Fuel Quality Directive the "life cycle greenhouse gas emissions" means all net emissions of CO_2, CH_4 and N_2O that can be assigned to the fuel (including any blended components) or energy supplied (FQD (2009/30/EC); Agentschap NL, 2011).

Sustainability requirements

Biofuels, whether locally produced or imported, have to comply with sustainability criteria. These criteria aim at preventing the conversion of areas of high biodiversity and high carbon stock for the production of raw materials for biofuels.

- *Biomass cannot originate from land with a high biodiversity value such as primeval, protected nature reserves and grasslands with a high value of biodiversity.*
- *The biomass cannot be produced on land with high carbon stocks, such as wetlands and continuously forested areas. This is also applicable to peat land, unless it is shown that the biomass production does not lead to drainage of formerly non-dewatered soil (2009/28/EC).*

Indirect land use change (ILUC)

Due to the introduction of the blending mandate, it happens that agricultural land, originally used for food production, changes of purpose, namely for biofuel production. In order for the farmers to continue food production, non-agricultural land (such as forests) is converted into new cropland. As a result, greenhouse gasses are emitted and biodiversity may be decreased (Peters et al., 2013). The policy instruments that are suggested in the two proposals to reduce these effects are the following:

- *Limit food food-based biofuels (first generation) to a maximum of 5 (also called a 5% CAP) of the targeted 10% in 2020 stated in the RED;*
- *Additional support for advanced biofuels by weighting differently their contribution to the 10% target (Double and quadruple counting);*

- *Obliging Member States and fuel suppliers to report the estimated indirect land-use change emissions of biofuels;*
- *Strengthening the sustainability criteria: 60% of Greenhouse Gas savings for all new plants (EU Proposals 2012/0288 and (2013)17, EC).*

5% CAP

One of the proposed measures to minimize indirect greenhouse gas emissions is to limit food-based biofuels to a maximum of 5% in 2020. The European Commission proposed the following addition to the Renewable Energy Directive:

"(d) for the calculation of biofuels in the numerator, the share of energy from biofuels produced from cereal and other starch rich crops, sugars and oil crops shall be no more than 5% (..) of the final consumption of energy in transport in 2020."

The proposal states that the Member States are free to decide their own percentage CAP adapted to the existing investments, so that such installations are not affected by the measure (2012/0288/(COD)).

3.3 Dutch biofuel policy

Member States should meet the targets of the RED and the FQD, however Member States are free to design their own strategies on how to reach these targets. In 2007 the Netherlands introduced a b lending mandate, introducing a target of 5.57% blending of biofuels in 2010. In 2008, Minister Cramer (Infrastructure and Environment) reduced the 2010- target from 5.57 to 4%. In 2009 the Netherlands delivered an action plan to the European Commission. The Dutch legislation has adopted the CO_2-reduction and renewable energy production targets and has set goals up to 2020 (Nationaal Actieplan voor Energie uit Hernieuwbare bronnen, 2009/28/EG) (Agentschap NL, 2012)."