

Name: Juriaan Zandvliet

Student number: 291380

1. Background

Biomass is organic matter formed by plants, mostly using photosynthesis. It has been used on a small scale for producing energy in the form of warmth and light for a long period of time. This changed after the oil crises in 1973.

This crisis was a result of the Yom Kipur War between Israel supported by the United States and Egypt and Syria. Because of this war oil producing countries (OPEC) raised the oil price by 70% and decreased the oil production by 5% every month. Countries that supported Israel directly even got banned from trade completely like the United States, the Netherlands and other Western countries. The oil market was in a supply shock.

In the years before the oil crisis of 1973 economic growth was big and the demand for cheap energy from oil grew largely. This made the energy mixture one-sided based on oil (Figure 1). The energy market was vulnerable to treats from supplying countries and the power of these countries was underestimated.

Because the military power of the oil producing countries was low in comparison with the West the embargo was lifted after a short period of time. Also non OPEC countries still traded oil to the West. But although the effect of the oil crisis on the economy was limited it changed a lot when it comes to the energy mixture in forthcoming years.

The crisis has shown the vulnerability of one-side energy supply and energy import.

In the forthcoming years policies were implemented to diversify the energy mixture of countries affected by the oil crisis to make them more independent. In Scandinavian countries like Sweden and

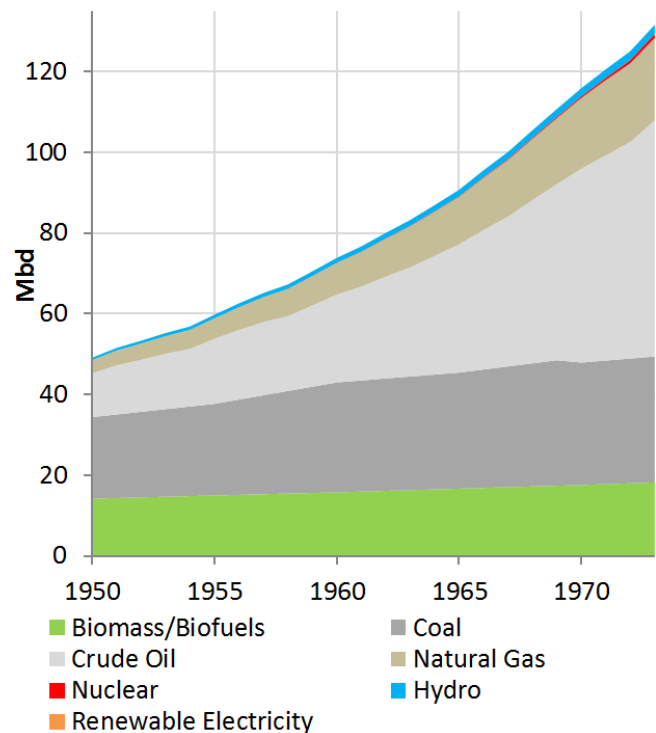


Figure 1 Energy mixture before oil crisis

Finland this caused a shift from energy from oil to energy from biomass. An energy source that is widely available in the country and causes independence.

Oil is still the cheaper energy source by far but because of the reasons listed above there is political interest in diversifying the energy mixture.

2. The role of policy

The role of policy is fundamental when studying the development of bioenergy in Europe. There are different benefits produced by the use of wood biomass for energy, which have been encouraged through different policies. A lot of these benefits are indirect and are not effecting the price of the good. These are called externalities, whether positive or negative.

Following some examples if externalities when it comes to energy from biomass.

+ Carbon neutral	- Cost
+ Availability	- Carbon neutrality
+ Local driver (economy)	- Deforestation
+ Energy sovereignty	- Loss of nutrients
+ Diversify	- Competition with food

Externalities require political actions to make the best decisions. There are types of policies related to bioenergy, these are: climate policies, agricultural policies and energy policies. These all have different intentions and interest so sometimes it is possible that these policies contradict each other on a national or international scale.

On an EU level the *energy policy* tries to secure a stable energy supply, protect the environment and promote competition. The energy policy is from great importance, in 2005 50% of the energy came from outside the EU. Examples political measurements are renewable targets, renewable energy roadmap and energy-climate change.

The *Agricultural policy* tries to increase the productivity, create a fair standard of living for farmers, guarantee of secure supply of food and create a reasonable retail price for consumers. Compared to other branches the agricultural policy is of most importance. In 2010, the EU spent €57 billion on agricultural development, of which €39 billion was spent direct on subsidies. Agricultural and fisheries subsidies form over 40% of the EU budget (EU Budget, 2010).

The *climate policy* tries to reduce greenhouse gases, increase the share of renewable energy and to improve energy efficiency. One of the instruments is the so-called 20-20-20 targets. By 2020 greenhouse gases should have been reduced by 20%, renewable energy increased by 20% and energy efficiency improved with 20%. Also consist of promoting other fuels with less emission.

A policy instrument is the European emission trading system (EU ETS). It is the first large greenhouse gas emissions trading scheme in the world. It was launched in 2005 to fight global warming and is a major pillar of EU climate policy. A maximum (cap) is set on the total amount of greenhouse gases that can be emitted by all participation installations. So called allowances for emission are then auctioned off or allocated for free, and can subsequently be traded.

During economic recessions the demand for carbon allowances might be low. This is because the demand for energy or other product is low. As an example during the economic crisis in 2007 the price for carbon allowances was so low that the bioenergy power plant in Joensuu could burn a lot of peat. This non sustainable energy source meant the power plant had to buy more allowances but because of the low price this was still more profitable than burning the more expensive biomass.

1. Description of the most common policy instruments to promote bioenergy development
2. Review of externalities produced by bioenergy utilization

3. Economic instruments

Economical instruments in energy policy can focus on the two sides of market trade: demand and supply. The market price is set by the demand and supply curve. When the price rises the demand will go down but supply will go up and vice versa. The effect of a changing price on the demand or supply is called elasticity. When the quantity changes a lot the product is elastic, when the quantity changes little the product is called inelastic. Examples of inelastic goods are oil, energy and food.

Elasticity effects the intensity of the economic instruments needed to accomplish the goals. With a very elastic product a small subsidy can cause big changes in demand or supply and vice versa. For instance: the demand curve of food products can be considered very inelastic, the demand will not change a lot when subsidies are given to these products.

Taxes and subsidies are examples of economic instruments to influence markets. There are different ways to implement these instruments. You can put taxes on consumption or production. The effect might be the same achieving lower quantities but the road towards it is different.

Taxation is used to discourage the use of market product, this can be done to compensate for negative externalities created by the use of the product. Subsidies can be given for product to compensate for positive externalities. For instance with the use of bioenergy, a positive externality is the effect on the local economy, for this reason subsidies can be given to promote the product.

Taxation and subsidies can also have indirect effects on other markets. By putting taxes on oil based energy the use of alternative energy sources might flourish by gaining competitiveness.

It is a game on how high taxes or subsidies should be to become effective without too much costs or effort. It has all to do with competitiveness and elasticity and reaching a turning point. When a subsidy is too low it might have no effect, when it is too high your losing money on the subsidy.

1. Effects of the subsidies in the markets as a tool to promote bioenergy
2. Effects of the taxes in the markets as a tool to promote bioenergy

4. Adoption dynamics in bioenergy

Bioenergy has positive externalities, to take these into account policies are needed. There is a conflict between the plantation owners and the policy maker. For the plantation owner his plantation is his business and he made investments into it. For the policy maker the energy from the plantation is just a share of the energy mix. The two have different perspectives, goals, objectives and shares.

A policy tool used during shortage of a product to reduce consumption is ration. During the oil crisis some countries set rations to the oil consumption and thereby limiting the quantity allowed to use. This is a very extreme policy measure and causes a lot of disruption in a market, it is only used under extreme circumstances.

A much less disruptive and less acute policy measure is providing research grants on specific topics to promote certain sectors like bioenergy. The effect is slow but the effect last much longer. This is a part of a capacity building. An organisation or individuals can provide the market with a capacity building to obtain, improve, and retain the skills and knowledge needed to do their jobs competently.

There are two types of sciences to increase biomass usage. Natural sciences focus on increasing efficiency, improve management and provide clonal material. Social sciences focus on adoption studies, policy incentives and profitability.

There are 5 stages of adoption dynamics. The first stage consist out of innovators and is penetrating the smallest part of the market. Then early adopters, early majority, late majority and then the so called laggards.

5. Market behaviour

Market economics follow certain rules concerning price, supply and demand. Suppliers are willing to produce for certain prices. When the price rises more suppliers will join the market, when the price droppes suppliers will leave the market. This is the other way around for demand, when the price rises consumers will choose other product. The point in price where the quantity of demand and the quantity of supply meet is the so called market price.

The equations of supply and demand look like the following:

Supply: $P = B_0 Q_s + B_1$

In the supply line B_0 is always positive, when the price rises the supply will also rise. The B_0 is controlling the angle of the line, and is therefore the indicator for the elasticity of the supply curve.

Demand: $P = B_0 Q_d + B_1$

In the demand line B_0 is always negative, when the price rises the supply will drop. The B_0 is controlling the angle of the line, and is therefore the indicator for the elasticity of the demand curve.

E.g. the government wants to promote the use of biomass and are willing to pay a subsidy to the suppliers. The current market price is 60€ per ton of biomass. The subsidy will be 20€ per ton of biomass. The producer will not earn 60€ now but in addition to that the 520 subsidy. The new price in the formula will be $(P+20)$. In this example B_0 is a positive value of 4 and B_1 value of -100.

$$(P+20) = 4 Q_s - 100$$

First rearrange the formula so the quantity is the dependable.

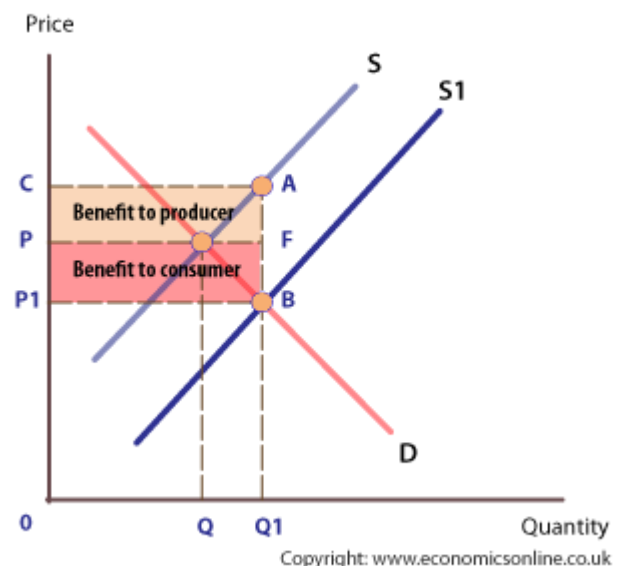
$$Q_s = \frac{1}{4} (P + 20) - 25$$

$$Q_s = \frac{1}{4} P + 5 - 25$$

$$Q_s = \frac{1}{4} P - 20$$

The line have moved down with the same amount of subsidy, 20€.

The market price has also changed, but not with the amount of the subsidy. This is because the market price is also depending on the demand curve. A part of the newly created surplus is not only for the suppliers but also for the consumers although they did not receive any subsidy.



6. Governance

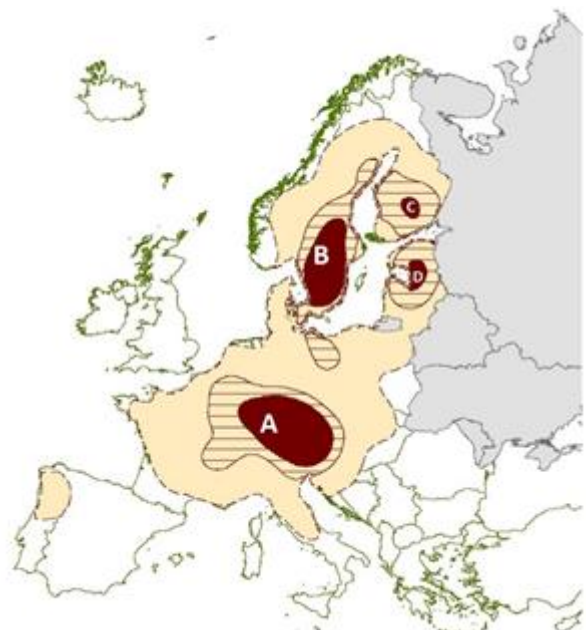
The global dimension of bioenergy trade has grown parallel to new challenges. Biomass is based on the extraction of natural resources, such as wood, that are not equally distributed along the geography. When this extraction fulfils sustainability criteria, in the environmental, economic and social dimensions, their impacts are minimal and contribute to several benefits. However, the policy frameworks that regulate these operations is variable along countries and geographies, creating unequal conditions: often the production of wood is located in one place, operated by a company from a different place, to be transported and consumed in another location. The subject of governance focuses on these "coordination mechanisms that rest outside the authority of states".



Wikipedia describes governance as following: the process of interaction and decision making among the actors involved in a collective problem that leads to the creation, reinforcement, or reproduction of social norms and institutions. In lay terms, it could be described as the political processes that exist in between formal institutions.

7. International bioenergy trade

The main idea is to optimise the transport of forest biomass in the most efficient way. For this you have to look at the transportation distance. The longer the transportation distance the more measurements you can carry out to optimise the energy content of the transport. For very short transportations from a plantation to power plant measurements are not reasonable. For long transportations it might be provable to chip the material before transport to optimise the energy content per unit of measurement.



Pellets, among other biofuels, present the advantage of a higher energy efficiency per unit of volume. In general, the energy ratio between oil and pellets is 1:3, which is a good value compared to wood chips or wood-fuel. This advantage facilitates the transportation and logistics of wood pellets, and make it a good example to explain international bioenergy markets. Many countries have developed a different profile, as a consumer or supplier of wood pellets, based on their resources, traditions, heat demand and policy framework among others. It must be underlined that wood pellets are a by-product of the forest industry, particularly sawmills, and whereas the supply and demand applies directly on timber products, it shows inefficiencies related to pellets (there can be a high demand of pellets and a low demand of timber products, therefore affecting the supply of pellets).

An example of the transport of forest biomass is from Canada to the Netherlands. According to the *Wood Pellet Association of Canada* 24% of Canadian shipments of pellets in 2011 were to the Netherlands. The transport is over approximately 5.000 kilometres which makes measurements to increase the energy content feasible. The transport is done in the form of wood pellets which have a relatively high energy content compared with other forest biomass. In cooperation with other fossil fuels like oil and coal, the energy content per unit is still low.

The Netherlands uses these pellets for power production to replace coal. The usage of these pellets for power is considered as green energy, this is a controversial thought. How green is an energy source that has to be shipped 5.000 kilometres in an inefficient way. The same ship might take German coal to Canada to be used there as a cheap energy source. Globalisation has brought mankind a lot of wealth and opportunities but are we going too far?

1. Current development of pellet markets in Europe. Describe situation, main threats and future trends
2. Locate and describe the main pellet production areas in Europe

8. Bioenergy regions

Like said before bioenergy is a local energy source because transportation of the material is considered inefficient compared towards oil. Because of this the bioenergy regions are mostly located in areas with high forest coverage. There are four main areas in Europe when it comes to bioenergy: Scandinavia, North Eastern Europe, Central Europe and Northern Spain/Portugal. The EU has made legislation on bioenergy concerning all areas mentioned above.

EC Biomass action Plan (2005); in the context of security of supply, the EU's increasing dependency on oil and gas imports, constantly rising oil prices and EU commitments to reduce greenhouse gas emissions, the development of renewable energy remains high on the agenda of European energy policy. However the take-off of renewable energy is still on hold with prospects of only 9 to 10 percent

for the share of renewables in the EU energy mix by 2010 instead of the 12 percent target. The Commission has decided to propose an ambitious action plan to promote the use of biomass energy, a renewable source of energy with a huge potential. The plan outlines measures in three sectors: heating, electricity and transport. The measures in favour of transport biofuels, in particular, are a response to the problem of high oil prices. In parallel, the Commission adopted a report on the different support plans of electricity from renewable energy sources, which concludes that governments need to step up efforts to cooperate among themselves and optimize their support schemes as well as to remove administrative and grid barriers for green electricity.

Renewable Energy Roadmap (2007)

Renewable Energy Directive (2009) establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020 – to be achieved through the attainment of individual national targets. All EU countries must also ensure that at least 10% of their transport fuels come from renewable sources by 2020.

1. Main policies affecting the production and use of energy wood in Europe

9. Models for energy systems

A carbon tax is a fee for greenhouse gas pollution. The costs of this tax are calculated per ton of carbon translated into a tax for fossil fuels. This encourages alternative energy sources and reduces fossil fuel use and CO₂ emissions. The carbon tax can also encourage to produce energy more efficiently.

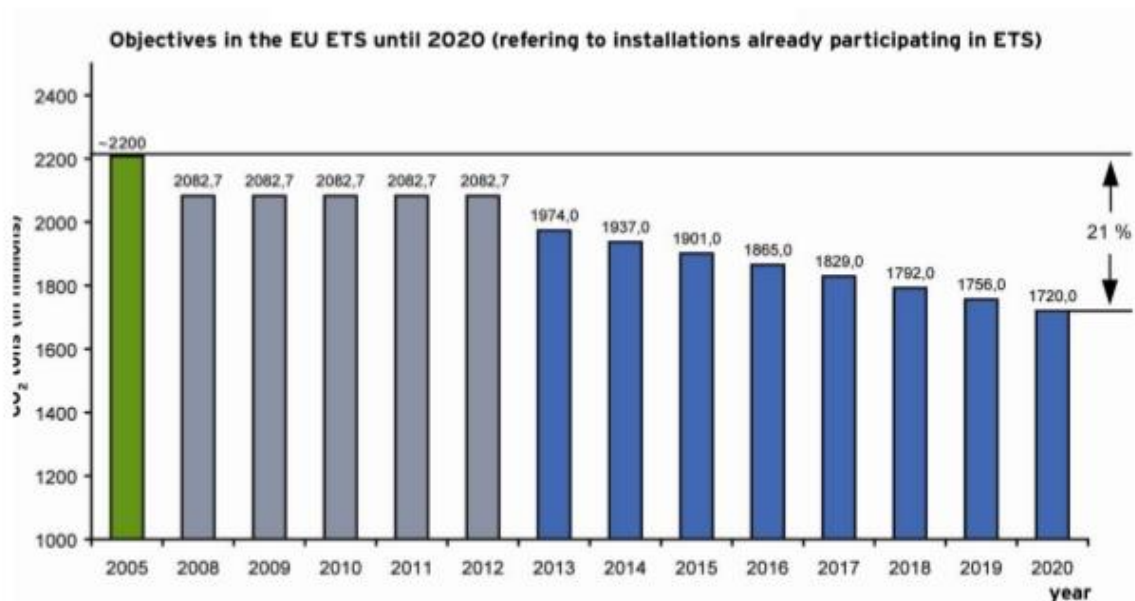
The idea sounds good but in reality the polluting industries shift to countries with no or lower carbon taxes. Resulting in a loss in industrial jobs that move to the other countries. It also might cause the opposite effect, by moving the industry the production might become more pollutive and products need to be shipped to the suppliers.

1. How different types of measures can affect bioenergy markets?

10. Bioenergy EU policies

Like mentioned before a big European policy that has major impact on the bioenergy market is the EU ETS. It is a cornerstone in the EU's policy to combat climate change and its key tool for reducing greenhouse gas emissions cost-effectively. A cap is set on the total amount of certain greenhouse gases that can be emitted by installations covered by the system. The cap is reduced over time so that total

emissions fall what can be seen in the graphic below. The cap is reduced with 21% compared to the emissions of 2005.



<http://globalchange.mit.edu/>

This means the supply is going down, the B_0 of the demand curve is 0 because the supply does not change as it is set by the cap. The price of carbon allowances is set by the demand curve. Bioenergy plants can benefit this policy by selling their allowances for the market price. The combustion of biomass for energy is considered neutral, therefore no carbon allowances are needed to produce energy.

Other energy suppliers that produce non-sustainable energy need to buy carbon allowances which will increase the price of the energy production. This makes energy from sustainable sources, like bioenergy, more compatible and more interesting to invest in knowing that the cap will be reduced even further coming years.

1. Carbon tax: mechanism, effects on the markets, advantages and disadvantages

11. Future trends

The future of bioenergy is according to me depending on policies and therefore uncertain. Energy from biomass is widely considered to be a sustainable, carbon neutral energy source. My view about this is different. Carbon dioxide emissions due to burning of biomass are taken up in growth. In the long term, this is likely to happen when the forest cover remains the same as currently. Although, in the short

term by burning biomass the atmospheric CO₂ will increase. This is further effected by CO₂ emissions due to the management, harvest and transport necessary to produce this biomass. Furthermore, CO₂ is emitted from the natural sink/source dynamics which are effected by the forest management. The energy based on forest biomass may not be carbon neutral but may reduce carbon emissions compared with coal. I see it as an energy source with great meaning during the transition to clean energy but not as the future energy source.

Eu policies are promoting the use of biomass for energy because of the sustainable characteristics of the source. This view can change and will have large effects on the biomass production, for example for biomass plantations that are highly dependable on subsidies to become profitable. Plantation owners are taking a risk when relying on subsidies because the initial investment for plantations is high and the rotation periods long.

The cost of bioenergy are expected to go down in the future and because of genetic improvements the yield will go up. The question is if this can make the energy source compatible with other renewable energy sources like solar and wind power. These other energy sources still have a high potential to become cheaper and more efficient.

The main advantage of bioenergy over these other sustainable energy sources is its ability to function in peak hours. Energy demand is not constant and varies a lot during the day, without a cheap and efficient way to store the energy in batteries these peak demands need to be met. A solar panel can't produce more during times of higher demand. For these peaks bioenergy plants can be turned on, because they can operate more flexible.

12. Policy incentives in Bioenergy markets

Description of the product or technology

Biogas is an energy source made from organic matter, especially plant matter, which is converted to a gas fuel and is therefore regarded as a potential energy source. Any gas fuel derived from the decay of organic matter, as the mixture of methane and carbon dioxide produced by the bacterial decomposition of sewage, manure, garbage or plant crops. In general, biogas consists of 70% methane and 30% carbon dioxide (EMIS, 2017).

Biogas can be made in different ways, most commonly used is the process of fermentation. Nowadays more and more biogas is used in developed countries in waste water treatment plants, waste dumps and fermentation plants. This is a common process in The Netherlands.

Description of the market

Biogas is most often used in combined heat and power plants. In The Netherlands biogas is mixed with natural gas and transported to the local houses and their heating facilities. In this case the largest part of the carbon dioxide has to be removed to achieve a sufficiently high calorific value.

Between 2005 and 2009 the amount of biomass used doubles from 5095 Tj to 10939 Tj. (CBS, 2018)

Year	Tj
2005	5 095
2006	5 879
2007	7 153
2008	9 258
2009	10 939
2010	11 984
2011	11 968
2012	12 165
2013	12 777
2014	13 094
2015	13 693
2016	13 453

Description of the policy measures

To increase the use of biogas a subsidy plan was implemented in 2003, called MEP-subsidy. This subsidy plan was set up to promote carbon neutral energy sources. But in 2006 a new government abolished the political measurement which caused a lot of new initiatives to quit. (Rijksoverheid, 2016)

In 2008, again by a new government, a new subsidy plan was implemented called SDE (Stimulation of Sustainable Energy). This did not give the boost to the market as expected because of too low reimbursement to compete with the cheaper getting oil. (Rijksoverheid, 2016)

Evaluation of the effect of measures

The numbers shown in chapter two show an increase in the usage of biogas. This increase is caused by different subsidy schemes. Although the effect of these measures are considered as a

disappointment. This is because of the dropped oil price in recent years. Biogas is a comparator of oil in when it comes to power plans.

In recent years the policy measures changed a lot concerning this market because of national political instability. This made potential investors insecure about future policies concerning subsidies.

Taxation on other energy sources or quotes for biogas have not been implemented. Probably because of economic interests of Dutch companies thriving on oil production like Shell.

1. Provide a case of the policy incentives that have been used to develop pellet markets, overview and evaluation
2. Provide a case of the policy incentives that have been used to develop biodiesel, overview and evaluation