Memo**: Report**[1] **on bus ticket no. 19 and 52**
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THE SUSTAINABILITY OF BIOMASS FOR BIOENERGY

Definition of the problem
Biomass is not always per definition more sustainable than other raw materials. To judge the sustainability of raw materials for the agro-sector a checklist with criteria and indicators has been developed . So far the various biomass streams have not been scored yet.

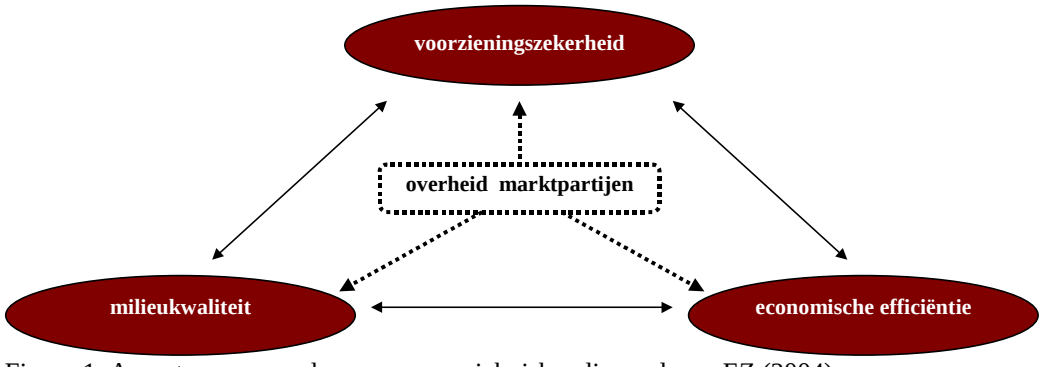
Questions
1. Under which conditions biomass may be considered the most sustainable?
2. Which production, supply chain and price measures must be taken into consideration to guarantee the sustainability of biomass for bioenergy?

Introduction

This is a report of a short study into the sustainability of biomass for bioenergy. The research questions have been formulated in two "BUS" project ideas (# 19 en #52)

The essence of the research topic is that the utilisation of biomass is technically possible but there are many social, economic or ecological barriers. Another description of the three fields is People, Profit, Planet. The Ministry of Economic Affairs (EZ) refers to three requirement for the energy supply system; Reliable (security of supply), Clean (environment) and affordable (economically efficient) (Stoop, 2004; Goos en Uitert ,2004).

The word sustainable is generally used with respect to ecological (planet, clean) sustainability. But often the other two factors (economic and social aspects) should also be included. In the context of this presentation we will look at all 3 dimensions.



Figuur 1. Aspecten van een duurzame energiehuishouding volgens EZ (2004)

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In the two project ideas the following questions have been formulated:

- Which sustainability criteria and indicators are "self evident" and over which will there be more disagreement?
- Which parties have to be brought together in order to come to a consensus?
- Which parties in the Netherlands are involved in this issue?
- Under what conditions is what biomass most sustainable?
- Which measures with respect to plant production, supply chain organisation, price have to be taken in order to achieve sustainable energy sources?

These type of questions are also the basis of a vision which has been drawn up by different actors in the Dutch Biomass field (Sustainable bio energy. A vision on socially acceptable bio energy. Van Son et al, 2002). Perhaps it is useful to see if the criteria and agreements which have been drawn up here are workable and if it is possible to get more insights in the underlying assumptions. A further refining of such a set of criteria and agreements could leave more space for to produce more biomass and more biomass at a higher level of sustainability.

The Main Research Question

The subject is very broad and a large body of knowledge already exists. An understanding of the existing discussions and opinions can help to enlighten the research priorities needed to bring large scale sustainable production and supply of biomass within reach.

The following research question was chosen:
Name and discuss shortly the factors in the three sustainability categories (Planet,People,Profit) that determine if biomass chains will or will not be constituted. Give an insight into the parties that play a role here at the national and the international level. What are the "Bottlenecks" and how can they be dealt with?

A table with factors pertaining to the 3 sustainability categories has been composed together with a short discussion and an indication if the factor can be considered a positive or a negative driver and if it can be considered a bottleneck.

Results and a short discussion

In table 1 to 3 an overview (not exhausting) is presented of often mentioned factors that may play an essential role in assessing biomass to bioenergy chains on the basis of environmental (planet), economical (profit), social (people) performance. The factors have been chosen from current literature. The assessment of the factor is based on ongoing discussions within the biomass field and literature. Systematic assessment of literature and interviews could make the list more objective and quantitative.

In the process of composing such a table it becomes clear that large differences exist between different (potential) bioenergy chains. What is an obstacle for one chain will be a driver for another biomass chain. For example the CO2 input/output ratio can be very different between different energy crops (rape versus switchgrass). Each biomass chain will have a different score.

The exercise of composing the table shows some other aspects that will be of importance. For example some factors differ in importance between countries:

- Erosion is not a large issue in the Netherlands and therefore also not a point of discussion in relation to biomass chains.
- Scarcity of water is another example of a factor that has different priorities in different countries.
- The use of GMO's is viewed even more differently.
- Biomass to energy chains based on genetically modified crops (imported or produced abroad) are a problem in Europe but will be OK in the USA.
- If climate is the main driver for development of bioenergy the CO_2 abatement potential is most prominent.

It other factors like high fossil fuel costs or security of supply are the main drives concessions may be made to the CO2 input/output score of a biomass to energy chain.

Much discussion exits about the necessary “level” of sustainability. What is sustainable, more sustainable and most sustainable. Here the claims abound but very little agreement exists about the hard figures (what is the yield, cost, etc). And there is little agreement about the the importance of the factors constituting sustainability. What is the value of biodiversity and what is the contribution or threat to sustainability of bienergy production systems. Many existing bottlenecks in biomass production and supply can be removed by providing more insight in the real numbers needed for assessment of PPP sustainability and the underlying mechanisms.

With respect to certification systems it should be possible to join in with other plant production systems that need to become more sustainable. FSC wood and by-products for energy is an example. Other production chains include sustainable palm-oil production, cocoa, etc.
Concerns may be raised about the viability of certification systems in the long term when very large amounts of biomass are needed. Does certification exclude too much non-certifiable biomass?

Two attachments have been included:
1. List with the PPP criteria to assess production chains as drawn up by LEI
2. Chapter form the GAVE rapport: Den Uil et al., 2003. Conventional bio-transportation fuels. An Update. ECN, ATO.

Table 1. Environment (Planet) factors and criteria that play a role in the discussion on biomass and bioenergy.

Factor or criteria	Positive aspects	Concerns	Country specific?	Is it a bottleneck?
Waste	Application for energy reduces waste production	Cascade use is better (also see competition)	More in the Netherlands than abroad	Not a real bottleneck
		Is the use of waste green? (see discussion on bone meal, chicken manure)	More in the Netherlands than abroad	In NL often a current bottleneck
		Bioenergy chains should not add to waste production (gypsum, ash, etc)		May become a bottleneck
Climate Change	Biomass is climate neutral (or mostly)	Is CO2 input/output of the chain low enough?	More in NL and EU than where Climate Change is the main driver	Yes. Is the main driver , determines discussion in NL and to quite an extent in EU.
		Emission of other climate gasses associated mostly to crop production (N2O fertilisation, etc)	More in NL and EU than where Climate Change is the main driver	Is bottleneck in many types of energy crops, especially annual crops.
Water-use	Energy crops can contribute to "watershed protection" more water retention	Energy crops use water (see also competition)	UK, USA less in NL	Over time it will be
Pollution (in general)	(Perennial) energy crops emit less pollutants (pesticides, fertilisers) than annual crops	Crop production may emit nutrient/pesticides		Yes, for annual crops
Biodiversity	A lot of biomass can be produced without adverse effects on biodiversity. Much synergy with	Use of "non-native" energy crops is a concern for biodiversity.	USA yes – In Europe it is not much part of the discussion	Yes, over time it will be a factor. When volumes increase.
		Monocultures are detrimental for biodiversity. Intensification of agriculture can reduce biodiversity	Is part of discussion in EU	Yes. Potentially if volumes increase
	Many biomass crop production systems	More demand for biomass will	NL and EU, in relation	Yes. It is a factor in

	(perennial) potentially can increase biodiversity compared to current agriculture.	lead to utilisation of marginal lands and nature areas	to importing biomass	discussions.
GMO	More efficient production is possible (less costs, more yield)	May have unwanted effects on biodiversity (super weeds, etc)	Concern in NL and EU less in USA and China	Yes in EU it is not feasible at the moment.
Soil fertility/ nutrient balance	This may be a co-drives for biomass chain development in NL. Many forms of bioenergy can contribute to more efficient recycling of nutrients (manure co-fermentation, ash recycling, etc). Removal of nutrients may be desired (verge grass, crop residues)	Long distance transport of large volumes of biomass may lead to nutrient imbalances in the world. Solutions lie in use of low nutrient half-products (pyrolysis oil, HTU, Et-OH, etc)	In NL importing nutrients is a problem. There are concerns over problems in Third world.	In short term synergies can be found. In longer term problem has to be dealt with
Erosion	Many biomass cropping systems can contribute to decrease in erosion (compared to current uses). Conversion of annual crops to perennial crops	If marginal lands are taken into production annual cropping can lead to erosion. (connected to biodiversity and economic and social sustainability.	In NL less of an concern. In USA and other countries it may be a co-driver for energy crops development.	Has to be dealt with. EU Biofuels directive mentions it as a potential bottleneck
Emissions to the air	Utilisation of biofuels (ethanol, biodiesel) can reduce emissions of nitrate, soot, etc)	Many bioenery forms contribute to emissions.	In NL it is a concern. In USA it is often a co-diver.	Yes. In NL one of the main problems.Many problems can be solved. Biodiesel will not be able to fulfil future emission standards in EU.

Table 2. Economic (Profit) factors and criteria that play a role in the discussion about biomass en bioenergy.

Factor or criteria	**Positive aspects/ explanation**	**Concerns**	**Country specific?**	**Is it a bottleneck?**
Competition for fibre (paper industries, wood products, etc)	Paper industries can also benefit because of new outlet for energy products (Electricity, ethanol, etc)	Energy uses should not compete for Recycled paper. Competition for wood	In NL it is an issue	Should be looked at
Competition for land (food production)				Yes, should be in longer term
Competition for				Yes, in longer run.

water				
Cost effectiveness	Many wastes and by-products will have a value as fuel.	Biomass is (generally) an expensive energy source	All	Yes
Business risks		Prevent diseases and plagues. Is issue in crop production, monocultures, importing biomass. Other examples: Self heating in biomass	All	Less. Not in long term
		GMO discussie	EU	In the long term
Waste	Waste utilisation	Waste production	Is a factor in NL more than in USA	Yes,
Security of supply	Biomass is often produced locally and sources of biomass are more diverse	Importing biomass may reduce political support and introduce uncertainties	In USA security of supply is main driver for biomass. IN EU it is important driver in NL discussion is limited (mainly Ministry of Economic affairs and industry concern is seems)	In shorter term it is an issue. Importing biomass from outside EU is political issue. There is pressure to come to WTO or bilateral agreements

Table 3. Social (People) factors and criteria that play a role in the discussion about biomass and bioenergy

Factor or criteria	**Positive aspects/ explanation**	**Concerns**	**Country specific?**	**Is it a bottleneck?**
Competition with food production	There are many possibilities to find synergy with food production. Biomass demand stimulates sustainable food chains in the shorter to medium term	Ethanol en biodiesel demand can compete with food demand. Especially in the third world this appears to be a concern.	In NL and EU this is a discussion especially in relation to third world.	Could be. Should be dealt with
Employment	Biomass production and conversion can create jobs. See Biodiesel claims in Germany. Job creation is sometimes a	Biomass production and conversion to energy does not require much employment per	In EU, USA less in NL	It should not be bottleneck but is always a factor. Especially mentioned in EU

	"co-driver" Indirect spin-offs in other areas like tourism (biomass production) or in sustainable chemistry that can also make use of biomass feedstock or " intermediates" (sugars, ethanol, pyrolysis oil, etc)	GJ or ha.	It appears a factor in all countries	and USA, less in NL. Can be a powerful "co-driver
Creation of prosperity in the third world and Eastern Europe.	Can contribute to prosperity.	It can compete for resources in these areas and lead to unwanted effect (see Green revolution)	No	Needs to be addressed. Can be co-driver

Literature

Goos, A. en G. van Uitert. 2004. Visie op gammaonderzoek bij de ontwikkeling en implementatie van energietechnologieën. Ministerie van Economische Zaken, Den Haag, februari 2004.

Son van P, et al., Sustainable bio-energy. A vision on socially acceptable bio-energy. 2002.

Achieving the goals set forth in this A *Vision for Bioenergy and Biobased Products in the United States* will have benefits that reach beyond the U.S. biomass industries:

- **National Security** – Domestic bioenergy sources could help our nation to substantially reduce dependence on petroleum.
- **Environmental Protection** – By offsetting fossil fuel use and related emissions of nitrogen oxides, sulfur dioxides, and other pollutants, bioenergy and biobased products will contribute to cleaner air and water. Further more, increased cultivation of carbon-fixing plants will help mitigate greenhouse gas emissions that contribute to global climate change. It will also provide a productive avenue for using agricultural, industrial, commercial, municipal, and forestry wastes.
- **Rural Economic Growth** – Growth in biobased products and bioenergy will stimulate rural development efforts in farming, forestry, and associated service industries.

By 2030, a well-established, economically viable, bioenergy and biobased products industry will create new economic opportunities for rural America, protect and enhance our environment, strengthen U.S. energy independence, provide economic security, and deliver improved products to consumers.

Uit: The vision for Bioenergy and Biobased products in the United States, 2002.

Attachment 1. Duurzaamheidschecklist van het LEI die helpt bij het beoordelen van de duurzaamheid van agrogrondstoffen (Meeusen, M., 2003).

Planet	
Transport	Beperking goederentransport
Energie	Energiebesparing
	Zelf-opgewekte energie
	Duurzame energie
Lucht	Luchtkwaliteit
	Reductie stankoverlast
Bodem	Reductie grondgebruik
	Bodemkwaliteit
	Reductie bodemerosie
Water	Besparing waterverbruik
	Kwaliteit oppervlaktewater
	Kwaliteit grondwater
	Grondwaterstand
Afval	Afvalpreventie
	Afvalverwerking
	Hergebruik van afval en materialen
Materialen	Gebruik van hernieuwbare grondstoffen
	Reductie gebruik hulpstoffen
	Reductie gebruik materieel
Fauna	Biodiversiteit
Flora	Biodiversiteit
	Aanplanting
Milieubewustzijn	Bevorderen milieubewustzijn
	Milieumanagement
People	
Arbeidsomstandigheden	Werkplek
	Welzijn van werknemers
Dierenwelzijn	Diergezondheid
	Natuurlijk gedrag
	Vrijheid van pijn, honger, dorst en stress
Voedselveiligheid	
Transparantie	Normstelling
	Controle en certificering
	Etikettering en voorzien van keurmerken
Normen en waarden	Emancipatie
	Respecteren van mensenrechten
	Voorkomen van dwang- en kinderarbeid
	Verdeling van welvaart
Locale omgeving	Landschap
	Natuur

	Historische gebouwen
	Recreatie
Maatschappelijke verantwoordelijkheid	Welzijn
	Maatschappelijke gevoeligheid
	Sociale cohesie
Profit	
Aanpassingsvermogen aan de markt	Productkwaliteit
	Innovativiteit
	Responsiviteit
Ketendoelmatigheid	Ketenafstemming
Kosten en efficiëntie	Prijs-kwaliteitverhouding
Strategisch potentieel	Concurrentiepositie
	Flexibiliteit
	Absorptievermogen
Ethiek in business-to-business-context	Bevordering marktwerking
	Rechtvaardige verdeling van lasten en baten over zakelijke partners
	Normstelling
	Zelf naleven van neven- en bovenwettelijke regels, codes, normen en afspraken
	Aanzetten van zakelijke partners tot naleving van neven- en bovenwettelijke regels, codes, normen en afspraken
	Controle en certificering
Werkgelegenheid	Kwantiteit van werkgelegenheid
	Kwaliteit van werkgelegenheid
Arbeidsproductiviteit	

Attachment 2. Chapter form the GAVE rapport: Den Uil et al., 2003. Conventional bio-transportation fuels. An Update. ECN, ATO.

Socio-economic factors

In the Netherlands mitigation of the greenhouse effect through a reduction of greenhouse gas emissions is the main motive for the use of biomass to displace fossil fuels. It is absolutely clear that the highest effect on reducing the greenhouse effect is reached through displacing coal for electricity production. Hence the question is why are bio-transportation fuels promoted if they are considered to have a lower effect on greenhouse effect mitigation? Clearly other environmental and socio-economic factors that are important play a role here.

In a recent report (IEA, 2002) three phases in are distinguished in the development of alternative fuels:

- Phase 1 = Experiments and small scale tests
- Phase 2 = Pilot projects and demonstration
- Phase 3 = Commercial activity

Many countries are in phase 3. For example Brazil and the USA with ethanol and Germany with bio-diesel. In the Netherlands some projects pilot projects and demonstrations have been implemented particularly with bio-diesel (Bio-diesel powered boats in canals in Amsterdam and some activities in Friesland, recent introduction in Venlo). These developments are based on support for a limited period and will die out if support and a structure for a longer period is not available.

The question would be how could development to phase 3, commercial activity be implemented in the Netherlands both for bio-diesel and for ethanol?

It will be necessary to have political support based on a mix of benefits (environmental, economic, and agricultural) and supported by a coalition of groups.

The motives that have been put forward to utilise bio-transportation fuels vary over time and between countries. In Table 1 a list of the most important motives has been compiled that have been used as arguments to implement bio-transportation fuels worldwide. Which mix of motives will lead to successful implementation of bio-transportation fuels? The motives deemed most relevant to the Netherlands are in italics.

An analysis of important factors that determine success of implementation of bio-transport fuel projects in the EU and USA was made in a recent report (IEA, 2002). Some of the most relevant conclusions are:

- In all countries where alternative fuels have been implemented to the commercial phase Agriculture has been one of the stakeholders. Politically, the potential effects of alternative fuels on agriculture and regional development have played an important role.
- Because alternative fuels are more expensive than fossil fuels (gasoline, diesel) support to cover the difference is costs is imperative. No implementation has occurred without this support and in cases where it has been removed, implementation has halted.
- Successful implementation of alternative fuels has incorporated the oil companies (distributors, blenders) in all cases.
- Commercial actors require definite rules, preferably aver a long time, such as legislation on fuels and magnitude of financial support.
- Countries in the phase of experiment, pilot projects and demonstration should benefit from the experiences in other countries already in commercial phase.

The Netherlands:

Agricultural pressure to introduce bio-fuels has been limited over the last decade in the Netherlands mainly due to the small area of set aside land approximately (10.000 ha) and the focus on other issues.

Since 1998 a some factors that are important for introduction of bio-transportation fuels have changed in the Netherlands:

- Animal diseases (Foot and Mouth Disease, BSE, Swine pest), feed contamination (, increased environmental restrictions (Nitrate, smell, etc) and popular pressures have led to political decisions to limit the use of many by-products in animal feed and to reduce the total number in farm animals over the coming decades (VROM 2001). This has led to a decreased demand for by-products, used as fodder, from the large Dutch agri-processing industry (potato peels, molasses, seed crushing industry, etc). An interest for alternative uses both for oil and fat and for sugar and starch containing by-products has arisen (see Chapter……)(Elbersen et al., 2002; Rabobank, 2001). The availability of these by-products will depend on alternative uses and on the price that can be paid when it is used as a bio-fuel feedstock.
- A EU directive has been put forward to replace an increasing amount of renewable transportation fuels. Starting with 2% in 2005 and increasing to 5.75% in 2010 (CEC, 2002).

Decisions have not been made on the EU directive but it is clear that bio-transportation fuels will have to be introduced in the Netherlands in the short term. The question is not if but how and when exactly bio-transportation fuels utilisation will have to be implemented.
It seems likely that utilisation of by-products and taking maximum advantage of the environmental effects that bio-transportation fuels offer could create the broadest support for a commercial introduction of biofuels.

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Table 1. Overview of motives arising from concern about the environment, economy and agriculture that contribute to implementation of the use of bio-transportation fuels by different countries, entities or organisations. The most relevant motives for the Netherlands are in *italics*.

General motive	Specific	Country	Reference
Environmental			
Reduction in greenhouse gas emissions. Kyoto protocol	Discussion about the impact continues	EU, Japan	CEU, 2002.
Reduction in air, water and soil, pollution.	Lower CO, hydrocarbons, particulates, air toxics, mutagenicity. Higher Nox	USA, China, EU,	Enguidanos et al., 2002. CEU, 2002.
The reduced pollution leads to specific implementation in areas where the impact is largest (example; captive fleets).	Biodiesel for: diesel powered boats (canals, recreation); Inner-city busses,	USA, EU,	EPA, 2002.
	Ethanol for: smog reduction (in winter),	USA,	
Economic			
Depletion of fossil fuels		USA, EU,	
Reduce dependency on foreign oil		USA, EU, (NL Min of Economic affairs, less with other entities)	EOS presentations 2002, CEU, 2002
Cost		Brazil	
Trade balance		Asia, USA	CEU, 2002
Getting experience – broadening the way for new developments			GAVE,
Agriculture			
Alternative utilisation options for organic by-products	Recent	NL, UK, USA,	Elbersen et al., 2002. Rabobank, 2001. CEU, 2002.
Utilisation of set-aside land		EU, USA	CEU, 2002
Rural income		EU, USA, not NL	CEU, 2002
Stabilisation of farmer income (sugar)	Examples are ethanol production from sugarbeets or wine if prices are low. This will result in stable prices and income	EU, France	
Promote more market oriented CAP (Common Agricultural Policy)	Multifunctional agriculture, new agro-products, sustainable rural development		CEU, 2002