Memo: **Report[1] on BUS ticket no. A22**
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SELF-SUFFICIENCY OF THE NETHERLANDS IN THE FIELD OF BIOMASS

Definition of the problem
Which influential studies address the question of how much biomass for energy The Netherlands is able to produce by itself. In the discussion on biofuels this is a recurring hot item.

Questions
1.What are the main assumptions and inaccuracies?
2. Which parties could jointly work together to give a conclusive answer on the self-sufficiency situation in The Netherlands?

1. Motivation

Various studies make judgements regarding the extent to which the Netherlands would be capable of producing biomass itself for energy applications. The results of these studies vary, thus giving us no clear picture of the availability of biomass in the Netherlands. There is therefore no adequate basis for businesses to take decisions on long-term or even shorter-term investments. This forms the motivation for SHELL to ask for greater insight into the studies that have been carried out in the field of the availability of biomass.

2. Objective

This memorandum aims to compile an overview of studies in which an assessment is made of the quantity of biomass for biofuel that the Netherlands is able to produce *itself* and – based on this – to provide an assessment of the extent to which these studies provide businesses with sufficient insight regarding the certainty of the supplies of raw materials.

For this purpose, an inventory has been made of studies in the field of the availability of biomass. The inventory focuses on insight into (a) the estimated quantity of biomass to be produced by the Netherlands and (b) the applicable price for this, particularly with an eye to (c) the assumptions chosen in this regard and (d) the uncertainties stemming from these.

3. Potential availability of biomass

Van der Broek et al. (2003) provide the most complete and up-to-date overview of the quantity of available biomass in relation to need, reasoned from the perspective of the development of the market for biofuels. They have derived and made an inventory of the required quantities of biomass for six different biofuels[2] for the extent to which this biomass is actually available. A wide range of studies has been consulted for this

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[2] The following fuels were examined: ethanol from sugar beet, wheat and residual biomass flows; ETBE (ethyl tertiary butyl ether), biodiesel from oilseed rape and methyl esters from residual biomass flows; options that could offer prospects in the medium to long term were not examined, namely lignocellulose ethanol and Fischer-Tropsch diesel.

purpose.[3] The added value of Van der Broek et al. (2003) is that all previous studies are brought together. They have carried out this analysis at Dutch, EU and global levels. The report does not provide a detailed picture of the potentially available biofuels *per biomass flow*.[4] With regards to the Dutch situation, Van der Broek et al. (2003) conclude that the potential availability of biomass is 80% higher than the quantity needed to meet the target percentage of 2% in 2005. This is set to change in 2010, when the target percentage will rise to 5.75%. In this case, there will be a shortfall in the Netherlands.

Elbersen et al. (2004) also point to the large quantity of biomass "flowing through the Netherlands." The Netherlands has a surface area of 3.3 million hectares (of which approximately 2 million hectares are agricultural land), meaning 13 tonnes of dry matter per hectare per year "flowing through the Netherlands." This gives the Netherlands a high biomass flux, argue Elbersen et al. (2004).

Table 1: Quantity of biomass "flowing through the Netherlands," in millions of tonnes

Source	Quantity
Import of mixed feed	15
Grass production and conversion into feed	10
Production of arable and horticultural products	7
Wood and paper	5
Arable residual materials	4
Import of nutrients	2
Total	43

Source: Elbersen, et al. (2004)

Accordingly, various quarters point to the large quantity of *potentially* available biomass for bio-energy. Whether these flows *actually* become available, and to what extent, is less clear. Van der Broek et al. (2003) therefore issue their own warning. They point to the fact that the figures indicate sufficient biomass in theory, but that the actual availability is determined by economic limiting conditions that differ by source. The extent to which the potentially available quantity of biomass actually becomes available is therefore variable. Van der Broek et al. (2003) therefore expressly state that the inventory deals with the *potentially* available quantity of biomass.

A number of studies are covered in the following sections, describing the actual availability of the individual biomass flows. The corresponding assumptions and uncertainties are illustrated. After all, we are dealing with the question of which factors determine whether and to what extent the potentially available quantity of biomass is actually available for bio-energy.

The biomass flows – also distinguished by Van der Broek et al. (2003) – are defined as follows:

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[3] Including the following: Van der Broek (2001), Faaij (1997), Vis (2002), Van Vaals (2003), LEI (1999), VNPI (2003), Van der Voort (2003), Berkhout (2003), CBS (2003)

[4] Van der Broek et al. (2003) have taken the available quantities per sub-flow as the starting point and added them together; the presentation in the report provides little insight into the chosen starting points at the sub-flow level.

- Cultivated biomass;
- Residual flows from the food, beverages and tobacco industry;
- Residual flows from agriculture;

These flows will be dealt with separately.

4. Factors determining the actual availability

4.1. Cultivated biomass

Table 2 presents an overview of the area and the production of a number of crops suitable for bio-energy.

Table 2: Overview of the area and the production of a number of energy crops in the Netherlands in the period 1985-2003, in 1,000 hectares and in 1,000 tonnes

	1985	1990	1995	2000	2003
Area (x1,000 hectares)					
Wheat	128.1	140.6	135.4	136.7	133.0
Sugar beet	130.5	125.0	116.1	111.0	102.8
Oilseed rape	10.1	8.4	1.5	0.9	1
Production (1,000 tonnes)					
Wheat	851.1	1,075.9	1,166.7	1,142.7	1,228.3
Sugar beet	6,334	8,623	6,449	6,727	6,209.8
Oilseed rape	30.6	25.5	4.5	2.9	2.0

Source: LEI/CBS, 2004

In the year 2004, wheat is primarily sold as animal feed. Higher prices are paid in this sector than in the bio-energy sector. If these ratios change, the feed wheat could also be used for bio-energy purposes. After all, wheat is an important crop in the grower's cultivation plan for crop rotational reasons. Wheat is unlikely to be removed from the cultivation plan.

Sugar beet is cultivated for the production of sugar as a foodstuff. Only so-called “C sugar” would be available for use in bio-energy production, due to its low price.[5] C sugar is the sugar that is produced in excess of the quota set by the EU. Growers receive a fixed price for sugar that falls within the EU quota; the sugar that the growers produce over and above that quote (C sugar) is sold at the world market price, which is lower. The assumption that this sugar could be made available for bio-ethanol is understandable, but a point for attention is that this surplus quantity varies each year and is a residual item for growers, rather than a principle activity. As such, there is less certainty of supply.

Oilseed rape is cultivated in limited quantities in 2004. There should be growth opportunities for oilseed rape; this crop could possibly count on more interest now that the biodiesel market is picking up. For this reason, Janssens et al. (not yet published) have looked at the conditions under which Dutch farmers will cultivate oilseed rape for biodiesel. In the year 2004, the competitive position of oilseed rape is

[5] Incidentally, the sugar policy of the European Union is currently undergoing reforms. The future sugar policy is very likely to be different from that of 2004. (de Bont et al., 2004)

not very attractive for arable farms in relation to the alternative offering the lowest returns (winter wheat). Oilseed rape is only financially attractive on fallow land, on which generally speaking no marketable crops are allowed to be cultivated. This area is a maximum of 5,000 hectares. Janssens et al. demonstrate that this situation will not really change as a result of the proposed changes in the Common Agricultural Policy. Measures to increase yields and to reduce costs could encourage the cultivation of oilseed rape; these measures could make oilseed rape a more attractive option than wheat.

This example also illustrates the gap between potential availability and actual availability. Although the potential area is estimated at 71,000 hectares on the basis of technical and crop rotational factors (Van der Voort, 2003), this appears to be much less if one looks at the matter from an economic perspective.

An additional warning is hereby issued. If the competition at crop level is "won" by an energy crop, one should not draw the conclusion that energy crops will be cultivated from that moment on. After all, the important factor is the competition on the use of the land: which usage provides the highest profit? Accordingly: if one crop becomes more competitive than another, but the profit to be gained through this land use is lower than from a competing land application outside arable farming or even outside agriculture as a whole, then that crop will not be chosen for cultivation.

4.2. Residual flows from the food, beverages and tobacco industry

Van der Broek et al. (2003) see a major role for the residual flows from the food, beverages and tobacco industry. These flows account for a large share of the potentially available quantity of biomass.

Various studies – of which an overview has been compiled by Elbersen et al. (2002a) – have made an inventory of the quantity of residual flows from the food, beverages and tobacco industry. These studies examined the by-products, which are the products not given the label of main products. This implies products for which (profitable) purposes and sales are arranged. Elbersen et al. (2002a) show that the food, beverages and tobacco industry produces approximately 10 million tonnes of by-products. See table 3.

Table 3: Quantity of residual flows stemming from the food, beverages and tobacco industry, in 1,000 tonnes and in PJ

	Quantity (1,000 tonnes)	Energy (PJ)
Abattoirs and meat processing	1,426	18.3
Fish processing	76	0.5
Vegetable and fruit processing	1,162	3.8
Manufacture of margarine, fats and oils	3,783	59.0
Manufacture of dairy products	280	4.4
Manufacture of flour	1,793	17.4
Manufacture of sugar	1,095	8.9
Manufacture of other foodstuffs	128	1.4

Manufacture of beverages	754	3.8
Tobacco processing	2	<1
Other	192	4.4
Total	10,691	122.1

Source: Elbersen et al., 2002a

As already stated, the majority of these by-products have an application: more than three quarters are used as a raw material for animal feed, approximately ten per cent is sold as a soil improver and the remaining ten per cent is burnt, dumped or sold outside the agricultural sector.

The current sales pattern is in transition. In particular, the animal feed market is becoming less attractive for by-products. Food safety is a hot issue, increasingly setting boundaries for the opportunities for the sale of by-products in animal feed. The shrinking cattle population will also lead to fewer sales opportunities. By-product producers are therefore urgently exploring alternative applications in the non-food sector. In this regard, the overview provided by Elbersen et al. (2002b) is illustrative. Elbersen et al. (2002b) show the by-products for which alternative applications were being sought in 2001. More than half a million tonnes were involved (see table 4). In time, this would grow to double that quantity, as shown in table 5.

Table 4: By-products for which alternative applications were being sought in 2001, in 1,000 tonnes per year

By-product	Quantity
Animal residual flows	305
Fat residual flows and additional flows	25
Frying fat	130
Residual flows from the sugar industry	22
Other by-products	68
Total	550

Source: Elbersen et al., 2002b

Table 5: By-products for which alternative applications will need to be sought in due course, in 1,000 tonnes per year

By-product	Quantity
By-products from the grain-processing industry	479
By-products from the potato industry	234
By-products from the sugar industry	154
By-products from the dairy industry	28.5
By-products from the fermentation industry	7.5
Animal fat	54
Other by-products	119
Total	1,077

Source: Elbersen et al., 2002b

In the search for non-food applications, in which (by definition) food safety is less of a restrictive factor, the highest-quality applications are explored first. Naturally, one first looks at applications that bring high returns; processing technologies that make these markets accessible are assessed according to their returns. Elbersen et al. (2004) sum up a number of these applications: (pharmaceuticals), fermentation, fuel, fertilizers, fire, flare, fill. For a number of by-products, they also show the (technical) possibilities within these markets. Accompanied by a market analysis, this provides a picture of the actual possibilities in alternative markets. If these bring better returns for the seller of the by-products, less with remain for use in bio-energy. Therefore: the shrinking animal feed market does not automatically mean that the by-products will become available for bio-energy. Competition now begins with other non-food applications. However, this flow is expected to be an interesting prospect for bio-energy.

Goorden and Meeusen (1999) note that flows become available right across the country, and that the quality is often low and not constant, because these flows cannot find any other application elsewhere. Goorden and Meeusen (1999) therefore saw a major role for large-scale agribusiness, within which supply and demand can be attuned to each other. In this regard, the initiative of Nedalco and Cerestar is also illustrative.

Goorden and Meeusen (1999) as well as Sanders (undated) also point to the fact that the use of residual flows from the food, beverages and tobacco industry ties in with the proposal of bio-energy: sustainability. After all, the environmental impact is limited, as more products are obtained from the crop and the energy share is only 'responsible' for part of the environmental impact. Moreover, the production of biomass in this way does not take up any space that may otherwise have been needed for the production of food.

4.3. Residual flows from agriculture

Van der Broek et al. (2003) show that animal manure in particular has a large share in the potentially available quantity of biomass. This biomass is expected to be used for fermentation. The other biomass flow that they mention is straw, which can be used particularly for electricity and – in time – for biofuels. Where residual flows from agriculture are concerned, for biofuels in the short term, the foliage of potatoes and sugar beet is named as the most interesting option (said by Elbersen, 2004). The quantity would be 1.5 million tonnes. Elbersen foresees that this resource will grow in importance for bio-energy. These by-products currently remain on the land, where they release nutrients (particularly nitrogen) at times when the plants do not require them; they therefore have very little use as fertilizers. A bigger problem is the fact that they die off, resulting in the nitrogen being released in the form of nitrate. This could make potato and sugar beet foliage an even more interesting source of biomass for bio-energy. Naturally, the same principle also applies here: one first needs to seek economically attractive (or more economically attractive) options before taking steps along a particular route towards bio-energy.

5. Market prices of the biomass flows

SenterNovem has commissioned the development of a databank by Ecofys, the Commodity Board for margarines, fats and oils and Probos, within which the prices at which various biomass flows are offered and/or sold are recorded. (http//212.0.231.227/biomassa/prijzen/). The databank makes a distinction between the following groups: (a) fresh wood; (b) used wood; (c) wood from processing, (d) shells/pods/husks, (e) peel/skin, membranes and seeds/pips, (f) pulp, (g) fats and oils, and (g) other residues from the food, beverages and tobacco industry.

6. Conclusions

A good overview is available of the potentially available quantity of biomass, but this is not sufficient …

There is a good overview of the potentially available quantity of biomass in the Netherlands. Van der Broek et al. (2003) provide a good impression of this. However, a picture of the *potentially* available quantity of biomass provides an insufficient basis for an industrial enterprise to gain insight into the biomass available to it at an acceptable price. After all, the actual available quantity of biomass is much less, and is strongly dependent on the prices and the market.

Potentially sufficient availability

One can conclude that the potentially available quantity is more than adequate to satisfy the EU directives on biofuels on a Dutch scale with regards to 2005. The Netherlands produces sufficient biomass to be able to produce the desired biofuels. However, there will be a shortfall with regards to the targets set for 2010.

Feed wheat available for bio-energy when the price falls

In the Netherlands, feed wheat is cultivated for use in animal feed. Feed wheat could become available for bio-energy if the price is competitive; at present, this is not yet the case.

C sugar is an interesting option with regards to price, but the supply is not constant or guaranteed

So-called C sugar, the sugar that is produced in excess of the price-guaranteed quota, comes onto the market at the lower world market price, and is thus a potential candidate for bio-energy. It should be noted that the supply of C sugar is variable, as it is a “residual product” for the grower.

Oilseed rape offers opportunities if returns first improve

The actual available quantity of cultivated oilseed rape in the Netherlands appears to be limited for the time being, due to the low returns. Other crops still bring better returns for the grower, even under the most pessimistic scenarios of the Common Agricultural Policy. If the yields increase and/or the costs fall, there will be space for oilseed rape. There are optimistic noises from the practical sphere that this combination will make the cultivation of oilseed rape a more realistic prospect.

Residual flows: an interesting prospect for bio-energy, but higher-quality applications are being sought first

Where the residual flows from agriculture and from the food, beverages and tobacco industry are concerned, the actual available quantity of biomass is greatly dependent on the alternative application possibilities. When these generate a higher yield price, the biomass flows in their direction and does not become available for bio-energy. It is a case of market effects, where the highest-quality application 'wins' as opposed to bio-energy. This can be seen particularly clearly in the residual flows from the food, beverages and tobacco industry of which, until recently, 85% was sold in the animal feed sector. Under the influence of the problems surrounding food safety, this has started to change, thus increasing the availability for bio-energy.

In short, the actual availability is much less than the potential availability
Our conclusion is that the potential quantity of biomass for the Netherlands is large, large enough to satisfy the demands of the biofuels directive. However, the actual quantity of biomass available for bio-energy is much less. Self-sufficiency at the Dutch level is by no means guaranteed.

7. Lastly

The above conclusion shows that the availability of biomass for bio-energy is determined by market and economic forces. The actual availability of biomass is thus the result of these forces, which can develop in different directions. A study of the actual availability and market prices soon becomes outdated, simply because the market is constantly on the move. A '*tour d'horizon*' of possible development directions therefore complements this, indicating the directions along which biomass could become available. Meeusen et al. (2003) have looked at the forces with the most influence, within both the energy market and the agricultural market. The Memorandum on “Energy and Society” (*Energie en Samenleving*) and the study entitled “Interpretation of the IPCC scenarios for Dutch agriculture” (*Invulling van de IPCC-scenario's voor de Nederlandse landbouw*) for the RIVM (National Institute of Public Health and the Environment) include comparable factors for the energy sector and the agricultural sector that are influential and/or uncertain, namely:

- The degree of collaboration, and
- The economic development.

Both factors can develop in various ways, and four ‘extremes’ can be defined, within which the energy and agricultural sectors can operate. The four global scenarios are:

- Free trade
- Isolation
- Large scale solidarity, and
- Ecology on a small scale.

The situation for both the energy and agricultural sectors, as well as the combined production of energy from biomass is outlined in figure 1 for the four world views.

“Free trade”: economics and money dominate, without national barriers *Biomass for energy in general* • All over the world, the production of and demand for biomass can be seen; there is a brisk trade in biomass for energy • The price of biomass for energy is low. • The Netherlands is a distribution country *Dutch agriculture* • The Netherlands produces in large-scale units, with the aid of the most advanced technologies, which increase production and reduce the cost price. This is a case of intensive production methods. • There is no longer any bulk production; the products must provide high added value. • The Netherlands is characterised by large-scale underground greenhouses, dairy farming in industrial-style units where the cows remain indoors, and 'pig flats' (multi-storey pig accommodation). • The agricultural area is greatly reduced. *Biomass for energy in the Netherlands* Producing biomass at a very low price – competing with the world market price - in large-scale, intensive agricultural systems (particularly greenhouse horticulture, dairy farming and intensive livestock farming), making use of profitable technologies; public support for technologies does not play a role. Manure is available in large quantities and forms the most important basis for the production of bio-energy.	Profit for here and now	“Isolation”: gradual gain dominates within national and regional limits *Biomass for energy in general* • Aiming for self-sufficiency in order to be independent of others. • Local and regional energy provision • Sustainable energy thrives in order to reduce dependence on others. • Biomass for energy is limited – self-sufficiency with regards to food has a higher priority. • The environment in general is not important, though the local environmental impact is. *Dutch agriculture* • The EU continues to provide the agricultural sector with strong support in order to guarantee the self-sufficiency of food; • All sectors are declining, but that shrinkage is much less marked in arable farming, for example, than in the free trade scenario; • The emphasis is placed on the large, specialised, professional agricultural enterprises. *Biomass for energy in the Netherlands* Use of residual flows and manure from specialised agricultural enterprises and businesses from the agricultural sector to supply the rural community with energy with the aid of local/regional units.
Worldwide institutions		Local networks
“Large scale solidarity”: global problems to be resolved together *Biomass for energy in general* • The Netherlands is a distribution country for energy. • The Netherlands is the world's chemical factory with a high level of attention for environmental management and energy efficiency. The use of renewable resources, including biomass, has largely replaced the use of fossil fuels. • Gaseous fuels that are attractive from an environmental perspective can be utilised easily and distributed within the remaining natural gas infrastructure. • Biomass produced in the Scandinavian countries on a large-scale. *Dutch agriculture* • The EU supports the preservation of characteristic European nature and landscapes by means of subsidies; • Multi-functional agriculture is supported; • Technology well accepted, as long as that technology contributes to sustainable agriculture;	Profit for the world and for later	“Ecology on a small scale”: global problems to be resolved locally *Biomass for energy in general* • Sustainable energy develops, as the Netherlands becomes more independent of others as a result. • Large-scale energy production units do not fit into the picture. • Biomass for energy is limited – and certainly not large-scale. • The natural gas network has been preserved. • The generation of energy must be sustainable and “socially responsible.” *Dutch agriculture* • The production is extensive and organised on a small scale. A lot of attention is paid to aspects of landscape, nature and care; • No high-tech technologies; instead, clean technologies that fit in with the “natural character” of agriculture; • Slight decline in the area used for agriculture; most of the land remains in production on small-scale enterprises; • Extensification of production hinders the large-

• More or less constant area of agricultural land; • Shrinkage in livestock farming. *Biomass for energy in the Netherlands* The agricultural residual flows from the chemical industry are used for gaseous fuels, distributed through the infrastructure formerly used for natural gas. The latest technologies are also used: technologies that fit in with economic growth and that contribute to sustainability. Sustainability is an important issue and new technologies are tested on this criterion first. Energy generated on the basis of grass on multi-functional dairy farms, where attention is devoted to nature and the landscape.		scale use of the agricultural land for non-food applications. *Biomass for energy in the Netherlands* Energy production on extensive, small-scale enterprises, supplying their own region. No new technologies will be used for this, only technologies that fit in with the concept of "natural agriculture." Residual flows are reused for energy production purposes; also on a small-scale, with clean technologies that have been labelled as "sustainable" in the social debate.

Figure 1: Overview of the four world views for agriculture, energy and energy produced from biomass

In the year 2004, a certain amount of attention has been devoted to the scenarios taking a globalised society as a basis. Large-scale production units are included, which need to be competitive. Biomass would be made available for bio-energy, alongside and in combination with "biomass for other applications" (food, animal feed); to this end, there are close interactions with the agricultural sector. In addition, a great deal of thought is devoted to the role of the Netherlands as an import country. New technologies may be helpful in this, particularly if the proposal is given a "sustainable" interpretation. The SHELL Prize for Biofuels Research also fits into this picture, awarded to Swaaij (de Wit, 2004). Swaaij does not see much scope for the large-scale cultivation of energy crops within the Netherlands, and places the focus on technological developments and the organisation of the trade flows.

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