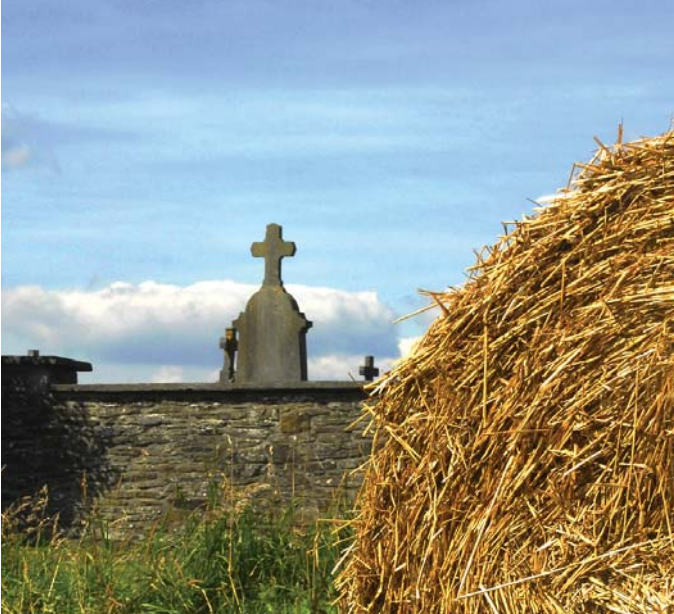

DR. IVÁN GYULAI

THE BIOMASS DILEMMA

CEEweb for Biodiversity

Magyar Természetvédők Szövetsége
Föld Barátai Magyarország

The Biomass Dilemma

This publication has been prepared by CEEweb for Biodiversity and the National Society of Conservationists – Friends of the Earth Hungary.

CEEweb for Biodiversity is an international network of non-governmental organizations in Central and Eastern Europe. The mission of the network is the conservation of biodiversity through the promotion of sustainable development.

The National Society of Conservationists – Friends of the Earth Hungary is a network of non-governmental organisations in Hungary and a member of CEEweb.

Written by dr. Iván Gyulai, President of CEEweb

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INTRODUCTION

Many think that biomass can be the solution for the energy and environmental problems of today. Environmentalists have urged for the use of biomass for two decades in vain because the secondary biomass energy source is not competitive with the fossil source without adequate financial subsidies.

However, times change and the aspiring markets, such as China, and the growing energy hunger created a boom for oil and gas. The constantly rising oil price (more than 115 USD/barrel in April 2008), the reports about depleting oil supply, the escalating demand and the oil dependence of some economic world-powers raise political concerns as well. More and more realize that we need new resources for our development.

Observing the international processes it can be clearly seen that the European Union's regulations on renewable energy threaten with non-desired social and environmental impacts – especially in the case of biofuels. It is awkward to see that whilst the EU is spearheading international actions in conserving biodiversity, it develops policies for reducing green house gases, which even more threaten biological diversity. Furthermore it is also an important issue, whether these suggested actions will lead to the required reduction or on the contrary it will result in even more burdens at a global scale.

In short time the suggestion of the environmentalists will turn into a boomerang. Even though the good-willed recommendations only wished to help the environment, they will strike back on it. First on the environment and then on us.

Today numerous NGOs in developed and developing countries warn about the danger. CEEweb for Biodiversity and the National Society of Conservationists also think that there is a huge need for precaution and careful considerations. If it is not too late already, because the development policies already favour the use of biomass and business has also taken its first, already very significant steps in the hope of future support.

In addition to sharing our views, we welcome other opinions and we are glad to learn from others' experiences as well.

I. THE STRATEGIC AND REGULATORY ENVIRONMENT OF RENEWABLE ENERGY SOURCES

The future of renewable energy sources is determined by the strategic and legal framework of the EU. These requirements are clearly set until 2010 and then they will probably become stricter. The strategic framework is given by the EU Sustainable Development Strategy, which links the necessity of spreading renewable energy resources to global climate change. The biomass targets of the EU are determined within a so-called White Paper[1] (1997) until 2010, which includes an Action Plan for renewable energy sources. The EU links the growth of biomass production with the creation of workplaces and the opportunities for raising rural incomes. The main objective is that the workers in the agricultural sector keep on working within agriculture without increasing unsellable stocks. This can be only realised if energy crops are grown on the fields instead of food crops. Hence biofuel production is an important target area of the cohesion policy and funding.

EU targets until 2010:

- **White Paper:** increasing the share of renewable energy from 6% to 12%.

[1] Energy for the future: renewable energy sources, White Paper for a Community Strategy and Action Plan, COM(97)599 final (26/11/1997)

- **Directive 2001/77/EC[2]:** increasing the share of renewable energy to 12% and the share of electricity produced from renewable energy sources to 22.1%.
- **Directive 2003/30/EC[3]:** increasing the share of biofuels and other renewable fuels to 5.75% calculated on the basis of energy content, of all petrol and diesel for transport purposes placed on the market.

The EU's high energy dependence on external resources, which is at the moment about 50% and in 20 years it can reach 70%, urges for the production of domestic renewable energy. Addressing this problem a Green Paper[4] aims the safety and diversification of the energy mix, the support of low coal content energy resources for electricity supply and emphasising the role of renewable energy. Besides the replacement of fossil fuels, the EU also attempts to improve the energy efficiency level. The Energy Efficiency Action Plan[5] specifies an annual 1% decrease of the energy consumption. The Fuel Quality Directive[6] determines the maximum content of ethanol, ether and other oxygenates as well as the vapour pressure for petrol (it cannot contain more than 5% v/v of bioethanol and more than 15% v/v of ETBE). The EN950 standard limits the maximum biodiesel content of diesel to 5% (4.6% on the basis of energy content). These regulations prevent the higher mixing of biodiesel with fuel, thus the Commission initiated the review of the Fuel Quality Directive.

According to the Biofuels Directive Review, the above mentioned target of 5.75% by 2010 is not likely to be achieved (about 4.2% is expected). Setting a new target, the Commission proposed a 10% minimum for the market share of biofuels in 2020, which was agreed by EU leaders at the European Council of March 2007. This joint will was translated into a proposal[7] by the European Commission on 23 January 2008 for a directive. It was ini-

[2] Directive on Electricity Production from Renewable Energy Sources (2001/77/EC)

[3] Directive on the Promotion of the Use of Biofuels or Other Renewable Fuels for Transport (2003/30/EC)

[4] European Strategy for sustainability, competitiveness and safety of energy support (COM (2006)105 final)

[5] Action Plan for Energy Efficiency: Realising the Potential (COM(2006)545 final)

[6] Directive amending Directive 98/70/EC relating to the quality of petrol and diesel fuels (2003/17/EC)

[7] Proposal for a Directive on the promotion of the use of energy from renewable sources (COM(2008) 19 final)

tially considered a good means of prompting governments and industry to invest in biofuels in order to reduce Europe's dependency on imported oil and contribute to the fight against climate change. However, many of the EU leaders at the 2008 Spring Summit seemed to have at least doubts about the implications of this proposed Directive, and expressed the possible need to amend the targets. Besides the rapidly growing food prices, they feared that the agricultural sector would be deprived of the arable land it needs to meet rising food demand at a time when global warming is already causing desertification and severe water shortages in many regions.

In spring 2008 the **European Commission** still seems determined to resist any move to amend the 10% target, which it feels as essential to reduce both the transport sector's dependence on oil and its impact on the environment.

II.1. Concepts

Primary energy sources can be divided into two groups. Non-renewable energy resources include coal, petrol, gas and fissile material, while renewable energy sources are solar, wind, water and biomass energy. The energy source can be also classified according to its depletion rate. Whilst non-renewable resources can be depleted, solar and wind energy are non-depletable, unlike the biomass energy, which can be also depleted.

From the primary resources secondary energy, such as fuel or electricity can be gained through various forms

II. THE USE OF BIOMASS

of transformation. These transformation processes greatly differ in their efficiency and their environmental impacts.

Thus biomass is renewable energy source, but it can be depleted. Biomass is biologically originated organic material; it consists of body mass of creatures living in biomes and biocoenoses or deceased terrestrial and water creatures (animals, plants and microorganisms); the products of biotechnological industries; and all sorts of products of the various transformers (human, animals, processing industry), waste and by-products. The body mass of humans is not included in the concept of biomass. The primary source of biomass is the assimilation activity of plants, the plant originated biomass is phytomass and the animal originated biomass is the zoomass. According to its place in the production-consumption chain biomass can be primary, secondary and tertiary. The primary biomass is the natural vegetation, crops, forests, fields, pastures, gardens and water plants. The secondary biomass is the fauna, the domesticated livestock and the products, by-products and the waste of livestock production. The tertiary biomass is the products, by-products and waste of the processing industry dealing with biologically originated materials and the organic materials of human settlements[8].

The main use of biomass is food and forage production, energy-purposed use and the production of agricultural raw-material. Among the energy-purposed use the most significant is burning, pelleting, pyrolisation and the production of biogas. One alternative of biomass use is composting. The fourth most common energy source after coal, oil and gas is biomass. Biomass provides 14% of the global energy use. The agriculturally originated energy sources are categorised as solid biomass, liquid biofuel and biogas.

The fields of energy-purposed production:

- Woody plantations with various rotation periods (locust, alder, willow, poplar clones, etc.)
- Herbaceous plant production (energy grass, reed, etc.)
- Oil seeds for biodiesel production (sunflower, rape, etc.)
- Crops for ethanol production (wheat, oat, corn, etc.)

The area created for energy production is called energy plantation. It can be woody or herbaceous plant culture.

II.2. Energy plants

II.2.1. Woody energy plants

Specific energy output of nature-like forests is between 15-20 GJ/hectare/year.

The combustion value of high moisture content wood is 10 MJ/kg. Combustion values of various tree species in totally dry state differ from each other by 5%. For firewood a combustion value of 17 MJ/kg is given.

[8] Környezetvédelmi Lexikon, Akadémiai Kiadó, 2002

The thought of energy-purposed tree plantations is supported by the fact, that utilizable wood from nature-like forests can only be exploited with difficulties, under specific conditions and in most cases expensively. The yearly energy output per hectare is also low.

Energy-purposed tree plantations can come into existence on agriculturally unutilized areas, where soil and habitat conditions do not allow effective agricultural production. Moreover, because of their penetrating roots, woody plants can utilize habitat characteristics better.

Regarding cultivation technology, two types of energy-purposed tree plantations should be distinguished. The replanted energy-purposed tree plantation is a high-density monoculture of some rapidly growing species with10-12 years rotation period, which is harvested and processed to wood shavings, then after soil preparation the forest is replanted. We can count on a yearly 8-15 t/hectare high moisture content yield, and a yearly 80-150 GJ/hectare energy content. Its disadvantages are the high costs of propagation material and the need of soil preparation after each rotation period.

In the course of the offshoot energy-purposed tree plantations, the wood is harvested after a one-year period, or in general after a 3-5-year period after planting, and repeatedly 5-7 times. The yield after harvesting comes from offshoot growth. Because of the short rotation period and the thin offshoot, cutting and chipping can be performed in one action. The specific energy output is given in 150-250 GJ/hectare/year. Its disadvantages are the need of first planting and the necessity of yearly row cultivation and fertilization in favour of higher production.

Referring to the results of the Energy Forest project in the 5th EU Framework Programme for research, Béla Marosvölgyi, professor of the University of West Hungary summarized the advantages of energy-purposed tree plantations as follows:

- several species and habitats can be taken into consideration;
- energy forest can be cultivated on flooded areas as well;
- one planting, more harvest;
- the lifetime of the energy forest equals to the lifetime of the power plant (about 25 years);
- high energy yield (200-350 GJ/hectare/year);
- high material and energy concentration at harvest;

- the harvest can be timed to agricultural off-season;
- delayed harvest does not cause yield loss;
- production purpose can be changed, for a smaller dependence on the buyer;
- the energy ratio is better (10-12) than in case of herbaceous plants (6-9).

Beside the advantages mentioned many times, it is worth to have a look at the tree species already involved in examinations. There are attempts with hard (locust) and soft (poplar clones, willows, tree of heaven) broad-leaved trees, as well as with woody shrubs (tamarisk, Russian olive, desert false indigo) throughout Europe. Regarding biodiversity, among these species only willows (white willow, goat willow and osier) can be accepted. Locust is under constant discussions, selected poplars endanger genetic stability of domestic poplars, while tree of heaven is not desirable because of its invasive character. Of course, the monoculture itself is doubtful for those worrying about biodiversity.

Site sensibility is an important aspect in case of selected species or varieties, highly affecting production and life chances. Poplars and willows need wet habitat and do not tolerate chemical residues well if planted to former agricultural areas. Sensibility to ecological conditions is shown by the fact, that species utilized effectively in other countries can even loose their viability under home conditions (drier, warmer). Accordingly, habitat characteristics effect the production highly, therefore increased production cannot be applied to all kinds of habitats.

The need of energy input also reduces the advantages of energy-purposed tree plantations against arable cultures. This input can only be decreased under extensive conditions, at the same time decreasing the energy density per area unit.

Both replanting and offshoot technologies demand propagation material. This propagation material can be cutting, rooted cutting and seedling, the latters suppose the work of nurseries for propagation material production. If we consider, offshooting can save only one plantation, because in this case the maximum age is 20 years, while at replanting technology it is 10 years. Planting can be success or failure, depending on planting conditions and climatic features of the year in question. In case of both technologies, planting follows soil preparation, which is usually started by a total chemical weed control. After it the autumn deep tillage takes place, then the spring cross ploughing, and mechanical and chemical weed control during the year. Discing, cultivating and soil disinfection is also needed before the autumn planting. Planting cuttings takes place in spring, followed by a chemical weed control then further mechanical or chemical weed controls are needed between the rows during the year. This has a special importance until trees grow out from herbaceous plants. In the first year, when tanning material content is low, the risk of game damage is high, defence must be provided. In the case of most plantings – except willow plantations – yearly row cultivation and fertilization is needed. After this harvesting, chipping, depositing and multiple transporting have energy demand. At the offshoot technology, especially at low cutting (can be one year), susceptibility of cut surfaces to diseases, fungal infections has to be taken into account, which claims for the utilization of plant protection methods after harvest.

It is important to mention, that there are no long-term experiences, which could show the actual production of energy-purposed tree plantations, the sustainability of this and the effect on habitats, therefore "results" showing great yield has still to be proved in practice.

Considering effects on soil life, comparing to a natural forest or an arable land, energy-purposed tree plantations occupy a middle position. Among dry fallen leaves of forest soils, arthropods and associated microbes have enough time to convert fallen leaves to water resistant, durable soil particles rich in humus. This has special importance in soil development and conservation of structural features. It is not possible on arable land except if sufficient time is provided for fallowing. In the case of energy-purposed tree plantations, especially at the replanting method, fallen leaves can possibly be reutilized for the soil biomass, but not to the extent of natural conditions. The future of our forests, or the changes of land use categories from agricultural areas to forests have to be considered in the light of climate change as well. Aims of biomass production and climate protection seem to be in conflict with each other. The role of forest coverage is invaluable in the aspect of temperature management and water retention as well. These two functions must be sustained. Energy-purposed utilization of forests or energy-purposed tree plantations endanger these functions. Forests are net carbon fixing agents until they are growing and reach a natural balance in climax. At present we need a lot of new, growing forests, which should be utilized as late as possible, when they release their fixed carbon. So as a tactical decision, the life of all trees should be prolonged until they fix carbon, and all new plantations should be planned for the longest possible period. The increased need for energy-purposed utilization of trees is in direct contradiction to the necessity of preserving trees in the forest for an optimal time. On the other hand, if we plan energy-purposed tree plantations with short rotation period (3-20 years), it is neutral regarding climate change aims, and may have the advantage of demanding less fossil energy than intensive arable cultures. In the point of view of climate change, the variation of production is an important aspect as well. According to present forecasts, less precipitation and higher temperatures make production decrease probable, which reduces the optimism of biomass potential hopes.

II.2.2. Energy grass

The Agricultural Research and Development Institute, Szarvas, Hungary carries out research from the 1980's with grass cultivars giving big dry material mass, utilizable in the energy, paper, building industries and for forage as well, which offer employment possibilities for handicapped regions. An outstanding result of the research program is considered to be the breeding of energy grass variety Szarvasi-1, which is a certified variety since 2004.

"Perennial, stolonnal thready grass. The strong roots probe deeply into the soil /1,8-2,5m/ in quantity from its stem. Its greyish-green stalk is sparsely leafy, straight, with smooth surface, hard and 180-220 cm high. The number of noduses is only 2-4. The greyish-green leaves are rigid, their surfaces are a little rough. The inflorescence is straight, 20-30 cm long, ear facing cluster.

It sprouts in the middle of April and flowers at the end of June - at the beginning of July. At the end of July - at the beginning of August, its graincrop is ripe to harvest. Its graincrop is the shape of a lance, 0,8-1,2 cm long. Thousandgraincrop mass is 2,8-3,8 g." (After the authors)

Agronomic features of energy grass:

- Tolerates well the extreme conditions (resistant to drought, salt and frost), can be cultivated on sand and saline soil as well;
- Can be cultivated on low production capacity areas;
- Long life: 10-15 years in one place;

- Resistant to plant diseases (brown/red rot, powdery mildew);
- Average yield in 1999-2000 was 15.82 t/hectare dry matter (in case of trees it is 12t/hectare/year);
- Combustion value: 14-17 MJ/kg dry matter (wood shavings 14,7 MJ/kg);
- Harvest is not expensive, no need for special machinery;
- Outstanding plant for bio melioration, its root system penetrates into the soil 1.8-2.5 m deep (protection against erosion, deflation);
- Simple and economic seed production;
- After first growth second crop production: pasturage, hay, silage and biogas production;
- Because of its great mass of roots, it supplies a good quantity of organic material after harvest;
- Plantation costs are less than 20% of forest plantation costs;
- Yearly utilizable, unlike woody plantations with 5-8 years harvest period;
- Substitutes wood, forest can be saved;
- Wide range of utilization: feedstock for energy and paper industry, industrial fibre;
- Compared to brown coal and gas boilers, it has the lowest cost for heating energy unit. The heating cost of a similar airspace flat is about half using bales, compared to coal or gas;
- Its sulphur content is low (0.12%), only 15-30th part of the coal's sulphur content, therefore SO_2 emission is minimal after burning. Compared to 12-15% ash content of coal, it contains a small amount of ash (2.8-4.2%), which can be well utilized for soil enrichment because of its potassium and phosphorous content;
- Economical.

Cost (eurocents) per 1 energy unit (1 MJ):

» natural gas	44
» oil	158
» locust	36
» brown coal	44
» energy grass (10 t/hectare yield, own land)	18
» energy grass (10 t/hectare yield, hired land)	26
» energy grass (15 t/hectare yield, own land)	12
» energy grass (15 t/hectare yield, hired land)	17

Questions regarding energy grass

Authors describe only advantages, and while there were no field ecologic examinations with the variety, or they had no publicity, simply unanswered questions can be asked. Considering the utilization of energy grass, authors write several advantages that make people think. They mention as an advantage, that it substitutes wood, and forests can be saved. This could be true, if energy grass provided sufficient renewable energy, and there was no need to use forests as well. For instance, more than half of Hungary's total area should produce energy grass to cover the present energy demand of the country.

They consider the energy grass widely utilizable. It is intended mostly to be burned in power stations. However, just because its deeply penetrating roots, it accumulates a lot of silicon, which melts over 900 degrees and form deposits on the wall of the furnace. Harvest can make troubles as well, thanks to the great mass. Haying is followed by drying. Everybody who is involved in hay harvesting knows, that this is a very sensitive procedure, it can highly be affected by weather even in case of low production natural grasslands. Drying has high energy demand, the harvested hay has to be spread out more times, then bales have to be made. The bales must be transported and stored. Considering the great volume, it requires severe logistic operations, which cannot be estimated while working with small production areas. The grass can be harvested twice a year, but there is a constant need for firing material, therefore logistic problems cannot be kept away.

There is no silicon deposition problem while burning on lower temperatures, therefore some users turned to pellets. If the bales are not burned directly, but pellets are made from them, the cost of the firing material increases from 3.97 EUR/kg (bale) to 11.11-11.90 EUR/kg (pellets). At the same time, the 14.9 MJ/kg combustion value of the bale increases only to 17.2 MJ/kg after this operation.

A further utilization possibility can be pyrolysis, in which pyrolysis gas is formed depending on temperature range and air shortage, while at lower temperatures pyrolysis oil is formed, which can be used as engine fuel.

It would be worth examining calculations and logic regarding energy balance as well. For this, only a few pieces of information are given, e.g. the need for 200 kg/hectare nitrogen fertilizer. Exact calculations require information on concrete transport routes and distances. At this point enthusiastic people start to review optimal supplier range around the power station. But the question is, whether everyone in the neighbourhood of an existing or a newly built power station can subordinate the present land use to energy-purposed use. Those worrying about nature conservation aspects are afraid of the unintended spreading of energy grass, its crossings with related species and the selective advantages of these. An answer to this, that seed dispersal can be prevented if haying takes place during flowering, later only if specifically produced for seed.

Naturally, time will decide these questions, but some heavy doubts can already be made up. Harvesting conditions, e.g. rainy periods can delay the harvest, so it can reach seed maturation. One can hardly believe, that farmers will sacrifice the yield in such cases. Hybridisation with couch grass cannot be excluded. They claim its different flowering time, but as a species tolerating a wide range of habitats, its flowering time can expand to large periods. It is especially hard to separate exact periods in the conditions of climatic changes, when we can experience a lot of odd phenomena. It is not likely, that the isolation from the high couch grass can be sustained for the end of times, like seed spreading can also be affected by unusual circumstances. In this aspect it is mostly the man who proves to be unreliable, either by his accidental or deliberate actions.

A further question is, that how much a plant with such a great organic material production exploit its habitat, and what kind of utilization is possible in the following period (after 10-15 years). Authors state, that the plant's deeply penetrating roots meliorate the soil. While others worry about how they can get rid of such a deeply penetrating plant if they want to use the land for other purposes.

II.3. Biodiesel

Until now 20-25 years of experience have been accumulated in relation with the plant oil operated diesel engines. Biodiesel is derived from oil seeds (rape and sunflower in Europe; soy and sunflower in the US, rape and tall-oil in Canada, oil palms in the tropical areas) through the extrusion of oil (triglyceride). Two commonly used production methods exist, which lead to two types of terminal products. First there is the so-called green diesel: the crude plant oil is cleaned and the resin is extracted. Second there is the variation, which is etherized with methanol in alkali environment. The etherized version of rape oil is called rape oil methyl ether (RME), while the soy's etherized version is called soy oil methyl ether (SME).

From 250 kg rape or 500 kg soy seeds 100 kg oil can be gained, and 100 kg cleaned plant oil etherized with 11 kg methanol gives 100 kg biodiesel and 11 kg glycerine. Further by-product is the protein rich extracted left-over.

Green diesel can be produced cheaper than the etherized version. Due to its high cethan number green diesel is suitable for mixing with diesel in order to increase its cethan number, and to substitute the nitrate based additives that are used to increase its efficiency.

Advantages of biodiesel over traditional fossil fuels and fossil fuel based lubricants are seen as the following:

- » The composition of the exhaust fumes of the biodiesel operated engines is more favourable than the emission of the diesel ones;
- » Due to the insignificant sulphide content (0,002% biodiesel, 0,15% diesel) oxidation catalysts can be applied and the nitrogen oxide can be reduced;
- » It is biologically degradable (it is degraded in the soil in few weeks) and as a lubricant it does not cause dead oil problem either;
- » The energy balance of RME is positive: 1,9:1, and also taking into the by-products (oilcake, glycerine) it is 2,65:1. The balance can be improved through the utilisation of heat energy if the dried part of rape is burnt;
- » The energy balance of SME is positive: 2,5:1, when etherized it can be raised to 4,1:1. The energy balance can be improved by varieties with higher yields and with more sparing production techniques;
- » Mixing with traditional diesel (5% mixing rate) there is no need for the alteration of the engines.

Disadvantages of biodiesel:

- » The nitrogen oxide content of exhaust fumes is higher than that of the traditional diesel, although it can be significantly reduced by delayed injection and oxidizing catalyst (for diesel engines no catalysts can be used because the sulphide content of the diesel "poisons" the catalyst);
- » Smell emission;

- More carcinogenic than the traditional gas[9];
- Due to its solvent characteristics it can harm the varnished parts;
- Its freezing point is -10 degree, in the case of diesel it is -15;
- Bad lubrication characteristics, components are abraded faster (can be improved with castor oil);
- The green diesel attacks the hosepipes, thus the pipes need to be changed to polyethylene or metal ones;
- If biodiesel is not clean enough it can cause the obstruction of the fuel filter;
- The energy content of biodiesel is 91% of that of the diesel[10];
- The efficiency of green diesel operated engines is usually not lower than of diesel engines, however, experience also shows a 5-10% reduction in efficiency (it can be tackled with turbo loading, and in the case of biodiesel-diesel mixing it does not occur);
- The by-products of biodiesel are not the best feedstocks, hence their utilisation is limited (burning and biogas production can be alternatives);
- At the moment it is only competitive with mineral oil if it is exempt from tax, but tax exemption reduces the national budget revenues;
- It is impossible to operate all the diesel engines with biodiesel because there is no sufficient area to produce the whole demand.

II.4 Bioethanol

Mixing or replacing petrol with alcohol is not unknown; it has been used since the 1920's. Nevertheless, its use gained momentum in the 1980's due to energy and environmental concerns, as well as agro-economic considerations.

Practically the production of bioethanol is the same as the production of food spirits. The most important sources among sugar containing crops are sugar-beet, sugar cane, fodder beet, sugar sorghum; among the starch containing crops: maize, wheat, oat, potato roots; ligno-cellulose products, such as maize stalk, woody plants and the industrial by-products, carrot molasses, milk whey, paper waste and sawdust.

[9] Volvo, referring to Swedish researches

[10] Popp, J; Somogyi, A.: Bioetanol és biodízel az EU-ban: áldás vagy átok? BIOENERGIA II.évfolyam 2007. 1. és 2. sz.

Average yield of some crops in Hungary and the extractable alcohol

Crop	Crop Area (1000 ha)	Average Yield (t/ha)	Total Yield (1000 t)	Extractable alcohol (l/ha)
Wheat	1 150	5,2	5 980	1 600
Sugar beet	60	50	3 000	5 000
Maize	1 225	7,1	8 700	2 400
Potato	29	25	725	2 500

Among the engine alcohols the most well-known biofuel is bioethanol (dehydrated alcohol). Bioethanol can be used as substitution of petrol or mixing with petrol. Mixing can occur directly or with adding isobutylene (the by-products of petrol refinement). Before adding bioethanol to petrol, it is reacted with isobutylene. In this way ethyl-tertio-butyl-ether

(ETBE) is formed, which is considered as biofuel due to its high content of bioethanol. ETBE is one of the most widely applied traditional octane number raiser. It is for the substitution of MTBE (methyl-tertio-butyl-ether), which is mixed with petrol to raise its oxygen content and octane number. ETBE is a sort of biofuel because the bioethanol used in its production is plant originated. On the contrary the methanol used for the production of MTBE is currently not derived from renewable resources, but from gas refinement.

The dehydrated alcohol used in the production of ETBE, which is the feedstock of bioethanol, can be sorted into two types. First it can be made from starch and sugar based agricultural products (wheat, maize, sugar-beet, potatoes, manioc and sugar cane) or it can be made from cellulose containing biomass (plant strands and fibres). The latter one is not so common.

The ligno-cellulose-based alcohol production could be promising, however, only initial researches have been carried out on this area for instance in Sweden. Besides the cheaply available great amounts of feedstocks, expensive investment and operation costs as well as low level of alcohol extraction can be expected.

Advantages of bioethanol:

- Exhaust fumes researches were carried out in France. In the analysis cars with and without catalysts were examined. According to the studies the emission of hydrocarbons and carbon monoxide were reduced. Furthermore numerous contaminating materials were not emitted, which are normally formed during the burning of petrol;
- Great diversity of feedstocks (sugar containing plants and its by-products, starch containing grain, ligno-cellulose);
- The products of agricultural overproduction can be utilized in this process;
- The by-products of bioethanol can be used as animal feed, thus well developed stock breeding in the surrounding area is favourable. Parallel with the growth of the ethanol production the quantity of by-products also increases. The marketing potential of the by-product has a serious effect on the profitability of the ethanol production[11].

Disadvantages of bioethanol:

- According to many the energy balance is negative: more energy is used for its production than the energy contained in the bioethanol. For instance during the maize production 30% more energy is used than it can be gained from the end product not mentioning the environmental impacts during the intensive plant production;
- With the use of ethanol only 13% of carbon dioxide emission can be saved due to the production procedure (emission during fermentation), but the emission of the feedstock production is not included in the calculation;
- High investment and operational costs;
- With ethanol the efficiency of the engine can reach only 70% of the efficiency of the petrol engines (other authors state 65%[12]);
- Unresolved problem of some by-products;
- High virtual water demands;
- It cannot be transported to longer distances through pipes because it binds the water and the contaminating materials occurring in the pipes;
- It attacks the rubber parts. The seals dilate significantly (by 20%);

[11] Popp, J; Somogyi, A.: Bioetanol és biodízel az EU-ban: áldás vagy átok? BIOENERGIA II.évfolyam 2007. 1. és 2. sz.

[12] Popp, J; Somogyi, A.: Bioetanol és biodízel az EU-ban: áldás vagy átok? BIOENERGIA II.évfolyam 2007. 1. és 2. sz.

- It also attacks the aluminium parts and because of its water content it harms the metal fuel containers through corrosion;
- The lubricant ability of the ethanol is even worse than in the case of petrol, which is unfavourable for the injection nozzle and the petrol pumps;
- Cold starting problems.

International review of biofuel production

The global production of biofuels reached 45 billion litres in 2005, out of which 41 billion litres was ethanol. The production of biodiesel is mostly remarkable in Europe and at a smaller scale in the USA. In 2005 the EU produced 3,1 billion litres of biodiesel out of the global 3.4 billion litres production. Namely inside the EU the share of diesel within the whole fuel consumption approximates 60%. Furthermore the EU is net importer of diesel while net exporter of petrol.

However, the 41 billion litres ethanol is only the 2% of the current petrol consumption. The world's biggest bioethanol producer is the US (in 2005 16.2 billion litres were produced) overtaking the previous market leader Brazil (the production was 15.5 billion litres in 2005). The third biggest producer is China (1,3 billion litres bioethanol was produced), while the EU is fourth with a significant lag. Its production was only 0.9 billion litres in 2005.

In Brazil obligatory ethanol mixing rate is determined. The achievability of this significantly depends on the world market price of sugar (Brazil is the main sugar exporter of the world, it gives 20% of the world production and 40% of the world trade), because during a global boom it is hard to fulfil the demands of the growing domestic market. It has already happened, when in February 2006 the mixing rate had to be reduced from 25% to 20%, then later it was raised to 23% and in July 2007 the original percentage was re-established. The Brazilian government sees the ethanol production as an important revenue and it hopes to double the production. For Brazil the most obvious market is the US due to its low transportation cost, however, the high tariffs and the subsidies for the American bioethanol production impedes the transport of a higher volume[13]. In 2005 Brazil exported 2.7 billion litres bioethanol, which increased to 3.4 billion

[13] Popp, J; Somogyi, A.: Bioetanol és biodízel az EU-ban: áldás vagy átok? BIOENERGIA II.évfolyam 2007. 1. és 2. sz.

litres in 2006 . According to governmental forecasts the ethanol production of Brazil will increase to 20 billion litres from the previous year's 17.5 billion litres by May 2008.

The US overtook Brazil in the bioethanol production in 2005, where it is produced mainly from maize and mostly for domestic use. The production capacity of the US extends much faster than in Brazil, but there is a lag in cost efficiency. Since 1978 energy tax legislation has existed, which supports the spread of the alternative energy sources with tax allowances. Obligatory mixing rate is also determined, which is 4% now. It should not be forgotten that it means a huge quantity (the quantity resulting from the compulsory mixing rate increases from 15 billion to 28 billion litres between 2006-2012), because the total petrol consumption is very significant. It is questionable though how sufficient amount of maize can be produced in order to fulfil the growing demands; through the reduction of the export, the intensification of the production, the rearrangement of the current product's structure (on the expense of soy) or the increase of the production area?

With the growth of ethanol production the amount of by-products raises as well. The main by-product of ethanol production is the dried (Distiller's Dried Grains with Solubles, DDGS) or wet distillers grains, which are used as fodder supplements. The marketing potential of by-products raises the profitability of the ethanol production. Drying is energy demanding, but the dried material can be stored well. The utilization of wet grains requires the farms to be nearby and the energy costs can be reduced.

In the production of biodiesel the US is in the second position behind the EU. The main feedstock of the biodiesel is soy, and the production mainly serves export aims unlike bioethanol[14].

The Biofuel Directive of the EU determined a 5.75% market share for the biofuel in the total fuel use by 2010. This means 12.6 million tonnes of bioethanol and 11.5 million tonnes of biodiesel use in the 25 EU Member States. According to the agreed targets until 2020 a minimum 10% of biofuel use has to be reached, though this might be reviewed in the future.

[14] Popp, J; Somogyi, A.: Bioetanol és biodízel az EU-ban: áldás vagy átok? BIOENERGIA II.évfolyam 2007. 1. és 2. sz.

The Energy Taxation Directive[15] allows for the Member States to provide a partial or whole tax exemption for biofuel produced from renewable energy sources. These tax exemptions are categorized as state support, hence cannot be applied without the previous permission of the European Commission. At the moment the tax exemption vary between 0,3-0,6 EUR/l. In some MSs compulsory use rate is determined, i.e. biofuels need to have a certain share on the national market.

The amount of bioethanol produced in the EU was estimated to be 720 thousand tonnes in 2005, which is 2% of the world's bioethanol production, although in the internal use it has a much higher significance. The main producers are Spain, France, Poland and Sweden. The major feedstocks are grains and sugar-beet, which are not included in the national quota, if it is guaranteed that they are produced solely for biofuel.

High tariffs are levied on bioethanol and the production of the EU is not competitive with the Brazilian and American production. This is indicated by the Brazilian ethanol's appearance on the EU market even despite current tariffs. The main ethanol producing developing countries already appear as exporters in the EU market under favourable tariffs.

Bioethanol production in some EU Member States in 2006

Member State	Production (t)
The Czech Republic	13 200
France	234 306
Germany	315 760
Hungary	4 818
Italy	102 400
Ireland	760
Latvia	9 600
Lithuania	14 000

15 Directive on restructuring the Community framework for the taxation of energy products and electricity (2003/96/EC)

The Netherlands	11 680
Poland	104 000
Spain	317 000
Sweden	57 600
Total:	1 185 524

Source: European Union of Ethanol Producers

In the EU 230 million tonnes diesel is used, while the current share of the biofuel is about 0.6% in contrast to the expected 5.75% by 2010. In order to achieve the target 14.5 million tonnes diesel have to be produced. The EU is one of the biggest biodiesel producer in the world (in 2005 it produced 3.2 million tonnes, which amounted to 90% of the world's total biodiesel production). At the same time the EU has 6.5 million tonnes production capacity, which can be further expanded by 25% in one year[16]. It can be seen that the capacities are excessive in light of the produced feedstocks in the EU countries.

Among the Member States Germany, France and Italy have the biggest production share. The main feedstocks of biodiesel are rape and sunflower seed.

Biodiesel production capacity in EU Member States in 2007

Member State	Production (1000 tonnes)
Austria	326
Belgium	335
Bulgaria	65
Cyprus	6
The Czech Republic	203
Denmark	90

[16] European Biodiesel Board

Estonia	35
Finland*	0
France	780
Germany	4,361
Greece	440
Hungary	21
Ireland*	6
Italy*	1,366
Latvia	20
Lithuania	42
Malta	8
The Netherlands	115
Poland	250
Portugal	246
Romania	81
Slovakia	99
Slovenia	17
Spain	508
Sweden	212
United Kingdom	657
Total:	**10,289**

Calculation based on 330 working days per year, per plant.

The above figures represent an overall picture of the EU-27 biodiesel capacity on July 1, 2007.

*Indicating additional capacities of hydrodiesel.

Source: European Biodiesel Board

The EU became a net importer of rape seed and rape oil in 2005. With the increase of biodiesel producers' demands for rape oil the food import of sunflower oil grew as well, while at the same time the sunflower seeds import decreased. The EU's net import position can be expected to extend in the future regarding plant oils. In Europe the biodiesel produced from palm oil is usually mixed with rape originated biodiesel with an amount of 15%. The import tariff is low for the raw materials of biodiesel (it is 0 in the case of oil seeds). The import of these products is foreseen to increase because the EU's internal feedstocks production is not sufficient for realising the mixing rate determined in the directive.

In Europe the most apparent feedstock is rape: 27.4 GJ energy can be gained from it, which is double than the energy input. As feedstock of biodiesel production 36 million tonnes of rape would be necessary, however, in 2007 the annual production was only about 15.5 million tonnes, which leads to import into the Member States.

II.5. The use of by-products and waste

Although opinions differ about the quantity of by-products and waste generated in the gardens, on the field and during agricultural processing, annually approximately 10 million tonnes of biomass is generated, 40-45% of which can be used for energy purposes. Naturally its use is determined by the energy production costs and subsidies. The costs are largely influenced by the size of the collection area, which determines the transport distances and the size and location of processing capacities. Nowadays mostly the production and use of the pellet is competitive, but the rising gas and petrol prices will foster the utilization of the waste, too.

The actual introduction of the alternatives is prevented or delayed by the already existing infrastructures. Even if the pellet is competitive as fuel, if people need to change their furnace or set up storage capacity, which means an investment, return of which can be only expected on the middle or long run, people might not afford it altogether. The necessary structural changes can be only forced with significant rise of the costs. However, the prices of the different energy sources are connected because of the market mechanisms and the demands for the fossil fuel, thus no remarkable price differences can be expected in the near future. The reason of this connection is that for the production of the alternative fuels and even for the production of the primary energy sources fossil fuel is utilized. Thus, it is an illusion to believe that the price of the biofuels can be separated from the price increase of the fossil sources. Of course there are exceptions, like in the case of the biogas where the energy gained from the secondary energy source covers the total cost of the energy production.

II.5.1 The use of biogas

Biogas is mostly gaseous and combustible product of organic waste containing carbohydrates or cellulose, protein and fat, which is dissolved (through biodegradation, putrefaction, fermentation) by anaerobe organisms in mesophilic temperature (30-40 °C). It mostly consists of methane and partially ammonium, sulphide hydrogen, carbon monoxide and carbon dioxide.

For the artificial production of biogas, finely processed organic materials, an air-tight environment, a steady temperature, continuous mixing, and the proper rate of symbiotically operating methanogenic and acidogenic bacteria tribes are required. During the generation of biogas, the organic compounds are dissolved into simpler compounds due to the contribution of the bacteria species (acid phase) and then disintegrate into the separate components: methane (60-70%), carbon dioxide (approx. 30-40%) and various other elements (H, N, S, etc.) depending on the base materials (methanogenic phase).

Biogas can be produced from biomass under mesophilic and thermophilic conditions - through fermentation for 25 days at approximately 35°C under mesophilic conditions or, for 15 days at approximately 56°C under thermophilic conditions. Additionally, biogas reactors also exist, where gas production can be conducted within a few hours; however, the extraction of depony gas (landfills) may require 15-20 years.

Biogas is produced in a fermentor which can operate continuously or in stages. Equipment producing batch biogas is filled periodically with base materials and silt, whereas permanent biogas production equipment is filled with feedstocks continually and presses out the same amount of silt from the container. The advantages of these installations are that a continuous biogas output can be approached if bacteria is supplied consistently and that they allow better control of the process. The fermentation process demands a great amount of heat, and, thus, external energy input, which can be supplied by approximately a quarter of the energy from the produced biogas.

Essentially any organic material is suitable for the production of biogas. The most important biogas base materials are liquid manure, litter manure, abattoir waste, fats, waste from food, forage and spirit production, used cooking oil, leftovers, organic waste, sewage, target plant production (crop) (corn, rye, sorghum, sun choke, vegetables and grasses).

The quantity of extractable biogas from different base materials

		Average total biogas (l/kg)	Utilisable biogas (l/kg)
Manure	Swine	445	338
	Bovine	200	152
	Poultry	465	353
	Horse	250	190
	Sheep	200	152
Agricultural	Wheat straw	250	190
By-products	Rye straw	250	190
	Oat straw	300	228
	Maize stalk	420	319
	Sunflower stalk	300	228
	Rape straw	200	152
Horticultural	Grass	415	315
By-products	Reed	215	163
	Foliage	250	190
Sewage		525	399

The composition and the combustion value of the gas are largely dependent on the organic base material and the technology. The average combustion value of biogas is 22.0 MJ/m3. According to a generally accepted value, biogas energy gained from the quantity of manure produced by a domestic animal in one day equals that of 0.8 kg of combustion oil. In practice, extreme values correspond with the energy production of 0.2 – 1 kg of combustion oil.

The produced biogas can be utilized for heating (in gas furnaces) and/or electricity production, as well as to supply natural gas networks. The residual, fermented manure remaining in the course of biogas production is called bio manure (bio humus), which is a well applicable, odourless material usable for garden and park fertilization.

Organic materials in communal landfills also decompose, due to their significant quantity, in an air-tight environment, whose by-product is the so-called depony gas. This process is slow and may last up to 15-20 years.

The gas is retrieved with gas extracting wells. These are suitably formulated, perforated pipes mainly made of plastic, installed vertically in the disposed waste layers laid in order, which make it possible to extract biogas created in the deeper layers.

The utilization of sewage biogas may be equally important. For instance in Hungary 700 thousand tonnes of municipality sewage is generated each year, about half of which is disposed of in landfills, and 40% is used in agriculture (compost, soil injection). Due to its relatively high investment and standard costs, it is more economical to plan its utilization for minimum 10,000 residents or, in the case of electricity and heat energy, for 20,000 residents.

The produced gas should be used as close to its production as possible. The most economical use of the gas is in furnaces, where it can be burned with 80% efficiency.

The advantage of biogas use is that it can process waste which would otherwise be handled at high costs, while energy and agricultural materials also result. This is a well-established, widely applied technology.

II.5.2 Composting

Nowadays energy-purposed use has exceeded the utilization of biomass by composting. However, energy can be also "produced" by not wasting it. All of the above discussed utilization options involve significant energy use, due to the energy demands of transportation, the necessary additional materials or the processing procedures. However, we could take a different approach. We have to keep soil in fertile condition, which is done in an artificial way nowadays. The production of fertilizers is energy demanding, especially if we take into account the virtual energy usage as well. The amount of the used energy is seen correctly if we take into account that plants use about tenth of the applied fertilizer, while the rest of it pollutes the environment.

According to current logic, we should collect the produced organic waste and burn it directly or after processing, whereby we obtain energy. This is followed by even more energy use to produce environmental pollutants to replace the combusted organic materials that could have nourished the soil.

This logic entails the destruction of life in two cycles. First by polluting the environment, and second by the withdrawal of nutrients from billions of living organisms, whereby we reduce biodiversity.

In the composting process the assimilation of organic materials is done by numerous species, which cannot operate if these materials are burned. The main contributors of the composting process are the microorganisms. Three groups of the bacteria can be classified here: psychrophiles, mesophiles and thermophiles. These microorganisms secrete enzymes, with which they digest the compostable organic materials. They need organic materials, water and air to function. The enzymes and the fungi decompose cellulose. Dozens of macro organisms busy themselves with the decomposition as well. Foremost of these are the worm species in humus composition. Whilst in the compost their services are free, we harm them and turn off their free support in the soil in the course of ploughing, fertilization, chemical protection, and even chemical plant protection . Worm species mostly enjoy the outer, peripheral parts of the compost heap, where the temperature is lower, as the inner parts are too warm for them. The significance of the worm and insect species is also that they chew through the compost and create channels, which are filled with air ensuring proper ventilation.

We must accept that, as a rule, we cannot invent anything better than nature. We are wise if we let nature work. If we work instead of it, we work against it, because we burden our environment, exploit its resources and emit pollutants in the process. Thus, in the process of composting we should primarily let nature work and only contribute by providing the proper conditions. One of the most crucial factors is that composting should take place as close to the formation of biomass and the utilization of the compost as possible. It is not environmentally sensible to transport the organic materials to big, central compost fields. On the other hand, the composting process can be controlled by selecting the main criteria influencing it. These are material composition, humidity, air supply, nutrient rate, the mixture of the materials, grain size, etc.

III. ARGUMENTS FOR AND AGAINST BIOMASS

III.1. General arguments for the use of biomass

In the EU there is a food overproduction in the agricultural sector, and partly because of the narrower market possibilities and partly because of the increasing international competition the products are hard to sell. However, if we cut back production we threaten the livelihood of the producers. So the situation can be solved if we keep up with the current production, but we inject the rest into energy supply. This is also good for the environment and the EU is able to fulfil the Kyoto requirements stating that the use of the biomass is carbon dioxide neutral, because we release as much carbon dioxide into the atmosphere as the plant fixed during its lifecycle.

The other general argument concerns energy dependence. The US, the EU and recently even China are in this situation: they are oil dependants, and apart from the US they are also gas dependants. The mitigation of this dependence is expected if they can cover their energy supply from partly domestically generated energy sources. The growing popularity of biomass among politicians can be explained with the oil price boom and the oil war connected with the oil dependence.

Many see development opportunity for the third world in the use of biomass, especially in the production of biofuels. Luiz Inacio Lula da Silva, the president of Brazil made it clear at the extended session of the G8 meeting (Heiligendamm, Germany) that if the developed West wants to get rid of the dependence on fossil sources and if it regards the GHGs as a serious issue, then it has to ally with Africa and South America in the field of biofuel production. Referring to the South America-Africa Summit in 2005, he sees that Brazil can hand over experience for the African countries and he regards biofuel production as a reinforcement of the Africa-South America Alliance and as a main driver of development.

The president believes that the vehicles using 25% alcohol have made it possible for Brazil to reduce the oil import and to curtail greenhouse gas emission with 120 million tonnes since 2003. The ethanol production established 1.5 million workplaces directly and 4.5 million indirectly. Moreover the start of biodiesel production also meant quarter million workplaces and it has been carried on ever since. In his view biofuel production does not endanger the security of food production in Brazil at all; the basic material production affects only 2% of the agricultural land. The president explained that the production of biofuel had a strategic meaning at a global scale in the elimination of environmental problems.[17]

The countries of Africa see their development in the fulfilment of the EU demands, especially being closer to Europe than Southeast Asia or South America. Louis Michel (European Commissioner for Development and Humanitarian Support) emphasised that the African nations could not miss this train, referring to the possibilities in the biofuel trade. Europe also has to invest into the African business[18].

III.2. Counterarguments and doubts

III.2.1 Territorial requirements

Clearly the most doubtful aspect of biomass use is the territorial limit. In addition, there are plenty other problems linked to territorial limits, such as the security of food production and the future of earth's remaining natural ecosystems.

Although many years ago the attention was already drawn to territorial limits, neither environmentalists, nor the business took the stubborn facts

[17] Source: http://www.accra-mail.com/mailnews.asp?id=1730

[18] Africa: Following Oil Boom, Biofuel Eyed on Continent Inter Press Service, Johannesburg 2007

into account. The question got into the spotlight when in October 2004 George Monbiot, a columnist of the Guardian strongly came out against biodiesel at the European Social Forum and he published an article in this topic with the title "Feeding cars not people"[19].

According to his opinion the swap to the biofuels would lead to a humanitarian and environmental catastrophe. He questioned the EU's views of the possibility to replace 5.75% of the fossil fuels with biologically originated fuels until 2010 with the example of the United Kingdom.

"Road transport in the United Kingdom consumes 37.6 million tonnes of petroleum products a year. The most productive oil crop which can be grown in this country is rape. The average yield is between 3 and 3.5 tonnes per hectare. One tonne of rapeseed produces 415 kilos of biodiesel. So every hectare of arable land could provide 1.45 tonnes of transport fuel. To run our cars and buses and lorries on biodiesel, in other words, would require 25.9m hectares. There are 5.7m in the United Kingdom. So every hectare of arable land could provide 1.45 tonnes of transport fuel. To run our cars and buses and lorries on biodiesel, in other words, would require 25.9m hectares. There are 5.7m in the United Kingdom."

Dozens of other examples could be mentioned. For instance according to the report by Friends of the Earth in Spain 27 billion litres diesel is consumed. The required 5.75% replacement of biodiesel until 2010 would require the production of 1,350 million litres biodiesel. Counting with 1,200 litres per hectare yield one million hectares would be necessary, which is 5.5% of the arable lands. For this additional area has to be still added to produce ethanol. There is a similar situation in Germany. In order to reach the 2010 goals 2 million hectares are needed for the production of the 2 million litres biodiesel. There is not sufficient area for this. Nowadays the produced 1.5 million tonnes of biodiesel crops come from France. In the United States the situation is even worse. For the petrol with the maize derived ethanol even the total land area is insufficient. The total fuel consumption of the States is 518 billion litres and its carbon emission is 308 billion kg.

The authors of an article in the Proceeding of the National Academy of Sciences compared the soy-based biodiesel with the crop-fermented eth-

[19] Guardian, 22 November, 2004

anol-based fuel. They concluded that the biodiesel is more effective than the ethanol. However, even in this case it can only cover 9% of the fuel demand of the US. Ethanol made from plants for food production can be suitable to cover 12% of the American fuel demand in the case if all maize fields were converted into feedstock producing lands.

Realising the possible territorial problems in Europe, it has become clear in an impact assessment that the realization of the 2007 Spring Council target (10% biofuel share in the market until 2020) would require the 72% of the lands of the Member States, and each produced litre of biofuel would cost twice as much as the normal fuel[20].

III.2.2 Competition of land use and social implications

The problem of territorial limit is culminated in the appearance of various land use demands, which compete with each other. Even if new areas can be involved into biomass production, we would like to produce energy grass for electricity production, energy forest, sugar-beet, maize for ethanol, rape for biodiesel, etc. at the same time. It was also Monbiot who pointed out that the competition goes beyond the options of biomass production; in reality the production of the renewable energy sources competes with food production and protected areas besides other land-uses. The growing energy hunger and the depleting fossil resources, the misinterpreted environmental targets forced people to produce biomass even when cheap fossil fuels are still available. It is also clear that with the growing pressure for biomass use the demand for crops also increases. With the growing demand the price goes up and more people see the possible profit. This results in the expansion of the cultivated areas, which happens on the expense of nature.

Thus it is not difficult to find out that the first victims of this competition are the natural ecosystems and then the food production. In this field – just like in other European efforts to improve the environment – the environmental burdens will be transferred to the third world. Because there are few legally protected natural ecosystems in the Member States, the food production and the energy crop production have to share the land. The logical response is giving up the current overproduction for energy crop production. However, these capacities are far from being sufficient

[20] Smith, E.: Can biofuels become sustainable? Energy Vol. 13 No. 27, 2007).

to reach the aims of the original environmental targets, consequently there is an urge to find external resources. This is logical, because the Southern countries have higher potential in the context of energy crops.

The soy and sugar cane plantations, which can be found in South American countries, and the oil palm fields in Indonesia and other Southeast Asian and African countries have been already the major causes of the degradation of tropical forests. For instance in Malaysia the palm fields were responsible for 87% of the deforestation between 1985-2000.

The danger today is not a possibility, but a fact.

The import of the EU plant oil in the 2005-2006 October-September season rose to 8.75 million tonnes from the 2004-2005 season's 7.8 million tonnes, wrote the Oil World magazine. Due to the quick rising of the internal production of biofuels, the EU has become the largest plant oil importer in the world. The season's biggest import item will be palm oil with 4.9 million tonnes, in contrast with the 4.4 million tonnes between 2004-2005. The EU became net soy oil importer in October-December, which is a new development, because it has been regarded as a soy oil exporter for a while. In spite of the growing rape seed-pressing turnover the rape oil demand cannot be ensured from domestic resources, which makes the EU as a net importer of rape as well. In 2005-2006 the import of rape oil will grow to 250 000 tonnes from the previous season's 28 000 tonnes. From this 100-130 000 will come from North America, but big amounts will be imported from Ukraine and Russia, too. Some sources of the paper say that Chinese import has already happened as well.

Based on the European export the Malaysian government recently declared that they built the fifth biodiesel refinery. Meanwhile in the country, just like in Indonesia, oil palm plantations replace tropical forests speedily, and in addition the burning of the forest and the drainage of peatlands lead to methane and carbon dioxide emission (territorial shifting of the environmental load). The fuel used in Europe would be produced in Brazil, where they cut out the Amazonian rain forest for the land. The favourable market condition would probably result in the expansion of the Brazilian sugar cane production, analysts count with 47% growth between 2005 and 2015. The land of Brazil is about 850 million ha, 320 million ha of which is agricultural area, the arable land and plantation constitute altogether about 60.4 million ha. The recent area of the sugar cane plantation is 5.3 million ha, but it can be extended to 20 times more.

If there is no room for usable land, at the moment the quarter of the terrestrial areas is used by agriculture, then the competition can start between the food production and energy crop production. And in parallel also between those who only want to satisfy their basic needs and those who not are not only able to eat, but also to fill up their cars. There is no doubt which stakeholders can lobby better and pay for all of this. The polarization of the society can even escalate more due to the biomass. The article of Monbiot refers exactly to this.

To fill the 100 litre tank of an SUV 204 kg maize ethanol is needed. The calorie content of this quantity is sufficient for the annual food of an adult according to Jeffrey McNeely, IUCN's Chief Scientist. If it goes on like this, 600 million people more will be starving in 20 years, states the International Crop Commission[21].

The threat to the poor does not only appear in the form of lack of food, but also in the form of significant rise of the food prices. This is already proven by the recent hunger riots in Mexico, Pakistan, Indonesia, Yemen, Haiti, Egypt, Ivory Coast, and El Salvador.

The price lifting role is also underpinned by the rise of the price of sugar."The price of raw sugar reached its peak in eleven years on Wednesday in the New York Stock, and the London prices reached its nine and half year peaks. Market analysts expect the continuation of the tendency. Why? In Thailand and Australia, sugar cane production is bad, and in Brazil some parts of the exportable sugar cane will be used as bioethanol. In an increasing number of countries, bioethanol is mixed with petrol, hence, the premium of sugar will increase – and so will its price. Moreover, there is a rather populous place, China, where massive sugar consumption has just begun, as only artificial sweeteners, such as saccharin, have been available to the population up till now."[22]

Because corn-based ethanol production is strongly promoted South Africa, 55 thousand new workplaces have been established, especially in rural areas; although, everybody suffers from higher expenses of the basic needs. The price of corn rose by 28%, while that of sugar by 12.6% in one single year. Mexico has also experienced the price lifting effect of the high

[21] Source: http://index,hu/gazdasag/vilag/bio070612/

[22] Világgazdaság, 2006

demand of corn through the rise of tortilla prices. In the beginning of the year, there were serious riots when the price of corn virtually doubled as the demand for biofuels jumped due to the increase of crude oil prices.

The expansion of the ethanol sector in the United States raises the question where to obtain the corn necessary for its production. While 40 million tonnes of corn was used for ethanol production in 2005, this amount will have at least doubled by 2010, which can only be provided at the cost of a decrease in its exportation. The compulsory use of ethanol has a price lifting effect in the case of corn. In 2006 the price of corn increased by 87%, which was partly caused by the reduction of crop production globally in that year.

Contrary to the thoughts of the Brazilian president, who can see the chance for a progress in the production and trade of the biofuels, the communities of local people are not so enthusiastic. The Quito Declaration adopted in their names express the fear of local people of losing their independence due to biofuels.

According to the declaration:
"The mass expansion of energy crops constitutes a threat to our traditional agricultural way of living. It means the taking over of the land we use to produce our food crops and foods consumed by the rest of Ecuadorians. It also means the disappearance of the last remaining tropical forests, those that apart from being important for the conservation of life, is the place where we develop our culture and guarantee our survival as peoples.

Rural development based on agro fuels, will benefit those of the agro industry represented by the big sugar engineers, the palm grower sector who are responsible for the mass deforestation of the forests in Esmeraldas and the Amazon region, and by companies such as PRONACA, representative of Monsanto transnational, who would introduce corn seeds for the production of ethanol.

Agro fuels could provide a doorway for the entry of transgenic crops with all the impacts that this entails. It is important to highlight that until now and due to civil pressure, Ecuador is a country free of transgenic crops.

With their economic power, the agro industry businessmen would establish relationships of dependency with local farmers, indigenous groups and afro-descendants that live in the areas that have been chosen for the development of fuel crops. We would lose our food sovereignty, and become company workers. This threatens our traditional way of life.

With the aim of generating fuel crops our best lands would be used as well as our water and labour, which will mean that we will stop producing food crops that we need for self consumption and we will instead feed the vehicles of the rich. On the other hand our sources of water will be contaminated by the use of agro toxins, which will affect our health and quality of life.

The current government has in front of it two alternatives: that of backing a model of diversification and sustainable production, that will guarantee food sovereignty, and the continuity of our traditional ways of life as indigenous groups, afro-descendents and local farmers and the conservation of biodiversity or that of backing the agro industry."

The fear of local people from the multinational companies seems to be justified. Some cases have already come to light when it was proved that companies illegally cut out rain forests. The most well-known case is the Wilmar scandal. The Wilmar company is one of the most well-known biodiesel producers, in Indonesia it is charged of cutting out areas, which did not belong to the concession area, but to the local communities[23].

The charity called Grain also attacked the expanding biofuel business with the support of farmers and local communities of developing countries. Referring to FAO, the organization also confirmed that the role of biofuels in the carbon sequestration is questionable. Based on their researches the organization stated that developing country governments along with biofuel companies displaced peasants and indigenous people off their land and established monoculture agriculture instead of the traditional, environmentally sound farming[24].

[23] Sterling T.: The Associated Press, 2007

[24] Harrabin, R, BBC News

III.2.3 The collateral effects of territorial rivalry

From an environmental point of view, additionally to the growing craving for land and the destruction of natural habitats, other dangers include the increasing intensification of agriculture and forestry. We can read about overbidding production results and energy outputs and increasingly efficient energy balances in the professional papers. As we could see, the modest energy production of a natural forest can be extended ten times by tree plantations for energy production purposes.. The production of crops can be also increased for the sake of higher yields and increased efficiency. Naturally, a given region with its particular biome can only provide a yield that is appropriate for its pertinent ecological conditions and requires external energy input in order to increase its production. Direct or indirect energy input is required not only for the direct energy demands—such as the power usage of mechanical equipment—but for the entire production process as well. The irrigation, the fertilizers, the pesticides, the transportation all represent energy usage and, of course, all resulting emission means burden on the environment.

A further option for increasing yields is the utilization of the genetic ability of plants, plant breeding and, as of late, the artificial modification of genes by genetic engineering. The article entitled "Bioethanol needs biotech now" published in Nature Biotechnology[25] enthusiastically discusses the high financial and environmental costs involved in the production of maize, a bioethanol feedstock, such as nitrogen fertilizer, soil erosion, weed- and insect-killer—and even mentions the threats to the natural habitats of developing countries. These problems can be tackled by biotechnology. "In the case of ethanol, currently produced from corn kernels and sugarcane, a recombinant DNA technology has been developed, which on one hand would raise ethanol output, and on the other hand would reduce the environmentally harmful effects of the feedstock, as well as enhance the efficiency of the process in the refineries." The article makes promises for the improvement of the efficiency of the CO_2 fixation of photosynthesis, the solution of the nitrogen fixation or the installation of the enzyme system that decomposes the starch in the endosperm to simpler sugar into the plants. Other researches have been initiated to discover the genome of oil palm, which is hoped to lead to

[25] 24,725. July 2006 (www.nature.com)

genetically modified species that are more tolerant of aridity and capable of higher production.[26]

Various other impacts should also be considered from a social aspect. As energy crop production requires large farms, super intensive monocultures may further distort land relations. According to Friends of the Earth Europe, the increasing intensity threatens further land concentration. For instance, 46% of the land in Brazil is concentrated in 1% of the rural population, which resulted from landowners having to leave their lands and previous occupation. They moved to the poorer districts of cities, or they tried to gain more land by deforestation.

The increase of territorial demand can have a price lifting effect for the landowners. Barely could smallholders seize the opportunities offered by high intensity energy crop production; thus, they may only count on selling their land at higher prices or charge higher rent.

III.2.4 Energy balance

We come upon a very chaotic situation regarding this area. We find conflicting results by various academic workshops, depending on the agenda each is trying to justify. The framework of this study does not allow recalculating the published data, as neither the calculation methods, nor the initial data are known.

The common mistake of the available balances is that they do not take into account the so-called virtual energy use and the resulting virtual environmental burdens, which also puts the results of the energy and environmental balances into question (e.g. related to carbon dioxide).

What is meant by virtual energy use?

Any kind of energy source ready for use has a whole life cycle, which is a complex, diversified system. In the case of a facility, life cycle analysis studies the environmental implications of establishment, execution (operation) and abandonment. In the case of a product, it traces the life cycle from cradle to grave. Although this thinking may be regarded as a major step forward and it would already be plausible if life cycle analyses were applied seriously, it must be noted that current life cycle

[26] PR Newswire

studies only examine a number of the links related to the actual cycle. In the cases of the certain products, the links are connected. In order to produce one litre of petrol, we need crude oil, which has to be fractioned, additives used, transported to the place of use and then combusted. Energy is needed for the transportation and disposal of the by-products and waste as well. If the cycle of petrol is examined only inside one refinery, it requires that much energy incrementally. And even there it is not merely that much. Each litre of fractioned oil represents a small portion of the environmental burden from creating the refinery, energy being used, obtaining the tools and operating the plant. Furthermore each branch opened involves an addition, small portion of environmental burden. For instance, the used constructing material involved environmental cost, resource demand, factory, etc. Then for the operation of the refinery energy was needed and, of course, more workers as well. Where should the transportation costs of the workers be calculated or the costs related to the machines and tools or the liability for the environmental damages?

And the above example only refers to refinery and its connection points. Another is connected to the refinery by the lifecycle of the feedstock's lifecycle. The crude oil had to be extracted, for which rigs were set up, for which materials had to be produced, which had to be transported and installed. The extracted oil had to be stored, for which storage was needed, then transported in barges or in pipes. For the transportation, energy was needed, as was for the manufacturing of the tools.

When we mention biodiesel, we think about a nice, blooming rape field or a less nice oil pressing machine. If we only regard the necessary materials for the production of biodiesel (methanol, caustic potash, natrium hydroxide, vitriol, phosphorus acid, hydrogen chloride, industrial water, carbon dioxide, nitrogen, electricity, gas) we would be quite surprised how many other materials had to be produced to reach our final product. We had to build a whole line of logistic facilities (temporary storage for the oil seeds, storage for the oil seeds, raw oil container, by-products container, technological materials container, final product container) which is involved with the moving and transportation of materials. It would be natural to take into account the energy costs and other burdens (carbon dioxide, waste, water use) of these when creating the energy balance sheet, but these are usually omitted.

In relation to petrol, indirect connections could be also mentioned, such as the costs of the restoration of environmental damages by a capsized tanker or the energy costs, environmental disasters and the social impacts connected with the oil related wars.

It would be impossible to trace the entire network and calculate how much barely measurable but real environmental burden one litre of petrol represents. Litre is a far too small unit for this, but the higher the measurement, the more perceptible the virtual burdens would become.

Of course, there have been attempts. The ecological footprint or ecological backpack tries to map out the hidden burdens. Even though approaching perfectionism is impossible, some of the emerged data may make us think for a while.

According to the calculation of the Wuppertal Institute for:

Toothbrush	1,5 kg
Mobile	75 kg
PC	500 kg
1 tonne of imported iron	20,000 kg waste is generated.

According to the World Water Council (2004) for:

1 kg wheat	1000 l
1 kg egg	2700 l
1 kg meat	13,500 l water is used.

From the following table it can be seen that the external costs only count with the burdens of the consequences of the primary effects and not the costs resulting from the whole network. For instance, the external cost of firewood cannot be zero, because the timber has to be produced and transported, not mentioning the external costs of forest rehabilitation and operation. The external costs of the baled hay already exist in connection with the operation of the baling machine.

The basic and environmental costs of energy resources (EUR/GJ)

Energy resources	Stocks, depreciation	External costs	Total costs
Brown coal	3.9	6.1	10
Coal	4.6	4	8.6
Oil	14.9	0.3	15.2
PB gas	8.6	0	8.6
Natural gas	3.8	0	3.8
Firewood	4.5	0	4.5
Energy plantation	3.1	0	3.1
Baled straw	3.4	0	3.4

Source: Technical Institute of the Ministry of Rural Development and Agriculture of Hungary

Certainly to different kinds and uses of biomass different energy balances belong. Clearly it is determining what production is possible for the certain crops under different ecological and production conditions.

Average yields of some crops

Crop	Biodiesel (l/ha)
Soybean, northern areas	375
Soybean, southern areas	900
Rape	1.000
Mustard	1.300
Palm oil	5.800
Algae	95.000

Source: Wikipedia 2006. Biodiesel. http://en.wikipedia.org/wiki/Biodiesel

According to the statistics, palm oil and sugarcane yield the highest amount of fuel per hectare in the tropical zone. Algae are the most promising in respect to biodiesel, but the technology needs improvement. Ethanol made from cellulose waste also shows high potential; however, the enzymatic extraction is expensive and the environmental factors of some of the elements are not clarified either[27].

Norbert Kohlheb has published energy input/output quotients in relation to woody and herbaceous species, field conditions and production intensity in an article[28]. While the best energy output rates are produced on a good field under extensive circumstances (except hemp) the highest energy outputs are attained on a good field with intensive production technologies. This also indicates that the field and the production technology influence the production and, accordingly, the possibilities of energy production. But generally speaking the energy input used to attain the larger yields with intensive production has smaller return than the extensive ones. Of course, the quoted figures do not include the missing virtual background; the calculations count with the energy used only on the plantations and in transportation. The energy demand of the preparation combustive material, logistic operation and additional materials is not discussed.

The environmentally sound use of nature-like forests can be characterized by a high energy output rate; the energy content of the produced wood exceeds the input energy by 50 times. Approximately half of the input covers the energy demand of transportation. The output/input rates of the energy-related tree plantations have wide threshold limits depending on whether they are used by extensive or intensive modes and what sort of field conditions are ensured.

The value of the quotient can reach 20 on an extensively used good field, while on a bad field the output is only three times of the input under intensive conditions[29]. Others credit even 50 times values in the case of favourable conditions.

The construction of the whole energy balance is largely influenced by the conversion ways, which make the not so clear picture even more complex. The highest energy demand presumably exists at the conversion. It may be 60%, depending on the type of the conversion method.

27 Friends of the Earth International

28 "The economical characteristics of the energy plantations in New Ways in Agriculture, Energy Club, 2005

29 Kohlheb, 2003

The professional press, but even the scientific literature, make contradictory declarations. Here are some examples:

The production of biomass can often be regarded unsustainable. The inputs are high: energy, pesticides, fertilizer, machines, etc. A good example of this is corn based bioethanol in the US. Some of the studies state that corn and ethanol demand six times the energy than the energy produced by the end product[30].

"While we are able to extract almost double of the applied energy from the soy-based biodiesel, in the case of ethanol barely 25% more energy is produced, than what it consumed during its production. This latter difference primarily comes from the fact that during the production of ethanol, fermentation processes have to be started, which require a relatively large amount of energy" according to National Geographic.

So the first question regarding biomass is whether the quantity of the extracted energy balance is positive or negative; is more or less energy needed for its production than the amount we can hope for from the renewable resources.

Science has been divided into two groups, depending on their respective agendas. The opponents refer to quite an early study by two American professors (David Pimental, Cornell University, Tad W. Patzek, Berkeley). Here are some of the calculations of the authors, whereby the energy balance is negative.

- Alcohol from corn +29% fossil fuel
- Alcohol from grass +45% fossil fuel
- Alcohol from wood +57% fossil fuel
- Diesel from soy + 27% fossil fuel
- Diesel from sunflower oil +118% fossil fuel

German authors (N. Schmitz, J. Henke[31] – as opposed to the American school – state that the energy balance is positive. According to them, the authors mentioned above are biased, the statistical data they use are

[30] Pescovitz, D. Ethanol Stirs Eco-Debate. Berkeley Eng. Lab Notes, Vol. 5, March 2006

[31] Innovation in the Production of Bioethanol and their Implications for Energy and Greenhouse Gas Balance

outdated and do not take into account the increasing efficiency of agricultural production, the improved technologies used to find new sources of energy, and the energy contents of crop remains. The German authors selected 12 new studies which showed net energy gains, as well as carbon dioxide savings.

It is rather hopeless to make a final judgment in relation to such analyses, since the results are indeed very much dependent on the factors taken into account. Although there are recommended calculating standards, the accuracy of those is also questionable. The main objection is that, in general, they look at first generation, direct energy demands without considering the whole ecological "package."

For instance, in case of plant cultivation, they consider the energy demands of mechanical soil cultivation, sowing, harvesting and transportation while neglecting those secondary and tertiary energy demands related to soil-amelioration, pesticides or irrigation. In addition the virtual water content of the above and the energy used for it also has to be considered, as we have already referred to it above.

We can see that it is also part of the debate whether the energy content of all the usable parts of the plant should be calculated into the energy balance. For example, after harvesting the seeds of rape, shall we use its stem as well? This question is raised in a different way also, in the debate about the utilization of biomass. Many believe that it is wrong, or even a waste, not to use the biomass of plants already produced, since it reduces the utilization of the natural resources invested in it. Those who adopt this argument say that the utilization of the remains should be solved first, only then can structural reorganisation (that is, cultivation for the sole purpose of gaining energy) follow. Others appeal to the minor energy density of biomass and to the high costs of its collection According to them, the priority is to attain the highest energy density possible, which is, in other words, utilization purely for energy.

Obviously, both types of argumentation focus only on primary economical aspects, neglecting system-approach considerations. If none of the produced biomass is returned into the soil and, as a result, the soil structure deteriorates, also taking into account the reduced effectiveness of fertilizers in the long-term, then it may happen that, ad absurdum, we will produce energy from the remains in order to preserve the soil. Some believe that the best and most effective way to use organic substance is to insert it into the soil. This way it increases the humus in the soil, which, in turn, helps to sustain the soil structure and enhances the soil fertility.

However, the picture is more complex. Under natural conditions, no one ploughs in any plant or animal remains. Left on the surface, these remains, with the help of living organisms, are transformed into stable soil crumbs, which are important for soil re-construction. In contrast, when stubble or manure is placed in the soil, it degrades very quickly, mainly because of the accelerated oxidation in the soil; thus, apart from being a source of nutrients for a short time, it does not enhance the soil structure . In certain conditions, it can even be harmful by releasing phylotoxic materials by way of their microbial decomposition. Although fertilizers can be a good source for nutrients and increase yields, they do not improve the soil structure. In the long run, natural processes are essential to sustain the quality of soil.

III.2.5. Environmental and ecological aspects

The following points must be considered in producing and using biomass:

- It should not lead – directly or indirectly – to further decrease or deterioration of the quality of natural habitats.
- The environmental burden in the area used for energy purposes should be decreased in comparison to the previous utilization.
- The land, used for such purposes, should show an improvement in biodiversity-indicators both in relation with quality and quantity.
- Production of invasive and genetically modified species must be excluded.
- The production technology chosen should adapt to and sustain the original ecological conditions and should not reduce the capacity of the ecological system to renew itself.

The truth is that if we want to avoid the deterioration of environmental conditions, it will inevitably conflict with high productivity, the main goal of using these plantations for energy purposes. And this is the purpose of such plantations; otherwise using natural systems under natural conditions would suffice.

It seems, however, that in the course of evolution nature somehow "failed" to create systems which would suit human demand and allow for endless quantities of production. Humans are now trying to make up for this lack, and these enthusiastic saviours of the world wish to demonstrate that systems with ever increasing productivity can be squeezed out of nature without any trade-off. It is as if we wanted to tap a barrel without pouring anything into it and still wanting to drink endlessly from it. We can always find a man who can drink more, but the barrel will only be empty sooner, if there is no refill.

How is it possible then that the elephantgrass improved by breeding by American scientists can produce 60 tonnes (probably in wet mass) in one hectare?

First of all, it creates a monoculture, since, with its height of four meters, hardly anything survives in its shadow. This means, we must already dismiss the aspect of increasing biodiversity. Even an arable land with its weeds produces higher biodiversity. Secondly, organic substance produced by plants is constructed with the help of solar energy from the carbon dioxide in air, from water and from the chemical elements which originate from decomposing organic substance in soil. The sun and the carbon dioxide are not inhibiting factors (unless we have too much of the latter); however, the water and the nutrients in the soil are in limited quantities at our disposal, and they are further limitated by both the excessive presence and the absence of the other. Therefore, high productivity without external resources cannot be sustained. The barrel will sooner or later be empty.

What we are left with is reliance on external resources. But it is a very simplified way of thinking about how ecological systems work, if one really believes that those organic elements in the soil can be substituted by ashes and that a small amount of fertilizers can supply the nitrogen and phosphorus the soil needs. Intensive agriculture, with its demands of ever increasing production, was based on similar ideology. And we can see the environmental impacts and problems it caused when it disregarded the limitations in the natural system`s capacity to sustain itself.

Biochemical cycles, which are essential for life to renew itself, require 30-40 elements. These are available in given amount in a certain system, which provides a limit. The interaction between water, air and soil provides the reserves for nutrients. The primary drivers behind this interaction is the mass of living organisms. Huge geological reserves are built in this cycle: they consists of gases (C,N,O), which make quick cycles possible, and of the reserves of sedimentary rocks (P,S) which are slow to mobilize and, consequently, are limiting factors. The operations of systems are full of such self-regulatory and interconnected functions. In the process of mineralization elements are transformed from organic-bonded to mineral-bonded with help of bacteria, and the organic substance in the soil is decreased, while the amount of nutrients available for the plants increases. In immobilization, which is the opposite process, it is the inorganic substance that is incorporated into some soil microbe, which subtracts the elements plants need. For instance, in soil which is rich in coal, microbes immobilize from the plant the nitrogen and phosphorus from the fertilizer. These antagonisms ensure that growth is not limitless and sudden and that it does not exceed the time needed for adaptation. These mechanisms can, to some degree, equalize the impacts of those erroneous human interferences caused by lack of knowledge.

The truth is that biomass production wants to use the whole vegetation culture. In a natural forest, there is much more organic substance than what can be gained by felling the trees, though that is not so easily accessible. In an energy plantation, everything that grows above the ground can be cut and taken. In a forest, a branch or a twig, because of its size, is useless for humans, just as are bushes and smaller plants. However, these will be used in the whole ecosystem of the forest, where the huge biomass from this "waste" sustains substance- and energy-flows both within and outside the ecosystem.

If we take everything that is above the ground, we break the interaction between soil and surface, and deprive the life that ensures substance- and energy-flows, because the process of mineralization, which is conducted by the contribution of heterotrophic organisms, is fed by the substance of deceased living organisms. In the course of this process, organic compounds disintegrate into inorganic compounds, and after some of the decomposed substances get into the atmosphere, the others become mineral substances in the soil and provide nutrients for the vegetation. The cycle of the above mentioned 30-40 elements in the soil in one square meter is ensured by an approximately 400 gram mass of living substances. For one hectare it means, in general, four tonnes of living substances, but in optimal conditions it can be as much as 30 tonnes. Behind these numbers, there are unbelievable numbers of species and entities, for example 1,014 bacteria, 1,011 fungi, 108 algae, etc.

per hectare. Every single intervention in the ecosystem, such as cultivation, trampling, the increase and decrease of the water levels etc. can lead to the disaster of microbe communities.

We are actually embarking on a serious interference in the ecological systems without knowing about the sub-systems and what happens there. Such bravery can be only rooted in ignorance. The general verdict then is that by burning biomass we smoke away the nutrients which are essential for renewing the ecological systems. All because we want to satisfy our endless craving for energy. In my view, burning the biomass is the greatest disaster humans bring on themselves. We are kicking out the foundation stones of the food pyramid from under ourselves.

III.2.6. The myth of carbon dioxide neutrality

In relation to biomass use, I have seen several arguments both for and against it. However, none of these arguments considered the question of burning the biomass within the whole global substance and energy-flows. Scientists reiterate over and over that the process of burning the biomass is carbon dioxide neutral, since the amount of carbon dioxide produced while burning the biomass is the same amount contained in the biomass. Others argue that it is the carbon dioxide produced during the production, transportation and burning of the biomass that equals the amount of carbon dioxide contained in the biomass. Another claim is that, although the process of burning the biomass is not carbon dioxide neutral, the amount is still much less than the amount released when burning fossil-type energy sources.

What is reality?

A plant cannot be analysed in itself, as it is in interaction with the soil, water, air and with other living organisms. Which means that if we want to examine a forest or an agricultural land, their whole substance and energy stocks need to be considered. This way, it is not only carbon dioxide but other greenhouse effect gases, such as methane, dinitrogen oxide that also play a role.

During photosynthesis, autotrophic organisms produce 180 billion tonnes of biomass per year, and more or less the same amount is used up by breathing and mineralization. The carbon content of the living biomass, in the case of land organisms, is 800 billion tonnes (20 years of duration), whereas organisms in the ocean represent five billion tonnes (0.2 years of duration). The carbon content of the non-living biomass is 1200 billion tonnes, and in the oceans it is 1000 billion tonnes (meaning that a relatively small amount of biomass can produce a lot!). For both, the duration is 30 years. The atmosphere contains 700 billion tonnes of carbon in the form of carbon dioxide[32], of which 35 billion tonnes of carbon are absorbed by land vegetation and the photosynthesis in the sea. When burning fossil-type energy sources, about 5.3 billion tonnes of carbon is released in the air, which is less than 5% of all carbon dioxide released in the air. For example, this process should be outbalanced by sedimentation and by the irreversible deposition in the soil, which, in the case of sea sediments, amounts to 0.5 billion tonnes of carbon, while in the case of irreversible deposition it is less than 0.1 billion tonne of carbon. Only half of the carbon dioxide released by human activity can be absorbed by the sea, leading to an increase of two billion tonnes (0.3%) of carbon in the atmosphere.

If we consider only one autotrophic organism in land, it burns one part of the organic substances produced in the process of photosynthesis, thus releasing them back to our environment. The other part it uses for itself, storing the carbon. This balance is positive until the organism is growing.

If we think of the whole ecosystem, then the autotrophic plants producing organic substance-are complemented by heterotrophic organisms, which burn the organic substance, oxidize the absorbed carbon dioxide, breath it out, while build parts of it into themselves. The already dead terrestrial biomass is slowly absorbed during decomposition, which withdraws carbon from the cycle for 30 years. If the organic substance (or the organism that consumed it) is under a condition where no air can get to it, then the carbon is fossilized, and is withdrawn from the cycle (108 years of duration). Of course, water in the soil also contains carbon or carbon dioxide, either in a dissolved form or absorbed by carbonates. Therefore, if we look at the whole ecosystem we can see that part of the carbon is withdrawn from the quick cycle.

However, humans directly or indirectly disturbing the soil can mobilize the carbon stored in it. Regular cultivation, ploughing, loosening etc. change the dynamics of natural processes in the soil.

32 Papp,S.-Kummel,R.: Környezeti Kémia Veszprémi Egyetemi Kiadó 2005

One important effect of tilling the soil is airing the soil, which contributes to mobilizing the carbon in two ways. Under ideal soil conditions, one-quarter of the soil volume consists of air, another quarter consists of water, 45% of minerals and 5% of organic substances. In the different sized pores, which are filled with air, the carbon dioxide content is about 6% (in water it is 0.037%). On the one hand, airing the soil leads to the release of greenhouse gases (carbon dioxide, methane, dinitrogen oxide), on the other hand, since it changes carbon dioxide concentration, it increases oxygen concentration, which results in excessive oxidative processes in the soil.

For instance only in Hungary, 30-32 billion cubic meter soil is moved on 4.8 billion hectares of land by farmers every year. During ploughing, the layering of the soil is either entirely or partly turned. As a result, deeper layers are moved from anaerobic to aerobic conditions, while top layers end up in layers with insufficient oxygen intake.

Major bacterial decay occurs in the lower layers, and mineralization slows down. In the top layers, the microorganisms are more active, and the decomposing and humus catabolism speed up. With the degradation of the humus, the structure of the soil declines. The construction deteriorates more by the compressing effect of raindrops and trampling mechanisms, which deflates the pore volume. The plow sole becomes packed, and the fermenting bacteria in it gain a more important role, which makes this part of the soil toxic for the roots, making them unable to use the depth of the soil.

As applied for the mitigation of the degradation caused by ploughing, deep loosening also increases the aerobe dynamics in the soil. Although it detoxicates the deeper layers, it also raises the oxygen concentration, thus mobilizing carbon. It can be observed that soil cultivation largely disturbs the biodynamics of the soil, and, at the same time, its effects on plant production are paradoxical. Concerning the carbon balance of the soil, it reduces the quantity of the organic coal and increases the carbon capacity release of the soil.

István Mihály Szabó writes in his book[33] referring to the works of Schneider (1975) and Keulen (1980): "The rise of the carbon-dioxide level of the

[33] A talajtan biolódiai alapjai, Mezőgazdasagi Könyvkiadó, 1986

atmosphere, whose effects will force us to have to deal with the climate change also affecting agricultural production within the next 50 years, may be attributed, in addition to the burning of fossil fuels, to the loss of the terrestrial soil's organic substance, (...) according to Stuvier (1978), the carbon reserve of the surface have been reduced by 100 gigatonnes (100 billion tonnes) between 1850 and 1950." This quantity approaches the amount of coal combusted in that period.

After this period, it is possible that the carbon dioxide originating from the combustion of fossil fuels has increased at a much higher scale than from its release by agricultural soil cultivation. The emission could have been abated by the changes of the agro-technological mechanisms and agricultural methods involving less soil cultivation, but the newer and newer lands subjected to farming obviously compensated for these favourable effects. Even if we only counted with the mobilization of one billion tonne of carbon, it would represent such a significant diffuse emission that directly contributes to the burdening of the atmosphere. In burdening the atmosphere with green house gases, soil cultivation also plays an important role through the fertilizers. As a natural process of soil biodynamics, the unnecessary amount of nitrogen is removed by denitrification. In the absence of oxygen, the facultative anaerobe bacteria species switch to breathing nitrate, whereby they burn organic materials. Therefore, in the denitrification, the nitrite and the nitrate transfer to nitrogen monoxide, nitrous oxide and nitrogen. Ten percent of the removed gases are nitrous oxide.

In earlier times it was thought that denitrification is a harmful process, because it reduces the nitrogen content of the soil. That is also why the enhanced ventilation of the soil was forced, because the oxygen released during the tilling mitigates the activity of the denitrification. Some might think it is very good, because less nitrous oxide reaches the air. But if denitrification does not eliminate the redundant nitrogen, then the nitrites and the nitrates lead to the nitration of the soil, the groundwater and the natural water bodies. However, the function of denitrifaction is essential precisely because humans artificially fix nitrogen from the air, and, in the forms of nitrogen fertilizers, dispose them in the soil. The exaggerated use of the fertilizer leads to nitrogen redundancy and enhanced denitrification activity. Ultimately, this is how fertilizers boost the green house gas effect. If we want to avoid these negative characteristics with the presence of oxygen, we mobilize even more carbon.

Naturally, human reasoning always fails on the self-regulating systems of the ecological systems (cybernetic open systems). Many think that the carbon dioxide accumulating in the atmosphere and the redundant nitrogen in the soil, as basic components of the organic materials, will intensify organic material production . But this is not how it works, because of the limits of the absorption of different nutrients. For example, genetic engineers will attempt to induce the plants for nitrogen fixation in vain, if the quantity of the fixation is limited by high energy demand, the presence of the molybdenum, iron, sulphide or the oxygen sensitivity of the process. The cumulative carbon dioxide concentration itself is a limiting factor in the soil, because it prevents the plants from absorbing water, potassium, nitrogen, phosphorus, calcium and magnesium.

Agrotechnological operations are accompanied with carbon dioxide emission, not only due to the disturbance of the soil biodynamics, but also due to indirect coal mobilization. Among the indirect processes, soil erosion (deflation) and the drainage of the wet areas must be mentioned, as the source of the mobilization of the temporarily stored carbon.

The most obvious correlation between agrotechnical operations and carbon-dioxide emission is the burning of fossil fuels for the execution of the operations.

It is not so apparent, however, that the virtual carbon emission of the fuels and lubricants used for the operations of the machines should be considered here, similarly to the virtual energy application in the energy balance.

The visible and virtual carbon costs of the fertilizers and manure, and the production costs of the pesticides, transport and disposal also belong to the energy balance. It would be appropriate to review all of the carbon dioxide emission related to the energy demands of the transportation routes and vehicles, as well as the visible and virtual energy usage of the logistical operations and facilities.

After this, the carbon emission represented by the energy demands of the conversion of the prime agricultural products should be reckoned. This alters by the attributes of the conversion methods, the number of its stages and its efficiency. It can be seen in the case of ethanol how important it is to count with virtual emission throughout the whole cycle. In the combusting of ethanol, its low carbon emission is emphasized, but it is not considered that at the fermentation of the alcohol the rest has already been emitted. In the US, a number of the ethanol plants are operated by coal, where the production and use of ethanol emits more carbon dioxide than the use of fossil fuels. As the tax exemptions are not bound to the technologies–it does not matter whether the energy source of the ethanol is biomass or fossil fuel–, the biofuel producers are motivated to reduce the production costs, not carbon emission or oil utilization[34].

This is followed by the consideration of carbon dioxide created by the burning of the fuel. Similarly to the energy balance, there is a significant question where to represent the costs of the carbon dioxide burdens of the energy input, dispensed for the restoration of the direct and indirect environmental damages.

After all of this, we can return to answering the three questions proposed in the introduction. It is evident that, when the fuels are combusted, as much carbon is burnt as it was previously bound by the fuels representing biomass. The whole biomass is not entirely combusted, as the leaves, roots, etc. are decomposed in the soil and are basically in balance in respect of emission and absorption. It has to be underlined that the temporarily stored carbon reserves are remarkably smaller than in the case if the biomass was entirely utilized by the soil. Therefore, the balance is positive on the output side compared to the initial stage. Of course, the first argument is misleading, because it forgets that the carbon emission of the process leading to the fuel combustion makes the balance sufficient even in the case of the shortest route. Thus, the second statement that as much carbon is emitted during the production, transport and combustion of the biomass as much it bound throughout its growth, is total nonsense.

The third statement - that the process itself is not carbon dioxide neutral, but compared to the combustion of the fossil fuel sources it saves carbon dioxide - may be considered.

As it is known from the ecological footprint concept, our energy consumption can be represented in area. Two calculation methods serve as

[34] Popp, J; Somogyi, A.: Bioetanol és biodízel az EU-ban: áldás vagy átok? BIOENERGIA II.évfolyam 2007. 1. és 2. sz.

the bases for this. The first counts with the size of the area to absorb the carbon dioxide derived from the combustion of fossil fuels. The other one, the so-called ethanol replacement method, indicates the size of the area needed for the production of a certain amount of energy equivalent to that coming from fossil fuels. The results of the formula by Rees and Wackernagel:

The productivity of energy resources (GJ/ha/year)

Energy resource	Productivity (GJ/ha/year)	The footprint of 100 GJ/year (ha)
Fossil - Ethanol method	80	1.25
Fossil - Carbon-dioxide sink method	100	1.0
Water plant (average)	1,000	0.1
Lower course of a river	150-500	0.2-0.67
Upper course of a river	15,000	00067
Solar collector	40,000	0.0025
Solar cell	1,000	0.1
Wind	12,500	0.008

As it can be observed, the method of ethanol replacement has a larger footprint. Why? Because in order to produce the biomass, to make it usable and to utilize it, fossil energy sources are needed.

Finally, the question whether the application of biomass is carbon dioxide neutral is entirely pointless, because the processes of the whole ecosystem and its greenhouse gas emission consequences can only be examined together. In this aspect, other greenhouse gas emissions have to be taken into account, such as methane, nitrous oxide and water vapour.

Besides these three questions, another one can be raised; namely, whether the change of the agricultural sector can be eventuated in saving energy and environmental burdens. The answer is a conditional yes, so now the question is what the new structure is. The fuel-purposed production would entail the alteration of the distribution of the recently used species, but it would not mean the change of the cultivation method. Contrarily, the change of the cultivation method in the changing of field plant production to energy-purposed wood plantations would alter the environmental productivity compared to the previous cultures. However, the natural process cannot be divided from the process of the conversion.

The carbon dioxide balances have to be examined not only inside one production chain, but on a global scale, in light of all environmental consequences. Studying the global balance of carbon dioxide in the context of biomass use, it has to be pointed out that natural forests designated for the production of feedstock for energy purposes emit much more carbon dioxide from the soil and from burning the wood than the transportation emits from its fuels. Presumably, one hectare of sugar cane absorbs 13 tonnes of carbon dioxide, but this quantity would be 20 tonnes if the original forest could have remained. Not mentioning that the climate balancing role of the forest is more favourable than that of the sugar cane plantations. The increased production of the feedstock needed for biofuel clearly demonstrates these global anomalies. The world is helpless in face of the facts that while in the developed world the greenhouse gas emission is desired to be reduced by the use of biofuel, an increasing amount of land is required for the production of the increased amount of required feedstock. There is a chance for this primarily in the tropical countries (Brazil, Indonesia and according to new promises, Africa), where areas are obtained for sugarcane and palm plantations by deforestation and swamp drainages. According to some calculations, one third of carbon dioxide emissions comes from the deforestation of the tropical forests and its conversion to fields.

The tropical peat forests store 42 megatonne carbon. Only in Indonesia, 15.6 million hectare natural forest was destroyed from 1995 till 2003 for the establishment of oil palm plantations. In Southeast Asia, out of 27 million hectare of peatland (peats and bogs), 12 million hectare was destroyed. Mostly oil palm plantations and acacia forests were established after the drainage and drying. From the soil of the artificial plantations, 70-100 t/ha carbon dioxide is released annually. The degradation of the peat is 632 million tonnes, and afterwards the drainage and the fires cause further 1400 million tonnes of carbon dioxide release. All together it is 2 billion tonnes annually, which means 8% of the annual global rate. Due to this, Indonesia is the third biggest carbon dioxide emitter in the world after the US and China. According to the calculation, 1 tonne of palm oil causes 10-20 tonnes of carbon dioxide emission. This is 3.6 – 10.9 times larger than the burning of diesel[35].

[35] WL/Delft Hydraulics and Wetlands International

The use of renewable energy sources can only provide environmental benefits if the energy from renewable sources substitutes energy production from fossil sources, and does not contribute to the speedy growth of the energy demand of mankind. The energy use increased by 57% in 30 years in OECD countries despite the growing efficiency, and by 124% in non-OECD countries. In our position there is a need for immediate freezing of energy use at the current level, and later for its gradual decrease, which can be realised through energy efficiency measures. In the first ten years an average 1% annual efficiency increase and use decrease shall be achieved, while in the following ten years 0.5% annual efficiency increase shall be targeted. The achievability of the target is proved by the fact that OECD countries showed an average 1.1% efficiency increase in the last 30 years. Within the energy portfolio it shall be ensured that the renewable energy sources more and more substitute non-renewable energy sources. In this field we deem 1% substitution of the fossil energy sources per year appropriate. Within the use of renewable energy sources the non-depletable sources (wind, sun) shall be preferred to the depletable ones (biomass).

IV. POSITION

Energy-purposed biomass production is only acceptable, if:

- the environmental pressure on the used area decreases in comparison with the previous land use;
- there is a positive environmental balance for the whole life cycle of the feedstock and energy production as well as energy use also taking into account the virtual energy demand;
- the energy input/output ratio is improved;
- biodiversity indices improve both in quantitative and qualitative terms;
- species native to the region are used excluding invasive and genetically modified species;
- a production technology is chosen which is adapted to and able to sustain the original ecological conditions (soil, water regime, climate) and does not decrease the renewal capacity of the ecosystem;
- the vegetation cover and intensity increases with comparison to the previous use;
- the purpose and results of use are proven to be more favourable to the society in comparison with the previous use;
- the use does not marginalise any groups, i.e. the possibilities to meet basic needs are not narrowed down and the social polarisation does not grow because of this energy use;
- based upon these considerations the sustainability model of different biomass uses shall be developed, and it shall be always proven that these criteria are met. Only those uses shall be allowed that give net social and environmental benefit during their whole life cycle.

We are only dreaming that the energy demand of biomass production and transformation itself can be fulfilled by energy gained from biomass, so biomass could replace all fossil fuels.

In this case, the following scenario would take place, which is also happening in nature; the production and the renewing of the resources are strictly controlled, where the net production is derived from the absorption of solar energy.

This is the sustainable way in the use of the resources, whose net production is more modest than the recent human demand. In a sustainable society we should be satisfied with this!

The boost of the production could be possible only by the input of energy not utilized by the bio-geochemical cycles, as long as this overproduction can be tolerated harmlessly by the living system. So far the system has been induced to faster production by the fossil fuels obtained from the geological reserves spared by the biogeochemical cycle, and now even renewable energy is added. These two are thoroughly impossible and it leads to the damage of the system and to structural and functional changes.

What if we could entirely replace the fossil resources? In this case, the necessary energy for the overproduction is obtained by renewable energy, and there is the single important question remaining: can we "overspin" the system?

The overspinning of the system is impossible without harming it, because, as it can be seen, the different processes limit each other via complex regulating mechanisms. If the overspinning was possible without harming the system, it would have been done already by the system, because the system would not leave the surplus of the solar energy unused.

It would be good to realize that there is no alternative for the reduction of energy use.

The Biomass Dilemma

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