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**KEF Fact Sheet 1/08** **09.05.2008**

# Agrofuels between Sustainability and Development

## Definitions, Analysis and Protagonists from the Point of View of Science and Research

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**Online Dossier:**
**http://www.oeaw.ac.at/kioes/biofuels.htm**

# Agrofuels between Sustainability and Development

**Viktor Bruckman and Birgit Habermann**

## Introduction

**Recent press coverage has repeatedly pointed out the fact that world wide oil reserves are facing their inevitable decline. A recent "World Energy Outlook (WEO)" report published by the International Energy Agency made waves with its warning about a significant fall-off of oil production and escalating prices by the year 2015.**

**In the face of this ominous scenario, a new generation of biogenous fuels has awakened optimism about being able to reduce dependency on petroleum. For this reason, innovative, sustainable and socially responsible concepts for energy resource management are in great demand. The present fact sheet should provide a comprehensive and objective overview of the current state of research, along with the protagonists and interest groups involved with the business of agrofuels.**

## Definition Biofuel

The word "biofuel[1]" designates liquids and gases derived from organic materials that can be used as fuel in combustion engines. At present, biodiesel and bioethanol along with biogas are the most common biofuels. However, other forms of alcohols and esters which could be used in combustion engines are currently being researched. In addition, other technologies are being developed which would make it possible for combustion engines to be run with pure vegetable oils.

That the prefix "bio" is used to indicate that the source material is derived from renewable feedstocks is considered to be misleading by many experts and environmental organi-

Source: Bruckman

zations. In many countries, "bio" is associated with the legally binding prefix for the products of organic agriculture. Organic agriculture, of course, indicates that synthetic pesticides, growth stimulants, fertilizers, genetic manipulation and radiation were not used, following the basic principle of maintaining the most natural and sustainable form of agricultural production. These criteria are usually not applicable to the cultivation of biofuel feedstock as the demands of crop maximization require intensive fertilization and chemical crop protection. Not to mention the fact that there are several initiatives around the world which are aiming at increasing crop yield for the production of biomass specifically through genetic manipulation.

Considering these facts, one can understand how the word "biofuel" could be misleading in this context. For this reason, many have encouraged the use of the word "agrofuel" because this notion clearly indicates that the source material was agriculturally produced (at least the first generation agrofuels). The current fact sheet has consciously used the most commonly used terms for its headings in order for readers to be better oriented and also made aware of important connections.

## Comparison with Fossil Fuels

Agrofuels certainly have the potential of generating more profit for agricultural land use, creating jobs in rural areas, reducing $CO_2$ emissions and diminishing dependency on petroleum. In the context of the EU, agrofuels could boost agricultural commerce with additional sources of revenue while stimulating economic and political stability.

Agrofuels compete with fossil fuels, especially gasoline and diesel products derived from petroleum. Recent developments have made it clear that the days of cheap and seemingly unlimited petroleum are over. Currently, approximately ten million tons of petroleum are consumed every day, an amount which is continually rising due to increasing energy needs in the newly industrializing countries. Only recently, Fatih Birol, the chief economist of the International Energy Agency (IEA), warned of an oil shortage within the coming years and of its economic consequences. Even now there are concrete signs that peak oil production has already occurred or will occur shortly[2], although this opinion is not universally shared, especially in petroleum industry circles. They claim, on the contrary, that there is still an enormous potential in difficult to exploit resources such as tar sand or deep-sea deposits and that these resources could provide enough fossil fuels for the foreseeable future in spite of the extremely high investment costs which would be necessary to exploit them.

Viewed from the perspective of oil consuming countries, however, this situation is even more problematic because the countries with the largest deposits of oil also tend to have an unstable political situation. For this reason, the future supply of crude oil is not only a question of remaining deposits but also of political developments.

[1] a comprehensive dossier on biofuels can be found at the website of the Commission for Interdisciplinary Ecological Studies of the Austrian Academy of Sciences: http://www.oeaw.ac.at/kioes/biofuels.htm

[2] compare C.J. Campbell: Oil Crisis. Multi-Science Publishing-Co-Ltd: 2005
and: http://www.odac-info.org/sites/odac.postcarbon.org/files/pdf/PFPO_Final.pdf

If one compares agrofuels to fossil fuels with regards to emissions released during combustion, agrofuels do much better in several respects. For example they contain less sulfur, not to mention that with agrodiesel, soot particles and particle matter emission is reduced.

However, if one compares the volumetric energy density of fossil and agrofuels, it is clear that agrofuels tend to have a lower value, depending on the blend ratio with fossil fuels, resulting in an increase in consumption for the same power output.

But in order to establish the most comprehensive basis of comparison with fossil fuels, it is also necessary to take the by-products into consideration. Considered this on the level of international trade, Austria exports about 500,000 tons of grains and imports 600,000 tons of soy pulp. If one would process the annual export of grains into ethanol, 160,000 tons of DDGS (Dried Distillers Grains with Solubles) would be produced, which would in part be able to take the place of the imported soy pulp. With vegetable oil production for agrodiesel, the advantage is even more pronounced: After the process of pressing, about 1/3 of the total weight can be recovered in the form of vegetable oil and about 2/3 in the form of pressed solid matter (pomace), the so-called "press cake", which could in part take the place of the soy pulp.

Considering these circumstances, the advantages of agrofuels are more pronounced in regional economies, especially in rural areas which would be less dependent on animal feed imports especially from the USA.

The current price advantage of agrofuels in comparison to fossil fuels can be explained by a significantly lower level of taxation. The production of conventional fuels tends at present to still be less expensive, which is without a doubt also a result of the large-scale production facilities already in operation around the world. If agrofuels were taxed to the same extent, they would tend to be more expensive than fossil fuels. In Germany, biofuel taxation has come to be held in part responsible for creating the situation that more and more oil mills are threatened with bankruptcy. If the market share of agrofuels increases, it will no doubt go hand in hand with an increase in taxation because otherwise the state would lose one of its most important sources of revenue.

### Biodiesel

First generation agrofuels such as agrodiesel (the equivalent of petrodiesel) are produced by means of the esterification of vegetable oils or animal fats. The esterification of clean oil (87%) results from adding methanol (12%) and a catalyst (1%) in most cases potassium hydroxide or sodium hydroxide. The resulting by-products are surplus methanol (4%), fertilizer (1%) and glycerin (9%). Thus 86% fatty acid methyl esters (FAME), or agrodiesel, can be extracted from this process. Different names are used according to the original feedstock such as, for example, "RME" for rapeseed oil methyl ester. The idea of refining vegetable oils is not new. Rudolf Diesel wrote in a patent application in 1912: "The use of vegetable oil as fuel might today be insignificant. But such products could with time become as important as the petroleum and coal-tar products of today."

In principle, all forms of vegetable oils or animal fats can be used to produce agrodiesel. In Europe, rapeseed oil is the most common vegetable oil to be processed into agrodiesel. The extent of the use of other vegetable oils or animal fats is limited.

### Alternative Feedstocks

The physic nut (*Jatropha curcas*) is currently under consideration as a possible feedstock for the production of agrodiesel because the oil derived from the nut is not edible and for this reason would not compete with the cultivation of foodstuffs. The production of agrodiesel using jatropha oil has been scientifically documented by among other sources the Karl Franzen Universität Graz in the journal Bioresource Technology 58 (1996) 77-82 "as a source for the production of biofuel in Nicaragua[3]." The cultivation of *jatropha* is relatively uncomplicated and can deal well with dry periods. For this reason it has been conceived as being able to grow on marginal soils in the tropics.

With this in mind, however, it is important to pose the question as to whether or not economic considerations (higher crop yields in better locations) might not lead to the production of *jatropha* in commercial plantations on fertile soil and in the end in fact compete with food cultivation.

| Biofuel | Annual Yield / Hectare | Conventional Equivalent | Price/Liter Q2/2008 |
|---|---|---|---|
| Vegetable Oil | 1.480 Liters | 1l = 0,96 l Diesel | 1,000 - 1,100 EUR |
| Biodiesel / Rapeseed oil methyl ester | 1.550 Liters | 1l = 0,91 l Diesel | 1,049 - 1,292 EUR |
| Ethanol Fuel | 2.560 Liters | 1l = 0,66 l Gasoline | 0,973 - 1,008 EUR* |
| Biomass-to-liquid fuel | 4.030 Liters | 1l = 0,97 l Diesel | n.a. |
| Biogas | 3.560 Liters | 1kg = 1,40 l Gasoline | n.a. |
| Source: Wikipedia, updated | | | *E85 |

## Generations of Agrofuels

### First Generation

Current discussions about agrofuels all have one thing in common: They almost exclusively deal with first generation agrofuels.

As a new source of revenue it would then only be advantageous for the local population if there were no competition with food production or other land use, especially nomadic livestock grazing. Other things which must be considered would be the ecological consequences of

[3] The full study is available at: http://www.sciencedirect.com

commercial plantations especially the use of fertilizer and pesticides.

An entirely new approach has been recently put forth. As part of the project "AlgenBioDiesel[4]" algae has been cultivated in order to obtain agrodiesel from its oil-rich biomass. Considering land use problems, this method would be a welcome alternative because its cultivation would not be dependent on the use of land. Current research, however, has not yet determined the effects of this cultivation on aquatic ecosystems. For this reason, further research is required before a comprehensive ecological and economic assessment can be made.

### Bioethanol

"Bio" ethanol (grain alcohol) or agro-alcohol, is intended to replace gasoline made by petroleum distillation. It is produced through the fermentation of plants high in sugars and starches such as corn, grains or sugar cane.

It can both be used for piston engines and fuel cells as well as for turbine engines. Sugar and enzymatically broken down starches from the biomass are fermented into alcohol. The abbreviations commonly used on gas pumps refer to the ratio of the mixture. For example, E85 is made up of 85% ethanol and 15% conventional gasoline. Some automobile manufacturers (Ford, Opel, Volvo…) already offer automobiles with so-called "flexi-fuel technology" which function with any ratio[5]. The EU has already stipulated that small amounts of agrofuels should be blended with conventional fuels. By 2020, all fuels should consist of 10% agrofuels. Currently in Austria about 5% is added, by 2010 the percentage should increase to 10%.

The most important feedstocks used for agro-alcohol production are corn, grains, sugar beets and cane sugar (*Saccharum officinarum*). Currently the main producers are the USA and Brazil. Because the materials used to make agro-ethanol are also used as food and feed, competition with the food market is even more significant. According to the IIASA, 42% more grains will be needed to sustain the population in 2030 than in the year 2000 (Nilsson S., IIASA conference 2007).

Signs of the impact of the food crisis began to appear in 2007, when the price of cornmeal increased so much (from approximately 40 cents/kg to about 75 cents/kg) that widespread protests spread throughout Mexico where cornmeal represents a staple food for lower income families. In particular, the United States produces agro-alcohol using corn. What is more, the production is heavily subsidized by the government. This has led to the situation that more and more farmers are growing corn and accordingly that the lobby for corn farming is continually increasing in influence.

[4] Heike Frühwirth, BDI Biodiesel http://www.oeaw.ac.at/kioes/biofuels.htm
[5] http://www.volvocars.com/; http://www.ford.de

Sugar cane plays especially in Brazil an important role for the ethanol production. Almost the total need of raw material is covered with sugar cane. Source: Bruckman

### Biogas

Biogas is produced by anaerobic fermentation of agricultural biomass and/or biogenic waste. In this process, a flammable mixed gas with differing percentages, depending on the feedstock used, of methane ($CH_4$), carbon dioxide ($CO_2$), hydrogen sulfide ($H_2S$) and water ($H_2O$) is produced. The mixed gas can be used to fuel cogeneration plants to generate electricity and heat.

Gas powered motor vehicles, however, require nearly pure methane necessitating a refinement of the mixed gas. In this process, the concentration of methane can be increased to almost 100%. Gas produced in this way can also be introduced into the existing natural gas system. Many different studies consider biogas to be the energy source with the most potential for reducing greenhouse gases.

In addition, it is already possible to use the entire plant to make energy, similar to concepts of second generation fuels, which would lead to considerably higher yield per hectare of exploitable energy.

## Second Generation

Recently, intense research has been directed towards developing second generation agrofuels, synthetic fuels which would make it possible to exploit cellulose and lignin from the biomass through the use of acids and enzymes. This procedure is also referred to as the "biomass to liquid process." First a synthesis gas is produced from the biomass. The gas is then transformed into fuel using the Fischer-Tropsch synthesis. The reactive elements of the synthesis gas (CO and $H_2$) react to cobalt-based catalysts and iron-based catalysts to form hydrocarbons. Second generation fuels have a number of important advantages over first generation fuels. Among other things, they do not contain sulfur or aromatic hydrocarbons and are therefore more environmentally sound. In principle, any source material could serve as a biomass. Straw and wood have already been successfully transformed into agro-alcohol (see: SEKAB Technology, Sweden and the MAXIFUEL-Project, Denmark). Wood scraps and loppings can also be processed into fuel resulting in a higher yield.

However, it still remains to be seen as to whether or not the supply of feedstock will continue to be available. Premium woods are too expensive to be transformed into fuel, and less valuable wood scraps have recently become increasingly expensive, especially due to their use in wood pellets. Similar qualities are also in demand for paper and particle board production. The loppings which previously were left behind in the forest would in principle be suitable for the production of fuel, but the soil would become disproportionately acidic and lacking in nutrients, because the branches and leaves have a much higher concentration of nutrients than wood[6].

If agricultural areas are used, the same conflicts would ensue with the food and feed crops as with first generation fuels, in spite of the higher efficiency which would result from the use of the entire above ground plant.

## Protagonists and Networks

### Civil Society and NGOs

As a problem concerning both civil society and economic development, nongovernmental institutions play a central role in shaping the discussion. Numerous organizations are active in Austria including the coordinative organization Arbeitsgemeinschaft Entwicklungszusammenarbeit[7] together with various environmental organizations (BirdLife Österreich, Forum Wissenschaft und Umwelt, GLOBAL 2000, Greenpeace CEE, Klimabündnis, Plattform Footprint, die umweltberatung Österreich, WWF Österreich) along with the Co-ordination Office of the Austrian Episcopal Conference for international Development and Mission (KOO). A collective policy paper and an informative folder have been published[8].

The OEKOBUERO published a study entitled **Nachhaltigkeitskriterien für Agrotreibstoffe** [Criteria for Measuring the Sustainability of Agrofuels] in December, 2007, as part of the project "Essen oder Fahren – Landwirtschaft im Spannungsfeld zwischen Ernäherungssicherheit und Biofuels" [Food or Fuel – Agriculture between Securing Food Resources and Biofuels][9].Coinciding with the publication, a podium discussion was held which accentuated the fact that the topic of agrofuels has about as many different points of view as it does unresolved problems[10].

## Governmental Organizations

The Umweltbundesamt [Austrian Environmental Protection Agency] uses a software program called GEMIS developed by the Institute for Applied Ecology in Freiburg which can be used to calculate the environmental effects of renewable sources of energy and fossil fuels[11].The Umweltbundesamt also offers information pertaining to the topic of "agrofuels[12]", including among other things a study that was already completed in 2003 concerning biofuels and their effect on greenhouse gas emissions in Austria[13].

The **Austrian Federal Ministry of Agriculture**, **Forestry, Environment and Water Management** commissioned a study to be made by the **University of Natural Resources and Applied Life Sciences Vienna** and **The Federal Research and Training Centre for Forests, Natural Hazards and Landscape (BFW)** which has made an optimistic prognosis for the use of forest biomass: The Austrian Federal Government has stated its goal of increasing the percentage of sustainable energy from the current 23% to at least 25% by 2010 and 45% by 2020. Energy production gained through the use of biomass currently represents 42% of this figure, according to a press release from November 11, 2007, made by Environmental Minister Pröll. He further explained that the intermediate results of the study suggest that the yield would increase by 7.6 million solid cubic meters by 2020. That would represent about 70% more biomass than was previously expected. According to Minister Pröll, increased exploitation of these resources is both economically cost-effective and ecologically defensible. With adequate timber harvests, no biomass imports would be required to satisfy demand[14].

One of the powerful lobbies represents producers who anticipate making a profit from agrofuels. Here too, studies and research projects have been funded which should establish the basis for further support of agrofuels.

In Austria, the Austrian **Biomasseverband** has become an important player. The first Central European biomass conference took place January 2008 in Graz focusing on agrofuels. Numerous prominent biomass experts were invited from Europe, Brazil, China and the USA, representing the European Commission, the Food and Agriculture Organization of the United Nations (FAO), along with various bioenergy associations, universities and governmental agencies. Representatives from both the government and industry were also invited. Political strategies for the development of bioenergy were on the agenda[15].

The **Austrian Development Agency**[16] warns that careful considerations must be made as to whether or not the production of agrofuels – by definition for the richer nations of the world – would not aggravate hunger and malnutrition for the poor (Weltnachrichten 3/2007, interview with Ambassador Freudenschuss-Reichl). The guidelines for "energy for sustainable development" were published in 2006 dealing with the question of biomass but not explicitly with agrofuels[17].

[6] compare G. Glatzel: Auswirkungen vermehrter Biomassenutzung auf den Nährstoffhaushalt von Wäldern. In: Wagener-Lohse, Georg (ed.) BioEnergie am Scheideweg. Proceedings of Praxiskongress BioEnergie für die Land-, Forst- und Energiewirtschaft. Cottbus 2007: 79-84
[7] AGEZ: http://www.oneworld.at/AGEZ/
[8] http://www.oneworld.at/agez/Positionspapier-Agrotreibstoffe-2007.pdf
[9] http://doku.cac.at/agrotreibstoffe_kriterien.pdf
[10] http://www.oekobuero.at/start.asp?ID=15927&nobackbut=&h=0,424&showmenu=
[11] http://www.umweltbundesamt.at/ueberuns/produkte/gemis/kraftstoff/
[12] http://www.umweltbundesamt.at/umweltschutz/verkehr/kraftstoffe/biokraftstoff/
[13] http://www.umweltbundesamt.at/fileadmin/site/publikationen/BE144.pdf
[14] http://www.glocalist.com/index.php?id=20&tx_ttnews%5Btt_news%5D=2549&tx_ttnews%5Bcat%5D=5&cHash=cc1adf0b66
[15] http://www.biomasseverband.at/biomasse?cid=26721
[16] http://www.oeza.at
[17] http://www.ada.gv.at/up-media/2421_leitlinie_energie_web.pdf

## Science and Research

There are many different scientific teams studying agrofuels supporting a broad spectrum of the positions held by the interest groups mentioned above. Scientists in Austria have been surprisingly restrained in expressing their criticism publicly. A conference held by the **Austrian Academy of Sciences** entitled "Vom Waldessen und Waldbrennen" [Consuming Forests, Burning Forests] brought together an international and highly critical panel which cautioned about the euphoric support of agrofuels, especially the question of the use of forests for the production of agrofuels[18].

The **IIASA** published the results of the EU project REFUEL in 2008 in a study entitled "Eyes on the Track, Mind on the Horizon: From inconvenient rapeseed to clean wood: A European road map for biofuels[19]." The IIASA made a study of the bio-physical production potential of the most important feedstocks along with other scenarios for the production of agrofuels in order to assess the availability of land for the production of agrofuels, while assuring that food and feed production and environmental concerns would not be gravely affected.

In Germany the **Union For The Promotion Of Oil And Protein Plants (UFOP)** commissioned the Institute for Energy and Environment (IE) to develop a study comparing the costs and ecological repercussions of biofuels based on domestic resources. The study compares calculations made by the IE with other sources presenting the full spectrum of possible results[20].

**Austrian Research Institutions and Project Groups:**

University of Natural Resources and Applied Life Sciences, Vienna:
**http://www.boku.ac.at**

The Austrian Academy of Sciences:
Commission for Interdisciplinary Ecological Studies:
http://www.oeaw.ac.at/kioes
Commission for Development Studies:
**http://www.kef-online.at**

BLT – Bundesanstalt für Landtechnik (Wieselburg) [Federal Institute of Agricultural Engineering]
**http://blt.josephinum.at/**

Austrian Biofuels Institute:
**http://www.biodiesel.at/**

Among other projects, the Vienna University of Technology (TU) administers an online databank for agrofuels
**http://www.vt.tuwien.ac.at/Biobib/biobib.html**

The Lower Austrian Chamber of Agriculture organized a conference entitled "Ethanol - Treibstoff aus der Region" in 2007:
**http://ethanol.agrarplus.at/**

Austrian Energy Agency:
**http://www.eva.ac.at/(de)/projekte/ren-in-a07.htm**

Austrian Research Centers GmbH - ARC:
**http://www.arcs.ac.at**

Austrian Bioenergy Centre GmbH
Interuniversity Institute for Interdisciplinary Studies Klagenfurt
**http://www.uni-klu.ac.at**

Joanneum Research GmbH, Institute for Energy Research:
**http://www.joanneum.ac.at**

Graz University of Technology: Institute of Thermal Engineering and the Institute of Process Engineering:
**http://www.tugraz.at**

Vienna University of Technology: Institute of Process Engineering, Thermal Process Engineering and Environmental Technology:
**http://www.tuwien.ac.at**

**International Research Organizations and Project Groups:**

Europe-wide: European Biofuels Technology Platform: **http://www.biofuelstp.eu/**

This group uses the results from a conference held in 2006 to work out long-term solutions for both technological and non-technological barriers to the use of agrofuels in the EU and worldwide. Austria is represented in this platform by the Federal Ministry of Economics and Labour and the Federal Ministry for Transport, Innovation and Technology.

**IEA-Expert Group on Research & Development Priority Setting and Evaluation:**

The international team of experts "R&D Priority Setting and Evaluation" was founded in 1994. Its goal is to analyze long-term research priorities. The project team – led by Dr. Herbert Greisberger – is made up of 13 OECD Nations including the USA, Japan, Korea and the European Union. Dr. Herbert Greisberger has been commissioned by the Federal Ministry for Transport, Innovation and Technology as the general secretary of the ÖGUT for the Committee on Energy Research & Technology (CERT) at the International Energy Agency (IEA):
**http://www.oegut.at/de/themen/energie/iea.php**

[18] http://www.oeaw.ac.at/kioes/veranstaltungen.htm
[19] http://www.iiasa.ac.at/docs/HOTP/Mar08/refuel-roadmap.pdf
[20] http://www.ufop.de/downloads/BioKS_kurz110308.pdf

A well-known study by Prof. Louise O. Fresco: "Biomass, food & sustainability: Is there a dilemma?" who works at the University of Amsterdam and is a member of the Supervisory Board of the Rabobank Nederland:
**http://www.rabobank.com/content/images/Biomass_food_and_sustainability_tcm43-38549.pdf**

The study focuses on the problem of competition with food production especially in developing countries and tries to demonstrate some potential alternatives.
Prof. Dr. Paul J. Crutzen, Nobel Laureate in Chemistry, has also published on biomass, climate change and the environment and has significantly contributed to developing the discussion further on a scientific basis:
**http://www.mpch-mainz.mpg.de/~air/crutzen/**

Prof. Rudy Rabbinge, Head of the Science Council of CGIAR has voiced his skepticism with respect to the use of agrofuels on many occasions:
**http://www.nedworc.org/index.php?option=com_content&task=view&id=195&Itemid=114**
**http://www.timesdaily.com/article/20070929/NEWS/709290333/1011/RSS&source=RSSetc.)**

## Commerce and Industry

The automobile industry has not let these recent developments pass them by. Volkswagen, for example, has already secured the trademark rights for SunFuel and SunDiesel, while Daimler has secured the brand name Biotrol. Some manufacturers already offer models which run on gasoline that are equipped with "flexifuel" technology which can run with any ratio of conventional gasoline and agro-alcohol (see above: "Bioethanol").

The German company Choren Industries has come to be specialized in the production of second generation agrofuels using a Carbo-V® process (SunDiesel), a three stage gasification process involving three sub-processes including low temperature gasification followed by high temperature gasification and finally an endothermic entrained bed gasification[21].

### Austrian Plant Manufacturers

CMB Maschinenbau & Handels GmbH, a company located in Graz, Austria, has focused on the planning and construction of agrodiesel plants on an international level.

BioDiesel International AG, also based in Graz, constructs agrodiesel plants all around the world. Currently they are building a plant in Hong Kong that can process waste such as fat and oily water left over from the commercial food service industry. The production capacity will be approximately 100,000 tons per year. This approach is to be welcomed because it uses byproducts that would otherwise be discarded as waste and thus does not compete with food production[22].

In an area directly southeast of Vienna called the Lobau, construction was begun by BioDiesel Vienna GmbH (BDV) in 2005 on one of Europe's largest and most modern agrodiesel plants. It is the largest plant of its kind in Austria. In the beginning its yearly capacity was only about 95,000 tons per year but production should be increased to 300,000 tons per year by 2010. With this one plant, the bulk of Austria's compulsory fuel blending will be covered (in 2010 approximately 500,000 tons per year). The plant will predominantly process rapeseed oil.

In the area of systems engineering, Austria could position itself in the international leading group. Source: Bruckman

### Financing

A number of Austrian financial institutions invest in agrofuel plants all around the world, most of all the RZB, which in the past few years has financed several plants. But the Hypo Group Alpe-Adria has also been active, investing in projects, according to the company, with a value of approximately € 270 million, including the world's largest agrodiesel production plant in Sachsen-Anhalt (Germany), with an investment volume of € 64 million[23].

## Problems

When considered more carefully, however, many of the celebrated advantages of agrofuels appear in a less favorable light. After weighing the difference in $CO_2$ emissions, agrofuels score better than fossil fuels, although the argument that burning agrofuels only produces as much $CO_2$ as would otherwise be generated during growth, that such fuels would be $CO_2$ neutral, should be regarded critically. The final energy balance must also consider the energy used for production and logistics. For a complete ecological assessment, it is necessary to take into consideration the effects of monocultures on the environment. An increased cultivation of energy crops would severely threaten biodiversity. In addition, uncultivated fields have a positive effect on species diversity in the cultivated landscape. Other interventions such as planting trees and bushes to protect from wind, diversity of land use, crop rotation and organic farming also contribute to higher biodiversity.

[21] More information available at: http://www.choren.com
[22] Further information: http://www.biodiesel-intl.com/
[23] http://www.hypo-alpe-adria.com/115/com_cms/group/home.nsf/index.html

The EU recently decided to allow the use of uncultivated areas in order to achieve the ambitious goals set for blending agro and conventional fuels. In 2008, a total of 10 million hectares of uncultivated land were opened up for use. This however directly contradicts the EU's policy for the preservation of biodiversity. The 2010 goals set in 2001 in Gothenburg for the preservation of biodiversity officially documented the EU's intent to stop the decline in biodiversity. According to international experts, this goal will not be able to be realized under the current conditions (Hardegger Erklärung, 2008).

### Land Use

According to the EEA report No. 7/2006[24], almost 13 million hectares of land will become usable in the EU-22 by 2010. A large portion of this will come from using formerly uncultivated land, which constitutes approximately 10% of the cultivable land. The European commission has made the assumption that by 2020 there will be enough land available to blend 10% agrofuels with conventional fuels without limiting the production of food. According to the agricultural spokesman for the Green Party, Dr. Wolfgang Pirklhuber, the goal of 10% agrofuel will only be achievable with an increase of 18 million hectares of additional land. But the use of hitherto uncultivated land will only make a further 7 million hectares available.

Professor Rudy Rabbinge, head of the Science Council of the Consultative Group on International Agricultural Research (CGIAR) has confirmed the impending land conflict between energy and food production. Especially the poorer countries will be the hardest hit by the current developments.

Meat consumption is increasing in newly industrializing countries such as India and China but also in other developing countries, which is leading to an increased demand for feed. The United Nations estimates that by 2030, the third world nations will increase their net imports of food by a factor of five. This will result in nations which are currently export-oriented becoming import-oriented.

Rabbinge has calculated that a diet based on meat requires about ten times more land than a vegetarian diet.
Professor Sten Nilsson from the International Institute for Applied Systems Analysis (IIASA) has estimated that by 2030, the worldwide demand for available farmland will have increased by between 250 to 300 million hectares. Alone the demands made by increased food and feed production will account for about 200 million hectares. As a result, it is expected that there will be an increase on a global level in competition for the use of agricultural area between food, feed and energy production.

### Competition with Food Production

The competition with food and feed production is one of the most fiercely debated issues. Although there is a clear commitment in Austria to the priority of food production, followed by feed production and then finally the production of energy crops, the global implications of the problem must still be taken into consideration.

In order to achieve the blend rate of 10% by the year 2020 in the EU, 72% of the entire agricultural area of the European Union countries will have to be devoted to energy crops, according to calculations made by the World-Watch-Institute. Proponents, however, reply that for decades there has been a trend of overproduction in Europe and that currently only a small portion of the capacities have been devoted to fuel production.

However, in Austria it is already the case that a significant portion of the feedstocks for biofuels have to be imported. These imports come in part from other EU countries, most of all from the East, but also from America and Asia.

But the current shortage of feedstocks is only indirectly responsible for increased imports. Since mid-2007, the price of rapeseed has increased from about € 250/ton to € 450/ton. Under these conditions, the operation of agrodiesel production facilities is no longer equitable, and for this reason, more cost-effective feedstocks have to be resorted to, mostly imported from developing countries. The greatly increased demand for palm oil in Southeast Asia, used for among other things the production of agrodiesel, has led to price increases which have been most painful to those using it as cooking oil. Palm oil is traditionally used as cooking oil in Asia and Africa. The higher price of palm oil has already led to food shortages in the slums of Mumbai, India, even though the increase in price can largely be traced to an increased demand in China. (The New York Times, 28/01/2008). The recent price increases have most of all struck the poorest members of society, due to the fact that they devote a larger percentage of their monthly income to basic dietary needs.

Shortfalls in the supply of products that are also used as food and feed have recently plagued agrofuel producers resulting in many plants on the brink of closure (Focus Money from 24/03/2008[25]).

A newly constructed AGRANA agro-ethanol plant in Pischelsdorf, Austria, which cost € 125 million to build and will have a capacity of 240,000 $m^3$ of alcohol did not go into service as planned in 2007 because the price of grains was too high, in spite of subsidies available for the production of agropetrol. Operations of the plant are planned to begin again in June, 2008.

### Efficiency

When assessing the use of agrofuels as a potential source of energy, the comprehensive energy efficiency must be taken into consideration. Rabbinge has shown for example that rape only converts about 0.5% to 1.5% of the energy it absorbs from the sun per year into biomass. According to Nilsson, anywhere from between 35% and 65% of the total energy is lost in the conversion of biomass into agrofuel. Here it is obvious that the

[24] See online-dossier

[25] http://www.focus.de/finanzen/news/biokraftstoff_aid_266652.html

comprehensive energy efficiency is low. The efficiency of ethanol production based on corn or grains moves within a similar range.

### Climate Protection

The biofuel industry has up to now based a number of its arguments on the question of climate protection. Scientific studies, however, have shown that the advantages for climate protection compared to fossil fuels vary widely, and in some cases, depending on the feedstocks and the methods used for production, even become negative. A recent study (see above: Paul J. Crutzen et al., 2008) indicates that agrofuels could even aggravate the greenhouse effect, due to the fertilization of crops with nitrates. Nitrous oxide ($N_2O$) is formed in moist soils from the nitrogenous fertilizer which is not used by the plants. The global warming potential for nitrous oxide, in comparison to carbon dioxide, is about 300 times greater. In order to achieve an economically viable crop yield, however, it is generally necessary for grain cultivation to use nitrous fertilizers. The argument defending the use of fuels made from renewable feedstock based on climate protection has for this reason recently come under fire. The authors stress that only the production of ethanol from sugarcane, as common for example in Brazil, has been shown to have a positive emissions balance due to the fact that fertilizer is not necessary. Thus agrofuels can only make a limited contribution to a policy of sustainable energy.

Furthermore, there are other dangers to extensive fertilizer use that only now are beginning to come to light: In the United States, an area as large as many thousand square kilometers around the mouth of the Mississippi in the Gulf of Mexico has turned into a so-called "dead zone". The lack of oxygen in the water is caused, to a large extent, by the effects of rotting algae which had been able to thrive due to excessive nutrients in the water caused by fertilizers, making massive areas of water uninhabitable for marine life like crabs and fish (see online dossier).

The production of biodiesel using fats from the fruits of the oil palm tree (*Elaeis guineensis*) has recently been heavily criticized because oil palm plantations are predominantly established on former rainforest land, with long-term negative effects on the climate protection balance. In addition, palm oils are important for food and feed as well as for the manufacture of cosmetics and for this reason are increasingly becoming too expensive to be used for agrodiesel production, not to mention some technical limitations to the use of palm oil.

There is good reason why the Verkehrsclub Österreich (VCÖ) [Austrian Transportation Club] and the OEKO-BUERO [a group coordinating environmental organizations] have demanded that the sustainability criteria must address both the total energy balance and the ecological compatibility of biofuels.

## A Look Towards the South

Fresco has warned that the production of agrofuels based on food crops will soon reach its limits (see above). Both Fresco and Leonard[26] have criticized the fact that so-called "bioenergy" is often obtained at the price of food resources. The cultivation of crops geared towards the

Competition with food production has especially dramatic consequences in developing countries. Source: Glatzel

production of agrofuels is in any case more cost-effective in the South: On the one hand due to the climate, on the other hand due to the current availability of large areas of cultivable land along with less expensive production costs due to lower salaries and in part unclear legal regulations frequently entailing a lack of any kind of norms or standards.

The shortage of feedstock in Europe has led a number of owners of agrofuel refinement facilities to relocate to areas close to production in Asia, Africa and Latin America. Other possible locations include Indonesia, Nigeria and Brazil. It costs about € 25 million to build a refinement facility in Europe. Both the construction and running costs of facilities are considerably lower in developing countries, but there is very little legal oversight of labor and environmental standards.

The competition for land in developing countries is growing steadily: Food crops and policies for the preservation of biodiversity, plantation-based production of agrofuels and forestation for $CO_2$ emissions certificates all have an increasing stake in land use policies. Because these forms of land use have all been argued to be good for climate protection and sustainability, policy-makers and scientists in Europe have for a long time ignored the possible adverse side-effects of these decisions.

In his Biofuels Manifesto, Mathews[27] has argued for the expansion of a biofuels industry in developing countries. He emphasizes the fact that the increased growth of agrofuel industries could set off a chain reaction for general growth that would be beneficial to developing countries. This will only be possible if the so-called developing countries themselves take the initiative and create projects for the production of renewable energy before the "developed countries" jump on the bandwagon in order to escape their dependency on fossil fuels.

[26] http://archive.salon.com/tech/htww/2006/11/03/the_battle_over_biofuels/
[27] See online-dossier

However, it appears as though political and economic interests have changed as a new kind of neo-ecological colonialism has begun to exploit these natural resources for the sake of developed countries.

From an Austrian standpoint, producers and plant manufacturers are looking to profit from Austria's good reputation in alternative energy technologies through exporting these technologies[28].The developing countries often do not have enough time to develop and adapt their own technologies, as Mathews recommends, before Western corporations have already developed their own facilities.

## Alternatives

The midterm and short term goals must be to improve energy conservation and the efficiency of given systems. Here it is important to note that moving from individual means of transportation to public transportation is an important step in this direction. It would be of the utmost importance for governments to make comprehensive investments in the area of public transportation.

For the long term, solar energy (photovoltaics, solar thermal energy) can be seen to represent an important sustainable alternative. In contrast to the use of biomass, solar energy directly converts the energy of the sun into electrical energy, thus passing directly to the production of energy without wasteful chemical transformation processes and environmental burden. Unfortunately, however, photovoltaic technology has a maximum degree of efficiency of 10% - 15%. By comparison, biofuel production based on biomass harnesses less than one half of a percent of the energy of the sun but it does this on a very large scale. New technologies such as thin layer PV cells can increase efficiency while lowering the costs of production. New areas of research are concentrating on the field of nanotechnology, where research is currently engaged in reducing structures to the level of the molecule making it possible for several electrons to be excited by a single photon at once which would make solar energy significantly more efficient, theoretically increasing the degree of efficiency to 45%.

Because the efficiency of current combustion engines is very low, new directions in research into engines would be important. Electric engines increasingly appear to be more promising. But in order for this to be feasible, progress must be made in increasing the capacity of rechargeable batteries.

[28] Compare: corporAID Magazin September 2007, pp.46-48

## Alternatives in the South

The developing countries are also involved in improving alternative energy resources and fuel production. Biogas plants, small power plants and solar energy appear to have a lot of potential. The Österreichische Entwicklungszusammenarbeit lists a number of promising trends[29] in decentralized energy production using alternative technologies such as biogas plants, wind parks, photovoltaic installations and water turbines. Small power plants using renewable energy are especially important for remote areas and islands. A decentralized network architecture instead of costly hierarchical integrated networks is essential. One of the principle problems, however, is the high initial cost for modern sources of energy: For this reason, other ways of bearing the costs, often including subventions, may be needed for each respective situation[30].

The production of the basic feedstocks used in agrofuels in developing countries should be viewed with a critical eye because these markets are heavily affected by speculators and the actual value for the country in which they are produced is often negligible. This is even the case when the refinement takes place in the respective country. The ideal situation involves local solutions for local markets using crops from the region that do not compete with food production. However, this would entail large-scale plantations and monocultures which would destroy traditional local land use. For the production of basic feedstocks, it could be possible to use organic agricultural methods and agroforestry. For financing, one might consider the innovative model of microcredit. An unresolved question remains concerning the development of adequate technologies requiring investors. The financing of large facilities for the production of agrofuels in developing countries becomes yet another way for these countries to go into debt and lose their financial independence.

The need for individual mobility is constantly increasing in developing countries.
Source: Mangold

Considering the increasing conflict between the production of "food crops" and "energy crops", it would be advisable to be more cautious in outlining goals for increasing the production of energy crops in Africa. If political and economic policies continue to follow the idea based on regional specialization in energy crop production as the "cash crops of the future", the political, ecological and social consequences could be catastrophic (see: Climate Change and Security, p.124).

[29] http://www.ada.gv.at/view.php3?f_id=1765&LNG=de&version=
[30] Compare: corporAID Magazin September 2007, pp.46-48

## Further Research is Needed

From a scientific perspective, the following problems concerning the production and use of agrofuels have yet to be adequately resolved:

**Economics:** Can needs and demand be met? What is the relationship between available land and the productivity of land use? What other factors should be considered? Numerous studies have voiced doubt concerning, among other things, the complexity of the chain of production. Because there is not enough available area in Europe and because production tends to be cheaper in developing countries, biofuels will probably be imported from tropical countries – where there are many problems with the infrastructure, availability of fertilizer and frequent extreme climatic conditions which could pose further problems for the reliability of supply. Are agrofuels really more economical or will they in the long run be dependent on agricultural subsidies?

**Politics:** What political strategies are being pursued with the production of agrofuels? While there is a clear international commitment to climate protection, it has only led to a limited amount of actions aimed at reducing consumption of energy. In Austria as much as elsewhere, it has become an ideological question as to which approach is supported by a respective political group, irrespective of whether or not agrofuels are really advantageous for climate protection. It is clearly dependent on whatever interests these groups might represent. Agrofuels could, for example, be a boon for farmers whereas solar energy would be beneficial to specialized industry. What are the long-term implications of these strategies? How are these decisions to be made on a political level considering international development and regulations?

**Social Effects:** The feedstocks used for agrofuels are almost exclusively cultivated in large-scale plantations and monocultures. This affects both the local job market and conditions of labor and at the same time has regional effects on the availability of land for food crops, thus also affecting the price of food. How robust are the social systems in the concerned areas? How are the affected small farmers and agricultural laborers organized to stand up to these trends? What mechanisms could be developed that would compensate and support the people who would be affected? Or is the export-oriented production of agrofuels fundamentally a social and ethical problem?

**Ecological Questions**: How sustainable are agrofuels in reality? What are the effects on domestic biodiversity of the practice of reclaiming uncultivated land as begun in 2008? What are the ecological effects of the necessary production infrastructure, the effects of plantation agriculture, monocultures and large-scale forestation (i.e. the effects of fertilization, irrigation, erosion, influences on the local climate, the damaging of biodiversity, etc.)? Which resources from sustainable production can be used to generate energy? Are there any alternative ecologically compatible resources available for the production of agrofuels? How high is the price to be paid for the destruction of biodiversity? How much water is going to be needed and will it be possible to have enough without hurting other areas?

**Developing Standards and Guidelines:** If agrofuels are to play a role in contributing to a sustainable energy policy, then the complexity of the issue requires internationally binding standards and guidelines which could be applied to the local context of the countries involved. In this way, detailed social and ecological criteria for sustainability and their practical implementation in national law must be worked out. If these are to be more than just empty words, then they must also be substantiated by solid scientific research that takes both the social and ethical effects into consideration.

Detailed lifecycle studies made by independent institutes would be necessary that would cover and assess economic, ecological and social parameters. Only by taking the entire chain of production into consideration will it be possible to make reliable conclusions about the ecological and social compatibility and cost-effectiveness of each particular method of production.

## Conclusions

Agrofuels are seen by many to be a way out of the climate crisis and the impending energy crisis. It is undisputed that alternatives must be found. The energy crisis in the 1970s made it clear that a one-sided energy policy can be extremely risky. Nonetheless, very little has changed since then with respect to our dependency on oil. The recent record oil prices have made it clear to everybody that a further oil crisis might already be in the making, possibly with consequences beyond what the world saw in the 1970s. In addition to this, a large portion of the world's remaining oil reserves are in regions with limited political stability. With respect to climate protection, agrofuels can in principle reduce $CO_2$ emissions, but only if a series of agrological and ecological guidelines are adhered to.

Alone decentralized and regional systems that are adapted to their economic and ecological environment can contribute to sustainable and clean energy resource management. On a regional level, biomass in the form of agrofuels will definitely be in the position of playing an important role as long as the criteria of sustainable production under ecologically acceptable conditions are adhered to. Furthermore, their use in agriculture should be embraced, especially in water protection areas, as agrofuels and biogenous lubricants are biologically degradable.

Developing responsible energy policies and dealing with climate change could become an area in which Europe might lead an international partnership – but only if it is a fair and well-managed cooperation taking into consideration both sustainable solutions for climate protection as well as reducing poverty[31]. For this to be possible, however, countries such as Austria will first have to develop their own policies, trying to avoid reckless strategies that might bring about fast results but without taking all of the consequences into consideration.

[31] Climate Change and Security Report: p.29

In the case of agrofuels, if governments had heeded the advice given by scientists in time, that is, if they had listened to the warnings various national and international experts had made, they would not be caught in the difficult situation of having supported a number of enterprises that follow unsustainable methods of production.

As has been outlined in the Climate Change and Security report, the global demand for energy is still growing. Between 1990 and 2005, China's percentage of the total primary energy supply has increased from 10% to 14.5%, while during the same time period India's percentage has increased from 4.1% to 5.5%. In addition, the Western countries have for the most part not met their energy goals. Austria, for example, is very far from achieving the goals they set in Kyoto.

It would be important now to provide well thought out support for developing countries to expand fuel and energy production following the criteria of sustainability which would take into account both social and ecological aspects. The demand for fuels in developing countries will continue to increase. If the industrial nations do not want to contribute to a further increase in the poverty and inequality of socially and/or geographically marginalized people, they cannot continue to count on satisfying their own demand using resources from developing countries.

## Imprint

Austrian Academy of Sciences (ÖAW)

Public body (BGBl 569/1921 idF BGBl I 130/2003)

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Fact sheet about current issues of research for development.

Photocredits cover page (from left to right): Pic1: BMLFUW/Kern; Pic2: Daniel Schwen/2007; Pic3: BMLFUW/Kern; Pic4: Gerhard Glatzel



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Kindly supported by:

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Bundesministerium für Wissenschaft und Forschung