Biofuel Production
by Farmers

Best practice examples
The Project - AGRI FOR ENERGY

- **Objectives**

  The project aims at boosting bioenergy in Europe through targeted actions during 26 months. It is coordinated by the Chamber of Agriculture and Forestry of Styria (AT) and 4 partners from IT, RO, SK and SI. It especially addressed the barriers lack of co-operation, information and training within the agricultural and forestry sector and lack of public awareness among decision makers. The most important objectives are:

  - To mobilise the large biomass potential from fragmented private owned forests and from agricultural land by increasing the co-operation among farmers and forest owners
  - To integrate the agricultural and forestry sector into the energy market as raw material supplier (e.g. woodchips) or as energy supplier (e.g. bio heat)
  - To stimulate local and trans-national exchange of experiences and know-how transfer.

- **Barriers to be addressed**

  Especially the following barriers to an actual involvement of farmers and forest owners are addressed:

  - Farmers and forest owners as well as associations and co-operatives of them which are searching for additional income possibilities.
  - Forest entrepreneurs, which are operating machinery to produce or supply biomass raw materials (e.g. harvester, chipper, woodchips trailer),
  - Advisory and service organisations within the agricultural and forestry sector (departments responsible for bioenergy, forestry, plant production, agricultural and forestry policy) – decision makers as well as technical and financial advisors
  - Companies working in the fields of biomass production and biomass supply,
  - Relevant decision makers from policy (e.g. mayors, district councillors), administration and municipal authorities, residential housing organisations.

- **Expected Results**

  This project will impulse new efforts for targeted actions that will increase significantly the biomass penetration in the market. Well experienced strategies how to integrate the agricultural and forestry sector in the energy market will be discussed at local and trans-national level directly with farmers/forest owners and decision makers. Five countries are participating but results will profit the whole Union, as the coordinator is also Vice-President of the European Biomass Association, which has members in 25 European countries.

  - Best practice booklets - disseminated to farmers, forest owners and decision makers
  - Training courses for farmers and forest owners
  - Workshops and study tours for farmers/forest owners and decision makers
  - Regional bioenergy coordinators as a link between farmers/forest owners, customers and professional advisory service.
Foreword

In the EU, transport is responsible for an estimated 21% of all greenhouse gas emissions that are contributing to global warming, and the percentage is rising. In order to meet sustainability goals, in particular the reduction of greenhouse gas emissions agreed under the Kyoto Protocol, it is therefore essential to find ways of reducing emissions from transport.

This is not the only challenge. Nearly all the energy used in the EU transport sector comes from oil. Known oil reserves are limited in quantity and restricted to a few world regions. Securing energy supplies for the future is therefore not only a question of reducing import dependency, but calls for a wide range of policy initiatives, including diversification of sources and technologies.

The EU is supporting biofuels with the objectives of reducing greenhouse gas emissions, boosting the decarbonisation of transport fuels, diversifying fuel supply sources and developing long-term replacements for fossil oil. The development of biofuel production is expected to offer new opportunities to diversify income and employment in rural areas.

Processed from biomass, a renewable source, biofuels are a direct substitute for fossil fuels in transport and can readily be integrated into fuel supply systems. Biofuels can be used in form of liquid or gaseous fuels as an alternative fuel for transport. Currently, two types of biofuels represent the bulk of renewable transport fuels around the world: bioethanol and biodiesel. Other fuels, such as biogas or synthetic gasoline and diesel, currently play only a minor role.

Both bioethanol and biodiesel can be produced from a wide range of feedstock. Bioethanol plants currently in production mostly use sugar or starchy crops. Biodiesel is mainly produced by transesterification of vegetable oils. Currently, the predominant oils used in biodiesel production are rape, sunflower and soya oil.

Both bioethanol and biodiesel can be used either as pure fuels, or blended with petrol and diesel. Low-rate biofuel blends (such as up to 5% of bioethanol in petrol, or of biodiesel in conventional diesel) generally do not require any modifications to existing vehicle engines. Higher shares of bioethanol or biodiesel require some modest modifications in tanks, fuel pipes, valves and/or engine components. A flex-fuel engine for motor vehicles which is compatible with any bioethanol blend share between 0% and 100% is available on some national markets, most notably in Brazil.

The involvement of European farmers in the biofuels market is mainly limited to the role of a raw material supplier for the production of biodiesel or bioethanol. However successful examples from Austria show that farmers are able to open up a new area of business as a regional supplier of biofuels like biodiesel, pure vegetable oil or biogas.
Biofuels in Europe

Biodiesel represents the biggest share of biofuel production in the European Union, with a market share of nearly 80% compared to bioethanol with just over 20% of the market. The European Union currently leads the world in the development of a biodiesel sector. Germany is the largest producer of biodiesel followed by France and Italy. For bioethanol, Spain, France, Poland and Sweden are the leading producers within the European Union.

In the Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport, the European Commission has set indicative targets for renewable fuel as a share of total transport fuels use in the EU. A guideline has been established of 2% of all transport fuels used by 2005, and rising to 5.75% of total use by 2010.

However, the biofuels goal is not mandatory and individual Member States are free to establish higher standards. As a result, the degree of participation varies substantially across EU Member States. Because the targets are not mandatory, no penalty for non-compliance is involved; however, Member States are expected to report annually those measures undertaken to aid compliance as well as on the sales of both total transport fuel and the share of biofuels. Despite various State and EU-wide policies designed to support biofuels production, the EU biofuels goal of 2% by 2005 was not achieved. Instead, it appears that biofuels attained an EU-wide share of only about 1.4% of transport fuels.

The EU’s Common Agricultural Policy (CAP) includes rules on agricultural land use, as well as a special payment for the production of crops dedicated to biofuels. Under the CAP, EU farmers are required to set aside 10% of their land to qualify for other CAP benefits. Participating farmers receive a set-aside compensation payment. In addition, EU farmers are allowed to plant oilseeds on the set-aside land as long as it is contracted solely for the production of biodiesel or other industrial products and not sold into either food or feed markets.

In 2003, a new round of CAP reforms established a special aid for energy crops grown on non-set-aside land. Energy crops – those grown for the production of biofuels of for use as biomass in the production of electric and thermal energy – were eligible for a premium of €45 per hectare. To establish a budgetary ceiling on such outlays, the energy payments were to be restricted to a maximum guaranteed area of 1.5 million hectares. In 2005, an estimated 0.5 million hectares received the energy crop payment.

The implementation of EU’s Biofuel Directive

- Austria

The Biofuels Directive was transposed into national law by the revised Fuels Ordinance of 4 November 2004, which defines a substitution requirement. Accordingly, from 1 October 2005, those subject to the substitution requirement must place on the market a proportion of 2.5% biofuels or other renewable fuels calculated on the basis of the total energy content of the petrol and diesel placed on the market in the transport sector each year by those subject to mineral oil tax in Austria. This proportion should increase to 4.3% from 1 October 2007 and to 5.75% from October 2008. Persons subject to the substitution requirement are those who place petrol and diesel fuels on the market for the first time in Austria or bring such fuels into Austria other than in a vehicle fuel tank.

This ordinance has to be seen in combination with the adaptation of the mineral oil tax law. Since October 2005 blended diesel (minimum 4.4% biodiesel) has a tax reduction of 0.028 €/litre as compared to fossil diesel. Starting October 2007 blended petrol will have a tax reduction of 0.033 €/litre as compared to fossil petrol. Pure biofuels are completely exempt from mineral oil tax.

There are currently nine large-scale and three small-scale biodiesel plants in operation in Austria. The total capacity amounts to more than 100 000 tonnes per year. For the large-scale plants farmers are only raw material suppliers. Only the small-scale plants are operated by farmer cooperatives. Because the existing biodiesel production capacity is not sufficient for the Austrian demand at present biodiesel is imported from neighbouring countries. However new biodiesel production plants will be built in Austria. There is currently no large-scale production of bioethanol in Austria, but until mid-2007 a plant with a capacity of about 200 000 cubic metres bioethanol and a raw material demand of over 500 000 tonnes of agricultural produce a year will be built.
- Italy

- Slovenia

- Slovakia

- Romania
Biofuels production technologies

A strong knowledge and expertise exists in Europe in the area of biofuel production, both for biochemical and thermochemical systems. The two pathways presently used in Europe are bioethanol production from sugar crops or starch (grain crops) and biodiesel from oil-seed crops (rapeseed, sunflower, soy bean and other raw materials) converted into methyl esters (Fatty Acid Methyl Ester or FAME). Today, fossil methanol is used for the esterification. A better option in the future would be to use bio-methanol in the FAME production, or the production of Fatty Acid Ethyl Ester (FAEE) with bioethanol instead of methanol.

Present biomass transformation processes:

![Diagram of biomass transformation processes]

Bioethanol
Bioethanol can be incorporated in the petrol pool, but only to a limited percentage (at present 5 %) without engine modifications. Some bioethanol is also used as an 85% blend (E85) in flexible fuel cars, mixed with diesel using a stabilising additive (e-diesel), and as fuel for diesel buses (with ignition improver). The most frequent use of ethanol in Europe at present is, however, through conversion into derivates such as ethyl tertiary butyl ether (ETBE).

The sugar-to-ethanol production process:
In producing ethanol from sugar crops, the crops must first be processed to remove the sugar (such as through crushing, soaking and chemical treatment). The sugar is then fermented to alcohol using yeasts and other microbes. A final step distils (purifies) the ethanol to the desired concentration and usually removes all water to produce “anhydrous ethanol” that can be blended with petrol. In the sugar cane process the crushed stalk of the plant, the “bagasse”, consisting of cellulose and lignin, can be used for process energy in the manufacture of ethanol.

The grain-to-ethanol production process:
The grain-to-ethanol production process starts by separating, cleaning and milling (grinding up) the starchy feedstock. Milling can be “wet” or “dry”, depending on whether the grain is soaked and broken down further either before the starch is converted to sugar (wet) or during the conversion process (dry). In both cases, the starch is converted to sugar, typically using a high-temperature enzyme process. From this point on, the process is similar to that for sugar crops, where sugars are fermented to alcohol using yeasts and other microbes. A final step distils (purifies) the ethanol to the desired concentration and removes water. The grain-to-ethanol process also yields several co-products, such as protein-rich animal feed (e.g. distillers dry grain soluble, or DDGS) and in some cases sweetener, although this varies depending on the specific feedstock and process used.

Biodiesel
Biodiesel is a methyl-ester of diesel quality produced from vegetable oil, animal oil or recycled fats and oils. It is produced by modifying the mentioned raw materials by mixing with methanol to produce an ester in order to remove the glycerol from the oil. Biodiesel is as fuel widely accepted by diesel
engineers. It is used both in pure form and admixed to diesel from mineral oil. Esterification of oils from biological origin with bioethanol could be a possibility in future to generate biodiesel independent from fossil fuels.

The biodiesel production process:
Biodiesel from fatty acid methyl esters (FAME) can be produced by a variety of Esterification technologies, though most processes follow a similar basic approach. First the oil is filtered and pre-processed to remove water and contaminates. If free fatty acids are present, they can be removed or transformed into biodiesel using pre-treatment technologies. The pre-treated oils and fats are then mixed with an alcohol (usually methanol) and a catalyst. The oil molecules (triglycerides) are broken apart and reformed into esters and glycerol, which are then separated from each other and purified. The resulting esters are biodiesel.

Pure vegetable oil
Pure vegetable oil is oil produced from oil plants through pressing, extraction or comparable procedures, crude or refined but chemically unmodified, which can be used as biofuel when compatible with the type of engine involved and the corresponding emission requirements. It has been tested in vehicle fleets with controversial results.

Biogas
The production of biogas is a third available pathway. Biogas is a fuel gas produced from biomass, which can be purified to natural gas quality for use as biofuel. It can be produced in agricultural biogas plants. Upgraded biogas compressed at a pressure around 200 bar can be used as an engine fuel. This option has to be assessed, but presently represents a niche market. However first pilot plants are already planned and will be realised in Austria within the next years.

Options for the future development of biofuels in Europe
For the large scale development of biofuels in Europe the Biofuels Research Advisory Council expects three main phases:

Phase I: Short term (until 2010)
- Improving existing technologies
- R&D into 2nd generation biofuels

Phase II: Medium term (2010 – 2020)
- Development of 2nd generation biofuel production
- Development of options for energy crops and sustainable agriculture

Phase III: Long term (beyond 2020)
- Large-scale production of 2nd generation biofuels

The following table provides an overview of biofuels and the feedstock and processes used in their production.

<table>
<thead>
<tr>
<th>First generation (conventional) biofuels</th>
<th>Biofuel type</th>
<th>Specific name</th>
<th>Biomass feedstock</th>
<th>Production process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioethanol</td>
<td>Conventional bioethanol</td>
<td>Sugar beets, grains</td>
<td>Hydrolysis &amp; fermentation</td>
<td></td>
</tr>
<tr>
<td>Pure vegetable oil</td>
<td>Pure plant oil (PPO)</td>
<td>Oil crops (e.g. rape seed)</td>
<td>Cold pressing/extraction</td>
<td></td>
</tr>
<tr>
<td>Biodiesel</td>
<td>Biodiesel from energy crops</td>
<td>Oil crops (e.g. rape seed)</td>
<td>Cold pressing/extraction &amp; transesterification</td>
<td></td>
</tr>
<tr>
<td>Biodiesel</td>
<td>Rape seed methyl ester (RME), fatty acid methyl/ethyl ester (FAME/FAEE)</td>
<td>Cold pressing/extraction &amp; transesterification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiesel</td>
<td>Biodiesel from waste (FAME/FAEE)</td>
<td>Waste/cooking/frying oil</td>
<td>Transesterification</td>
<td></td>
</tr>
<tr>
<td>Biogas</td>
<td>Upgraded biogas</td>
<td>(Wet) biomass</td>
<td>Digestion</td>
<td></td>
</tr>
<tr>
<td>Bio-ETBE</td>
<td>Bioethanol</td>
<td></td>
<td>Chemical synthesis</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Second generation biofuels</th>
<th>Biofuel type</th>
<th>Specific name</th>
<th>Biomass feedstock</th>
<th>Production process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioethanol</td>
<td>Cellulosic bioethanol</td>
<td>Lignocellulosic material</td>
<td>Advanced hydrolysis &amp; fermentation</td>
<td></td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------</td>
<td>-------------------------</td>
<td>-----------------------------------</td>
<td></td>
</tr>
<tr>
<td>Synthetic biofuels</td>
<td>Biomass-to-liquids (BTL)</td>
<td>Lignocellulosic material</td>
<td>Gasification &amp; synthesis</td>
<td></td>
</tr>
<tr>
<td>Synthetic biofuels</td>
<td>Fischer-Tropsch (FT) diesel</td>
<td>Synthetic (bio)diesel</td>
<td>Gasification &amp; synthesis</td>
<td></td>
</tr>
<tr>
<td>Synthetic biofuels</td>
<td>Biomethanol</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synthetic biofuels</td>
<td>Heavier (mixed) alcohols</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Synthetic biofuels</td>
<td>Biodimethylether (Bio-DME)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiesel (hybrid between 1st and 2nd generation)</td>
<td>NExBTL</td>
<td>Vegetable oils and animal fat</td>
<td>Hydrogeneration (refining)</td>
<td></td>
</tr>
<tr>
<td>Biogas</td>
<td>SNG (Synthetic Natural Gas)</td>
<td>Lignocellulosic material</td>
<td>Gasification &amp; synthesis</td>
<td></td>
</tr>
<tr>
<td>Biohydrogen</td>
<td></td>
<td>Lignocellulosic material</td>
<td>Gasification &amp; synthesis or Biological process</td>
<td></td>
</tr>
</tbody>
</table>
Biomass feedstock for Biofuel production

Currently biofuel production is mainly based on conventional agricultural products like oily seeds and sugar or starch rich crops.

**Oily seeds**
In Europe biodiesel is produced from different vegetable oils (rapeseed, sunflower, soy bean and other raw materials), animal oil or recycled fats and oils. Biodiesel production from oil crops results in co and by products, namely animal feed from cake. Feedstock is characterised by the type and concentration of fatty acids present: generally saturated, mono-unsaturated, or poly-unsaturated. Feedstock with similar compositions can be used interchangeably in processes designed for those compositions, depending on prices. For biodiesel, the perfect feedstock is composed of 100% mono-unsaturated fatty acid.

**Sugar rich crops**
Bioethanol is traditionally produced from the fermentation of glucose (sugar) by yeast, therefore sugar cane and sugar beets which contain a substantial amount of sugar constitute the main biomass source of bioethanol production worldwide, even if the US production from maize is nowadays almost as important in volume as from sugar cane in the world Other suitable sources of sugar are molasses (a by product of sugar industry and sweet sorghum). About 60% of the world ethanol production is from sugar crop and molasses, mainly from sugar cane as Brazil is by far the largest producer. Sugar beet is used in Europe, especially France, with a feedstock cost much higher than of sugar cane. The uses of other sources of biomass like fruits and to certain extend to sweet sorghum is limited due to cost effectiveness.

**Starch rich crops**
Because starch, largely present in many agricultural products, is easily converted into glucose, the largest part of bioethanol in Europe is made from cereals. Yeast and enzymes for starch conversion and glucose fermentation are commercially available. The potential feedstock includes maize, wheat and potato. In the conversion of grain to ethanol process, only the starchy part of the feedstock is used, which represents a relatively small percentage of the total plant mass, in particular to compare to the cellulosic part (husk and straw for wheat). Even on the grain itself, starchy ethanol production results in numerous co and by products like animal feed from corn in the dry mill processing and gluten.

**Make the best use of the whole plant**
Currently, agricultural and forestry systems exploit only part of their production, i.e. “primary” products, while they leave unexploited significant “residual” quantities. In future the use of both the primary and the residual resources through integrated and sustainable pathways should be promoted. It will also be necessary to utilise biomass fractions that are presently discarded and to make the best use of the whole plant. Specific non-food, high-yield biomass can be developed but needs to take into account of issues, such as biodiversity and labour conditions. When non-European feedstock is used they need to meet the same sustainability criteria as in the EU.
How much biofuel can be produced per hectare?

Increasing biomass supply
The main challenges concerning biomass resources are:
- Secure raw material supply
  - Efficient land use by the use of whole crop solutions and by exploiting both fertile and marginal land.
  - Ensure that both primary production and residues are evaluated for their energy potential.
  - Sustainability in biomass production – handling techniques.
- Improve the acceptability of the biomass sector by strengthening the communication channels among the relevant stakeholders, especially the farming and forestry sectors with the respective fuel and energy sectors.
- Local biomass production vs. international biomass trade.

Different sectors – food, feed, fibre, chemicals and energy – compete for land, therefore biomass production for energy has to be as efficient as possible per unit area in order to minimise the competition for land. The use of biomass should be promoted in all three sectors: heat, electricity, transport fuels. At least up to 2010, there will be no major competition for raw material: biofuels rely mainly on agricultural crops while electricity and heating rely mainly on wood and wastes. Planning efforts should focus on choosing the best available cropping solutions for each region and land type.

It can be noted that there are three parallel paths in the biofuel development:

1. The first path is to use food-type feedstock (wheat, vegetable oils…).
2. The second path is to make biofuels out of the residues or waste of current agriculture or forestry and industry.
3. The third path is to use energy crops, i.e. biomass that is grown on purpose for biofuels applications. The potential for energy crops can be massive.

Energy crops
Energy crops represent a promising outlet to security of supply issues for future biofuel production. Like the other biomass resources, they can be converted into virtually any energy form. However, their main advantage is that they can be developed to optimise key characteristics for energy applications. Energy crops may also have significantly higher yields per unit of land area than natural stands. These higher yields improve their cost effectiveness over conventional crops and minimise land requirements, associated chemical use, and hauling requirements.
Taking into account current agricultural systems as well as the respective legislative and political framework in the EU and individual Member States, energy crops are expected to play an increasingly significant role as future biofuel resources, starting from existing oil, starch and sugar crops for the first generation of biofuels and progressing to high yield and moderate input cropping solutions.
Biofuel production by farmers - Best practice example from Austria

The involvement of farmers in the biofuel production sector in Austria is restricted to the production of pure vegetable oil and biodiesel. However it has to be mentioned that most of biodiesel production in Austria is based on industrial plants and also the first bioethanol production plant will be an industrial one. Nevertheless, innovative Austrian farmers have shown, that particularly in rural areas, biofuel production by farmers offers a genuine alternative to fossil fuels. Growing rapeseed and processing it into biodiesel has opened up completely new perspectives and sources of income for rural farmers.

“Bioenergie Mureck”, Austria

The central aim of Bioenergie Mureck is to be able to open up a new area of business for the farmer as a regional supplier of energy. In this way he and the region become less dependent on fossil oil markets and their instable prices. Bioenergie Mureck has played a key role in the overall transformation of what was once a highly underdeveloped region. What makes its contribution so special is the fact that this development was instigated by the farmers themselves, without the aid of a major investor from outside the region or a powerful local energy utility. In the meantime Bioenergie Mureck consists of three companies:

- SEEG Südsteirische Energie- und Eiweißerzeugung reg.Gen.m.b.H.: a cooperative producing biodiesel and protein
- Nahwärme Mureck GmbH: a provider of local heat produced in a biomass district heating plant
- Ökostrom Mureck GmbH: a provider of local heat and electricity produced in a biogas CHP plant.

From the field to the tank

Since 1987 the idea that farmers can produce their own fuel for their tractors and cars has become reality in the region around Mureck in the southern part of Styria near the Slovenian border. Hatched by August Jost, Ferdinand Potzinger and Karl Totter over a few beers in the pub on December 30, 1985, the idea was borne to move away from the age of fossil fuels towards clean biofuels by unleashing the impressive potential of natural sunlight, flourishing fields of rape and constantly regenerating biomass. It called for a return to the proven cycles of traditional farming. The central idea was that farmers should produce rapeseed on their fields, dry and store it in existing regional depots, process it to biodiesel at the biodiesel plant in Mureck and use the biodiesel and the rapeseed cake at their farms.
The importance of regional cycles
After undergoing trials at the agricultural college in Silberberg near Leibnitz from 1987 to 1989, this form of cyclical farming was finally launched in Mureck. A cooperative of 580 farmers called “SEEG Südsteirische Energie- und Eiweißerzeugung reg.Gen.m.b.H.” was founded. Its main target was to produce biodiesel and protein in southern Styria. Currently the production capacity amounts to 10 million litres of biodiesel per year. 15% of biodiesel is produced from rapeseed, 70% from used cooking oil and 15% from animal fat. The main customers of SEEG are farmers, local authorities, public and private transport companies, freight forwarders and hauliers and petrol stations. While it is true that biodiesel alone is not the solution, it has become increasingly important for the region to strengthen its cycles and structures in order to reduce the volume of road traffic. One way to achieve this is to create jobs in the region, which is what Bioenergie Mureck has done. With all their activities in the sectors biofuels, bioheat and bioelectricity they have created 17 permanent local jobs within the company and further 15 to 20 permanent jobs in partner companies for the collection of used cooking oil. Furthermore 11 permanent jobs have been created at surrounding farms through production and supply of raw materials (rapeseed for biodiesel, woodchips for biomass district heating, maize and grass for biogas).

A regional cycle replaces raw material sales
Comparison of revenue from rapeseed sales and the use of produced biodiesel and rapeseed cake at the own farm (per tonne of rapeseed):

<table>
<thead>
<tr>
<th></th>
<th>Rapeseed sales</th>
<th>Use of biodiesel and rapeseed cake at the own farm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EUR/tonne of rapeseed</td>
<td>EUR/tonne of rapeseed</td>
</tr>
<tr>
<td>Biodiesel price:</td>
<td>EUR 0,70</td>
<td>200</td>
</tr>
<tr>
<td>Rapeseed price:</td>
<td>EUR 0,20</td>
<td>233</td>
</tr>
<tr>
<td>Biodiesel price:</td>
<td>EUR 0,80</td>
<td>220</td>
</tr>
<tr>
<td>Rapeseed price:</td>
<td>EUR 0,21</td>
<td>277</td>
</tr>
<tr>
<td>Biodiesel price:</td>
<td>EUR 0,90</td>
<td>240</td>
</tr>
<tr>
<td>Rapeseed price:</td>
<td>EUR 0,22</td>
<td>321</td>
</tr>
</tbody>
</table>
Drive around the world 491 times every year
Up to 1350 litres of biodiesel can be obtained from one hectare of rapeseed. About 800 hectares of land is currently being used by SEEG’s suppliers to grow rapeseed, leading to a production volume of some 1.08 million litres of biodiesel. In addition, some 140 litres of fuel are required to cultivate a field of one hectare, meaning that 7710 hectares of fields can be cultivated from the current 800 hectares. At Bioenergie Mureck almost all of the farmers run their tractors on biodiesel. Put in another ways and assuming an average consumption rate of five litres per 100 kilometres, this is the same fuel needed to travel 21.6 million kilometres, enough to meet the complete fuel requirements of 1550 Austrian drivers or to drive around the world 491 times every year.

Positive balance of energy in biodiesel production

<table>
<thead>
<tr>
<th>Energy deployed</th>
<th>Energy yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total oil consumption (for planting, harvesting, drying, transport)</td>
<td>Total energy generated (biodiesel, rapeseed cake, glycerine phase, others)</td>
</tr>
<tr>
<td>Processing of biodiesel (electricity, methanol, KOH)</td>
<td></td>
</tr>
<tr>
<td>Transport of finished products (biodiesel, rapeseed cake, glycerine phase)</td>
<td></td>
</tr>
<tr>
<td>Straw harvest</td>
<td>Resultant positive balance of energy</td>
</tr>
<tr>
<td>Total energy deployed</td>
<td>1 : 4.44</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Energy deployed</th>
<th>Energy yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total energy deployed</td>
</tr>
</tbody>
</table>

Rapeseed improves crop rotation
Due to the nine months it spends in the soil and its system of deep roots, rapeseed is actually ideal for the overall system of crop rotation, since it helps to relieve the strain on underground water. The cultivation of rapeseed has improved the quality and compactness of the soil, leading to improved crop rotation. By moving away from single crop farming, Bioenergie Mureck has managed to allay a frequently raised concern of the local population.
Rapeseed is used completely in Bioenergy Mureck’s energy cycle: the oil is turned into biodiesel; glycerine energy is harnessed for local heating and for production of biogas, while rapeseed cake is a quality source of high protein fodder. Thus sustainability is experienced here in the form of cyclical farming.

Biodiesel or pure rapeseed oil
Converting rapeseed oil into biodiesel requires both methanol and energy. Converted engines can also run directly on rapeseed oil. While both statements are completely true, in Mureck they also see a number of other biodiesel benefits from using regional systems: Biodiesel can be used in all standard diesel engines with relatively small conversion costs, but conversion for pure vegetable oil use is more expensive (EUR 3000 – 4000). Hence there are cost benefits at the moment from using biodiesel. Initially, SEEG also intended that the farmers only use vegetable oil but given the third-party drying costs and high expenditure on storage and handling the farmers decided to opt for a regional biodiesel system.
In SEEG’s overall concept, the by product of transesterification – the glycerine phase – is used as a form of energy in the local heating plant and in the biogas unit. In future the system should be able to meet its own requirements for methanol. This means that the fossil methanol which is currently used will eventually be replaced by methanol made from sustainable sources.

Aspects of sustainability

- Biodiesel can be said to make an indirect contribution to securing peace, because it offers independence from the vagaries of the world market and the insecurity of the oil-producing countries.
- The use of biodiesel in motor vehicles leads to a reduction in the amount of most pollutant emissions (especially CO, HC, particles, and 50% less soot emissions).
- Furthermore, this fuel does not contain sulphur. However, the use of biodiesel can also lead to slightly higher NOx emissions, especially when engines are driven to their performance limits.
- The amount of fine particles in biodiesel is somewhat less than in fossil diesel, a point which is of particular relevance to the current debate.
Since biodiesel is rapidly bio-degradable, it reduces the level of environmental risk particularly in sensitive areas such as water reserves, gravel ditches, ski slopes, etc.

Avoidance of climatically relevant CO₂ emissions: biodiesel combustion leads to reduced direct greenhouse gas emissions caused by motor vehicles. There is considerable potential for achieving savings if the whole of the fuel manufacturing process is taken into account, because the growing plant bonds with the same amount of CO₂ as is emitted during fuel combustion.
From the frying pan to the tank

Mureck turns into a source of energy what elsewhere is a headache for the local wastewater treatment authority. The Styrian capital of Graz offers a good example of how neglected sources of energy can be used: Used cooking oil from Graz is converted in Mureck to biodiesel and returns as environmentally friendly biofuel in the tanks of the city’s buses.

Convince the public
Initially, most private households used to dispose of their used cooking oil by flushing it down the sink while used cooking oil in industry was transported to the Netherlands and Belgium as feed to be used in pig-farming. So the search was on to find an alternative together with the government of Styria and the local authorities. Thus from the very start the collection of used cooking oil was tied in with the need to carry out a lot of work to convince the public why it should support the scheme. Here, the message that the sewerage system would not take everything that could be poured into it was at the heart of the public interest.

Special logistics system
As well as the public information campaign a special logistics system also had to be devised for households and restaurants. A specially developed container called “Fetty” was set up for practical and clean household collections. It was jointly introduced by the participating local authorities and waste management associations. Companies and restaurants can make use of special containers at fixed sites, which are emptied whenever required.

Benefits for local authorities
10% of the participating local authorities buy back the biodiesel, which they can use as fuel for public and local authority transport. The local authorities benefit from the difference in price between fossil diesel and biodiesel made from used cooking oil, and the cost-savings from not having to dispose of the used cooking oil. The municipality of Leibnitz is the local authority with the most enthusiastic collectors. Cost benefits of over EUR 9000 a year have been obtained from a very high collection rate and use of biodiesel in authority’s vehicle fleet.

Improve collection rate
The potential is limited by people’s average consumption of cooking oil, which amounts to 3 kg per person and year. Collection yields depend heavily on the activities of the local waste management associations. In this connection Styria still has enormous room for improvement, for while the waste management association of Leibnitz is way ahead with almost 2 kg per person, 0,47 kg per person and year is still considered an above-average result in the other localities. Consequently, the actual potential for development in this field is very clear.

Disposal areas
At the current time used cooking oil is disposed of in very wide areas. In addition to the local authorities in Styria, collection partners also carry out proper disposal in areas in Tyrol, Salzburg, Upper Austria and Carinthia. Clearly, however, not every region can adopt the strategy of producing biodiesel from used cooking oil in establishing a sustainable energy supply. For SEEG a collection radius of 200 km is useful and necessary at the present time. Apart from the participating local authorities, AME customers (AME: biodiesel from used cooking oil) include the Graz public transport authority, major hauliers and some biodiesel filling stations. In addition, SEEG also exports to Slovenia and Germany.

Aspects of sustainability
- Awareness-raising among the population – not everything should be flushed down the sink. Waste is a raw material.
- Local authorities deliver a troublesome waste material to SEEG and receive precious fuel in return, enabling the cyclical approach to be experienced as a business.
- Improperly disposal of used cooking oil often end up being flushed down the sink. Collections enable maintenance and cleaning costs of the sewerage system to be minimised.
- Wastewater treatment plants are subject to less pressure, important in view of the increasingly stringent regulations on discharges for local authorities.
- The separate collection of used cooking oils and fats and their processing in Styria safeguards jobs in collection and processing.
- The upgrading of an otherwise cost-generating waste material into a fuel enables added value to remain in the local region and reduces reliance on energy imports.
As producer of a renewable fuel SEEG contributes actively to climate protection (CO₂ neutral).
Contacts

Coordinator

LK-Stmk    Landeskammer für Forst- und Landwirtschaft in Steiermark

Partners of the project

AIEL    Associazione Italiana Energia dal Legno
FIS/GIS    Slovenian Forestry Institute / Gozdarski Institut Slovenije
BIOMASA    Združenje pravnickyh osob (BIOMASA)
CHIMINFORM    Chiminform Data