AGRANA BIOETHANOL
REFUELLING THE ENVIRONMENT

AGRANA

TABLE OF CONTENTS

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FOREWORD

With rising greenhouse gas emissions causing changing climatic conditions around the globe, strategies to reduce such emissions by harnessing environmentally friendly energy from sustainable sources are becoming ever more important. As a signatory to the Kyoto protocol, Austria is committed to reducing its greenhouse gas emissions between 2008 and 2012 by 13 percent compared to 1990 levels.

In 2007, transport, accounting for 27.6 percent of greenhouse gas emissions, was one of the two main contributors to Austria's total greenhouse gas emissions of 88 million tonnes CO_2 equivalent[1] (CO_2 eq). In fact, greenhouse gas emissions from the transport sector in Austria have almost doubled since 1990.

As already highlighted by the 2007 climate report in which a reduction of one million tonnes CO_2 eq was recorded, sustainable biofuels make a key contribution in efforts to cut greenhouse gas emissions and to ensure energy independence. Furthermore, the drive to harness the potential of biofuels is helping to open new doors to ways of ensuring the long-term viability of agricultural activities within the European Union.

Politicians have recognised the benefits of using biofuels to power vehicles, and have set an EU-wide target which stipulates that, by 2020, ten percent of fuels used in the EU must be produced from renewable sources. Austria has plenty of renewable raw materials, with collaborative efforts to harness such resources, involving politicians, farmers, industrial and private stakeholders, being vigorously pursued. Bioethanol represents an important cornerstone of this strategy.

In cooperation with Austrian sugar beet farmers, AGRANA operates a bioethanol plant in Pischelsdorf, Austria, while through its involvement with HUNGRANA Kft. it also runs a combined starch and bioethanol processing plant in Szabadegyháza, Hungary. According to studies carried out by Joanneum Research Forschungsgesellschaft, bioethanol from AGRANA and HUNGRANA production plants in Austria and Hungary reduces greenhouse gas emissions by around 50 percent compared to petrol, taking into account the entire life cycle from producing the raw materials, fertilising, transporting and processing it to using bioethanol in combustion engines.

Despite this convincing argument underpinning the sound environmental credentials of biofuels, criticism abounds, citing competition between food and energy crops for land and the low levels of sustainability when producing biofuels, particularly in developing countries. There is no question that food production should take precedence over energy crop production; however it makes sense to produce biofuels in industrialised countries that have structural crop surpluses – this does not affect European crop production and brings many other advantages. When considering the degree of sustainability of biofuels, the key is to take a different perspective and to examine closely the environmental, economic and social framework conditions. For this reason, the EU decided to introduce sustainability criteria pertaining to the production of biofuels, and to ensure these criteria are applied to biofuels produced both in the EU and in third-party countries which export to the EU.

The aim of this brochure is to provide a summary of the key prerequisites and framework conditions associated with biofuel production in Europe, together with the use of renewable fuels, focusing particularly on bioethanol. This brochure concentrates primarily on the sustainable production of bioethanol in the AGRANA and HUNGRANA bioethanol plants in Austria and Hungary, which already meet the EU target of a 50 percent cut in greenhouse gas emissions by 2017.

Johann Marihart
Chief Executive Officer AGRANA Beteiligungs-AG

[1] CO_2 equivalent: see Glossary on page 26

WHAT ARE BIOFUELS AND WHAT ARE THEY MADE FROM?

Biofuels are made from biomass, i.e. vegetation or vegetable waste, and are used to power internal combustion engines. The raw materials needed for this come from agricultural activities, residential waste or agricultural and forestry by-products. Bioethanol and biodiesel represent the most commercially important biofuels.

BIODIESEL

Biodiesel refers to a fuel made from vegetable oils or animal fats. In Europe, biodiesel is made primarily from rapeseed, with a small proportion coming from used cooking oil and animal fat. In other parts of the world, raw materials such as palm oil and soya are also used to produce biodiesel.

Biodiesel as a substitute for diesel

In line with legal admixture obligations, biodiesel is added to diesel and sold as 100 percent biodiesel at filling stations throughout Austria.

BIOETHANOL

Bioethanol is a fuel made from the fermentation of carbohydrate-rich biomass such as sugar and starch with an alcohol content of at least 99 percent by volume, making it practically water-free.

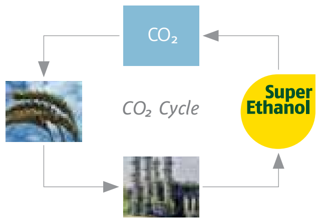
Bioethanol can essentially be produced from any raw material that contains either sugar or starch. Given that specific kinds of raw materials grow better under certain climatic conditions, there are regional preferences in the kinds of raw materials used to produce bioethanol. In Europe, the most important raw materials used to produce bioethanol include any crops containing starch, as well as concentrated sugar beet juice. In the USA, bioethanol is largely made from corn, while in tropical regions such as Brazil; sugar cane has become the sole source of this fuel.

Raw material	Yield	Bioethanol
Sugar cane	75–85 to/ha	6.7–7.3 m^3/ha
Sugar beet	45–70 to/ha	6.5–7.3 m^3/ha
Corn	8.5–10.0 to/ha	3.2–4.0 m^3/ha
Wheat	6.5–8.0 to/ha	2.5–3.0 m^3/ha
Triticale	5.0–6.0 to/ha	2.0–2.5 m^3/ha
Rye	4.6–5.2 to/ha	2.0–2.2 m^3/ha

Source: Joanneum Research Forschungsgesellschaft mbH

Environmental benefits of bioethanol over fossil fuels

When burned, bioethanol is largely CO_2-neutral because plants absorb as much CO_2 when growing as they release when burned. Moreover, bioethanol burns without leaving any residual soot and it is free from sulphur.



Bioethanol as a substitute for petrol

In line with legal admixture obligations, bioethanol is mixed with petrol in Austria and is also used as a separate, environmentally friendly fuel known as SuperEthanol E85[2], which is a mixture of petrol and up to 85 percent of bioethanol. So-called flexible fuel vehicles (FFVs)[3] are needed to use SuperEthanol E85. These vehicles can run on both SuperEthanol E85 and petrol, as well as on an admixture of the two fuels (up to an 85 percent concentration of bioethanol).

[2] SuperEthanol E85 fuel: see page 24
[3] Flexible Fuel Vehicles: see page 24

LEGISLATION
CONCERNING THE USE OF BIOFUELS IN THE EU, AUSTRIA AND HUNGARY

REGULATORY FRAMEWORK IN THE EU

On 26 March 2009, the European Parliament and Council passed the final directive on the promotion of the use of energy from renewable sources, amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

The EU Directive 2009/28/EC on the promotion of the use of energy from renewable sources sets the following targets to be achieved by 2020:

- a 20 percent cut in greenhouse gas emissions,
- 20 percent renewable energy, with 10 percent of fuels to come from renewable sources.

In accordance with this directive, the reduction in greenhouse gas emissions using biofuels must amount to a minimum of 35 percent, calculated over their life cycle[4]. As of 1 January 2017, the total reduction must be 50 percent, with this rising to at least 60 percent for facilities that begin production after this point in time.

LEGISLATION IN AUSTRIA

Austria incorporated the EU biofuels directive into its national legislation by amending the Austrian Ordinance on Automotive Fuels (Kraftstoffverordnung) to include an admixture obligation in November 2004. It should be noted that Austria set targets which were considerably more ambitious than those defined by the European Union.

Substitution targets pursuant to EU Biofuels Directive 2003/30/EC and Directive 2009/28/EC and pursuant to the 2004 Austrian Ordinance on Automotive Fuels:

Target year	EU	Austria
2005	2.0%	2.5%
2007		4.3%
2008		5.75%
2010	5.75%	
2020	10%	

Since 1 October 2008, 5.75 percent of the total energy content[5] of all fuel used for transportation in Austria must be substituted by biofuel. In order to achieve the stipulated admixture targets, both biofuels, such as pure biodiesel and the environmentally friendly fuel SuperEthanol E85, petrol with up to an 85 percent concentration of bioethanol, and fuels such as diesel and petrol mixed with lower percentages of biofuels, are taken into account.

The Austrian admixture obligation in the transport sector of 5.75 percent of the fuels' energy content is currently achieved due to more biodiesel being mixed with diesel. At the moment, this amounts to a concentration of 6.3 percent (energetic) biodiesel in diesel fuel dispensed at filling stations in Austria. Given that there is no standard in Austria for a five percent (energetic) admixture concentration of bioethanol to petrol, only around 3.4 percent (energetic) bioethanol (roughly five percent by volume) is currently mixed with petrol.

A tax incentive is offered to encourage efforts to achieve the admixture target, namely that the biogenic proportion of the fuel is exempt from mineral oil tax. As a result, a tax saving on petrol of € 33 per 1,000 litres of fuel can be achieved with an admixture of at least 4.4 percent of biogenic fuel, calculated according to the volume.

Petrol consumption in Austria

In 2008, petrol consumption in Austria amounted to approximately 1.84 million tonnes (2.47 million m³) – with the overall national fuel consumption totalling around 7.92 million tonnes. In order to substitute the 5.75 percent of petrol consumption from 1 October 2008, measured by energy content, around 165,000 tonnes (8.4 percent by volume or 208,000 m³) of bioethanol is needed. This is equivalent to the annual production of the Pischelsdorf plant.

[4] Calculating life-cycle analyses: see pages 12 ff.
[5] Weight, volume and energy content conversion ratios for liquid fuels: see Glossary on page 26

LEGISLATION IN HUNGARY

Since 1 July 2009, it has been law in Hungary for petrol to have a concentration of 3.1 percent (energetic) bioethanol. At least 4.8 percent by volume is to be blended; otherwise the tax levied on the fuel will be higher.

AGRANA believes in bioethanol

In a similar vein to the German model, AGRANA is committed to raising the admixture target for biogenic fuel to 6.25 percent by 2010, achieving 10 percent in Austria as swiftly as possible. Furthermore, AGRANA is lending its support to expanding the network of SuperEthanol E85 filling stations, advocating the promotion of SuperEthanol E85-compatible vehicles for use by the public sector.

"In reducing greenhouse gas emissions by around 50 percent over those from petrol, bioethanol from sustainable production practices in Austria and Hungary is already playing an important role in achieving Austria's climate protection targets for transportation – a fact which should not be forgotten."

Johann Marihart

Chief Executive Officer AGRANA Beteiligungs-AG

"A great communal effort is required to meet climate targets, particularly in the area of transport. Changing to alternative fuels plays a key role here. In order to accelerate this, we have been promoting the conversion of vehicle fleets, on the one hand, and the setting up or conversion of filling stations for alternative fuels, on the other hand."

Niki Berlakovich

Federal Minister of Agriculture, Forestry, Environment and Water Management

PRODUCING BIOETHANOL

PRODUCING BIOETHANOL AT THE AGRANA PLANT IN PISCHELSDORF, AUSTRIA

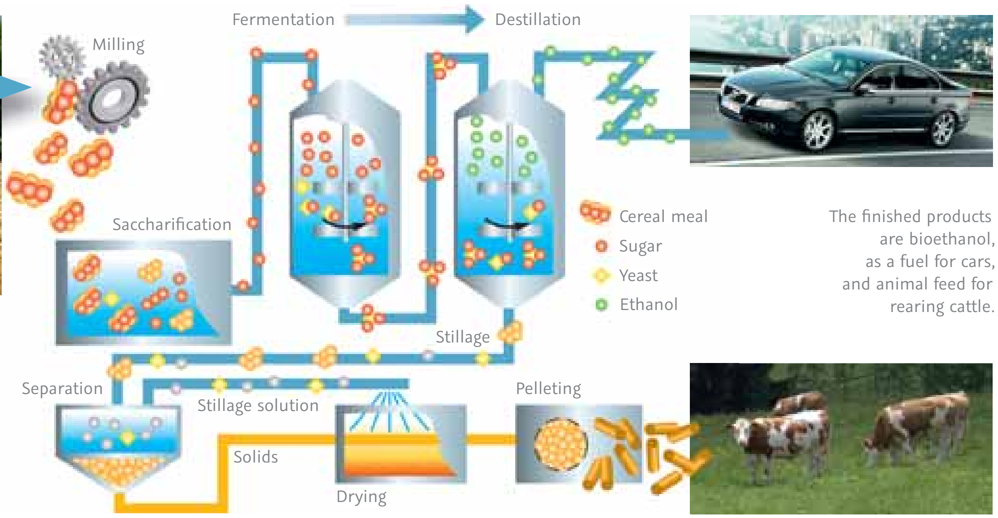
At its site in Pischelsdorf, Lower Austria, AGRANA has built a bioethanol fuel plant which was commissioned in June 2008. The site on the industrial estate in Pischelsdorf was selected in view of its location in the heart of the raw material producing region, its excellent links to the Danube, roads and railway, as well as the ideal range of energy supply possibilities. The bioethanol plant is equipped with two energy supply systems: a calorific power plant located nearby and a thermal waste incineration plant owned by the EVN group (a Lower Austrian energy provider) supplying high-pressure steam.

Each year, up to 620,000 tonnes of crops can be converted into 240,000 m³ or 190,000 tonnes of bioethanol at the plant in Pischelsdorf. In addition to bioethanol, up to 190,000 tonnes of high-quality protein-rich animal feed called DDGS (Distiller's Dried Grain with Solubles) can be produced each year and marketed under the name ActiProt®. This high-quality, certified GMO-free protein-rich animal feed helps to make the production of bioethanol commercially viable, with the quantities produced replacing up to a quarter of Austria's soya imports from countries that can no longer guarantee GMO-free produce.

Production of bioethanol from cereals

As the crops grow, CO_2 is converted into starch or sugar and stored in the plant's biomass. When processed in the bioethanol plant, this sugar is then turned into alcohol. The production process, from the raw material to the end product bioethanol, takes several days and involves a number of stages.

In contrast to crops that are used to make food, those destined to produce bioethanol have lower protein levels. Special varieties of wheat are especially suited for the production of bioethanol due to their high starch levels. At the moment, the Pischelsdorf plant uses primarily wheat and corn, as well as some triticale.



The finished products are bioethanol, as a fuel for cars, and animal feed for rearing cattle.

The flowchart right illustrates how Austria's first bioethanol plant, in Pischelsdorf, works. The raw materials are mainly wheat and corn. In addition to bioethanol, the plant also produces top-quality, protein-rich, animal feed.

The raw materials are transported to the bioethanol plant by boat, train and lorry. When delivered, they are weighed and then subject to strict quality controls. These involve taking samples and analysing them immediately in the adjacent labratory.

Firstly, moisture, starch and protein levels are automatically measured, along with the hectolitre weight. Next, a visual inspection is performed in which the raw materials are checked for contamination and pests. In addition to this, the samples are tested for mycotoxins, with corn samples also being subjected to genetic testing. Once this inspection is complete, reference samples are archived and the raw materials can then be unloaded and stored in silos to await use.

The Pischelsdorf bioethanol plant operates using dry milling technology. The raw materials are ground in hammer mills in accordance with demand and then pass on to the mashing process, during which water, enzymes and nutrients are added to the raw materials. Enzymes are protein molecules that serve as a catalyst to accelerate chemical reactions and break down starch found in sugar molecules.

During the first stage, liquefaction, the long glucose chains inherent in starch molecules are broken down into small sections. The liquefied mash is then allowed to cool before the fermentation process.

In the second stage, simultaneous saccharification and fermentation, the individual glucose molecules serve as a culture medium for the added yeast which produces bioethanol under hermetically sealed conditions. In the following distillation process, the alcohol is separated from the mature mash using hot steam. As the degree of purity achieved by distillation can only reach a maximum of 96.4 percent, the substance is also subject to drying by means of molecular filters. This way, the ethanol content can be increased to over 99 percent and the water content reduced to below one percent.

The extracted alcohol is cooled and stored in tanks from which the bioethanol is then delivered to the buyers, mainly mineral oil companies that use the bioethanol for blending with petrol, in railway tank wagons.

Facts and figures about the AGRANA bioethanol plant in Pischelsdorf

- ***Amount of investment:*** *approximately € 125 million*
- ***Nominal capacity:*** *240,000 m³ (= 190,000 tonnes) of bioethanol per year*
- ***Employees:*** *approximately 80*
- ***Raw materials used:*** *up to 620,000 tonnes of crops (primarily wheat and corn)*
- ***By-product:*** *up to 190,000 tonnes of high-quality, GMO-free protein-rich animal feed, marketed as ActiProt®; substitutes around a quarter of Austrian imports of soya-based animal feed from overseas*

Producing the high-quality protein-rich animal feed, ActiProt®

The waste, called stillage, which is produced during the bioethanol production process is separated by means of centrifuges. The solid waste is immediately dried, whereas the liquid waste is first boiled down to a syrup-like consistency. Both of these by-products are mixed, dried and pelletized, being turned into the high-quality, GMO-free, protein-rich animal feed, ActiProt®, for use in livestock breeding as feed for cattle, pigs and poultry.

The laboratory at Pischelsdorf enjoys certification in accordance with ISO 9001, the Feed Additive and Premixture (FAMI) QS code and standards to identify genetically modified organisms (GMO). This is where samples from the entire production process are analysed for the purposes of quality assurance. Similarly, before both the bioethanol and ActiProt® feed finished products are delivered, samples are once again taken, analysed and archived.

PRODUCING BIOETHANOL AT THE HUNGRANA PLANT IN SZABADEGYHÁZA, HUNGARY

HUNGRANA Kft. in Szabadegyháza, Hungary, in which AGRANA has a 50 percent stake, produces isoglucose[6] and bioethanol in a combined starch processing plant with a nominal capacity of up to 187,000 m^3 per year. Corn, corn gluten and livestock feed are by-products of the process to produce isoglucose and bioethanol.

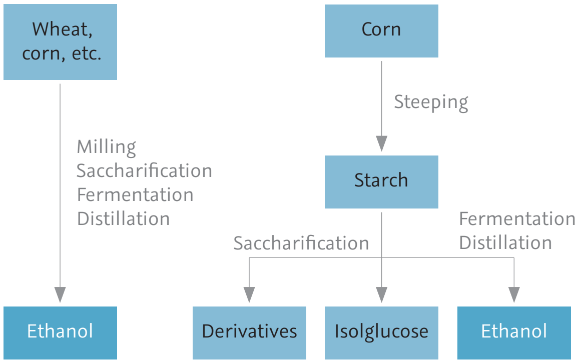
The plant is run using so-called wet milling technology.

Corn is the only raw material used by HUNGRANA. This takes the form of so-called wet corn, which is supplied after being freshly harvested four months a year, while dry corn is used for the rest of the year.

The bioethanol produced at the HUNGRANA plant in Szabadegyháza is used in line with the EU directive on the substitution of petrol and corresponds to a share of around 6.2 percent (energetic) of current Hungary petrol consumption.

Dry milling
AGRANA Pischelsdorf

Wet milling
HUNGRANA Szabadegyháza



[6] Isoglucose is a viscous saccharification product which has a fructose content of 42 percent. This means it is as sweet as sugar and therefore used as a sugar substitute.

ASSESSING THE SUSTAINABILITY OF BIOETHANOL PRODUCTION

USING LIFE-CYCLE ANALYSES

METHODOLOGY OF LIFE-CYCLE ANALYSES

In order to assess the sustainability of bioethanol production at the AGRANA facilities, the Institute for Energy Research at Joanneum Research Forschungsgesellschaft carried out life-cycle analyses. This involved performing energy and global warming impact assessments (life-cycle assessments) for the AGRANA bioethanol plant in Pischelsdorf and the HUNGRANA plant in Szabadegyháza.

In accordance with the Directive of the European Parliament and Council on the promotion of the use of energy from renewable sources, the reduction in greenhouse gas emissions using biofuels must reach at least 35 percent, calculated over their life cycle. As of 1 January 2017, the total reduction must be 50 percent, with this rising to at least 60 percent for facilities that begin production after this point in time. The EU energy allocation method[7] is to be used to compile the life-cycle analysis.

A life-cycle analysis calculates emission levels and the cumulated primary energy demand which are associated with providing a certain transport service using a bioethanol or petrol-driven car. Each individual material and process involved in both transport services is recorded ("from the cradle to the grave"), ranging from the way in which the raw material is extracted from the environment to how material and energy is discharged. This analysis includes every process related to emissions and energy, both domestically and abroad, which is necessary to run vehicles on bioethanol. Finally, the results are compared with the assessments of the supply and application of petrol.

The process of considering the entire life cycle for bioethanol incorporates five key steps:

- Planting and harvesting the raw material, taking into consideration the yield, use of fertilizer and of equipment
- Transporting the raw material to the bioethanol facilities, taking into consideration the method and length of transportation
- Producing bioethanol and its by-product, taking into consideration the energy mix of process heating and electricity, additives etc.
- Transporting bioethanol in the filling station distribution network, taking into consideration the method and length of transportation
- Using bioethanol in combustion engines

Greenhouse gases

The three greenhouse gases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O – laughing gas) are referred to when considering total greenhouse gas emissions[8]. In order to be able to add up the greenhouse gases CO_2, methane, and nitrous oxide to calculate the total emissions, methane and nitrous oxide are converted into equivalent CO_2 quantities using certain factors according to their global warming potential:

- 1 kg of methane corresponds to 23 kg CO_2 eq
- 1 kg of nitrous oxide corresponds to 296 kg CO_2 eq

[7] EU energy allocation method: see Glossary on page 26
[8] Global warming potential of gas: see Glossary on page 26

LIFE-CYCLE ANALYSIS BASED ON THE EU DIRECTIVE ON THE PROMOTION OF THE USE OF ENERGY FROM RENEWABLE SOURCES, TAKING THE AGRANA BIOETHANOL PLANT IN PISCHELSDORF AS AN EXAMPLE

The key data needed to analyse the bioethanol plant are obtained on the basis of the plant's key performance indicators. The life-cycle analysis is designed and calculated using the GEMIS (Global Emission Model of Integrated Systems) model, based on generic data records for Austria together with current data obtained from relevant research work.

Energy demand

Depending on the nature and quantity of the final energy source used (bioethanol, petrol, natural gas or electricity), the exact amount of primary energy necessary to supply the final energy source is calculated. As a result, the total primary energy demand incorporates every instance of energy use that is associated with running vehicles on bioethanol and petrol. The primary energy needs for transport services with bioethanol comprise the energy used during the cultivation, harvesting, transporting and processing of the raw material as well as for the supply of bioethanol. In cases of transport services with petrol, the energy required to locate and extract crude oil, as well as turning this into petrol and providing it to the consumer, is considered.

This total primary energy demand is also known as the "cumulated energy demand" (CED). The term "primary energy source" refers to crude oil, natural gas, coal, hydropower, biomass and other renewable energy sources (e.g. wind and solar power) as well as alternative energy sources (e.g. waste).

Modelling of the life-cycle analysis[9]

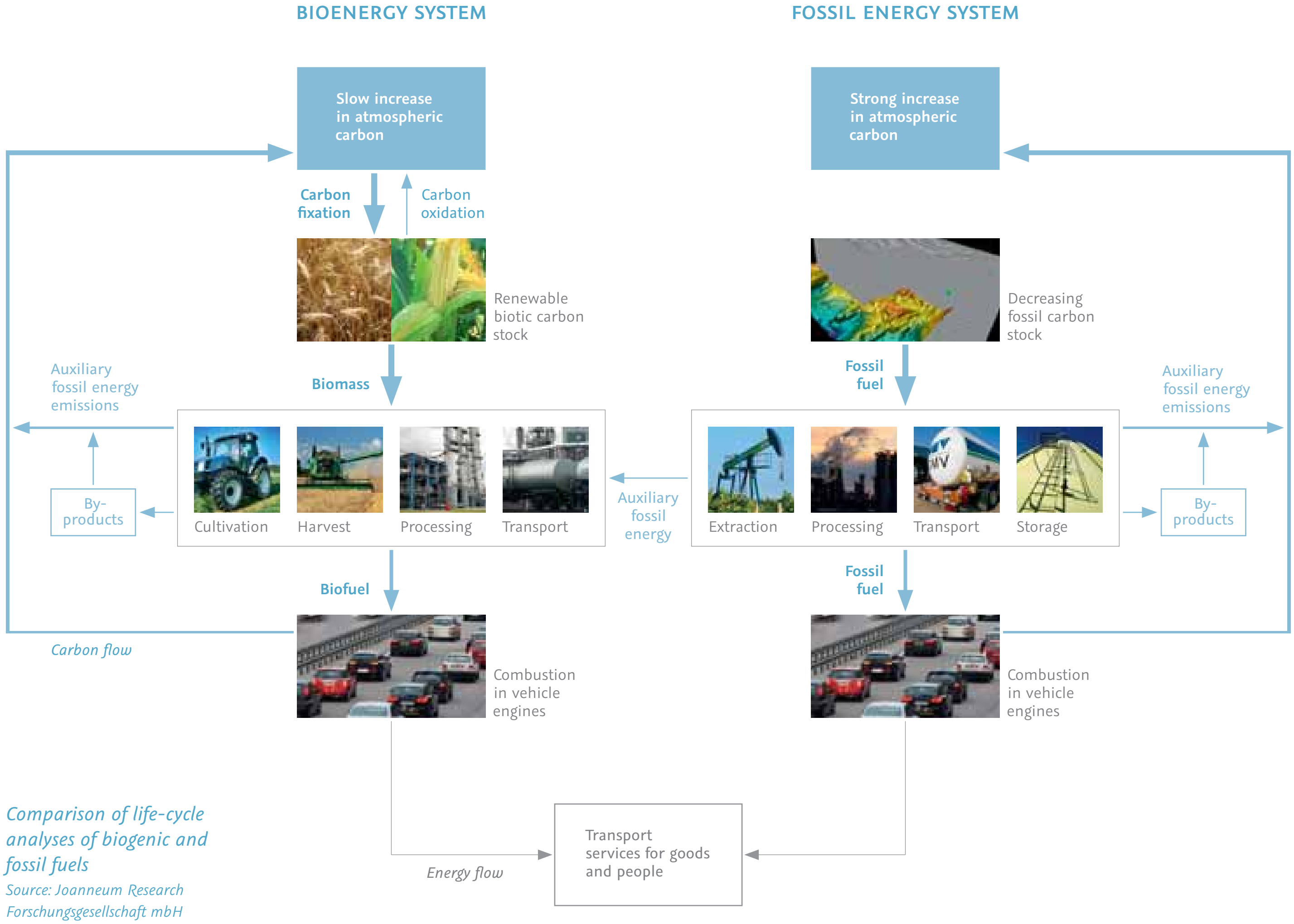
As the bioethanol and petrol transport systems are being compared with each other, the same quantity of feed and use of agricultural areas must be determined in addition to providing the same transport services. The EU energy allocation method makes it possible to account for the by-products (e.g. DDGS) derived from bioethanol production. In doing so, the resulting greenhouse gas emissions are divided up between the biofuel and the by-products according to their energy content. When cultivating agricultural produce, it was assumed that the straw remains in the field and is worked into the soil.

Base data	
Wheat reference number per m³ of bioethanol (70% starch in the dry substance, 14% water content)	2.50 to
Corn reference number per m³ of bioethanol (72% starch in the dry substance, 14% water content)	2.43 to
Calorific value of bioethanol per litre	21.20 MJ
Calorific value of bioethanol and DDGS per litre	31.70 MJ

The energy content of 240,000 m³ of bioethanol per year amounts to 5.1 PJ[10] per year, which roughly corresponds to 6.1 percent of the current annual Austrian consumption of petrol of 83.1 PJ. Therefore, assuming that the bioethanol-powered vehicles are as energy efficient as the petrol-powered ones, 5.1 PJ of petrol can be substituted.

For petrol and bioethanol-powered cars (e.g. FFVs), the fuel requirements were assumed to be 0.7 kWh per car km. As a result, the transport service comprises up to two billion car km per year.

[9] Modelling of the life-cycle analysis: see Glossary on page 26
[10] Conversion table for energy content: see Glossary on page 26



Comparison of life-cycle analyses of biogenic and fossil fuels

Source: Joanneum Research Forschungsgesellschaft mbH

ENERGY BALANCE

When producing 240,000 m^3 bioethanol using 100 percent dry corn as the raw material, the cumulated fossil primary energy demand over the entire life cycle amounts to around 530 GWh per year or 7.95 MJ per litre of bioethanol. The largest proportion of fossil energy demand is the result of processing in the bioethanol plant, totalling around 66 percent, while cultivating and harvesting the raw material account for 12 percent. On the other hand, the bioethanol produced has a calorific value of 1,413 GWh per year or 21.2 MJ per litre of bioethanol, therefore making the ratio of the energy content of the bioethanol produced to the fossil energy needed as 2.7.

> ***The energy balance illustrates that with just one unit of fossil energy almost three units of renewable energy from bioethanol can be produced.***

The fossil-based proportion of the cumulated primary energy demand when producing bioethanol is up to 70 percent lower than is the case for the petrol transport system, given the fact that almost 100 percent of the energy used in the latter is fossil-based. If you were to use DDGS, the by-product of bioethanol production, to obtain process heating, it would even be possible to reduce the amount of fossil energy needed by 85 percent. It should be noted, however, that this scenario is not currently a commercially viable one due to the excellent feed quality of the by-product. This means that between 0.5 and 0.7 litres of petrol can be saved by using one litre of bioethanol.

GREENHOUSE GAS BALANCE

The findings of the life-cycle analysis for greenhouse gas emissions were sorted according to the location and industrial sector of the emissions (Austria, abroad, Austrian transport sector, industrial sector). The greenhouse gas emissions were calculated in CO_2 eq (incorporating carbon dioxide CO_2, methane CH_4, and nitrous oxide N_2O) for every location and for each of the following stages: cultivation and harvesting of the raw materials, transport to the bioethanol plant, distribution to the filling stations, combustion in the car engine.

Greenhouse gas emissions of the petrol transport system

Over its total life cycle, the petrol transport system was responsible for around 484,000 tonnes CO_2 eq of emissions or 95 g CO_2 eq per MJ, of which 398,000 tonnes CO_2 eq are emitted in the transport sector in Austria.

Greenhouse gas emissions of the bioethanol transport system

Seeing as the by-product DDGS is used as animal feed, the bioethanol transport system is responsible for between 236,000 and 258,000 tonnes CO_2 eq of emissions over its entire life cycle, or 46 to 51 g CO_2 eq per MJ, depending on the mix of raw materials used. 18,000 tonnes CO_2 eq of these emissions are emitted in the transport sector in Austria.

Depending on the raw material used at the Pischelsdorf bioethanol plant, the following greenhouse gas savings can be made by substituting the energy content of a litre of petrol with bioethanol:

Raw material used to produce bioethanol	Greenhouse gas emissions saving by using bioethanol instead of petrol
100% wheat	51–53%
100% wet corn	57–58%
100% dry corn	52–53%

> ***These findings reveal that the 35 percent target for greenhouse gas emission savings as set out in the directive, and the 50 percent savings target set for 1 January 2017, are already being met.***

Overall, by using bioethanol produced in Pischelsdorf, 380,000 tonnes CO_2 eq can be saved per year in the Austrian transport sector, equivalent to 1.58 kg CO_2 eq of emissions per litre of bioethanol.

When examining the life-cycle analysis, the same energy efficiency was assumed for vehicles run on petrol and bioethanol (isocaloric substitution of petrol). A possible increase in efficiency for Otto engines using bioethanol was not accounted for in the values stated above. According to studies carried out by the Vienna University of Technology, efficiency levels can be increased by an average five percent, and up to ten percent in the case of modern compressor engines operating at high capacity, when SuperEthanol E85 is used.

RESULTS FROM THE LIFE-CYCLE ANALYSIS OF THE HUNGRANA BIOETHANOL PLANT IN SZABADEGYHÁZA, BASED ON THE EU DIRECTIVE ON THE PROMOTION OF THE USE OF ENERGY FROM RENEWABLE SOURCES

All the information relevant for the life-cycle analysis of the bioethanol production at the HUNGRANA plant in Szabadegyháza was made available by HUNGRANA. Additional information was also required in the form of generic data from the Hungarian database in GEMIS.

As it is not possible to fully harness the total theoretical bioethanol production potential due to the combined isoglucose and bioethanol production, the life-cycle analysis for the HUNGRANA ethanol plant assumes that 180,000 m^3 of bioethanol is produced per year. This annual bioethanol production quantity corresponds to an energy content of 3.8 PJ. This analysis is used as part of the EU directive on the admixture of petrol, corresponding to a share of around 6.2 percent (energetic) of the current Hungarian petrol consumption of 61.0 PJ per year.

Likewise, HUNGRANA also produces animal feed as a by-product of ethanol production and this is also taken into consideration. The raw material used for the combined isoglucose and bioethanol plant is wet corn for four months of the year, with dry corn being used during the remaining eight months.

GREENHOUSE GAS BALANCE

The global warming effects are also calculated for the bioethanol produced by HUNGRANA. The most significant emissions data are recorded in the life cycle and compared to those of petrol. Based on the assumptions made, bioethanol production at HUNGRANA generates the following results:

Greenhouse gas emissions for the petrol transport system

The total emissions from the use of petrol amount to 90.9 g CO_2 eq per MJ, of which 74.4 g CO_2 eq per MJ come from vehicles and 16.5 g CO_2 eq per MJ from when filling stations are supplied with petrol.

Greenhouse gas emissions for the bioethanol transport system

The total emissions associated with bioethanol amount to 37.3 g CO_2 eq per MJ. The emissions coming from the vehicle being insignificant, 13.3 g CO_2 eq per MJ come from the cultivation of the raw material and 24.0 g up to the point where the filling station is supplied with bioethanol.

As a result, it is possible to achieve a 59 percent reduction in greenhouse gas emissions when calculating the savings made by using a bioethanol-run instead of a petrol-run transport system.

Consequently, by using bioethanol produced at the HUNGRANA plant, the total greenhouse gas emission saving achieved already exceeds the 50 percent target set by the EU directive for 2017.

ANIMAL FEED AS A BY-PRODUCT OF THE BIOETHANOL PRODUCTION

ACTIPROT® – GMO-FREE INDEPENDENCE FROM AUSTRIA

ActiProt®, produced primarily from wheat and corn, is a by-product from AGRANA's bioethanol production In a downstream process, the solid waste of the bioethanol production, called stillage, is dried, before being mixed, dried and pelletised together with liquid waste that has been boiled down to a syrup-like consistency.

AGRANA's number one premise is the fact that ActiProt® is completely GMO-free. ActiProt® may be marketed in the EU without the need for labelling, in accordance with Regulation (EC) Nos. 1830/2003 and 1829/2003, and used to produce GMO-free food. According to Codex regulations, it is suitable for making GMO-free food, which represents a key prerequisite for its use in feeding dairy livestock.

Strict measures are in place to guarantee the quality of the product from the delivery of the raw material to the finished pelletised protein-rich animal feed. These quality measures have received ISO 9001:2000 certification together with certification in accordance with the Feed Additive and Premixture (FAMI) QS code. Monitoring of mycotoxin levels in both the raw material and the end product, ActiProt®, ensures both compliance with the regulations laid down for animal feed and its risk-free application in feeding cattle and pigs.

The benefits of ActiProt® for feeding animals

In its fresh state, ActiProt® contains at least 30 percent raw protein. The high proportion of indigestible protein of 45 percent, together with its excellent palatability and a higher raw fat content than soya grits, make ActiProt® the ideal source of protein for dairy and beef cattle. In addition to this, the use of ActiProt® can improve the overall absorption of forage. The stillage from the production of bioethanol can be used to feed ruminants in view of its ability to meet their protein needs. (Source: Wiedner, 2008, Wie passt ActiProt in die Ration? Die Landwirtschaft, Schwerpunkt Fütterung, 4–6).

In many countries, stillage has been used in pig feed for decades. Tests carried out by the University of Natural Resources and Applied Life Sciences, Vienna, together with information from journals and the practical experience of Austrian companies, indicate that it is essentially possible to completely substitute soya grits with ActiProt®, supplementing the essential amino acids without having a negative impact on the growth and carcass quality and ensuring that sufficient feed is consumed. It seems that the levels of yeast, protein and dietary fibre in the stillage have a positive effect on the digestive tract of fattening pigs. To this end, the production of GMO-free pork in Austria using ActiProt® as a source of protein may also play an interesting role in the future. As far as poultry feed is concerned, ActiProt® can be used to substitute up to ten percent of the total feed.

[11] Indigestible protein

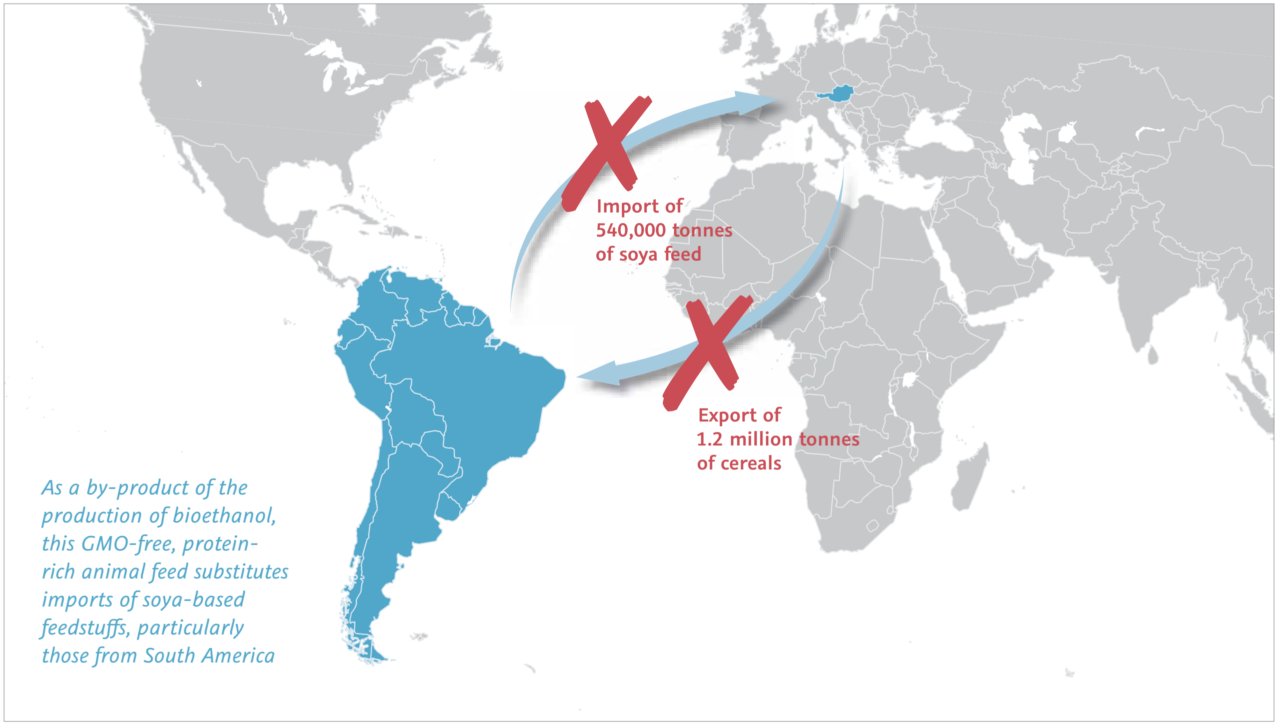
ActiProt® substitutes expensive soya feed imports from abroad

In 2008|09, Austria exported 1.2 million tonnes of cereal crops but, in return, it had to import 540,000 tonnes of soya feed. Now, Austria's excess cereal crops are turned into bioethanol at the Pischelsdorf bioethanol plant, producing the exact amount of the high-quality feed ActiProt® needed to replace the soya being imported, thereby freeing up land in soya-producing countries for growing food. As a result, domestic bioethanol production improves our balance of trade, helping to retain added value and jobs in the country.

"I have been feeding Actoprot® as a sole source of protein since autumn 2008. I was looking for high performance without the use of soya – and I found it!"

Stefan Müllner

Spotted cattle breeder, Weiten, Lower Austria



BIOFUELS – A BLESSING OR A CURSE?

Although it is impossible to imagine a sustainable energy scenario for individual mobility in the 21st Century without renewable sources, there are still a number of reservations as to whether the production of biofuels is in fact environmentally, economically and ethically tenable, given the prevailing situation of rising food prices in industrialised countries and famines in the world's poorest countries. By the same token, studies appear to call into question just how effective biofuels are at curbing greenhouse gas emissions.

In Europe, foodstuffs and biofuels do not compete for available land

Whenever there is a debate in Europe on increasing the admixture obligation for petrol and diesel with biofuels, the issue of land competition between raw materials for foodstuff and for energy production is often raised. At this juncture, it should be clearly stated that substituting ten percent of fossil fuels with biofuels is entirely realistic in Europe and can be achieved by using existing European farming areas without jeopardising in any way the cereal supply in Europe.

Quite the opposite, in fact. Up until the ten percent set-aside scheme was lifted by the EU Commission with effect from 1 January 2009, a considerable amount of farming land lay fallow. When excess crops cannot be used for bioethanol production, farming land will again be forced to remain inactive in order to avoid surpluses. Bioethanol can make good use of this surplus in European crop production. At the same time, high-quality, GMO-free protein-rich animal feed can be produced which eliminates the need to import soya feed from abroad, meaning that soya-growing areas in export countries can be used to grow foodstuffs.

Why biofuels are morally tenable under certain conditions, even in times of global famine

Time and again, biofuel production is accused of causing a surge in the price of agricultural raw materials, rendering these ever more expensive for people living in industrialised countries and making basic foodstuffs virtually unattainable for many people living in the world's poorest, most politically unstable countries. It goes without saying, of course, that providing food for people has paramount importance, but the production of biofuels must be considered from a different perspective.

The usual catalyst for an increase in the price of grain is a poor yield in key producing countries, leading to a fall in stock levels of grain around the world. Supply-side price increases are often amplified by activity in the international finance sector. This last became apparent in 2007 when a looming international financial crisis compounded the impact of several crop failures, causing a dramatic rise in the price of grain. As a result of the turbulent times on the international financial markets, starting in summer 2007, millions of dollars of speculative capital flowed from share markets into commodity markets, triggering a wave of speculative trading. In doing so, an existing upward price trend caused by poor harvests was exaggerated still further.

These are the two main factors which constitute the driving forces behind prices on the international grain markets and not, as is often falsely claimed, the production of bioethanol – in 2008, just four percent of the world's grain was used for this purpose, taking the combined production of animal feed into consideration.

It is usually the case that in times of high grain prices on the global market, structural problems within the farming sector become particularly evident. In many countries with chronic hunger problems, the low price of agricultural produce on international markets over many decades, together with ongoing civil wars and corrupt regimes, meant that there was not enough incentive to make the necessary investment in their agricultural sectors. This, in turn, has meant that many of these countries are now forced to buy grain on the international market even at high prices due to their own agricultural failings.

Nevertheless, there is no real shortage in the supply of foodstuffs in the world – there should be enough for everyone. Hunger is primarily the result of poor distribution. Under normal political conditions, with seeds being made available to poor countries and small local farmers receiving fair market prices, nobody should go hungry anymore. In order to ensure the future supply of food for the global population, the key is to develop sustainable production incentives for the cultivation of agricultural produce in developing countries. The single most convincing piece of evidence in favour of this is that people were suffering from hunger even before biofuels were produced and while global stockpiles were high.

Investment in agriculture is absolutely vital for developing and emerging nations to buck this trend and set a new course. Rising levels of affluence in the emerging markets, notably in India and China, are engendering a shift in eating habits, as people consume more meat. However, an increase in the demand for meat also entails an increase in the demand for animal feed – 2 kg of feed are needed to produce 1 kg of chicken meat, while at least 8 kg of feed are required to produce 1 kg of beef. Once several hundred million people start eating more meat, there will be an enormous demand for additional feed and, by extension, agricultural produce.

In line with this argument, it should be noted that when the term “global hunger” is used, it actually refers to poor or deficient nutrition; this largely means that too little protein is being consumed rather than too few carbohydrates. From this point of view, bioethanol does not restrict the supply of food given the fact that it only makes use of the carbohydrates in plants, while the protein is turned into animal feed.

Why the production of biofuels makes sense from an environmental perspective

Emissions

The key rationale behind the drive to produce biofuels is not in question: the raw materials from which biofuels are made grow back every year, while crude oil does not. Most experts even believe that we have already passed the point of peak oil supply. As a result, barring considerable changes in individual mobility behaviour, there is no viable alternative to biofuels.

When produced under certain environmental, economic and social conditions, which are assessed using sustainability criteria, bioethanol can make a significant contribution to reducing greenhouse gas emissions. As a general rule, studies on the greenhouse gas emissions of biofuels are to be scrutinised in isolated cases, particularly regarding their initial assumptions, basis for calculation and their scope of validity.

The life-cycle analyses carried out by Joanneum Research Forschungsgesellschaft, based in Graz, for the AGRANA bioethanol facilities in Pischelsdorf and Szabadegyháza took into account all associated greenhouse gas emissions. It was evident that, while still releasing some emissions, the use of bioethanol as opposed to petrol reduced the overall level of greenhouse gas emissions by around 50 percent.

Rainforest deforestation

Biofuels are often accused of accelerating the pace of rainforest deforestation. There is, however, no basis to the argument that huge swathes of Brazilian rainforest are being cleared to make room for sugar cane plantations destined for bioethanol production. Brazil currently cultivates an area of around 67 million hectares, of which eight to nine million hectares are used for sugar cane production. Moreover, the country has the potential to cultivate a further 100 million hectares or so of fallow and pasture land. This means that Brazil does not need to touch any rainforest or conservation areas in order to develop new areas of arable land. A study carried out by WWF Brazil in 2009 also came to this conclusion. Moreover, the conditions in Brazil's rainforest areas – particularly in Amazonia – are not ideally suited to producing sugar cane. This is reflected in the fact that the largest sugar cane plantations are actually to be found many thousands of kilometres away to the south of Amazonia in the provinces of São Paulo and Rio de Janeiro.

In Europe different regulations apply

In Europe, but especially in Austria, a totally different set of rules and regulations apply. All economically useful crops, including those destined for energy production, are cultivated in line with strict environmental criteria. It is illegal to cut down forests to produce bioethanol in Europe. Energy crops to be used for bioethanol production are grown on existing areas of land or on land which had previously been forcibly laid fallow in order to limit exports and which was once again made available for agricultural production by the EU Commission in 2009.

Water consumption

In the temperate regions of Europe, it is not usually necessary to artificially irrigate the crops, particularly wheat and corn, needed to produce bioethanol. If you take into account the average amount of rainwater which falls per square metre, you can easily see how the media comes to the sensationalist conclusion that several thousand litres of water are necessary to produce one litre of bioethanol. One forgets, however, that the same amount of rainwater would also fall on a square metre of fallow land. Other agricultural products such as cotton and coffee are considerably more water-intensive.

During the production of bioethanol, approximately six litres of water are needed to produce one litre of ethanol; this water is, however, part of a continuous cycle and is reused time and again.

In conclusion, the question of whether the production of biofuels is a blessing or a curse can be answered by highlighting the fact that it is possible to produce biofuels in a sustainable way under suitable environmental, economic and social conditions. Given that these criteria may need to be examined on a case-specific basis, it is crucial for an international certification system for biofuels to be introduced –as is currently planned by the EU.

THE LARGEST CONSUMERS OF BIOETHANOL – BRAZIL AND USA

Bioethanol is a proven fuel that has been used in Brazil for decades. A number of other countries such as the USA, however, have also recognised the benefits of the fuel and have been encouraging its use.

Brazil

After the first oil crisis and in order to reduce its dependence on expensive oil imports, this South American country began producing bioethanol in 1975 from its widely available stock of sugar cane as part of its so-called "Proálcool" programme. Bioethanol enjoyed a boom in Brazil at the end of the 1970s and the government subsidy programme supported both the production of alcohol and that of so-called "alcohol cars". In addition to this, a comprehensive ethanol distribution network was established.

Once the price of oil fell again, using alcohol as a fuel was no longer commercially viable, even in Brazil, and demand for "alcohol cars" declined. With oil prices rising again in recent years, the bioethanol industry in Brazil has recovered. Nowadays however, anhydrous rather than hydrous alcohol is used which can be admixed to petrol in any ratio. The existing filling station infrastructure set up in the 1970s could once again be put to good use. The first flexible fuel vehicles (FFVs), which can run on both SuperEthanol E85 and petrol, were developed and manufactured, attracting the attention of so many Brazilian consumers that the car manufacturer Volkswagen actually sold the two millionth FFV in Brazil in 2009. Nowadays in Brazil virtually every car is available in an FFV version.

USA

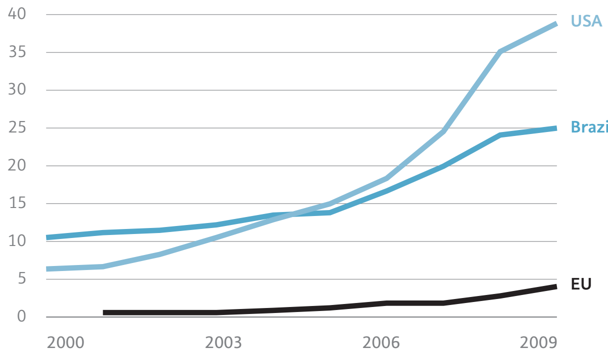
History shows that even Henry Ford (1863–1947), the great pioneer of personal mobility, was fascinated by bioethanol. He believed this was the fuel of the future that could also help breathe new life into the North American agricultural sector. The legendary Ford T model, affectionately known as Tin Lizzy and which he used to revolutionise mass car production, was based on the assumption that bioethanol would be the fuel of choice for this "people's car".

Some years ago, the USA identified biofuels as a way of reducing air pollution and helping in the fight against global climate change. With this in mind, the US Congress commissioned the US Environmental Protection Agency (EPA), together with the US Department of Energy and the Department of Agriculture, to draw up a subsidy programme.

In May 2009, the Renewable Fuel Standard 2 (RFS 2) was passed, in which a biofuel admixture obligation of 11.1 billion gallons or 10.21 percent by volume is required for 2009. By 2022, the admixture obligation is set to rise to 36.0 billion gallons.

Largest global producers of bioethanol 2000 to 2009 in billion litres

Source: F. O. Licht



As set out in RFS 2, the proportional minimum emission savings of biogenic fuels over petrol in 2005 based on life-cycle emissions are as follows:

First generation biofuels	20%[12]
Second generation biofuels[13]	50%
Biodiesel	50%
Cellulosic ethanol[14]	60%

In the USA, bioethanol is used in SuperEthanol E85. The legislation on the admixture ratio of bioethanol to petrol, together with the need to label the fuel mixture on offer, is left to the individual US state governments. It is permissible in every state to add ten percent ethanol to petrol and it is often the case that this is not explicitly labelled. Work is currently underway in the USA to develop a suitable filling station infrastructure to distribute SuperEthanol E85. At present, the most comprehensive network of E85 filling stations is to found in the so-called “corn belt” states.

Austrian Federal Environmental Initiative to adapt filling stations

In spring 2009, the Austrian federal government set up an initiative to promote the conversion of filling stations to supply alternative fuels. Currently, a subsidy in the amount of € 4,000 is available to convert a pump to supply SuperEthanol E85. More information can be found at www.public-consulting.at

Subsidies available when purchasing FFVs in Austria

Aside from the advantage of lower costs associated with bioethanol, the amount of Austrian NoVA vehicle tax levied when purchasing an FFV is reduced by € 500. Moreover, a number of provinces such as Lower Austria subsidise the costs of either purchasing new, SuperEthanol E85-powered cars or converting an existing car to run on this fuel. In the same vein, financing companies such as Raiffeisen Leasing offer a € 300 bonus for FFVs (Valid: 30 September 2009).

“The use of SuperEthanol E85 is a future-oriented means of limiting traffic-related CO_2 emissions despite rising traffic volumes. This biofuel makes it possible to combine resource management with the use of efficiency-increasing motor technologies such as downsizing and high supercharging rates.“

Bernhard Geringer

Director of the Institute for Internal Combustion Engines and Automotive Engineering at the Vienna University of Technology

[12] For facilities on which construction work began after 19 December 2007
[13] Second generation biofuels: see page 25
[14] Cellulosic ethanol: see page 25

BETTER ENGINE PERFORMANCE AND A CLEAR CONSCIENCE

As a study carried out by the Institute for Internal Combustion Engines and Automotive Engineering at the Vienna University of Technology reveals, using bioethanol as a fuel, whether blended with petrol or as SuperEthanol E85, considerably improves the performance of an engine and reduces greenhouse gas emissions.

SuperEthanol E85 – the fuel of the future

SuperEthanol E85 is an environmentally friendly fuel consisting of up to 85 percent bioethanol and 15 percent petrol during the summer and up to 75 percent bioethanol and 25 percent petrol during the winter (this is due to the fuel's properties). A so-called flexible fuel vehicle (FFV) is needed to be able to use SuperEthanol E85. Modern petrol engines can also be converted to run on SuperEthanol E85 by installing an electronic control unit.

Flexible Fuel Vehicles (FFVs)

The difference between FFVs and conventional petrol-driven engines is minimal. This means that it is possible to achieve high performance with either SuperEthanol E85 or a bioethanol/petrol admixture and with a considerable variation in the mixture ratio, as a sensor informs the engine of the current fuel mixture and adjusts it accordingly. As a result, FFVs can be introduced to a market regardless of whether a network of SuperEthanol E85 filling stations exists. In Austria, FFVs are offered by many car manufacturers; on the international market, they are offered by virtually every car manufacturer.

Benefits of SuperEthanol E85

Using SuperEthanol E85 improves the full-load torque output of modern turbo engines by up to 14 percent and more, with the partial load consumption, important during vehicle operation, being improved by up to five percent. The considerably higher anti-knock resistance enjoyed by SuperEthanol E85 is advantageous for engines operating at high performance levels, and it is also responsible for the engine parts in the exhaust area being exposed to lower temperature levels.

In addition to this, the favourable chemical properties of ethanol bring benefits in terms of consumption and emission levels during normal use. Therefore, using bioethanol as a fuel represents a real alternative to conventional fuels, both in its production and its direct use in engines.

The benefits of SuperEthanol E85 at a glance

- *SuperEthanol E85 is a sustainable fuel.*
- *SuperEthanol E85 is a high quality fuel which has been used in several countries for many years.*
- *SuperEthanol E85 can be distributed through the existing filling station network with minimal changes needed at the pump.*
- *SuperEthanol E85 is able to curb greenhouse gas emissions by 50 percent compared to petrol.*
- *SuperEthanol E85 is a commercially attractive alternative when oil prices are high as the share of bioethanol in the fuel is exempt from fuel tax.*
- *The buyer of an FFV does not incur any risk because every FFV can be powered by both SuperEthanol E85 and petrol blended with any amount of bioethanol.*

FIRST VERSUS SECOND GENERATION OF BIOETHANOL PRODUCTION

FIRST GENERATION

The so-called first generation of bioethanol production includes every conventional fermentation procedure for agricultural raw materials containing sugar and starch in which the fruit of the respective raw material plant is exploited.

SECOND GENERATION

The key advantage of second generation production is that, in future, any kind of biomass such as timber or vegetable waste could be utilised. Biomass-to-liquid (BtL) fuel refers to synthetic fuel made from biomass. A basic distinction is made between chemical and biotechnological processes.

Chemical processes

In the chemical processes, biomass is converted into synthesis gas. From this, hydrocarbons are then extracted by means of the so-called Fischer-Tropsch or the methanol-to-gasoline processes. After being synthesised, the resulting liquid hydrocarbons are sorted into heavy, middle and light fractions and subsequently processed. This involves refining the product so that it then has the desired fuel properties.

Biotechnological process

During a biotechnological fermentation process, cellulose or hemicellulose[15] are made available for fermentation, in addition to the easily fermentable starches, making full use of the entire plant. Ethanol made from vegetable waste is described as being cellulosic ethanol or lignocellulosic ethanol. In contrast to conventional bioethanol, cellulosic ethanol possesses an improved carbon footprint and does not compete with the production of foodstuffs.

Despite a considerable number of similarities in the fermentation of starch and lignocelluloses, the latter involves a number of hurdles that have to be overcome. First of all, the lignocellulose must be subjected to liquification and saccharification. This is considerably more difficult to perform than for starch seeing as the glucose chains are not readily accessible. As a result, the vegetable matter must first undergo either a chemical or thermal pre-treatment process. Only once this has been done can saccharification take place with the help of special enzymes. Given that a significant extra number of enzymes are required compared to starch saccharification, additional costs are inevitable. Next, yeast must be used to ferment the mixture from various different types of monosaccharides into bioethanol. The fermentation, distillation and drying processes are similar to the classic bioethanol fuel process practiced by AGRANA today.

Future perspectives – second generation

Regardless of whether the chemical or the biotechnological process is employed, so-called second generation biofuels are to be produced from the entire cellulosic part of plants, i. e. from stalks or leaves, from grass, timber or timber waste, for instance. This should make it possible to yield twice as much as is currently the case with first generation processes. Although the technologies have been successfully tested in pilot studies, it will be several years before they can be used on a large-scale industrial basis. Once the biotechnological process has been perfected and can be used on a large-scale, this technology could be introduced to first generation facilities, such as the AGRANA bioethanol plant in Pischelsdorf.

ONLY ONCE THE FIRST GENERATION HAS BEEN SUCCESSFULLY HARNESSED CAN A SECOND ONE DEVELOP

In order to meet the expectations of the European Commission, which has set the target of replacing ten percent of fossil fuels with biofuels by 2020 with the help of a significant percentage of biofuel coming from second generation processes, the first generation technology currently available must be used optimally. After all, the first generation is serving to build up a working infrastructure and to create a market for second generation biofuels. Without this first generation being successful, the investments in technologies and infrastructure for the second generation will not be made.

[15] Cellulose, hemicellulose and lignocellulose (combined with lignin) make up part of the cell wall of plant cells and support the plant.

CO_2 EQUIVALENT (CO_2 eq)
In order to be able to quantify and measure the global warming effect of various different greenhouse gases, the so-called global warming potential of gases is used. It determines the extent to which different gases contribute to the greenhouse effect and expresses this in the form of an equivalent quantity of CO_2. Therefore, the global warming effect of a kilogramme of gas is expressed as a multiple (equivalency factor) of the global warming effect of a kilogramme of CO_2.

AVERAGE ENERGY CONTENT AND DENSITY AS A BASIS FOR ASCERTAINING THE ADMIXTURE TARGETS ASSOCIATED WITH ENERGY CONTENT

Fuel	Energy content	Density
Diesel	11.78 kWh/kg	0.832 kg/l
Biodiesel	10.25 kWh/kg	0.883 kg/l
Petrol	11.59 kWh/kg	0.742 kg/l
Ethanol	7.41 kWh/kg	0.794 kg/l

Source: Ordinance of the Federal Minister for Agriculture, Forestry, Environment and Water Management, 4 November 2004, amending the Ordinance on Automotive Fuels 1999 (Kraftstoffverordnung)

SPECIFIC CALORIFIC VALUES OF FOSSIL AND BIOGENIC FUELS

Fuel	NCV[16] per m^3	NCV[16] per to
toe[17]		41.9 GJ/to
Petrol	31.9 GJ/m^3	42.7 GJ/to
Bioethanol	21.2 GJ/m^3	26.7 GJ/to
Diesel	35.4 GJ/m^3	42.7 GJ/to
Biodiesel	32.8 GJ/m^3	37.3 GJ/to

Source: AEBIOM, European Biomass Statistics 2007

KEY DECIMAL NUMBERS FOR ENERGY CALCULATIONS

10^1	Deca (da)
10^2	Hecto (h)
10^3	Kilo (k)
10^6	Mega (M)
10^9	Giga (G)
10^{12}	Tera (T)
10^{15}	Peta (P)
10^{18}	Exa (E)

Source: AEBIOM, European Biomass Statistics 2007

EU ENERGY ALLOCATION METHOD
Greenhouse gas emissions can be allocated to bioethanol and its by-products by means of the so-called admixture method or the energy allocation method as part of life-cycle analyses. The admixture method is suitable for political analyses in line with EU regulations, while the energy allocation method is to be used for regulatory purposes and for individual emissions entries of producers and fuels.

MODELLING THE LIFE-CYCLE ANALYSIS
When producing bioethanol and DDGS for the biogenic carbon used, it is assumed that the balance of net carbon fixing during photosynthesis, the amount of carbon stored and the combustion of bioethanol and DDGS use, is zero, as set out in the guidelines for the energy industry produced by the Intergovernmental Panel on Climate Change (IPCC).

[16] NCV refers to the specific net calorific value of a fuel measured in GJ per m^3 or tonne
[17] toe: one tonne of oil equivalent

LEGAL SOURCES

- Directive of the European Parliament and the Council for the promotion of the use of energy from renewable sources and for the amendment and subsequent repeal of Directives 2001/77/EC and 2003/30/EC, 5 June 2009

- Ordinance of the Federal Ministry for Agriculture, Forestry, Environment and Water Management through which the Ordinance on Automotive Fuels (Kraftstoffverordnung) 1999 was amended, 4 November 2004, last amended as reported in the Federal Law Gazette (BGBI. II), No. 168/2009

- Directive (1829/2003/EC) of the European Parliament and Council concerning genetically modified food and feed products, 22 September 2003

- Directive (1830/2003/EC) of the European Parliament and the Council concerning the traceability and labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC, 22 September 2003

- BMGFJ-75210/0014-IV/B/7/2007: Ordinance for the definition of the GMO-free production of food products and their labelling, 6 December 2007

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The SuperEthanol initiative provides further information about SuperEthanol E85, together with a filling station finder for Austria and a newsletter, on its website *www.superethanol.at*.