

The summary below is part of the work for IEA Bioenergy Task 39: “Liquid Biofuels”. The objective of this task is to provide participants with comprehensive information that will assist them with the development and deployment of biofuels for motor fuel use.

Summary of the Austrian Workshop

“Biofuels today, tomorrow and in future“

by Dina Bacovsky, BLT Wieselburg

The Austrian representatives of IEA Bioenergy Task 39: “Liquid Biofuels” Manfred Wörgetter, Task 33: “Thermal Gasification of Biomass” Hermann Hofbauer and IEA Bioenergy ExCo member Josef Spitzer hosted a national workshop on biofuels. About 40 participants – mostly academic and governmental personnel – gathered at the University of Technology, Vienna on June 17th 2005. Presentations given were grouped into 1st, 2nd and 3rd generation biofuels, biofuels in the context of IEA Bioenergy, and ongoing research projects in Austria.

Hermann Hofbauer, whose institute of chemical engineering provided the location for the workshop, welcomed the attendees. **Brigitte Weiss** from the Federal Ministry for Traffic, Innovation and Technology spoke about the R&D policies in Austria. Bioenergy is the number one issue in the energy research and technology concept, 60 % of the funds go into renewable energy and energy conservation. Work is carried out within the programs “Austrian Program on Technologies for Sustainable Development” and “A3 – Austrian Advanced Automotive Applications”; international collaboration takes place within IEA and ERAnet.

Manfred Wörgetter was chairman of the first session on 1st Generation Biofuels.

The first speaker was **Werner Körbitz**, Austrian Biofuels Institute. He described the new trends in the development of biodiesel world-wide. 8 key trends can be observed:

1. increasing variety in feedstock availability
2. increasing efficiency in process technology
3. stricter parameters for biodiesel fuel quality
4. accelerating production development
5. broad variety in marketing strategy
6. challenges for further diesel engine warranties
7. solid legal framework in Europe pushing the markets and
8. broadening information basis and easier access.

Josef Modl, Vogelbusch, described the trends of bioethanol. Ethanol finds good political support nowadays, there is mature technology (ethanol from sugar cane, wheat etc.) as well as developing technology (ethanol from lignocellulosics). As the price of the biomass accounts for 70 % of the production costs, ethanol will be established most easily where cheap biomass is available. Josef Modl highlighted the situation of ethanol in Brazil (largest producer, cheapest raw material: sugar cane, E 25 available at filling stations), the United States (large production already, capacities are expanded still, will start exporting ethanol soon) and Europe (driven by the EU directive on the promotion of biofuels capacities are built, the sugar and starch industry is investing in plants, but raw material

and energy costs are much higher than in Brazil); he considers the maximum potential of ethanol world-wide to be about 10 % of the total transport fuel consumption.

Biogas – an automotive fuel was the title of **Kurt Pollaks** presentation, OMV. He argued, that if you want to promote biogas for transport you need to promote the use of natural gas, for both of these can not be used in conventional vehicles. At the moment the situation in Austria is poorly developed, there are only about 300 gas vehicles in operation and only 0.01 % of the total transport fuel consumption are natural gas. Development is hindered by insecure taxation conditions, preventing people from buying gas vehicles. Additional problems with the use of biogas are: to ensure the supply-demand balance at the filling stations and in the grid, and the gas upgrade for injection into the natural gas grid. It can be concluded that the bottleneck for the implementation of biogas as an automotive fuel is to build up the necessary infrastructure.

Stefan Salchenegger, Umweltbundesamt, presented Austrias system of biofuel monitoring. The European directive on the promotion of biofuels has been implemented into national law in November 2004 by a change in the national fuel directive. The national targets for biofuel use are more strict than the European ones. In order to reach these targets, biofuels will be blended into fossil fuels anonymously. Blends have to fulfill international standards (EN228, EN590) and are controlled regularly. But there is no quality monitoring for pure biofuels in Austria.

2nd and 3rd Generation Biofuels chaired by **Hermann Hofbauer**:

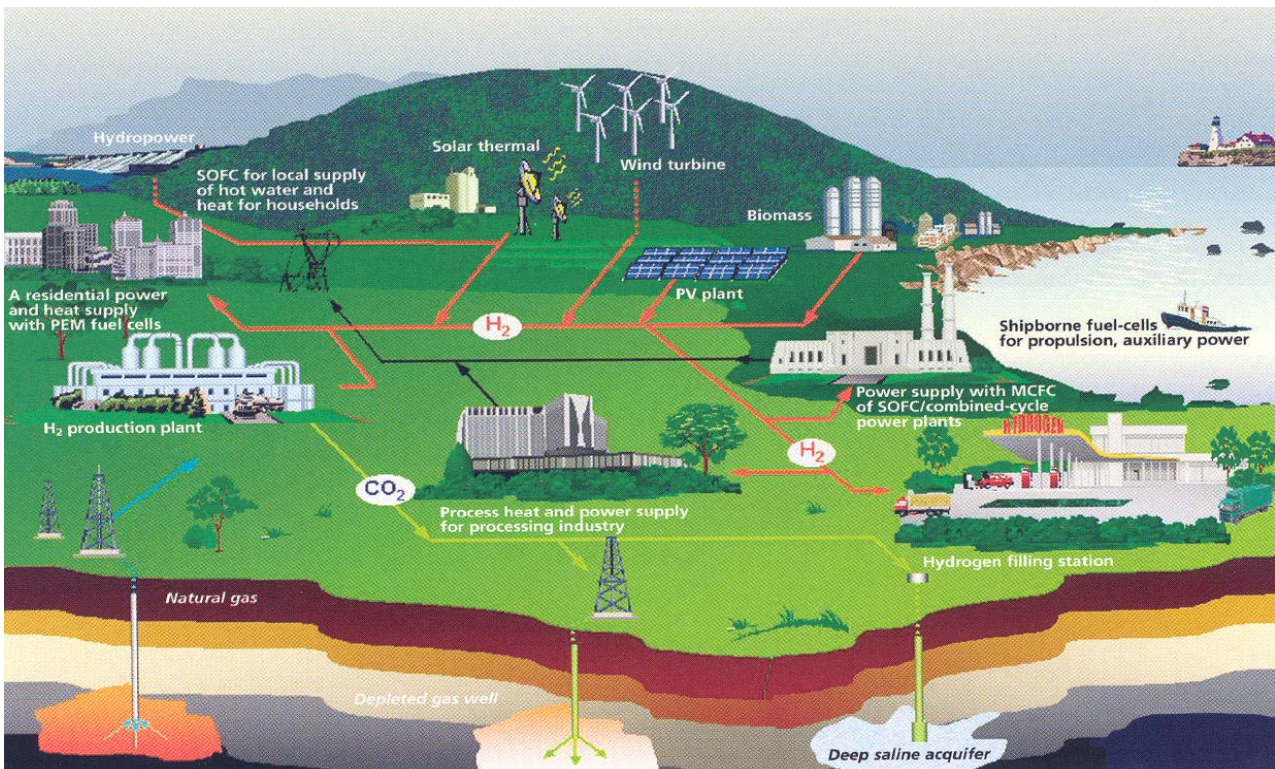
1st generation biofuels are those available today: biodiesel, bioethanol, ETBE and biogas; the 2nd generation is under development right now and will be competing with today's fuels in the near future; the 3rd generation could be hydrogen, but, naturally, exact predictions are not possible. **Alfred Ecker**, Arsenal, gave an overview on synthetic fuels from coal, natural gas and biomass, which are considered as 2nd generation fuels. He started off with synthetic fuels made from coal; these fuels can be produced with fixed bed gasifiers, fluidized bed gasifiers and entrained flow gasifiers. The production technology is well developed, but – same as for fuels from fossil oil – CO₂-emissions are high. Another possible C source is natural gas, 100 billion m³ of which are now flared at the oil pumps in Algeria, Angola, Indonesia, Iran, Mexico, Nigeria, Russia and Venezuela. It can be reformed into a synthesis gas from which various liquid products can be generated. Production plants should be combined with the chemical industry; hydrogen could also be generated.

The most environmental friendly way to produce synthetic fuels would be to use biomass as a raw material. There are several different production technologies, mostly consisting of two steps: pulping of the biomass (gasification, extraction, hydrolysis, anaerobic degradation, pyrolysis, hydrothermal liquefaction) and its chemical conversion (synthesis, esterification, fermentation). For some technologies, e.g. Fischer Tropsch Synthesis, only very large plants will be economically feasible, thus the raw material availability at the production site is crucial. This makes the use of biomass especially difficult, because large volumes will have to be transported to the production site. Further problems are the high water content (drying required), oxygen content (lowers the calorific value), content of alkali (produce ash) and the tenacity of the biomass, which makes the crushing very

difficult. Nevertheless high reduction of CO₂-emissions and the possibility to produce a liquid fuel make the Biomass-to-Liquid route attractive.

Gerfried Jungmeier, Joanneum Research, presented the European Commissions plans on hydrogen. The European Commission has developed a European Hydrogen & Fuel Cell Roadmap, for the transformation from a fossil-fuel based economy to a hydrogen-oriented economy.

Renewable hydrogen fits into the context of energy policies in Europe and Austria: it reduces CO₂-emissions as well as other local emissions; but the technology is not at all mature yet, nor for the fuel nor for the vehicles, it can not be implemented into the existing infrastructure, and the costs are far too high.



Source: EC, DGTREN

The above picture shows a possible, hydrogen-based future. Renewable hydrogen could be produced from biomass by gasification or fermentation and steam reforming, or via electrolysis from green electricity; it would then be stored, compressed, liquefied, distributed and finally used. For the production of heat or electricity the direct use of biomass would be better, but for mobile applications, e.g. transportation fuels, the generation of renewable hydrogen could make sense. The use of renewable hydrogen will decrease CO₂-emissions and the demand for fossil energy; but at the moment the vehicle costs are far too high. Ongoing projects include the HyCentA and the 1st Austrian Hydrogen Conference.

Biofuels in the context of IEA Bioenergy

Josef Spitzer, Joanneum Research, chaired this first afternoon session and explained the goals and structure of IEA Bioenergy to the auditorium. The IEA Bioenergy Implementing Agreement is one out of 40 implementing agreements of the International Energy Agency. It was founded in 1978, and currently 21 countries are participating; work is divided into 11 tasks, and the current budget is 1.14 Mio US\$/a. The scope of works covers resources, conversion, utilization in markets and integrating themes. The IEA Bioenergy network contributes to the technology development in the bioenergy sector; in the future it will increase policy related output, better involve industry, analyse opportunities for climate protection and improve the co-ordination with other international R&D programmes and networks.

The following presentation by **Manfred Wörgetter**, BLT Wieselburg, reviewed the work carried out on liquid biofuels within IEA Bioenergy. First activities started within Task XII from 1995 to 1997, and work was continued in the Liquid Biofuels Task 27; then the group joined with the ethanol-from-lignocellulosics task to form Task 39 in 2001. The group contributed to the international conference on biodiesel standardisation in Vienna and released a Liquid Biofuels Newsletter (both within Task XII), and compared biofuel strategies of different countries to find out that biofuels have only been implemented successfully where appropriate policy and regulatory decisions have been made that allow them to compete economically (result of Task 27). From the work carried out within Task 39/I the group concluded that new production technologies for new feedstocks are required, e.g. production of EtOH from lignocellulosic biomass like wood, corn stover and wheat straw. Four reports were prepared during the first working period of Task 39, and they will soon be published in the internet.

Worldwide there is a growing interest in biodiesel. A strong driver is the "EU Biofuels Directive"; for a successful implementation marketing of the fuel will be an issue, and co-operation of all stake holders is necessary. As his personal view Manfred Wörgetter mentioned that sustainable and efficient use of energy is the key issue; highly developed SI and CI engines are available today and will be improved further; in 2010 today's technology will be the number 1 on the market, CI may dominate in Europe; transport systems in 2020 will be mainly based on conventional fuels and the transition to new power train systems will be slow because of the need for new distribution systems.

The working program of the current period of Task 39 was presented by **Dina Bacovsky**, BLT Wieselburg. The overall goal of Task 39 is to support the development and implementation of biofuels. The task is divided into 4 subtasks, each of which carries out individual work. The policy subtask aims to collect information required to identify and eliminate non-technical barriers to biofuels implementation; formation of a strong Biodiesel Community that will address issues like environmental impact, world-wide production and international standardisation are the goals of the biodiesel subtask, and continuous information exchange on scientific findings in the field of ethanol production from lignocellulosic raw materials is carried out by the ethanol subtask. The news subtask disseminates all gathered information by means of the task 39 newsletter and the recently redesigned website. The national information dissemination is up to the country

representatives; e.g. Manfred Wörgetter distributes conference summaries, IEA reports and information on national events to a list of Austrian stakeholders.

Reinhard Rauch, University of Technology, Vienna, profiled Task 33: Thermal Gasification of Biomass. The task aims to identify the technical and non-technical barriers to commercialization of biomass gasification. The semi-annual task meetings are organized as workshops on selected subtasks with participation of academic and industrial experts. Reports resulting from task activities are posted on the task 33 website. The minutes of all meetings can also be downloaded from there. Reinhard Rauch listed ongoing activities in the field of synthesis gas, an area with much research going on. Products are focussed on transportation fuels, mainly because of political reasons (the EC wants to increase the amount of transportation fuels from renewables, and the US want to decrease the dependency from imported transportation fuels).

The last session on **Ongoing Research Projects in Austria** was again chaired by Hermann Hofbauer.

The first project to be presented was BIODIEPRO. This is an EU-funded project with the full title of “Demonstration of the Production of Biodiesel from Tallow and Recovered Vegetable Oil (RVO)”, as **Martin Mittelbach** explained. The working group for renewable resources at the Karl-Franzens-University Graz was involved into work package 3 that investigated whether prion proteins are inactivated and/or destroyed by the biodiesel production process. Due to TSE (Transmissible Spongiform Encephalopathies) cases in the early 1990ies, especially in Great Britain many thousands of cattle had to be killed. Tremendous amounts of specified risk material from their carcasses are still around and could be processed into useful biodiesel if prion proteins were proven to be destroyed or inactivated by the production process. Special safety precautions had to be taken for the laboratory spike experiments. The biodiesel production process was divided into the process steps preesterification, transesterification and vacuum distillation. Infected material was added before each process step, and its content after the process step was measured. The high depletion factor for the entire process lead to the conclusion of the European Food Safety Authority that the applied biodiesel process was safe for treatment and use of ABP of category 1.

Gerfried Jungmeier, Joanneum Research, presented the VIEWLS project. This is an EU-funded project aiming for a clear view on clean fuels. Joanneum Research, Austria, was involved into a review of existing international studies on the environmental and economic performance of biofuels. 12 different biofuels, 12 different biomass resources and 3 different propulsion systems were to be considered. The total of 80 different combinations was reduced to about 30 very relevant ones. For these combinations 370 studies could be found, 73 of which were considered relevant and analysed in detail. Detailed data sheets, study fact sheets and biofuel fact sheets were elaborated from these studies and summed up in summary biofuel fact sheets. It was concluded that all biofuels produce significant lower CO₂-emissions than their fossil equivalents, but their costs are higher. Results can be downloaded from the website at www.viewls.org.

Werner Körbitz, Austrian Biofuels Institute, is currently working on innovative biodiesel. This is part of a clustered project within the European altener programme and the name of the full project is “Local and Innovative Biodiesel”. The innovative part of the project aims

to broaden the biodiesel feedstock sourcing by searching for new raw materials worldwide, including non-food oil crops. This will result in lower feedstock costs on the one hand and the possibility to design the properties of the produced biodiesel on the other hand. Due to the varying shares of short chain and long chain and saturated and unsaturated fatty acids in the different oils, properties like CFPP, oxidation stability and cetane value can be influenced. The research group is seeking for the “ideal fatty acid profile”, but as the same fatty acid has positive and negative effects on the biodiesel properties, any ideal profile can only be a compromise. Besides this analytical work a video has been produced on DVD, introducing into biodiesel in general, the modern management of a city bus fleet in Graz, and the usage of biodiesel and special adaptation works. The DVD is available in 11 different languages.

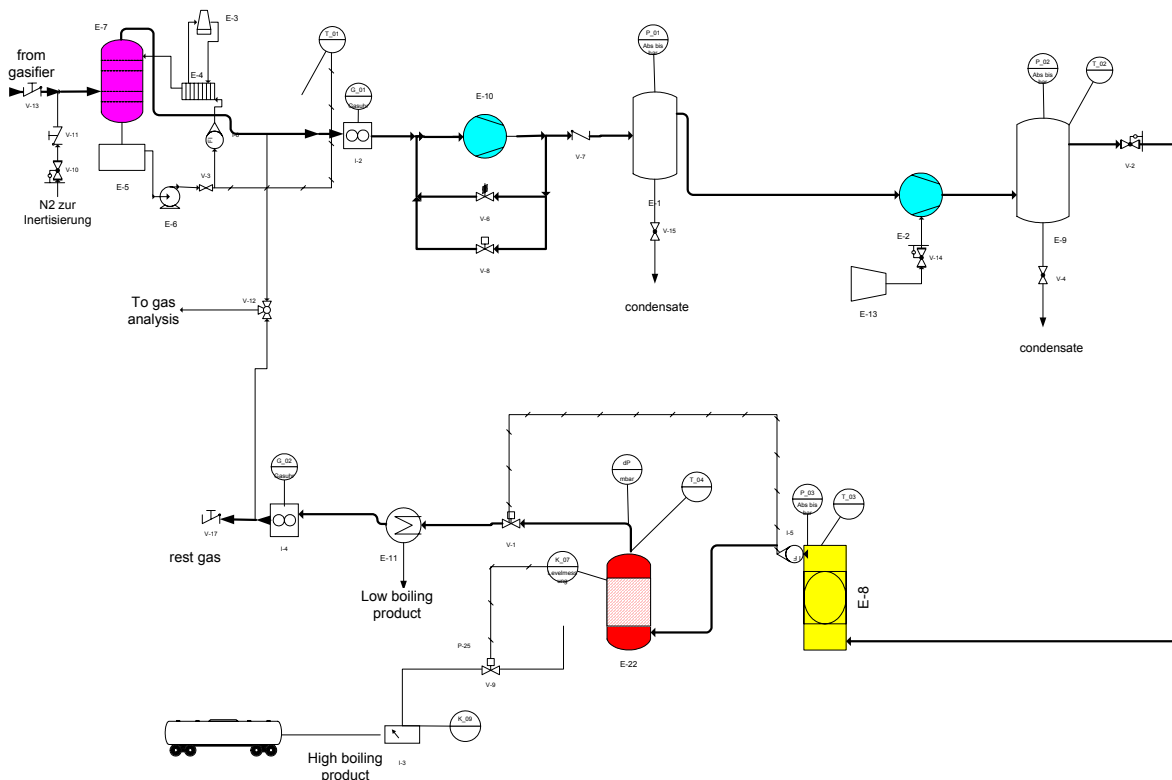
Anton Friedl, University of Technology, Vienna, presented his work on a project called Polygeneration. Bruck an der Leitha, a region in the East of Vienna, aims to be self-sustaining in its energy supply. A biogas production plant and electricity production from biomass combustion are already installed. The polygeneration project investigated whether an ethanol production plant could be integrated successfully. As during the bioethanol production process the amounts of heat to be transferred in and out are about the same, it should be possible to reuse the heat from one process step for another. Furthermore the remaining amount of heat to be brought in for the distillation step could be inserted from the biogas plant. Modeling of the ethanol plant (planned capacity 60 000 t/a), the biogas production facility and the biomass combustion was carried out and proved the made assumptions. Fossil energy could nearly completely be replaced by energy from renewable resources.

The title of the next project was “Experiences in the use of pure rape seed oil for tractors and cars”, and was presented by **Josef Breinesberger**, Agrar Plus. The ongoing project investigates the effects of the use of straight vegetable oil in 21 tractors. The tests so far show no considerable negative effects; the power of the engines is equal, fuel consumption is slightly higher than for operation on fossil fuel. CO and HC emissions decrease, NOx emissions increase. Additionally to the tractor tests Agrar Plus has started investigating the effect of pure rape seed oil on passenger cars. With the 3 cars tested, no problems have occurred so far.

The use of straight vegetable oil is more attractive for farmers than the use of biodiesel, which can not be processed by themselves. Farm tractors operate relatively few hours, but in stationary applications with high operating hours straight vegetable oil may cause problems with engine deposits.

“Bio-fuels for transport with a focus on ligno-cellulosic feedstock” is the full name of a project known as RENEW; **Reinhard Rauch** explained its objectives: in order to reach the EU target of 20 % biofuels in 2020, biofuels additionally to biodiesel, ethanol and methanol are needed. RENEW targets the development of premium fuels, its intention is to develop the engines and the fuels hand in hand; the target of RENEW is to provide the technologies that can produce biofuels at costs of 70 cents/liter once applied at industrial scale. This project has strong industry involvement (automotive industry, mineral oil and ethanol industry, plant engineers and electricity producers) as well as a large field of scientific researchers.

It is divided into subprojects, and the University of Technology, Vienna is involved in SP2: Process optimisation of BTL production; work is carried out in Guessing, Austria: from an existing CHP (production of 2000 Nm³/h gas) 10 Nm³/h are taken out and processed into synthetic natural gas and Fischer-Tropsch Diesel. The flow chart below shows the gas drying (violet), 2-step compression of the product gas up to 30 bar (blue), gas cleaning (yellow) – this is the most difficult process step, and the Fischer Tropsch reactor (red). 800 litres of FT-Diesel will be produced for engine tests at the automotive industries. The complete FT-plant is in operation since begin of June 2005, and the first catalyst is operating satisfactorily. A second, more expensive catalyst (Co) will be tested when experiments with the first catalyst (Fe) are completed. The Fischer Tropsch process is a very slow process and it takes 200 operating hours until the catalyst starts working; thus it also reacts very slowly to changes of conditions, which makes all experiments last for a very long time.



Wolfgang Schnitzhofer, Profactor, presented the project “Biogas: Upgrading and Injection into the Natural Gas Grid”. An existing CHP plant in the region of Upper Austria already produces biogas. 10 m³/h of the produced biogas are used for the mentioned project. This biogas stream is upgraded by CO₂ elimination in order to increase the CH₄ content, and by degradation of H₂S by certain bacteria that are attached to a trickling filter. The upgraded biogas is injected into the local gas grid and used for heating purposes. The upgrading plant was taken into operation in June 2005.

A guided tour through the laboratory of the institute of chemical engineering – presenting the two lab-scale biomass gasification plants to the visitors - concluded the workshop.