Newsletter Issue #28 October 2011

Commercializing Liquid Biofuels from Biomass

Task 39
IEA Bioenergy

Inside This Issue

Gentlemen, luckily not in front of illicit drugs storage

From the Task

By Jack Saddler, Jana Hanova and Jim McMillan

Thanks to our generous colleagues at Petrobras, IEA Bioenergy Task 39 held a very successful Task meeting in Rio! This most recent business meeting was run in conjunction with several other meetings and field trips that were all held in the State of San Paulo during the second half of August. Many of our country representatives participated in the three main events which were:

1- BBEST – the 1st Brazilian Bioenergy Science and Technology Conference with a dedicated Task 39 full day session, from 14-18 August
2- An invaluable field tour that explored Brazil's sugarcane and ethanol infrastructure and featured Brazil's leadership in both industrial areas 18/19 August
3- An IEA Bioenergy Task 39 Business Meeting hosted by Petrobras, featuring numerous industry guest speakers and biofuel industry experts from Brazil, held in Rio from 20-23 August

BBEST (1st Brazilian Bioenergy Science and Technology Conference)

The BBEST conference was held in a scenic mountain town of Campos do Jordão about 2 hours away from São Paulo along a sinuous touristic road, with beautiful viewpoints over the region of the Paraíba Valley and the Mantiqueira Mountains. The conference itself covered a diverse range of topics from biomass, biofuel technologies, biorefineries, sustainability and process integration.

IEA Bioenergy Task 39 held two parallel sessions and featured two additional

Continued on Page 2...

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speakers in additional sessions bringing the total presentation count to ten; additionally, we were actively engaged in discussions, posters session, and have been asked to take an active role in the 2nd BBEST meeting that will be held in a few years' time. The conference attracted a diverse international audience and catalyzed invaluable discussion and connections between biofuels thought-leaders. Presentations from the meeting can be sources at the BBEST website (www.bbest.org.br).

Task 39 @ BBEST Research and Mill Tour

After attending the successful BBEST conference, Task 39 speakers participated in a tour organized by BBEST to help expose an international audience to Brazil's best practices in biofuel technologies and production.

- The first stop was CTBE, Brazil's newest bioethanol research centre, which is integrated to the Brazilian Center of Research in Energy and Materials (CNPEM), a private non-profit linked to the Brazilian Government.
- The second stop of the tour was the São João sugarcane mill, a pioneer mill founded in 1944 and currently processes 3.7 million tons of sugarcane and employs 2100 workers. The mill's annual output is ~300 000 t of sugar and 130 million litres of anhydrous and hydrous ethanol along with 60 000 MWh of electricity.
- The tour continued at RIDESA, an inter-university research facility that assists in the development of the sugar-ethanol sector. RIDSESA is formed by several Brazilian Federal universities and relies on 31 experimental stations strategically located throughout Brazil.

The current capability and the enormous potential for Brazil to truly become the "Saudi Arabia of Biofuels" were evident in both the tours and the presentations given by our Brazilian colleagues! A brief press release on the BBEST conference is available on: http://agencia.fapesp.br/en/14441

IEA Bioenergy Task 39 Business Meeting in Rio de Janeiro

Prior to the business meeting itself, our Petrobras colleagues had organised tours round Rio to give us an idea of the beauty of the city. The group had the experience of travelling round in an overheating, open-topped "safari-type" truck in the rain! A great bonding experience that won't be forgotten! (Nor will the beauty of Rio, despite the rain.)

The business meeting itself was initiated by Mr. Ricardo Dornelles, the Executive Committee representative from Brazil who provided an overview of Brazil's participation in IEA Bioenergy and emphasized that Brazil hopes to play a role in providing guidance for social sustainability as it relates to bioethanol and biodiesel production and use.

Continued on Page 3…

Upcoming Conference: Biorefinery Conference – Copenhagen 2012

We would like to encourage all biofuels stakeholders **to register** for the much anticipated upcoming **Advanced Biofuels in a Biorefinery Approach Biorefinery** conference on Feb 28th - March 1st, Denmark.

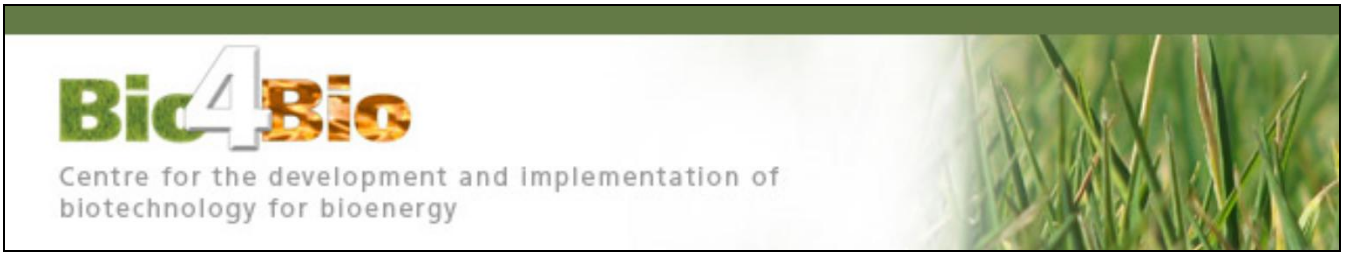
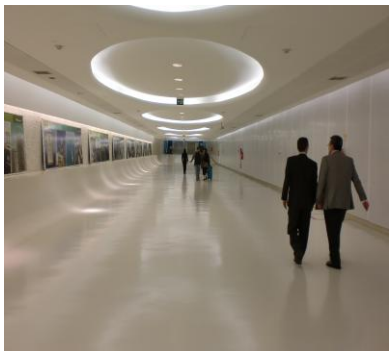


Image Source: esf.edu.com

We would like to thank and acknowledge our colleagues at Petrobras who were gracious, informative and impressive hosts and to thank all the other Brazilian colleagues who travelled to Rio to show us the breadth and strength of Brazils industry, government and university groups working in the biofuels area! They truly showed us how Brazil has been called the Saudi Arabia of biofuels!



Our other Country Representatives provided an overview of their countries most recent industry and policy developments as well as the current issues affecting biofuel innovation and deployment. As usual, the Task is fortunate to have the active participation of industry groups such as Inbicon and Borregaard who shared their insights about their progress and the types of research questions that still need to be resolved.

Over two days of the business meeting more than 20 presentations were given as well as updates on the commissioned work in areas such as; progress and potential of "drop-in" biofuels, a comparison of various biofuel policies used by Task 39 participants and an analysis of the energy and GHG balance of various biomass-to-biofuels process that are currently being pursued. The joint executive summary on Algal biofuels that was commissioned by IEA Bioenergy Task 39 and the Advanced Motor Fuels (AMF) Implementation Agreement (IA) was also discussed and has since been posted on the task 39 website.

All-in-all, it was a very successful meeting and we look forward to repeating this success at our upcoming symposium and business meeting that will be held in Copenhagen in late February with our colleagues in IEA Bioenergy Task 39.

We welcome your feedback on the layout and scope of the Newsletter – Please **Contact Us!**

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Transportation Biofuels Research in Austria

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1 Introduction

Shifting to a post-fossil economy requires substantial change in our current economy. Industry leaders such as Fatih Birol, Chief Economist of the International Energy Agency, call for an energy revolution. Aware of the challenges ahead, the Austrian government supports setting ambitious sustainable energy and energy technology goals while providing substantial government funding. While the Austrian industry is currently on the cutting edge of renewable energy technology, many anticipate strong competition from emerging market forces in China and India. Over the next decade, a new generation of highly efficient and intelligent technologies needs to be deployed on the global market and Austria strives to be at the forefront of this revolution. RD&D will not only pave the way to sustainable energy, but will also secure Austria's position as a leading player in the renewable energy industry.[1]

2 Biofuels policy, goals and promotion

The EU has set up a legal framework concerning transport fuels – these include the **Renewable Energy Directive RED 2009/28/EC** on the promotion of the use of energy from renewable sources and the **Fuel Quality Directive FQD 2009/30/EC**. The RED has set a goal of a 10 % share of renewable energy in the transportation sector by 2020 while the FQD demands a minimum 6% reduction of GHGs per energy unit of transport fuel by 2020. Both directives include sustainability criteria for biofuels, demanding at least 35 % savings in GHG emissions as compared to fossil fuels by 2011 and 2013, respectively. This requirement increases to at least 50 % by 2017, and 60 % by 2018 for biofuels produced by new facilities. These EU Directives are binding for all member states and need to be implemented into respective national laws.

Member states have specific targets in line with the overall "20-20-20" goal which mandates savings of 20 % of the Union's primary energy consumption and GHG emissions as well as the inclusion of 20 % of renewable energies as part of overall energy consumption by 2020. Austria established a **National**

[1] PAULA, Michael : *Biokraftstoffe: Energie für den Transportsektor – Begrüßung.* Highlights der Bioenergieforschung V; 30.-31.03.2011, Wieselburg, Austria, 2011 - German

Renewable Energy Action Plan which aims to stabilize the end-use energy consumption at 1 100 PJ in 2020. Also by 2020, the renewable energy component will account for 388 PJ. This is an increase of 20 % from 2008. The renewable energy mix in 2020 is expected to include 51 % bioenergy, 41.2 % hydropower, 4.5 % wind and 0.5 % photovoltaic. In 2009, Austria reached a renewable energy share of 30.1 %; which is almost as ambitious as the 2020 target of 34 %.[2]

In the biofuels sector, Austria plans to introduce E10 in 2012. This will allow for a 6.25 % substitution in the transportation sector with 6.3 % in diesel (B7) and 6.1 % in gasoline (E10). For older vehicles, E5 will remain available with a market share of 15 %. In 2017, either B10 or B7+3 (7% FAME + 3% hydro-treated vegetable oil) will be introduced, increasing the substitution to 8.45 %. The balance of the goal to achieving a 10 % GHG emission reduction goal is hoped to be attained through e-mobility in vehicles and trains.

RED and FQD biofuel sustainability criteria are being implemented into Austrian law by two separate ordinances. These are; the cultivation of feedstock being regulated by the **ordinance on agricultural feedstock for biofuels and bioliquids**[3], while the **fuel mandate**[4] that is expected to come into force in 2011 will govern the certification of commercialized biofuels. Feedstock produced in Austria must of course comply with EU regulations. Imported feedstock or biofuels must be certified by another Member State or a voluntary scheme approved by the EC or Austrian control bodies. Double counting of GHG savings made by biofuels produced from wastes, residues, non-food cellulosic material and lignocellulosic material will be assessed on a case-by-case basis. In 2011, biofuels do not yet need to be verified by a third party in order to be counted towards the national substitution target.

3 Current biofuel production and use[5] [6]

Biodiesel is the main biofuel produced in Austria. Biodiesel production capacity in Austria is ~ 650 000 t/a and spans across 16 production facilities (Figure 1).

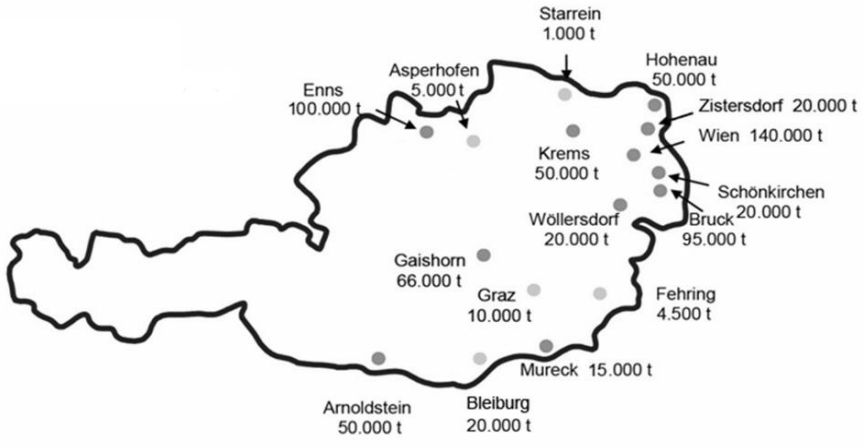

Figure 1: Biodiesel production capacities in Austria

[2] *National Renewable Energy Action Plan 2010 for Austria (NREAP-AT)*, Federal Ministry of Economy, Family and Youth, 30.06.2010

[3] *Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über landwirtschaftliche Ausgangsstoffe für Biokraftstoffe und flüssige Biobrennstoffe*; BGBL.II Nr. 250/2010

[4] Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über die Festlegung der Qualität von Kraftstoffen und die nachhaltige Verwendung von Biokraftstoffen; final draft, understanding of the four involved ministries required

[5] THAYER, Reinhard : *Biokraftstoffproduktion in Österreich*. Highlights der Bioenergieforschung V; 30.-31.03.2011, Wieselburg, Austria, 2011 - German

[6] WINTER, Ralf : *Biokraftstoffe im Verkehrssektor in Österreich 2010.* Umweltbundesamt, 2010

The actual production in 2010 was nearly 337 000 t of biodiesel (Figure 2). The total biodiesel consumption in Austria was 522 000 t in 2009, of which 406 000 t were mixed with fossil diesel, and 116 000 t were used directly.

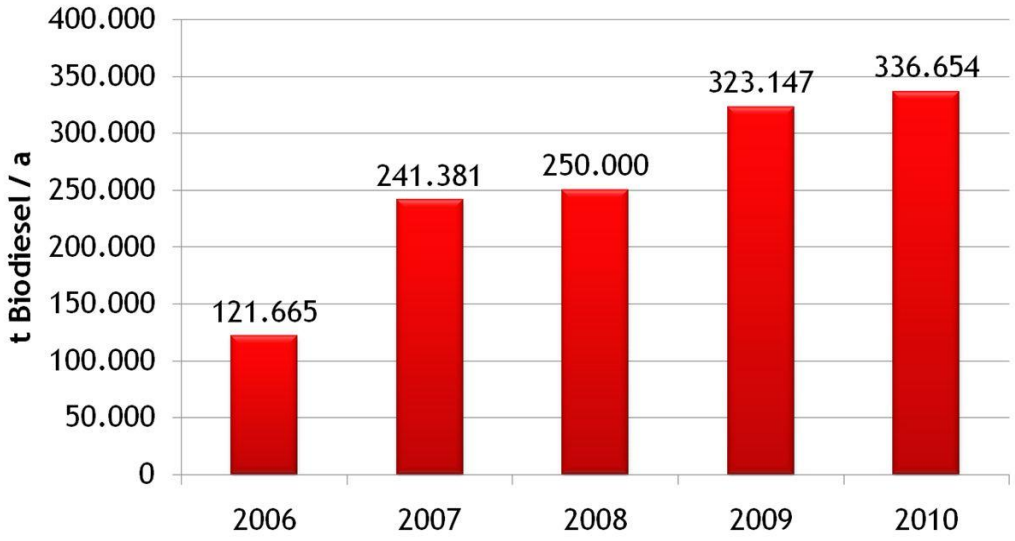

Figure 2: Biodiesel production in Austria

The **production of bioethanol** in Austria is lower than the biodiesel production at 157 000 t in 2010 (Figure 3). However, E5 and E85 usage reached nearly 100 000 t in 2009. Austrian E10 bioethanol demand can be achieved via the production capacity of a single plant, the AGRANA bioethanol plant in Pischelsdorf. The plant has a capacity of 240 000 m^3 bioethanol per year and is capable of displacing 1/3 of the Austrian soy protein imports through DDGS co-production. The plant's emission reductions of 50 % GHG have been certified by Joanneum Research.[7]

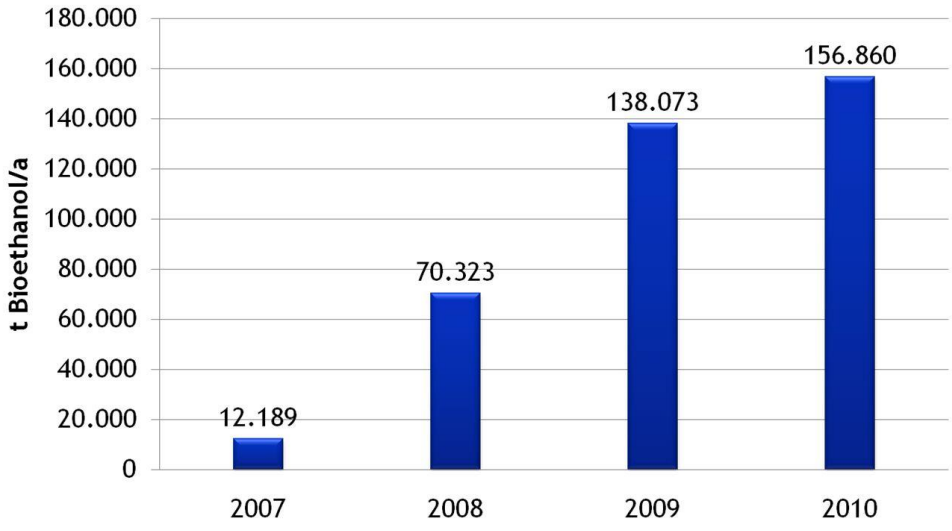

Figure 3: Bioethanol production in Austria

[7] MARIHART, Johann : *Landwirtschaft und Biokraftstoffe*. Highlights der Bioenergieforschung V; 30.-31.03.2011, Wieselburg, Austria, 2011 - German

In recent years **pure plant oil** is increasingly used as fuel, in particular by agricultural vehicles and road freight transport. While national production data isn't readily available, recycled plant oil for fuelling purposes is estimated to be 17 800t (2009). **Biogas** produced in Austria is mainly used on site for heat and power production, with an estimated production ranging from 380 – 600 mill m^3 of biogas per year. Efforts are being made to introduce "Bio-CNG" into the transport fuel market, but the number of CNG vehicles still must be increased. Austria continuously exceeds the **required blending rates**: In 2009 the target was 5.75 % (energy content) and the actual substitution was 7.0 % (% of biofuels used in the transport sector).

4 Technology providers

A number of Austrian companies have successfully developed technologies for biomass processing into transport biofuels.

BDI – BioEnergy International (www.bdi-bioenergy.com) is a market and technology leader in the construction of customized biodiesel plants using a multi-feedstock technology developed by the company. This technology is suitable for conversion of a wide range of raw materials such as crude vegetable oils, used cooking oils, animal fats, trap grease and others. Through the combination of a biodiesel plant and a biogas plant, waste streams from numerous industrial operations can be converted into biofuels and other valuable by-products.

VOGELBUSCH Biocommodities works on the commercialization of advanced bioethanol. In recent years numerous ethanol processes based on cellulosic and hemicellulosic feedstocks have been developed and tested at the pilot scale. In January 2010, Denmark-based Inbicon started commercial operations at a demonstration plant that converts straw into ethanol, which is complemented by downstream Vogelbusch processing technology. The process reduces technology risk, optimizes energy input for carbon credits, alternative raw materials and integrates advanced processes in commercial facilities.[8]

A commercial breakthrough in gasification technology has been reached with the construction of a Biomass Gasification CHP Plant in 2001 by Renewable Power Technologies Company (REPOTEC www.repotec.at). Since 2001, the plant has been reliably supplying the town of Güssing with electricity and district heat. A steam blown fluidised bed gasifier is used as the gasification technology, producing gas with high calorific value and very low tar and nitrogen content. The favourable characteristics of the product gas (high hydrogen content) make it a preferred source for highly sophisticated gas uses. Pprojects involving the production of SNG, FT Diesel and electricity in a solid oxide fuel cell are also underway. Today REPOTEC is constructing plants in Germany, Sweden, France, Italy and Brazil.[9]

The Austrian **ANDRITZ GROUP** is a global market leader for the supply of processing equipment and systems for the hydropower, pulp and paper, steel and other specialized industries (solid/liquid separation, feed and biofuel technologies). The group offers reliable equipment for biomass into liquid biofuels, heat, and electricity. Process steps covered by the Andritz Group include biomass handling, biomass feeding, and thermal and mechanical pre-treatment. The group's R&D and pilot projects are deployed in Austria and the US and they are active in developing and deploying advanced biofuels processing equipment.

[8] LEHR, Markus : *Is 2G Bioethanol Commercialized Yet? Technical issues and challenges of second generation demonstration plants*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[9] For further information contact: c.aichernig@repotec.at

5 Research, development and demonstration

5.1 Feedstock and logistics

The use of firewood for home heating has a long history in Austria. In previous decades, the market for wood chips and pellets has grown substantially, but presently, the interest in woody biomass for transport fuels is gaining increased attentio. As a result of increased competition, fuel procurement has become more challenging and prices have risen. The **potential of biomass feedstock** in Austria has been analyzed in many studies. The results clearly show that there is potential for biomass to contribute to the energy system, but the available amount is limited and cheap and timely access to feedstock will be a challenge.

The Austrian Marketing University of Applied Sciences, Campus Wieselburg, has investigated the **availability of forest fuels and regional energy models**. Proactive resource planning based on a regional model has the potential to stabilize forest biomass markets and ensure future supply and greater price stability.[10] In Austria, considerable unused wood potential exists, but establishing efficient transportation will require effort and time. Increasing biomass demand for material and energy use has led to strong competition between the traditional wood industry and emerging biomass markets. As shown in a BIOENERGY 2020+ study on **forest biomass availability,** biomass supply of conversion plants requires substantial amount of coordination and strategic planning.[11] In Austria, small private forest owners are managing the largest amount of unused biomass resources (Figure 4). To optimize operations and wood use, Austria participates in the EU-funded **AFO Activating Private Forest Owners** (www.afo.eu.com) and shares expertise in harvesting and biomass processing logistics.

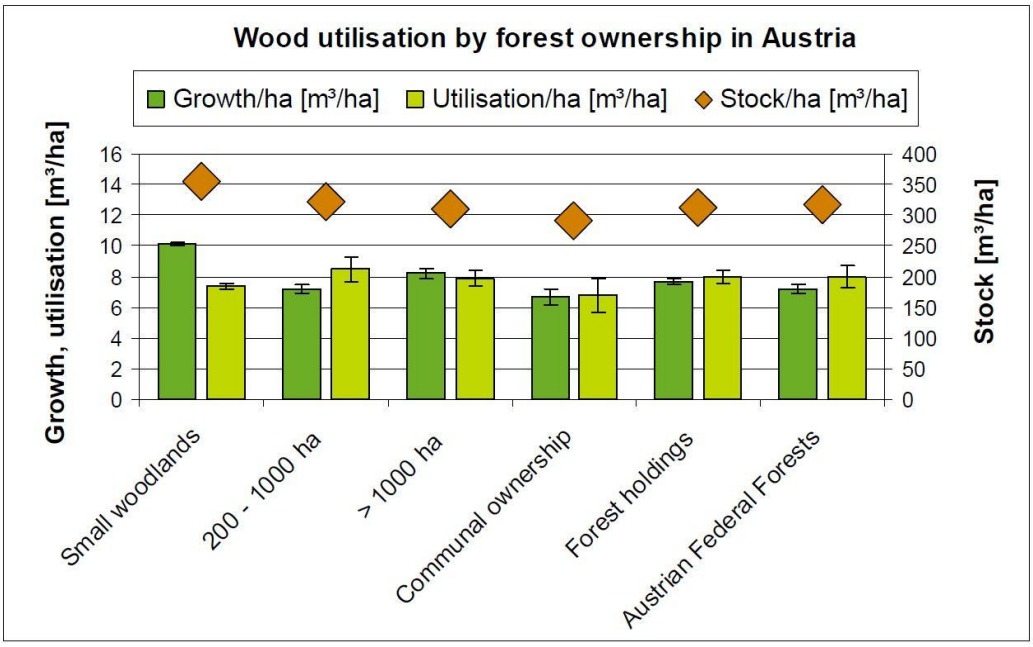

Figure 4: Wood utilisation in Austria

[10] WALCH, Josef : *Availability of forest biomass: regional energy concepts and consumer acceptance*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[11] EHRIG, Rita; WÖRGETTER, Manfred; KRISTÖFEL, Christa; LUDWICZEK, Nikolaus; POINTNER, Christian; STRASSER, Christoph : *Biomass mobilisation for industrial scale bioenergy plants – practical approach for establishing real biomass supply pathways in Austria.* 19th European Biomass Conference, Berlin, 2011

The logistics and agricultural process engineering for dedicated energy crops are the main research focus of the BLT Wieselburg. Studies on short rotation forestry mainly examined the mechanization, labour input and production chain costs (field preparation, planting, weed control, fertilization, and harvesting). The primary focus has been on poplar and willow with harvest cycles between two and four years. Tractor-pulled trailers were found to be the most effective transport mechanism for wood chips for distances up to 10 - 15 km, but lorries (trucks) are more cost effective for long distance hauling. The institute also examined transport options for miscanthus, as either chopped material or square bales and determined that square bales are more effective for long haul distances.[12]

The enzymatic degradation of complex plant material through hydrolytic microbial organisms and/or the direct use of isolated enzymes are important research foci at the Graz University of Technology. Within the **MacroFun project** a research group investigates the genetic alternation of enzymes and hydrolysis mechanisms. In addition to affecting bioethanol production, depolymerisation of cellulose, hemicelluloses and lignocelluloses have also been identified as limiting factors for anaerobic digestion of biomass. The following topics are also investigated:

- Populations with a specific xylanolytic enzyme activity were selectively enriched.
- Immobilization of zeolites was used to investigate the influence of introduced populations to batch-fermentation experiments, resulting in higher methane yields compared to controls with pure zeolite. Introduction of a functional microbial group stimulates the degradation process, making it faster and more efficient.[13] [14]

The Institute of Chemical Engineering, Vienna University of Technology investigates **fungal strain improvement for enzymatic degradation of cellulosic biomass** for biofuel production. Enzymes produced by *Trichoderma reesei* are used most frequently for cellulose and hemicellulose degradation. To improve fungal strains used in industrial enzyme production, mutagenesis approaches have been applied. Genome analysis of *T. reesei* showed that it has the genetic capability to reproduce sexually although it had been considered asexual since its discovery. The application of sexual approaches are associated with considerable advantages for strain improvement. These findings advance the field toward economically feasible biofuel production by increasing the efficiency of industrial strain improvement of *T. reesei*. [15]

Algae for biofuels require significant R&D efforts to reach commercialization. The most promising algae-based pathways in Austria are analyzed by the "Algae – a future renewable energy source?" project. The project investigates R&D objectives of greatest relevance to Austria, the current state and potential of algae to contribute to Austrian energy and climate objectives by 2020 and 2050.[16]

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[12] HANDLER, Franz; BLUMAUER, Emil : *Logistic chains for wood chips from short rotation forestry.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

13 WEIß, S., TAUBER, M., SOMITSCH, W., MEINCKE, R., MÜLLER, H., BERG, G., GUEBITZ, G.M. : *Enhancement of biogas production by addition of hemicellulolytic bacteria immobilised on activated zeolite*. *Water Research* 44 (6), 1970-1980.

[13] WEIß, S., TAUBER, M., SOMITSCH, W., MEINCKE, R., MÜLLER, H., BERG, G., GUEBITZ, G.M. : *Enhancement of biogas production by addition of hemicellulolytic bacteria immobilised on activated zeolite*. *Water Research* 44 (6), 1970-1980. 2010

[14] WEIß, S., ZANKEL, A., LEBUHN, M., PETRAK, S., SOMITSCH, W., GUEBITZ, G.M. : *Investigation of mircroorganisms colonising activated zeolites during anaerobic biogas production from grass silage*. *Bioresource Technology*, doi: 10.1016/j.biortech.2010.12.076, *In Press.* 2010

[15] SEIDL-SEIBOTH, Verena : *New avenues for fungal strain improvement towards enzymatic degradation of cellulosic biomass for biofuel production*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[16] HINGSAMER, M.; JUNGMEIER, G.; KÖNIGHOFER, K.; PENA, N.; RAUCH, R.; BOCHMANN, G.; DROSG, B.; BACOVSKY, D.; SONNLEITNER, A. : *Algae for energy – Identification of the most promising algal-based pathways in Austria*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

Cultivation of microalgae in Austria will be demonstrated by **ecoduna** (www.ecoduna.com). The company plans to build and operate a large photobioreactor unit for microalgae with a capacity of 90 m^3. The algae will be used for the production of DHA (an omega-3-fatty acid).

BDI – BioEnergy International has focused its algae research on biodiesel production. The results show that algae oil is a challenging raw material due to its fatty acid profile and a high percentage of unsaponifiables. Mature technologies are required to convert and purify algae oil. BDI is involved in the EU demonstration project AllGasOil in which wastewater is used for algae cultivation in a 10 ha plant in Spain.[17]

5.2 Conversion technologies

Experts at BLT Wieselburg have been working in the field of liquid biofuels for more than two decades and are heavily involved in the biofuels standardization process at national and international levels. The main focus of the group is the analysis of vegetable oil (pure plant oil, PPO) and Biodiesel (FAME). The laboratory facilities capabilities cover the production chain including

- Pressing of oilseeds
- Transesterification to
- PPO and FAME properties analysis
- Engine power and emission tests

The institute is involved with numerous projects, including nationally funded efforts; for instance, nationally-funded multi-year project involves a study of farm tractors fuelled with PPO.[18] Based on an analysis of data sets containing more than 100 FAME samples, a calculation model for the cold temperature behavior, i.e. cold filter plugging point (CFPP), cloud point (CP) and pour point (PP), has been developed.[19]

Biogas upgrading plants using gas permeation for the separation of CO_2 from biogas have been in operation since 2007. Two demonstration plants have been used to assess membrane lifetime, energy consumption and plant performance. The "BiogasOxiSulf" project has led to the inclusion of a chemical-oxidative scrubbing process, since reliable removal of hydrogen sulfide is a crucial step for the operation of the subsequent membrane process. Superior, with regard to energy consumption and reliable operation, has been achieved through multistage gas permeation processes based on membrane cascades that have been implemented in commercial plants in Germany (500 m^3/h biogas, Figure 5) and Austria (220 m^3/h). Researchers at the Vienna University of Technology have developed modeling tools suitable for the design and performance prediction of multistage permeator designs, such as those used in Austrian biogas upgrading plants.[20]

[17] FRÜHWIRTH, Heike : *State of the art and perspectives of biodiesel from algae.* Workshop Algae – an energy source for Austria?; 16.03.2011, Graz, Austria, 2011

[18] RATHBAUER, Josef; KRAMMER, Kurt; ZELLER, Rudolf : *Status and prospects for pure plant oil as transport fuel.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[19] RATHBAUER, Josef; ZELLER, Rudolf : *Cold Temperature Properties of Fatty Acid Methyl Esters.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[20] HARASEK, Michael : *Biomethane for CNG and Grid Injection using Membrane Processes: New Developments and Technology Rollout*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

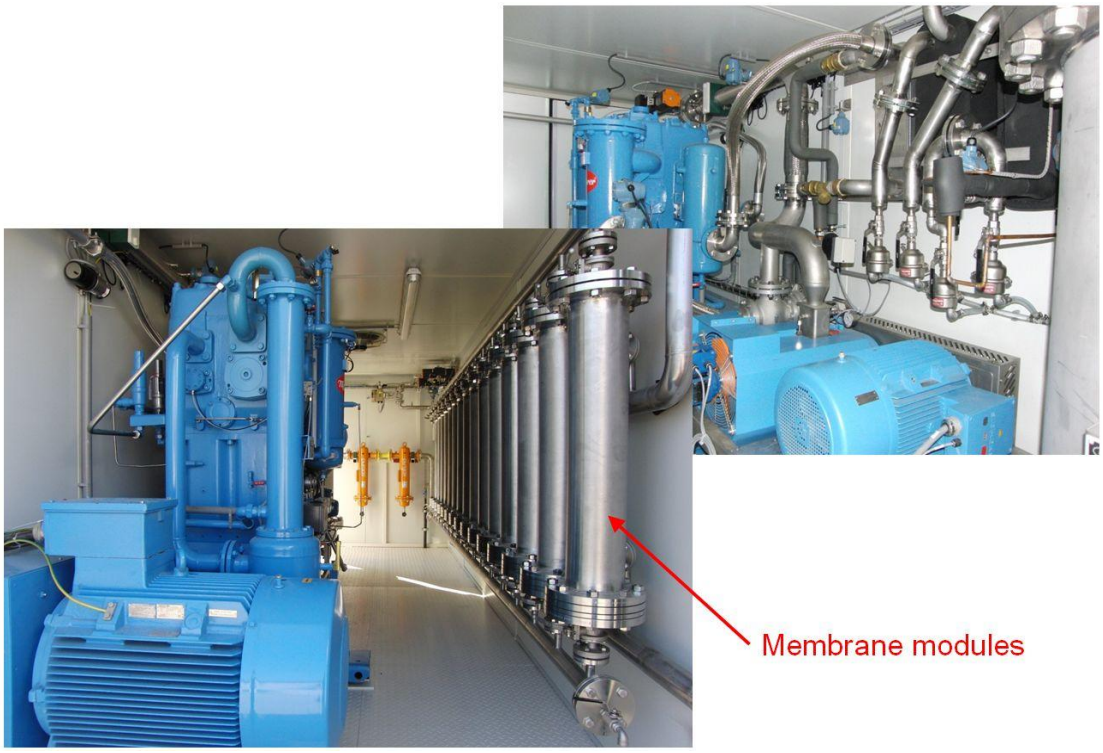

Figure 5: Recent start-up of first AXIOM plant in Germany

JOANNEUM RESEARCH and the Vienna University of Technology have assessed **lignocellulosic bioethanol concepts** that would be most suitable in Austria. Ethanol production from straw and wood is anticipated to take place in biorefineries, because type and volume of by-products significantly influence the economic and environmental performance. The integration of a lignocellulosic bioethanol plant with existing infrastructure, e.g. in the pulp and paper industry or in conventional bioethanol plants can reduce costs. The models developed at these institutions suggest that GHG-reductions can range from 41 % to 76 %, and costs from 0.6 to 1.0 €/L gasoline equivalent.[21]

During the energy crisis in the 1980's and 1990's, Voest Alpine, the leading Austrian steel producer, developed the **"VABIO-process" for the production of ethanol and chemicals from lignocellulosic feedstock** such as straw. However, after the oil crisis, the pilot plant closed. In 2008, the University of Applied Sciences in Upper Austria revitalized and improved the process and the ethanol content has been increased from 3 % to 8 % through improvements in processing controls. The construction of a pilot plant is planned to further investigate removal of inhibitors, as well as adaption of yeast to the inhibitors.[22]

Advanced biofuels via gasification play an important role in the Austrian biofuel scenarios. The majority of Austrian gasification RD&D is done at the **biomass CHP plant in Güssing** (Figure 6), where bBio-synthesis gas is produced at industrial scale with 7 000 hours of operation per year for nearly a decade. The gasifier reliably delivers syngas of desired qualities even when the specifications require with a high hydrogen and low nitrogen content. Several advanced biofuels technologies like BioSNG, FT-fuels, mixed

[21] KÖNIGHOFER, Kurt; KRAVANJA, Philipp; CANELLA, Lorenza; JUNGMEIER, Gerfried; FRIEDL, Anton : *Assessment of lignocellulosic bioethanol concepts in Austria – technical, economic and environmental aspects.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[22] KAHR, Heike; JÄGER, Alexander : *The current situation of lignocellulosic bioethanol – with regard to straw in Austria*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

alcohols as well as Bio-hydrogen have been investigated in the past. The EU-funded BioSNG project demonstrated effective integration of the entire value-chain: from wood to natural gas, including the usa of the synthetic natural gas in a CNG vehicle. Today, the technology is commercialized with a further 32 MW plant being planned for deployment in Göteborg (Sweden). FT synthesis is currently investigated in the lab, with about 5 kg of FT fuels produced daily. This is in addition to the synthesis of mixed alcohols occuring at the lab scale as well. Presently, hydrogen from biomass via the thermochemical pathway is one of the most economic options to produce renewable hydrogen from biomass.[23]

Figure 6: BioSNG demonstration plant Güssing

Fluid Catalytic Cracking (FCC) of bio-oils has also been investigated at lab scale. The addition of bio-oils has no significant influence on the operation of a FCC-plant in a refinery, but the product spectrum is slightly modified. The oxygen content of bio-oils has not been found to cause problems in downstream processing. The resulting product has an octane number comparable to high quality gasoline pools from traditional refineries, while the light hydrocarbons fraction contains more propylene and ethylene (from which biopolymers can be produced).[24]

Hydrogen from biomass and the integration of biomass gasification with refineries is a research field at the Institute of Chemical Engineering at the Vienna University of Technology. A hydrogen production plant simulated in one example project based the following parameters:

- Dual fluidized bed steam gasification system
- CO-shift step
- CO_2-separation with a pressurized water scrubber
- PSA system,
- Steam reformer and advanced gas cleaning components

The model results show that 30 MW of hydrogen could be produced from 50 MW of wood chips. Specifics of the demonstration plant have been analyzed in cooperation with OMV (www.omv.at), a company that has an interest in integrating the hydrogen with one of its refineries. The overall process configuration design provides a starting point for developing the basic engineering logistics of a prototype plant. Crucial

[23] RAUCH, Reinhard : *Advanced biofuels by gasification – status of R&D work in Güssing.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[24] REICHHOLD, A.; SCHABLITZKY, H.; BIELANSKY, P.; WEINERT, A. : *Direct use of biomass in FCC-plants.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

process components have now been identified and are currently under investigation to prepare for demonstration at a relevant scale in the near future.[25]

Researchers at the Vienna University of Technology have also investigated **biological production of hydrogen from biomass** within the European HYVOLUTION project. The proposed process consists of a pretreatment step to increase the accessibility of sugars to thermophilic bacteria, fermentation to produce hydrogen (as well as CO_2 and intermediates), followed by a photo-heterotrophic fermentation step, in which intermediates are converted to hydrogen and CO_2. Raw gas produced from both fermentation steps is purified up to 97 % (v/v) hydrogen in a gas-upgrading step.[26]

5.3 Biofuels end use

The use of biofuels in diesel and spark ignition engines has been investigated for decades at the Institute for Powertrains and Automotive Technology, Vienna University of Technology. One of the most recent studies investigates the impact of oxygenate diesel and FAME additives such as Tetra Glyme, Alcohol, Polyether, Tributylcitrat, Levulinat and on engine emissions and combustion properties. The project assesses the potential of oxygen-rich components and their influence on the combustion process.[27] The influence of liquid and gaseous alternative fuels such as bioethanol and biogas are also being analyzed to determine emissions profiles. Tank-to-Wheel analyses have shown CO_2 reduction potential of various alternatives relative to Eurosuper.[28] The potential of synthetic diesel fuels are another research topic, as is how hydrotreated vegetable oil influence different combustion processes and injection strategies.[29]

Carcinogenic diesel engine emissions have become a matter of increasing public concern. The "BioE"-project investigates emissions of rape seed oil from diesel engines. The results for gaseous emission components from the bio-oil correspond to results from previous measurements (i.e.slightly increased NO_x and decreased particulate emissions). In the tests conducted in Austria, there was no evidence of direct mutagens. However, an increase in premutagens was found for vegetable oil tests. The findings of these tests are currently being investigated, and a proposal for standardizing evaluation and test series comparisons from different institutions is currently being developed.[30]

Aviation biofuels may play a major role in the future. LT-Fischer Tropsch is one of the potential pathways for bio jetfuel production. Parafins must be isomerised, dewaxed or hydrocracked to meet the required low temperature properties. Higher quality products can be produced by oligomerisation of olefins made from HTFT or dehydrated alcohols or via DME. These steps were tested at the JK-University in Linz in a nationally-funded study. The fuels have passed the first "proof of concept" test for the new ASTM D 7566 Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons.[31]

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[25] MÜLLER, S.; KOTIK, J.; PRÖLL, T.; RAUCH, R.; HOFBAUER, H. : *Hydrogen from Biomass for Industry – Biomass Gasification for Integration in Refineries*. ICPS - International Conference on Polygeneration Strategies, Vienna, 2011

[26] WUKOVITS, Walter; FOGLIA, Domenico; FRIEDL, Anton : *HYVOLUTION – biological production of hydrogen from biomasses: process balances and process integration*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[27] TEINER, Philipp; GERINGER, Bernhard; HOFMANN, Peter; MALY, Markus; STAUB, Peter : *Impact of oxygenates in diesel fuel blends on engine emissions and combustion properties*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[28] URBANEK, Michael : *Der Einfluss von flüssigen und gasförmigen alternativen Kraftstoffen auf die Emissionen von Kraftfahrzeugen bei der ottomotorischen Verbrennung.* Univ.-Prof. Dr. Bernhard Geringer, TU Wien, VDI Verlag, 2011

[29] PFLAUM, Heiko : *Potenzial von synthetischen Dieselkraftstoffen im motorischen Betrieb unter besonderer Berücksichtigung der Auswirkungen alternativer Brennverfahren und Einspritzstrategien auf die Ruß- und Stickoxidbildung.* Univ.-Prof. Dr. Bernhard Geringer, TU Wien, VDI Verlag, 2011

[30] BLASSNEGGER, J.; KNAUER, M.; CARRARA, M.; NIEßNER, R.; KUNZE, J.; SCHRAMM, K.-W. : *BioE – Emissions from the engine combustion of biofuels and fuel mixtures.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[31] ECKER, Alfred : *A new way to aviation biofuels.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

5.4 Biofuels and sustainability

JOANNEUM RESEARCH has been assessing life cycles of bioenergy chains for decades, with major projects including an assessment of the most important Austrian production plants as well as the methodology of the European Renewable Energy Directive. Austrian plants exceed the minimum GHG required savings of 35 %. Most show GHG savings between 45 % and 55 %, with one plant reaching reductions of up to 80 %. The RED-methodology can be applied to existing industrial biofuel production plants. [32] The institute also assessed biogas grid and results were optimistic, relative to traditional use of fossil energy, and GHG emission reductions between 56 % and 400 %. The lower end of the reduction spectrum is achieved by energy crops, while the higher reduction rates can be reached when residues and very high rates when liquid manure are digested.[33]

Biofuels production and related sustainability issues in Africa and other developing countries being investigated by several Austrian institutes through various projects. Some of the most crucial factors of sustainable production include the water source (e.g. water rights, water access etc.), applicable land laws and transfer of land-use rights to foreign investors. Long-lasting and reliable co-operation between agribusiness and smallholders is needed, and energy crop production must be embedded into local agriculture practices.[34] Biofuel production from food crops, along with rising food demand in **developing countries** will continue to lead to food price increases. On the other hand, growing jatropha in marginal areas e.g. in Guatemala could potentially generate additional income for rural families. However, realistic crop yields must be anticipated, as recent production data from India suggests that productivities are less than farmers had been led to believe. Other topics that could be explored include rural electrification based on jatropha oil, biogas, and a battery charging station.[35]

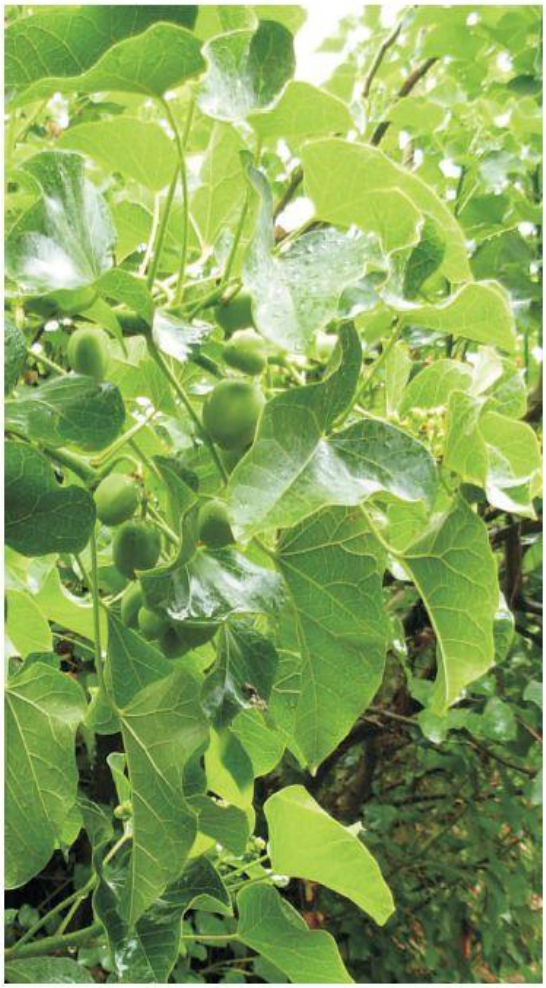

Figure 7: Jatropha curcas L. plant

Jatropha is also assessed in the ERA-ARD project **Bioenergy in Africa, Opportunities and Risks of jatropha** (www.bioenergyinafrica.net). This project investigates the opportunities and risks related to the production and utilisation of biofuels in East Africa and Central America. *Jatropha curcas* L. (*Figure 7*) was chosen since this feedstock has experienced a strong support and sometimes controversial assessment. The project also appraised the feedstock's social and environmental impacts and develops decision support tools to increase the sustainability of the fuel's production.[36]

[32] JUNGMEIER, Gerfried; CANELLA, Lorenza : *Experiences and Lessions Learned of Applying the GHG-Methodology of the European Directive to Austrian Biofuel Plants*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[33] PUCKER, Johanna; JUNGMEIER, Gerfried; LEONHARTSBERGER; Christian; SCHINNERL, Daniel; BEYL, Jan : *Environmental Assessment of Biomethane Injected into the Gas Grid*. Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[34] ZWIAUER, Katharina : *Biofuel production in Africa – case studies.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

[35] BAUER, Hannes : *Developing Countries - Programs and Lessons learned.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

6 Networking

The exchange of information on the progress of R&D is crucial for the deployment of new technologies. The International Energy Agency (IEA) has established the **IEA Energy Technology Network** which shares information on energy technologies via several Implementing Agreements that cover the most pertinent topics. Austria is an active member of several IEA Implementing Agreements, IEA Bioenergy and IEA Advanced Motor Fuels, being the two most relevant for transportation biofuels. . The Austrian participation in the IEA Energy Technology Network is financed through the "IEA Forschungskooperation" (Federal Ministry for Transport, Innovation and Technology). These Implementing Agreements form global networks in which experts from all participating countries meet regularly to give updates on R&D progress in their countries.

In the field of transportation biofuels, **IEA Bioenergy Task 39** is the most important group in which Austria participates. Updates on the biofuel development in Austria are provided to the international community through the national delegate at task meetings. Likewise, information obtained through the Task 39 network is disseminated in Austria through the Network Biofuels (www.network-biofuels.at). The Network Biofuels website offers relevant information on biofuels, news articles and links to publications, as well as an overview of Austrian experts and projects and links to related networks and organizations.

The most comprehensive overview of Austrian R&D activities in the biofuels sector was presented at the **National Task 39 Workshop** in March 2011. This event offered Austrian biofuel experts the opportunity to present their work and their R&D results to more than 150 participants. The highlights from this workshop are summarised in this article, but additionally, all presentations are available at the Task 39 website (Transportation Biofuels Research in Austria 2011).

Acknowledgements

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Some of the references (footnotes) refer to the National Task 39 Workshop which has been held in the course of the conference Highlights of Bioenergy Research in March 2011 in Wieselburg, Austria. All presentations of this workshop in English language are available at http://www.task39.org/Publications/TransportationBiofuelsResearchinAustria2011.aspx.

Some of the presentations are only available in German at http://www.nachhaltigwirtschaften.at/results.html/id6296.

[36] SONNLEITNER, Andrea; BACOVSKY, Dina : *ERA-ARD: Bioenergy in Africa - Opportunities and Risks of Jatropha and Related Crops.* Highlights of Bioenergy Research V; 30.-31.03.2011, Wieselburg, Austria, 2011

Reports and Research

Policy and Standards

US International Trade Commission

A report measuring the effects of unilateral liberalization of U.S. import restraints, distributed by the he International Trade Commission (ITC) on September 12, concluded that American consumers would save US$2.6 billion by 2015 if high tariff rates and other restrictive import policies were removed. Eliminating ethanol trade barriers alone would present the highest U.S. welfare gain according to the Commission, totaling over US$1.5 billion. More…

U.S. DOE Releases Billion-Ton Study Follow Up Report

"Biomass as Feedstock for a Bioenergy and Bioproducts Industry: The Technical Feasibility of a Billion-Ton Annual Supply," commonly referred to as the Billion-Ton Study, has found consistency with the original in terms of magnitude of resource potential under the same assumptions. But the follow up, "U.S. Billion-Ton Update: Biomass Supply for a Bioenergy and Bioproducts Industry," finds differences in specific feedstock availability and includes a number of elements the Billion-Ton Study did not. More…

Sustainability

First EU sustainability schemes for biofuels get the go-ahead

Biofuels can be an environmentally-friendly replacement of fossil fuels. However, the EU needs to ensure that tropical forests and carbon rich peatlands are not turned into oil palm or sugarcane plantations. The EU also has to guarantee that compared to fossil fuels biofuels used in the EU deliver tangible greenhouse gas savings. To this end, the sustainability of biofuels needs to be checked by Member States or through voluntary schemes which have been approved by the European Commission. More…

Sustainability criteria for residual flows of biomass

The Corbey Commission, that advises the Dutch government about sustainability issues and biomass, recently published a recommendation about the sustainability criteria of residual flows. With the rise of a sustainable and green economy, waste has become business. Waste is a valuable resource and residual flows are used often for new processes or products. In its report, the Commission Corbey gives an advice on the definition of residual flows from biomass, and the sustainability criteria. More…

Technical / Innovation / Other

A new catalyst for ethanol made from biomass

Researchers in the Pacific Northwest have developed a new catalyst material that could replace chemicals currently derived from petroleum and be the basis for more environmentally friendly products including octane-boosting gas and fuel additives, bio-based rubber for tires and a safer solvent for the chemicals industry. More…

In the News

Global Biofuel Information Tool

The Global Biofuel Information Tool (GBIT) provides an overview of the state of development of the biofuel sector in the global south. Its interactive map presents national production and consumption data and an overview of key investments in the sector. For selected investments, more elaborate company profiles are available. More…

Elsevier Launches Biofuel Research and Discovery Tool

Elsevier announced the launch of Elsevier Biofuel, an online search and discovery tool that provides biofuel managers and research development professionals instant access to the highest level of scientific, industrial, and commercial information to solve their continued innovation requirements. Through content and information, Elsevier Biofuel will assist companies in making key decisions surrounding the Biofuel and the Bio-energy markets, making developments in the industry quicker and more efficient. More…

Continuous biodiesel production with new method

French researchers have developed a monolithic BioHybrid foam catalyst that makes the continuous production of biodiesel possible. The team has already obtained a patent for this. Conventional biodiesel production is based on a transesterification reaction. Transesterification is a process in which a vegetable oil (90%) and alcohol (10%) are converted into methyl esters and glycerol. An adverse side effect of this is saponification, a chemical reaction that creates fatty acid and alcohol. Fatty acids have a constraining effect on the catalysis, and thus on the production of methyl ester, the main ingredient in biodiesel. More…

Policy and Standards News

Sugarcane ethanol performs at or beyond level expected from second generation biofuels

Ethanol produced from sugarcane already delivers an environmental performance similar to or better than what is expected from 2nd gen ethanol, when it becomes commercially available. That fact, already pointed out in several studies, was highlighted by the Sustainability Manager of the Brazilian Sugarcane Industry Association (UNICA), Luiz Fernando do Amaral, during the event IEA Bioenergy Task 39 – *Commercializing Liquid Biofuels from Biomass*, held on August 23 at the Centre for Research and Development (Cenpes), in Rio de Janeiro, Brazil. More…

Commission launches major investment programme (NER300) for innovative low-carbon technologies, including bioenergy

The European Commission launches today the first call for proposals for the world's largest programme of investment in low carbon and renewable energy demonstration projects. The initiative, known as NER300, will provide substantial financial support for at least eight projects involving carbon capture and storage (CCS) technologies and at least 34 projects involving innovative renewable energy technologies. More…

Certain Biofuel Mandates Unlikely to Be Met by 2022 Unless New Technologies, Policies Developed
New analysis of the National Research Council (National Academy of Sciences) on the U.S. RFS Strategy. Absent major technological innovation, the RFS2-mandated may be cost-competitive only in conditions with high oil prices, technological breakthroughs, and a high carbon price. RFS2 may be an ineffective policy for reducing global GHG emissions because the effect of biofuels on GHG emissions depends on how the biofuels are produced and what land-use or land-cover changes occur in the process. More…

Sustainability News Items

'Serious' Error Found in Carbon Savings for Biofuels
The European Union is overestimating the reductions in greenhouse gas emissions achieved through reliance on biofuels as a result of a "serious accounting error," according to a draft opinion by an influential committee of scientists and academics. The European Environment Agency Scientific Committee writes that the role of energy from crops like biofuels in curbing warming gases should be measured by how much additional carbon dioxide such crops absorb beyond what would have been absorbed anyway by existing fields, forests and grasslands. More…

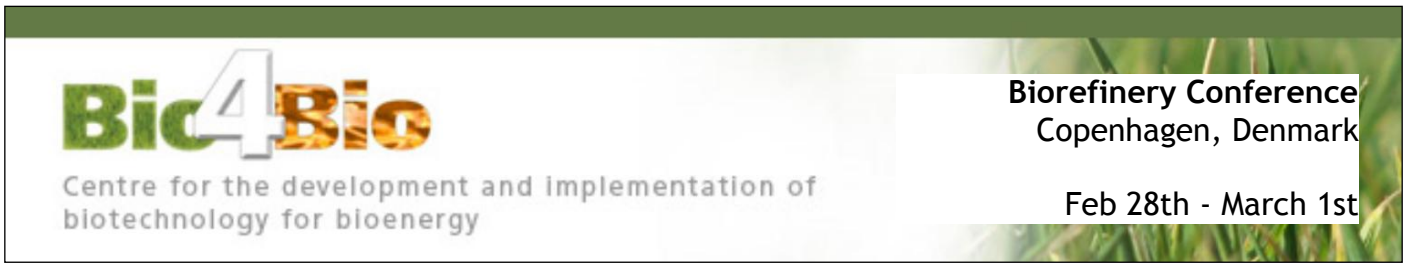
Commission launches public consultation on Indirect Land Use Change (ILUC) and Biofuels
The EC has launched a public consultation on Indirect Land Use Change (ILUC) and biofuels, which will run From 30/07/2010 to 31/10/2010. Comments are invited from all biofuels stakehdolers and the wider public. Indirect land use change is a subject of great complexity. The Commission is therefore consulting on a wide basis; seeking advice on both the scale and characteristics of the problem, as well as, if the scale of the problem is significant enough, how it should be addressed. More…

Industry Developments

World's largest ethanol facility shows "confidence in the future"
Recent announcement by major companies in the Brazilian sugarcane industry to increase cane crushing and boost production of ethanol and sugar are a positive development that should be duly noted. According to the President and CEO of the Brazilian Sugarcane Industry Association (UNICA), Marcos Jank, a joint effort between the São Martinho Group and Petrobras Biofuel totaling R$520 million (about US$288 million), is an example of the drive and confidence in the future that permeates the industry. More…

Crop of IPOs Provides Expanded Biofuel Bets
In the last 18 months, a new wave of initial public offerings has come from companies focused on creating biofuels using everything from wood chips to grass clippings. Three biofuel deals have hit the IPO market this year, from Gevo Inc., KiOr Inc. and Solazyme Inc., after two last year. All five have proprietary biotechnology to produce biocatalysts and microbes to create different types of fuel using everything from sugar cane to pine-tree chips. More…

Jet Green
When it comes to boys and their toys, it doesn't get bigger than the Paris Air Show. The latest in attack helicopters and stealth fighters line the tarmac nose to tail with double-decker Airbus A380s, a Boeing Dreamliner and a solar-powered plane. Chattering Chinese military officers stroll past American antiaircraft batteries as French President Nicolas Sarkozy's motorcade roars up to inspect displays of Gallic aeronautical prowess. More…



Neste Oil expands its renewable raw material base with jatropha and camelina oils
Neste Oil will expand the raw material base used to produce NExBTL renewable fuel with jatropha and camelina oils. By introducing these new raw materials in its feedstock base, Neste Oil increases the proportion of non-food materials and raw materials that can be grown on cultivation areas less suited for food plants in its raw material procurement. More…

First endurance test results with E10 fuel
A collaboration of various European automobile interest groups, including the Dutch ANWB and the German ADAC, is currently carrying out an endurance test using the new E10 fuel. It is looking into whether and when damage occurs, and whether or not this damage is caused by the fuel. In the case of mistakenly refuelling with E10, the advice is to top up the tank as quickly as possible with the recommended fuel. More…

Other News Items

From Barracks to the Battlefield

Throughout its history, the U.S. Department of Defense (DoD) has invested in new ways of harnessing energy, but until recently, the U.S. military's innovation agenda has not placed a high premium on energy efficiency and new sources of energy and fuels. The US military is investing in reducing its energy dependence and securing reliable, renewable energy supplies for its operations. More…

Following Brazil's example
Brazilian ethanol is a good example of how industrialized countries can make biofuels an alternative in substituting part of their energy grids with a source of renewable energy. The evaluation was made by the participants of a round-table discussion on the volume of biofuels that could be produced in the world, held during the first Brazilian Bioenergy Science and Technology Conference (BBEST), on Aug 14-18 in Campos do Jordão. More…

Workshop: Development of torrefaction and impacts on global bioenergy use and bioenergy trade
IEA Bioenergy Task 32 and Task 40 jointly organized a workshop in Graz in January 2011, as a side-event of the Central European Biomass Conference (CEBC), Graz, Austria. The workshop was visited by over 250 participants. The workshop gave a comprehensive overview of fundamentals of torrefaction, the main advantages of and the challenges in producing torrefied biomass, including ongoing R&D, demonstration plants under construction or already in operation and the possible implications for international bioenergy trade. More…

Upcoming Meetings & Conferences

Upcoming International Conferences

XIX ISAF - International Symposium on Alcohol Fuels

October 10-14, 2011 Verona, Italy

The main theme is "Innovation for Local and Global Sustainability of Alcohol Fuels". It emphasizes the importance of Innovations for Sustainability of Alcohol Fuels, in today's World scenario. Many experts and will be participating to discuss and successfully make over the subject of identifying new non-food feedstocks and new technologies for production of 2nd gen of bioethanol and methanol.

Second International Conference on Cellulosic Ethanol

October 11-13, 2011 Verona, Italy

Following the success of last year's conference, the Directorate General for Energy of the European Commission has decided to organise the 2nd Conference on Lignocellulosic Ethanol in Verona in cooperation with Brazil. The Conference will be facilitated by Mossi & Ghisolfi/Chemtex and the participants will be able to visit its research facilities.

Future Role of Bioenergy from Tree Biomass in Europe

November 6-11, 2011 Vienna, Austria

Researchers from fields including Forestry, Bioenergy Studies, Social and Environmental Sciences are invited to participate in The Future Role of Bio-energy from Tree Biomass in Europe conference. In 2011, the Year of the Forest, the COST-ESF will contribute to understanding bio-energy drivers, options and impacts on forest growing, management and production of traditional goods and services in the future.

Upcoming Conference: Bio4Bio Biorefinery Conference

February 28th - March 1st, 2012 Copenhagen, Denmark

The program provides you with an excellent opportunity to get a full update on advanced biofuels production including these topics: plants for a future biorefinery incl. molecular breeding and synthetic biology, feedstock production for biorefieries - linking eco system services with energy service demands, biomass processing to fuels, chemicals and materials, biorefinery technologies, and many other topics.

IEA Bioenergy Task 39 Meetings

The following is a tentative schedule of Task 39 meetings over the course the next two years (2010-2012). Please contact us for more detailed information:

- Verona- *October 2011 (ISAF XIX 2nd Lignocellulosic Ethanol Confr.)*
- Copenhagen, Denmark - *February 2012 (Technical workshop)*
- Vancouver, Canada - *May 2012 (Planning/Technical Conference)*
- Vienna, Austria – November *2012 (IEA Bioenergy Conference)*