



TASK 39

IEA Bioenergy

LIQUID BIOFUELS FROM BIOMASS

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EDITORS NOTES

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Welcome to the twelfth issue of the Task 39 newsletter. In this issue, we provide you with an abbreviated form of the minutes of our last Task 39 Workshop, held in Kyoto, Japan from December 13-15, 2004. We encourage you to contact authors of interesting studies in order to get the full details of their work.

In this issue, you will see that we are continuing in our efforts to upgrade the look and feel of the Task 39 Newsletter in order to serve you better. This year, we plan to move to an online format which will hopefully streamline your access to this material, and which will tie our website (under redevelopment) and our newsletter more closely together. We are currently in the midst of testing formats for this approach in order to make the transition as seamless as possible.

As always, we encourage all Task members to make use of this newsletter, to contribute content, and to suggest changes that can further improve the document. We look forward to your contributions over 2005!

UPCOMING MEETINGS

Warren Mabee

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The next IEA Bioenergy Task 39 meeting will be held as a Special Session of the 27th Symposium on Biotechnology for Fuels and Chemicals, to be held in Denver CO from May 1-4 of this year. Our session is in the afternoon of May 2, and will include between 8 and 10 presentations from members of industry on the question 'What is the key barrier to commercializing biofuels?'

IEA Task 39 will also be hosting a Session at the IUFRO (International Union of Forest Research Organizations) meeting, to be held in Brisbane,

Australia from August 8 to 13, 2005. Our session will focus on the linkages that exist between changing forest practices and biomass production, and their linkages to the areas of biofuels and bioenergy. More details about this meeting, including registration and accommodation costs, may be found on the conference website at <http://www.iufro2005.com/>.

The next dedicated IEA Task 39 Workshop will be held in the fall of 2005, in Lund, Sweden. It has been proposed that this workshop be developed as a short course on bioconversion. More details will be announced as the date grows closer.

FROM THE TASK LEADER

Jack Saddler

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In the first newsletter of 2005, I look forward with pleasure to a variety of endeavours. We are in the midst of commissioning a number of reports in the areas of biofuel policy and biodiesel development which I think will add significantly to our understanding of both issues. Task 39 is leading three meetings this year in a variety of settings, including an international biotechnology symposium, a forestry congress, and a dedicated teaching workshop. Finally, we continue to look to innovative methods of disseminating information to our Task 39 membership.

I would like to extend my personal thanks to Dr. Shiro Saka, who hosted our last meeting in Kyoto, Japan. I think I speak for all attendees when I say that all details were wonderfully handled. I would also like to thank Hisashi Miyafuji and Katsunobu Ehara for their contributions.

I also would like to thank Dr. Bärbel Hahn-Hägerdal and Dr. Guido Zacchi for their offer to host a Task 39 workshop next fall in Lund, Sweden. I know that they have some great ideas for our next session.

We are always looking for organizers, presenters and writers and all it takes to get started is an email to one of the Task executive members listed later in this article.

Best wishes from Vancouver!

IEA TASK 39 WORKSHOP KYOTO, JAPAN – 13-15 DECEMBER 2004

Warren Mabee

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On December 13-15, 26 people gathered for an IEA Task 39 workshop in Kyoto, Japan. The 3-day workshop was graciously hosted by Dr. Shiro Saka and the 21 COE Program at Kyoto University. Together, we represented ten countries, including Austria, Canada, Denmark, Finland, Germany, Japan, South Korea, Sweden, the UK and the USA. This gathering included current members and potential future members of IEA Bioenergy.

The meeting started on Monday December 13 with an afternoon temple tour. The first session was held that evening, with introductions from Shiro Saka and Jack Saddler. Dr. Saka presented special welcoming remarks from the President of Kyoto University and introduced the city and university to the group. He spent some time describing the 21 COE Program, which included the Task 39 Workshop as a preliminary session to its symposium held Dec. 17-18). The first evening ended with a keynote presentation from Dr. Yoshiyuki Sasaki, which set the scene for the meeting.

The meeting was organized into seven sessions in total, including the introductory session. The second session provided an overview of some of the links between technical and policy issues; a third session examined more specific country-level policies. Three further sessions examined technical progress towards commercialization. The final session of the workshop was set aside for general discussion. Summaries of each session and the resulting discussion are provided on the following pages. The two-day workshop offered a number of opportunities for both formal and informal interaction between the various participants.

At the end of the meeting, Saddler reviewed the list of desired outcomes and discussed the mission of Task 39 as it continues into the next triennium of IEA funding. The group emphasized the importance of continuing to extend invitations to non-IEA ethanol producers, such as Brazil, India and China. The task will continue to operate in much the same fashion as in the past triennium with three newsletters and two or three workshop meetings every year. On the suggestion of the group, these meetings will vary in format and size depending on the task at hand.

SESSION 1 SETTING THE SCENE

Yoshiyuki Sasaki (AIST Chugoku, Japan)

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Dr. Yoshiyuki Sasaki discussed the use of biomass for carbon management. His presentation ranged from large-scale to small-scale management options, and included descriptions of biorefining and materials recovery (industrial or 'cart-it-to-market') as well as in-plant utilization or local energy (self-utilization or 'use-it-yourself'). He reviewed some biomass conversion technology including combustion, gasification, molecular transformation and physical treatment.

In the general discussion that followed, it was pointed out that converting biomass to fuel makes a much larger impact on energy demand than does the conversion of biomass to chemicals. Policy decisions then become highly influential in determining the ultimate use of biomass, as sometimes the goal of policy is less related to energy demand than to other factors such as rural employment.

SESSION 2 POLICY/TECHNICAL REVIEW

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Warren Mabee presented a brief introduction to the work of the Forest Products Biotechnology group at the University of British Columbia, as well as the policy-related work of IEA Task 39. He then presented the results of an ongoing analysis of the Canadian bioethanol/biorefining sector. Finally, a review of the policy levers that have been successful in creating bioethanol/biorefining capacity was presented, and it was shown that direct funding for infrastructure is much more successful at creating capacity than are excise taxes, or even biomass availability, although it is speculated that the latter is only true in the short term.

Eric van den Heuvel presented background on biofuels programmes/policy in the Netherlands. It has been shown through research that sufficient biomass is

available in the Netherlands to meet the 2005 target of the EC Biofuel Directive, but not enough for the 2010 target. Therefore, import and trade is the strategy that will be pursued by the Netherlands in the mid-term, and a smart implementation plan is required in order to prevent negative side-effects in other countries. The presentation was concluded with some observations on how IEA Task 39 might better contribute to ongoing development of policy instruments for implementation.

Andre Faaij presented some material on launching a new task (IEA Bioenergy Task 40, International Trade) and tried to identify opportunities for collaboration between T39/T40. T40 will focus on securing biomass supply, as well as demand. It is necessary to show a large-scale potential for biomass supply, including demand for food, production efficiency, demand for wood, etc. What conditions are needed for a global commodity market, and how can it be set up in a sustainable way?

SESSION 3 COUNTRY PERSPECTIVES

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Bill Cruickshank introduced his talk by stating that a powerful driver for biofuels in Canada is the national commitment under the Kyoto Protocol, combined with a need for rural employment and the desire to promote sustainable technology. The target for biofuel use in Canada is to blend 35% of consumed gasoline with 10% ethanol (E10) by 2010, and to provide an additional 500 million metric tonnes (MMT) of biodiesel. Government support for bioethanol includes an excise tax waiver of 10¢/litre on ethanol blended with gasoline and the Ethanol Expansion Program which totals \$107.5 million over three years. Government support for biodiesel is a 4¢/L excise tax waiver and \$11.9 million over 4 years to support development.

Bernard Rice introduced Ireland's biofuel priorities, which include rapeseed oil use in adapted engines, biodiesel from high free-fatty-acid (FFA) feedstocks, and bioethanol from straw and wood residues. In order to meet the EC Biofuels Directive targets, about 80,000 tonnes of liquid biofuels would need to be produced. State support for biofuels includes a promised (but not delivered) waiver on road excise tax for approved biofuels projects. There are three small biodiesel projects based on rapeseed oil production totalling about 5,000 metric tonnes (MT), which were largely driven by farmer support, and there is a 25,000 MT biodiesel proposal that is awaiting the excise decision.

Guido Reinhardt gave us an overview of a German biofuel study. The main objective of this initiative is to reduce fossil fuel consumption and GHG emissions, and to identify the most promising biofuels. Alternatives were chosen with high mass potentials (20, 30, or 40 % of total needs) and good chances to enter the market competitively and cost-effectively. Preferred options were to increase efficiency of internal combustion engines (ICE's), natural gas, biodiesel, BTL, hybrid engines with flexible fuel, and bio-hydrogen. Biodiesel production has risen dramatically in 10 years, and Germany is now the primary producer worldwide with almost 1 MMT's per year. Since June of this year, a tax exemption for biofuels has been introduced that will operate until 2009. This provides the German industry with an additional incentive to produce biofuels.

Kurt Messner presented material on bioethanol research in Austria. The research program at Vienna focuses on three sections, industrial microbiology, fermentation, and bioengineering. The industrial microbiology group focuses on microbial pre-treatment of lignocellulosics. The fermentation group focuses on gene technologies, and on genetic engineering of yeasts. The bioengineering group is trying to integrate ethanol fermentation into biomass incineration and biogas production. There is also a focus on membrane development for ethanol recovery, and some research on biodiesel production and acetone-butanol production through fermentation.

Don Erbach presented some ideas on the commercialization of biofuels and bioenergy in the United States. Public pressure can be a big driver for the biofuels area, but right now in the US the concern about these issues is relatively low. There have been policy initiatives, including the Farm Bill of 2002 and the recently passed Jobs Bill which have done a reasonable job of supporting biofuels. There is a 51¢/gallon excise tax credit for bioethanol, \$1/gallon

excise tax credit for 'new' (non-recycled) biodiesel oil, and 50¢/gallon credit for used biodiesel oil. The ban of MTBE has created a market for bioethanol on the coasts and in the south. It is estimated that 30 million gallons of biodiesel and 3.5 billion gallons of bioethanol are produced annually in the US, which is almost sufficient to make the concept of an RFS obsolete. Research in the hydrogen area has had impacts on biofuel funding in the US.

SESSION 4 TECHNICAL PROGRESS AND COMMERCIALIZATION A (BIOETHANOL TECHNOLOGY)

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Dr. Wyman provided us with an overview of the consortium for applied fundamentals and innovation (CAFI) project, which was organized in late 1999 to coordinate research on pretreatment methodologies as part of a system that includes hydrolysis and fermentation. The project is funded by USDA (CAFI 1, \$1.2 million) and the DOE Office of the Biomass Program (CAFI 2). CAFI 1 used corn stover and studied pretreatments including dilute acid, flowthrough pretreatment, controlled pH pretreatment, steam explosion, lime pretreatment, AFEX, and ARP. CAFI 2 will use poplar as feedstock.

Dr. Saka introduced the next talk by discussing some of the research programs at Kyoto University. One technology under investigation is supercritical (SC) pretreatments, which use water at high temperatures and pressures (380 °C, 40 MPa) to break down lignocellulosics. This treatment shows little difference between hardwoods and softwoods. The reaction takes place in less than one second and is thus difficult to control, but has great potential.

Lars Rohold presented some ideas on taking bioethanol from research to commercial technology. One Danish company has established a patent on wet explosion pretreatment, which uses thermo hydrolysis, wet oxidation and steam explosion. This process can improve recovery of hemicellulose and dry solids, with no acid addition and less inhibitor production. It was reported that Denmark has established a Danish Centre for Biofuels, under the leadership of Dr. Birgitte Ahring.

Katsunobu Ehara described the antioxidant activities of lignin, which are proposed as a value-added coproduct that may be produced with bioethanol. Poplar was pretreated with an ethanol organosolv treatment, and the liquid fraction was recovered and the precipitates from the liquid fraction were then collected for antioxidant activity testing. Lignin antioxidant activity ranged from 5 to 125 ARP, compared to known antioxidants such as Vitamin E (260 ARP). Temperature was found to be the primary controlling factor in changing the ARP value of recovered lignin from ethanol organosolv pretreatment.

Dr. Hahn-Hägerdal discussed the ethanol program, which has run for the past seven years in Sweden and which is coming to a close at the end of this calendar year. Swedish ethanol programs range throughout the country. There have been research activities in multiple locations, a development activity which has taken place at Lund University, and a pilot plant that has been created at Örnsköldsvik. It is a two-step diluted acid and enzymatic hydrolysis plant, and has a capacity of 2 tons or 500 l ethanol every 24 hours. It cost about US\$ 15 million, which was derived in part from the ethanol program.

SESSION 5

TECHNICAL PROGRESS AND COMMERCIALIZATION B (BIODIESEL TECHNOLOGY)

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Dr. Wörgetter spoke about driving forces and barriers to biofuel development, and identified the most important driving force as policy which must be considered at the regional, national, and global levels. The EU goal for alternative fuels is 23% by 2020, which includes a mix of biofuels, natural gas and hydrogen, which are considered as options that move from fossil to bio- or hydrogen-based systems. Biodiesel is slightly ahead of bioethanol in terms of development, having almost entered the competitive state and having been proven through technical standards developed in early 2004. In some nations, diesel is more attractive due to taxation structures; for instance, Austria has seen vast increases in diesel use over the past 30 years. Raw material for biodiesel is primarily rapeseed oil, followed by sunflower and then used oils.

Dr. Lee then provided us with some recent developments on biodiesel and bioethanol in South Korea. National consumption of fuel is about 30 MMT gasoline and 28 MMT diesel in 14 million vehicles, with all oil imported. The largest motivation for biofuels is severe air pollution in the Seoul area, followed by fears of global warming and the fact that South Korea joins the Kyoto Protocol in 2013. Other options, such as liquefied natural gas (LNG), have not been successful due to fears from the populace about fuelling stations in their area. Bioethanol development in Korea stems from the development of a pilot process in the early 1990's, and the creation of a process development unit, using ammonia percolation as pretreatment.

Dr. Chiba discussed the production of biodiesel in Kyoto, which has the largest production facility (5,000

L/8-hr day) in Japan and includes a small distribution network. Biodiesel is used as B20 in city buses, and B100 in garbage trucks. It is derived from used cooking oil, 90% of which is derived from restaurants and the remaining 10% of which comes from households. There are 800 collection points today, but that will be increased to 2000 points in the future. The quality of BDF derived from cooking oil in Kyoto meets both the EN and ASTM standards.

Dr. Saka and Dr. Yamaguchi discussed the use of non-catalytic supercritical (SC) methanol treatment. Two SC methods were described, including one-step (esterification or transesterification) and two-step (hydrolysis followed by esterification) processes. These methods are useful with high water and high fatty acid contents, as opposed to alkali-catalyzed and acid-catalyzed approaches. The two-step reaction process has been developed as part of a consortia effort between the Asahi Kasei Corporation, Kyoto University, and three other companies.

SESSION 6

TECHNICAL PROGRESS AND COMMERCIALIZATION C (INDUSTRIAL COMMERCIALIZATION)

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Liisa Viikari provided an overview of the current consumption of bioethanol in the European Union, including Finland (16,000 MT/year), compared to 144,000 MT/year in Sweden. There is no current production of bioethanol in Finland but strong research initiatives into renewables including bioethanol, biomethanol and hydrogen. A wide range of enzymes have been examined at VTT, with a focus on protein engineering of the catalytic domain and the cellulose-binding domain. There is also a strong research program on pentose utilization by yeasts. Recent results in the enzymology program at VTT have explored the role of changing hemicellulose and lignin content on the hydrolysis yield, and have shown that high

hemicellulose content can reduce the yield significantly.

Joel Cherry then provided us with an overview of Novozymes research program. He pointed out that the cost of producing ethanol from starch vs. the cost from lignocellulosics is low, and the enzyme cost for lignocellulosic production is very high by comparison. It takes 0.5 g of protein to produce a gallon of ethanol from starch, but it takes 50-100 g of protein to produce a gallon ethanol from lignocellulosics. This puts lignocellulosic bioconversion at a disadvantage from the beginning. Novozymes has been involved in a long-term project with the DOE that is concluding in early 2005 to reduce enzyme costs. The focus of this research has been to identify new component proteins, and new synergies between proteins. Future needs for commercialization will include increasing solids loading, reducing the toxicity of pretreatment in order to remove washing stages, and better process integration.

Dr. Himmel discussed biomass recalcitrance and the importance of this for the biorefining industry. To enable the biorefinery, we must deal with high feedstock costs, and a lack of capital for processing plant development. To overcome these challenges, bioethanol yields must be as high as possible while enzyme and pretreatment costs must be as low as possible. There are fundamental issues that must be dealt with, including the interdependencies that exist between biomass composition, structure (ultrastructure), pretreatment, and enzyme action. NREL has produced visual representations of enzyme interaction with cellulosic substrate, which provides a powerful educational tool. Significant questions remain about the structure of biomass and its relationship to enzymes and the surrounding media.

Tony Sidwell provided some results of well-to-wheel analyses of ethanol produced from wheat in the UK. Biofuels discussions in the UK have been guided by a number of studies, which have provided different answers and ranges of answers. The studies have focused on ethanol from wheat starch as this is the only technology that is commercially available today. The areas identified as requiring the most attention include basic process energy requirements, energy generation and management, N₂O emissions from agriculture, coproduct credits (using the substitution method), potential use of straw, and reference systems. It was pointed out that all stakeholders in the project agreed which was a very important finding. In the UK, there is very little use of biofuels with only imported Brazilian ethanol and some domestically-produced, waste oil-based biodiesel in use. British Sugar has applied for

planning permits for a 55,000 tons per year bioethanol plant as of mid-December 2004.

SESSION 7 GENERAL DISCUSSION

In response to Dr. Saddler's earlier question ('What is the most pertinent policy question that IEA Task 39 should respond to?'), the workshop participants provided a number of responses. In particular, the following five questions were offered.

1. How can we justify the implementation of bioenergy?
2. Why hasn't the lignocellulosic-to-ethanol process been commercialized to date?
3. What are the positives and negatives associated with the current emphasis on the biorefinery concept? Will this emphasis accelerate or decelerate commercialization of biofuels?
4. How can we reduce the number of biofuel options for the future, in order to reduce the number of engine/powertrain technologies required from the automotive industry?
5. How can we engage market-pull organizations, and in particular the motor engine sector, more closely in Task 39?

In the discussion that followed, a number of important points were raised. One point is the need to get people involved in the biofuel initiative, and to build grassroots efforts to support biofuels. Closely related is the need to engage both the biomass suppliers and the market-pull organizations, and to ask each of these groups what they require from the emerging biofuels sector. How can farmers justify the cost of expensive new equipment to supply low-cost feedstocks? The current emphasis for low-cost feedstocks actually runs counter to major policy goals of returning funds to rural communities, and takes away the incentive for farmers to get involved. There is a need to get policymakers to understand this in the face of increasingly urban voting populations.

FUTURE WORKSHOPS/SYMPOSIA

Clean Energy Power

Berlin

January 26 – 27, 2005

<http://www.energiemessen.de/engl/index.htm>

National Biodiesel Conference & Expo

Ft. Lauderdale, Florida

January 30-February 2, 2005

<http://nbb.org/expo2005/>

2005 National Ethanol Conference

The Camelback Inn, a JW Marriott Resort & Spa
Scottsdale, AZ

February 7-9, 2005

<http://www.ethanolrfa.org/nec.shtml#four>

Expoenergia 2005

San Pedro Sula, Honduras

February 23-25, 2005

www.expoenergia2005.com

Latin America Renewable Energy Fair

February 15-17, 2005

Rio de Janeiro, Brazil

<http://www.rio5.com/programme/index.html>

erneuerbare energien 2005

February 25-27, 2005

Boeblingen, Germany

<http://www.erneuerbareenergien.com/engl/index.htm>

POWER-GEN

March 1-3, 2005

Las Vegas, NV

<http://pgre05.events.pennnet.com/>

World Sustainable Energy Days 2005

March 2-4, 2005

Wels, Austria

<http://www.esv.or.at/esv/index.php?id=1>

Global Alternative Fuels 2005 Exhibition and Forum

March 8-10, 2005

Berlin, Germany

<http://www.theenergyexchange.co.uk>

The Cairo 9th International Conference on Energy

March 13-19, 2005

Cairo, Egypt

Sugar and Ethanol Brazil

March 14-16, 2005

Sao Paulo, Brazil

<http://www.agra-net.com>

Task 32 Meeting

March 16-27, 2005

Apeldorn, The Netherlands

www.ieabcc.nl

Third USDA Symposium on Greenhouse Gases and Carbon Sequestration in Agriculture and Forestry

March 21-24, 2005

Baltimore, MD

<http://soilcarboncenter.k-state.edu/conference>

Mondial Bioenergie

March 13, 2005 – April 3, 2005

Paris, France

<http://www.itebe.org/>

ENEX - New Energy 2005 kompakt

Kielce, Poland

March 21 – 23, 2005

<http://www.enex-expo.com/engl/>

GVC-Fachausschuss Biokraftstoffe

April 5-6, 2005

Karlsruhe, Germany

<http://www.vdi.de/vdi/organisation/schnellauswahl/fgkf/gvc/organisation/11018/index.php>

Biomassa; Kans of bedreiging

April 7-8, 2005

Wageningen

<http://www.wau.nl/wbs/index.cfm?fuseaction=program.display&recordid=63>

BIOSquare 2005

April 13-15, 2005-01-24 Lyon France

<http://www.ebdgroup.com/biosquare>

The Third USDA Symposium on Greenhouse Gases and Carbon Sequestration in Agriculture and Forestry

April 20-22, 2005

Orlando, FL

<http://soilcarboncenter.k-state.edu/conference>

BIO-Windhover

April 25-27, 2005

Washington, DC

<http://www.biowindhover.com/>

Salon des Energies Renouvelables 2005

April 27-30, 2005
Lyon, France
<http://www.energie-ren.com/2005/>

27th Symposium on Biotechnology for Fuels and Chemicals

May 1-4, 2005
Denver, CO
<http://www.eere.energy.gov/biomass>

Asia Pacific Conference

Wellington, New Zealand
May. 9 - 2005 to May. 11 - 2005
<http://www.apcseet.org/>

Global Carbon Market Fair and Conference

May 11-13, 2005
Cologne
<http://www.carbonexpo.com/>

Symbios: Second-Generation Automotive Biofuels

May 18-20, 2005
Stockholm, Sweden
<http://www.ecotraffic.se>

2005 World Renewable Energy Congress

May 22-27, 2005
Aberdeen, Scotland
<http://wrec2005aberdeen.co.uk/>

WasteTech – 4th International Trade Fair and Congress on Waste Management

May 31, 2005 - June 3, 2005
Moscow, Russian Federation
<http://www.sibico.com/waste-tech/2005>

3rd Dubrovnik Conference on Sustainable Development of Energy, Water and Environment Systems

June 5-10, 2005
Dubrovnik, Croatia
<http://www.dubrovnik2005.fsb.hr/>

ENGVA Annual Conference

June 8-12, 2005
Bolzano, Italy
<http://www.engva.org/view.phtml?page=conferences.phtml>

A Profitable Environment for NGVs

June 8-12, 2005
Italy
<http://www.engva.net/bolzano2005/>

Renewable Energy Finance Asia

June 15-16, 2005
Hong Kong
<http://www.greenpowerconferences.com/events/RenewableFinanceAsia.htm>

BIO 2005 Annual International Convention

June 19-22, 2005
Philadelphia, PA
<http://www.bio.org/events/2005/>

21st Annual Int. Fuel Ethanol Workshop & Expo

Kansas City Marriott Downtown Hotel & Kansas City Convention Center
June 28-July 1, 2005
<http://www.fuelethanolworkshop.com/>

Non-CO2 Greenhouse Gases (NCGG-4)

Utrecht, The Netherlands
Jul. 4 - 2005 to Jul. 6 - 2005
<http://www.milieukundigen.nl/pages/ncgg4/>

Green Power Central and Eastern Europe

September 7-9, 2005
Prague
<http://www.greenpowerconferences.com/events/GreenPowerCEE.htm>

Bioenergy 2005 in Wood Industry: International Conference and Exhibition

September 12-15, 2005
Jyvaskyla, Finland
<http://www.finbioenergy.fi>

Renewable Energy 2006

October 9-13, 2006
Makuhari Messe Japan, www.re2006.org

14th European Conference and Exhibition: Biomass for Energy, Industry and Climate Protection

October 17-21, 2005
Paris, France
http://www.conference-biomass.com/Biomass2005/conference_Welcome.asp

Eurolipids: International Trade Fair for Fats & Oil

November 2-4, 2005
Messe Frankfurt, Germany
<http://www.mfa.de>

Green Power Mediterranean

November 15-16, 2005
Rome, Italy
<http://www.greenpowerconferences.com/events/greenpowermed.htm>

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Please find information below for both the IEA Bioenergy contacts and IEA Bioenergy Task 39 contacts. Additional information is available at www.iea.org and at www.ieabioenergy.com.

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