EERA Bioenergy NEWS

Issue 1 December 2012

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Kai Sipilä, Joint Programme Coordinator



The European Energy Research Alliance (EERA) represents one of the most important initiatives in the public research domain in Europe. Created in 2007 by ten founding institutions, EERA involves today more than 2,000 researchers from over 150 European organisations.

By cooperating and aligning their activities in 13 Joint Programmes (JP), energy research organisations in Europe will be able to accelerate the development of low-carbon technologies and support the European Strategic Energy Technology Plan (SET-Plan). For further information on EERA, please visit <u>www.eera-</u>

<u>set.eu</u>.





The EERA Bioenergy programme started at the beginning of 2010, with full activities continuing until 2013. There are 29 RTD institutions participating from 13 countries with estimated personal resources of 100 person years. Currently there are five focused Sub Programmes on transportation biofuels and bioenergy production;

- Biomass thermochemical processing coordinated by ECN;
- Sugar platform coordinated by LNEG;
- Biofuels from algae coordinated by DTU;
- Cross-cutting issues in bioenergy coordinated by INRA;
- Stationary power and heat from bioenergy coordinated by SINTEF.

In the initial phase, key priority areas and Sub Programmes were selected to follow the priority areas of the European Industrial Bioenergy Initiative (EIBI) and its seven value chains which focus on creating new solutions for biofuels in



Welcome

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transport. EERA acts as a complementary tool to EIBI in the SET-Plan for 2020. The SET -Plan will accelerate the technological development and market introduction of new solutions in order to reach the ambitious 2020 targets in Europe. A new Sub Programme on Heat and Power has been approved supporting the RTD activities highlighted in the European technology platform of Renewable Heating and Cooling. There are 17 participants in this Sub Programme coordinated by SINTEF.

At the EERA annual conference held in Brussels in May 2012, strategic evaluations of new programmes including EERA Bioenergy were presented. The evaluators highlighted the need for strong integration of RTD activities, research infrastructure and future joint activities in order to provide solid RTD support to industrial research and development activities, and to serve as a collaborative basis for increasing the cooperation among national bioenergy research programmes.

In the current EU FWP7 call, a new instrument of integrated research programmes is launched which will open up new attractive opportunities for the EERA Bioeneray Joint Programme (JP). We are actively drafting the application to be delivered at the beginning of January 2013, and if approved by the EC, will start a new phase of work at the end of 2013 for five years. Additionally, the EC and eight member states have opened the call ERANET+ "bioenergy sustaining the future". The seven areas in this call are following the EIBI value chains. Each project consortium should include two industrial and one RTD member from two countries. For industrial large

scale innovative investments, the so called flag ship projects are waiting a final decision from the EC and member states in the NER300 call boosting the demonstration of the next generation biofuels production technologies.

The EERA Bioenergy JP has been operational for two years. Networking has been successful and the first joint efforts and deliverables can been seen. In order to boost the external visibility and networking opportunities we have launched the EERA Bioenergy website www.eera-bioenergy.eu, plus this newsletter. We will be holding an advisory board meeting in January 2013, when representatives from national agencies and industrial persons from technology platforms and energy initiatives will give auidelines on how the collaboration and impact from the EERA Bioenergy JP can be further developed and activated.

The EERA Bioenergy JP has successfully created new joint reports, publications, project programmes, workshops and promotional activities, such as the website, flyers and posters. During 2012 we have successfully improved our working processes and networking skills. The forthcoming year 2013 will be very challenging when actively creating new processes and joint efforts for European and national bioenergy related programmes with increasing interaction with industrial stakeholders.

Kai Sipilä

EERA Bioenergy Structure







Sugar Platform Update



Sub Programme 2



Sub Programme 2 Coordinator Francisco Gírio (LNEG, Portugal)

Overview

This Sub Programme aims to improve the competitiveness of NextGen Biofuels produced within the Sugar Platform, by addressing the following two major value chains of the European Industrial Bioenergy Initiative (EIBI):

- Ethanol and higher alcohols from sugar containing biomass (renewable transportation fuels such as gasoline components, E-85);
- Renewable hydrocarbons
 from sugars containing

biomass via biological and/or chemical processes (main markets: renewable transportation fuels for jet and diesel engines).

The overall objective of this Sub Programme is to align precompetitive research activities at EERA institutes to give a technical and scientific basis for further development of the sugar based route, and to explore the possibilities for joint development of the technology required for the production of biofuels via the sugar platform. The focus is to create a common research agenda that both accelerates progress in removing technology barriers and allows a more robust set of endpoints in the production of second generation biofuels from lignocellulosic biomass by biotechnological approaches.

It comprises three Work Packages (WP) covering precompetitive R&D topics as follows:



WP1 - Biomass Deconstruction

The activities in this Work Package will result in the alignment of analysis methods used for feedstock and products from the deconstruction processes, via information exchange on activities at the different partner institutes, as well as identifying the possibilities for joint development of technology. The main challenge of this WP is to enhance European research cooperation towards standard and mature pre-treatment lowcost technologies for rendering lignocellulosic biomass into fermentable sugars.

The result of the complementary R&D work will contribute to:

- The development of novel pre-treatment processes that improve the economic and ecological performance of the integrated processes;
- The integration of pretreatment with hydrolysis of sugar polymers to reduce costs.

WP2 - Cell Factories and Enzymes

This Work Package includes four research themes relevant to the biochemical route of biomass conversion into biofuels. The goal of the activities is both the improvement of current bioconversion processes, as well as to share the knowledge about the development of novel pathways to biofuels. The main challenges within the WP2 are the improvement of enzymatic hydrolysis of biomass, the fermentation of sugars into existent and novel biofuels, and

Sugar Platform

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the competitive integration of these two bioprocesses.

The result of the complementary R&D work will contribute to:

- Improving the existent biochemical route enabling conversion to biofuels, either through the identification of novel enzymes and/or organisms, or through optimization and/or integration of current bioprocesses;
- Identifying and/or generating novel biochemical pathways for biofuels.

Process integration and scaleup of the processes covered by WP1 and WP2 are critical steps for technology development and industrial deployment in both the medium and long term, in order to leverage the remaining high risk associated with the development of these technologies to market.

WP3 - Pilot Scale and Modelling

The specific strategic goals of this WP are to:

 Develop advanced conversion enhancements to permit sustainable and competitive sugar platform biofuels progress as per: integrated processing (SSF, CBP, enzyme processing integration), high solids loadings, milder conditions, improved separations, cell and/or enzyme recycling;

- Assess production of hydrogen (with MECs) and other gaseous biofuel (Biogas);
- Optimize downstream processing.

The activities in WP3 range from identifying and tackling main hurdles in scaling up

processes of pilot plants to building a common methodology to assess bioprocesses feasibility. The goal is to translate research efforts into near future demo and commercial initiatives undertaken by industry.

In 2011, Sub Programme activities were implemented via:

- Scientific workshops in Amsterdam (July 5th) and Toulouse (Sept 19/20th);
- A joint report about existing pilot plant and equipment infrastructures available for public and private partnerships in Europe amongst EERA members;
- A Round Robin test on the analysis of biomass feedstock, with a comparative analysis of wheat straw among six EERA Bioenergy partners.



Figure 1: In 2011, EERA Bioenergy SP2 ran a Round Robin comparative analysis of wheat straw.

WP updates continued on next page

Work Package Update

WP1: Biomass Deconstruction Coordinator: Herman den Uil (ECN, the Netherlands)

The analysis of the feedstock used and the products (sugars) made is of crucial importance for comparison of the results generated in joint activities. Experience shows that, although analysis protocols exist, it is not obvious that analysis results generated at different research institutes are comparable. Different methods, different practices and also interferences of components not analyzed, e.g. inhibitors formed, can influence the results of the analysis. These topics have been discussed in Amsterdam during a workshop held in July 2011.

A Round Robin study using wheat straw as feedstock has been implemented by six EERA members. More sustainable biomass pre-treatments/fractionation processes are clearly a subject identified as a cornerstone amongst EERA members and further steps for jointly tackle this challenge have been reached. Furthermore, the integration of pre-treatment with enzymatic hydrolysis has also been identified as a future research topic for joint cooperation.



Sugar Platform



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Work Package Update

WP2: Cell Factories & Enzymes Coordinator: César Fonseca (LNEG, Portugal)

The efficient bioconversion of biomass into advanced biofuels represents one of the most critical technological challenges in the bioenergy sector. WP2 addresses the R&D needs for the deployment of biological routes in the conversion of carbohydrates from biomass into ethanol, higher alcohols and hydrocarbons for advanced biofuels.

The main topics covered in WP2 include the enzymatic hydrolysis of biomass, the microbial conversion of sugars into existent and novel biofuels and the competitive integration of these two bioprocesses. In order to establish a common R&D agenda on these topics and align research activities among EERA bioenergy partners, first year activities included two workshops, as follows:

- Consolidated Bioprocessing (CBP) systems, and novel enzymes and organisms for biofuels;
- Biofuels for jet and diesel engines.

During those workshops, EERA partners had the opportunity to present their current R&D activities on WP2 topics and address most of the activities foreseen for the first year:

- Industrial initiatives on advanced biofuels were pointed out, with focus on large scale facilities on second generation bioethanol;
- Current R&D projects in the field involving EERA partners were identified and their scope discussed;
- Key factors on second generation bioethanol technology were highlighted, as benchmarks for the production of advanced biofuels from biomass;
- Specification of fuels and the biochemical routes for the production of advanced biofuels from sugars were introduced;
- The latest R&D developments in the field were discussed and priorities identified.

Among EERA Bioenergy partners, most R&D efforts on WP2 topics have been devoted to enzymatic hydrolysis of biomass and fermentation of lignocellulosic sugars into ethanol. The combination of enzymatic hydrolysis of biomass and the production of advanced biofuels by means of a Consolidated Bioprocessing (CBP) was identified as a research priority for future projects involving EERA partners.

WP2 activities will continue covering the exploitation of microbial biodiversity, metagenomics, biocatalysis, protein engineering, metabolic engineering, fermentation technology and synthetic biology towards advanced biofuels from sugar containing biomass.

See next page for W3 update



Figure 2: WP2's first year activities have included a workshop focusing on biofuels for jet and diesel engines.

Sugar Platform



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Work Package Update

WP3: Pilot Scale and Modelling *Coordinator: Inês Echeverria (CENER, Spain)*

The development and integration of the process, beyond the technological development of its most critical stages, allows its overall assessment and feasibility analysis. This WP aims at identifying and defining joint research efforts to overcome current barriers at pilot and demonstration scale in ethanol and higher alcohol biological conversion paths, and on the deployment of biological and/or chemical processes to produce renewable hydrocarbons from carbohydrates containing biomass.



Between Sub Programme partners, a wide variety of relevant and cutting edge equipment and installations are available. Therefore, the first task in this Work Package was to get a complete view of the available pilot plant infrastructures and equipment for biochemical conversion of biomass into ethanol (or other alcohols, hydrocarbons and chemicals) and gaseous biofuels (biogas and biohydrogen) within EERA Bioenergy SP2 members in order to foster optimal infrastructure sharing and valorisation.

A questionnaire was produced to collect complete information on equipment available per process step as shown in Figure 3 below. After compiling the information, a detailed analysis has been conducted in order to draw-up a distribution of capabilities available for both the whole process, as well as the individual stages of sugar platform biofuels.

The results obtained show that the whole production chain can be reproduced combining capacities identified within the SP2 partnership, and that a wide range of process configurations can be tested and developed. Pre-treatment alternatives include several technologies like steam explosion, dilute acid, autohydrolysis, ultrasonics, wet oxidation and extrusion.

Process configurations range from SSF, SHF to CBP; allowing work in different conditions and to obtain ethanol, butanol and other bioproducts, including gaseous biofuels. Process capacity goes from a few litres to cubic meters in order of magnitude.

Finally, an interactive database of available pilot infrastructures within EERA Bioenergy SP2 partners is currently under construction, in order to better integrate activities and resources regarding sugar platform process development.



Figure 3: The WP3 questionnaire collated equipment information on each of the process steps detailed above.

Cross-Cutting Update



Sub Programme 4



Sub Programme 4 Coordinator Benoît Gabrielle (INRA, France)

Summary

Bioenergy is expected to be a major player in the energy transition toward low-carbon economies, in response to the impending challenges of climate change and dwindling fossil resources. Such high expectations are reflected in aggressive bioenergy targets recently set by the EU and the US, with an expected share of 20% to 30% for biomass within the next 20 years.

This implies a multi-fold increase compared to the present production of biomass, especially for liquid biofuels for transport, and poses major challenges for agriculture and forestry since bioenergy expansion will rely mostly on lignocellulosic species. Firstly, the availability of terrestrial land to grow the feedstock imposes major constraints on potential biomass supply, and secondly the conditions for a sustainable and reliable supply are yet to be defined.

Biomass production interacts with a host of environmental, ecological, economic and social



Figure 1: Harvest of Miscanthus in Mons, northern France (© Stéphane Cadoux, INRA).

issues, ranging from human health to biodiversity and water quality. Its expansion may therefore have negative or positive impacts on the areas where the feedstock is grown depending on local climatic conditions and the design of the bioenergy projects. Optimal use and performance of biomass production systems are regionally specific, but research and development are still needed to provide a generic methodological background to support this goal.

The selection and estimation of the criteria relevant to sustainability is fraught with uncertainties and pitfalls, including:

- Greenhouse gas (GHG) emissions are highly variable over time and space;
- Short-range impacts like water quality strongly depend

on local soil and hydrological conditions;

- Economic costs and profitability vary according to market fluctuations,
- The management and overall performance of energy plants are still being researched.

Stakeholders should be provided with an assessment framework capable of addressing the various dimensions of sustainable development while taking into account issues and characteristics specific to the areas in which bioenergy projects are developed (e.g. the preservation of water resources, biodiversity or soil organic matter stocks).

The Cross-Cutting Sub Programme on sustainable biomass production and

Cross-Cutting Update

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bioenergy chains aims at bridging the knowledge gap on the conditions necessary for the large-scale deployment of bioenergy and biomaterials, and the assessment of their social, economic and environmental impacts.

These will be approached both at supply-area and value-chain levels. Implications for policy design and certification schemes are also analysed, and scenarios to reach the 2020 targets of the EU SET-Plan will be developed.

This Sub Programme comprises three Work Packages (WP):

- WP1 Innovative agricultural and forestry feedstock production systems and supply chains;
- WP2 Analysis of the impact of certification schemes and policy frameworks;
- WP3 Global sustainability analysis of bioenergy systems, deployment scenarios and case-studies.

Sub Programme 4 activities involve workshops, exchanges and benchmarking of data sets, methods and tools, and a joint review of biofuel deployment scenarios, roadmaps and political frameworks in place in the member states of the EU. This Sub Programme organized a workshop in June 2012 in Amsterdam, and contributed to two FP7 projects on improved biomass logistics from forest residues (INFRES) and energy crops (LogistEC*), which started in September 2012.

* See page 12 for further details about the LogistEC project.





Figure 3: Same plot as Figure 2 above. The Miscanthus has been removed in preparation for sowing of wheat. The metal frames are used to monitor N_2O and CO_2 emissions from this plot.

EERA Bioenergy partners involved in Sub Programme 4

- INRA & Metla (coordinators)
- CENER
- CIEMAT
- DTU
- ECN
- ImDea

- LNEG
- SINTEF
- UKERC
- VTT
- WUR



Biofuels from Algae



Sub Programme 3

Synthesis of neutral lipids can be induced by cell-cycle arrest in conditional mutants of two microalgae species

Article by Shuo Yao, Anders Brandt, Helge Egsgaard and Claes Gjermansen (Technical University of Denmark)

We have isolated temperature sensitive cellcycle mutants of Chlamydomonas reinhardtii and Chlorella vulgaris with the aim to identify mutants that over-produce neutral lipids when challenged by higher temperatures. Crucial indicators for the selection of these mutants at the restrictive temperature were a block in cell division but not for growth. As a result, the cells increased in size as a recognizable terminal phenotype.

Most pronounced were the mutants of C. reinhardtii that showed their cellular volume increase as compared with the wild-type cells at the restrictive temperature. Among the temperature sensitive mutants, nine out of forty-one mutants in C. reinhardtii and eleven out of fifty-three in C. vulgaris accumulated neutral lipids at the restrictive temperature under nutrient complete conditions. The remaining temperature sensitive mutants that are arrested in growth are expected to be of a different nature.

As a result of the neutral



Figure 1: Fluorescence microscopy of C. reinhardtii wild-type cells and temperature sensitive mutant cells after 48 hours of incubation at 22°C and 34°C. Nile red stained. Red color, chlorophyll auto fluorescence; yellow gold fluorescence, lipid bodies.

lipids accumulation in temperature sensitive mutants of *C. reinhardtii*, the polar lipids were dramatically decreased and the final amounts of lipid per cell at the permissive and at the restrictive temperatures were quite similar. This suggests that the neutral lipids are produced at the expense of the polar lipids, indicating a shift in lipid metabolism from membrane lipid to storage lipid synthesis in the two out of the three temperature sensitive mutants of *C. reinhardtii* we have isolated.

In non-stressed

Chlamydomonas wild-type cells, the neutral storage lipid is barely detectable while membrane lipids rich in polyunsaturated fatty acids

Biofuels from Algae

Sub Programme 3



Synthesis of neutral lipids can be induced by cell-cycle arrest in conditional mutants of two microalgae species...continued

are present. However, in the temperature sensitive mutants of *C. reinhardtii*, neutral lipids accumulated at the restrictive temperature with a composition rich in saturated and monounsaturated fatty acids similar to many plant oils.

The fatty acid profiles of the neutral lipids in the temperature sensitive mutants of *C. reinhardtii* at the permissive and the restrictive temperature are very similar to the wild-type strain grown under nitrogen deplete and replete conditions, respectively, implicating that temperature sensitivity and nitrogen starvation may have a similar biochemical basis.

The production of microalgae based oil is both dependent on the growth rate, the final cell density and the total lipid per cell. It is encouraging that we were able to isolate mutants that could accumulate neutral lipids at a higher level than the wildtype at the restrictive condition, while growing similar to the wild-type at the permissive condition.

These mutants could contribute to an enhanced lipid production per cell or programmed lipid accumulation, i.e. to use



Figure 2: Triacyl glycerol accumulation in C. reinhardtii wild-type and ts-Cr-37 mutants after 48 hours of incubation at 34°C in TAP medium +/- nitrogen source. Thin layer chromatograms of neutral lipids are shown and lipids were loaded on an equal cell number basis and visualized by brief iodine staining.

temperature as a signal to induce neutral lipid formation. This will be an important next step to evaluate the feasibility of isolating mutants with properties that, without compromising productivity, allow an efficient transition from biomass production to lipid accumulation in a microalgal based biodiesel production process.

Occasionally, we have observed that mutant cells break after prolonged incubation at the restrictive temperature with the consequence that oil droplets are released to the growth medium. This needs to be further investigated and may provide an additional process advantage for neutral lipids at the restrictive temperature under nutrient.

Reference

S. Yao, et al., Neutral lipid accumulation at elevated temperature in conditional mutants of two microalgae species, Plant Physiology and Biochemistry (2012), http:// dx.doi.org/10.1016/j.plaphy.2012.09.007

New Biomass & Waste Database Phyllis2

EERA Bioenergy member, the Energy research Centre of the Netherlands (ECN) has merged its biomass database 'Phyllis' with the BIODAT database as part of its contribution to <u>BRISK</u> Work Package 5. This new database known as 'Phyllis2' is available at <u>www.ecn.nl/</u> <u>phyllis2/</u>.

Here you will be able to find information on the composition of biomass and waste, including analysis data of individual biomass or waste materials, or average values for a group of materials. It enables users to find answers to questions such as:

- What is the average sulphur content of wood?
- What is the ash content of willow?
- What is the average calorific value of chicken manure?

Development of Phyllis2 was co -funded by the EU 7th Framework Programme through the BRISK project.

For further details contact <u>biomass@ecn.nl</u>

The Phyllis2 database contains

information on:

- Algae
- Char
- Fossil fuel
- Grass/plant
- Husk/shell/pit
- Manure
- Non-organic residue
- Organic residue/product
- RDF and MSW
- Sludge
- Straw (stalk/cob/ear)
- Torrefied material
- Treated wood
- Untreated wood
- And many other types of biomass

<u>www.ecn.nl/phyllis2/</u>









LogistEC: New Project



Logistics for Energy Crops Biomass

The LogistEC project started in September 2012 and will end in February 2016. It is funded by the European Commission Seventh Framework Programme.

Objective

Cost-efficient, environmentalfriendly and socially sustainable biomass supply chains are urgently needed to achieve the 2020 targets of the European Strategic Energy Technology Plan (SET-Plan) which are likely to be impeded by the potential scarcity of lignocellulosic biomass from agriculture.

Innovative techniques for crop management, biomass harvesting and pre-treatment, storage and transport offer a prime avenue to increase biomass supply while keeping costs down and minimizing adverse environmental impacts.

The LogistEC project aims at developing new or improved technologies for all steps of the logistics chains, and at assessing their sustainability at supply-area level for small to large-scale bio-based projects. It encompasses all types of lignocellulosic crops: annual and multi-annual crops, perennial grasses, and short-rotation coppice. Through specific metaanalyses, laboratory tests, field trials, ecosystem modelling and mechanical engineering, the project will deliver recommendations for optimal technologies, as well as new equipment and systems.

A framework will be developed to integrate chain components and assess their sustainability in terms of environmental, economic and social impacts. It will enable a multi-criteria optimization of the supply chains, making the most of the progresses achieved in the new logistics technologies. The optimization system will be developed and tested in a set of bioenergy and biomaterial case-studies across Europe.

Improved logistics will be demonstrated at pilot and industrial scales in two regions (eastern France and southern Spain) for existing bioenergy and bio-material value chains. All technology developments will be carried out with industrial partners, to speed up their transfer to market. Project results will be disseminated to the relevant stakeholder groups via scientific and technical conferences, targeted events in connection with the demonstration sites, the project website and newsletters.



See also pages 7-8 for an update from Benoît Gabrielle regarding the EERA Bioenergy Sub Programme 'Cross-Cutting'.



Partners

- INRA (France)
- CIEMAT (Spain)
- Riso DTU (Denmark)
- RRES (UK)
- SINTEF (Norway)
- SSSA (Italy)
- FCBA (France)
- CRL (UK)
- AEBIOM (France)
- MRBB (Norway)
- Nobili SP (Italy)
- SG BioDrying Ltd (UK)
- MHG Systems Oy Itd (Finland)
- Bourgogne Pellets (France)
- CF Nielsen A/S (Denmark)
- Averinox (Netherlands)
- Spapperi (Italy)

For further information contact: Project Coordinator Benoît Gabrielle INRA E: <u>benoit.gabrielle@</u> agroparistech.fr

https://www4.nancy.inra.fr/ sad-aster/Projets/LogistEC

NER Funding Programme



The European Commission has published <u>interim results</u> of the selection process under the first call for proposals of the NER300 funding programme for innovative low-carbon technologies. With the bulk of the project selection work completed, the technical document takes stock of progress and includes preliminary lists of candidate and reserve projects that could be awarded co-funding. The Commission formally asked Member States to confirm the projects and national co-funding in early October 2012, with a view to finalising its funding decisions by the end of this year.

The Commission estimates that co-funding of €1.3-1.5 billion could be available for the first call. This would allow some carbon capture and geological storage projects and up to 16 renewable energy projects to be co-funded.

A number of bioenergy projects are among the Candidates for Award Decisions within the renewable energy section as detailed in <u>SWD(2012) 224 final:</u> <u>NER300 - Moving towards a low</u> <u>carbon economy and boosting</u> <u>innovation, growth and</u> <u>employment across the EU.</u>

Biofuel Research Opportunities



Are you interested in:

- Biofuels?
- Thermal biomass conversion?
- Using the facilities of leading European laboratories?

BRISK opens up a wide variety of research infrastructures via Transnational Access, allowing researchers outside and inside the project to conduct experiments.

Infrastructure is available to all in Europe and qualifying countries. The BRISK network will encourage and facilitate cooperative research in the project partners' laboratories as follows:

- Researchers can apply to go to any of the project partners located outside their home country to utilize the thermal biomass conversion facilities;
- The project will pay for facility access costs along with a grant for travel and subsistence for those researchers based in an eligible country.

Biofuels Research Infrastructure for Sharing Knowledge



Applications for access

If you are interested in applying for access, or require further information please visit the BRISK website.

www.briskeu.com

International Bioenergy Events



DECEMBER 2012

20th-22nd IREC 2012 - The Fourth International Renewable Energy Congress Sousse, Tunisia

JANUARY 2013

21st-22nd Fuels of the Future Berlin, Germany

23rd-24th <u>3rd Annual Biofuels Summit</u> Milan, Italy

27th-30th <u>Bioenergy, Environment and</u> <u>Sustainable Technologies -</u> <u>BEST2013</u> Tiruvannamalai, India

29th-31st BIOGAS Annual Conference and Trade Fair Leipzig, Germany

FEBRUARY 2013

5th-7th National Ethanol Conference Las Vegas, USA

27th-28th Energy from Waste London, UK

27th February-1st March World Sustainable Energy Days 2013 Wels, Austria

MARCH 2013

4th-6th <u>Canadian Biogas Conference</u> <u>and Exhibition</u> Ontario, Canada 12th-14th World Biofuels Markets Rotterdam, Netherlands

13th-14th Bio-based Chemicals Rotterdam, Netherlands

19th-21st Green Polymer Chemistry 2013 Cologne, Germany

20th-24th Salon Bois Energie 2013 Nantes, France

APRIL 2013

8th-10th International Biomass Conference & Expo Minneapolis, USA

10th-11th <u>European Biomass to Power</u> Krakow, Poland

16th-18th <u>Sustainability Live</u> Birmingham, UK

17th-18th <mark>Argus European Biomass <u>Trading</u> London, UK</mark>

23rd-25th BioGas World 2013 Berlin, Germany

24th-25th European Algae Biomass Vienna, Austria

25th-27th <u>The 3rd Annual Congress of</u> <u>Bioenergy</u> Nanjing, China 25th-27th <u>RENEXPO® Central Europe</u> Budapest, Hungary

MAY 2013

16th-17th World Biomass Power Markets Amsterdam, Netherlands

JUNE 2013

3rd-7th 21st European Biomass Conference and Exhibition Copenhagen, Denmark

5th-7th <u>RRB-9 Renewable Resources</u> <u>& Biorefineries</u> Antwerp, Belgium

9th-14th BioEnergy IV: Innovations in Biomass Conversion for Heat, Power, Fuels and Chemicals Otranto, Italy

17th-19th <u>AEBIOM Bioenergy</u> <u>Conference</u> Brussels, Belgium

JULY 2013

3rd-4th <u>UK AD & Biogas 2013</u> Birmingham, UK

3rd-5th Bioenergy China Beijing, China



Biomass through Applied R&D and Business Strategy

The conference will have a heavy focus on case study examples of latest technologies in operation in • Harvesting, dewatering, drying and oil extraction: the global algae industry and low-cost production of microalgae. Discussion will focus on technical challenges faced when optimising the cultivation of algae, the current and future commercial markets for • Biofuel production and biorefining; algae products, and the challenges faced during the commercialisation process including the views from three different end markets.

- Accelerating the Commercialisation of Algal The future for European algae biomass: View from diverse markets;
 - Algal culture systems: Latest developments from laboratory and field;
 - Maximising efficiency & reducing cost;
 - Commercial algae production: Case study examples:

 - Algae-based CO₂ capture;

T: +44 20 7981 2503

 Algae as an investment opportunity: An investor's viewpoint.

Key topics will include:

- Commercial market analysis and forecasts;
- Strain selection and genetic engineering;
- www.wplgroup.com/aci/conferences/eu-eal3.asp



BC&E 2013

21st European Biomass Conference and Exhibition etting the course for a biobased economy Bella Center - Copenhagen, Denmark • Conference 3 - 7 June 2013 • Exhibition 3 - 6 June 2013

For over 30 years, the European Biomass Conference and Exhibition (EU BC&E) has combined a very renowned international scientific conference with an industry exhibition. The EU BC&E is held at different venues throughout Europe and ranks on top of the world's leading events in the biomass sector.

It provides a high-level scientific programme and parallel events which attract participants from wide ranging backgrounds: researchers, engineers, technologists, standards organisations, financing institutions and others.

Such a global exchange platform of current knowledge in turn attracts industrial exhibitors, making the conference events a significant tool for technology transfer and innovation.

This event is supported by European and international organizations such as the European Commission, UNESCO - United Nations Educational, Scientific and Cultural Organization,

Natural Sciences Sector, WCRE - the World Council for Renewable Energy, EUBIA - the European Biomass Industry Association, and other organisations.

The technical programme is coordinated by the European Commission, Joint Research Centre-JRC.

Conference subjects will include:

- Biomass resources:
- R&D on biomass conversion technologies for heating, electricity and chemicals;
- R&D on processes for solid, liquid and gaseous fuels from biomass:
- Industrial demonstration and business concepts;
- Biomass policies, markets and sustainability. •

For further information contact:

T: +39 055 5002280 ext. 221

E: biomass.conference@etaflorence.it

www.conference-biomass.com



BioEnergy IV: Innovations in Biomass Conversion for Heat, Power, Fuels and Chemicals

Engineering Conferences International

An ECI Conference Series

June 9-14, 2013

Basiliani Resort, Otranto, Italy

This conference will address the scientific and technological challenges for biomass conversion into heat and power, fuel and chemicals. It will:

- Highlight the current progress in bioenergy and biomass conversion research and development;
- Identify industrial successes and good practices;
- Discuss the most promising future directions;
- Assess the means to overcome the current constraints for commercialization of biochemical and thermochemical technologies and downstream refining.



http://www.engconfintl.org/13aa.html



The **AEBIOM Bioenergy Conference** organized by the European Biomass Association is the fourth edition of the growing series. The annual conference has grown ever since its first edition in 2010 and has quickly become Europe's major occasion for discussion and networking amongst important industry leaders and policy makers.

Bioenergy is the largest renewable energy source in Europe and we expect around 300 industry representatives to be present at this event which is one of the leading bioenergy conferences in Europe.

The 4th edition will be co-organized with the European Pellet Council and the Industrial European Pellet Suppliers. The event is supported by the European Biogas Association'

www.aebiom.org/conference T: +32 24 00 10 29 E: <u>olaru@aebiom.org</u>



Useful Publications





BIOFUELS

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Biomass and Bioenergy: Special

Issue, Volume 38 Overcoming Barriers to Bioenergy: Outcomes of the Bioenergy Network of Excellence 2003-2009 Edited by A.V. Bridgwater Publisher: Elsevier Publication Date: March 2012

Biofuels - Alternative Feedstocks and Conversion Processes Edited by Ashok Pandey, Christian Larroche, Steven Ricke, Claude-Gilles Dussap, Edgard Gnansounou Publisher: Elsevier Publication Date: July 2011



The Pellet Handbook - the Production and Thermal Utilization of Biomass Pellets Authors: Ingwald Obernberger and Gerold Thek Publisher: Earthscan Publication Date: September 2010



Proceedings of the Bioten Conference on Biomass, Bioenergy and Biofuels 2010; Bioten Edited by A.V. Bridgwater Publisher: CPL Press Publication Date: October 2011



Biomass Gasification and Pyrolysis - Practical Design and Theory Author: Prabir Basu Publisher: Academic Press Publication Date: June 2010



Thermochemical Processing of Biomass: Conversion into Fuels, Chemicals and Power Edited by Robert C Brown Publisher: Wiley Publication Date: March 2011



Botes



PelHeat

The Beginners Guide To Pellet Production







Biomass Pyrolysis - A Guide to UK Capabilities

Edited by A.V. Bridgwater and I.I. Watkinson Publisher: Aston University Publication Date: May 2011 *To download a free copy of this guide visit <u>www.pyne.co.uk/?_id=120</u>*

Biofuels: Ethical Issues

Publisher: Nuffield Council on Bioethics Publication Date: April 2011 *To download a free copy of this guide visit: <u>www.nuffieldbioethics.org/</u> <u>biofuels-0</u>*

Bioliquids-CHP

Power Generation from Biomass Main Project Results 2011 To download this brochure click on the 'Bioliquids-CHP' link above.

Beginners Guide to Pellet

Production Publisher: PelHeat Click on the above links to download this and other free guides from PelHeat.

BRISK NEWS

Published November 2012 The newsletter of the BRISK Consortium (Biofuels Research Infrastructure for Sharing Knowledge) To download this free newsletter visit the Publications section at www.briskeu.com

Handbook Biomass Gasification Second Edition Edited by: H.A.F. Knoef Publisher: BTG Biomass Technology Group BV Publication Date: September 2012

To visit the website of each of these publications click on the relevant title to open the hyperlink.





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