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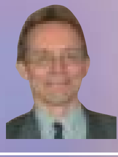

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# Energy And Activated Carbon From Environmental Tree Crops

*By Colin Stucley, Enecon Pty Ltd, Australia*

An innovative demonstration-scale Integrated Wood Processing (IWP) plant, which combines power generation and co-products as commercial drivers for environmental tree planting, is being constructed by energy company Western Power in the Western Australian wheatbelt town of Narrogin.

*Figure 1: Construction work on demonstration plant in WA, February 2003. Photo courtesy of Western Power Corporation.*

*Figure 2: Belts of trees across Western Australian farmland help manage water and salinity.*

Australia faces a major environmental problem from a phenomenon known as dryland salinity, which is causing widespread salt and water damage to farms and rural infrastructure. Planting trees helps reduce salinity, as transpiration by trees helps to lower the water table to safe levels. In Western Australia, the Department of Conservation and Land Management (CALM) has initiated large scale plantings of native mallee eucalypt trees. These are planted in rows through productive agricultural land, allowing farmers to continue farming with annual crops or livestock. The rows of mallees can be harvested regularly and new trees coppice successfully from the stumps. Over the past decade hundreds of farmers in WA have planted more than 20 million mallee trees.

Commercial uses for the trees will greatly increase the scale of tree planting. In low rainfall areas conventional plantation forestry is not competitive and mallees were initially selected as a tree crop with the aim of commercial returns from eucalyptus oil distilled from the mallee leaves.

## Expert Meeting on Pyrolysis and Gasification of Biomass and Waste

*Further details on page 13.*

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**Co-ordinator**
Tony Bridgwater

**Newsletter & Website Administrator**
Claire Humphreys

Bio-Energy Research Group,
Aston University, Birmingham B4 7ET.
UNITED KINGDOM.
**Tel** +44 121 359 3611
**Fax** +44 121 359 6814

**Email** a.v.bridgwater@aston.ac.uk
c.l.humphreys@aston.ac.uk

**Website** http://www.pyne.co.uk

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In 1998 Enecon developed the concept of integrated wood processing, which combines extraction of oil from the leaves, manufacture of activated carbon from the wood, and recovery of energy from the processes and residues. Enecon is the managing licensee for activated carbon technology developed by CSIRO. This technology uses fluidised beds, firstly for production of charcoal and then for steam activation of the charcoal to make activated carbon. Thus far, CSIRO has taken the technology to the pilot scale.

The IWP concept was introduced to Western Power Corporation, which, together with the Rural Industries R&D Corporation, provided funding for feasibility studies in 1999. The results of the studies were encouraging, and a decision was made by Western Power to build a demonstration scale plant that would prove-up the technology and the feedstock delivery systems. Financial support for this plant from the Australian Greenhouse Office and Ausindustry is gratefully acknowledged. Western Power has established a wholly owned subsidiary, Western Carbon Pty Ltd, which is the owner of the plant and intellectual property associated with it.

A schematic diagram for the plant is provided below. The plant will process 20,000 tonne/year of fresh, whole tree feed. This feed can allow the production of approximately:

- 700 tonne/year of activated carbon for water treatment applications.
- up to 250 tonne/year of eucalyptus oil for use as a natural solvent.
- 1 MW of renewable electricity.

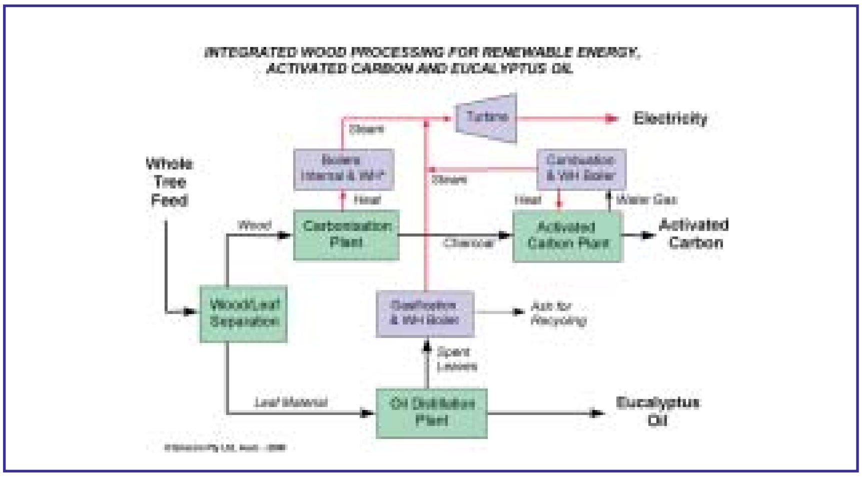


*Figure 3: Integrated wood processing for renewable energy, activated carbon & Eucalyptus Oil.*

Considerable work has been required to design a full-scale plant, and the system is still unproven. With construction now well underway, plant commissioning is expected to commence mid 2003, but it may be the end of the year before the plant is proven commercially.

Success with this first plant will open the way for a number of larger plants to be built by Western Carbon in years to come. These large, integrated processing plants will provide commercial incentives for environmental tree planting and also act as a major driver for employment and income for rural communities. It is also hoped that success in this new industry will show the way for other examples of energy and co-products to be developed into new, commercial forestry industries in rural Australia.

***For further details contact:***

Colin Stucley
Managing Director
Enecon Pty Ltd
35 Whitehorse Rd
Deepdene
Victoria 3103
Australia
Tel: +61 3 9817 6255
Fax: +61 3 9817 6455
Email: cstucley@enecon.com.au
Website: www.enecon.com.au

# Renewable resins for industrial wood based panel production – RenuResin

## EC Contract QLK5-CT-2002-01596

*By Tony Bridgwater, project coordinator*

Aston University

The overall objective is to develop and produce a renewable and sustainable substitute for phenolic adhesive resins for use in the wood-based panel industry that will produce end-products which fully meet all national and European standards.

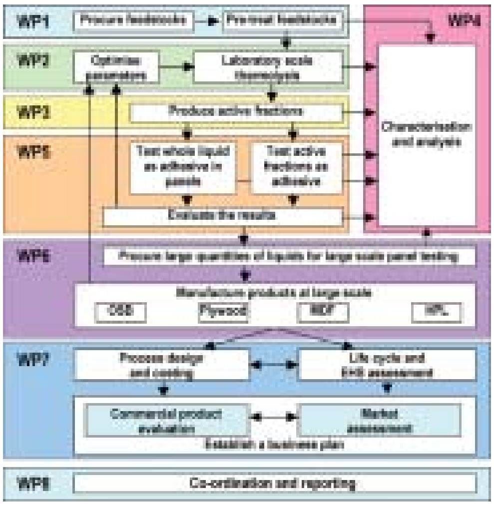


*Figure 1: Structure and activities in the project.*

The specific aims of the project are to:

- Produce a range of liquids from different biomass types under different pyrolysis conditions, paying particular attention to methods for increasing the liquid reactivity and improving product acceptability in terms of reduced odour.
- Separate the liquid into the active fractions of phenolics and aldehydes as an alternative or complementary approach to maximising effectiveness of the process and the product.
- Test each whole liquid and separated liquid fraction at laboratory scale for their effectiveness as a substitute for synthetic resins in a variety of products in the wood panel industry including medium density fibreboards, oriented strand boards, plywood, and high pressure laminates with the objectives of maximising substitution of phenol and formaldehyde.
- Evaluate the results of these laboratory tests on wood panel products and test the most promising liquids at pilot and industrial scales of production.
- Carry out a comprehensive technical, economic, environmental (life cycle and safety) and sectoral market assessment of the complete process and the preferred resin products. This will provide detailed product costs and the size and extent of the potential market for each product application.

The structure and activities are summarised in Figure 1 and the partners at the kick-off meeting are shown in Figure 2.

The project started on 1 January 2003 and will run for 3 years. The contract value is €1.64 million.

*Figure 2a & b: Partners at the Kick-off meeting.*

### PARTNERSHIP

Co-ordinator
Tony Bridgwater
Aston University
Bio-Energy Research Group
Chemical Engineering & Applied Chemistry Subject Group
Birmingham
B4 7ET, UK
Tel: +44 121 359 3611
Fax: +44 121 359 6814
Email: a.v.bridgwater@aston.ac.uk

**Partners**

Eleftheria Athanassiadou
Adhesives Research Institute Ltd (ARI)
88, Them. Sofouli Str
Kalamaria, Thessaloniki
GR-551 31, GREECE
Tel: +30 2310 424167
Fax: +30 2310 424149
Email: eathan@ari.gr

Dietrich Meier
IWC – Institute for Wood Chemistry
Leuschnerstrasse 91, Hamburg
D-21031, GERMANY
Tel: +49 40 739 62 517 or 516
Fax: +49 40 739 62 502 (Almost direct)
Email: d.meier@holz.uni-hamburg.de

Gerfried Jungmeier and Niv Graf
Joanneum Research
Institute of Energy Research
Elisabethstr. 5, Graz
8010, AUSTRIA
Tel: +43 316 876 1313
Fax: +43 316 876 1320
Email: gerfried.jungmeier@joanneum.at

and

Tel: +43 316 876 2441
Fax: +43 316 876 2441
Email: niv.graf@joanneum.a

Dennis Rasmusson and Geer Schuren
Trespa International
Wetering, 20, Postbus 110
Weert, 6000 AC
NETHERLANDS
Tel: +31 495 458 803
Email: d.rasmusson@trespa.com

and

Tel: +31 495 458 296
Fax: +31 495 458 878
Email: g.schuren@trespa.nl

Aires Coutinho and Isabel Lucas
Valbopan
Quinta do Castelo
Famalicao da Nazaré
2450, PORTUGAL
Tel: +351 262 569060
Fax: +351 262 569061
Email: acoutinho@investwood.pt

and

Tel: +351 262 569 060
Fax: +351 262 569 066 (direct)
Email: ilucas@investwood.pt

# An Assessment of Bio-Oil Toxicity for Safe Handling and Transportation – Biotox

## Contract n°: NNE5-2001-00744

*By Philippe Girard, CIRAD- Forêt, FRANCE*

*BIOTOX Kick off meeting, February 2003.*

### Objectives

The aim is to comprehensively assess the toxicity and biodegradability of a representative bio-oil after preliminary screening of a wide range of bio-oils from different processes and temperatures in order to:

- identify the best operating conditions to avoid or minimise toxic components in bio-oils.
- produce a comprehensive and definitive MSDS with the proper preventive and remedial procedures to adopt during production, transport and use of bio-oils.
- to minimise the impact of bio-oil during production and transport on human health and environment by avoiding bio-oils production presenting potential toxic characteristics.

### Methodology and Approach

The project will proceed in four steps as follow:

*Bio-oils production and procurement*

Bio-oil composition strongly depends on feedstock, pyrolysis technology and process conditions. Bio-oils will be produced from different reactors (fluid bed, rotating cone, circulating fluid bed, ablative pyrolysis, vacuum pyrolysis) and under different temperature conditions (450 to 600°C) in order to relate those parameters to oil composition, toxicological characteristics and biodegradability.

*Bio-oils analysis and screening tests*

These will concern chemical and physical analyses of oils, determination of concentration ranges in each chemical family and characterisation of the oils versus operating conditions. These analyses will be completed with toxicological screening tests for a first evaluation of bio-oils toxicity and biodegradability.

*Complete toxicological and eco-toxicological test*

Complete analyses will be carried out on a selected oil, representative of the market and based on the previous results, to test their behaviour in terms of toxicology, eco-toxicology and biodegradability.

*Recommendations for safety procedures and dissemination of the results*

This will include the preparation and presentation of the “dossier” for substance notification, and recommendations on the best operating conditions to be used to obtain environmentally friendly products. Dissemination of the results and recommendations will be done through PyNe.

***For further information please contact:***

**Co-ordinator**
Dr Philippe Girard
CIRAD – Forêt
Energy Environmental Unit
TA 10/16
73 Rue Jean Francois Breton
Montpellier Cedex 5
34398, FRANCE
Tel: +33 4 67 61 44 90
Fax: +33 4 67 61 65 15
Email: philippe.girard@cirad.fr

**PARTNERS**

| | |
|---|---|
| Cirad-Forêt | France |
| Aston University | UK |
| BFH | Germany |

**Sub Contractors**

| | |
|---|---|
| CARE | UK |
| CIT | France |

# A new competitive liquid biofuel for heating – combio

## Contract no ENK5-CT-2002 00690

*By Yrjö Solantausta, VTT Processes, FINLAND*

### Objectives

The general aim of the project is to verify a new liquid biofuel chain for heat production. The following specific scientific objectives are defined to solve major technical problems and to address the principal economic uncertainties within the proposed scheme:

1) Generation of process performance data (proof of a concept) of pilot-scale pyrolysis oil (PO) production.

2) Defining three classes of preliminary PO fuel specifications.

3) Generation and reporting of performance and emission data of various boilers in long term tests.

4) Generation of fundamental PO combustion data to assist in developing higher quality fuels with less emissions.

5) Improving PO fuel quality in PDU-scale. Two main technologies are studied: emulsions and hot vapour filtration (HVF).

6) Improving economic competitiveness of the bioenergy chain.

| Participant | Contact | |
|---|---|---|
| VTT Processes | Yrjö Solantausta<br>VTT Processes<br>PO Box 1601<br>FIN-02044 VTT, Espoo, Finland | Tel +358-9-456 5517<br>fax +358-9-460 493<br>yrjo.solantausta@vtt.fi |
| Fortum Oil and Gas | Steven Gust<br>Fortum Oy<br>P.O. Box 310<br>FIN-06101 Porvoo, Finland | Tel +358 10 452 3738<br>Fax +358 10 452 6691<br>steven.gust@fortum.com |
| CGSI – University of Florence | Piero Baglioni / David Chiramonti<br>Conzorzio interuniversitario per lo Sviluppo dei Sistemi a Grande Interfase – CSGI<br>Via della Lastruccia 3<br>I-50119 Sesto Fiorentino – Florence, Italy | Tel +39-055-457 3033<br>Fax +39-055-457 3036<br>baglioni@apple.csgi.unifi.it<br>d.chiaramonti@ingfi1.ing.unifi.it |
| Istituto Motori – CNR | Patrizio Massoli<br>Istituto Motori – CNR<br>Viale Guglielmo Marconi 8<br>I-80125 Napoli, Italy | Tel +39-081-7177 183<br>Fax +39-081-239 6097<br>p.massoli@motori.im.na.cnr.it |
| Fortum Värme | Eva-Katrin Lindman<br>AB Fortum Värme samägt med Stockholm stad<br>Tegeluddsvägen 1<br>S-11577 Stockholm, Sweden | Tel +46-8-671 7000<br>eva.katrin.lindman@fortum.com |
| Vapo | Timo Nyrönen<br>Vapo Oy<br>PL 20<br>FIN-40101 Jyväskylä, Finland | Tel. +358-14-623 623<br>Fax +358-14-623 5622<br>timo.nyronen@vapo.fi |
| ETA | Gianluca Tondi<br>ETA – Energia Transporti Agricolture S.r.l<br>Piazza Savonarola 10<br>I-50132 Florence, Italy | Tel +39-055-500 2174<br>Fax +39-055-573 425<br>gianluca.tondi@etaflorence.it |

### Description of the work and Expected Results

The pyrolysis process is able to produce high yields of liquid products which can be shipped, stored and utilised more economically than solid fuels in the small to medium size class. However, up to date there have been no long-term experiences with pyrolysis oil (PO) in this size class due to lack of sufficient quantities of suitable quality fuel. To confirm the concepts proposed and to satisfy future market requirements, the project will generate data and know-how on selected technical and economic aspects related to the whole utilisation chain. A stage-wise approach for R&D work is adopted in this project. The first stage is to verify continuous pilot-scale production of PO (proof of a concept), followed by industrial scale use in a boiler. Initially heavy fuel oil (HFO) will be replaced. Based on earlier short-term tests, this is technically feasible, but longer time experiments are needed to generate performance and emission data and to improve handling procedures of PO. This approach makes it possible to verify and develop the whole utilisation chain, which is a necessary step before further R&D on improving product quality. In this project, large quantities of PO are produced, long-term utilisation tests are carried out, fuel specifications for PO are determined, PO quality is improved, and the whole concept from biomass to PO use is verified from market perspective.

### Exploitation Plans

It is envisaged that to be able to enter into heating fuel markets, the new liquid biofuel chain has: 1) To be competitive economically with chips, pellets, and light fuel oil (LFO) in heat production, and 2) To fulfil specifications required by users. The companies involved have plans of producing and using PO.
The R&D organisations aim in improving the process and PO quality.



# Fast Pyroliquefaction or Pyrogasification of Biomass in a Cyclone Reactor

*By Jacques Lédé, Monique Ferrer and François Broust, CNRS-LSGC, Nancy (France)*

The concept of biomass fast pyrolysis appeared in 1975 with the aim of producing maximum fractions of gases (CO, $H_2$, ethylene, acetylene, ...). Nowadays, it is mainly carried out for the optimal production of liquids (bio oils). In most of the processes of biomass thermal upgrading, cyclones are settled downstream of the reactor in order to separate the solid particles.

The use of a cyclone heated at its walls as the reactor itself, offers several advantages – Table 1, ref. (1). The CNRS Laboratoire des Sciences du Génie Chimique of Nancy (France) is working on the feasibility of such a process at the micropilot scale (ADEME and CNRS contract). One of the aims is to evidence the possibility of producing either maximum yields of oils (fast pyroliquefaction) or of gases (fast pyrogasification) in a single cyclone reactor.

### Experimental set up and main results

The set up includes a refractory stainless steel cyclone reactor (6cm diameter and 500cm$^3$ volume) heated by induction. It is fed by a steady state flow of wood sawdust (500-800 µm) delivered by a screw feeder and transported by an inert gas and/or steam. While the char is automatically separated at the bottom, the gases and vapours products escape at the top. Liquids and aerosols are collected in a series of condensers and filters. The permanent gases are analysed by chromatography.

With mass balances closures between 85 and 108%, the main results are:

- The char fractions range between 5 and 15%, depending on the reactor temperature and the nature of carrier gas.
- The maximum biomass throughput is close to 1kg/h, a noticeable capacity considering the small volume of the reactor.
- The gases and oils fractions considerably depend on walls temperature (Figure 1). Oils yields of about 75% are reached near 900K in fast pyroliquefaction, while gas yields reach 85% near 1200K in fast pyrogasification (2). Similar variations (3) are observed with smaller cyclones (2.8 and 4cm).
- The gases may contain up to 80% of $H_2$+CO mol fractions and their heating values may reach 18 MJ/Nm$^3$.

### Theoretical developments

The complete mathematical modelling of the reactor is now in progress in order to derive general scaling up relationships. It includes several laws representing: heating and hydrodynamics of the gas and solid phases; the consumption of biomass particles (chemical and transfer elementary processes); the production of gases or oils by either the thermal cracking or quenching of the primary liquids and vapours.

An important result is that cracking may occur inside the main volume of the reactor, and also inside a thin hot boundary layer close to the walls (1).

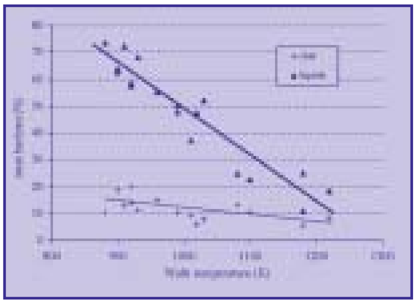

*Figure 1 : Mass fractions of char and oils Gas fractions are close to the complement to 100% (good mass balances).*

*Table 1: Main advantages of the cyclone reactor.*

- Efficient particles–hot walls heat exchanges.
- Multifunctional reactor : heating and pyrolysis of particles, separation of solid products and cracking and/or quenching, in the same vessel (in about 1s).
- Hydrodynamics of particles comparable to a plug flow.
- Particles residence time adjustable, at will, by changing carrier gas flowrate.
- Residence times of particles and gas vary in opposite ways.
- Temperature reached by the gas lower than that of the particles.
- Minimization or enhancement of secondary cracking reactions by simply changing the experimental parameters.
- High particles throughput for a small volume of reactor.
- Scaling laws for hydrodynamics and transfer processes already known for both phases.

### References :

(1) Lédé, J. The cyclone : a multifunctional reactor for the fast pyrolysis of biomass. Ind. Eng. Chem. Res., 39 (2000), 893-903.

(2) Broust, F., Lédé, J., Ferrer, M. Fast Pyrolysis of Biomass in a Multifunctional Cyclone Reactor. To be published in the Proceedings of AIChE 2002 Annual Meeting, Indianapolis, In. USA. Nov 4-8th. 2002.

(3) Lédé, J., Broust, F., Ferrer, M. Fast Pyrogasification and/or Pyroliquefaction of Biomass in a Cyclone Reactor. To be published in "Pyrolysis and Gasification of Biomass and Waste. Expert Meeting", Strasbourg, France. Sept 30th-Oct 1st 2002. CPL Press.

***For further information please contact:***

Dr Jacques Lédé
Laboratoire des Sciences du Génie Chimique
1, rue Grandville – BP 451 – 54001
NANCY Cedex
France
Tel: +33 (0)3.83.17.52.40
Fax: +33 (0)3.83.32.29.75
Email: Jacques.Lede@ensic.inpl-nancy.fr

# Belgian actors in pyrolysis technologies and research

*By Yves SCHENKEL, CRA, Belgium*

A survey of companies, universities, research centres active or interested in pyrolysis technologies was conducted in Belgium in 2001. A questionnaire was sent to all the members of the PyNe Belgian database (35 members). Nine of them replied and sent back their completed questionnaires: 4 equipment manufacturers, 1 consultant, 4 departments of universities and research centres.

The questionnaire was short, covering the following issues: type of organization, pyrolysis activity and services offered. The results of this survey are described below, starting with the 4 manufacturers, then the consultant and the research organizations.

*Figure 1: CRA – Pyrolysis gases analysing system.*

### BOUGARD ENGINEERING

BOUGARD ENGINEERING is a manufacturer of concentrated and submerged combustion equipment, suitable to burn gasifier, pyrolysis and thermolysis gases as well as other gases and fuels. The range of products consists in hot gases direct generators, water evaporator, water heating systems (direct and indirect). The nominal power of these equipment ranges from 250 to 16000 kW. The company also offers engineering services.

***For details please contact:***

Mr. BOUGARD
Tel: +32 67 214367
Fax: +32 67 221177

### LAMBIOTTE & Cie

LAMBIOTTE & Cie is a supplier of carbonisation retorts as well as engineering services. The Lambiotte SIFIC/CISR retorts are carbonisation vertical retorts producing between 2000 to 6000 tons of charcoal per year on a continuous basis. Lambiotte & Cie also offers licensing possibilities for technology transfer.

***For details please contact:***

Ms. F. HERLA
Tel: +32 2 3744465
Fax: +32 2 3753155
Email: mail@lambiotte.com

### UMICORE ENGINEERING

UMICORE ENGINEERING (former NESA) is a provider of service and supplier of turn-key industrial units used in the field of environment protection. These units are based on the use of various technologies including those of multiple hearth furnace, fluidised bed furnace and rotary kiln. The company has developed and marketed an original pyrolysis process for thermal valorisation of wastes, including plastic residues and waste paper sludge with production of energy as well as by-products to be recycled and valorised such as metakaolin. Several industrial references in the field of pyrolysis for more than 20 years. UMICORE ENGINEERING also offers the service of a testing facility.

***For details please contact:***

Mr. J-P MAUCHIEN
Tel: +32 10 475611
Fax: +32 10 450401
Email: jeanpierre.mauchien@um.be

### CENTRE DE RECHERCHES AGRONOMIQUES, CRA

CRAs' Department of Agricultural Engineering activities in the field of slow pyrolysis have been described in PyNe Newsletter issue 9. Research is focused on interactions between the biofuel physico-chemical characteristics, carbonisation operational parameters and products (gas, oil and charcoal). Tests are also conducted on demolition and contaminated wood thermolysis treatment. CRA also offers laboratory services for biofuels physico-mechanical analysis (ultimate and proximate composition, density, etc). The CRA Pyrolysis gases analysing system can be seen in Figure 1.

***For details please contact:***

Dr. Y. SCHENKEL
Tel: +32 81 627148
Fax: +32 81 615847
Email: schenkel @cragx.fgov.be
Website: www.cragx.fogv.be

*Figure 2: Photo of the glass fiber pyrolysis recycling plant of ISOVER NV developed by ISSeP.*

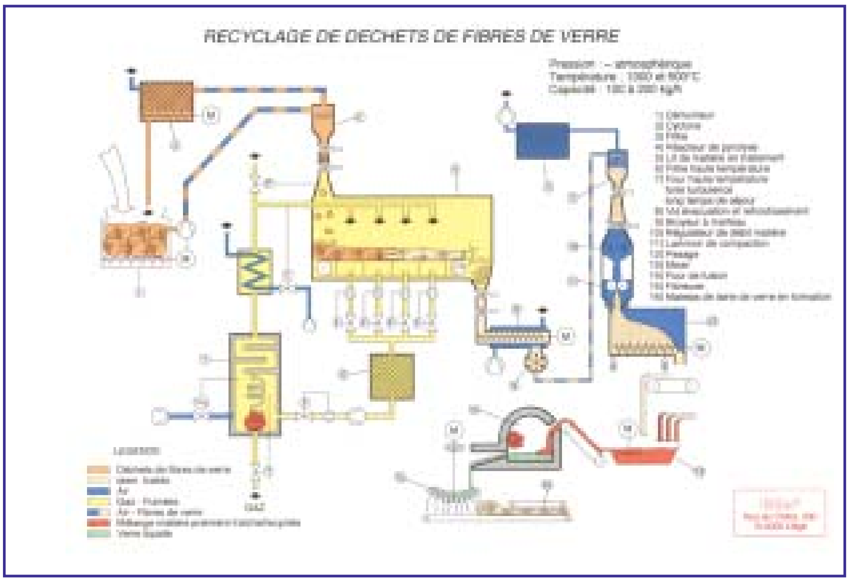


*Figure 3: Flowsheet of the glass fiber pyrolysis recycling plant of ISOVER NV developed by ISSeP.*

**DE SMET ENGINEERING**

DE SMET ENGINEERING is a manufacturer and supplier of equipment and engineering for edible oil processing.

***For details please contact:***

Mr. V. VAN DEN SCHRIECK
Tel: +32 3 4440400
Fax: +32 3 4440444
Email: vvs@desmetgroup.com

**FAC CONSULT**

FAC CONSULT provides services of consulting in the field of bioenergy and pyrolysis in particular. The company carries out technico-economic and market surveys.

***For details please contact:***

Mr. H. ZIBETTA
Tel/fax: +32 2 6468520
Email: anetec@linkline.be

**ISSEP**

ISSEP (Institut Scientifique de Service Public), is a research centre, has conducted studies, erected many pilot plants on flash pyrolysis and thermolysis : hydrogenopyrolysis under pressure of peat, recovery of glasses wood after pyrolysis of phenolic resin (one demonstration unit is still running in the Netherlands). ISSEP has also carried out studies or market surveys, environmental impacts, health and safety of pyrolysis technologies. The institute provides services such as testing facilities, laboratory analyses and engineering studies. The ISSeP glass fibre pyrolysis recycling plant of ISOVER NV can be seen in Figures 2 and 3.

***For details please contact:***

Mr. D. PLATIAU
Tel: +32 4 2298217
Fax: +32 4 2524665
Email: d.platiau@issep.be

Figure 4: Experimental facility for the pyrolysis of wood chips: downdraft fixed bed reactor with gas cleaning system.

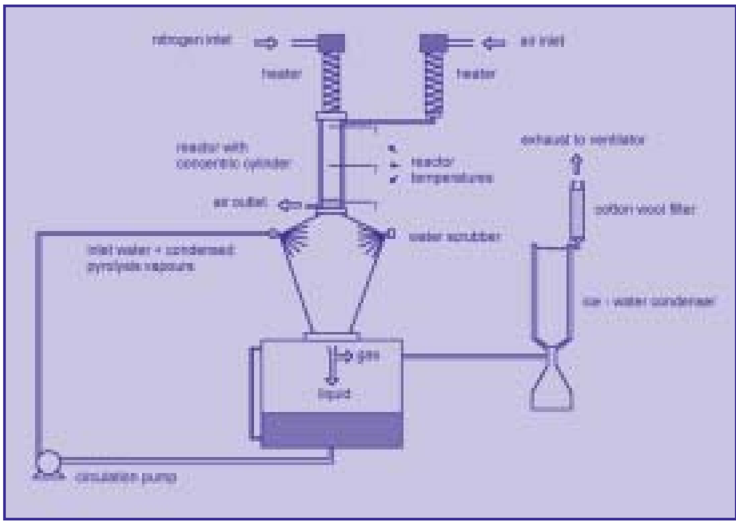


*Figure 5: Schematic presentation of the Experimental facility for the pyrolysis of wood chips: downdraft fixed bed reactor with gas cleaning system.*

*Figure 6: The laboratory batch rotating pyrolysis furnace (capacity 200g, up to 650ºC).*

### CATHOLIC UNIVERSITY LEUVEN – KUL

The Division Applied Mechanics and Energy Conversion (TME) of the Mechanical Engineering Department of the Catholic University Leuven (KUL) has investigated the fundamentals of slow pyrolysis applied to metal impregnated wood waste (see PyNe Newsletter issue 12). Particular attention is paid to the behaviour of the metals (arsenic, copper and chromium) during the pyrolysis process in order to develop a safe and environmental friendly valorisation technology. TME also offers engineering services (laboratory and modelling studies). The experimental facility of the pyrolysis of wood chips: downdraft fixed bed reactor with gas cleaning system can bee seen in Figures 4 and 5.

***For details please contact:***

Dr. L. HELSEN
Tel: +32 16 322505
Fax: +32 16322985
Email: lieve.helsen@mech.kuleuven.ac.be

### GENERAL CHEMISTRY AND CARBOCHEMISTRY UNIT (GCCC)

The General Chemistry and Carbochemistry Unit (GCCC) of the Free University of Brussels (ULB) conducts fundamental research and techno-economic studies on the thermolysis of waste materials. Several aspects are covered: material and energy upgrading, tests from laboratory to pilot scale, pollutant tracing and interactions, techno-economic evaluation of waste treatment processes. ULB-GCCC Unit provides services such as testing facilities, laboratory analyses, economic and market studies. The laboratory batch rotating pyrolysis furnace (capacity 200g, up to 650ºC) can be seen in Figure 6.

***For details please contact:***

Prof. A. FONTANA
Tel: +32 2 6502988
Fax: +32 2 6503575
Email: afontana@ulb.ac.be

# Recovery of chemicals from pyrolignous liquors from charcoal production

*By Jean-Guy Mares, France*

The production of charcoal results in a liquid by-product often referred to as pyroligneous liquor. This contains many potentially valuable organic chemicals. Figure 1 shows the basic flow from pyroligneous condensates to the main families of products. It was applied at Usine Lambiotte in Prémery, central France, recently closed; and is still partly applied by Chemviron in Bodenfelde, Germany and in a few plants still operating in Eastern European countries. Figure 1 shows details of the carbonisation plant at Premery. The pyroligneous condensates from slow carbonisation of wood contain around 70% water, 10% acetic acid, 2% methanol, and many other organics such as 0.04% maltol.

The main operation for the recovery of organic products is the elimination of water, which is not possible through a simple distillation due to the number of compounds with similar boiling point and which therefore cannot be separated. After distillation of the light products, depending upon the water: organics ratio, two main methods are used,

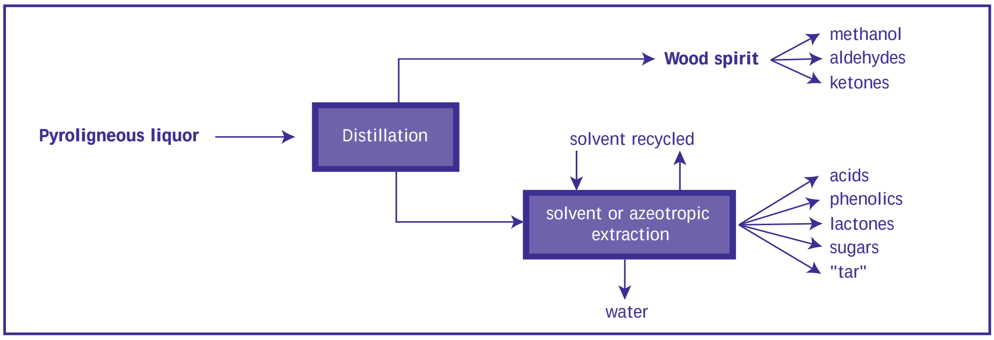


*Figure 1: Main processes and products in recovery of chemicals from pyroligneous liquor.*

*Figure 2: Carbonisation plant at Premery.*

- solvent extraction for high water content fractions.
- azeotropic distillation for low water content fractions.

In both cases the energy consumption is rather high: in the first case to evaporate the solvent, and in the second case to evaporate the azeotropic solvent.

The separation of the organic compounds is then a matter of classical extraction technologies. However the affinity of some molecules, or the lifting of some molecules by some blends lead to original processes.

The valuable compounds are, of course, those that have a sufficient market. As the price of the major products such as acetic acid or methanol is set by synthetic products from natural gas, it is necessary to extract a sufficient range of fine chemicals to make the business economic.

The main families of product having a value are:

- acids: acetic, formic and propionic.
- methanol.
- phenolic substances: such bas creosote and guaïacol.
- aromatic substances: such as cyclotene, maltol, diacetyl.

Sugars, like levoglucosan have found no application yet. However all the possibilities have not been found and there are probably applications for some compounds as precursor for synthesis, for which markets have to be created.

The liquids from flash pyrolysis contain different proportions of water and compounds that are very different from the condensates from slow carbonisation. It will be interesting to evaluate the value of the products that can be extracted from them with the know-how from slow carbonisation chemistry. It is known that this difference is mostly due to the limited cracking reactions from rapid cooling of the vapours. It would, therefore, be interesting to evaluate the possible transformation of these condensates through modified processes. Processes that improve the production of some valuable molecules can be conceived and should be investigated.

***For further information please contact:***

Jean-Guy Mares
Tel: +33 3 86377200
Fax: +33 3 86377226
Email: jgmares@free.fr

# Technical and non – technical barriers for implementation of fast pyrolysis technologies

*By Wolter Prins, BTG Biomass Technology Group, The Netherlands*

It is well recognised that implementation of advanced biomass conversion technologies is hampered by a wide range of problems and technical and non-technical barriers, and this led to adoption of a specialist group to review and address this topic in the PyNe network.

*Figure 1: Co-combustion of bio-oil produced by BTG Biomass Technology Group in Electrabel's 350 MWe gas-fired power station in Harculo, The Netherlands. Photograph of the burner front side showing the pressurized bio-oil lines including the atomization pressure indicators. Reproduction of the photographs is subject to permission by Electrabel and BTG.*

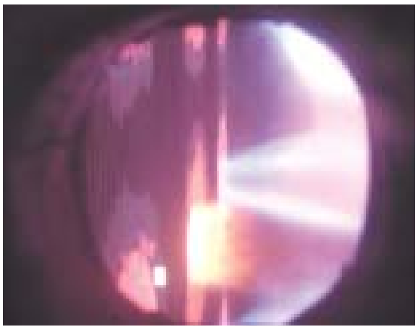

*Figure 2: Co-combustion of bio-oil produced by BTG Biomass Technology Group in Electrabel's 350 MWe gas-fired power station in Harculo, The Netherlands. Photograph of the boiler room side of the bio-oil burner and its (orange) flame. Eight other burners in the boilers house (55 MWth each) were fired on natural gas (blue flame). Reproduction of the photographs is subject to permission by Electrabel and BTG.*

January 2002 provided the first workshop to review barriers when Manfred Wörgetter from BLT reviewed non-technical barriers as applied to liquid fuels and Aad van Dongen from Reliant's Hemweg coal power station reviewed the project concerned with co-combustion of pyrolysis oil from Pyrovac's vacuum-pyrolysis technology. He listed 15 technical constraints for large-scale production and application of bio-oil, together with 10 non-technical barriers. Both speakers concluded that pyrolysis research and development should be concentrated in centres of excellence, and these should be more actively supported by the EU and by national governments.

In order to progress this topic, a questionnaire was completed by PyNe members to identify problems and barriers, make a priority ranking, and then decide on possible actions. These might include producing expert papers, collecting practical experiences, developing research proposals, promotion and lobbying. Results of the questionnaire were reviewed at the PyNe meeting in Hagenau in September 2002 and will form the basis for development of the topic.

It is generally recognised that demonstration of flash pyrolysis on a larger scale is a crucial step in development. Such a demonstration should include process reliability and safety, environment, economics, and product standardisation. Significant bio-oil samples will be needed to allow the development and demonstration of applications. Future research and development should focus on improvement and control of the bio-oil quality to a grade that can be recognised by authorities and accepted by consumers.

A number of non-technical topics need special attention. The public perception of biomass conversion, and especially fast pyrolysis, is poor. Promotion of the use of bio-oil, both by better networking and the distribution of publications and brochures, should be intensified. Secondly, the need for subsidies to bridge the gap from science to commercial application is still very urgent. Governmental institutions that support the introduction of biomass technologies should be convinced that fast pyrolysis is a valuable complementary technology to gasification.

It is important to distinguish between problems and barriers:

- Problems are usually well recognised and can be resolved in that solutions are, in principle, available for example through expenditure of effort.
- On the other hand, a barrier is like a closed gate; it prevents progress. For instance, insufficient financial incentives for companies to acquire, develop or promote technology is a real non-technical barrier.

The next meeting of PyNe (Florence, April 2003),will propose actions to make some progress in diminishing or demolishing the barriers for introducing fast pyrolysis technology in the market.

Despite the problems and barriers that appear to hinder the demonstration and implementation of bio-oil production and application, progress has been made in this field including at least three very successful large scale tests:

- 8 tonnes of a slurry made from slow-pyrolysis oil and char were converted to a tar free syngas in a 5 MWth entrained flow gasifier operated at 26 bar and 1200 to 1500$^{o}$C in Freiberg, Germany.
- 1 tonne of real bio-oil was gasified in an atmospheric unit in Freiberg.
- 15 tonnes of bio-oil were co-combusted without problems in a 350 MWe gas-fired power station in Harculo, owned by Electrabel in The Netherlands.

***For further information please contact:***

Dr Wolter Prins
BTG Biomass Technology Group
University of Twente
PO Box 217
7500 AE ENSCHEDE
The Netherlands
Tel: +31 53 486 2282
Fax: +31 53 432 5399
Email: prins@btgworld.com
w.prins@utwente.nl

# International workshop on pyrolysis and bio-oil – CSIRO, Melbourne, Australia. 25, 26 November 2002

*By Paul Fung, CSIRO and Tony Bridgwater, Aston University*

The theme of the workshop was Bio-oil Production Opportunities for New Liquid Fuels and Chemicals through Research and Development. A comprehensive programme on a range of current and proposed R&D areas in biomass pyrolysis was prepared by Paul Fung of CSIRO, assisted by Mike Connor, University of Melbourne; Julio Soria, Monash University; and Vanessa Dusting of CSIRO (see Figure 1). The areas covered included fast pyrolysis; slow pyrolysis; bio-oil properties; R&D requirements and opportunities; liquid fuel for diesel engines and gas turbines; combustion for heat and power; chemicals including wood preservatives, adhesives, resins, agriculture, fine chemicals, specialist products; markets.

*Photo 1: Organising committee reviewing workshop from left to right: Julio Soria, Vanessa Dusting, Paul Fung and Mike Connor.*

The workshop brought local and international researchers together, together with investors and the fledgling bio-oil interests in Australia where there is excellent potential to develop a bio-oil industry. Overseas specialists interacted with Australian researchers and industry interests to identify opportunities for cooperation in research, development and implementation. This will hopefully lead to an international coalition of stakeholders to develop effective bio-oil industries in Australia.

30 delegates attended the meeting, many of whom presented their current work or potential research topics for developing biomass pyrolysis for liquid fuels and chemicals. 15 papers were presented and copies of the meeting notes can be obtained from Paul Fung.

### Background

Australia is highly dependent on fossil fuels for energy production, which has resulted in Australia becoming the highest emitter of greenhouse gases on a per capita basis. Substitution of fossil fuels with renewable bioenergy sources will help reduce GHG emissions to more acceptable levels. Biomass is an excellent source of sustainable energy as it can be derived from a wide range of raw and waste agricultural and forestry materials. Bio-oil is well suited for production, distribution and use in rural areas to reduce reliance on crude oil based products. Regionally based bio-oil industries could help create rural employment opportunities using sustainably produced feedstocks derived from farm residues and tree plantings established on degraded land to overcome soil erosion and salinity. This latter topic is described on the front cover and page 2.

### Conclusions

The seminar concluded that biomass pyrolysis offered exciting opportunities for research and development and commercial implementation in several parts of Australia and in several industries.

There was considerable interest in the potential of the high yields of fast pyrolysis oil compared to the low yields of slow pyrolysis oil currently achieved. The potential of a storable and transportable liquid fuel that could be used for energy and chemicals was well appreciated.

*Photo 2: Participants at Melbourne workshop.*

The benefits and advantages of participating in the IEA Bio-energy Pyrolysis Task (PyNe) were fully explained and well appreciated and plans were initiated to continue the workshop concept and make a determined effort to join PyNe.

It was agreed that future activities should be focused on:

- Assessment of the competitive advantages of different technologies.
- Raise political awareness of the opportunities for biomass to energy and chemicals, and improve the public image of biomass in Australia.
- Consider funding of a new and focused R&D programme to include fundamental and applied research. Some of the topics identified include:
  - Evaluation of biomass feedstocks for bio-oils
  - Identification of opportunities in Australia,
  - Establishment of research facilities to study bio-oil for various energy and chemical applications,
  - Characterisation of bio-oils from different local feed materials,
  - Examination of the potential market as a diesel fuel substitute.
- Consider establishing a PhD exchange program and provide a structure to offer undergraduate research projects to encourage interest.
- Establish R&D facilities in a university or research institute in Australia.

***For further information please contact:***

Paul Fung
CSIRO
Forestry and Forest Products
Bayview Avenue, Clayton, Vic
Private Bag 10, Clayton South
Vic, 3169
AUSTRALIA
Tel: +61 3 9545 2487
Fax: +61 3 9545 2448
Email: Paul.Fung@ffp.csiro.au

# Expert Meeting on Pyrolysis and Gasification of Biomass and Waste

The future for pyrolysis and gasification of biomass and waste; status, opportunities and policies for Europe

*By: Tony Bridgwater and Harrie Knoef*

The PGBW meeting took place at the Holiday Inn Hotel in Strasbourg, France on September 30 and October 1, 2002. The future for pyrolysis and gasification was clearly supported by the attendance of more than 150 participants only 3 months after the 12th EU conference on Biomass and Waste. The expert meeting was organised by the EU-Thermonet project and sponsored by the European Commission through Altener and further sponsored by Cirad and CEA. During the two day programme keynote speakers presented an up to date review on the technology status of pyrolysis, gasification and waste conversion. In addition, case studies were presented by industrial companies on demonstration and commercial plants focussing on the problems that have been encountered and how they were overcome. The overviews and case studies generated valuable input to the six workshops organised during the PGBW meeting on Gasification, Pyrolysis, Waste, Syngas and synfuels, Power generation and Economics. The aim of the workshops was to discuss how to improve the rate, extent and success of implementation of both technologies.

*Photo 1: Workshop panel at the pyrolysis workshop.*

*Photo 2: First prize winner Jacques Lédé (centre) with Philippe Girard, left and Tony Bridgwater, right.*

More than 70 poster presented diverse new developments on pyrolysis and gasification. All presentations and poster papers will be published in the proceedings of the PGBW meeting which will be available from the publisher, CPL Press (www.cplpress.co.uk) early in 2003.

Prizes were awarded for the best posters in terms of technical content and visual presentation to J. Lédé et al from CNRS (First Prize), Y Solantausta et al from VTT (Second Prize) and M. Kleinhappel of TU Graz (Third Prize).

The expert meeting was organised to assist the European Commission to develop policies in the area of bio-energy. The main observations were:

- Considerable progress has been made on fast and slow pyrolysis in recent years; fast pyrolysis for liquid bio-oil production and slow pyrolysis for charcoal production and waste conversion. The main barrier is the limited availability of large quantities of bio-oil for applied research and development work. Co-firing is a particularly attractive option as bio-oil can readily be stored and/or transported to the power plant. A further opportunity lies in use of bio-oil as an energy carrier to more effectively and efficiently transport and convert biomass in a liquid form for further secondary processing. In this capacity, energy efficiencies of over 90% can be anticipated.

- Gasification of biomass and waste is closer to the market but current demonstration projects are showing limited success. Despite a few successful demonstration projects, progress in gasification is still hindered by gas cleaning, in particular with fouling of heat exchangers. Positive developments are the multiple stage gasification processes and steam gasification with indirect heating. However, promising results have recently been obtained for complete tar removal and/or cracking and these should enable the technology to move forward. Co-firing and gasification of waste are the most attractive options in the short term. Syngas production, supercritical gasification and $H_2$ production are the main research topics.

- Pyrolysis and gasification technologies are not competitors; each have their own strengths and applications. It is important to find niche markets in the short term to demonstrate these emerging technologies and build a robust platform on which to base a viable thermal biomass conversion industry.

# Bioenergy Australia 2002 Conference

*By Steve Schuck*

152 delegates attended the third annual Bioenergy Australia Conference and Exhibition, held on 2nd and 3rd December at the Manly Pacific Parkroyal Hotel, Manly, Sydney, Australia. The theme of the conference was 'Sustainable Energy for Society, the Economy and the Environment' and included over 50 oral and poster presentations. A technical tour on 4 December visited Sydney Water Corporation's 497 kW Cronulla Sewage Treatment anaerobic digestor, Energy Development's Lucas Heights 11 MW landfill gas power plant and Brightstar Environmental's SWERF gasification plant near Wollongong. A feature of the conference was two extended panel discussions and forums on 'Achieving Sustainability Through Bioenergy' and on 'The Evolving Market for Bioenergy'.

*Figure 1: Brightstar Environmental's SWERF gasification plant near Wollongong, Australia.*

The conference was linked to an IEA Bioenergy Task 36 meeting (Energy from Integrated Solid Waste Management Systems) at the same venue (5-6 December) and several international experts from this Task participated and contributed to the conference program. Professor Tony Bridgwater was invited to give a presentation "Advances in Thermal Biomass Conversion" at the conference. It it hoped to muster sufficient support in Australia for participation in the IEA Bioenergy Task 34 on "Pyrolysis of Biomass".

The full set of papers/presentations in hardcopy are available from Dr Stephen Schuck for AUD$140 (including handling and overseas postage). A limited number of CD ROMs are available to those who missed the conference for AUD$55.

***For further details please contact:***

Mr Stephen Schuck
Australian Biomass Taskforce Manager
Stephen Schuck and Associates Pty Ltd
7 Grassmere Road
Killara
Sydney
New South Wales
NSW 2071
AUSTRALIA
Tel: +61 2 9416 7575
Fax: +61 2 9416 9246
Email: sschuck@bigpond.net.au

# Fast Pyrolysis Oil Upgrading

*By Douglas C. Elliott, Process Research at Pacific Northwest National Laboratory, Richland, Washington, USA*

With funding from the U.S. Department of Energy, laboratory work began anew this winter on upgrading by catalytic hydrogenation of fast pyrolysis oil produced from biomass. The work scope involves testing and assessment of new catalyst formulations in the hydrogenation using both batch and continuous-flow reactor systems. There will also be an effort in updating the processing economics in light of new reaction conditions, products, and hydrogen requirements. The work will involve collaborations with Ensyn and Dynamotive, who are providing bio-oils for testing.

***Further details will be forthcoming in future editions.***

 

# Diary of Events

*Information compiled by Claire Humphreys, Aston University, UK*



**Symposium on Biotechnology for Fuels and Chemicals**
**Venue:** Breckenridge, Colorado
**Date:** 4-7 May 2003
**Contact:** Sara Huntley, Conference Coordinator
National Renewable Energy
Laboratory 1617 Cole Blvd.
Golden, CO 80401-3393
**Tel:** +1 303 275 4317
**Email:** sara_huntley@nrel.gov
**Website:** www.nrel.gov/biotech_symposium

**The World Sustainable Energy Exhibition & Conference**
**Venue:** Amsterdam, The Netherlands
**Date:** 13-15 May 2003
**Contact:** Marc V Sterel
Product Manager Energy & Environment
Amsterdam RAI
PO Box 77777
NL-1078 MS
Amsterdam
**Tel:** +31 (0)20 549 1212
**Fax:** +31 (0)20 549 1843
**Email:** sustain2003@rai.nl
**Website:** http://www.sustain2003.com

**Energy and the Environment 2003 First International Conference on Sustainable Energy, Planning & Technology in Relationship to the Environment**
**Venue:** Halkidiki, Greece
**Date:** 14-16 May 2003
**Contact:** Gabriella Cossutta
**Fax:** +44 (0)238 029 2853
**Email:** gcossutta@wessex.ac.uk
**Website:** www.wessex.ac.uk/conferences/2003/energy2003/1.html

**1st International Seminar on Evolution of the Refining Industry**
**Venue:** Boumerdes, Algeria
**Date:** 19-20 May 2003
**Contact:** Sonatrach/IAP/Refining and Petrochemical Dept
Avenue du 1er Novembre
35000 Boumerdes, Algeria
**Tel/Fax:** +213 24 81 50 04
**Email:** EVINDRAF2003@yahoo.com
**Website:** www.sonatrach-dz.com/EVINDRAF2003.htlm

**The XIVth Global Warming International Conference & Expo**
**Venue:** Boston, USA
**Date:** 27-30 May 2003
**Website:** hwww.GlobalWarming.Net

**International Conference on Energy and the Environment**
**Venue:** Shangliai, China
**Date:** 22-24 May 2003
**Contact:** Dr. Daoping Liu
Executive Secretary of ICEE 2003
University of Shanghai for Science and Technology
P.O. Box 224, No. 516
Jun Gong Road
Shanghai, 200093, China
**Tel:** +86-21-65689564; 86-21-65680843; 86-21-65671982
**Fax:** +86-21-65680843; 86-21-65692958
**Email:** dpliu@online.sh.cn

**7th International Conference on Energy for a Clean Environment**
**Venue:** Lisbon, Portugal
**Date:** 7-10 July 2003
**Contact:** Maria Fernanda Afonso
Instituto Superior Técnico
Mechanical Engineering Department
Av. Rovisco Pais, 1049-001
Lisbon – PORTUGAL
**Tel:** +351-21-8417378/8417186
**Fax:** +351-21-8475545
**Email:** cleanair@esoterica.pt
**Website:** http://navier.ist.utl.pt/cleanairr

**Bioenergy2003 International Nordic Bioenergy Conference and Exhibition**
**Venue:** Jyväskylä Paviljonki, Finland
**Date:** 2-5 September 2003
**Contact:** Ms Mia Savolainen
FINBIO, PO Box 27
FIN-40101 Jyäskylä,
Finland
**Tel:** +358 14 445 1115/7
**Fax:** +358 14 445 1199
**Email:** bioenergia@jsp.fi
**Website:** http://www.gwu.edu/~eem/ICEE/committeesnew.htm

**Exhibition for Renewable Resources, Technologies and Products**
**Venue:** Erfurt, Germany
**Date:** 11-13 September 2003
**Contact:** Dr Katrin Vogel
Messe Erfurt AG
Gothaer Strasse 34
99094 Erfurt, Germany
**Tel:** +49 361 400 1810
**Fax:** +49 361 400 1112
**Email:** info@narotech.de
**Website:** www.messe-erfurt.de

**2003 Shanghai International Expo on Renewable Energies**
**Venue:** Shanghai, China
**Date:** 10-12 October 2003
**Contact:** Ms Shyliva Chen
Worldwide Exhibitions Service Co,.Ltd
**Fax:** +86 21 52340649
**Email:** wezhou@online.sh.cn

**International Conference for Renewable Energy, Energy Saving and Energy Education**
**Venue:** City of Havana, Cuba
**Date:** 28-31 October 2003
**Contact:** Dr Ing. Tomas Delgado Lopez
Secretary to the Conference
**Email:** cier2003@ceter.ispjae.edu.cu
**Website:** www.cujae.edu.cu/eventos.cier

# PyNe Membership

## Please contact your country representative for further information.

### Co-ordinator

**Tony Bridgwater**
Bio Energy Research Group
Aston University
Birmingham
B4 7ET
UNITED KINGDOM
Tel: +44 121 359 3611
Fax: +44 121 359 6814/4094
Email: a.v.bridgwater@aston.ac.uk

### Austria

**Maximilian Lauer**
Institute of Energy Research
Joanneum Research
Elisabethstrasse 5
A-8010 Graz
AUSTRIA
Tel: +43 316 876 1336
Fax: +43 316 876 1320
Email: max.lauer@joanneum.at

### Belgium

**Yves Schenkel**
Centre for Agricultural Research (CRA)
Chaussée de Namur, 146
Gembloux
B–5030
BELGIUM
Tel: +32 81 627148
Fax: +32 81 615847
Email: schenkel@cragx.fgov.be

### Denmark

**Karsten Pedersen**
Danish Technological Institute
Julsoevej 6
DK-8600 Silkeborg
DENMARK
Tel: +45 8684 5822
Fax: +45 8684 5811
Email: kp@chemidan.dk

### Finland

**Anja Oasmaa**
VTT Energy
New Energy Technologies
PO Box 1601
Espoo, FIN-02044 VTT
FINLAND
Tel: +358 9 456 5594
Fax: +358 9 460 493
Email: Anja.Oasmaa@vtt.fi

### France

**Philippe Girard**
Cirad Forêt
Energy Environmental Unit
TA 10/16
73 Rue Jean Francois Breton
Montpellier Cedex 5
34398
FRANCE
Tel: +33 467 61 44 90
Fax: +33 467 61 65 15
Email: philippe.girard@cirad.fr

### Germany

**Dietrich Meier**
BFH-Institute for Wood Chemistry
Leuschnerstrasse 91
D-21031 Hamburg
GERMANY
Tel: +49 40 739 62 517
Fax: +49 40 739 62 502
Email: d.meier@holz.uni-hamburg.de

### Greece

**Ioanna Papamichael**
C.R.E.S. – Biomass Department
19th km Athinon Marathonos Ave
GR 190 09
Pikermi – Attikis
GREECE
Tel: +30 10 660 3389
Fax: +30 10 660 3301
Email: ioannap@cres.gr

### Ireland

**Seamus Hoyne**
Irish Bio-Energy Association
c/o Tipperary Institute
Clonmel, Co.
Tipperary
IRELAND
Tel: +353 504 28472
Fax: +353 52 80442
Email: shoyne@tippinst.ie

### Italy

**Colomba Di Blasi**
Universitá degli Studi di Napoli
'Federico II'
Dipartimento di Ingegneria Chimica
P. le V. Tecchio
80125 Napoli
ITALY
Tel: +39 081 768 2232
Fax: +39 081 239 1800
Email: diblasi@unina.it

### Netherlands

**Wolter Prins**
BTG
Business & Science Park
Pantheon 12
PS Enschede
7521
NETHERLANDS
Tel: +31 53 486 2282
Fax: +31 53 432 5399
Email: w.prins@ct.utwente.nl

### Norway

**Morten Gronli**
SINTEF Energy Research
Thermal Energy and Hydropower
7034 Trondheim
NORWAY
Tel: +47 73 59 37 25
Fax: +47 73 59 28 89
Email: Morten.Gronli@energy.sintef.no

### Portugal

**Filomena Pinto**
INETI-ITE-DTC
Edificio J
Azinhaga dos Lameiro
Estrada do Paço do Lumiar
1699 Lisboa Codex
PORTUGAL
Tel: +351 1 716 52 99
Fax: +351 1 716 65 69
Email: Filomena.Pinto@ineti.pt

### Spain

**Jesus Arauzo**
Universidad de Zaragoza
Chemical & Environmental Engineering
Department
Centro Politecnico Superior
María de Luna 3
E 50015 Zaragoza
SPAIN
Tel: +34 97 676 1878
Fax: +34 97 676 1879
Email: qtarauzo@posta.unizar.es

### Sweden

**Erik Rensfelt**
TPS Termiska Processer AB
Studsvik
S-611 82 Nykoping
SWEDEN
Tel: +46 155 221385
Fax: +46 155 263052
Email: erik.rensfelt@tps.se

### USA

**Stefan Czernik**
NREL
1617 Cole Boulevard
Golden, Colorado,
80401, USA
Tel: +1 303 384 7703
Fax: +1 303 384 6363
Email: Stefan_Czernik@NREL.Gov

*PyNe and GasNet technical visit earlier this year*

IEA Bioenergy

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For further details or offers to contribute, please contact Claire Humphreys (see inside front cover for details). Any opinions published are those of the contributors and do not reflect any policies of the EC or any other organisation. EoE
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