Biorefinery Researcher

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Contents:

BIOREF-INTEG

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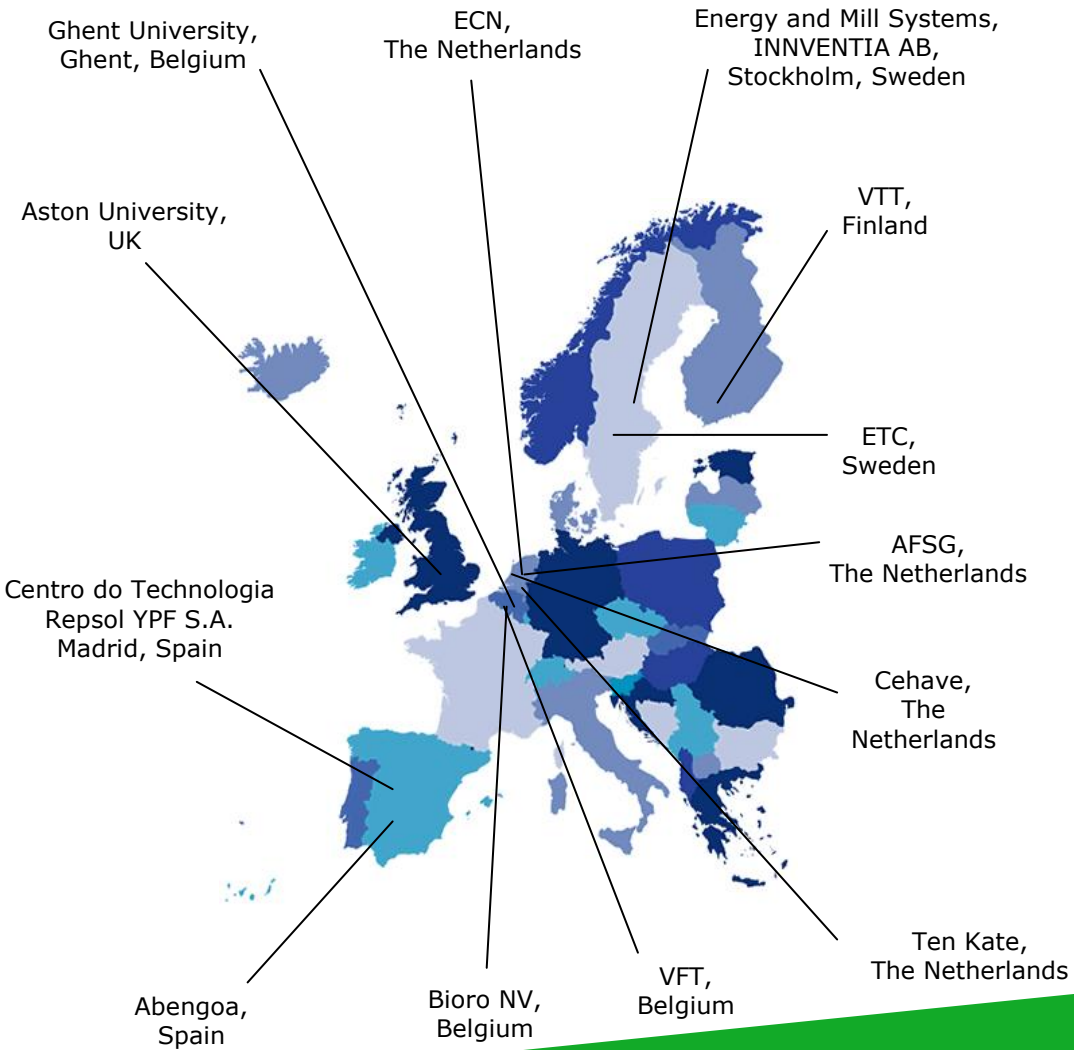
Project Web Site
http://www.bioref-integ.eu

Development of Advanced **BIOREF**inery Schemes to be **INTEG**rated into Existing Industrial Fuel Complexes
June 2008 - May 2010

BIOREF-INTEG Partners



BIOREF-INTEG Progress

An introduction from Hamid Mozaffarian, BIOREF-INTEG Coordinator

This issue of 'Biorefinery Researcher' begins with a summary of the annual activity report detailing the progress achieved per work package during the first year of the project. This is followed by an article about research being conducted at Sweden's Solander Science Park into the transition of pulp mills into biorefineries. After that is a series of project updates from BIOREF-INTEG partners, including VFT, INNVENTIA, ECN and Repsol.

Also contained within this edition, is a thought-provoking interview with Professor Tony Bridgwater regarding resources for the future and the food versus fuel debate. Other interesting reading includes an overview of the recently published International Energy Agency (IEA) Executive Summary and a selection of some of the report's key findings regarding share of bioenergy in the world primary energy mix, as well as global biomass supply and demand.

Summary Annual Activity Report
The project is conducted by 7 separate but strongly interrelated work packages, as presented in the figure below.

Work package 1: Identification of existing industrial (fuel producing) complexes in Europe
For each considered biomass processing sector, the existing industrial (fuel producing) complexes have been identified for the six partner-related countries (Belgium, Finland, Spain, Sweden, United Kingdom and the Netherlands). Based on the performed survey, at least one reference case per sector has been defined as a realistic representative of that sector.

The reference cases include different feedstocks: cereals, oilseed crops, sugar beet, micro-algae, grass, wood, milk and slaughter byproducts. The cases use different conversion technologies: fermentation, transesterification, anaerobic digestion, combustion, gasification, fluid catalytic cracking and hydrotreating.

The reference cases are briefly described, including a block diagram with main overall mass and energy balances. The reference cases will be evaluated in WP4, where they will also be upgraded to high efficiency advanced biorefinery schemes, co-producing added value products and fuels.

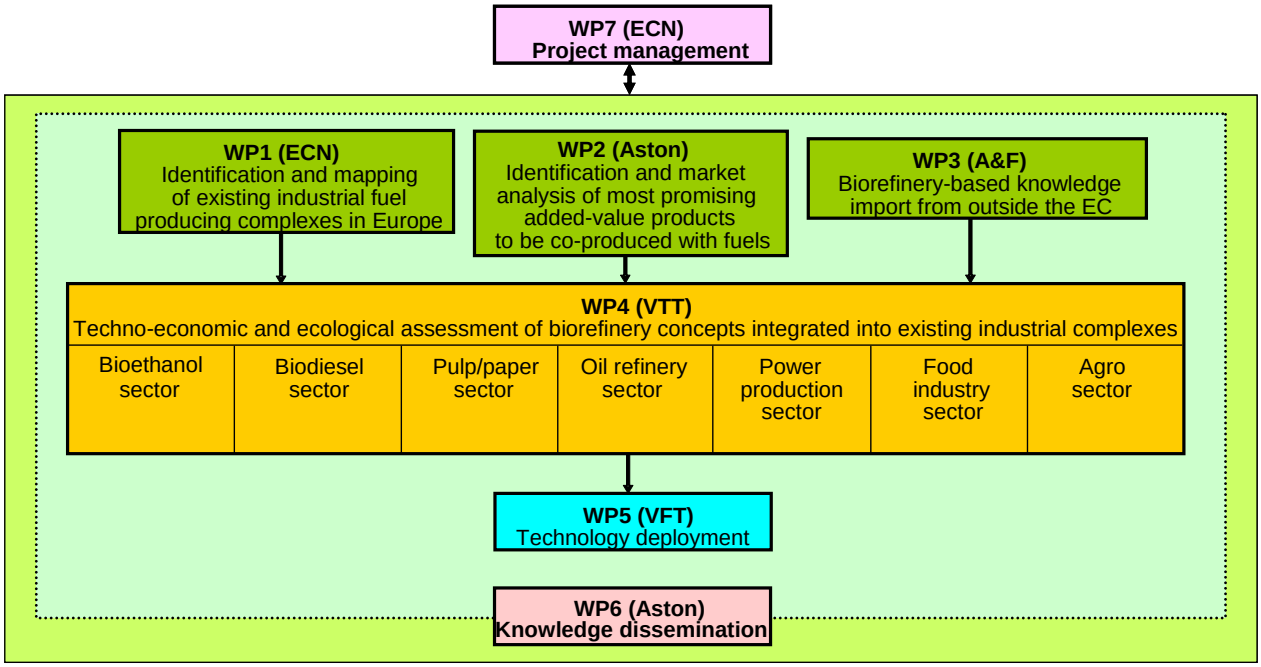


Figure 1: BIOREF-INTEG Work Packages

BIOREF-INTEG Progress...continued

Work package 2: Definition of most promising added value bioproducts

A literature analysis has been conducted within the field of biomass-derived products in order to identify current and potential materials and chemicals. The analysis has been based on the composition of the raw materials of the selected reference cases within WP1, i.e. wheat, straw, potatoes, rapeseed, sugar beet, micro-algae, grass, wood, pulp/paper residues, food industry residues and agro residues.

More than 300 chemicals have been identified that can be derived from a biorefinery and that are of interest. There is a relatively small number of 'key' chemicals (around 60) that act as primary sources for families of chemicals and are, therefore, potentially of greater importance. These have a well established presence, well established infrastructure, and well established markets, which have been identified too.

A literature and web analysis on current market prices and volumes of the materials and chemicals identified is still ongoing. The longer-term potential market developments that directly affect the future market volume demand and market price of these products will also be roughly assessed.

Work package 3: Knowledge import from outside the EC

The workshop 'Knowledge import from outside EU on advanced biorefineries' was organised by AFSG on 29 January 2009 in Osnabruck, Germany. Professor Shiro Saka (Kyoto University, Japan), Professor Telma Franco (University of Campinas, Brazil), and Professor Bruce Dale (Michigan State University, USA) shared their views on the topic of biorefineries.

Work on biorefinery views and activities outside the EC is still ongoing, comprising the analysis of conference proceedings and websites on biorefinery-related information, including information from the IEA Task 42 on biorefinery (coordinated by AFSG).

Work package 4: Integral technical, economic, and ecological system assessments to select the most promising market specific integrated biorefineries

Economic data of the selected reference cases within WP1 have been gathered from the partners by VTT. Together with the data on mass and energy balances of the reference cases, resulting from WP1, these data have been used for a techno-economic assessment of the selected cases. In the next step, the results of WP1 to WP3 will be used to define the integrated biorefinery schemes for each selected biomass-related sector.

ECN has developed a biorefinery cashflow model for modelling purposes within WP4. Based on the gathered mass, energy and economic data, the cashflow model will calculate the production cost of the main product of each selected sector for both the reference case as well as for the integrated biorefinery scheme.

The objective is to evaluate to what extent the co-production of added value products from by-products of each reference case could enhance the economic competitiveness of the main product (fuel).

Work package 5: Technology deployment

The objective of WP5 is to evaluate the maturity of business models for the most promising integrated biorefinery processes. Tasks include the evaluation of commercial and technical feasibility and a SWOT analysis of the different biorefinery schemes, leading to conclusions on the most opportune schemes.

The work package entails the technology deployment of the selected integrated biorefinery concepts and will be based on input from WP1 to WP4. For this reason, activities in WP5 will take place during the second year of the project. The model to be used within this work package is designed by VFT (WP5 leader) and it will measure the technical and commercial feasibility of the selected integrated concepts. This model is based on a list of statements that has to be responded to by a number of experts.

Based on the aggregated answers, it will be possible to allocate a commercial and technical feasibility score to each concept. A graphical presentation will allow comparison of the projects and a decision on which option should be prioritised. At this stage, the frame of the model has been designed completely and the process of completing the list of relevant statements is ongoing.

Work package 6: Knowledge dissemination and training

The public website for the project has been set up by ECN (http://www.bioref-integ.eu/), containing information about the project and the partners, links to other related projects and events in the biorefinery area and links to our publications. In addition, an extranet site has been established for sharing of information among the partners.

BIOREF-INTEG Progress…continued

A project brochure, which has been realised by AFSG, has been widely disseminated to contacts of the partner organisations. It is also available on the publications page of the project website.

A joint newsletter has been established by Aston University, working in collaboration with the SUSTOIL project, which is also funded by the seventh framework programme of the EC. Within the first year of the project, two issues of the newsletter have been published in December 2008 and June 2009 and disseminated to partners and contacts, and at the RRB5 Conference in Ghent in June. The newsletters are also available on the publications page of the project website.

The first workshop on 'Knowledge import from outside the EC' was organised in January 2009, as mentioned above. A summary report and copies of the presentations are available on the publications page of the project website.

A second workshop on 'Preliminary results assessments and innovative biorefinery concepts' is planned for December 2009.

The Project Advisory Board has been established by ECN and the first meeting of the Advisory Board was held on 9 June 2009, during the Third Project Meeting. The Board consists of the following four members:

- Dr. Carlos Alberto Fernández López from IDAE, Spain (www.idae.es);
- Dr. Yves Verschuren from Essenscia, Belgium (www.essenscia.be);
- Professor Kai Sipilä (Finland) from VTT / European Biofuels Technology Platform (www.vtt.fi / www.biofuelstp.eu);
- Ir. Kees Kwant from SenterNovem, the Netherlands (www.senternovem.nl).

The BIOREF-INTEG project has been represented with poster presentations at the Biorefinica conference in Osnabruck (Germany) in January 2009 and at the RRB5 Renewable Resources & Biorefineries conference in Ghent (Belgium) in June 2009.

Work package 7: Project management
Activities within this work package include general project management, organisation of the project meetings, coordination of the work packages and the project Advisory Board. Our Fourth Project Meeting, combined with the Second Project Workshop, is planned for December 2009 in Birmingham.

Hamid Mozaffarian
BIOREF-INTEG Coordinator, ECN

From Wood to Wheel

Solander Science Park

Sweden's Solander Science Park (SSP) serves as a centre where researchers and technology vendors meet, share knowledge and collaborate about the transition of pulp mills into biorefineries.

Research at SSP is primarily focused on accelerating the transition of pulp mills into biorefineries by solving crucial problems in several different areas. At present, it is impossible to predict exactly how the biorefineries will be configured, hence a broad approach is adopted and several of the most promising sub-processes are investigated.

The overall aim of the program is to demonstrate a number of possible technologies that enable an efficient use of all the different components in wood for production of forest based chemicals, materials and fuels. Research areas include:

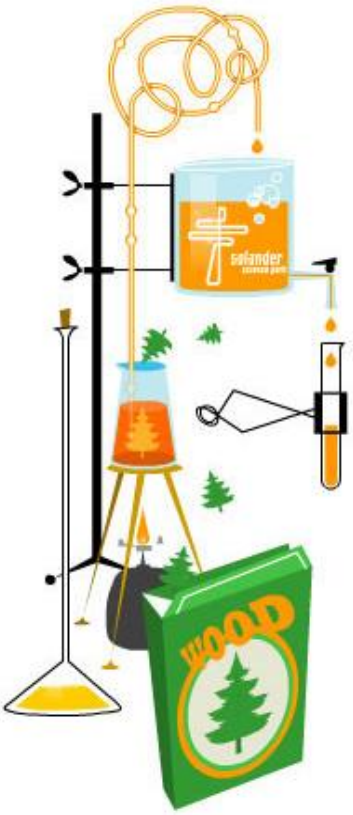
- Raw material characterisation and supply;
- Thermochemical and biochemical conversion of biomass;
- Process integration;
- Energy economic system analysis.

The Solander Business Centre located in Piteå has a number of facilities to help forest based biorefinery companies to become more competitive, including access to:

- ETC bioenergy lab, run by experienced personnel for a safe result;
- World leading researchers within the area of combustion and gasification;
- Building which contains the world's only pressurised black liquid gasifier;
- Site where SSP are building the only BioDME pilot plant in the world;
- Business Incubator – together with Aurorum Business Incubator (ABI), SSP can coach and support new technology-based, knowledge-oriented and leading-edge companies.

For more information visit www.solanderscience park.se

Alternatively email: robert.bergman@ solanderscience park.se



Solander Research Projects	
Ongoing	• Fuel synthesis via BLG. Performed by LTU/ ETC during 2008-2010 • Feeding of biomass at elevated pressures. Performed by ETC during 2008-2009 • Evaporation of alkali in entrained flow gasification. Performed by LTU/ETC during 2008-2009 • Entrained flow biomass gasification within HighBio. Performed by ETC/LTU during 2008-2011
Planned	Direct gasification of biomass for fuel production. Performed by ETC/LTU/IVAB 2009-2012
Finished	Lignin extraction from black liquor (BioLime). Performed by Smurfit Kappa kraftliner/Kiram/ETC during 2007-2009

See also article on pages 25 and 26 - 'The Forest Biorefinery in Piteå, North Sweden'

Microalgae Biorefinery: An Investment for the Future

Microalgae are fast growing organisms with a lot of environmental, economical and societal potential. As a matter of fact, using marketing 'buzz' words, algae can contribute to 4 P's: Planet, Profit, People and Politics.

Environmental Impact
Microalgae grow on light and CO_2, contributing significantly to addressing global warming issues. Algae can also be vehicular to cleaning waste effluents, by digesting organic material, nitrogen and phosphorous pollutants present in waste water.

Economical Impact
Microalgae are probably the organisms leading to the highest biomass yield per surface area. This biomass contains several valuable components. On macroscale, algae can accumulate up to 50% of its dry mass in oil that can be directly burned or used as feedstock for biodiesel. Based on recent findings, we can expect yields of 50.000 l oil/ha, to compare to 1.300 l/ha for rapeseed oil. Next to oil, the algae cake is a protein-rich source, containing 50 - 75% proteins, depending on the algae strain. These proteins are valuable feed or food ingredients. The remainder is mainly a carbohydrate, a potential carbon source for fermentation projects. On microscale, microalgae contain several value-added components, such as poly-unsaturated fatty acids (omega 3…), colorants and antioxidants (astaxanthin), cosmetic ingredients etc.

Societal Impact
Algae can grow in open ponds, closed photobioreactors or mixed systems. In any case, there is no need for (large surfaces) of arable land, only limited demand for fresh water, even the possibility to use salt water. An algae biorefinery is not in competition with food crops. On the contrary, algae biorefineries can be a source of food and feed on land with no or limited agronomical value.

Political Impact
Algae have the potential to turn CO_2 into fuel. In doing so, algae can contribute to the Kyoto requirements, to complying to European Directives on biofuel and renewable energy, to self-sufficiency in energy… without compromising on industrial activities and economical growth.

An Algae Biorefinery
There are many possible designs for an algae biorefinery: integration in power plants, chemical plants, cement factories etc have been demonstrated on pilot scale. A smaller scale operation, with many integration potential, could be the combination with an anaerobic fermentation plant. Algae could process the thin digestate, the CO_2 produced in the anaerobic digestion plant and turn these waste streams into valuable products. Also the heat and electricity from the cogeneration can be effectively utilised in the algae biorefinery.

The BIOREF-INTEG project has selected this concept as a model for an algae biorefinery and will evaluate its potential for industrial implementation.

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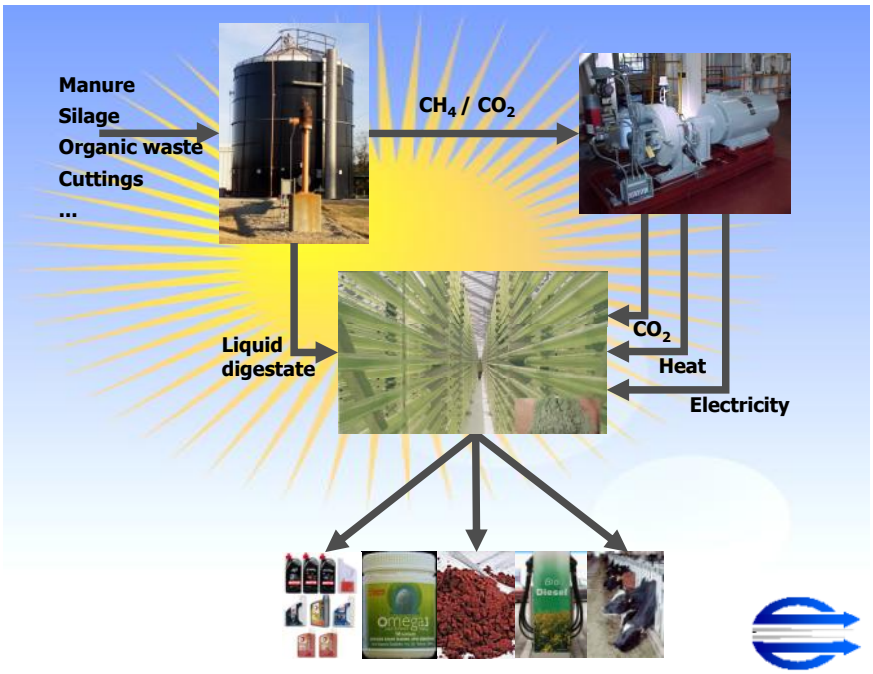

BIOREF-INTEG

Process Simulation used to evaluate Biorefinery concepts

Detailed full mill simulation models for various pulp and paper processes have been developed at Innventia, one of the Bioref-Integ partners. The models can be used to handle different issues that can be raised in a pulp mill, or for research and development. With increased competition and the need for cost-effective production, a pulp mill may need to be converted to a biorefinery, producing not only pulp, but also wood based fuels, chemicals and materials. Process simulation in combination with economical assessments can be a powerful tool for finding opportunities for improvements, optimising or evaluating different biorefinery concepts and comparing them on a consistent base.

A modern kraft pulp mill produces considerable amounts of organic by-products, with a rather low heat-value, in the form of black liquor and bark, which can be converted into valuable products. Three biorefinery concepts will be evaluated within Bioref-Integ using these models. One is to gasify the black liquor (BLG). The synthesis gas can be used to produce transportation fuels such as methanol and FT-diesel or for green power generation in a combined cycle. These products are classified as renewable, with the aim being to replace fossil-based products.

Another concept to be evaluated is LignoBoost, which started up a demonstration plant during January 2007. The LignoBoost process utilises an energy surplus in the mill to extract lignin from the black liquor. The extracted lignin is a biofuel with a very high energy value (26.4 MJ/kg DS) and low content of impurities. The extracted lignin is also interesting as a raw material for plastics, carbon fibres and chemicals. In studies using the developed process models, the LignoBoost concept showed itself to be very competitive.

There are many current on-going research projects concerning pulp mills as biorefineries that have used or will use these theoretical full mill models, EU-project WaCheUp, the KAM and FRAM - programmes and the BLG-programme. At an early stage, the theoretical process models are used for investigating how these new processes could affect the process from an overall system point of view. The researchers are given valuable feedback, which will be used to improve the new concept throughout the research project.

This article has focused on pulp mills. However, full mill models for other processes have also been created at Innventia.

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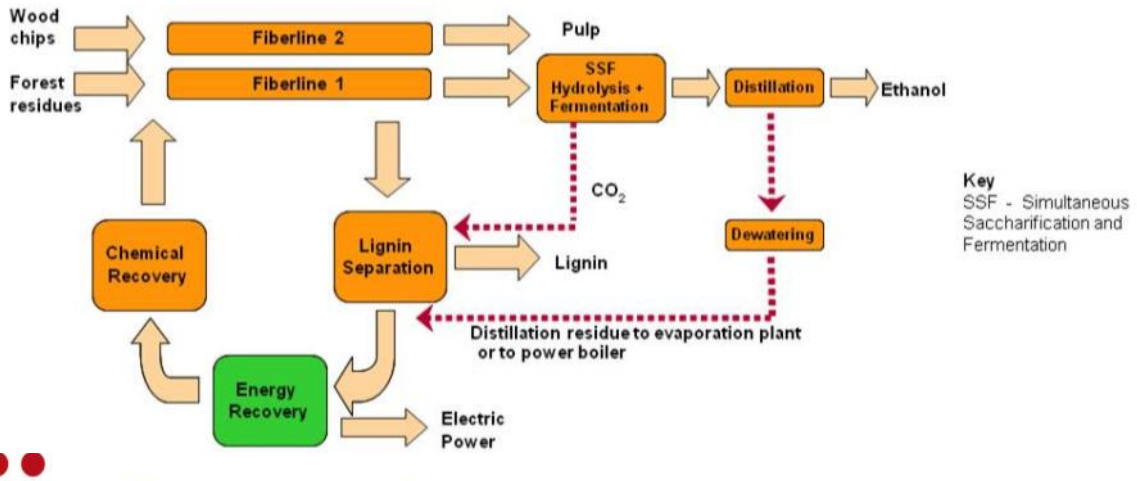
Christian Hoffstedt of Innventia provides an insight into current research projects concerning pulp mills as biorefineries.



Resources for the Future

Award-winning Professor Tony Bridgwater reflects on the food versus fuel debate and the challenges facing tomorrow's world.

Question: In your opinion, what are the main challenges facing mankind in the future?

Tony Bridgwater: There are few of us who are unfamiliar with the threats of the effects of climate change which have been extensively reported and discussed. The consequences will be dramatic and severe and affect many aspects of rain, water, temperature and sea levels with different effects felt all over the globe. Shortages of resources such as food, water, soil, energy and minerals could have a profound impact on our future.

Question: With such shortages that are predicted, what part do you believe renewable energy will play in sustaining future needs?

Tony Bridgwater: Renewable energy is being promoted as a solution to managing the increasing carbon dioxide levels that are predicted to have profound effects in tomorrow's world. There are three primary renewable energy forms available to us: electricity, heat and biomass. Of these only biomass can provide orthodox transport fuels and many of the chemicals needed to substitute for oil and gas derived consumer and industrial products.

Biomass absorbs carbon dioxide that is increasing and causing global warming so is important as a control mechanism. Food is effectively cultivated and carefully selected biomass, and biomass can also be a major source of renewable energy. Use of 1 tonne of biomass for energy replaces about 0.5 tonnes oil or gas and about 0.7 tonnes coal which can be left in the ground.

Question: So what effects will the production of energy from food crops have on food supplies and competition for agricultural land?

Tony Bridgwater: The competition for land, which is a finite resource, has become a major issue - from the destruction of rain forests, which absorb carbon dioxide and help to mitigate the greenhouse effect - to the substitution of energy crops for food crops.

Food yields (tonnes/hectare) have grown considerably in the last 100 years as a consequence of the introduction of artificial or synthetic fertilisers, synthetic biocides and crop development. This is a direct consequence of availability of cheap oil and gas and the inventiveness and imagination of scientists and engineers.

There are however some limits as to how much food can be produced by the world. The first theoretical upper limit is based on the availability of energy from sunlight and limits yield to about 50 to 150 t/ha/year on a dry yield basis depending on latitude. The second theoretical upper limit is the amount of land available to grow crops. The total land area in the world is 148,500,000 square km (14850 million ha) of which between 13 and 24% is arable depending on definitions and less than 40% is used for agriculture. There is general agreement that the world is capable of producing sufficient food for everyone, even for a larger population than at present.

However, the key question is whether there is enough land available to both feed everyone and provide their energy and consumer needs particularly with a growing population.

Question: And what are your personal views on this?

Tony Bridgwater: A number of questions spring to mind...How many people can the world support? What is a sustainable population level? How are we going to reach it?

Continued overleaf...

Resources for the Future...continued

Statistics predict that if world population fertility rates stay at 2000 levels, this gives a projected population of 244 billion by 2150 and 134000 billion by 2300. This is clearly unsustainable.

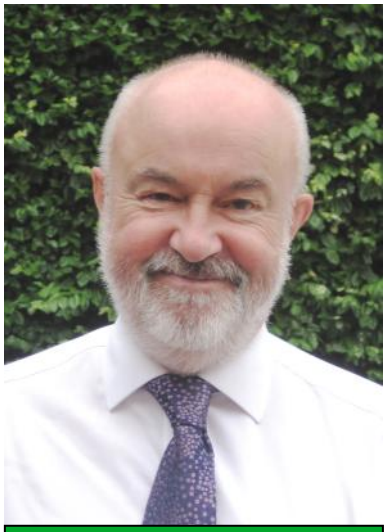
The consensus of opinion of numerous population studies is that the maximum sustainable population of the world is between 2 and 3 billion.

Question: You mentioned some alarming statistics there. How optimistic do you feel for the future of mankind?

Tony Bridgwater: During the next 100 years, the world potentially faces food, water and energy shortages, climate change and population growth. Mankind is competitive and resourceful. There has been such technical development in the last 150 years into areas that would have been unthinkable and unimaginable before they were invented, such as flight, computers, radio and television that we cannot predict what developments and innovations are waiting to be discovered.

There is sufficient evidence from our recent history to justify an optimistic and positive view of our future. Examples include artificial photosynthesis, cold and hot fusion, terraforming unusable landscapes for vegetation, and many other imaginative ideas.

So, I am not just hopeful but confident and optimistic that the future of the world is safe, although the journey there will be rocky and dangerous at times.



Professor Bridgwater was recently awarded the Don Klass Award for Excellence in Thermochemical Conversion Science – see page 28 for further details.

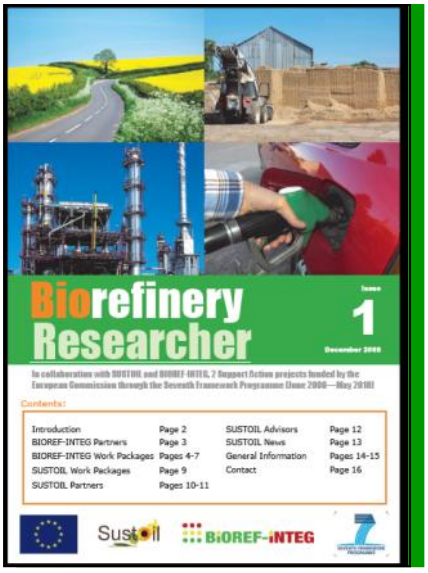
BIOREF-INTEG Newsletters and Web Site

The BIOREF-INTEG website can be found at:

http://www.bioref-integ.eu

Here you will find:

- Previous issues of Biorefinery Researcher newsletter (Issues 1 & 2);
- A comprehensive overview of the project, including details about partners and the various Work Packages;
- Event information – a synopsis of forthcoming bioenergy and biorefinery related events;
- Useful links to other bioenergy projects.



BIOREF-INTEG

Durable Chemistry: Opportunities for Biorefineries

The Region of Flanders (Belgium) recently launched a study to investigate the feasibility for an innovation platform around durable chemistry, acronymed FISCH (Flanders Initiative for Sustainable Chemistry). The aim is to create an environment in which multinationals, mid caps, SME's, research organisations and universities can collaborate in an open way on projects focused on durable chemistry.

It is not surprising that Flanders took this initiative, knowing that the chemical industry is the largest industrial sector in this region. The project is driven by Essenscia Flanders, the sector federation with assistance of the main Universities (Leuven, Ghent, Antwerp and Brussels), VITO and Value for Technology and benefits from a large support of the industry. Both large multinationals, as SME's active in chemistry, are supporting this initiative.

At this stage, the study is scheduled to finish by December 2009- FISCH is considering a three pillar organisation:

1. A project-based module;
2. An open infrastructure module;
3. A Centre for Durable Chemistry.

Project Module
The idea is that in the future, FISCH will have the opportunity to finance projects corresponding to the criteria set for durable chemistry: 'greening' (= with reduced environmental footprint) and 'blueing' (= innovative) the technology and products. On top of this, FISCH-labelled projects will address six aspects:

- Research
- Development
- Entrepreneurship
- Education
- Training
- Open

Practically, this means that 'FISCH projects' will have knowledge creation and dissemination dimensions and will lead to business creation.

Open Infrastructure
The objective is to draw up an inventory of equipment in industry and knowledge centres which is available for/open to third parties. Once this inventory is made, it will be promoted to members to stimulate cost savings and competence sharing in research and development.

Centre for Durable Chemistry
This centre will generate knowledge around the concept of durable chemistry, by developing criteria and measurement tools to evaluate durability. The Centre for Durable Chemistry will also give guidance on durable chemistry aspects to consortia editing FISCH projects and will act as a counter for advice on durable chemistry aspects.

Above all, FISCH aims to be a forum, where soul mates interested in durable chemistry can debate, exchange ideas and find each other in common projects.

FISCH and biorefineries
A questionnaire addressed to industry (17 large enterprises and 14 SME's) and knowledge centres (20) revealed that alternatives to fossil sources, biomass conversion and valorisation of side streams are the most important issues when considering durable chemistry. This opens perspectives for integrating biorefineries to chemical complexes and proposing bio-based molecules to the chemical industry.

Biorefineries will be an inherent part of the future FISCH activities. Networks and initiatives/projects leading to biomass conversion will be highly promoted; the 'Open Infrastructure' module will make equipment and know-how available to biorefinery experts; the Centre for Durable Chemistry will deliver objective metrics to promote bio-based alternatives.

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Biofuel Policies for Dynamic Markets

Elobio, an EU funded project, aims at developing low-disturbing policy options that enhance biofuels while minimising the impacts on e.g. food and feed markets, and markets of biomass for power and heat.

The project consists of seven work packages:

Work package 1 - compromises the overall management and coordination of the project. ECN functions as the project coordinator.	ECN
Work package 2 - lead by VITO, reviews biofuel policy measures applied in the European member states and in relevant regions outside the European Union and their impacts on the market. Furthermore, it describes status of knowledge of induced market disturbances towards feed, food and other markets.	VITO
Work package 3 - investigates the policies directly or indirectly supporting the use of lignocellulosic biomass, which could otherwise be used for biofuels production. The scope of this package includes identification of relevant policies, programs, strategies and market tendencies in the field of renewable electricity and heat production as well as agricultural and forest policy. Leader of the work package is IPIEO/EC BREC.	IPIEO
Work package 4 - lead by COWI, enables the key platform in which iterative stakeholder-supported development of low-disturbing biofuels policies can be achieved.	COWI
Work package 5 - focuses on providing the necessary information to identify fine-tuned sets of policy measures that while promoting biofuels will avoid/ minimise negative impacts on land use patterns, environment and agricultural markets. Lead by IIASA, this WP will include modelling the impacts of increased demand for biofuels on food and feed markets, and assessing the effects of different policies and measures aiming at a reduction of market, land use and environment disturbances.	IIASA
Work package 6 - Chalmers University considers how biofuel policies, including their specific instruments such as obligation targets, influence the market for lignocellulosic biomass, primarily focusing on the stationary energy sector (heat and electricity). This work package further develops and assesses policies capturing and enhancing the bridging role of specific near term biomass use options in promoting future expansion of 2nd generation biofuel system based on lignocellulosic biomass.	CHALMERS
Work package 7 – ECN determines the biofuel potentials, costs and impacts on the biofuel market of the different sets of policy measures selected. It executes modelling of potentials and costs of biofuels, given these policy measures. In more details; one of the objectives is to evaluate the impact of volatilities in feedstock, and biofuel markets on the investment climate for first- and second-generation technologies. This work package explores the different risk profiles of first and second generation technologies, links them to their respective cost of capital and assesses how the latter influences their market penetration rates, under different combinations of finance structure and specific incentives for second generation. Finally it explores how biofuel policies can be shaped in order to stabilize biofuels markets and reduce investment risks.	ECN

For further information visit http://www.elobio.eu

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Intelligent Energy Europe

CENIT-PiIBE PROJECT 2006-2009

Rubén Miravalles Gutiérrez from Repsol provides an insight into the Research Project for the Impulse of Biodiesel in Spain.

Introduction
Repsol is not just an oil company. It is an energy company, in the widest sense of the term. And being an energy company that is committed to the environment, it supports the different strategies set out for its protection.

The development of biofuels is part of the European energy strategy. They contribute to reducing emissions of greenhouse gases and to diversifying energy sources, thus reducing the dependence on oil.

For some years, Repsol has been committed to the use of biofuels as a way to reduce the greenhouse effect and energy dependence in Spain. Along these lines, since the year 2000, Repsol decided to convert its MTBE (methyl-tert-butyl ether) units to ETBE (ethyl-tert-butyl ether), to substitute fossil methanol by bioethanol in fuels formulation. Through this route, Repsol uses around 150 ktonnes/year of bioethanol, being the European leader in the use of bioethanol.

Repsol also promotes the use of biodiesel in gasoil production. Besides its positive effect on the environment, it contributes to the reduction of the European deficit in medium distillates, which in Spain exceeds 12 million tonnes/year. In Repsol, business development is supported by an R&D programme in biofuels, strengthened since 1999 to ensure the highest quality of biofuels and biofuels blends. An excellent example of this effort in biofuels development is the CENIT-PiIBE Project.

What is the CENIT-PiIBE project?
The CENIT Innovation Project for the Promotion of Biodiesel in Spain (National Strategic Consortia for Technological Research), is promoted by the Spanish State to foster stable public/private cooperation on Research, Development and Innovation (R+D+i). It aims to promote and develop great industrial research projects of a strategic nature.

The consortium, led by Repsol, is made up of 15 national companies and 23 national R&D centres. The total budget for the programme is 23 M€ for a 4 -year duration (2006-2009), co -financed by 50% through the CDTI (Centre for Industrial Technological Development, Spanish Ministry of Science and Innovation).

What is the specific objective of the CENIT Biodiesel project?
To contribute to the introduction of biodiesel onto the national market through an R+D+i programme aimed at reducing production costs, increasing the availability of local raw materials and finding new and better applications for these products.

Structure of the project: Technological map and building blocks
The project took shape after drawing up a technological map of the biodiesel value chain, from obtaining the raw materials required to its applications. 3 building blocks in this chain were identified in which promising lines of work in R&D appeared (see diagram).

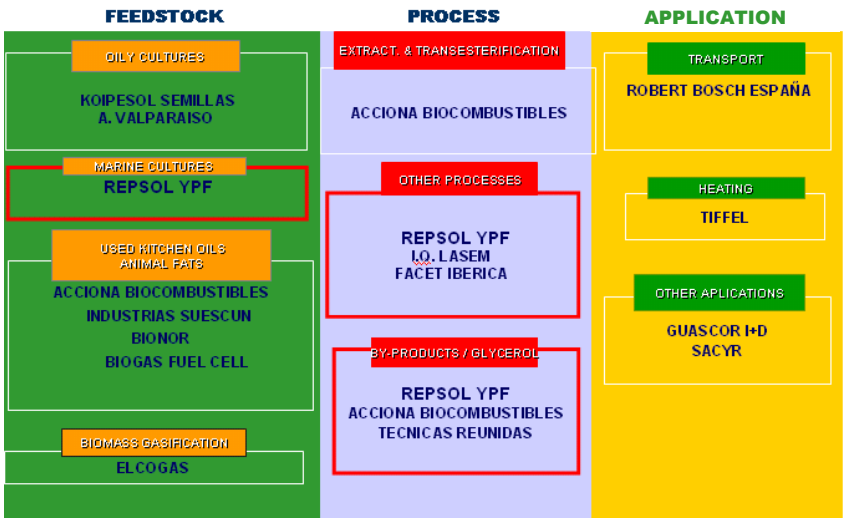
1. Feedstock (raw materials) block objectives:
Oily cultures: to produce different species from oily cultures in field and evaluate its potential for the production of biodiesel in different agroclimatic areas of Spain.

Marine cultures: to evaluate biodiesel production from marine seaweed.

Used kitchen oils and animal fats: to validate new raw materials to produce biodiesel, developing a system to identify useful fats gathered, improving the control of raw materials.

Biomass gasification: biodiesel production by biomass gasification.

Continued overleaf...



...continued

2. Process block objectives:
Extraction and transesterification: to develop new methods of vegetal oil extraction and a process of ethylester production.

Other processes: to identify new technologies for biodiesel production (heterogeneous catalysis). To identify new loads of vegetal origin to refinery units. To obtain esters with higher alcohol for high quality lubricant applications. New systems of filtration of FAME.

By-products – Glycerine: to evaluate different applications of by-product glycerine: glycerine for production of biodiesel, added-value petrochemical products, lubricants and animal feed etc.

3. Application block objectives:
Transport: to manufacture fuel filters and to detect potential problems in other components of the injection system.

What are the most significant results of the project?
The CENIT biodiesel project has achieved a qualitative leap in the scientific and technological knowledge in this field, in Spain. Some examples of the discoveries and innovations that have been produced are:

- **Presentation of three patents** (FotoBioReactor (FBR) for algae culture, heterogeneous catalyst for FAME production and synthesis process for propyleneglycol carbonate);
- Record of a new alga specie with high oil content and high productivity potential;
- Development of four new commercial products in the lubes area;
- Definition of operating conditions to co-process vegetal oil in existing refining units, that will be applied in an industrial trial;
- Publishing of several scientific papers in the field of biofuels production.

For further information visit:
www.repsol.com/es_en/todo_sobre_repsol_ypf/conocer_repsol_ypf/innovacion_y_tecnologia/proyecto_cenit_biodiesel/cenit__el_proyecto_i.aspx

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RRB5 Review

From June 10th to 12th 2009, the fifth international conference on **'Renewable Resources and Biorefineries'** was hosted at 'De Bijloke', a former monastery and hospital located in the historical city centre of Ghent in Belgium.

The conference aimed to bring together academic researchers, industrial experts, policymakers and venture capital providers in order to discuss the challenges emerging from the transition towards a biobased economy and the new developments in this area. Not only did the conference offer a forum for leading political, corporate, academic and financial people to discuss recent developments, it also gave them an opportunity to set up collaborations. Moreover, the conference provided an overview of the scientific, technical, economic, environmental and social issues of renewable resources and biorefineries. Up to 232 participants from 22 countries joined in numerous plenary sessions, oral presentations and poster sessions, thus proving the importance of this conference.

The conference program was organised in two parallel sessions throughout the three days, with over 50 high quality presentations by international experts, covering both technical and policy aspects of the bio-based economy. The sessions focused respectively on the following topics:

- Bioprocesses & biorefineries;
- Industrial fermentations;
- Thermo-chemical processing of biomass;
- Biocatalysis;
- Sustainability;
- Bioplastics & biomaterials;
- Industrial crops;
- Financing the bio-based economy;
- Bio-energy;
- Bio-based chemicals;
- Metabolic engineering;
- Pre-treatment and processing of biomass.

The bio-based economy will be a reality, and all the participants of this fifth edition of the conference on 'Renewable Resources and Biorefineries' have contributed to the impact of it. RRB5 was once again a successful event and preparations for the next edition are well underway at the moment. RRB6 will be hosted at the Rheinterrasse in Düsseldorf from June 7th to 9th 2010.

Please visit the RRB website at http://www.rrbconference.com
Here you will find all of the presentations from RRB5.

Contact: Barbara Toch
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IEA Bioenergy Review of the Bioenergy Sector

The International Energy Agency has recently published an Executive Summary containing an authoritative review of the entire bioenergy sector aimed at policy and investment decision makers. The report focuses on three main areas:

- A global perspective of the potential for Bioenergy;
- The main opportunities for deployment in the short and medium term;
- The principal issues and challenges facing the development of the sector.

A selection of some of the key findings can be found in the diagram below.

Share of global energy consumption

Today, biomass supplies some 50 EJ[1] globally, which represents 10% of global annual primary energy consumption. This is mostly traditional biomass used for cooking and heating. See Figure 1.

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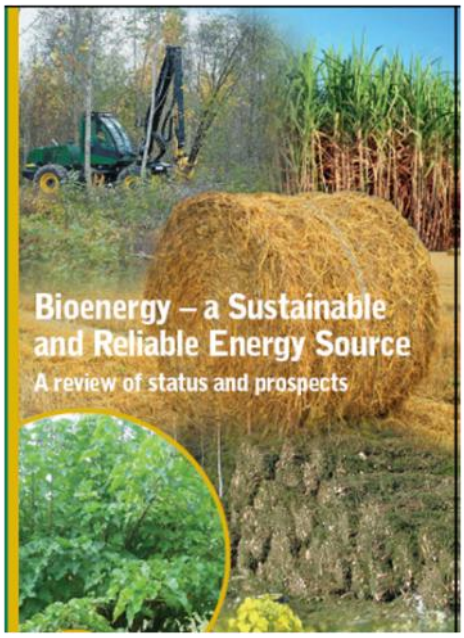
The full report 'Bioenergy – a Sustainable and Reliable Energy Source' is available at

www.ieabioenergy.com/MediaItem.aspx?id=6360



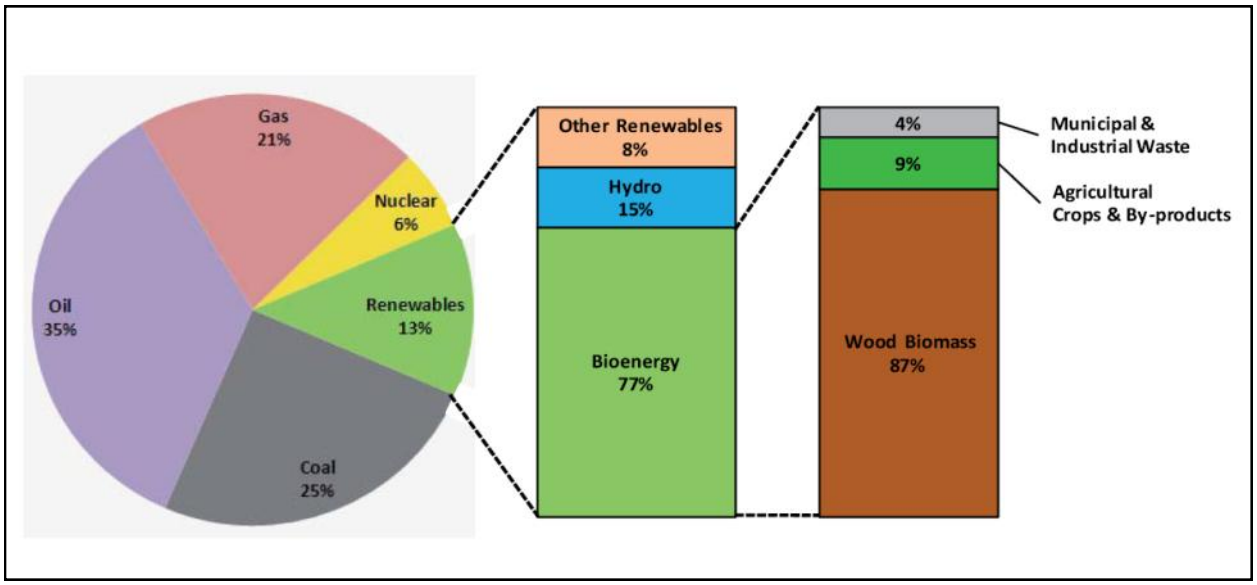


Figure 1: Share of bioenergy in the world primary energy mix. Source based on IEA, 2006; and IPCC, 2007

[1] 1 EJ = 10^{18} Joules (J) = 10^{15} kilojoules (kJ) = 24 million tonnes of oil equivalent (Mtoe)

...continued

Supply and demand
The technical potential for biomass is estimated to be possibly high as 1500 EJ/yr by 2050. Forestry and agricultural residues and other organic wastes (including municipal solid waste would provide between 50 and 150 EJ/year, while the remainder would come from energy crops, surplus forest growth and increased agricultural productivity (see Figure 2 below).

Projected world primary energy demand by 2050 is expected to be in the range of 600 to 1000 EJ (compared to about 500 EJ in 2008). Scenarios looking at the penetration of different low carbon energy sources indicate that future demand for bioenergy could be up to 250 EJ/yr. This projected demand falls well within the sustainable supply potential estimate, so it is reasonable to assume that biomass could sustainably contribute between a quarter and a third of the future global energy mix.

Other interesting areas highlighted within the Executive Summary include:

- Biomass conversion technologies;
- Bioenergy markets;
- Interactions with other markets;
- Bioenergy and policy objectives;
- Lessons for the future;
- The way forward.

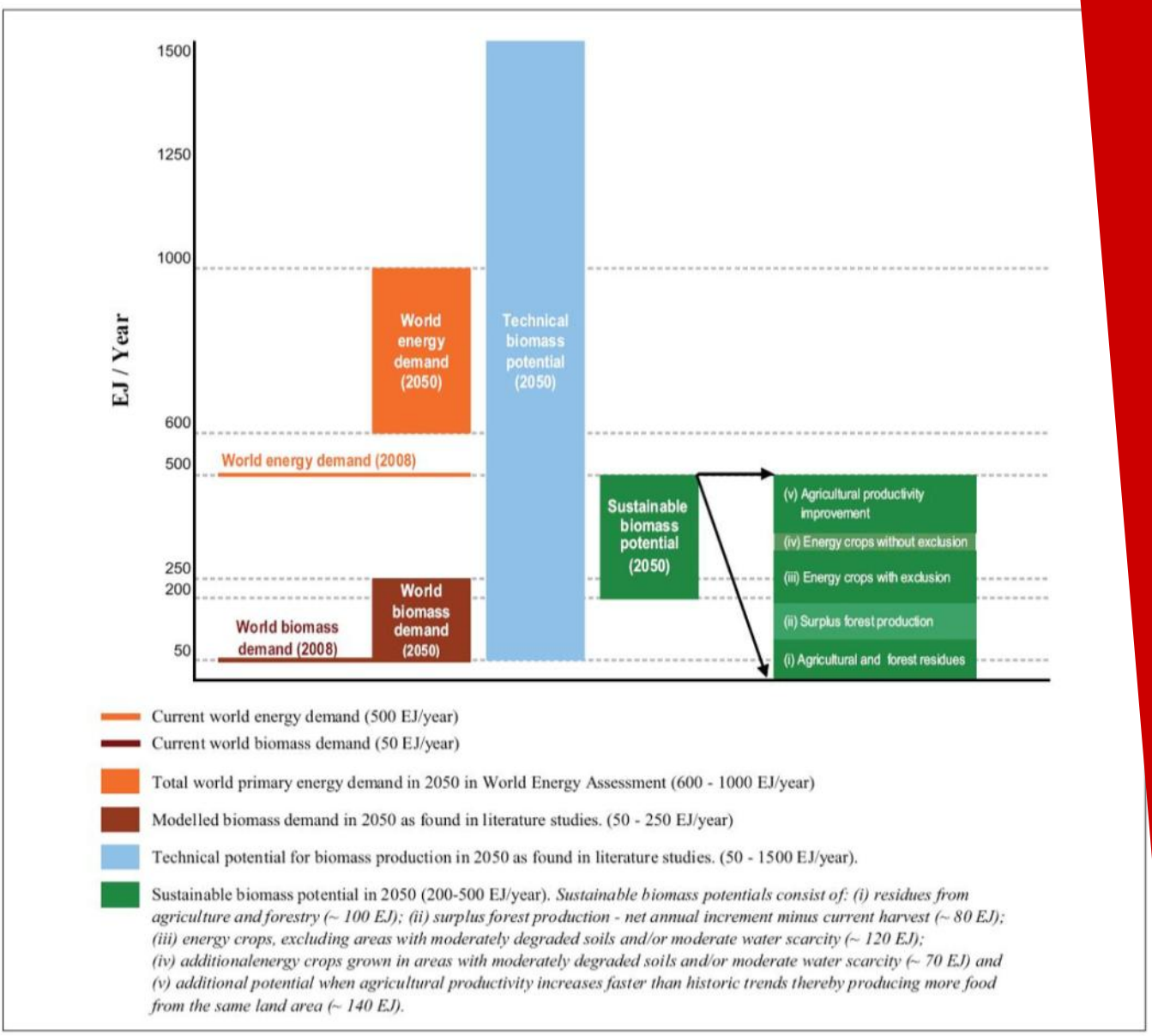


Figure 2: Technical and sustainable biomass supply potentials and expected demand for biomass (primary energy) based on global energy models and expected total world primary energy demand in 2050. Current world biomass use and primary energy demand are shown for comparative purposes. Adapted from Dornburg et al. (2008) based on several review studies.

Developing advanced biorefinery schemes to convert whole EU oil-rich crops into energy, food and bioproducts. This will make optimal use of the side streams generated during farming/harvesting, primary processing and secondary processing.

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Web: http://www.sustoil.org

SUSTOIL Partners

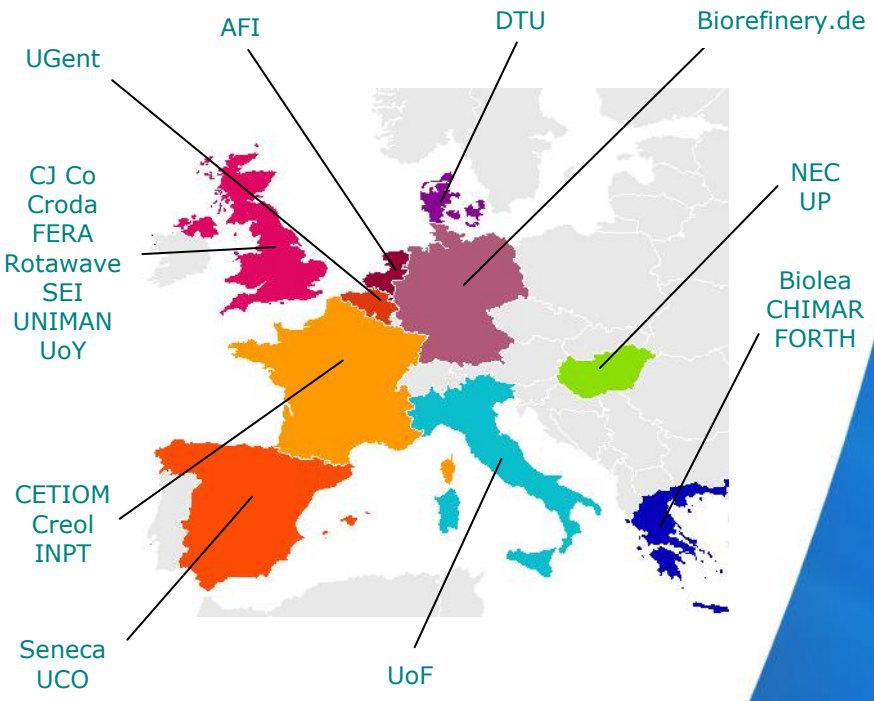
SUSTOIL will integrate the expertise of 22 project partners with the expertise of an Advisory Board composed of experts from the EU, US and beyond.

Economic, social and environmental costs benefits of optimal integrated schemes will be assessed and main technological challenges/ knowledge gaps will be identified.

Resulting in recommendations of key activities for future collaborative projects.

The map below shows where the partners are located-

1. Agrotechnology and Food Innovations BV, The Netherlands
2. BioCentrum-DTU, Denmark
3. Biolea, Greece
4. Biorefinery.de GMBH, Germany
5. CETIOM, France
6. Charles Jackson & Co Ltd, UK
7. Chimar Hellas SA, Greece
8. Creol, France
9. Croda International PLC, UK
10. Food and Environment Research Agency, UK
11. FORTH, Greece
12. INP Toulouse, France
13. Nógrádi Erdökémia Co, Hungary
14. Rotawave Ltd, UK
15. Seneca Green Catalyst SL, Spain
16. Stockholm Environment Institute, UK
17. University of Cordoba, Spain
18. University of Foggia, Italy
19. University of Ghent, Belgium
20. University of Manchester, UK
21. University of Pannonia, Hungary
22. University of York (Coordinator), UK



June 2008—May 2010

Work Package 5 Progress Update:
Social, environmental and economic cost-benefits analysis of biorefinery schemes

As the effort for this Work Package is progressing we have already developed a number of models for different biorefinery-related processes based on the ASPEN PLUS process simulator and the ASPEN CUSTOM MODELLER modelling environment. We have used these models to perform parametric studies, in order to identify windows of the "best" operating conditions for a number of processes, two of which are presented on page 19.

Furthermore, we are combining these process models with Life Cycle Analysis (LCA) tools in order to assess the environmental as well as the economic sustainability of these schemes. The simulation set-up for the production of biodiesel and the subsequent processing of glycerol as well as for the production of biogas are presented on page 19.

Biodiesel Production and Glycerol Uses

Biodiesel can be created from various different oils. In this scheme we have considered biodiesel created from rapeseed oil. However using information provided from work packages 1-3 (including CETIOM and CREOL) we can also model how the oil is extracted from the rape seed crop. The flowsheet simulated for producing Biodiesel starting from oils seeds is shown in fig. 1 (please see page 19).

The extraction of oil from the seeds currently only involves pressing and filtering of the solid seeds with the assumption that this will give 80% of the available oil. If we also know the oil content of the seeds (~40% for rapeseed) and the moisture content then we can model this process with a

custom model, in ASPEN CUSTOM MODELLER, which contains a few simple equations.

In order to produce biodiesel this extracted oil is then reacted with methanol in the presence of an acid-based catalyst (H_2SO_4) with the overall reaction:

Oil + 3 Methanol ←→ 3 FAME + Glycerol

This reaction is carried out in a continuously stirred tank reactor with a very high ratio of methanol to oil (30:1) in order to obtain a high conversion (over 95%) of oil to FAME (biodiesel). To achieve this high ratio it makes sense to include a separation and recycling of around 60-90% of the unreacted methanol coming out of the reactor.

In addition to biodiesel, this process also produces glycerol, which is mixed with methanol and water. We have considered two options (see fig. 2a and b) for dealing with this glycerol: purification to approximately 95% so it can be sold or conversion to higher value succinic acid through fermentation. The purification can be modelled by the addition of another separation unit. However the fermentation requires the use of a custom unit which integrates a set of kinetic expressions to derive the final concentration of the fermentation output. The kinetics in question are derived from lab and bench-scale experiments with thanks to our experimental colleague Anestis Vlysidis and to Prof. Colin Webb.

Biogas Production

We have also constructed a model (shown on page 19 in fig. 3) for extracting biogas from crop residues (straws and meals) using data provided by FORTH. This feed is mixed with water to bring the moisture content to around 65% before it is passed into a digestion reactor. The reaction used inside the reactor is designed to satisfy the product composition (60% methane 40% carbon dioxide) which is:

1.52 **Residue** → 0.15 **Inert Residue** + 11.04 **CO_2** + 45.44 **CH_4**

where the numbers allow the mass of reactants and products to match. The inert residue represents the part (~10%) of the residues which can not be broken down into biogases.

The conversion of this reaction is assumed to be 90% meaning that 10% of the crop residues exit the reactor unchanged in the liquid digestate. In order to reduce the water requirement and increase the efficiency of the process, a recycle is added so that some of the digestate is fed back into the reactor. The fraction of the digestate which should be recycled is a parameter which should be optimised.

The biogas released in the digester can then be fed into a combined heat and power unit which burns the methane and releases more carbon dioxide. This is modelled simply with a single reaction and a specified conversion (90%, thanks to FERA)

$CH_4 + 2O_2 \rightarrow 2H_2O + CO_2$

A more complex model involving multiple reactions and kinetics could be used instead if we wanted more accurate energy and product composition data.

The energy produced by this reaction is computed from the thermodynamics of reactions and components involved together with the flow rates.

Approximately 36% of this energy is then converted into electricity with remainder either lost (~10%) or sold as heat energy (~54%)

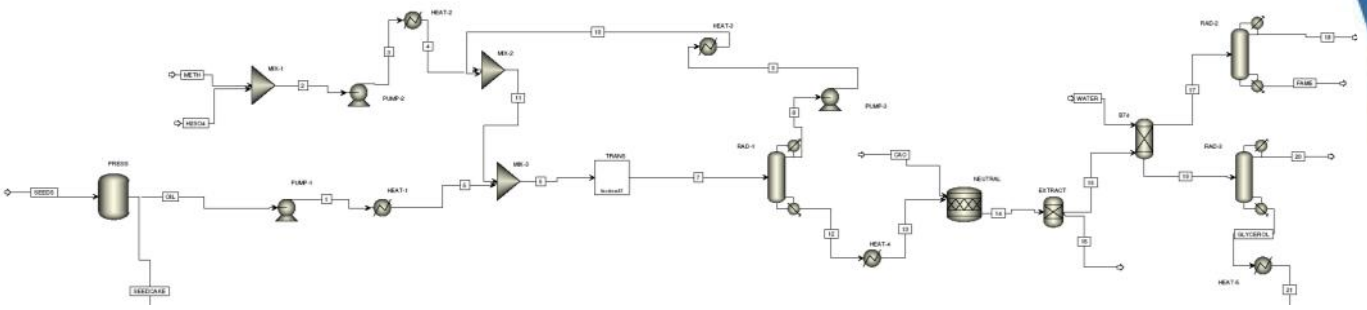


Figure 1. Simulation of Biodiesel Production

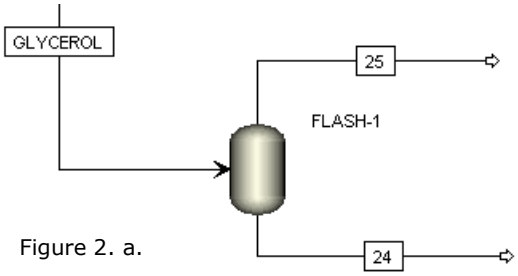


Figure 2. a.

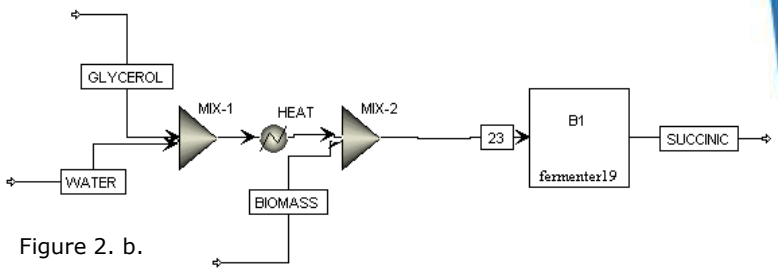


Figure 2. b.

Figure 2. a. Glycerol Purication, b. Bioconversion Through Fermentation

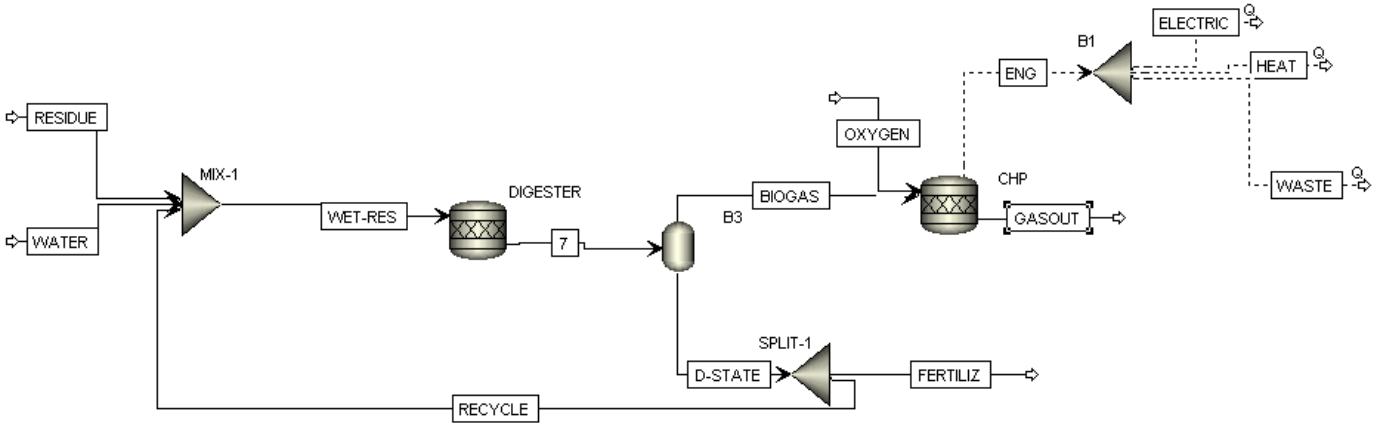


Figure 3. Simulation of Biogas Production

Dr. Michael Binns, University of Manchester

Dr. Binns received his MPhys in Theoretical Physics, and his PhD in Chemical Engineering at the University of Manchester and he is currently a Post-Doctoral Research Associate at the School of Chemical Engineering and analytical Science in the group of Dr. C. Theodoropoulos. His work includes large-scale computations and using advanced numerical methods as well as mathematical techniques for complex networks, model reduction and optimisation. His research interests include systems biology, modelling, design and optimisation.

Dr. Constantinos Theodoropoulos University of Manchester

Dr. Theodoropoulos is a Senior Lecturer at the School of Chemical Engineering and Analytical Science. He is the Work Package leader for WP5. His research focuses on the multi-scale modelling of chemical and biochemical processes.

The aim is the development and application of novel computational methods and model reduction techniques for the efficient simulation, design, optimisation and control of complex multi-scale systems. Specific applications include biorefinery processes, multi-scale microreactor design, combustion, catalytic processes and biochemical networks including metabolic pathways.

CHIMAR HELLAS S.A.—Partner Profile

Introduction

CHIMAR HELLAS, successor of ACM Wood Chemicals, has already reached 32 years of industry service in the area of resins and chemicals for wood panels. Throughout its history, the company and its predecessors have invested in research and development (R&D) as the flagship of their business activities. The primary focus for CHIMAR R&D has always been to provide their customers with tailor -made technologies, anticipating their needs. CHIMAR solutions were aimed at respecting the environment, protecting human health and supporting sustainability.

Core Business Description

CHIMAR HELLAS S.A. is an innovating developer and provider of industrial technology for resins and chemicals for wood-based panels.

Its main activities include technology development and licensing, manufacturing support and application support for resins, chemical additives, and processes for producing particleboards, fibreboards, plywood, oriented strand boards, laminating papers.

CHIMAR in parallel offers engineering and procurement of industrial plants producing formaldehyde, UFC and chemical additives.

The company is active worldwide and offers no-frontier services. It always strives to stay at the forefront of developments throughout the world.

In Detail

CHIMAR develops in-house and licenses knowhow for the production of formaldehyde-based resins, laminating syrups and chemical additives and their application in the manufacturing of particleboard, medium density fibreboard (MDF), plywood, oriented strand board (OSB) and laminating paper.

CHIMAR also undertakes the engineering, commissioned construction and procurement of plants producing formaldehyde, urea-formaldehyde pre-condensate (UFC), formaldehyde resins and additives. It has already completed 12 construction projects worldwide. Its experience covers all the major formaldehyde production systems and processes.

CHIMAR offers R&D services, technical support and training both remotely and on-site based on its multi-lingual human resources.

CHIMAR continuously focuses on "green" chemicals and technologies, fulfilling the eco-efficiency principles. It has important research experience on resins from renewable resources, on panels produced from agricultural wastes as well as on recycling technologies.

CHIMAR undertakes long, medium and short-range Research and Development as well as lab scale testing, everyday problem solving and final stages of development and industrial implementation, thus creating value from research results. CHIMAR applies modern techniques and Information Technology tools in research. It also has a focus on collaborative R&D with established research and industrial organisations of the field.

The technology developed by CHIMAR has been applied so far in more than 70 industrial plants located in 36 countries. The company has 32 years experience in transferring new technology into the resin and panel industry and in providing knowhow all around the world.

CHIMAR R&D

The aim of CHIMAR R&D is to develop and provide tailor-made technologies, anticipating industry evolutions and helping customers to achieve sustainable competitive advantage.

CHIMAR owns a well equipped chemical laboratory for advanced synthesis and analysis of resins and chemicals. It is there where elaborate trials are performed by CHIMAR scientists and ideas are taking shape, to form new products. The company affords wood panel production and performance testing via means of an accompanying technical laboratory.

It is further equipped with pilot scale installations for resin making.

Medium to Long-Term R&D

CHIMAR is involved in research projects, either self-funded or partly supported by the European Commission and implemented in cooperation with established European research/industrial organisations of the field. The aim is to develop and promote innovative products and technologies, while cooperating with the best partners. The project results are properly protected and disseminated worldwide.

There is currently an experience of participation in 26 European funded projects and in 3 scientific networks.

The company is also active in paper presentations in international conferences and refereed journals.

Continued overleaf...

CHIMAR Human Resources

The success of CHIMAR, however, mainly relies on its strong team of highly skilled researchers, technical and administrative support personnel: chemists, chemical engineers, forest and petroleum scientists and technologists, computer engineers, financial and legal advisors, personnel with managerial skills. It is multi-lingual personnel, with exceptional drive and initiative, who are on call any moment and can offer services to customers all around the world.

Strong leadership with innovative vision has been driving the company's lengthy presence in the development and application of industrial knowhow for producing resins and resin additives for the manufacture of wood-based panels.

CHIMAR New Division: ChimarIP

The CHIMAR department for the management and protection of the company knowhow and Industrial Property Rights (IPR) all around the world has expanded its activities by offering services to third parties (companies & individual inventors) as regards the protection and exploitation of knowhow, trade secrets and Industrial Property Rights (patents, trademarks, industrial designs). These services are addressed to various sectors such as chemistry, chemical technology, computer science, electronics and mechanical engineering.

CHIMAR and SUSTOIL

The participation of CHIMAR in SUSTOIL is based on its extensive work on developing resins from natural biomass products or by-products for application in wood-based panel production. This is in line with the CHIMAR strategy to promote sustainable development by providing performance and cost effective alternative resins to the industry.

Contact:
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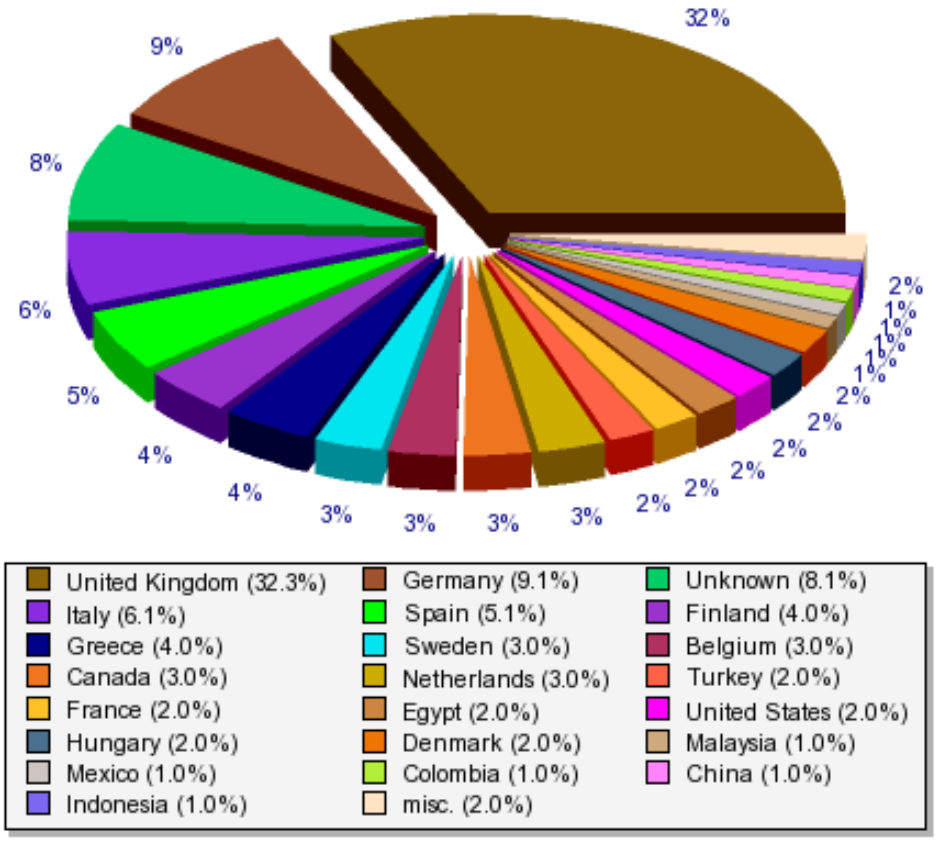
SUSTOIL Website Statistics

Our website (http://www.susoil.org) has continued to improve the number of visitors to the site.

It currently stands at:

- Overall Unique Visitors: 4,709
- Average per Day: 7
- Total Page Views: 22,495

We have people visiting from all over the world and the chart below breaks the overall visitors by location.



Takeoff for the Bird...

In the 2008 Joint Biorefinery Call, with a total budget of 57 million Euro, 2 million Euro was dedicated to a European Coordination Action. In recognition of the multidisciplinary nature of research related to biorefineries, five European Technology Platforms, five prominent research organisations and one civil society organisations submitted a proposal together. The proposal was called "*Strategic Targets for 2020 – Collaboration Initiative on Biorefineries"* or in short "*Star-COLIBRI*".

Critical Mass

As such, the Star-COLIBRI consortium represents stakeholders from the energy sector, the forest-based sector as well as the chemical, agricultural and manufacturing sectors. Actually it is the first time in Europe that we have a real critical mass along the whole biorefinery value-chain in terms of all biomass sources.

Good Things Come to Those Who Wait...

After passing the evaluation and successfully negotiating the contract, we are now only waiting for the signing of the contract by the European Commission.

The Star-COLIBRI Mission

There are probably thousands of research projects related to biorefineries in Europe, so what is special about Star-COLIBRI? Well, the idea is to help Europe to use the results of research more easily and to do research more efficiently.

We want to identify synergies and help to avoid fragmentation among research projects. We will identify research projects that are especially important and make them more visible to industry as well as policy makers and other research projects. We will give advice for future research funding, propose a joint research road map and a biorefinery vision that can be shared by all the stakeholders of the five European Technology Platforms involved in the project.

European cooperation is needed to balance market demand and raw material supply, find new opportunities as well as create awareness for mutual interests. If everything goes well, this provides the necessary background for a public-private partnership in the area of biorefineries.

Key Project Objectives

- To facilitate information exchange and cross-fertilization in the area of biorefineries research
- To support break through innovations by speeding up and facilitating industrial exploitation of research results
- To overcome fragmentation in the field of future R&D funding and facilitate the creation of future Public-Private Partnerships in the area of biorefineries.

Star-COLIBRI and SUSTOIL...

Several partners of the Star-COLIBRI consortium are involved in CSAs (such as SUSTOIL, BEE, Biorefinery Euroview and BIOPOL) that has contributed, or still contributes to describing the biorefinery research situation in the European Union, as well as the issue of biomass resources. This allows Star-COLIBRI to continue building on the good results of these projects. We should not do again what has already been done before. Instead, we should together promote information exchange, synergies and cross-fertilization in the area of biorefinery research.

Contact: Johan Elvnert, Coordinator of Star-COLIBRI

The kick-off meeting for STAR-Colibri took place in Stockholm in November 2009. The project is the only co-ordination and support action project to be funded from the joint biorefinery call which was announced in the last issue of biorefinery researcher. Sustoil and the Green Chemistry Centre, York will have a key role in providing results and network experience for the new project. Partners include CEI-Bois (Belgium), EPSO (Belgium), EBio (Belgium), FNR (Germany), TUD (Germany), UoY (UK), VTT (Finland), IAR (France), A+F (IAR), DBFZ (Germany) and FTP (Belgium)

Processum—"Biorefinery of the Future"

Processum site in Örnsköldsvik

Following the Star-COLIBRI meeting in Stockholm which was held in parallel with FTP2009 an optional study tour was also organised to Processum in Örnsköldsvik, the "Biorefinery of the Future". Processum is a biorefinery cluster based on a site originally used for pulp and paper processing and the companies based there now specialise in added value products from wood processing. These include cellulose for textiles (Domsjö) cellulose derivative for paint formulations (Akzo Nobel) and bioethanol produced by SEKAB.

A more recent development by Domsjö is the use of lignosulphonate as a concrete additive. This was originally supplied as an aqueous solution but the company has recently invested in large scale spray-drying to enable this material to be supplied as a powder thereby reducing transport bulk. Lignosulphonate is not only a renewable material but its use reduces water requirement for concrete production and increases the strength of the concrete meaning less mass can be used and the energy requirement and GHG emissions are relatively lowered. The site has integrated CHP plant that provides energy for the site and also exports energy to the surrounding area. This is powered solely from by-products produced on site and also imports by-products from the neighbouring area.

Our tour included excellent presentations from Erik Normark and Jan Åhlund of Holmen Skog that illustrated the entire cycle of forest management and timber recovery, a presentation from Ola Hildingsson, Managing Director of Domsjö illustrating their move into high value cellulose applications and a talk from Sune Wännström of SEKAB on the cellulose bioethanol pilot plant. A tour of the site demonstrated both the range of operations already there but also the potential to expand into other biorefinery applications based on forest raw materials. The day was hosted by Clas Engström, Managing Director of Processum and our thanks go to him and his team for such an excellent and informative day.

Contact: Ray Marriott
Email: rm555@york.ac.uk

Featured Advisor—Andy Proctor

Andy Proctor is a native of West Yorkshire and obtained a BSc. degree in Chemistry and Biology at Queen Mary College, University of London and after spending a few years teaching in further education obtained MS and Ph.D. degrees in the USA at the University of Arkansas Food Science Department. His doctoral research was on the mechanism of adsorption of pigments during vegetable oil processing by silicates.
He subsequently obtained an Assistant Professor position in Food Science at The Ohio State University where he earned tenure and promotion to the rank of Associate Professor.

During that time he studied the use of bio-silicates from rice hull waste streams as a source of amorphous silica for adsorption processing of vegetable oils. He later returned to University of Arkansas to work with the rice industry to develop silica and carbon industrial products from rice hulls where he was promoted to Professor. Proctor continues to work with the US rice industry on utilization of rice hull and rice straw but is also focusing in oil research on the development of conjugated linoleic acid (CLA) rich oil by photoisomerization of soy oil linoleic acid.

His research group is optimizing the technology and conducting spectroscopic and chromatographic analysis of the oil. Recent animal nutrition studies conducted by Dr. Latha Devereddy at the University of Arkansas has shown that CLA rich soy has the ability to reduce total cholesterol in obese rats by 38% while increasing the ratio of HDL (good cholesterol) to LDL (bad cholesterol).

From left the right, the lab members are: Jeta Kadamne, Utkarsh Shah, Brooke Henbest, Andy Proctor, and Chelsey Castrodale

Jeta is working on developing rapid FTIR methods for measuring CLA in CLA rich soy oil and foods containing this oil. Utkarsch is working on CLA fatty acid isolation and concentration Brooke is working on optimization of soy oil processing for CLA yields Chelsey is studying lipid oxidation of CLA rich oil

He is also involved in education activities relating to use of renewable resources. Proctor is the US leader of a US government funded EU-US Atlantis student exchange program, 'Integral Valoization of Bioproduiction' with Iowa State University and Kansas State University. The EU partners are University of Ghent, Belgium; Karl Franzens University, Graz, Austria; and the Toulouse Polytechnic University, France. This consortium is involved in providing multidisciplinary, transatlantic research and classroom experiences to postgraduate and undergraduate students.

Proctor is a Senior Associate Editor of the Journal of the American Oil Chemists Society and is currently serving a second term on the Governing Board of the American Oil Chemist Society. He is also a Fellow of the Royal Society of Chemistry.

An article written by Andrew Proctor and Vishal Jain can be found on the SUSTOIL website.

Titled: A novel CLA production method comes to light

Ref: *Inform*, May 09, Vol. 20 (5), 280-281

http://www.york.ac.uk/res/sustoil/Pages/CLA INFORM.PDF

The Forest Biorefinery in Piteå, North Sweden

The pulp and paper industry in Sweden faces many challenges such as decreasing high quality paper demand due to increasing digitalisation and severe competition from South America, where cheap raw material and labour is available. Furthermore novel methods of converting hardwood to paper have been developed in South America which will further increase the pressure on the Swedish paper industry.

In such a situation, the industry in Sweden has not just been a spectator in a rapidly changing world, but has chosen to take a path of innovation, diversification and sustainability.

Piteå is a small town located in the north of Sweden, around 800km from Stockholm which has a thriving paper industry with two large factories, one owned by Smurfit Kappa, and the other owned by SCA.

Smurfit Kappa has an output of around 700,000 tonnes per annum of Kraftliner, a base paper used for the manufacture of high quality corrugated packaging. There are a number of biorefinery activities at the Smurfit Kappa site which complement the main production.

Figure 1: The Smurfit Kappa paper mill where the new Bio-DME plant is under construction.

Bio-DME- An Alternative Fuel for Trucks

The pulp and paper industry can produce a large amount of by-product called 'black-liquor' which can be converted to dimethyl-esters using gasification and chemical processing. His Majesty King Carl XVI Gustaf of Sweden initiated the construction of the world's first plant for the production BioDME at the Smurfit Kappa site. The plant will be built by Chemrec with a production capacity of 4 tons per day using forest residues as the feedstock. The plant is expected to begin production in July 2010 and other members of the project include, Haldor Topsøe, Volvo, Preem, Total, Delphi and ETC (www.biodme.eu).

Combined Heat and Power

The Smurfit Kappa paper mill has recently installed a large scale biomass boiler which not only provides electricity for the mill, but also supplies hot water to the local community. The main feedstocks include bark and by-products of the paper mill which provide enough heat for 20,000 local homes. The boiler operations are controlled remotely using a high-tech system as shown in figure 2.

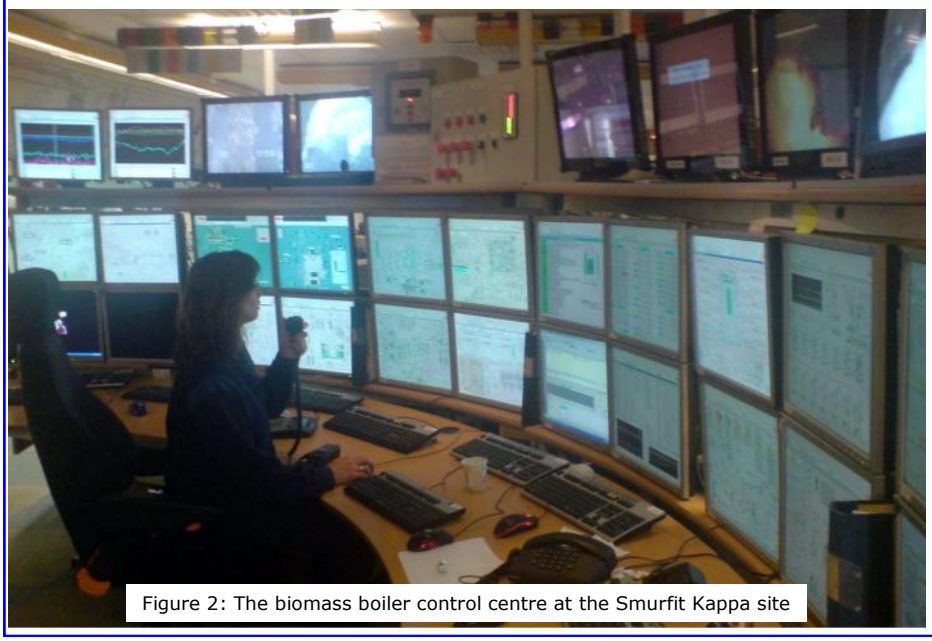


Figure 2: The biomass boiler control centre at the Smurfit Kappa site

TallDiesel

Crude tall oil is a byproduct of the kraft processing of pinewood for pulp and paper. Crude tall oil starts as tall oil soap separated from recovered black liquor in the kraft pulping process. The tall oil soap is acidified to yield crude tall oil which contains 40-50% fatty acids such as oleic and linoleic acids; 5-10% sterols, alcohols and other components.

Normally CTO is first depitched and then upgraded by distillation to produce more valuable products such as tall oil fatty acids and tall oil rosin.

However, SunPine AB is building a production plant in Piteå, Sweden to convert crude tall oil either to "crude tall diesel" for subsequent hydroprocessing at a refinery into a renewable diesel component or, via purification, into standard EN14214 biodiesel. The plant will have a capacity of up to 100,000 m3 of crude tall diesel per year. Construction work has started and production is expected to start soon.

Figure 3: The Sunpine construction site in Piteå on the 11th of November 2009

Solander Science Park

The Solander Science Park is made up of a large number of companies, academics and government organisation in and around the Piteå area. The park acts as a catalyst for innovation, networking and collaboration for the development of forest-based biorefineries in the area (www.solandersciencepark.se).

The Solander Symposium took place in Piteå, Sweden on 11-12 November 2009 and the theme of the symposium was 'From Wood to Wheel'. This was an opportunity for the participants to meet, discuss and exchange ideas about the future of Forest Bioenergy and pulp mill Biorefinery technology.

Some of the key participants included Robert Bergman, **Chairman, Manager Solander Symposium**; Ola Alterå, **Ministry of Enterprise and Energy and communication**; Marco Mensink, **Energy & Environment Director, Cepi, Confederation of European Paper Industries**; Marie S. Arwidson**, CEO, Swedish Forest Industries Federation;** Pierre Schellekens**, Head of European Commission Representation in Sweden**

Figure 4: The Swedish State Secretary, Mr Ola Alterå, Ministry for Enterprise, Energy and Communications presented at the Symposium

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See also article on page 6 - 'From Wood to Wheel, Solander Science Park'

Public Deliverables Now Available

BIOPOL

www.biorefinery.nl/biopol

BIOPOL, a 2-year European Commission FP6 project concluded in June 2009.

It was launched to address the fact that the wider expectations for biorefineries had not yet yielded clear definitions for biorefinery concepts, or an understanding of the then current status and prospective benefits of biorefining in Europe. The overall goal was to assess the status (technical, social, environmental, political and implementation) of innovative BIOrefinery concepts and the implications for agricultural and forestry POLicy.

The final report which contains the main results, conclusions and recommendations can be found at **http://www.biorefinery.nl/biopol/public-deliverables**

A number of other public deliverables can also be found here including, for instance, the following reports:

- Market acceptance of biorefinery concepts amongst consumers;
- Assessment results concerning the impact of biorefineries on rural development, employment and environment;
- Implications of renewable, forestry and agricultural policies for biorefinery viability;
- Technical, economic and ecological system assessments and market perspectives of biorefinery systems and platform chemicals.

Biorefinery Publications

Training Courses

Biorefinery Course: "ADDING VALUE TO THE SUSTAINABLE UTILISATION OF BIOMASS", co-funded by the FP6 Integrated project BIOSYNERGY and the IEA Task 42 Biorefineries. http://www.biosynergy.eu/publications/biorefinery-course-presentations/
and http://www.biosynergy.eu/fileadmin/biosynergy/user/docs/TrainingCourseDisseminationDOC.pdf

Reports

International Energy Agency; Bioenergy – a Sustainable and Reliable Energy Source www.ieabioenergy.com

BIOPOL—Assessment of BIOrefinery concepts and the implications for agricultural and forestry POLicy; Final report (www.biorefinery.nl/biopol). See also article on page 26 regarding other reports available from BIOPOL

Kamm, B.; Biorefinica 2009, International Symposium Biobased Products and Biorefineries, CLEAN, A Journal of Sustainability and Environmental Safety, 37, 3 (1009) 190 (www.clean-journal.com)

Kamm, B.; Hempel, M.; Erb, R.; Biorefinica 2009, Biogene Rohstoffe raffinieren, International Symposium Biobased Products and Biorefineries, Nachrichten aus der Chemie, 57, April 2009, 453 (www.gdch.de)
See: www.biorefinica.de

Review

KAMM, B.; Ölwechsel. Biokraftstoffe und nachhaltige Mobilität. Uwe Lahl, Rhombos Berlin, 2009, Nachrichten aus der Chemie, 57 (2009), 804

Books and Journal publications

P.J. de Wild, H. den Uil, J.H. Reith, A. Lunshof, C. Hendriks, E.R.H. van Eck, H.J. Heeres, " Biomass valorisation by a hybrid thermochemical fractionation approach", International Journal of Chemical reactor Engineering, Vol.7, 2009, Article A51. http://www.bepress.com/ijcre/vol7/A51

Bennett, S. J., Annevelink, E. (2009) Establishing a sustainable biorefining industry. Biofpr (Biofuels, Bioproducts & Biorefinery Journal) 3 (3)

Peck, P., Bennett, S. J., Bissett-Amess, R., Lenhart, J., Mozaffarian, H. (2009) Examining understanding, acceptance, and support for the biorefinery concept among EU policy-makers. Biofpr (Biofuels, Bioproducts & Biorefinery Journal) 3 (3)

Menrad, K., Klein, A., Kurka, S. (2009) Interest of industrial actors in biorefinery concepts in Europe. Biofpr (Biofuels, Bioproducts & Biorefinery Journal) 3 (3)

Kamm, B.; Beckmann, J.; The LCF Biorefinery – Combination of forestry with the production of platform chemicals and materials, In [Papermaking Research Symposium 2009, Eds.: Elina Madetoja, Heidi Niskanen and Jari Hämäläinen, PRS, 1-4 June, 2009, Kuopio Finland], CD-ROM

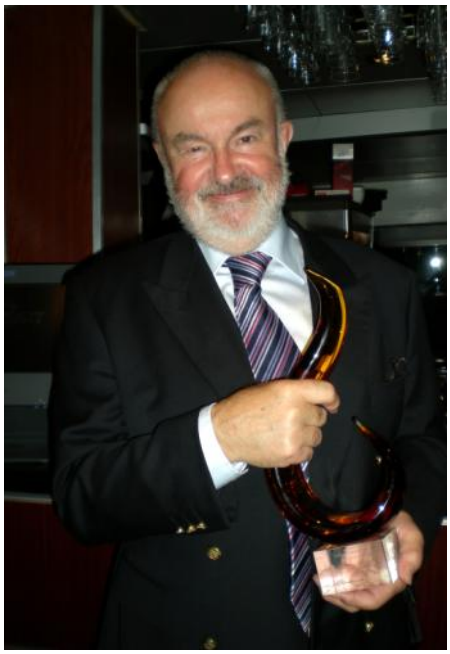
Kamm, B.; Bioraffinerie- Schlüssel für effiziente Ressourcen, Gesellschaft Deutscher Chemiker, Wochenschau Nachhaltige Chemie, Kap.4, 53-54

KAMM, B.; Integrated Biorefineries- Bottom-up approach from Green Biomass Fractionation In: Biotechnology in Agriculture and Forestry, Springer, Heidelberg (invited article)

KAMM, B.; SCHÖNICKE, P.; KAMM, M.; Biorefining of green biomass – technical and energetic considerations, CLEAN 2009, 37 (1), 27-30

KAMM, B.; Carbohydrate-based food processing wastes as biomass for biorefining of biofuels and chemicals, In: Handbook of waste management and co-product recovery in food processing Vol. 2, Woodhead Publishing Ltd, Cambridge, England, (invited article, accepted)

BIOREF-INTEG Work Package leader, Professor Tony Bridgwater, wins prestigious Award



Tony Bridgwater, leader of BIOREF-INTEG Work Packages 2 and 6, and Professor of Chemical Engineering at Aston University, UK has been awarded the Don Klass Award* for Excellence in Thermochemical Conversion Science.

Presented to Professor Bridgwater on September 16th 2009 at the international conference on thermochemical conversion science - *tcbiomass 2009*, in Chicago, USA, this prestigious award recognises his extensive contributions to the field of bioenergy, as well as his past efforts as organiser of World Biomass Conferences.

Globally recognised as a leading bioenergy researcher, Tony has worked at Aston University for most of his professional career and currently leads an internationally renowned research group, the Aston University Bioenergy Research Group (BERG). His major research interests over the last 20 years have been in thermochemical processing of biomass and other solid fuels including waste and refuse to produce valuable fuels and chemicals.

These products include conventional and unconventional gaseous and liquid fuels; oxygenates as fuel additives and chemical intermediates; and commodity chemicals such as methanol, and ammonia for fertilizer production.

Tony and his team of over 20 researchers are developing innovative processes and products whereby fast growing wood, energy crops, agricultural wastes and other biogenic materials can be thermally converted into liquids, gases and solids for production of electricity, heat, transport fuels and a wide variety of chemicals.

Key achievements include:

- 45 years research experience in chemical engineering;
- Founder of Bioenergy Research Group (BERG), one of the world's biggest research groups in this field;
- Founder of PyNe (Pyrolysis Network), a global forum for researchers in fast pyrolysis of biomass to exchange information on new scientific and technological developments of biomass and related technologies;
- Technical Director of the UK SUPERGEN Bioenergy Consortium – the UK centre of excellence for biomass, bioenergy and biofuels;
- Member of over 34 European Commission sponsored research projects, including:
  - ◊ Core member of the EC sponsored DIBANET project;
  - ◊ Core member of the EC Bioenergy Network of Excellence;
  - ◊ Core member of the EC sponsored Integrated Project on biorefineries – Biosynergy;
  - ◊ Co-ordinator of the EC sponsored ThermalNet Network;
  - ◊ Task leader for the IEA Bioenergy Task on Pyrolysis;
- Johannes Linneborn Prize winner – in 2007 at the 15th European Bioenergy Conference for "Outstanding contributions to bioenergy";
- Edwin Walker Prize winner – awarded by the Institution of Mechanical Engineers for "Best conference transaction publication" in 2002;
- Chairman and organiser of 9 international bioenergy conferences in Europe and North America;
- Publication of 30 books and over 400 papers on biomass and bioenergy.

* The Don Klass Award is a tribute to the late Dr Donald Klass, who was President of the Bioenergy Research Association (BERA), and organised many well known and respected conferences around the world, including "Bioenergy from Biomass", which ran for 20 years from 1976 onwards.

BIOREF-INTEG

The Low Carbon Economy Offers Opportunity for UK Business

How UK Trade & Investment can assist "green" business to grasp future business.

"Low Carbon" permeates all sectors; it is therefore everybody's business and everybody's opportunity. The Stern report of 2006 warned that unmitigated global warming will cost between 5 and 20% of global gross domestic product by 2050. Since that report was published, the indications are that the implications of failure to tackle climate change will be even more severe. Put simply, there is no high carbon future; there must be a transition to a low carbon future. The good news is that international momentum on tackling climate change is building fast.

The UK is taking low carbon to the heart of the economy. It is showing the world how to create a thriving low carbon economy aligning commercial needs to social and environmental responsibilities by placing carbon management in the economic mainstream. This strategy is based on two key foundations; a vision for the global low carbon economy of the future, where low carbon is central to every business, and the UK's low carbon strengths.

Those strengths include:

- Sustainable construction
- Carbon trading
- High value manufacturing and engineering
- Waste management
- Water and waste water treatment
- Sustainable community management
- World leading climate change institutions
- World class professional services
- Top class universities

The UK is currently implementing its Low Carbon Transition Plan, designed to reduce UK carbon emissions by 34% of 1990 levels. Transforming the country into a cleaner, greener and more prosperous place to live is at the heart of the UK's economic plans for 'building Britain's future' and ensuring the country is ready to take advantage of the opportunities ahead.

By 2020:

- More than 1.2 million people will be in green jobs.
- 7 million homes will have benefited from whole house makeovers, and more than 1.5 million households will be supported to produce their own clean energy.
- Around 40 percent of electricity will be from low-carbon sources, from renewables, nuclear and clean coal.
- We will be importing half the amount of gas that we otherwise would.
- The average new car will emit 40 percent less carbon than now.

British companies are already putting low carbon at the heart of their businesses and they are doing this because it makes commercial sense.

Today, exports of low carbon technologies represent just 10% of the UK's overall figure of around £250billion. It is estimated that the global marketplace for Environmental Goods and Services alone will reach $688billion (£420billion) by 2010. This figure has grown on average by 5% per annum since 2002 and is expected to grow even faster in years to come as businesses and governments worldwide realise the need to reduce fossil fuel usage, construct more energy efficient buildings and vehicles and develop a low carbon economy. In March 2009, President Obama announced a ten year, $150billion program of investments in clean energy technologies, designed to boost the US economy. Masdar, in the UAE, is currently building a zero carbon, zero waste city, investing in a range of new energy technologies, establishing a post-graduate research institution and developing a carbon management unit. All these activities, and a range of other initiatives, are aimed at laying the groundwork for vital and sustainable new industries. The long-term aim is to create a broad range of innovative industries generating a steady flow of new ideas and technologies and advances, which will transform Abu Dhabi from a 20th Century, carbon-based economy into a sustainable 21st Century high-technology economy.

The UK has developed a Low Carbon International Marketing Strategy reaching across all sectors. For example, on energy, it is closely aligned with the UK Energy Excellence strategy (www.ukenergyexcellence.com).

Continued overleaf...

Designed to showcase UK expertise and provide compelling evidence of the UK's energy excellence, the related website offers a unique high profile access point to overseas buyers and investors, connecting the world to the UK energy industry. At the same time it supports the international marketing efforts of UK companies by providing a range of online marketing resources.

How can UK Businesses Get Involved?

UK businesses can find support across a wide variety of organisations. For those seeking advice on reducing their carbon footprint, organisations such as the Carbon Trust offer advice on resource efficiency, while there exist a host of Trade and Professional associations which can assist their members.

Business Link (www.businesslink.gov.uk), a UK wide business support organisation assists businesses to access support and funding, including accessing Grants for Research and Development.

For businesses looking to trade overseas, speaking to an adviser from UK Trade & Investment is an ideal way to assess the potential for your goods and services in overseas markets. Our International Trade Teams are located in over 40 local offices around the country. Every UK region also has dedicated sector specialists who can provide support tailored to your industry.
An International Trade Adviser will provide professional advice on a range of our services, including financial subsidies, export documentation, contacts in overseas markets, overseas visits, e-commerce, export training and market research.

UK Trade & Investment is the government organisation that helps UK-based companies succeed in the global economy and assists overseas companies to bring their high quality investment to the UK. For further information, please visit: www.uktradeinvest.gov.uk

Alastair Gardner is Yorkshire & the Humber's Regional International Trade Adviser specialising in Chemicals, Life Sciences and Environmental Technologies. A chartered chemist, Alastair worked as a research scientist for DuPont before moving into manufacturing related roles in the UK, where his involvement in the commissioning of new products in coating and drying processes helped in the decision to build a new multi-million pound production facility on the Leeds site. Alastair then worked on technology transfer projects and travelled to the USA, where he was involved in troubleshooting on an existing production facility and to China, to help set up and commission a new printing plate manufacturing operation for the China market. On his return from China, Alastair set up and ran China-Britain Business Council's office in Newcastle, paving the way for new regional offices opening in other English regions.

He joined UK Trade Investment's team in Yorkshire & the Humber in April 2004. Alastair's interests lie in the applications of renewable energy technologies and in how businesses in the sector can access the funding and support necessary to bring new technologies to market. Alastair is married with two children and lives in County Durham.

Alastair Gardner

Chemicals, Biotechnology and Environmental Technologies Sector Specialist

UK Trade & Investment Yorkshire & the Humber

RRB6—6th International Conference

6th International Conference on Renewable Resources and Biorefineries will take place in Düsseldorf (Germany) from 7-9 June 2010.

As during the previous editions, this three day international conference will consist of plenary lectures, oral presentations and a poster session. The conference aims at bringing together academic researchers, industrial experts, policymakers and venture capital providers to discuss the challenges emerging from the transition towards a bio-based economy and to present new developments in this area.

The conference will provide a forum for leading political, corporate, academic and financial people to discuss recent developments and set up collaborations.

More information about the previous editions of the conference can be found on their website:

http://www.rrbconference.com/

Events

NOVEMBER 2009

15th - 17th
2nd International Congress on Biodiesel: The Science and The Technologies
Munich, Germany

16th - 17th
3rd European Renewable Energy Policy Conference
Flagey Convention Centre, Brussels, Belgium

17th - 19th
European Paper Week 09 - Including Seminars on Biorefinery
Paris, France

19th - 21st
ORBIT 2009—Biomass and Organic Waste as Sustainable Resources
China Agricultural University, Beijing

26th - 28th
RENEXPO®: International Trade Fair and Conference for Renewable Energy and Passive House
Trade Fair Center, Salzburg, Austria

DECEMBER 2009

2nd
Opportunities for Enhancing Your Business with Green Chemistry
York, UK

1st - 7th
Annual World Congress of Gene - 2009
Foshan, China

2nd - 3rd
BIOREF-INTEG Workshop and Meeting
Birmingham, UK

10th - 11th
European Energy Agency Conference – New Goals Demand New Action
Malmö, Sweden

JANUARY 2010

18th - 20th
New Frontiers in Biofuels
New Delhi, India

26th - 27th
Energy from Biomass and Waste
London, UK

FEBRUARY 2010

4th - 7th
Bioenergy Expo - renewable resources event
Verona, Italy

25th - 27th
CEP® CLEAN ENERGY & PASSIVEHOUSE - trade fair and congress
Stuttgart, Germany

26th
4rd International Conference on Application of Biomass Gasification
Stuttgart, Germany

MARCH 2010

15th—16th
Achieving Optimum Value and Efficiency in Biomass Processing
Amsterdam, the Netherlands

APRIL 2010

14th - 16th
6th International Congress & Exhibition for South-East Europe: Energy Efficiency & Renewable Energy Sources
Sofia, Bulgaria

MAY 2010

3rd - 7th
18th European Biomass Conference and Exhibition
Lyon, France

5th - 6th
Waste to Energy - International Exhibition & Conference for Energy from Waste and Biomass
Bremen, Germany

17th - 19th
Engineering for Waste and Biomass Valorisation
Beijing, China

19th - 20th
All - Energy 2010
Aberdeen, UK

JUNE 2010

7th—9th
RRB6—6th International Conference on Renewable Resources and Biorefineries
Düsseldorf, Germany

JULY 2010

11th - 15th
Pyrolysis 2010 - 19th International Symposium on Analytical and Applied Pyrolysis
Montreal, Quebec

SEPTEMBER 2010

15th - 19th
14th International Biotechnology Symposium and Exhibition - Biotechnology for the Sustainability of Human Society
Palacongressi, Rimini, Italy

21st - 23rd
Bioten - Biomass, Bioenergy, Biofuels and Biorefineries
Birmingham, UK

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