9th LAMNET Project Workshop

Bioenergy

LAMNET

Ribeirão Preto, São Paulo, Brasil, 13 - 17 September 2004

Hotel JP
Anhanguera Highway km 308, Ribeirão Preto, Brazil,
Ribeirão Preto, São Paulo, Brazil, 13 – 17 September 2004

Workshop PROCEEDINGS

LAMNET - Latin America Thematic Network on Bioenergy
Coordination: WIP, Germany
Coordinator/ focal contact point:
Dr. Rainer Janssen (rainer.janssen@wip-munich.de)

The LAMNET Project Workshop "International Workshop on Bioenergy Policies, Technologies and Financing" took place in Riberão Preto, São Paulo, Brazil, from September 14th to 17th, 2004. It was organised by WIP-Munich, Germany, in collaboration with the Brazilian National Reference Centre on Biomass - CENBIO and the Biomass Users Network within the framework of the LAMNET project funded by the European Commission, DG Research. The workshop was attended by 110 participants from the academic, non-governmental, official, social, and private sector. A variety of scientific contributions, and presentations were prepared by LAMNET Members and invited speakers. The special focus of this workshop was on biodiesel production and utilisation in Brazil, as well as on the further promotion of Flex Fuel Vehicles. Besides the symposium, the workshop included a guided visit to the International Sugar and Alcohol Industrial Fair (FENASUCRO), as well as a technical tour to the sugar and energy production facility Companhia Energética Santa Elisa.

Workshop Organisation Support

Prof. José Roberto Moreira, CENBIO – Centro Nacional de Referência em Biomassa, Brazil

Armando Gomez Filho, CENBIO – Centro Nacional de Referência em Biomassa, Brazil

Dinorah Folli, CENBIO – Centro Nacional de Referência em Biomassa, Brazil

Manoel Regis Lima Verde Leal, CTC - Copersucar Technology Center, Brazil

Manfred Wörgetter, BLT Wieselburg, Austria

Dr. Giuliano Grassi, European Biomass Industry Association – EUBIA

Dr. Herbert-Peter Grimm, WIP-Munich, Germany

Dr. Peter Helm, WIP-Munich, Germany

Editor of Workshop Proceedings

Dr. Rainer Janssen, WIP, Germany
Anton U. M. Hofer, WIP, Germany

Published by: WIP-Munich
Sylvensteinstr. 2
81369 Munich, Germany
Phone: +49 89 720 127 35
Fax: +49 89 720 127 91
E-mail: wip@wip-munich.de
Web: www.wip-munich.de

Programme

TUESDAY 14th SEPTEMBER 2004

08:00 – 08:30	Registration of Workshop Participants	

Inauguration Session: Welcome, Bioenergy Strategies and Policies

Moderators: Prof. José Roberto Moreira, CENBIO and Dr. Peter Helm, LAMNET

08:30 – 09:00	Welcome Address Prof. José Roberto Moreira, CENBIO, Brazil	9
09:00 – 09:20	Inauguration Address Mr. Mauro Jardim Arce Secretary of Energy - Hydric Resources and Sanitation of the Government of the State of São Paulo	
09:20 – 09:40	LAMNET A Global Network on Bioenergy – Progress and Results Dr. Rainer Janssen, WIP – Renewable Energies, Germany	11
09:40 – 10:20	Future Worldwide Perspectives of Bio-diesel Utilisation Hofrat DI Manfred Woergetter, Austrian Bioenergy Centre, IEA Task Leader Bio-diesel	22
10:20 – 10:45	Coffee Break	
10:45 – 11:15	Industrial Production of Bio-diesel using Heterogeneous Catalysts – The AGROPALMA Process Mr. César Modesto Abreu, Agropalma, Brazil	25
11:15 – 11:45	Technical Aspects of Bio-diesel Production Mr. Miguel Dabdoub, University of São Paulo (USP), Brazil	28
11:45 – 12:15	Bio-diesel Strategies and Policies in Brazil Antonio René Iturra, Ministry of Science and Technology, Brazil	31
12:15 – 12:45	Discussion Round: Opportunities for Bio-diesel Production and Utilisation in Brazil Moderator: Hofrat DI Manfred Woergetter	
12:45 – 14:00	Lunch Break	

Afternoon Session: Bioenergy for Sustainable Rural Development

Moderators: Mr. Armando Shalders Neto, General Office of Energy, Hydric Resources and Sanitation of the Government of the State of São Paulo and
Dr. Giuliano Grassi, General Secretary European Biomass Industry Association

14:00 – 14:30	Keynote Address Oswaldo Lucon, Secretary of Environment of the State of São Paulo	37
14:30 – 15:00	Utilisation of Biomass European Technologies and Expectations Dr. Herbert-Peter Grimm, WIP – Renewable Energies, Germany	39
15:00 – 15:30	Discussion Round 1: Bioenergy for Sustainable Rural Development Moderator: Oswaldo Lucon	
15:30 – 16:00	Coffee Break	
16:00 – 16:30	Status and Prospective Future of Renewable Energy Development in China Mr. Tian Yishui, Ministry of Agriculture Centre for Energy and Environment Protection, China	45
16:30 – 17:00	Future Prospects of Bioenergy Utilisation in the South African Sugar Industry Mr. Denis Tomlinson, Illovo Sugar Ltd., South Africa	49
17:00 – 17:30	Bioenergy in Chile Upcoming Workshop ‘Bioenergy for Sustainable Development in Viña del Mar, Chile Dr. German Aroca, Catholic University of Valparaiso, Chile	50
17:30 – 18:00	Discussion Round 2: Bioenergy for Sustainable Rural Development Moderator: Mr. Denis Tomlinson	

WEDNESDAY 15th SEPTEMBER 2004

Morning Session: Innovative Bioenergy Technologies and Applications A

Moderator: Mr. Li Baoshan, Ministry of Science and Technology, China and
Dr. Peter Grimm, LAMNET

08:30 – 09:00	Implementation of Bioenergy International Cooperation Projects Dr. Giuliano Grassi European Biomass Industry Association (EUBIA)	52
09:00 – 09:30	Hydrolysis of Sugar Cane Bagasse – The Dedini Process Dr. Manoel Regis Leal, Copersucar, Brazil	55
09:30 – 10:00	Plant Biomass The Sustainable Source of Energy and Industrial Organic Chemicals Miller, Joseph, Universidade Federal da Paraíba	58
10:00 – 10:20	Discussion Round: International Cooperation Opportunities Moderator: Dr. Manoel Regis Leal	
10:20 – 10:50	Coffee Break	
10:50 – 11:15	Production of Vegetable Coal using an Innovative Briquetting Process Mr. Leonardo Nardoto Conde, Bioenergy, Brazil	63
11:15 – 11:40	CARENSA-Cane Resources Network for Southern Africa Frank Rosillo-Calle, Imperial College London, U.K.	65
11:40 – 12:05	Electricity from Small Producers Mr. Marcos R. Escobar, Co. Paulista de Força e Luz (CPFL)	68
12:05 – 12:25	Bioware Biomass-to-energy Projects in Brazil Dr. José Dilcio Rocha, Bioware, Brazil	70
12:25 – 12:45	Discussion Round: Opportunities for Briquetting and Pelleting Technologies in Brazil Moderator: Mr. Leonardo Nardoto Conde	
12:45 – 14:00	Lunch Break	

Afternoon Session: Innovative Bioenergy Technologies and Applications B

Moderators: Prof. José Roberto Moreira, CENBIO and Norbert Vasen, ETA-Florence

14:00 – 14:30	Future Perspectives of Flexfuel Vehicles in Brazil Mr. Henry Joseph Junior, ANFAVEA, Brazil	74
14:30 – 15:00	Petrobrás' Activities in the Field of Bio-diesel Marcia Leite Drachmann, Petrobrás, Brazil	78
15:00 – 15:20	Discussion Round: The Future of Flexfuel Vehicles in Brazil Moderator: Mr. Henry Joseph Junior	
15:20 – 15:50	Coffee Break	
15:50 – 16:10	Current Status of Bio-fuel Development in China Mr. Xiao Mingsong Chinese Association of Rural Energy Industry (CAREI)	79
16:10 – 16:30	Global Biomass Potential for Power and Heat Generation Dr. Nasir El Bassam International Research Centre for Renewable Energy, Germany	80
16:30 – 16:50	Mutual Exchange of Biofuel Experience between Brazil and Europe for International Co-operation Mr. Norbert Vasen, ETA – Renewable Energies, Italy	84
16:50 – 17:15	The World's Carbon Market Mr. Marco Monroy, MGM International, Brazil	85
17:15 – 17:40	Discussion Round: Trading in Carbon Markets – Risks & Opportunities Moderator: Mr. Marco Monroy	
17:40 – 18:00	Conclusions - Workshop Closing	
20:00 – 23:00	Cultural Event – Workshop Dinner and Brazilian Music	

THURSDAY 16th SEPTEMBER 2004

Guided Visit to the International Industrial Fair FENASUCRO

Time: 09:30 – 18:00
Location: Paulo Merlin Exhibition Park, Sertãozinho, São Paulo

FENASUCRO – The Largest Sugar and Alcohol Exhibition in the World

Denomination:	XII International Sugar And Alcohol industrial Fair
Nature:	Technical -Business Promotion Fair
Place:	Paulo Merlin Exhibition Park – Sertãozinho / São Paulo / Brazil
Period:	September 14th to 17th, 2004
Admittance time:	From 10:00 a.m. to 18:00pm
Exhibition Area:	20.000 square meters
Number of exhibitors:	About 240 expositors
Number of visitors:	29.000 visitors
Web Site:	www.fenasucro.com.br

Fenasucro has taken place since 1993, when CEISE – Industrial Center of Sertãozinho and CIESP - São Paulo State Industrial Center, invited Multiplus -Production and Enterprise Ltda, to promote together a fair of suppliers of equipment and services for all the mills and alcohol and sugar distilleries of the whole country. With a public of more than 25 thousand visitors from all around Brazil and from countries of all continents, more than 200 national and international exhibitors, for ten years, Fenasucro has grown and become the main world event of the sucroalcohol industry.

Nowadays, the most important business, and the largest interchange of technology in this area takes place at Fenasucro. It is the place where the professionals and technicians of all around the world meet to search for technological innovation, information, knowledge and good business. These professionals are looking for modern and efficient machines, equipment, consumable items and service, increasing the production and reducing costs, strengthening the area and supplying the country.

FRIDAY 17th SEPTEMBER 2004

Technical Tour: Visit of a Biomass based Cogeneration Plant in the State of São Paulo

Time: 07:30 – 18:00
Location: ***Energy Company Santa Elisa***, Armando de Salles Oliveira Highway 346,3 , Sertãozinho, São Paulo, Brazil

The LAMNET workshop in Riberão Preto included a technical tour to the Companhia Energética Santa Elisa, a sugar production facility that started production in 1933. After continuous development and expansion, today, the Santa Elisa plant employs 4,000 workers. The annual production reaches 500,000 tons of sugar and 210 million litres of alcohol.

In Mai 2003, President Lula inaugurated the company's new thermal plant that produces 60 MW of electricity per hour. Thereof about 30 MWh are transferred to the utility company serving 500,000 households with electricity. A significant increase in the sugarcane bagasse based electricity generation is realised through the introduction of innovative high-pressure boilers feeding two high temperature and high pressure multistage turbines of TGM-Turbinas operating at 510°C with an inlet pressure of 63 bar. This new line of turbines is especially designed and manufactured in order to improve efficiency levels in conventional or combined thermal cycles. Compared to the harvesting period 2002/2003, the electricity generation was quadruplicated when the new thermal plant was put into operation.

Further information on the ***Energy Company Santa Elisa*** is available at ***www.santaelisa.com.br.***

Workshop Inauguration

International Workshop on Bioenergy Policies, Technologies and Financing
9th LAMNET Workshop – Riberão Preto, Brazil 2004

Welcome Address

Prof. José Roberto Moreira
Centro National de Referência em Biomassa – CENBIO
São Paulo, Brazil
E-mail: Bun2@tsp.com.br - www.cenbio.org.br

The Welcome Address of Prof. José Moreira from CENBIO, Brazil included a general overview of the LAMNET project as well as an outline of previous events and publications within the project. Within the retrospection of the project, the efforts of LAMNET members led to significant progress and valuable results within the project.

The LAMNET World Network on Bioenergy succeeded in setting-up a trans-national forum for the promotion of the sustainable use of biomass in Latin America, Europe, China and Africa. Currently, the global network LAMNET consists of 48 institutions (Knowledge Centres and SMEs) from 24 countries worldwide, thereby involving a large number of members with excellent expertise in the field of biomass.

Currently, the global bioenergy network LAMNET consists of 48 partners and 150 associate partners from more than 35 countries worldwide with excellent expertise in the field of biomass. In the last 3 years the LAMNET World Network on Bioenergy succeeded in setting-up a trans-national forum for the promotion of the sustainable use of biomass in Latin America, Europe, China and Africa.

Several workshops and seminars have been organised in the framework of this project with the participation of members of the Thematic Network and interested persons or organisations from Latin America and other emerging countries. These workshops served to stimulate the exchange of knowledge between the experts from the European Union, Latin America, Asia and Africa and they provided the basis for the elaboration of reports and recommendations on key topics in the field of bioenergy.

The following workshops have been organised up to now:

1st LAMNET Project Workshop, 19th June 2002, Amsterdam, The Netherlands

The first LAMNET project workshop was organised on the occasion of the 12th European Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection. Key topics of the workshop included prerequisites for the implementation of future successful CDM projects and the impact of the Kyoto Protocol in Latin America and other emerging economies.

2nd LAMNET Project Workshop, 19th - 21st August 2002, Durban, South Africa

This workshop was organised on the occasion of the World Summit on Sustainable Development (WSSD) in Johannesburg as a joint event of the Thematic Networks LAMNET, CARENSA and SPARKNET funded by the European Commission, DG Research. The objectives of this workshop included energy generation from sugar cane bagasse, advanced pelleting technologies as well as small-scale bioenergy technologies for household applications.

3rd LAMNET Project Workshop, 2nd – 4th December 2002, Brasilia, Brazil

This workshop was organised in collaboration with the Brazilian National Reference Centre on Biomass (CENBIO) and focussed on strategies and policies as well as ethanol based fuel cell technologies and sustainable electricity generation opportunities in Latin America.

4th LAMNET Project Workshop - International Bioenergy Forum: China - EU Cooperation, 28th – 30th September 2003, Guangzhou, China

This Forum for International Cooperation, co-organised by the European Biomass Industry Association (EUBIA), discussed cooperative efforts in the field of bioenergy between China, the EU and other supporting countries. The workshop objectives included the preparation of future bioenergy projects such as the large-scale integration of bioenergy within crude-oil refinery plants.

5th LAMNET Project Workshop - International Seminar on Bioenergy and Sustainable Rural Development, 26th – 28th June 2003, Morelia, Mexico

The objective of this seminar was to promote and increase the knowledge of the Bioenergy potential in Mexico and in the world as motor for sustainable rural development, agricultural and forestry diversification and the improvement of national and international environmental quality. A major outcome from the seminar was the creation of the Mexican Network on Bioenergy that will provide a forum to catalyse projects, information exchange and activities in the field of bioenergy.

6th LAMNET Project Workshop - The International Conference on Bioenergy Utilisation and Environment Protection, 24th – 26th September 2003, Dalian, China

The main objective of this conference was to promote international cooperation and knowledge exchange in the field of bioenergy technology as well as to promote the development of commercial biomass energy utilization in China in order to guarantee environmental protection and sustainable rural development.

7th LAMNET Project Workshop - International Conference on Bioenergy and Liquid Biofuel Development and Utilization, 20th – 23rd April 2004, Beijing, China

The aim of this conference was to promote international cooperation and knowledge exchange between actors from China, Europe, Africa and Latin America in the field of liquid biofuels and other bioenergy technologies. This biofuels conference included a technical tour to the world's largest bio-ethanol prodcution facility implemented by Jilin Fuel Ethanol Co. Ltd. in Jilin City on 23rd April 2004.

8th LAMNET Project Workshop, 9th May 2004, Rome, Italy

This workshop was organised on occasion of the 2nd World Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection, 10th – 14th May 2004, Rome, Italy. The main focus of the workshop was on bioenergy for rural income generation and sustainable development.

A Global Network on Bioenergy – Progress and Results

Dr. Rainer Janssen
WIP-Munich, Sylvensteinstr. 2, 81369 Munich, Germany
E-mail: rainer.janssen@wip-munich.de - www.wip-munich.de

ABSTRACT: The LAMNET World Network on Bioenergy succeeded in setting-up a trans-national forum for the promotion of the sustainable use of biomass in Latin America, Europe, China and Africa. Currently, the global network LAMNET consists of 48 institutions (Knowledge Centres and SMEs) from 24 countries worldwide, thereby involving a large number of members with excellent expertise in the field of biomass. In the field of bioenergy technologies, opportunities for international co-operation, technology transfer and joint-ventures are identified and promoted by the LAMNET network and the establishment of initial business contacts is supported through advice and recommendations by expert network members. Additionally, partners of the LAMNET project are actively involved in a variety of policy initiatives and contribute with their knowledge to the strengthening of the role of renewable energy for worldwide poverty reduction and sustainable development.

Keywords: bio-energy policy, sustainable use of biomass, liquid biofuels

1 INTRODUCTION

The LAMNET world network on bioenergy was established in early 2002 with the purpose:

- to address the adequate utilisation of biomass residues and energy crops
- to make use of selected reliable and proven practical technologies and systems
- to arrive at local, regional, national and international solutions for bioenergy applications
- to contribute to poverty alleviation and sustainable development
- to develop and implement policies for the enhanced utilisation of biomass and bioenergy

Several workshops and seminars have been organised in the framework of this project with the participation of members of the Thematic Network and interested persons or organisations from Latin America and other emerging countries. These workshops served to stimulate the exchange of knowledge between experts from the European Union, Latin America, Asia and Africa and they provided the basis for the elaboration of reports and recommendations on key topics in the field of bioenergy.

Thereby, the focus of the network activities lies on the identification of currently available, efficient, cost-competitive and reliable bio-energy technologies which provide opportunities for the conversion of biomass to energy services as well as on the elaboration of policy options for the promotion of the sustainable use of biomass.

Figure 1: LAMNET World Network on Bioenergy - Logo

2 INTERNATIONAL BIO-ENERGY POLICY PROGRAMMES AND INITIATIVES

New and renewable sources of energy have been considered as an alternative to conventional sources for thirty years and during the last ten years their potential contribution to global pollution abatement has been widely acknowledged. Nevertheless, their participation in the world primary energy matrix is still quite modest (less than 2%). Today, several barriers inhibit the enhanced utilization of new and renewable energy sources, such as economic and financial, institutional and legislative, environmental as well as socio-political barriers [1]. In order to overcome this large variety of barriers, it is necessary to create a portfolio of policies to foster the use of new and renewable energy sources.

The following policy examples have been brought to the agenda of the LAMNET global network on bio-energy.

2.1 EC Directives on the promotion of the use of bio-fuels

The European Union's new Directives promoting the use of 'green' transport fuels and restructuring the taxation frameworks of energy products and electricity are a further step in the European Union's quest for alternatives to petrol and diesel and will enable progress towards a more sustainable transport system for the future [2,3]. For the first time, each Member State will have to set targets for the market share of bio-fuels. These targets will have to be based on challenging benchmarks set by the Directive: 2% market share by December 2005; 5.75% market share by December 2010. Any country setting lower targets will have to justify them using objective criteria.

Although during the next few years the new EU bio-fuel directives will focus on strengthening the European bio-fuel market and contributing to the crucial 'security of supply' issue within Europe, it is assumed that in the long run, i.e. through the emergence of domestic bio-fuel markets, these directives will have a positive impact on the creation of sustainable global bio-fuel (e.g. bio-ethanol) markets. The latter is of prime interest for several LAMNET network partners from countries in Latin America, Asia and Africa.

2.2 The Brazilian Alcohol Programme (PROÁLCOOL)

One of the very common arguments against renewable energies is their failure to economically compete with fossil fuels. The Brazilian Alcohol Programme (PROÁLCOOL) presents an example for significant cost reduction of a renewable fuel achieved through supportive Government programmes, acting on the demand side of large markets and thereby lowering costs through the 'learning curve effect'. PROÁLCOOL was established in 1975 with the purpose of reducing oil imports by producing ethanol from sugar cane. The program has positive environmental, economic and social aspects, and has become the most important biomass energy program in the world [4].

Ethanol production costs were close to 100 US dollars a barrel in the initial stages of the Program in 1980 (see figure 2; Prices paid to producers are proxies for costs). Until 1985, as production increased, prices paid to producers reflected average costs of production. During this initial phase, prices fell slowly reflecting the gains in agro-industrial yield and economies of scale captured by producers, and transferred to consumers through the pricing regulation scheme. After 1985, however, prices were set at levels below the average costs of production, while the federal government tried to curb inflation by controlling public prices, inclusive of fuels. Due to this factor, together with economies of scale, the price fell much more rapidly.

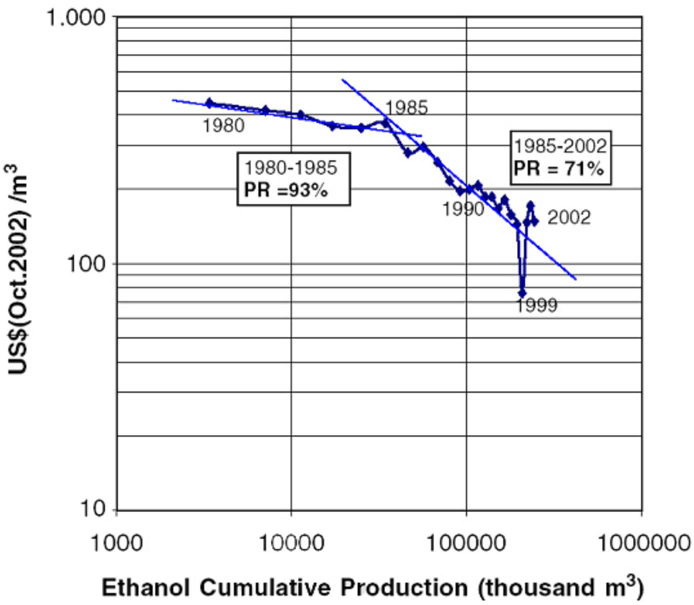


Figure 2: Brazilian bio-ethanol learning curve

As the efficiency and cost competitiveness of ethanol production evolved over time, and fuel prices were liberalized, Government support was no longer needed and was not applied. Of great significance is the fact that the total amount of investments in the agricultural and industrial sectors for the production of ethanol for automotive use in the period 1975–1989 in Brazil reached a total of US$ 4.92 billion (US$ of 2001) directly invested in the program. On the other hand, fuel import savings evaluated at international prices, have amounted to US$ 52.1 billion (Jan. 2003 US$) from 1975 to 2002 [5]. Presently, there are no subsidies for anhydrous or hydrated ethanol production. Hydrated ethanol is sold for 60–70% of the price of gasohol at the pump station, due to significant reductions in production costs. These results show the economic competitiveness of ethanol with respect to gasoline in Brazil. This economic competitiveness is a reality for several years already and will continue for years to come, especially with the current increase of the crude oil prices on the world market.

2.3 Bio-ethanol and bio-diesel programme in Colombia

The Colombian bio-ethanol programme from sugar cane is based on a new law approved by the Colombian Congress which mandates the use of 10% ethanol blends in gasoline, starting in the year 2006. This programme thereby follows the successful example set by the Brazilian Alcohol Programme. The production of bio-ethanol will be between 2.0 and 2.5 million litres per day (900 million litres per year) to be produced in nine agro-industrial complexes, located in nine different regions near main Colombian cities. These activities will require an additional area of 150.000 hectares harvested with sugar cane and it will generate 170.000 new employments, mainly for farmers in rural areas of Colombia [6].

Bio-ethanol sales are expected to be of the order of 400 million dollars per year and the cash flow for sugar cane business will be 240 million dollars per year, increasing the agro-GDP by about 3% and generating a 'cluster' for regional development. Within this program, the LAMNET partner 'Corporation for the Industrial Development of Biotechnology and Clean Production (CORPODIB)' has been playing a very important role during the last eight years.

Presently, there is another new law under negotiation in the Colombian Congress which is concerned with the introduction of bio-diesel from palm oil and other vegetable oils to be blended with diesel fuel oil, probably by the year 2008. The environmental benefits of both projects (bio-ethanol and bio-diesel) will be of great importance for the country, especially with carbon dioxide savings which through Kyoto Protocol Clean Development Mechanism will generate additional income by the commercialisation of CO_2.

2.4 Policy dialogue on bio-energy for Southern Africa

A Policy Dialogue Workshop on Co-generation and Bio-ethanol for Southern Africa was organised in Durban (figure 3), June 2004, in close co-operation with the South African LAMNET partner Illovo Sugar Ltd. and the European Energy Initiative for Poverty Eradication and Sustainable Development (EUEI). One of the main aims of this dialogue was to discuss successful Brazilian bio-energy experiences in a Southern African context with representatives from several South African Government Departments.

South African Government representatives emphasized their support for a coherent bio-energy strategy and outlined the current status and targets as published in the South African White Paper on Renewable Energy Policy approved by the Cabinet in November 2003. The target of the White Paper is to achieve a contribution of 10,000 GWh to the final energy supply based on renewable energies (mainly from biomass, wind, solar and small-scale hydro) by 2013. The White Paper's vision of an energy economy in which modern renewable energy plays an increasing role was presented showing how renewable energies could contribute to sustainable development and environmental conservation.

Figure 3: Participants of the Bioenergy Policy Dialogue in Durban

In order to realise this vision, the South African Government is committed to cooperate with bio-energy stakeholders and reliable information and data have been requested from involved industries. It was concluded that for the future development of bio-energy in South Africa a pro-active approach and 'leadership' by the private sector as well as a close dialogue between industries and Government are of crucial importance. As a first step the South African Department of Minerals and Energy (DME) has initiated an assessment study of the current and future biomass potential in the paper and sugar industry in summer 2004.

Representatives from the South African sugar industry highlighted the current fragile economics of the world sugar market, countering this with supporting theories for the need to develop bio-energy strategies and industries. It was stated that bio-energy may serve to 'rejuvenate' the sugar industry and help to secure the 350,000 jobs currently employed in the South African sugar industry.

As a main outcome of the policy dialogue workshop, the establishment of a South African Bioenergy Association is recommended as an important enabling factor for the realisation of the target and the vision of South Africa's White Paper on Renewable Energy and Clean Energy Development. The main aims of this South African Bioenergy Association will be to provide a common platform for bio-energy stakeholders and to act as clearinghouse and focal point for the collection and distribution of clear, credible and reliable data and information on all relevant aspects of bio-energy. In the initial stages, emphasis will be given to determining the biomass potential for key South African industries, to exploring the opportunities of small-scale bio-energy technologies for the provision of clean household energy, as well as to assessing the employment generation aspect of bio-energy solutions in South Africa.

In order to ensure impartial and reliable information suitable for the formulation of bio-energy policy recommendations, all relevant stakeholders from the agricultural, environmental, industrial and energy sector shall be involved in the activities of the South African Bioenergy Association and the Association shall set-up a regular forum for contacts with Government representatives.

2.5 The Chinese fuel ethanol programme

Large-scale application of fuel ethanol in China shows the potential to address three issues of crucial national importance, namely the reduction of dependence on petroleum imports, the improvement of air quality and the development of rural economy. In the framework of the Chinese fuel ethanol program, launched in 2000, field tests of 10,000 vehicles with gasoline-ethanol blends (gasohol) have been performed [7].

Five cities, Nan Yang, Zhengzhou and Luoyang city in Henan province as well as Harbin and Zhaodong city in Heilongjiang province were chosen for these field tests with E10 gasohol since June 2001. In order to regulate these field tests and the future promotion of fuel ethanol, two national standards were issued for ‘Denatured fuel ethanol’ and ‘Gasohol for vehicles’ in April 2001. Based on an economic assessment, proposals on tax incentives for fuel ethanol have been considered, which include exemption of sales tax and fuel tax as well as reduction of value added tax.

As the second step of launching fuel ethanol in China, three new plants were approved to be constructed in Jilin, Henan and Anhui province. The total capacity of these plants will be 1,220,000 t/y, and the Jilin fuel ethanol plant with a capacity of 600,000 t/y will be the largest producer worldwide. The Jilin ethanol project is implemented in two stages, the first of which has been put into operation in October 2003 with an ethanol production capacity of 300,000 t/y (see figure 4). This ambitious development of fuel ethanol production in China offers great opportunities for international technology cooperation. In the framework of the 7th LAMNET workshop in Beijing, April 2004, a technical tour to the impressive Jilin bio-ethanol production plant and its outstanding research facilities was organised by the Jilin Fuel Ethanol Co. Ltd. (JFA) management in collaboration with the technology provider and LAMNET partner Vogelbusch from Austria.

Figure 4: Fuel ethanol plant in Jilin, China

In September 2003, the Jilin provincial government decided to totally replace pure gasoline with E10 gasohol. Until today, about 500,000 tons of E10 gasohol have been sold and used nationwide. Based on the success of using blends of ethanol and gasoline, the central government decided to expand the vehicle fleet and the area for using gasohol. By the end of 2005, gasohol will totally replace gasoline in five provinces and partially in four provinces. The consumption of E10 will exceed 10 million tons, which is about 25% of the total consumption of gasoline nationwide.

3 INTERNATIONAL CO-OPERATION ON BIO-ENERGY TECHNOLOGIES

Within the LAMNET project it is one of the main objectives to identify currently available, efficient, cost-competitive and reliable bio-energy technologies which will provide opportunities for the conversion of biomass to energy services in Latin America, Europe, Africa and China. Relevant technologies and systems are selected on the basis of maturity of the technology, cost-effectiveness, simplicity of maintenance, social acceptability and the impact on development. Opportunities for international co-operation, technology transfer and joint-ventures in the field of bio-energy technologies are promoted by the LAMNET network and the establishment of initial business contacts is supported through advice and recommendations by expert network members.

3.1 Small-scale modern autonomous bio-energy complexes

The European Biomass Industry Association (EUBIA) has recently conducted a detailed analysis of worldwide bio-energy potentials. Hereby, special efforts have been dedicated to the development and implementation of modern concepts for integrated ‘food-feed-energy’ biomass schemes. EUBIA has identified a series of typical, small-scale, sustainable ‘bio-energy complexes’. These complexes are especially attractive for remote villages, as they will be able to not only satisfy the villagers’ basic energy needs, but also provide sufficient amounts of clean energy for comfort and production activities. Therefore, bio-energy complexes might prove to be solutions to the sustainable development of rural areas [8].

Within the activities of the LAMNET project it was one of the key objectives of the Forum for EU – China International Cooperation on Bio-energy, which took place in Guangzhou in September 2003, to stimulate international co-operation for the implementation of modern bio-energy complexes in China and in other Asian, Latin American and African countries. European Industries which are potential suppliers of bio-energy technologies for bio-energy complexes were invited for presentations of their products in the framework of this forum.

3.2 Sugar cane bagasse pelleting for South Africa

Sugar cane bagasse pelleting offers great opportunities for the production of ‘green energy’ in bagasse based co-generation plants in Southern Africa. Through improved transportation and storing of the biomass feedstock, bagasse pelleting is an important step in providing energy from bagasse on a year-round basis. Another potential application of bagasse pelleting can be taken advantage of, if a low-temperature pelleting process is employed that does not alter the chemical composition of the bagasse. With this innovative pelleting technology the feedstock availability at modern chemicals extraction plants can be increased, and thereby the economics of the production of high-value chemicals (e.g. furfurals) from bagasse pellets can be significantly improved.

Within the framework of the LAMNET project a cooperation agreement between Illovo Sugar and European manufacturers of innovative pelleting technologies has been initiated and a pilot pelleting facility is operated in South Africa in order to investigate the suitability of bagasse pellets for the chemicals extraction process.

3.3 Bio-diesel production from palm oil in Colombia

In order to prepare the implementation of the bio-diesel programme for Colombia (see section 2.3), the LAMNET partner CORPODIB has constructed a bio-diesel production pilot plant investigating a variety of potential feedstock and conversion processes in close collaboration with the public transportation system in Bogota (figure 5). This pilot plant additionally serves as a valuable tool for public dissemination purposes and as showcase for potential plant operators and owners.

Figure 5: Bio-diesel pilot plant, Colombia (Source: CORPODIB)

Within the LAMNET project international co-operation opportunities in the field of bio-diesel technology are being exploited to benefit the implementation of this ambitious Colombian bio-fuel programme. Thereby, valuable input can be provided by bio-diesel experiences recently gained in European countries.

3.4 Straw gasification technology for China

At the International Conference on Bioenergy Utilization and Environment Protection - 6th LAMNET Workshop - in Dalian, a technical tour was organised by the China Association of Rural Energy Industry (CAREI) in co-operation with the Dalian Academy of Environment Sciences, visiting a gasification demonstration plant located in the Sanjianbu township of the city of Lü Shun (Figure 6) [9]. This demonstration plant, which was put in operation 4 years ago, has been developed for the thermal conversion of a variety of biomass residues into bio-gas through incomplete combustion. The capacity of the installation under full-load operation is sufficient to supply 5000 households in the vicinity of the plant with bio-gas for cooking and heating.

Figure 6: Straw gasification demonstration plant, China

As biomass residue gasification worldwide is still in the demonstration phase, this technical tour provided valuable input for future co-operation activities among LAMNET partners.

3.5 Flex Fuel Vehicles (FFV) for the Brazilian car market

Recently, a new technology has started spreading throughout the Brazilian automobile industry. Flex Fuel vehicles can be powered with gasoline and/or alcohol or any mixture of both fuels. The first model that came onto the market was the Volkswagen Gol Total Flex 1.6, and by today the manufacturers Volkswagen, Ford, Fiat, GM etc. have introduced 19 car models on the Brazilian market. Sales are booming and, in very short term, fuel use will be a consumer choice at the pumping station. In 2003, 48 thousand units were sold and forecasts are 280 thousand in 2004 (figure 7). Around 60% of the light vehicles are expected to be fuel flexible by 2007.

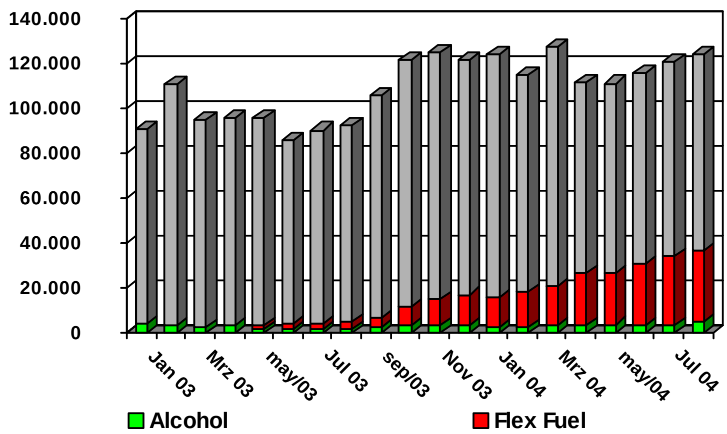


Figure 7: Flex Fuel Vehicle (FFV) sales in Brazil (January 2003 – August 2004)

The emergence of Flex Fuel vehicles in Brazil (and eventually also in other parts of the world) is expected to contribute to a further increase of the market penetration of ethanol as transport fuel. Ethanol use already has significantly improved the air quality conditions in metropolitan areas of Brazil, removing lead from gasoline and reducing sulphur emissions.

Currently, more than 100 countries worldwide, mostly developing countries, produce sugarcane and could also produce ethanol for internal use as well as for export, thereby alleviating their trade balances. OECD countries could also benefit from such imports by improving local air quality and, through a more liberalised market, promoting their environmentally sound technologies. Worldwide bio-ethanol production, utilisation and trade has been one of the key issues addressed in the framework of the LAMNET project, as renewable transport fuels show the potential to significantly contribute to the reduction of GHG and noxious emissions as well as to ensuring security of energy supply.

4 LAMNET DISSEMINATION ACTIVITIES

4.1 LAMNET web site

During the year 2004 the project web site www.bioenergy-lamnet.org continued to be LAMNET's window to the world. The success of this internet platform has been proven by a significant number of 'hits' by visitors from a large variety of countries. The LAMNET web site served to stimulate interest in the project activities among biomass stakeholders from the European Union, Latin America, Asia and Africa as well as to widely disseminate the project results such as the proceedings of LAMNET bio-energy workshops in The Netherlands, South Africa, Brazil, Mexico, China, Italy, Venezuela and Chile.

4.2 LAMNET project workshops

Several workshops and seminars have been organised in 2004 by the LAMNET world network on bio-energy.

The 7th LAMNET Project Workshop - International Conference on Bioenergy and Liquid Biofuel Development and Utilisation was held in Beijing, P.R. China, from 20-23 April 2004. It was organized jointly by the China Association of Rural Energy Industry (CAREI), the Center for Energy and Environment Protection (CEEP) of the Chinese Ministry of Agriculture, the Chinese Ministry of Science and Technology and the LAMNET Global Network on Bioenergy. One of the main aims of this conference was to promote international cooperation and knowledge exchange between actors from China, Europe, Africa and Latin America in the field of liquid bio-fuels. Renowned international bio-energy experts reported on global liquid bio-fuel strategy and policy issues and presented recent developments in key countries, such as Brazil, Sweden, South Africa and China. Agreements for future co-operation activities have been reached and several bio-fuel projects are currently under preparation with the assistance of representatives of the LAMNET network.

The 8th LAMNET project workshop was organised in collaboration with the Food and Agriculture Organisation of the United Nations (FAO) on the occasion of the 2nd World Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection, Rome, 10-14 May 2004. This workshop served as platform for discussions focusing on 'Bioenergy for Rural Income Generation and Sustainable Development' among renowned international experts from a large variety of national and international organisations and knowledge centres. Participating organisations included the Brazilian National Biomass Reference Centre (CENBIO), FAO, the European Biomass Industry Association (EUBIA), the European Biomass Association (AEBIOM), the German Federal Agricultural Research Centre (FAL) and the World Bank.

5 RESULTS AND CONCLUSIONS

During the year 2004, partners of the LAMNET project have been actively involved in a variety of policy initiatives and contributed with their knowledge to the strengthening of the role of renewable energy for worldwide poverty reduction and sustainable development. Additionally, opportunities for international co-operation, technology transfer and joint-ventures have been promoted in the field of bio-energy technologies, such as:

- Small-scale modern autonomous bio-energy complexes
- Sugar cane bagasse pelleting for South Africa
- Bio-diesel production from palm oil in Colombia
- Straw gasification technology for China
- Flex Fuel vehicles

A major outcome from the International LAMNET Seminar on Bioenergy and Sustainable Rural Development, 26-28 June 2003 in Morelia (Mexico) was the creation of the Mexican Network on Bioenergy (Red Mexicana de Bioenergía). This network will provide the first national forum to catalise projects, information exchange and activities in the field of bio-energy in Mexico. The coordination of the network will be initially organized by the LAMNET partner National Autonomous University of Mexico (UNAM), and the network is based within the National Solar Energy Association of Mexico (ANES).

Figure 8: Mexican Network on Bioenergy – Logo (Source: UNAM, Mexico)

Finally, under the patronage of EUBIA, the LAMNET Global Network on Bioenergy succeeded to win the year 2003 round of the CTO Award as 'Best Renewable Energy Partnership with Developing Countries'. The handing-over of the awards took place in a prestigious ceremony on the 19th January 2004 in Berlin within the frame of the three-day 'European Conference for Renewable Energy – Intelligent Policy Options'.

6 REFERENCES

[1] J.R. Moreira, Brazilian Biomass Reference Centre (CENBIO), Proc. 5th LAMNET Workshop – International Seminar on Bioenergy and Sustainable Rural Development, 26-28 June 2003, Morelia, Mexico, 15.

[2] Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels and other renewable fuels for transport.

[3] Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity.

[4] Goldemberg J, Moreira JR. The alcohol program. Energy Policy 1999; 27(4), 229–45

[5] José Goldemberg, Suani Teixeira Coelho, Plinio Mario Nastari and Oswaldo Lucon. Biomass and Bioenergy 26 (2004), 301-304.

[6] H. Echeverri, C.V. Martinez, Corpodib, Colombia, Proc. 5th LAMNET Workshop, 26-28 June 2003, Morelia, Mexico, 44

[7] Dehua Liu, Tsinghua University, Department of Chemical Engineering, LAMNET-NEWS, 5th Issue – September 2004, 5

[8] G. Grassi, Zhou Qiong, A. Grassi, T. Fjallstrom,P. Helm, Proc. 12th European Conference on Biomass for Energy, Industry and Climate Protection, 17-21 June 2002, Amsterdam, The Netherlands, 1460

[9] R. Janssen, Proc. 6th LAMNET Workshop, 24-26 Sept. 2003, Dalian, P.R. China, 131

Acknowledgements

The project Latin America Thematic Network on Bioenergy (LAMNET) is funded by the European Commission in the framework of the specific research and technological development programme 'Confirming the International Role of Community Research' under the contract ICA4-CT-2001-10106.

Worldwide perspectives of Biodiesel production and utilization
Review on the results of the IEA Bioenergy Task 39 "Liquid Biofuels"

Manfred Wörgetter, Dina Bacovsky
BLT Wieselburg – Federal Institute of Agricultural Engineering
A 3250 Wieselburg, Austria
E-mail: Manfred.woergetter@blt.bmlfuw.gv.at - www. blt.bmlfuw.gv.at

The development biodiesel made within the last decade is remarkable. In 1980, research on the production and use of oilseed derived products was not yet taken seriously. Nevertheless, in 1987 France and Austria started commercializing biodiesel. At that moment the prices for crude oil and protein feed were high, and biodiesel was regarded as a possibility to develop rural areas. Sponsered by public programmes, from 1988 on first demonstration plants took up production in Aschach (Austria), Compiegne (France) and Livorno (Italy). Industry suffered from the decrease of crude oil prices at the beginning of the 1990´s, but rising energy prices revived the market and supported its further development.

European biodiesel production reached a total of nearly 1.2 Mio tons in 2002, which is equivalent to an increase of more than 37% compared to 2001. Germany became the leading biodiesel producer (550 000 t in 2002), overtaking France (350 000 t in 2002). Germany has further been investing to develop its production capacity and it is today the number one producer with a production capacity of 1.1 Mio t. Unlike France, where only a given quota of biodiesel is tax exempted per year, the German government does not impose any limits in term of volumes of biodiesel that can benefit from adjusted taxation; this is mainly driven by Germany´s intention to secure employment and the regional development as well as the intention to reduce global and local pollution. Italy has also increased its production to reach 220 000 t. Austria follows with a production of 30 000 t in 2002, whereas the production capacity has been increased to even 100 000 t in 2004 (see also http://europa.eu.int/comm/energy/res/sectors/bioenergy_en.htm).

Commercially available diesel vehicles can be operated with a blend of biodiesel and fossil diesel, or, also, with B100 (pure biodiesel). A B5 blend performs very well, but for the performance of B100 the automotive industry had objections: rubber materials might be attacked, and the viscosity of biodiesel and its distillation curve might influence the injection and combustion. In order to prove the suitability of B100 and to develop biodiesel-suitable vehicle technology, several European countries carried out extensive studies including fleet tests with B100 and B30. Research and industry cooperated in the development of quality parameters, and national standards were established in France, Austria, Sweden, Italy, Germany and the Czech Republic. Ordered by the European Commission finally European standards were elaborated at CEN, the European Standardization Organization. Hence, leading European manufacturers like Volkswagen were able to approve the use of high quality biodiesel as B100 in their vehicles. Meanwhile standards for biodiesel were also elaborated in North America, thus now the requirements for failsafe operation are given in all countries with high numbers of vehicles.

The new "Biofuels Directive" released by the European Union requires a market share of 5.75% biofuels in each member state by 2010. A complementary directive permits complete tax exemption of biofuels. These are indicative targets, and the member states are free in their way to achieve these goals. Member states are obliged to report progress and actions annually, including information on the reduction of CO_2 emissions.

Some countries, like Germany and Austria, focus on biodiesel for the next years. The position other countries take is not yet known, but will be evident as soon as their reports to the European Commission are released. However, besides biodiesel, bioethanol and biogas will be important, too. Additionally there are programs which encourage the production of Fischer-Tropsch Fuels in Germany; these may bring further amounts of biofuels onto the market by 2010.

While the driving forces for the implementation of biofuels – as there are security of supply, regional development, and reduction of pollution – are similar in Europe and North America, the markets are different. Whereas in North America mainly heavy-duty vehicles operate on diesel, diesel vehicles have been generally adopted for private transport in Europe in the past years. The European automotive industry has accomplished enormous progress in the development of diesel engines for passenger cars. The fuel consumption is very low and because of turbo charging the engines are (nearly) as strong as gasoline engines; their high torque at part load is fun to drive. Surplus gasoline production is exported from Europe to North America, and the European refineries are interested in additional volumes of diesel fuels.

The Biodiesel Subtask of Task 39 has carefully observed the development of oilseed derived fuels in the past period, and has elaborated three studies:

- A Worldwide Review on Biodiesel Production: The study defines the state of the world-wide development of biodiesel and is made in a modern form - a multitude of well arranged links offers the access to the comprehensive biodiesel web world.
- A Best Case Studies on Biodiesel Production Plants in Europe: This study gives a comprehensive overview on selected examples of the impressive European biodiesel industry. Data on companies, feedstock supply, installed technology, capacity, quality management and financial issues are included.
- A Review on Biodiesel Standardization World-wide: The study describes general aspects of the standardization process, important regulations and recommendations as well as the state of the standardization in Europe, North America, Australia and Brazil and reflects the actual state of the biodiesel standardization world-wide.
- Additionally the Biodiesel Subtask has worked out a small study on the state of the development of rapeseed oil as fuel for farm tractors with interesting information on the situation in Germany.

It is planned to publish these reports in a CD version as well as in the Internet. For more information on the Biodiesel Subtask, please contact: Manfred Wörgetter (Manfred.woergetter@blt.bmlfuw.gv.at) or Dina Bacovsky, (Dina.bacovsky@blt.bmlfuw.gv.at)

Liquid Biofuels in IEA Bioenergy

The International Energy Agency was founded in 1974 as an autonomous body within the OECD to implement an international energy program in response to the oil shocks. Membership consists of 25 of the 29 OECD member countries. Activities are directed towards the IEA member countries' collective energy policy objectives of energy security, economic and social development, and environmental protection. One important activity undertaken in pursuit of these goals is a program to facilitate co-operation to develop new and improved energy technologies (www.iea.org). Activities are set up under Implementing Agreements. These are independent bodies operating in a framework provided by the IEA. There are 40 currently active Implementing Agreements, one of which is IEA Bioenergy.

IEA Bioenergy is set up in 1978 by IEA with the aim of improving cooperation and information exchange between countries that have national programs in bioenergy research, development and deployment. The work of IEA Bioenergy is carried out through a series of Tasks, each having a defined work program. (www.ieabioenergy.com).

The extent to which biofuels have entered the marketplace varies by country. The reasons are complex and include policy and market issues. While biofuels offer significant potential, in most cases the prices of biofuels are higher than their petroleum equivalents. As a result, biofuels have been successfully implemented only in those countries that have recognized the value of those benefits and have made appropriate policy decisions to support biofuels. (www.liquid-biofuels.com/FinalReport1.html).

The objectives of the past Task 39 “Liquid Biofuels” period (2001-2003) were to work jointly with governments and industry to identify and eliminate non-technical barriers which impede the use of fuels from biomass in the transportation sector, and to identify technological barriers to Liquid Biofuels technologies (www.forestry.ubc.ca/task39). The Task was composed of 10 members (Austria, Canada, Denmark, European Union, Finland, Ireland, The Netherlands, Sweden, USA and UK) interested in working together for a successful introduction of biofuels. Under the leadership of the US Department of Energy this Task reviewed technical and policy issues. The overall goal was to provide participants with comprehensive information that assist them with the development and deployment of biofuels for motor fuel use. The Task:

- Provided information and analyses on policy, regulatory and infrastructure issues that will can participants to encourage the establishment of the infrastructure for biofuels
- Catalyzed cooperative research that will help to develop processes for converting lignocellulosic biomass to ethanol.
- Provided information and analyses on specialized topics relating to the production and implementation of biodiesel technologies.

Work was carried out in three subtasks:

- Policy, regulative and infrastructure issues to assist with the implementation of liquid biofuels (Subtask leader Dr. Don Stevens, Pacific Northwest National Laboratory, USA)
- R & D & D issues used to expand the use of technologies that convert lignocellulosics to ethanol (Subtask leader Dr. Jack Saddler, UBC, Canada)
- Specialized topics and information exchange on biodiesel (Subtask leader Manfred Wörgettel, BLT Wieselburg, Austria)

Work is continued in the period from 2004 to 2006 under the leadership of Dr. Jack Saddler from the University of British Columbia in Canada (www.forestry.ubc.ca/task39/GT4/Frames/T39contacts.html).

"PALM DIESEL"
O PROCESSO AGROPALMA

Eng. César A. Modesto de Abreu
Prof. Donato Aranda
AGROPALMA, ESCOLA DE QUÍMICA/UFRJ
E-mail: cesar@grupoagropalma.com.br - www.agropalma.com.br

Much has been said on environment preservation, suitable occupation of the Amazon region and sustainable development. Agropalma Group is a good example of the economy/ecology integration. Agropalma encompasses a total area of 82.000 ha., where 50.000 hectares are environmental preservation areas, with maintenance of the original vegetable cover and where hunting and fishing are banished as a commitment to keep the ecosystem unchanged. During implantation of new areas, priority is given to degraded areas to be recovered by palm plantation. Riparian forests, which protect water courses, have been preserved in its totality. For future projects of new areas implantation, either by Agropalma or by any third party, it will be mandatory the use of degraded areas.

The culture of the palm itself is regarded as reforestation. All waste resulting from the extracting and production processes of the palm fruit is used. Domestic waste also have an adequate application aiming environment preservation. The resultant waste of the palm oil and palm kernel oil extraction process are also utilized. Empty bunches are used as organic fertilization in the Green Seal areas (for organic oil production). Fibers resulting from fruit pressing are used as fuel in the vapor generator boilers, which will set turbo-generators in motion in order to produce electrical power; and the same residual vapor is used for sterelization and generating enough heat for the oil extraction process. Effluent is totally destined to ferti-irrigation of the palm plantation near the industrial area. No effluent reach rivers or creeks ("igarapés").

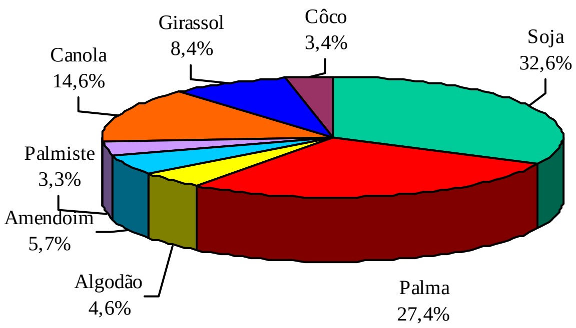
On top of that, the companies use biological methods for plague and diseases control, reducing as much as possible the application of chemical defensives. All solid waste are collected separately, classified as organic, recyclable and non-recyclable and properly disposed. Currently, such waste is taken to the Garbage Recycling Plant in Mojú (one of the very few located in the State of Pará).

At the refinery, oil is naturally refined through a free effluent process. Only natural ingredients are used. Due to such environmental friendly process, the refinery is the first in Brazil to be granted a license by the Instituto Biodinâmico to refine organic oils. The Environmental Management System - EMS is the company's declaration of principles on its environmental performance, supplying structure to actions and establishment of objectives and goals, which policies are:

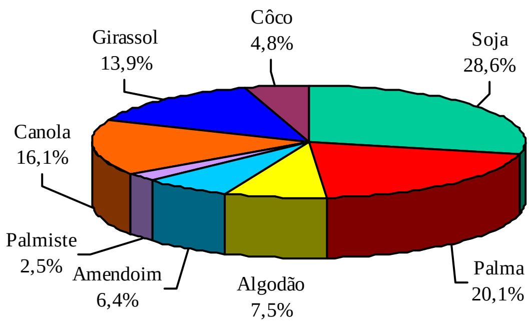
- Environmental awareness of the workforce, aiming the prevention of environmental damages;
- Comply with current environmental legislation and other applicable environmental requirements;
- Proper use of natural resources necessary to the productive process;
- Provide resources and conditions for the fulfillment of the present policy;
- Perform a environmentally friendly expansion;
- Establish programs associated to aspects of decrease of environment;
- Promote continuous improvement of environmental performance, aiming pollution prevention.

The major vegetable oil resources worldwide:

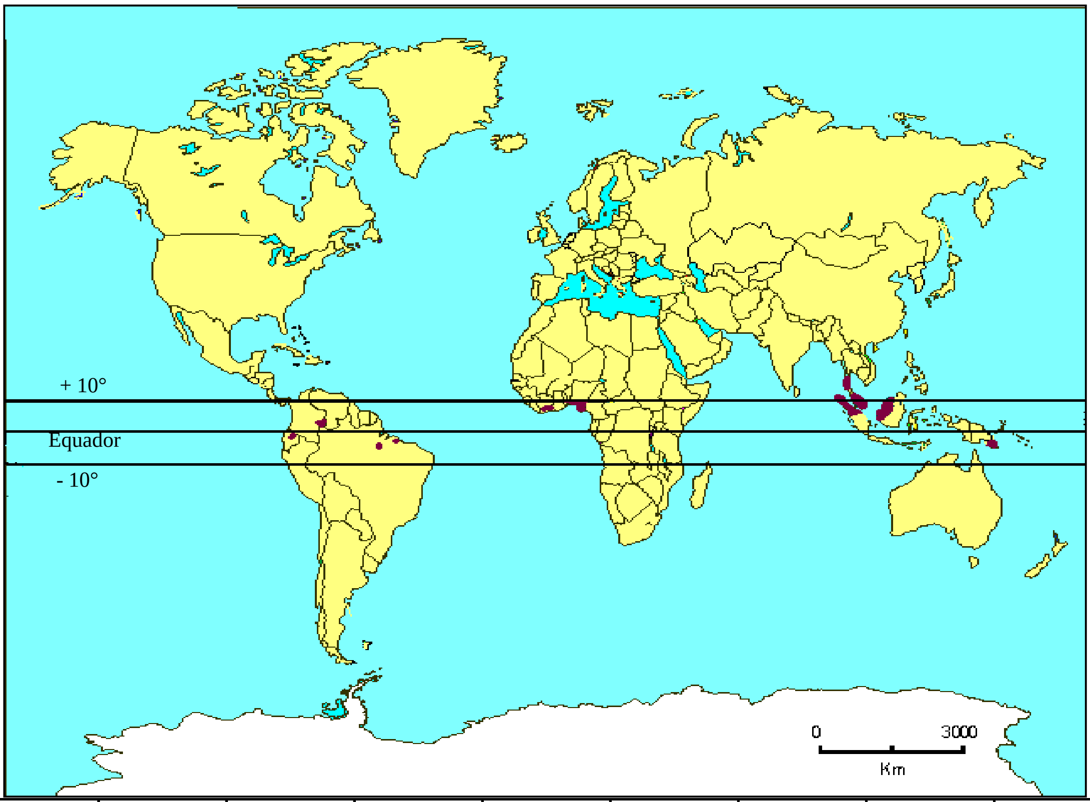
2002 = 91.24 Mio. tons



1992 = 58.8 Mio. tons



Most relevant areas of palmoil plantation and production (ton - milhões) Período: 1996 à 2015

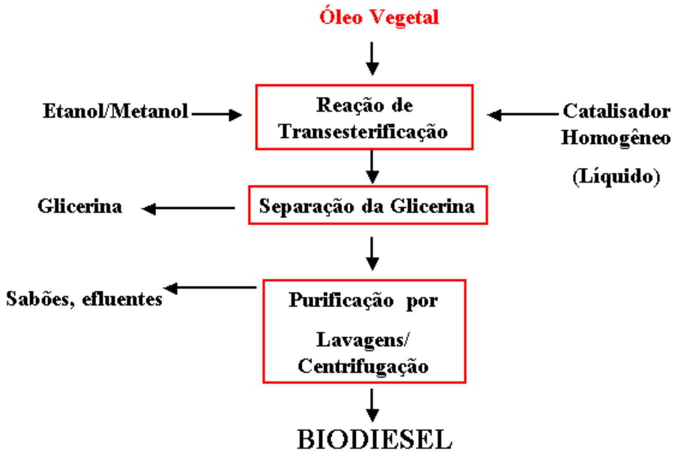


Anos	Malásia	Indonésia	Nigéria	Costa do Marfim	Colômbia	Brasil	Outros	Mundial
1996/00	9,0	5,4	0,7	0,3	0,4	0,0	2,1	17,9
2001/05	11,0	8,3	0,8	0,4	0,4	0,1	2,5	23,5
2006/10	12,7	11,4	0,9	0,4	0,5	0,2	3,1	29,2
2011/15	14,1	14,8	1,0	0,5	0,5	0,3	3,8	35,0

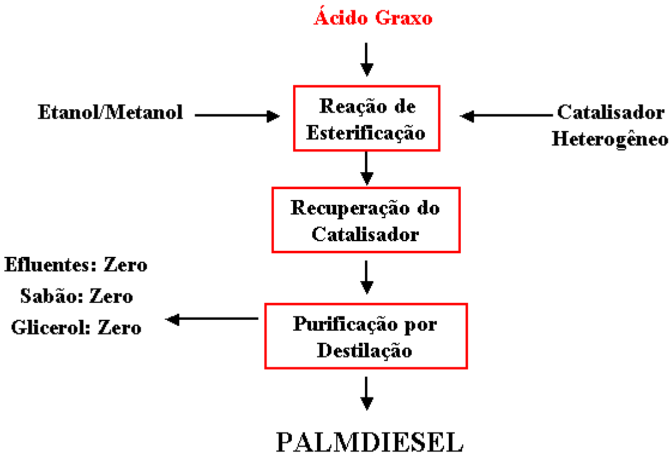
FONTE : OIL WORLD

Flow-charts of the conventional biodiesel process and the Agropalma Process

Conventional Biodiesel Process



Agropalma Process



Advantages/Emissions of PalmDiesel B100 compared to regular diesel:

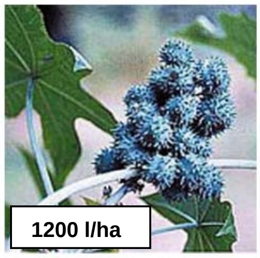
- Increased cetane numer (PalmDiesel 65, biodiesel 55, regular diesel 43)
- 85% less greenhouse gases;
- 50% less CO;
- 50% less particle matters
- 1,000 times less sulfur;

TECNOLOGIA DO USO E DA PRODUÇÃO DE BIODIESEL ETÍLICO NO ESTADO DE SÃO PAULO

Prof. Dr. Miguel J. DabdoubDepartamento de Química – FFCLRP
LADETEL – Laboratório de Desenvolvimento De Tecnologias LimpasUniversidade de São Paulo
Ribeirão Preto, São Paulo, Brazil
E-mail: dabdoub@biodieselbrasil.com.br - www.biodieselbrasil.com.br

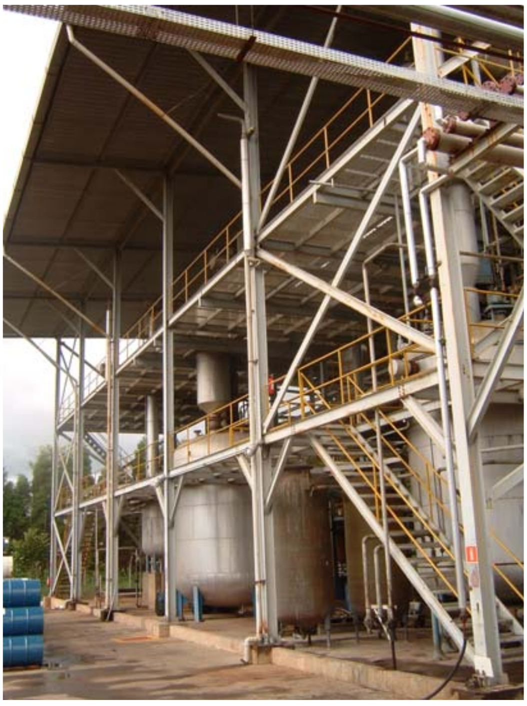
Biodiesel conversion yields of available feedstock in Brazil

The Laboratório de Desenvolvimento De Tecnologias Limpas (LADETEL) carried out a survey in order to identify the conversion yields of available feedstock in Brazil. The outcomes showed that there are considerable varieties of conversion yields for the production of biodiesel.



Biodiesel production facility in Charqueda, São Paulo

The total costs of the new biodiesel production facility in Charqueda are estimated at 4,5 million US$. Until 2005, the production capacity will reach the final value of 300 million liters per day. The produced biodiesel is mainly exported to Germany at a total price of 0,57 US$ per liter, while the glycerine is sold to the national cosmetics and explosives industry at a price of 1,2 milion US$ per tonne.



Biodiesel utilisation in Brazil

The first commercial vehicle fleets from PSA Peugeot Citroen are running on B30. Currently, new vehicle engines, running with B100, are under development. In this context, it is necessary to develop new sealing materials and injection pumps that can resist pure biodiesel utilization. The major diesel engine producers of Latin America (Ford, Land Rover, Massey Ferguson) are also interested in developing new biodiesel engines. In order to improve the biodiesel production and utilization, LADETEL will further develop biodiesel production processes and biodiesel fuel technologies.

Brazils new PROBIODIESEL program

Antonio René Iturra
Senior Analyst of Brazil´s Science and Technology Ministry
E-Mail: iturra@ibict.br

Paulo César Ribeiro Lima
Energy Consultant of Brazil´s Federal House of Representatives
Paulocesar.lima@camara.gov.br

Due to Brazil's inadequate coal reserves (high ash content and low calorific value), it is necessary to import the coal, needed for the country's industry. Until the 1990´s even a great percentage of the needed oil was imported. Today, Brazil needs to import about 15 percent of the national consumption, that reaches 1,800 barrels per day. Within the end of 2006, the increase of Brazil's oil production should be sufficient to reach self-sufficiency. This however could be a threat to the development of alternative energy sources, as the self-sufficiency may end up weakening necessary activities within future ethanol and biodiesel production.

Therefore, it is important to discuss the qualitative and quantitative fuel sources under a new paradigm that focuses on clean, efficient and renewable energy sources. The production and utilisation of liquid biofuels will become the most important part of the future energy mix.

Due to Brazil's inadequate coal reserves (high ash content and low calorific value), it is necessary to import the coal, needed for the country's industry. Until the 1990´s even a great percentage of the needed oil was imported. Today, Brazil needs to import about 15 percent of the national consumption, that reaches 1,800 barrels per day. Within the end of 2006, the increase of Brazil's oil production should be sufficient to reach self-sufficiency. This however could be a threat to the development of alternative energy sources, as the self-sufficiency may end up weakening necessary activities within future ethanol and biodiesel production.

As the world's leader in fuel ethanol, Brazil now focuses on the production and utilisation biodiesel. With Directive 702 of the Ministry of Science and Technology (MCT), Brazil has implemented research and technology development activities for a national biodiesel program. In 2003, the Interministerial Workgroup evaluated the feasibility of biodiesel in Brazil and set recommendations for a biodiesel program. After the implementation of the first biodiesel specifications (ANP 255/03), in 2004 the country set the permission to utilise 2 percent biodiesel admixture to regular diesel (B2). Finally, on December 6, 2004 the National Biodiesel Program PROBIODIESEL was announced. The program aims to develop technology for the production, utilisation and industrialisation of biodiesel.

In the past, Brazil's consumption and imports of mineral diesel have been rising rapidly. According to the country's legislation, Brazil wants to reduce its dependence on diesel imports, as it has already successfully been done with petroleum through the PROÀLCOOL program.

Brazil has several crops can be used for biodiesel production, including soybean, palm, coconut, castor seed, cottonseed and sunflower. Within this, the amount of soybean accounts for the vast majority of Brazilian oilseed production and therefore presents the most viable option for a national biodiesel industry. The current Brazilian administration considers that the Brazilian PROBIODIESEL program brings further social inclusion and job creation. Even though Brazil's biodiesel program is still in its infancy, it offers great potential for the future.

Brazil faces the challenge of a new energy PARADIGM

Antonio René Iturra
Senior Analyst of Brazil´s Science and Technology Ministry
E-Mail: iturra@ibict.br

Paulo César Ribeiro Lima
Energy Consultant of Brazil´s Federal House of Representatives
Paulocesar.lima@camara.gov.br

Introduction

Nowadays it is becoming more and more relevant to find strategical solutions to assure the supplying of energy for a growing worldwide demand in a scenario that points out to a new oil crisis. But at this time the crisis will be caused by supply shortage and not by political and market issues as the previous ones.

In such a scenario, more important than discussing the sustainability of fossil fuel supply from finite reserves is to move forward, discussing the qualitative and quantitative fuel sources under a new paradigm focused on clean, efficient and renewable sources. Ethanol and biodiesel have the potential to be the new worldwide source of energy.

Prior to discuss the main subject of this paper, it is important to make some comments concerned to approach given by the international media on this matter. We must realize that many times the correct approach it is not well emphasized. Sometimes the media shows no commitment to the development of a true citizenship.

It is becoming obvious what globalization means to the humankind. We must be aware of the true wealth of the nations. In fact the true wealth should not be dominated by the international financial system that can produce currencies that are just “painted papers” supported by market expectations.

Some people may found it a weird statement but that are enough evidences to confirm it. The growing international tensions caused by energy, potable water and minerals shows what are the true wealth of nations that can support and give credit to currencies. Otherwise it will occur more and more stock market crisis as we are used to see in the headlines generating “speculative bubbles” that causes scandals and even suicides like in Japan.

Since Bretton Woods agreement, the support of the “strong currencies” is mainly based on the wealth of the third world countries. Suddenly Mr. Bush realized that, after years of friendship and weird agreements with Irak government, Saddam is a dictator that do not care for human rights. Everybody knows that Irak´s invasion was caused by the “wealth” of that nation.

In such scenario, Brazil and many countries located between tropics have to assume their role because they hold the true wealth not just because their happy and peaceful people. Brazil, in particular, and other countries in the Amazon Area should prioritize their efforts to keep the domain of this wealthy area of the planet.

In the energy field, it is important to emphasize that the end of the oil era and the externalities caused by it, mainly the environmental ones, should leave us alert, not sleeping on our vast territory.

Like an iceberg that shows just its tip, the world energy matrix shows just the tip of a critical situation for the current status quo. Countries like Japan, Germany, France and most countries of western Europe do not have oil in their territories and are fully dependent on imports. The USA reserves can supply the internal market for just four years. The biggest oil reserves are in the middle east, where the Americans are showing their military hegemony.

The analysis of the actual scenario shows the tropical countries should take this opportunity and promote technological research in a professional way, specially in the case of renewable sources of energy like they do in fossil fuel and hydroelectricity matters.

Brazil recently promoted a Public Hearing at the Commission of Amazon, National Integration and Regional Development of the Federal House of Representatives where it was proposed the creation of a National Agency for Renewable Energy – ANER. This initiative had strong support of the House of Representatives members. After this event the President of the House of Representatives has sent a formal indication for the creation of this Agency. Next October it should occur another Public Hearing with similar scope.

ANER should foment the production and rational use of renewable energy like solar, eolic e small hydroelectric plants besides biomass plantation for ethanol, biodiesel and wood production. Those biofuels may be essential for supplying of the local, regional and national demand, and also for supplying the fuel demand of developed countries.

Background of Brazilian Energy Sector

The energy model imposed on underdeveloped countries and on other ones by the “western civilization” has been based on fossil fuels, initially on mineral coal and after that on oil. The coal fired by Brazilian industries had to be imported because the internal produced coal was inadequate due to the high ash content and the low calorific power. Up to the nineties, great percentage of the oil was also imported.

Nowadays Brazil is importing about 15% of the national consumption which reach a figure of 1800 barrels a day. The Brazilian self-sufficiency, to be reached in 2006, could be, however, a threat to the development of alternative sources of energy. It can make PETROBRAS, the State oil owned company, even stronger. The self-sufficiency may end up weakening important activities for regional and national growing like ethanol and biodiesel production as they are oil concurrent.

According to Brito(1), this model was applied on every tropical area of the planet – the model so called “pragmatic rationalism” – overtaking cultural resistance of people who had adopted different ways of thinking and social organization. In China the implementation of this model was slow and incomplete.

In some countries the western expansion was initially more complicated due to the vast areas, the exuberance of life and the great natural resources. These regions fascinated the Europeans making stronger their interest in conquering them. But by copying the western industries standard, the tropics became dependent of imported sources of energy.

The conquers were not humble enough and did not have the knowledge to deal with those new regions. By now the nature has denied to understand the “model” and it is reacting to the destruction with more destruction. The Brazilian people has in their minds the failure it was the giant projects like Fordland and Belterra, Jari, Carajás and others.

The forest, the trees, the animals and the Indians were seen as enemies. The Brazil´s colonization period is a history of war against nature that is reflected in our culture and language. Even today some people sees Amazon as “the green hell”.

The task of putting down trees even today is described as "cleaning the terrain" where the wild life is eliminated, even the more peaceful animals like birds and wild pigs. Even today there is a popular saying that "up tree, farmer in bed".

Some Brazilian and foreign experts did not realize that technology is the material expression of a culture they keep on trying to destruct. In accordance with Mammana technology is not a commodity and in fact it is a safe way to better place Brazil at the international market. Products that come from technology can not be degraded as easy as commodities like minerals, agricultural goods or non qualified work force.

In fact it is becoming consensus that technology is a trade good and not a panacea. Technology can change the free market. It is obvious that the abuse of confidence restricts the diversification of suppliers and that some people believes in the predestination of our inferiority and in our incompetence.

According to Mammana(2) many times we had to passively watch long time of darkness, deleterious actions of government which stimulated the economical agents to buy a new type of indulgence they use to call "technology transfer". For many years in name of this belief, the Brazilian market have offered great opportunities to foreign countries and has denied these opportunity to internal agents.

Energy and Development

It is well known that energy plays a special role on civilization development as a production factor and a consumption good. The first allow the use of the other factors, mainly work force, and the second is linked to the notions of comfort and quality of life.

What it is not so obvious, according to Brito(3), is that the development of the energy matrix by its strategical value and by its own dynamics bring huge influence to other sectors of the economy and to the social organization.

More than that, teach Deber et all(4), "the growing use of energy creates the "energy income" and the social group that controls the energy system gets this income, making its power even greater". In accordance with the report of the Industrial Department of Brazil(5), the technological options adopted inside the system have a direct relation to the economical power structure once the energy supports, shapes and defines the civilization way of life.

The model imposed on tropical countries has been questioned. Fortunately the Brazilian people knows that. The seventies oil crisis have shown how fragile is a model based on oil which is a finite source of energy. At the end of the seventies, Brazil´s oil import accounted for 45% of the exports.

In developed countries, however, alternative energy sources as biomass and others are marginal due to their natural limitations. On the other hand the tropical countries can take a different approach and become huge exporters of alternative, clean, cheap and renewable fuels, without causing the fossil fuel externalities.

Despite the huge potential of tropical countries there are problems. The cultural mimicry with roots in the colonial times and the established model make those countries regard the production and rational use of biomass as old-fashioned and limited. In fact in actual world scenario the sustainability is a key issue and means modernity.

Brazil has a great potential for energy production from renewable sources as biomass. There are 325 million of hectare land inappropriate for agriculture, but adequate for forest. Half of this area, that represents 20% of Brazil´s territory, can produce 17,8 million of oil equivalent per day. A 309 million hectare land is suitable for agriculture in Brazil and just 60 million of it has been used. If half of those unused land becomes available for plantation aiming to ethanol and biodiesel production it could be produced at least 7 million of equivalent oil per day, which is 4 times greater than Brazil´s consumption.

According to Brito(3) if all tropical countries were accounted for, those figures can be two to three times greater which means that the potential for energy production in the tropics is equivalent to the current energy produced from oil. Furthermore the energy from tropics is renewable, provides income for people and regional development.

As we can see the biomass can deeply change the world energy scenario and the economic power structure that is reason why energy provokes so much controversy. The “good people that cares for the holly scripture” could make efforts for getting a more balanced life standards worldwide with smaller a gap between rich and poor countries. Of course the people who lives in tropics should also play its role with competence and effectiveness. It is urgent the tropical region assume its role in the world context.

Based on this reasoning and on the previous Brazil´s experience with vegetable coal, ethanol(6) and biodiesel(7), the analysts are aware of the great opportunity the current scenario is offering to the tropical nations in order to change their current state of submission and to construct a better future. The Brazil´s ethanol national program needs to be improved in terms of social, economical and environmental benefits and to attend the international demand for it. The biodiesel national program to be created should consider the different raw materials, technologies and production scales.

The conditions for those changes are: social awareness about the world scenario, political incentives from top decision makers and adequate technological development for production and use of energy from biomass.

Final Comments

Brazil and other tropical countries have to take this historical opportunity to get their own development, promoting a rational occupation of their territory and promoting income distribution from biofuels production initiatives. The societies of tropical nations urgently need to know the huge potential their countries have for energy production according to thermodynamics principles. They must also be aware that biofuels production can solve some of the greatest problems they have like hunger and diseases.

So it is necessary to go deep on technological development of solutions compatible to their cultural values using the natural resources of each region of their vast territory and integrating the production process to the national economy, maximizing the social benefits that photosynthesis can bring to them – this approach will lead many underdeveloped countries to a better future.
This debate is far from over but today there is a general awareness that it is not just a simple question of energy from biomass. In fact biomass and energy matters incorporates many factors like ideology, politics, philosophy and others, to technical, environmental and economical issues.

It is not just about technological choices but it is an opportunity to implement a new model that can bring benefits to underdeveloped countries and to all humankind. By that reason, it is important to understand this new paradigm and to keep on moving forward on energy from renewable sources. The tropical countries will be called to supply the growing international demand for fuels.

Fortunately, the international scenario aims to a new energy matrix as well as to meet the international treaties on environment protection. Germany, for instance, increases day-by-day its biodiesel production from colza and USA is doing the same with ethanol from corn wich is less efficient than sugar cane. In 2007 USA may be reaching the same figures of Brazil´s production. Brazil shows great comparative advantages and can be considered the “Saudi Arabia of renewable fuels” and for sure it will supply fuels of the era creating a new energy paradigm in terms of quality, quantity and cost.

Evidently nothing happens based on just potential conditions. The tropical nations should create national bodies to foment the new model proposed on this article. In Brazil it is being proposed the creation of the National Agency for Renewable Energies Development – ANER. The Amazon, National Integration and Regional Development Commission of the Federal House of Representatives is doing a great effort in this direction aiming to dissociate renewable fuels from fossil fuel body which have different approach to energy issues.

The creation of biofuels institutional bodies engaged on efficiency and effectiveness is a key action to get biofuels at competitive prices and good quality. Those bodies will contribute to current Brazilian government programs like PROINFA and CCC. PROINFA aims to incorporate power generation from solar source, small hydroelectric plants and biomass to national integrated electric system. The objective of CCC program is to equalize the prices of the energy produced mainly from fossil fuel in Amazon Region with the prices charged in the other areas of Brazil.

Concluding this article it is important to make a special mention to Prof. José Walter Bautista Vidal(8) - a great Brazilian that has written powerful and provocative books and has taken part in many challenging decisions – and Gilberto Freyre, the first Brazilian to foresee the potentialities of Brazil as a tropical nation, proposing a systematic investigation of the theme. He wrote a book named “Man, Culture and Tropics” spreading the basis of the so called “Tropicology”, an multidisciplinary science created do uncover the potentialities of tropical regions that can bring huge benefits to humankind.

References:

1. Brito, S. de S. 1993. Os Trópicos e a Civilização. In: Carta: falas, reflexões, memórias. Darcy Ribeiro n 1. Pg. 185-195.

2. Mammana, C.Z. 1987. Tecnologia, expressão material de uma cultura. In: Rev. Bras. Tecnol., Brasília, v. 18(5):14-15.

3. Brito, S. 1984. Energia em países em desenvolvimento. In: La Rovère, E.L. (org.). Economia e Tecnologia da Energia. Rio de janeiro.

4. Deber, J.C, J.P.Delage e D. Hemery. 1986. Les servitudes de la puissance, une histoire de l´energie. Ris, Flammarion.

5. STI/MIC. 1986. Energia da Biomassa: alavanca de uma nova política industrial. Brasília.

6. Iturra, A.R. 2004. Análise Histórica das Microdestilarias de Álcool no Brasil. Relatório apresentado ao MDA e à Comissão Executiva Interministerial do Biodiesel coordenado pela Casa Civil. Mimeo, 35 p. Brasília.

7. Iturra, A.R. 2003. Análise Histórica do Biodiesel no Brasil. Relatório apresentado à Comissão Executiva Interministerial do Biodiesel coordenado pela Casa Civil. Mimeo, 39 p. Brasília

8.Bautista Vidal, J.W. 1987. Do Estado Servil à Nação Soberana. Civilização Solidária dos Trópicos. Petrópolis. Vozes/UnB e Civilização dos Trôpicos, uma Resposta à Barbárie. Humanidades, 16,V, 1988, entre outros.

The Brazilian Ethanol Learning Curve

Oswaldo Lucon*, Suani Teixeira Coelho*, José Goldemberg* and Plinio Mario Nastari**
*SMA, the São Paulo State Environmental Secretariat, Brazil
**DATAGRO, Brazil
E-mail: oswaldol@cetesb.br

Economic competitiveness is a frequent argument against the introduction of renewable energies worldwide. The Brazilian experience with bio-ethanol provides the proof that economies of scale and technological advances can lead to increased competitiveness of renewable alternatives with respect to conventional fossil resources. It clearly shows that supportive and sound Government programmes can cause positive environmental, economic as well as social development in emerging economies. This is an important paradigm to developed countries as well, which could review the incentives provided to fossil fuel, shifting to renewable sources and to a more open trading of biofuels and environmentally sound energy commodities.

One of the very common arguments against renewable energies is their failure to economically compete with fossil fuels. Renewable energies can become more competitive with correct incentives - and with corrections of distortive subsidies still given to the conventional fossil sources. The following article presents an example for significant cost reduction of a renewable fuel achieved through supportive Government programmes, acting on the demand side of large markets and thereby lowering costs through the ‘learning curve effect’.

The learning curve represents graphically how market experience reduces prices for various energy technologies and how these reductions influence the dynamic competition among technologies. One of the most important examples is provided by the Brazilian Alcohol Program (PROALCOOL), established in 1975 with the purpose of reducing oil imports by producing ethanol from sugar cane. The program has positive environmental, economic and social aspects, and has become the most important biomass energy program in the world [1].

In 1975, 91 Mt of sugarcane was produced, yielding 6 Mt of sugar and 555 km^3 of ethyl alcohol (ethanol). In 2002, sugarcane production reached 320 Mt, yielding 22.3 Mt of sugar and 12.6 Mm^3 of ethanol. Since the creation of PROALCOOL, prices received by ethanol producers were determined by the federal government, as were the prices of fuels in general. In May 1997, the price of anhydrous ethanol was liberalized, and the same occurred with the price of hydrated ethanol in February 1999.

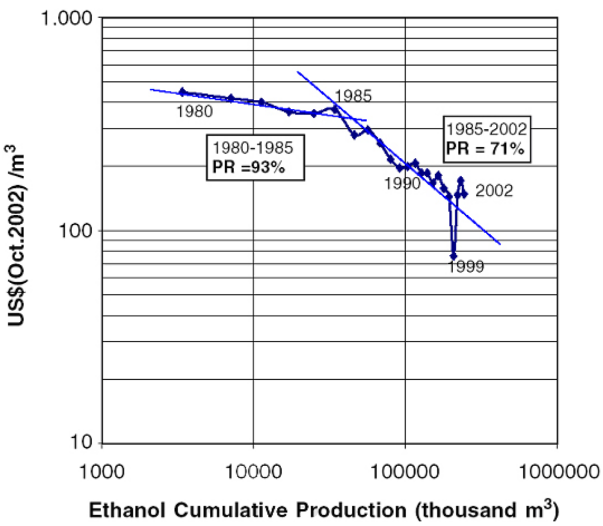
Ethanol production costs were close to 100 US dollars a barrel in the initial stages of the Program in 1980 (see Figure 1; Prices paid to producers are proxies for costs). Until 1985, as production increased, prices paid to producers reflected average costs of production. During this initial phase, prices fell slowly reflecting the gains in agro-industrial yield and economies of scale captured by producers, and transferred to consumers through the pricing regulation scheme. After 1985, however, prices were set at levels below the average costs of production, while the federal government tried to curb inflation by controlling public prices, inclusive of fuels. Due to this factor, together with economies of scale, the price fell much more rapidly.

As the efficiency and cost competitiveness of ethanol production evolved over time, and fuel prices were liberalized, this support was no longer needed and was not applied. Of great significance is the fact that the total amount of investments in the agricultural and industrial sectors for the production of ethanol for automotive use in the period 1975–1989 reached a total of US$ 4.92 billion (US$ of 2001) directly invested in the program. On the other hand, savings with foregone imports evaluated at international prices, have amounted to US$ 52.1 9 billion (Jan 2003 US$) from 1975 to 2002 [2,3].

Presently, there are no subsidies for anhydrous or hydrated ethanol production. Hydrated ethanol is sold for 60–70% of the price of gasohol at the pump station, due to significant reductions in production costs. These results show the economic competitiveness of ethanol with respect to gasoline in Brazil. This economic competitiveness is a reality for several years already and will continue for years to come, especially with the current increase of the crude oil prices on the world market.

Today, in Brazil so-called 'flexible fuel' vehicles are being sold, which can run with any gasoline-ethanol blend (i.e. from E26 gasoline to E100 hydrated ethanol). Sales are booming and, in very short term, fuel use will be a consumer choice at the pumping station. In 2003, 48 thousand units were sold and forecasts are 280 thousand in 2004. Around 60% of the light vehicles are expected to be fuel flexible by 2007. Ethanol use already has significantly improved the air quality conditions in metropolitan areas of Brazil, removing lead from gasoline and reducing sulphur emissions. Nitrogen oxides can be controlled with appropriate exhaust catalysts and antioxidants. The acetaldehydes emitted are 100 times less toxic than the formaldehydes from gasoline.

Currently, more than 100 countries worldwide - mostly developing countries - produce sugarcane and could also produce ethanol for internal use as well as for export, thereby alleviating their trade balances. OECD countries could also benefit from such imports by improving local air quality and, through a more liberalised market, promoting their environmentally sound technologies.



Brazilian bio-ethanol learning curve

References:

[1] Goldemberg J, Moreira JR. The alcohol program. Energy Policy 1999;27(4):229–45

[2] Datagro. Costs of fuels and cumulative sales in Brazil and Rotterdam. São Paulo: Datagro; 2003.

[3] Nastari PM. Poupança de divisas com o uso do álcool combustível no Brasil (Savings by the use of ethanol fuel in Brazil). São Paulo: Informativo Datagro; January 2003.

Utilisation of Biomass – European Technologies and Expectations

Herbert-Peter Grimm
WIP-Renewable Energies
E-Mail: wip@wip-munich.de - www.wip-munich.de

The interest in bioenergy is rapidly growing, as bioenergy is a very diverse type of energy with very different sources, processes and feedstock. Energy from biomass and waste encompasses the production of heat, electricity and/or fuels from agriculture, industry and municipal wastes. Because of its potential contribution to security of supply, it has become an important element of energy, environment and agriculture policy. The utilisation of solid biomass is becoming increasingly popular around the globe for various reasons: 1) Political and social concerns about the environmental impact of fossil fuel combustion; 2) Government support and subsidies for renewable energy; 3) Relatively quickly power generation and 4) Relatively low-cost measure for renewable energy generation.

According to the Eurostat convention in the EU-15 a total gross inland consumption of 54.5 Mtoe was based on biomass energy in 2000, which corresponds to a share of 3.73% of the total gross inland consumption and around 60% of the total of renewable energies. The target of the Eurostat convention is to reach 205 Mtoe or 13% of the total gross inland consumption in 2020, corresponding to a share of 6.5% of the renewable energies contribution. Biomass based renewable heat production was 42.9 Mtoe with a target of 100 Mtoe in 2020 [EREC]. The contribution of biomass to electricity generation was 39.2 TWh in 2000 with a projection to 282 TWh in 2020. The contribution to the biomass based new generation capacity was in 2000 in the range of 2.6 GW and is expected to increase to 45.3 GW in 2020.

The present work examined the use of solid biofuels for stationary decentralised energy generation, focusing on technical and socio-economic aspects.

Biofuels, as alternative fuels for stationary energy generation offer several benefits, as i.e.

- Sustainability,
- Reduction of greenhouse gases and other pollutant emissions of fossil fuels,
- Regional development,
- Support of social structure and agriculture,
- Security of supply.

Bioenergy from all the different resources like wood, energy crops or municipal and industrial waste is already in use in the European Union. Depending on the different countries the diffusion of the utilisation varies widely. This depends on e.g. the countries tradition or their political background. The biggest contribution to the energy supply by Renewable Energy Sources (RES) nowadays and in the future is by far made by large-scale hydro and biomass for heat production. In many parts of the EU-15 countries solid biomass is already intensively used for the generation of heat and electricity and in several countries of the EU-15, bio-energy is estimated to substitute up to 10% of the national primary energy consumption. The situation in the Accession Countries is relatively new and not many facts can be presented yet. Compared to the EU-15 countries the present use of bioenergy is marginal in the Accession Countries. Traditionally in some Eastern European countries wood is still used to provide heat for private households. Some Accession Countries already began implementing first demonstration plants some years ago mostly with the commercial aid from western investors.

Many techniques employed for exploiting biomass have been used for a number of years, e.g. furnaces for combustion, while others are only just being tested and demonstrated, e.g. gasification. Others appear to have good potential for becoming conceivable future techniques, although they have not yet been fully tested. The techniques of greatest current interest are:

- Direct combustion in boilers,
- Advanced thermal conversion of biomass into a secondary fuel by thermal gasification or
- pyrolysis, followed by use of the fuel in an engine, turbine and/or fuel cell,
- Biological conversion into methane by anaerobic bacterial digestion
- Thermochemical or biochemical conversion of the organic material into hydrogen, methanol, ethanol or diesel fuel.

In summary, different technologies can be applied to biomass to generate the commodities as given in the following table.

Process	Product	Applications	
Combustion/Incineration	Hot exhaust gas	Boiler / steam engine / steam turbine	Space heating, process heat, hot water, heat+power
Gasification	Fuel gas (producer gas)	Boiler, gas engine, gas turbine, fuel cell	Heat / heat + power
Steam reforming	Synthesis gas	Synthetic natural gas, liquid motor fuels, chemicals, heat	Heat, heat + power, transport
Pyrolysis	Gas (fuel), Liquids (fuel oil), char (solid fuel)	Boiler, engine, high value products	Heat + power, chemicals
Anaerobic digestion	Fuel gas	Boiler, gas engine, gas turbine, fuel cell, Substitute Natural Gas (SNG)	Heat / heat + power, products
Fermentation extraction	Liquids	Oil burners, liquid motor fuels, fuel cells	Heat/heat + power, transport

Although all these technologies are used in Europe, not all are fully developed. A number of obstacles must be overcome before all technologies can be developed and implemented commercially.

Compared to the standard solid fossil fuel “coal”, solid biomass fuels represent a high proportion of volatile components and of oxygen and low carbon content. These biochemical characteristics are resulting in a combustion behaviour that cannot be compared to that of coal. In accordance the standard combustion technologies used for coal are usable in a limited extent only.

Combustion is the most common way of converting solid biomass fuels to energy. It is well understood and commercially available, and can be regarded as a proven technology. The main disadvantages of small-scale applications that are based on natural draft and operated batch wise, such as fireplaces, wood stoves and wood log boilers, are their high levels of emissions from incomplete combustion. For smaller industrial plants, fixed bed systems usually are cost-effective. Fluid bed combustion plants are of special interest for large-scale applications normally exceeding 30 MW thermal power. The low excess air required reduces the flue gas volume flow and increase combustion efficiency. Scale-effects ensure that large installations can be equipped with flue gas cleaning more economically. For small-scale applications equipment manufacturers need to be encouraged to develop novel, low-cost, combustion installations and filtration technologies that result in low particulate emissions. The desire to burn uncommon fuels, to improve efficiencies, to reduce costs, and to decrease emission levels continuously results in improved technologies that are being developed.

Co-firing of biofuels can be done in many of the existing coal and peat burning combustion systems and solid biomass fuels can be co-fired in all furnaces using grates, fluidised bed combustion and dust injection furnaces. Co-firing of biofuels has been examined in a broad extent in coal power stations up to 2,500 MW thermal power. In many cases it still is in use. Preferably plants are used which have good burn-out efficiencies for problematic fuels as e.g. dust injection combustors and fluidised bed combustors, either stationary or circulating. Grate furnaces are suited too when adjusted to the different combustion properties of the fossil fuel and the biofuels. Advantage is given when biofuels are used having similar characteristics as the coal, given for e.g. lignite.

Good experience was gained with hard coal burning units having coal dust injector burners and biofuels quantities up to around 10% fuel power when separate burners injected the biofuels. Combined milling of coal and biomass raises limits for biomass in the feed stream. Separate milling and biomass injection into the combustion chamber will enlarge the biomass quantities to be co-fired and quantities of up to 40% fuel power are envisaged. Compared to energy crops, straw and cereals, higher co-firing quantities of woody biofuels are expected because of their lower contents of alkali metals and chlorine. However, because of economical reasons for biomass provision in Central Europe the upper co-firing limit of biomass to coal is assumed to be in the range of 50 to around 100 MW. More fuel power substitution will increase the area needed for biomass provision and transportation distances. For co-firing possibly not technical but ash utilisation aspects could be the limiting fact.

The term ‘incineration’ stands for burning of waste in a furnace at a high temperature for a short amount of time, in order to reduce both its weight and volume. The Landfill Directive (LD) will significantly reduce the disposal possibilities of biodegradable, i.e. organic/combustible waste in landfill. Dedicated waste incineration with energy recovery is a robust economic and environmentally sound recovery option that is regulated under the Directive on the Incineration of Waste (WID). Because of the flue gas cleaning requirements nowadays only industrial applications and CHP utilisation is commercially feasible. The most widely implementation nowadays is seen with grate furnaces having different designs and with fluidised bed incinerators. There are several state-of-the-art technologies for converting MSW to energy. The technology is mature and implemented commercially.

Municipal Solid Waste (MSW), when treated and upgraded, produces a Solid Refuse Fuel (SRF) and/or Refuse Derived Fuel (RDF). RDF is relatively clean and offers significant environmental and market opportunities. The European Commission has issued a mandate to CEN/TC 343 for the adoption of European standards for SRF/RDF so that such fuels could be traded in the energy market for numerous energy applications replacing fossil fuels. All incinerators using alternative fuels must comply with the relevant EC Directives on waste incineration as well as the regional emission and/or immission limits regulation.

Gasification is the partial combustion of solid biomass in a reduced oxygen environment to produce a combustible product gas. The gas compounds mainly are carbon oxide, hydrogen, carbon dioxide, methane, ethane, etc.. Besides of these acidic materials and higher hydrocarbons, tars, are produced. When processing heated biomass with oxygen and steam in a so-called steam reforming process applying the ‘water gas shift reaction’ a gas is produced that is called ‘synthesis gas’ and/or ‘syngas’. Because of the equilibrium reaction of carbon dioxide and water steam the content of hydrogen and carbon monoxide is increased.

The most popular gasifier systems are fixed bed gasifiers i.e. up-draft/counter-current and down-draft/co-current reactor systems that are considered especially for smaller, i.e. < 10 MW fuel power, because of their relatively simple and robust construction. Fluidised bed gasifiers are better suited to installations having >10 MW fuel power, but many different systems have been tested or are under development.

The producer gas or synthesis gas can be burned directly in combustion units. After downstream gas treatment producer gas is a clean and efficient energy source. When it is used in an ‘Integrated Gasification Combined Cycle (IGCC)’ process, producer gas is burned in a high efficient gas turbine. The flue gas is fed to a boiler. The steam from the boiler heated with the flue gas of the turbine can power a second turbine, resulting in an improved energy conversion efficiency than of conventional steam boilers. However, future development for syngas utilisation is focusing on direct fuelling to a fuel cell. A further option is to upgrade the producer gas to a quality to mix the upgraded gas, a so-called ‘Substitute Natural Gas’ to the natural gas distribution grid.

The investment costs for gasification and mainly steam reforming processes are high. The systems are not yet technically mature and cannot be commercialised at the time being. Gas cleaning, gas cooling and tar removal is required for optimised utilisation of biomass gasification. In contrast to combustion, biomass gasification is more difficult to operate and requires more sophisticated instrumentation and controls. Most probably gasification will only become commercially successful, if in decentralised CHP installations cheap biomass can be used. However, in most gasification systems of today’s technology the fuel quality requirements are much higher than for biomass combustion.

The biomass pyrolysis is attractive because solid biomass can be readily converted into liquid products. These liquids have advantages in transport, storage, combustion, retrofitting and flexibility in production and marketing. Bio-oil has a clear advantage over wood chips and straw in transport bulk density and notably in energy density. For longer distance collection of biomass this difference may be a decisive factor. Also because of seasonal variations in biomass production and energy or products demand some storage will always be required. Apart from the bulk density and the energy consideration, it is important to notice, that raw biomass will deteriorate during storage due to biological degradation processes.

In consequence of the rapid thermal process, the chemical structure of bio-oil is quite different from that of crude fossil oil derived fuel oil. Char and bio-oil as the main pyrolysis products are relatively stable and will not biologically degrade. This bio-fuel can be used in boilers, medium-speed diesel engines and certain stationary gas turbine engines with relatively minor modifications. Current oil fired boilers cannot be fuelled directly with solid biomass and require modification of the unit. However, bio-oil and char slurries are likely to require only relatively minor adaptation of the equipment or even none in some cases.

Several technologies are in use for carbonisation. For the production of liquids the technology is not yet mature. In small-scale utilisation are the units of Ensyn/RTP, Canada, and Dynamotive, Canada. Several technological as well as environmental questions must be investigated. These questions embrace the process development to improve the product quality and to reduce the costs as well as environmental health and safety issues in handling, storage and transport of the product. However, pyrolysis of biomass could offer a very interesting route for producing high value chemicals; the liquid remainder later can be used for energy.

Anaerobic digestion is a process by which organic matter is decomposed by bacteria in the absence of oxygen to produce methane and other by-products. Mostly biomass residues or organic waste with high moisture content are used as feedstock. The primary energy product is a low to medium calorific gas, normally consisting of 50 to 60% methane. The gas can be fuelled to boilers. However, the biogas mainly is used as fuel with modified Diesel or spark ignition Otto engines coupled to generators for producing electricity and hot water in a combined cycle power generation plant. New developments are oriented to feed Stirling engines or a gas turbine topping cycle and a steam turbine bottoming cycle.

Despite of some given technical problems, biogas production can be considered state-of-the-art and in the beginning of standardisation and/or modularisation. It is a strong technology for converting all kinds of wet organic waste streams from the European animal sectors, food processing sectors, organic waste generating industrial sectors as well as waste from households. However, anaerobic digestion has not yet been perfected and will be complicated by the fact that the feedstock must be regarded as two principal fractions, (1) the soluble cell components that are digested rapidly and (2) the fibres, which require a very prolonged digestion time.

Improved biochemical conversion efficiency by using specifically developed bacteria species is one of future goals. Based on several investigations and plant process control measures big efforts are required for process monitoring, controlling and managing systems. Further process development should also involve the improved and simplified biogas purification and upgrading for its utilisation in CHP-units, feeding of SNG to the natural gas grid, as a transportation biofuel and as biofuel for fuel cell application. The main weakness, however, is nowadays that biogas production potential is estimated to be, conservatively, only at 3 MW/t, which is around 60% conversion factor of feedstock dry matter having 4.8 MW/t.

Combined Heat and Power (CHP) based on biofuels is not a specifically developed technology but the combination of proven technologies. Even in small- and medium scale the status of technological development is medium to high. Conventional steam engine/steam turbine technology is a state-of-the-art technology. The biofuels allow only for relatively low combustion temperatures because of low ash agglomeration temperature and fouling problems.

Small-scale CHP systems based on solid biomass fuels have moderate electric efficiencies of only 10 to 16% electric power output/fuel power input. A considerable potential to improve the electric efficiency of small-scale systems will come with the development of direct closed cycle screw-type steam engines, Stirling engine cycles and Organic Rankine Cycles (ORC) where up to 20% of electric efficiency are expected in heat controlled operation. Further improvement can be envisaged by increasing the allowed maximum inlet temperature when modifying this engine from steam driven mode to hot gas – air-driven – mode where inlet temperatures of up to 500 °C should be available. For the ORC technology further improvement of the electric efficiency is envisaged by the utilisation of new working fluids and by the application of 2-stage-cycles. Stirling engine technology can be improved by the design and automatic cleaning of the Stirling engine heater and the internal Stirling engine cycle but especially by improving the air-pre-heating and flue gas recirculation cycle.

Without question, the implementation of more and more bio-energy plants will have an impact on the European society as well as on social matters. The most important effect will be the creation of new employment. In the Renewable Energy sector a study expects by 2010 about 1,000,000 new employments and more than 2,000,000 new jobs by the year

2020. Many of these new jobs are envisaged in rural areas of the EU-15 which will lead to positive economical and social effects in otherwise poor settlements. Within the renewable industry employment growth is greatest for the biomass sector, i.e. wood fuels and biofuels respectively, providing additional 422,000 up to 695,000 jobs in 2010. This reflects almost 60% of the total renewable industry employment growth in 2010.

The agricultural sector also accounts for large employment growth in both of the years 2010 and 2020. With a total of 320,000 up to 699,000 jobs in 2010, this can have a significant effect on overall agricultural employment in the EU-15. But the growth in agricultural employment for the renewable energy sector does not necessarily mean that new people are brought into agriculture. Some of the growth will be from increased utilisation of part-time and seasonal agricultural workers. The main difference will be that the agricultural employment security will be greatly improved, as the energy sector will enable the development of long-term contracts and steady incomes within a high risk and low-income sector. Many new jobs in rural areas will strengthen the regional economy. As a consequence of increased biomass production the importance of the farmers will be increased. They will become energy producers. The employment effect by technology is also investigated. According to the used technology, in average between 5 and 10 total jobs per MW biomass plant capacity will be created by a new biomass fired plant. The new jobs will be on the one hand direct at the plant and for manufacturing and spare parts. On the other hand there will be jobs created in the region as a result from the purchase of local goods and services by suppliers to the bio-energy plant. Of course, there are differences to be expected in actual job creation in consequence of e.g. the specific technology used or the plant size.

No reliable facts can be presented yet to the Accession Countries. However, they hold large possibilities for the use of biomass as a source of energy. About one third of the land in the Eastern European Countries is farmland that will be without subsidies in the future. Also, in the Accession Countries about a quarter of the employed population works in the agricultural sector. It has also to be mentioned that the increase of new jobs in the bio-energy industry could lead to resistance by employees in the field of the conventional energies. As an example, as Poland is highly dependent on locally produced coal the Polish coal miners might fear of a job loss as a consequence of new biomass plants.

Finally, the security of the fuel supply is an important aspect. Unlike fossil fuels, biomass is a local resource that is produced nearby the heat/power plant. It has not to be imported from foreign countries such like fossil fuels. Fossil fuels like crude oil are found mostly in politically unstable regions like Western Africa or the Middle East. The security of supply of crude oil from such unstable countries is questionable. Also every political problem will influence the fuel price. In contrast, biomass is no subject to the above-mentioned problem.

For industrial use, with plants having a capacity of several hundreds of kW up to the range of several MW, the investment costs are also presented. There are already a huge number of existing plants, some are demonstration and pilot projects, and some are plants under profitable conditions.

	Investment costs [Euro/kW]	Specific electricity costs [Euro/kWhel]
Co-firing	50-200	0.01-0.04
Incineration	Around 4,000	n.a.
Gasification	2,200-5,900	0.14-0.20
Pyrolysis	700-3,000	n.a.
Biomass CHP	2,500 – 5,000	0.106-0.142

For small-scale utilisation, the investment costs for boilers for household use in the nominal capacity range between 20 kW and 60 kW are from 150 Euro/kW up to 1,000 Euro/kW.

Co-firing applications request only little investment and are already today economical and result only in a small increase in energy production costs. Already nowadays co-firing in coal-fired boilers and biomass-fuelled integrated combined-cycle units for the forest industry were two areas specifically recognised in the literature as having good potential, with co-firing giving the lowest cost and technical risk. When co-firing is performed in parallel systems, e.g. gasification of the biomass and firing the producer gas into the coal power unit, the ashes can be separately discharged and can be used as commonly is practised.

Small-scale district heating based on biofuel combustion already today is economical viable. Many studies explained that the investment cost for large-scale technology is likely to decrease in the future. The reasons are given with new results of the latest research as well as starting mass production for e.g. Sterling engines and other means for a combined heat and electricity generation.

Both, gasification and pyrolysis, are demanding for intensive further investigation. However, both technologies offer very interesting aspects for future implementation. Biogas plants can be profitable on farm sites if co-ferments, like e.g. bakery wastes or slaughterhouse remainders allowing for a high yield of biogas, are used.

For the example of the USA: Already only the non-fuel costs, i.e. capital and O&M costs, of electricity generation fired by biomass were almost the same as the total costs in the coal conventional and gasification systems. Therefore, without improvements in electricity generation technology or/and inclusion of social costs, it would be impossible for biomass to compete with coal in electricity generation. Further benefits and costs may also arise from the removal of logging residues when producing forest woods. The benefits include, among others, reductions in site preparation and planting costs, and fire and disease risks. The potential adverse effect is the concern about the loss in soil productivity.

It can be summarised that already today the profitability in comparison to fossil fuels is given with small-scale technology for heat application in households. Medium- to large-scale biofuels based plants for district heating and CHP can be profitable if the boundary conditions are positive. There is, however, a large potential for break-through development for all technologies discussed in this study to reach the economic scale.

The lack of a favourable political framework in Europe for the renewable heat sector is preventing higher market penetration so far. But with the creation of such a political framework the expectations can be raised and the contribution is especially significant in the biomass sector. In addition to the strong political efforts of the last years in regard to environmental aspects additional political action is required to ensure the continuous market penetration of bio-energy in Europe.

Rural Renewable Energy Development & Promotion Policies inChina

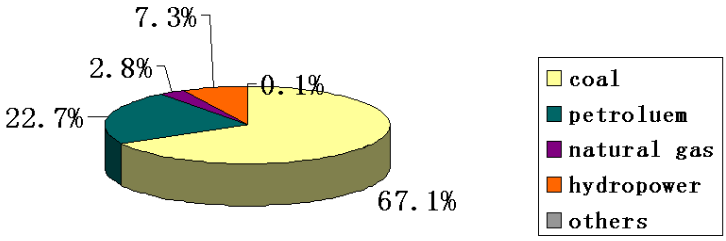
Mr. Tian Yishui, Ministry of Agriculture
Centre for Energy and Environment Protection, China
E-mail: yishuit@yahoo.com

Energy Production, Consumption and Demand

The commercial energy production of China in 2003 was estimated at 1.603 billion tce, which means an increase of 11%, compared to 2002. The primary energy sources are as follows:

- Coal: 1.667 billion tons
- Crude oil: 170 million tons
- Natural gas: 34.5 billion m³
- Power generation: 1,900 billion kWh (increased by 15.5% compared to 2002)

In 2003, the energy production was 1.68 billion tce, and increased by 13% compared to 2002. The following figure shows the energy consumption of different energy resources.



Chinese Energy consumption of different energy resources

Chinese overall national economic development plan:

- GDP in 2020 twice that in 2000. GDP per capita in 2003 was over 1000 US$, and it should reach 3000 US$ in 2020.
- To achieve the target, the total energy demand is forecasted as 2.3 and 3.0 billion tce respectively, in year 2010 and 2020, based on assumptions including technical progress, adjustment of economic development structure, adoption of high-efficient energy utilization measures etc.
- By 2020, it is estimated that dependence on the international market of oil and natural gas would reach 60% and 40%, respectively.
- In 2050, GDP per capita is expected to reach 12,000 US$, three times that in 2020. The total energy demand would be around 7.0 billion tce, twice that in 2020.

Constraints of Energy Development

- Shortage on energy resource availability
  - Total energy reserve: 820 billion tce;
  - Total energy exploitable: 150 billion tce, 10% of the world total and mainly coal;
- Per capita Chinese resources:
  - Coal: 70% of the world average;
  - Oil: 10% of the world average;
  - Natural gas: 5% of the world average;
  - Rich in hydropower resources

- Heavy reliance on coal that results in enormous environmental pollution
    - Contribution of coal to the energy matrix: 67.1%;
    - 90% of total SO_2 and 70% dust emitted in atmosphere are from coal combustion;

- Backwards energy utilization technology with low efficiency
    - Average total energy utilization efficiency is around 32%, 10 % lower than in advanced countries;
    - Output efficiency of resource is much lower than the world advanced level;
    - The output efficiency of resource in China is 28.6% of that in US, 16.8% of that in EU, and 10.3% of that in Japan.

Renewable Energy Resources & Development

- Hydropower

The economically exploitable hydro resources of China account for 390 million kW. This potential capacity could annually generate about 1700 billion kWh of electricity. By 2003, the total installed capacity of existing stations was 90 million kW, in which 30 million kW is small hydropower stations. Another 50 million kW of stations are being constructed.

- Wind Energy

The exploitable amount of conventional wind energy is estimated at 250 million kW, while the potential capacity of off-shore wind parks would be 750 million kW. Currently, the installed capacity of grid-connected wind generators is 570,000 kW. Off-grid small-scale wind generators account for 180,000 sets with a total installed capacity of 35,000 kW. At the moment, the wind energy resources are being re-evaluated, and a pre-feasibility study on large-scaled wind farms will be performed.

- Solar Energy

Two thirds of the Chinese territory have annual sun-hours of about 2,200. The annual sunshine radiation amounts 3,340-8,400 MJ/m^2. By 2003, the following solar energy utilization facilities have been installed:

Photovoltaics:

50,000 kW, mainly for remote households, transportation, and communication;
There are over 10 PV panel manufacturers/assemblers with a total production capacity of over 20,000 kW/y.

Solar water heaters:

52 million m^2 were being used, 40% of the world utilization;
Annual production: 12 million m^2 of heaters;
One square meter solar water heater can save around 120 kgce.

- Bioenergy

The overall biomass resources are estimated at about 500 million tce yearly. Annual crop residues are estimated at more than 600 million tons, of which 350 million tons are available for energy purposes, equivalent to 150 million tce. Organic waste water from industries and livestock farms can be fermented in order to produce about 80 million m^3 of biogas, equivalent to 57 million tce. The firewood from forestry and waste from wood processing can be utilised at an equivalent of 200 million tce while annual municipal solid waste production amounts for 120 million tons and estimated to reach 210 million tons by 2020.

Currently, the household-scale biogas digesters account for 13 million installations with an annual gas production of 3.3 billion m³, while large and medium scale biogas plants are estimated at 2,200 units with a yearly gas production of 1.2 billion m³. The total installed capacity of biomass-fueled power generation is >2 million kW and mainly consists of bagasse, rice husk, biogas, wood processing wastes, municipal solid waste, etc.

The **National Renewable Energy Development Plan** includes the following targets:

Hydropower:

- By 2020, total installed capacity: 75 million kW to replace 80 million tce;
- By 2030, most of the small hydropower resources should be exploited and the installed capacity 100 million tce.

Wind Energy:

- By 2020, total installed capacity: 20 million kW to replace 15 million tce;
- By 2030, most of the small wind power resources should be exploited and the installed capacity 50 million tce.

Solar Energy:

- By 2020, total installed capacity of PV panels: 1 million kW;
- By 2020, total area of solar water heaters: 270 million m^2.

Bioenergy

- By 2020, key technologies used to convert biomass into clean gas, bio-fuels, electricity etc.
- Total installed capacity of biomass-fueled power generation: 20 million tce;
- 50 million households with biogas digesters to produce 12.5 billion m^3 of biogas, equal to 9 million tce;
- Biogas produced from industry and livestock farm waste: 10 billion m^3 ;
- 210 million tons of municipal solid wastes will be produced annually. Considering to use 30% of them as combustion power generation and 60% as landfill to produce biogas, then the installed capacity can reach 2.5 million kW.

In order to reach these targets, the Chinese government develops guidelines and directives, economic incentives, RE technology R&D activities and information campaigns. This includes:

- 21st Century Agenda for China
- Countermeasures on Environment and Development
- Guidelines for new and renewable energy development and targets for 2010
- Renewable Electricity law
- Energy conservation law
- RE industry development planning
- Five-year RE energy development plan

The economic incentives include RE technology cost subsidies for household biogas digesters and household wind generators. Within this, RE price subsidies for produced electricity from wind farms are granted.

In the future, the Chinese government will put greater efforts to promote renewable energy development by launching laws and regulations and setting up market-oriented mechanism etc., which not only benefits China, but also contributes to global environmental protection.

Future Prospects of Bioenergy Utilisation in the South African Sugar Industry

Denis Tomlinson, Illovo Sugar Ltd
E-mail: dtomlinson@illovo.co.za - www.illovo.co.za

The first part of the South African White Paper on the Promotion of Renewable Energy and Clean Energy Development was released in August 2002. It supplements the Government's energy policy, set out in the 1998 White Paper on the Energy Policy of the Republic of South Africa. The country's energy policy promises support for the development, demonstration, and implementation of renewable energy sources for small-scale and large-scale applications.

While the medium-term target is the contribution of additional 10,000 GWh of renewable energy by 2012, South Africa's long-term objective is the establishment of an industry, producing energy from modern energy sources in a sustainable, fully non-subsidised way as an alternative to fossil fuels.

Targets of the initial phase 2004 – 2007:

ELECTRICITY

Sugar Bagasse	59%
Solar Water Heating	23%
Small Hydro	10%
Landfill Gas	6%
Bio-mass Paper / Pulp	1%
Wind	1%

FUEL

Bio-diesel tax incentives in place.
Voluntary uptake (5%) of bio-ethanol in discussion.
Determination of financing arrangements for bio-ethanol.

SECOND PHASE 2007 +

Implementation of blending targets.

Within the current White Paper, the Government's vision of an energy economy, in which modern renewable energy has an increased share and provides affordable and sustainable energy to the people of South Africa, is defined. The policy principles of the White Paper can be seen as the fundamental premises to be used in order to develop, test and apply relevant policies and actions, including decision-making, legislation, regulation, and enforcement. In the future, the Government will encourage the inclusion of all stakeholders in energy governance. Within the Clean Development Mechanism of the Kyoto Protocol there are also several opportunities for renewable energy development. South Africa is a country with abundant biomass resources and adequate infrastructure for renewable energy projects.

The South African sugar industry will increase the dialogue with the Government regarding bioenergy opportunities and renewable energy commitments that includes volumes and pricing. Furthermore, the industry plans to utilise the excess bagasse at “Raw Sugar Mills“ to generate electricity and to develop voluntary trade schemes for renewable energy certificates in Southern Africa.

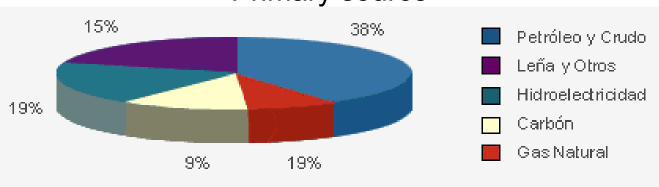
Bioenergy in Chile

Germán Aroca A.
School of Biochemical Engineering
P. Universidad Católica de Valparaíso, Chile
E-mail: garoca@ucv.cl

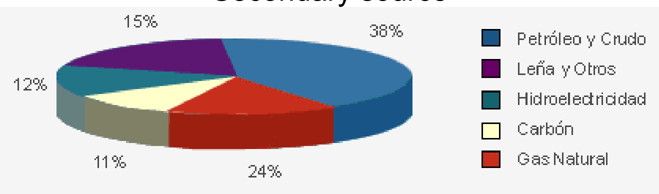
Energy resources in Chile:

The energy matrix of Chile strongly relies on fossil energy resources. Therefore, the main issue for the future is to promote and improve knowledge about the opportunities and benefits of bioenergy. Bioethanol from lignocellulosic materials, biodiesel and rape oil are promising options to substitute liquid fossil fuels. Biogas from landfill, effluent treatment plants and marine biomass can help to utilise the available biomass resources for renewable energy production.

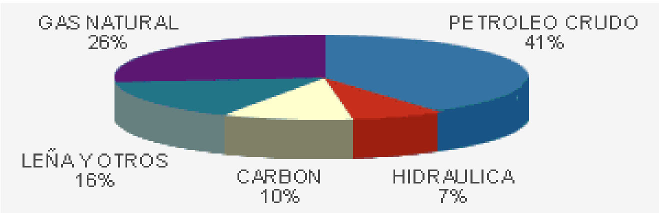
Primary source



Secondary source



Bioenergy in Chile:



Recent projects:

- About 13,000,000 hectares of native forest
- 20 % of the total energy could be obtained from sustainable sources
- Rural electrification project financed by UNDP
- Biomass gasification
- 40 KW in Butachauques Island, X Region

Termoelectric Plant using sawdust and bark from cellulose pulp plant
Constitucion, VII Region
8,7 MW, 50 ton/h

Termic plant, using sawdust and bark
San Francisco de Moztazal, VI Region
25 ton/h steam generation

Bioenergy perspectives:

- Bioethanol from lignocellulosic materials
- Biodiesel from raps oil
- Biogas from Landfill
- Biogas from effluent treatment plants
- Biogas from marine biomass
- Biogas from seaweed
- Energy from Nopal

Preliminary results show a maximum yield of 300 (mL/g) under non optimal conditions. 300 (m^3/ton) (65 % methane) =>1760 KWh /ton of seaweed. This system could be used for bioenergy generation in small coastal communities

8.300 Kg base húmeda	1.000 Kg base seca (12% sólido)
.	200 Kg (2.450.000 Kcal / expresados como GLP)
.	2.770 Kg de lombrices = 249 Kg Harina
.	2.770 kg Humus
.	2846,8 Kwh (g)
.	9490 Kwhe (eficiencia 30 % en motores Comb.Interna)
.	7.304 l de agua recuperada

Biofuel for Transport

Dr. Giuliano Grassi, European Biomass Industry Association – EUBIA
E-mail: eubia@eubia.org - www.eubia.org

In the next 20 years the expected growth of the world economy will increase the demand of oil, in particular for transport (source Exxon) from ~85 million barrels/day to the huge value of ~ 330 million barrels/day (8 times the Saudi-Arabian capacity). For the transport sector (now 100% dependence on oil) a contribution to this immense energy supply volume will be provided by the alternative liquid fuels derived from natural gas (but with an energy loss for conversion of ~ 45% and thus significant decreasing CO_2 emissions) and at medium-long term from biofuels some of which (as can seen from the enclosed table) have the technical-economic potential to cover most of the medium term needs with a large impact on rural development (new jobs) and great benefits for the environment (zero CO_2 emissions, no SO_2 emissions for optimised closed bioenergy complexes). Among several biofuels, bioethanol appears to be the most promising in short, medium and long term for the following reasons:

1. It is a refined high quality energy carrier with specific energy content ~70% of gasoline

2. It can be utilized as blending component of gasoline (or diesel fuel in small amounts: 3%) or for gasoline reformulation (ETBE) acceptable in conventional vehicles as well as in the new **Flexible-Fuel-Vehicles** (FFV) able to run on any mixture of gasoline and ethanol. These FFV constitute a breakthrough in the transition towards dedicated ethanol-fuelled vehicles (under development but not yet commercial) that once optimised should present an efficiency increase of 7% in comparison with gasoline vehicles (6% if biomethanol is used

Alternative Fuels for Transport

BIOETHANOL (BIO - ETOH): is a colourless, liquid fuel with the chemical formula: C_2H_5OH. This biofuel is a refined product and it is a suitable transport fuel for gasoline and diesel fuel blending, reformulation or substitution for **flexible fuel vehicles** (equipped with a compromise designed engine but able to run with any gasoline-alcohol mixture) or for optimised ethanol engines commercially not yet available. The incremental cost for mass-production of FFV is estimated to be ~ 150 € which is much lower than for compressed natural gas vehicles. Bioethanol is 30% less energetic than gasoline to future optimised ethanol engines should be ~ 7% more efficient than present gasoline engines. Bioethanol can be produced frm sugar, starch, ligno-cellulosic biomass as well as from town sludge/MSW (~ 20 li/kg of solid residue).

BIO-ETBE (Bio-Ethyl Tertiary Butyl Ether): is a colourless, flammable, oxygenated hydrocarbon with the chemical formula: $C_2H_5OC_4H_9$. This biofuel is produced by mixing bioethanol (48% in volume) and tertiary butanol (or bioethanol with iso butylene) and reacting them with heat over a catalyst. This biofuel (octane rating: 112) can be used in existing gasoline engine without any modification shows excellent performance and environmental benefits replacing aromatics and benzene. Bio-ETBE is acceptable for direct refinery blending and for common pipeline transport.

BIODIESEL: At world level the average diesel - oil consumption is ~ 145 l / person. The interest for substitution with vegetal - oils locally produced is significant. In Europe there is a specific crop (rapeseed with a productivity of 1 - 1,5 t/ha of oil extracted from the seeds) of particular interest for farmers. Because vegetal - oils are not very good fuels for direct injection engines (high viscosity and thermal instability) it has been found to be a good solution by transforming the vegetal - oil in ester (Biodiesel) as follows: 1 t (oil) + 100 Kg methanol = Biodiesel + 100 K (glycerine). The best solution is blending (~ 5%) of Biodiesel in diesel fuel, but existing diesel engines can run with 100% biodiesel. Currently in Germany there are 1600 Biodiesel refuelling stations.

BIOMETHANOL (BIO - MEOH): might become a preferred fuel for fuel cell vehicles (with on board hydrogen reforming) because of its high hydrogen content. Biomethanol (CH_3OH) can be produced from bio-syn-gas, mixtures of H_2 and CO derived from biomass via a well - known oxygen/allothermal gasification process, by steam reforming of charcoal and subsequent process by catalytic synthesis process of CO_2 and H_2. At present, methanol is mostly produced from natural gas (world production 27 mio t/year) with a conversion efficiency of ~ 55%. Biomethanol has in a longer term the economic potential of substituting the methanol derived from natural gas. Experiments of biomethanol direct synthesis by electrolysis of supercritical CO_2-water solution (over GA as cathalist) show positive results with a current efficiency of ~100%.

BIO-MTBE (Bio-Methyl-Tertiary Butyl Ether): is similar to Bio-ETBE and obtained by mixing biomethanol (36% in volume) and tertiary butanol with heat over catalyst.

BIOGAS (a mixture of ~ 60% methane and ~ 40% CO_2): is produced mostly by anaerobic fermentation of very humid biomass (livestock liquid manure, sludges, wastes, etc.). Small size plants are widely diffused in developing countries (~ 10 mio units in China), large plants are deployed mostly in industrial countries for treatment of urban sludges or for disposal of agro-industrial wastes.

BIO-DIMETHYL ETHER (Bio-DME): is promising fuel for diesel engines due to its combustion and emission properties and could become of great interest for very low GHG vehicles. This biofuel is liquid once pressured at ~ 5 bar. It is similar to LPG (a mixture of propane and butane) in terms of physical characteristics. It can be used as substitute for LPG or as oxygenated addictive in gasoline or as blending component of diesel fuel (easily soluble) or as diesel-fuel substitution for modified diesel engines. A potential 2% contribution to the diesel-oil pool is considered possible in a medium term but biomass must compete with DME derived from natural gas. DME can be produced from bio-syn-gas. At present DME is produced from pure methanol by an acid catalyst (Aluminium Oxide or Aluminium Silicate) in a fixed bed of low pressure and temperature (260 °C – 350 °C). The resulting mixture (DME + methanol + water) is separated by distillation. Direct conversion of CO in DME (now under development) will be more economical.

BIOSYNTHETIC FUELS: A wide range of very clean synthetic fuels can be obtained from "biosyngas" derived from biomass through the "Fisher-Tropsch" (FT) process, by building different polymer chains from the CO and H_2 basic molecules. The FT stands out as the most attractive process because it can produce a wide range of high quality fuels, some of high value, like: FT bio-diesel oil (sulphur free), Bio-Middle Distillates, Bio-nafta (basic gasoline), Bio-methane, etc.; now the problem of how much sulfur should be allowed in gasoline is emerging worldwide due to refining difficulties and to environmental constraints.

BIOHYDROGEN: is defined as the hydrogen derived from biomass resources. It is an excellent clean fuel, very energetic (~ three times that of oil per unit weight) and does not emit CO_2 in combustion processes. It can be obtained in several ways:

- By water electrolysis utilising bioelectricity. This is a very efficient process but the investment cost and the H2 production cost is relatively high (2,000 ÷ 3,000 €/t of H2 with ~ 4.5 KWhe/m3 of H2)
- By catalytic shifting of "biosyngas", CO-H2 mixture derived from solid biomass. From trials it seems that it could also be produced at reasonable cost (~ 1700 €/t) via steam reforming of charcoal/pellets obtained from low cost biomass residues (30 €/d ton)
- By membrane separation from biosyngas
- From bioethanol-water solution (99% mass conversion efficiency – 75% energy conversion efficiency)
- From biomethanol via Steam Reforming

CHARACTERISTICS OF BIOFUELS:

	Diesel engines				Otto engines				
	Diesel	Bio-diesel	DME	F-T diesel	Gasoline	Ethanol	ETBE	Methanol	MTBE
Chemical formula	$C_{12}H_6$	Methyl ester	CH_3O-CH_3	Paraf-fins	C_8H_{16}	C_2H_5-OH	C_4H_9-OC_2H_5	CH_3OH	C_4H_9-OCH_3
Cetane number	50	54	55-60	> 74	8	11	-	5	-
Octane number (MON)	-	-	-	-	86	92	105	92	100
Density (kg/l)	0.84	0.88	0.67	0.78	0.75	0.80	0.74	0.79	0.74
LHV (MJ/kg @ 15°C)	42.7	37.3	28.4	44.0	41.3	26.4	36.0	19.8	35.2
Stoich. air / fuel ratio (kg/kg)	14.5	12.3	9.0	-	14.7	9.0	-	6.5	-
Oxygen content (wt-%)	0-0.6	9.2-11.0	-	~ 0	-	-	-	-	-
Kinematic viscosity (mm^2/s)	4	7-4	-	3.6	-	-	-	-	-
Flash point (°C)	77	91-135	-	72	-	-	-	-	-
Boiling temperature	-	-	-	-	30-190	78	72	65	55

HYDROLYSIS of Sugar Cane Bagasse – The DEDINI PROCESS

Dr. Manoel Regis Leal
Copersucar, Brazil
E-mail: regis@copersucar.com.br - www.copersucar.com.br

In order to continue the development of the promising DEDINI Rapid Hydrolysis Process (DHR), in 1997 the COPERSUCAR CENTER OF TECHNOLOGY (CTC) and DEDINI S/A settled a cooperation agreement. Currently, the process design for a commercial unit, based on DHR technology, is prepared and evaluated to plan the next steps of the project. The benchmark to turn this process feasible, is a yield of about 12,000 liters ethanol per ha of integral cane. This will almost double the current yield of 6,400 liters of the traditional process.

In 1997 The COPERSUCAR CENTER OF TECHNOLOGY (CTC) and DEDINI S/A settled a cooperation agreement with the aim of continuing the development of the DEDINI Rapid Hydrolysis Process (DHR) in order to hydrolyze and convert the sugars available in bagasse to ethanol.

Bagasse is the final biomass residue that is available in large amounts, after extracting the sucrose juice of the sugar cane. In its composition, it is similar to hardwoods, being a complex of cellulose, hemicellulose and lignin. Due to this complex structure, sugar units from cellulose are not readily available for fermentation to ethanol or the production of any other chemicals. The process to be developed, deals with the conversion of polymeric carbohydrates of bagasse to pentose and hexose monomers.

The chemical decomposition of highly complex cellulose structures includes several prerequisites, such as appropriate conditions of temperature, pressure and acid concentration. At these extreme conditions, a large quantity of the sugar monomers is destroyed, diminishing the yield of the process.

The DEDINI Rapid Hydrolysis Process (DHR) introduces a solvent in order to dissolve lignin and to change the structure of the cellulose-hemicellulose-lignin complex. The required chemical reactions can then be accomplished at a lower temperature and pressure, while the saccharification reaction is faster and sugar decomposition can be minimized.

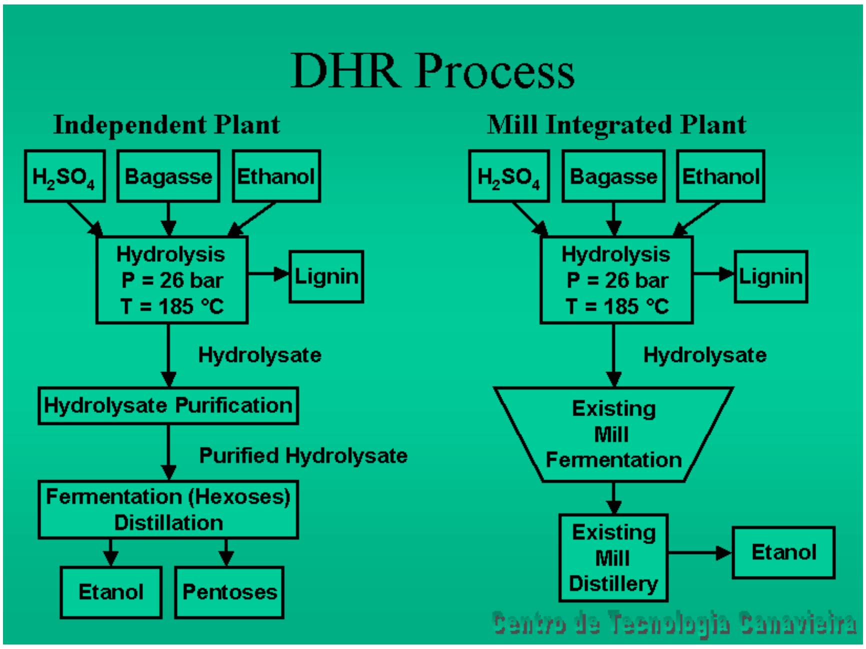
The pilot unit was projected to study and optimize the conditions for the conversion of cellulose and hemicelluloses to low molecular weight sugars (pentoses and hexoses) in order to collect engineering parameters and to determine the technical and economic feasibility of the DHR process.

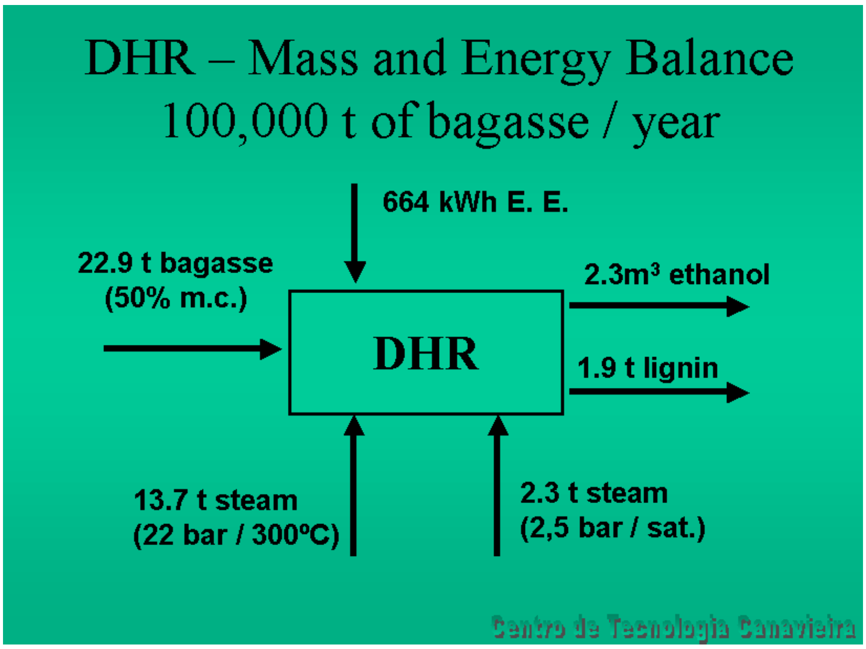
In the pilot unit, raw bagasse is continuously fed into a process reactor where it is treated with sulfuric acid as a catalyst, diluted in a mixture of water and an organic solvent (ethanol). The chemical reaction takes place - lignin is dissolved and hemicellulose as well as cellulose are saccharified. Immediately after the reaction time has elapsed, the liquor is flash-cooled in order to avoid decomposition of reaction products. Furthermore, some by-products are recovered at this stage of the process.

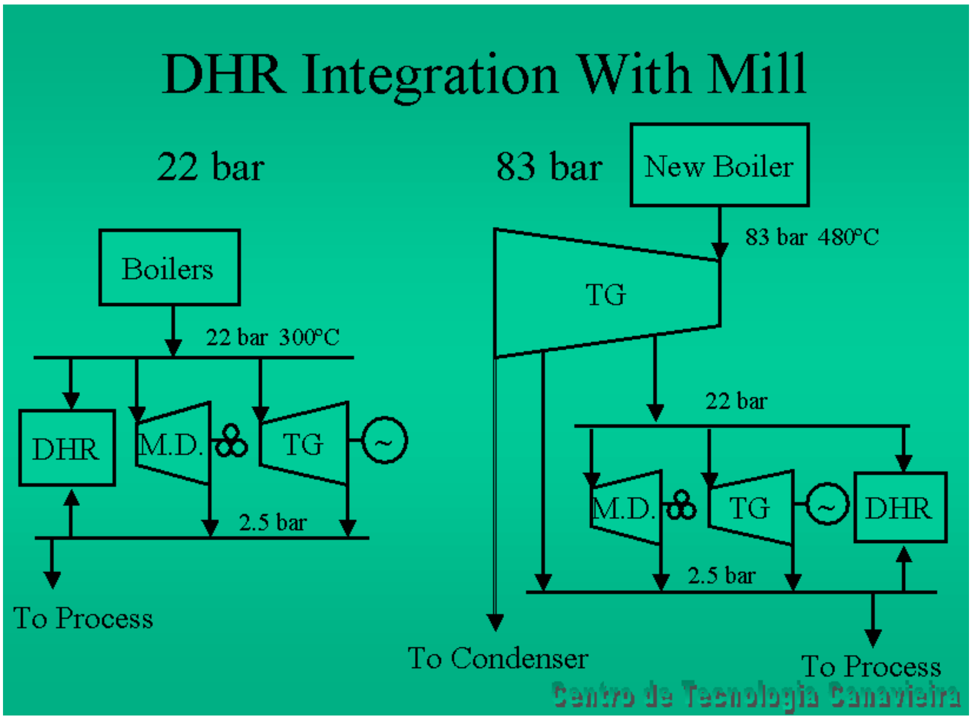
The liquor is fed into a distillation tower where the solvent is removed and returned to the process. The stream of sugar liquors and the lignin are recovered at the bottom of the distillation unit. The collected sugar liquors need to be clarified, concentrated and removed from fermentation inhibitors.

With this final sugar liquor, the conversion of bagasse hexoses to ethanol is accomplished by fermentation, followed by distillation to ethanol. At the first stage of the process, only the hexoses are intended to be fermented to ethanol. Within the second step, the conversion of the pentoses to ethanol (or other chemicals) will be considered. The residual lignin will be burned to sustain the energy demands of the process. Other applications for the lignin will be considered in the future.

The process design for a commercial unit based on DHR technology is currently prepared and evaluated in order to plan the next steps of the project. The benchmark to turn this process feasible, is a yield of about 12,000 liters ethanol per ha of integral cane. This will almost double the current yield of 6,400 liters of the traditional process.







DHR/Mill Integration Alternatives (1)

Alternative	Bagasse surplus (t/year)	Required trash (t/year)	Ethanol produced m^3/year	Electricity surplus MWh/year
22 bar/w.o. DHR	122,000	-	86,000	17,900
22 bar/with DHR	-	4,000	96,000	15,900
83 bar/w.o. DHR	102,000	-	86,000	89,000
83 bar/with DHR(2)	-	18,000	96,000	92,000
83 bar/with DHR(3)	-	-	93,800	92,000

Notes:

1- All cases considers 100% cogeneration mode and operation only during the season

2- Use lignin in boilers plus supplement of trash

3- Without lignin and no trash

Centro de Tecnologia Canavieira

PLANT BIOMASS: THE SUSTAINABLE SOURCE OF ENERGY AND OF INDUSTRIAL ORGANIC CHEMICALS

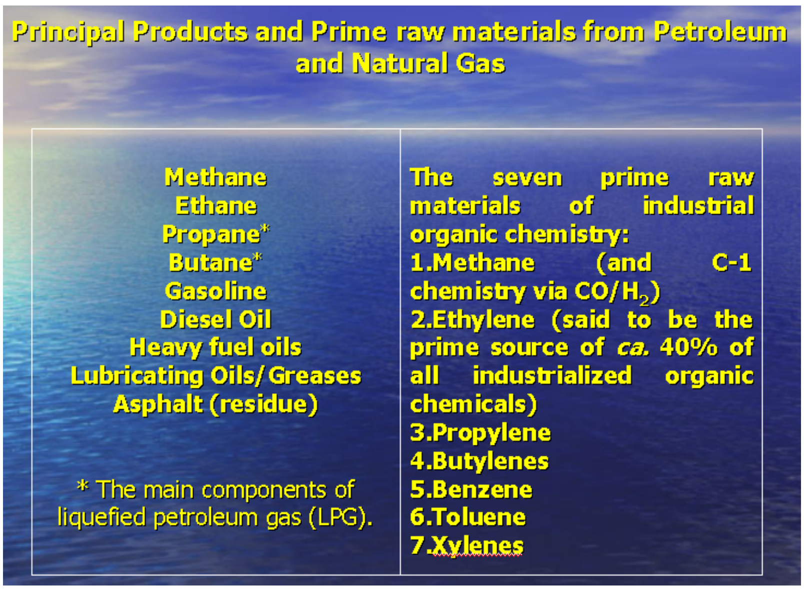
Joseph Miller
Universidade Federal da Paraíba
E-mail: jomiller@ltf.ufpb.br

ABSTRACT:

We have developed efficient economic continuous processes for the dilute acid hydrolysis of the cellulose of plant biomass (ligno-cellulose) to glucose, for fermentation to ethanol; of the hemicellulose to pentoses and associated processes for the conversion of pentoses via furfural to tetrahydrofurfuryl nitrate (THFN) – a safe cheap additive which allows azeotrope ethanol to substitute Diesel fuel. The lignin is converted via lignin coke by reaction with steam to Synthesis Gas for C-1 chemistry, including methanol, whose conversion to aromatics to C-10 is well-known as is the Fischer-Tropsch process to produce liquid fuels which can be cracked, reformed etc.: "Fischer-Tropsch petrochemistry". The aromatics include benzene, toluene and the xylenes while the conversion of ethanol to ethylene, propylene and the butylenes is also well-known. Thus globally the seven prime raw materials of industrial organic chemistry, currently produced from petroleum and natural gas, can be substituted. As a bonus we have shown that the autohydrolysis of plant biomass produces an excellent feed for ruminants.

Keywords: acid hydrolysis; biomass conversion; chemicals from biomass.

We demonstrate in this paper how plant biomass (ligno-cellulose) can provide for a sustainable future without petroleum, natural gas and petrochemistry providing energy and industrial organic chenicals. It is not only a renewable resource but its very growth consumes carbon dioxide – the villain among greenhouse gases – as well as producing oxygen. It has been estimated that the world´s land masses produce annually some one hundred billion tons dry weight of plant biomass. It is convenient now to present in chart form the principal products and prime raw materials currently obtained from petroleum, natural gas and petrochemistry.

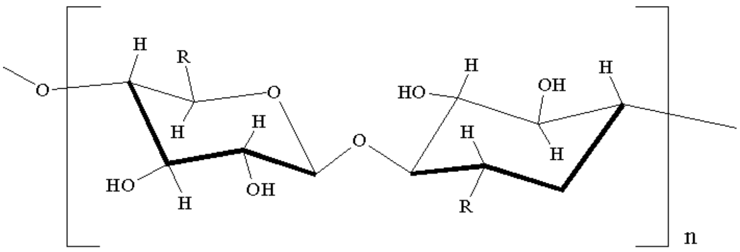


It is convenient to present next some basic data on Plant Biomass [ligno-cellulose] as a % age of dry weight, and structures:

Some basic data on Plant Biomass (as a % age of dry weight)

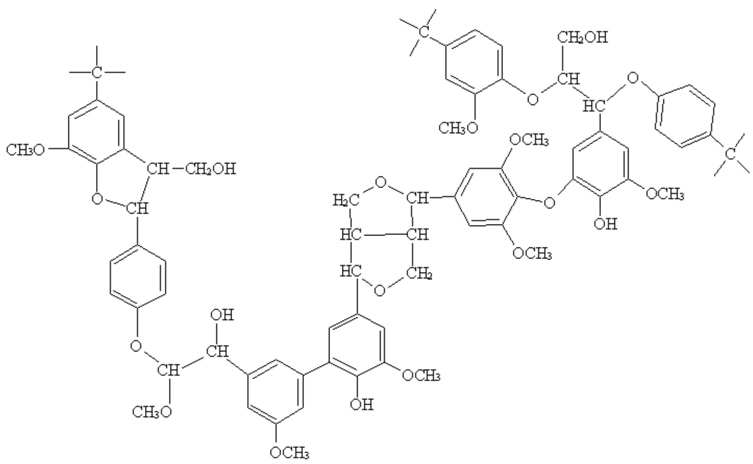
Type / Principal Components	Wood	Agricultural residues
Cellulose	40 – 45	up to 40
Hemicellulose	15 – 30	15 – 26
Lignin	20 – 35	22 – 30
Ash	up to 1	1 - 8

The following generic structure serves for cellulose and hemicellulose.

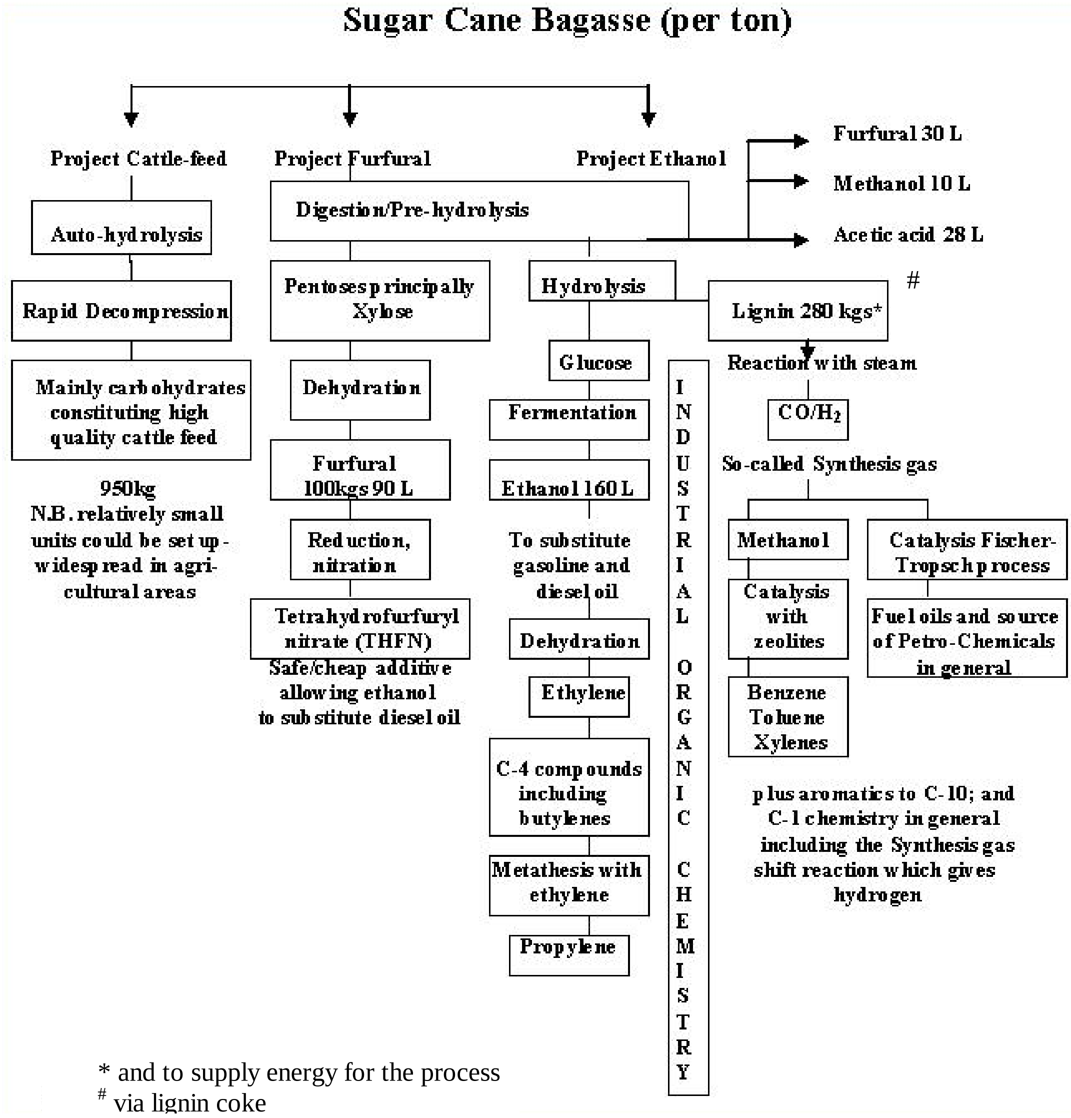


Cellulose R=CH_2OH; Hemicellulose R=H

A part-structure of lignin



The use of lignin is discussed below.
A summary of the principal processes for plant biomass utilization follows-shown for sugar-cane bagasse (an agricultural residue).



Some additional comments are appropriate:

1. Ethanol as its azeotrope with water is a good substitute for gasoline and is so used in Brazil for 1-2 million cars and light vehicles.Ethanol with added THFN (tetrahydrofurfuryl nitrate) serves well as a substitute for ordinary Diesel fuel, proven by extensive road tests. As little as 3-4% THFN seems to be effective. Ordinary Diesel fuel is improved (higher cetane number) by adding THFN. Methanol with added THFN also serves as a substitute for ordinary Diesel fuel.

2. As already emphasized, ethanolic fermentation is a key component in substituting fossil fuels by plant biomass. This is already carried out on an enormous scale in Brazil using sucrose (from sugar-cane) even though batch processes are used: it can just as easily be carried out using glucose. In the long-term continuous ethanolic fermentation will be highly desirable. There is already know-how for this in Brazil and in other countries, so that it should not be too long before large-scale commercial continuous ethanolic fermentation processes are in place.

3. There is no need to restrict ethanolic fermentation to the sole use of Saccharomyces cerevisiaea: research is active in the employment of other micro-organisms.

A bacterium of the Zymomonas genus is especially promising with the advantage of being able to ferment to 18% ethanol. The possibility of continuous fermentation is also being studied.

4. The principal challenge with the ethanol scenario remains the development of energy-sparing processes for separating ethanol from ethanol-water mixtures. The most promising possibilities at present are (a) the use of membrane technology; (b) the use of a low-pressure system with heat exchangers, in which ethanol is continuously pumped off. The development of thermophilic bacteria for ethanolic fermentation may also make a positive contribution to the solution of this problem.

5. What about Lignin? Its key planned use is to convert it to Synthesis gas (CO/H_2).

Thus

$$\text{Lignin coke} + H_2O\,(g) \rightarrow CO + H_2$$

This can be coupled with the Synthesis gas shift reaction to produce more hydrogen:

$$CO + H_2O(g) \rightarrow CO_2 + H_2$$

These are essential for the overall substitution of C-1 chemistry of petrochemistry by plant biomass. It needs to added that the corresponding reactions with

$$\text{Coal/Coke/Lignite} + H_2O(g) \rightarrow CO + H_2$$

would form a key part of a scenario for the interim substitution of Petroleum and Natural gas by Coal and Lignite etc.

6. Our presentation has already illustrated how plant biomass can subtitute petroleum, natural gas and petrochemistry.

To round off the picture it is worth re-emphasizing some recent developments and selecting new developments/perspectives.

1 Large-scale continuous processes of ethanolic fermentation should become commercially available in the not-too-distant future.

2 Use of micro-organisms other than Saccharomyces cerevisiaea for ethanolic fermentation

   - Zymomonas bacteria are very promising candidates
   - possible use of thermophilic bacteria.

3 Development of energy-sparing processes for separating ethanol from ethanol-water mixtures remains something of a challenge, although there are promising developments.

4 Bacterial conversion of glucose to hydrogen (and water). The inventors are studying the possibility of converting cellulose to hydrogen – sometimes referred to as “the Clean fuel” since its combustion forms water.

5 Use of ethanol, methanol and hydrogen in fuel cells is a real possibility.

6 Use of hydrogen for catalytic reduction of carbon dioxide to methanol.

7 Use of methanol and ethanol to produce methyl- and ethyl-tertiary butyl ethers (MTBE and ETBE), especially ETBE, to improve conventional gasoline – higher octane number and less noxious exhaust gases in particular.

8 Aerobic fermentation of sugars to Single Cell Protein (SCP). As example a product with 45-50% protein has been obtained using Torula utilis.

9 Aerobic fermentation of methanol to SCP.

10 Aerobic fermentation of sugars to amino-acids.

11 Aerobic fermentation of glucose using Alcaligenes entrophus to give a stereoregular biodegradable copolymer of □-hydroxybutyric acid and □-hydroxyvaleric acid: HO(CH2)3CO2H and HO(CH2)4CO2H.

12 Anaerobic fermentation of organic residues, including “rubbish”, to methane (so-called Biogas).

13 Well-known fermentation routes to acetic, butyric, citric and lactic acids, to acetone, butanol, butylenes, glycol inter alia.

14 Genetic modification of plants so as to increase the amount of biomass. As example a current study in Brazil is concerned with increasing the biomass produced in Eucalyptus plantations.

15 In those areas where “Biodiesel” is a valid additional option it will be necessary in the future to use methanol and ethanol from biomass.

16 There are many areas of the world unsuitable for commercial crops which could be utilized to produce plant biomass.

17 A key aspect of the utilization of Plant Biomass to substitute petroleum, natural gas and petrochemistry is that its very growth consumes carbon dioxide. This does not diminish the importance of chemical and enzymatic studies specifically directed to recycling carbon dioxide.

18 Auto-hydrolysis of plant biomass produces an excellent feed for ruminants.

References

GEREZ, J.C.C+., GEREZ, M. de C. A. and MILLER, J. Process and Installation for obtaining ethanol by the continuous acid hydrolysis of cellulosic materials. United States Patent. 4529699, Jul. 16, 1985.

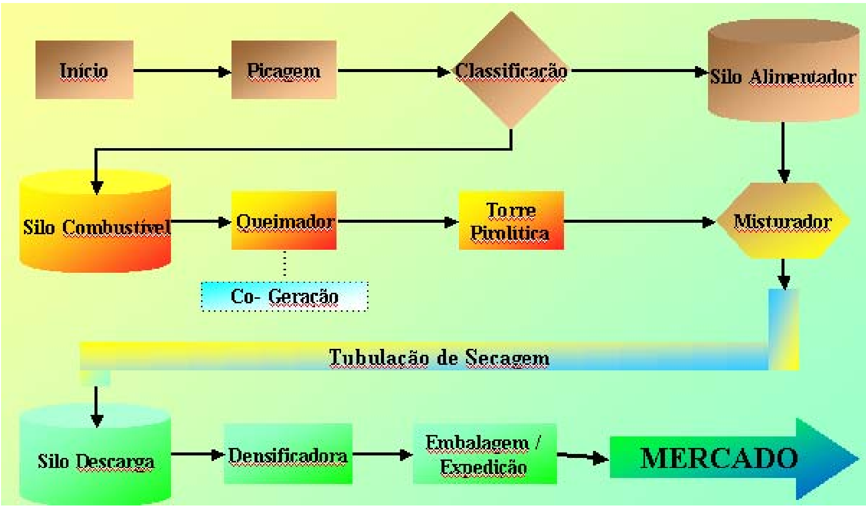
GEREZ, M. do C. A. and MILLER, J. “Biomassa pode substituir Petróleo”. Química Industrial. n. 4, Jun., São Paulo, 1988. pp. 31-33.

Production of Vegetable Coal Using an Innovative Briquetting Process

Mr. Leonardo Nardoto Conde, Bioenergy Brazil
E-mail: bioenergy@escelsanet.com.br

A new briquetting process for the production of vegetable coal was developed by the company Bioenergy Brazil. Starting with the first prototype in 1986, the continuous development of the production process recently led to the innovative briquetting technology that uses a metal container furnace. With this, the durability of the furnace was improved significantly while the production efficiency was increased. Furthermore, the implementation of the container furnace brings better labour conditions for the employees and increases the automation and standardisation compatibility.

The following flow-chart shows the whole production chain from the raw material to the marketing of the vegetable coal briquettes.

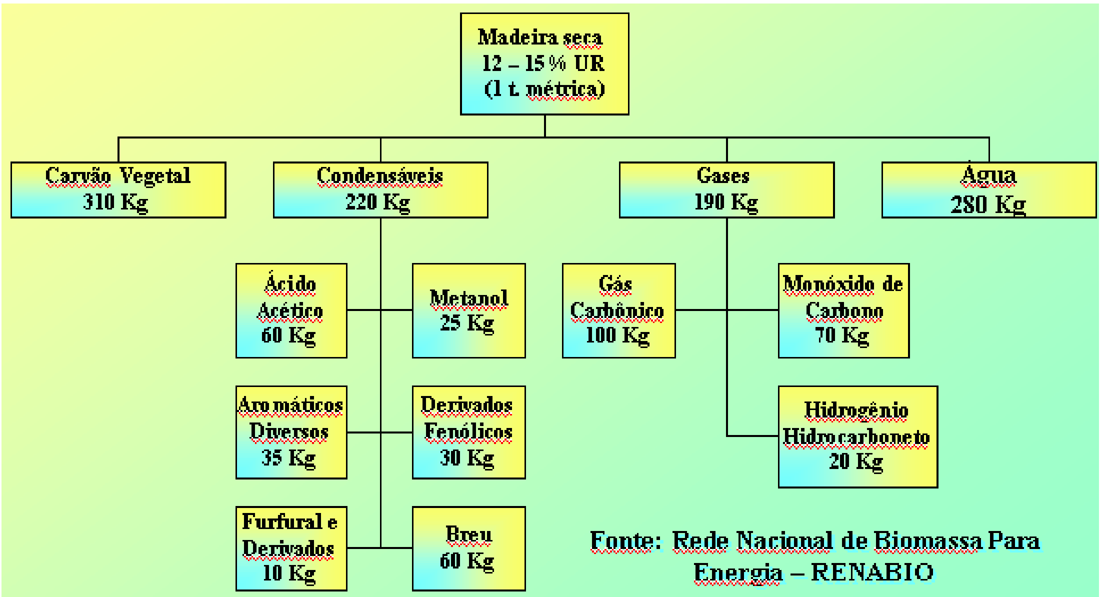


The characteristics of fuelwood and high density biomass (HDB) is shown in the following table. The main benefit of HDB is the halved weight and the very low humidity of 4 percent.

UNIDADE	COMBUSTÍVEL	
	LENHA	HDB
Peso	1.000 Kg	476 Kg
Umidade Relativa	37 %	4%
Densidade	0.4 Kg/ dm3	1.2 Kg/ dm3
Poder Calorífico	1.850 Kcal/ Kg	4.516 Kcal/ Kg
Potencial Calorífico Primário	1.850.000 Kcal/kg	-
Energia Térmica Gasta no Processo	-	(318.471 Kcal)
Energia Elétrica Gasta no Processo	-	850 Kcal/Kwh x 95 Kwh= 80.750 Kcal
Potencial Calorífico Útil	1.850.000 Kcal	2.150.519 - (80.750 +318.471)= 1.751.298 Kcal (-0,53 %)

Compared to fuelwood, the high density biomass contains the same amount of energy, however the needed storage space and the weight can be decreased drastically. The obvious difference is shown in the following figure.

The chemical composition of the output materials



Cane Resources Network for Southern Africa - CARENSA

Frank Rosillo-Calle, Imperial College, London, U.K.
E-mail: f.rosillo-calle@imperial.ac.uk

The CARENSA network has four principal contractors responsible for the network and nine members. The project team was designed to place the key issues in their proper regional and global context, while also promoting north-south and south-south cooperation on cane resource development. There are four European organisations, four African organisations, three international or regional organisations, and two organisations based outside of Africa in the world's two largest cane-producing countries (Brazil and India), as listed below:

- SEI, Stockholm Environment Institute (Coordinator)
- ICL, Imperial College London, Env. Sci. and Tech., London, UK (Principal Contractor)
- UM, University of Mauritius, Chemical and Sugar Eng. Dept. (Principal Contractor)
- UND, University of Natal, Durban, South Africa (Principal Contractor)
- AUA, Agricultural University of Athens, Greece (Member)
- CIRPS, Interuniversity Research Centre on Developing Countries, Italy (Member)
- BUN, Biomass Users Network, Zimbabwe (Member)
- CEEEZ, Centre for Energy, Environment, and Engineering, Zambia (Member)
- ISO, International Sugar Organisation (Member)
- FAO, Food and Agricultural Organisation (FAO), United Nations (Member)
- WII, Winrock International India (Member)
- CENBIO, National Reference Centre for Biomass, Brazil (Member)
- SADC, Southern African Development Community (Member)

CARENSA has thirteen partner organisations around the world as well as many associates and interested subscribers. In this issue, we provide a concise review of some of the research and analysis undertaken in recent months and present recent developments that may impact future opportunities for developing cane resources in southern Africa as well as internationally. The first article considers some of the climatic, agronomic, and economic issues regarding the role of sweet sorghum as an alternative feedstock in southern Africa. The second article reviews the global outlook for ethanol production and markets. The third article considers the impacts of ongoing sugar policy reforms on future bioenergy developments, in terms of the incentives for product diversification within the sugar industry. The fourth article outlines a general methodological framework for evaluating how expanded production and markets for sugarcane co-products can contribute to sustainable development. The newsletter also includes a roundup of relevant recent and future activities. If you have comments and/or wish to receive future newsletters, please let us know by sending e-mail with your full contact details to info@carensa.net and also visit our website at www.carensa.net.

World Ethanol Production and Outlook

Frank Rosillo-Calle, Imperial College, London, U.K.
E-mail: f.rosillo-calle@imperial.ac.uk

World ethanol production has increased annually for the past several years (Table 1). Almost 38 billion litres were produced in 2003 and production is forecast to exceed 40 billion litres in 2004. By the end of the decade, over 60 billion litres of ethanol could be produced annually. The key players continue to be Brazil and the United States, both of which have nationwide ethanol programmes. In addition, new and potentially large markets are beginning to emerge including the European Union, China, India and Thailand. Ethanol is used in beverages, industry, and as fuel.

Table 1. World Ethanol Production

Country/Region	2004	2003	2002	2001	2000
Europe	4,06	3,90	3,86	3,77	3,54
- EU-15	2,71	2,58	2,53	2,54	2,40
America	30,36	26,37	22,10	19,54	18,13
- Brazil	15,33	14,43	12,62	11,50	10,61
- United States	13,95	10,90	8,43	6,96	6,47
Asia	7,00	6,56	6,02	5,89	5,74
Oceania	1,71	1,65	1,60	1,80	1,48
Africa	6,42	6,23	5,79	5,50	5,37
- South African CU	4,10	4,04	4,03	3,99	3,95
World Total	**42,24**	**37,63**	**32,71**	**29,93**	**28,09**

The largest driver of increased demand for ethanol is a worldwide interest in ethanol fuel as a substitute for petrol in the transportation sector. Brazil was the first country to introduce ethanol fuel on a large scale in the 1970s in response to the world oil crises. More recently, many countries have already introduced, or are planning to introduce, ethanol fuel programmes, including Australia, Canada, Colombia, China, India, Mexico and Thailand. Most of these ethanol fuel programmes are characterized by ethanol and gasoline blending targets to be achieved in the near term (by around 2010). Ethanol fuel use is motivated by different factors in every country, but common concerns include:

- The Environment – Concern with clean air and greenhouse gas reductions are social and political priorities around the world;
- Energy Security – Increasing dependency on imported energy supply is a concern, especially in Europe and the United States;
- Social and Economic Development – Many countries regard alternative fuels as an effective tool for socio-economic development, particularly in rural areas.

For all of these reasons, many governments support renewable transport fuel (RTF) programmes through legislation and tax incentives. Support measures can take many forms including, among others, fiscal incentives, tax rebates on vehicles with low emissions and support for research and development. Valuable examples of legislation used to promote the development of ethanol fuels can be found in the EU and the United States. The EU Commission's Green Paper: Towards an European Strategy for the Security of Energy Supply [COM (2000) 547] introduced the objective to substitute 20% alternative fuels in the transport sector by 2020. More specific legislation has furthered EU progress towards this goal. A Promotional Directive (Directive 2003/30/EC) allows Member States (MS) to set national indicative targets for alternative fuel ratios, though a reference value is set at 2% of all transport fuels by 2005 and 5,75% of all fuels by 2010. A second Directive on Taxation of

Energy Products (Directive 2003/96/EC) provides for the exemption or reduction of excise duties on fuels from renewable sources. The most important legislation to promote renewable fuels in the US includes: The Alternative Motor Fuels Act of 1988 (AMFA) which created incentives for the production of vehicles designed to operate on any combination of fuel alcohol and gasoline; The ban placed on MTBE2 by California and other states; and The Clean Cities Program (CCP) which was designed to encourage communities to coordinate the voluntary acquisition of alternative fuel vehicles (AFVs). These and any other ethanol fuel programmes must have in place several key elements to ensure their success including:

- A regulatory fiscal and policy framework
- Availability of feedstock, at reasonable costs
- Availability of ethanol and ETBE production capacity
- Awareness and general support among the general population
- Interest on the part of policy makers
- Consensus between and among allied industries and policymakers

The emergence of fuel ethanol programs will provide for new markets to drive the continued expansion of fuel ethanol production. The EU market, for example, could represent between 8,4 and 14,0 billion litres per year by 2010. This market is of significance to ethanol fuel producers in developing nations as the EU does not have the domestic capacity to produce ethanol in large enough quantities to meet Kyoto targets for CO2 emissions reductions without reverting to carbon trading or large-scale ethanol imports.

The future expansion of ethanol production will largely depend on the liberalisation of the international market. Currently, a major shortcoming of the industry is that ethanol fuel is not an internationally traded commodity. Only about 3 billion of the almost 40 billion litres produced each year are traded. The rest is consumed internally. This acts as a barrier to further expansion of ethanol fuel programmes since demand remains too inelastic to encourage further production. This will not change significantly until ethanol markets are liberalised and barriers-to-trade removed.

Technology issues must also be addressed to fully understand the implications of world ethanol markets on sugar producers in new potential markets such as Southern Africa. The transfer of technologies from experienced ethanol producers in Brazil and elsewhere should be encouraged when domestically available technology is not sufficient to produce cost competitive ethanol. There is a need for further research into emerging technologies like the hydrolysis of bagasse to fermentable sugars and the extraction of ethanol from cane leaves. Although sugarcane will remain the lowest cost feedstock in the near-term, alternative feedstocks (maize, sweet sorghum, and cassava) should also be considered.

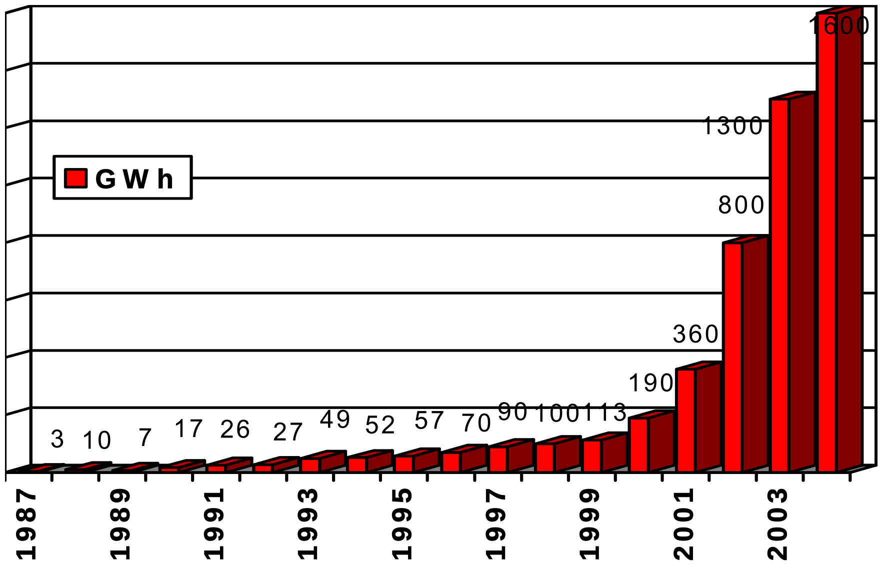
Finally, government policies regarding ethanol in Southern Africa have thus far not been coordinated through the regional economic trading bloc – the Southern African Development Community (SADC). Harmonizing the demand, supply, and transportation with policy goals for the region, with respect to the development of fuel ethanol industries and markets, could be achieved through more effective and targeted legislation.

Ethanol production is likely to continue to increase in the next decade. Developed countries, with strong ethanol fuel programmes already in place, will continue to consume increasing amounts of ethanol fuels. The introduction of flexfuel vehicles and more aggressive fuel blending schemes will also increase the demand for ethanol. The extent to which increased ethanol is supplied by developing countries, however, will depend largely on technology and policy developments that will allow for more complete utilization of sugarcane and other biomass resources.

Electricity from Small Producers

Mr. Marcos R. Escobar
Co. Paulista de Força e Luz – CPFL Energia
E-mail: marcosescobar@cpfl.com.br - www.cpfl.com.br

CPFL Energia is a Brazilian energy company that has a market share of 12 percent, about 5.5 million clients and 4,000 employees. The company's overall capacity of 812 MW in 2002 is planned to be increased to 1,989 MW in 2009. Energy production from biomass has been increased steadily and reached a total of 1,600 GWh in 2004. Within this, CPFL Energia strongly promotes co-generation units as an efficient energy back-up for the Brazilian energy matrix. The following graph shows the development of energy production from biomass in Brazil.



The Programme for Alternative Electric Energy Sources (PROINFA)

The Brazilian Alternative Energy Sources Incentive Programme (Programa de Incentivo às Fontes Alternativas de Energia Elétrica - PROINFA) was created by Law 10,438 of April 26, 2002. Its objective is to increase the share of Brazil's electricity generation capacity represented by wind, small-scale hydro, and biomass. Within this programme, which will be implemented in two phases, the electricity has to be produced by Autonomous Independent Producers (Productores Independentes Autônomos - PIAs). Due to Law 10,438 PIAs comprise electric power producers, which are not controlled by or associated with any generation, transmission of distribution concessionaire.

The long-term goal of PROINFA is to increase the contribution of renewable energy to 10 percent of the annual electricity consumption within the next 20 years. Therefore, the Government of Brazil has obligated the federal state-owned power utility Eletrobras (Centrais Elétricas Brasileiras S.A.) to purchase the electric energy by signing long-term power purchase agreements (PPAs) with renewable energy facilities.

In order to identify suitable renewable energy projects, Eletrobras will award projects with Environmental Installation Licenses (LIs) and Environmental Previous Licences (LPs). Generally, LI-awarded projects will have the priority of implementation. If the total capacity exceeds the planned amount to be contracted by Eletrobras, projects with a shorter licence remaining term will be pre-drawn.

In the first phase, Eletrobras is to sign 15-year contracts for the implementation of 3,300 MW of renewable energy sources by April 29, 2004. The first phase of PROINFA is to add 1,100 MW of wind energy (2.89 TWh/year), 1,100 MW of Small Hydro Plants (SHPs) (5.78 TWh/year) and 1,100 MW of Bioenergy Plants (6.75 TWh/year). Phase 2 is to add 6,518 MW of wind energy (17.13 TWh/year), 6,518 MW of SHPs (34.26 TWh/year) and 6,518 MW of Bioenergy Plants (39.97 TWh/year). The contracted projects are scheduled to begin operation by December 30, 2006. The power purchase agreements will cover each of the above mentioned renewable energy sources. The price is going to be adjusted to the specific economic value and will account for at least 80 percent of the average energy supply tariff charged from end-consumers in Brazil.

The second phase of PROINFA will start immediately after the initial target of 3,300 MW is achieved (foreseen in 2006) and should increase the contribution of renewable energy by 15 percent annually, until it reaches 10 percent of the total electric energy consumption. The PPAs will also have a validity of 15 years and the purchase price, will correspond to the economic value. This price is to be defined as the weighted average cost of electricity, generated by hydropower plants with a capacity of more than 30 MW, and natural gas fuelled power plants. The following table shows the foreseen purchase prices that are paid for the generated electricity.

Type of Energy Source	**R$ / MWh**	**~ € /MWh** (1€=3.85R$)
Small Hydro	117.02	30.39
Wind (operational factor < 32.4%)	204.35	53.07
Wind (operational factor > 41.9%)	180.18	46.80
Wind (32.4% < op. factor < 41.9%)	204.35 – 180.18	53.07 – 46.80
Sugar cane	93.77	24.36
Rice Husks	103.20	26.80
Firewood	101.35	26.32
Biogas	169.08	43.92

Renewable energy generators will be entitled to receive a supplemental credit that will be disbursed monthly with funds from the Energy Development Account (Conta de Desenvolvimento Energético - CDE). The CDE will be funded with annual payments from the electricity generation concessionaires, the administrative fines imposed by the Brazilian Electricity Regulatory Agency (Agência Nacional de Energia Elétrica – ANEEL), as well as the annual fees paid by electricity retailers. The supplemental credit paid to renewable energy generators is foreseen to cover the difference between the economic value of the relevant renewable energy source and the competitive value, paid by Eletrobras.

Besides the creation of PROINFA and the CDE, Law 10,438 has created further benefits for renewable energy. Thus, renewable energy projects are entitled to receive a discount on transmission and distribution fees. The discount will be determined by ANEEL and must not be less than 50 percent. Another benefit for renewable energy producers is, that they are entitled to sell electric energy directly to end-consumers.

Regarding the future development and expansion of Brazil's renewable energy sector, the PROINFA is a promising programme. In order to bring it to success, it is necessary to ensure regulatory stability within the issues of financing, pricing and security of supply. Furthermore, the public acceptability, as well as economic and financial viability of the involved renewable energy sectors are prerequisites for success. As the PROINFA is currently at the initial stage, it is hard to make early valuations about its future influence on renewable energy in Brazil. However it is clear, that the introduction of PROINFA can be seen as a further, ambitious step to the promotion of renewable energy within the future energy supply.

Biomass-to-energy Projects: The case of Bioware a spin-off company

Dr. José Dilcio Rocha, Bioware Brazil
E-mail: jdr@bioware.com.br - www.bioware.com.br

Bioware deals with the energetic use of biomass residues. The company´s aim is to produce energy, fuels and renewable goods of a high aggregate value and ecologically friendly by employing modern and efficient thermoconversion technologies. Bioware develops biomass conversion systems and carries out projects of implementation for new process technologies and industrial plants to improve their efficiency. Furthermore the company offers training courses and consulting services in different fields related to the subject. During the last ten years, the company has been engaged in R&D in the biomass thermoconversion field, focusing on the combustion, gasification and pyrolysis processes. The Bioware management facility is established at INCAMP, Incubator of Companies on a Technological Basis from the State University of Campinas (UNICAMP).

The bubbling fluid bed technology used in the sugar cane bagasse and trash, rice and coffee husk, and elephant grass thermoconversion has been optimized and its patent has been petitioned. In Brazil, the company has pioneered the application of the fast pyrolysis process in reactors of bubbling fluid bed to produce bio-oil and charcoal powder. Bioware is active in many industry segments such as chemical, petrochemical, energy, sugar and alcohol forestry and organic waste recycling, currently seeking new technologies and raw materials to increase their productivity and profitability.

Fast Pyrolysis Demonstration Plant for Biomass Conversion

Dr. JoséDilcio Rocha, Bioware Brazil
E-mail: jdr@bioware.com.br - www.bioware.com.br

Abstract

The first facility using fast pyrolysis principle in Brazil is described here. The country has a long time experience in wood carbonisation and is the biggest charcoal producer in the world with an annual production of 12 million tonnes produced in traditional mansory kilns. The demonstration fast pyrolysis plant to biomass conversion is located at the *Centro de Tecnologia Copersucar* (CTC) in the city of *Piracicaba*, *São Paulo* state. It was built as part of a *Unicamp-CTC-IPT* joint-research project. The reactor is a fluidised bed 5 m length and 0.417 m as internal diameter. It is continuously fed by a conveyor belt that fills the hopper inside which a screw conveyor carries the biomass to the reactor. There is a cyclone system to charcoal recovering connected to the top of the reactor and a bio-oil recovering system connected to last cyclone. The temperature operation is in the range of 450-500ºC. Running tests, product quality and yield analyses, preliminary economic assessment, and computer simulation results are reported here.

Introduction

The 6.4 million tonnes per year Brazilian lump charcoal production is mainly used in the industrial sector to reduce iron ore and for barbecues. Slow pyrolysis is spread nation-wide. Its average yield is 25% wt based on raw feedstock. Currently, the tar is not condensed during slow carbonisation. Just a small quantity of the volatile matter produced during wood carbonisation is recovered and processed to give some fractions [1, 2].

The carbonisation technology used in Brazil is very traditional. The mansory kilns are the only commercial technology available due its low capital cost. In the form of summit the cheapest and more rudimentary kind of brick kilns found in rural areas near the firewood source produce 70% of all charcoal in the country. Their productivity is of 14 tonnes of charcoal per month and yields range from 28 to 33% is dry basis related to wood. They are easy to build and take to pieces and therefore easy to transport and rebuild somewhere. These kilns are built with bricks and mud. Cylindrical kilns are bigger and more detailed than summit kilns. They are equipped with an underground ignition chamber, 20% of all charcoal in Brazil are made in these types of kilns. With a 40 tonnes of charcoal per month capacity, they yield from 28 to 35% in dry basis. The biggest model of kilns to charcoal production in Brazil is the rectangular kilns. They have mechanised loading and unloading processes. The rectangular kilns capacity is 100 tonnes per month and they yield from 35 to 37% in dry basis. Vapour recovering systems are possible in rectangular kilns to produce from 15 to 50 kg of tar per month. Rectangular kilns without tar recovering represent 8% and rectangular kilns with tar recovering only 2% of the national charcoal production respectively [3, 4].

Fast pyrolysis is a novel concept to transform biomass into bio-oil. As a process, it is the opposite of the ancient slow pyrolysis or carbonisation. Short residence time for vapours is required in fast process to yield up to 75% in liquids. To produce and process such liquids a kind of bio-refinery is necessary. Bio-oil can substitute fuel oil in electricity generation or heating systems and be a source of chemical. Fast pyrolysis reactor is a central technology that needs to be developed to start thinking about a bio-refinery plant [5].

Bio-oil has a potential use as petrochemical phenol replacement in PF resins. Brazil spends 50,000 tonnes of phenol to produce 90,000 tonnes per year of phenolic resins. Bio-oil can replace about 50 wt. of the phenol in this application. The fine charcoal will be tested in iron ore pelletization to produce a sort of pre-reduced pellets. As a by-product, the gas (about 10% wt) will be burnt *in situ* to supply additional heat to the process [6].

The fast pyrolysis plant is able to process all kind of finely divided biomass. Nowadays, the demonstration plant uses elephant grass from experimental crops and sugar cane bagasse from industrial mills. Raw material availability and costs are being investigated for Brazil. Other biomass such as forestry residues, rice husk, coconut shells, and coffee hulls are also available to be processed through this technology. The pyrolysis gases are burnt in a flare but it is intended to supply the heat process requirements in the future [7].

Experimental Part

The first large-scale experience in fast pyrolysis technology in Brazil is the Unicamp/Copersucar reactor. The facility is located at the Centro de Tecnologia Copersucar (CTC) in Piracicaba, State of São Paulo. It is a 417 mm internal diameter fluidised bed reactor with 100 kg/h nominal capacity. It is ready to pyrolyse sugar cane bagasse, grass, and all kind of dispersed biomass. Air is the fluidised gas and about 10% of the biomass is burnt to generate the process heat during pyrolysis. Pyrolysis gas represents 10-12% wt of the feedstock and will be an additional source of heat.

Results

Biomass fast pyrolysis produces 3 products such as bio-oil, charcoal and gas. In this stage when the reactor hydrodynamics has been tested only powder charcoal has been recovered. All gas and vapour (volatile) have been burned in the flare. The physical-chemical properties for charcoal are recorded in Table 1. They are correlated to the operational conditions. Figure 1 shows the distribution function curve for elephant grass charcoal.

TABLE 1
THE ELEPHANT GRASS CHARCOAL YIELD AND PROPERTIES

Biomass and process conditions			Charcoal Properties							
Particle size, mm (higher retention range)	Moisture % (wb)	Process temperature, °C	Yield, % (db)	Ash, % (db)	Fixed C., % (db)	C %	H %	N %	O %	HHV, MJ/kg
2-4	10-12	450-500	10-15	30-35	40-45	50-55	1-2	1-1,5	41-43	20-25

The elephant grass charcoal has high ash content due its high ash content in the raw material (11 wt% db). Its high volatile content is related to low residence time for solids. Charcoal particles from both sample points present different particle size as shown in Figure 1. The cyclone efficiency is low for smaller particles. Most of charcoal elutriated particles from the reactor has average diameter smaller than 149 μm.

Preliminary tests carried out in the demonstration plant in a broad temperature range allowed to verify the charcoal yield variation tendency *versus* the average bed temperature. Such a behaviour is shown in Figure 2. Three different regions are found. The first one where the temperature is as low as 450-550°C yield high charcoal quantity elutriated from the reactor due low devolatilization rates and low carbon conversion. These charcoal volatile content is very high although its residence time is high.

Figure 1: Distribution function curve for elephant grass charcoal

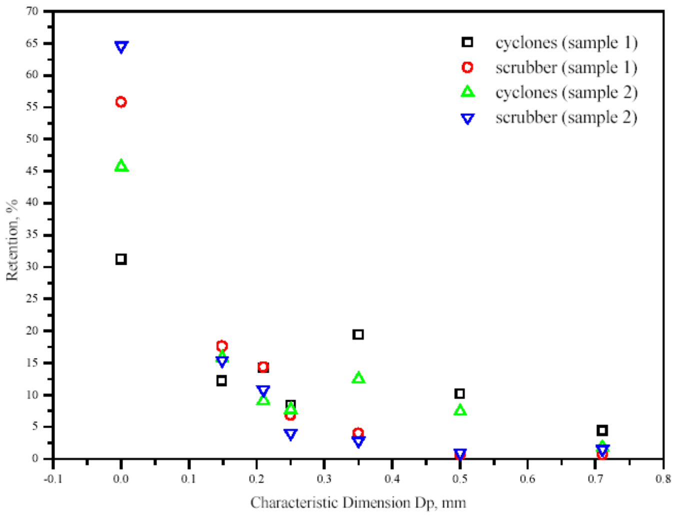
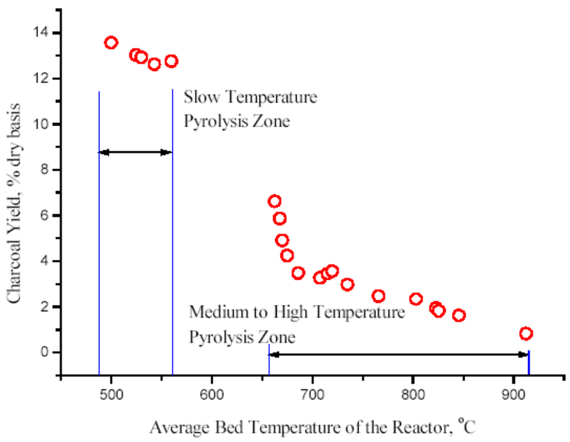


Figure 2: Charcoal yield variation versus average temperature in the fluidised bed



The second region presented moderate temperatures in the range of 550 to 650oC when bio-oil is produced. The typical fine charcoal yields in this kind of technology have a maximum of 10% (db), from 15-20% for gases and vapour, and 70-75% liquids (organic plus water in db). In the third region the fast pyrolysis happens at high temperatures. This process is more like a gasification than a pyrolysis. The charcoal yields are very low, high ash content and low volatile. High yield of fuel gas is produced. The pyrolysis vapour is highly cracked due high temperatures and charcoal particles are quickly devolatiled and converted. The solid and gas residence times are the lowest. From these results it is clear that higher efficient separation systems are needed in this reactor to guarantee the bio-oil quality in terms of solid content.

Conclusion

As a new technology concept fast pyrolysis is appropriated to Brazil due to biomass availability and pricing. Fluidised bed reactors are relatively easy to operate, stable under pyrolysis conditions, and they are able to give high bio-oil yields. The technology allows using the gas in the process as additional source of heat. The charcoal in fine powder is also recovered and can be used in agriculture, iron ore pre-reduction, briquetting, or burned as fossil fuel substitutes. Such an integral and high efficient use is the most environmentally friendly application for biomass.

Acknowledgements

The authors thank FAPESP – the São Paulo State Research Foundation (Grants No. 01/08152-7 and 01/10841-5) and FINEP (Biomass Integrated Project - PIB) for the financial support.

References

1. F. Rossillo-Calle *et al*. (1996) The Charcoal Dilemma, Finding a sustainable solution for Brazilian Industry, Intermediate Technology Publications, London.
2. BEB, Brazilian Energy Balance (2001), Ministério de Minas e Energia, available for download at http://www.mme.gov.br/sen/ben/ben.html.
3. Rossillo-Calle, F., Bajay, S.V., Hothman, H. (eds) (2000) Industrial Uses of Biomass Energy, The Example of Brazil. Taylor & Francis, London.
4. Pinheiro, P.C.C., Sampaio, R.R., Resende, M.E.A., (2001) Fundamentos e prática da carbonização da biomassa. Belo Horizonte, Brazil, 120p. (in Portuguese).
5. Bridgwater, A. V. *et al. (eds),* (1999) Fast Pyrolysis of Biomass: A Handbook, CPL Press, London.
6. ABIQUIM, (1999) Statistical Yearbook of the Brazilian Chemical Industry, Associação Brasileira da Indústria Química.
7. Gomez, E. O., Cortez, L.A.B., Seye, O., Mesa, J. M.M., Rosillo-Calle, F. (2000) In: 1st World Conference on Biomass for Energy and Industry, Seville, Spain, v. II. p.1807-1810.

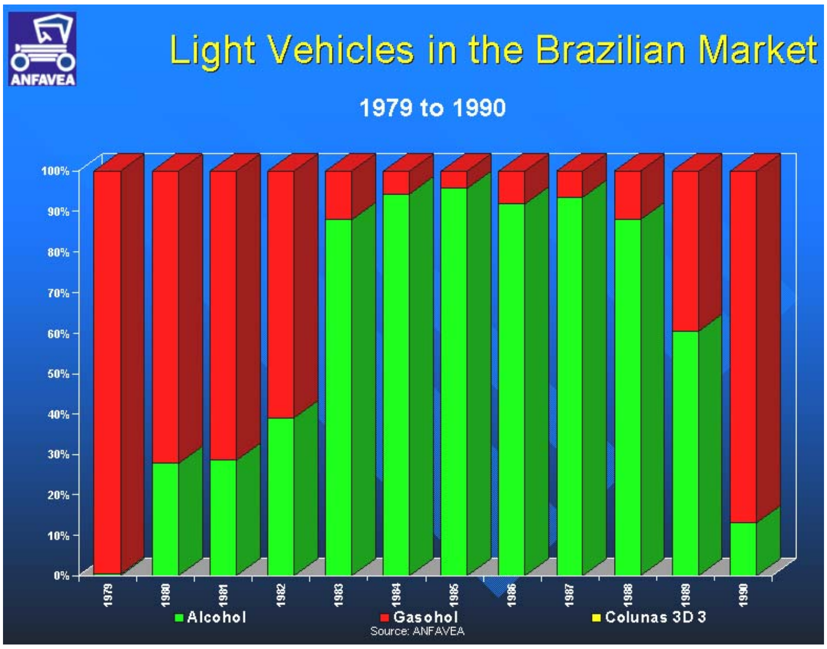
Future Perspectives of Flexfuel Vehicles in Brazil

Mr. Henry Joseph Junior
Brazilian Automobile Manufacturers Association – ANFAVEA, Brazil
E-mail: anfavea@anfavea.com.br - www.anfavea.com.br

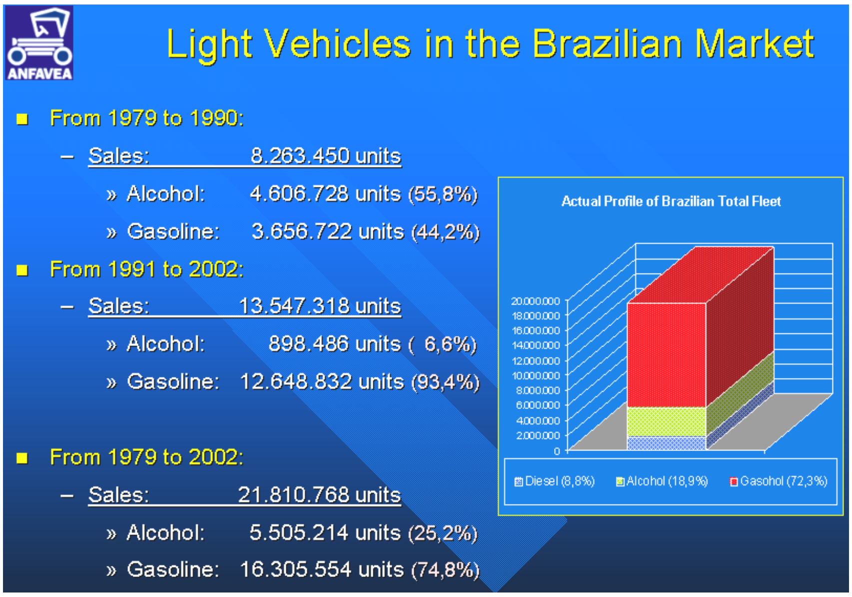
Adopted by the Brazilian government in 1975, the PROALCOOL programme was the nations response to the international oil crisis. The programme aimed at the introduction of gasohol (blend of gasoline with ethanol) to the Brazilian market and the incentive to develop pure ethanol fueled vehicles.

In order to support the alcohol program, in 1976 the vehicle manufacturers and the Brazilian Government have signed an "Memorandum of Understanding" to produce ethanol fueled cars. Due to the fact that at this time there was not enough international experience available on ethanol fuel, the manufacturers decided to develop ethanol vehicles in Brazil. The first alcohol car prototype was tested in 1977, while in 1979 the first alcohol model vehicle was sold.

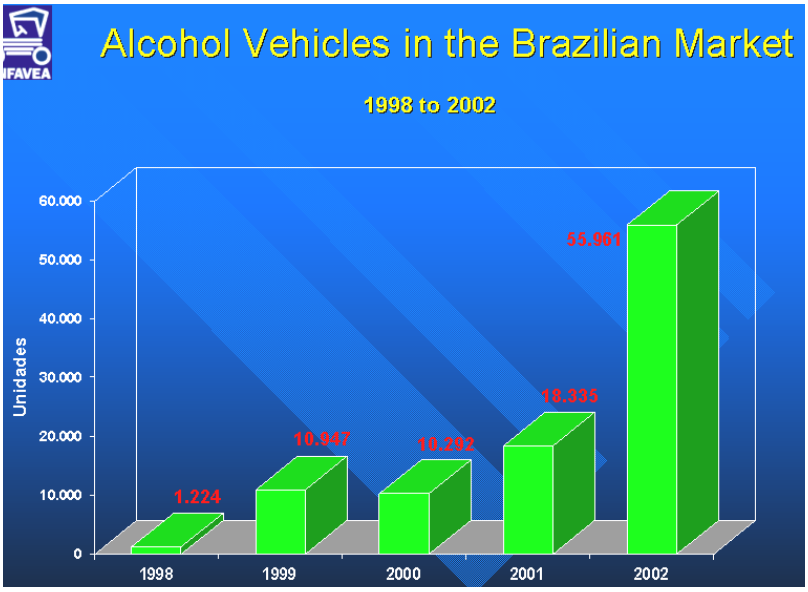
In 1978, the Brazilian Government adopted some financial measures to provide incentives for the use of ethanol fuel to customers. This measures included a guarantee for ethanol fuel prices (≤ 65% of gasoline price), a five percent tax reduction for alcohol fueled vehicles, subsidized loans for ethanol producers in order to improve capacity, compulsory sales of ethanol at fuel stations and governmental control of ethanol fuel stocks to guarantee the supply and price.



Due to economical difficulties at the end of 80's the government started to remove the ethanol fuel subsides and the price became comparable to the gasoline price. The official loans to producers were drastically reduced and the international sugar price increased. Many alcohol producers decided to make sugar instead of ethanol, causing an alcohol supply shortage. Therefore, the ethanol reserves were quickly drained off and the sales of new alcohol fueled vehicles fell and the retail value of the used alcohol cars became very low.

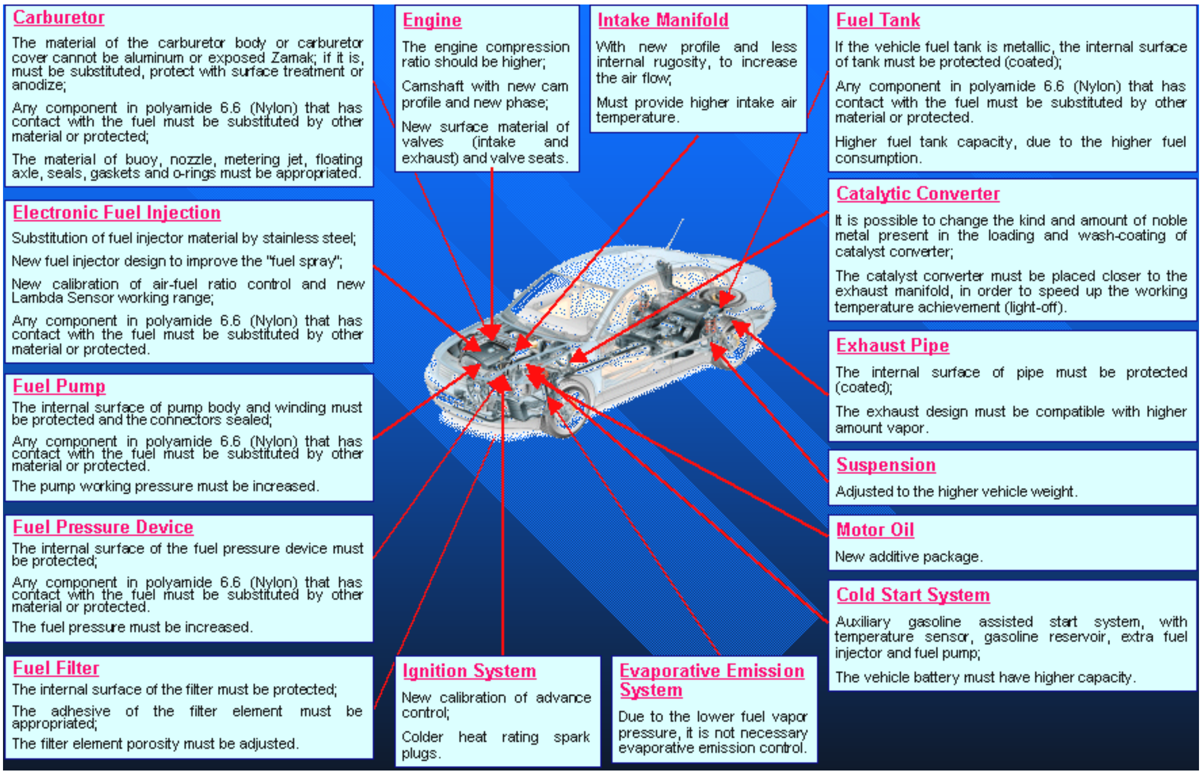


In the 2nd half of the 90's the ethanol supply stabilized at low levels (½ of gasoline price). The Brazilian automobile industry continued to offer alcohol cars and the international press started to valorize renewable fuels. The climatic change became a matter of big concern and the Kyoto Protocol was issued. That circumstances led to the publication of many papers regarding the environmental advantages of ethanol. At the end of the 90's the sales of alcohol vehicles began to rise again.

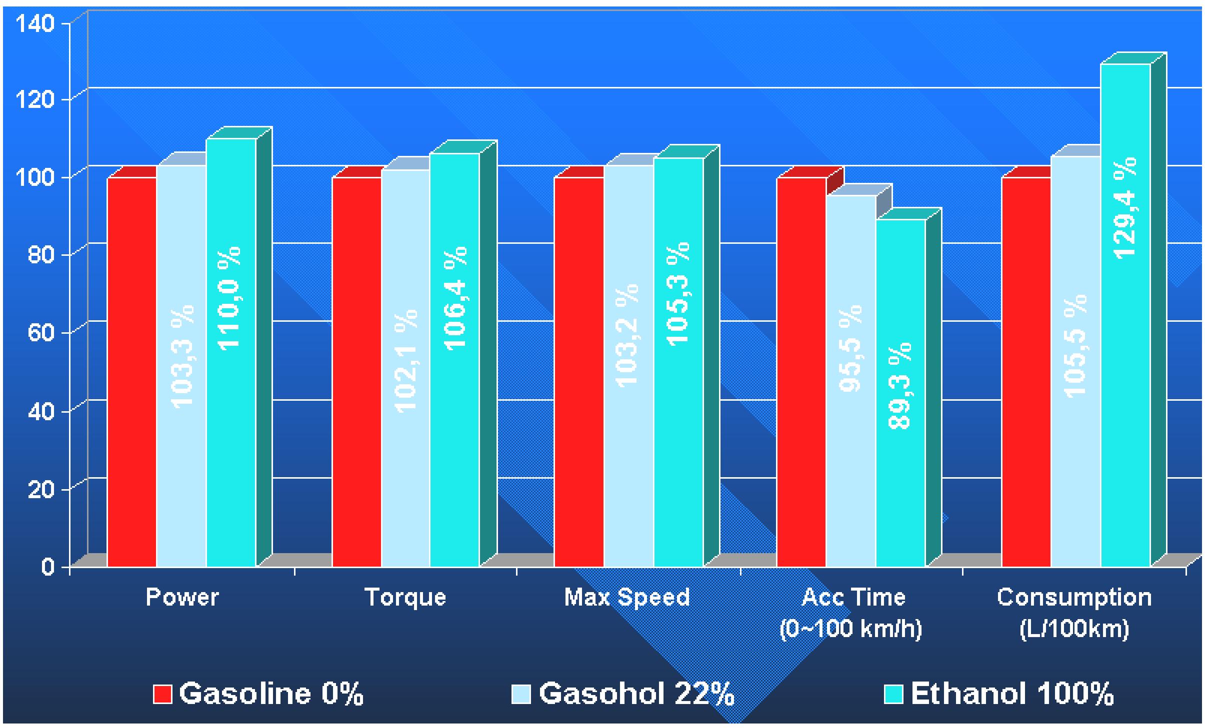


In 2003 the first Flexfuel Vehicles were introduced to the Brazilian market. Since that time, the new transport technology is spreading throughout the Brazilian automobile industry. It is the dual fuel engine, powered with gasoline and/or alcohol, giving the consumer total liberty in choosing one of the fuels, or mixing them in any proportion. By today the manufacturers Volkswagen, Ford, Fiat, GM etc. have introduced 19 car models on the Brazilian market. It is expected that around 600.000 or 30% of the car sales in Brazil during 2004 will be Flexfuel cars. By the end of 2007 even 67% of the overall car sales are believed to be equipped with the Flexfuel technology.

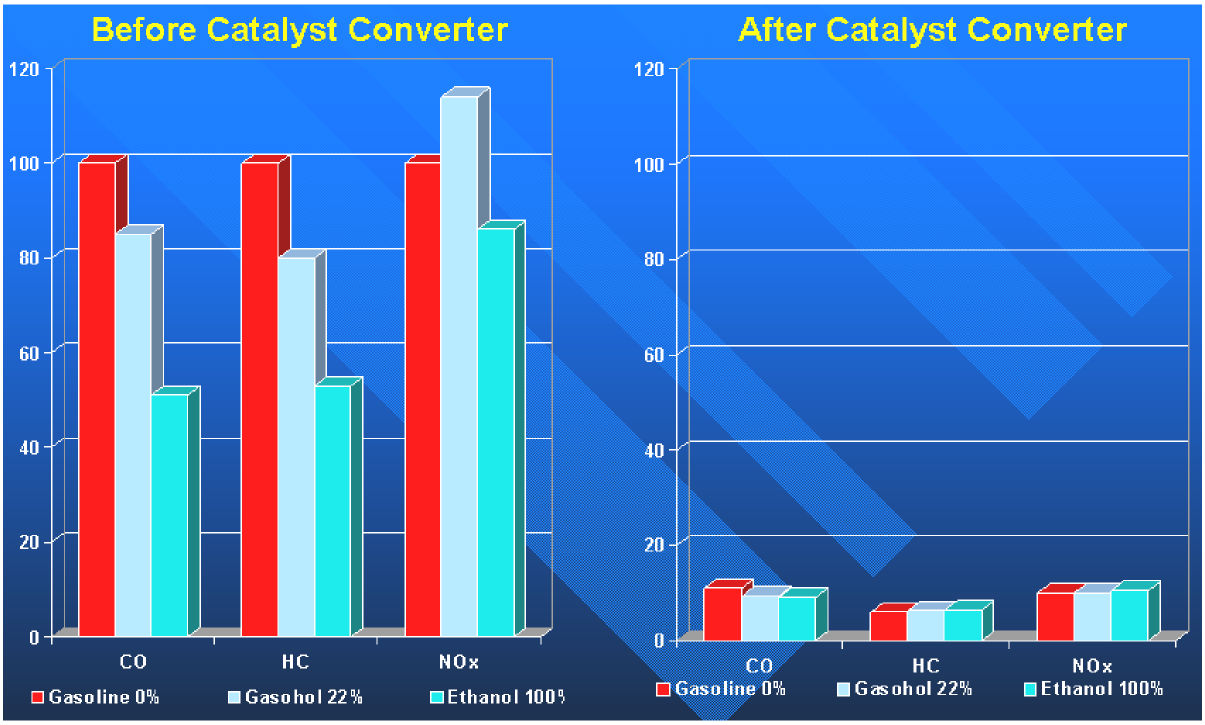
The introduction of Flexfuel technology requires several modifications of the engine. This is due to the corrosion of metallic materials, the chemical attack to the plastic materials and the low molecular energy content. Furthermore, the different air / fuel ratio for combustion and the low vapor pressure need to be taken care of. The following diagram shows the necessary modifications for Flexfuel vehicles.



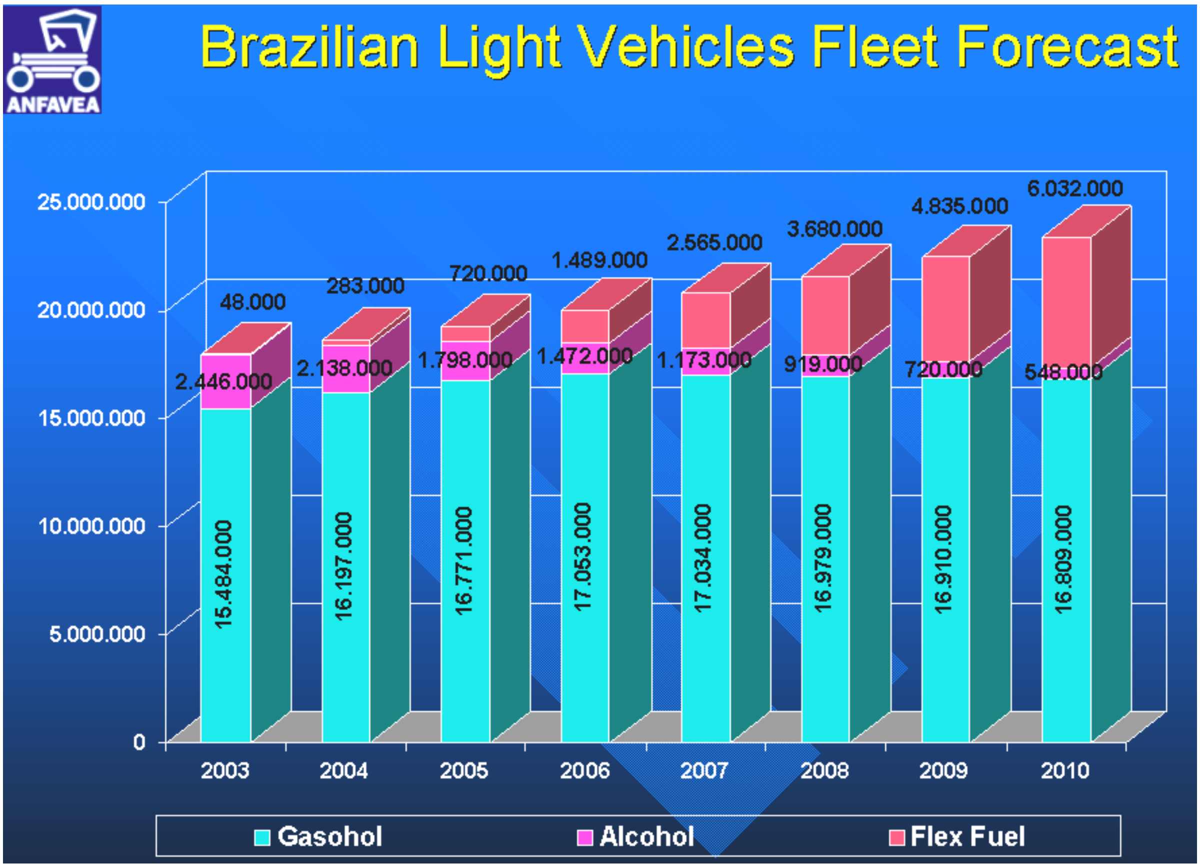
Relative Performance of Ethanol Engines



Comparative Exhaust Emissions of Ethanol Engines



Light Vehicles Sales Forecast



Petrobrás´ Activities in the Field of Biodiesel

Marcia Leite Drachmann
Petrobrás Brazil
E-mail: marciad@petrobras.com.br - www.petrobras.com.br

Petrobras was established in October 1953 with the objective of executing the activities of the oil sector in Brazil on behalf of the Federal Government. The former Petróleo Brasileiro S/A began its activities with assets transferred from the former National Council of Petroleum (CNP). Eversince, Petrobras is committed to sustainable development and the improvement of energy efficiency, linked to mitigation of climate change.

Petrobras in Numbers:

Production Platforms: 98 (68 fixed; 30 floating)

Daily Production: 1,701 million barrels per day - bpd (oil and NG), 53 million m³ NG

Refinaries: 16

Refining Capacity: 1,732 million barrels per day

Pipelines: 27.120 km

Ship Fleet: 97 (54 Petrobras' property)

Service Stations: 5.074

Fertilisers: 2.141 metric tons ammonia, 2.437 metric tons ureia

The Petrobrás main line of action for renewable energy includes the development of a portfolio on renewable energies. In the past, the company was strongly involved in the PROALCOOL programme which can be seen as the world's largest renewable liquid fuel program. Currently Petrobrás is working on the development of an internal energy efficiency programme that promotes the rational use of energy.

The corporative strategies for the implementation of renewable energies in Petrobrás foresee a total investment of US$ 50,000,000 in 2004. The goal for overall contribution of renewables in Petrobras electricity consumption is set to 10 percent in 2010.

Due to the high interest from the Brazilian Government for implementing biodiesel in large scale, Petrobras is planning to significantly participate in the whole biodiesel chain, including: production, distribution, transport and commercialization. Within this, the necessity of further developments of involved technologies, especially those concerning glycerol, ethanol separation and specification are most important for Petrobras. Therefore the company is currently establishing partnerships with various bioenergy enterprises that are involved in the biodiesel sector.

The extensive planted areas and the mild climate conditions of Brazil are very promising for an improvement of the biodiesel conversion yield and performance figures. The compliance with Kyoto protocol and the trade with carbon credits can help to support the acquisition of needed investment. The development of the biodiesel sector will furthermore support the social development and the job generation in rural areas of Brazil.

Current Status of Bio-fuel Development in China

Xiao Mingsong
Chinese Association of Rural Energy Industry - CAREI
E-mail: xiao-ms@tom.com

Recently, China has revitalized the agricultural sector by introducing a supportive programme that provided impressive growth and structural change. This included the introduction of increased producer prices and an enlarged role of market principles. Sustainable and stable growth in the agriculture sector and the rural economy was set at the top of the agenda of the Chinese Government. This strategy aims at the achievement of a greater self-sufficiency in grain production and the development of new industry sectors that speed up the improvement of agricultural products and the elimination of poverty. In order to achieve these objectives, the Government intends to protect and expand agricultural land, in order to invest in irrigation, improve research and technology and to expedite the commercialization of agricultural products. The increased investment in rural and agricultural enterprises should help to finance various types of agricultural development projects in China.

The air quality is a serious problem in most of China's urban regions. There is a classification of three different levels. Level one means almost zero pollution, while level three stands for serious pollution. The State Council recently approved a plan to curb air pollution in 113 key cities, including Beijing and Shanghai, which requires that air quality in the cities need to be improved in order to meet the national standards by 2005. Therefore local governments are pushed to promote the use of clean energy sources, such as natural gas, liquid gas, and different biofuels. Within this, the consumption of coal needs to be reduced urgently as most of the enterprises still use backward technologies and consume large quantities of non-sustainable energy. These facilities need to be upgraded or shut down. In the future, the management of automobiles will be strengthened and the development of automobiles powered by clean energies, as well as public transport, will be enhanced.

In order to achieve greater energy self-sufficiency and to reduce the expenditures for oil imports, China intensively researches the implementation of appropriate biofuels. Therefore, several bioethanol plants have been built, such as the new Jilin Fuel Ethanol Plant. With a final capacity of 600,000 tons per year, i.e. 2.3 million litres per day, the plant will be the world's largest bioethanol production facility. The plant`s start-up and continuous operation is fully satisfactory and the demand for the produced bioethanol will be guaranteed by the decision of the Jilin and other provincial governments. It is planned to replace pure gasoline with gasohol, an E10 gasoline-ethanol blend, at all filling stations in respective Chinese provinces.

The Heilongjiang province will sell and utilize the ethanol-gasoline mixture. Increasing the contribution of renewable energy will not only relieve the energy shortage, furthermore it will promote the reduction of exhaust emission from all types of vehicles. According to experts, the ethanol-gasoline mixture can be produced and sold at the same quality and price like conventional gasoline.

Since July 2001, 5,000 buses in the Henan province are running on a ethanol-gasoline mixture. The Tianguan Group is one of the 'trial' provinces that were determined by the state to produce ethanol for transport purposes. The fuel ethanol equipment can produce up to 300,000 tons of denatured fuel ethanol. On the basis of three 'trial' cities (Zhengzhou ,Luoyang and Nanyang), the development of the new transport fuel has been completed and is now spreading out within the province.

Innovative Transportation Fuels

Prof. Nasir El Bassam
Federal Agricultural Research Centre
Bundesallee 50, 38116 Braunschweig, Germany
E-mail: Nasir.bassam@fal.de - www.fal.de

Future alternative fuels should offer the possibilities to be used as the current fuels within the existing infrastructure, to contribute to the reduction of greenhouse gases, to promote the development of new technologies of the recent combustion systems and energy generation (i.e. fuel cells), to be affordable, sustainable and they should be renewable. Moreover, they have to ensure a safe supply within the regional and global markets.

Biomass can be considered as the best option and it has the largest potential, which meets these requirements and could insure fuel supply in the future. Plant oils, bio diesel, biogas and ethanol have been successfully introduced and are already in use. Innovative synthetic fuels are related to aspects and the new developments in conversion technologies of lignocellulosic to fuels: Gasification, pyrolysis and upgrading to gasoline, diesel and hydrogen, methanol, DME as well as the possibilities of their generation from biomass.

Fuels derived from biomass are not only potentially renewable, but they are also sufficiently similar in origin to fossil fuels in order to provide direct substitution opportunities. They can be converted into a wide variety of energy carriers (biogas, biodiesel, ethanol, methanol, DME, diesel, gasoline, hydrogen) as of recent fossil fuels through conversion technologies, and thus have the potential to be significant new sources of energy for the 21st century (Fig. 1).

The input/output energy balance ratio may reach up to 1:25. The CO_2 mitigation potential of energy crops as energy sources is considerably large. Data related to global conversion of solar energy to biomass are summarised in table 1 and the possible contribution of biomass in future global energy supply is given in table 2.

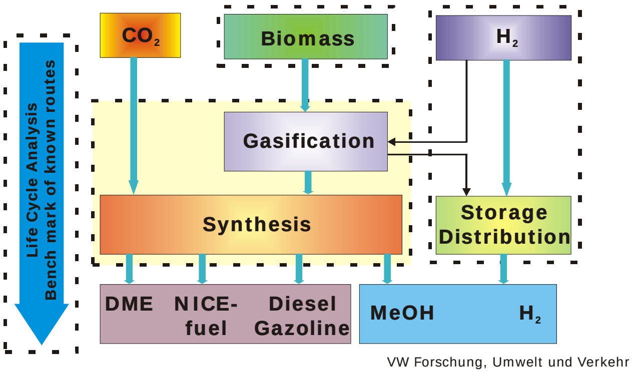


Figure 1: Pathways to Renewable Fuels (from plant to tank)

1000 kWh is 3.6 GJ and 1 ha is 10 000 m², so the total annual energy is	36 000 GJ
One third of this delivered during the growing period	12 000 GJ
20% of which reaches the growing leaves	2 400 GJ
After a further loss of about 20% by reflection	2 000 GJ
50% of this is photosynthetically active radiation	1 000 GJ
30% of which is converted into stored energy	300 GJ
But 40% is consumed in sustaining the plant, leaving	180 GJ
Corresponds to	10 t ha^{-1} y^{-1} GJ

Table 1: Conversion of Solar Energy (Annual Solar Energy Radiation is 1000 kWh m^{-2} y^{-1}. ha^{-1})

Scenario	**Year of Scenario**		
	2025	2050	2100
IEA (1998)	60*	--	--
IIASA/WEC (1998)	82**59***	153** 97***	316** 245***
Shell (1996)	85	200-220	--
IPCC (1996)	72	280	320
Greenpeace (1993)	114	181	--
Johansson *et al* (1993)	145	206	--
WEC (1993)	59	94-157	132-215
Dessus *et al* (1992)	135	--	--
Lashof and Tirpak (1991)	130	215	--

* *2020 (Total primary energy supply)*
** *Scenario A3 (High growth – biomass and nuclear)*
*** *Scenario C1 (ecologically driven - large renewables, no nuclear)* **Source: Hall (1999)**

Table 2: The role of modernized biomass in the future global energy use (Present biomass energy use is about 55 EJ/year)

Biomass can be considered as a source for carbon and hydrogen (table 3). The possible outcome of oil from biomass depends on the productivity of energy plants and up to 9000 l oil through modern conversion technologies from one hectare could be achieved (table 4).

Fuel	*Ratio of atoms*			*% by weight*		
	C	H	O	C	H	O
Coal	1	1	<0.1	85	6	9
Oil	1	2	0	85	15	0
Methane	1	4	0	75	25	0
Wood	1	1.5	0.7	49	6	45

Table 3: Proportions of carbon, hydrogen and oxygen in fuels

Biomass Yield ($t\ ha^{-1}.\ y^{-1}.\ kg^{-1}$)	Energy content *($MJ\ .\ kg^{-1}$)*	*eta Conversion Efficiency*	*Fuel Yield ($t.\ ha^{-1}.\ y^{-1}$)*	*Fuel Yield ($l.\ ha^{-1}.\ y^{-1}$)*
10	*17,5*	*0,48*	*1,9*	*2448 (3000)*
20	*17,5*	*0,48*	*3,8*	*4895 (6000)*
30	*17,5*	*0,48*	*5,7*	*7343 (9000)*

Table 4: Fuel yields from biomass

More than 100 plant species have been identified for different region of the world to serve as biomass sources for biofuels. A summery of energy plant species which could be grown under various climatic conditions have been documented in the tables 5-7.

Table 5: Representative energy plant species for different climate (temperate climate)

- Cordgrass (*Spartina spp.)*
- Fibre sorghum *(Sorghum bicolor)*
- Giant knotweed (*Polygonum sachalinensis)*
- Hemp (*Cannabis sativa)*
- Kenaf (*Hibiscus cannabinus)*
- Linseed (*Linum usitatissimum)*
- Miscanthus *(Miscanthus x giganteus)*
- Poplar *(Populus spp.)*
- Rape *(Brassica napus)*
- Reed Canary Grass (Phalaris arundinacea.*)*
- Rosin weed *(Silphium perfoliatum)*
- Safflower (*Carthamus tinctorius)*
- Soy bean (*Glycine max)*
- Sugar beet (*Beta vulgaris)*
- Sunflower (*Helianthus annuus)*
- Switchgrass *(Panicum virgatum)*
- Topinambur *(Helianthus tuberosus)*
- Willow *(Salix spp.)*

Table 6: Representative energy plant species for different climate (aride and semiaride climate)

- Argan tree (*Argania spinosa)*
- Broom (Ginestra) *(Spartium junceum)*
- Cardoon (*Cynara cardunculus)*
- Date palm (*Phoenix dactylifera)*
- Eucalyptus (*Eucalyptus spp.)*
- Giant reed (*Arundo donax)*
- Groundnut *(Arachis hypogaea)*
- Jojoba *(Simmondsia chinensis)*
- Olive (Olea europaea.*)*
- Poplar *(Populus spp.)*
- Rape (*Brassica napus)*
- Safflower (*Carthamus tinctorius)*
- Salicornia (*Salicornia bigelovii)*
- Sesbania (*Sesbania spp.)*
- Soybean *(Glycine max)*
- Sweet sorghum *(Sorghum bicolor)*

Table 7: Representative energy plant species for different climate (aride and semiaride climate)

- Aleman Grass (*Echinochloa polystachya)*
- Babassu palm *(Orbignya oleifera)*
- Bamboo (*Bambusa spp.)*
- Banana (*Musa x paradisiaca)*
- Black locust (*Robinia pseudoacacia)*
- Brown beetle gras (*Leptochloa fusca)*
- Cassava *(Manihot esculenta)*
- Castor oil plant *(Ricinus communis)*
- Coconut palm (*Cocos nucifera)*
- Eucalyptus *(Eucalyptus spp.)*
- Jatropha (*Jatropha curcas.)*
- Jute *(Crocorus spp.)*
- Leucaena (*Leucaena leucoceohala)*
- Neem tree (*Azadirachta indica)*
- Oil palm (*Elaeis guineensis)*
- Papaya (*Carica papaya.)*
- Rubber tree *(Acacia senegal)*
- Sisal *(Agave sisalana)*
- Sorghum *(Sorghum bicolor)*
- Soybean *(Glycine max)*
- *Sugar cane (Saccharum officinarum)*

Figure 2 shows the energy plantation of the Federal Agricultural Research Centre (FAL) which represents the "Oilfields of the 21st century.

Figure 2: A VW car fuelled with "SunFuel" from biomass on the energy plantation of FAL.

Summery and Perspectives

- Annual primary biomass production: 220 billion DM, 4,500 EJ = 10 times of world primary energy consumption.
- Biomass used for food: 800 millions DM = 0.4% of primary biomass production.
- Annual food production corresponds to 140% of the needs of world population.
- Biomass currently supplies 14% of the worldwide energy consumption. The level varies from 90% in countries such Nepal, 45% in India, 28% in China and Brazil with conversion efficiency of less than 10%. The potential of improving is efficiency through novel technologies is very high.
- Large areas of surplus of agricultural in USA, EU, East Europe and former soviet countries and could become significant biomass producing areas (> 200 millions ha).
- Microalgae have the potential to achieve a greater level of photosynthetic efficiency than most other forms of plant life. If laboratory production can be effectively scaled up to commercial quantities levels of up to 200 mt/ha/yr may be obtained.
- The efficiency of photosynthetic is less than 1%. An increase in this efficiency (through genetic engineering) would have spectacular effects in biomass productivity: successful transformation of C_4-mechanism (from maize) to C_3-crops (rice). New achievement in accelerating cell division opens opportunities to speed up the growing seasons, resulting in several harvests per year and an overall increase in biomass.
- Developments in car technologies is leading to significant reduction in fuel consumption, i.e. less areas will be needed for more cars.

Conclusion

Of all options, biomass represents the largest and most sustainable alternative to substitute fossil transport fuels as "Win-Win" strategy.

Reference

El Bassam, N. (1998) Energy plant species: Their use and impact on environment and development. James&James Science Publishers, UK.

Exchange of Biofuel Experience between Brazil and EU

Norbert Vasen
ETA-Renewable Energies, Italy
E-mail: norbert.vasen@etaflorence.it - www.etaflorence.it

The most prominent motivation for experience exchange and technology cooperation in the field of biofuels are the innovative technologies and the long-term experience of Brazil. Within this, the realisation of concrete projects and the transfer of experience can help to bring success to international cooperation activities. The development of feasibility studies and the evaluation of financing schemes could help to further develop the biofuel sector in Brazil and the EU.

Technology Overview:

- Mechanical low energy pelletising technology
    - Utilisation of sugar cane waste as solid and modern fuel
    - Hydrogen and biomethanol from pellets
    - Pellets for replacing expensive cokes
    - Charcoal pellets for water purification
    - Large units for cost reduction
    - Small mobile units to pelletise voluminous biomass on place
- New synthetic crystals for decreasing energy for:
    - Desalination of water
    - Distillation of alcohol
    - Sugar condensation for better storage
    - distillers can work whole year on sugar
- Distributed small scale generation
    - Small pelletisers and steam engines
    - Alcohol for microturbines
    - infrastructure already present (in Brazil)
- Flexfuel Vehicles

Potential Technolgy Transfer to EU

- Large juice extractors and distillation technology
- Scale enlargement of pellet machines
- Evaluation of large scale application of alcohol in transport
- Presence of alcohol infrastructure for knowledge
- about market and testing of microturbines

Potential Technolgy Transfer to Brazil

- Mechanical low energy pelletising technology
- New synthetic crystals for decreasing energy for:
- Sugar dehydration (easier storage to gain time for processing)
- Distributed small scale generation
- Pelletisers and steam engines
- Microturbines

The World´s Carbon Market

Marco Monroy
MGM International Brazil
www.mgminter.com

The objective of MGM International Brazil is the identification, design, negotiation, as well as execution and support of CDM projects. MGM International believes that even though the CDM currently faces some obstacles, in future the development and implementation of CDM projects will ease and the CDM market will be developed. Hopefully, successful CDM experience can be gained long before 2012 when the first committment period ends. This would encourage both Annex 1 and non-Annex 1 countries to make further committments to mitigate climate change.

Prototype Carbon Fund

The Prototype Carbon Fund (PCF), which is operational since April 2000, is the first mechanism of this kind to be developed internationally. This carbon fund was created by the World Bank as an innovative public/private partnership. The main target is to create a market for project-based greenhouse gas emission reductions, while promoting a sustainable development. Furthermore, a learning-by-doing opportunity for its stakeholders helps, that other entities may gain from this experience. The PCF utilises funds from companies and governments in order to invest in projects designed to generated emission reductions which are fully consistent with the Kyoto Protocol and the rules of the CDM. Currently, six governments (Canada, Finland, Norway, Sweden, the Netherlands and Japan) and 17 companies are contributing 180 million U.S. dollars in funds to the PCF. At present, 30 projects with an emission reduction potential of about 166 million U.S. dollars are under preparation and 26 projects with a total worth of 134 million U.S. dollars have progressed to advanced stages.

Global Environment Facility Programme

Established in 1991, the Global Environment Facility (GEF) helps countries in transition to fund global environment protection projects and programmes. The GEF is a financial mechanism structured as a trust fund that operates in collaboration and partnership with the United Nations Development Programme (UNDP), the United Nations Environment Programme (UNEP), and the World Bank. It supports projects that are related to biodiversity loss, climate change, ozone depletion, land degradation, and persistent organic pollutants (POPs). The GEF bring together 175 governments and has allocated 4.5 milliard U.S. dollars in grants and additionally 13 milliard U.S. dollars in co-financing to support more than 1,200 projects.

Community Development Carbon Fund

Providing carbon finance to small-scale projects in rural areas, the Community Development Carbon Fund (CDCF) was launched by the World Bank, the International Emissions Trading Association (IETA), and the United Nations Climate Change Secretariat in September 2002. The public/private fund was designed on the basis of the PCF experience and is operational since July 2003 with an expected size of 100 million U.S. dollars. The CDCF makes it possible to link private investors with community development projects. The involvement of local intermediaries and the application of CDM compatible project procedures will lower the transaction costs and risks implied in small-scale projects.

BioCarbon Fund

The BioCarbon Fund proposes to use the successful PCF and CDCF model to expand carbon finance to ecosystem and land management projects. The third World Bank fund will finance projects that sequester or conserve greenhouse gases in forests and other ecosystems. It will test and demonstrate in what way land use, land-use change, and forestry (LULUCF) activities can generate enormous reductions in GHG emissions. Like the PCF and the CDCF, the BioCarbon Fund is a public/private initiative with an expected size of 100 million U.S. dollars. Private companies, governments, and non-governmental organisations (NGOs) contribute the capital in exchange for Emission Reduction Units (ERUs).

The European Emissions Trading System

The main goal of the European Union's climate change policies is to promote the reduction of greenhouse gas emissions in a cost-effective and economically efficient manner. In October 2003 the European Parliament and the Council of the European Union adopted Directive 2003/87/EC that calls for the establishment of an emissions trading scheme in Europe. The so called Emissions Trading Scheme (ETS) is one of the key element in the European Union's strategy of meeting the commitments under the Kyoto Protocol.

Article 9 of Directive 2003/87/EC required the Member States of the European Union to publish National Allocation Plans (NAPs) by the end of March 2004 and to notify it to the EU Commission and the other Member States. These National Allocation Plans must indicate how many emission allowances the Member State intends to issue during the three-year trial period (2005-2007).

Generally, a National Allocation Plan consists of two parts. The first part, called *Macroplan* defines the national emissions budget and determines the total quantity of allowances to be allocated. The second part of the NAP is the *Microplan* that defines the intended allocation of allowances to operators of eligible installations, as well as the amount of emission allowances to be set aside for the new entrant reserve.

In order to create a promising National Allocation Plan it is necessary to set ambitious reduction targets that can be met by the total of all allowances. Therefore, proper projections of future emissions are needed in order to involve current changes, as well as future development in the different sectors (e.g. industry, transport, agriculture). Another component of National Allocation Plans should be the implementation of incentives that stimulate the investment in carbon low energy sources and energy efficient technologies. In order to ensure the acceptability of the industry sector, the National Allocation Plans should be developed in full transparency.

At the end of March 2004, only five countries (Austria, Denmark, Finland, Germany, and Ireland) had officially notified the Commission of their National Allocation Plans. Due to the fact that the industry sector worries about the economic costs and the loss of global competitiveness, several governments have had problems with finalising their NAPs.

Currently, the European Commission is evaluating the submitted National Allocation Plans. At the end of June 2004 the Commission will either reject or approve the submitted NAPs. However, the European Environmental Bureau (EEB) has already expressed disappointment, as many governments have taken non-ambitious emission trends as the basis of their total allocation. According to the EEB, this could lead to actual increases in emissions within the trial period. Contrary to potential problems and delays, the official start of emissions trading in the European Union is planned for January 1, 2005.

International Sugar and Alcohol Industry Fair (FENASUCRO)

FENASUCRO is the main event in the sugar and ethanol sector worldwide. Since 1993 the event brings together suppliers of equipment and services for sugar mills as well as alcohol and sugar distilleries. The aim is to stimulate the technological development, encourage the trade and give an impulse for future business. FENASUCRO 2004 was attended by 320 exhibitors who presented the whole spectrum of technologies and services, related to the sugarcane and ethanol industry. About 35,000 visitors from Latin America and other countries of the world visited the event.

Participants of the guided visit to FENASUCRO

Technical Tour - Companhia Energética Santa Elisa

The LAMNET workshop in Riberão Preto included a technical tour to the Companhia Energética Santa Elisa, a sugar production facility that started production in 1933. After continuous development and expansion, today, the Santa Elisa plant employs 4,000 workers. The annual production reaches 500,000 tons of sugar and 210 million litres of alcohol.

In Mai 2003, President Lula inaugurated the company's new thermal plant that produces 60 MW of electricity per hour. Thereof about 30 MWh are transferred to the utility company serving 500,000 households with electricity. A significant increase in the sugarcane bagasse based electricity generation is realised through the introduction of innovative high-pressure boilers feeding two high temperature and high pressure multistage turbines of TGM-Turbinas operating at 510°C with an inlet pressure of 63 bar. This new line of turbines is especially designed and manufactured in order to improve efficiency levels in conventional or combined thermal cycles. Compared to the harvesting period 2002/2003, the electricity generation was quadruplicated when the new thermal plant was put into operation.

High pressure boilers at the Companhia Energética Santa Elisa

LAMNET Project Coordination

WIP
Sylvensteinstr. 2
81369 Munich
Germany
Coordinator: **Dr. Rainer Janssen**
Phone: +49 89 720 12 743
Fax: +49 89 720 12 791
E-mail: rainer.janssen@wip-munich.de
Web: www.wip-munich.de

LAMNET Coordination Partner

ETA – Energia Trasporti Agricoltura
Piazza Savonarola, 10
50132 Florence
Italy
Contact: **Ms. Angela Grassi**
Phone: +39 055 500 2174
Fax: +39 055 573 425
E-mail: angela.grassi@etaflorence.it
Web: www.etaflorence.it

LAMNET Coordination Partner

EUBIA – European Biomass Industry Association
Rond Point Schuman, 6
1040 Brussels
Belgium
Contact: **Dr. Giuliano Grassi**
Phone: +32 2 28 28 420
Fax: +32 2 28 28 424
E-mail: eubia@eubia.org
Web: www.eubia.org

LAMNET Coordination Support Point South America

CENBIO – Centro National de Referência em Biomassa
Avenida Prof. Luciano Gualberto 1289
05508-900 São Paulo
Brazil
Contact: **Prof. Dr. José Roberto Moreira**
Phone: +55 115 531 1844
Fax: +55 115 535 3077
E-mail: Bun2@tsp.com.br
Web: www.cenbio.org.br

LAMNET Coordination Support Point Central America

Universidad Nacional Autónoma de México
Instituto de Ecología
AP 27-3 Xangari
58089 Morelia, Michoacán, México
Contact: **Dr. Omar Masera**
Phone: +52 55 5623 2709
Fax: +52 55 5623 2719
E-mail: omasera@oikos.unam.mx
Web: www.oikos.unam.mx

Steering Committee

Contact: **Dr. Peter Helm**
E-mail: peter.helm@wip-munich.de

This Thematic Network is funded by the European Commission, DG Research, (Project No. ICA4-CT-2001-10106).