Latin America Thematic Network on Bioenergy (LAMNET) (RWS1)

On occasion of the 12th European Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection

RAI International Exhibition and Congress Centre, Amsterdam, The Netherlands

Wednesday, 19 June 2002, 11:00-18:00

Organised by: Rainer Janssen, WIP-Munich, Germany

WORKSHOP PROCEEDINGS

This Thematic Network is funded by the European Commission, DG Research, in the framework of the programme 'Confirming the International Role of Community Research' (Project No. ICA4-CT-2001-10106).

Latin America Thematic Network on Bioenergy (LAMNET) (RWS1)

On occasion of the 12th European Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection

RAI International Exhibition and Congress Centre, Amsterdam, The Netherlands

Wednesday, 19 June 2002, 11:00-18:00

Organised by: Rainer Janssen, WIP-Munich, Germany

Chairperson: Giuliano Grassi, EUBIA – European Biomass Industry Association

In order to promote the sustainable use of biomass in Latin America it is the general objective of the Latin America Thematic Network on Bioenergy to establish a transnational forum of Knowledge Centres (Universities, R&D Institutes) and SMEs from Latin America in collaboration with such organisations from European and non-European countries. The LAMNET network is funded by the European Commission. The overall co-ordination of the network is carried out by WIP-Munich in partnership with ETA-Florence and EUBIA, the European Biomass Industry Association, while the Latin American organisations, Brazilian National Reference Centre on Biomass (CENBIO) and the National University of México (UNAM) act as co-ordination support points on the South- and Central American continent.

Agenda:

11:00 – 11:15	Opening: Introduction and progress of the LAMNET project Dr. Rainer Janssen, WIP, Project Co-ordinaton
11:15 – 11:40	Towards a European Research Area Mr. Dirk Pottier, European Commission – DG Research
11:40 – 12:00	Promotion of Small-scale Decentralised Bioenergy Systems Dr. Giuliano Grassi, EUBIA – European Biomass Industry Association
12:00 – 12:20	Pre-requisites for Biofuel Programs promoting Sustainable Development Prof. José Roberto Moreira, CENBIO – Centro Nacional de Referência em Biomassa
12:20 – 12:40	Sugar Cane Biomass – Current and potential use for heat & power cogeneration in Cuban sugar cane industry Dr. Paulino López Guzmán, Ministerio del Azúcar, Cuba
12:40 – 13:00	Spatial Analysis of Biomass Energy Production and Consumption Patterns for Strategic Planning: The WISDOM Approach Dr. Omar Masera, UNAM – Universidad Autónoma de México
13:00 – 14:00	Lunch Break
14:00 – 15:40	Plenary Discussion: Pre-requisites for CDM and Joint Implementation projects in Latin America and other emerging economies Moderated by: Dr. Roland Geres, FutureCamp
15:40 – 16:00	Overview on Conversion Technologies of Cellulose Biomass Resources Mr. Jan Lindstedt, BAFF – BioAlcohol Fuel Foundation
16:00 – 16:20	Overview on Biomass based Co-generation and Syngas/Hydrogen Production Dr. Peter Grimm, WIP – Renewable Energies
16:20 – 18:00	Poster Presentation by LAMNET members/Coffee Break

‘LAMNET’ Workshop

Introduction and Progress of the LAMNET Project

Rainer Janssen
WIP
Sylvensteinstr. 2
D-81369 Munich, Germany
Email: rainer.janssen@wip-munich.de
Internet: www.wip-munich.de

Abstract:

Objectives and Strategies of the LAMNET Project

In order to promote the sustainable use of biomass in Latin America it is the general objective of this Thematic Network to establish a transnational forum of Knowledge Centres (Universities, R&D Institutes) and SMEs from Latin America in collaboration with such organisations from European and non-European countries.

The focus of the project will be the identification of technological objectives and the development of policy options to boost deployment of decentralised biomass production and biomass based energy generation. Concerning the large-scale promotion of bioenergy and the realisation of significant benefits from the deployment of modern, efficient and sustainable bioenergy systems, the following key **Thematic Priorities** have been identified and are addressed during the implementation of this project:

- Analysis of the Energy Policy Framework
- Assessment of Energy Demand and Biomass Resources
- Assessment of available Technologies and Systems
- Development and Implementation of Technology and Policy Options for the Promotion of Bioenergy

Focus of Network Activities

- Large-scale implementation of bioethanol production based on sugar cane and other suitable biomass resources (e.g. sweet sorghum) including agro-forestry residues; creation of a global bioethanol market
- Promotion of small- and medium-scale decentralised bioenergy systems such as advanced pelleting technologies, small plants for co-generation and refrigeration systems (tri-generation) syngas generators, micro-distilleries for ethanol production, charcoal pellets, activated charcoal for water purification

Dissemination Activities

The efficient dissemination of the results of this project is realised through the publication of a periodical newsletter and the establishment of a project web site (www.bioenergy-lamnet.org). It is a focus of this project to set-up a shared data-base to allow for enhanced comparability and long-term accessibility of the results of this project.

Several workshops and seminars will be organised during the project with the participation of members of the Thematic Network and interested persons or organisations from Latin America and European as well as non-European countries.The first LAMNET Project Workshop is organised on the occasion of the 12th European Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection on 19th June 2002. The second LAMNET project workshop is scheduled to take place in Durban, South Africa, 19-21 August 2002.

***Additional information** is provided in the Power Point Presentation Viewgraphs.*
(PDF-File: PPT-1-Janssen-LAMNET-WS-Amsterdam)

A GLOBAL NETWORK ON BIOENERGY – OBJECTIVES, STRATEGIES AND FIRST RESULTS

R. Janssen[1], P. Helm[1], P. Grimm[1], A. Grassi[2], A. Agterberg[2], B. Coda[3], G. Grassi[3], T. Fjällström[4], J. Lindstedt[5], J.R. Moreira[6], O. Masera[7], Li Baoshan[8], B. Sada Sy[9]

[1]WIP-Munich, Sylvensteinstr. 2, 81369 Munich, Germany; wip@wip-munich.de
[2]ETA-Florence, Piazza Savonarola, 50132 Florence, Italy; eta.fi@etaflorence.it
[3]European Biomass Industry Association – EUBIA, Rond-Point Schuman, 6, 1040 Brussels, Belgium; eubia@eubia.org
[4]Energidalen, Energihuset, Nipan, 88152 Sollefteа, Sweden; energidalen@solleftea.se
[5]BioAlcohol Fuel Foundation – BAFF, P.O. Box 826, 89118 Ornskoldsvik, Sweden; jan.lindstedt@baff.info
[6]Centro National de Referência em Biomassa – CENBIO, Av. Prof. Luciano Gualberto 1289, 05508-900 São Paolo, Brazil; bun2@tsp.com.br
[7]Universidad Nacional Autonóma de México, AP 27-3 Xangari, 58089 Morelia, Michoacan; omasera@oikos.unam.mx
[8]Ministry of Science and Technology, No B51, Fu-Xing Road, 100862 Beijing, P.R. China; libs@mail.most.gov.cn
[9]SEMIS, BP 652, 5 Place d'Independence, Dakar, Senegal; semis@metissacana.sn

ABSTRACT: In order to promote the sustainable use of biomass in Latin America and other emerging countries it is the general objective of this Thematic Network to establish a transnational forum of Knowledge Centres (Universities and R&D Institutes) and SMEs from Latin America and other emerging countries and the European Union. The activities of the Thematic Network include the analysis of existing energy policy frameworks, the assessment of energy demand and biomass resources, the analysis of available bioenergy technologies and systems as well as the development and implementation of policy options for the promotion and deployment of bioenergy. The main focus will thereby be on the promotion of small- and medium-scale decentralised bioenergy systems and the large-scale implementation of bioethanol production and generation of heat and electricity based on sugar cane and other suitable biomass resources including agro-forestry residues.

Keywords: bio-energy policy, sustainable use of biomass, bio-ethanol

1 INTRODUCTION

Good management of resources, alleviating poverty and improving the socio-economic conditions of living as well as the identification of sustainable technical and economical schemes are key objectives for research and development efforts in emerging countries and the EU partnership with emerging countries. Projects focussing on scientific co-operation and policy research in general and especially in the field of renewable energies are of great importance today, as the European Commission recognises that the creation of suitable policy frameworks is required prior to the development of more advanced technologies in order to successfully tackle the main challenges of sustainable development.

In the past the political dimension and the international role of science was often limited to specific fields like aviation and space, nuclear energy and oil. Today, it is agreed upon that science forms the 4th pillar of External Relations together with the fields of politics, trade and international co-operation. Therefore, scientific co-operation and the linkage of scientists, decision makers and entrepreneurs in Thematic Networks is expected to gain an ever increasing importance in the relation between the European Union and countries from Latin America, Asia and Africa.

In order to contribute to these objectives this Thematic Network is funded by the European Commission in the framework of the specific research and technological development programme 'Confirming the International Role of Community Research'.

2 OBJECTIVES AND STRATEGIES

The main objective of this global Thematic Network is to establish a transnational forum for the promotion of sustainable use of biomass in Latin America and other emerging countries. This network of 48 institutions (Knowledge Centres and SMEs) from 24 countries worldwide is set up to face urgent needs for improved and regionally adapted bioenergy applications.

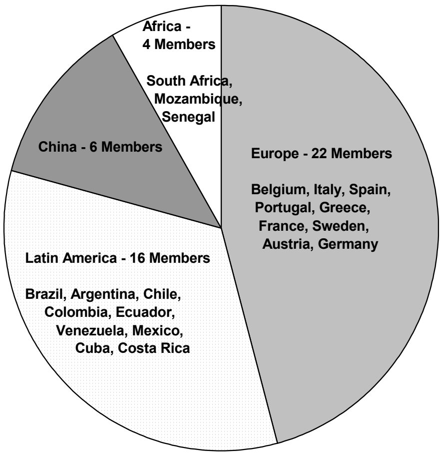


Figure 1: Membership of the Global Network

The focus of the project will thereby be the identification of technological objectives and the development of policy options to boost deployment of decentralised biomass production and biomass based energy generation. Concerning the large-scale promotion of bioenergy and the realisation of significant benefits from the deployment of modern, efficient and sustainable bioenergy systems in Latin America and other emerging countries the following key Thematic Priorities have been identified and will be addressed during the implementation of this project.

2.1 Analysis of the energy policy framework

In order to facilitate the elaboration of suitable policy options for the promotion of bioenergy it will be essential to directly address existing national and regional energy policy frameworks and to assess benefits and drawbacks of existing bioenergy programs.

Energy policies in emerging economies should aim at the strengthening of energy and power infrastructure, the diversification of economy in order to reduce the dependence on petroleum and the exploitation of alternative energy sources including renewable energies.

The contribution of bioenergy to the realisation of these objectives can be significant due to the large potential of biomass resources. Moreover, the production of liquid fuels from biomass can help to reduce the dependence on petroleum especially in the important sector of transport, and small-scale decentralised biomass power generators can improve the energy supply of remote villages in rural areas.

2.2 Assessment of energy demand and biomass resources

The assessment of quantitative and qualitative energy demand of various actors in society will address the specific needs of villages, families, SMEs, industries, transport and public infrastructure (hospitals, schools, tourist resorts etc.). Special emphasis will be given to the assessment of current and future primary energy consumption of the heat, electricity and transport sector as well as the demand for high quality fuels for transportation. Additionally, an analysis of local market prices for various energy sources will be performed and economic opportunities, income generation and local rural development options will be identified.

The present and future resources for the use of biomass will be assessed in order to indicate possibilities to meet demand with locally available resources. An important aspect to be addressed is an increased availability of biomass resources. This can be achieved by an enhanced recovery of various agro-forestry residues and the plantation of dedicated crops on surplus, marginal soils.

2.3 Analysis of available technologies and systems

Suitable and practicable technologies and systems for bioenergy production will be investigated for application in emerging countries. Relevant technologies and systems will be selected on the basis of maturity of the technology, cost-effectiveness, simplicity of maintenance, social acceptability and the impact on development.

Moreover, the benefits in comparison with conventional energy supply and the possibility of local production of the technology will be taken into consideration. The main aim is thereby to develop efficient and cost-competitive solutions for the conversion of biomass to energy services and the focus of the activities of the global network will be on the following thematic priorities:

- Small, medium and large scale biofuel (e.g. bio-ethanol, vegetal oil) production
- Small, medium and large scale cogeneration and trigeneration
- Small and medium scale biogas and charcoal production
- Gas generation from agro-forestry residues
- Combustion and co-combustion technologies; Low pollution stoves
- Technologies for the conversion of biomass crops and residues in pellets and briquettes
- Integrated Bioenergy complexes in emerging economies
- Comparison with conventional energy supply with respect to cost-effectiveness, simplicity of maintenance, social acceptability, impact on development

2.4 Development of policy options for the promotion of bioenergy

Based on the identification of the energy policy framework and the technical conditions to meet the demand with local resources, policy options for the promotion of bioenergy will be elaborated. In order to indicate sound technical solutions, an involvement of local authorities, project responsibles, decision-makers on the one hand and the Network of Knowledge Centres and SMEs on the other hand has to be assured. The following thematic priorities will be addressed in the framework of this global network:

- Potential and barriers for CDM (Clean Development Mechanism) projects, Joint Implementation and carbon trading
- Strategies for biomass trade (e.g. biofuels)
- Analysis of successful projects/programs (best practice) of biomass use in Latin America, China and Africa including problems faced and overcome
- Programs for the use of modern biomass fuel in the transportation sector
- Promotion of international co-operation (e.g. Int. Governmental Coalition on Bioethanol)
- Potential and barriers for technology transfer and joint-ventures
- Economic aspects of the promotion of bioenergy (financing and loan schemes, credit mobilisation, investment capital, market penetration)

2.5 Implementation of Policy Options for the Promotion of Bioenergy

In order to implement the proposed policy options the global network will assure that they are elaborated in consultation with and are widely disseminated among local authorities, decision-makers, utilities, project responsibles, private investors and communities of highly motivated people.

The network will contribute to the promotion of joint-ventures and technological co-operation activities and to the identification of potential demonstration (best practice) projects.

Emphasis of the network’s activities will be laid on the design and screening of Joint Implementation and CDM project candidates as well as the elaboration of training programmes and awareness campaigns in the fields of operation and maintenance, financing and management.

3 PROJECT RESULTS

During the 'kick-off' meeting of the global network on bioenergy in Brussels in March 2002 it was concluded, that the network's activities regarding the promotion of bioenergy utilisation in emerging countries will mainly focus on the following topics:

- Promotion of small and medium scale decentralised bioenergy systems such as advanced pelleting/drying technologies, small plants for co-generation and refrigeration systems, syngas generators, micro-distilleries for ethanol production, charcoal pellets, activated charcoal for water purification. These small-scale bioenergy systems are strongly supported by the European Biomass Industry Association (EUBIA), as the penetration to markets of small scale systems is expected to proceed at a faster pace due to the lower investment level and the reduced required supply of biomass resources.
- Large scale implementation of bioethanol production and generation of heat and electricity based on sugar cane and other suitable biomass resources (e.g. sweet sorghum) and the creation of a global bioethanol market.

In the long term the potential worldwide production of bioethanol is estimated to be at least 2 billion tons per year (t/y), with 0.5 billion t/y from sugar/starch crops and 1.5 billion t/y from lignocellulosic biomass. In order to achieve large market penetration the price of bioethanol has to decrease to approximately 250 US$ per ton. At this price level bioethanol will become an alternative commodity of strategic interest for the transport sector due to its high energy content, its potential contribution to a sustainable energy supply, its socio-economic impact for rural population and its multitude of applications. Thereby, the future market penetration of bioethanol is estimated to amount to 550 million t/y in the transport sector (20% of the present consumption), about 500 million t/y in the heat and power sector (10% of the total worldwide power plants), 200 million t/y for the production of industrial chemicals and several 100 million t/y for domestic markets [1].

Today, the largest producer of bioethanol is Brazil, where ethanol produced from sugar cane is continuously used as automobile fuel since 1975. Ethanol production in Brazil (14 billion litres) is divided between anhydrous alcohol (6 billion litres) and hydrated alcohol (8 billion litres) and the ethanol consumption in the transportation sector is roughly equivalent to 45% of the gasoline consumption. Anhydrous alcohol is blended with gasoline and used in conventional engines, while hydrated alcohol is utilised as neat alcohol in adapted engines. Ethanol use as neat fuel has declined in Brazil during the last 10 years, whereas the consumption of anhydrous alcohol has continuously increased. Thereby, the total demand for ethanol in the transportation sector has slowly diminished due to structural problems of the Brazilian Alcohol Program (PROALCOOL) and currently no national policy exists ensuring the long-term sustainability of the Program. The reduction of the contribution of renewable energy sources to the Brazilian energy system will continue unless a global effective policy for renewables will be implemented such as the creation of a global ethanol market with the involvement and commitment of a large number of countries. According to the Centro National de Referência em Biomassa (CENBIO), Brazil, it will thereby be necessary to focus on large scale markets (e.g. bioethanol) in order to develop sustainable economies of emerging countries, whereas decentralised, small scale energy systems may contribute to the reduction of poverty in rural areas of the world [2].

Additionally, there is a key interest in various sugar-producing countries (e.g. Brazil, Cuba, Mexico, Kenya, South Africa, Thailand) to exploit the large potential of sugar cane bagasse resources for the generation of electricity and heat [3]. Bagasse based co-generation is in line with policies implemented by national governments in order to diversify electricity generation by using indigenous resources. Cogeneration units thereby constitute an attractive option for financing through Clean Development Mechanisms (CDM). In Brazil, for example, among several policies under discussion, the implementation of a large scale co-generation program for the sugar/ethanol sector is regarded as a favourable option for both its environmental and social impact. Furthermore, revenues from electricity sales could lead to a further reduction of the alcohol production costs and accelerate the large scale market penetration of bioethanol [4].

Sugar cane has been grown and milled in the Southern African region for centuries. The Southern African Development Community comprising the sugar producing countries Malawi, Mauritius, Mozambique, Swaziland, South Africa, Tanzania, Zambia and Zimbabwe constitute one of the world's largest sugar producing areas with an average annual production of 3.8 million tons.

Nevertheless, there are still mayor constraints to the large-scale market penetration of sugar cane based bioenergy production in Southern Africa. Among these are the state-controlled electricity supply, offering low revenues for the producers of bioenergy and obstructing the access to the local grid as well as the large investment costs required to up-grade boilers and/or generators for heat and power generation at sugar mills. Therefore, it is regarded as a promising option to take the opportunity to use Carbon Credits to kick-start co-generation in sugar mills operated by Illovo Sugar in Southern Africa [5].

With respect to the various options for the implementation of sustainable biomass use in Latin America and other emerging countries it is the aim of this Thematic Network to develop suitable policy options for the promotion of bioenergy, which carefully take into account the specific local and national framework conditions as well as demand and available resources. Thereby, it is essential to combine the expertise of different stake-holders such as policy makers, donors, investors, private sector entrepreneurs and scientists in order to reach truly sustainable and sound bioenergy based development opportunities.

4 EVENTS OF THE THEMATIC NETWORK

The first workshop of the Thematic Network was organized as a Conference Related Event on the occasion of the 12th European Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection, Amsterdam, 17-21 June 2002. This workshop constituted a platform for dialogue between the members of the network and interested delegates who were interested to benefit from a group of international experts working on the application of bioenergy in Latin America and emerging countries.

The second project workshop will take place in Durban, South Africa, 19-21 August 2002 and will be organized in close co-operation with the project partner Illovo Sugar Ltd. This workshop will include a technical tour to a sugar mill operated by Illovo Sugar Ltd and the thematic focus will be on ‘Bioenergy from sugar cane bagasse’ and ‘Rural energy – woodfuels, charcoal and household issues’.

5 CONCLUSIONS

This global network on bioenergy has successfully started to establish a transnational forum for the promotion of sustainable use of biomass in Latin America and other emerging countries. The main activities of this Thematic Network will comprise the development of policy options for the large scale implementation of bioethanol production based on sugar cane and other suitable biomass resources (i.e. sweet sorghum) as well as for the promotion of small and medium scale decentralised bioenergy systems, in particular small scale village complexes suited to perform an integrated full processing of agro-forestry residues and dedicated crops [6].

In order to realise these objectives several workshops and seminars will be organised in the framework of this project. These events will be organised under participation of members of the Thematic Network and interested persons or organisations from Latin America and other emerging countries.

Information on project activities including workshops and seminars are available at the project website www.bioenergy-lamnet.org and at www.wip-munich.de and www.etaflorence.it.

6 REFERENCES

[1] G. Grassi, European Biomass Industry Association, Workshop ‘Industrial World Perspectives for Bioethanol’, 1st World Conference and Exhibition on Biomass for Energy and Industry, Seville, Spain, 5-9 June 2000, p. 2131

[2] José R. Moreira, José Goldemberg, Suani T. Coelho, ‘Biomass Availability and Uses in Brazil’, CENBIO, Internal Report, March 2002, São Paolo, Brazil

[3] Dr. Paulino López Guzmán, Bioenergy Development Programme – Ministerio del Azúcar, Cuba, private communication

[4] S. T. Coelho, M. F. Bolognini, C. E. Paletta, P. M. Guardabassi, ‘Evaluation of Externalities in Sugar-cane Origin Cogeneration Process in Brazil, Proc. 1st World Conference and Exhibition on Biomass for Energy and Industry, Seville, Spain, 5-9 June 2000, p. 80

[5] D. Tomlinson, Illovo Sugar Limited, private communication

[6] G. Grassi, ‘Large-scale integration of bioenergy with petrochemical complexes, to be published in Proc. 12th European Conference and Technology Exhibition on Biomass for Energy, Industry and Climate Protection, Amsterdam, The Netherlands, 17-21 June 2002

‘LAMNET’ Workshop

Towards a European Research Area

Dirk Pottier
European Commission, DG Research
Email: dirk.pottier@cec.eu.int
Internet: europa.eu.int/comm/dgs/research/

Introduction:

European Research Commissioner Philippe Busquin’s presentation of the Sixth Framework Programme for Research & Technological Development (FP6) on 27 June 2002 marks a decisive step towards the involvement of Europe’s research and scientific networks in the transformation of the European Union into the most dynamic and competitive knowledge-based economy in the world. The Sixth Framework Programme is the Union’s main instrument for the funding of research in Europe. Proposed by the Commission and adopted by the Council and Parliament in co-decision, it is open to all public and private entities.

The overall budget covering the four-year period 2003-2006 is €17.5 billion, representing an increase of 17% from the Fifth Framework Programme and making up 3.9% of the Union’s total budget (2001) and 6% of the Union’s public (civilian) research budget. Seven key areas for the advancement of knowledge and technological progress within FP6 have been chosen: genomics and biotechnology for health; information society technologies; nanotechnologies and nanosciences;aeronautics and space; food safety; sustainable development; and economic and social sciences. With a view towards achieving the biggest possible impact, over €12 billion is being allocated to them.

The main focus of FP6 is the creation of a European Research Area as a vision for the future of research in Europe. It aims at scientific excellence, improved competitiveness and innovation through the promotion of increased co-operation, greater complementarity and improved co-ordination between relevant actors, at all levels.

Aims of the European Research Area (ERA)

- Make the best possible use of the scientific capabilities and material resources within the EU
- Implement national and European policies in a coherent fashion
- Circulation of knowledge and personnel without restriction

ERA – The International Dimension

- Making the ERA more attractive to the best scientists and making it a world class reference centre
- Opening EU programmes to participation by third country researchers and organisations
- Develop specific international S&T activities **(INCO-DEV, INCO-MED)** useful to the implementation of EU foreign policy and development aid
- Enlist S&T resources of EU and third countries in initiatives that provide a response to world problems (e.g. food safety, environmental sustainability, major diseases connected with poverty)

Budget for International S&T co-operation

- 300 mio € for INCO mainstreaming in the thematic priorities (solely for third country entities)
- 315 mio € for a specific INCO programme (bi-regional S&T co-operation) of which 100-150 mio € reserved for INCO-DEV

Instruments

Two new instruments for the thematic priorities, **networks of excellence** and **integrated projects**.

The old instruments (joint research, CA, TN) for the specific INCO programme

Priority thematic areas of research in FP6

- Genomics and biotechnology for health
- Information Society technologies
- Nanotechnologies and nanosciences**,** knowledge-based multifunctional materials and new production processes and devices
- Aeronautics and space
- Food Quality and Safety
- **Sustainable development, global change and ecosystems**
- Citizens and Governance in a Knowledge-based society
- Specific activities covering a wider range of research

6. Sustainable development, global change and ecosystems

The Treaty confirms Sustainable Development as a central objective of the European Community; this was emphasised by the recent European Council in Göteborg. In this context, global change, energy security, sustainable transport, sustainable management of Europe's natural resources, and their interaction with human activities motivate this research priority theme. The activities carried out within this priority aim at strengthening the scientific and technological capacities needed for Europe to be able to implement a sustainable development model in the short and in the long term, integrating its social, economic and environmental dimensions, and make a significant contribution to the international efforts to mitigate or even to reverse current adverse trends, to understand and control global change and preserve the equilibrium of ecosystems.

6.1. Sustainable energy systems

Research activities having an impact in the short and medium term

- Clean energy, in particular renewable energy sources and their integration in the energy system, incl. Storage, distribution and use: supporting stakeholders committed to establishing "sustainable communities", socio-economic approaches to "green electricity", biofuels, heat.

  The aim is to bring to the market improved renewable energy technologies and to integrate renewable energy into networks and supply chains, for example by supporting stakeholders who are committed to establishing "Sustainable Communities" employing a high percentage of renewable energy supplies. Such actions will adopt innovative or improved technical and/or socio-economic approaches to "green electricity", heat, or biofuels and their integration into energy distribution networks or supply chains, including combinations with conventional large scale energy distribution.

  Research will focus on: increased cost effectiveness, performance and reliability of the main new and renewable energy sources; integration of renewable energy and effective combination of decentralised sources, with cleaner conventional large-scale generation; validation of new concepts for energy storage, distribution and use.

- Energy savings and energy efficiency: in relation to the objective of reducing the energy demand by 18% by 2010. Research will focus on Eco-Buildings, combined production of electricity, heating and cooling systems.

  The overall objective is to reduce the demand for energy by 18% by the year 2010 in order to contribute to meeting the EU's commitments to combat climate change and to improve the security of energy supply. Research activities will focus in particular on Eco-Buildings to generate energy savings and improve environmental quality as well as quality of life for occupants. “Polygeneration” activities will contribute to the Community target of doubling the share of cogeneration (CHP) in EU electricity generation from 9% to 18% by 2010, and improve the efficiency of combined production of electricity, heating and cooling services, by using new technologies such as fuel cells and integrate renewable energy sources.

Research will focus on: improving savings and efficiency mainly in the urban context, in particular in buildings, through the optimisation and validation of new concepts and technologies, including combined heat and power and district heating/cooling systems; opportunities offered by on-site production and use of renewable energy to improve energy efficiency in buildings.

- Alternative motor fuels: related to the EU target of 20% substitution of diesel and gasoline fuels by alternative fuels in the road transport sector by 2020.

  The Commission has set an ambitious target of 20% substitution of diesel and gasoline fuels by alternative fuels in the road transport sector by the year 2020. The aim is to improve the security of energy supply through reduced dependence on imported liquid hydrocarbons and to address the problem of greenhouse gas emissions from transport. In line with the Communication on alternative fuels for road transportation, short term RTD will concentrate on three types of alternative motor fuels that potentially could reach a significant market share: biofuels, natural gas and hydrogen.

  Research will focus on: the integration of alternative motor fuels into the transport system, particularly into clean urban transport; the cost-effective and safe production, storage, and distribution (including fuelling infrastructure) of alternative motor fuels; the optimal utilisation of alternative fuels in new concepts of energy efficient vehicles; strategies and tools to manage the market transformation process for alternative motor fuels.

Research activities having an impact in the medium and longer term

- Fuel cells and their applications in buildings, industry and road transport:

  these represent an emerging technology which is expected, in the longer term, to replace a large part of the current combustion systems in industry, buildings and road transport, as they have a higher efficiency, lower pollution levels and a potential for lower cost. The long term cost target is 50 euro/kW for road transport and 300 euro/kW for high-durability stationary applications and fuel cell/electrolysers.

  Research will focus on: cost reduction in fuel cell production and in applications for buildings, transport and de-centralised electricity production; advanced materials related to low and high temperature fuel cells for the above applications.

- New technologies in particular hydrogen:

  The aim is to develop new concepts for long term sustainable energy supply where hydrogen and clean electricity are seen as major energy carriers. For H_2, the means must be developed to ensure its safe use at an equivalent cost to that of conventional fuels. For electricity, decentralised new and in particular renewable energy resources, must be optimally integrated, within inter-connected European, regional and local distribution networks to provide secure and reliable high quality supply.

  *Research will focus on : Clean cost-effective production of **hydrogen**; hydrogen infrastructure including transport, distribution, storage and utilisation; For electricity the focus will be on new concepts, for analysis, planning, control and supervision of electricity supply and distribution and on enabling technologies, for storage, interactive transmission and distribution networks.*

- New and advanced concepts in renewable energy technologies: photovoltaics, biomass. For biomass, barriers in the biomass supply-use chain will be addressed in the areas of production, combustion technologies, gasification technologies for electricity and hydrogen production and biofuels for transport.

  Renewable energy technologies have, in the long term, the potential to make a large contribution to the world and EU energy supply. The focus will be on technologies with a significant future energy potential and requiring long-term research, by means of actions with high European added value in particular to overcome the major bottleneck of high investment costs**,** and to make these technologies competitive with conventional fuels.

*Research will focus on**:** for photovoltaics : the whole production chain from basic material to the PV system, as well as on the integration of PV in habitat and large scale MW-size PV systems for production of electricity. For biomass barriers in the biomass supply-use chain will be addressed in the following areas: production, combustion technologies, gasification technologies for electricity and H_2/syngas production and biofuels for transport. For other areas the effort will be focused on integrating at European level specific aspects of RTD activities which require long term research.*

- Capture and sequestration of CO_2 associated with cleaner fossil fuel plants

  Cost effective capture and sequestration of CO_2 is essential to include the use of fossil fuels in a sustainable energy supply scenario, reducing costs to the order of 30€ in the medium term and 20€ or less in the longer term per tonne of CO_2 for capture rates above 90%.

  Research will focus on: developing holistic approaches to near zero emission fossil fuel based energy conversion systems, low cost CO_2 separation systems, both pre-combustion and post-combustion as well as oxyfuel and novel concepts: development of safe, cost efficient and environmentally compatible CO_2 disposal options, in particular geological storage, and exploratory actions for assessing the potential of chemical storage.

6.3. Global change and ecosystems

Global Change encompasses the complex dynamic changes over different time-scales in the physical, chemical and biological components of the Earth system (i.e. atmosphere, oceans and land) in particular those influenced by human activities. The objectives of this priority area are: (i) to strengthen the capacity to understand, detect and predict global change and develop strategies for prevention, mitigation and adaptation, in close liaison with the relevant international research programmes and in the context of relevant conventions such as the Kyoto Protocol and the Montreal Protocol; (ii) to preserve the ecosystems and protect biodiversity which would also contribute to the sustainable use of land and marine resources. In the context of global change, strategies for integrated, sustainable management of agricultural and forest ecosystems are of particular importance for the preservation of these ecosystems and will contribute substantially to the sustainable development of Europe.These objectives will be best achieved through activities aiming at the development of common and integrated approaches necessary to implement sustainable development, taking into account its environmental, economic and social aspects, as well as the impact of global change on all countries and regions of the world. It will foster the convergence of European and national research efforts for common definitions of thresholds of sustainability and estimation methods, and encourage international co-operation in order to achieve common strategies to respond to global change issues.

Research Priorities

- Impact and mechanisms of greenhouse gas emissions and atmospheric pollutants on climate, ozone depletion and carbon sinks (oceans, forests and soil). Research on all sources like energy supplies, transport and agriculture to understand and predict global climatic change and associated phenomena.
- Bio-diversity functioning and ecosystems.

***Additional information** is provided in the Power Point Presentation Viewgraphs.*
(PDF-File: PPT-2-Pottier-LAMNET-WS-Amsterdam)

Promotion of Small-scale Decentralised Bioenergy Systems

Giuliano Grassi
European Biomass Industry Association
Rond-Poit Schuman, 6
1040 Brussels, Belgium
eMail: eubia@eubia.org
Internet: www.eubia.org

Abstract:

In the framework of the project LAMNET, it is EUBIA’s purpose to follow a pragmatic focus on the promotion of bioenergy by stimulating joint-ventures and transfer of technologies. EUBIA’s opinion is that it is a main project objective to undertake complementary actions to the development of policy strategies by tackling bioenergy market opportunities in Latin America, China, and on the African Continent.

The contribution of EUBIA will be particularly focused on the promotion of small-scale, decentralised bioenergy technologies. Small-scale is envisaged as its penetration (in comparison to large-scale systems) could be much easier especially in terms of supply of biomass resources and investment level.

In the initial phase of the project, EUBIA is going to prepare a series of documents describing projects and technologies, which can be promoted in the framework of LAMNET activities. These documents include a detailed technological and economical analysis of the following commercial sub-systems, which can be easily implemented in all the regions tackled by LAMNET:

- new, advanced pelletisation/drying technology
- small co-generation plants (50 , 100, 500 kWe) with an overall electrical efficiency $\eta el = 22\%$ and a guarantee lifetime of 15 years
- syngas generators
- micro-distilleries for small-scale ethanol production
- charcoal pellets (advanced technology)
- activated coal for water purification
- refrigeration systems

'LAMNET' Workshop

Pre-requisites for Biofuel Programs Promoting Sustainable Development

José Roberto Moreira
The National Reference Centre on Biomass
Avenida Prof. Luciano Gualberto 1289
05508-900 São Paolo, Brazil
Email: bun2@tsp.com.br
Internet: www.cenbio.org.br

1. THE TECHNOLOGICAL ISSUE

Biofuel as other renewable sources of energy has the potential to replace fossil fuel while reducing global pollution (essentially GHG emissions) and local pollution (mainly SO_X and micro particulates). A recent evaluation of the technological potential of renewable energy sources concluded that biomass, wind, and solar energy can provide, each one alone, more energy than was globally consumed in the year 2000. Combining their supply it is possible to satisfy global energy needs even for the most International Panel of Climate Change (IPCC, 2001) energy intensive scenario during this century using available technologies (see Table 1). This is the first of the pre-requisites necessary for the implementation of a biofuel program. Availability of technology is important since a biofuel program should be implemented immediately in order to take advantage of the opportunities to curb GHG emission and, from the other hand, to show considerable impact ten years from now.
Technology includes the existence of human know-how to grow, harvest and transport biomass, and transforms it in a useful form of energy. It also includes physical conditions like convenient temperature, abundant solar irradiation, water availability, and the abundance of land areas with reasonable soil quality (see Table 2). Most of these conditions are identifiable in several tropical countries (see Table 3).

2. THE ECONOMIC ISSUE

Energy production is extremely intensive in capital. Every dollar expend with energy acquisition, in average, produces fifteen dollars in the economic activity that uses this energy (Hall et al., 2001) . Focusing only in capital intensiveness we conclude that it may be more rewarding for a country to import energy, saving investment demanded for its production, and invest in other less capital intensive sectors. This may be a good option for developed countries with easy access to hard-currency. For these countries the only drawback is the risk associated with stable energy supply. For developing countries with limited access to hard-currency investment in energy production is a guarantee that this fundamental economic driver is available even during national and international economic crises. These options impose a further pre-requisite for biofuel production – the decision about what degree of external energy supply is acceptable.

Countries willing to invest in energy production should consider that capital intensive activities usually implies in low number of high qualified employment demand. This is the case for the conventional energy sector, where through centralized production and processing large economic revenue is produced with few workers (see Table 4). But, this is not the case for biofuels. Biomass plantation is a dispersed activity, and since biomass transportation is limited to small distances by economic reason, its processing is also dispersed. Energy cropping, maintenance, harvesting, and transformation in final energy are man-power intensive, and more than that uses rural and unskilled labors. Through biofuel production it is possible to create employment for rural population engaging them in the economic market (see Table 4). This advantage also imposes another pre requisite for large-scale biofuel production – availability of low-cost manpower.

Considering previous comments it is clear that some countries are very poor to carry out an investment program for biofuel production, others may have the money but prefer to make more efficient use of it, and finally there are others that have the money and do not want to be over exposed to the risk of supply or poor performance of the economy. Any of these situations do not preclude the use of biofuels. The only difference between these approaches is that some countries may invest in autonomous production while others may import the fuel.

Another important consideration is that energy is an international commodity that adds cost to all products. As such, if energy has s high cost in a country it will impact the final cost of all products and even services, in a minor extend, thus decreasing the country competitiveness in the global market. As a conclusion, important pre-requisite is the decision to use such kind of energy, either investing in energy production, either importing, provided it has a reasonable cost compared with conventional energy price. At this point it is important to remind that since energy is intensive in capital, low-cost money is one important ingredient for energy production at competitive cost. This is an intrinsic advantage for developed countries.

3. ARE AVAILABLE TECHNOLOGY AND ECONOMIC RESOURCES THE ONLY PRE-REQUISITES?

Almost all commercial energy used in the world is derived from fossil fuels. Coal, oil and natural gas represent around 90% of the energy supply, while hydro and nuclear electricity represent 5% of the commercial energy supply. The new and renewable sources (modern biomass, solar, wind, geothermal, small hydro) represent a little over 2%, and from this total 1.7% is due to modern and sustainable uses of biomass. (see Figure 1)

It is worthwhile to remember that new and renewable sources became to be considered as potential contributors to the energy matrix at almost 30 years ago with the oil crisis of 1973 and 1979. During these 30 years their contribution, in absolute value, looks impressive (see Table 5 and Table 6), but, on relative basis, increased modestly from zero to 2%. Several barriers prevent their expansion.

- **Economic/financial barrier**. A major constraint for many biomass schemes is the relatively high cost per unit of output, because of the small-scale nature of most biomass energy-based projects, high capital and initial investment, high costs of raw material, low cost of competitive fuel, etc. Biomass schemes have to compete with scarce resources and it is a major difficulty to find adequate funding, but even more, that the financial community understands what is being proposed. It is well documented that many biomass schemes, although technically well prepared and costed, often overlook the financial implications. All these factors have combined in discouraging potential financial bankers and investors in biomass energy projects.
- **Institutional and legislative:** Bureaucratic obstacles can be a major problem, because the generally poor understanding that such bureaucracies have about biomass, in particular those in the conventional energy institutions, owing to the different nature in which they operate. Integrating new energy sources into the existing energy systems has always required a long time span. Until quite recently almost all major energy suppliers were state monopolies or large private corporations which has made it very difficult for small independent energy producers to enter the market. This situation is changing rapidly where the energy sector is open to competition. The regulatory and legal framework, whether at national, regional or local levels, can often be a barrier, as in most cases legislation deals with conventional (fossil or nuclear based) energy sources and is often behind with regard to other sources. This vacuum creates confusion, delays, etc., when it comes to planning permission. Thus it is important that there is legislative support to ensure that small independent producers have access to the national grid, or integration with other provincial or local lines, etc.
- **Environmental:** All biomass energy schemes have environmental costs and benefits which need to be quantified and compared with non-biomass ones. Public perception of biomass schemes is important and their views on possible disruption to habitats, ecosystems, conservation areas, visual effects, etc., must be taken into consideration. This has been notoriously lacking in many cases.
- **Socio-political:** Social acceptability and participation are important elements for the success of any modern biomass energy scheme. It is also important that biomass energy schemes do receive political support, to understand the policy implications and to have access to decision-makers, so that they understand the problems, what is being proposed and that issues of competence are well understood. The experience from Austria, Brazil, Sweden, and Denmark, for example, shows that these elements must combine for successful implementation. However, similar policies are still lacking in many countries (World Energy Commission 2000 Report).

From the above list of barriers it is possible to derive, at least, 2 other pre-requisites. One is that biofuel program should be planned to use large-scale biomass resources, even if at the start it involves small amount of energy production. The second pre-requisite deals with the institutional creation of a biofuel market. The existence of the figure of Independent Power Producers, either for electricity or fuel production, is the key for the establishment of such market.

Considering such large number of barriers it is clear that expansion of new and renewable sources of energy requires other appropriated policies to succeed . The high cost for their production is a serious issue that can be mitigated through significant investments in R&D. This pre-requisite never was fulfilled, either by developed or developing countries. A review of the amount of R&D public investments in new and renewables sources carried out by the G-7 countries shows that less than 7% of the total investment in energy R&D has been directed to new and renewables, and in particular less than 0.7% to modern biomass uses, in the period 1973-1995 (Figures 2 and 3) (Criqui et al., 2000). Cost effectiveness is only one ingredient. Policies are also needed to mitigate other barriers. A good example is provided by the recent situation of the Brazilian Alcohol Program. Through production of more than 200 million cubic meters of ethanol, production costs declined significantly (see Figure 4). Environmental barriers are minimal, since its use displaces oil derivatives known as being a major source of global air pollution. But, even with production costs lower than US$ 0.75/gallon, consumption is declining compared with values occurred in early 90s, due lack of interest of consumers triggered by shortage of economic information and lack of stable product supply. Even if a new product is cost-competitive, economic barriers may obstruct its widespread use due market failures and/or institutional imperfections. Market failures include misplaced and distorted incentives and prices to conventional sources of energy and the inability to transfer to the cost of energy some costs that are paid by the society and not by the energy user (known as externalities). Institutional imperfections include high transaction costs, lack of information, tariffs on imported equipments, and restrictive regulation (Sathaye et al., 2001)

Thus the explanation for the small participation of new and renewables sources is the difficulty to overcome not only economic barriers but also socio-economic barriers.

Socio-economic barriers are in general associated with social and cultural aspects which manifest through human behavior, values and attitudes. They include institutional structure and design, national policy styles, lack of effective regulatory agencies, and inadequate consideration of human motivation (Sathaye et al., 2001). When society recognizes the relevance of a new product it pays a higher price for the new one even if in the short term the new and the conventional products may yield the same result. One example is organic products, which feed the person as well as the ones produced with traditional agricultural practices, but are sold at higher price since it is supposed to be healthier in the longer term. As opposed to this example, the awareness of persons to acquire an automobile is strong enough to shadow the impact of its use as a source of GHG emission. C emission in the transportation sector has increased at almost a constant annual rate (2.5%) for the last 30 years and if this trend is maintained this sector will be, in the near future, the major end-use sector responsible for CO_2 emission (see Figure 5). During this time better technology was developed making cars more energy efficient but even this effort was unable to avoid the continuous and constant C emission increase every year. This means that values of society, presently, are such that use of individual transportation is more valuable than the risk of climate changes.

4. SUSTAINABLE DEVELOPMENT

Another important pre-requisite is the identification of synergism between biofuel programs and sustainable development.

There are many definitions for sustainable developments and for this discussion it is better to think about the most significant challenges to achieve sustainable development. They are:

- Clean air
- Clean water
- Food
- Energy
- Land use
- Transport

- Housing
- Employment
- Waste management
- Health

Examining the list of items presented, it is possible to conclude that biofuels have direct connection with some of these challenges and, if properly managed, impact positively on clean air, energy, food, land-use, and employment. Some energy crops are also food producers providing a benefic synergism. The land-use challenge is addressed by opening opportunities to use lands set in stand-by due food/fodder overproduction, and creating demand for unused potentially productive land increasing rural revenue. The three other challenges were already discussed above.

Biofuel has indirect relations with transport, housing, and health. Transport availability depends on fuel quantity, quality, and prices. All these attributes may be satisfied through liquid biofuel production. Housing and health issues may be mitigated through the engagement of the population in the market economy. Employment, largely created through biofuel production, is the most direct way for integrating people in the market.

Biofuels production requires water and land management. Planting and harvesting biofuel may impact water quality through soil erosion, fertilizers and pesticides application. Biomass transformation to biofuels may also be a source of pollution. These impacts may be properly avoided with good practices. It is important to note that some energy crops require pluriannual plantation and forests may take more than 20 years to be renewed. Thus soil erosion is much less intensive with these plantations than with most food cultures. Fertilizers and pesticides are also used with much less intensity in energy crops and forests than in food crops. This is a major requirement to guarantee biofuels cost competitively with conventional energy sources. Biomass processing to final energy forms requires care with air and water pollution. Air pollution can be controlled with conventional and simple technologies used in industrial boilers, while water pollution requires water cleaning or its use as a complement for irrigation. There are examples in the world where these practices are performed in a cost-effective way.

Waste management is directly associated with biofuel production. Large amount of biomass is harvested but with proper design of the energy system all residues may be used in productive ways. One example is sugarcane crop used for ethanol production in Brazil. During many years bagasse was a burden and burned in an inefficient way in sugar mills just to get rid of it. Today, electricity generation for the grid become another interesting commercial activity for sugar mills and bagasse is being used as an efficient source of electricity generation (see Figure 6).

5. CONCLUSION

Considering the limited participation until now of new and renewable sources of energy vis-a-vis its importance to mitigate climate change, its contribution to sustainable development, the difficulty to correct market failures, and the slowly changes occurred in habits and attitudes of society we conclude that the most needed pre-requisites are policies.

Governments exist for choosing what is the best for society and uses its power to solve complex problems that may not be solved by market forces. Thus, appropriate policies able to increase public awareness for new and renewables sources in detriment of fossil fuels should be set and enforced. There are multiple government-driven pathways for technology innovation and changes. Through regulation of energy markets, environmental regulations, energy efficiency standards, and market-based initiatives such as energy and emission taxes, government can induce technology changes and influence the level of innovations. Important examples of government policies on energy sector include the Clean Air Act in the USA, the Non Fossil Fuel Obligation in the UK, the Feed-in Law in Germany, the Alcohol Transport Fuel Program in Brazil, and utility deregulation that began in UK and has now moved to the USA, Norway, Argentina, Brazil and many other countries (Moomaw et al., 2001). In particular, for the case of biofuels, this last kind of pre-requisites should complement the technological and economic capability, allowing a significant expansion of the market with the consequent decline in cost associated with the “learning-by-doing’ mechanism. Such procedure should be applicable to developed and developing countries since, as pointed out earlier, biofuels can be locally produced or imported, and even when produced, it is not clear the advantage of tropical countries over developed ones due the balance between natural resources and capital costs.

REFERENCES

Criqui, P., N. Kouvaritakis, L. Schrattenholzer, 2000. In (eds L. Berstein and J. Pan) Proceedings of IPCC Expert Meeting on Sectoral Economic Costs and Benefits of GHG Mitigation, Eisenach, Germany, 14-15 February, published by RIVM, The Netherlands.

FAO – Food and Agricultural Organization, 1991. Agricultural land use: inventory of agroecological zones studies, FAO, Rome.

Goldemberg, 1996, **The Evolution of Ethanol Costs in Brazil, Energy Policy 24 (12): 1127-1128**

Grainger, A., 1988 – Estimating areas of degraded tropical lands requiring replenishment of forecast cover, International Tree Crop Journal 5:31-61

Grassi G. (1996) Potential employment impacts of bioenergy activity on employment. Proceedings of the 9th European Bioenergy Conference, Vol 1, pp. 419 - 423. Eds. P. Chartier, et al. Elsevier, Oxford;

Hall, C., D. Lindenberger, R. Kummel, T. Kroeger, and W. Eichhorn, 2001. *The Need to Reintegrate the Natural Sciences with Economics*, Bioscience, Vol 51, No 8, p 663

IPCC – International Panel on Climate Change, 1991, Climate Change: The IPCC response strategies, Island Press, Washington DC.

IPCC – International Panel on Climate Change, 2001, Climate Change 2001 – Mitigation, eds. B. Metz, O. Davidson, R. Swart, J. Pan, Cambridge University Press, Cambridge UK.

Martinot et al, 2002 – Martinot, E.; A. Chaurey; D. Lew; JR Moreira; . Wamukonya, 2002, "Renewable Energy Markets in Devoloping Countries", Forthcoming in Annual Review of Energy and the Environment, 2002, (Vol. 27).

Moomaw, W. R., J. R. Moreira, K. Blok, D. L. Greene, K. Gregory, T. Jaszay, T. Kashiwagi, M. Levine, M. McFarland, N. S. Prasad, L. Price, H-H. Rogner, R. Sims, F. ZHOW, P. Zhow, 2001. *Technological and Economic Potential of Greenhouse Gas Emissions Reduction,* in (eds. B. Metz, O Davidson, R. Swart, J. Pan) Climate Change 2001 – Mitigation, Third Assessment Report, IPCC, Cambridge University Press

Sathaye, J., D. Bouille, D. Biswas, P. Crabbe, L. Geng, D. Hall, H. Imura, [a] Jaffe, L. Michaelis, G. Peszko, A Verbruggen, E. Worrel, F. Yamba, 2001. *Barriers, Opportunities, and Market Potential of Technologies and Practices*, in (eds. B. Metz, O Davidson, R. Swart, J. Pan) Climate Change 2001 – Mitigation, Third Assessment Report, IPCC, Cambridge University Press

Scrase, J. I., (1997). Biomass Energy and Employment in the European Union, Biomass Users Network, Kings College London (Unpublished document);

WEA – World Energy Assessment, 2000 - Energy and the Challenge of Sustainability, UNDP, UNDESA and WEC, Washington DC.

WEC – World Energy Council, 2000 – **World Energy Council Report 2000**

World Resources 1992 – 1993, A Guide to the Global Environment, Oxford University Press

***Additional information** is provided in the Power Point Presentation Viewgraphs.*
(PDF-File: PPT-3-Moreira-LAMNET-WS-Amsterdam)

TABLE 1 LONG TERM TECHNICAL POTENTIAL - RENEWABLE ENERGY SUPPLY		
	Long-term **Technical Potential (EJ/yr)**	
HYDRO	**>50**	**Demand for SRES Scenario ranges 515-2737 EJ/yr**
GEOTHERMAL	**>20**	
WIND	**>630**	
OCEAN	**>20**	
SOLAR	**>1600**	
BIOMASS	**>440**	
TOTAL RENEWABLE	**>2800**	

SOURCE: IPCC, 2001

TABLE 2
PRESENT [a] AND POTENTIAL[b] CROPLAND FOR 91 DEVELOPING COUNTRIES
MILLION HECTARES

	Present Cropland	Potential Cropland						
		Low Rainfall	Uncertain Rainfall	Good Rainfall	Natural Flooded	Proble m Land	Desert	Total
CENTRAL AMERICA	37.6	2.2	13.3	18.5	5.7	31.4	3.5	74.6
SOUTH AMERICA	141.6	26	37.5	150.3	105.7	492.7	2.8	815.0
AFRICA	178.8	73.4	96.8	149.3	71.3	358.1	3.8	752.7
ASIA (ex-China)	348.3	59.8	67.0	67.4	80.5	117.1	20.3	412.5
TOTAL	706.3	161.4	214.7	385.5	263.1	999.7	30.4	2,054.9

a) World Resources Institute, 1992
b) As estimated by the Food and Agricultura Organization (FAO) in 1991 (FAO, 1991). Potential cropland is defined by the FAO as all land that is physically capable of economic crop production, within constrains. It excludes land that is too steep or too dry or having unsuitable soils.

TABLE 3 THE PROSPECTS FOR PLANTATIONS IN DEVELOPING REGIONS[a] *MILLION HECTARES*						
	Cropland Measures			**Alternative measures of land areas potentially available for plantations**		
	Present Cropland[b]	Potential Cropland[b]	Cropland Required in 2025[c]	Excess Potential Cropland in 2025[d]	10% of Cropland + perm. Pasture + forest & wood-lands[e]	Degraded lands suitable for resforestation[f]
LATIN AMERICA	179.2	889.6	269	621	171	156 (+ 32)
AFRICA	178.8	752.7	268	484	176	101 (+148)
ASIA (ex-China)	348.3	412.5	522	-110	111	169 (+ 150)
TOTAL	**706.3**	**2,054.9**	**1,059**	**995**	**458**	**426 (+330)**

a Except for the last two columns on the right, the data here are for the 91 developing countries for which the FAO estimated potential cropland areas (FAO, 1991).
b. From Table 2
c. The response Strategies Working Group of the Intergovernmental Panel on Climate Change has estimated that the area required for cropland in developing countries will increase 50 percent by 2025 (IPCC, 1991)
d. This is the difference between the potential cropland and the cropland requirements in 2025.
e. World Resources Institute, 1992.
f. The data refer to all countries on these continents, including China. The first entry is the sum of the land areas in logged forests, forest fallow, and deforest watershels-all of which are estimated to be suitable for reforestation (Grainger, 1988). The number in parenthesis is 1/5 of the desertified drylands-the fraction of desertified drylands in developing countries estimated to be suitable for reforestation (Grainger, 1988).

Table 4 Direct Employment Requirements

Sector	Fuel Production (person-years per million tonnes oil equivalent)	Power Generation (person-years per TWh)
Natural Gas	428	250
Petroleum	396	260
Offshore oil	450	265
Coal	925	370
Nuclear	100	75
Energy saving	2000	-
Bioenergy (solid fuels)	2500	1145
Wood energy	4500	1000
Bioenergy (net of displaced jobs)		28-406

SOURCE: Grassi (1996), Scrase (1997)

Table 5 Renewable Energy Markets in Developing Countries	
Application	**Indicators of Existing Major Markets**
1. Rural residential and community lighting, TV, radio, and telecomm	11 million households receive lighting from biogas 950,000 households with solar home systems (out of 300-500 million households not connected to electric grid) 170,000 household-scale wind-power generators 25,000 PV-powered cellular and satellite phones (serving a rural community)
2. Rural small industry, agriculture, and other productive uses	10,000 PV or wind-powered water pumps (out of 10 million off-grid water pumps total, mostly diesel powered) 100 PV-powered drinking water purifiers/pumps 40 MWp PV for off-grid industrial and telecommunications needs
3. Village-scale mini-grids	5,000 small hydro mini-grids (relative to 100,000 diesel-powered mini-grids) 200 solar or wind hybrid village mini-grids (with diesel)
4. Rural residential and commercial cooking	250 million more-efficient biomass stoves (out of [#] households that use biomass for cooking) 7000 solar cookers 20000 households cook with biogas fuel
5. Residential/ commercial heating	110,000 homes with solar hot water systems 8700 MWth geothermal direct heat production
6. Grid-based bulk power markets	55,000 MW installed capacity producing 200,000 GWh/year (mostly biomass and small hydro)[1]
7. Transport fuels	15 billion liters/year ethanol vehicle fuel produced from biomass 180 million people live in countries mandating mixing of ethanol with gasoline

SOURCE: Martinot et al, 2002

TABLE 6 – RENEWABLE ELECTRICITY GRID-BASED GENERATION CAPACITY INSTALLED AS OF 2000 (MEGAWATTS)		
Technology	**All countries**	**Developing countries**
Wind power	18,000	1,700
Small hydropower	36,000	19,000
Biomass power	38,000	30,000
Geothermal power	8,500	3,900
Solar thermal power	350	0
Total renewable power capacity	100,000	55,000
Large hydropower	680,000	260,000
Total world electric power capacity	3,400,000	1,500,000

SOURCE: Martinot et al, 2002

[1] Some of this capacity serves small village mini-grids rather than central power grids

FIGURE 1

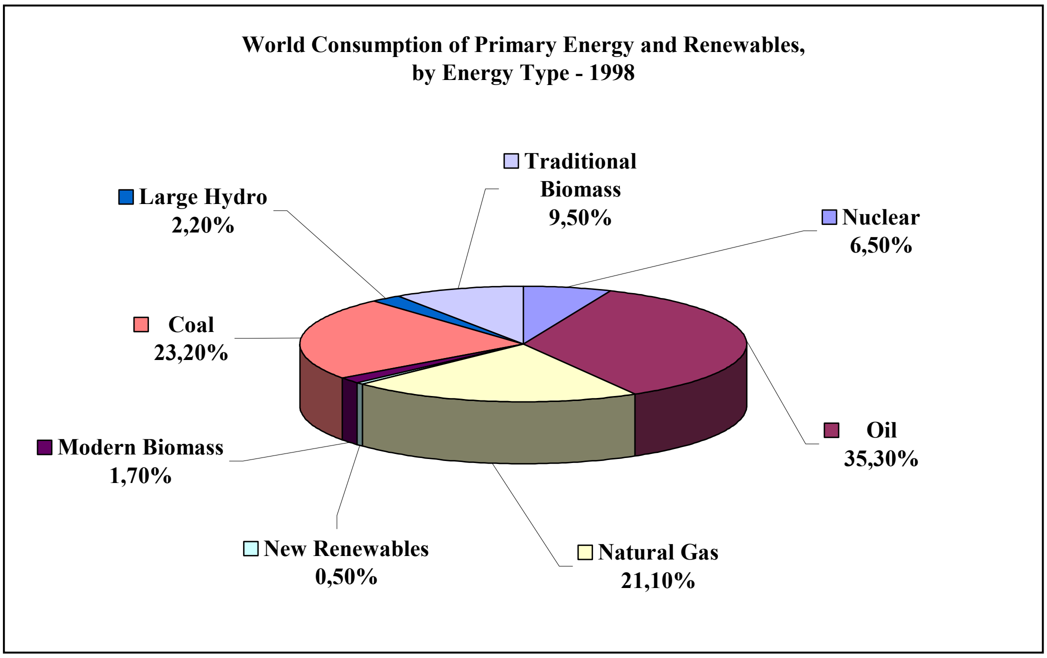


FIGURE 2 - Cumulative Public Energy R&D by Main Category (10^6\$90)

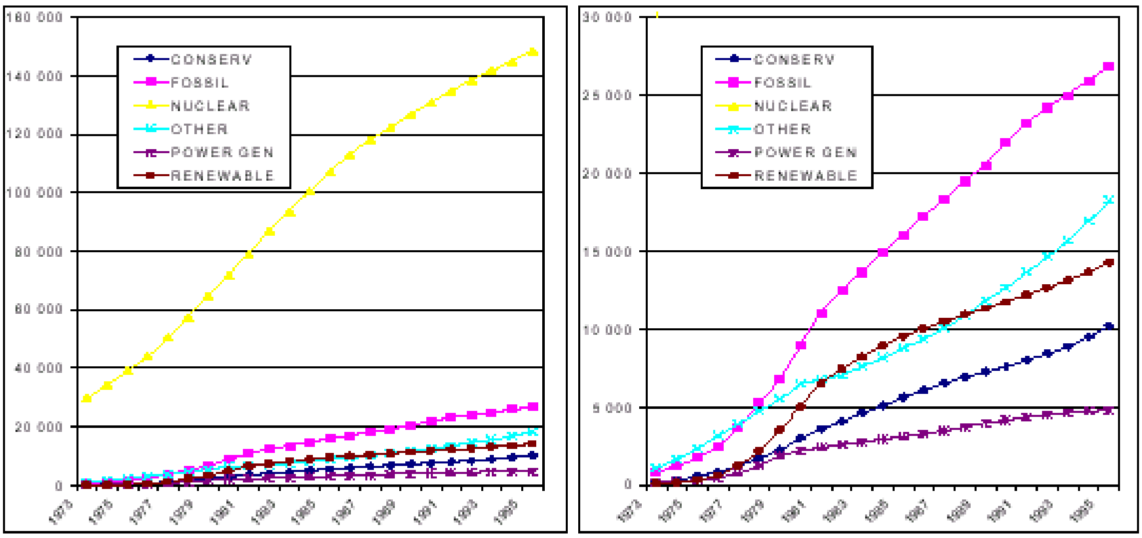
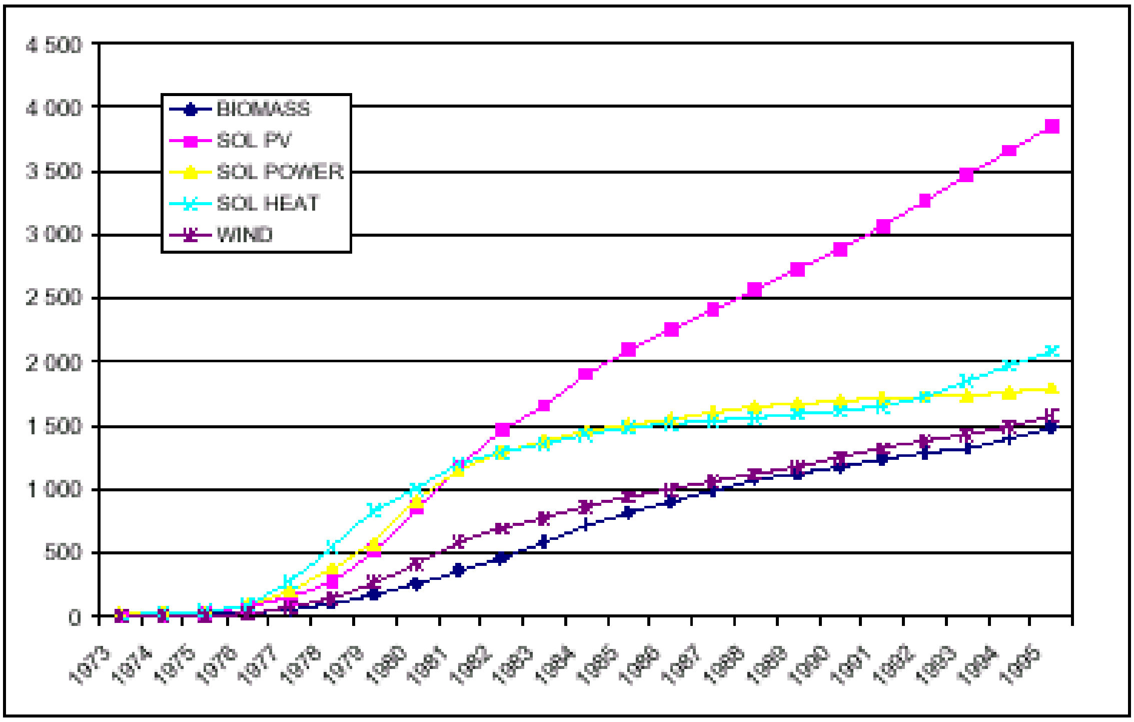
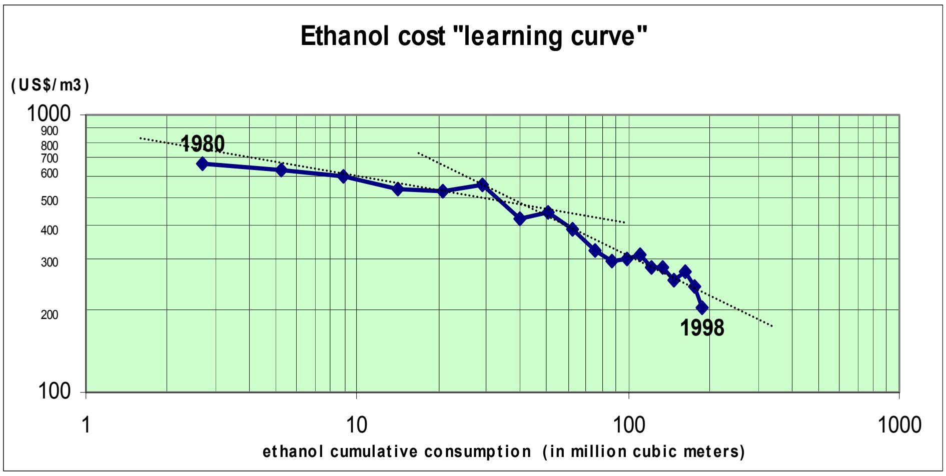


FIGURE 3 - CUMULATIVE PUBLIC ENERGY R&D - RENEWABLE ENERGY (10^6\$90)



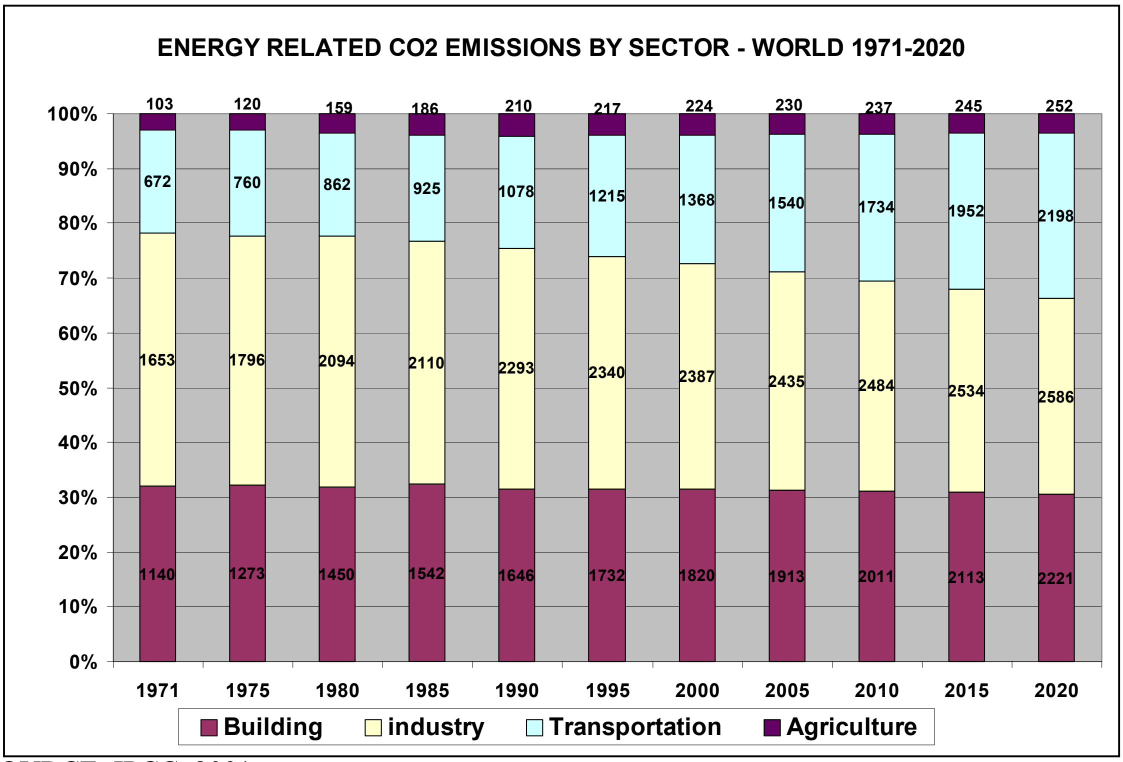
SOURCE: Criqui et al 2000

FIGURE 4



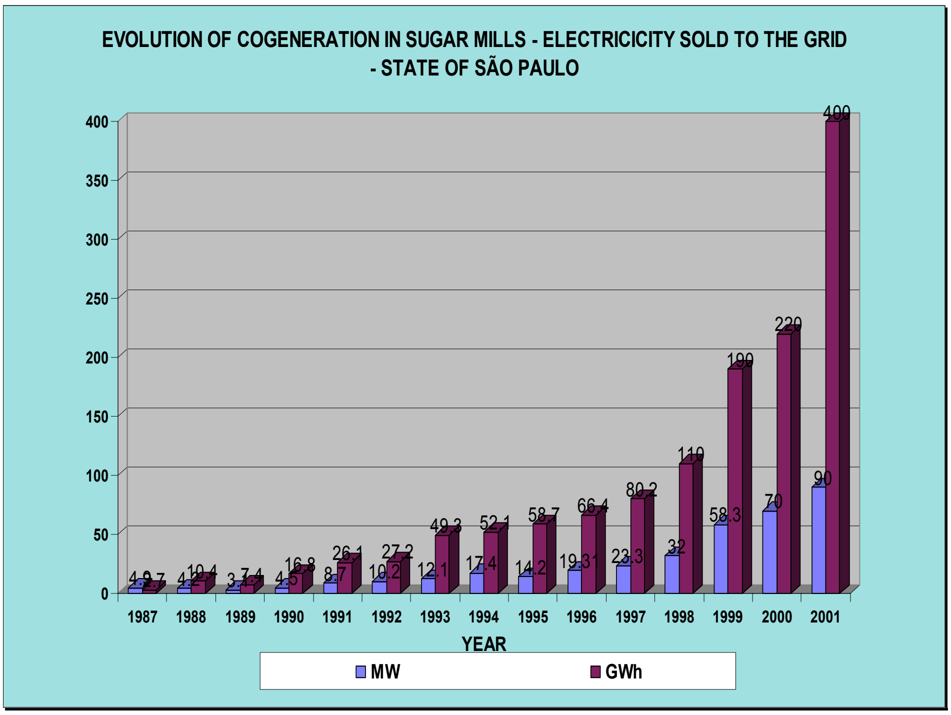
SOURCE: Goldemberg, 1996 and updated by author

FIGURE 5



SOURCE: IPCC, 2001

FIGURE 6



‘LAMNET’ Workshop

Sugar Cane Biomass – Current and Potential Use for Heat & Power Cogeneration in Cuban Sugar Cane Industry

Paulino Lopez
Ministerio del Azucar – Science and Technological Division
P.O. Box 6413
Ciudad de La Habana, Cuba
Email: paulino@ocentral.minaz.cu

Abstract:

Current Situation in the Cuban Sugar Cane Industry

- Total Supply of the Heat Demand for Raw Sugar Production (2500 kcal/kg raw sugar)
- Partial Supply of the Electricity Demand of Raw Sugar Production Process (95%)

Electricity Balance of the Sugar Agro-Industry sector

- Consumption: 2,140 GWh/a
- Production: 1,600 GWh/a
- Supply from Grid: 730 GWh/a

Principal Targets of the Energy Development Programme set-up by the Cuban Ministerio del Azucar:

- Medium Term Co-generation equals Sugar Sector Demand
- Long Term Co-generation exceeds Sector Demand, Sales to National Grid

Strategic Components of the Energy Development Programme

- Increase efficiency of energy use in the industry
- Increase energy production during crushing season with new boilers (efficiency 85-90%) and steam turbines at steam pressure higher than 28 bar
- New power plants fuelled by sugar cane biomass

Technology of Integrated Sugar Cane Power Plants

- Biomass-fired boiler, extraction condensing steam turbine
- Biomass Gasification – Gas Turbine – Combined Cycle
- Biomass Pyrolysis

Long Term Projection

- 39 Sugar Mills have been selected for investment
    - 24 with adjoining power generation plants
    - 15 with existing installed capacity to be expanded/up-graded
- Result: Increase of Installed Capacity by about 1,1015 MW

Impact on Global Climatic Change

- CO_2 Abatement (medium-term) 385 MMt/a
- CO_2 Abatement (long-term) 6,175 MMt/a

***Additional information** is provided in the Power Point Presentation Viewgraphs.*
(PDF-File: PPT-4-Lopez-LAMNET-WS-Amsterdam)

‘LAMNET’ Workshop

Spatial Analysis of Biomass Energy Production and Consumption Patterns for Strategic Planning: The WISDOM Approach

Omar Masera
Instituto de Ecología, UNAM
Circuito Exterior s/n cd Universitaria, Delegación Coyocan
04510 México, DF. México
Email: mnetto@unfccc.int
Internet: www.unfccc.int

Abstract:

Adequately assessing priority areas for bioenergy interventions and projects, particularly within developing countries, requires a better knowledge of the spatial patterns of woodfuel supply and demand. Usually, broad generalizations about the impacts and patterns of woodfuel use are made based on aggregate information averaged over the whole nation or state. However, these generalizations lead to misleading conclusions, as the patterns of wood fuel demand and supply are extremely site-specific.

The “Woodfuel Integrated Supply-Demand Overview Mapping” (WISDOM) is a methodological tool designed to provide a spatial representation of woodfuel demand and supply patterns. The combined analysis of these two layers helps to identify current and future priority regions according to woodfuels production/ consumption trends. In other words, WISDOM serves as an ASSESSING and STRATEGIC PLANNING tool to identify PRIORITY places for action (i.e., woodfuels “hot spots”).

WISDOM is being developed by the Wood Energy Programme at FAO together with the Instituto de Ecología, National University of Mexico. It is based on two main spatial layers resulting from the development of DEMAND and SUPPLY modules. The Demand layer is aimed at visualizing the spatial demand of woodfuels situation and its overall dynamics at the lowest administrative level within a country or a large region. The Demand layer helps to identify those regions showing increasing woodfuel needs and potentially facing shortages. The Supply layer is aimed at a spatial representation of natural and man-made woodfuels sources, their change rates and their sustainable productive capacities.

The methodology was initially tested in Mexico, where it helped identified 273 “priority municipios” (counties) –out of a country total of 2,460- showing the: largest consumption of fuelwood, largest growth and density of fuelwood users and a very high pressure from fuelwood collection on local forests.

***Additional information** is provided in the Power Point Presentation Viewgraphs.*
(PDF-File: PPT-5-Masera-LAMNET-WS-Amsterdam)

‘LAMNET’ Workshop

Plenary Discussion:
Pre-requisites for CDM and JI projects in Latin America and other emerging economies
Moderated by:

Roland Geres
FutureCamp
Chiemgaustr. 116
D-81549 Munich, Germany
Email: roland.geres@future-camp.de
Internet: www.future-camp.de

Abstract:

The emerging of emissions trading schemes leads to a new paradigm in energy policies: By pricing the greenhouse gas emissions, especially CO_2, environmental benefits become part of business planning on the revenue side.

The presentation is explaining the mechanisms shortly and the steps necessary for project developers to integrate emissions trading into business planning. It focuses on the possible financial impact of emissions trading for projects in the biomass sector.

One project-based example from the electricity sector is explained and discussed more detailed: “The bundling of several decentralized smaller units to a single project”.

Especially the innovative approach of project-bundling is of growing importance for projects under the framework of the Kyoto-Protocol. Projects under the Clean Development Mechanism or Joint Implementation cause special transaction costs (e.g. for baseline determination, verification) that can be to high for single smaller units like small biomass plants.

Method, advantages and uncertainties are shown and, finally, some options for the biomass community are presented.

***Additional information** is provided in the Power Point Presentation Viewgraphs.*
(PDF-File: PPT-6-Geres-LAMNET-WS-Amsterdam)

Overview on Conversion Technologies of Cellulose Biomass Resources

Jan Lindstedt
BioAlcohol Fuel Foundation
P.O. Box 826
89118 Ornskoldsvik, Sweden
Email: jan.lindstedt@baff.info
Internet: www.baff.info

ETHANOL FROM AGRICULTURAL AND WOOD WASTE IN A BIOENERGY REFINERY

Jan Lindstedt, BioAlcohol Fuel Foundation, Sweden
e-mail jan.lindstedt@baff.info

Abstract

In The Green Paper "Towards a European strategy for the security of Energy supply" the Commission discuss a goal to substitute 20 % of the fossil fuels in the transport sector by the year 2020. The first steps have been taken in the EU commissions proposal for a directive to introduce biofuels, 2 % until 2005 and 6 % to 2010 in the transport sector.

Feasibility's studies with Energy and material integration's based on hydrolysis of agriculture and wood waste, show that the price of the ethanol is accounted for in the interval between 0,36-0,45 EURO /litre ethanol.

Ethanol production in a stand alone unit, based on cellulosic raw material is hard to motivate today due to high costs and low energy output. We have made about ten different feasibility studies in Sweden integrating ethanolproduction with municipality power plants, sawmills, pelletising units etc.

In such a bioenergy refinery, we can utilize up to 85% of the energy input in useful products such as bioethanol, electricity, lignin pellets and heat for dryers or house heating. With energy- and CO_2 tax reduction on bioethanol, today ethanol fuels is competitive to gasoline in Sweden.

Feedstock

Softwood is the feedstock with biggest potential in Sweden and many other countries for ethanol production. Softwood residues from harvesting or from sawmills and other wood based production units can be used. Hard wood residues and cultivated energy crops is an interesting feedstocks, when pentoses can be fermented in industrial environment.

This paper present wood based ethanol production, which includes as well cultivated crops, wastefibers and other cellulose containing material. The only differences will be pretreatment, process variables, yield and economic analyze. The Mid Sweden University have in a 250 liters bach reactor, tested different rawmaterial and they all can be hydrolyzed and fermented to ethanol. There could be problems to mix all of them to a general feedstock or mixing after pretreatment, because of different processvariables. This has to be studied more in the planned pilotplant.

In Sweden the pricerange in different feedstocks from sawdust at the sawmill to thinning from the forest is 9-17 EURO/ MWh. Some waste fibers can be bought at a very low price. In Sweden most of the newsprint, liner and other fibers like milkpackage are recycled to the pulp and paper industry, but they can as well as agricultural cellulose material be used in the process.

Technology for Ethanol production

Several process alternatives for hydrolysis of cellulose materials have been evaluated. Diluted acid in two steps and a third enzyme step seems to be the most suitable for softwood. For hardwood and straw probably just one step of diluted acid is necessary.

Basically wood consists mainly of cellulose, hemicellulose and lignin. The cellulose and hemicellulose are converted to sugars, hydrolysed, and sugar is fermented to produce ethanol which is distilled to 95 % ethanol and dehydrated to 99,8 % ethanol. Most of the lignin remains as a solid product after the process.

The process can be shown as follows:

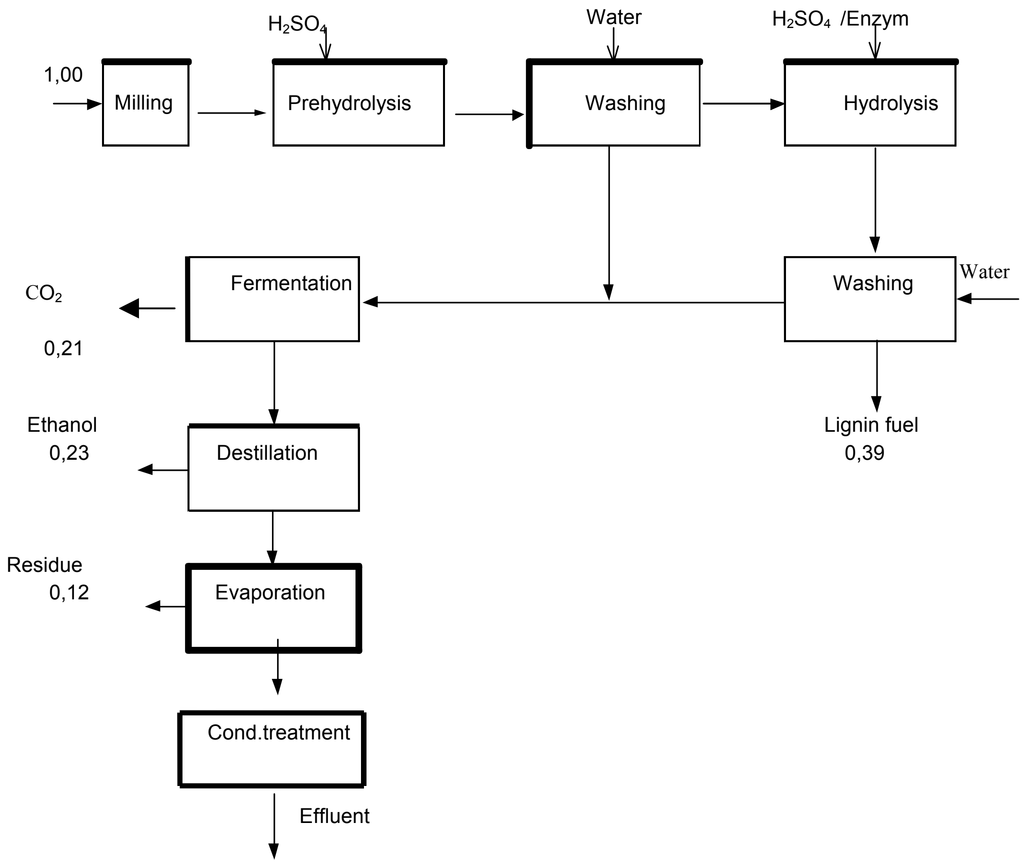


Figure 2. Schematic process design of ethanol production from wood. Figures in ton per odt (ton dry matter) raw material.

The process design is based on two step continues reactors for diluted sulphuric acid. The last step could be replaced or a third step added with enzymehydrolysis when this is developed for softwood and tested in industrial processes.

Some of the hemicellulose and cellulose are not converted to ethanol but solved in the process water and evaporated to a liquid fuel residue, comparable with syrup or spent liquor. This residue is burned in the boiler and could in some applications correspond to the total energy need in the plant. The lignin is used as a fuel in the refinery, sold as pelletising additive or as a biofuel for special purposes. The ligninfuel is very suitable for gas turbines and as a reburning additive, because it has low alkali content and high energy value, 6,2 MWh/odt. In the future it can also be a raw material for "green" chemicals.

Bioenergy refinery

It was found in the studies that an integration of an ethanol plant together with a municipality heat and electricity power plant will increase energy efficiency 10-15 % compared to separated plants for ethanol respectively heat and power generation.

Integration of steam production in a combinate increases the annual load on the steam turbine up to 60 %. The energy balance varies according to existing facilities, feedstock supply, process design and downstream energy need. Since each location has its own design, only examples can be given of how it can be arranged. For a new location of a municipality heat and electricity power plant we can compare the energy balance with and without ethanol plant shown in figure 3.

A graasroot-stand alone ethanol plant has a total utilized energy efficiency of 55-60%.

BIOREFINERY ETHANOL, HEAT, EL			
	Enzyme process	Diluted acid process	Single heat and el. Energy plant
Feedstock	1310	1160	725
Electricity	200	205	190
Heat	410	410	410
Ethanol	360	255	0
Total utilized energy	975	870	600
Total utilized energy	75 %	75 %	83 %

Figure 3. Schematic energy balance of municipal heat and power plant with and without ethanol production. Figures in GWh annually. First case with enzyme process includes process development the second with diluted acid build in the near future.

Regional energy companies in Sweden are the most committed stakeholders in ethanol development at the moment. They have a vision to give energy support to the inhabitants in all fields, electricity, district heating, and fuel for transport. This could be described in the following figure representing a medium-sized municipality in Sweden with about 60 000 inhabitants. A capacity of 50 000 ton ethanol/year is what we can call a ”normal-sized” Swedish plant. In this case roughly most of the energy demand in the municipality for transport, heating of buildings and small and medium sized enterprises is supported from the refinery excluding bigger industry. Energy saving can increase the share even more.

We get the same result if we combine the ethanol plant with a sawmill, including a dryer for board and deal and a pelletising plant for upgrading biofuels. Studies have also been carried out to integrate an ethanol plant with a pulp mill. We get the same economy for such integration but the location is very depending on the energy balance in the existing plant. The balance can drastically change if a new paper machine is added or production is increased.

Economic evaluation

All studies are originally based on design data and investment costs from the preproject that was carried out for a plant in Ornskoldsvik in 1995 and the Etek Etanolteknik AB project in 1999-2000 with process design for a pilot plant placed in Örnsköldsvik and a production plant placed in Skellefteå.
It was found in the studies that the capacity of the plant has to be optimized according to heat demand in the low temperature downstream system, boiler and turbine capacity in existing plant and finally supply and balance of feedstock and lignin product. Investment in a ”normal sized” ethanol plant in Sweden will be about 100 million EURO depending on site specific data such as existing infrastructure, boiler capacity etc. If a new boiler and turbine has to be built the investment will increase with 15-20 million EURO. In the economic evaluation, the byproduct has big importance as can be seen in figure 5. This is particularly the case in the near future, for the first two-three ethanol plants with diluted acid hydrolysis process.

PRODUCTION COST
OF ETHANOL FROM CELLULOSE

	Sweden 2000	Sweden 2010	NREL 2000	NREL 2010
Feedstock	0,20	0,20	0,13	0,08
Energy	0,14	0,10	- [1)]	-
Chemicals	0,04	0,03	0,05	0,03
Credit from biproduct	-0,13	-0,13	-0,01 [1)]	-
Fixed operating costs	0,05	0,05	0,04	0,02
Capitalcosts [1)]	0,15	0,12	0,11	0,06
TOTAL EURO/LITRE	**0,45**	**0,36**	**0,32**	**0,18**

1) The Energy is produced from the lignin burnt in a boiler
Fixed annual instalment 9,5%
Feedstock in Sweden 10,59 EURO/MWh

Figure 4. Production cost of 95% ethanol.

The price of bioethanol for the fuel market in Sweden is about 0,45 EURO/liter (USD 1,6 /gal). Main part of the ethanol used as fuel, 12 000 ton/year, are at the moment based on distilled wine from southern Europé and import of sugar cane ethanol. About 15 % is supplied from the only sulphitepulpethanol plant still in operation. In the 60-ties there were about 40. The plants were closed down because they had rather low capacity and could not manage the increased environmental aspects.

In the long run, the price of bioethanol in the fuel market will decrease to about 0,36 EURO/liter (USD 1,20/gal) to compete with supply of bioethanol from other countries and with gasoline.

Sweden have tax reduction on ethanol regarding carbon dioxid- and energy tax. Prices and taxes for both renewables and gasoline and diesel are under discussion in Sweden and in EU.

Today taxes in Sweden on gasoline is 70% of the price and 30% for E85. To compare you need about 1,2-1,3 times as much E85 to drive the same range with todays engine technique. For buses you need 1,6-1,7 times as much. The conclusions must be that it is possible and interesting for Sweden and other countries to produce ethanol in biorefineries.

Future development in a pilotplant

Etek Etanolteknik AB has made a process design of a pilot plant or Process Development Unit (PDU) with a capacity of about 400-500 liter ethanol/day or a feedstock input of 2 ton of dry substance/day. The plant is basically design for development of the diluted acid hydrolysis process of softwood. It will be designed for a completion with enzymatic reactors when this technique is further developed for softwood. The second reactor is a Countercurrent reactor designed by Metso and NREL.

The pilot plant will be open for cooperation with partners all over Europe and may be other countries. Location for the Pilotplant will be in Ornskoldsvik northern part of Sweden, close to the existing sulfitepulpethanol plant.

Different feed stocks like hardwood and annual crops like straw and reed canary grass will also be tested in the pilot plant.

Al financial decision have been taken and the plant is supposed to be in operation in the end of 2003. The investment costs is about 12 million EURO and the annual running cost about 1,3-2,0 million EURO depending on the research program.

Production plant

In the same project a design and a feasibility study of a full-scale softwood based ethanol plant in Sweden was carried out. The plant is in the study located together with an existing biobased municipality heat and powerplant in Northern part of Sweden. On the existing site there is also a pelletising plant with the annual capacity of about 75 000 ton dry pellets for household heating or delivery to MHP plants in the Stockholm area.
Process design in the production plant is basically the same as in the pilot plant. Annual capacity of this plant will be about 75 000 000 liters of ethanol. The investment costs for the production plant will be about 130 million EURO. The plant can be in operation year 2006 if the decision to build the pilot plant and develop the process follows the plans.

References:

(1) NUTEK, ”System study-Techno/Economical Reviews of a number of Process Combinations or Ethanol Processes and other relevant Industrial Processes”, Report No. R 1995:13.

(2) Lindstedt, J et al 1995, ” Process design of a diluted acid plant in Ornskoldsvik” SSEU Report P-3100. (Swedish)

(3) Lindstedt, J, 1995, ”Feasibility studys of a biorefinery in Falun”, SSEU report No. P-0630. (Swedish)

(4) L. Åstrand, et al 1996, ”Local planning for extended use of forest resources for renewable energy”. Alterner program Contract No. 4. 1030/Z95-123.

(5) Jonsson, K., B. Rehnlund, 1997 ”Alternative fuels For a better climate, environment and improved public health”

SOU 1996:184 (Swedish, a short version in English)

(6) Mikkelsen, J.D., J. N. Saddler, A. Wallis, 1997 ”International evaluation of the NUTEK Ethanol Development Programme”. NUTEK Report No. R 1997:51.

(7) Lindstedt, J, L. Åstrand, 1997 ”Feasibility study of a biorefinery in Eksjo/Nassjo”, SSEU report No. P-9903. (Swedish)

(8) EnergyCentre North, Project report “Research/pilot plant in Örnsköldsvik” Report No P-98-2280 (Swedish)

(9) EnergyCentre North, Project report ”Demo-plant in Hedensbyn, Skellefteå” Report No. 2000-001 (Swedish, one-paged English summary)

(10) EnergyCentre North, Final Project report ”Diluted acid hydrolysis process of softwood in pilot-and full scale” Report No 2000-002 (Swedish, one-paged English summary)

'LAMNET' Workshop

Overview on Biomass based Co-generation and Syngas/Hydrogen Production

Herbert-Peter Grimm
WIP
Sylvensteinstr. 2
D-81369 Munich, Germany
Email: peter.grimm@wip-munich.de
Internet: www.wip-munich.de

Abstract:

Energy is the basis of all life. In the mankind's history mainly biomass, and beside of that water and wind, has been the main source of energy. 2000 years ago the specific energy consumption was approximately 7.2 GJ per capita and year. In the 20th century the specific energy consumption increased to approx. 115 GJ per capita and year and it is delivered mainly on the basis of fossil fuels and nuclear energy. Only in the last decades men became aware of the huge impacts on the environment caused by the burning of fossil fuels. And only in the last decades developments are oriented to modify energy generation and to look for solar energy.

Biomass is converted and stored, and storable, solar energy which can be used as a single source and/or in combination with other solar energy sources. As an energy source biomass is available in solid and liquid form and, following to conversion, as gas.

Biomass as a solid fuel can be used for energy production in systems like small units as stoves, boilers, etc., in central heating plants and thermal power plants and, with increased overall conversion efficiency, in co-generation units to generate heat and electricity. Nowadays also systems for tri-generation to produce heat, electricity and also cooling are under development. In co-generation systems biomass is burnt to produce steam, steam is conducted to engines which make use of the energy difference between high pressure, high temperature water vapour and the expanded low pressure, low temperature steam and/or condensate. This energy difference is transformed to electricity either in reciprocating engines and/or turbines.

Solid biomass can be, however, also bio-chemically converted into chemicals as alcohols (bio-ethanol) and/or thermo-chemically by pyrolysis systems converted into a liquid, mainly called 'bio-oil'. In its natural liquid form biomass occurs as a vegetable oil. The liquids can be fuelled to stationary systems, e.g. burner/boiler combinations, and engines to produce energy by combustion modes. They are also best suited to transportation systems.

Through digestion systems solid biomass can be bio-chemically converted into a gas which in a large extent consists of methane. Thermo-chemically solid biomass can be converted by gasification units to a gas which contains inert compounds like nitrogen and combustible compounds like hydrocarbons and carbon-oxydes. Depending on the technology used and based on the water gas shift reaction gases which contain in a bigger extent hydrogen are produced which, are called 'Synthesis Gas'. This gas can be either converted by a chemical process to e.g. methanol and/or it can be cleaned and purified to hydrogen.

Gas from biomass sources can be used in burners and engines to produce energy. Very novel technologies, which are not yet state-of-the-art, e.g. fuel-cells can be fuelled directly with synthesis gas and the hydrogen produced after cleaning in order to produce electricity and, depending on the fuel cell system, heat.

***Additional information** is provided in the Power Point Presentation Viewgraphs.*
(PDF-File: PPT-7-Grimm-LAMNET-WS-Amsterdam)

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 Paolo
Brazil
Contact: **Prof. Dr. José Roberto Moreira**
Phone: +55 115 531 1844; +55 115 531 4502
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
Circuito Exterior s/n cd Universitaria, Delegación
Coyoacan
04510 México, DF. México
Contact: **Dr. Omar Masera**
Phone: +52 55 5623 2709
Fax: +52 55 5623 2719
E-mail: omasera@ate.oikos.unam.mx
Web: www.ate.oikos.unam.mx/gira

This Thematic Network is funded by the European Commission, DG Research, in the framework of the programme 'Confirming the International Role of Community Research' (Project No. ICA4-CT-2001-10106).