Annual Report 1998

IEA Bioenergy: ExCo: 1999:01

IEA Bioenergy

IEA Bioenergy is an international collaborative agreement set up in 1978 by the International Energy Agency (IEA) to improve international cooperation and information exchange between national bioenergy RD&D programmes. IEA Bioenergy aims to realise the use of environmentally-sound and cost-competitive bioenergy on a sustainable basis, to provide a substantial contribution to meeting future energy demands.

To: IEA

IEA BIOENERGY ANNUAL REPORT 1998

The IEA Committee on Energy Research and Technology (CERT) has recommended that an Annual Report shall be submitted for each of the IEA Implementing Agreements.

This document contains the report of the IEA Bioenergy Executive Committee.

This year, we have presented a special feature of the work being undertaken by Task 25 on "Greenhouse Gas Balances of Bioenergy Systems".

The contributions from the Task Leaders and Operating Agents to this report are gratefully acknowledged.

Olav Gislerud — Chairman

John Tustin — Secretary

Contents

Editor: John Tustin, IEA Bioenergy Secretary, Rotorua, New Zealand.

Design and layout of cover and colour section: Joanneum Research, Graz, Austria; especially Bernhard Schlamdinger, Reinhard Madlener and Anton Stachl, along with members of Task 25.
Also Carlin Valenti Ltd, Tauranga, New Zealand.

Further information on IEA Bioenergy can be obtained from the Executive Committee Secretary, see Appendix 5 of this Annual Report.

A list of country representatives in the Executive Committee is given in Appendix 6.

The opinions and conclusions expressed in this report are those of the authors.

Greenhouse Gas Balances of Bioenergy Systems —

a synopsis prepared by Task 25

Introduction

The IEA Bioenergy Task on Greenhouse Gas (GHG) Balances of Bioenergy Systems offers an opportunity to coordinate the work of national programmes on the ways GHG balances can be set up for a wide range of bioenergy technologies and on ways of implementing GHG mitigation strategies. The Task was started in 1995 as Task XV, with an initial duration of three years, and is continuing as Task 25 until the end of the year 2000.

Surplus straw is regarded a substantial biofuel resource in many countries. (Courtesy of ORNL, USA)

Objectives

The goal of Task 25 is to analyse, on a full fuel-cycle basis, all processes involved in the use of bioenergy systems, with the aim of establishing overall GHG balances.

Particularly, this means to

- collect and compare existing data of net GHG emissions from various biomass production processes in agriculture and forestry and from biomass conversion;
- improve the common analytical framework ("standard methodology") for the assessment of GHG balances developed within Task XV;
- use the standard methodology to compare different bioenergy options and assist in the selection of appropriate national strategies for GHG mitigation;
- compare bioenergy and fossil energy systems in terms of their GHG balance;
- evaluate the trade-offs between strategies of maximized carbon storage (afforestation, forest protection) and maximized fossil fuel substitution with biofuels;
- identify missing data and R&D requirements;
- contribute to the work of IPCC/OECD/IEA, especially to promote the possible role of bioenergy for GHG mitigation.

Apart from the scientific value of the results gained, recommendations made by the Task are considered especially useful for decision-makers wishing to determine the maximum net GHG emission reductions achievable from bioenergy projects.

Focus and output

Workshops

Each year, one or two workshops are organized with the aim of attracting experts in the field from around the world, enabling them to exchange their experiences, and to have a creative forum for collaboration.

Wood logs are an important source of bioenergy. (Courtesy of Joanneum Research, Austria)

Bibliography

A bibliography on the Task topic, containing existing publications, unpublished reports, databases, and a directory of researchers and research groups active in the field, with short descriptions of their projects, was first published in February 1996. An updated version will be available by early 1999.

Standard methodology

One focus of the Task has been to develop a common analytical framework for GHG balances, described in the paper "Towards a standard methodology for greenhouse gas balances of bioenergy systems in comparison with fossil energy systems" (Biomass & Bioenergy, 13(6): 359–375), of which a short description is given in this special feature.

Scientific and technical support

The Task has contributed to the work of the IPCC/OECD/IEA Programme on National Greenhouse Gas Inventories, especially to set up approaches for estimating net emissions of carbon dioxide from harvested wood products. This issue has important implications, e.g., on the incentives to use imported biofuels for GHG mitigation.

Task 25 was also active in interpreting the provisions of the Kyoto Protocol on land use, land use change and forestry, and will contribute to an IPCC special report on that issue, to be completed by the year 2000.

Networking between National Programmes and Experts

The work of the Task is organised such that international expertise is made available to the participating countries and the dissemination of Task-related research findings is fostered.

Soil carbon studies on paired land uses (pasture vs. pine) have been carried out at different sites in New Zealand. (Courtesy of Forest Research, New Zealand)

Cornerstones of the standard methodology

Introduction

The increased reliance on bioenergy systems, in place of fossil fuel-based energy systems, could result in net emission savings of greenhouse gases to the atmosphere. In order to understand when such savings are possible, and the magnitude of the opportunities, a systematic framework for estimating the net effect on GHG emissions for the full bioenergy system and the full energy system that it would displace is needed. The major aspects ("cornerstones") of such a common analytical framework or "standard methodology", and a schematic structure, are introduced below.

Carbon Storage Dynamics

Carbon storage in plants, plant debris and soils can change when biomass is grown and harvested. Such changes in carbon storage might extend over longer periods of time, after which a new equilibrium is approached, thus necessitating time-dependent analyses.

Clear-cut harvest, Finland.(Courtesy of Finnish Forest Research Institute, E. Oksanen, Finland)

Trade-offs

Afforestation or forest protection measures may be regarded as effective measures for mitigating the rise of CO_2 in the atmosphere and may compete with bioenergy strategies for land use opportunities.

In such cases trade-offs between biomass harvest and carbon storage in biomass must be considered. Bioenergy options provide long-term benefits whereas, e.g., afforestation is regarded as a temporary measure only.

Afforestation of erodible, marginal pastures is common in New Zealand. (Courtesy of B. Schlamadinger, Austria)

Permanence

Bioenergy provides an irreversible mitigation effect by reducing carbon dioxide at its source. By contrast, afforestation and forest protection are conditional mitigation options, subject to future management regimes.

Native forest, Cairns/Australia. (Courtesy of B. Schlamadinger, Austria)

Emission factors

Biomass fuels can have higher carbon emission rates (amount of carbon emitted per unit of energy) than fossil fuels (e.g., oil or natural gas). This fact is relevant, however, only when biomass fuels are derived from unsustainable land use practices, where a decrease of biological carbon stocks occur over time.

The Enocell Pulp Mill, Uimaharju/Finland, is a modern chemical pulp mill which produces excess heat and power by using process wastes as fuel. (Courtesy of Enso Group, Finland)

Efficiency

The efficiency of bioenergy systems currently in use may in many cases be lower than that of fossil energy systems. However, more recent installations and technology developments (e.g., Integrated Gasification Combined Cycle – IGCC) have brought about highly efficient bioenergy systems.

Upstream Energy Inputs

Production, transport and conversion of biomass fuels require auxiliary inputs of energy, which must be included in the assessment, as must the energy requirements for the supply of fossil fuels on which the reference energy system is based.

By-products

Bioenergy is often produced as a by-product. There are also cases where bioenergy is the main product and other by-products have to be considered. The emissions and offsets associated with both products and by-products must be estimated and allocated.

Leakage

The use of biomass fuels does not always avoid the use of fossil fuels to the extent suggested by the amount of bioenergy actually used, a phenomenon commonly referred to as "leakage". Biomass may simply provide a new energy source and add to the total energy consumption.

Other GHGs

Greenhouse gas emissions associated with both fossil and bioenergy fuel chains include not only CO_2, but other gases (e.g., CH_4 and N_2O) that also alter the radiation balance of the earth's atmosphere.

The IGCC plant in Värnamo/Sweden is the first thermal biomass gasification plant worldwide, with a substantially increased power-to-heat ratio relative to conventional boiler/steam turbines. (Courtesy of Sydkraft, Sweden)

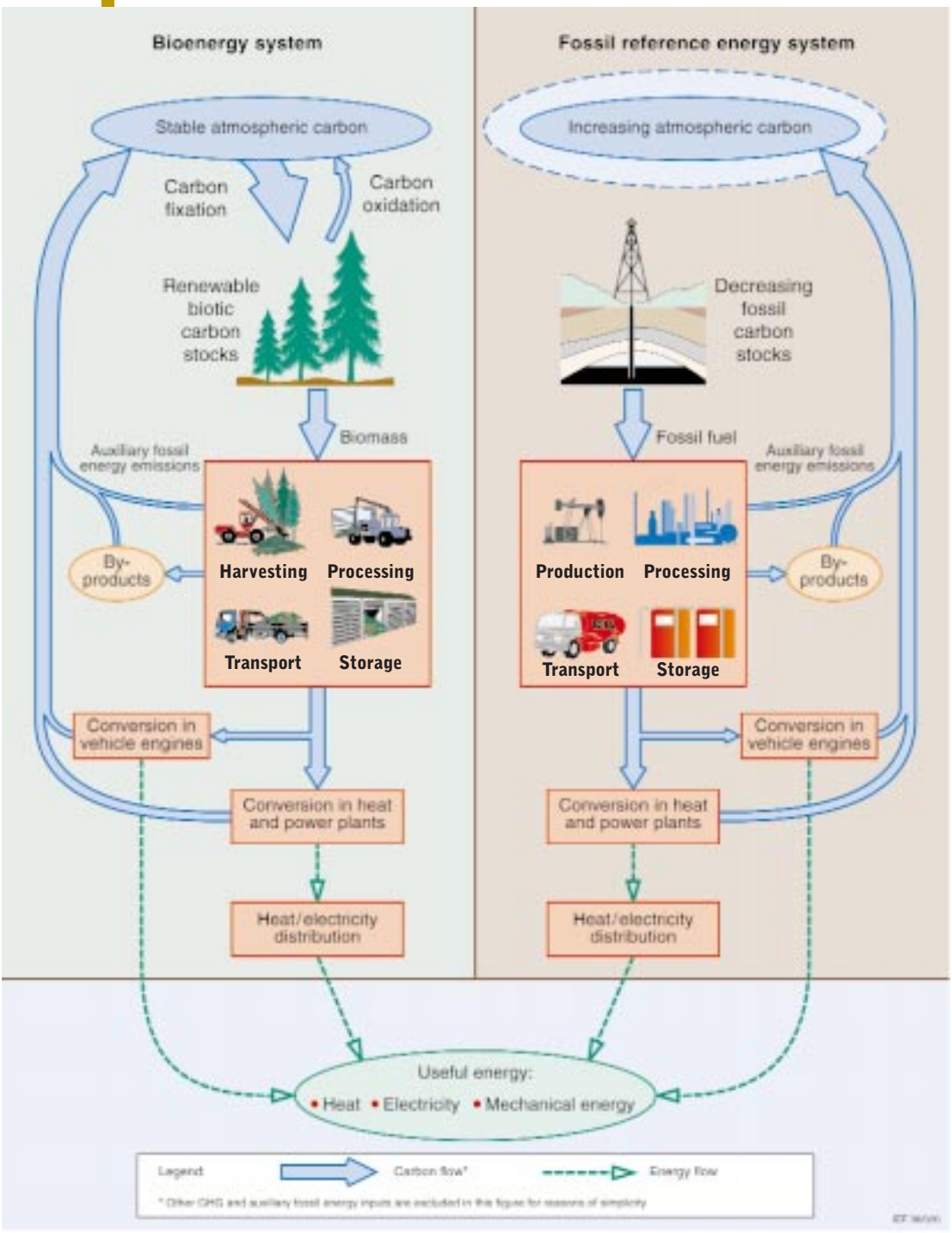
Skidding/forwarding of severed seven-year-old hybrid cotton wood, James River/USA. (Courtesy of ORNL, USA)

Wood from conventional forestry provides residues for energy and is often used for durable wood products, which store carbon and displace more energy-intensive materials. (Courtesy of Forest Research, New Zealand)

Wood chips storage facility for biomass district heating plant, Bad Mitterndorf/Austria. (Courtesy of LEV, Austria)

Seutula landfill gas utilisation plant, Vantaa/Finland. Landfill gas, a mix of methane and CO_2, is explosive and a greenhouse gas of considerable potency. Hence its use for energy has multiple benefits. (Courtesy of Helsinki Metropolitan Area Council YTV, Finland)

Standard methodology: schematic structure



For a description of models based on the standard methodology, developed and applied by Task participants for work relevant to Task 25 (e.g. CBM-CPS/CBM-CFS$_2$, GORCAM, SIMA, STANDPAK/FOLPI, etc.) see: http://www.joanneum.ac.at/iea-bioenergy-task25/model

Selected Results

Selected results of research in the Task 25 countries can be found below. For further information about the work described here please contact the authors directly.

A model of lifecycle energy use and greenhouse gas emissions of transportation fuels and electricity

Prepared by M.A. Delucchi
(madelucchi@ucdavis.edu)

This model of fuel cycle energy use and emissions, developed with funding from the University of California and the U.S. Dept. of Energy, is one of the most detailed and thoroughly documented of its kind. The model or its results have been used by a wide range of public agencies and private firms, including the U.S. Dept. of Energy, the International Energy Agency, and the Intergovernmental Panel on Climate Change.

The model estimates emissions of greenhouse gases and other pollutants, and the use of energy, for the complete fuel cycle for a variety of combinations of energy feedstocks, fuels, and end-use technologies.

The Table below shows a sample of the output (CO_2 equivalent emissions in g/mile, and % changes relative to gasoline, in the year 2010) for light-duty vehicles using biofuels. Even with a full accounting of all fossil-fuel inputs, biofuels based on biomass, as process energy, still provide substantial reductions in life-cycle emissions of greenhouse gases relative to gasoline.

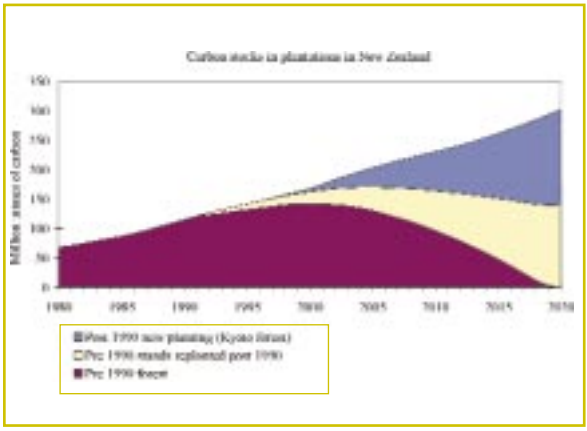
General fuel	**Ethanol**	**Ethanol**	**Methanol**	**Natural gas**
Fuel spec (feedstock)	85% ethanol from corn, 15% gasoline	85% ethanol from wood/perenn grass, 15% gas	85% methanol from wood, 15% gasoline	Compressed natural gas from wood
Vehicle operation	338.4	338.4	326.6	312.3
Carbon recycled through photosynthesis	-207.7	-207.7	-185.8	-214.7
Fuel dispensing, storage and distribution	9.7	5.9	7.2	14.9
Fuel production	168.1	35.6	48.2	22.8
Feedstock transport	6.8	8.2	8.5	7.6
Feedstock and fertilizer production	67.8	27.3	21.3	19.8
Land use changes, cultivation ("-": C sink)	44.5	-53.4	-69.4	-73.7
CH_4 and CO_2 leaks and flares	2.2	2.2	2.7	7.0
Emissions credits for co-products	-34.1	-43.6	0.0	0.0
Total (fuel cycle)	**395.7**	**112.9**	**159.3**	**96.1**
% changes vs. gasoline (fuel cycle)	**-15.8**	**-76.0**	**-66.1**	**-79.6**

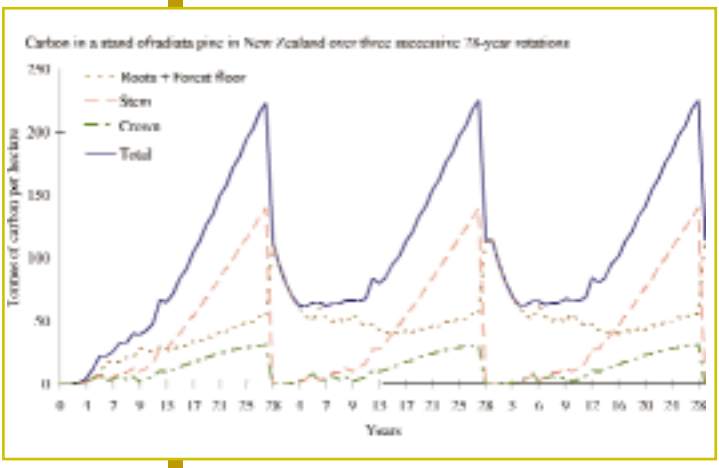
Carbon modelling in New Zealand

Prepared by J. Ford-Robertson, P. Maclaren, and K. Robertson (robertsj@rimu.fri.cri.nz)

The calculations to derive carbon stocks in Pinus radiata stands are performed within the CARBON module of the stand modelling system STANDPAK, which is widely used by the forest industry in New Zealand. Based on the silvicultural regime of a particular stand, the carbon content of different fractions of the stand can be estimated for the entire rotation, or subsequent rotations. In the Figure below, elements have been combined into major groupings for a 28-year rotation, which includes pruning at age 6, 8 and 9 years, and thinning (to waste) at age 6 and 9 years. Logs are only extracted from the site at clearfell (age 28).

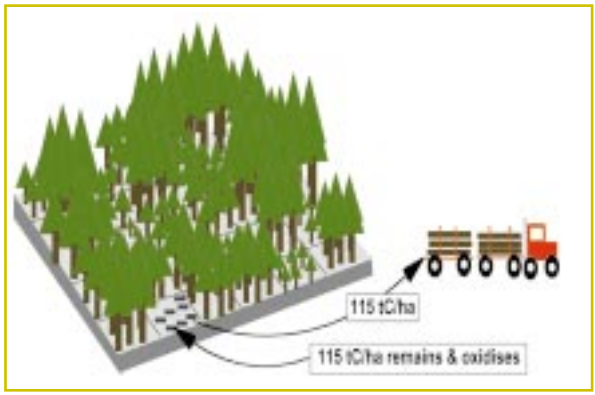
The Diagram below shows results from the CARBON module for individual stands, used in conjunction with the National Exotic Forest Description (a database of age and silvicultural regime for all plantations in New Zealand) in the estate modelling system FOLPI. This can be used to model scenarios of new planting rates and estimated rotation lengths to derive estimates of the carbon stocks in the national forest estate.





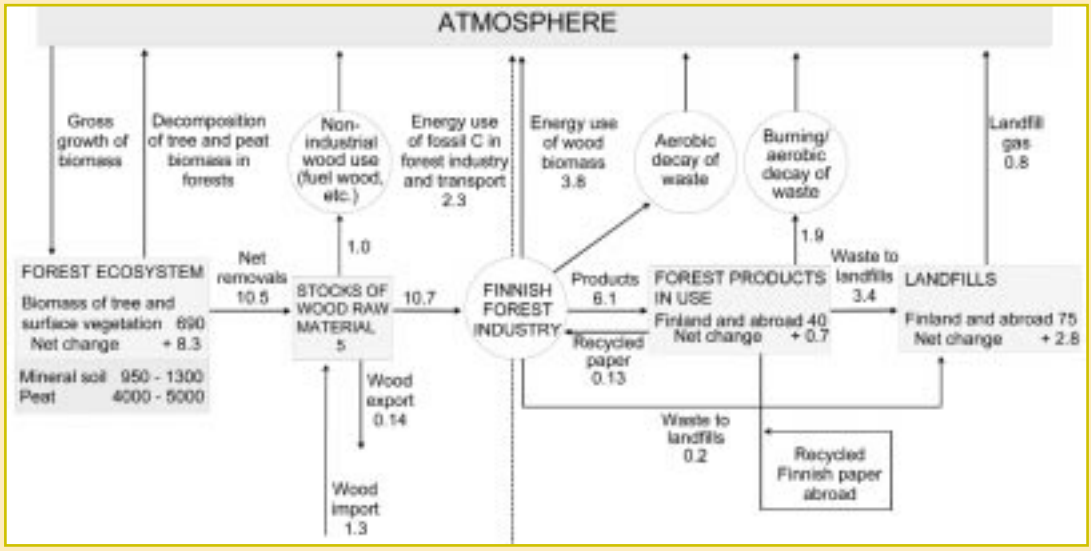
In a 'normal forest' there is an equal area in each age class. In this case (as shown in the Figure below) when one stand is felled, approximately half of the stand carbon is removed in the logs, and the remainder is oxidised over time in the forest. The remaining stands in the forest continue to sequester carbon thus maintaining an equilibrium of total carbon stock in the entire forest.

Under the Kyoto Protocol, only forests that have been planted since 1990 can be offset against emissions. In New Zealand, it is expected that commercial forests planted after 1990 ("Kyoto forest") will become increasingly important relative to the existing estate.



Modelling the Finnish forest sector carbon balance

Prepared by K. Pingoud and T. Karjalainen (kim.pingoud@vtt.fi)



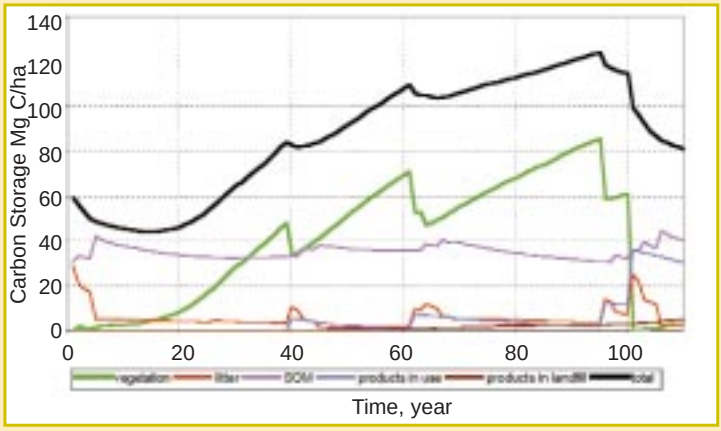


Figure top: The carbon reservoirs (Tg C), the changes in them and the fluxes (Tg C a-1) of the Finnish forest sector in 1990 were estimated by Pingoud et al.(1996). The carbon reservoir of wood-based products in Finland and its rate of change were estimated with the aid of direct inventories of wood products in buildings and elsewhere. However, most of the products were exported, and the total reservoir estimates including the exports are based on an extrapolation. The calculated greenhouse gas balance of the Finnish forest sector depends crucially on the approach for estimating the fate of carbon from forest harvesting and wood products (Pingoud, 1997).

An example of the development of carbon stocks in forests and wood products is shown in the Figure lower right. The simulation was made with a carbon budget model for forests and wood-based products (Karjalainen, 1994). The simulation was started after clearcut. The whole system is a source of carbon during the first ten years, while more carbon is released from decomposing litter and soil organic matter (SOM) than is sequestered by young, growing trees. The stand is thinned tree times (years 39, 61 and 94) and clearcut year 100. After each harvest, part of the living biomass is transferred to litter (harvest residues), to wood products and into the atmosphere (processing losses). The model has been applied to estimate the impact of different forest management practices and climate change on forest and wood product carbon budget, both on stand level and on regional level (e.g. Karjalainen 1996, Pussinen et al. 1997, Mäkipää et al. 1998).

CO_2 mitigation cost for biomass and natural gas systems with decarbonization

Prepared by L. Gustavsson and A. Karlsson (leif.gustavsson@miljo.lth.se)

Reductions of greenhouse gas emissions can be achieved by several technological options in the energy supply sector. We have analysed the carbon mitigation cost for biomass systems and natural gas systems with decarbonization.

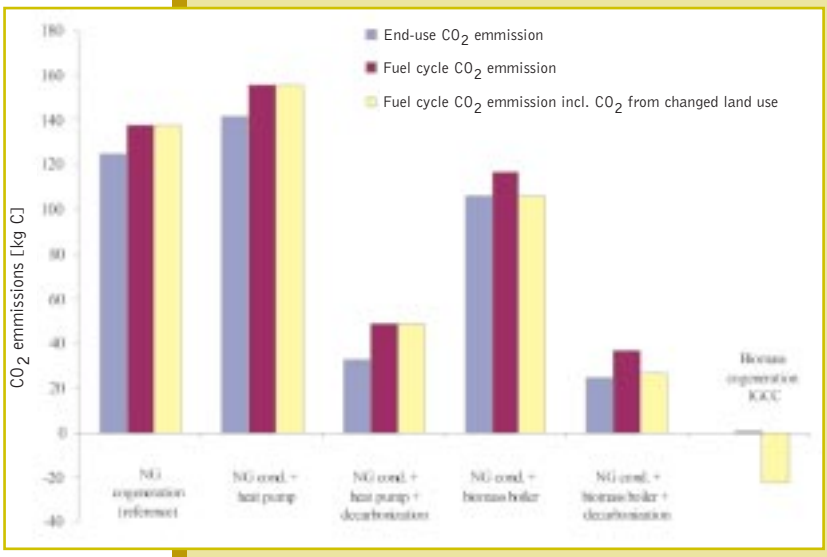


Diagram upper left: End-use and fuel-cycle CO_2 emission of producing 1.0 MWh of power and 1.0 MWh of heat for different energy systems, as well as the CO_2 emission balance when both the fuel-cycle CO_2 emission and the CO_2 emission from the change of land use are included. Biomass is Salix cultivated instead of annual food crops.

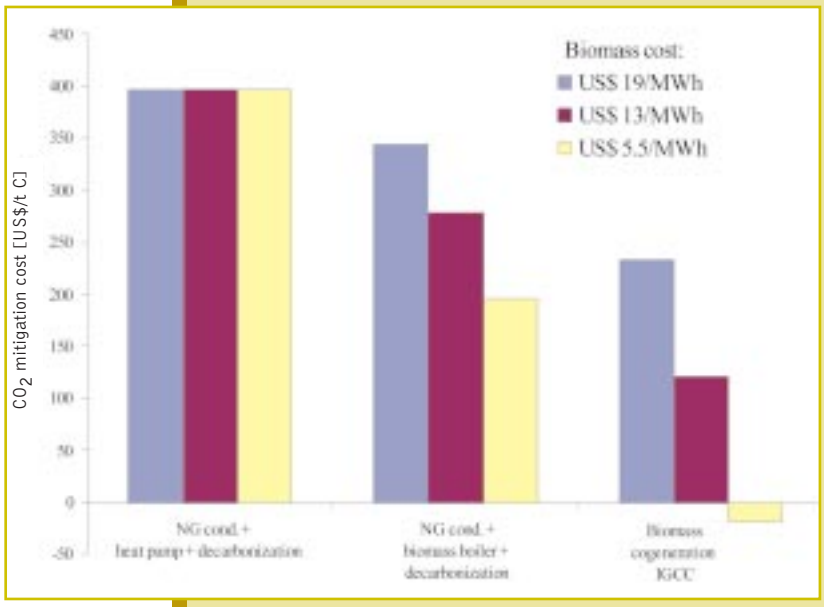


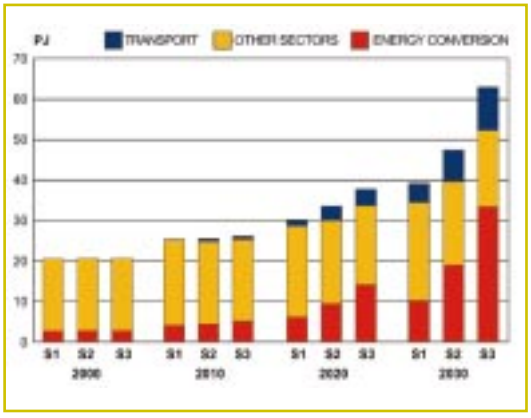
Diagram lower left: CO_2 mitigation cost when considering the fuel-cycle CO_2 emission including the CO_2 emission from change in land use. The reference energy system is a natural gas-fired, cogeneration plant with combined cycle technology and the reference land use is the cultivation of annual food crops on mineral soils. The current cost of Salix in Sweden is about 19 US$/MWhfuel which might be reduced to 13 US$/MWhfuel by improvements in plant breeding and cultivation methods. Transportation cost of 3 US$/MWhfuel is included. Salix is also a suitable crop for a vegetation filter and if used for waste water treatment, the cost including transportation might be 3-8 US$/MWhfuel. The CO_2 mitigation cost is lower for biomass systems using IGCC technology than for natural gas systems using decarbonization and the cost could even be negative. [L. Gustavsson and P. Börjesson (1998) Energy Policy 26:9, pp. 699–713].

Energy Strategy of Croatia: bioenergy use and related GHG emission reductions

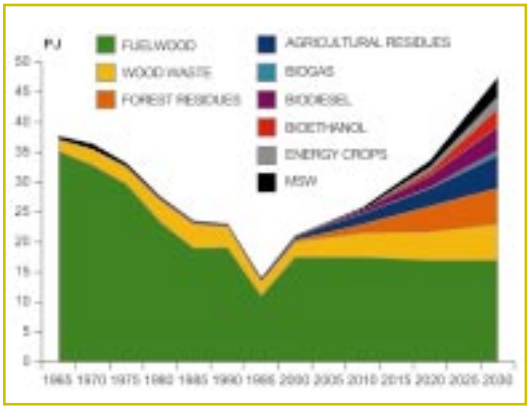
Prepared by J. Domac and V. Jelavic
(jdomac@eihp.hr)

The Energy Strategy of the Republic of Croatia, issued in 1998, has considered three different scenarios. The first of them (S-1, "low") was based on a slow introduction of advanced technologies and does not include any governmental support. The second scenario (S-2, "moderate") includes stronger concerted policy for introduction of new technologies, use of renewables and increasing energy efficiency. Finally, the third scenario (S-3, "high"), a "very environmental" scenario, comprises that problems with pollution and greenhouse effects will significantly affect energy policy in Croatia as early as 2010. Unlike other renewables, bioenergy has a significant position in all scenarios (see Figure below).

Energy scenarios for biomass use in Croatia



Past and future energy production and biomass use in Croatia



Bioenergy systems in Croatia offer significant possibilities for GHG emission reductions in Croatia (more than 10% in scenario S-3) and should be given more attention in the future (see Figure above and Table below).

Contribution of bioenergy systems to GHG emission reductions in Croatia

Scenario/year	2010	2030
S-1 ("low")	5.9 %	5.4 %
S-2 ("moderate")	6.3 %	7.0 %
S-3 ("high")	6.5 %	10.1 %

Research of GHG balances of bioenergy systems in Croatia involves scientists and experts from the following institutions: EKONERG holding, Energy Institute "Hrvoje Pozar", and the State Directorate for Environment.

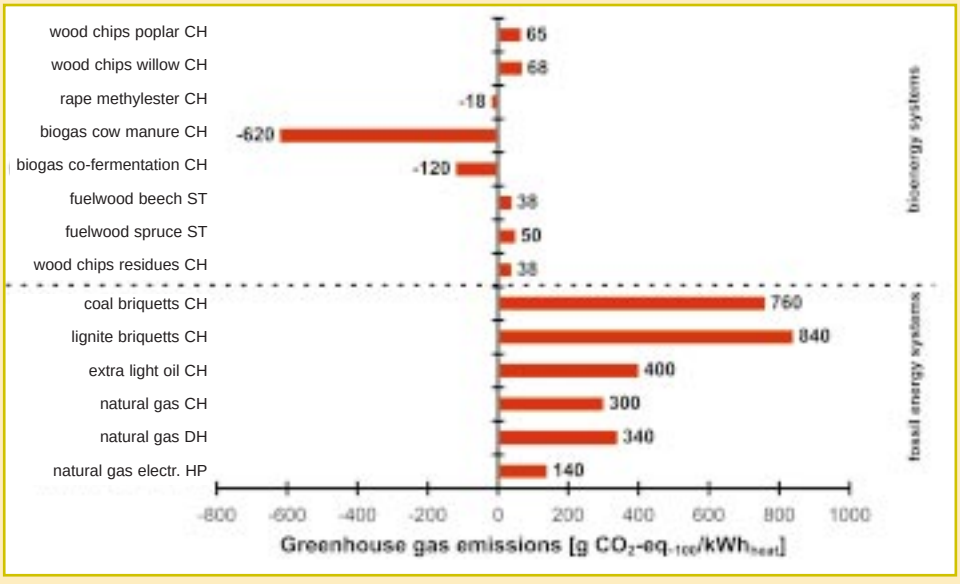
Greenhouse gas balances of bioenergy systems in Austria – first results

Prepared by G. Jungmeier
(gerfried.jungmeier@joanneum.ac.at)

In this project we apply the standard methodology developed by IEA Bioenergy Task 25. Different bioenergy systems, supplying electricity and/or heat from various sources of biomass, are analysed based on the situation in Austria in 2000 and 2020. The life cycle emissions of greenhouse gases (CO_2, N_2O, CH_4) are calculated for about 300 biomass and 100 fossil energy systems and compared with each other. Greenhouse gas implications of land use changes, reference use of biomass and of by-products are considered.

The first results of the life-cycle greenhouse gas emissions, here for heat supply systems, demonstrate that some bioenergy systems are associated with "negative" emissions, as shown in the diagram below for biogas and methylester. In the case of biogas this is mainly because emissions from the reference biomass use are avoided (the reference use of manure is storing the manure – associated with uncontrolled emissions of methane). In the case of biodiesel it is due to substitution effects of by-products (the by-products of methylester are glycerin that substitutes for conventionally-produced glycerin for chemical use and rape cake that substitutes for soybean feed).

The comparison of bioenergy systems with fossil energy systems shows that a significant reduction of greenhouse gas emissions is predicted in all possible "combinations" of bioenergy and fossil energy systems in the Diagram. The net reduction of emissions is greatest when central heating based on lignite briquettes is displaced by central heating with biogas from cow manure.



CH Central Heating
ST Stove
DH District Heating
HP Heat Pump

1 g CO_2 = 1 g CO_2 Eq.100, 1 g CH_4 = 21 g CO_2 Eq.100, 1 g N_2O = 310 g CO_2 Eq.100

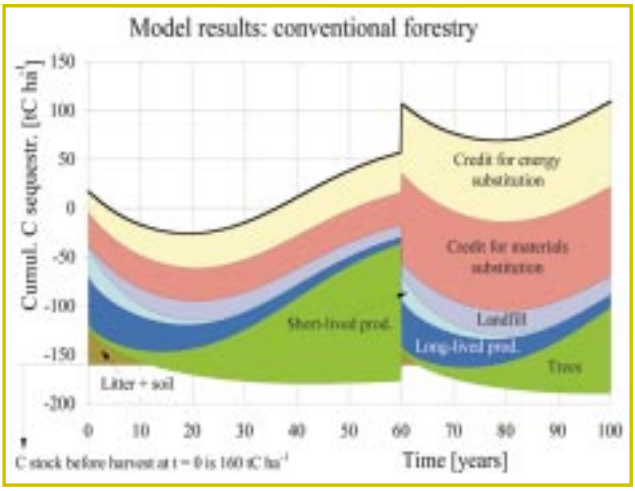
Some results from the Graz/Oak Ridge Carbon Accounting Model (GORCAM)

Prepared by B. Schlamadinger and G. Marland
(bernhard.schlamadinger@joanneum.ac.at)

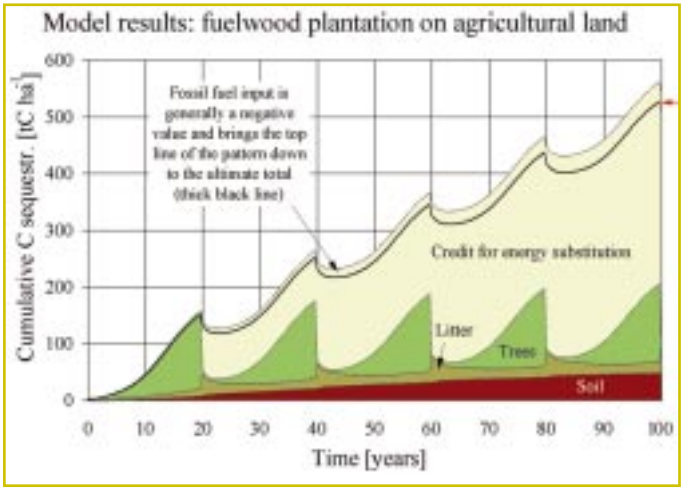
GORCAM is an Excel spreadsheet model that has been developed to calculate the fluxes and stock changes of carbon associated with land use, land use change, bioenergy and forestry projects. The model considers 1) changes of carbon (C) stored in vegetation, plant litter and soil, 2) reduction of C emissions because biofuels replace fossil fuels, 3) C storage in wood products, 4) reduction of C emissions because wood products replace energy-intensive materials like steel or concrete, 5) recycling or burning of waste wood, and 6) auxiliary fossil fuels used for production of biofuels and wood products. Some illustrations of model output are shown below.

The diagram below shows the modelled scenario for 1 hectare of agricultural land that is afforested to produce biofuels on a 20 year harvest cycle. The diagram shows, successively from the bottom, net carbon (C) uptake in soil and litter, net C increase in trees, and saved C emissions from fossil fuels because biofuels from the plantation are used instead.

There is an input of fossil fuels required for land management, processing biofuels, etc. To the extent that this exceeds the comparable energy requirements of the displaced fossil fuel, the appropriate amount of C emissions is subtracted from the top line and the final net gain in C sequestration is represented by the line indicated with the red arrow.

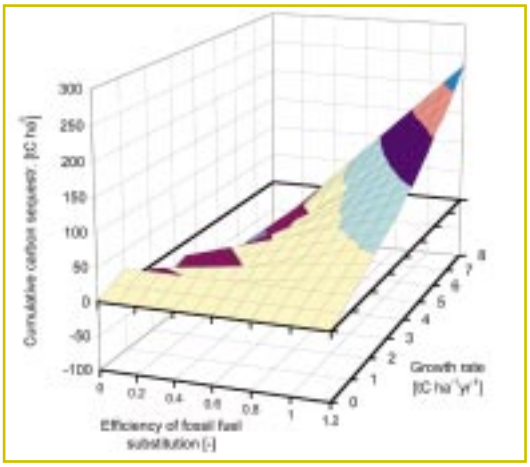


The diagram above, shows the scenario for a forest of 160 tC/ha that is harvested at time = 0 to produce wood products and biofuels and is then replanted. Due to the initial harvest there is an initial net loss of on-site carbon, so that the baseline of the plot starts at -160 tC/ha. The harvest-rotation period is 60 years.



The diagram over page shows, successively from the bottom, net carbon (C) uptake in soil and litter (net decreases are represented by a drop in the baseline of the plot), net C increase in trees, net C storage in long-lived products, net C storage in short-lived products, net C storage in landfills, C in fossil fuels not burned due to substitution of wood-based materials for more energy-intensive materials, and C in fossil fuels displaced by biofuels.

This diagram shows the relative advantage after a period of 40 years if surplus agricultural land is used for biofuel production (and fossil fuel substitution) rather than for afforestation without harvest. The net carbon advantage depends on the growth rate of the site and on the efficiency with which fossil fuel carbon emissions are reduced through the use of biofuels. Biofuel production is the better choice especially with efficient use of biomass and for high growth rates.

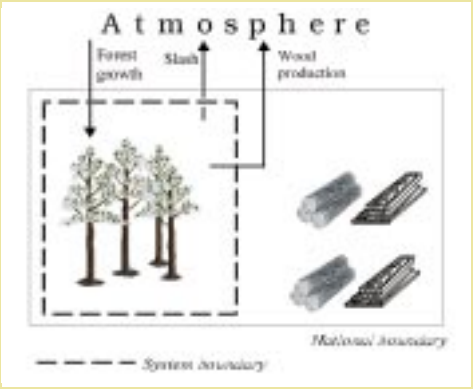


Accounting for wood products in national greenhouse gas inventories

Prepared by B. Schlamadinger (bernhard.schlamadinger@joanneum.ac.at)

The Intergovernmental Panel on Climate Change (IPCC) has prepared guidelines which countries use to prepare inventories of their greenhouse gas emissions. For carbon fluxes in forestry and wood products the IPCC approach (shown in the Diagram right) has been used in the last few years, which essentially only considers carbon stock changes in forests. IPCC is now investigating alternative approaches (1 to 3 in the Diagrams following) to better deal with wood products. These approaches are presented here. The Task 25 involvement comes from our concern that biomass fuels continue to be treated as a renewable source of energy in national greenhouse gas inventories.

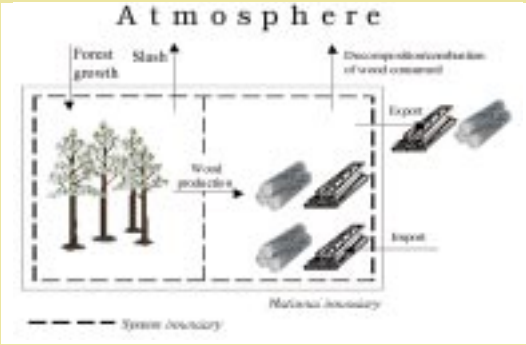
Current IPCC approach:



Stock changes in forests of a country are accounted for in the national inventory of greenhouse gas emissions. The system boundary is around the forest of a particular country. Biomass fuels are accounted for as CO_2 neutral.

Stock change = forest growth - slash - wood production

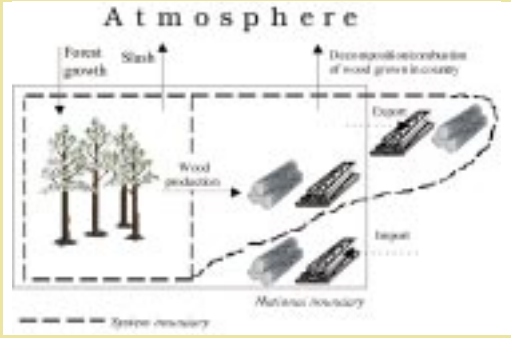
Alternative 1:



Stock change approach: Stock changes in forests of a country, and in addition in wood products used in that country, are accounted for in the national inventory of greenhouse gas emissions. The system boundary is around the forests and wood products of a particular country. Biomass fuels are accounted for as CO_2 neutral.

Stock change = (forest growth - slash - wood production) + (wood consumption - decomposition / combustion of wood consumed)

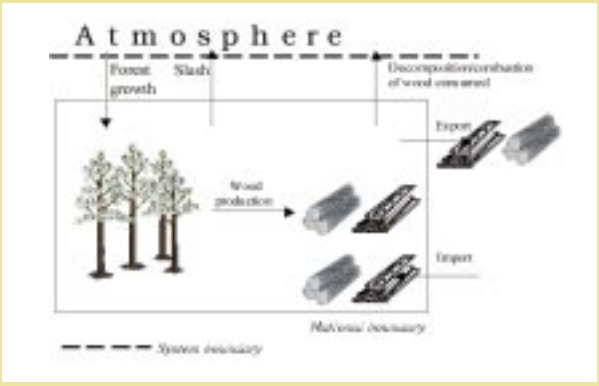
Alternative 2:



Production approach: Stock changes in forests of a country, and in addition in wood products produced by that country, are accounted for in the national inventory of greenhouse gas emissions. The system boundary is around the forests of a particular country, and around the products from wood grown in that country. Biomass fuels are accounted for as CO_2 neutral.

Stock change = (forest growth - slash - wood production) + (wood production - decomposition/combustion of wood grown in country)

Alternative 3:



Atmospheric flow approach: Carbon flows to and from the atmosphere are accounted for in the national inventory of greenhouse gas emissions. The system boundary is between the country and the atmosphere. Biofuels are treated like fossil fuels, i.e., the end user reports emissions from combustion.

Atmospheric flow = forest growth - slash - decomposition / combustion of wood consumed

International Energy Agency

The International Energy Agency (IEA) is an autonomous body which was established in 1974 within the framework of the Organization for Economic Cooperation and Development (OECD) to implement an international energy programme. It carries out a comprehensive programme of energy cooperation among its member countries.

The basic aims of the IEA are:

- to improve the world's energy supply and demand structure by developing alternative energy sources and increasing the efficiency of energy use;
- to maintain and improve systems for coping with oil supply disruptions;
- to operate a permanent information system on the international oil market;
- to promote rational energy policies in a global context through cooperative relations with non-Member countries, industry and international organizations;
- to assist in the integration of environmental and energy policies.

A. Introducing IEA Bioenergy

Welcome to this Annual Report for 1998 from IEA Bioenergy!

IEA Bioenergy is the short name for the international bioenergy collaboration within the International Energy Agency - IEA. A brief description of IEA is given on the preceding page.

Bioenergy is defined as material which is directly or indirectly produced by photosynthesis and which is utilized as a feedstock in the manufacture of fuels and substitutes for petrochemical and other energy intensive products. Organic waste from forestry and agriculture, and municipal solid waste are also included in the collaborative research, as well as broader "system studies" on techno-economic aspects and greenhouse gas balances.

The IEA Implementing Agreement on Bioenergy, which is the "umbrella agreement" under which the collaboration takes place, was originally signed in 1978 as IEA Forestry Energy. A handful of countries took part in the collaboration from the beginning. In 1986 it broadened its scope to become IEA Bioenergy and to include non-forestry bioenergy in the scope of the work. The number of participating countries has increased during the years as a result of the steadily increasing interest in Bioenergy worldwide. At the end of 1998, eighteen parties participated in IEA Bioenergy: Austria, Belgium, Brazil, Canada, Croatia, Denmark, Finland, France, Italy, Japan, Netherlands, New Zealand, Norway, Sweden, Switzerland, United Kingdom, United States and the Commission of the European Communities.

IEA Bioenergy is now 20 years old and is a well-established collaborative agreement. All OECD countries with significant national Bioenergy programmes are now participating in IEA Bioenergy, with very few exceptions. Recently, the IEA Governing Board has decided that the Implementing Agreements within IEA may be open to non-member countries, i.e. for countries that are not members of the OECD. For IEA Bioenergy, this has resulted in a large number of inquiries from potential participants, and as a consequence of this, a number of new members are expected.

The work within IEA Bioenergy is structured in a number of Tasks, which have well defined objectives, budgets and time frames. The collaboration which earlier was focused on Research, Development and Demonstration is now increasingly also emphasising Deployment on a large scale and worldwide.

There are twelve ongoing Tasks during the period 1998-2000:

Task 17: Short Rotation Crops for Bioenergy

Task 18: Conventional Forestry Systems Bioenergy

Task 19: Biomass Combustion

Task 20: Thermal Gasification of Biomass

Task 21: Pyrolysis of Biomass

Task 22: Techno-Economic Assessments for Bioenergy Applications

Task 23: Energy from Thermal Conversion of MSW and RDF

Task 24: Energy from Biological Conversion of Organic Waste

Task 25: Greenhouse Gas Balances of Bioenergy Systems

Task 26: Biotechnology for the Conversion of Lignocellulosics to Ethanol

Task 27: Liquid Biofuels

Task 28: Solid Biomass Fuels Standardization and Classification

In addition, there is a special kind of Task (Task XVI: Technology Assessment Studies for the Conversion of Cellulosic Materials to Ethanol in Sweden) involving two participants - USA and Sweden. This Task which began in the previous programme period, is the first effort within IEA Bioenergy to undertake a more market orientated programme, with strong industrial involvement.

Members of IEA Bioenergy are invited to participate in all of the Tasks, but each member is free to limit its participation to those Tasks which have a programme of special interest. The Task participation during 1998 is shown in Appendix 1.

A progress report for IEA Bioenergy for the year 1998 is given in Section B of this Annual Report.

B. Progress Report

1. THE EXECUTIVE COMMITTEE

The IEA Bioenergy Executive Committee acts as "the board of directors" of IEA Bioenergy. The Committee plans for the future, appoints persons to do the work, approves the budget and, through its members, raises the money to fund the programmes and administer the Agreement. The Executive Committee (ExCo) also scrutinizes the progress reports and accounts from the various Tasks within IEA Bioenergy.

The 41st ExCo meeting took place in Saltsjöbaden, Sweden, on 13-14 May 1998. The 42nd ExCo meeting was held in Christchurch, New Zealand, on 18-19 November 1998.

During 1998, Olav Gislerud from Norway was Chairman of the ExCo and Josef Spitzer from Austria was Vice Chairman. At the ExCo42 meeting, Josef Spitzer was elected Chairman for 1999, and Kyriakos Maniatis of the CEC was elected Vice Chairman.

On 1 January 1998, the ExCo Secretariat moved from Tellus Energi AB, Sweden to Rotorua, New Zealand under the new Secretary, John Tustin. At the same time, the fund administration for the ExCo and Task funds was also consolidated with the Secretariat, and the newsletter and website transferred from Aberdeen University to Rotorua. This consolidation of the management of IEA Bioenergy was a major step. It was implemented successfully with good cooperation of all those involved, especially the outgoing Secretary, Tor Leif Andersson and Paul Mitchell at Aberdeen. The new addresses can be found in Appendix 5.

The work in the ExCo, with some of the achievements and issues during 1998, is described below.

The new programme for 1998-2000

During 1997, much of the meeting time in the Executive Committee was devoted to the preparation of a new programme for the period 1998-2000. In doing this, the ExCo decided to introduce a new system for the administration of the collaborative work within the Tasks. The "old" system was based on a few Tasks (3-5), each with a number (5-10) of Activities. Each Task had its own administration, including fund handling, and funding was provided so the Operating Agent could hire a person to be the administrator/coordinator for the Activities within the Task. As a result of this, the IEA Bioenergy Budget was spread over a number of member countries and was approved in a number of currencies.

In the new system which started from January 1998, the work is organized in a larger number (around 13) of smaller Tasks, each with very well focused objectives, and lead by a Task Leader. The Operating Agent is the ExCo Member of the country that is leading the Task, and the Operating Agent will not use any IEA Bioenergy funding for that role. The funding for all the Tasks, as well as for the ExCo Secretariat, is managed by a Fund Administrator, who is the same person as the ExCo Secretary. All the funding is now handled through one place, and all the budgets (for the Tasks and for the Secretariat) are in US dollars. By this, the ExCo has made an effort to get a consolidated, more focused programme at a lower cost.

Ten new Annexes were approved at ExCo40 viz. Annexes 17-26 inclusive. Two additional new Annexes have been approved since that time as follows: Task 27: Liquid Biofuels at ExCo41; and Task 28: Solid Biomass Fuels Standardization and Classification at ExCo42, see Appendices 1 and 2.

In connection with the start of this new programme, the duration of the Implementing Agreement on Bioenergy was prolonged until 31 December 2001.

Supervision of Ongoing Projects. Review and Evaluation

The progress of the work within IEA Bioenergy is reported by the Operating Agents to the Executive Committee twice per year in connection with the ExCo meetings. As part of this process, at ExCo40 it was decided that two or three Task Leaders should be invited to attend each ExCo meeting to make the Task presentation on their progress and programme of work personally. The idea was to improve the communication between the Tasks and the Executive Committee and also to involve the ExCo more with the Task programmes. Previously, there had been Technical Advisory Committees in most of the Tasks, which had also monitored progress and assisted the Operating Agents in the evaluation of the work and in the planning for the future. For the new Tasks, there are no Technical Advisory Committees.

The work within IEA Bioenergy is regularly evaluated by the IEA Committee for Energy Research and Technology (CERT) via its Renewable Energy Working Party (REWP) and reported to the IEA Governing Board. An evaluation of the period 1995-1998 was made during 1998. In connection with this, the Secretary and Chairman prepared a comprehensive reply to a REWP questionnaire. The outcome of the review was that IEA Bioenergy was regarded as a strong and well-established programme with appropriate objectives and good management. However there were some recommendations for initiatives which would strengthen the collaboration. These included: increased participation from member and non-member countries, stronger links to other relevant Implementing Agreements (especially those under the REWP) and closer coordination with the European Commission's bioenergy programmes.

There is regular contact between the IEA Bioenergy Secretariat, and IEA Headquarters in Paris. There is also active participation by ExCo representatives in relevant meetings. For example, in 1998 the ExCo had two participants at the IEA Expert Workshop, Biomass Energy: Data, Analysis and Trends. Other interactions included representation at the 34th meeting of the REWP, providing comments on the draft REWP Strategy document and discussion with the relevant Chairman of how IEA Bioenergy could assist the CERT contribution to the 1999 Ministerial meeting.

Approval of Task and Secretariat Budgets

The budgets for 1998 approved by the Executive Committee for the ExCo Secretariat and for the Tasks are shown in Appendix 2. Total funds invoiced in 1998 were US$1,044,080; comprising US$112,050 of ExCo funds and US$932,030 of Task funds. Appendix 2 also shows the financial contributions made by each member country. Very substantial "in-kind" contributions are also a feature of the IEA Bioenergy collaboration but these are not shown because they are more difficult to value in financial terms.

For Task XVI, the budget is US$500,000, part of which is covered by industrial partners. These funds are not shown in Appendix 2 because they are not handled by the IEA Bioenergy Fund Administrator. In addition, there are also considerable "in-kind" contributions to this Task.

Fund Administration

The ExCo account managed by the Swedish National Energy Administration was closed on 31 March 1998. The sum of US$79,113 was transferred to the new IEA Bioenergy account in New Zealand. Audited accounts for the ExCo fund to 31 March 1998 were approved at ExCo41.

The audited accounts for Tasks XII to XV inclusive were approved at ExCo42. The sum of US$25,671 of unspent Task funds was returned to the Executive Committee.

The International Energy Agency, Bioenergy Trust Account, at the National Bank of New Zealand is functioning smoothly. The account is accessed electronically by Forest Research on behalf of the Secretariat. The account is an interest bearing account denominated in US dollars. Details for making payments are:

Remit funds to:	Chase Manhattan Bank, New York, USA Swift Code: CHASUS33
For credit of account:	The National Bank of New Zealand Limited Wellington, New Zealand
Account number:	001-1-941473
Quoting:	IEABIO-USD00 plus the invoice number.

The currency for the whole of IEA Bioenergy is now US Dollars. KPMG is retained as an independent auditor. The main issues faced in fund administration are slow payments from some member countries, and unidentified transfers to the Bioenergy Trust Account.

Strategic Plan 1998-2002

The first Strategic Plan for IEA Bioenergy was issued early in 1995 and was based on the Shared Goals that had been adopted by the IEA Ministerial Meeting in 1993. In 1997, it was felt that a revised Strategic Plan should be developed. The need for this was recognition of the impact of increased bioenergy use on predicted global climate change, increased interest shown by non-member and developing countries to participate in IEA Bioenergy, the changing information needs of the developing bioenergy industry, revision of the REWP strategy, reorganization of the Task and operational structure of IEA Bioenergy, and increased access to the Internet. Paul Mitchell and Don Stevens were contracted by the ExCo to consult widely with IEA Bioenergy participants and to produce a final draft for discussion and approval at ExCo42. The finalized plan was published and circulated in December 1998, see Appendix 3.

New Participants

It is pleasing to report that Brazil and Croatia both joined IEA Bioenergy during 1998. Brazil signed the Implementing Agreement on 24 June with the National Department of Energy Development of the Ministry of Mines and Energy as the Contracting Party. Croatia signed the Implementing Agreement on 25 September with the Energy Institute "Hrvoje Pozar" as the Contracting Party. In addition, Australia requested a formal invitation to join the Collaboration at ExCo42. Through Dr Stephen Schuck of the Australian Biomass Taskforce, they are in the process of forming groups to participate in various Tasks. Australia is expected to join in 1999.

The increase in inquiries from non-participants noted previously has been ongoing in 1998. At the end of 1998 there were around six possible new participants who had indicated their interest to a greater or lesser extent and who had sent observers to ExCo meetings.

Seminars and Workshops

A large number of seminars and workshops are arranged every year by individual Tasks within IEA Bioenergy. This is a very effective way to exchange information between the participants. These meetings are described in the progress reports from the different Tasks later in this Annual Report and the papers presented at some of these meetings are listed in Appendix 3.

Occasionally, seminars and workshops are also arranged by the Executive Committee. In March 1998, the ExCo supported a series of workshops and seminars in New Zealand and Australia. These included:

- a conference "Bioenergy in the Environment" organized with the New Zealand Energy Efficiency and Conservation Authority. This meeting was supported by all of the Tasks and had 70 participants.
- a workshop "Fundamentals of Waste to-Energy" organized with the Waste Management Institute of New Zealand. This meeting was supported by Task XIV with a focus on MSW opportunities. There were 80 participants.
- a Task XII "End-of-Task Study Tour" with 50 participants.
- a Task XV/Task 25 Workshop "Effects of Kyoto Protocol on Forestry and Bioenergy Projects for Mitigation of Net Carbon Emissions" with 48 participants.
- an End-of-Task Workshop "Accomplishments in Bioenergy Production Research 1995-97". This was a Task XII meeting also supported by the other Tasks and held in conjunction with CSIRO Division of Forestry and Forest Products. It included a number of Australian guests.

The benefits from this exercise were to stimulate New Zealand and Australian R&D programmes in bioenergy, to encourage the Australasian bioenergy industry to participate in this research, to highlight contributions already being made to IEA Bioenergy and to encourage formal Australian participation in the IEA Bioenergy collaboration. Overall, this series of meetings was judged to be very successful and the key input from northern hemisphere IEA Bioenergy members was greatly appreciated.

Information Material and Promotion

Early in 1998, a new publicity brochure for IEA Bioenergy was designed, printed and distributed. This has proved very useful for answering inquiries and also to distribute at conferences and exhibitions in support of the IEA Bioenergy poster display. Copies are available from the Secretary on request.

The new brochure initiative was followed by the preparation of a new four-panel, poster display for conference and trade exhibition use. At ExCo41, it was decided that the Secretary would send copies of the new posters to each ExCo member on a floppy disk to facilitate publicity within each member country. More recently, copies of the new posters were also sent to each Task Leader on disk. These contained a template for a fifth poster so that each Task Leader could make a poster about his specific Task which was compatible with the existing four IEA Bioenergy posters. It is expected that this action will result in some good promotion for IEA Bioenergy. Access to the poster display can be through the Secretary, any ExCo member or the Task Leaders.

There has been a unanimously favourable reaction to the "new look" IEA Bioenergy News. Two issues of this IEA Bioenergy newsletter were published in 1998. A free subscription is offered to all interested and there is a wide distribution outside of the normal IEA Bioenergy network. Much work has been done to upgrade and refine the mailing address database. It is proposed that future editions will be distributed in June

and December each year which follows the pattern of ExCo meetings. Because postage is a major cost item, it is proposed that use of the website for distribution will be a major initiative after December 1998. Another economy move is to organize centralized distribution from an agreed base within those member countries which are prepared to assist in this way. The contacts for the Newsletter Editor are provided in Appendix 5.

A World Wide Web page for IEA Bioenergy on the Internet was established in 1996. This website was moved from Aberdeen University to Rotorua, New Zealand, in early 1998. The new address is: http://www.forestresearch.cri.nz/ieabioenergy/home.htm. In June, a total revamp of the site was released with a "frames" format for clarity and simple navigation between sections. Links are provided to the homepages of each of the current Tasks as well as the IEA Headquarters Homepage, other IEA Implementing Agreement sites and other Bioenergy sites. The site is proving a popular source of information about IEA Bioenergy. In the future, the site will include more detailed information on each of the Tasks and be used more frequently to distribute "hot topic" news items, and the regular IEA Bioenergy newsletters.

An article on IEA Bioenergy was provided to IEA GreenTie for the April 1998 issue of its quarterly newsletter. The circulation is 15,000 subscribers in 37 countries.

IEA Bioenergy took an exhibition stand at the 10th European Conference on Biomass for Energy and Industry in Würzburg, Germany and displayed the new posters. Details on IEA Bioenergy were published in the exhibition catalogue using material supplied by the Secretary and copies of the new brochure were placed in all the participant kits. The Chairman gave an oral presentation on IEA Bioenergy which was well attended by delegates. Overall, a significant profile for IEA Bioenergy was achieved.

Position Paper on Greenhouse Gas Mitigation

At ExCo41 it was decided that IEA Bioenergy was well placed to produce a position paper on Greenhouse Gas Issues and in so doing, provide leadership on this important topic. Accordingly, with the help of ExCo members and other experts, Task 25 prepared a position paper on "The Role of Bioenergy in Greenhouse Gas Mitigation" for the Fourth Conference of the Parties to the United Nations Framework Convention on Climate Change in Buenos Aires, Argentina, 2-13 November 1998. This paper is reprinted for readers in Appendix 7.

2. PROGRESS IN 1998 IN THE TASKS

TASK XVI: Technology Assessment of Cellulosic Materials to Ethanol in Sweden

Overview of the Task

The objective of Task XVI is to develop technologies for the conversion of straw and wood to ethanol for transportation fuels. The aim is also to advance the design and assessment of the biomass to ethanol processes for production in Sweden, based on straw and wood residues. Included in the objectives is establishment of combustion characteristics of the lignin remaining after the ethanol production and development of a technical database that can be used for the design of a commercial scale plant. This is the first effort within IEA Bioenergy involving a more market-oriented Task and strong industrial participation.

The participating countries are Sweden and the USA

As in other Tasks, a Task Leader, appointed by the Operating Agent (the USA) directs and manages the work programme. For each participating country, a National Team Leader is nominated who is responsible for coordinating the national participation in the Task.

For further details on Task XVI, please refer to Appendices 2-5 inclusive and www.forestresearch.cri.nz/ieabioenergy/home.htm under "Current Tasks" on the IEA Bioenergy website.

Progress in R&D

The Task was initiated on 15 October 1997 and is planned as a comparatively short (1 year) common effort between Sweden and the USA. The Task has experienced delays due to internal matters within Sweden, but these have been overcome and the project is scheduled to begin in 1999.

The Task held its first meeting in May 1998 in Stockholm, Sweden immediately following ExCo41. This was primarily a planning meeting to discuss the expectations of the participants.

A second meeting, in conjunction with a larger technical meeting, was held in Würzburg, Germany during June 1998 to discuss the anticipated Programme of Work in more detail.

The Task has encountered several difficulties in coming to closure on this agreement. Although the contractual mechanisms were in place, Task funding could not be approved until a reorganization was completed within the Swedish government which led to the formation of a new energy agency - The Swedish National Energy Administration. Delays were also compounded by intellectual property concerns on the part of the Swedish government. Fortunately, these impediments have been overcome and considerable progress has been made.

Work will begin in 1999 at the National Renewable Energy Laboratory in the USA and contracts are now in place that will provide funds to carry out Task work.

Because the project involves proprietary information and the leasing of intellectual property, this will restrict technology transfer. The Task Leader will be reporting to the Executive Committee periodically, at which time reports will become available.

Preliminary informal discussions have taken place on expanding the work to include certain experimental work on softwood fermentation in Phase II.

TASK 17: Short Rotation Crops for Bioenergy

Overview of the Task

The objective of Task 17 is to meet the need of bioenergy industries through technical improvement of biomass crop production technologies, through documenting and disseminating information on the potential environmental benefits of biomass crop production systems, and through developing information to enhance market development in collaboration with the private sector. The overall aim is to further develop the existing short rotation biomass production systems, to improve awareness of the bioenergy production potential of the concept, and to promote use of biomass for energy in participating countries. The intention is to strengthen the contact and cooperation between scientists, machine developers, entrepreneurs in the production chains, and end users, with the aim to improve understanding of the problems and to find means of solving them.

"Short Rotation Crops for Bioenergy" means woody crops such as willows, poplars, *Robinia* and *Eucalyptus* with coppicing abilities as well as lignocellulose crops such as reed canary grass, switchgrass, *Miscanthus* and others.

The country participation includes Canada, Croatia, Denmark, France, Italy, the Netherlands, Sweden, UK, USA, and the CEC. Ireland has expressed its interest to become a member and so have Australia, Finland and Estonia.

The Task Leader participated in the IEA Bioenergy ExCo41 meeting in Sweden 13-15 May 1998, presented Task 17, and gave a slide presentation of the programme of Short Rotation Forestry in Sweden.

For further details on Task 17, please refer to Appendices 2-5 inclusive.

Progress in R&D

Task meetings

The first meeting of Task 17 took place in Uppsala, Sweden, 4-6 June 1998. It was a joint meeting between the representatives of the countries participating in Task 17, representatives of interested IUFRO countries, and members of the Department of Short Rotation Forestry of the Swedish University of Agricultural Sciences. All participating countries were represented with the exception of the CEC, Canada, Italy and UK. Italy sent overheads which were presented by the Task Leader. The proceedings from the meeting is in press.

At the meeting, the main aims of the Task were discussed and formulated as follows:

- to stimulate the full-scale implementation of energy crops in participating countries;
- to strengthen the contacts and cooperation between participating countries, scientists, biomass producers, machine developers, entrepreneurs, and end users;
- to select the most urgent research and development areas, and to suggest projects for cooperation;
- to deliver proceedings from the meetings; and to inform the Executive Committee.

During the meeting in Uppsala each participant gave an overview about activities concerning biomass production for energy purposes in their respective country. They have also submitted a manuscript on the same topic. These manuscripts are now being reviewed and will be published as soon as possible.

Two questionnaires were sent out to the participants. In one of them they were asked to indicate which species they were interested in cultivating for energy purposes in their country, which production, harvesting, and transportation systems they were using, what their end use was, and how the present economy was developing. They were also asked to indicate the environmental consequences of biomass production for energy purposes. In a second questionnaire, they were asked to indicate how many hectares of different energy crops they are cultivating as research and as commercial plantations.

The Task Leader has participated, as chairman of one of the sessions, in an IUFRO conference in Seoul, 12-17 October 1998, with the theme: "Forest Ecosystem and Land Use in Mountain Areas". Many scientists interested in biomass for energy purposes participated and the Task Leader had the opportunity to discuss IEA Bioenergy in general and Task 17. The Task Leader is also Coordinator of the IUFRO group 1.09.00 of Short Rotation Forestry. At an informal meeting members of IUFRO interested in biomass, it was decided to organize a joint meeting of Task 17 and IUFRO group 1.09.00 on Short Rotation Forestry in the Philippines, 3-7 March 1999.

The next Task meeting will be in Iowa USA, probably in the beginning of September 1999, following the 4th Biomass Conference of the Americas in California. This meeting will focus on lignocellulosic crops such as switchgrass, reed canary grass and others. The problems of implementation of biomass in full scale will be one of the main discussion topics of this meeting, together with optimum water conditions for full utilization of the growth potential of interesting species.

Deliverables for 1998

All the manuscripts from the meeting in Uppsala have been refereed and are in press for publication in a scientific series edited by the Department of Short Rotation Forestry, SLU. The results of the questionnaires will also be published.

TASK 18: Conventional Forestry Systems for Bioenergy

Overview of the Task

The objectives of Task 18 are to develop systems and guidelines for environmentally sustainable and economic production of biomass for energy from conventional forestry systems, and to promote their acceptance and use in relation to silviculture, forest management, harvesting and transportation.

The Task is developing and synthesizing information needed to design or implement sustainable forest management and harvesting systems for production of biomass for energy in conjunction with other forest products. Within the overarching theme of sustainability, Task collaborators evaluate productivity, environment, social, economic, and legal and institutional criteria, within the context of plantation and naturally regenerated forests in key forest regions of member countries. These criteria are common to the international processes defining sustainable forest management such as the Montreal Process.

Task collaborators envisage that, through their efforts, integrated assessments of forest management practices, environmental conditions and socio-economic factors will improve productivity, forest health and efficient utilization of forest resources, including biomass for energy, from plantations and naturally regenerated forests in the major forest biomes. The primary end users for Task outputs are forest managers, researchers and bioenergy planners, but Task outputs will also be useful for policy makers, NGOs and the interested public.

Participating in the Task in 1998 were Belgium, Canada, Denmark, Finland, the Netherlands, New Zealand, Norway, Sweden, the UK, the USA and the European Commission. The Task was led during the year by an international team from Canada, Finland and New Zealand. The national teams in participating countries comprise an extensive group of scientific and technical collaborators.

For further details, please refer to Appendices 2-5 inclusive and also the main IEA Bioenergy website at www.forestresearch.cri.nz/ieabioenergy/home.htm.

Progress in R&D

Synthesis publication

A primary Task output is a publication that synthesizes available ecological, physical, operational, social and economic information, and identifies gaps in knowledge related to sustainable biomass production and harvesting systems. During 1998, the general concept of the synthesis publication was developed by the Task leadership team. It was discussed at length during the annual Task workshop and plans for its preparation were elaborated, including a draft outline.

The document will be organized around the criteria for sustainable forest management: productivity, environment, social, economic, and legal and institutional framework. The book will emphasize guiding principles and state-of-the-art knowledge in a concise and distilled form, rather than trying to provide a detailed "how-to" handbook covering every possible situation. The scale of resolution for the information will be primarily at the "forest region" level. Site-specific data or case studies will be used to highlight important information or exceptions. An attempt will also be made to provide information or interpretations on generalizable principles that span forest regions, such as effects of

management on soil carbon. This Task output will also be useful for regional or global modelling applications.

The publication will enable forest resource managers and planners to evaluate the ability of specific forest regions to sustainably meet bioenergy production demands. For some criteria, this process may require specifying scenarios and assumptions related to demands for bioenergy production capacity.

Task workshops

Initial Task meetings were held 14 March in Rotorua, New Zealand and 18 March in Canberra, Australia in conjunction with the End-of-Task workshop and field study tour of IEA Bioenergy Task XII. These meetings, together with visits by Task leaders to Belgium, Croatia, the Netherlands, Sweden and the USA, facilitated development of Task strategies and improved contact and communication between Task participants and prospective participants.

The first annual Task workshop took place in Nokia, Finland 7-11 September 1998. The theme of the workshop was "Developing systems for integrating bioenergy into environmentally sustainable forestry". Workshop technical sessions focussed on evaluation criteria related to the environment and socio-economic issues, and initiated the process of developing a synthesis document. Invited and volunteer papers (21 in all) were presented under the following topics related to criteria of sustainable forest management:

- legal and institutional framework;
- socio-economic issues;
- environmental issues;
- carbon balances and sequestration in conventional forestry (biomass) systems a joint session with Task 25.

The workshop included 2½ days of technical sessions and 2½ days of field visits. Field visits provided opportunities to view and discuss recovery of logging residues for bioenergy and its impacts, the use of such residues in small, medium and large scale heating and combined heat and power plants, the role of fuelwood in early thinnings, and spreading of wood ash and pulpmill sludge in the forest. The workshop in Finland was preceded by a separate field study tour at Vindeln in north-central Sweden 4-5 September. The pre-workshop tour focussed on whole-tree harvesting and its implications for sustainability, new silvicultural systems including wood fuel recovery, the use of biosolids as fertilizer for wood crops that may be used for energy, and the carbon dioxide balance in the forest ecosystem. The Swedish visits were made partly in conjunction with an international meeting on "Modelling carbon-nutrient interactions of forest under climate change".

Forty-eight participants from 13 countries took part in the workshop, 16 participants from 7 countries in the pre-workshop tour. The proceedings of the workshop are being published through the New Zealand Forest Research Institute. In order to expedite publication, the material presented at the workshop by authors has been compiled with a minimum of revision and editing.

Communications and promotion

Communication of the goals, activities and outputs of the Task is a vital element of the promotional aspect of the Task. A strong presence for the Task has been established on the Internet, through the main IEA Bioenergy website, and is being actively maintained. Most Task informational materials are made available through this site, including workshop announcements and a list of collaborators.

A poster describing and illustrating Task goals and the approach taken to achieving them was produced and presented at the 10th European Biomass Conference in Germany in June 1998, along with a four-page poster paper. The poster is presently on display at the Washington, DC headquarters of the US Forest Service.

A full-colour brochure was printed for the Task, modelled on the IEA Bioenergy brochure. Copies of the brochure, which contains basic Task information and contacts, have been distributed through national team leaders and ExCo members.

The Task has prepared the first of a series of Technical Notes, intended primarily to communicate to forest managers and practitioners valuable practical information emerging from Task activities. This first Note, which will be distributed early in 1999, will include a review of the technical lessons to be learned from field visits associated with the workshop in Finland, as well as information on energy wood production in Denmark and the Netherlands.

Collaboration with other Tasks

Several other current IEA Bioenergy Tasks have objectives and interests that are complementary to those of Task 18. Strong links are maintained with these Tasks through sharing of information and joint workshops. The 1998 workshop of Task 18 was held in conjunction with a workshop of Task 25 "Greenhouse gas balances of bioenergy systems" on the theme of "Between COP3 and COP4: the role of bioenergy in achieving the targets stipulated in the Kyoto Protocol". A joint half-day session was held by the two Tasks and opportunities for future collaboration were discussed, including a possible joint paper on soil carbon sequestration and bioenergy options.

Discussions took place with Task 17 "Short rotation crops for bioenergy" regarding possible collaboration, recognizing that there is no clear boundary between the biomass sources of interest to the two Tasks. Opportunities for collaboration and cooperation with other international researchers, organizations and activities are also being pursued, particularly where there is involvement in issues of sustainability of forest ecosystems.

TASK 19: Biomass Combustion

Overview of the Task

Task 19 builds on the work programme of the previous Biomass Combustion Activity within the "old" Task XIII, which ceased in December 1997. Since combustion is well-established commercially and accounts for over 90% of the bioenergy conversion technologies in use, the scope of the work emphasises the expanded use of biomass combustion for heat and power generation, in close cooperation with industry. The main benefits of combustion compared with other technologies (i.e. gasification, pyrolysis, liquefaction) is that combustion technology is commercially available and can be integrated with existing infrastructure. For further implementation, combustion technology should nevertheless be continuously optimised to maintain competitiveness with improving gasification and pyrolysis technologies.

The objective of Task 19 is to stimulate the use of biomass combustion for the production of heat and power on a wider scale. This objective will be achieved by generating and disseminating information on technical and non-technical barriers and solutions. Significant factors in Task 19 are industrial participation, interaction with other IEA Bioenergy Tasks and interaction with the relevant CEC programmes. Enhancement of the industrial participation can be realised by formulating joint projects between participating members and industry.

The emphasis of the activities in the Task is therefore on:

- market introduction for expanding the use of biomass combustion in the short term;
- optimization of biomass combustion technology to remain competitive in the longer term.

The country participation includes Austria; Belgium; Brazil; Canada; Denmark; Finland; France; Netherlands; Norway; New Zealand; Sweden; Switzerland; UK; USA and the Commission of the European Communities. The Task Leader has also received notification of interest from India, Poland, Italy and the Czech Republic.

For further details on Task 19, please refer to Appendices 2-5 inclusive.

Progress in R&D

Task 19 meetings

The first meeting for Task 19 took place in Würzburg, Germany on 9 June 1998 in combination with the 10th European Biomass for Energy and Industry Conference. At this meeting the work programme of Task 19 was agreed upon, using the outcome of a questionnaire filled out earlier by the Task participants. The minutes of this meeting have been distributed amongst the collaborators.

The second meeting took place on 21 October 1998 in Herning, Denmark, in combination with the seminar "Boosting the market for Bioenergy in Europe". At this meeting, the progress of the projects was monitored. In addition, a questionnaire on modelling activities was distributed and a first draft of the state-of-the-art report was discussed. Further, the results of the "International Biomass Ash Workshop" and the Netherlands Best Practise List for biomass fuel and ash analysis were distributed. Industry visits to a gasifier and a chip/grain fired district heating plant were organised by Henrik Houmann Jakobsen from Denmark. The minutes of this meeting are in preparation. With respect to industry participation, it was agreed that all member countries will prepare a list of industry involvement in national biomass projects. In the forthcoming Task meetings, these member country projects will be presented and discussed.

Task 19 projects and progress

Based on the priorities identified and discussions during the first meeting, six projects have been formulated. These are summarised below.

- *Ash related problems during combustion (Coordinator: USA).* The work programme for this project was presented in Herning after which the project started. The subjects being addressed include: agglomeration, deposit formation, aerosol formation and corrosion. The contributors to this project include USA, New Zealand, Sweden, Denmark, Switzerland, Austria and Finland.
- *Ash handling during disposal (Coordinator: Austria).* The subjects being addressed include: characterization, development of a database, legislation, ashes from co-firing and ash treatment. The proceedings of the workshop "Ashes and Particulate Emissions from Biomass Combustion" were distributed to the participants. Among others, this report contains guidelines for ash utilization and the presence and removal of heavy metals from ash. The contributors to this project include Austria, Denmark, the Netherlands, USA, Sweden and Switzerland.

- *Classification of biofuels (Coordinator: the Netherlands).* In the first instance, the subjects being addressed include: an inventory of activities, and an inventory of standards. The project will eventually be structured into more detailed topics after which the member countries may jointly contribute. A Best Practice List on analysing biomass fuels and ashes prepared by the Netherlands, has been distributed. The Task agreed to start a round robin test programme, focussing on biomass fuel and ash analysis. A starting document has been prepared with a description of the project. Items to be analysed are moisture content, ash composition and particle size. The round robin should assess analysis problems and eventually lead to an IEA Bioenergy standard. Austria will prepare and distribute the fuel and ash samples, while the Netherlands will take care of the communication and reporting.
- *Modelling (Coordinator: the Netherlands).* The subject being addressed is an inventory of activities. A questionnaire has been prepared to assess and collate the modelling activities that have been performed in various programmes both within and outside of IEA Bioenergy. Organizations to be approached are the members of Task 19, all Task Leaders of other IEA Bioenergy Tasks and the thirty CEC-JOULE projects that include modelling activities. Task members have as well been requested to distribute the questionnaire to relevant organizations in their respective countries. The contributors to this project are all of the participating member countries.
- *CHP (Coordinator: Switzerland).* The subject being addressed is dissemination/ technology transfer. Switzerland is the sole contributor at this stage. Because it has only recently been initiated, there are no outputs at this stage.
- *State-of-the-art combustion (Coordinator: the Netherlands).* The subjects being addressed include wood stoves, small scale, medium scale, large scale, co-firing and CHP. A draft report has been prepared by the Netherlands and distributed amongst the Task members for comments and additions. Additional inputs to the report are expected in the field of pellet stoves (Sweden), wood stoves (Norway), CHP (Denmark) and emissions (Switzerland). The contributors to this project include the Netherlands, Sweden, Switzerland and Finland. It is intended to publish the final state-of-the-art report as a joint effort with IEA CADDET.

Collaboration with other Tasks

The work of Task 19 is closely related to other IEA Bioenergy Tasks, especially Biomass Gasification, Co-firing of Biomass and Techno-economic Analysis. Coordination of the activities and mutual information exchange is stimulated by arranging exchange of meeting minutes, reports and joint meetings.

TASK 20: Thermal Gasification of Biomass

Overview of the Task

The objectives of Task 20 are to review and exchange global information, seek continuing industrial involvement, and promote coordinated research, development, and demonstration among the participants to eliminate technological impediments to the development and commercialization of thermal gasification of biomass. The ultimate objective is to promote the commercialization of biomass gasification for the production and direct utilization of clean-burning fuel gas as a substitute for conventional fuels; for industrial and power generation applications; and for the production of synthesis gas for chemicals and transportation fuels.

In this Task, "Gas upgrading" means gas clean-up and processing to either enhance the quality of the fuel gas and/or adjust the composition of the gas for subsequent conversion to other fuel forms.

The participating countries are Austria, Brazil, Canada, Denmark, Finland, Italy, Norway, Sweden, Switzerland, the Netherlands, UK, USA and the Commission of the European Communities.

For further details on Task 20, please refer to Appendices 2-5 inclusive.

Progress in R&D

Work Scope, Approach and Industrial Involvement

The proposed approach for the Gasification Task for the period 1998-2000 will build and improve upon that adopted by the previous Gasification Activity within the "old" Task XIII which ceased in December 1997. Information exchange and industrial involvement have been very effective to date and will continue as basic foundations for the work programme of the new Task.

With increasing interest and commitment to "green-energy" in many of the Western countries, emphasis in the work programme will be given to review, discussion, and identification of mature and near-mature small, medium, and large scale gasification technologies that could find immediate application for district heating, cogeneration, and distributed and central power generation. In addition, the participants or working group members (WGM) will study and identify critical technological impediments to commercial implementation of biomass gasification. This study will help the working group members to prioritize and develop their respective organizational and national RD&D plans. When successfully implemented, these RD&D programmes will collectively contribute to expediting the acceptance and commercialization of biomass gasification.

As in previous work, the Task as a whole will review a variety of subtask studies and the key issues related to each subtask study, by electronic mail, faxes, letters and at the semi-annual Task meetings. In this process the projects will be prioritized, a coordinator will be assigned by consensus to lead individual project teams, and schedules will be developed for conducting studies, their review, and ultimately for the publication and distribution of project reports. The Task Leader in consultation with the working group members will conduct joint meetings with other Tasks, and other related national and international organizations to add value to the semi-annual Task Meetings.

The Task will continue the practice of inviting industrial experts to the Task Meetings, to promote interaction between industry and working group members. This interaction is expected to promote the development of technologies where there is clearly an identified need and to incorporate the specific needs of the planned demonstration and commercialization projects in industries' product development and manufacturing plans and schedules.

Task Meetings

Biomass gasification is recognized as an efficient and environmentally clean energy conversion process that can make a significant beneficial impact on the environment. Recognizing this potential, many of the participating countries have either initiated significant biomass gasification projects or they are in the process of developing such programmes to demonstrate their commitment to renewable fuels and to ultimately contribute to mitigating greenhouse gas emissions. In addition to these environmental benefits, renewables-based gasification coupled with advanced power generation schemes are expected to provide reliable and cost-effective energy supply closely coupled with a self-sustainable infrastructure that could provide new employment opportunities and rural

development. Consequently, most of the participating countries have opted to send more than one representative to attend the Task meetings.

The first Task meeting took place in Brussels, Belgium, from 18-20 March 1998. At this meeting, the participants discussed and finalized the work plan consisting of seven subtask studies as described below. The Task participants also agreed on the following schedule for future Task meetings, seminars/workshops on special topics and plant visits:

- End of March 1999 - Lahti, Finland. A one day workshop on "Overview, System improvements, & Research Needs" will be organized with industrial experts. The Plant visit will be to see the Lahti demonstration biomass gasification and co-firing project.
- Mid October 1999 - Province of Quebec, Canada, Special Topic - "Process Waste Treatment, Minimization, & Disposal".
- End of March 2000 - the Netherlands, Special Topic - "Biomass Gasification for the 21st century".
- Mid October 2000 - UK, Special Topic - "Biomass Gasification Fuel Gas Energy Conversion Systems".

The second Task meeting was held from 12-14 October 1998 under the auspices of the Electricity Supply Board in Dublin, Ireland. Mr Nial O'Donnachu inaugurated the second Task meeting with some remarks on the role of renewables in Ireland's future energy mix. The 15 year power purchase agreement incentive plan includes tax breaks for energy produced from wind, biomass, solar etc. Wind is considered to be the best source of renewable energy for Ireland. The national goal is to produce 12% of electricity from renewables by the year 2010. Ireland is considering installing a pilot (about 100 MW) wave energy project. At present 55-66% of primary energy is imported. If the present policies continue and renewable energy is not developed, this number will increase to 96% in the near future. The long term solutions include staged privatization of power production (28% of the power market is targeted to be privatized by year 2000) and implementation of the Alternative Energy Resources plan.

During this meeting the subtask coordinators presented status reports on the work being conducted with the cooperation of working group members (WGM). Following is a list of the subtasks, along with the names of subtask coordinators and associated working group member(s). Most of these subtasks are still in their formative stage which involves definition of the subtask scope and assignment of responsibilities to working group members.

1. *Update surveys, reviews and evaluation of - national RD&D programmes, national gasification projects* (inc. pilot plants and demonstration plants), commercial gasification technologies (suppliers, specifications, performance, cost, and warranties if available). Subtask Coordinator: Kees Kwant, NOVEM, the Netherlands. WGM: All Task participants.

2. *Gas clean-up and gas processing for small-scale gasification plants, treatment, minimization, and utilization of process waste streams, and commercial gas clean-up and gas processing technologies* (suppliers, specifications, performance, cost, and warranties if available). Subtask Coordinator: Henrik Christiansen, DEA, Denmark. WGM: To be announced.

3. *Gas clean-up and gas processing for large-scale gasification plants, treatment, minimization and utilization of process waste streams, and commercial gas clean-up and gas processing technologies* (suppliers, specifications, performance, cost, and warranties if available). Subtask Coordinator: Richard Bain, NREL, USA. WGM: To be announced.

4. *Gas utilization and energy conversion - commercial gas utilization and energy conversion technologies* (suppliers, specifications, performance, cost, and warranties if available). Subtask Coordinator: Nick Barker, AEAT Environment, UK. WGM: To be announced.

5. *Innovative systems, system improvements, research needs and future applications.* Subtask Coordinator: Kyriakos Maniatis, CEC, Belgium. WGM: Richard Bain, NREL, USA.

6a. *Sampling, measuring, and testing procedures: Tar measurement protocol.* Subtask Coordinator: Kyriakos Maniatis, CEC, Belgium. WGM: Nick Barker, AEAT Environment, UK; Esa Kurkela, VTT Energy, Finland. Based on the work conducted since the March 1998 Task meeting in Brussels, draft reports for tar measurement protocols for both large scale and small scale systems have been prepared and reviewed by the Task participants. Discussion is in progress to consolidate these into a single protocol.

6b. *Sampling, measuring, and testing procedures: Fuel gas heating value*. Subtask Coordinator: Lars Waldheim, TPS Termiska Processer AB, Sweden. WGM: To be announced.

6c. *Sampling, measuring, and testing procedures: Evaluation of small-scale gasification systems.* Subtask Coordinator: Ruedi Buehler, IU&E, Switzerland. WGM: Nick Barker, AEAT Environment, UK; Henrik Christiansen , DEA, Denmark; Hube Stassen, BTG, the Netherlands; Richard Bain, NREL, USA; Reinhard Rauch, TU, Austria; and Emanuele Scoditti, ENEA, Italy.

6d. *Sampling, measuring, and testing procedures: Evaluation of large-scale gasification systems.* Task Coordinator: Gert Huisman, Schelde Engineers, the Netherlands. WGM: Erik Rensfelt, TPS Termiska Processer AB, Sweden; Richard Bain, NREL, USA; Esa Kurkela, VTT Energy, Finland; Henk de Lange, Bioelettrica, Italy; and Nick Abatzoglou, University of Sherbrooke, Canada.

7. *Project implementation case studies.* Subtask Coordinator: To be announced.

Task Deliverables for 1998

Four IEA Bioenergy "Thermal Gasification Activity" reports from the past triennium (1994-1997) were completed. Two copies of each will be distributed to the "old" Technical Advisory Committee and also to members of the current Executive Committee (see Appendix 3).

The 1998 Task deliverables include conducting two Task meetings combined with biomass gasification plant visits; submitting meeting minutes; and preparation of the Task progress reports. As stated above under subtask 6a, draft reports have been prepared for a Tar Measurement Protocol for small scale and large scale gasification systems. These reports are being reviewed and the final reports should be ready by September 1999.

All Task reports will be distributed to the Task participants, the ExCo members and the Secretary, IEA Bioenergy.

End of Task Deliverables

The End of Task deliverables will include seven reports, one for each project, plus an overall end-of-Task report. In addition six semi-annual meeting minutes will be produced and distributed.

TASK 21: Pyrolysis of Biomass

Overview of the Task

The overall objective of Task 21 is to develop and extend the Pyrolysis Network (PyNe) that provides a forum for the discussion, evolution and dissemination of all aspects of biomass fast pyrolysis from preparation of feedstock through the fast pyrolysis process to utilization of the liquid product for energy, electricity and chemicals production.

The specific objectives of PyNe are:

- to establish a forum for promotion and development of biomass fast pyrolysis;
- to establish good interactive and collaborative links between researchers, industry and policy makers;
- to actively contribute to the development of the science and technology and resolve major issues to enable the technology to be implemented more quickly and more effectively;
- to ensure that the benefits and advantages of fast pyrolysis are communicated to as wide an audience as possible.

The activities in the Task are focussed on subject groups for development and evolution of science and technology which are discussed and reviewed at regular meetings. These meetings are held two or three times a year. Reports from all these activities are reported in the newsletter and are further disseminated via the website. Each of these topics is reported on below.

The Task is a joint programme between IEA Bioenergy and the CEC. The participating countries are: Austria, Belgium, Brazil, Canada, Denmark, the Commission of the European Communities, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, UK and USA.

As in other Tasks, a Task Leader, appointed by the Operating Agent (the Commission of the European Communities), directs and manages the work programme. In each country participating in Task 21 a National Team Leader is nominated, responsible for the co-ordination of the national participation in the Task.

For further details on Task 21, please refer to Appendices 2-5 inclusive.

Progress in R&D

Task 21 Meetings and Workshops

Three meetings/workshops were held in 1998 as follows:

- a kick off meeting in Salzburg, Austria, February 1998;
- the first Subject Group Workshop in Stratford-upon-Avon, UK, July 1998, which covered Science and Fundamentals. See Apppendix 3;
- the second Subject Group Workshop in De Lutte, Netherlands, November 1998, which covered Implementation. See Apppendix 3;
- the third Subject Group Workshop in De Lutte, Netherlands, November 1998 which covered Environment Health and Safety. See Appendix 3.

Minutes have been published and distributed for all these meetings. Of particular note at the last two meetings was the significantly higher attendance and the high level of industrial participation at over 50% of the attendees.

The technical and scientific focus of the Task is on Subject Groups which are described below.

Analysis and Characterization Group - Dietrich Meier, IWC, Germany and Anja Oasmaa, VTT, Finland

Pyrolysis of biomass means the thermal degradation of their polymeric constituents - cellulose, hemicelluloses and lignin. The unspecific breakdown of the biopolymers leads to the formation of a huge number of compounds ranging from low molecular simple gaseous products to condensable monomeric and oligomeric chemicals with different functional groups, molecular sizes and weights. Thus, the analysis of the liquid products is a challenge due to the complexity of the composition which depends not only on the pyrolysis conditions but also on the type of feedstock and pretreatment procedures. For a comprehensive analysis, many physical and chemical methods have to be applied. Therefore, an ambitious task list for the subject group was established to provide information on feedstocks, standard and novel methods and results of round robin tests. After thorough discussions within PyNe the following objectives were agreed on:

- provide data on feedstock analyses and methods of analysis. Include a few different examples (untreated hardwood and softwood, one agricultural feedstock e.g. straw) including analyses of feedstock and pyrolysis products, and including process type, conditions (pyrolysis temperature, residence time) and char removal method;
- collect data on the effect of pretreatment (e.g. washings) of the feedstock on pyrolysis products;
- collect feedback from pyrolysis liquid end-users (such as Ormrod, Neste, and Orenda) for identifying important properties and evaluating and/or developing suitable test methods;
- evaluate alternative standard methods and new methods for measuring physical properties;
- evaluate new methods for chemical characterization (HPLC, SPE i.e. solid phase extraction, 13C-NMR, FTIR, HS i.e. head space analysis, GPC,);
- conduct a new round robin on physical (water, solids, particles, viscosity etc) and chemical characterization (pyrolytic lignin, water solubles). Suggested samples: fast, slow and vacuum pyrolysis liquids produced under well-defined and documented conditions;
- study and evaluate methods for measuring pyrolysis liquid quality;
- organise a workshop to review progress and present developments in these areas.

The first Subject Group workshop is to be a combined meeting with the Upgrading and Stabilization Subject Group in Montpelier from 23-26 April 1999. The Analysis and Characterization Workshop will take place on 23-24 April and the Upgrading and Stabilization workshop on 25-26 April 1999.

A state-of-the-art review of analysis and characterization is going to be presented at the 4th Biomass Conference of the Americas in Oakland, USA, on 29 August to 2 September 1999.

Health, Safety and Environmental Subject Group - Philippe Girard, CIRARD, France

Fast pyrolysis bio-oils are complex, dark brown coloured, viscous, highly polar and acid substances. The amount of aromatic hydrocarbons in these products is mainly related to process parameters during production and feedstock. Conversion of solid biomass to a liquid fuel can potentially achieve a large reduction in both CO2 and SO2 emissions. However, the bio-oil contains several hundreds of different chemicals in widely varying proportions. Therefore, health, safety and environmental (HSE) issues need to be

considered to assess the impact fast pyrolysis activities can have on these. They can be divided into three sections to assess the consequences of fast pyrolysis activities:

- health and safety in the work place;
- environmental protection;
- incidents occurring during distribution and use.

Fast pyrolysis activities in Europe are increasing due to the development of knowledge and construction of pilot and demonstration plant. According to national and European regulations, producers of any potentially toxic chemicals have a duty to assess and declare the hazards related to the chemicals and risks of exposure (acute or chronic effects).

The main results of the last HSE Subject Group meeting held in the Netherlands included:

- the need to define fast pyrolysis oils as a substance (with the composition and a range of possible concentrations for each component);
- to investigate how to notify this new substance in terms of hazards and risks during manufacture, transport and use, in order to meet the EU chemicals regulation.

A comprehensive set of information will therefore be necessary for official notifications in the CEC. This will certainly constitute a new challenge for the PyNe members and the pyrolysis community.

Implementation Subject Group - Max Lauer, Joanneum Research, Austria

During its first meeting in the Netherlands in November 1998, this PyNe group developed an overview on all the aspects that can influence the rate and extent of implementation of fast pyrolysis technology. Six presentations were given from a range of companies working in the field that showed the problems facing those involved with biomass pyrolysis technologies.

Two workshops were held to consider and overcome the barriers to implementation. As a result of these two workshops, a prioritized list of the barriers that inhibit pyrolysis technology implementation was drawn up and also a set of recommendations developed for handling them. These will be included in the report of the workshops.

The activities of the Implementation Subject Group in the next two years will concentrate on:

- development of an information file for assessment of the opportunities for biomass pyrolysis and applications. This information file will consist of technical data and cost data as well as other necessary information to aid developers and those involved with implementation. PyNe country representatives and other interested persons will then be able to better identify applications with good chances for implementation under the specific regional conditions (such as biomass availability, energy taxes, subsidies, etc) and to also identify applications with more limited opportunities and where further RTD work may be of lower priority;
- comparison of the opportunities and requirements for implementation in different countries and regions;
- preparation of recommendations to give concise but comprehensive views on the opportunities for implementation of all the possible applications for biomass pyrolysis technologies. These recommendations will also be used to identify further promising activities such as research, development and demonstration.

Science and Fundamentals Subject Group - Jan Piskorz, RTI, Canada

A very successful workshop "Science and Fundamentals of Fast Pyrolysis" was held in Stratford-upon-Avon, UK, 22-24 July 1998, (see PyNe Newsletter 6). The workshop was dominated by international experts in the field of mathematical modeling and computer simulation (including Di Blasi, Wojtowicz, Suuberg, Groenli, Arauzo, Peacocke, Antal and Solantausta). The presentations given at the workshop have been submitted to a formal peer review process and it is planned that accepted papers will be published by PyNe. An introduction to pyrolysis modelling is provided on the PyNe website (http://www.pyne.co.uk/). Also please see the summary by Colomba Di Blasi from the University of Napoli "Federico II", Italy.

The importance of the workshop lay in unifying scientists on difficult issues related to the kinetics of cellulose pyrolysis. For years, the kinetic parameters of cellulose pyrolysis have been evaluated by many researchers by means of thermogravimetric analysis. Some of the conclusions from the presentations and discussion included:

- there are several varieties of research grade and technical quality cellulose (micro-crystalline and fibrous) available to researchers;
- these can be easily differentiated and "finger-printed" by routine thermogravimetric analyses, often coupled with other modern analytical methods;
- it is possible to derive rigorous chemical kinetics from carefully obtained thermogravimetric data, but such kinetic parameters should be reported with a detailed characterization of the feed and products. Clearly, important effects of mass and heat transfer limitations in the obtaining and evaluating thermogravimetric data have to be addressed by researchers.

The Group will continue to review and develop this topic and contribute to an improved understanding of the science and fundamentals of fast pyrolysis to aid the technology developers.

Stabilization and Upgrading Group - Stefan Czernik, NREL, USA, and Rosanna Maggi, UCL, Belgium

Biomass pyrolysis oils are known to contain many reactive components and to exhibit significant changes in physical and chemical properties, especially when exposed to air or at elevated temperatures. This oil instability can often be observed as formation of deposits and gums, an increase in viscosity, a decrease of volatility, a phase separation and other undesirable changes occurring on storage or during utilization in boilers, engines or for other applications. These phenomena result from chemical reactions between certain oil components or between the oil components and oxygen. Therefore, an understanding of the bio-oil chemistry is a critical step in preventing or minimizing the processes that degrade oil quality and limit its applications.

The goals of the PyNe Stabilization and Upgrading Group are to explore the nature of the chemical processes occurring in the oil and their relationship with the oil physico-chemical properties, and, finally, to propose methods to prevent or at least to slow down the undesirable processes. These long-term goals will require a substantial effort which will be difficult to employ within the voluntary activity. For this reason, the following shorter-term, more realistic objectives have been agreed:

- review the state-of-the-art work on stability of biomass pyrolysis oils;
- review the literature on stability and stabilization methods for diesel fuel and determine their relevance for bio-oil;
- review the literature on physical and chemical upgrading of bio-oils;
- propose methods for bio-oil stability testing;
- organize a round robin test on stability of crude bio-oil and bio-oil stabilized by two selected methods.

The Upgrading and Stabilization Subject Group is organising a workshop in common with the Analysis and Characterization Subject Group in Montpellier from 23-26 April 1999. The activities carried out and studied in these two fields are complementary and extensive interaction is therefore anticipated. The Analysis and Characterization Workshop will start on Friday 19 April and finish Saturday 20 April 1999 and the Upgrading and Stabilization workshop will start Sunday 21 April and finish on Monday 22 April 1999.

In addition, the group is preparing the review of different chemical and physical upgrading processes. This review entitled "A Review of Physical and Chemical Methods of Upgrading Biomass Derived Fast Pyrolysis Liquids" is co-authored by Stefan Czernik, Rosanna Maggi and Cordner Peacocke and will be presented at the 4th Biomass Conference of the Americas which will be held in Oakland, USA, from 29 August to 2 September 1999.

Newsletter and Website

The biannual newsletter is growing in popularity with continuing demands for copies - 3000 copies are printed and distributed all round the world. Much of the information, including back copies in PDF format, is available on the PyNe Internet site: www.pyne.co.uk.

Promotion

A one page A4 flyer has been produced to promote PyNe. Copies are available from the Task Leader, Tony Bridgwater.

Website

A website for Task 21, www.pyne.co.uk, has been created by extending, and updating the homepage of the CEC-sponsored network which preceded this Task.

Collaboration with other Tasks

To date there has been little collaboration with other IEA Bioenergy Tasks, but firm plans have been made for 1999 and 2000.

TASK 22: Techno-Economic Assessments for Bioenergy Applications

Overview of the Task

The objectives of Task 22 are to promote the commercialization of new bioenergy technologies and products by carrying out site-specific prefeasibility studies, and to support the development of new technologies for appropriate bioenergy applications.

Together with industrial partners, the Task participants will study selected bioenergy applications on a techno-economic basis. Technologies to be studied include small scale power production, active flue gas condensation in biomass district heat plants, pyrolysis for alternative fuel oil to be used within a city, and production of chemicals from fast

pyrolysis oil. Prefeasibility studies will be produced. The results of the studies will be utilized by industry, funding agencies and research organizations.

The Task is planned for one and half years. The last meeting is planned in connection to the 4th Biomass Conference of the Americas in August 1999.

The countries participating are Austria, Brazil (from August 1998), Canada, Finland, Sweden, and the USA. The companies involved currently are Joanneum Research, RTI Ltd, Sermet Oy, and Stockholm Energi AB.

For further details, please refer to Appendices 2-5 inclusive and also the Task website, www.vtt.fi/ene/bioenergy

Progress in R&D

Task meeting and current programme of work

The kick-off meeting was arranged in connection to the conference "Power from Biomass III" in Espoo, Finland, from 14-15 September 1998, and in Stockholm, Sweden, 16 September 1998. Participants were informed about the plans of Stockholm Energi AB (SEAB) to increase their use of renewable fuels. The Swedish study in this IEA Task will be carried out together with SEAB.

Most of the work has been started - participating industry has been contacted and data is being collected for individual case studies. These are being carried out in Austria, Canada, Finland, Sweden and the USA. Work in Brazil has not been initiated yet. The following progress has been achieved to date.

Austria: Improved heat recovery in biomass district heat plants

An improved version of the current flue gas condensation concept is envisioned, where a larger fraction of the available condensing heat of flue gas is used for district heating. Technical aspects with real site data is employed, together with economic and environmental aspects. The concept was proposed by Joanneum Research, Graz, Austria.

Heat recovery from flue gas in biomass furnaces of district heat plants increases efficiency because of the high water content of wood chip and bark fuel. Due to the water content of the biofuel, the low heating value is commonly reduced to 50% of dry wood. However, if the flue gas is cooled to about 30°C, large quantities of heat (30-50% of the furnace capacity) may be recovered by condensation (Figure 1).

If a heat pump is used, the low temperature condensation heat recovered from the flue gas may be lifted to the temperature of the district heat return level. For this purpose a resorption heat pump with mechanic compression unit should be used due to the large coefficient of performance (Podesser, E. 1997). The mechanic compression unit is powered either by a grid-connected electric motor, or by a flue gas-powered Bio-Stirling engine. Detailed calculation and design of a resorption heat pump plant following the Lorenz Process for heat recovery from the flue gas is carried out. The economic assessment shows that due to the high coefficient of performance the amortization times of such plants may be between 4-6 years. Research and development work should be started to investigate and improve this special type of heat pump technology.

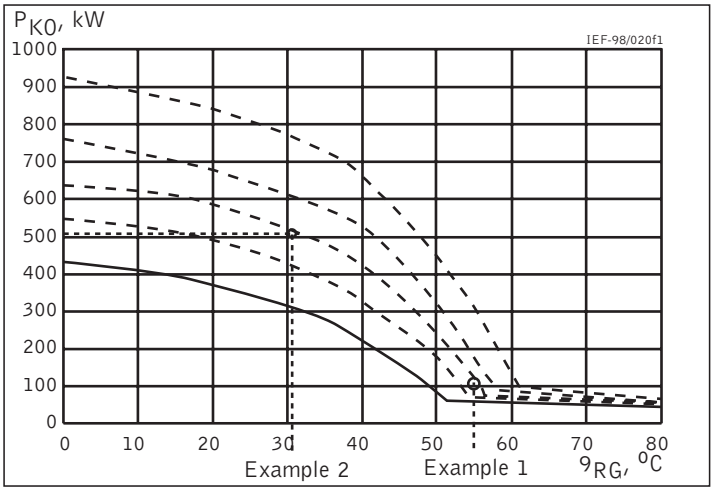


Figure 1: Two examples for heat recovery by flue gas condensation; Example 1: Conventional condensation plant, Example 2: Active condensation with resorption heat pump.

Podesser, E.: Resorptionswärmepumpen zur Nutzung der Kondensationswärme an Biomassefeuerungsanlagen zur Fernwärmeversorgung, Joanneum Research, IEF-B-06/97.

Canada: By-products from fast pyrolysis liquid

Production of fertilisers, chemicals and fuel from fast pyrolysis liquid is being evaluated viz.

1. Production of slow release fertilizers from bio-oil produced by fast pyrolysis. An analysis of the process producing slow release nitrogenous fertilizers starting with a bio-oil feed is being carried out. Comparison is made with the alternative ammoxidation process for nitrogenous fertilizer production. The process has been patented (Radlein et al. 1997).
2. Upgrading of bio-oil by reaction/blending with to improve bio-oil properties for fuel applications. Analysis is made of the value added to the bio-oil fuel versus the costs of the upgrade. A European patent application has been made concerning this process (Radlein et al. 1995).
3. Production of sugars (levoglucosan) by fast pyrolysis of wood. Analysis is made of the process to produce sugars from wood via fast pyrolysis. The wood is pretreated by acid hydrolysis prior to conversion to bio-oil by fast pyrolysis. Water is added to the bio-oil, producing a solid phase consisting of lignin, and an aqueous phase containing soluble sugars. The sugar solution can be used to produce chemicals, or to produce ethanol by fermentation.

Each of these processes was developed by Resource Transforms International, RTI, of Waterloo, Canada. The objective is to estimate which of the proposed concepts would be most competitive for further research and development.

Radlein, D., Piskorz, J., Majerski, P., Method of upgrading biomass pyrolysis liquids for use as fuels and as a source of chemicals by reaction with alcohols. European patent application EP 0 718 292 A1, 22 December, 1995.

Radlein, D., Piskorz, J., Majerski, P., Method of producing slow-release nitrogenous organic fertilizer from biomass. USA Patent 5,676,727, 14 October 1997.

Finland: Small scale power production

The first BioPower co-generation power plant (0.9 MW power - 6 MW heat) suitable for sawmill and district heat operation, will be commissioned by Sermet Oy, Kiuruvesi, Finland, during the fall of 1999. A comparison between the conventional steam boiler power plant and two new concepts proposed (gasification - gas engine, pyrolysis - diesel engine) is being carried out to study the competitiveness of the BioPower concept.

Small-scale electricity production is often proposed as a potential market for biomass. Especially advanced cycles are promoted for this market. The comparison in this work is carried out in power only production mode. Operating small power plants in combined heat and power mode would be more economic. However, sufficient heat loads are not always available.

It should be noted that only the conventional system is ready for commercial operation. There are several technical uncertainties related to the new cycles proposed. The comparison is carried out to define in which conditions the conventional cycle is preferable.

Electricity production costs of the three concepts are compared as a function of annual operation time in Figure 2. Because of the small scale, electricity costs are quite high for all the cases. It may be seen that above 3000 annual operating hours the Rankine cycle leads to the lowest power production cost, around 0.14 US$/kWh at 5000 h/a. This may be compared to 0.04 or 0.06-0.08 US$/kWh, which are typical costs for power produced in a large natural gas combined-cycle, and a large wood fired Rankine cycle power plant, respectively.

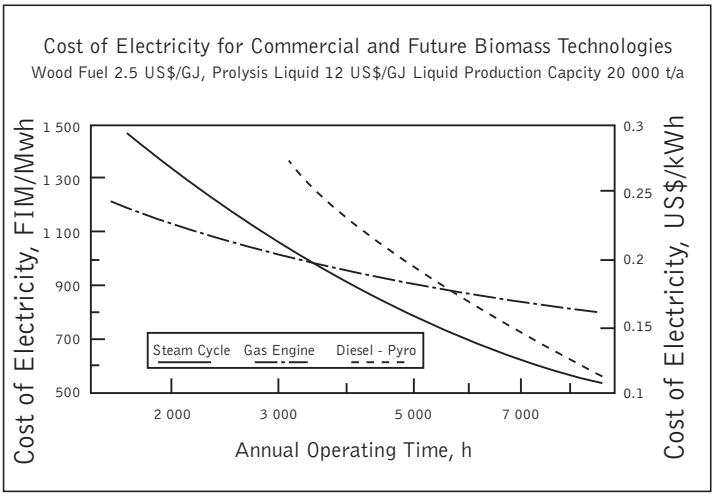


Figure 2. Power production costs at 2 MWe with three technologies. Investment Costs: Steam boiler power plant (PP) 6 MUS$, Gasification - gas engine PP 9 MUS$, Pyrolysis diesel PP 3 MUS$, Pyrolysis liquid production plant 13 MUS$.

Sweden: Pyrolysis liquids as boiler fuel

Stockholm Energi AB, Sweden, is currently using wood pellets and tall oil pitch as renewable fuel for district heating within the Stockholm city area. Pyrolysis liquid is a potential substitute for petroleum fuel oil. A technical, economic, and environmental assessment for the whole utilization chain is being carried out (Figure 3).

In Sweden a major test with pyrolysis liquid is planned to be carried out by Stockholm Energi AB. With a start in 1997 by test combustion of pyrolysis liquids in amounts of tonnes, larger amounts are scheduled to be used in 1999 followed by a possible commercial application in 1999 and thereafter.

Stockholm Energi AB is using several biofuels such as wood pellets and tall oil pitch. Thus, an opportunity is established for a techno-economic comparison between different ways of utilizing biofuels from wood.

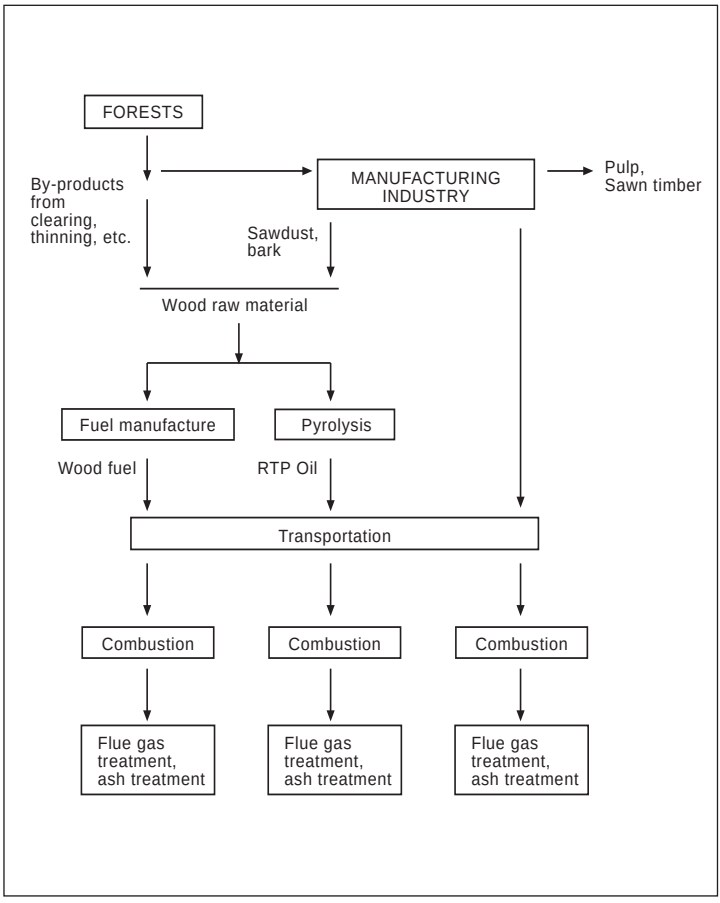


Figure 3. Renewable fuel alternatives in Stockholm

The Swedish forests are used as a source for several wood products. By-products are obtained in the forests (light thinning, clearing, etc) as well as in the subsequent manufacturing processes (sawdust, tall oil, black liquor, etc). To some extent they are already in use for energy production. However, further utilization is regarded feasible.

With the support of Stockholm Energi AB and some other companies involved in fuel manufacture, basic data on energy consumption, investment, transportation cost etc., is collected either as specific figures in actual cases or as estimates with an acceptable accuracy.

The techno-economic evaluation will be carried out in a conventional way. Two cases are considered for boiler combustion, one with a mineral oil-fired existing boiler, and one with a modified boiler.

A major uncertainty for biofuels concerns prices and taxes. This will be handled as sensitivity calculations.

USA: Small, modular biopower projects

The US DOE is working with industry to develop small, modular biopower systems. The intended output range is from 5 kW to 5 MW. Ten cost-shared contracts have been awarded in gasification and combustion technologies. Two of these cases will be reported through this Task.

Deliverables

The deliverables from the Task will include: prefeasibility studies of selected technologies; a summary report; feedback to the technical activities within IEA Bioenergy on the feasibility of new systems; a joint meeting with Task 21 Pyrolysis of Biomass; presentations at conferences; and development of the website; www.vtt.fi/ene/bioenergy

TASK 23: Energy from Thermal Conversion of MSW and RDF

Overview of the Task

The objective of Task 23 is to produce a comprehensive status report of the latest developments in, and deployment of, conversion technologies for Municipal Solid Waste (MSW) and Refuse Derived Fuel (RDF).

Energy recovery utilizing conventional systems (grate fired mass burn incineration) is an established mature technology and dominates the market. Over the last few years attention has focused on newer technology such as fluidized bed combustion and, even more recently, on gasification and pyrolysis based systems. A number of commercial scale facilities based on these newer technologies are currently under construction, or at an advanced stage of planning. Their performance may well impact on the nature of the energy recovery market.

In addition to technology development, waste management policies and practices have become ever more sophisticated and complex. In order to effectively progress with developing the waste management infrastructure it is vital that policy and decision makers have access to the latest information on the potential and application of technology and be aware of international trends in this sector. The work programme in this Task aims to provide such information.

The participating countries are, Canada, France, Finland, Japan, Sweden, Norway, the Netherlands and the UK.

As in other Tasks, a Task Leader, appointed by the Operating Agent (the UK), directs and manages the work programme. In each country participating in Task 23 a National Team Leader is nominated, responsible for the coordination of the national participation in the Task.

For further details on Task 23, please refer to Appendices 2-5 inclusive.

Progress in R&D

Two Task meetings were held in 1998. The first during May, in Brescia, Italy, was a joint meeting with ISWA Thermal Treatment Working Group. A seminar was held on 7 May entitled "Waste to Energy - A Step Towards Renewable Energy" which was organized jointly between IEA Bioenergy, the ISWA Working Group on Thermal Treatment of Waste, Federambiente and ASM Brescia. Approximately 250 people attended the seminar. Two papers were presented by the IEA Bioenergy Group: "Waste to Energy and RDF - UK Experience and Perspective" and "Waste as a Renewable Energy Source".

A site visit to the Brescia Waste to Energy Plant was included as part of the seminar. At this meeting the work programme for the Task was agreed and Topic Leaders were assigned for each of the modules in the programme of work as follows.

- Topic 1: The Management of Residues from Thermal Conversion - Gerry Atkins, SELCHP; Lucy Howlett, Energy from Waste Association, UK;
- Topic 2: Advanced Conversion Technologies for MSW Treatment - Vera Ortmanns; Remmert Slagter VVAV, Netherlands;
- Topic 3a: Fluidised Bed Combustion of MSW - Part 1: Elisabeth Poncelet, Ademe, France;
- Topic 3b: Fluidised Bed Combustion of MSW - Part 2: Ben Anthony/David Granatstein, CANMET Energy Technology Centre, Canada;
- Topic 4: Co-firing of MSW and RDF - Raili Vesterinen/Kai Sipilä, VTT, Finland;
- Topic 5: Review of MSW Management Policies and Technology Deployment Trends - Grace Gordon/Niranjan Patel, AEAT Environment, UK.

The second meeting of Task 23 was held in Chicago, USA in October 1998. One of the main aims of the meeting was to visit the Robbins Resource Recovery Facility, located in Robbins, a suburb of Chicago. This facility represents the largest such project in the world - a waste-to-energy plant capable of handling 1600 tons (1450 tonnes) of municipal solid waste per day. The Robbins Resource Recovery Facility is also one of the plants being studied as part of the second FBC module, and a draft case study report has now been prepared.

Collaboration with Industry

The Swedish participant Åsa Hagelin from RVF is also secretary for the ISWA Thermal Treatment Working Group, so a close collaboration between the two groups is envisaged. It is planned to hold another joint seminar with ISWA/WGTT on New Incineration Technologies in October 1999. Topics 1 and 5 above will be carried out in cooperation with the ISWA/WGTT.

Collaboration with other Tasks

In addition to attending the Task XII End of Task meeting in New Zealand/Australia the Task Leader attended two workshops "Bioenergy in the Environment (International Lessons learned)" and a "Workshop on the Fundamentals of Waste to Energy", both organized by NZFRI. Two papers were presented: "An Overview of Municipal Solid Waste Management in the UK: Current Status and Trends" and "Cost and Environmental Assessment of Options for Municipal Solid Waste Management". The Task 23 meeting in Chicago was also attended by the Task Leader of Task 20: Suresh Babu.

Collaboration with other IEA Agreements

A joint project between IEA Bioenergy and IEA CADDET has produced a report entitled: "Advanced Thermal Conversion Technologies for Energy from Waste". The report covers the latest advances in the pyrolysis and gasification of municipal and industrial waste.

TASK 24: Energy from Biological Conversion of Organic Waste

Overview of the Task

The objective of Task 24 is to provide information exchange and promote the use of anaerobic digestion of municipal and industrial solid wastes to generate energy, reduce pollution and recycle organic matter and nutrients.

Energy recovery from organic wastes using anaerobic digestion to process particular wastes (sewage treatment, industrial wastewaters, landfill gas) is an established mature technology and dominates these specific markets. However, there are sites where appropriate deployment of anaerobic digestion has not been made in these established markets and demonstration of the benefits needs to be made. Also, many other organic wastes that are appropriate for energy recovery through anaerobic digestion are not exploited and thus have the potential of additional unnecessary pollution. Over the last few years attention has focused on the environmental impact of landfill and incineration of organic wastes and newer systems have been developed to recover the energy from "solid" organic waste and to recycle the organic matter. A number of commercial scale facilities based on these newer technologies have been built and the number of facilities is increasing. However, market penetration is still low.

The participating countries are Denmark, Finland, Sweden, Switzerland and the UK.

As in other Tasks, a Task Leader, appointed by the Operating Agent (the UK), directs and manages the work programme. In each country participating in Task 24 a National Team Leader is nominated, responsible for the coordination of the national participation in the Task.

For further details on Task 24, please refer to Appendices 2-5 inclusive.

Progress in R&D

A Task meeting was held in May 1998 in Sweden, 27-29 April 1998. The meeting established contact with representatives of the ZEUS project, a pan-European project investigating zero emission vehicles which has strongly promoted biogas use. The meeting also included site visits to anaerobic digestion plants at Stockholm and Kalmar and the biogas upgrading and biogas fuelled bus scheme in Linköping. At the meeting the detailed work programme for the Task was established and Topic Leaders were assigned for each of the modules in the programmes of work as follows:

Topic 1: Revision and Editing of Systems and Markets Report - Pat Wheeler/Sam Isaac, AEAT Environment, UK;

Topic 2: Biogas Upgrading Technologies - Anna Lindberg, SWECO, Sweden; Art Wellinger, Nova Energie Switzerland;

Topic 3: Source Separation Technologies of Organic Wastes - Simon Lundeberg, RVF Sweden;

Topic 4: Quality Management of Digestate - Jens Bo Holm Neilsen, SUC, Denmark;

Topic 5: Sanitization Workshop - Art Wellinger, Nova Energie Switzerland; Jens Bo Holm Neilsen, SUC Denmark;

Topic 6: Plant Database - Pat Wheeler/Grace Gordon, AEAT Environment, UK.

Plant Database

A database of anaerobic digestion plants and contacts has been maintained and distributed electronically to the participating members. The collection of data is an ongoing activity in the Task and the database will be updated regularly. This database will also be used to update the information in the highly successful brochure from the last anaerobic digestion Activity (Task XIV).

Biogas upgrading

A first draft of a review of biogas upgrading technologies has been completed. This review forms part of the assessment of advanced biogas utilisation. The final report will detail the current state of the technology of improving biogas quality to be used either in pipeline quality or vehicle use. This technology will also be important for advanced gas use applications such as fuel cells. The report is expected to be completed by mid-1999.

Source separation of organics

A review of source separation systems for the collection of organics from households will be progressing during 1999. Initial results were received in January 1999 but a full report will be available later in the year.

"Veterinarians" Conference

The Task members have organised a conference titled "Hygienic and Environmental Aspects of Anaerobic Digestion: Legislation and Experiences" which will be held in Stuttgart, Germany, 31 March 1999. This conference will develop the experience from operating digesters and research work on the pathogen kill and biological safety of the use of the products from anaerobic digestion. The conference is targeted at official veterinarians and others who have a role in the development of regulations for use of wastes-based materials on land.

TASK 25: Greenhouse Gas Balances of Bioenergy Systems

Overview of the Task

The objective of Task 25 is to analyze, on a full fuel cycle basis, all processes involved in the use of bioenergy systems, with the aim of establishing overall greenhouse gas balances.

The participating countries are Austria, Canada, Croatia, Finland, New Zealand, Sweden, the UK and the USA.

As in other Tasks, a Task Leader, appointed by the Operating Agent (the Republic of Austria), directs and manages the work programme. In each country participating in Task 25 a National Team Leader is nominated, responsible for the coordination of the national participation in the Task.

For further details on Task 25, please refer to Appendices 2-5 inclusive and also the Task 25 website at www.joanneum.ac.at/iea-bioenergy-task25

Task 25 workshops

The first meeting of Task 25 took place on 9 and 13 March, 1998, in Rotorua, New Zealand. The meeting was jointly organized by Joanneum Research, Graz, Austria, and the New Zealand Forest Research Institute, Rotorua, New Zealand, and simultaneously served as the End-of-Task event for the predecessor Task XV. A workshop was held on the topic, "Effects of the Kyoto Protocol on forestry and bioenergy projects for mitigation of net carbon emissions". Task participants also gave presentations at the seminar "Bioenergy in the Environment" held on 10 March, organized by the Energy Efficiency and Conservation Authority - EECA. A field study tour on 11 and 12 March included radiata pine silvicultural systems, harvesting operations and residue recovery from landings, and a tour of the Kinleith Cogeneration Plant.

The proceedings of the Rotorua workshop were published in April 1998. By the end of 1998 approximately 280 copies had been distributed. Several revised papers out of the Rotorua proceedings, plus a group of additional ones, are currently in a peer-review process and will be published in Environmental Science & Policy as a Special Issue in March 1999. The special issue will comprise a total of about 12 papers, and will serve as a useful basis for the Intergovernmental Panel on Climate Change (IPCC) special report on "land use, land-use change, and forestry".

The second meeting of Task 25 took place in Nokia, Finland, 8-11 September 1998. It was jointly organized by Joanneum Research, Graz, Austria, and VTT Energy, Espoo, Finland. A workshop was held on the topic, "Between COP3 and COP4: The Role of Bioenergy in Achieving the Targets Stipulated in the Kyoto Protocol". Also included was a half-day joint session with Task 18 (Conventional Forestry Systems for Bioenergy) on "Carbon Balances and Sequestration in Conventional Forestry Systems", as well as two full-day field study tours organized by Task 18.

More detailed information on both events can be found on the Task 25 website as well as in the proceedings of the workshops held in Rotorua and Nokia (see Appendix 3).

Other Task 25 meetings

In July 1998 a group of Task 25 experts (L. Gustavsson, T. Karjalainen, G. Marland, I. Savolainen, B. Schlamadinger and M. Apps) convened a one-week meeting at the Oak Ridge National Laboratory, Oak Ridge, Tennessee, hosted by Gregg Marland, on the issue of "baselines". Baselines, both in terms of reference land uses and reference energy systems, are needed as a benchmark to derive the net carbon benefits of forestry, bioenergy, or other land-use related projects.

A first draft of the paper resulting from this meeting was presented and discussed at the Task 25 workshop in Nokia. An improved version has been included in the proceedings of the Nokia workshop. The paper will be expanded in 1999 to include case studies based on bioenergy projects.

COP4 Position Paper

On behalf of IEA Bioenergy and with the help and feedback provided by ExCo members and other experts, Task 25 prepared a position paper on "The Role of Bioenergy in Greenhouse Gas Mitigation" for the Fourth Conference of the Parties (COP4) to the United Nations Framework Convention on Climate Change (UNFCCC) in Buenos Aires, Argentina, 2-13 November 1998 (see Appendix 7). Altogether 1650 copies of the position paper were shipped to Buenos Aires for distribution amongst the conference delegates, observers, and media. Further copies can be requested from the Task Leader. Alternatively, a downloadable version of the position paper can also be found on the Task 25 website.

Task 25 Folder

A Task 25 folder has been completed and was available from November 1998. 800 copies of this folder were sent to COP4 for distribution. Further copies can be requested from the Task Leader. Again, a downloadable version of the folder can be found on the Task 25 website.

The 8-page Task 25 folder forms the basis of the Special Section of this IEA Bioenergy Annual Report, to which selected results from Task 25 - related work has been added.

Task 25 Bibliography

Work has been initiated on compiling literature for an updated version of the bibliography that was prepared within Task XV. The new bibliography is scheduled for publication by early 1999 and can be expected to constitute a valuable tool for the authors to the IPCC special report on "land use, land-use change, and forestry". The full title will be: "Bibliography on greenhouse gas balances of bioenergy, forestry, wood products, land use, and land-use change". In connection with this work, a form has been disseminated to experts connected to Task 25 and to selected mailing lists. Contributions from experts that have not yet received a copy of this form are still welcome and will be acknowledged (the form can also be filled in online, see the Task 25 website). There are plans to make the bibliography available - apart from a hard copy version - on the Task 25 website, thus providing a possibility to update the bibliography more frequently, and allowing it to be searched for information online.

Website

A website for Task 25 (www.joanneum.ac.at/iea-bioenergy-task25) has been created by redesigning, further extending, and updating the homepage of the predecessing Task XV. Many of the changes made were based on the discussion that took place and decisions that were made at the first Task 25 workshop in Rotorua, New Zealand, and information provided by the participants thereafter. Most of the information from the old Task XV homepage has been put into a directory "Task XV Archive" and thus is still readily accessible via the Internet.

The website offers a Task 25 description, information on previous and upcoming workshops, lists of national contacts, a list of experts and projects in the participating countries, downloadable files, links to other sites, etc. As in the past, the website will be updated and extended continuously, depending to a large extent on the information and feedback provided by people and institutions connected to the Task.

Collaboration with other Tasks

During the joint Task 18 and Task 25 session of the workshop in Nokia, an intensified future collaboration between Tasks 18 and 25 was discussed. It can be considered a first step that the proceedings published by Task 18, and by Task 25, both contain a section with the presentations given during the joint session. Also, it is envisioned that Task 18 and Task 25 experts will jointly write a paper on soil carbon and its possible inclusion under Article 3.4 of the Kyoto Protocol (increasing the amount of soil carbon could be regarded an "additional human-induced activity" in the language of Article 3.4).

Contributions to work of the Intergovernmental Panel on Climate Change (IPCC)

- *IPCC Expert Meeting in Dakar, Senegal*

  Several experts involved in Task 25 participated in the IPCC Expert Meeting on land-use change and forestry in Dakar, Senegal, 5-6 May 1998, and also took part in the subsequent writing of the meeting report. This involvement has been considered

important because it provided an opportunity to expose the advantages of using bioenergy and wood products as a greenhouse gas mitigation option.

- *Participation of Task experts at the SBSTA/IPCC Workshop in Rome, Italy*

  Several Task 25 experts were present at the SBSTA (a subsidiary body of the UN Convention on Climate Change) / IPCC Workshop in Rome, 23-25 September 1998, at which the data needs and modalities for inclusion of afforestation, reforestation and deforestation in the Kyoto Protocol were discussed.

- *Contribution to IPCC Special Report on Land Use, Land-Use Change and Forestry*

  Six of the Task 25 experts have been named as potential lead authors by the IPCC for the special report on land use, land-use change, and forestry to be published in 2000.

TASK 26: Biotechnology for the Conversion of Lignocellulosics to Ethanol

Overview of the Task

The main objective of Task 26 is to promote the establishment of biomass-to-ethanol demonstration plants which are championed and funded by industry. Specific goals within the three-year timescale of the Task have been formulated and these are detailed below.

The participating countries are Canada, Denmark, Finland, the Netherlands and Sweden.

As in other Tasks, a Task Leader, appointed by the Operating Agent (Canada) directs and manages the work programme. For each participating country, a National Team Leader is nominated who is responsible for coordinating the national participation in the Task.

For further details on Task 26, please refer to Appendices 2-5 inclusive and www.forestresearch.cri.nz/ieabioenergy/home.htm under "Current Tasks" on the IEA Bioenergy website.

The participants have R&D programmes within their countries in order to meet the above objectives and carry out co-operative research work based on their national programmes.

The work of the Task is structured around the following goals:

- to provide a forum for participating countries interested in developing biomass-to-ethanol processes;
- to communicate progress in the commercialization of biomass-to-ethanol processes;
- to continue the exchange of the technical and economic assumptions and the models used in various techno-economic modelling efforts of participating groups;
- to catalyze or initiate "special projects" funded by additional funding outside of the IEA.

Progress towards these four goals is reported below.

To provide a forum for participating countries interested in developing biomass-to-ethanol processes

Exchange of Personnel. The exchange of personnel has continued with students, post-doctoral scholars and research staff participating in international conferences to both familiarise themselves with other work and encourage discussion on collaboration or exchange. A meeting in Norway identified specific people that will be "exchanged" between groups - see Sarpsborg Meeting below.

Organization of workshops/symposia. Following are workshops/symposia that have been held to date by Task 26. The plans for future meetings are also presented.

Gatlinburg Meeting. Task 26 sponsored a Special Topic Discussion Group entitled "Technical and Process Advances in Biomass to Ethanol from an International Perspective" which was held within the 20th Symposium on Biotechnology for Fuels and Chemicals in Gatlinburg on 6 May 1998. The workshop had 44 participants from 11 countries and represented academia, the public sector, consultants and industry. Six individuals presented material. The highlights of these presentations are provided in the Task 26 second newsletter which can be found at the IEA Bioenergy website. A listing of the presenters and the topic of their presentations is contained in Appendix 3 - List of Reports.

Vancouver Meeting. A recent workshop in Vancouver, 20 and 21 May 1998, was a special project that drew in additional funding or services from the British Columbia Provincial Government, Council of Forest Industries, Forest Renewal BC and the Pulp and Paper Institute of Canada. The title of the workshop was "Bioconversion of Wood Residues to Ethanol, a BC Opportunity?: A Workshop to Assess the Feasibility of Establishing a Wood Residue-to-Ethanol Industry in British Columbia". This meeting illustrated the mix of industrial, governmental and R&D interests that can be brought together to discuss this topic. Total attendance was over 65 with roughly one third representing government/research groups and the remainder representing commercial interests. The highlights of the presentations can be found in the Task 26 third newsletter at the IEA Bioenergy website. A compendium of the presenters materials has been compiled and loosely bound in three-ring binders for distribution to member countries. A listing of the presenters and the topic of their presentations is contained in Appendix 3 - List of Reports.

Sarpsborg Meeting. This meeting held in Borregaard Manor, Sarpsborg, Norway, 9-11 November 1998; was a joint arrangement between the Nordic Energy Programme and IEA Bioenergy Task 26. The host was Borregaard Industries, the largest Nordic producer of ethanol as a by-product of sulphite pulping. There were 40 participants from Belgium, Canada, Denmark, Finland, the Netherlands, Norway, Russia, Sweden and USA. The title of the meeting was "Ethanol from Lignocellulose - Young Scientist Conference". The idea behind the conference was to create a forum in which young researchers had the opportunity to exchange ideas with more established experts from both research institutions and industry. The experts also got an opportunity to learn more about what is going on at the forefront of research in the topics presented. Cooperation between various researchers, research groups, industry and governmental groups was also encouraged. Twenty individuals provided oral presentations and in addition there were nine poster presentations. A listing of the presenters and the topic of their presentations is contained in Appendix 3 - List of Reports.

Other Meetings. Two further meetings at Anaheim, USA, and South Africa are at an advanced stage of organization. In addition, enquiries regarding the Pacifichem 2000 meeting are in progress and prospects for a spring 2000 meeting in Gatlinburg are being explored.

External Collaboration and Technology Transfer. The recent symposia facilitated participation by European (Sweden, Finland, the Netherlands, Norway, Denmark, Russia), North American (USA and Canada) and South American (Brazil) countries. The Task Leader has also received enquiries for information on lignocellulosics-to-ethanol processes from researchers and consultants in Australia, South Africa, Cuba, Mexico, UK, Croatia, Indonesia, Pakistan and India. These enquiries often result in discussions about other IEA activities and lead to individuals becoming observers/presenters at Task meetings.

The newsletters, although representing a substantial time commitment and expense to create and distribute, have been very successful at transmitting information to both participating and non-participating countries. The Task reviewed the technical requirements for producing a Task 26 web presence on the IEA Bioenergy website and moved to this by the end of 1998. Through the website the ease of distributing the newsletter will be enhanced and costs will be reduced. Jack Saddler, the Task Leader, spent a month at the New Zealand Forest Research Institute and took the opportunity to discuss and plan with John Tustin, the Secretary, ways to enhance interaction both within Task 26 and with other IEA Bioenergy programmes.

To communicate progress in the commercialization of biomass-to-ethanol processes

Progress in commercialization of biomass-to-ethanol processes has been communicated through both the newsletter and the symposia at Gatlinburg, Vancouver and Sarpsborg.

Three issues of the newsletter have been sent out to all of the past participants in the biomass-to-ethanol network, and participants in the new Task. The newsletters have provided a forum to accomplish a number of the Task's goals. Each newsletter has included; a brief memoranda from the Task leader; a description of some of the past and proposed plans for techno-economic modelling efforts; a profile of regional efforts to commercialize the biomass-to-ethanol process; a listing of the proposed symposia for this Task and a description of the results from each symposium.

The Task has expanded the mailing list for the newsletter to over 450 individuals or organizations. The feedback on the newsletters has exceeded expectations. They are providing appropriate information and international perspectives on the global status of technology associated with the lignocellulosics-to-ethanol process and information on upcoming events. Through email and posting at the IEA Bioenergy website, the effort and cost of sending the newsletter has dropped dramatically and the cost of printing has been offloaded to the participants. The Task Leader is slowly receiving all of the email addresses of the participants and hopes to reach full coverage by the middle of 1999. Each newsletter issue has been added to the IEA Bioenergy website by sending a copy to the IEA Bioenergy webmaster.

To continue the exchange of the technical and economic assumptions and the models used in various techno-economic modelling efforts of participating groups

The Task is currently in the process of developing a survey that will be sent to the various techno-economic modelling groups to determine the economic, financial and political differences found in the various countries. Over the time period of this Task, they hope to incorporate these differences into the UBC model to provide more widespread applicability of the comparison. The Task is also currently in the process of documenting the UBC model to provide a comprehensive package for distribution to other IEA Bioenergy techno-economic modelling groups.

To catalyze or initiate "special projects" funded by additional funding outside of the IEA

The Vancouver meeting was an example of a special project with funding coming from outside of the IEA. The current interest in GHG reduction opportunities associated with a lignocellulosic-to-ethanol process has drawn in many different interest groups from various countries and includes industrial partners. This bodes well for the potential to develop and follow through on a number of special projects.

TASK 27: Liquid Biofuels

Overview of the Task

The objective of Task 27 is to identify and eliminate non-technical barriers that impede the deployment of liquid fuels. To meet this objective, participants will conduct information exchange and analysis activities to provide governments, policy makers, and stakeholders with improved information on non-technical issues related to biofuels.

Current participants in Task 27 are Austria, the European Commission, Sweden and the USA; with USA serving as Operating Agent.

For further details on Task 27, please refer to Appendices 2-5 inclusive.

Progress in R&D

Task meetings

The Task became active in late 1998. It held its first working group meeting in Washington DC in January 1999. A second meeting is planned for Stockholm, Sweden on 31 May - 1 June 1999.

Based on a survey distributed to participants in 1998 and the meeting held in Washington DC in January 1999, a detailed work programme was developed. The work of the Task will include the following elements.

Providing Information for Governments and Policy Makers

The overall objective of this component is to provide governments and policy makers with improved information that will help them identify and eliminate non-technical barriers to liquid fuels deployment.

Six issues identified as being highest priorities to the participants will be considered in 1999. These will be the focus of work to improve the availability of information in the following areas:

- *Fuel properties and standards.* Including current commercial uses (e.g. B5, B20, B100, E10, E20, E85) current specifications, substitutes and additives, current classifications in countries, commonalties/differences between participants and others.
- *Tax issues.* Identify and compare domestic taxes, export/import issues, taxes as driving forces including CO2, alternate motor fuel taxes, barrier taxes, and others.
- *Business-related issues.* Identify and compare industry financing mechanisms, including mechanisms and sources; examine ways industry has been able to quantify value-added benefits such as calculating the cost/kg of carbon dioxide savings.

- *Life-cycle analyses.* Identify and compare existing life-cycle analyses on biofuels, conduct more detailed analysis if needed.
- *Regulatory and policy issues.* Identify and analyze other non-technical barriers including feedstock incentives, set asides, clean air incentives, financial incentives, and others.
- *Customers.* Identify who are biofuels customers, why they are successful, and provide case studies of successful biofuels applications.

Involving Stakeholders in the Task

The objective of this effort is to identify and involve potential liquid biofuels stakeholders in the Task. The industrial and trade associate stakeholders are very important to the development of biofuels. Providing better access to those people and organizations will help the participants by making each of them aware of stakeholders outside of their own particular region. The planned work includes:

- identifying who are the major stakeholders in each region, beginning with trade associations, profile the association, and inquiring about interest;
- involving selected people in Task 27 meetings to have them identify barriers and ways to eliminate them;
- having stakeholders help develop a "vision" for biofuels needs and priorities.

Interacting with Related IEA Tasks and Others

The Task is coordinating its work with other related activities including IEA Bioenergy Tasks 16, 22, and 26; the IEA Bioenergy Greenhouse Gas Task; the IEA Alternate Motor Fuels Agreement, and others as needed

Website

The Task has begun construction of a website to improve access to the information developed by this Task. The website will be available in early 1999.

TASK 28: Solid Biomass Fuels Standardization and Classification

Overview of the Task

The objectives of Task 28 are to:

- develop a set of standards for Solid Biomass Fuels to be used by efficient and economical energy conversion systems;
- promote the standardization of the specifications and classification for Solid Biomass Fuels by international standards bodies such as ISO;

- help create an international Solid Biomass Fuels market in which Solid Biomass Fuels can be traded amongst producers (farmers, foresters, fuel companies) and users (utilities, district heating companies, industries, etc.) with quality assurance and guarantees. The Solid Biomass Fuels Market will help to promote bioenergy in general, assist in the penetration of biomass conversion technologies into the energy market and provide a stable framework for all stakeholders; fuel producers, equipment manufacturers and end users. This will assist IEA Bioenergy Member countries in attaining the Kyoto Protocol objectives.

The participating countries are the Commission of the European Communities, Denmark, Norway and the USA.

This Task is a joint programme between IEA Bioenergy and the CEC. As in other Tasks, a Task Leader, appointed by the Operating Agent (the Commission of the European Communities), directs and manages the work programme.

For further details on Task 28, please refer to Appendices 2-5 inclusive.

Progress in R&D

The work to develop a set of standards for solid biomass fuels (or solid biofuels) is proceeding through a Workshop on Solid Biofuels established by CEN (the organization responsible for the production of European Standards) under a Programming Mandate from the European Commission (EC). The Workshop receives technical support through a combined project supported by the EC's THERMIE and FAIR Programmes, and coordinated by Green Land Reclamation Ltd and the University of Stuttgart.

The first meeting of the CEN Workshop was held in Brussels on 24 November 1998, and established priorities for preparatory work needed for a kick-off meeting of all THERMIE and FAIR partners, CEN representatives and participants in IEA Bioenergy Task 28 to be held in Stuttgart, Germany, on 9 and 10 March 1999. That meeting will consider:

- a preliminary review of the status of existing national and international standards for solid biofuels;
- proposed definitions, classification and scope of fuels to be included in the standardization work, including a definition of the borderline between solid biofuels and wastes; and
- a preliminary critical assessment of available standards and the need for work to refine them for use on a European/international scale.

The aim of the CEN Workshop is to propose a work programme to the CEN Technical Board that lists the standards needed to facilitate and support the expansion of the solid biofuel market. The work programme will include the title, scope and target dates of the standards as well as an indication of which standards must be developed first. It is intended to finalise the work programme by the end of February 2000, at the latest. Once the work programme has been agreed, it is expected that the European Commission will issue a Standardization Mandate to CEN for the production of the standards given the highest priority. At that point, a full CEN Technical Committee will be constituted to produce European Standards (ENs) with continued technical support from the joint THERMIE and FAIR projects.

Table 1 - IEA BIOENERGY TASK PARTICIPATION IN 1998

Task	AUT	BEL	BRA	CAN	CRO	DEN	FIN	FRA	ITA	JAP	NEL	NOR	NZE	SWE	SWI	UK	USA	CEC	Total Participants in Task
XVI. Tech assessment of cellulosic materials ethanol in Sweden														•			•		2
17. Short rotation crops for bioenergy				•	•	•		•	•		•			•		•	•	•	10
18. Conventional forestry systems for bioenergy		•		•		•	•				•	•	•	•		•	•	•	11
19. Biomass combustion	•	•	•	•		•	•	•			•	•	•	•	•	•	•	•	15
20. Thermal gasification of biomass	•		•	•		•	•		•		•	•		•	•	•	•	•	13
21. Pyrolysis of biomass			•	•													•	•	4*
22. Techno-economic assessments for bioenergy applications	•		•	•			•							•			•		6
23. Energy from thermal conversion of MSW and RDF				•			•	•		•	•	•		•		•			8
24. Energy from biological conversion of organic waste						•	•							•	•	•			5
25. Greenhouse gas balances of bioenergy systems	•			•	•		•						•	•		•	•		8
26. Biotechnology for the conversion				•		•	•				•			•					5
27. Liquid biofuels	•													•			•	•	4
28. Solid biomass fuels standardization and classification						•						•					•	•	4*
Total Task Participation	5	2	4	9	2	7	8	3	2	1	6	5	3	11	3	7	10	7	95

* Actual participation is higher because these are joint programmes with CEC participants.

BUDGET IN 1998: SUMMARY TABLE

Table 2: Budget for 1998 by Member Country ($US)

Member country	Total ExCo funds*	Total Task funds	Total funds
Austria	6,250	52,784	59,034
Belgium	4,900	20,283	25,183
Brazil	5,800	33,501	39,301
Canada	8,050	93,282	101,332
Croatia	4,900	21,661	26,561
Denmark	6,700	61,319	68,019
European Commission	6,700	49,879	56,579
Finland	7,600	90,744	98,344
France	5,350	30,181	35,531
Italy	4,900	14,596	19,496
Japan	4,450	15,320	19,770
Netherlands	6,700	59,799	66,499
Norway	5,800	44,421	50,221
New Zealand	5,350	34,166	39,516
Sweden	8,500	113,522	122,022
Switzerland	5,350	28,741	34,091
UK	7,150	78,922	86,072
USA	7,600	88,909	96,509
Total	112,050	932,030	1,044,080

* This excludes some funds still due for 1997.

BUDGET IN 1998: SUMMARY TABLE

Table 3: Budget for 1998 by Task ($US)

Task	Number of participants	Annual contribution per participant	Total Task funds
Task XVI: Tech. assessment of cellulosic ... etc.	2	in kind	0
Task 17: Short rotation crops for bioenergy	10	7,778	77,780
Task 18: Conventional forestry systems ... etc.	11	13,200	145,200
Task 19: Biomass combustion	15	7,083	106,245
Task 20: Thermal gasification of biomass	13	6,818	88,634
Task 21: Pyrolysis of biomass	4*	9,600	28,800*
Task 22: Techno-economic assessments ... etc.	6	10,000	60,000
Task 23: Energy from thermal conv. of MSW ... etc.	8	15,320	122,560
Task 24: Energy from biological conversion ... etc.	5	14,840	74,200
Task 25: Greenhouse gas balances ... etc.	8	13,883	111,064
Task 26: Biotechnology for the conversion ... etc.	5	9,600	48,000
Task 27: Liquid biofuels	4	15,000	60,000
Task 28: Solid biomass fuels standardization ... etc.	4*	#	9,547*
Total			932,030

*Actual participation is higher than indicated because these are joint programmes with the CEC. The total budget for these Tasks is therefore also substantially higher than indicated. The "Total" column only shows funds handled by the IEA Bioenergy Secretary.

#The programme commenced on 1 October 1998 and will run for 2.5 years. There is a differential IEA Bioenergy contribution for CEC and non-CEC participants in this programme. In 1998, CEC countries who wish to take a more active role in the programme will pay $2,000 and non-CEC countries $5,547.

LIST OF REPORTS

Except where noted, the reports are available through the Task Leader of the relevant Task. For the addresses, please see Appendix 5.

Reports issued by the Executive Committee

Gambles, R. and Page, G. (Editors). Accomplishments in Bioenergy Production Research 1995-1997. Proceedings of the IEA Bioenergy, Task XII, End-of-Task Workshop. Canberra, Australia. March 17-20, 1998. 239pp. IEA Bioenergy: T12: 1998: 01.

IEA Bioenergy Implementing Agreement Strategic Plan 1998-2002.

IEA Bioenergy. "The role of bioenergy in greenhouse gas mitigation". A position paper prepared by Task 25, on behalf of IEA Bioenergy for the Fourth Conference of the Parties (COP4) to the United Nations Framework Convention on Climate Change in Buenos Aires, Argentina. 2-13 November, 1998. 4pp.

The above are available through the ExCo Secretary - address in Appendix 5.

IEA Bioenergy News Volume 10, No. 1. August 1998.

IEA Bioenergy News Volume 10, No. 2. December 1998.

The newsletters are available through the Newsletter Editor - address in Appendix 5.

Reports from Task XVI

No reports have been issued at the current time due to the delay in Task initiation.

Reports from Task 17

Publication of the manuscripts from the meeting in Uppsala is planned for 1999.

Reports from Task 18

Richardson, J., Hakkila, P. and Smith, T. Environmental sustainability in conventional forestry systems for bioenergy: an IEA Bioenergy Task. p. 827-830 IN Kopetz, H., T. Weber, W. Palz, P. Chartier & G.L. Ferrero 1998. 10th European Conference and Technology Exhibition, Biomass for Energy and Industry. Proceedings of the International Conference, Würzburg, Germany, 8-11 June 1998. CARMEN, Rimpar, Germany. 1829 p.p.

The proceedings of the first annual Task Workshop in Nokia, Finland will be published in 1999.

Reports from Task 19

Minutes of the first meeting of Task 19 at Würzburg, Germany, 9 June 1998.

Minutes of the second meeting of Task 19 at Herning, Denmark, 21 October 1998.

Reports from Task 20

Barker, N. Biomass Fuel Gas Energy Conversion Devices. Report from the Thermal Gasification Activity, Task XIII.

Abatzoglou, N. Biomass Gasifier "Tars": Their Nature, Formation, and Conversion. Report from the Thermal Gasification Activity, Task XIII.

Fleck, T. and Hofbauer, H. Co-combustion of Natural Gas with LCV Biomass Gasification Fuel Gas. Report from the Thermal Gasification Activity, Task XIII.

Fleck, T. and Hofbauer, H. Gasification Feedstock Data Base. Report from the Thermal Gasification Activity, Task XIII.

Minutes of the first meeting of Task 20 at Brussels, Belgium, 18-20 March 1998.

Minutes of the second meeting of Task 20 at Dublin, Ireland, 12-14 October 1998.

Reports from Task 21

Minutes of the first meeting of Task 21 at Salzburg, Austria, February 1998.

Minutes of the meeting and workshop of Task 21 at Stratford-upon-Avon, UK, July 1998.

Minutes of the Steering Committee meeting of Task 21 at Stratford-upon-Avon, UK, July 1998.

Minutes of the meeting and two workshops of Task 21 at De Lutte, the Netherlands, November 1998.

PyNe Newsletter No. 5, March 1998.

PyNe Newsletter No. 6, September 1998.

Papers presented at the Task 21 Workshop on the "Science and Fundamentals of Fast Pyrolysis", Stratford-upon-Avon, UK. 22-24 July 1998.

Piskorz, J. Pyrolysis of Cellulose - From Oligosaccharides to Synthesis Gas.

Boutin, O. Radiant Flash Pyrolysis of Cellulose: Evidence for the Formation of Short Life Time Species.

Meier, D. Cellulose Dehydration and Depolymerization Reactions During Pyrolysis in The Presence of Phosphoric Acid.

Suuberg, E. Tar Vaporization in Biomass Pyrolysis.

Pakdel, H. New Developments in Vacuum Pyrolysis.

Arauzo, J. Kinetic Studies on the Thermal Decomposition of Lignocellulosic Residues.

Antal Jnr, M. Total, Catalytic, Supercritical Steam Reforming of Biomass.

Penninger, J. Chemistry of Diphenyl-Ether in Supercritical Water.

Lahousse, C. The Role of Coke (or Char) in Biomass Pyrolysis.

Di Blasi, C. Formulation and Application of Biomass Pyrolysis Models for Process Design and Development.

Grønli, M. A Mathematical Model for Wood Pyrolysis Comparison of Experimental Measurements with Theoretical Predictions.

Wójtowicz, M. Pyrolysis Behavior of Different Classes of Biomass.

Solantausta, Y. Estimating the Performance of Industrial Fast Pyrolysis Processes.

Papers presented at the Task 21 Workshop on the "Implementation" De Lutte, the Netherlands. 28-29 November 1998.

Lambiotte, M.U. EHS problems in biomass carbonisation.

Morris, K. How Research and Development can be scaled up and commercialised.

Burdon, I. and McLellan, M. Presentation on how bioenergy projects are evaluated.

Radlein, D. Problems facing small companies in bioenergy.

Rossi, C. Problems facing large utilities when implementing bioenergy projects.

Gust, S. Problems of modifying equipment for new fuels.

Papers presented at the Task 21 Workshop on the "Environment Health and Safety", De Lutte, the Netherlands. 30 November to 1 December 1998.

Rossi, C. EHS problems in producing bio-oil.

Brandt, H. EHS and oil handling.

Snoeij, N. Toxicology and EHS.

Radlein, D. Chemistry of bio-oil and EHS.

Reports from Task 22

A summary report is planned for 1999 which is the last year of this Task.

A website is available; www.vtt.fi/ene/bioenergy

Reports from Task 23

Brown, A. Waste as a Renewable Energy Source.

Patel, N. and van Santen, A. Waste to Energy and RDF - UK Experience and Perspective.

Advanced Thermal Conversion Technologies for Energy from Solid Waste

A joint report between IEA Bioenergy and IEA CADDET.

Minutes from the First Meeting of Task 23 at Brescia, Italy. May 1998.

Minutes from the Second Meeting of Task 23 at Chicago, USA. October 1998.

These reports are available from Grace Gordon, AEAT Environment, B154 Harwell, Didcot, Oxon, OX11 ORA, UK: Email: grace.gordon@aeat.co.uk.

Reports from Task 24

Aumonier, S. Life Cycle Assessment of Anaerobic Digestion: A literature review. Available from Pat Wheeler, AEA Technology Environment, E6 Culham, Abingdon, Oxfordshire, OX14 3ED, UK, email patrick.wheeler@aeat.co.uk.

Biogas and More! - Systems and markets overview of anaerobic digestion, 1997. Available from Pat Wheeler, AEA Technology Environment, E6 Culham, Abingdon, Oxfordshire, OX14 3ED, UK, email patrick.wheeler@aeat.co.uk.

Wellinger, A. Translation (into English) of computer model of anaerobic digestion - Biogas! Available from Nova Energie, CH-8356 Ettenhausen or downloadable from http://www.softplus.net/industrie/biogas/dateien.htm.

Minutes from the First Meeting of Task 24 at Linköping, Sweden. May 1998. Available from Pat Wheeler, AEA Technology Environment, E6 Culham, Abingdon, Oxfordshire, OX14 3ED, UK, email patrick.wheeler@aeat.co.uk.

Minutes from the Second Meeting of Task 24, Paris, France. 14-15 January 1999. Available from Pat Wheeler, AEA Technology Environment, E6 Culham, Abingdon, Oxfordshire, OX14 3ED, UK, email patrick.wheeler@aeat.co.uk.

Reports from Task 25

B. Schlamadinger and R. Madlener (Editors). Effects of the Kyoto Protocol on forestry and bioenergy projects for mitigation of net carbon emissions. Proceedings of the Task XV/25 Workshop in Rotorua, New Zealand, 9 and 13 March 1998. April 1998.

A subset of these proceedings, plus other papers, is forthcoming as a 1999 Special Issue of Environmental Science & Policy entitled "Land use, land use change, and forestry in the Kyoto Protocol".

Ward, M. Sinks and the Kyoto Protocol - interpretations, implications and unfinished business.

Schlamadinger, B. and Marland, G. Some technical issues regarding land use change and forestry in the Kyoto Protocol.

Bradley, D. Silvicultural carbon sequestration options under the Kyoto Protocol.

Parrish, M. Implications for forestry of government commitments under the FCCC.

Marland, G. and Schlamadinger, B. Does the Kyoto Protocol make a difference for the optimal forest-based C mitigation strategy? Some results from GORCAM.

Le Blanc, A. Some issues related to including biotic carbon offsets in a GHG emissions trading system.

Bird, D.N. Greenhouse gas emissions avoidance through fire management - theory and proposed methodology for estimation.

Gustavsson, L. Replacing fossil fuels with forest fuels - baselines, CO_2 reduction and mitigation cost.

Pingoud, K., Lehtilä, A. and Savolainen, I. Bioenergy and forest industry after the Kyoto Protocol.

Ford-Robertson, J., Robertson, K. and Maclaren, P. The effect of land use practices on greenhouse gases.

Karjalainen, T., Pussinen, A., Kellomäki, S. and Mäkipää, R. How to determine baseline scenarios for a forest sector carbon balance.

Clemens, A.H., Hennessy, W.W., Matheson, T.W. and Whitney, R.S. Establishing a basis for the assessment of greenhouse gas and other impacts from combustion of biomass compared with coal.

Maclaren, P. Workshop Summary.

Apps, M.J., Kurz, W.A. and Bhatti, J. Energy, bioenergy and the carbon budget of the Canadian forest product sector.

Madlener, R. and Pingoud, K. (Editors). Between COP3 and COP4: The role of bioenergy in achieving the targets stipulated in the Kyoto Protocol. Including a joint session with IEA Bioenergy Task 18. Proceedings of the Task 25 Workshop in Nokia, Finland, 8-11 September 1998. November 1998.

Papers presented at the Joint Task 18/Task 25 half-day workshop on "Carbon Balances and Sequestration in Conventional Forestry Systems", Nokia, Finland.

Buford, M.A., Stokes, B.J., Sanchez, F.G. and Carter, E.A. Using biomass to improve site quality and carbon sequestration.

Smith, C.T., Ford-Robertson, J., Tate, K.R. and Scott, N.A. Framework for assessing the contribution of soil carbon to New Zealand CO_2 emissions.

Pussinen, A., Karjalainen, T., Liski, J. and Nabuurs, G.-J. Towards future European forest carbon budget (LTEEF-II project).

Olsson, B. Long-term effects of whole-tree harvesting on carbon pools in coniferous forest soils.

H. Eriksson, J. Vinterbaeck, M. Parikka, and B. Hektor. Whole-tree harvesting - effects on the N budget of forest soils in Sweden.

Liski, J. Forestry, climate change and carbon in soils.

Savolainen, I., Lehtilä, A., Liski, J. and Pingoud, K. Role of forestry and biomass production for energy in reducing the net GHG emissions in Finland. Assessment concerning the history and future.

Papers presented at the Task 25 all-day workshop on "Between COP3 and COP4: The Role of Bioenergy in Achieving the Targets Stipulated in the Kyoto Protocol", Nokia, Finland.

Jelavic, V., Domac, J. and Juric, Z. Greenhouse gases emissions and possibilities for reduction using biomass for energy in Croatia.

Barbier, C. and Schwaiger, H. Fuelwood in Europe for Environment and Development Strategies (FEEDS): an overview.

Trossero, M. A Unified Wood Energy Terminology (UWET) FA0 and climate change.

Heikkinen, A. Bioenergy and power production; power company's perspective.

Bradley, D. Potential impact of forestry initiatives on Canada's carbon balances.

Gustavsson, L., Karjalainen, T., Marland, G., Savolainen, I, Schlamadinger, B. and Apps, M. Project-based greenhouse gas accounting: guiding principles with focus on baselines.

Spitzer, J. The role of bioenergy in greenhouse gas mitigation. A position paper prepared by IEA Bioenergy Task 25 "Greenhouse Gas Balances of Bioenergy Systems".

IEA Bioenergy Task 25 - Position Paper. "The role of bioenergy in greenhouse gas mitigation". A position paper prepared on behalf of IEA Bioenergy for the Fourth Conference of the Parties (COP4) to the United Nations Framework Convention on Climate Change in Buenos Aires, Argentina, 2-13 November, 1998. 4pp.

Gustavsson, L. and Börjesson, P. CO_2 mitigation cost: bioenergy systems and natural gas systems with decarbonization. Energy Policy, 1998, 26(9): 699-713.

Ford-Robertson, J.B. Carbon balance calculations for forest industries - a review. NZ Forestry, 1997, 42(1): 32-36.

Mann, M.K. and Spath, P.L. Life cycle assessment of a biomass gasification combined-cycle power system. National Renewable Energy Laboratory, NREL/TP-430-23076, Golden, Coroado, December 1997. (http://www.eren.doe.gov/biopower/life_cycle.html)

Price, D.T., Mair, R.M., Kurz, W.A. and Apps, M.J. Effects of forest management, harvesting and wood processing on ecosystem carbon dynamics: a boreal case study. In: M.J. Apps and D.T. Price (eds), Forest ecosystems, forest management and the global carbon cycle Springer-Verlag, Berlin/Heidelberg, 1996.

Pingoud, K., Savolainen, I. and Seppälä. Greenhouse impact of the Finnish forest sector including forest products and waste management. Ambio, 1996, 25(5): 318-326.

Maclaren, J.P. New Zealand's planted forests as carbon sinks. Commonwealth Forestry Review, 1996, 75(1): 100-103.

Schlamadinger, B. and Marland, G. The role of forest and bioenergy strategies in the global carbon cycle. Biomass & Bioenergy, 1996. 10(5/6): 275-300.

Karjalainen, T., Kellomäki S. and Pussinen, A. Carbon balance on the forest sector in Finland during 1990-2039. Climatic Change, 1995, 30: 451-478.

Jelavic, V. et al. Greenhouse gases emission estimate for Croatia. State Directorate for Environment, Zagreb, Croatia, 1995.

Reports from Task 26

Newsletter for IEA Bioenergy Task 26 "Biotechnology for the Conversion of Lignocellulosics to Ethanol". No. 1. January 1998.

Newsletter for IEA Bioenergy Task 26 "Biotechnology for the Conversion of Lignocellulosics to Ethanol". No. 2. May 1998.

Newsletter for IEA Bioenergy Task 26 "Biotechnology for the Conversion of Lignocellulosics to Ethanol". No. 3. November 1998.

Papers presented at the Task 26 workshop on "Technical and Process Advances in Biomass to Ethanol from an International Perspective" Gatlinburg, USA. 6 May 1998.

Katzen, R. Case history of design, costing and construction of biomass/sugar-to-ethanol plants.

Benson, B. The Tembec story.

Nguyen, Q. Opportunities for ethanol production from softwood residues in the Western United States

Zacchi, G. "How do we hydrolyze softwoods?"

Zimbardi, F. The Italian steam pretreatment and enzymatic hydrolysis programs at ENEA.

Ramos, L. A Brief Update on the Biomass-to-Ethanol Programme in Brazil

Papers presented at the Task 26 workshop on "Bioconversion of Wood Residues to Ethanol A BC Opportunity?: A Workshop to Assess the Feasibility of Establishing a Wood Residue-to-Ethanol Industry in British Columbia", Vancouver, Canada. 20-21 May 1998.

McCloy, B. Volume of sustainable wood residue available in BC, regional locations and current/potential uses for this residue.

Jordan, M. Canfor's experience with residue utilization.

Clinton, R. West Frazer's experience with residue utilization.

Norgren, R. Weyerhaeuser Canada's experience with residue utilization.

O'Connor, D. Mohawk Oil's Experience with Ethanol.

Benson, B. The Tembec Ethanol Strategy.

Vallander, L. The Swedish Government Strategy.

Tiangco, V. Forest Residues to Ethanol - California.

Sarkkinen, K. Finnish Experience with Fuel Alcohol.

Nguyen, Q. NREL's Programme to Aid Commercial Development.

Vanderland, B. Ethanol Production - BC Communities.

Cruickshank, B. Tax Credits to Encourage an Ethanol Plant.

Dolenko, A. Federal Strategy to Kyoto Agreement.

Foody, B. The Iogen Biomass-to-Ethanol Strategy.

Dow, D. The Arkenol Biomass-to-Ethanol Strategy.

Wyman, C. The BC International Biomass-to-Ethanol Strategy.

Papers presented at the Joint Task 26/Nordic Energy Programme meeting "Ethanol from Lignocellulose - Young Scientist Conference" Sarpsborg, Norway. 9-11 November 1998.

Kristiansen, B. Production of ethanol from lignocellulose: The industrial reality.

O'Connor, D. Ethanol Production in Western Canada over 20 years.

Benson, B. Continuous Fermentation in Tembec's Pilot Plant.

Nguyen, Q. R&D Progress on Conversion of Softwood Residues to Ethanol at NREL.

Stenborg, K. Ethanol from Softwood using SSF.

Zacchi, G. How do we Hydrolyse Softwood?

Thomsen, A.B. Recent Developments in Denmark on Pretreatment.

Klinke, H.B. Degradation Products from Pretreated Biomass: Inhibitors in Ethanol Production.

Teeri, T.T. Structural and Functional Characteristics of Efficient Cellolytic Enzymes.

Eriksson, T. Synergism between Endoglucanase I and Cellobiohydrolase I of Trichoderma reesei during Hydrolysis of Lignocellulose.

Karlsson, J. Small Endoglucanases of Trichoderma reesei: Cloning, Expression and Characterization of Hydrolysis Properties.

Tengborg, C. Inhibition of Enzymatic Hydrolysis of Softwood.

Palonen, H. Adsorption of Trichoderma reesei Cellulases: Use of Tritium Labelling.

Szengel, Z. Cellulase production of Trichoderma reesei Rut C30 using Steam Pretreated Spruce.

Hahn-Hägerdal, B. Phsyiological Engineering for Ethanol Production from Lignocellulose.

Clausen, A. Transformation of Thermoanaerobacter mathranii A3M4 with Plasmid pUB110 Carrying Kanamycin Resistance.

Träff, K.L. Recombinant Saccharomyces cerevisiae for Xylose Utilization.

Torvari, M. Engineering Saccharomyces cerevisiae for Xylose Utilization.

Ahring, B. Measurements of Intracellular Metabolites and Enzymes in the Glykolysis of Thermoanaerobacter mathranii A3M1.

Larsson, S. Fermentation Inhibitors in Lignocellulose Hydrolysates of Spruce.

Reports from Task 27

Minutes from the First Working Group Meeting of Task 27 at Washington, DC, USA. January 1999.

A website is planned for 1999.

Reports from Task 28

No reports have been issued as this Task did not commence until 1 October 1998.

KEY PARTICIPANTS IN EACH TASK

TASK XVI - Technology Assessment of Cellulosic Materials to Ethanol in Sweden

Operating Agent: Ray Costello, Department of Energy, USA

For contacts see Appendix 6.

Task Leader: Ray Costello, Department of Energy, USA

For contacts see Appendix 6.

The Task is a joint initiative between Sweden and USA. Strong industrial participation is planned. The contact person in each country is listed below:

Country	National Team Leader	Institution
Sweden	Stan Flodin	Swedish Ethanol Development Foundation
USA	Raymond Costello	US Department of Energy

TASK 17 - Short Rotation Crops for Bioenergy

Operating Agent: Lars Tegnér, Swedish Nat. Energy Administration, Sweden

For contacts see Appendix 6.

Task Leader: Lars Christersson, Swedish University of Agricultural Sciences, Sweden

For contacts see Appendix 5.

The Task is organized with "National Teams" in the participating countries. The contact person (National Team Leader) in each country is listed below:

Country	National Team Leader	Institution
Canada	Andy Kenny	University of Toronto
CEC	Ann Segerborg-Fick	CEC - DGXII
Croatia	Davorin Kajba	University of Zagreb
Denmark	Uffe Jorgensen	Danish Institute of Agricultural Sciences Research Centre
France	Hilaire Bewa	ADEME
Italy	Georgio Schenone	ENEL S.p.A. - Polo Energie Alternative
Sweden	Lars Christersson	Swedish Univ. of Agricultural Sciences
the Netherlands	Leen Kuiper	SBH Stichting Bos en hout
UK	John Seed	Border Biofuels Ltd
USA	Lynn Wright	Oak Ridge National Laboratory

TASK 18 - Conventional Forestry Systems for Bioenergy

Operating Agent: Peter Hall, Dept. of Natural Resources, CFS, Canada

For contacts see Appendix 6.

Task Leader: Jim Richardson, Ottawa, Canada*

For contacts see Appendix 5.

Associate Task Leader: Pentti Hakkila, Finnish Forest Research Institute

Associate Task Leader: Tat Smith, NZ Forest Research Institute**

The Task is organized with "National Teams" in the participating countries. The contact person (National Team Leaders) in each country is listed below:

Country	National Team Leader	Institution
Belgium	Jean-Françoise Van Belle	CRA
Canada	Jim Richardson*	Canadian Forest Service*
Denmark	Niels Heding	Forest & Landscape Research Inst.
CEC	Johannes Klumpers	CEC - DGXII
Finland	Pentti Hakkila	Finnish Forest Research Inst.
the Netherlands	Niek Borsboom	State Forest Service
New Zealand	Tat Smith**	NZ Forest Research Inst.
Norway	Simen Gjølsjø	Norwegian Forest Research Inst.
Sweden	Heléne Lundkvist	Swedish Univ. of Agric. Sciences
UK	Barrie Hudson	Forestry Contracting Association
USA	Carl Trettin	USDA Forest Service

* now retired from the Canadian Forest Service.

** Texas A&M University from 1 January 1999.

TASK 19 - Biomass Combustion

Operating Agent: Gerard Smakman, NOVEM, the Netherlands

For contacts see Appendix 6.

Task Leader: Sjaak van Loo, TNO, the Netherlands

For contacts see Appendix 5.

The Task is organized with "National Teams" in the participating countries. The contact person (National Team Leader) in each country is listed below:

Country	National Team Leader	Institution
Austria	Ingwald Obernberger	Technical University of Graz
Belgium	Yves Schenkel	Département de Génie Rural
		Centre de Recherche Agronomiques

Continued from Task 19

Country	National Team Leader	Institution
Brazil	Francisco Domingues Alves de Souza	Institute for Technological Research - IPT Cidade Universitária - CEP
Canada	Peter Hall	Department of Natural Resources CFS
CEC	Michail Papadoyiannakis	CEC - DGXII
Denmark	Henrik Houmann Jakobsen	dk-TEKNIK
Finland	Heikki Oravainen	VTT-Energy
France	Severinne Bouvot-Maudit	ADEME
the Netherlands	Sjaak van Loo	TNO-MEP
Norway	Johan Hustad	NTNU/SINTEF
New Zealand	John Gifford	NZ Forest Research Institute Ltd
Sweden	Claes Tullin	Swedish National Testing and Research Inst.
Switzerland	Thomas Nussbaumer	Verenum
United Kingdom	William Livingston	Mitsui Babcock Energy Limited
USA	Donald Hardesty	Sandia National Laboratories

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The Role of Bioenergy in Greenhouse Gas Mitigation

Summary

Biomass can play a dual role in greenhouse gas mitigation related to the objectives of the United Nations Framework Convention on Climate Change (UNFCCC), i.e. as an energy source to substitute for fossil fuels and as a carbon store. However, compared to the maintenance and enhancement of carbon sinks and reservoirs, it appears that the use of bioenergy has so far received less attention as a means of mitigating climate change. Modern bioenergy options offer significant, cost-effective and perpetual opportunities toward meeting emission reduction targets while providing additional ancillary benefits. Moreover, via the sustainable use of the accumulated carbon, bioenergy has the potential for resolving some of the critical issues surrounding long-term maintenance of biotic carbon stocks. Finally, wood products can act as substitutes for more energy-intensive products, can constitute carbon sinks, and can be used as biofuels at the end of their lifetime.

Introduction

The importance of solar-based renewable energy sources for the reduction of greenhouse gas (GHG) emissions has been widely recognized. Since the signing of the United Nations Framework Convention on Climate Change (UNFCCC) in Rio de Janeiro in 1992, there has been an intensification of interest. Among these solar-based renewable sources, energy from biomass is considered to be one of the most promising to replace some of the fossil fuels – whose combustion is by far the main source of anthropogenic greenhouse gases, notably CO_2.

The inclusion of biological sources and sinks for the accounting of national GHG emissions (Articles 3.3 and 3.4 of the Kyoto Protocol) has pointed out another potential role of biomass in GHG mitigation – the long-term storage of carbon in forests, on other land, and in wood products. While many details of the accounting systems have yet to be specified, it has become clear that biomass can contribute substantially to GHG mitigation through both reduction of fossil carbon emissions and long-term storage of carbon in biomass (Figure 1).

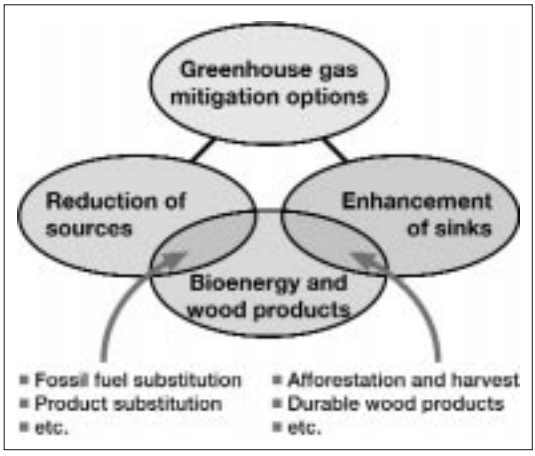

Fig. 1: The role of bioenergy and wood products in greenhouse gas mitigation

All forms of biomass utilization can be considered part of a closed carbon cycle. The mass of biospheric carbon involved in the global carbon cycle provides a scale for the potential of biomass mitigation options; whereas fossil fuel combustion accounts for some 6 Gigatons of carbon (GtC) release to the atmosphere annually, the net amount of carbon taken up from and released to the atmosphere by terrestrial plants is around 60 GtC annually (corresponding to a gross energy content of approximately 2100 EJ p.a. of which bioenergy is a part), and an estimated 600 GtC is stored in the terrestrial living biomass.

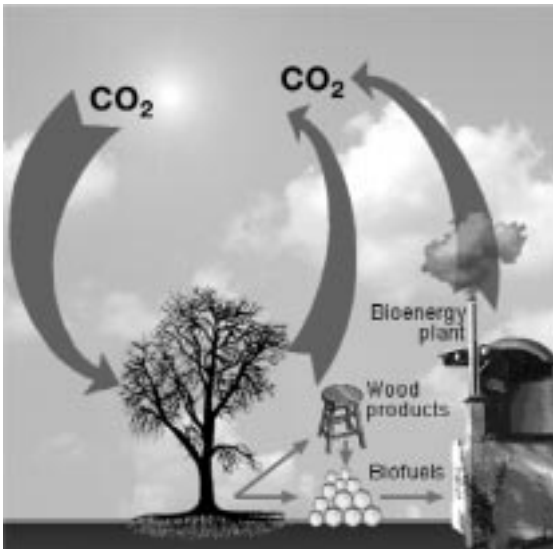

Fig. 2: Biomass utilization and the carbon cycle

The Kyoto Protocol, if and when ratified, would allow sources and sinks of GHGs in land-use change and forestry activities to be counted towards compliance with emission reduction commitments. However, these activities are limited to afforestation, deforestation and reforestation since 1990 (Article 3.3). The Kyoto Protocol also provides options to permit additional human-induced activities related to changes in GHG emissions by sources and removals by sinks in the agricultural soils and the land-use change and forestry categories to be added later in the negotiation process. Article 2, paragraph 1(a) of the Kyoto Protocol, stipulates that its goals include:

- promotion of sustainable forest management practices, afforestation and reforestation, as well as sustainable forms of agriculture in light of climate change considerations;
- research on, and promotion, development and increased use of, new and renewable forms of energy, of CO_2 sequestration technologies and of advanced and innovative environmentally sound technologies;
- limitation and/or reduction of methane emissions through recovery and use in waste management.

The use of bioenergy can play a crucial role in the achievement of all these goals. Today, many technologies and methods to realize bioenergy options are basically available. In many cases they only need some further optimization in order to become competitive by current standard economic criteria. Full cost calculations (i.e. including external costs) depict economic advantages of bioenergy against, say, fossil energy already today.

Current Role of Bioenergy

Today bioenergy is the second largest solar-derived commercial renewable energy source after hydropower. If non-commercial consumption is counted as well, it is probably the largest. Current total biomass use for energy is in the range of 50 EJ per annum (about 12% of world primary energy consumption of 406 EJ p.a. including biomass), mainly in traditional applications for cooking and heating in developing countries, but also in some industrial countries for heat and power production. Modern bioenergy technologies that feature high efficiencies, cleanliness, and convenience, are now becoming technically and (in many cases) commercially viable. Considering the renewable biomass potential still available and the need to reduce consumption of fossil fuels, bioenergy will be among the most important energy sources of the future.

Solid, liquid and gaseous biofuels can replace fossil fuels in almost every application. However, sustainable production and efficient conversion of biofuels have to be assured. Today's main sources for biofuels are residues from forestry and agriculture. In the future energy

plantations could provide additional sources, opening up new opportunities for agriculture and forestry in the energy market.

Biofuels play a different role among countries regarding the extent and the way they are used. Whereas they only provide some 3% of total primary energy in the industrialized countries, they account for some 40% in developing countries. Countrywise, the contribution ranges from essentially zero in countries like Japan and The Netherlands to over 95% of total energy use in countries like Nepal and Tanzania. Among the industrialized countries, Sweden, Finland and Austria are examples with relatively high shares of bioenergy (in the order of 15%), in part due to the widespread use of district heating systems (Figure 3).

Scenario	Year		
	2025	2050	2100
Shell (1996)	85	200–220	–
IPCC (1996)	72	280	320
Greenpeace (1993)	114	181	–
Johansson et al. (1993)	145	206	–
WEC (1993)	59	94–157	132–215
Dessus et al. (1992)	135	–	–
Lashof and Tirpak (1991)	130	215	–

Table 1: The role of biomass in future global energy use (in EJ)

Source: D. O. Hall and J. I. Scrase (1998), Biomass & Bioenergy 15(4/5), pp.357–367

Opportunities for Bioenergy

Table 1 provides a range of estimates regarding the future role of biomass. The large potential of bioenergy to substitute for fossil fuels can also be illustrated for the case of the European Union. In the White Paper on Renewable Energy (COM(97)599: 26.11.1997) it was proposed that biomass energy in total in the EU could contribute an additional 3.8 EJ annually by 2010, as compared to the current contribution of about 1.9 EJ p.a. Of this additional amount, energy crops (trees, perennial grasses, etc.) are expected to provide 1.9 EJ, grown on just about 4% of the total EU land area. If these additional 1.9 EJ p.a. from energy crops replaced coal, they would reduce net CO_2 emissions by 50 MtC p.a. (or some 18% of the present EU total anthropogenic CO_2 emissions of 890 MtC p.a.).

Even without additional land use for biomass there is a variety of possibilities for improved use of existing biomass resources for energy. Examples include the use of residues from forestry and agriculture, residues from the food and wood processing industry, and the biomass fraction of municipal solid waste (paper, landfill gas, disposed wood products). Thus a large fraction of the globally available biomass residues (representing a potential for about 40% of present energy use of 406 EJ p.a.) could be available for bioenergy.

The resource size of recoverable crop, forest and dung residues has been estimated to offer a yet untapped supply potential in the range of 40 EJ p.a., which could meet about 10% of the present global primary energy demand. Moreover, the difference between the annual growth increment and actual harvest from the world's forests is believed to be substantial.

New technologies for the production of biofuels in large quantities have been developed. Once demand exceeds the amount that can be supplied from residues, a change of land use and land use practices may be required in some cases. The utilization of biofuels does not depend

on the development of any fundamentally new technology. Only in some applications the properties of biofuels are such that modification of conventional fossil fuel technologies is required.

Over the last decade a great variety of bioenergy technologies have emerged (e.g. Biomass Integrated Gasification Cycle, fully automatic residential wood-pellet heating systems, etc.). Biomass combustion for heat production is based on technologies that are fully developed and economically competitive in many cases. The availability of efficient technologies for biofuel application in power production, in contrast, is still rather limited – although modern technologies exist for the combined-heat-and-power production in district heating schemes and industry needs. For the transport sector various technologies are available as well, although these are often not cost-competitive yet under low fossil energy price regimes, and will have to be employed on a broader scale first in order to take more advantage of economies of scale.

Issues Associated with Bioenergy

Bioenergy supplies are more spatially dispersed than fossil fuel supplies. Whereas dispersion tends to increase harvest and transport costs, modern biomass options offer the potential for generating employment and thus additional income in rural areas. Moreover, the local availability of biomass for energy has the potential of reducing energy imports and hence of increasing a country's self-sufficiency.

Due to the limited availability of land, sometimes conflicts may arise between bioenergy and other options for land use, especially food production. Concerns about future food supplies for the world's population, which in many locations is still increasing, have sometimes been used to discount the potential for bioenergy. These concerns are associated with the (disputable) assumption that in some regions, particularly in developing countries, land may not be available in significant quantities for biomass production for energy – unless the agricultural systems are substantially modernized.

While providing residues for energy use, wood is also widely used for long-lived products, with a CO_2 mitigation benefit that is at least threefold. First, use as a substitute for more energy-intensive products (e.g. concrete, steel) leads to indirect replacement of fossil fuels. Therefore, the enhanced use of wood products can help in reducing CO_2 emissions to the atmosphere. Second, the stock of carbon in wood products can be increased considerably (a one time effect, though). Third, wood products can be used as biofuels at the end of their life cycle, thus additionally displacing the use of fossil fuel.

Fig. 3: Wood chips storage facility for biomass district heating plant, Bad Mitterndorf/Austria (Courtesy of LEV, Austria)

Possible Interaction with Sinks

Bioenergy, through the substitution of coal, oil or natural gas, will reduce CO_2 emissions from energy systems. A

combination of bioenergy with sink options can result in a maximum benefit for GHG mitigation strategies. Afforestation of agricultural or pasture land can increase the carbon density of the land, while also yielding a perpetual source for biofuels and wood products. The use of the accumulated carbon in forests and wood products for biofuels alleviates the critical issue of maintaining the biotic carbon stocks over a long time. Enhanced use of perennial biomass crops, while providing a sustainable energy source, can also lead to increased levels of soil carbon storage.

Existing forests, if managed for a sustainable flow of forest products, are likely to contain less carbon than if protected to store carbon. However, the sustained displacement of fossil fuels repeatedly offers net carbon benefits over time, provided the productivity of the forest is high and the wood is harvested and used efficiently. Furthermore, the extraction of forest residues can result in a reduced carbon pool of decomposing residues and soil carbon, but this is a one-time effect and the carbon-pool size approaches a new equilibrium. Again, the displacement of fossil fuel through the repeated use of the biomass for energy will by far exceed this loss, especially in the long term.

Long-term and sustainable reductions of CO_2 emissions through land-based activities will to a large extent have to come from the use of wood for bioenergy and products. The provisions of the Kyoto Protocol with respect to sinks can be seen as a valuable incentive to protect and enhance carbon stocks now, while at the same time providing the biomass resources needed for the continued substitution of fossil fuels in the future.

Conclusion

Modern bioenergy options offer significant, cost-effective and perpetual opportunities for greenhouse gas emission reductions. Additional benefits offered are employment creation in rural areas, reduction of a country's dependency on imported energy carriers (and the related improvement of the balance of trade), better waste control, and potentially benign effects with regard to biodiversity, desertification, recreational value, etc.

In summary, bioenergy can significantly contribute to sustainable development both in developed and less developed countries, provided that all issues related to its practical exploitation are carefully considered.

This Position Paper was prepared by Task 25 participants to illustrate the benefits of the use of biomass in view of the provisions of the Kyoto Protocol adopted at the Third Conference of the Parties to the United Nations Framework Convention on Climate Change in December 1997.

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