UNITED BIOENERGY COMMERCIALIZATION ASSOCIATION
ASSESSING THE POTENTIAL OF BIOENERGY

Final Report for the Period
October 1, 1997 - September 30, 1998

Jonathan Kirschner
Joseph Badin

UBECA
7164 Gateway Drive
Columbia, MD 21046

PREPARED FOR THE UNITED STATES
DEPARTMENT OF ENERGY
Under Financial Assistance Award
No. DE-FG-36-94GO10025, Amendment A006

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

MASTER
DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.
DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.
# Table of Contents

- Executive Summary ............................................. 1
- Deliverables ..................................................... 1
- Meetings and Conferences ..................................... 2
- Conclusions ....................................................... 2
- Appendix
EXECUTIVE SUMMARY

As electricity restructuring proceeds, traditional concepts of how energy is produced, transported, and utilized are likely to change dramatically. Marketplace, policy, and regulatory changes will shape both the domestic and global energy industry, improving opportunities for clean, low-cost energy, competitively priced fuels, and environmentally responsible power systems. Many of these benefits may be obtained by commercial deployment of advanced biomass power conversion technologies.

The United BioEnergy Commercialization Association represents the U.S. biomass power industry. Its membership includes investor-owned and public utilities, independent power producers, state and regional bioenergy, equipment manufacturers, and biomass energy developers. To carry out its mission, UBECA has been carrying out the following activities:

- production of informational and educational materials on biomass energy and distribution of such materials at public forums;
- technical and market analyses of biomass energy fuels, conversion technologies, and market issues;
- monitoring of issues affecting the biomass energy community;
- facilitating cooperation among members to leverage the funds available for biomass commercialization activities.

DEVELOPABLES

The monthly reports filed for this grant are included in the Appendix. The deliverables specified for this grant (DE-FG36-94GO10025, Grant Agreement A006j, entitled United BioEnergy Commercialization Association (UBECA) Assessing the Potential of Bioenergy), have been sent to the Report Control Center under separate cover, and include the following items:

**Deliverable No. 1**

- UBECA Biomass Fact Sheet
- UBECA Membership Information
- Copy of Poster Display for BioEnergy '98 Conference
- Draft Biomass Cofiring Brochure (being produced in conjunction with NREL)
- Hardcopies of pages from the UBECA Web Site
- UBECA Industry Statement

**Deliverable No. 2**

- Proceedings of Workshops, including Presentations
- Information from the UBECA Annual Meeting (Agenda, Registration List, Presentations)
MEETINGS AND CONFERENCES

UBECA has been engaged in an active program of industrial outreach with a focus on information dissemination and technology transfer. In this regard, the members and staff of the Association have participated in a number of meetings designed to bring together experts from government and industry. These meetings have served as the main forum for the exchange of ideas concerning the future of biomass power and have been characterized by strategic planning sessions, technical presentations, and discussions of policy issues. UBECA has played a leading role in attracting speakers to some of these meetings and has made presentations at others. Among the meetings which UBECA has participated in are the following:

- Joint Annual Meeting with the National BioEnergy Industries Association
- Biomass Co-firing Workshops (DOE-sponsored)
- Biomass Interest Group meetings (EPRI-sponsored)
- BioEnergy '98
- Meetings of the BioEnergy Research Association (BERA)

CONCLUSIONS

Biomass power has developed into a diverse industry. Some 350 biomass power plants with a combined rated capacity of 7000 MW feed electricity into the nation’s power grid, while an additional 650 enterprises generate electricity with biomass for their own use as cogenerators. Estimates of the ultimate potential for biomass energy vary and depend on agricultural forecasts, waste reduction by industry, and paper recycling. The Electric Power Research Institute puts the estimate as high as 8% of the nation’s electricity by the year 2010. In addition, it is estimated that 10% of the country’s transportation fuels will be supplied by biomass by 2010, and as much as 50% by 2030. While the proposed Comprehensive Electricity Competition Act and other energy bills are tied up in congressional committees, most industry watchers agree that when legislation is passed, it will include a provision mandating the sale of green power. When that happens, it will give biomass developers a boost.

UBECA envisions the overall biomass power market expanding in response to a number of domestic and international events:
• Electric utility restructuring - The need to diversify and differentiate products in anticipation of greater competition will cause utilities to consider biomass' uniqueness as an energy product. When customers are given the opportunity to choose their electric power provider, corporate goals and differentiated services will have a great impact at the retail and wholesale levels. Also, a portfolio standard or wires charge, if implemented, is anticipated to support continued development of renewable energy resources, including biomass power as an attractive option.

• Global climate change - Stricter international agreements for the mitigation of greenhouse gas emissions are expected to be developed in the wake of the Kyoto Climate Change Summit. If new agreements are implemented, bioenergy will be one of the most feasible near-term options to meet ever-tightening air quality standards and may produce tradeable emissions credits.

• Burgeoning electricity requirements of developing countries - Three factors will affect the biomass market in developing nations: (1) Price--for many countries biomass is a cheap alternative to fossil fuel power options; (2) Familiarity--biomass will be favored for its familiarity in use as a traditional fuel; and, (3) International pressure--if the use of fossil fuel power expands to accommodate expected population growth, the demand for global climate change compliance will intensify.

• Government endorsement - DOE, USDA, and the White House Office of Science and Technology Policy all recognize the synergistic benefits of bioenergy and predict that it will receive greater government attention in the coming years. As pressure to meet new air quality standards builds, it is likely that the development of biomass initiatives will accelerate.

• Community service appeal - In their role as providers of electric power, utilities have traditionally maintained a sense of obligation to their service region. Despite changes in the industry, this sense of obligation will not disappear. Even in a competitive era, utilities can have a great impact on rural economic development. Biomass power can benefit the local economy by providing incentives for farmers, improving air quality, creating jobs, and utilizing local resources.

The biomass industry is fragmented, focusing on an array of technologies that strive to produce a host of energy products. There is a need for greater integration in the industry due to the range of potential benefits for power generation, production of transportation fuels, and the development of new coproducts. UBECA will continue to work to realize the vision of an integrated biomass industry which is market driven and industry led.
APPENDIX
Monthly Reports
UNITED BIOENERGY COMMERCIALIZATION ASSOCIATION

REPORT ON ACTIVITIES PERFORMED IN MARCH 1998

Activities Completed in March

- Completed first draft of recruitment brochure.
- Attended March 4th hearing of the House Commerce Subcommittee on Energy and Power concerning the Kyoto Conference. Obtained testimony of Stuart Eizenstat, Under Secretary of State, and distributed to the membership.
- Attended March 10th hearing of the Senate Appropriations Subcommittee on Energy and Water Development. Obtained testimony of Dan Reicher and Martha Krebs and distributed key points to the membership.
- Published and distributed weekly newsletter on global climate change and electricity restructuring.
- Submitted abstract for possible poster session to Bioenergy ‘98 (Madison, Wisconsin).
- Received notification that UBECA grant application ($100K) had been approved by the DOE Golden Field Office.
- Submitted draft Statement of Work to the DOE Fossil Energy Office/Federal Energy Technology Center (FETC). Statement of Work is currently in review, $100K has been set aside.
- Contacted organizations to enhance UBECA’s communication network and improve its recruiting potential (see complete list attached).
- Contacted members about the DOE/Sandia National Laboratory Request for Quotations (RFQ) on Small Modular Biomass Power Projects including Burlington Electric Dept., Bioten GP, Westinghouse, Niagara Mohawk.
- Received Request for Pre-Proposals from the United Soybean Board (USB) for projects intended to increase the export of soy-based products to Asian markets. Contacted members (Golden State Import Export) and non-member companies (as appropriate) concerning the USB solicitation, as well as a solicitation by the U.S. Department of Agriculture (USDA) on emerging markets for U.S. agricultural products. Contacted non-member companies manufacturing soy diesel and soy-based hydraulic fluid about possible partnership with UBECA members.
• Contacted two companies involved in the development of Stirling engines to inform them about other relevant RFPs. In accordance with our mission to increase membership, we are using a recruitment strategy which entails notifying candidate companies about relevant solicitations and informing them about potential partnerships with UBECA members.

• Researched other sources of funding, including foundations and philanthropic organizations that might provide support for biomass power projects based on the benefits of such projects to local economic development.

• Invoiced the following members for 1998 dues: Westinghouse Electric

Planned Activities in April 1998

• Complete arrangements for spring Board of Directors meeting.

• Attend seminar on “Carbon Trading: Opportunities and Hurdles in the Post-Kyoto Environment” at the Forum for Environmental Law, Science, Engineering, and Finance in Washington, DC.

• Obtain copies of missing invoices from DOE; contact accounting firm to prepare UBECA taxes.

• Follow up DOE/FE/FETC Statement of Work.

• Complete drafts of new UBECA organizational and recruitment literature.

• Continue contacting potential members.

• Complete draft summary of fall ‘97 Board meeting.

• Follow up with United Power Associates for possible membership (discussions in progress).

Outstanding Issues:

• TTC closeout still not completed.

• Must finalize arrangements with accounting firm to file UBECA income tax return.
International Lead and Zinc Research Organization (ILZRO) on matters of phytoremediation

Sustainable Energy Coalition for weekly information exchange

Business Council for Sustainable Energy

Biomass Fuel Cell Council (Eric Simpkins)

Bob Lawrence and Associates

Coal Utilization Research Council (co-firing)

Public Technologies, Inc. (PTI) to discuss joint activities geared towards urban and rural communities

American Forest Products Association

Institute of Paper Science and Technology

Weyerhauser Corporation

Peabody Coal

United Soybean Board

U.S. Geological Survey

United Power Associates
UNITED BIOENERGY COMMERCIALIZATION ASSOCIATION

REPORT ON ACTIVITIES PERFORMED IN APRIL 1998

Activities Completed in April:

- Completed one-page information document.
- Published and distributed weekly newsletter on global climate change and electricity restructuring.
- Provided information concerning states’ activities in establishing a renewable standards portfolio.
- Contacted organizations to enhance UBECA’s communication network and improve its recruiting potential (see complete list attached).
- Obtained copies of missing invoices from DOE; contacted accounting firm to prepare UBECA taxes.
- Researched other sources of funding, including foundations and philanthropic organizations that might provide support for biomass power projects based on the benefits of such projects to local economic development.
- Attended Clean Coal Technologies Conference in Reno, Nevada.
- Invoiced the following members for 1998 dues: TVA.

Planned Activities in May 1998:

- Complete arrangements for spring Board of Directors meeting.
- Follow up DOE/FE/FETC Statement of Work.
- Complete drafts of new UBECA organizational and recruitment literature.
- Continue contacting potential members.
• Complete final draft summary of fall ‘97 Board meeting with comments received from Board members.

• Follow up with United Power Associates for possible membership (discussions in progress).

Outstanding Issues:

• TTC closeout still not completed.

• Must finalize arrangements with accounting firm to file UBEC A income tax return.

UBEC A Contact List - April 1998


► Peabody Holding Company

► Institute of Gas Technology

► Coal Utilization Research Council

► Southern States Energy Board
UNITED BIOENERGY COMMERCIALIZATION ASSOCIATION

REPORT ON ACTIVITIES PERFORMED IN MAY 1998

Activities Completed in May:

- Completed four-page membership information document.
- Attended hearing of the House Committee on International Relations concerning the Kyoto Climate Change Treaty.
- Met with Public Technologies, Inc. (Washington, DC) about possible cooperation and recruitment of municipalities (urban and rural jurisdictions).
- Met with ERC and requested information on the Biomass Fuel Cell Council.
- Changed UBECA Website over to <www.energeticsservices.com/ubeca.htm>

Planned Activities in June 1998:

- Information requests to be sent for membership directory.
- Complete arrangements for Board of Directors meeting.
- Follow up DOE/FE/FETC Statement of Work.
- Complete drafts of new UBECA recruitment literature.
- Continue contacting potential members.
- Complete final draft summary of fall ‘97 Board meeting with comments received from Board members.
- Follow up with United Power Associates for possible membership (discussions in progress).
- Begin updating the information on the UBECA website.
Outstanding Issues:

- TTC closeout still not completed.
- Must finalize arrangements with accounting firm to file UBECA income tax return.

UBECA Contact List - May 1998

- Public Technologies, Inc.
- Institute of Gas Technology
- TransAlta
- Peabody Holding
- Energy Research Corporation
UNITED BIOENERGY COMMERCIALIZATION ASSOCIATION

REPORT ON ACTIVITIES PERFORMED IN JUNE 1998

Activities Completed in June:

- Attended the DOE-sponsored Biomass Co-firing Workshop at the Edison Electric Institute.
- Hosted the UBECX Board of Directors meeting in Washington, DC.
- Entered UBECX's name on the electronic Bioenergy Mailing List hosted by the Center for Renewable Energy and Sustainable Technologies (CREST) as a means of increasing contacts within the biomass community.
- Attended reception in Washington sponsored by Fibrowatt Ltd., pollution control and energy technologies.
- Discussed membership opportunities with Trigen-Biopower and with PennState University.
- Held discussions with NREL on collaborative effort to publish Co-firing brochure as part of our program of industrial outreach.
- Began collecting information from members for a UBECX membership directory and BioEnergy '98 poster.
- Completed an assessment of the records received from UBECX’s former management team; presented our findings to the Board.

Planned Activities in July 1998:

- Begin work on the membership directory and on the co-firing brochure in conjunction with NREL. Activity is underway to propose a more comprehensive communication plan.
- Meet with the White House Office of Science and Technology Policy to discuss initiatives for following up PCAST recommendations and other interagency biomass opportunities.
• Follow up DOE/FE/FETC Statement of Work.

• Complete layout of new UBECA recruitment literature (to parallel the membership directory).

• Continue contacting potential members.

• Begin draft summary of June '98 Board meeting.

• Continue sending weekly electronic newsletter to members (*Climate Change and Utility Restructuring News*)

• Continue updating the information on the new UBECA website.
Activities Completed in July:

- Met with Sam Baldwin of the White House Office of Science and Technology Policy (OSTP) to discuss following up PCAST recommendations and other interagency biomass opportunities.

- Completed paper for Bioenergy ‘98 poster session with contributions from UBECA members. Began work on poster layout.

- Began updating the new UBECA web site.

- Followed up DOE/FE/FETC contract funding and spoke with Phil Goldberg, FETC. The Statement of Work has been approved and a sole source justification has been submitted. Currently awaiting additional paperwork and DOE transfer of funds.

- Continued discussions with Jim Jones of NREL on collaborative effort to publish co-firing brochure as part of our program of industrial communication and outreach.

- Requested that TTC turn over all outstanding UBECA records to Energetics.

Planned Activities in August 1998:

- Continue working on the membership directory and on the co-firing brochure in conjunction with NREL.

- Make arrangements to attend Bioenergy ‘98 and to hold a UBECA “planning session” with the members.

- Complete layout of new UBECA recruitment literature (to parallel the membership directory).

- Begin draft summary of June ‘98 Board meeting.

- Continue sending weekly electronic newsletter to members (Climate Change and Utility Restructuring News)

- Continue updating the information on the new UBECA website.

- Begin preparation of the FY ‘99 Financial Assistance Package to DOE/Golden Field Office along with the next UBECA planning document.

- Contact NBIA about plans for joint annual meeting in Washington.
Activities Completed in August:

- Met with Ray Costello to discuss EERE funding situation for FY’ 99.
- Completed draft summary of the June Board of Directors meeting and sent it out for review and comment.
- Continued work on BioEnergy ‘98 poster layout.
- Continued updating the new UBECA web site (www.ubeca.org).
- Followed up DOE/FE/FETC contract funding. Currently awaiting additional paperwork and DOE transfer of funds.
- Began working with Jim Jones of NREL on co-firing brochure as part of our program of industrial communication and outreach.

Planned Activities in September 1998:

- Continue working on the membership directory and on the co-firing brochure in conjunction with NREL.
- Continue working on new UBECA recruitment literature.
- Complete the poster for BioEnergy ‘98.
- Continue sending weekly electronic newsletter to members (Climate Change and Utility Restructuring News)
- Continue updating the information on the new UBECA website.
- Prepare FY’99 UBECA Program Plan.
- Plan for next board Meeting.
UNITED BIOENERGY COMMERCIALIZATION ASSOCIATION

REPORT ON ACTIVITIES PERFORMED IN SEPTEMBER 1998

Activities Completed in September:

- Completed BioEnergy '98 poster.
- Submitted biomass article for publication to *Renewable Energy World* magazine.
- Continued updating the new UBECA web site (www.ubeca.org).
- Followed up DOE/FE/FETC contract funding. DOE transfer of funds to UBECA has been completed for Phase I activities. A second transfer of funds is pending.
- Continued working with Jim Jones of NREL on co-firing brochure as part of our program of industrial communication and outreach.

Planned Activities in October 1998:

- Continue working on the membership directory and on the co-firing brochure in conjunction with NREL.
- Submit deliverables to DOE Golden Field Office.
- Continue working on new UBECA recruitment literature.
- Attend BioEnergy '98 in Madison October 4-8.
- Submit brief article on BioEnergy '98 to *Renewable Energy World* magazine.
- Continue sending weekly electronic newsletter to members (*Climate Change and Utility Restructuring News*)
- Continue updating the information on the new UBECA website.
- Prepare FY'99 UBECA Program Plan.
- Continue follow-up of recruiting activities and other strategic alliances.
- Plan for next Board meeting in early December.
UBECA Produced Brochures

- Biomass Fact Sheet
- UBECA Membership Information
- Poster Display for BioEnergy '98
- Draft Cofiring Brochure (being produced in conjunction with NREL)
- UBECA Web Site
- UBECA Industry Statement

***

Prepared by

UBECA
United BioEnergy Commercialization Association
Columbia, Maryland

Prepared under contract to the
U.S. Department of Energy
Biomass Power Program

September 1998
What Is Biomass?

Biomass is an energy resource derived from the organic waste of natural and human activities. Biomass is obtained from many sources, including timber industry by-products, raw forest material, agricultural crops, household waste, and demolition wood.

Why Should Biomass Fuels Be Considered for Generating Electricity?

Carbon dioxide or CO₂, the primary greenhouse gas, is released whenever fossil fuels are burned. Our reliance on these fuels means that atmospheric levels of CO₂ are increasing at an alarming rate as world living standards rise. Renewable energy technologies that include biomass can help to reduce the level of carbon dioxide and other greenhouse gases in the atmosphere. Biomass is a readily available fuel that can be fired in existing power plants which currently burn coal.

How Can The Use of Biomass Fuels Help Reduce Atmospheric CO₂?

Biomass power is one of the most attractive options for addressing concerns over CO₂ because trees and other plants sequester atmospheric carbon dioxide. The growth of plants and their conversion to energy as biomass fuels thus recycles atmospheric carbon. The result is no net addition of CO₂ into the atmosphere.

What Other Environmental Benefits Can Be Realized From The Use of Biomass Fuels?

Biomass, if properly managed, is a renewable resource. Its low sulfur content means that emissions of sulfur dioxide gas are minimized. Ash resulting from the burning of biomass is low in heavy metals and can be recycled into soil amendment and other products. Power plants that currently burn only coal can be easily adapted today to co-fire blends of coal and biomass. It has been estimated that as much as a 15% blend of biomass can be co-fired without major equipment modifications and can result in a corresponding reduction of fossil-based carbon emissions.

Is Biomass Currently Being Used to Produce Electricity?

The use of biomass for power generation has increased over the last decade. In the U.S., total electricity generation grew by only 1.5% each year between 1990 and 1994. During the same period, the portion generated from biomass grew by 7% annually, reaching 59,000 GWh in 1994—nearly 2% of all electricity generated (utility and non-utility) in the U.S. In Europe too, biomass energy currently accounts for about 5% of total energy consumption. Estimates of future opportunities for increasing biomass to electricity generation vary. In the U.S., the estimate is that by 2030, the biomass industry could produce as much as 5% and in Europe 15% of all electricity consumed.
United BioEnergy Commercialization Association

List of Member Companies and Associations (7-23-98)

Members

Electric Utilities and Associations

Burlington Electric Department (Burlington, Vermont)
Central and South West (Tulsa, Oklahoma)
Edison Electric Institute (Washington, D.C.)
General Public Utilities (GPU) Genco (Johnstown, Pennsylvania)
National Rural Electric Cooperative Association (Arlington, Virginia)
Niagara Mohawk Power Company (Syracuse, New York)
North American Power Group (Englewood, Colorado)
Northern States Power Company (Minneapolis, Minnesota)
Northern Indiana Public Service Company (Hammond, Indiana)
Southern Company (Birmingham, Alabama)
Tennessee Valley Authority (Chattanooga, Tennessee)

Associate Members

Electric Power Research Institute (Palo Alto, California)
Bioten GP (Knoxville, Tennessee)
Council of Great Lakes Governors (Chicago, Illinois)
Golden State Import Export (Pomona, California)
MEMBERSHIP INFORMATION

BACKGROUND

The United BioEnergy Commercialization Association (UBECA) was formed in 1994 to encourage the development of sustainable biomass resources and economically competitive biomass energy conversion technologies for the benefit of electric utilities, power producers, fuel suppliers, their customers, and society. Electric utilities and other power producers joined together to form the nonprofit association in collaboration with the Electric Power Research Institute (EPRI) and the U.S. Department of Energy (DOE). Building upon the experience of its members, UBECA is responding to the challenge of commercialization by defining appropriate commercialization paths for various biomass technologies. UBECA also provides contacts and facilitates joint development projects as, and where, appropriate.

UBECA activities reflect the needs of the marketplace. Of significant near-term interest to UBECA members is cofiring biomass with coal. This technology, which can reduce coal consumption by as much as 15%, has been demonstrated at several power plants to be technically feasible. Because the possibility of cofiring in coal-fired facilities exists today, this pathway can be a near-term contributor to greenhouse gas reduction. In addition to cofiring, UBECA’s interests extend to advanced gasification technologies and to promoting the use of forest and agricultural residues, short rotation woody crops, such as poplar and willow, and dedicated herbaceous energy crops, such as switchgrass.

Located in the Washington, D.C. area, UBECA maintains close contact with the U.S. Department of Energy’s Office of Energy Efficiency and Renewable Energy which administers the DOE Biomass Power Program. UBECA also maintains contact with the National Renewable Energy Laboratory in Golden, Colorado and the Oak Ridge National Laboratory in Oak Ridge, Tennessee. Along with other leading institutions, these National Laboratories are working to develop low-cost, high-quality biomass feedstocks and efficient technologies for converting those feedstocks to energy.

UBECA invites and encourages the support of qualified members to join with other industry leaders to promote the use of biomass as the renewable fuel of choice for companies who have coal-firing assets and experience, and for companies seeking fuel flexibility and other strategic competitive advantages.
UBECA’s mission is to serve as the primary voice of power producers with an interest in biomass power generation, and to encourage the development and commercialization of sustainable biomass fuel resources and economically competitive biomass energy conversion technologies. To achieve this, UBECA has developed the following four-point strategy:

- **Encourage the private sector commitment:** UBECA acts as a forum for the exchange of ideas on how biomass can be utilized to the maximum benefit of both the electric service provider and the customer. UBECA identifies opportunities for new bioenergy conversion technologies in both domestic and foreign markets, and assists its members to identify barriers that may restrict the entry of those technologies.

- **Track government research, development and demonstration activities:** UBECA stays up to date on the annual budget process of the U.S. Department of Energy’s Biomass Power Program. UBECA members are kept apprised of trends in funding and of new government initiatives to increase the use of biomass in electric power applications. Such initiatives may include cooperative agreements which make it possible for members to leverage their participation in the program. Members are also informed of legislative and regulatory issues which might impact the market for biomass power technologies.

- **Monitor restructuring of the electric power industry:** Members are provided with information on utility restructuring initiatives at both the federal and state levels, renewable portfolio standard disclosure requirements, and changes in the fast-developing area of emissions allowance trading. UBECA keeps its members informed through its weekly electronic newsletter, *Climate Change and Utility Restructuring News*, and in so doing, on the competitive edge in an age of increasing market uncertainty.

- **Nurture cooperation and partnership:** UBECA brings together representatives of the power industry, agriculture, the federal government, and the financial community in a concerted effort to ensure America’s sustainable energy future and continued prosperity.

As the electric power industry transforms itself to meet the needs of a deregulated marketplace, it will become ever more critical to identify and develop high-value bioenergy market niches while pursuing environmentally benign methods of electricity production. Successful research, development, and demonstration projects must be linked to commercialization strategies that provide incentives, and lower the risks and costs associated with new facilities. UBECA can help its members evaluate new and unique technologies for this competitive marketplace, and facilitate their advancement toward full commercialization.
MEMBERSHIP BENEFITS

As utility restructuring proceeds, traditional concepts of how energy is produced, transported, and utilized are likely to change dramatically. Marketplace, policy, and regulatory changes will shape both the domestic and global energy industry, improving opportunities for clean, low-cost energy, competitively priced fuels, and environmentally responsible power systems. Membership in UBECA provides a mechanism for your company to be kept informed of the issues and important developments taking place in the areas of global climate change and utility restructuring. While Congress debates ratification of the Kyoto Climate Change Treaty, the Administration has put forward a five step Climate Change Proposal to reduce greenhouse gas emissions. The proposal includes binding targets for reducing greenhouse gas emissions below 1990 levels and a $6 billion program of tax cuts and R&D spending to spur the development of key renewable technologies, such as biomass. Power generators are therefore facing the prospect of having to reduce carbon dioxide emissions while, at the same time, adapting to the uncertainties of a deregulated marketplace. UBECA acts in concert with allied trade associations to ensure that biomass is considered along with such renewable energy sources as wind, hydroelectric, and solar in the context of "green pricing" or a renewable energy portfolio standard, wherever such standards become law.

In addition, member companies receive the following benefits:

- Access to current industry developments through UBECA’s weekly electronic newsletter Climate Change and Utility Restructuring News.

- Point of contact to address common problems related to biomass technologies and their commercialization.

- Information clearinghouse and source of data for the biomass power industry.

- Annual conference conducted jointly with the National Biomass Industries Association featuring speakers from government, industry, and the world financial community.

WHO CAN JOIN

UBECA welcomes the participation of all companies who have an interest in advancing the use of biomass as a renewable energy resource. Any power producer may become a Regular (voting) Member of UBECA, and any other interested organization may become an Associate (non-voting) Member. Our membership includes investor-owned and public utilities, independent power producers, state and regional bioenergy organizations, equipment manufacturers, industrial cogenerators, fuel suppliers, and biomass energy developers. The membership application on the back lists the various categories of membership and the dues for each category.
UBECA Membership Application

My organization is applying for Regular Membership. It is an (check one):

☐ Electric utility
☐ Owner or operator of independent, non-utility generation equipment
☐ Owner or operator of power generation equipment used for supply of own electric load
☐ Organization of electric utilities or other power producers
☐ Other (describe) ______________

or, my organization is applying for Associate Membership:

☐ Describe: ____________________________

A. For Regular Membership Application: Our dues for a 12-month introductory membership will be:

☐ $2,000 $1,000 (for revenues less than $30 million)
☐ $3,000 $1,000 (for revenues between $30 and $300 million)
☐ $6,000 $1,000 (for revenues between $300 million and $3 billion)
☐ $8,000 $1,000 (for revenues greater than $3 billion)
☐ $14,000 $1,250 (for multi-organization member*)

* This membership option is available to organizations such as joint action agencies and their municipal members, generation & transmission cooperatives and their power distributors, holding companies and their operating companies, and power producers and their parent organizations and subsidiaries. Any such family of companies, if they do not wish to join as individual members, may join UBECA as a group for a single, total fee of $10,000. Membership privileges (e.g., participation on committees, member fees at meetings, inclusion on Member Mailing List, receipt of UBECA publications) are available to all related organizations within the family. The only limitation to a family membership is that only one voting (member) representative may be appointed. This option applies to power producer families provided the included subsidiaries are 100% owned by the parent company.

B. For Associate Member Application: Our dues for a 12-month introductory Associate membership will be:

☐ $2,000 $500 (for all Associate Members)

C. For all applicants:

☐ Payment of the membership fee is enclosed.
☐ Payment of an invoice for the membership fee will be paid within 60 days.

Upon becoming a member, ___________________________, agrees to abide by the By-Laws of the United BioEnergy Commercialization Association. All dues shall be in effect for one calendar year from date received in this office.

Company:________________________________________________________
Designated representative:__________________________________________
Address:__________________________________________________________
Phone:_________________ Fax:_________________ E-mail:_________________
Date:_________ Authorized signature ________________________________

UBECA, 7164 Gateway Drive, Columbia, MD 21046, Phone: 301/621-3002, 621-3003, Fax: 301/621-3725
**UBECA MISSION**

- To serve as the primary voice of power producers with an interest in biomass power generation.
- To encourage the development and commercialization of sustainable biomass fuel resources and economically competitive biomass energy conversion technologies.

**KEY ACTIVITIES**

- **Production of information** and educational materials on biomass energy and distribution of such materials at public forums;
- **Technical and market analyses** of biomass energy fuels, conversion technologies, and market issues;
- **Monitoring and reporting** on Congressional, State, and Administration issues affecting the biomass energy community; and
- **Assistance to members** in commercializing biomass in a restructured energy marketplace.

**MEMBERS**

United BioEnergy Commercialization Association

**List of Member Companies and Associations**

**Electric Utilities and Associations**
- Burlington Electric Department (Burlington, Vermont)
- Central and South West (Tulsa, Oklahoma)
- Edison Electric Institute (Washington, D.C.)
- General Public Utilities (GPU) Genco (Johnstown, Pennsylvania)
- National Rural Electric Cooperative Association (Arlington, Virginia)
- Niagara Mohawk Power Company (Syracuse, New York)
- North American Power Group (Englewood, Colorado)
- Northern States Power Company (Minneapolis, Minnesota)

**Northern Indiana Public Service Company**

- Hammond, Indiana

**Southern Company**

- Birmingham, Alabama

**Tennessee Valley Authority**

- Chattanooga, Tennessee

**Associate Members**

- Bioten GP (Knoxville, Tennessee)
- Council of Great Lakes Governors (Chicago, Illinois)
- Golden State Import Export (Pomona, California)

---

**Equipment Development and Deployment**

**BIOTEN GP**

- BIOTEN GP has developed both a biomass fuel processing system and a gas turbine power plant. The fuel processing system provides the unfueled, dry biomass fuel stream needed to support firing conditions. The compressor provides the power needed for the system, including the fan, reduction, and production module and producing useable thermal energy and electricity.

---

**Council of Great Lakes Governors**

The Council of Great Lakes Governors is a private, nonprofit organization devoted to working cooperatively on public policy management in eight member states: Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. The Council of Great Lakes Governors operates under the guidance of the U.S. Department of Energy. The direction of the program is to stimulate the production and use of biomass for energy by developing and disseminating information about market-ready biomass technologies and awareness to both the public and private sector.

---

**Central and South West Corporation**

Central and South West (CSW) has received recognition for its power renewable energy technology services. CSW has operated a wind farm and solar farm in southern Texas since 1999. CSW is also evaluating to sell turn-key plants and the economic-environmental benefits in an accurate manner for potential biomass companies. A consulting feasibility study will be conducted later this year.
Utilities Take Measure of Biomass Cofiring
Cofiring biomass with coal has environmental advantages, including reducing greenhouse gases such as carbon dioxide (CO₂) and acid rain precursors such as sulfur dioxide (SO₂) and nitrogen oxides (NOₓ). Almost all biomass is low in sulfur content, so SO₂ reductions are typically proportional to the biomass input. Furthermore, some biomass fuels, such as wood, are also low in nitrogen content. Recent tests sponsored by the Electric Power Research Institute (EPRI) and the U.S. Department of Energy (DOE) conducted at 10 utility boilers cofiring up to 7% wood show NOₓ emissions can be reduced as much as 15% compared with coal-only operation. The results—which depend on firing configuration and boiler type—did not explore optimizing NOₓ reductions.
Industry Surveys Performance

Several years of operating experience and testing have allowed power companies to delineate the technical and economic issues associated with cofiring biomass with coal.

Economic Requirements
The economics of cofiring are highly site-specific and depend on the layout of the power plant and the availability of low-cost biomass fuels. A typical cofire installation includes modification to the fuel-handling system and storage for biomass. Costs can increase significantly if facilities for wood drying or size reduction are required, or if a separate feed to the boiler is required. For pulverized-coal boilers, retrofit costs range from $150 to $300 per kilowatt (kW) and higher. The lowest-cost opportunities are with cyclone boilers, for which costs may be as low as $50 per kW.

The more important cost factor, however, is fuel supply. Costs for biomass fuels depend on a number of factors such as climate and proximity to population centers and industries that handle and dispose of wood. Usually the cost of biomass fuels must be equal to or less than the cost of coal (per MBtu) for cofiring to be economically successful. Some utilities reduce fuel costs by cofiring with biomass; the Tennessee Valley Authority, for example, estimates it will save $1.5 million per year in fuel costs cofiring at its Colbert plant.

Technical Challenges
Several technical questions having to do with fuel feed, boiler chemistry, and ash deposition and disposal have been defined and are approaching resolution. Losses in boiler efficiency due to cofiring are small (0.3 to 0.6 points out of 85 to 88 percentage points) and are usually due to higher moisture content in the biomass fuels. A consensus is emerging that cofiring is feasible at the majority of coal-fired power plants.

However, many power companies sell fly ash for use in making Portland cement: currently the standard set by the American Society for Testing and Materials require only "coal ash" be used in the mixture. Until this standard is changed to specify performance instead of "coal ash," cofiring biomass may alter the ability of plant managers to sell ash for use in making cement. Several utilities are working with the U.S. Department of Energy (DOE) to resolve this issue.

Biomass Cofiring Plants
In Commercial Operation
- Demonstrations Conducted
- Tests Planned

Over the last decade, electric utilities across the country have implemented biomass cofiring in demonstrations and in commercial operations. Today, five power plants are cofiring coal with wood residue products and a sixth plant recently shut down after 10 years of operation. Five more plants are planning tests some time in the next year. As a result of this experience, information is now available on the technical and economic performance of cofiring biomass with coal.
In a deregulated market, power producers with coal generation may use biomass cofiring to improve their overall environmental performance for customers who are sensitive to environmental issues.

Biomass cofiring may represent an opportunity for both consumers and power companies. In recent polls, consumers have indicated their willingness to support green-pricing and renewable energy programs. Some consumers are paying a premium for renewable energy, typically 10% or less of their entire bill. For power generators, biomass may represent the most plentiful and economic supply of locally available renewable energy.

Cofiring may also represent an opportunity for power companies to provide with new services to important customers. This opportunity exists for providing industries such as construction or transportation a way to discard large quantities of wood, or providing industries such as forestry, wood products, pulp and paper, agriculture, and food processing a way to dispose of large quantities of residues. In these locations, the cost of biomass fuels can be relatively low. Thus cofiring can provide both a service to industrial customers and renewable energy for environmentally conscious customers at the same time.
- UBECA -

PROCEEDINGS OF:

• Workshops
  - Presentations

• Annual Meeting
  - Agenda
  - Registration List
  - Presentations

♦♦♦♦

Prepared by
UBECA
United BioEnergy Commercialization Association
Columbia, Maryland

Prepared under contract to the
U.S. Department of Energy
Biomass Power Program

September 1998
- UBECA -

WORKSHOPS

- Presentations

BOARD OF DIRECTORS MEETINGS

- Meeting Summaries
- Presentations
Semi-Annual Meeting
USDOE Biomass Power Program

January 21 - 22, 1998
The Mayflower Hotel
1127 Connecticut Ave NW, Washington, D.C.
(202) 347-3000

Wednesday, January 21, 1998

9:00 - 10:15 am  DOE Overview and Comments
Moderator - Lynne Gillette
Allan Hoffman - Invited Comments
Gary Burch - Invited Comments
Ray Costello - Program Overview
Lynne Gillette - Technology Characterizations

10:15 - 10:30  Break

10:30 - 12:15  Project Overviews
Moderator - Lynne Gillette

10:30 - 10:50  Biomass Power for Rural Development - Jim Spaeth, GO
10:50 - 11:10  Vermont and Hawaii Status - Robert Martin, GO
11:10 - 11:30  Sandia Overview: Modular Systems RFP and Combustion Studies -
Tom Mancini, SNL
11:30 - 11:50  Feedstocks - Lynn Wright, ORNL
11:50 - 12:10  NREL Overview - Helena Chum, NREL

12:15 - 1:30  Lunch

Afternoon Sessions - Stakeholder Organizations
Theme: Organizational overview and ways to work together
Moderator: Lynne Gillette

1:30 - 2:00  NBIA
2:00 - 2:30  UBECA
2:30 - 3:00  World Bank

3:00 - 3:15  Break

3:15 - 3:45  USDA - Roger Conway
3:45 - 4:15  DOE Regional Biomass Program
4:15 - 4:45  USAID - Ross Pumfrey
4:45 - 5:15  Business Council for Sustainable Energy - Michael Marvin

5:30 - 7:00  Reception
United BioEnergy Commercialization Association

Joe Badin
Executive Director

Presentation to the Semi-Annual Meeting of the U.S. DOE Biomass Power Program

January 21, 1998
Membership: Serving Diverse Needs

- Current Membership
  - 16 Full Members
  - 4 Associate Members
- Key Strategic Objective:

Self-sustaining association after 5 years (2003)

Target industrial cogenerators, agricultural organizations, independent power producers, and “green” power marketers.
UBECA Inputs

Legislative/Regulatory Drivers

- Farm/Agriculture Bills
- Energy Policy Act
- Utility Deregulation
- Global Climate Change International Protocols
- Clean Air Act Amendments
- State Regulations
Biomass Commercialization

- Major drivers
- Major markets
- Major challenges
Major Industries

- Forest products
- Pulp and paper
- Other large cogenerators
Benefits of Cofiring

- Achieve reductions in atmospheric CO$_2$
  - Low-cost, low-risk, near-term solution
- Biomass is easily stored and dispatched (compared to other renewables)
- Makes best use of existing assets
- Greatly expands the potential market for biomass
- Reduces waste disposal at landfills
Major Challenges

- Fuel availability
- Transportation costs
- Low cost of conventional fuels
- Public awareness of biomass as "green"
Member Needs

- Keeping well-informed
  - Swiftly changing industry - analyze uncertainties
  - Regulatory changes and incentives
  - Technology cost & performance, R&D issues
  - Coordinated activities

- Obtaining competitive edge
  - Identify near-term, creative niche markets
  - Reduce deployment risk
  - Identify cost-effective integrated systems
  - Identify business partners and appropriate financial arrangements
UBECA’s Emerging Agenda

- Provide a forum to promote bioenergy
- Expand outreach to encompass agricultural, forestry, and environmental stakeholders
- Develop a near-term game plan for increasing market awareness
- Identify critical RD&D needs and targets
- Accelerate commercialization: establish a biomass project finance network
Key Messages

- Resources are large, low-cost, and widely available
- Environmental benefits are significant and can be gained today
- Biomass energy can help to revitalize rural economies
- Biomass power can improve a utility’s image with its customers
- Cofiring makes sense today ... and other technologies are on the horizon
UBECA Members

16 Regular Members
Burlington Electric
Edison Electric Institute
Electric Power Research Institute
General Public Utilities:
    Pennsylvania Electric Company
    GPU Service Corporation
    GPU Genco
    GPU Energy
National Rural Electric Coop. Assoc.
Niagara Mohawk Power Corp.
North American Power Group, Ltd.
Northern Indiana Public Services Co.

Northern States Power Company
Central and South West Services
    Southern Company:
    Georgia Power Company
    Southern Company Services
    Tennessee Valley Authority

4 Associate Members
Bioten GP
Council of Great Lakes Governors
Westinghouse Electric Corporation
Golden State Import Export
UBECA Activities Lead to Market Results

Briefs
- feedstocks
- technologies
- power conversion processes

Issues
- regulatory
- economic
- financial
- commitments of potential partners

Case Studies
- components of successful projects
- lessons learned

Cost-Benefit Analyses
- target costs vs. real costs
- cost-effective biomass energy systems

Accelerate Commercialization
UBECA

- Membership Update
- Activity Summary
- EPRI Biomass Interest Group

JOSEPH S. BADIN
June 24, 1998
MEMBERSHIP UPDATE
MEMBERSHIP STATUS

- Currently UBECA has 15 member organizations with total 1998-1999 dues of $72,000.

- On-going recruitment activities:

  Interested Organizations:

  - Delmarva Power (Connectiv) - Mike Zoccola
  - Foster Wheeler - Neil Raskin
  - Penn State, Energy and Fuels Research Center - Joel Morrison
  - State University of New York - Tim Volk

- Issues

  - Honorary membership for National Laboratories
  - Joint membership option with NBIA
CURRENT MEMBERS

- Bioten GP
- Burlington Electric Dept.
- Central and South West
- Council of Great Lakes Governors
- Edison Electric Institute
- Electric Power Research Institute
- General Public Utilities (GPU) GENCO
- Golden State Import Export
- National Rural Electric Cooperative Assoc.
- Niagara Mohawk
- North American Power Group
- Northern Indiana Public Service Company
- Northern States Power
- Southern Company
- Tennessee Valley Authority
EXTENDING OUR PROFESSIONAL NETWORK

- DOE FEMP Renewable Energy Working Group
- Sustainable Energy Coalition
- Business Council for Sustainable Energy
- Biomass Fuel Cell Council
- Public Technologies, Inc.
- Coal Utilization Research Council
- Renewable Energy Policy Project
- Australian Biomass Energy Task Force
- The World Bank (Brazil)
CONTINUING CONTACTS

- Institute of Paper Science and Technology (Gary Baum)
- Weyerhauser Corporation (Del Raymond)
- Peabody Coal (John Wooten)
- United Power Associates (Steve Shurts)
- Institute of Gas Technology (Francis Lau)
  - Endesco (IGT subsidiary)
- Minnesota Power (Mike Cashin)
- Trans Alta Utilities (Malcolm McDonald)
- National Association of State Departments of Agriculture (Jeff Anliker)
OTHER PROSPECTS

- American Forest Products Association
- Independent Power Producers
  - Trigen Energy
  - Calpine
  - Others
- The White House (OSTP)
- Collaborations for Foundation Gants
  (Education and local economic development)
- Proposed strategic planning and technology roadmapping role
crosscutting several sectors
ACTIVITY STATUS

- Published and distributed weekly newsletter on global climate change and electricity restructuring
- Produced new UBECA membership literature (new 1-pager and new 4-pager). Focused on recruitment efforts.
- Collecting information for a member directory
- Disseminated literature at the House Renewable Energy Caucus Expo
- Attended the EPRI Biomass Interest Group meetings
- Attended post-Kyoto hearings, appropriations hearings, a seminar on Carbon Trading, and a BERA meeting.
- Attended biomass energy reception at the British Embassy
- Distributed information on RFPs (small modular biomass power projects and other opportunities with USDA, the United Soybean Board)
ACTIVITY STATUS (CONTINUED)

- Attended DOE Cofiring Workshop
- DOE Golden grant ($100K) is active
- DOE/FE/FETC grant is pending
  - Proposed changes in scope to include planning/roadmapping and monitoring of international activities
- Reviewed DOE/FETC SBIR Phase I Biomass Gasification Proposal
- Expand communications, outreach, and website development activities
- Poster accepted for BioEnergy '98
- Developing column for biologue and article for trade publication
- Sorting through information and preparing options for reasonable TTC closeout
OVERVIEW OF EPRI BIOMASS INTEREST GROUP MEETING

MAY 28-29, 1998
EPRI BIOMASS INTEREST GROUP
(EVAN HUGHES)

- About 35 attendees
- See enclosed agenda and background summary
- Common key drivers
  - Economics and operational justification
  - Renewable Portfolio Standards
  - Green Power
  - Customer Retention/Relations
  - Other competitive advantages/benefits
EPRI BIOMASS INTEREST GROUP
(EVAN HUGHES) (CONTINUED)

- Discussion resulted in the following list of needs (not in priority order) for demonstration projects:
  - Reduce to least capital cost
  - Determine best way to feed into a boiler
  - Environmental benefits
  - Leverage dollars
  - Gain more interest
  - Select projects with agreed criteria
  - Regulatory supports
    - incentives
    - eliminate barriers
    - information exchange
  - “Roadmap” (proposed UBECA role)
    - consensus vision
    - definitions
    - quantify RPS mandate and ability to meet
Discussion resulted in the following list of needs (not in priority order) for demonstration projects: (continued)

- Credibility
- Real sites to visit
- Meet a mix of needs (research, demo, others)
- No policy positions
- Intellectual property/credits/rights
- Capture Europe (experience and market)
- Ash quality (marketability)
- Outreach/synergy/collaborations - avoid overlaps
- Bring in wood, chemicals, industries
- Answers: pollutants, char burn out; size, infrastructure; corrosion; costs
- Disseminate results; get feedback
Discussion resulted in the following list of needs (not in priority order) for demonstration projects: (continued)

- Public information/web page
- Work load sharing
- Monitoring legislation and regulations
- Meetings/site visits/technical exchange
- Issue appropriate reports
WRAP-UP

• Open Discussion
• Questions
• Recommendations
- UBECA -

ANNUAL MEETING

- Agenda
- Registration List
- Presentations
BIOMASS ENERGY:
DYNAMIC SOLUTIONS TO GLOBAL PROBLEMS

hosted by the
National BioEnergy Industries Association
and the
United BioEnergy Commercialization Association
in
Washington, DC
at
The Jefferson

December 8-9, 1997

The National BioEnergy Industries Association (NBIA) and the United BioEnergy Commercialization Association (UBECA) will host a one-day workshop to examine the role of bioenergy in addressing the global climate change issue.

On October 22, 1997 President Clinton announced the U.S. Administration's official negotiating position, to address global climate change, at the UN Global Climate Change Convention in Kyoto, Japan. In addition, President Clinton outlined several domestic policy measures to reduce greenhouse gases that, if adopted, should benefit the U.S. bioenergy industry.

The biomass industry has a unique window of opportunity, with this post-Kyoto workshop, to meet, strategize and to exchange ideas on how to create new market opportunities for bioenergy development, and to work with the public sector in order to facilitate greater bioenergy utilization.
PRELIMINARY AGENDA

December 8, 1997

- NBIA Board of Directors Meeting
- UBECA Members Meeting
- Biomass Stakeholders Strategy Meeting

December 9, 1997

- Continental Breakfast

WELCOME & OPENING REMARKS
Joseph Badin, UBECA
Scott Sklar, NBIA
Dan Reicher, Dept. of Energy

SESSION I:
Biomass Energy's Role in Carbon Sequestration and Reduction
Evan Hughes, EPRI
Jim Cooper, Chariton Valley Project
Ted Dahill, BIOTEN GP

SESSION II:
Financing Biomass Projects - Domestic & International
Kevin McNamara, Taylor DeJongh
Masaki Takashi or Luis Vaca-Soto, World Bank
Craig O'Conner, U.S. Export-Import Bank (invited)

SESSION III:
Policy - Government's Role
Ray Costello, Dept. of Energy
J.P. Dowd, Senator Leahy's Office
Janet Cushman, ORNL

LUNCH

December 9, 1997

SESSION IV:
Creating Market Opportunities for Biomass Energy
Ken Campbell, MnVAP
Ron Buckhalt, AARC

DISCUSSION:
Issues & Options for Biomass Energy
David C. Allen, Wheelabrator
Environmental Systems, Inc.
Ralph Overend, NREL
Larry Mansueti, Dept. of Energy

Who Should Attend?

- Equipment Manufacturers
- Companies/Organizations interested in entering the biomass energy market
- Power Producers/Rural cooperatives
- Congressional & Legislative staff
- Government officials and Government Agency staff
- Public Interest and Policy Groups (Energy, Agriculture & Forestry)
- Environmentalist
NBIA/UBECA Workshop
December 8-9, 1997

Meeting Registration

Registration Fees:
- Members $50
- Non-Members $65

__ NBIA Member  __ UBECA Member  __ Non-Member

Time is short, space is limited, so return the registration today!

Name: ____________________________________________
Title: ____________________________________________
Company: _________________________________________
Address: __________________________________________
City, State: _________________________________________
Zip, Country: _______________________________________
Telephone: _________________________________________
E-mail: ___________________________________________
Fax: _____________________________________________

Cancellations received by December 1, 1997 will receive a 50% refund. There will be no refunds for cancellations received after December 1, 1997.

Payment
- Check  __ VISA  __ Mastercard
Card No: _________________________________________
Expiration Date: _________________________________
Signature: _______________________________________

Please send payment with registration form to NBIA/UBECA Workshop, NBIA, 122 C Street, NW, Washington, DC 20001

The Jefferson
Sixteenth & M Street, Washington, DC 20036
Phone: 202/347-2200 or 800/368-5966 Fax: 202/331-7982

A special NBIA/UBECA Workshop room rate of $180/night plus 13% DC tax and $1.50 hotel tax has been reserved. You must guarantee your room reservation by November 24, 1997 with a credit card to ensure the group rate.

For additional information contact:
Karen Seho, NBIA
Tel: 202/383-2540 Fax: 202/383-2670
Jonathan Kirschner, UBECA (managed by Energetics)
Tel: 301/621-8432 Fax: 301/621-3725

NBIA and UBECA have arranged for a discount with US Airways for travel to the workshop. The discount consists of 5% off First or Business Class or 10% off unrestricted coach. The discount fares require at least 7-day advance reservation and ticketing. To receive the special airfare, call 800/234-8544 and refer to gold file no: 71170448.
UBECA Strategic Planning Meeting
Jefferson Hotel
Washington, D.C.
December 8, 1997

Agenda

I. 1998 Activities

1. Government Relations
   - Legislative Alerts

2. Outreach and Education
   - Recruitment
   - Communications
     - Recruitment Literature
     - Updated UBECA Directory
     - Web Site
     - Trade Journal Articles
     - Press Releases
     - Industry Statements
     - Brown Bag Seminars
     - Workshops/Conferences
     - Publications
       - Proceedings
       - Reports

3. Technical/Market Analyses
   - Provide clearinghouse function only

4. Commercialization Strategies
   - Financing/Development Workshop
   - Project Investment Network
   - Project Opportunities Study

5. Management and Administration

II. Other Ideas, Strategies, Priorities, or Areas of Interest

III. Subcommittees Based on Member Interest

IV. Open Discussion
Final Registration List

Biomass Energy: Dynamic Solutions to Global Problems

The Jefferson Hotel
Washington, DC
December 8-9, 1997

Serge Adamain
Ecotrade, Inc.
220 S Kenwood St, Suite 305
Glendale, CA 91205-1671
Phone: (818) 240-4500
Fax: (818) 240-4501

syndamian-
ecotrade@worldnet.att.net

David C. Allen
Wheelabrator Environmental Systems
20811 Industry Road
Anderson, CA 96007
Phone: (916) 365-9172
Fax: (916) 365-2035

Stephen Aylor
Technology & Management Services, Inc.
18757 N Frederick Rd
Gaithersburg, MD 20879
Phone: (202) 295-7020
Fax: (202) 466-3428

savlor@tms-hq.com

Joseph Badin
United Bioenergy Commercialization Association
7164 Gateway Drive
Columbia, MD 21046
Phone: (301) 621-3002
Fax: (301) 621-3725
j_badin@energetics.com

Richard L. Bain, Ph.D.
National Renewable Energy Laboratory
1617 Cole Blvd MC-1613
Golden, CO 80401
Phone: (303) 275-2946
Fax: (303) 275-2905
richard_bain@nrel.gov

Irvin Barash
Vencon Management, Inc.
301 West 53rd Street
New York, NY 10019
Phone: (212) 581-8787
Fax: (212) 397-4126

Joseph J. Battista
GPU Genco
1001 Broad Street
Johnstown, PA 15907
Phone: (814) 533-8234
Fax: (814) 533-8315
 jbattista@gpu.com

David Beecn
Department of Energy
FE-23, Department of Energy
Washington DC 20585-0002
Phone: (301) 903-2787
Fax: (301) 903-8350

Ronald Belval
Burlington Electric Dept
583 Pine Street
Burlington, VT 05401
Phone: (802) 865-7410
Fax: (802) 865-7400
belvalrp@vtmail.champlain.edu

Frank Beve
Westinghouse
4400 Alafaya Trail
Orlando, FL 32826
Phone: (407) 281-3393
Fax: (407) 281-5014
bevecpp@notes.westinghouse.com
Seth Bouvier  
National BioEnergy Industries Association  
122 C Street, 4th Floor  
Washington DC 20001  
Phone: (202) 986-4695  
Fax: (202) 383-2870  
seth.bouvier.97@alum.dartmouth.org

Doug Boylan  
Southern Company  
Box 2625, Bin 14N-8195  
Birmingham, AL 35202  
Phone: (205) 257-6917  
Fax: (205) 257-5367  
douglas.m.boylan@sesnet.com

Jan Brinch  
United Bioenergy Commercialization Association  
7164 Gateway Drive  
Columbia, MD 21046  
Phone: (301) 621-3002  
Fax: (301) 621-3725  
jan_brinch@energetics.com

Kenneth Brown  
Morbark Sales Corp.  
PO Box 1000  
Winn, MI 48896  
Phone: (800) 233-6066  
Fax: (517) 866-2280

Ron Buckhalt  
AARC Corp.  
1400 Independence Ave SW  
Mail Stop 0401  
Washington, DC 20250-0401  
Phone: (202) 690-1624  
Fax: (202) 690-1655

Gary D. Burch  
Office of Solar Thermal, Biomass Power and Hydrogen Technologies  
Department of Energy, EE-13  
1000 Independence Avenue, SW  
Washington, DC 20585  
Phone: (202) 586-0081  
Fax: (202) 586-5127  
gary.burch@hq.doe.gov

Ken Campbell  
MNVAP  
453 Old Farm Road  
Shoreview, MN 55126  
Phone: (612) 483-4643  
Fax: (612) 483-4532  
kenem@pioneerplanet.infl.net

Zhong-Ying Chen  
SAIC  
11251 Roger Bacon Drive  
M/S R-3-1  
Reston, VA 20190  
Phone: (703) 318-4694  
Fax: (703) 709-1042  
zhou-yin.chen@saic.com

Helena Chum  
National Renewable Energy Laboratory  
1617 Cole Blvd., MS:1613  
Golden, CO 80401  
Phone: (303) 875-2949  
Fax: (303) 275-2905  
chumh@tenlink.nrel.gov

Roger Conway  
US Dept of Agriculture  
Office of Energy  
1800 M Street NW  
Room 2129  
Washington DC 20036  
Phone: (202) 694-5020  
Fax: (202) 694-5665

Jim Cooper  
Chariton Valley Resource Conservation and Development  
RR 3 Box 116A  
Centerville, IA 52544  
Phone: (515) 437-4376  
Fax: (515) 961-4715

Ray Costello  
US Department of Energy  
Office of Solar Thermal, Biomass Power and Hydrogen Technologies (EE-13)  
1000 Independence Ave SW  
Washington DC 20585-0121  
Phone: (202) 586-4898  
Fax: (202) 586-5127  
rwmond.costello@ee.doe.gov
Kevin R. Craig
National Renewable Energy Laboratory
1617 Cole Blvd., MC-1613
Golden, CO 80401
Phone: (303) 275-2931
Fax: (303) 275-2905
kevin_craig@nrel.gov

Janet Cushman
Oakridge National Lab
PO Box 20008
Oakridge, TN 37831
Phone: (423) 574-7818
Fax: (423) 576-8143
hcus@ornl.gov

Edward Dahlill
Bioten GP
10330 Technology Drive
Knoxville, TN 37932
Phone: (423) 675-2130
Fax: (423) 966-2070
bioten@noi.com

Pat DeLaquill
Energy Works
8201 Corporate Drive
Landover, MD 20785
Phone: (301) 918-7363
Fax: (301) 459-2842
patd@energyworks.com

Christian Dometer
Antares Group
4351 Foden City Dr., Suite 301
Landover, MD 20785
Phone: (301) 731-1900
Fax: (301) 731-1904

Reid Detchon
Biomass Energy Advocates
1001 G Street NW, Suite 900E
Washington DC 20001
Phone: (202) 659-0384
Fax: (202) 393-5510
detchon@podesta.com

J.P. Dowd
Office of Senator Patrick Leahy
United States Senate
433 Russell Senate Office Bldg
Washington, DC 20510
Phone: (202) 224-4242
Fax: (202) 224-3479
jdowd@senate.gov

James Easterly
DynCorp I&ET
6101 Stevenson Avenue
Alexandria, VA 22304
Phone: (703) 461-2035
Fax: (703) 461-2020
jtime@dyniet.com

Gary Elliot
International Applied Engineering
2160 Kingston Court, Suite E
Marietta, GA 30067
Phone: (770) 955-8284
Fax: (770) 955-8194
fae@mindspring.com

Janine Fintell
Technology & Management Services, Inc.
18757 N Frederick Rd
Gaithersburg, MD 20879
Phone: (202) 296-7020
Fax: (202) 466-3428

Alia Ghandour
National Bioenergy Industries Association
122 C Street NW, 4th Floor
Washington DC 20001-2109
Phone: (202) 383-2552
Fax: (202) 383-2670
agli@compuserve.com

Thomas Gialier
Detroit Stoker Co.
1510 E First Street
Monroe, MI 48161
Phone: (313) 241-9500
Fax: (313) 241-7126
tgialier@detroitstoker.com
Paul Klimas  
Saudi National Labs  
MS 0704  
Albuquerque, NM 87112  
Phone: (205) 844-8159  
Fax: (205) 844-7786  
pklimas@saudia.gov

Jeff Larkin  
Westinghouse Power Generation  
4400 Alafaya Trail, MC 381  
Orlando, FL 32826-2399  
Phone: (407) 281-2472  
Fax: (407) 281-5014  
larkinjj@notes.westinghouse.com

Francis Lau  
Institute of Gas Technology  
1700 S. Mount Prospect Road  
Des Plaines, IL 60018  
Phone: (847) 768-0592  
Fax: (847) 768-0600  
lau@igt.org

Larry Manuezi  
US Department of Energy  
Office of Energy Efficiency and  
Renewable Energy, EE-10  
Washington DC 20585-0121  
Phone: (202) 586-2588  
Fax: (202) 586-1640  
larry.manuezi@ee.doe.gov

Blake McBurney  
McBurney Corp.  
4274-A Shackleford Road  
PO Box 1827  
Norcross, GA 30091  
Phone: (770) 925-7100  
Fax: (770) 925-7400

William McKeough  
Stirling Thermal Motors  
238 Waterside Drive  
Grover, MO 65040  
Phone: (314) 458-0169  
Fax: (314) 458-4937  
mick.quer@aol.com

Kevin McNamara  
Taylor DeLongh  
1050 17th Street NW  
Washington, DC 20036  
Phone: (202) 775-0899  
Fax: (202) 775-1668  
kevin@taylor-delongh.com

Gregg Morris  
Future Resources Assoc. Inc.  
2039 Shattuck Ave, Suite 402  
Berkeley, CA 94602  
Phone: (510) 644-2700  
Fax: (510) 644-1117  
gmorris@er.net

Craig O'Connor  
Export Import Bank  
811 Vermont Ave NW  
Washington DC 20571  
Phone: (202) 565-3946 ext. 3939  
Fax: (202) 565-3932  
craig.ocommar@exim.gov

Paul Orentas  
Team Systems International  
700 13th St NW, Suite 950  
Washington, DC 20005  
Phone: (202) 434-1517  
Fax: (202) 434-4599  
re.orentas@worldnet.cit.net

David Ostlie  
Energy Performance Systems  
4900 N Highway 169, 3rd Floor  
Minneapolis, MN 55428  
Phone: (612) 533-0503  
Fax: (612) 533-1530

Ralph P. Overend  
National Renewable Energy Laboratory  
1617 Cole Blvd., MC-1613  
Golden, CO 80401  
Phone: (303) 275-4450  
Fax: (303) 275-2905  
rph_overend@nrel.gov

William Partanen  
Power Generating Inc.  
2501 Parkview, Suite 500  
Fort Worth, TX 76102  
Phone: (207) 883-3052  
Fax: (207) 883-0964  
pdc-portland@worldnet.aol.com
Rick Peterson
Northern States Power Company
414 Nicollet Mall
Minneapolis, MN 55401
Phone: (612) 330-5831
Fax: (612) 330-5913
richard.d.peterson@nspeco.com

Jon Pietruszakiewicz
Bechtel
9801 Washingtonian
Gaithersburg, MD 20873
Phone: (301) 417-3755
Fax: (301) 869-3770
jpletrus@bechtel.com

John R. Puskar
CEC Consultants, Inc.
6907 Brookpark Road
Cleveland, OH 44129
Phone: (216) 749-2992
Fax: (216) 398-8403
cecc@ank.net

Dan Reicher
US Department of Energy
Office of Energy Efficiency and
Renewable Energy, EE-1
1000 Independence Ave, SW
Washington DC 20585-0121
Phone: (202) 586-9260
Fax: (202) 586-9260
daniel.reicher@ee.doe.gov

Martha Rollings
Tennessee Valley Authority
1101 Market Street (WR 5H)
Chattanooga, TN 37402-2801
Phone: (423) 751-4712
Fax: (423) 751-2463
rollings@tva.gov

Tom Rosenberg
Biomass Energy Advocates
1001 G Street NW, Suite 900E
Washington DC 20001
Phone: (202) 639-0384
Fax: (202) 393-3150
rosenberg@podestra.com

James A. Rydellus
Simpson Paper Company
PO Box 68
Korbel, CA 95519
Phone: (707) 668-4431
Fax: (707) 668-4402
jrydel@simpson.com

Irving Sacks
Division of Energy Resources
100 Cambridge St #1500
Boston, MA 01880
Phone: (617) 727-4732 (131)
Fax: (617) 727-0093

Karen Seho
National BioEnergy Industries Association
122 C Street NW, 4th Floor
Washington DC 20001
Phone: (202) 383-2540
Fax: (202) 383-2670
kseho@compuserve.com

Kitty Sibold
Environmental Protection Agency
401 M Street SW, MC-2171
Washington DC 20460
Phone: (202) 260-4314
Fax: (202) 401-0454
sibold.katherine@epamail.epa.gov

Eric Simpkins
Energy Research Corp.
1634 Erie Street NW, Ste 900
Washington DC 20006
Phone: (202) 737-1372
Fax: (202) 737-7537
erco@erco.com

Russel E. Smith
Texas Renewable Energy Industries Association
PO Box 16469
Austin, TX 78761-6469

James J. Spaelth
Department of Energy
1617 Cole Blvd.
Golden, CO 80401
Phone: (303) 275-4706
Fax: (303) 275-4753
james_spaelth@ncrl.gov
Scott Sklar
National BioEnergy Industries Association
122 C Street NW, 4th Floor
Washington DC 20001
Phone: (202) 383-2540
Fax: (202) 383-2670

George Sterzinger
Advanced Renewables
1616 P Street NW Suite 410
Washington, DC 20036
Phone: (202) 939-3349
Fax: (812) 342-6285
sterzinger@msn.com

Sam Tagore
Department of Energy
1000 Independence Ave
Washington DC 20585
Phone: (202) 586-9210
Fax: (202) 586-5127
sam.tagore@hq.doe.gov

Masaaki Takahashi
World Bank
1818 H Street NW
Washington DC 20433
Phone: (202) 473-1269
Fax: (202) 522-3486
mtakahashi@worldbank.org

Michael VanBuren
Hearth Products Association
1601 N Kent Street, Suite 1001
Arlington, VA 22209
Phone: (703) 522-0086
Fax: (703) 522-0548
vanburen@hearthassoc.org

Jerry Whitfield
Pyro Industries
695 Pease Road
Burlington, WA 98233
Phone: (360) 757-9728
Fax: (360) 757-9720
whitfield@whitfield.com

Don Wichert
Division of Energy
101 E Wilson St 6th Floor
PO Box 7868
Madison WI 53707-7868
Phone: (608) 266-7312
Fax: (608) 257-6931
wichetd@mail.state.wi.us

Lynn L. Wright
Oakridge National Lab
PO Box 2008 Oakridge, TN 37831-6422
Phone: (423) 574-7378
Fax: (423) 576-8143
llw@ornl.gov

Fred H. Zerbel
Institute of Gas Technology
3540 South George Mason Drive
Alexandria, VA 22302-1034
Phone: (703) 845-4918
Fax: (703) 845-7905
fzerbel@igt.org
Fossil Carbon Mitigation

- If sustainable and closed-loop, biomass has role
- With super high yield crops, biomass could have 25% role
- Reduction = displace a fossil source (present or future)
- Fossil energy use can be <7% of biomass fuel value, so net greenhouse gas reduction is at least 93%
- Sequestration = grow but don’t burn nor allow decay

"Mitigation Curve" for Biomass Cofiring

**Input**
- Supply versus cost for low-cost biomass (wood wastes?)
- Categories of cofiring: % wood, boiler type, feed mode

**Intermediate Step**
- Capital and operating costs of cofiring (increment over base)
- Performance considerations, especially moisture losses

**Output:** CO₂ reduction vs. cost to get increments of reduction
What are the hurdles to Biomass Commercialization?

- Logistics of Collection and Transportation of Fuel.
- Price
- Application of tax credit only to "closed-loops" biomass
- Regulatory Issues
- Economic and Financial Issues
- Technology Performance needs to be demonstrated
- Geographic factors
- Public Perceptions of Biomass as a "Consumer of Forests"
- Acceptance of Co-fired Ash

How can the Hurdles be overcome?

- Marketing and public relations: Identify what makes biomass an attractive alternative and publicize it.
- Broaden the definition of what constitutes "closed loop" biomass
- Give tax credits to farmers who practice conservation and produce energy crops
- Initiate a government/private sector dialogue. Encourage both government and private sector financing for commercial projects.
- The term "tax credit" needs to be more specifically defined.
- Involve municipalities in biomass energy projects. Identify what will make biomass attractive to municipalities.
- Reinforce the image of biomass as green power and mainstream technology (need more units in operation).
- Get EPA and other government agencies to distinguish "renewable carbon" from "fossil carbon".
- Demonstrate the viability of co-firing and solve the supply issue.
- Involve the forest products industry
- Develop advanced modular biomass units (50 KW - 5 MW) that can be packed and shipped overseas.
- Government involvement in the form of tax incentives is important, but we also must demonstrate a viable technology that can sell.
• Understand the fundamental socioeconomic issues that make biomass energy attractive. Tax credits are only transitory.
• Demonstrate that biomass can be used for district heating, as well as for power generation.
• Leverage private investment with public funds set up as a "Renewable Energy Fund" to help limit the risk.
• Have a good understanding of the regulatory climate.
Looking to the Future:
The Department of Energy's Role
in Developing Biomass Resources

Why?
What?

Janet H. Cushen and Lynn L. Wright
Oak Ridge National Laboratory
Oak Ridge, Tennessee
December 3, 1997

Biomass resources will determine the
size of the bioenergy industry

• They are diverse
• They have competing uses
• They can be increased through R&D

Resource questions become more
Important

• With scale
• With time

Questions about both future and current
resources revolve around

• Cost
• Quantity
• Environmental effects

Cost? Quantity? Environment?

Long-run questions focus on:
• Competition with food and fiber
• Sustainability

The Department of Energy's long-run
research emphasizes energy crops

Although wood and wood wastes, municipal
solid wastes, and crop residues are all important
potential resources ..., energy crops are the most
tempting prize.

Union of Concerned Scientists
Powering the Midwest (1993)
Species Screening 1979-1989
Selection of model species reflected cost, quantity, and environmental considerations
- Perennial
- Productive
- Efficient

Crop Development 1986-Present
Virtual crop development centers are increasing productivity and reducing production costs for poplar and switchgrass
- Genetics
- Physiology
- Management

Current and long-run resource availability are different issues
- U.S. farmers are looking for new markets, including energy
- Integrating energy crops with food production barely explored
- Reclamation, remediation, and recycling wastes could increase resource base

Cost? Quantity? Environment?
Near-term questions focus on:
- Comparisons with other energy options
- Rate of adoption
- Effectiveness as solutions for environmental problems

The Department of Energy's near-term feedstock research includes:
- New tools for integrated analysis
- Links to USDA analysis systems
- Carbon cycling studies
- Scale-up and feasibility projects
- Support to demonstration projects

BIOCOST: A tool to estimate energy crop costs on a PC
- Approximates average production costs
- Users can change inputs
- Distributed on diskette

ORECCL: Oak Ridge Energy Crops County Level database
- 43 crop-related variables per county
- Includes BIOCOST production cost estimates
- Available on world-wide web
11-State GIS-based Study
- Includes transportation networks
- Enables exploration of relationships between facility size and feedstock costs
USDA's POLYSYS modeling system
- DOE/USDA project
- Adds energy crops to agricultural sector model
- Enables assessment of relationships with food crops

Scale-up and demonstration projects are "multiple use" sites for research
- Production economics
- Operational scale productivity
- Landowners/producer relationships
- Environmental research

Cost? Quantity? Environment?

DOE supports investments in bioenergy with research to understand and enhance biomass resources
Feedstock Supply Curves--2000
Moderate Scenario

Delivered Price ($/dry ton) vs. Quantity (Million Dry Tons)

- ■ Ag Residues
- ► Hardwood Waste
- ★ Softwood Waste
- □ SRWC
- × Switchgrass
- ▲ RDF

Legend:
- Ag Residues
- Hardwood Waste
- Softwood Waste
- SRWC
- Switchgrass
- RDF
Department of Energy
Biomass Power

Dan Reicher
Assistant Secretary for
Energy Efficiency and Renewable Energy,
U.S. Department of Energy

Projected Carbon Emissions (mmt)

- EIA Projections without the President's Plan
- 455 Million Tons
- 1990 levels
President's Three Stage Approach

- 1997  Prime the Pump
- 2004  Review and Evaluate
- 2008-2012 Meet Binding Targets

President's Action Plan

- $5 Billion in Tax Cuts and Federal R&D
- Credit for Early Action
- Industry-by-Industry Consultations
- Encouraging the Use of Energy-Efficient Products
- Federal Procurement and Energy Use
- Electricity Restructuring
- Setting a Concentration Goal
- Bilateral Dialogues
- Economics and Science Reviews
Kyoto Meeting

Other Drivers
- Electric Restructuring
- Clean Air
- Energy Security
Synergistic Partnerships

Biomass Power Across America
Biofuels/Biopower Budget
Administration's Request
($000)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofuels</td>
<td>42,099</td>
<td>40,540</td>
<td>40,040</td>
</tr>
<tr>
<td>Biomass Power</td>
<td>38,281</td>
<td>40,339</td>
<td>36,390</td>
</tr>
<tr>
<td>Total</td>
<td>80,380</td>
<td>80,879</td>
<td>76,430</td>
</tr>
</tbody>
</table>

Biofuels/Biopower Budget
Congressional Appropriation
($000)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofuels</td>
<td>27,180</td>
<td>27,328</td>
<td>31,150</td>
</tr>
<tr>
<td>Biomass Power</td>
<td>28,120</td>
<td>27,375</td>
<td>28,600</td>
</tr>
<tr>
<td>Total</td>
<td>55,300</td>
<td>54,730</td>
<td>59,750</td>
</tr>
</tbody>
</table>

Major Challenges

- Institutional
  - Utility Restructuring
  - Legislation
- Technical
  - Sustainability
  - System Integration
Future Opportunities -
New Initiatives

- Co-firing
- Modular Systems
United BioEnergy Commercialization Association

UBECA

Program Plan and Budget
FY 1998

Presented to:
UBECA Board of Directors

July 29, 1997
Corporate Overview - Energetics, Incorporated

- Established in 1979
- Employs over 100 energy and environmental professionals

Business Areas

- Energy Technology and Market Assessment
  - Electric Power Conservation and Utility Programs
  - Fossil Energy Programs

- Technical and Management Services
  - Strategic and Program Planning
  - Technology Development and Technology Transfer
  - Training and Outreach

- Environmental Services
Recent Biomass Energy Publications by Energetics


Recent Biomass Energy Analyses

References

Technology RD Roadmap - Forest Products Industry

For DOE Office of Industrial Technologies:

Proposal by Senator Tom Harkin (D-IA)

Case Study - Analysis of the Switchgrass Electric Generation Concept

Biomass Gasification

- Direct-Fired Biomass
  - Biomass Co-Firing

- Review of Technology Characterizations

For DOE Office of Utility Technologies:

Performed by Energies
Initial Contacts Have Been Made

- U.S. DOE Biomass Power Program
  - Ray Costello, Lynne Gillette, Gary Burch
- DOE-FE Office of Coal and Power Systems: Vic Der
- DOE-FE Office of Advanced Research: Howard Feibus
- DOE-FETC
  - Perry Bergman, Phil Goldberg, Mark Freeman
- NBIA: Scott Sklar, Karen Seho
- EPRI: Evan Hughes
- University of Pittsburgh: Jim Cobb
- NREL: Kevin Craig
- GPU Genco: Joe Battista
- Union of Concerned Scientists: Paul Jefferiss
- MIT: Howard Herzog
UBECA Program Plan and Budget
Proposed
FY 1998

ENERGETICS
Mission
Market Leadership for Effective Commercialization

- To serve as the primary voice of power producers with interests in biomass power generation
- To encourage the development and commercialization of sustainable biomass fuel resources and economically competitive biomass energy conversion technologies
Goals

- Develop cost-shared industry-led projects to
  - demonstrate advanced energy concepts
  - diversify U.S. fuel base
  - decrease greenhouse gas emissions
  - revitalize the rural economy

- Strengthen communication and increase membership
  - Government Relations
  - Outreach and Education
  - Market/Technology Analyses
  - Commercialization Strategies
Member Needs

- Keeping Well-Informed
  - Swiftly changing industry - analyze uncertainties
  - Legislative developments
  - Regulatory changes and incentives
  - Technology Cost & Performance, R&D Issues
  - Strong coordinated activities

- Obtaining Competitive Edge
  - Identify near-term, creative niche markets
  - Reduce deployment risk
  - Identify cost-effective integrated systems
  - Identify business partners and appropriate financial arrangements
The Challenge of Commercialization - Meeting Market and Developer Needs

Conditions to Satisfy:

- Evidence of sustained interest in biomass technology and confidence that the technology will be competitive with alternative technologies;
- Market research showing significant revenue/sales potential;
- Identification of situations where biomass technology may be applied immediately;
- Early buyer involvement, providing design inputs which result in cost and performance standards;
- Identification of uncertainties and manageable risks;
- Understanding and acceptance of cost/benefit profiles;
- Market incentives leading to investment, promotion, and success; and
- Government participation in cost-shared development and demonstration programs, and translation of public interest into legislation and regulations.
Developments in Legislation and Regulation

- Federal
  - Administration Budget and OMB Passback
  - House Authorizations Bill
  - House and Senate Appropriations Bill
  - Conference Committee Report
  - Restructuring Bills
  - FERC Rulemakings
  - EPA Regulations

- State
  - Electricity Restructuring
    -- Legislation
    -- PUC Orders
Strategic Approach

- Focus on members’ and other stakeholders’ needs through a program of industrial outreach;
- Nurture partnerships with key stakeholders;
- Build on past project successes and experience;
- Analyze complex information and present it clearly, accessibly, and persuasively; provide timely and effective dissemination of results;
- Use technical and market analyses as the guiding tool in creating commercialization strategies; and
- Leverage budgeted resources through joint participation in activities with other organizations in the bioenergy community.
Meeting the Needs

ACTIVITY AREAS:

- Government Relations
  - Congress
  - DOE
  - USDA
  - U.S. Forest Service
  - White House OSTP

- Outreach and Education
  - Utilities (IOUs and Munis)
  - IPPs
  - "Green" Power Marketers
  - Industries (cogenerators)

- Market/Technology Analyses

- Commercialization Strategies
Task Plan

TASK 1. GOVERNMENT RELATIONS

OBJECTIVES:

- Monitor Congressional activities and provide timely information to UBECA members on legislation affecting the DOE Biomass Power Programs so that appropriate actions can be taken;

- Plan an active role in promoting policies, incentives, and regulations that encourage integrated biomass power development in the United States and abroad.

ACTIVITIES

1.1 Disseminate Legislative Updates and Alerts

1.2 Prepare White Papers

1.3 Exchange Communications
Task Plan

TASK 2. OUTREACH AND EDUCATION

OBJECTIVES:

- Foster partnerships among stakeholders in both the public and private sectors;
- Ensure cooperation of energy and related programs at the federal, regional, state, and local levels; and
- Provide a forum for DOE program managers to interface with their private sector constituents.

ACTIVITIES

2.1 Increase UBECA Visibility
2.2 Create Annual Achievement Awards
2.3 Expand Communication Mechanisms (UBECA Journal)
2.4 Expand Information Assets (World Wide Web site)
2.5 Conduct Workshops/Seminars
Task Plan

TASK 3. TECHNICAL/MARKET ANALYSES

OBJECTIVES:

- Assess opportunities for new bioenergy conversion technologies in both domestic and foreign markets;
- Assist UBECA members to identify barriers that may restrict the entry of those technologies; and
- Assess alternative strategies to help overcome those barriers.

ACTIVITIES

3.1 Collect and Disseminate Market Data

3.2 Conduct Technology Assessments

3.3 Evaluate Changing Power Market
TASK 4. COMMERCIALIZATION STRATEGIES

OBJECTIVES:

- Develop guidelines and a framework of workable strategies for commercialization of bioenergy conversion technologies; and

- Raise the awareness of the financial community about opportunities that exist for investment.

ACTIVITIES

4.1 Case Studies

4.2 Commercialization Workshop
Task Plan

TASK 5. MANAGEMENT AND ADMINISTRATION

OBJECTIVES:

Support corporate business matters, membership records, financial administration and duties, and other activities of the UBECA Board of Directors and officers.

ACTIVITIES

5.1 Board of Directors Administration

5.2 Membership Administration

5.3 Management Policy Papers

5.4 Contract Administration and Reporting

5.5 Financial Administration

5.6 FY 1999 Program Plan and Budget
## Task Plan

<table>
<thead>
<tr>
<th>Task</th>
<th>Deliverables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Government Relations</strong></td>
<td>Legislative Updates and Alerts</td>
</tr>
<tr>
<td></td>
<td>White Papers</td>
</tr>
<tr>
<td></td>
<td>Briefing Materials</td>
</tr>
<tr>
<td><strong>2. Outreach and Education</strong></td>
<td><em>UBECA Journal</em></td>
</tr>
<tr>
<td></td>
<td>Annual Meeting</td>
</tr>
<tr>
<td></td>
<td>Annual Achievement Awards</td>
</tr>
<tr>
<td></td>
<td>Press Releases</td>
</tr>
<tr>
<td></td>
<td>Trade Press Articles</td>
</tr>
<tr>
<td></td>
<td>World Wide Web Site</td>
</tr>
<tr>
<td></td>
<td>Executive Seminars/Workshops</td>
</tr>
<tr>
<td></td>
<td>Technical Seminar</td>
</tr>
<tr>
<td></td>
<td>Brown Bag Seminars</td>
</tr>
<tr>
<td><strong>3. Technical/Market Analyses</strong></td>
<td>Market Data Compilation</td>
</tr>
<tr>
<td></td>
<td>Technology Assessments</td>
</tr>
<tr>
<td></td>
<td>Utility Restructuring Analysis</td>
</tr>
<tr>
<td><strong>4. Commercialization Strategies</strong></td>
<td>Case Studies</td>
</tr>
<tr>
<td></td>
<td>Commercialization Workshop</td>
</tr>
<tr>
<td><strong>5. Management and Administration</strong></td>
<td>Board Administration</td>
</tr>
<tr>
<td></td>
<td>Membership/Financial Administration</td>
</tr>
<tr>
<td></td>
<td>Management Policy Papers</td>
</tr>
<tr>
<td></td>
<td>Contract Administration/Reports</td>
</tr>
<tr>
<td></td>
<td>FY 1999 Program Plan &amp; Budget</td>
</tr>
</tbody>
</table>
## Revenue Target

**FY 1998**

### REVENUE TARGET

<table>
<thead>
<tr>
<th>Source</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member Dues</td>
<td>$50,000</td>
</tr>
<tr>
<td>Meeting Sponsorship</td>
<td>$10,000</td>
</tr>
<tr>
<td>Meeting Fees</td>
<td>$5,000</td>
</tr>
<tr>
<td>U.S. Department of Energy</td>
<td>$285,000</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$350,000</strong></td>
</tr>
</tbody>
</table>
# Budget Summary
## FY 1998

<table>
<thead>
<tr>
<th>Task</th>
<th>Total $K</th>
<th>%</th>
<th>DOE $K</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1. Government Relations</td>
<td>77</td>
<td>22</td>
<td>65</td>
<td>23</td>
</tr>
<tr>
<td>Task 2. Outreach and Education</td>
<td>96</td>
<td>27</td>
<td>85</td>
<td>30</td>
</tr>
<tr>
<td>Task 3. Technical/Market Analyses</td>
<td>66</td>
<td>19</td>
<td>50</td>
<td>17</td>
</tr>
<tr>
<td>Task 4. Commercialization Strategies</td>
<td>69</td>
<td>20</td>
<td>60</td>
<td>21</td>
</tr>
<tr>
<td>Task 5. Management and Administration</td>
<td>42</td>
<td>12</td>
<td>25</td>
<td>9</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>350</strong></td>
<td><strong>100</strong></td>
<td><strong>285</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
Budget Issues

- Intensify membership recruitment
  - Review member dues rates and structure
  - Enhance value of products and services
- Solicit funding from other federal and state agencies
- Increase cost-share with other associations
- Leverage in-kind member services
- Availability of cost-shared DOE funds
Conclusions

- UBECA is building the base constituency for the DOE Biomass Power Program

- UBECA provides unique forum for information exchange and technology transfer

- Federal dollars are leveraged effectively

- Together, the public and private sector can accelerate the commercialization of biomass energy and reap the national benefits.
Global Situation

◆ Global energy requirements continue to grow rapidly driven by:
  □ Economic and population growth
  □ Pressures to improve quality of life
◆ Governments recognize that the availability of affordable, reliable commercial energy supplies is vital to all sectors of society
Global Situation (continued)

- Growing concerns about potential global climate change and greenhouse gases
- Biomass energy can have a significant strategic value to the U.S. and to all growing economies

Strategic Value of Biomass Energy

- Vital resource for achieving a sustainable economy
- Very large and wide-spread resource base
- Can be integrated into the established infrastructure
- Potential to be a reliable and affordable resource
- Reduce landfill wastes
Strategic Value of Biomass Energy (continued)

- Carbon dioxide neutral
- Reduce dependence on imported fuels
- Local economic benefits/jobs
- May fulfill requirements of a Renewable Portfolio Standard
- May produce tradeable emissions credits

Strategic Value of Biomass Energy (continued)

- Can utilize wide-ranging, new and improved energy conversion technologies for baseload and peaking generation
- Can provide flexible, convenient, and diverse forms of energy to meet various end-use needs
Our Vision

Biomass Energy - Sustainable Pathways for a CO₂ Constrained Future

- Advanced Technologies
- Hydrocarbon Feedstocks
  (bio, bio, biomethanol)
- CO₂ Capture from Biomass
- C/CO₂ Separation andCapture
- Advanced, Multi-Product Forest & Agricultural Management

How can we get there?

- How UBECA helps
Who We Are...
United BioEnergy Commercialization Association

How Can We Get There?

- Have a clear vision
- Identify technology and market pathways
- Establish competitive targets
- Encourage demonstrations and replications to showcase successes
- Build the biomass community
- Find champions and sponsors
- Provide input to public policy
How Can We Get There?
(continued)

◆ Create market-based incentives
◆ Form partnerships
  □ Company and Company
  □ Industry and Industry
  □ Industry and Government
◆ Ensure effective communication and outreach

How UBECA Helps

◆ Provides a forum to promote bioenergy
◆ Facilitates communication, innovation, technology transfer, and accelerates commercialization
◆ Provides strategic briefings to interested groups
◆ Expands outreach to encompass agricultural, forestry, coal, industrial, and environmental stakeholders
How UBECA Helps (continued)

◆ Monitors restructuring activities
◆ Identifies market opportunities today and charts the roadmap to the future
◆ Represents technology developers, end-users and operators: the source of technical cost and performance requirements
◆ Identifies critical R&D needs and targets

How UBECA Helps (continued)

◆ Partners with communities (education and economic development)
  □ Rural
    ◆ forest residues
    ◆ energy crops
    ◆ poultry and animal wastes
  □ Urban
    ◆ reduce landfills
    ◆ potential waste and demolition wood resources
How UBECA Helps (continued)

◆ Provides case studies and success stories
◆ Assists with market assessment
◆ Proposes market incentives
◆ Endorses policy actions
◆ Educates and communicates

How Can I Participate?

Contact
Joe Badin, Executive Director or
Jonathan Kirschner, Project Coordinator

301-621-3002
301-621-3003
FAX 301-621-3725
e-mail: enesupf@ix.netcom.com
AGENDA

UBECA Meeting
Held at Edison Electric Institute
July 29-30, 1997

- Minutes of the June 10, 1997 UBECA Board of Directors Meeting (Approval)
- FY 1998 UBECA Program Plan & Budget (Approval)
- DOE Application for Funding of Management Support Services (Approval)
- Management Support Agreement between UBECA & Energetics (Approval)
- Termination Agreement between TTC & UBECA (Approval)
- Committee to Plan Joint UBECA/NBIA Annual Meeting (Assign)
- Workshop Topics (Discussion)
- Membership (Discussion)
- Other Business
UNITED BIOENERGY COMMERCIALIZATION ASSOCIATION
MINUTES OF THE BOARD OF DIRECTORS MEETING:
July 29-30, 1997
Edison Electric Institute
Washington, DC

TUESDAY, JULY 29, 1997

Attendance

Board Members

Ron Belval, Chairman - Burlington Electric Dept.
Chuck Linderman - Edison Electric Institute
Ed Neuhauser - Niagara Mohawk
John Holt - National Rural Electric Cooperative Association
Doug Boylan - Southern Company
Dan Mahoney (Counsel) - Soble International

Energetics Personnel

Harvey Weisenfeld
Joe Badin
Jonathan Kirschner

Department of Energy Personnel

Ray Costello
Lynne Gillette
Jake Kaminsky

Approval of Meeting Minutes of April 8 and June 10

Both sets of minutes were approved.

FY 1998 UBECA Program Plan and Budget

Joe Badin presented Energetics' corporate qualifications and described four task areas outlined in the FY 1998 Program Plan and Budget prepared by Energetics:

- Government Relations
- Industry Outreach and Education

These minutes cover only those deliberations that Energetics personnel were present for.
The major points of the discussion were:

- **UBECA** is prohibited from lobbying, but timely legislative alerts to the Board and the membership would be useful in keeping them informed of pending Congressional action.

- **UBECA Journal** was not reaching as many people in the utility industry as perhaps publishing articles in the leading trade journals would. It might be more cost effective to contribute articles to *Electricity Journal, Public Utilities Fortnightly, and Rural Electrification* magazines.

- Brown-bag seminars are a great tool for reaching the membership and for encouraging action and ideas. It was suggested that a brown-bag seminar be held at EEI and one possibly at the Washington office of the Northeastern Regional Biomass Program (Rick Handley is main contact). One topic that was proposed for a brown-bag seminar was *Barriers to Biomass Co-firing*, possibly with the participation of EPA and ASTM. Coal ash is presently considered a non-hazardous substance that can be sold for flowable fill, however no ASTM standard currently exists for co-fired ash, and this is an obstacle to the broader acceptance of biomass/coal co-firing. Efforts must be made to reach beyond UBECA and to inform people who are outside the association of the brown-bag lunches.

- The President's Million Solar Roofs program will increase competition from the photovoltaic sector. Also, micro gas turbines have demonstrated that they can produce electricity for $300/KW. As of yet, no life cycle costing analyses had been performed for biomass. The possibility of leveraging the efforts taking place at NREL and Lawrence Berkeley Lab, was mentioned.

- It was suggested that an ad hoc Commercialization Committee be formed from the membership.

Ray Costello, DOE Program Manager, told the Board that he was very supportive of UBECA and wanted maximum benefit for everyone, however, he said, only $100K would be available from DOE's Biomass Energy Program for UBECA in FY 1998. This was considerably less than the level of support originally anticipated by the association (about $285K), and the Board met that afternoon, in closed session, to re-examine UBECA's activities in the face of the reduced level of funding and to discuss completion of arrangements with TTC, including signing a letter closing out TTC support of UBECA.
WEDNESDAY, JULY 30, 1997

Attendance

Board Members

Ron Belval, Chairman - Burlington Electric Institute
Chuck Linderman - Edison Electric Institute
Ed Neuhauser - Niagara Mohawk
John Holt - National Rural Electric Cooperative Association
Doug Boylan - Southern Companies

Energetics Personnel

Joe Badin
Jonathan Kirschner

Discussions focused on ways to adapt the UBECA FY 1998 Program Plan and Budget to a lower level of DOE funding. It was agreed that while all of the tasks were important, a specific list of deliverables would help identify the most crucial aspects of each. Ed Neuhauser said that legislative tracking was extremely important for his utility, as well as being notified of any Requests for Proposals (RFP) that DOE might issue that could be of interest to UBECA members. It was decided that the organization would publish two brochures initially. The first would be of a general nature, intended to help recruit potential members. The second would be a brief, but informative piece designed to show how biomass was currently being used to reduce emissions of greenhouse gases. This brochure would be distributed by Chuck Linderman at the Kyoto Global Climate Change Summit in December. The target date for shipping materials to Japan was November 20.

Other suggestions for disseminating information to members included legislative alerts and quarterly updates of important meetings, programs, and government solicitations. A monthly update was also suggested if there is sufficient activity to warrant it. The following ideas for UBECA activities were discussed:

- UBECA should move away from developing white papers to assembling information that is already available.
- Membership and/or revenue targets should be set (i.e., increase revenues from utility memberships to $80K or increase membership by 30% over the next twelve months).
- Set publication targets, such as publishing 3 major articles in 4 journals during the coming year.
- Communication with the National Laboratories that are doing biomass work must be improved. UBECA should be involved in the annual DOE Contractors' Review Meeting.
Centers of Excellence, such as the McNeil Power Generating Station in Vermont could be the subject of concept papers.

One activity that was mentioned was an evaluation of the changing power market, and the possibility of publishing 2 case studies, one on the fuels side and one on the technology side, was discussed.

It was decided that fees for legal services performed by Soble International be paid out of members' dues, and not out of the Department of Energy grant.

The joint UBECA/NBIA meeting was also discussed.

It was decided that Energetics would redraft the FY '98 Program Plan and Budget based upon an assumed budget of $300K ($100K from membership, $200K from DOE)\(^2\) and resubmit it to the Board.

\(^2\) The level of DOE funding ultimately awarded for FY'98 was only $100K. The final version of the FY'98 Program Plan and Budget reflects a level of activity that corresponds to this reduced award.
**United BioEnergy Commercialization Association**

**Board of Directors**

**MEETING AGENDA**

**November 19, 1997**  
**10:00 am - 3:00 pm**  
**at**  
**Energetics, Inc.**  
**501 School Street, SW, Washington, DC**  
**Suite 500**  
**L’Enfant Plaza Metro (Dept. of Transportation Exit)**

<table>
<thead>
<tr>
<th>TIME</th>
<th>TOPIC</th>
<th>FACILITATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 - 10:05</td>
<td>Welcome and Introduction</td>
<td>R. Belval</td>
</tr>
<tr>
<td>10:05 - 10:10</td>
<td>Agenda</td>
<td>J. Kirschner</td>
</tr>
<tr>
<td></td>
<td>- Acceptance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Additional Items</td>
<td></td>
</tr>
<tr>
<td>10:15 - 11:45</td>
<td>Treasurer’s Report</td>
<td>C. Linderman</td>
</tr>
<tr>
<td></td>
<td>Ratification of Management Services Contract and Settlement of Prior Account</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Membership Update</td>
<td>J. Badin</td>
</tr>
<tr>
<td></td>
<td>FY 98 UBECA Program Plan and Budget</td>
<td>R. Belval</td>
</tr>
<tr>
<td></td>
<td>Joint UBECA/NBIA Workshop</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review of DOE Funding Agreement</td>
<td></td>
</tr>
<tr>
<td>11:45 - 12:00</td>
<td>Status of EPRI Biomass Power Program</td>
<td>E. Hughes</td>
</tr>
<tr>
<td>12:00 - 1:00</td>
<td>Luncheon/Discussions</td>
<td>L. Gillette</td>
</tr>
<tr>
<td>1:00 - 1:20</td>
<td>Status of the DOE Biomass Power Program and Plans for FY 1998</td>
<td>R. Belval</td>
</tr>
<tr>
<td>2:30 - 3:00</td>
<td>Wrap-up</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Other Business</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Action Items</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Next Meeting Plans</td>
<td></td>
</tr>
<tr>
<td>3:00</td>
<td>Adjourn</td>
<td></td>
</tr>
</tbody>
</table>
MEETING SUMMARY

Attendance

UBECA Board Members

Ron Belval, Chairman - Burlington Electric Dept.
Chuck Huling - Georgia Power Company
John Holt - National Rural Electric Cooperative Association
Chuck Linderman - Edison Electric Institute
Ed Neuhauser - Niagara Mohawk

Other UBECA Members

Evan Hughes - Electric Power Research Institute

Energetics Personnel

Joe Badin - Executive Director, UBECA
Jonathan Kirschner - Project Coordinator, UBECA
Harvey Weisenfeld - Corporate Advisor, UBECA
Jan Brinch - Senior Associate, Energetics
Rich Scheer - Assistant Vice-President, Energetics

Department of Energy Personnel

Lynne Gillette - Program Manager, DOE Biomass Power Program

The Board met in a closed-door Executive Session from 9:30 a.m. until 10:45 a.m. to discuss the closeout arrangements with Technology Transition Corporation (TTC).

Approval of Agenda

The agenda was approved without modification.
Approval of Meeting Minutes of July 29-30, 1997

The draft meeting minutes were accepted with some modifications which appear in the final version.

Treasurer’s Report

Chuck Linderman, UBECA Treasurer, reported that he had signed a check to pay Energetics’ invoice of $7,100 thereby leaving an ending balance in the UBECA account of approximately $39,200.

Ratification of Management Services Contract and Settlement of Prior Account

The Board ratified the management services contract with Energetics, but noted that Technology Transition Corporation had an outstanding invoice (August 1997) for $67.5K. It was decided that members of the Board should meet with Bob Mauro of TTC to discuss the outstanding invoice and to arrive at an agreement for closing out TTC support of UBECA.

Membership Update

Joe Badin announced the recruitment of two new members, Central and South West Services and Golden State Import and Export. Joe also announced that he had met with Dave Beecy of the Office of Fossil Energy, U.S. Department of Energy. Dave was interested in biomass’ potential to reduce coal consumption by as much as 35%. Joe said that he would meet again with Dave and discuss additional support for UBECA’s activities from the DOE Office of Fossil Energy and from the Federal Energy Technology Center (FETC). It was suggested that Chuck Linderman and John Holt accompany Joe Badin and Harvey Weisenfeld to meet Dave Beecy and George Rudins (Deputy Assistant Secretary, Office of Coal Technology).

FY 98 UBECA Program Plan and Budget

The main message being conveyed by the FY 98 UBECA Program Plan and Budget is that UBECA is an industry-driven organization whose focus is on technology transfer. Harvey Weisenfeld said that both DOE’s Office of Energy Efficiency and Renewable Energy (EE) and its Office of Fossil Energy (FE) were exploring incentives to get these technologies into the marketplace. These incentives included capital buy downs, production credits and a government-sponsored insurance pool to defray much of the risk associated with such projects.

Joe Badin announced that he would be representing UBECA on the Board of Directors of the Bioenergy Research Association (BEA) and that he would be coordinating with Don Klass (BERA Chairman) to hold brown-bag lunches during the coming year. There was some discussion about utility restructuring and broadening the scope of materials that could be considered as biomass fuels, specifically the use of farm waste products that could be gasified and combusted in a microturbine. Joe Badin mentioned that Sandia National Laboratory would be issuing a Request for Proposals (RFP) for just such a demonstration project. It was expected that the RFP would be released within a few weeks.
Joint UBECA/NBIA Workshop

The upcoming UBECA/NBIA Workshop was discussed and it was decided that UBECA would host a joint biomass stakeholders’ meeting entitled “Obstacles to Commercialization” the day before the main meeting. A summary of the proposed speakers was also delivered.

Review of DOE Funding Agreement

Joe Badin stated that the application had been submitted to the DOE Field Office in Golden, Colorado where it was still being reviewed.

Status of EPRI Biomass Power Program

Evan Hughes said that EPRI’s Biomass Power Program was not a single program but resided in various parts of EPRI (Coal Combustion Performance, NOx, Fossil Boilers, Renewables). Evan explained that the EPRI membership was giving biomass low priority. The best thing that UBECA could do to help would be to bring both traditional utilities and new power generating companies to not only accept biomass as a fuel source, but to see biomass as the renewable of choice for companies who have coal-firing assets and experience.

EPRI had conducted six co-firing tests in utility boilers during the previous year: GPU/Penelec (wood fuel, wall-fired boiler); TVA-Allen (wood in a cyclone boiler); TVA-Colbert (wood, wall-fired boiler); New York State Electric and Gas (NYSEG) (wood, tangential boiler); Madison G&E (switchgrass, wall-fired); and Northern Indiana (wood waste, cyclone boiler). A test firing of short rotation willow growth at NYSEG (a member of the Salix Consortium) ran into handling problems caused by the fibrous willow wood and had to be postponed. The willow was successfully co-fired later, as a smaller fraction of the heat input to the boiler. Evan summarized by saying that co-firing had been proven to be technically feasible but that the price differential with coal was not great enough to make it attractive to utilities, at least not while the focus is on competition, cost cutting, and meeting NOx standards, while spending capital budgets only on items having a 3-year (or less) payback.

Status of the DOE Biomass Power Program and Plans for FY 1998

Lynne Gillette, DOE Program Manager, gave a presentation on the Department of Energy’s Biomass Power Program. Lynne described 5 major continuing projects:

- Hawaii Gasification Project whose goal is to demonstrate direct integrated biomass gasification/turbine technology with hot-gas clean up.

- Vermont Gasification Project whose goal is to demonstrate indirect biomass gasification technology for power production.

- Minnesota Agri-Power Project whose goal is to demonstrate a fully integrated biomass system utilizing alfalfa stems to produce 75 MW of power.
• New York Salix Project whose goal is to scale up willow trees as an energy crop for co-firing by the year 2000.

• Iowa Switchgrass Project whose goal is to demonstrate closed-loop systems using switchgrass to fire a 35 MW facility.

Lynne also described two new initiatives, including a small modular systems Request for Proposals (RFP) that would soon be issued by Sandia National Laboratory and a co-firing initiative that was still under development.

The issue of whether or not to broaden the definition of biomass was raised again. Lynne Gillette said that DOE was more interested in developing energy crops such as willow and switchgrass. It was not really interested in Municipal Solid Waste. Ed Neuhauser discussed the difficulties inherent in removing organic matter from soil (issues of soil fertility and erosion needed to be addressed). Ed also explained that Timber Stand Improvement (TSI), involving the thinning out of forests, could create a vast new biomass resource, although no utility would be willing to invest money in TSI on land which it may not own when the trees mature. The Board decided that broadening the definition of biomass fuels should not be pursued at this time, but should be left as a topic for further discussion.

The remainder of the meeting was spent drafting the industry statement to be issued prior to the Kyoto Conference on Global Climate Change. The statement was approved by the Board and issued on November 24th.

Other Business

Rick Peterson (Northern States Power), who was unable to attend the meeting, telephoned to announce that Northern States Power Co. (NSP) had selected District Energy St. Paul, Inc. and Lindroc Energy of Encinitas, California, to each supply 25 megawatts of biomass power to the NSP system beginning in summer 2002. These two projects represent Phase II of NSP’s legislative commitment for a total of 125 MW of biomass generation to be in place by the end of 2002. Rick also said the NSP was in the final stages of negotiating a fuel supply contract with MnVAP, the Minnesota Valley Alfalfa Producers.

Next Meeting

It was decided that the next meeting of the UBECA Board would be held in the spring of 1998.

- meeting adjourned at approximately 3:00 p.m. -
United BioEnergy Commercialization Association

Board of Directors

MEETING AGENDA

June 24, 1998
9:00 am - 3:00 pm
at
Energetics, Inc.
501 School Street, SW, Washington, DC
Suite 500
L'Enfant Plaza Metro (Dept. of Transportation Exit)

<table>
<thead>
<tr>
<th>TIME</th>
<th>TOPIC</th>
<th>FACILITATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00 - 10:00</td>
<td>Executive Session (Board Members Only)</td>
<td>R. Belval</td>
</tr>
<tr>
<td>10:00 - 10:05</td>
<td>Welcome and Introduction</td>
<td>R. Belval</td>
</tr>
<tr>
<td>10:05 - 10:10</td>
<td>Agenda &lt;br&gt;• Acceptance &lt;br&gt;• Additional Items</td>
<td></td>
</tr>
<tr>
<td>10:10 - 10:20</td>
<td>Review of Minutes (November 19, 1997)</td>
<td></td>
</tr>
<tr>
<td>10:20 - 10:35</td>
<td>Treasurer's Report</td>
<td>C. Linderman</td>
</tr>
<tr>
<td>10:35 - 10:55</td>
<td>Settlement of Prior Account and Other Outstanding Invoices</td>
<td></td>
</tr>
<tr>
<td>11:25 - 11:40</td>
<td>Status of Restructuring / Renewable Portfolio Standards</td>
<td>J. Bergman</td>
</tr>
<tr>
<td>11:40 - 12:00</td>
<td>PTI Overview and Potential Biomass Interest in Urban and Rural Communities</td>
<td>Ama Frimpong, PTI</td>
</tr>
<tr>
<td>12:00 - 1:00</td>
<td>Luncheon/Discussions</td>
<td></td>
</tr>
<tr>
<td>1:00 - 1:20</td>
<td>Allowance Trading Agreement Between NIMO and Suncor</td>
<td>E. Neuhauser</td>
</tr>
<tr>
<td>1:20 - 1:40</td>
<td>Update on DOE/FETC Activities</td>
<td>P. Goldberg, FETC</td>
</tr>
<tr>
<td>1:40 - 2:00</td>
<td>Update on DOE Biomass Power Program</td>
<td>L. Gillette</td>
</tr>
<tr>
<td>2:00 - 3:00</td>
<td>Wrap-up &lt;br&gt;• Other Business &lt;br&gt;• Action Items &lt;br&gt;• Next Meeting Plans</td>
<td>R. Belval</td>
</tr>
<tr>
<td>3:00</td>
<td>Adjourn</td>
<td></td>
</tr>
</tbody>
</table>
MEETING SUMMARY

Attendance

UBECA Board Members

Ron Belval, Chairman - Burlington Electric Dept.
Doug Boylan - Southern Company
John Holt - National Rural Electric Cooperative Association
Chuck Linderman - Edison Electric Institute
Ed Neuhauser - Niagara Mohawk
Steve Soble - Soble International
Simon Langer - Soble International

Other UBECA Members

Joe Battista - GPU Genco
Phil Badger - TVA (afternoon session only)

Energetics Personnel

Joe Badin - Executive Director, UBECA
Jonathan Kirschner - Project Coordinator, UBECA
Elaine Weber - Contracts Administrator

Invited Speakers

Lynne Gillette - Program Manager, DOE Biomass Power Program
Phil Goldberg - Advanced Crosscutting Technologies, Federal Energy Technology Center
Ama Frimpong - Public Technologies, Inc.
Jennifer Bergman - Energetics, Inc.

Others

Joel Morrison - Energy and Fuels Research Center, Penn State University
The UBECA Board of Directors met in a closed-door Executive Session from 9:00 a.m. until 10:30 a.m. to discuss the closeout arrangements with Technology Transition Corporation (TTC). Present at the Executive Session were the Board members, legal counsel, and Energetics personnel. Elaine Weber reported that it was her belief that UBECA, under TTC, had over billed the Department of Energy (DOE) by $1452 in 1997 (as an adjustment to its 1996 billing) and it was her best estimate that the association, under TTC, had also over billed the membership by $15,545 for the same period. She also reported that TTC still had not turned over all of the UBECA records to Energetics, and it was decided, on the advice of counsel, that no settlement should be made with TTC until this had been achieved. In exchange for all the records, UBECA would make a final separation payment to TTC based upon an estimate of what is owed less the amounts over billed. Both parties would then sign a settlement statement releasing them from all outstanding claims against each other. It was also decided that UBECA would make an initial payment of $1280 to Soble International out of the membership budget to cover an invoice which TTC had failed to pay. The UBECA Board resolved to make every effort to settle all other outstanding payables to Soble International in a timely manner.

Upon conclusion of the Executive Session, the non-board members and speakers who were present were invited into the meeting. Joel Morrison from Penn State University’s Energy and Fuels Research Center was in Washington to attend the DOE-sponsored co-firing workshop and was considering membership of his organization in UBECA. Similarly, Joe Battista of GPU Genco and Phil Badger of TVA (both UBECA members) stayed in Washington an extra day to attend the board meeting. Joel Morrison said that Penn State was experimenting with burning hog fat as #6 fuel oil. Joe Battista described his company’s experiments with blends of coal and sawdust at the Shawville Power Station and with separate injection of sawdust at their Seward Power Station. GPU’s experiments had shown that heavily composted sawdust burned too slowly. Joe said that a $2 million test burn of utility waste wood (penta poles, creosote poles, cross arms and pallets) was scheduled for this coming winter. While tipping fees were not very high, the charge for hauling away such waste wood could vary anywhere from $80 - $200 a ton. Joe Badin requested a schedule of the upcoming test burns so that UBECA members could be kept up to date.

Phil Goldberg of FETC introduced himself saying that his principal area of research was developing coal-fired power systems and that he was expecting FETC to develop a working relationship with UBECA in order to further develop co-firing.

Approval of Agenda

The agenda was approved without modification, although the order of presentations was altered slightly to accommodate the presenters’ schedules.

Approval of Meeting Summary of November 19, 1997

The November meeting summary was accepted.
Treasurer’s Report

Chuck Linderman, UBECA Treasurer, reported that the UBECA checking account balance as of June 22 was $14,675.65 and that the association was awaiting payment of $19,300.91 from DOE Golden Field Office for Energetics’ services. Outstanding liabilities for the association were reported to be $95,543.26. This amount was contingent upon the final settlement with TTC, and could be expected to be reduced considerably.

Membership Update and Report on EPRI Biomass Interest Group Meeting (May 28-29)

Joe Badin gave an update on recruitment activities. In his report, Joe stated that UBECA would like to extend membership to the National Laboratories and to grass roots organizations. By expanding membership beyond the utility industry, the association could seek foundation grants for solving waste disposal and energy problems. Joe had also held meetings with several people at the World Bank, including Masaki Takahashi who had been working on a bagasse gasification plant in Brazil, and who was also interested in coal gasification (John Holt mentioned that the NRECA was funding a 3 MW plant that would use Brazil nut hulls as fuel).

Joe also reported on a meeting that was held with Dr. Steve Schuck of the Australian Biomass Energy Taskforce who had visited the U.S. last winter on a fact-finding tour. A meeting was also held with Ama Frimpong of PTI. This initial meeting was very fruitful and members of PTI are interested in working with UBECA. This could lead to additional funding for the association through foundation grants (see “PTI Overview” below). Joe was also continuing his contacts with Gary Baum of the Institute of Paper Science and Technology Association (IPSTA) and a member of the Board of the Biomass Energy Research Association (BERA), and Del Raymond of Weyerhauser Corporation. UBECA had also initiated contact with the White House Office of Science and Technology Policy to discuss an interagency biomass initiative.

Joe distributed the agenda and a handout from the EPRI Biomass Interest Group (BIG) meeting held in May. Since Evan Hughes was not present, Joe highlighted the major issues that were discussed at the BIG meeting, including pooling resources to do collaborative research, development, and demonstration projects on biomass energy.

Status of Restructuring / Renewable Portfolio Standards

Jennifer Bergman of Energetics presented an overview of the status of utility restructuring and renewable portfolio standards in the United States. The key messages of her presentation were:

- Restructuring was attracting new players into the electricity industry, but the future for new market players is uncertain;

---

1A meeting was subsequently held July 7th with Sam Baldwin, Principal Scientist on the National Science and Technology Council and Study Executive Director for the President’s Committee of Advisors on Science and Technology (PCAST) Energy Research and Development Panel. The panel published its *Report to the President on Federal Energy Research and Development for the Challenges of the Twenty-First Century* in November 1997.
• Congress and the Administration were considering federal restructuring legislation (19 bills had already been introduced) but no action could be expected this session;

• There was a great deal of diversity among state restructuring activities but some common themes exist (retail choice by date certain, rate reductions, stranded cost issues limiting progress, mechanisms to address public purpose programs are in place).

• Thus far, six states have enacted renewable portfolio standards (AZ, CT, ME, MA, NE, VT).

Chuck Linderman pointed out that the gas industry was adamantly opposed to federal restructuring legislation and that many of the key Congressional committee chairmen came from gas-producing states.

Ed Neuhauser said that New York State was using a systems benefits charge to support three areas of activity within the state: assistance to low income families, energy efficiency and renewable energy programs, and environmental protection. The State of California had also opted for a systems benefits charge instead of a renewable portfolio standard.

PTI Overview and Potential Biomass Interest in Urban and Rural Communities

Ama Frimpong gave an overview of Public Technologies Inc. (PTI) and explained that its main mission was to facilitate the transfer of technology to American cities in order to help them solve pressing problems, such as the year 2000 computer bug. PTI is divided into five Task Forces:

• Energy
• Environmental Protection
• Transportation
• Information Technology
• Public Safety

PTI is funded mainly through monies appropriated by Congress to the Urban Consortium, but also earned money through the sale of its publications. PTI was interested in biomass as an alternative fuel for municipal electricity generation and was looking forward to working with UBECA to heighten awareness among city managers.

Allowance Trading Agreement Between Niagara Mohawk (NIMO) and Suncor Energy

Ed Neuhauser described the greenhouse gas emissions reduction trade worked out between his utility (Niagara Mohawk) and the Canadian oil and gas company, Suncor Energy. This arrangement, which was announced on March 5th, is one of the first which attaches an actual value to carbon dioxide and could be worth as much as $6 million over 10 years. According to the agreement, Suncor will make an initial purchase of 100,000 metric tons of greenhouse gas emission reductions from Niagara Mohawk with an option to buy up to an additional 10 million tons of reductions over ten years. The agreement means that Suncor will use the reductions below 1990 levels achieved by NIMO to achieve its own voluntary emission reduction targets.
while providing Niagara Mohawk with additional funding for research and renewable energy projects. The agreement has won praise from both the American and Canadian governments as a demonstration of a market-based approach to reducing greenhouse gas emissions.

**Update on DOE Biomass Power Program**

Lynne Gillette, DOE Biopower Program Manager, provided an update of activities taking place under the DOE Biomass Power Program. There are currently four major projects continuing:

- Hawaii Gasification Project (in close-out phase)
- Vermont Gasification Project
- Minnesota Agri-Power Project (which was held up for a year until the details of a twelve-year power purchasing agreement could be worked out)
- New York Salix Project

Other projects include the Iowa Switchgrass Project, the goal of which is to demonstrate a closed-loop biomass system using switchgrass to fire a 35 MW facility. Additional work is being carried out in support of thermochemical conversion research and biomass feedstock development.

The board discussed the possibility of inviting Ken Campbell of the Minnesota Valley Alfalfa Producers (MNVAP) to the next meeting to offer advice on drawing up a model power purchasing agreement. It is hoped that having a model contract would facilitate future biomass power projects, and might help speed up progress on the Iowa Switchgrass Project.

Lynne announced the ten winners of the Small Modular Power Systems feasibility study contracts. The list included UBECA members Bioten GP and Niagara Mohawk. A solicitation for Phase II of the project is anticipated for October 1999. She also described the DOE Co-Firing Initiative which is jointly sponsored with EPRI and FETC. This initiative includes ongoing demonstration projects and some new projects to be launched in 1999, as well as information development and dissemination for power generation decision makers. Among the projects mentioned was a co-firing brochure to be developed cooperatively by UBECA and NREL.

**Update on DOE/FETC Activities**

Phil Goldberg, from the Advanced Cross-Cutting Technologies division of FETC (Pittsburgh), gave the board an overview of FETC coal/biomass co-firing results. Phil explained that while biomass was really the domain of DOE’s Office of Energy Efficiency and Renewable Energy, FETC was interested in co-firing as a means of reducing fossil-based emissions of CO2, SO2, and NOx, and also to promote fuel diversity and reduce waste. The coal industry was FETC’s primary customer and they were now looking at biomass as a response to the gas industry. However, he said, while anyone could burn biomass in a specially-designed plant, the real challenge was to use existing capital.

Biomass-related projects were appearing in many FETC product line portfolios and additional activities were being considered. Many FETC projects are biomass specific, have a biomass
element, or are relevant technical development activities. Specifically, Phil mentioned the following:

- Co-firing R&D
- Co-firing demonstrations
- Integrated Gasification Combined Cycle (IGCC)
- Gas to liquids
- Advanced turbine systems
- Fuel cell demonstrations
- Fluidized bed combustion (FBC) co-firing
- FETC in-house R&D and analyses

As part of its DOE mission, FETC promotes energy security and sustainable development by improving environmental and economic performance of power systems. Long-time FETC stakeholders include organizations that design, build, operate, regulate, and supply fuels or equipment to the power industry. According to Phil, FETC’s coal-fired power systems technologies are the key to accelerated near-term use of biomass fuels in co-firing applications and optimized future use of biomass. Ed Neuhauser raised the issue of ASTM standards C9 and 618 pertaining to co-fired coal ash, and Phil responded that FETC was not doing any work on commingled ash. Ed said that it was critical that the commingled ash issue be settled or the entire New York Salix project could grind to a halt.

Wrap-up

The meeting resulted in the following list of action items for the UBECA management team:

- Draft a letter to TTC requesting that all remaining UBECA records be sent immediately to Energetics;
- Begin the process of updating the UBECA web site;
- Begin work on a membership directory;
- Produce a paper and poster for the BioEnergy ’98 conference scheduled for October 4-8;
- Work with NREL on the co-firing brochure;
- Contact the National Bioenergy Industries Association (NBIA) about holding a joint meeting in the fall.2

- meeting adjourned at approximately 3:00 p.m. -

2It was subsequently learned that due to committee report language in the 1999 Energy and Water Appropriations Bill restricting DOE funding of trade associations, it is doubtful that funds will be available for a joint meeting this year.
- UBECA -

Biomass Energy
Near-Term Opportunities

★★★★

Prepared by
UBECA
United BioEnergy Commercialization Association
Columbia, Maryland

Prepared under contract to the
U.S. Department of Energy
Biomass Power Program

September 1998
BIOMASS ENERGY - NEAR-TERM OPPORTUNITIES

TABLE OF CONTENTS

PART I: PULP & PAPER INDUSTRY

Energy Use Breakdown for the Pulp and Paper Industry

American Forest, Wood, and Paper Industry Gasification Combined Cycle Initiative

Sector Emissions and Mitigation Options

Industrial Cogeneration and Distributed Generation Program for Carbon Emission Reduction

Industry Statistics

PART II: INTERNATIONAL OPPORTUNITIES

Biomass Gasification Opportunities in the Sugar Processing Industry

International Biomass Energy Statistics
PART I: PULP & PAPER INDUSTRY

ENERGY USE BREAKDOWN FOR THE PULP AND PAPER INDUSTRY
Energy Use Breakdown for the Pulp and Paper Industry

The paper and allied products industry (SIC 26) manufactures pulp, paper and paperboard from virgin and recycled fiber. The tens of thousands of products produced by the industry include newsprint, printing and writing papers, tissue, heavy-grade kraft paper, cardboard, corrugated, and construction-grade paper-board. The industry can be divided into two principal sectors. The energy intensive mill sector processes raw materials into paper and paperboard, and includes the SIC codes 261 (Pulp Mills), 262 (Paper Mills), and 263 (Paperboard Mills). The converting sector further processes the sheets of paper and paperboard into other finished products such as envelopes and boxes, and includes SIC codes 264 (Coating and Glazing), 265 (Paperboard Boxes and Containers), and 266 (Building Paper and Board). The mill sector accounts for about 95% of energy use in the pulp and paper industry, and is the focus of this analysis.

Over the last twenty years or so, many of the smaller, older mills have been closed down and replaced with larger integrated mills. The integrated mills produce both pulp and paper and/or paperboard. The trend is distinctly toward larger size (over 2000 tons/day) plants with the capability to consistently process high-quality products at higher speeds. The larger plants are better able to take advantage of energy-efficient cogeneration and process improvement technologies through economies of scale.

As shown in Table 1, the pulp and paper industry consumed over 2.5 quads of energy in 1995. The industry is the third-largest industrial energy consumer in the U.S., behind only petroleum refining and chemicals. Table 1 also shows that a large portion (about 57%) of the industry’s energy demands were met by self-generated and residue fuels, such as hogged wood, bark, and spent pulping liquor. The use of self-generated and residue fuels by the industry has increased by 72% since 1972. The industry has also significantly increased its cogeneration capacity, and generates more than 40% of the total on-site electricity produced by the U.S. manufacturing sector. Despite the industry’s impressive record for cogeneration and utilizing waste materials for energy, the industry still ranks third in energy purchases and ranks first in fuel oil consumption (though the industry has decreased its use of fuel oil by

### Table 1. Historical Fuel and Energy Use in the U.S. Pulp and Paper Industry
(trillion Btu unless otherwise indicated)

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Purchased Fossil Fuel and Energy</th>
<th>Total Self-Generated and Residue Fuels</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>1972</td>
<td>1,246</td>
<td>847</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>1,126</td>
<td>1,494</td>
<td></td>
</tr>
<tr>
<td>1994</td>
<td>1,116</td>
<td>1,451</td>
<td></td>
</tr>
<tr>
<td>1995</td>
<td>1,105</td>
<td>1,459</td>
<td></td>
</tr>
</tbody>
</table>

\[\text{Total Energy}^1 = 2,093, 2,520, 2,557, 2,554\]

\[\text{Total Production} (000 short tons) = 65,036, 84,558, 98,582, 100,141\]

---

^1 Numbers may not add to totals due to rounding.

Source: American Forest & Paper Association, Washington, D.C.
almost 68% since 1972). In 1994, the industry spent about $6.2 billion on purchased energy, or nearly 4.3% of the value of its shipments.¹

**Energy Consumption Trends**

As shown in Table 1, total energy consumption in the U.S. pulp and paper industry has grown by about 0.5 quads since 1972 (an increase of 22%) while production in terms of tons of product produced has grown by over 74%. The industry has significantly improved its energy efficiency, reducing the total energy use per ton of product produced from 32 million Btu/ton in 1972 to 25.6 million Btu/ton in 1995.² These improvements in energy efficiency have been achieved through increased use of cogeneration, improved “housekeeping,” waste reduction, waste heat recovery, and chemical and wood residue recovery; by using advanced production and process control technology; and by closing older, less efficient mills. The industry has significantly cut its use of fuel oil since 1972, largely replacing it with self-generated and residue fuels. As shown in Figure 1 (attached), the majority of the industry’s energy demands today are met by spent pulping liquor, followed by natural gas and coal.

Projections for energy consumption to the year 2010 and 2020 are based on the Energy Information Administration’s (EIA) most recent annual forecast, the Annual Energy Outlook 1997 (AEO/97).³ AEO/97 presents forecasts of energy supply, demand, and prices through 2015 for the pulp and paper industry. The analysis presented here extends the AEO’s forecast to the year 2020 by using a linear regression of the data. AEO’s projections are based on the results of the EIA’s National Energy Modeling System (NEMS). The NEMS Industrial Demand Module forecasts energy consumption and energy intensity subject to the forecasted delivered prices of energy, technology mix, and macroeconomic variables representing employment and value of output in each industry. AEO/97 presents a forecast for three different economic growth scenarios: reference (business-as-usual) case, low economic growth and high economic growth. For each of these three cases, NEMS uses different fundamental assumptions concerning factors that affect the domestic economy and world oil markets, as explained in the sidebar.

---


Table 2. Projected Energy Consumption in the U.S. Pulp and Paper Industry (trillion Btu)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reference Case</strong></td>
<td>2571.3</td>
<td>2679.8</td>
<td>2805.3</td>
<td>2867.1</td>
<td>2895.0</td>
<td>3013.9</td>
</tr>
<tr>
<td>Fossil Fuels</td>
<td>1050.8</td>
<td>1043.6</td>
<td>1040.2</td>
<td>1019.0</td>
<td>988.3</td>
<td>983.5</td>
</tr>
<tr>
<td>Purchased Electricity</td>
<td>259.5</td>
<td>279.1</td>
<td>291.2</td>
<td>295.2</td>
<td>296.0</td>
<td>310.9</td>
</tr>
<tr>
<td>Renewables</td>
<td>1261.0</td>
<td>1367.1</td>
<td>1473.9</td>
<td>1552.9</td>
<td>1610.7</td>
<td>1720.1</td>
</tr>
<tr>
<td><strong>High Economic Growth</strong></td>
<td>2571.3</td>
<td>2731.0</td>
<td>2915.0</td>
<td>3044.3</td>
<td>3148.8</td>
<td>3307.8</td>
</tr>
<tr>
<td>Fossil Fuels</td>
<td>1050.8</td>
<td>1058.7</td>
<td>1073.0</td>
<td>1078.8</td>
<td>1058.1</td>
<td>1070.3</td>
</tr>
<tr>
<td>Purchased Electricity</td>
<td>259.5</td>
<td>285.7</td>
<td>303.9</td>
<td>314.2</td>
<td>322.6</td>
<td>343.6</td>
</tr>
<tr>
<td>Renewables</td>
<td>1261.0</td>
<td>1386.6</td>
<td>1538.1</td>
<td>1659.3</td>
<td>1765.1</td>
<td>1890.2</td>
</tr>
<tr>
<td><strong>Low Economic Growth</strong></td>
<td>2571.3</td>
<td>2630.3</td>
<td>2696.8</td>
<td>2688.2</td>
<td>2640.8</td>
<td>2704.6</td>
</tr>
<tr>
<td>Fossil Fuels</td>
<td>1050.8</td>
<td>1028.7</td>
<td>1007.2</td>
<td>966.1</td>
<td>916.3</td>
<td>894.4</td>
</tr>
<tr>
<td>Purchased Electricity</td>
<td>259.5</td>
<td>272.9</td>
<td>279.5</td>
<td>276.4</td>
<td>269.8</td>
<td>278.8</td>
</tr>
<tr>
<td>Renewables</td>
<td>1261.0</td>
<td>1328.7</td>
<td>1410.2</td>
<td>1445.7</td>
<td>1454.7</td>
<td>1531.8</td>
</tr>
</tbody>
</table>


Table 2 shows projected energy consumption for the pulp and paper industry through 2020 for the three economic scenarios. In the reference, or "business-as-usual" case (which is charted in Figure 2, attached), total energy consumption is projected to grow at an average rate of 0.6% per year, increasing overall consumption from over 2.5 quads in 1995 to just over 3 quads in 2020. This growth rate is well below the industry's average annual growth of about 1% per year for the period 1972 through 1995.

In all three scenarios it is anticipated that consumption of fossil fuels will continue to decline, and that consumption of purchased electricity and self generated fuels and residues (labeled as "renewables" by the EIA) will continue to increase.

Energy Intensity Trends

According to recent data from the American Forest & Paper Association (AF&PA), the pulp and paper industry has reduced its total energy intensity by about 22% since 1972. Table 3 shows industry energy intensity for the years 1972, 1994 and 1995. Fossil fuel consumption per ton of product produced has decreased even more -- by over 40%. The consumption of self-generated and residue fuels per ton of product produced has increased slightly -- from 13 million Btu/ton in 1972 to 14.6 million Btu/ton in 1995.

The AEO forecasts energy intensity for each of the major energy-intensive industries, including pulp and paper. A key assumption used in the NEMS Industrial Demand Module is the Unit Energy Consumption (UEC) estimate, which measures the amount of energy required to produce one unit of the industry's output. Table 4 shows the UECs developed by the EIA for the pulp and paper industry. EIA calculates UECs for three different technology levels: existing (the UEC of average installed capacity in 1991); new
Table 3. Historical Energy Intensity in the U.S. Pulp and Paper Industry (million Btulon production)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Energy</td>
<td>32.1</td>
<td>26.0</td>
<td>25.6</td>
</tr>
<tr>
<td>Fossil Fuels</td>
<td>19.1</td>
<td>11.3</td>
<td>11.0</td>
</tr>
<tr>
<td>Self Generated Residues</td>
<td>13.0</td>
<td>14.7</td>
<td>14.6</td>
</tr>
</tbody>
</table>

Source: American Fine Paper Association, Washington, D.C.

Table 4 shows the projected energy intensity for the pulp and paper industry in each of the three economic scenarios, as projected by the AEO/97. Here energy intensity is presented as the amount of energy consumed per constant dollar of output. Again, the AEO/97 projects values to the year 2015; we extended the analysis to 2020 by conducting a linear regression of the data. In the reference case, energy intensity is projected to decline at an average rate of 1.2% per year, from 21,270 Btu per dollar of output in 1995 to 15,520 Btu per dollar of output in 2020. The consumption of fossil fuels per unit of output shows the sharpest decline of the different fuel types, going down from 8,690 Btu per dollar of output to 4,870 per dollar of output, a decrease of almost 44%.

Table 4. Unit Energy Consumption (UEC) for the Pulp and Paper Industry (10^6 Btulon process step product)

<table>
<thead>
<tr>
<th>Process Step</th>
<th>Existing UEC</th>
<th>New 1991 UEC</th>
<th>New 2015 UEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood Preparation</td>
<td>0.3</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Pulping</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kraft Pulping</td>
<td>15.7</td>
<td>11.5</td>
<td>9.4</td>
</tr>
<tr>
<td>Waste Paper Pulping</td>
<td>2.8</td>
<td>2.6</td>
<td>2.5</td>
</tr>
<tr>
<td>Semichemical Pulping</td>
<td>7.4</td>
<td>5.4</td>
<td>5.2</td>
</tr>
<tr>
<td>Mechanical Pulping</td>
<td>5.7</td>
<td>4.8</td>
<td>4.7</td>
</tr>
<tr>
<td>Bleaching</td>
<td>6.7</td>
<td>5.0</td>
<td>4.6</td>
</tr>
<tr>
<td>Papermaking</td>
<td>9.5</td>
<td>7.1</td>
<td>5.3</td>
</tr>
<tr>
<td>TOTAL UEC</td>
<td>25.8</td>
<td>19.4</td>
<td>15.9</td>
</tr>
</tbody>
</table>

Source: Energy Information Administration, unpublished data received January 1997.

The overall education in energy intensity for the reference case of 1.2% closely matches the historical level of 1.3%, calculated using data provided in Table 3. As shown in Table 5, the difference in energy intensity between the high-economic growth and low-economic growth cases are not very significant. This reflects the expectation that the implementation of process efficiency improvements in the U.S. pulp and paper industry will occur regardless of small upturns or downturns in the domestic economy and world oil markets.
Table 5. Projected Energy Intensity in the U.S. Pulp and Paper Industry (10^3 Btu/$87 output)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference Case</td>
<td>21.27</td>
<td>19.84</td>
<td>18.56</td>
<td>17.62</td>
<td>16.87</td>
<td>15.52</td>
</tr>
<tr>
<td>Fossil Fuels</td>
<td>8.69</td>
<td>7.72</td>
<td>6.88</td>
<td>6.27</td>
<td>5.75</td>
<td>4.87</td>
</tr>
<tr>
<td>Purchased Electricity</td>
<td>2.15</td>
<td>2.07</td>
<td>1.93</td>
<td>1.81</td>
<td>1.73</td>
<td>1.61</td>
</tr>
<tr>
<td>Renewables</td>
<td>10.43</td>
<td>10.05</td>
<td>9.75</td>
<td>9.54</td>
<td>9.39</td>
<td>9.05</td>
</tr>
<tr>
<td>High Economic Growth</td>
<td>21.27</td>
<td>19.74</td>
<td>18.42</td>
<td>17.47</td>
<td>16.73</td>
<td>15.32</td>
</tr>
<tr>
<td>Fossil Fuels</td>
<td>8.69</td>
<td>7.66</td>
<td>6.78</td>
<td>6.15</td>
<td>5.62</td>
<td>4.69</td>
</tr>
<tr>
<td>Purchased Electricity</td>
<td>2.15</td>
<td>2.06</td>
<td>1.92</td>
<td>1.80</td>
<td>1.72</td>
<td>1.59</td>
</tr>
<tr>
<td>Renewables</td>
<td>10.43</td>
<td>10.02</td>
<td>9.72</td>
<td>9.52</td>
<td>9.39</td>
<td>9.04</td>
</tr>
<tr>
<td>Low Economic Growth</td>
<td>21.27</td>
<td>19.94</td>
<td>18.70</td>
<td>17.79</td>
<td>17.05</td>
<td>15.77</td>
</tr>
<tr>
<td>Fossil Fuels</td>
<td>8.69</td>
<td>7.80</td>
<td>6.98</td>
<td>6.39</td>
<td>5.92</td>
<td>5.07</td>
</tr>
<tr>
<td>Purchased Electricity</td>
<td>2.15</td>
<td>2.07</td>
<td>1.94</td>
<td>1.83</td>
<td>1.74</td>
<td>1.63</td>
</tr>
<tr>
<td>Renewables</td>
<td>10.43</td>
<td>10.07</td>
<td>9.78</td>
<td>9.57</td>
<td>9.39</td>
<td>9.08</td>
</tr>
</tbody>
</table>

Figure 1. U.S. pulp and paper industry energy sources

Total Energy Use

2.55 Quads

Figure 2. Projected Energy Consumption in the U.S. Pulp and Paper Industry
Reference Case

Total Energy
Renewables
Fossil Fuels
Purchased Electricity

AMERICAN FOREST, WOOD AND PAPER INDUSTRY
GASIFICATION COMBINED CYCLE INITIATIVE

Executive Summary:

Three joint Forest Products Industry-Department of Energy (DOE) projects have so far been endorsed by both the Chief Technology Officers Working Group and the CEO Climate Change Options Advisory Group of the American Forest & Paper Association as appropriate to demonstrate biomass and black liquor gasification. If proven, these technologies offer great potential for improved capital effectiveness, energy efficiency, environmental performance, global competitiveness and safety in the forest, wood and paper industry. These advantages will be gained from:

- the ability to increase electrical power production capability by up to 300%;
- providing the potential to positively impact greenhouse gas emissions by over 30 million metric tons of carbon per year;
- making available these technology options early enough for the majority of U.S. industry to utilize them in normal capital replacement decisions; and
- providing U.S. facilities with significantly more effective and efficient power houses compared to currently growing segments of the global industry, such as southeast Asia.

The three projects are:

- Champion's Courtland, Alabama mill to demonstrate a full-scale pressurized, oxygen-based Kraft black liquor gasification system,
- Georgia Pacific's Big Island, Virginia mill to demonstrate semi-chem caustic/carbonate liquor gasification, and
- Weyerhaeuser's New Bern, North Carolina mill to demonstrate gasification of residual biomass.

Each of the three projects utilizes a different gasification technology in a different application. Choosing one technology over another to demonstrate on a sequential basis would result in significant delay of getting the technology to the marketplace for use by all segments of the industry. The combination of these three projects ensures that the broadest range of the pulp and paper industry will benefit from the proposed demonstrations. Each of the applications may be used separately, or may be combined for the highest level of benefits. Demonstrating them in different mill configurations ensures that, if proven, the technology will find broad market acceptance in a wide range of facilities in the industry—be it for replacement of current technology or for incremental new capacity.

Because of the age of the industry’s powerhouses, these technologies need to be demonstrated in parallel if they are to be available in time for broad application across the industry. Due to the diversity of the industry’s needs, no one technology can provide a full solution. Though the three technologies differ, there are fundamental issues of chemistry and physics that are common across each project. This can reinforce the robustness of the projects, reduce the risk of failure, and—in the event of a project delay or diminished success—provide an adaptable alternative.
The Agenda 2020 Energy Performance research area task group has included gasification combined cycle in their most recent request for proposals, since there may be other opportunities as well. The intent is to seek out the full range of sites and technologies where biomass and black liquor gasification can be demonstrated for broad application within the industry, thus increasing the likelihood that pulp and paper manufacturers will have the best technology options from which to choose.

In the following document, the history of how the industry arrived at this point is reviewed, the importance of the technology to the industry and the nation is discussed, a brief description of the technologies involved is provided, the necessity for government funding is established, a management oversight plan is suggested and a path forward is proposed.
# Table of Contents

**EXECUTIVE SUMMARY**: .......................................................................................................................... 1

**TABLE OF CONTENTS** ............................................................................................................................. 3

**THE HISTORY** ......................................................................................................................................... 4

**THE TECHNOLOGIES** ............................................................................................................................... 6

- *Kvarner Chemrec™ Pressurized Black Liquor Gasification System*: ......................................................... 9
- *MTCI/StoneChem PulseEnhanced™ Steam Reforming Process*: ................................................................. 10
- *Battelle/FERCO Low Inlet Velocity Gasification System*: ........................................................................ 12

**THE NECESSITY FOR GOVERNMENT FUNDING** .............................................................................. 13

**MANAGEMENT OVERSIGHT PLAN** ....................................................................................................... 14

**THE PATH FORWARD** ............................................................................................................................ 15

**ATTACHMENT I** ...................................................................................................................................... 16

- *Kvarner Chemrec Technology Demonstration* ......................................................................................... 16

**ATTACHMENT II** .................................................................................................................................... 22

- *MTCI/StoneChem Technology Demonstration* ......................................................................................... 22

**ATTACHMENT III** .................................................................................................................................... 28

- *Battelle/FERCO Technology Demonstration* ........................................................................................... 28
**The History**

Gasification of various carbonaceous feedstocks has been practiced successfully for over forty years for the production of synthesis gas for chemicals.

In the mid 1970's, the pulp and paper industry around the world began to realize that the industry's energy conversion equipment of that time was inefficient, capital intensive, and had safety and environmental issues. The Gunnar Sundblad Conference in Stockholm, Sweden addressed this issue in May 1976. At that conference, four new technology options for Kraft recovery were proposed. Twenty-two years later, the industry is ready for first commercial demonstrations. Through the Agenda 2020 process, three specific demonstration projects have been identified.

The Tomlinson recovery boiler has been the dominant technology for recovery of chemicals and energy from the spent pulping liquor (black liquor) of the Kraft pulping process since the 1930s. There have been many attempts to develop alternatives, but none have achieved commercial success. While many improvements have been made in the Tomlinson furnace since its introduction, it still has relatively low thermal efficiency and a low power-to-steam output ratio. In addition, it is high in capital and maintenance costs, and the potential for a smelt water explosion remains. There are more than 200 Tomlinson boilers in the U.S., and about 80% of them were built or rebuilt before 1980. Therefore, most recovery boilers will need major modifications or replacement within the next 20 years.

In semi-chem operations, as in the Kraft process, it is important to the economics of the process to recover the sodium chemicals used in pulping. The majority of semi-chem plants use a Copeland fluid bed boiler in which there is no recovery of the energy value of the lignin. Three mills use Tomlinson recovery boilers to recover the cooking chemicals, but all use supplemental fuel to sustain combustion.

As recently as 1970, hog fuel or wood room waste was considered to have little value and was regarded as more of a nuisance than a fuel. Many mills preferred to landfill it rather than reduce boiler capacity by displacing then cheap oil. Higher fossil fuel prices focused more attention on the value of hog fuel; and today, it is commonly burned in a boiler designed specifically for such wastes or in a combination boiler burning fossil fuels as well. Hog fuel or combination boilers have drawbacks similar to recovery boilers in that the power-to-steam output ratio is low and they have fairly high capital and maintenance costs. Today, it is frequently uneconomic to transport and burn forest residuals for their energy value. However, they represent a significant potential fuel source if they could be utilized more efficiently.

In spite of their poor characteristics, the industry can be proud of the progress it has made in using these fuels to supply its steam and electric power needs. In 1972, these fuels supplied about 36% of its steam and power needs; but through conservation efforts and improvements in combustion and power generation efficiencies, about 54% of these needs for the pulp, paper and packaging sector are currently supplied with these same materials.

Never without new challenges, the industry has continued to upgrade the equipment used for pulping, papermaking, and forest products to increase production, achieve greater efficiency in fiber use and improve the quality of its products. Industry customers have become far more demanding about quality, particularly as the technologies using its products have become much more advanced. High-speed printing presses, copiers, facsimile machines and the like are less tolerant of small quality changes and variations in paper, forcing specifications once thought unrealistic. At the same time, environmental regulations have become more stringent, and the
industry has had to add significant environmental control processes and equipment to its mills. The Cluster Rules have added new requirements, and greenhouse gas initiatives may well do the same.

What have these issues to do with energy? The changes that have been made to the industry's processes and equipment have resulted and continue to result in a shift in the amount of steam and power needed per pound of product to less steam but far more electric power. A modern paper machine has an electric power load per ton that is 1.5–2 times that of an older machine.

The industry is meeting some of its needs by increasing the amount of power generation in the mill, but the additional power generally is purchased from a local utility supplier. The electric utility industry is changing even more rapidly than the forest products industry. During the next several years, the entire electric utility industry could be deregulated. The industry's supplier of electric power in the future may be the local utility, a utility a thousand miles away, or even a broker buying and selling kilowatt hours the same way stocks are traded today. For some mills, this may mean lower cost electric power; for some, deregulation could mean a trade-off between reliability and cost. In any event, electric utility deregulation means changes for the forest products industry that could place a premium on its ability to self-generate electrical energy from non-fossil fuels.

Most of the pulp, paper and forest products produced in North America are consumed in North America; and, until recent years, international exports and imports of these products was not a significant factor in the economic profit of producers. That picture has also changed rapidly. The industry is facing ever-increasing international competitive pressures in both the export and import markets. High tariffs and government subsidies in Europe, Asia and South America threaten its ability to compete and to remain a viable industry in the future. To remain viable, operating costs need to be reduced; and energy—in most cases, the third highest cost after raw materials and labor—has to be one of the primary targets for cost reduction.

In summary, the Agenda 2020 technology visioning process has recommended the early demonstration of gasification combined cycle technologies and is currently supporting significant fundamental research to enhance their success. A wide membership of the industry has expressed serious interest and support for these demonstrations. Significant learnings have been and are being derived from prior pilot facilities—including demonstrations of the MTCI PulseEnhanced™ Steam Reforming process at Inland Container and Weyerhaeuser, the Kvaerner Chemrec black liquor process at Frövifors, Sweden, and the Battelle/FERCO Low Inlet Velocity process at Burlington, Vermont.

Currently, Champion, Georgia Pacific and Weyerhaeuser have proposed to work together with the DOE and the AF&PA to obtain government cost share for three technology demonstration projects. Funding is expected to come from the three companies as well as the DOE. In addition, a request for proposals has been issued which seeks additional opportunities for effective demonstration of these or other technology options. The U.S. Department of Energy has been briefed and has expressed considerable support and willingness to participate. To facilitate the timely success of these first units, an alliance of the industry is also a possibility.

The President's Commission on Science and Technology has recommended these technologies for their potential to make a significant contribution to the country's obligations under global climate. Those present at the American Forest & Paper Association Agenda 2020 Chief Technology Officers Working Group Meeting on March 3 & 4, 1998 unanimously agreed to pursue a gasification initiative and an early technology implementation; and on May 19, the CEO
Global Climate Change OAG informed the AF&PA Board of their unanimous support of the
planned path forward.

**The Technologies**

*Gasification:* The conversion of low cost solids or liquids into clean burning gases
for replacement of expensive fossil fuels.

*Combined Cycle:* The use of a gaseous fuel in a gas turbine followed by the
production of steam, which is subsequently used in a steam turbine such that both
turbines produce electric power.

Kraft black liquor and semi-chem caustic-carbonate liquors are mixtures of organic components
dissolved from the wood, inorganic cooking chemicals and water. Even when concentrated in
multiple effect evaporators, they contain large percentages of water and are low quality fuels.
Gasification allows separation and recovery of the inorganic cooking chemicals while producing
from the organics in the liquor a combustible gas product that, when cleaned, is a very viable
medium Btu fuel. As applied to biomass, gasification allows one to take a fuel that is roughly
half water by weight and produce from it a higher quality fuel. These fuel gases can be used as
direct replacements for fossil fuels.

A key impetus to commercialize biomass and black liquor technologies is the ability to fire the
product gases in a gas turbine and to use the gas turbine exhaust, which is at about 1000°F, to
raise steam that can be passed through a steam turbine to generate additional electric power. In
recent years, the industry has become a significant user of gas turbines as it has increased the
amount of power generated on mill sites. Where this has occurred, it provides the basis for
partial or complete replacement of natural gas with syngas from black liquor and biomass as
natural gas prices increase. In spite of these trends, there is still a substantial and growing
amount of power purchased from utilities. Gasification combined cycle has the potential for
greatly increasing the amount of electric power generated per unit of fuel.

For example, if one takes the black liquor and hog fuel generated in a 1,500 ton-per-day
integrated Kraft mill, it is possible to generate about 70 MW of power using the current
technology of a Tomlinson recovery boiler, a combination boiler, and a steam turbine generator.
Replacing the Tomlinson recovery boiler with an integrated gasification combined cycle (IGCC)
black liquor system increases the potential power generation to nearly 200 MW. The same black
liquor and hog fuel supplied to a combination of black liquor and biomass gasification in IGCC
configuration can generate nearly 300 MW of power (approximately a 300% and 400% increase,
respectively). The efficiency gain depends on the specific configuration examined; but typically,
the overall cycle efficiency of an IGCC plant can be up to 10% higher than a conventional cycle.

The shared vision of the industry is reflected in the figure at the top of page 7 where a
hypothetical powerhouse configuration is shown utilizing both black liquor and biomass
gasification. Having these developing technologies available by 2010 or before will allow the
majority of the industry to have these significantly improved options as they make necessary
powerhouse replacement decisions.
Power Recovery Island of 2010 Possible Configuration

The impact these technologies can have (reference Eric Larson, Princeton) is shown in the figure below.

**Total Power Production for a 1500 tpd Integrated Kraft Mill**
Process Energy Demand: 200 MWh assembly & 1600 MWhp

- **Case 1:** Tomlinson boiler + biomass power boiler, back-pressure steam turbine (BPST)
- **Case 2:** Black liquor gasifier + biomass power boiler in combined cycle with BPST
- **Case 3:** Black liquor gasifier + biomass gasifier in combined cycle with BPST

All gasification combined cycle technologies (IGCC) include cleaning of the product gases from the gasification step prior to their final combustion. Therefore, it is possible to better control the quality of the gas and to remove some of the precursors of adverse environmental emissions. The overall result is lower environmental emissions than current technology.
The recent greenhouse gas protocol agreed to by the U.S. in Kyoto, Japan calls for sharp reductions in emissions of greenhouse gases. The U.S. forest products industry is, on the one hand, provides large sequestration of carbon both through long-term storage in its products and by planting and growing trees. On the other hand, it is an emitter of carbon dioxide through its manufacturing processes. As a large user of energy, regulatory initiatives that are developed to meet the goals of the Kyoto agreement are likely to have a huge impact on the economic viability of the forest products industry.

If proven to be economically and commercially viable, biomass and black liquor gasification combined cycle technologies offer tremendous opportunities for this industry to make a positive contribution to the reduction of greenhouse gas emissions. Initial estimates indicate that, if fully implemented, these technologies have the potential to reduce carbon emission by 30 to 60 million metric tons per year, depending on whether the fossil fuel displaced is natural gas or coal. Significantly less than 10% of the industry's boilers would have to transition to the new technology to achieve a 7% reduction goal for the industry. These impacts are graphically represented below.

Furthermore, these technologies are believed to have crosscutting applications for other energy intensive industries, such as chemicals, petrochemicals, utilities and refining. By demonstrating these technologies in the forest products sector where there is a high likelihood of success, the Department of Energy—along with key gasification technology suppliers—could help facilitate the transfer of the technology to other potential applications. This would expand the potential for improved energy efficiency and environmental performance in other sectors.

As stated above, the industry has recognized the advantages for itself and for the Nation of biomass and black liquor gasification technologies since the late 70's. Since this time, it has worked with the DOE and others to bring these technologies to commercial reality. Safety, energy efficiency, capital effectiveness and global competitiveness have been consistent drivers for the advancement of these technologies.

If proven successful, some of the specific benefits of IGCC include:

- Higher energy efficiency—up to 10%
- Higher reduction efficiency for Kraft cooking chemicals—typically 5% improvement
- Higher electrical power generation—in excess of twice the kWh/ton
- Lower environmental emissions
- Improved safety and capital effectiveness
These benefits, however, are to some degree offset by risks—particularly to the first users of the technologies. These risks include:

- Capability of the suppliers
- Ability to keep units on line in the early years
- Maintenance costs
- Impact on production
- Possibility of failure to achieve design performance

The aging of industry powerhouses and the current national emphasis on global climate change create a window of opportunity for rapid demonstration. The Industry supports developing the structure and the federal funding for pursuing the timely demonstration of these technologies, and the Administration's initiative on reducing carbon emissions may provide the extra support needed to "lift" these technologies over the economic and feasibility barriers to show that they are attractive, reliable and robust. In addition, the industry speaking with one voice instead of fragmented will greatly enhance its ability to achieve the benefits these technologies offer in a manner that is consistent with national goals.

**Kvaerner Chemrec™ Pressurized Black Liquor Gasification System**

![Diagram of Kvaerner Chemrec™ System]

Development of the Kvaerner Chemrec™ System began in the early 1980s. The original parent company of this technology, SKF Steel, began the development of plasma-based gasifiers for black liquor, but excessive carryover of alkali materials and high electrical power consumption caused them to abandon this approach. They built a lower temperature pilot plant in 1987 that established that black liquor gasification was feasible without plasma energy support. Kvaerner purchased the technology in 1990 and continued development in both low-pressure air-blown
pilot and commercial facilities and a high-pressure oxygen-blown pilot facility, leading to the proposed entrained flow configuration for this demonstration.

Concentrated black liquor, preferably at 65% solids or higher, is injected into the upper portion of the gasifier together with atomizing steam and oxygen. The gasifier operates at about 1700–1800°F and around 400 psi. The high pressure and a very short residence time result in a very compact unit. The organics in the liquor are partially oxidized to form a combustible gas while the inorganics melt and flow down the gasifier as entrained droplets or a thin layer on the walls. The small amount of smelt in the gasifier and the absence of large quantities of water ensure that a smelt water explosion is precluded.

The product gases from the gasifier contain combustible gases as well as hydrogen sulfide and steam. They are cooled in a heat exchanger to generate process steam and are scrubbed of hydrogen sulfide in a conventional absorber/stripper system—technology long in use in the petrochemical industry. The concentrated hydrogen sulfide stream from the stripper is treated in a conventional Claus plant to form elemental sulfur for use in preparation of polysulphide cooking liquors. The cleaned product gases can be burned in a boiler or gas turbine.

A similar demonstration of the Kvaerner Chemrec™ gasifier at an unbleached linerboard mill in Sweden is under discussion. Should that demonstration go forward, the information available to the U.S. industry is likely to be limited and delayed. Further, there will be virtually no information available on the very important aspect of integration of black liquor gasification into the kraft process.

**MTCI/StoneChem PulseEnhanced™ Steam Reforming Process**
The StoneChem gasification process employs indirect heating of a steam fluidized, bubbling bed of sodium carbonate solids. Black liquor is sprayed directly into the bed, where the liquor droplets uniformly coat the bed solids, resulting in high rates of heating, pyrolysis and steam reforming. Bed temperatures are maintained at approximately 1100°F, thereby avoiding liquid smelt formation and the associated smelt-water explosion hazards. Neither combustion (burning) of the black liquor nor alkali smelt formation occurs in the steam reforming process. Steam reacts endothermically with the black liquor char to produce a medium-Btu syngas rich in hydrogen. This product gas passes through a cyclone to remove particulate matter followed by a heat recovery unit. It is then further cooled and scrubbed to recover additional chemicals and produce a clean burning fuel. Chemical recovery is accomplished by continuously purging the dry (sodium carbonate and potassium carbonate) solids from the reformer bed and dissolving them in a mix tank.

Heat required for the endothermic steam reforming reactions is supplied by heat exchangers immersed in the fluidized bed. The heat exchangers consist of bundles of pulsed heater resonance tubes that supply the necessary heat by burning a portion of the product gas, thus making the PulseEnhanced™ Steam Reformer self-sufficient with regard to fuel. The excess product gas and the hot combustion gases leaving the pulsed heaters are sent to a waste heat boiler to generate process steam and preheat combustion air for the pulsed heaters.

Georgia Pacific believes that there are three extensions of this technology. First, it is a new process for high-yield chemical pulping where historically there have been only three dominant processes—namely, NSSC, Billerude and the soda process. Each of these processes have serious limitations which have prevented expansion of high-yield chemical pulping. Inclusion of a gasifier in the soda process makes this process reliable and energy efficient, thereby giving the industry a process choice that will likely increase the use of the high-yield pulping process.

Second, the PulseEnhanced™ Steam Reformer process is expected to be compatible with the inclusion of wood waste, especially sawdust. While it is beyond the scope of the proposal, Georgia Pacific intends to investigate this possibility and change the mill power island in accordance with the resulting economics.

Third, as demonstrated on a small pilot scale by Weyerhaeuser, the PulseEnhanced™ Steam Reformer process is also applicable to kraft black liquor. The current view is that the initial application is most probable in conjunction with a recovery boiler as supplemental capacity or as replacement for one boiler in a multi-boiler mill. Although the Big Island unit is designed for a soda process, there is a small sulfur reduction capability. If, as expected, the Big Island unit as constructed is found to be capable of processing kraft black liquor, Georgia Pacific will seek an environmental permit for a demonstration of this capability. This trial could be conducted on “imported” black liquor and could be of several days duration. It would investigate the compatibility of refractory material and the lower and narrower range of temperatures identified in the earlier trials at Weyerhaeuser, New Bern. The capability of the PulseEnhanced™ Steam Reformer unit to process commercial quantities of kraft black liquor would in this way be demonstrated. While beyond the scope of the currently proposed project, it is a question that Georgia Pacific wants to answer before its next recovery boiler rebuild or purchase.
The Battelle/FERCO biomass gasification system (initially developed by Battelle) has been the subject of several evaluations by Weyerhaeuser over more than a decade. It seems particularly suited to a pulp mill environment since it operates at close to atmospheric conditions, produces a medium Btu gas, is tolerant of changes in feed quality, requires less attention to fuel drying and holds the promise of requiring significantly less capital. The medium Btu gas (450–500 Btu/scf) produced from wood residuals is accomplished without an oxygen plant. A gas having a heating value in this range can normally be readily utilized by existing oil or gas-fired equipment without de-rating and with little retrofit equipment.

Wood is fed, with size reduction and partial drying, into a gasifier where it is contacted with hot sand and a conveying stream of steam. The wood reacts, producing a medium Btu product gas and char which, along with the sand, is separated from the product gas by cyclones. The solids discharge of the cyclone directs the sand and char mixture into a combustor where the char reacts with air to reheat the sand, which then returns to the gasification vessel. The product gas continues on to heat recovery and water scrubbing to remove condensable organic material. The flue gas from the combustor at 1,900°F provides a valuable heat source for generation of steam or other process heating applications.

The inherent high reactivity of wood and other biomass feedstocks makes it possible to utilize extremely compact equipment for generation of the medium Btu product gas. Specific throughputs of over 2,000 lbs/hr-ft² of reactor area have been achieved in the research unit and are expected to be even greater in the development unit currently in start-up at Burlington, Vermont. These throughputs are more than an order of magnitude higher than conventional fluid
bed gasification reactors. This should translate to lower capital cost than systems requiring larger equipment. In addition, the two-zone system allows the heating value of the cool, cleaned product gas to remain constant—exclusive of the moisture level of the feed.

Although the Burlington demonstration is an essential step in the evolution of this technology, as was the Weyerhaeuser pilot facility in the evolution of the PulseEnhanced™ Steam Reformer technology, it leaves many questions unanswered. The risks that will be addressed at New Bern include integration of a fuel dryer, use of the syngas in a lime kiln application, significant improvement in design resulting from a chemical process plant, as opposed to a boiler, design philosophy, long-term operability and maintenance costs, and process control philosophies in a pulp mill integrated environment. In addition, the New Bern proposed facility represents a significant scale up to a size typical of the needs of pulp mills.

**The Necessity for Government Funding**

The government is asking industry to meet stringent environmental and energy efficiency standards through numerous regulations, including potential new treaty obligations on greenhouse gases. These cannot be met in a cost efficient way without significant new advances in technology, such as those provided by the gasification processes. The U.S. government recognizes this.

The gasification technologies discussed here have been in development for several years, but the risk and costs associated with full-scale demonstration have prevented them from becoming commercialized. Industry estimates indicate that the first project for each technology approach will cost 30–40% more in capital than subsequent projects and will also have increased initial start-up and demonstration costs.

The figure on the right from the Electric Power Research Institute Technical Assessment Guide represents the experience of the utility industry, which is typical of process industries like forest products. This figure clearly shows that the first commercial units are significantly higher in capital than later units.

Host facilities and key suppliers are now in place and willing to share the cost and risk associated with proving these new technologies with the Department of Energy through the framework of Agenda 2020. The DOE-funded demonstrations are intended to bring the technologies to the marketplace—it is unlikely that they would otherwise make it because of the cost and risk involved. As shown here, the three projects being recommended to the DOE have a five-year cost of ~$200,000,000. The
industry is proposing approximately a 50–50 cost share between DOE and the private sector participants.

In addition to financial support, the demonstration of these new technologies will need support from the Environmental Protection Agency (EPA). Due to the timing of the proposed MACT II rules, the projects will each need assurance from EPA that the mills will have the flexibility needed to complete the demonstrations without being in violation of EPA regulations.

The anticipated compliance deadline of the MACT II rules could be as early as 2001, yet the proposed demonstrations are not anticipated to be completed until 2002 to 2004. If the demonstrations fail, which is unlikely, the mills will need at least 18–24 months to restore the old technology and retrofit it to be in compliance with MACT II. Since the proposed new technologies provide numerous environmental benefits, it is anticipated that EPA will be willing to work with the host facilities to allow the demonstrations to proceed with the needed regulatory flexibility.

**Management Oversight Plan**

The demonstrations of these technologies will offer numerous benefits to the industry as a whole. Jointly funded DOE demonstrations require that the ultimate results be shared with the public. Through the American Forest & Paper Association’s Chief Technology Officers group, agreed-upon progress reports will be shared with the AF&PA membership. This will allow participation by member companies in the demonstration of the technology.

Additionally, the final report will be extremely detailed, as required by law, and will be made available to AF&PA members as well as the public. If these technologies can be proven to be commercially viable, then subsequent installations will have a major advantage of installing technology that bypasses the deficiencies of the initial demonstration without the risk and added cost associated with being first.

The management oversight recommendations which follow incorporate DOE requirements, but have been supplemented by using principles learned in highly successful joint activities including BLRBAC (Black Liquor Recovery Boiler Advisory Committee). Those principles are:

1) Written goals
2) Generation of accurate data
3) Mutually agreeable goals
4) Scheduled meetings to share data
5) Joint problem solving
6) Routine reports to members
7) Routine reports to the industry

Each of the three gasifier project proposals will incorporate the major input from the Agenda 2020 process. This will lead to mutually agreeable goals. The resulting proposals will specify technical and commercial goals with deliverables and milestones. This will provide written goals.

It will be the primary responsibility of each company to achieve their milestones and goals, and the DOE will have primary oversight responsibility. Reports will be generated on the required schedule with the required format and content. This is one phase of generation of accurate data.
However, the three gasification projects have an unusual supporting relationship and will be of significant interest to the pulp and paper industry. Each of the three projects will distribute periodic progress reports directly to the Agenda 2020 CTO Working Group. This is another phase of reports to the committee and to the industry.

Each project has the opportunity and is encouraged to request key industry technical experts to participate in problem-solving activities. This arrangement will allow for an unprecedented opportunity for joint problem solving, and should maximize the transfer of technology.

Finally, each project will designate a realistic number of “open house” days where industry representatives can see the units in sustained operation.

All of the foregoing activities will ensure that alternatives and techniques learned on one project will be available to the other projects. For example, a risk analysis of the Big Island project showed a potential high risk for maintenance to the pulse chambers of the gasifier. This has led to a request to design two separate combustion chambers instead of a single chamber. This design may permit isolation of a single chamber so maintenance can be performed on the “idle” chamber. This design alternative, whether used or not, will be available to the other projects. Other opportunities for sharing of information include materials of construction, refractory technology, gas cleaning technology, liquor filtering, fuel feed mechanisms, predictive maintenance, and control strategies. This high degree of technical cooperation is expected to significantly increase the probability of success.

Each project will distribute its final report to the DOE and to the Agenda 2020 CTO Working Group. This is one of the last steps in reports to the industry. Finally, each project will submit a peer reviewed technical or management article to the Technical Association of the Pulp and Paper Industry (TAPPI) or the Paper Industry Management Association (PIMA) for publication and presentation at a conference. This “committed” distribution and publication will result in an unprecedented sharing of technology.

The Path Forward

A significant effort will be required to develop and execute these projects over the next 4–5 years. Some of the most significant early activities are listed below:

- **July 10, 1998**, communicate opportunities around this issue to interested AF&PA members
- **July 14–31, 1998**, make recommendation of gasification projects to DOE
- **September–October, 1998**, begin negotiation of contracts with DOE
- **July – October, 1998**, discussions with EPA regarding assurances for regulatory flexibility for demonstrations
- **November, 1998**, complete DOE contract negotiations
- **December, 1998**, begin first phase of Champion and Georgia Pacific projects
- **December, 1999**, begin first phase of Weyerhaeuser project
- **Continued outreach** to industry and other potentially interested parties including suppliers, universities and national labs
- **Lobby as an industry group** for needed federal funds
- **Develop and execute demonstration projects**
Attachment I

Kvaerner Chemrec Technology Demonstration
Pressurized Oxygen-Blown Black Liquor Gasification
and Integrated Combined-Cycle Cogeneration

Targeted Agenda 2020 Energy Performance Area: Commercialization of combined-cycle
gasification technologies for both black liquor and biomass

Abstract
Champion International Corporation, together with Air Products and Kvaerner Chemrec™, plans
to demonstrate pressurized oxygen-blown black liquor gasification and combined-cycle co-
generation at Champion's Courtland, Alabama paper mill. Phase 1 is the detailed engineering of
a 1.2 million pounds/day black liquor solids gasification plant including gasifier, heat recovery,
gas cleaning, and sulfur management. Phase 2 is the construction of the facility, and Phase 3 is
the start up and initial operation. The combustible product gas would be fired initially in a
bubbling fluidized bed boiler; and, when the quality of the gas is assured, it would be fired in a
gas turbine as partial replacement for the current natural gas fuel.

Black liquor gasification offers the potential for up to ten percent higher energy efficiency over
conventional technology, higher reduction efficiency of Kraft pulping chemicals, up to twice the
electrical power generation per pound of black liquor, lower environmental emissions and
positive greenhouse gas effects, improved safety, and improved capital effectiveness. The
Kvaerner Chemrec™ System is the most advanced black liquor gasification technology, and
offers the highest potential for successful commercialization. The Courtland facility offers the
possibility of demonstrating the firing of the product gas in an existing gas turbine. This is a
unique opportunity to bring this high-potential technology to the pulp and paper industry.

The demonstration program, including design, construction and operation, would span
approximately five years. This proposal discusses the first-year detailed engineering phase of the
program in some detail with Phases 2 and 3 in more general terms. The Phase 1 effort would
provide more detail on these latter phases.

Proposer
Champion International Corp.
One Champion Plaza
Stamford, CT 06921
Attn. Edward G. Kelleher

Sub-proposer
Air Products and Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195
Attn. David R. Ruprecht

Sub-proposer
Kvaerner Chemrec AB
Floragatan 10 B
S-114 31 Stockholm, Sweden
Attn. Lars L. Stigsson
Background

The Kraft process accounts for more than half of the pulp produced in the United States and 80% of paper contains Kraft pulp. Forecasts do not indicate any change in this for the foreseeable future. Recovery of the cooking chemicals is key to the economics of the Kraft process, and the Tomlinson recovery boiler has been the dominant technology for this since the 1930s. There have been many attempts to develop an alternative to the Tomlinson boiler, but none have been commercially successful. While many improvements have been made in the Tomlinson boiler since its introduction, it still has relatively low thermal efficiency and a low power-to-steam output ratio. It is high in capital and maintenance cost, and there is the potential for a smelt water explosion. There are more than 200 Tomlinson boilers in the U.S. and about 80% of them were built or rebuilt before 1980. Therefore, most recovery boilers will need major modifications or replacement within the next 20 years.

Gasification of various kinds of carbonaceous feedstock has been practiced successfully for over forty years for the production of synthesis gas for chemicals. Gasification of black liquor has been studied for many years, most intensely starting in the early 1980s. In 1990, Kvaerner purchased the parent gasification technology of today’s concept and continued its development. An atmospheric pressure air-blown demonstration gasifier was installed at the AssiDoman Froiffors mill in Sweden in 1991; and, in 1997, a commercial atmospheric pressure air-blown gasifier was started up at the Weyerhaeuser New Bern mill in North Carolina. In addition, Kvaerner Chemrec built a pressurized pilot gasifier at a Swedish mill in 1994. Learnings from these operations have been incorporated into the conceptual design for the proposed demonstration.

Integrated gasification combined cycle (IGCC) technology is the marrying of carbonaceous fuel gasification, firing of the product gas in a gas turbine, followed by the production of steam and subsequent generation of additional electrical power in a steam turbine generator. Several large-scale IGCC plants, based mainly on coal gasification, are operating at the present time. The development of IGCC technology based on black liquor presents many challenges compared to other feedstock, but would have significant benefits for the pulp and paper industry if proven successful.

The proposed project has not received any prior government funding.

Objectives

The objective of Phase 1 of this project is to do a detailed design and cost estimate of the gasification plant, heat recovery, gas cleaning and sulfur management facilities, and the integration of the demonstration plant with the existing Courtland mill—including provisions for liquor supply, initial product gas combustion, product gas combustion in a gas turbine, green liquor ties, white liquor ties, and utility ties. The estimate would include all costs to complete the demonstration.

The objectives of the overall project include:

- Demonstration of large-scale pressurized oxygen-blown black liquor gasification
- Demonstration of product gas clean up and sulfur management
- Demonstration of combustion of the product gas in a gas turbine (igcc)
- Demonstration of sulfur recovery from the product gas of black liquor gasification
• Production of polysulfide-containing white liquor from the recovered sulfur
• Investigation of the yield effects of using polysulfide-containing white liquor in the kraft pulping process
• Comprehensive process analysis of the integration of black liquor gasification into the kraft process

Pre-Project Requirements
In order to proceed with the latter phases of the project, the EPA must include an 'innovative technology' provision in the MACT II regulations or grant a site-specific waiver so that Champion will be assured sufficient time to implement conventional modifications to Courtland's No. 1 recovery boiler should the subject demonstration not be successful. It is also necessary that the State of Alabama approves the project and grants the necessary permits.

General Project Approach
The work under Phase 1 will entail detailed engineering, cost estimating, and process analysis of the demonstration plant integrated into the existing Courtland Kraft mill. The project cost estimating will be in sufficient detail to provide a ±10% estimate of the full demonstration. Champion will focus on the process integration with its existing facility. Air Products will engineer the demonstration plant in cooperation with Kvaerner Chemrec and suppliers for the various plant components. Kvaerner Chemrec will focus on the design of the gasifier and integration of the facility's sulfur management system with the Kraft pulp system. It is expected that, due to internal manpower availability, subcontract support will be engaged for some elements of the detailed design. At the end Phase 1, there should be sufficient detailed information for all parties to determine their interest in proceeding with the latter phases.

The latter phases of the project include procurement of the equipment, construction of the demonstration plant, commissioning, and operation. Since the existing No. 1 recovery boiler has about twice the capacity of the proposed gasification plant, it would remain in operation, but at a reduced rate when the demonstration plant is operating. Initially, it is planned to burn the product gases in an existing fluidized bubbling bed boiler to which a scrubber is being retrofitted. When it has been demonstrated that the product gases are consistently of the quality required for gas turbines, it is planned to fire the product gases in the existing Frame 6 gas turbine, replacing up to fifty percent of the natural gas fuel on a Btu basis. This demonstration should provide all of the information necessary to make a decision on the commercial viability of the process and all of the data necessary to substantiate the benefits expected from the technology.

Benefits to the Industry
The benefits to the industry of the successful demonstration of this technology are many and include:
• Higher overall energy efficiency—up to 10% higher—resulting in less demand for fossil fuels
• Higher green liquor reduction efficiency—5% improvement expected as typical
• Higher electrical power generation—up to twice the kWh/ton as conventional cycle
• Lower environmental emissions—including nox and CO₂ emissions
Improved safety—eliminates the potential for a smelt-water explosion present with a Tomlinson boiler

Higher kraft pulp yields from polysulfide-containing white liquor usage

Once the technology is demonstrated, the industry can apply it at any Kraft facility as a way to get incremental capacity and/or as a replacement for recovery boilers when they reach the end of their useful life.

The U. S. pulp and paper industry is facing ever increasing international competitive pressures. High tariffs and government subsidies in Europe, South America and Asia threaten its future competitiveness. Successful demonstration of this technology would be a major contributor to helping keep the U. S. Kraft industry viable and competitive in addition to all of the other benefits of the technology.

Schedule

<table>
<thead>
<tr>
<th>Phase 1 - Engineering</th>
<th>Start</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engineering</td>
<td>4Q98</td>
<td>1Q00</td>
</tr>
<tr>
<td>permitting</td>
<td>4Q98</td>
<td>4Q99</td>
</tr>
<tr>
<td>process optimization</td>
<td>4Q98</td>
<td>1Q99</td>
</tr>
<tr>
<td>definitive estimate</td>
<td>2Q99</td>
<td>1Q00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 2 - Construction</th>
<th>Start</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>2Q00</td>
<td>4Q01</td>
</tr>
<tr>
<td>bid package awards</td>
<td>2Q00</td>
<td>2Q00</td>
</tr>
<tr>
<td>gasifier package</td>
<td>2Q00</td>
<td>4Q01</td>
</tr>
<tr>
<td>O2 supply</td>
<td>2Q00</td>
<td>4Q01</td>
</tr>
<tr>
<td>sulfur management</td>
<td>4Q00</td>
<td>4Q01</td>
</tr>
<tr>
<td>mill interfaces</td>
<td>1Q01</td>
<td>4Q01</td>
</tr>
<tr>
<td>pulping line modifications</td>
<td>3Q01</td>
<td>4Q01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 3 - Demonstration</th>
<th>Start</th>
<th>Completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demonstration</td>
<td>1Q02</td>
<td>2Q03</td>
</tr>
<tr>
<td>start up</td>
<td>1Q02</td>
<td>2Q02</td>
</tr>
<tr>
<td>baseline operation</td>
<td>2Q02</td>
<td>1Q03</td>
</tr>
<tr>
<td>gas turbine integration</td>
<td>1Q03</td>
<td>2Q03</td>
</tr>
<tr>
<td>commercial operation</td>
<td>2Q03</td>
<td></td>
</tr>
</tbody>
</table>

Budget and Funding

All spending is in millions ($1,000,000) of dollars.

<table>
<thead>
<tr>
<th>Phase 1 - Engineering</th>
<th>Proposers</th>
<th>DOE</th>
<th>Project Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>fiscal 99</td>
<td>1.00</td>
<td>1.00</td>
<td>2.00</td>
</tr>
<tr>
<td>fiscal 00</td>
<td>0.25</td>
<td>0.25</td>
<td>2.50</td>
</tr>
<tr>
<td>Phase 2 - Construction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>fiscal 00</td>
<td>10.00</td>
<td>10.00</td>
<td>22.50</td>
</tr>
<tr>
<td>fiscal 01</td>
<td>10.00</td>
<td>10.00</td>
<td>42.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 3 - Demonstration</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>fiscal 02</td>
<td>11.75</td>
<td>11.75</td>
<td>66.00</td>
</tr>
<tr>
<td>fiscal 03</td>
<td>0.75</td>
<td>0.75</td>
<td>67.50</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Phase 1</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Products and Chemicals labor</td>
<td>1.145</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kvaerner Chemrec labor</td>
<td>0.430</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Champion International labor</td>
<td>0.550</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel</td>
<td>0.075</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outside contracts</td>
<td>0.300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.500</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Key Personnel

**Champion**

Edward G. Kelleher, Director, Energy Management; Eng.Sc.D. in chemical engineering; 18 years pulp and paper experience including powerhouse simulation, energy optimization and power generation. Principal Investigator on DOE project DOE/CS/40341-T4-6, Feasibility of Black Liquor Gasification in Combined Cycle Co-generation

Ronald McCarty, Director, Utilities; BS in electrical engineering; 38 years pulp and paper experience including project design, power systems operations, plant engineering, maintenance.

Lars Danielsson, Director, Pulping; BS in chemical engineering; 33 years pulp and paper experience including pulping research, mill operations, process design, advanced pulping technologies.

Fred Magee, Mill Engineer (Courtland); BS in civil engineering; 22 years pulp and paper experience in project engineering.

David Myers, Manager, Chemical Recovery and Utilities (Courtland); BS in chemical engineering; 22 years pulp and paper experience in process engineering, power and recovery operations, power and steam distribution.

Gary Martin, Fiber Supply Manager (Courtland); BS in pulp and paper technology; 19 years pulp and paper experience including pulping, bleaching, and lime kiln/causticizing operations, process engineering.

**Air Products**

David R. Ruprecht, Sr. Development Manager; degrees in metallurgical engineering and business; 27 years experience in the development and commercialization of industrial gas and power applications.

John J. Lewnard, Engineering Associate; Ph.D. in chemical engineering; 12 years experience in development of advanced energy systems including fluidized bed boilers, gas turbines and gasification technologies.

July 11, 1998
Robert N. Miller, Sr. Contract Development Manager; Ph.D. in geochemistry; 20 years experience in research and managing government contracts.

Kvaerner Chemrec

Lars L. Stigsson, Vice President, Studies and Configurations; BS degree in chemical engineering; 20 years experience pulp and paper research and the development of technologies related to black liquor gasification.

Niklas Berglin, Lead Process Engineer; Licentiate - Heat and Power Technology; several years experience in pulp mill energy analysis and black liquor gasification integration.

Proposers' Contract Specialist

Robert N. Miller
Air Products and Chemicals, Inc.
7201 Hamilton Blvd.
Allentown, PA 18195

Bibliography


Industra Inc., Engineers and Consultants, Black Liquor Recovery Alternate Study DE-FC02-93CH-10563, Golden, 1996.

Attachment II

MTCI/StoneChem Technology Demonstration

Steam Reforming Black Liquor Gasification at Georgia-Pacific’s Mill in Big Island, Virginia

Abstract

Georgia-Pacific Corporation, together with StoneChem, Inc., proposes to demonstrate PulseEnhanced\textsuperscript{TM} Steam Reforming black liquor chemical recovery at Georgia-Pacific’s mill in Big Island, Virginia. The technology was developed and patented by Manufacturing and Technology Conversion, International (MTCI) and is currently licensed to StoneChem, Inc. for use in North America. Pilot studies of steam reforming have been carried out on a 25 ton per day reformer at Inland Container’s Ontario, California mill and on a 50 ton per day unit at Weyerhaeuser’s New Bern, North Carolina mill.

This full-scale demonstration project will include engineering, construction, startup, and operation of a 400,000 pounds per day black liquor solids steam reformer plant including reformer reactor, gas cleanup system, heat recovery, and chemical recovery. The project will replace existing smelters and provide the entire chemical recovery capacity for the Big Island mill. Excess product gas will be burned in a heat recovery unit to produce 600 psig process steam to replace a portion of the steam currently generated by higher cost natural gas. This represents an energy recovery opportunity currently not available to Big Island or other non-sulfur semi-chemical mills.

The Big Island Mill converted to non-sulfur caustic-carbonate pulping in 1972, and has extensive experience in processing the high viscosity and difficult burning sodium based black liquor. Pilot tests on Big Island black liquor at MTCI’s facility in Baltimore, Maryland have shown the capability of the steam reforming process and confirmed the potential energy and environmental benefits. The Big Island mill represents a unique opportunity to demonstrate the capabilities and applicability of the Steam Reformer Gasification Technology for chemical recovery in the Pulp and Paper Industry. The extremely low sulfur chemistry of this facility provides a lower risk opportunity for demonstration of the technology, while the size of the mill provides the opportunity for this process to provide complete chemical recovery.

The demonstration program, which includes design, construction, and operation, will cover a four-year period. This proposal describes the project approach, schedule, benefits, and objectives.

Proposed by: Sub-proposer:

Georgia-Pacific StoneChem, Inc.
PO Box 105605 6001 Chemical Rd.
Atlanta, Georgia 30348-5605 Baltimore, Maryland 21226
Attention: Benjamin A. Thorp Attention: Lee Rockvam

July 11, 1998
Background

The recovery process is an essential component of a pulp and paper mill operation from both an economic and an environmental aspect. Chemicals used in the pulping process are recovered and spent liquor organic solids are converted to energy (typically process steam). The Tomlinson recovery boiler has been the predominant technology; however, fluidized bed combustors have also been used successfully in some segments of the industry. Both technologies have inherent deficiencies including low thermal efficiencies, high capital and maintenance costs, and various operational problems. The Tomlinson unit has the additional potential for smelt-water explosions.

Gasification of black liquor represents a new and better approach for the chemical recovery process and eliminates many of the deficiencies of the Tomlinson and fluid bed combustion technologies. Gasification benefits include increased efficiency in energy conversion and chemical recovery, elimination of the smelt-water explosion hazard, reduced maintenance costs, and significantly lower environmental emissions including particulate, TRS, NOx, VOC, and greenhouse gases. The benefits are particularly attractive to semi-chemical non-sulfur processes that require higher cost auxiliary fuel to sustain combustion of the black liquor.

The steam reforming technology is ideally suited to the conversion of a variety of variable moisture content organic feedstocks, such as black liquor. Carbon conversion efficiency to gas can be high, typically 95%. The MTCI Steam Reformer technology is unlike the other gasification processes currently available. The process employs indirect PulseEnhanced™ heating of a steam fluidized bed of sodium carbonate solids. This process produces an endothermic reaction converting black liquor organics to a gas in the absence of air or oxygen at temperatures below those required for smelt formation. This approach avoids the shortcomings of exothermic reactions found in other gasification processes that utilize higher temperatures and produce smelt. MTCI has carried out studies of spent liquor reforming in a 0.5 ton per day black liquor solids pilot unit since 1990. Successful pilot trials have been conducted steam reforming Big Island black liquor for 108 continuous hours at this facility. Tests on the product gas from the pilot trials have confirmed the potential energy and environmental benefits. A 25 ton per day black liquor solids reformer was operated on mill sludge and imported black liquor at Inland Container Corporation’s Ontario, California, mill in March 1992. A nominal 50 ton per day black liquor solids pilot demonstration plant began operation at Weyerhaeuser’s New Bern, North Carolina, Kraft mill in the spring of 1994. A 500 hour continuous test was successfully completed at New Bern in August 1995. Although neither is in current operation, the results from both units identified improvements that will be incorporated into the design of the proposed demonstration unit.

A project team was formed to analyze the alternatives for the Georgia-Pacific mill in Big Island to meet the requirements of the EPA Cluster Rule MACT I regulations and MACT II proposed regulations. After analyzing various options, two project alternatives were determined to be economically viable and capable of meeting the requirements of the project. A conventional (Tomlinson) recovery boiler option could meet the project objectives with proven technology and demonstrated safety, environmental and energy performance. A steam reformer, while not a proven technology for this application, offers to meet the project requirements with better safety, environmental and energy performance than a conventional recovery boiler.
Objectives

The project will install a steam reformer and associated equipment to process all of the black liquor (400,000 pounds of black liquor solids per day) from the pulping process at the Georgia-Pacific mill in Big Island, Virginia. The steam reformer and associated equipment will operate with environmental emissions at or below the limits set by the environmental permit. The equipment installed will maximize the recovery of energy and chemicals while producing a sodium carbonate solution suitable for use in the pulping process.

Pre-Project Requirements

In order to proceed with the project, the EPA must include an ‘innovative technology’ provision in the MACT II regulations. An alternative would be for EPA to provide Georgia-Pacific official documentation that if the steam reformer technology fails to meet the project requirements, additional time will be allowed to implement a conventional recovery boiler option.

The Virginia Department of Environmental Quality must grant a revised air permit for Big Island prior to beginning any construction. The steam reformer supplier must guarantee that the permit requirements can be met under all conditions and at all times. The preliminary engineering and detailed cost estimate must confirm the economics obtained from the budget estimates. The project must also obtain the necessary funding and corporate approvals for this technology.

General Project Approach

The work will consist of preliminary engineering required to completely define the scope of the project and secure the necessary funding. Preliminary engineering will be followed by detailed engineering to specify and procure all of the equipment required, finalize the process design, design all foundations, steel, piping, electrical, instrumentation and process controls and finalize the construction sequence and schedule. Prior to the completion of the detailed engineering, a firm will be contracted to provide the construction services for any equipment not purchased on a ‘turn-key’ basis. The construction contractor will provide the supervision, labor and construction equipment to install the equipment, piping, electrical, instrumentation and controls required by the project. As the construction activities are completed, commissioning teams comprised of personnel from Georgia-Pacific, the equipment manufacturers, the engineering company and the construction contractor will commission and start up the equipment. Training for Big Island mill supervision, operations and maintenance will be conducted by Georgia-Pacific staff personnel and representatives from the equipment manufacturers.

The project will be started up and placed in service with the existing Smelter equipment kept on standby. The existing equipment will be utilized during periods when the steam reformer or associated equipment must be modified or adjusted. After the steam reformer is operating reliably, it will be tested to demonstrate environmental compliance as well as contractual compliance. The existing Smelter equipment will be removed from service after successful steam reformer testing.

Benefits to Industry

Successful completion of this project will demonstrate this technology to be capable of providing the full chemical recovery capacity for a mill. The project will demonstrate the reliability and operational flexibility of the technology and all of the associated equipment. Once the
technology is demonstrated, the industry can apply this at other facilities to obtain better energy conversion, improved safety and environmental performance.

The predicted total thermal efficiency of the steam reformer technology is over 70% compared to approximately 65% for conventional recovery boilers. The improvement in thermal efficiency will provide over 120 MBtu per day of additional process steam. This is equivalent to 4,600 pounds of high-pressure steam per hour at Big Island. The predicted environmental benefits to the industry of the steam reformer technology compared to conventional recovery boiler technology are listed below:

<table>
<thead>
<tr>
<th>Emissions</th>
<th>Reformer</th>
<th>Recovery Boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRS (ppmv)</td>
<td>1</td>
<td>1-2</td>
</tr>
<tr>
<td>NOx (ppmv)</td>
<td>25</td>
<td>150</td>
</tr>
<tr>
<td>CO (ppmv)</td>
<td>25</td>
<td>250</td>
</tr>
<tr>
<td>HCl (ppmv)</td>
<td>ND</td>
<td>5</td>
</tr>
<tr>
<td>Particulate (gr/dscf)</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>VOC's (ppmv)</td>
<td>5</td>
<td>80</td>
</tr>
</tbody>
</table>

Preliminary Schedule

Activity                                                                 | Start | Complete |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MACT II regulations published</td>
<td>1998.3</td>
<td>1999.2</td>
</tr>
<tr>
<td>Environmental modeling</td>
<td>1999.2</td>
<td>1999.4</td>
</tr>
<tr>
<td>Environmental permit</td>
<td>1999.1</td>
<td>1999.2</td>
</tr>
<tr>
<td>Preliminary engineering</td>
<td>1999.3</td>
<td>2000.1</td>
</tr>
<tr>
<td>Final engineering</td>
<td>1999.4</td>
<td>2000.1</td>
</tr>
<tr>
<td>Purchase major equipment</td>
<td>2000.2</td>
<td>2001.2</td>
</tr>
<tr>
<td>Construction</td>
<td>2001.3</td>
<td>2002.1</td>
</tr>
<tr>
<td>Start up and modifications</td>
<td>2002.1</td>
<td>2002.3</td>
</tr>
<tr>
<td>Performance &amp; compliance tests</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry Demonstration</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Preliminary Spending Schedule

All spending in $ x 1,000,000

<table>
<thead>
<tr>
<th>Year</th>
<th>G-P</th>
<th>DOE</th>
<th>Project Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999.1</td>
<td>0.20</td>
<td>0.20</td>
<td>0.40</td>
</tr>
<tr>
<td>1999.2</td>
<td>0.20</td>
<td>0.20</td>
<td>0.80</td>
</tr>
<tr>
<td>1999.3</td>
<td>0.30</td>
<td>0.30</td>
<td>1.40</td>
</tr>
<tr>
<td>1999.4</td>
<td>0.40</td>
<td>0.40</td>
<td>2.20</td>
</tr>
<tr>
<td>2000.1</td>
<td>1.50</td>
<td>1.50</td>
<td>5.20</td>
</tr>
<tr>
<td>2000.2</td>
<td>1.75</td>
<td>1.75</td>
<td>8.70</td>
</tr>
<tr>
<td>2000.3</td>
<td>1.75</td>
<td>1.75</td>
<td>12.20</td>
</tr>
<tr>
<td>2000.4</td>
<td>3.00</td>
<td>3.00</td>
<td>18.20</td>
</tr>
<tr>
<td>2001.1</td>
<td>2.15</td>
<td>2.15</td>
<td>22.50</td>
</tr>
<tr>
<td>2001.2</td>
<td>1.50</td>
<td>1.50</td>
<td>25.50</td>
</tr>
<tr>
<td>2001.3</td>
<td>0.65</td>
<td>0.65</td>
<td>26.80</td>
</tr>
<tr>
<td>2001.4</td>
<td>1.05</td>
<td>1.05</td>
<td>28.90</td>
</tr>
<tr>
<td>2002.1</td>
<td>1.00</td>
<td>1.00</td>
<td>30.90</td>
</tr>
<tr>
<td>2002.2</td>
<td>0.40</td>
<td>0.40</td>
<td>31.70</td>
</tr>
<tr>
<td>2002.3</td>
<td>0.40</td>
<td>0.40</td>
<td>32.50</td>
</tr>
<tr>
<td>2002.4</td>
<td>0.25</td>
<td>0.25</td>
<td>33.00</td>
</tr>
</tbody>
</table>

Gasifier Option - Projected Spending

Does not include contingency

Total Project Cost: $33,000,000

July 11, 1998
Qualifications Of Key Personnel

Georgia-Pacific Corporation

Gerald Laughlin - Project Manager: Over 30 years pulp & paper project management experience, 20 years with Georgia-Pacific on projects ranging in size from $10 million to over $150 million.

J. Pat Moore - Environmental Responsibility: B. S., M.S. Environmental Science; 13 years experience in environmental engineering and compliance in the forest products industry.

Mike Ohl - Process Responsibility: B.S. Applied Science Paper Technology; 27 years pulp & paper experience. Experience includes research & development, process engineering and process control engineering.

Keith Flynt - Operations Responsibility: BSME; 13 years experience in power and recovery operations at the Big Island mill.

Ralph Sisk - Project Engineering Responsibility: BSCET; 19 years experience. 7 years at the Big Island Mill in engineering and operations.

Philip Campbell - Staff Consulting Engineer – Pulp: B.S. Math; 31 years pulp & paper experience. Experience includes operations, mill engineering, environmental engineering, project engineering, and mill management.

Robert DeCarrera - Staff Consulting Engineer – Power & Recovery: BSCE; 23 years pulp & paper experience. Experience includes operations, construction, project management and design and staff engineering.

StoneChem, Inc.

Momtaz N. Monsour - President StoneChem Inc.: PhD. Engineering Sciences; M.S. Aeronautics; B.Ae.E. Aeronautics; Director and Co-Founder of MTCI, Inventor of steam-reforming and pulsed combustion technology, Previous leadership responsibilities include Director Fuel Cell Div. of Department of Energy.

Lee Rockvam - Vice President- Pulp & Paper Applications StoneChem Inc.: B.S. Chemical Engineering; Master Studies Industrial Management; 19 years Paper Industry experience including positions as Technical Director, Pulp Mill Manager, Paper Mill Manager, and Manager of Business Planning.

William Steedman - Principal Engineer- ThermoChem Inc.: B.S. Chemical Engineering. Currently responsible for design of steam reforming technology. Experience includes Group Leader for development of fluidized bed boilers; Process design engineering at Battelle Laboratories.
Proposer's Contracting Specialist

Benjamin A. Thorp
Director, Pulp & Paper Engineering

Mailing Address:
Georgia-Pacific Corporation
PO Box 105605
Atlanta, Georgia 30348-5605
GA030-18

Shipping Address:
Georgia-Pacific Corporation
133 Peachtree Street, N.E.
Atlanta, Georgia 30303
GA030-18

Phone: 404-652-4618
FAX: 404-584-1466
E-mail: bathorp@gapac.com

Bibliography

MTCI, "Pulse Enhanced\textsuperscript{TM} Steam Reforming and Recovery of Kraft Spent Liquor", Report to Department of Energy of Results of the Weyerhaeuser, New Bern Demonstration, Revised September 1997


Stigsson, L., "Chemrec\textsuperscript{TM} Black Liquor Gasification", TAPPI International Recovery Conference, Tampa, FL, June 1998

July 11, 1998
Attachment III

Battelle/FERCO Technology Demonstration
Low Inlet Velocity Gasification of Biomass, Weyerhaeuser New Bern Mill, North Carolina

For many years, Weyerhaeuser has evaluated and encouraged the development of biomass gasification combined cycle technology in general and, in particular, the technology developed by Battelle Memorial Institute and currently licensed to Future Energy Resources Company (FERCO). This technology is being piloted at the 200 BDT/day size at the McNeil Power Station in Burlington, Vermont. As part of a DOE feasibility study, Weyerhaeuser is participating on the Burlington Project Team with the objective of helping that demonstration to be successful as well as providing efficient technology transfer for the first large-scale demonstration facility being evaluated for construction at Weyerhaeuser’s mill in New Bern, North Carolina.

The New Bern market pulp mill represents a unique opportunity for this demonstration in that its incremental thermal energy is supplied by #6 and #2 oil. The mill has had a long history of interest and activity in the gasification area, and currently operates the world’s largest atmospheric black liquor gasification system, designed to process 0.73 M lb/d BLS. The knowledge and experience that has been achieved from the mill’s activities with gasification—coupled with its dependence on oil as an incremental fuel and its high power costs—provides a unique opportunity for the effective demonstration of the Battelle/FERCO technology.

Proposed by: Weyerhaeuser Company
CC II-103
PO Box 2999
Tacoma WA 98477-2999
Attention: Delmar R. Raymond

July 11, 1998
Background

Biomass gasification combined cycle technology has continued to be a high industry energy priority for several years. Sharing the industry’s interest in this technology, Weyerhaeuser has been actively following and encouraging its development. The Company believes that this technology is ready for a first large-scale demonstration and has offered to provide a host site. Following the completion of a feasibility study, partially funded by the DOE through the National Renewable Energy Laboratory, a proposal for the initial steps toward engineering and construction of the first large-scale demonstration plant based on the FERCO/Battelle technology was submitted through the Agenda 2020 Energy Task Group and was subsequently funded. Weyerhaeuser believes that the New Bern mill is a unique location for the demonstration project and has researched this possibility in detail. The project there is anticipated to cost ~$60,000,000 with the funds being committed in the 2000-2003 time frame. Approximately $30,000,000 will be required from the federal government or other sources to make this project viable and successful.

Objectives

The project will install a FERCO/BCL Low Inlet Velocity Gasification system and associated equipment to process ~700 BDT/day of wood residuals and pulp mill sludges. The medium Btu syngas from the system will replace oil currently being burned in the mill’s lime kiln and power boilers. The specific objectives achieved for the industry will include a thorough understanding of:

- capital and operating costs and opportunities for capital cost reductions in future units;
- the impact of utilizing medium Btu gas in lime kilns and power boilers previously fired with oil; and
- operating and control strategies to optimize the capital effectiveness of the equipment.

All of the learnings surrounding the above objectives will be reported to industry participants through the Agenda 2020 mechanism in a timely fashion.

General Project Approach

Preliminary engineering for the New Bern installation is being done under Weyerhaeuser’s current project with the Department of Energy. The additional engineering required to secure the necessary funding will be done as part of this project. This will be followed by detailed engineering to specify and procure all of the required equipment; finalize the process design; design all foundations, steel, piping, electrical, instrumentation and process controls; and finalize the construction sequence and schedule. Prior to the completion of the detailed engineering, a firm will be contracted to provide the construction services for any equipment not purchased on a “turn-key” basis. The construction contractor will provide the supervision, labor and construction equipment to install the equipment, piping, electrical, instrumentation and controls required by the project. As the construction activities are completed, commissioning teams comprised of personnel from Weyerhaeuser, the equipment manufacturers, the engineering company and the construction contractor will commission and start up the equipment. Training for New Bern mill supervision, operations and maintenance will be conducted by Weyerhaeuser staff personnel and representatives from the equipment manufacturers.
Once the system is operating satisfactorily, a minimum demonstration period of one year will be undertaken. During this time, interested industry representatives will be invited to observe the plant’s operation at times acceptable to local operating management.

Benefits to the Industry

Although the pulp and paper industry is currently No. 1 in the industrial generation of electricity, there is a clear movement toward more and more dependence on purchased electrical power. This undeniable trend is the result of a combination of changes in the industry’s manufacturing processes. To remain competitive and satisfy stricter environmental requirements, mills are undergoing modernization and process optimization with a resulting decrease in built-in capacity for cogeneration of electricity. Added environmental control equipment, primarily scrubbers and precipitators, create greater electrical demand. Alternatives to chlorine bleaching sequences, involving on-site oxygen/ozone generation, and an industry trend towards more thermo mechanical pulp also contribute to increased demand. Recycling is having electric power consequences, since using recycled fiber adds to electrical demand (except in TMP fiber replacement). Another consequence of recycling is that it leaves no appreciable amount of residue, as wood does, that can be used as fuel.

Conversion efficiency can be increased through innovations in drying biomass before conversion to useful energy, but will be attained primarily through advances in conversion technology. The Dutch-oven boiler of the 1950’s operated at less than 15% overall thermal conversion efficiency to electricity with a condensing turbine. It is expected that the advanced biomass gasification combined cycle (BGCC) technologies now emerging will produce three times as much electrical energy from the same amount of biomass, operating at close to 45% efficiency. If these technologies can be shown to be cost competitive, they will become the technologies of choice over the next 10–15 years. Biomass and black liquor will not be delivered to furnace cavities, but rather to gasifiers. The gases exiting the gasifier will be cleaned and used to fuel gas turbine combustors and lime kilns. Steam will be produced in heat recovery steam generators downstream of the gas turbines. This steam will be used for further power generation and for process steam. The result will be a significant technology shift for many of the industry’s manufacturing facilities, from high-steam/moderate-electricity operation to lower-steam/higher-electricity operating designs. BGCC systems will be an important part of that technology shift.

In order to achieve this technology shift, three things must happen. The new technology must be shown to be available for less capital than current technology. The new technology must be shown to be more environmentally compatible and to be able to produce significantly more electricity for the same thermal load. This project will demonstrate the validity and magnitude of these attributes.

Preliminary Schedule

Complete an engineering estimate suitable for capital allocation* ........................................ June, 1999
Develop the business case that justifies the economic sustainability of the demonstration project* ........................................ June, 1999
Quantify federal funding possibilities .................................................................................. October, 1999
Secure the necessary funding and contractual obligations ..................................................... January, 2000
Complete engineering for construction .............................................................................. May, 2000

July 11, 1998
Preliminary Schedule (continued)

Complete construction ................................................................. November, 2001
Complete shakedown and testing .................................................... November, 2002
Carry out industry demonstration .................................................... November, 2003

*funded under current DOE project

Preliminary Spending Schedule

<table>
<thead>
<tr>
<th>Year</th>
<th>Weyerhaeuser</th>
<th>DOE</th>
<th>Project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$ x 1,000,000</td>
<td>$ x 1,000,000</td>
<td>$ x 1,000,000</td>
</tr>
<tr>
<td>2000</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>2001</td>
<td>10</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>2002</td>
<td>10</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>2003</td>
<td>5</td>
<td>5</td>
<td>60</td>
</tr>
</tbody>
</table>

Total Project Cost: $60,000,000

Qualifications of Key Personnel

Delmar R. Raymond – Program Director
  PhD ChE; over 25 years management experience in the pulp & paper industry

James F. Lincoln – Project Manager
  BSME and MBA; over 20 years pulp & paper experience, including process engineering and project management

Craig A. Brown – Process responsibility
  MSME; over 17 years experience in the pulp & paper industry, including managing gasification demonstration project

William Koos – Project engineering responsibility
  BSME; 11 years experience at Weyerhaeuser’s New Bern mill with responsibility for all major maintenance and capital projects; 13 years prior engineering experience

Others to be determined.

Proposer’s Contracting Specialist

Judith A. Kieffer

Mailing Address:
  Weyerhaeuser Company
  CC II 103
  PO Box 2999
  Tacoma WA 98477-2999

Phone: 253-924-6200
Fax: 253-924-6812
E-mail: kieffej@wdni.com

Shipping Address:
  Weyerhaeuser Company
  Campus Center II
  501 South 336th
  Federal Way WA 98003

July 11, 1998
Relevant Publications

Report on New Bern Biomass to Energy Project, Phase 1 Feasibility Study
  Weyerhaeuser Company, Stone & Webster Engineering, Amoco, and CP&L
  June, 1995

Advanced Biomass to Energy Conversion Technologies for the Pulp & Paper Industry
  D. R. Raymond and J. A. Kieffer
  2nd Biomass Conference of the Americas; Portland, Oregon; August, 1995

Alternative Energy Sources and Technologies for the Pulp & Paper Industry
  D. R. Raymond; Applied Biochemistry and Biotechnology; Vol. 57/58, 1996

Report on the Workshop on Commercializing Black Liquor & Biomass Gasification for Gas
  Turbine Applications in the Pulp & Paper Industry
  D. R. Raymond and E. D. Larson; Princeton, New Jersey; January, 1997

Commercializing Black Liquor and Biomass Gasifier/Gas Turbine Technology
  E. D. Larson and D. R. Raymond; TAPPI Journal; December, 1997
PULP AND PAPER

Contribution to U.S. Greenhouse Gas Emissions

Carbon emissions from combustion of fuels in the forest products industry has been calculated based on energy consumption data collected for the Manufacturing Energy Consumption Survey (MECS). These are shown in the table below. Direct emissions are based on end-use only. Primary emissions include energy losses from the generation and transmission of electricity, based on the fuel mix for the national grid. Forest products includes pulp and paper mills, as well as the manufacture of lumber products.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Carbon Emissions</td>
<td>55.57</td>
<td>60.76</td>
<td>64.79</td>
<td>69.15</td>
</tr>
<tr>
<td>Primary Carbon Emissions</td>
<td>65.77</td>
<td>71.91</td>
<td>76.72</td>
<td>82.40</td>
</tr>
</tbody>
</table>

Background on the Pulp and Paper Industry

The U.S. has the world’s largest installed pulp, paper, and paperboard production capacity, some 86 million air-dry metric tons (ADMT) per year in 1993, or about 30 percent of global capacity. Manufactured products from the paper and allied products industry (SIC 26) include newsprint, printing and writing paper, tissue, paper plates, card stock, corrugated cardboard, cartons, and construction-grade paperboard. The industry can be divided into two principal sectors. The energy-intensive mill sector processes raw materials into paper and paperboard, and includes the SIC codes 261 (Pulp Mills), 262 (Paper Mills), and 263 (Paperboard Mills). The converting sector further processes the sheets of paper and paperboard into other finished products, and includes SIC codes 264 (Coating and Glazing), 265 (Paperboard Boxes and Containers), 266 (Building Paper and Paperboard), and 267 (Miscellaneous Converted Paper Products, e.g., bags, envelopes, sanitary products, etc.).

In 1994, the industry as a whole employed 621,400 workers and shipped products valued at almost $144 billion (about 4% of all U.S. manufacturing shipments in 1994). Total value added by manufacture was estimated to be over $63 billion. The value of shipments from the mill sector alone was $58 billion and the value added was $26 billion. Average hourly earnings for the industry’s 479,000 production workers was $14.33, about 15% above the 1994 national industry average. The value of exports and imports in 1993 was
$9.6 billion and $10.6 billion, respectively. Major imports were newsprint, printing and writing paper, and bleached kraft pulp. Major exports included paperboard, waste paper, and bleached kraft pulp. In addition to traditional competitors in the world such as Canada and Scandinavian countries, the U.S. industry is facing increasing competition from low cost producers such as Chile, Indonesia, Brazil and South Africa.

The U.S. is home to close to 550 pulp and paper mills located in 42 states. The majority of this capacity is in the South (54%), with the other forested U.S. census regions about evenly dividing the remaining capacity (Northeast 13.5%; North Central 18.4%; Mountain and Pacific 14%). Over the last twenty years or so, many of the smaller, older mills have been closed down and replaced with larger integrated mills. The integrated mills produce both pulp and paper and/or paperboard. The trend is toward larger size (over 2000 tons/day) plants with the capability to consistently process high-quality products at higher speeds.

Energy and Materials Consumption

The paper and allied products industry is the third-largest industrial energy consumer in the U.S., behind only petroleum refining and chemicals. It accounts for 12.4 percent of total manufacturing energy use, or about 3 percent of national energy use. The mill sector of the industry accounts for the majority of energy use -- about 95% of all energy used in the paper and allied products industry (and thus is the focus of most energy-related data collection efforts for the industry). In 1995, the industry consumed over 2.5 quads of energy. A large portion of this energy demand (about 57%) was self-generated from residue fuels such as spent pulping liquor solids, hogged fuel, and bark, as well as a small amount of hydroelectric power. Since the early 1970s, the industry has increased its use of self-generated and residue fuels by over 70%. The industry has also significantly increased its cogeneration capacity and generates more than 40% of the total on-site electricity produced by the manufacturing sector. Energy-efficiency has also greatly improved: the total energy use per ton of product produced has dropped 22% since 1972 -- from 32 million Btu/ton in 1972 to 25.6 million Btu/ton in 1995. Fossil fuel and other purchased energy consumption per ton of product has decreased even more -- by over 40% since 1972.

Environmental Issues

Many environmental issues and concerns affect the industry. Sustainable forestry management is needed to provide an assured source of high-quality virgin fiber while meeting environmental objectives to protect soil, water and air quality, wildlife and fish habitat, and species biodiversity. The industry is also committed to aggressive paper recovery and recycle/reuse goals. In addition, the industry produces a variety of solid,
liquid and air emissions that are subject to federal and state regulatory control. According to recent reports, the industry generated about 220,000 tons of hazardous waste in 1989 and about 1.5 million tons of air pollutant emissions in 1991. The industry spends about $3 billion per year on pollution abatement and environmental improvements, representing over 20% of total capital expenditures.

Factors Shaping Industry Response

Competitive and Structural Factors

Capital intensive: New capital expenditures in the last decade have averaged 10.4 percent of revenues (AFPA, 1994), making paper and allied products the most capital intensive of the manufacturing industries. On average, the industry has invested over $120,000 of plant and equipment for every industry employee, more than twice the average of other manufacturing industries in the U.S. The high capital costs restrain the ability of the industry to install new technologies -- especially technologies that will not significantly contribute to lowering production costs.

Energy intensive: The energy intensity of the paper and allied products industry was 21 MJ (20,000 Btu) per dollar value of shipments in 1991, ranking it as the second most energy intensive industry group in the manufacturing sector. Despite the industry’s impressive record for cogeneration and utilizing waste materials for energy, the industry still ranks third in energy purchases and ranks first in fuel oil consumption. In 1994, the industry spent about $6.2 billion on purchased energy, or nearly 4.3% of the value of its shipments. Rising fossil fuel costs would create additional incentives to increase reliance on self-generated energy and further increase the energy efficiency of pulp and paper production processes.

Environmental concerns: Manifested in changing market demands and more stringent environmental regulations, environmental concerns are among the most important drivers of technological change in the pulp and paper industry.

Technology Options

There are major opportunities for improving the efficiency of process energy use in the pulp and paper industry. A number of new energy-saving process technologies such as digesters and paper or pulp dryers, are under development or recently commercialized, and process heat integration analysis has been applied in several mills. Most process-specific changes that bring energy efficiency improvements also bring productivity and other improvements. Reducing process energy needs per ton of product will lead directly
to reductions in CO₂ emissions. At the same time, it may also facilitate quantum improvements in cogeneration technologies for on-site heat and power generation. Advanced biomass-based cogeneration systems, which would provide major improvements in efficiency over existing systems, are currently undergoing rapid development. Black liquor/biomass gasification systems currently being studied are potentially 30% more efficient at producing electricity than existing recovery boilers. Such systems are likely to be commercially ready by around the turn of the century.
INDUSTRIAL COGENERATION AND DISTRIBUTED GENERATION PROGRAM FOR CARBON EMISSION REDUCTION
1.0 Background

The production of electricity is a major source of carbon emissions. Electricity generation currently accounts for 36 percent of total carbon emissions, according to EIA. Coal, which accounts for about one-half of electricity generation, produces 80 percent of the (electricity related) carbon emissions. Carbon emissions from power generation is very likely to increase as coal continues to account for about one-third of new capacity. EIA projects that close to 300 GW of new capacity will be required will be needed by 2015 to meet rising demand and compensate for the retirement of 38 GW of nuclear capacity. This added capacity, if met by the current mix of technologies, will result in a 34 percent increase in carbon emissions from 1995 levels.

The United States currently accounts for approximately 40 percent of the new capacity additions in the world and thus has a significant impact on global carbon emissions. While the U.S. share of new additions will decrease as other countries continue to electrify, U.S. manufacturers provide over 60 percent of the equipment worldwide and are play a leading role in the development of power generation technology.

Emissions will increase as demand increases unless cleaner technologies are brought to market.

<table>
<thead>
<tr>
<th>COAL</th>
<th>OIL</th>
<th>NATURAL GAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2193</td>
<td>1857</td>
<td>1261</td>
</tr>
</tbody>
</table>

CO₂ Emission Factors for Several Power Generation Technologies (lb/MW,hr)
readiness through U.S. manufacturers. Advanced cogeneration technologies can provide a near-term reduction in carbon emissions and nitrous oxides while renewable technologies become established in the market. For example, the natural gas-fired Advanced Turbine System (ATS) produces 60 percent less carbon emissions and 95 percent less NOx than coal-fired central power station technology on an output basis (lbs/MWh). Gas turbines are more efficient than steam boiler electricity generation, primarily found in the industrial and commercial sectors.

Industrial scale cogeneration, around 20 MW, is becoming increasingly important as the technology’s cost drops, the electric industry restructures and distributed generation increases.
The manufacturing sector will want to adopt these technologies to lower costs and provide flexibility in the power markets as well as lower their emission profile. Support for the advanced cogeneration program will encourage both the manufacturing and the power generation industry to implement these clean technologies while providing a bridge to the next generation of renewable energy options.

Cogeneration, which is the sequential production of electricity and heat from a single fuel source, is a extremely effective means of reducing carbon emissions. Efficiencies of close to 60 percent can be obtained in combined cycle systems, where electricity is generated both from the turbine and steam raised from the turbine exhaust heat. In combined heat and power cycles, where the exhaust heat is used in the manufacturing process or for space conditioning, thermal efficiencies can approach 85 percent. With cogeneration, lower carbon emissions are obtained through the replacement of coal-fired central power plant and the elimination of local boilers.

Cogeneration and industrial on-site power generation will be important elements in the restructuring of the electric utility industry. Industrial power plants (around 20 MW) are being installed to support local "load pockets," which would normally require expensive upgrades to the transmission systems. There is a movement away from centralized generation to "distributed" generation which is located closer to the load. Because of the uncertainty in the electricity market and the nation-wide overcapacity in generation, there is a reluctance to invest in large (1000 MW) plants. Industrial, commercial and institutional users will find utilities less willing or able to deter their investments in on-site generation.

In order to reduce carbon emissions in the generation of electricity while providing a bridge to renewable technologies as they continue their progress into the marketplace, five near-term technologies should be supported. These include:

- **Advanced Turbine Systems Program:** ATS is the highest efficiency distributed power system available in the 2000-2005 time frame. The program should be accelerated to meet market entry in 2000 to coincide with increasing distributed generation capacity. The program has projected 50 GW of ATS capacity by 2010, which would translate to a Carbon emissions reduction of 153 million tons annually, or 4 percent of total U.S. emissions.

- **Natural Gas Reciprocating Engine Development Program:** Reciprocating engines, also known as diesel engines, are widely used to provide on-site generation (typically between 100 and 3,000 kW) in baseload, peak shaving and emergency backup applications. The engines are also used in machine drive applications, to drive, for example, pumps and compressors. Some 3500 engines are sold annually. Natural gas engines are derived from diesel oil models. There is a significant amount of technology in the laboratory phase that needs to be developed and integrated into the natural gas engines to improve emission performance and efficiency. The successful adaptation of these technologies will increase the market share of natural gas engines in the reciprocating market to over 50 percent, thereby reducing CO\textsubscript{2} emissions by 4-million tons and NO\textsubscript{x} emissions by 6000 tons annually.
Black Liquor Gasification Combined Cycle: Black liquor contains the lignin (the carbohydrate “glue” holding wood fibers together) that is removed in the reduction of wood to fiber in the pulping process. It is currently burned in recovery boilers, which produce steam for process use and electricity generation along with CO₂, NOₓ and other air toxins. The gasification of the black liquor will increase the efficiency of its recovery and thereby lower emissions. Over the next 5 to 10 years, more than one-half the recovery boilers will be replaced. The next window of opportunity will occur in 40 years, at the start of the next life cycle of the boilers. The cogeneration potential in the forest products industry is estimated to be 8300 MW.

Fuel Cell-Gas Turbine Combined Cycle: The combination of the fuel cell with a gas turbine has the potential of achieving electric generation efficiencies approaching 75 percent. The fuel, either natural gas or a coal or biomass-derived gas, would first be fed to a fuel cell. The hot exhaust gas from the fuel cell would be combined with any reformed fuel and expanded in the gas turbine. Carbon emissions would be extremely low, and the system would displace electric generation plant with higher carbon emissions. This program incorporates the technologies of the Advanced Turbine Systems program and the Fuel Cell programs.

Micro turbines: Micro turbines can be simple, inexpensive to operate and maintain as well as they have the potential to run on multi-fuels such as diesel, natural gas, propane, landfill gas and biogas. Small generating equipment, in the 40 to 200 kW range, will play an important role in distributed generation. These “micro-generators” can be placed at the point of demand and avoid the need for substations, transformers and overhead wires. Micro turbines have low emissions with the use of a catalytic burner. NOx levels are below 3 ppm.
INDUSTRY STATISTICS
Table A1. Total Primary Consumption of Energy for All Purposes

<table>
<thead>
<tr>
<th>Industry/SIC Code</th>
<th>Total (trillion Btu)</th>
<th>Net Electricity* (million kWh)</th>
<th>Residual Fuel Oil (1000 bbls)</th>
<th>Distillate Fuel Oilb (1000 bbls)</th>
<th>Natural Gasc (billion cu. ft.)</th>
<th>LPG (1000 bbls)</th>
<th>Coal (1000 short tons)</th>
<th>Coke and Breeze (1000 short tons)</th>
<th>Otherd (trillion Btu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Kindred Products/20</td>
<td>956</td>
<td>49,536</td>
<td>4,317</td>
<td>2,968</td>
<td>NA</td>
<td>1,433</td>
<td>6,913</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Textile Mill Products/22</td>
<td>274</td>
<td>29,532</td>
<td>1,966</td>
<td>1,064</td>
<td>105</td>
<td>629</td>
<td>1,362</td>
<td>0</td>
<td>13</td>
</tr>
<tr>
<td>Paper and Allied Products/26</td>
<td>2,506</td>
<td>58,896</td>
<td>24,883</td>
<td>1,593</td>
<td>NA</td>
<td>1,379</td>
<td>13,252</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Chemicals and Allied Products/28</td>
<td>5,051</td>
<td>129,093</td>
<td>NA</td>
<td>2,410</td>
<td>2,162</td>
<td>NA</td>
<td>423</td>
<td>526</td>
<td>NA</td>
</tr>
<tr>
<td>Petroleum and Coal Products/29 (Petroleum Refining/2911)*</td>
<td>5,967</td>
<td>30,782</td>
<td>10,111</td>
<td>3,683</td>
<td>813</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>4,864</td>
</tr>
<tr>
<td>(Hydraulic Cement/3241)</td>
<td>(5,762)</td>
<td>(29,152)</td>
<td>(10,292)</td>
<td>(1,525)</td>
<td>(769)</td>
<td>(15,889)</td>
<td>(134)</td>
<td>(4,733)</td>
<td>NA</td>
</tr>
<tr>
<td>Stone, Clay, and Glass Products/32</td>
<td>880</td>
<td>30,814</td>
<td>1,377</td>
<td>3,431</td>
<td>370</td>
<td>NA</td>
<td>13,132</td>
<td>NA</td>
<td>(8,736)</td>
</tr>
<tr>
<td>(Blast Furnaces, Steel/3312)</td>
<td>(312)</td>
<td>(9,455)</td>
<td>(138)</td>
<td>(638)</td>
<td>(38)</td>
<td>(12)</td>
<td>(232)</td>
<td>(36)</td>
<td>NA</td>
</tr>
<tr>
<td>Primary Metals Industry/33</td>
<td>2,467</td>
<td>146,276</td>
<td>NA</td>
<td>1,868</td>
<td>688</td>
<td>NA</td>
<td>32,243</td>
<td>11,228</td>
<td>72</td>
</tr>
<tr>
<td>(Blast Furnaces, Steel/3312)</td>
<td>(1,673)</td>
<td>(38,183)</td>
<td>(NA)</td>
<td>(NA)</td>
<td>(408)</td>
<td>(74)</td>
<td>(30,904)</td>
<td>(9,802)</td>
<td>(16)</td>
</tr>
</tbody>
</table>

*Net Electricity* is obtained by summing purchases, transfers in, and generation from noncombustible renewable resources, minus quantities sold and transferred out. It does not include electricity inputs from onsite cogeneration or generation from combustible fuels because that energy has already been included as generating fuel (for example, coal).

b Distillate Fuel Oil* includes Nos. 1, 2, and 4 fuel oils and Nos. 1, 2, and 4 diesel fuels.

c Natural Gas includes natural gas obtained from utilities, transmission pipelines, and any other supplier(s) such as brokers and producers.

d Other* includes net steam (the sum of purchases, generation from renewables, and net transfers), and other energy that was used to produce heat and power or as feedstock/raw material inputs.

For the petroleum refining industry only, the feedstocks and raw material inputs for the production of nonenergy products (i.e., asphalt, waxes, lubricants, and solvents) and feedstock consumption at adjoining petrochemical plants are included in the *Other* column, regardless of type of energy. The remaining columns for the petroleum refining industry include only energy that was consumed for the production of heat and power. The *Other* column also includes net steam and other energy used in the production of heat and power. Those inputs and feedstocks that were converted to other energy products (e.g., crude oil converted to distillate and residual fuel oils) are excluded.

Source: MECS 1991
### Table A2. Components of Total Electricity Demand (Estimates in Million Kilowatthours)

<table>
<thead>
<tr>
<th>Industry/SIC Code</th>
<th>Purchases</th>
<th>Transfers In*</th>
<th>Total Onsite Generationb</th>
<th>Sales and/or Transfers Offsite</th>
<th>Net Demand for Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Kindred Products/20</td>
<td>NA</td>
<td>NA</td>
<td>5,743</td>
<td>988</td>
<td>55,273</td>
</tr>
<tr>
<td>Textile Mill Products/22</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>29,866</td>
</tr>
<tr>
<td>Paper and Allied Products/26</td>
<td>63,744</td>
<td>1,308</td>
<td>53,831</td>
<td>9,012</td>
<td>109,671</td>
</tr>
<tr>
<td>Chemicals and Allied Products/28</td>
<td>131,858</td>
<td>7,201</td>
<td>41,428</td>
<td>9,967</td>
<td>170,520</td>
</tr>
<tr>
<td>Petroleum Refining/2911</td>
<td>NA</td>
<td>NA</td>
<td>12,993</td>
<td>2,410</td>
<td>42,145</td>
</tr>
<tr>
<td>Hydraulic Cement/3241</td>
<td>9,490</td>
<td>0</td>
<td>NA</td>
<td>NA</td>
<td>9,888</td>
</tr>
<tr>
<td>Blast Furnaces, Steel/3312</td>
<td>NA</td>
<td>NA</td>
<td>6,235</td>
<td>1,297</td>
<td>44,417</td>
</tr>
</tbody>
</table>

* Transfers In* are the quantities purchased by a central purchasing agent or other establishment of the same company.

b "Onsite Generation" includes cogeneration, generation by renewable energy sources, and conventional generation by combustible fuels.

Source: MECS 1991

### Table A3. Total Consumption of Offsite-Produced Energy for Heat, Power, and Electricity Generation

<table>
<thead>
<tr>
<th>Industry/SIC Code</th>
<th>Total (trillion Btu)</th>
<th>Net Electricity* (million kWh)</th>
<th>Residual Fuel Oil (1000 bbls)</th>
<th>Distillate Fuel Oil (1000 bbls)</th>
<th>Natural Gas (billion cu. ft.)</th>
<th>LPG (1000 bbls)</th>
<th>Coal (1000 short tons)</th>
<th>Coke and Breeze (1000 short tons)</th>
<th>Other (trillion Btu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Kindred Products/20</td>
<td>922</td>
<td>50,518</td>
<td>4,317</td>
<td>2,966</td>
<td>497</td>
<td>1,429</td>
<td>6,913</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Textile Mill Products/22</td>
<td>272</td>
<td>29,522</td>
<td>1,866</td>
<td>1,064</td>
<td>105</td>
<td>629</td>
<td>1,362</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Paper and Allied Products/26</td>
<td>1,540</td>
<td>65,052</td>
<td>24,888</td>
<td>1,566</td>
<td>532</td>
<td>NA</td>
<td>13,063</td>
<td>NA</td>
<td>307</td>
</tr>
<tr>
<td>Chemicals and Allied Products/28</td>
<td>2,674</td>
<td>139,059</td>
<td>7,247</td>
<td>1,999</td>
<td>1,616</td>
<td>1,119</td>
<td>11,153</td>
<td>132</td>
<td>221</td>
</tr>
<tr>
<td>Petroleum Refining/2911</td>
<td>1,065</td>
<td>31,562</td>
<td>36,915</td>
<td>826</td>
<td>762</td>
<td>6,235</td>
<td>134</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Hydraulic Cement/3241</td>
<td>312</td>
<td>9,490</td>
<td>138</td>
<td>616</td>
<td>38</td>
<td>12</td>
<td>8,736</td>
<td>232</td>
<td>35</td>
</tr>
<tr>
<td>Blast Furnaces, Steel/3312</td>
<td>842</td>
<td>39,480</td>
<td>4,966</td>
<td>901</td>
<td>387</td>
<td>74</td>
<td>1,075</td>
<td>9,553</td>
<td>10</td>
</tr>
</tbody>
</table>

* "Electricity" consists of quantities of electricity that were purchased or transferred in.

b "Distillate Fuel Oil" includes Nos. 1, 2, and 4 fuel oils and Nos. 1, 2, and 4 diesel fuels.

* "Natural Gas" includes natural gas obtained from utilities, transmission pipelines, and any other supplier(s) such as brokers and producers.

* "Other" includes all other energy that was purchased or transferred in and not shown elsewhere.

Source: MECS 1991
Table A4. Capability to Switch from Electricity to Alternative Energy Sources (Estimates in Million Kilowatthours)

<table>
<thead>
<tr>
<th>Industry/SIC Code</th>
<th>Total Receipts</th>
<th>Switchables</th>
<th>Not Switchable</th>
<th>Natural Gas</th>
<th>Distillate Fuel Oil</th>
<th>Residual Fuel Oil</th>
<th>Coal</th>
<th>LPG</th>
<th>Coal Coke and Breeze</th>
<th>Other&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Kindred Products/20</td>
<td>50,518</td>
<td>1,305</td>
<td>45,174</td>
<td>325</td>
<td>378</td>
<td>193</td>
<td>244</td>
<td>15</td>
<td>183</td>
<td>NA</td>
</tr>
<tr>
<td>Textile Mill Products/22</td>
<td>29,522</td>
<td>266</td>
<td>28,232</td>
<td>0</td>
<td>NA</td>
<td>0</td>
<td>NA</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Paper and Allied Products/26</td>
<td>65,052</td>
<td>3,181</td>
<td>59,815</td>
<td>1,406</td>
<td>576</td>
<td>649</td>
<td>859</td>
<td>128</td>
<td>47</td>
<td>230</td>
</tr>
<tr>
<td>Chemicals and Allied Products/28</td>
<td>139,059</td>
<td>2,377</td>
<td>130,168</td>
<td>1,414</td>
<td>532</td>
<td>156</td>
<td>322</td>
<td>0</td>
<td>225</td>
<td>259</td>
</tr>
<tr>
<td>Petroleum Refining/2911</td>
<td>31,562</td>
<td>1,360</td>
<td>29,664</td>
<td>1,122</td>
<td>376</td>
<td>574</td>
<td>NA</td>
<td>0</td>
<td>556</td>
<td>233</td>
</tr>
<tr>
<td>Blast Furnaces, Steel/3312</td>
<td>9,490</td>
<td>109</td>
<td>9,288</td>
<td>NA</td>
<td>10</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

*Alternative Types of Energy* consist of those energy sources that could have been substituted for electricity receipts during 1991. The quantities are expressed in millions of Kilowatthours, and therefore represent the quantity of electricity that could have been displaced by the given alternative type of energy.

<sup>a</sup> "Total Receipts" represents those quantities of electricity generated off the manufacturing establishment site and available at the site for consumption.

<sup>b</sup> "Other" includes all other types of energy not already identified that could have been consumed in place of electricity.

Source: MECS 1991
Table A5. Quantity of Electricity Sold to Utility and Nonutility Purchasers (Estimates in Million Kilowatthours)

<table>
<thead>
<tr>
<th>Industry/SIC Code</th>
<th>Total Sold</th>
<th>Utility Purchaser</th>
<th>Nonutility Purchaser</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Kindred Products/20</td>
<td>988</td>
<td>940</td>
<td>48</td>
</tr>
<tr>
<td>Textile Mill Products/22</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Paper and Allied Products/26</td>
<td>9,012</td>
<td>8,254</td>
<td>759</td>
</tr>
<tr>
<td>Chemicals and Allied Products/28</td>
<td>9,967</td>
<td>7,269</td>
<td>2,698</td>
</tr>
<tr>
<td>Petroleum Refining/2911</td>
<td>2,410</td>
<td>1,029</td>
<td>1,381</td>
</tr>
<tr>
<td>Hydraulic Cement/3241</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Blast Furnaces, Steel/3312</td>
<td>1,297</td>
<td>490</td>
<td>807</td>
</tr>
</tbody>
</table>

* "Utility" is a company that produces and/or delivers electricity and/or natural gas, and is legally obligated to provide service to the public within its franchise area.

* "Nonutility Purchaser" includes independent power producers, small power producers, and cogenerators not located at the establishment site.

Source: MECS 1991

Table A6. Components of Onsite Electricity Generation (Estimates in Million Kilowatthours)

<table>
<thead>
<tr>
<th>Industry/SIC Code</th>
<th>Total</th>
<th>Cogeneration</th>
<th>Renewables</th>
<th>Other*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food and Kindred Products/20</td>
<td>5,743</td>
<td>5,579</td>
<td>6</td>
<td>157</td>
</tr>
<tr>
<td>Textile Mill Products/22</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Paper and Allied Products/26</td>
<td>53,831</td>
<td>45,447</td>
<td>2,856</td>
<td>5,528</td>
</tr>
<tr>
<td>Chemicals and Allied Products/28</td>
<td>41,428</td>
<td>38,348</td>
<td>NA</td>
<td>3,079</td>
</tr>
<tr>
<td>Petroleum Refining/2911</td>
<td>12,993</td>
<td>NA</td>
<td>0</td>
<td>NA</td>
</tr>
<tr>
<td>Hydraulic Cement/3241</td>
<td>NA</td>
<td>NA</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Blast Furnaces, Steel/3312</td>
<td>6,235</td>
<td>4,560</td>
<td>0</td>
<td>1,674</td>
</tr>
</tbody>
</table>

* "Other" is that electricity obtained from a generator fueled by combustible energy sources such as diesel or other fuel oils.

Source: MECS 1991

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>SIC 20</td>
<td>1,442</td>
<td>1,456</td>
<td>1,500</td>
<td>1,567</td>
<td>1,625</td>
<td>4,185</td>
<td>4,287</td>
<td>16,062</td>
</tr>
<tr>
<td>Textiles</td>
<td>SIC 22</td>
<td>292</td>
<td>297</td>
<td>308</td>
<td>324</td>
<td>338</td>
<td>875</td>
<td>900</td>
<td>3,334</td>
</tr>
<tr>
<td>Pulp &amp; Paper</td>
<td>SIC 26</td>
<td>1,841</td>
<td>1,853</td>
<td>1,903</td>
<td>1,979</td>
<td>2,051</td>
<td>5,345</td>
<td>5,586</td>
<td>20,558</td>
</tr>
<tr>
<td>Chemicals</td>
<td>SIC 28</td>
<td>2,633</td>
<td>2,774</td>
<td>2,985</td>
<td>3,249</td>
<td>3,516</td>
<td>9,809</td>
<td>11,068</td>
<td>36,034</td>
</tr>
<tr>
<td>Petroleum Refining</td>
<td>SIC 29</td>
<td>729</td>
<td>739</td>
<td>763</td>
<td>801</td>
<td>837</td>
<td>2,181</td>
<td>2,259</td>
<td>8,309</td>
</tr>
<tr>
<td>Stone, Clay, &amp; Glass</td>
<td>SIC 32</td>
<td>153</td>
<td>165</td>
<td>182</td>
<td>203</td>
<td>224</td>
<td>644</td>
<td>760</td>
<td>2,331</td>
</tr>
<tr>
<td>Primary Metals</td>
<td>SIC 33</td>
<td>513</td>
<td>524</td>
<td>545</td>
<td>576</td>
<td>603</td>
<td>1,569</td>
<td>1,622</td>
<td>5,952</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td>7,603</td>
<td>7,809</td>
<td>8,186</td>
<td>8,699</td>
<td>9,194</td>
<td>24,608</td>
<td>26,482</td>
<td>92,580</td>
</tr>
</tbody>
</table>

Source: RCG/Hagler, Bailly, Inc., February 1992
PART II: INTERNATIONAL OPPORTUNITIES

BIOMASS GASIFICATION OPPORTUNITIES IN THE SUGAR PROCESSING INDUSTRY

India

India represents the largest sugar market in the world, with over 450 sugar mills currently operating. The subcontinent benefits from the two or more monsoon seasons which yield longer caning seasons and therefore a greater supply of bagasse for cogeneration projects. A majority (it is difficult to accurately determine, but some experts suggest 80-90%) of sugar mills already have some form of power self-generation already installed. Furthermore, there is evidence suggesting that most sugar industrialists are beginning to install larger cogeneration facilities and indeed a few are already selling electric power to the regional State Electricity Boards (SEBs). The power market in India has undergone a dramatic deregulation since 1993 and a framework is developing for long-term, commercial-contractual sales and agreements. As of this writing, major foreign investors are near financial closing of up to US$ 4 billion worth of projects in the traditional fossil fuel energy sector.

These trends bode well for the biomass energy sector. If one assumes that the average sugar facility is 2,500 tons of cane crushed per day (tcd), which yields approximately 12 MW of power under conservative assumptions, the market potential can be estimated at $450 \times 12 = 5,400$ MW or $5.4$ billion.

Initiators of this proposal have been in contact with sugar industrialists in India, and there is reason to believe that over 100 MW of capacity will be installed in 1995 alone. Moreover, the initiators of this discussion paper have received some initial interest from a North American consortium which is developing two 50 MW projects in the Indian state of Uttar Pradesh. The same have also held early discussions with an established U.S. power developer which is pursuing a 25 MW project in the southern state of Tamil Nadu (TN).

Brazil & the Phillipines

While no specific data on the biomass fuels markets is presented here, both countries have large and well-developed sugar processing industries, as well as other agricultural industries with potential biomass-fuel by-products. One obstacle to commercial development of Brazil, however, remains in the form of artificially low tariff rates for utility-generated electricity sold to industrial consumers. Further restructuring of the Brazilian energy sector will be necessary before small-scale power generation is commercially viable as envisioned by the Fund.

In the Phillipines, however, sugar production, tobacco, and paper mills, among others, present strong potential in an environment more conductive to private-power production for industrial use. Several studies of renewable energy potential have been completed and non-
government organizations activity in promotion of biomass fuels is high. There is a promising potential for commercially-viable biomass cogeneration in the Philippines.

Central America

Central America as a region represents another significant market potential. Costa Rica, in particular, has over 20 sugar mills, two of which are already equipped with 30 MW cogeneration capacity. Guatemala and El Salvador have a similar number of mills and in 1994 a bagasse-fired cogeneration project in Guatemala received co-financing from the IFC. Therefore, overall market potential in Central America is roughly estimated at 50 mills x 20 MW = 1,000 MW or US$ 1 billion. The existing bagasse projects and continued demand for electric power in the region suggest that this market will continue to expand through the rest of the decade.

Mexico

Mexico has 64 sugar mills, and while the sugar industry has been depressed in Mexico since its privatization in 1992-1993, there are indicators which point to a brighter future. Since privatization, the industry has downsized its workforce and stabilized production. In the medium term, the sugar market will face an overall increase in demand, including from the export sector beginning in 1995. Therefore, the initiators of this proposal believe that the Mexican market may reach approximately 50 mills, assuming some mills will be shutdown given a more competitive environment. Again, this yields an overall investment potential estimated at US$ 1 billion.
Table 1: Biomass Fuel Consumption and Production
1985-1990

<table>
<thead>
<tr>
<th>Region</th>
<th>Biomass Fuel Production and Consumption (Quadrillion Btu)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>3.63</td>
</tr>
<tr>
<td>Europe</td>
<td>0.99</td>
</tr>
<tr>
<td>Nordic Countries</td>
<td>0.24</td>
</tr>
<tr>
<td>EEC</td>
<td>0.23</td>
</tr>
<tr>
<td>Central Europe</td>
<td>0.03</td>
</tr>
<tr>
<td>Southern Europe</td>
<td>0.33</td>
</tr>
<tr>
<td>Eastern Europe</td>
<td>0.16</td>
</tr>
<tr>
<td>Africa</td>
<td>2.1</td>
</tr>
<tr>
<td>Asia</td>
<td>4.4</td>
</tr>
<tr>
<td>Latin America</td>
<td>1.5</td>
</tr>
<tr>
<td>Ocean</td>
<td>0.1</td>
</tr>
</tbody>
</table>


Table 2: Biomass Energy Resources and Market Potential in Asia and the Pacific and Africa

<table>
<thead>
<tr>
<th>Country</th>
<th>Biomass (Megawatts)</th>
<th>Resource Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Market Potential</td>
<td></td>
</tr>
<tr>
<td>ASIA AND THE PACIFIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>---</td>
<td>a</td>
</tr>
<tr>
<td>India</td>
<td>3,800</td>
<td>17,000</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1,800</td>
<td>10,000</td>
</tr>
<tr>
<td>Pakistan</td>
<td>300</td>
<td>---</td>
</tr>
<tr>
<td>Philippines</td>
<td>9</td>
<td>b</td>
</tr>
<tr>
<td>Russia</td>
<td>---</td>
<td>c</td>
</tr>
<tr>
<td>Subtotal</td>
<td>5,909</td>
<td>27,000</td>
</tr>
<tr>
<td>AFRICA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>South Africa</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

a = 260 million tons oil equivalent.
b = 105 million terawatts-electric annual yield.
c = 60 million tons oil equivalent.

Note: Letters indicate availability of only partial totals or totals in different units. Dashes indicate data not available.

Table 3: Biomass Energy Resources and Market Potential in Asia in the Americas

<table>
<thead>
<tr>
<th>Country</th>
<th>Biomass (Megawatts)</th>
<th>Market Potential</th>
<th>Resource Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CENTRAL AMERICA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Costa Rica</td>
<td>a</td>
<td>b</td>
<td></td>
</tr>
<tr>
<td>El Salvador</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Guatemala</td>
<td>--</td>
<td>500</td>
<td></td>
</tr>
<tr>
<td>Honduras</td>
<td>c</td>
<td>d</td>
<td></td>
</tr>
<tr>
<td>Nicaragua</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Panama</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>NORTH AMERICA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mexico</td>
<td>--</td>
<td>1,000</td>
<td></td>
</tr>
<tr>
<td>CARIBBEAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barbados</td>
<td>--</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Dominica</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Dominican Republic</td>
<td>--</td>
<td>15-45</td>
<td></td>
</tr>
<tr>
<td>Haiti</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Jamaica</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>--</td>
<td>27-57</td>
<td></td>
</tr>
<tr>
<td>SOUTH AMERICA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Argentina</td>
<td>--</td>
<td>e</td>
<td></td>
</tr>
<tr>
<td>Bolivia</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>3,200</td>
<td>8,800</td>
<td>--</td>
</tr>
<tr>
<td>Chile</td>
<td>--</td>
<td>f</td>
<td></td>
</tr>
<tr>
<td>Peru</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>Subtotal</td>
<td>3,200-8,800</td>
<td>--</td>
<td></td>
</tr>
</tbody>
</table>

a = 17 to 500 million kilowatthours per year from sugarcane.
b = 400 to 500 million kilowatt hours per year from sugarcane.
c = 54 million kilowatthours per year from sawmill.
d = 30 million kilowatthours per year from sawmill.
e = 50 megawatts at Copahue field, otherwise unknown.
f = Large but inaccessible.

Note: Letters indicate availability of only partial totals or totals in different units. Dashes indicate data not available.