
**ANIMAL MANURE AND RELATED BIOMASS FEEDSTOCK
MARKET ASSESSMENT AND PRELIMINARY FEASIBILITY STUDY
FOR A PAPERMILL BIOMASS/COGEN FACILITY**

Task 1 Summary Report

for

**Southern States Energy Board
SERBEP Program**

with

South Carolina Energy Office

Submitted by:

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Animal Manure and Related Biomass Feedstock Market Assessment and Preliminary Feasibility Study for a Paper Mill Biomass Cogeneration Facility

Linpac Paper

Task 1 Summary Report

Summary of Relevant Biomass and Energy Information

Table of Contents

<u>Section</u>	<u>Page</u>
Table of Contents	1
Task 1 Summary	2
Anaerobic Digestion for Biogas Production	3
Literature and Informational Search Results	4
Conclusions	5
Appendix A: Bibliography and Literature Search Results	

Animal Manure and Related Biomass Feedstock Market Assessment and Preliminary Feasibility Study for a Paper Mill Biomass Cogeneration Facility

Linpac Paper

Task 1 Summary Report

Summary of Relevant Biomass and Energy Information

Task 1 Summary:

Task 1 involved documenting federal, state and locally relevant information for the proposed Linpac Biomass/Cogen facility project. A literature search and investigation for relevant materials was successfully conducted providing for information and documentation that can be used to support the remaining tasks and project work. The materials collected include:

- Books/Handbooks/Proceedings/Symposium Publication
- Articles/Publications
- Internet Accessible Websites/Documents
- News/Press Releases
- Linpac/RRSI/CCI/Enron/CEPES In-house Data

The literature search has been successfully completed, and the documentation and information are suitable for use in later project tasks to meet task requirements and act as appropriate references. The initial review of the literature search materials and project partner in-house materials provides for a reasonable assumption that anaerobic digestion technology is suitable for use in biogas production, that CCI's BTA technology can be used as the basis for the project, that a wide variety of biomass feedstocks, including animal manures and related biomass, can be used as raw material supply for an anaerobic digestion, and that the biogas is a valuable fuel that can act as a substitute that can be competitive with market natural gas purchases for steam and power cogeneration.

Anaerobic digestion is essentially microbial action on organic material in the absence of significant oxygen, with the goal to produce methane for use as fuel. A wide range of organic materials may be successfully processed in an anaerobic digester. An initial review of the literature and documentation on biogas generation indicates that animal manures, agricultural crop residues, animal renderings, food processing waste, human manures, industrial pulp and paper waste, forest products residuals, commercial waste, MSW and other biomass organic materials are often usable as feedstocks for biogas generation.

An initial review of the CCI literature for the BTA anaerobic digestion process and a site review of the CCI Newmarket facility suggests that application of the technology in the SERBEP region is potentially feasible and beneficial. The CCI process targeted for the facility will use a two stage process. In the two stage version, the feedstock consistency and operating temperature of the two stages are different from each other. While the digestion process depends on extremely complex interactions of many kinds microbes and materials, operation of anaerobic digestion systems does not require detailed knowledge of these interactions. Basic principles of process flow, temperature control and feedstock quality monitoring may be followed to achieve a fairly predictable outcome. This patented BTA technology has been found to offer some of the best process efficiencies. The biogas is suitable for use as fuel and a replacement for natural gas in a cogeneration facility.

More in-depth study and comparison of this information against the proposed technology and facility work results will be important to make a solid feasibility assessment.

Anaerobic Digestion for Biogas Production

The facility intends to use CCI's BTA anaerobic digestion technology as the process basis. Based on provided CCI data, the literature search and available documentation including the other project partners in-house materials, a general description of a typical anaerobic digestion process for biogas production can be provided as follows:

Anaerobic Digestion

Anaerobic digestion is essentially microbial action on organic material in the absence of significant oxygen. In some cases, the goal is to reduce BOD/COD of wastewater. In others, including this project, the goal is to produce methane for use as fuel.

Feedstock Materials

A wide range of organic materials may be successfully processed in an anaerobic digester. Animal manures, animal parts and renderings, agricultural residuals, human fecal waste, food processing scraps, spoiled fruits and vegetables, plant and wood pulp, waste paper, even municipal solid waste (MSW) have all been used to generate biogas. Many of these biomass feedstocks currently represent environmental disposal problems with regard to watersheds and landfill considerations. The use of anaerobic digestion technology can provide a viable solution to waste problems while producing a valuable renewable energy from these materials.

Digestion Conditions

Anaerobic digesters are typically operated at elevated temperatures to reduce digestion time, although a slow digestion is also possible at room temperature. The material to be digested is typically mixed in a slurry with low solids content, typical in the range of 0.5% to 10% solids by weight. Larger solid materials are typically broken up to increase surface area for digestion. Mesophilic bacteria operate optimally somewhere between 35 and 50C, while thermophilic bacteria operate best in the range 60 to 75C. Digesters may be operated in a single stage or a two-stage fashion. In the two stage version, the feedstock consistency and operating temperature of the two stages are different from each other. The CCI process targeted for the facility will use a two stage process. While the digestion process depends on extremely complex interactions of many kinds microbes and materials, operation of anaerobic digestion systems does not require detailed knowledge of these interactions. Basic principles of process flow, temperature control and feedstock quality monitoring may be followed to achieve a fairly predictable outcome.

Two or Three Stage Digestion Process

Numerous varieties of bacteria and other microorganisms can exist and even flourish in an aerobic setting. The exact populations of particular species vary significantly with the material undergoing digestion, temperature, populations of other species and a number of other factors. Very roughly, the microbes can be classified into hydrolyzing, acid-forming and methane-forming varieties, with each type acting approximately in succession on starches and cellulose. The digestion succession is somewhat different in the cases of proteins and other materials, but typically there are two to three steps in the breakdown or digestion process, with different bacteria involved in different steps of the digestion.

Products formed on completion of digestion

If the digestion process is allowed to approach completion, methane and carbon dioxide will typically be the predominant gases, along with smaller amounts of ammonia and hydrogen sulfide. The gas generated by biopower digesters typically contains 50-75% methane, with carbon dioxide

making up most of the balance. The solids remaining will include bacterial cell matter as well as undigestible material, suspended in water. These can be converted to a high quality compost.

Biogas Quality and Use

In order to use the biogas for power generation, removal of excess moisture from the gas as well as scrubbing of any significant detrimental quantities of toxic hydrogen sulfide may be required. For some types of combustion, carbon dioxide percentage in the biogas may also need to be reduced from the biogas. The biogas is then suitable for use as fuel and as a viable replacement for Linpac's purchased natural gas or in green power production

Literature and Informational Search Results:

A literature search and investigation for relevant materials was successfully conducted providing for information and documentation that can be used to support the remaining tasks and project work. A partial, preliminary summary of significant bibliographic references is included in Appendix A of this report. Copies of specific articles or materials can be obtained from RRSI upon request. The materials were collected from the following sources:

- Books/Handbooks/Proceedings/Symposium Publication
- Magazine Articles/Publications
- Internet Accessible Websites/Documents
- Recent News/Press Releases
- Linpac/RRSI/CCI/Enron/CEPES In-house Data

For Task 1, in-house materials and data from the project partners has provided a good baseline for future project task requirements and reference. The materials provide are applicable to the technology and provide engineering and technical information useful for future task work. The general literature search has provided excellent background materials and documentation which has turned up important information about anaerobic digestion technology for biogas generation and production, and disposition of key facility residuals such as compost. Additional information pertaining to the regulatory environment, energy market, compost market and related project peripheral concerns has been obtained.

An initial review of the CCI literature for the BTA anaerobic digestion process and a site review of the CCI Newmarket facility suggests that application of the technology in the SERBEP region is potentially feasible and beneficial. This patented anaerobic digestion technology has been found to offer some of the best process efficiencies observed. It appears to be capable of delivering a high quality biogas product from a variety of biomass feedstocks including animal manures and other related wastes. Given appropriate feedstocks and "recipes", the facility residuals will consist of a biomass byproduct that provides a good solid residual material appropriate for composting and sale.

An initial survey of literature on biogas generation indicates that animal manures, agricultural crop residues, animal renderings, food processing waste, human manures, industrial pulp and paper waste, forest products residuals and other organic materials are often usable as feedstocks for biogas generation. Some industrial pulp and paper by products must be handled with care as feedstocks because of the presence of residual biocides, which adversely affect the microbes which carry out anaerobic digestion. For a continuously operating anaerobic digestion system such as that implemented by CCI/BTA, various "recipes" or mixes of a range of feedstocks are developed for optimum performance. Industry data categorized by SIC code suggest that a variety of viable feedstocks may be available in the region of probable facility siting near Linpac Paper in Cowpens, S.C. region.

Solid organic residuals are expected from biogas production facility in most cases, suitable for biomass compost production. Depending on the feedstocks, several residuals from the biogas generation process may be obtained, some of which may be marketable. In addition to the compost fraction, marketable facility residuals may include plastics, metals, aluminum and glass. First, depending on the feedstocks, there may be reject material not appropriate for digesting. This is particularly true if mixed municipal solid waste (MSW) or other mixed solid waste is used as feedstock. These rejects may in some cases be sorted into recyclable materials and non-recyclable materials. Markets may be sought for reject plastics, metals and glass. Other miscellaneous reject materials would most likely be landfilled. Liquid residuals may also arise from the digestion process, depending on the water balance in the digestion process the liquid residual may be an excellent fertilizer appropriate for land application. Land application is regulated at the federal and state levels, and appropriate permits must be obtained.

Conclusions:

The literature search has been successfully completed, and the documentation and information are suitable for use in later project tasks to meet task requirements and act as appropriate references. The initial review of the literature search materials and project partner in-house materials provides for the following:

- it is reasonable to assume that anaerobic digestion technology is suitable for use in biogas production, and CCI's BTA technology is a viable technology that based on preliminary indication can be used as the basis for this project.
- a wide variety of biomass feedstocks, including animal manures and related biomass, can be used as raw material supply for an anaerobic digestion.
- solid organic residuals from the facility can be converted into a high quality compost for use in soil amendment and silviculture industry(s).
- biogas is a valuable fuel that can act as a substitute that can be competitive with market natural gas purchases for steam and power cogeneration.

The information found will be incorporated into and act as reference for future technical, engineering and project development tasks. More in-depth study and comparison of this information against the proposed technology and facility will be important to make a solid feasibility assessment.

Appendix A

Bibliography and Literature Search Results

Engineering Bibliography and Literature Search Results

Anaerobic Digestion and Biogas Generation

[NAS, 1977] *Methane Generation from Human, Animal, and Agricultural Wastes*, Washington D.C.: National Academy of Sciences, 1977, 131pp.

[Hobson & Wheatley, 1993] Hobson, Peter N. and Andrew D. Wheatley, *Anaerobic Digestion: Modern Theory and Practice*, London: Elsevier, 1993, 269pp.

[Ecotope, 1975] "Process Feasibility Study: The Anaerobic Digestion of Dairy Cow Manure at the State Reformatory Honor Farm, Monroe, Washington," prepared for The State of Washington Department of Ecology by Ecotope Group and Parametrix, Inc., 1975, 119pp.

Dr. Oestreich, G., *The BTA-Process Anaerobic Digestion of Biowaste, Commercial Wastes and Treatment of the Residual Wastestream*, BTA, Munich, 1994.

Company Technical Profile: *Canada Composting Inc., The BTA-Process, Newmarket Facility*

Cogeneration of Power and Heat

[Wooden and Williams, 1988] Wooden, Donald K. and W. L. Williams III, eds., *A Reference Handbook for Cogeneration for the Pulp and Paper Industry*, Atlanta: TAPPI Press, 1988, 161pp.

[Spiewak and Weiss, 1997] Spiewak, Scott A. and Larry Weiss, *Cogeneration and Small Power Production Manual, Fifth Edition*, Lilburn, GA: The Fairmont Press, 1997, 344pp.

[Orlando, 1996] Orlando, Joseph A., *Cogeneration Design Guide*, Atlanta, GA: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1996, 345pp.

Company Technical Profile: Lincac Paper, *Cogeneration Feasibility Study*

Regulations and Permitting Requirements

40 CFR Part 503, United States Federal Sewage Sludge Rule.

South Carolina State House Network 1999 Code of Regulations 61-9: Water Pollution Control Permits. Of particular interest are subsections 122 (NPDES), 124 (Decisionmaking), 403 (Pretreatment), 504 (Industrial sludge) and 505 (Land Application).

South Carolina State House Network 1999 Code of Regulations 61-62: Air Quality Permits.

Official Code of Georgia 12-9-1: Georgia Air Quality Act.

Official Code of Georgia 12-8-20: Georgia Comprehensive Solid Waste Management Act of 1990.

Official Code of Georgia 12-5-20: Georgia Water Quality Act.

Georgia Environmental Protection Division Rules 391-3-1 (Air Quality Rules), 391-3-4 (Solid Waste Management Rules, Rev. 1997), 391-3-6 (Water Quality Control).

MERA Operational Memorandum #15: Default Type A Cleanup Criteria, Sept. 30, 1993, Michigan Dept. of Natural Resources.

MERA Operational Memorandum #8, Revision 3: Type B Cleanup Criteria, Feb. 4, 1994.

General Bibliography and Literature Search Results

Books/Handbooks/Proceedings/Symposium Publications

Bioenergy 2000 Moving Technology into the Marketplace , The Ninth Biennial Bioenergy Conference, Northeast Regional Biomass Program, Buffalo New York, 2000.

Biofuels for Sustainable Transportation, Michigan Ethanol Workshop, The US Department of Energy, Lansing Michigan, 2000.

Company Market Profile: Enron North America Corporation, *State Energy Regulatory Summaries*

Klass, D.L., *Biomass for renewable energy, fuels, and chemicals*, Academic Press: San Diego, 1998, 651 p.

Biomass energy: key issues and priority needs: Paris, France: conference proceedings, OECD: Paris, 1997, 474 p.

Saha, B.C., Woodward, J., editors, *Fuels and chemicals from biomass*, American Chemical Society: Washington DC, 1997, 356 p.

Wereko-Brobby, C., *Biomass conversion and technology*, J. Wisely & Sons: Chichester; New York, 1996, 203 p.

DynCorp Meridian, *Assessment of biomass cogeneration in the Great Lakes Region: a Great Lakes casebook*, Great Lakes Regional Biomass Energy Program: Chicago, 1995, (p 53 – 54)

Himmel, M.E., Bakers, J.O. Overend, R.P, editors, *Enzymatic conversion of biomass for fuels production*, American Chemical Society Washington DC, 1994, 499 p.

Himmel, M.E., Bakers, J.O. Overend, R.P, , *ACS symposium series (from a symposium sponsored by the Division of cellulose, Paper and textiles)*, American Chemical Society: Washington DC, 1994,

Patterson, W.C., *Power from plants: the global implications of new technologies for electricity from biomass*, Earthscan & The Brookings Institution: Washington DC, Royal Institute of International Affairs Energy and Environmental Program: London, 1994, 102 p.

Golob, R., *The almanac of renewable energy*, H. Holt, New York, 1993, 348 p.

Saddler, J.N., *Bioconversion of forest and agricultural plant residues*, CAB International: Wallingford Oxon: UK, 1993, 349 p.

Potential environmental impacts of bioenergy crop production, US Congress, Office of Technology: Washington DC, 1993, 71 p.

Grassi, G., Trebbi, G., Pike, D.C. editors, *Electricity from biomass*, CPL Press: Newbury, Berkshire, 1992, 68 p.

Pasztor, J., Kristoferson, L.A., editors, *Bioenergy and the environment*, Westview Press: Boulder: Colorado, 1990, 410 p.

Dovring, F., *Farming for fuel: the political economy of energy sources in the United States*, Praeger: New York, 1998, 152 p.

Biomass energy: a resource management, US Department of Energy & US G.P.O: Washington DC, 1987, 43 p.

McMinn, J.W., *Wood energy potential in northwestern South Carolina*, U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station, 1986, 8 p.

Klass, D.L., Emert, G.H., editors, *Fuels from biomass and wastes*, , 1981, 592 p.

Agricultural waste products as alternative energy sources, U.S. Govt. Printing Office, 1980, 74 p.

Compost science/land utilization, editor, *Biomass and alcohol fuels production: proceedings of a seminar on biomass energy for city, farm, and industry*, 1980.

Magazine Articles/Publications

Chynoweth, D.P., Owens, J.M., Legrand, R., *Renewable methane from anaerobic digestion of biomass*, *Renewable Energy* 22 (2000) pp. 1-8, 2000.

Mata-Alvarez, J., Mace, S., Llabres, P., *Anaerobic digestion of organic solid wastes. An overview of research achievements and perspectives*, *Bioresource Technology* 74 (2000) pp. 3-16, 2000.

O'Keefe, D.M., Brigmon, R.L., Chynoweth, D.P., *Influence of methane enrichment by aeration of recirculated supernatant on microbial activities during anaerobic digestion*, *Bioresource Technology* 71 (2000) pp. 217-224, 2000.

Roos, A., Graham, R.L., Hektor, B., Rakos, C., *Critical factors to bioenergy implementation*, *Biomass and Bioenergy* 17 (1999) pp. 113-126, 1999.

Gracia-Ochoa, F., Santos, V.E., Naval, L., Guardiola, E., Lopez, B., *Kinetic model for anaerobic digestion of livestock manure*, *Enzyme and Microbial Technology* 25 (1999) pp. 55-60, 1999.

Ratusznei, S.M., Rodrigues, J.A.D., Camargo, E.F.M., Zaiat M., Borzani, W., *Feasibility of a stirred anaerobic sequencing batch reactor containing immobilized biomass for wastewater treatment*, *Bioresource Technology* 75 (2000) pp. 127-132, 2000.

Wright, L.L., Walsh, M.A., Downing, M.E., Kszos, L.A., Cushman, J.H., Tuskan, G.A., Mclaughlin, S.B., Tolbert, V.R., Scurlock, J., Ehrenshaft, J., Ehrenshaft, A.R., *Biomass Feedstock Research and Development for Multiple Products in the United States*, Bioenergy Information Network, 2000.

Wright, L.L., *Demonstration and Commercial Production of Biomass for Energy*, Bioenergy Information Network, 1999.

Holman, H.F., *Energy Technology: Oxy-Moron? Or Moxie Home Run?*, Robertson Stephens, 1999

Hansen, K.H., Angelidaki, I., Ahring, B., *Improving thermophilic anaerobic digestion of swine manure*, *Water Resource*, Vol.33, No. 8, pp. 1805-1810, 1999.

- Cook, J., Beyea, J., *Bioenergy in the United States: progress and possibilities*, Biomass and Bioenergy 18 (2000) pp. 441-455, 1999.
- Fantozzi, F., Ferico, S.D., Desideri, U., *Study of a cogeneration plant for agro-food industry*, Applied Thermal Engineer 20 (2000) pp. 993-1017.
- Jone, J.M., Pourkashanian, M., Williams, A., Hainsworth, D., *A comprehensive biomass combustion model*, Renewable Energy 19 (2000) pp. 229-234.
- Charters, W.W.S., *Developing markets for renewable energy technologies*, Renewable Energy 22 (2000) pp. 217-222.
- Walsh, M.E., *Method to estimate bioenergy crop feedstock supply curves*, Biomass and Bioenergy 18 (2000) pp.283-289.
- Hill, D.T., Bolte, J.P., *Methane production from low solid concentration liquid swine waste using conventional anaerobic fermentation*, Bioresource Technology 74 (2000) pp. 241-247.
- Lomas, J.M., Urbano, C., Camarero, L.M., *Influence of recirculation flow in a pilot scale downflow stationary fixed film anaerobic reactor treating piggery slurry*, Biomass and Bioenergy 18 (2000) pp. 421-430.
- Dagnall, S., Hill, J. Pegg, D., *Resource mapping and analysis of farm livestock manures – assessing the opportunities for biomass-to-energy schemes*, Bioresource Technology 71 (2000) pp. 225-234.
- Tiquia, S.M., Tam, N.F.Y., *Co-composting spent pig litter and sludge with forced-aeration*, Bioresource Technology 72 (2000) pp. 1-7.
- Ong, H.K., Greenfield, P.F., Pullammanappallil, P.C., *An operational strategy for improved biomethanation of cattle-manure slurry in an unmixed, single-stage, digester*, Bioresource Technology 73 (2000) pp. 87-89.
- Moller, H.B., Lund, I., Sommer, S.G., *Solid-liquid separation of livestock slurry: efficiency and cost*, Bioresource Technology 74 (2000) pp. 223-229.
- Masse, D.I., Lu, D., Masse, L., Droste, R.L., *Effect of antibiotics on psychrophilic anaerobic digestion of swine manure slurry in sequencing batch reactors*, Bioresource Technology 75 (2000) pp. 205-211.
- Weterman, P.W., Bicudo, J.R., *Tangential Flow Separation and Chemical Enhancement to Recover Swine Manure Solids, Nutrients and Metals*, Elsevier Science Ltd., 2000.
- Gas Daily: Biomass competes with gas on emissions*, Financial Times Energy, 2000.
- Richardson, D., *Strength Through Science, Energy Efficiency and Renewable Energy*, DOE Office of Biopower and Hydropower Technologies, 2000.
- Lomas, J.M., Urbano, C., Camarero, L.M., *Evaluation of a pilot scale downflow stationary fixed film anaerobic reactor treating piggery slurry in the mesophilic range*, Biomass and Bioenergy 17 (1999) pp. 49-58.
- Westerman, P.W., Bicudo, J.R., *Tangential flow separation and chemical enhancement to recover swine manure solids, nutrients and metals*, Bioresource Technology 73 (2000) pp. 1-11.
- Moore, T., *Harvesting the benefits of biomass*, EPRI Journal, May/June 1996.
-

JAYCOR [//rredc.nrel.gov/biomass/doe/rbep/summ-nfor/], *Regional assessment of non forestry-related biomass resources: summary volume*, DOE, SRBEP, 1990.

Hansen, R.W., *Methane Generation from livestock wastes*, Colorado State University Cooperative Extension, 1998?

Fulhage, C., Sievers, D., Fischer, J.R., *Generating methane gas from manure*, University of Missouri, 1993.

Chum, H.L., Milne, T.A., Johnson, D.K., Agblevor, F.A., *Feedstock characterization and recommended procedures*, NREL, 1994.

Osburn, L., Osburn, J., *Biomass resources for energy and industry*, 1993.
Biomass Energy Program, *Case studies of sewage treatment with recovery of energy from methane*, Biologue.

Stanton, T., *Biomass energy: It's not just for breakfast anymore*, Michigan Public Service Commission, 1995.

Roos, K.F., Moser, M.A., editors, *The AgStar Handbook ****, USEPA.

Cal Poly Project, *Lagoon-based systems: Anaerobic digestion at dairy farms*, Biocycle.

Process Feasibility Study: *The Anaerobic Digestion of Cow Manure at the State Reformatory Honor Farm Monroe Washington*, Ecotope Group, Seattle Washington, 1975.

Badger, B.C., *Biologue Biomass Energy Program Reports: Southeast Region*, NBIA, 1994.

Walsh, M.E., Graham, R.L., *Evaluating the Economic Costs, Benefits and Tradeoffs of Dedicated Biomass Energy Systems: The Importance of Scale*, National Renewable Energy Laboratory, Golden Colorado, 1995.

Strawn, N., Hinman, N., *Methanol from Biomass*, National Renewable Energy Laboratory, 1995.

BioPower Renewable Electricity from Plant Material, EREN.

Forester, T.D., Case Study: *Dow Corning Corporation Biomass Cogeneration Plant*, Dow Corning Corp., 1994.

Breuk, R., Faaij A., Wijk, *Biomass Combustion Power Generation Technologies*, Utrecht University, 1995.

Biomass: Clean Energy for America's Future, American Bioenergy Association, 2000.

Covinton, E., Kloot, R., Atkins, J., *Tool for Animal Feeding Operations Siting*, ArcUser, 2000.

Hansen, R.W., *Methane Generation from Livestock Wastes*, Colorado State University Cooperative Extension, 1995-1999.

Fulhage, C., Sievers, D., Fischer, J.R., *Generating Methane Gas from Manure*, Department of Agricultural Engineering, College of Agriculture, University of Missouri-Columbia, 1993.
Drake, B., *Biomass Tobacco FAQ's*, Bill Drake, 1998.

Chum, H.L., Milne, T.A., Johnson, D.K., Agblevor, F.A., *Feedstock Characterization and Recommended Procedures*, Industrial Technologies Division, National Renewable Energy Laboratory.

Osburn, L., Osburn, J., *Biomass Resources for Energy and Industry*, 1993.

Biologie Northwest: Municipal Solid Waste Combustion Characteristics, NBIA, 1994.

Internet Accessable Websites/Documents

***AgStar, www.epa.gov/agstar

Minnesota – Biofuels and Ethanol

Resources, www.me3.org

National Association of State Energy Officials, www.naseo.org

Alternative fuels data center, www.afdc.nrel.gov

Amercian Bioenergy Assoc, www.biomass.org

American Farm Bureau, www.fb.com

Ethanol Producers & Consumers, www.ethanol.mt.org

Renewable Fuels Assoc., www.ethanolrfa.org

USDA, www.usda.gov

National Biodiesel Board, www.nbb.org

Oak Ridge-Bioenergy Feedstock Development Program, www.esd.ornl.gov/bfdp

Regional Biomass Energy Program, [//rredc.nrel.gov/biomass/doe/rbep/](http://rredc.nrel.gov/biomass/doe/rbep/)

Governor’s Ethanol Coalition, www.ethanol-gec.org

NAL/USDA Biofuels, www.nal.usda.gov/ttic/biofuels

Bioenergy Initiative, www.eren.doe.gov/bioenergy initiative; www.bioproducts-bioenergy.gov

Bioenergy Feedstock Development Program, www.esd.ornl.gov/bfdp/bfdpmain.html

Biomass Power Program, www.eren.doe.gov/biopower

Regional Biomass Energy Program, www.ott.doe.gov/ofd/biomass.html

Southeastern Regional Biomass Energy Program, serbep.org

South Carolina Energy Office, state.sc.us/energy

Biomass Energy Research WWW, www.doe.gov/ber/berhome.html

Biomass Resource Information Clearinghouse, [//rrdec.nrel.gov/biomass](http://rrdec.nrel.gov/biomass)

American Bioenergy association, www.biomass.org

Electric Power Research Institute, www.epri.com

Renewable Energy Annual, www.eia.doe.gov

Sources of Information on Renewable Energy, www.americangreen.org

Biomass Research, www.nrel.gov/research

Sources of Information on Renewable Energy, www.americangreen.org

Biomass Research, www.nrel.gov/research

South Carolina Agricultural Statistics, [//cherokee.agecon.clemson.edu/ag_stat.htm](http://cherokee.agecon.clemson.edu/ag_stat.htm)

Bioenergy Update, www.bioenergyupdate.com

Energy Links, Ces.iisc.ernet.in/hpg/envis/Energylinks97.html

EIA's Pages for: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Tennessee, Virginia and West Virginia,
www.eia.doe.gov.html

Future Biomass Resources, http://rredc.nrel.gov/biomass/doe/rbep/ms_biomass/future.html

Prosper Business Development Corp, www.4prosper.com

Altra Energy Technologies Inc, www.altranet.com

AMERICAN Direct Access eXchange, www.amdax.com

APB Energy, Inc., www.apbenergy.com

Automated Power Exchange, www.apx.com

Aquila Energy (Utilicorp), www.aquilaenergy.com

Associated Systems, Inc., www.assocys.com

Checkfree.com, www.checkfree.com

ChooseEnergy.com, www.chooseenergy.com

Colorado Wind Power, www.cogreenpower.org

Conectiv, www.conectiv.com

ConneXt, www.connext.com

Continental Power Exchange, www.cpex.com

Solstice, www.crest.org

Data Transmission Network Corp., www.dtnenergy.com

Keystone Energy Services, www.earthchoice.com

e-ChoiceNet, www.e-choicenet.com

ElectricityChoice.com, www.electricitychoice.com

Enercom, www.enercomusa.com

Energy.com, www.energy.com

EnergyChoice, www.energychoice.com

ENERGYguide, www.energyguide.com

Energy Interactive, Inc., www.energyinteractive.com

EnergyOn.com, www.energyon.com

EnergyPortal.com, www.energyportal.com

EnergyPrism.com, www.energyprism.com

Enermetrix.com, www.enermetrix.com

Enron, www.enrononline.com

Essential.com, www.essential.com

Exelon Energy, www.exeloncorp.com

Clean N' Green Energy, www.go-green.com

Green-e Renewable Electricity Program administered by the Center for Resource Solutions, www.green-e.org

Greenmountain.com, www.greenmountain.com

HoustonStreet.com, www.houstonstreet.com

Inventure.com, www.inventure.com/energy

CellNet Data Systems, www.myenergyinfo.com

Natsource, www.natsource.com

Nexus, www.nexusenergy.com
New York Mercantile Exchange, www.nymex.com
OM Technology, www.omtechnology.com
Power Direct (AES), www.powerdirect.com
Commonwealth Energy Corp., www.powersavers.com
SCT Utility Systems, www.sctcorp.com
Silicon Energy, www.siliconenergy.com
Association of Power Exchanges, www.theapex.com
Usource, www.unitil.com/unitil/index.htm
UtiliSave.com, www.utilisave.com
Utility.com, www.utility.com
WeatherTrade, www.weathertrade.com
