

Report on a Forum:

Co-Firing Wood With Coal in Utility Boilers

prepared by

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Introduction

Operating under a grant from the U.S. Department of Energy, the Coalition of Northeast Governors' Policy Research Center administers the Northeast Regional Biomass Program whose mission is to encourage and expand the use of renewable biomass energy. On September 27, 1994, CONEG held a forum in Philadelphia, Pennsylvania on the possibilities of co-firing wood with coal in electric utility boilers in the Northeast. This forum, organized in cooperation with the U.S. Department of Energy, the Forest Service of the U.S. Department of Agriculture, and the Pennsylvania Energy Office, is the first of two organized by CONEG. The other, held on October 12 in Hartford, Connecticut, addressed the issue of siting an ethanol facility using a biomass feedstock in the Northeast.

To the first forum were invited individuals representing coal-firing electric utilities to discuss co-firing potential with state and federal government officials who have participated in CONEG's Regional Biomass Program, as well as with state regulatory officials, and university and private research organizations. Forty-five individuals participated in this day-long forum.

The forum was led by Barry R. Lawson, Ph.D., a professional, neutral facilitator who worked with the group in confirming an agenda for the day, setting and maintaining a schedule for accomplishing the goals of the forum, helping participants determine the most significant barriers to co-firing in the Northeast, and identifying the most appropriate strategies to overcome these barriers. Dr. Lawson prepared a draft report on the forum for review and comment by all participants and, subsequently, produced this final report.

Two recorders, Ms. Joy Cazeaux and Ms. Susan Savitt, documented the details on the forum discussions while Dr. Lawson maintained a flip-chart record of the major points and conclusions of the facilitated discussion. It is largely from these sources that this report has been prepared.

Six experts were invited to provide data and other information relevant to co-firing. All participants had the opportunity to comment on or ask questions of these contributors during the morning and afternoon sessions.

Purpose of the Forum

The Northeast Regional Biomass Program is an applied research and technology transfer program whose mission is to increase acceptance and application of appropriate biomass energy technologies by the private sector and local governments. The purpose of the forum was for the invited stakeholders to assist in formulating and implementing its co-firing strategy. An objective of the forum was to identify any critical gaps in the existing body of research available to utilities and regulators so that the Program can tailor its applied research and technology transfer agenda to fill those gaps. Another objective was to determine ways in which to encourage communication and joint efforts among organizations to resolve issues that stand in the way of co-firing wood with coal in utility facilities.

After an introductory information and discussion session, the second half of the forum addressed the following concerns:

- Identification of barriers;
- Identification of a strategy to overcome most significant barriers; and
- Commitments and partnerships to implement this strategy.

Attendees

The forty-five participants represented a variety of stakeholders and included representatives of organizations that have had experience in co-firing. The general composition of the group was as follows:

- Electric generating utilities;
- State public service commissions;
- State environmental regulatory officials;
- State energy offices;
- Private firms/contractors providing services and/or research to utilities;
- University and utility research organizations;
- US DOE officials;
- Independent power producers;
- State and Federal forestry departments; and
- Northeast Regional Biomass Program personnel and contractors.

A list of individual participants is included in the appendix of this report.

Schedule of the Forum

The forum opened with an introduction by the sponsors and hosts followed by opening comments on the agenda, schedule and procedures to be used during the forum. The balance of the morning session included presentations from four individuals on co-firing technology, wood availability, the regulatory context for co-firing, and financial considerations. Each of the presentations was followed by comments from two individuals who have valuable experience in co-firing. Questions and comments were then taken from all participants regarding each of the individual topic areas.

In the afternoon the participants, led by the facilitator, developed a list of potential barriers to wood-coal co-firing in the Northeast and further refined this list to the barriers that were determined to be most significant. Working from this list of significant barriers, the group then developed strategies for overcoming these barriers. Finally, the Northeast Regional Biomass Program solicited personal and organizational commitments to implement these strategies, or to assist the Program in fulfilling its mandate.

Principal Conclusions

First among the conclusions drawn from the presentations, comments, and facilitated dialogue at the forum was that co-firing wood with coal has considerable promise in the Northeast. This was based on a number of factors, including the facts that:

- co-firing has been successfully used in other sections of the country and demonstrated in a limited number of utilities in the northeast;
- the technology exists for co-firing wood with resulting net benefits with regard to air emissions;
- there is an abundant supply of wood available in many forms in the region, and wood processing technology is being developed rapidly to utilize these resources efficiently;
- as experience grows, more is being learned about the economics of co-firing and the institutional changes needed to fulfill its potential;
- despite acknowledged resistance within the utility industry to accepting co-firing, there is optimism that the economic viability of co-firing can be convincing; and

- this forum reflected a growing realization within the utility industry and government that the use of wood as a co-firing option can be mutually beneficial.

Major Points of Forum

The morning session featured four brief presentations and responses to these presentations by wood co-firing experts. Following are the major points made by the presenters and/or respondents, and points raised during the discussions. These points are organized according to the four major topics under consideration -- technology, resource availability, regulatory issues, and economic considerations.

After each of the following presentations were made, Wally Benjamin from NYSEG and Steve Segrest from Combustion Energy, Inc. responded with comments, based on their considerable experience in wood co-firing.

Technology

The presenter was Jane Turnbull of the Electric Power Research Institute (EPRI). She advocated a "total systems approach" in which technology plays only a part in determining the viability of wood co-firing. Turnbull made the following points.

- To become a major energy resource, biomass must compete successfully with other fuels and with other crops and land uses; moreover, an effective biomass feedstock production and distribution infrastructure must be developed.
- EPRI has conducted an assessment of biomass use in each of nine TVA coal-fired power plants, determining in the process the cost per dry ton and the cost per BTU of energy generated. It is essential to undertake viable resource assessments and to develop location-specific supply curves for biomass feedstock.
- Several wood-firing technologies are under development, including Whole Tree Energy, BIG/STIG, Oak Ridge National Laboratory-Massachusetts Institute of Technology project on thermal combustion, EPRI's hybrid biomass/natural gas technology, and the skid-mounted mobile technology for use in forest management areas of the Pacific Northwest.

Wood Co-Firing Forum Report

- Few generalizations can be made, because every coal-firing plant has its own specific conditions. However, a number of issues must be considered, among them : slagging potential, derating, the extent of retrofit required, the resulting ash content, and potential sulfur and carbon dioxide emission offsets created through wood/coal co-firing.
- Biomass could become more than 10% of the U.S. electricity supply over the next ten years, but it will be important to take account of the entire "system", that is, the collaboration of foresters, farmers, and utilities who have little if any experience in working together.

Other points on technology:

- Fuel (biomass) source and cost (for each plant) are most important elements.
- Co-firing provides an excellent opportunity to build from a coal base, rather than starting fresh with a wood-only fired plant.
- The capital costs of co-firing technology are not a major barrier relative to new plant construction, usually in the range of \$300/KW to modify a pulverized coal (PC) boiler. The internal rate of return for such a modification can approach 30%.
- Environmental impacts include the effects on landfilling of ash, storm water toxics, as well as possible reductions for SO₂, NO_x, and CO₂.
- A utility can look at co-firing as partnering, i.e., helping customers with their wood waste disposal problems while acquiring a competitively priced fuel.
- There have been no precipitator performance problems associated with TVA tests.
- Coal and biomass fuels have been injected separately at some plants, and mixed prior to injection in smaller utilities (i.e., in some cycloner or stoker plants), although some plant engineers have resisted mixing wood with coal.

- Experience in the Southeast (Savannah, GA) has demonstrated great success in co-firing with percentages reaching as high as 50% wood and 50% coal, using direct injection of wood through separate burner ports and highly refined processed wood waste. Surveys show that over 1.3 million tons of waste wood is available annually within 150 miles of the Savannah, Georgia power plant. A proposed plant will allow area wood waste haulers and local industries to pay lower tipping fees to a privately contracted fiber fuel processing facility. This feedstock will be screened from contaminants, dried in a wood-fired rotary dryer and reduced to a fine particle size with multi-staged grinding. The tipping fees can offset a majority of the fuel processing costs, making the wood fuel cost lower than area coal costs.
- Sulfur reductions are possible from co-firing because there is low or non-existent sulfur content in wood.
- Cooperative Research and Development Agreements (CRADAs), which are available through all federal research facilities, encourage private sector and federal government partnering in order to optimize joint research efforts. These are highly individualized and flexibly structured arrangements that enable private industry, state and local governments, foundations, and academic institutions to access and cooperatively use unique federal research facilities, capabilities and staff expertise. There is no payment of federal funds in a CRADA, and the funding terms of each agreement are negotiated between the parties involved.

Resource Availability

Jeff Fehrs from C. T. Donovan made the presentation, focusing on wood waste at a macro-level which, he cautioned, is not a substitute for site specific resource assessments. Among the points Fehrs made were:

- It is not necessary to use only "clean" wood. Much "treated" wood is also suitable for co-firing.
- Several types of wood waste are suitable as feedstock, including harvested wood from silviculture and land clearing, mill residue from primary and secondary wood products industries, and such municipal solid waste as pallets, construction/demolition wood, railroad ties, telephone poles, etc.

Wood Co-Firing Forum Report

- An estimated 23,950,000 green tons of wood waste is discarded in the Northeast each year. Perhaps one-half of this is available for fuel (3/4 of which is from untreated wood waste) providing the potential for 120×10^{12} BTU/yr. This yields about 5,000 BTUs per pound. Dry wood yields about 8,500 BTUs per pound.
- CCA (chromated copper arsenate) is a problem from an ash standpoint; however, facilities burning wood waste treated with pentachlorophenol and/or creosote compounds are meeting environmental standards. When co-firing with about 10% of the heat input from wood, treated wood is even less of an environmental concern.
- As might be expected, the tighter the specifications for wood fuel (e.g., low moisture content and small particle size) the higher the cost of the fuel.

Other comments regarding resource availability:

- The experience of New York State Electric & Gas since 1988 shows that 46,000 tons of biomass has offset 23,000 tons of coal. The wood fuel averaged 5,200 BTU/lb.
- It is wise to bring the state departments of environmental regulation into the process early. In New York, for example, the state has closely scrutinized emissions from waste wood burning.
- Tax credits (i.e., Section 29 of the IRS Code [retrofitting plants with facility operational by end of 1995] and Section 45 [growing biomass for explicit use as fuel]), can make co-firing projects economical. According to one respondent, he has never seen a scenario in which co-firing worked financially without including potential clean air allowances and BTU tax credits. One often needs a partner, such as a utility customer, to obtain a tax credit. Section 29 is expiring in 1995-96.
- Utilizing wood waste can provide opportunities for local business growth.

Regulatory Issues

Doug Leshner of the Pennsylvania Department of Environmental Regulation addressed these issues. Among his points were:

- There are no great obstacles to wood co-firing from the air quality permitting point of view.
- Emission decreases (e.g., NO_x, volatile organic compounds (VOCs)), could create emission reduction credits, a valuable asset.

- Other Clean Air Act Amendment activities may compete for resources that might be used otherwise to convert to co-firing (BACT installation, Titles III, IV, and V).

Other points made regarding regulation:

- In New York State, it has been a long process to obtain necessary permits for co-firing. The installation of continuous emissions monitoring devices in PC units may be helpful.
- The results obtained for NO_x reduction are very plant-specific, but recent tests indicate co-firing biomass may prove to be superior to competing technology with respect to NO_x reduction.
- One pound of coal burned releases 2.6 pounds of CO₂. Biomass emits the same amount of CO₂ when it decomposes as it does when it is burned; therefore, biomass combustion is CO₂ neutral.
- In Maryland, the greatest regulatory concern is with Title III of the Clean Air Act Amendments and the air toxics from treated wood.
- States vary on what is required before a wood co-firing permit can be obtained. In Maryland, for example, some stack testing will be required to examine air toxics, while in Pennsylvania officials may rely in part on test data from similar plants in other areas.
- Wood ash disposal is not significantly different from coal ash disposal.
- New York State Department of Environmental Conservation has determined that ash from the combustion of "unadulterated" wood can be beneficially used as a soil amendment or fertilizer at an application rate of the nutrient needs of crop(s) being grown, but not to exceed 16 dry tons/acre/year. The NYSDEC has determined that unadulterated wood ash is a "predetermined beneficial use", meaning that generators of the ash do not need to apply to the NYSDEC for a beneficial use determination. Under New York's Solid Waste Management regulations, solid wastes for which beneficial use determinations have been granted are exempt from the Regulations.
- In a well operating plant, volatile organic compounds (VOCs) need not be a problem.
- EPRI has a Scandinavian scientist arriving to assess the impact of greenhouse gas (GHG) emissions with biomass-using utilities.

- Instead of thinking only of the environmental and economic barriers to the use of biomass, perhaps one should look at the ways biomass can be used to help achieve economic and environmental goals.
- The goals of the Pennsylvania Public Utility Commission are to lower the price of electrical service, extend the life of plants, lower fuel costs, promote economic development, and assure the reliability of fuel supply (especially if biomass were to replace a more volatile fuel supply such as natural gas).
- Each utility must have the flexibility to make fuel choice decisions, and using biomass might be a way to lower fuel costs with the utility passing a portion of the savings on to ratepayers.
- It is not necessary to become adversaries with the coal industry because the purpose of using biomass is not to displace coal, but to comply with environmental regulations while still using coal. Both are indigenous resources. With wood, one can continue to burn higher-sulfur eastern coal instead of replacing it with low-sulfur western coal.
- In New York it would seem appropriate to retrofit existing coal-fired plants because of the current surplus generating capacity.

Economics

Ed Gray from the Antares Group presented the economic issues. Among the points he made were the following:

- In competing with the independent power producers (IPPs), "least cost" is the big motivator for utilities now.
- Determining whether biomass co-firing is cost effective is very site-specific, with the fuel supply cost curve being the most important factor.
- The benefits of co-firing include: keeping production costs about even; tax credits (EPACT requires a dedicated fuel feedstock supply system); customer/community relations; environmental benefits (i.e., emission reduction credits); and (in the future viz. a viz. the Rio Accords) CO₂ emissions.

Wood Co-Firing Forum Report

- With respect to costs, there is a tradeoff between making capital investment in fuel handling and combustion equipment retrofits, and buying premium processed fuel. The capital costs for gasification range from \$100/KW to \$600/KW. Also it may be costly to obtain permits.
- Because tipping fees may disappear if a utility's demand for waste wood increases, it may be unwise to depend on them for the future.
- Co-firing can be a competitive strategy (versus wet scrubbers) for earning sulfur credits.
- As operating costs from co-firing are about equal to those of coal, it is important to meet other goals and benefits.
- 38% of the coal plants in the Northeast are in rural areas where there are significant amounts of wood residue.

Other points included:

- A utility cannot jump into the use of dedicated fuel feedstocks right away because it takes four years from the first plantings to obtain a harvest with a subsequent harvest every three years. As a result, it is necessary to start with wood residues such as mill waste as a feedstock. In New York, there are plenty of these residues available.
- Not all biomass combustion results in tax credits. The fuel must be a dedicated source. Moreover, the IRS will not give a utility tax credits until a plant is built. Gasification in the preparation of fuel (which is then directly injected) may suffice to meet IRS requirements.

Major Barriers Confronting Co-firing in the Northeast

After a series of presentations, comments and discussions regarding technology, resource availability, regulatory concerns and the economic realities, the focus of the forum shifted to the identification of the major barriers to overcome if wood co-firing is to become successfully integrated into an electric utility's fuel options. After the barriers were initially identified, group discussion eliminated or combined some of the barriers. The following table presents the final list of barriers identified by participants, presented in the order of priority in which the group believed the barriers should be addressed. These have been separated, to the degree possible, into the four major issue areas, plus a fifth area called Political Aspects.

Those barriers highlighted in met a subjectively and democratically set level for "most significant" (i.e., at least four participants identified them as among the three most significant barriers).

No. of Participants Defining Barrier as Among 'Most Significant'	Technological Barriers
16+	Inadequate number of proper wood-firing test facilities, equipment, demonstrations and protocols from which to draw valuable lessons
5	Uncertainties surrounding the beneficial use of pulverized coal ash from co-fired power plants
1	Uncertainties regarding the availability of capacity (units) for co-firing

	Resource (Wood) Availability Barrier
14+	Inconsistency in the quality of wood available for fuel

	Economic Barriers
9	Questions regarding how costs associated with integrating wood co-firing would be recovered or amortized over time
8	Current low cost of fuels that would compete with wood
6	Difficult to convince utility production staffs to accept biomass as an option to coal
4	Current energy and capacity prices are very low
2	Future tax rulings that could affect the use of wood as a fuel are unknown and uncertain
2	Engineering and other utility staffs are already stretched thin, which makes it difficult to spend time introducing a new fuel; also, using wood as a fuel is considered more labor intensive than coal
1	Perceived high price, relatively speaking, of biomass as a fuel
	Uncertainty of future landfill tipping fees (that might affect costs of waste wood for fuel)

	Regulatory Barriers
5	Current lack of information disseminated to appropriate groups on the emission characteristics from burning treated wood
4	Failure of many to consider bio-fuels as a form of recycling
3	Constraints or difficulty in obtaining tax credits for using biomass fuels for reducing emissions
	Poor experiences with using 'captive' fuel operations in the past

	Political Barriers
7	The need to prepare a 'case' for the co-firing option with public utility commissions and with the public in general
	Current opposition of coal companies and the railroads (viewed as a regional issue)
	Current opposition of utility holding companies (viewed as a regional issue)
	Current opposition of unions dependent on coal production and use (viewed as a regional issue)
	Current reluctance of the legislature, acknowledged as reflecting the political strength of coal interests in general

Strategies for Overcoming Barriers to Wood Co-firing

After the forum participants set priorities on the barriers, their focus shifted to identifying strategies appropriate for overcoming them. The following tables summarize the suggestions made, by type of barrier.

Technological Barriers	Suggested Strategies

<p>Inadequate number of proper wood-firing test facilities, equipment, demonstrations and protocols from which to draw valuable lessons</p>	<ul style="list-style-type: none"> • Develop consortia for initiating demonstrations of co-firing • Encourage cooperative research and development through government laboratories and in the private sector • Northeast Regional Biomass Program could use its bibliography as a starting focal point for circulating information and flyers to encourage organizations to join collaboration efforts • EPRI should be at the forefront of cooperative efforts among utilities • For utilities to participate cooperatively there needs to be some attention paid to U.S. DOE and others regarding protection of utilities from the disclosure of utility-specific information • Overcome the liability for both producers and combusters inherent in using a new technology <ul style="list-style-type: none"> • Cooperative Research and Development Agreements (CRADAs) allow for development activities, scale-up studies, even small-scale demonstrations that could persuade potential end-users to take a chance on a technology or a fuel formulation
<p>Uncertainties surrounding the beneficial use of pulverized coal (PC) ash</p>	<ul style="list-style-type: none"> • Ask ACAA and EPRI to collect and distribute data regarding the use of PC ash from co-fired plants

Resource (Wood) Availability Barrier	Suggested Strategies
Inconsistency in the quality of wood available for fuel	<ul style="list-style-type: none"> • Conduct a literature search on available wood processing technologies • Fund and conduct a demonstration; NYSERDA may provide a good start • Develop standard specifications for wood for co-firing; consider the work of the Scandinavians in this regard • Refer to a report due in Fall '94 on classification of woods for fuels • A 'white paper' will be published in 12/94 by a subcommittee of the Association of Agricultural Engineers (see Brian Jenkins, UC-Davis) • Need to have input for state air quality regulators and solid waste officials with regard to consistency and quality of wood/coal fuel; also could benefit from consistency among states on regulations • NRBP could encourage participation and 'buy-in' from regulatory officials and work with private industry on the development of appropriate specifications for wood fuel • Standards already exist for pelletized fuels • Learn from the experiences of such 'leader' states as New York

Economic Barriers	Suggested Strategies
Questions regarding how costs associated with integrating wood co-firing would be recovered or amortized over time	<ul style="list-style-type: none"> • Need more feasibility studies and business plans such as those emanating from the New York study conducted by EPRI • Must consider 5 - 10 year contracts for fuel; possibility consortia could help to spread the risk regarding fuel purchase • Answer will come through generic studies; need a commitment to undertake these studies
Current low cost of fuels that compete with wood	<ul style="list-style-type: none"> • Fuel procurement people need to take into account the fact that subsidies encouraging wood as a fuel are currently available • Should study the ramifications on fuel choice if tax credits were to disappear
Difficult to convince utility production staffs to accept biomass as an option to coal	<ul style="list-style-type: none"> • See strategies under first economic barrier (above)

<p>Current energy and capacity prices are very low</p>	<ul style="list-style-type: none"> • As each electric generating facility is its own business, it must learn how to take risk by trying wood as a co-firing fuel • Need to pay attention to the current operation at each plant and find a way to integrate existing and new technologies (through engineering contractors) • Present the case to fuel procurement staffs for reducing their costs by using a currently inactive resource
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<p>Regulatory Barriers</p>	<p>Suggested Strategies</p>
<p>Lack of information disseminated to appropriate groups on the emission characteristics from burning treated wood</p>	<ul style="list-style-type: none"> • NYSERDA's treated wood study should be disseminated • Need to gain knowledge through the experience of utilities' going through the regulatory process • Some treated wood (e.g., CD) requires more research and it is evolving quickly; must overcome barriers inherent in having multiple sources of this wood • Could benefit from testing and sampling protocols • Need to address the issue of people in one state being comfortable with the results of experiences in other states • Must recognize that variation in wood fuel sorting systems can result in variations in fuel quality • California's experience may be helpful with respect to the use of 'urban' wood and the use of the middle person in procurement
<p>Failure of many to consider bio-fuels as a form of recycling</p>	<ul style="list-style-type: none"> • Need to educate regulators, environmental and other non-government groups (e.g., the Sierra Club) • If wood use could be considered as "recycling", it could help financially (perhaps CONEG could influence its state contacts on this matter); Rhode Island could be a good example

<p>Political Barriers</p>	<p>Suggested Strategies</p>
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<p>The need to prepare a 'case' for the co-firing option with public utility commissions and with the public in general</p>	<ul style="list-style-type: none">• Need to realize that this is probably a site-specific issue in most cases• This may not be such a large issue if only 'token' amounts of wood are being considered• Again, a demonstration could provide useful evidence for this case• The results from 'successful' cases need to be communicated widely• Important to have the public and PUCs vested in co-firing option• Need to identify where biomass can help utilities meet their strategic goals• Periodicals and other outreach packages should be assembled• A synopsis of this forum with a press release should be sent to influential trade journals (e.g., Power Magazine, Biocycle). Biocycle is not a power industry trade journal but a wood and yard waste recycling magazine.
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Commitments

At the conclusion of the forum several of the participants offered to take steps toward implementing the strategies outlined above. Time did not permit the group to set priorities on the strategies to be undertaken nor to match the commitments to specific strategies. Among the commitments offered:

- GPU Service Corporation will convene a meeting of forestry personnel and PUC regulators in Pennsylvania and New Jersey with the purpose of initiating a dialogue among these parties;
- The Pennsylvania Energy Office will establish a dialogue among the significant parties in that state;
- The Northeast Regional Biomass Program will try to build a regional consortium for encouraging opportunities to integrate and coordinate outreach and information transfer efforts;
- The Pittsburgh Energy Technology Center, the National Renewable Energy Laboratory, and other Federal laboratories are willing to undertake CRADAs in the area of wood co-firing;
- The University of Pittsburgh may be able to offer interns (some perhaps 'free') to help in this effort;
- The University of Maryland at College Park has a research program that can be helpful;
- The Pennsylvania State University has combustion facilities through which demonstrations may be possible;
- Opportunities may exist for a workshop on the experience with biomass fuel for utility companies and others at regularly scheduled conferences (e.g., one is being scheduled for the University of Pittsburgh for 1995);
- Burlington County (NJ) has a wood processing program and a supply of wood fuel that might be put to use in a demonstration; and
- The Empire State Biopower Consortium (NYS) is looking for a feasibility study using dedicated feedstocks; perhaps a linkage can be made.

